METROPOLITAN COAL PROJECT

PREFERRED PROJECT REPORT

MAY 2009

Peabody

HELENSBURGH COAL

METROPOLITAN COAL PROJECT

PREFERRED PROJECT REPORT

MAY 2009
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1 INTRODUCTION

Helensburgh Coal Pty Ltd (HCPL) owns and operates the Metropolitan Colliery which is located approximately 30 kilometres (km) north of Wollongong in New South Wales (NSW) (Figure 1). HCPL is a wholly owned subsidiary of Peabody Pacific Pty Limited (Peabody Pacific). HCPL is the proponent of the Metropolitan Coal Project (the Project), which is currently under consideration by the NSW Minister for Planning, under Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act).

The Project Application for the Project was lodged with the NSW Minister for Planning in July 2008. An Environmental Assessment (EA) to accompany the Project Application was lodged with the NSW Department of Planning (DoP) in October 2008. The EA was placed on public exhibition from 22 October to 24 November 2008. The Planning Assessment Commission (PAC) was requested by the NSW Minister for Planning on 14 November 2008 to review the Project. The PAC conducted public hearings on 11 and 12 March 2009.

In recognition of concerns raised by key stakeholders during the formal PAC assessment process, HCPL considered it appropriate to reduce the proposed extent of the original Project longwall mining area. This reduction in the extent of longwall mining results in a significant reduction to the extent of potential subsidence effects to the Waratah Rivulet and the Eastern Tributary and a reduction in the consequential potential environmental impacts.

On 20 April 2009, the DoP requested a Preferred Project Report (PPR) for the Project. This PPR has been prepared in response to that request and in accordance with Section 75H(6)(b) of the EP&A Act. This PPR describes the proposed changes to the original Project mine plan and describes the consequential environmental benefits of these changes.

Attachment 1 provides HCPL's Statement of Commitments outlining environmental management, mitigation and monitoring measures for the Preferred Project.

This PPR does not propose significant changes to the scale or nature of the original Project and should be read in conjunction with: the EA prepared for the original Project; the responses to submissions provided to the DoP and the PAC; and other supplementary information provided to the DoP and the PAC.

The remainder of this PPR is structured as follows:

Section 2	Describes the original Project.
Section 3	Outlines the process to date, post-exhibition of the EA.
Section 4	Outlines the reasons why this PPR has been prepared.
Section 5	Describes the objectives and various components of the Preferred Project.
Section 6	Presents the consequential environmental benefits of the Preferred Project when compared to the original Project.
Section 7	Lists the documents referenced in this PPR.

2 THE METROPOLITAN COAL PROJECT AS ORIGINALLY PROPOSED

2.1 PROJECT APPLICATION

The Project was determined to be a "Major Project" to which Part 3A of the EP&A Act applies in accordance with the *State Environmental Planning Policy (Major Projects) 2005* (Major Projects SEPP) on 8 October 2007 by the Director-General of the DoP, as delegate of the NSW Minister for Planning.

The Project Application for the Project was lodged with the NSW Minister for Planning, under Part 3A of the EP&A Act, in July 2008.

2.2 DIRECTOR-GENERAL'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

The EA considers the potential environmental impacts of the original Project in accordance with the Director-General's Environmental Assessment Requirements (EARs) issued by the DoP on 30 July 2008 (Attachment 2). The EARs were issued in accordance with the requirements of Part 3A of the EP&A Act and Part 1A of the *Environmental Planning and Assessment Regulation, 2000* (EP&A Regulation). On 17 October 2008 the DoP, in consultation with other relevant agencies, determined that the EA adequately addressed the EARs.

Source: Topographic Map Base - (Sydney Special, Wollongong Special) Geoscience Australia 2006, Reserve Boundaries - Department of Lands NSW 2003 and Sydney Catchment Authority Special Areas - Sydney Catchment Authority 2006

METROPOLITAN COAL PROJECT

FIGURE 1
Regional Location

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2.3 EXHIBITION OF THE ENVIRONMENTAL ASSESSMENT

The EA was placed on public exhibition from 22 October to 24 November 2008 at the following locations:

- DoP, Information Centre, Ground Floor, 23-33 Bridge Street, Sydney;
- Wollongong City Council (WCC), 41 Burelli Street, Wollongong;
- Nature Conservation Council of NSW, Level 2, 301 Kent Street, Sydney; and
- HCPL, Metropolitan Colliery, off Parkes Street, Helensburgh.

During and following the exhibition period, the DoP received submissions on the original Project from interested parties.

2.4 ENVIRONMENTAL ASSESSMENT

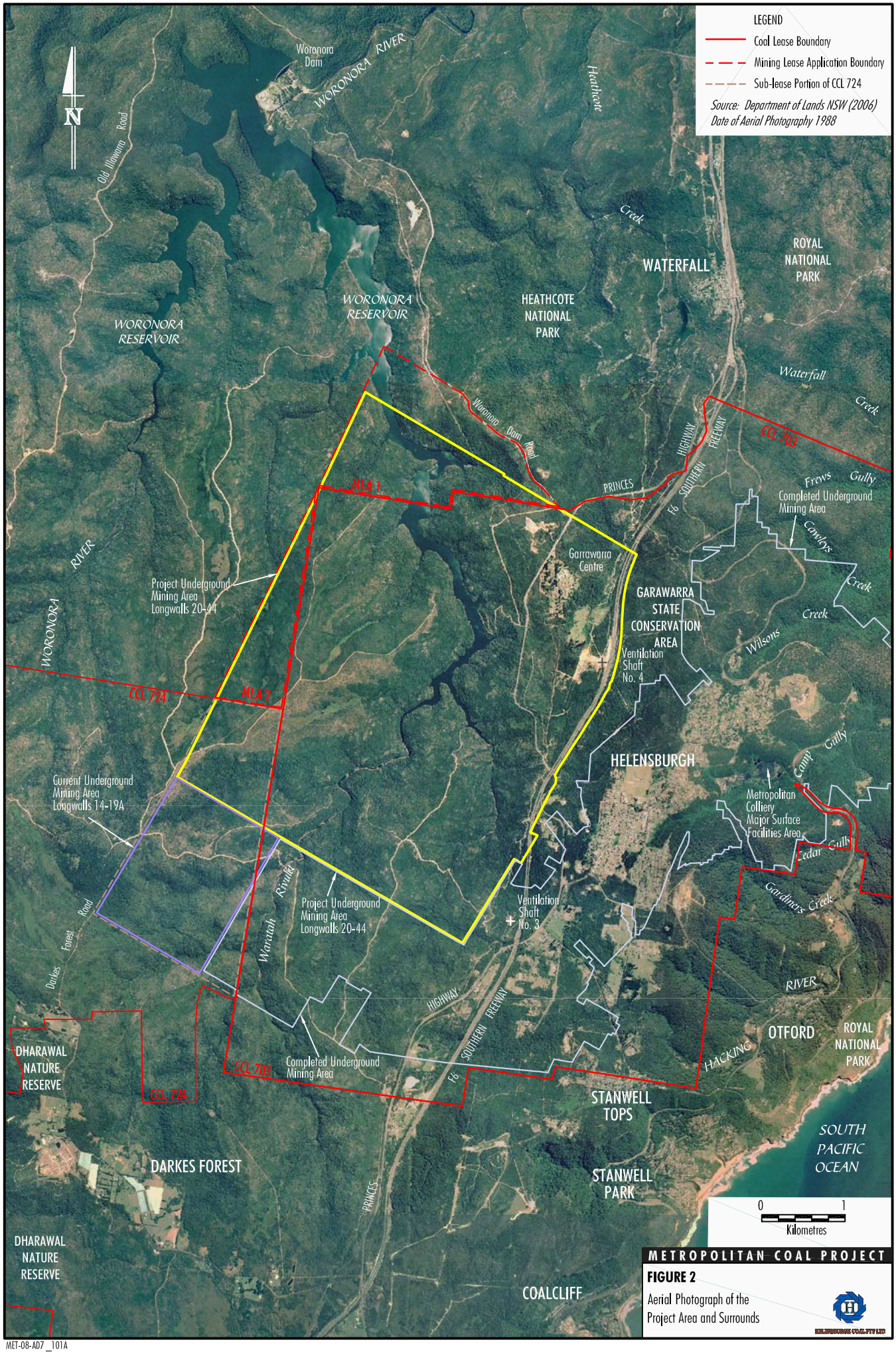
This section presents a summary of the original Project, as described in the EA. For a detailed description of the original Project, refer to Section 2 of the EA.

The original Project comprises continuation, upgrade and extension of underground coal mining operations and surface facilities at the existing Metropolitan Colliery. The Metropolitan Colliery is located approximately 30 km north of Wollongong in NSW (Figure 1) and the existing Metropolitan Colliery Major Surface Facilities Area is located in the town of Helensburgh (Figure 2). The Metropolitan Colliery is owned and operated by HCPL, a wholly owned subsidiary of Peabody Pacific.

Original Project Summary

The main activities associated with development of the original Project would include:

- ongoing surface and underground exploration activities in the Project Underground Mining Area and Current Underground Mining Area;
- continued development of underground mining operations within the existing HCPL coal lease (Consolidated Coal Lease [CCL] 703) and associated sub-lease (a portion of CCL 724) and two new Mining Lease Application (MLA) areas (MLA 1 and MLA 2) (Figure 2);
- upgrades of the existing mining and materials handling systems (e.g. longwall machinery and conveyors) to facilitate an increased run-of-mine (ROM) coal production rate (up to approximately 3.2 million tonnes per annum [Mtpa]);
- continued use of the existing Metropolitan Colliery Major Surface Facilities Area and the existing supporting infrastructure;
- production of approximately 2.8 Mtpa of hard coking and semi-hard coking coal (including minor quantities of thermal coal) for export and domestic markets;
- upgrades of the coal handling and preparation plant (CHPP) to facilitate increased production of washed coal, including the addition of a beneficiation circuit;
- coal reject would continue to be produced, with quantities to increase in line with increased ROM coal production;
- continued transport of coal reject to the Glenlee Washery (Figure 1) which is owned and operated by SADA Services Pty Limited (SADA) (with annual road movements capped at the existing maximum rate);
- continued transport of product coal by road to Coalcliff and Corrimal Coke Works (Figure 1);
- construction of a coal reject paste plant and associated coal reject stockpile, pumping, pipeline and underground delivery systems to facilitate the underground backfilling of the mine void using coal reject materials as an integrated component of the longwall mining operation;
- train loading and train movements associated with the transport of product coal to Port Kembla Coal Terminal (Figure 1) 24 hours per day, seven days per week;
- surface access and associated works within the Woronora Special Area (Figure 1) and surrounds that is required for environmental monitoring, management and remediation of mine subsidence;
- upgrades and/or extension of the existing supporting infrastructure systems (e.g. underground access, water management system, yard area, conveyor transfers and drives, ventilation, gas management and electrical systems) as required;



METROPOLITAN COAL PROJECT

FIGURE 2

Aerial Photograph of the Project Area and Surrounds

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- extension of the life of the Metropolitan Colliery by approximately 23 years; and
- other associated minor infrastructure, plant, equipment and activities.

Table 1 provides a summary snapshot of the original Project components including upgrades and extensions as compared with a summary of the existing Metropolitan Colliery operations.

Original Project General Arrangement

The proposed original Project involved the extension of existing underground mining operations in the Bulli Seam to north of the Current Underground Mining Area and the Completed Underground Mining Area to recover a coal reserve of approximately 63 million tonnes (Mt) of ROM coal from proposed Longwalls 20 to 44 (Figure 3).

The general arrangement of the original Project was designed to maximise the utilisation of the existing Metropolitan Colliery Major Surface Facilities Areas and existing Metropolitan Colliery infrastructure.

The original Project general arrangement and progressive development of longwalls (i.e. Longwalls 20 to 44) over the life of the original Project are shown on Figure 3.

The general arrangement of the Metropolitan Colliery Major Surface Facilities Area is shown on Figure 4. The main activities associated with the development of the original Project are described above.

Original Project Underground Mining Operations

Underground mining operations would continue to be conducted 24 hours a day, seven days a week.

Provisional Mine Schedule

The provisional mine schedule for underground mining operations presented in Table 2 is based on the planned maximum production rate.

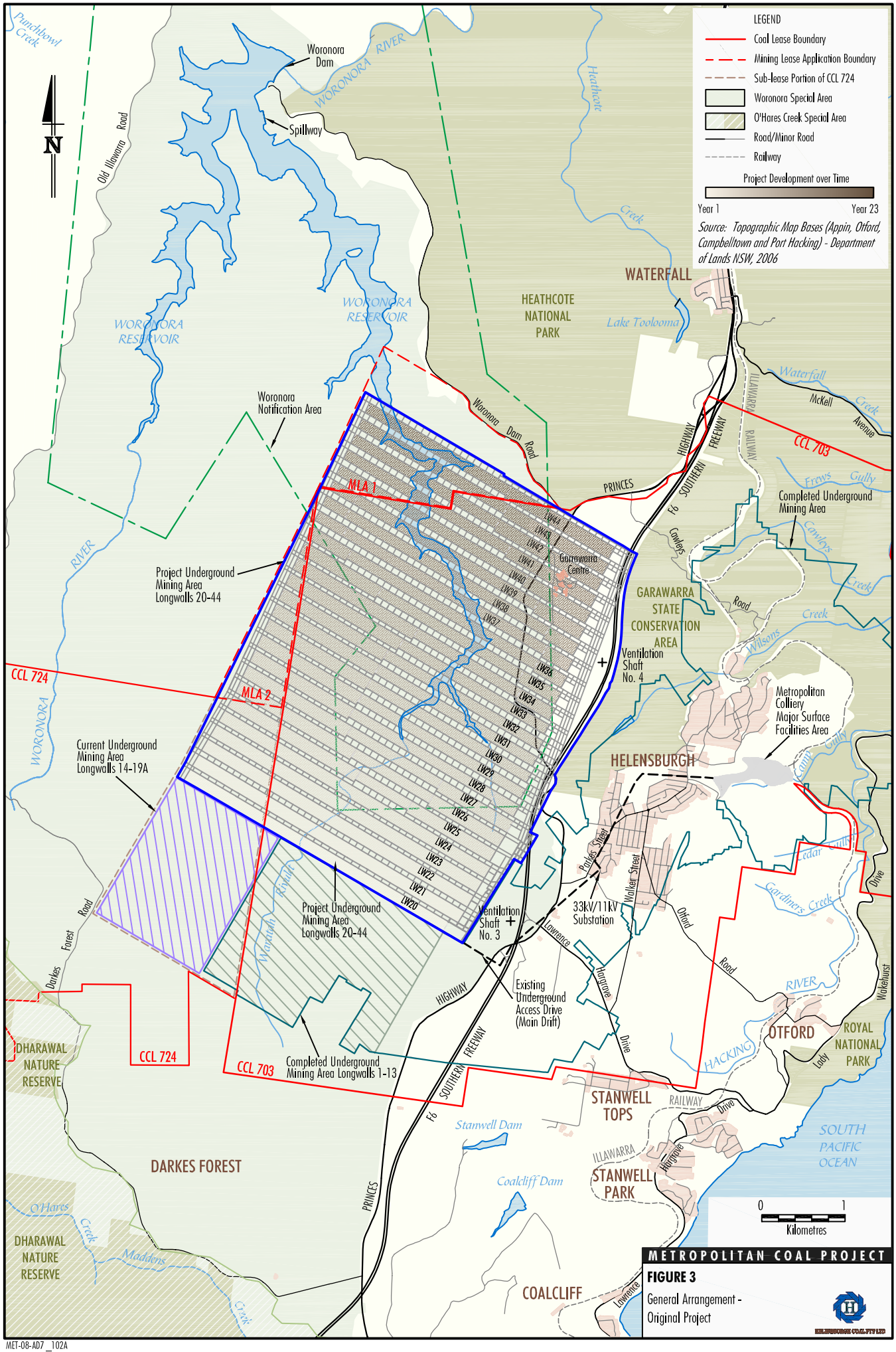
Table 1
Original Project Snapshot

Project Component	Summary of Existing Metropolitan Colliery Operations	Summary of Original Project
Underground Mining and ROM Coal Production	• Production of approximately 1.8 Mtpa of ROM coal.	• Production of up to approximately 3.2 Mtpa of ROM coal.
CHPP	• The CHPP has a washing capacity of approximately 400 tonnes per hour (tph).	• The CHPP and associated material handling systems would be upgraded to increase CHPP throughput up to approximately 600 tph. • Installation of a beneficiation circuit in the CHPP.
Product Coal	• Production of approximately 1.5 Mtpa of hard coking and semi-hard coking coal for export and domestic markets. • Product coal is transported by train to the Port Kembla Coal Terminal and by truck to the Corrimal and Coalcliff Coke Works.	• Production of approximately 2.8 Mtpa of hard coking and semi-hard coking coal (including minor quantities of thermal coal) for export and domestic markets. • Continued product coal transport by train to the Port Kembla Coal Terminal with increased rail movements in line with increased coal production. • Trucking of product coal to the Corrimal and Coalcliff Coke Works would continue at the existing maximum rate of annual road movements.
Coal Reject Management	• Coal reject is produced at the CHPP, stockpiled temporarily and then transported by truck to the Glenlee Washery. • No coal reject emplacement is currently undertaken at the existing Metropolitan Colliery Major Surface Facilities Area.[1]	• Coal reject would continue to be produced, with production to increase in line with increased ROM coal production. • Trucking of coal reject to Glenlee Washery would continue at the existing maximum rate of annual road movements.

Table 1 (Continued)
Original Project Snapshot

Project Component	Summary of Existing Metropolitan Colliery Operations	Summary of Original Project
Coal Reject Management (Continued)		• Construction of a coal reject paste plant and associated infrastructure to facilitate underground backfilling of the mine void by goaf injection. • In the event that the quantity of coal reject is greater than anticipated or commissioning of the underground goaf injection technique is delayed, emplacement may take place into the old underground workings via Ventilation Shaft No. 1.
General Surface Facilities and Supporting Infrastructure	• Existing general surface facilities include administration buildings, coal handling infrastructure, bath house, workshops, equipment service facilities, car park, washdown and fuel storage facilities. • Extensive supporting infrastructure including systems associated with: - underground drift access and conveyors; - electricity supply, reticulation and control; and - ventilation and gas management.	• The existing surface facilities would be utilised, however, the original Project would include the upgrade of some infrastructure and construction of additional components as required. • Supporting infrastructure systems would be extended and upgraded as required.
Water Management	• A network of water storages is utilised to manage surface water that accumulates on-site. • Make-up water demand is met by sourcing stored water in historical workings, surface water runoff recovered from the existing Metropolitan Colliery Major Surface Facilities Area and purchase from Sydney Water as required. • Water treatment, reuse and off-site release in accordance with Environment Protection Licence (EPL) No. 767.	• Continued use and (where required) upgrade and augmentation of existing water management infrastructure, including upgrade of underground water management systems. • Installation of an additional water tank.
Life of Mine	• Longwalls 14 to 19A are currently scheduled for completion in 2010.	• An additional mine life of approximately 23 years.
Employment	• HCPL currently has an operational workforce (staff and on-site contractors) of approximately 320 people.	• The operational workforce is expected to remain at approximately 320 people. • It is anticipated that a peak construction workforce of up to 50 employees would be required.

[1] HCPL currently retains a WCC approval for development of a coal reject emplacement in Camp Gully (Section 2.8.5 and Figure 1-3 of the EA).



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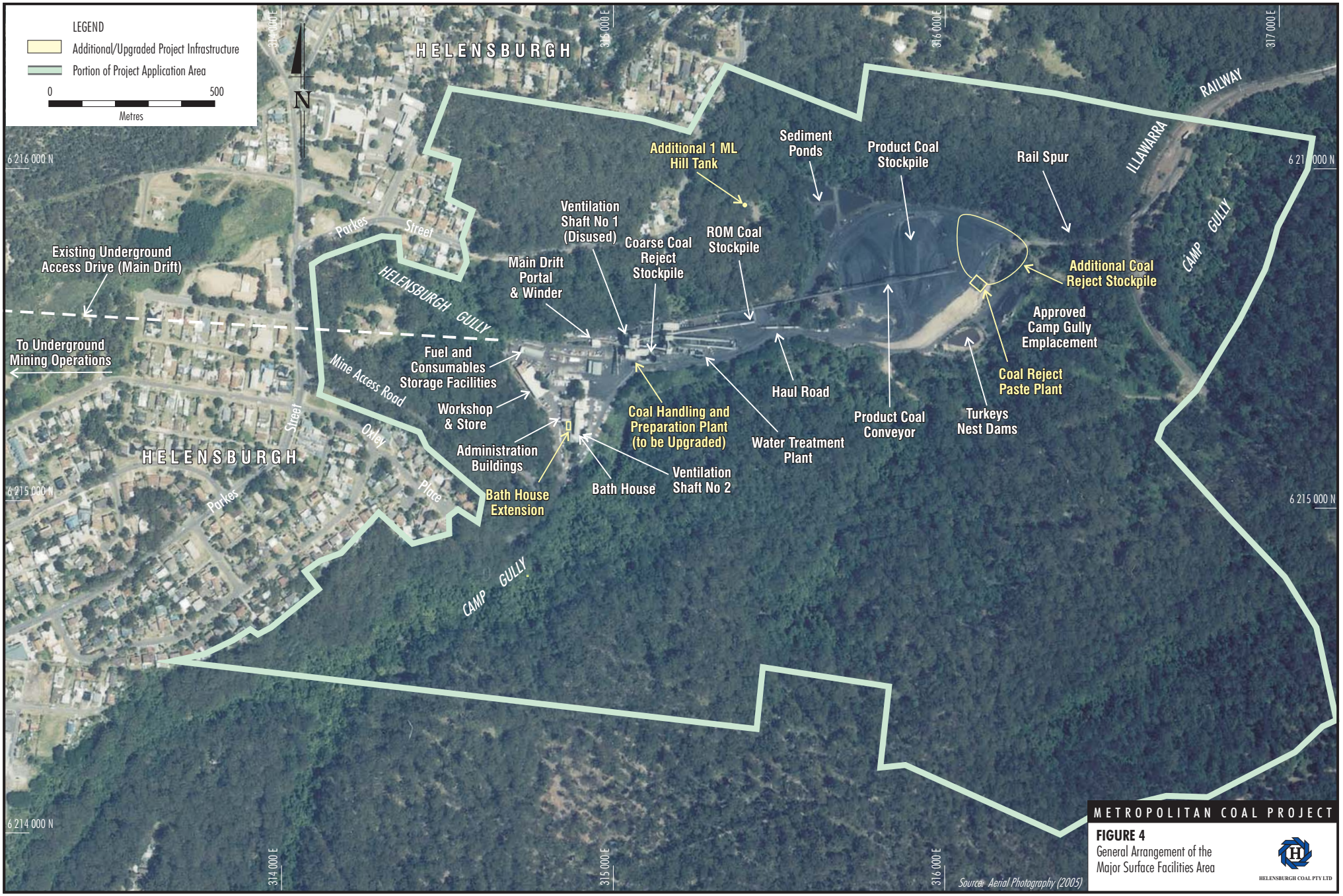

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FIGURE 4
General Arrangement of the Major Surface Facilities Area

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Table 2
Original Project Provisional Mine Schedule

Year	Total ROM Coal (Mtpa)	Total Coking Coal (Mtpa)	Total Thermal Coal (Mtpa)	Total Coal Reject (Mtpa)
1	1.80	1.53	0.03	0.24
2	1.91	1.62	0.03	0.26
3	2.13	1.81	0.03	0.29
4	2.50	2.12	0.04	0.34
5	2.45	2.08	0.04	0.33
6	2.60	2.21	0.04	0.35
7	2.61	2.22	0.04	0.35
8	2.61	2.22	0.04	0.35
9	2.72	2.31	0.04	0.37
10	2.86	2.43	0.04	0.39
11	2.91	2.48	0.04	0.39
12	3.06	2.60	0.05	0.41
13	3.10	2.63	0.05	0.42
14	2.99	2.54	0.05	0.40
15	3.19	2.71	0.05	0.43
16	3.02	2.56	0.05	0.41
17	3.03	2.58	0.04	0.41
18	2.86	2.43	0.04	0.39
19	2.97	2.53	0.04	0.40
20	3.03	2.58	0.04	0.41
21	3.15	2.68	0.04	0.43
22	2.80	2.38	0.04	0.38
23	2.60	2.21	0.04	0.35
Total	**62.90**	**53.46**	**0.94**	**8.50**

Source: HCPL (2008).

Longwalls 20 to 44 are bounded by the Current and Completed Underground Mining Areas to the south and the Garawarra State Conservation Area and the F6 Southern Freeway to the east. To the west and north, the longwalls are bounded by the Woronora Special Area and MLA 1 and MLA 2 and the Heathcote National Park (Figure 3).

As shown on the original Project general arrangement (Figure 3), the Project Underground Mining Area comprises a rectangular area approximately 3.5 km wide and 5 km long.

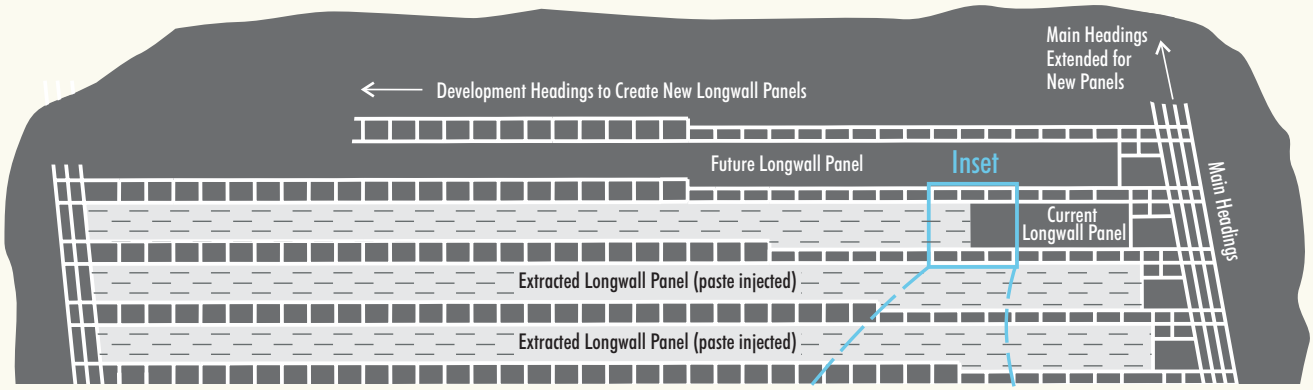
The Bulli Seam varies from approximately 2.6 metres (m) to 3.5 m in thickness and it is expected that its full thickness would be extracted during the original Project underground mining operations.

Mine Access and Development Works

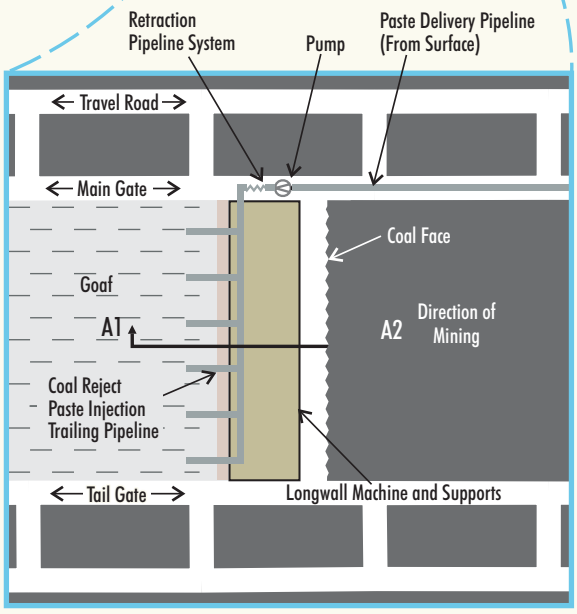
Access to the underground mining operations from the existing Metropolitan Colliery Major Surface Facilities Area would continue to be via the main drift which extends from the portal at the surface to the completed and current Longwall 1 to 19A underground mining areas (Figures 3 and 4). A drift extension would be developed once the longwalls have progressed to shorten the length required for underground coal transport.

Each longwall panel would be formed by developing gate roads (the tail gate and main gate roads). To construct the gate roads, two roadways (headings) would be driven parallel to each other using continuous miners (Figure 5).

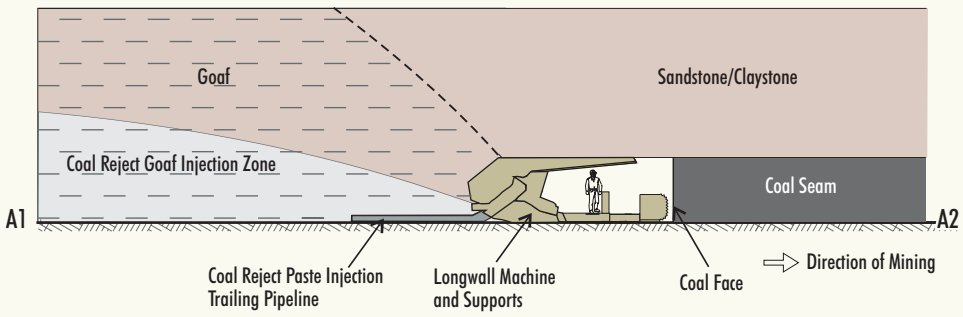
Plan View



Inset - Plan View



Section View



After MSEC (2007) and AWA (2008)

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FIGURE 5
Longwall Mining Method -
Conceptual Cross Section and Plan

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Not to Scale

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The dimensions of the headings or roadways would be approximately 5 m wide and 3.2 m in height. The headings would be connected approximately every 90 m by driving a cut-through from one heading to the other. This leaves a series of pillars of coal along the length of the gate road which support the overlying strata (Figure 5).

Within the Woronora Notification Area (Figure 3), the longwall layout has been varied to generally conform with the preliminary guideline provided by the NSW Dams Safety Committee (DSC) *Mining in Notification Areas of Prescribed Dams* (DSC, 1998). For mining near stored waters, where the depth of cover is greater than 120 m, these guidelines prescribe the following:

- panel width should be less than one third of the depth of cover;
- pillar width should be greater than 15 times the height of the extraction and one fifth of the depth of cover; and
- pillar length should be not less than its width.

3 PROCESS TO DATE POST-EXHIBITION OF THE ENVIRONMENTAL ASSESSMENT

3.1 RESPONSE TO SUBMISSIONS

Submissions on the original Project were received as a result of the public exhibition process. HCPL has provided the responses to submissions to the DoP. These are included as Appendix A of this PPR.

3.2 PLANNING ASSESSMENT COMMISSION

On 14 November 2008, the NSW Minister for Planning, pursuant to Section 23D(1)(b)(ii) and Schedule 3 of the EP&A Act and Part 16(B) of the EP&A Regulation, requested the PAC to review the Project. The PAC comprises:

- Dr Neil Shepherd, Chairperson;
- Mr Colin Mackie;
- Dr John Tilleard;
- Professor Jim Galvin; and
- Professor Jeffrey Bennett.

The terms of reference for the PAC are to (Attachment 3):

a) *carry out a review of the potential subsidence related impacts of the Metropolitan Coal Project on the values of Sydney's drinking water catchment, and in particular its potential impact on the Waratah Rivulet and Woronora Reservoir, taking into consideration the recommendations of the Southern Coalfield Inquiry;*

b) *advise on the significance and acceptability of these potential impacts, and to recommend appropriate measures to avoid, minimise, or offset these impacts; and*

c) *identify and comment on any other significant issues raised in submissions regarding the Metropolitan Coal Project or during the public hearings.*

The NSW Minister for Planning also directed that public hearings be held into the Project. Submissions on the EA were forwarded to the PAC for its consideration. The PAC also received further public submissions on the Project. The PAC conducted public hearings on 11 and 12 March 2009.

During and following the PAC hearings, the PAC requested various Project information from HCPL. Responses to PAC's queries and additional information requests have been provided to the PAC, for consideration in its review. It is understood that the PAC will also take into account this PPR in its review.

4 THE REASON FOR THIS PREFERRED PROJECT REPORT

In recognition of concerns raised by key stakeholders during the formal PAC assessment process, HCPL considered it appropriate to reduce the proposed extent of the original Project longwall mining area. This reduction in the extent of longwall mining results in a significant reduction to the extent of potential subsidence effects to the Waratah Rivulet and the Eastern Tributary and a reduction in the consequential potential environmental impacts.

On 20 April 2009, the DoP requested a PPR for the Project. This PPR has been prepared in response to that request and in accordance with Section 75H(6)(b) of the EP&A Act. This PPR describes the proposed changes to the original Project mine plan and describes the consequential environmental benefits of these changes. This PPR does not propose significant changes to the scale or nature of the original Project and should be read in conjunction with: the EA prepared for the original Project; the responses to submissions provided to the DoP and the PAC; and other supplementary information provided to the DoP and the PAC.

5 PREFERRED PROJECT

The Preferred Project reduces the extent of longwall mining when compared to that proposed for the original Project. Specifically, the Preferred Project changes the layout of the Project Underground Mining Area to incorporate a sterilised coal pillar under reaches of the Waratah Rivulet and Eastern Tributary, so as to further minimise (i.e. very narrow longwalls were already proposed in the original Project) the original Project's potential environmental impacts. The general arrangement for the Preferred Project longwalls is shown on Figures 6a and 6b.

The Preferred Project mine layout minimises subsidence effects on reaches of the Waratah Rivulet and the Eastern Tributary to the extent that restoration methods proposed in the original Project on the Waratah Rivulet would be used only as a contingency if unexpected subsidence impacts occur. In particular, the modified layout is designed to avoid the subsidence impact of drainage of any pools along the majority of the reach of the Waratah Rivulet from Longwall 24 to full supply level of Woronora Reservoir.

The following sections present: the objectives of the Preferred Project (Section 5.1); a summary of the detailed evaluation of alternatives undertaken to determine the optimal mine layout for achieving the objective of the Preferred Project (Section 5.2); and a description of the Preferred Project (Section 5.3).

5.1 OBJECTIVE OF THE PREFERRED PROJECT

The objective of the Preferred Project is to further minimise the original Project's potential environmental impact to the Waratah Rivulet and the Eastern Tributary.

Specifically, the Preferred Project mine plan avoids the drainage of pools[1] along the majority of the lower reach of the Waratah Rivulet (from Longwall 24 to the full storage level of Woronora Reservoir).

This objective reduces the potential environmental impact of the original Project whilst generally allowing continuity of underground mining operations. Without the full extraction of Longwalls 20 and 21, and extraction of the majority of Longwalls 22 and 23, continuity of underground mining operations would not be achieved and Metropolitan Colliery would be at threat of closure.

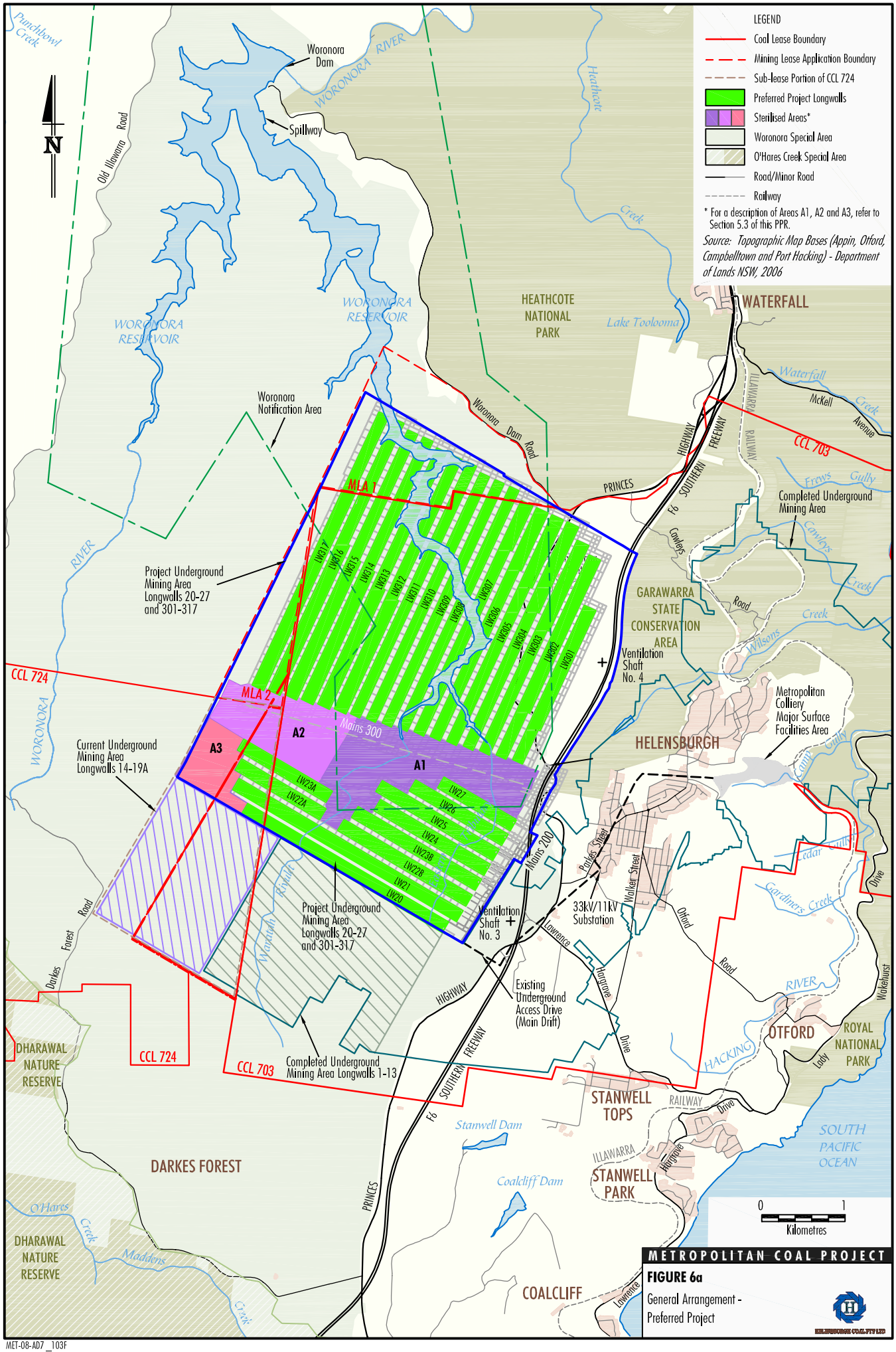
The Preferred Project mine plan also significantly reduces the potential subsidence effects on the lower reaches of the Eastern Tributary.

5.2 CONSIDERATION OF ALTERNATIVE MINE PLANS

A detailed evaluation of alternative mine plans has been conducted to determine the optimal mine layout for achieving the objectives of the Preferred Project. In each case, the dimensions of the coal pillar(s) required to achieve the objectives of the Preferred Project has been based on the assumption that cumulative predicted valley closure should be less than 200 millimetres (mm). This value represents the threshold value that if exceeded empirical data sets indicate that the drainage of pools may occur along the Waratah Rivulet. The relevant mine layout cases considered in the development of the Preferred Project include:

- Case 1 – original east-west layout with variable stand-offs each side of the Waratah Rivulet;
- Case 2 – original east-west layout with a 500 m stand-off each side of the Waratah Rivulet;
- Case 3 – original east-west layout with full extraction of Longwalls 20, 22, 25, and 28, and with larger stand-offs for Longwalls 21, 23, 24, 26 and 27; and
- Case 10c – re-alignment of underground main roads below the Eastern Tributary and Waratah Rivulet leaving an "island" coal pillar.

[1] Drainage of pools is where a portion of surface flows are redirected to a shallow fracture network. This is most evident during periods of low flows.



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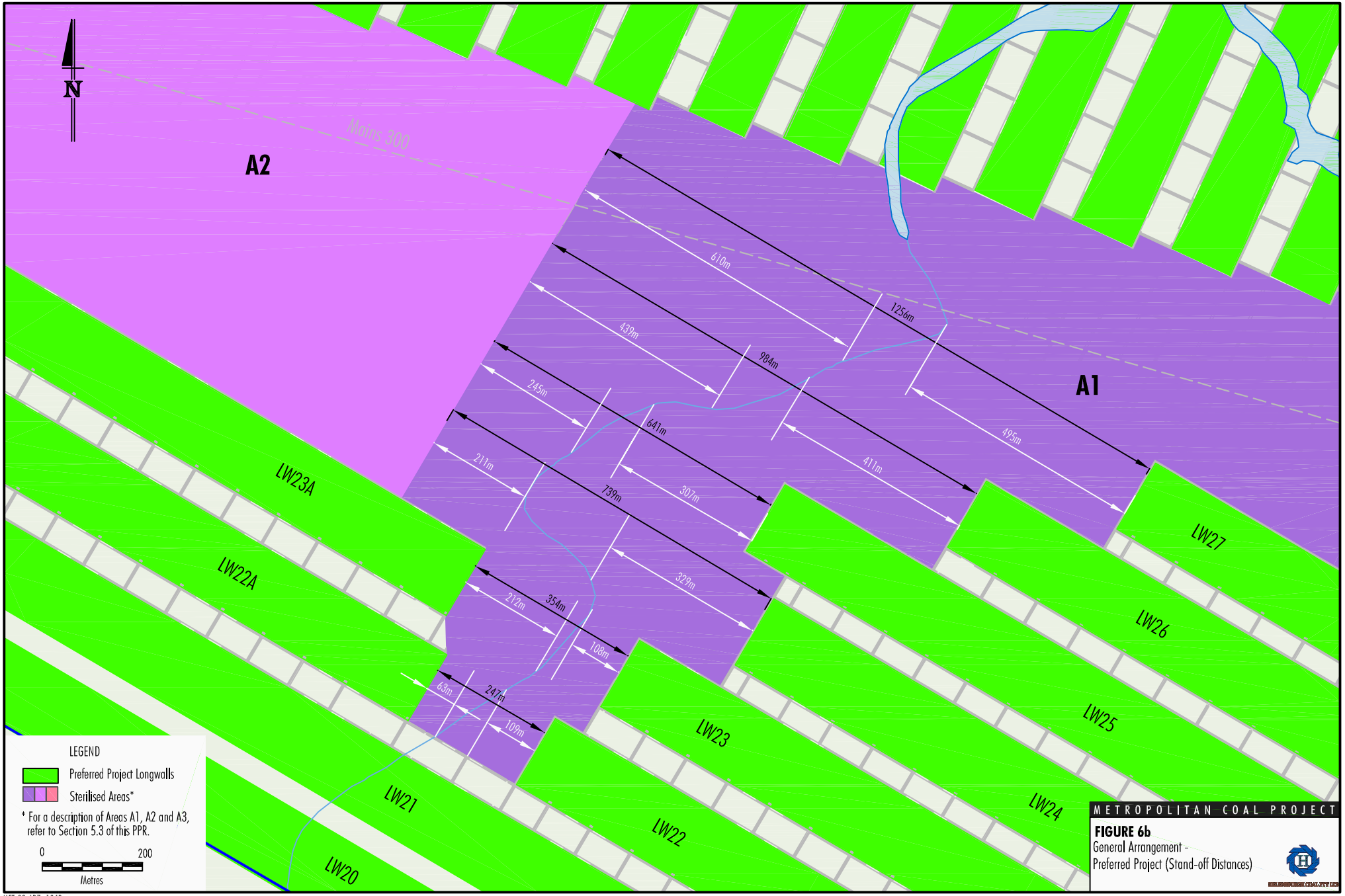

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Case 1 – Variable Stand-offs Each Side of the Waratah Rivulet

Case 1 would require a stand-off for each longwall from Longwall 20 onwards that would maintain cumulative predicted valley closure to less than 200 mm along the remaining reach of the Waratah Rivulet from Flat Rock Crossing to the full supply level of the Woronora Reservoir. The mine layout relevant to Case 1 is shown on Figure 7. This scenario was also described in the EA.

Since the extraction of Longwalls 1 to 19A would have resulted in a cumulative predicted valley closure approaching the threshold value of 200 mm, very large stand-offs (i.e. greater than 800 m) would be required to be left for Longwalls 20 and 21 to reduce predicted valley closure to less than 200 mm. Therefore, this case was determined to be economically prohibitive because in addition to a significant amount of coal being sterilised it would result in a loss of continuity of mining operations and mine closure.

Further, this case would provide no further reduction in the potential for subsidence effects to the lower reaches of the Eastern Tributary.

Case 1 was therefore rejected and not considered further.

Case 2 – 500 m Stand-off

Case 2 would incorporate a 500 m stand-off each side of the Waratah Rivulet. The mine layout relevant to Case 2 is shown on Figure 8. This scenario was also described in the EA.

A review of this case demonstrates that, on the western side of the Waratah Rivulet, Longwalls 20 and 21 would be reduced in length such that coal extraction from these areas would be economically prohibitive. This would result in a loss of continuity of mining operations and mine closure.

Case 2 was therefore rejected and not considered further.

Case 3 – Full Extraction of Longwalls 20, 22, 25, and 28

Case 3 was based on the extraction of Longwalls 20, 22, 25, and 28 at full length with suitably increased stand-offs in remaining walls to achieve the target of 200 mm predicted valley closure at any point along the Waratah Rivulet beyond Longwall 22. The mine layout relevant to Case 3 is shown on Figure 9.

This case assumes that it would not be economically viable to reduce the predicted valley closure above Longwalls 20 or 21 to below 200 mm. The extraction of every third longwall below the Waratah Rivulet would require the stand-off distance for each intervening longwall to be lengthened such that the cumulative valley closure would remain below the 200 mm threshold value from Longwall 22 to the full supply level of the Woronora Reservoir.

This case was rejected given:

- very short longwalls on the western side of the Waratah Rivulet, likely to result in an economically prohibitive mine layout and loss of continuity of mining operations;
- high development to extraction ratio in the early years of the Project;
- complicated mine plan, when combined with narrowed walls within the Woronora Notification Area;
- inefficient resource recovery; and
- lack of reduction in potential subsidence impacts to the Eastern Tributary.

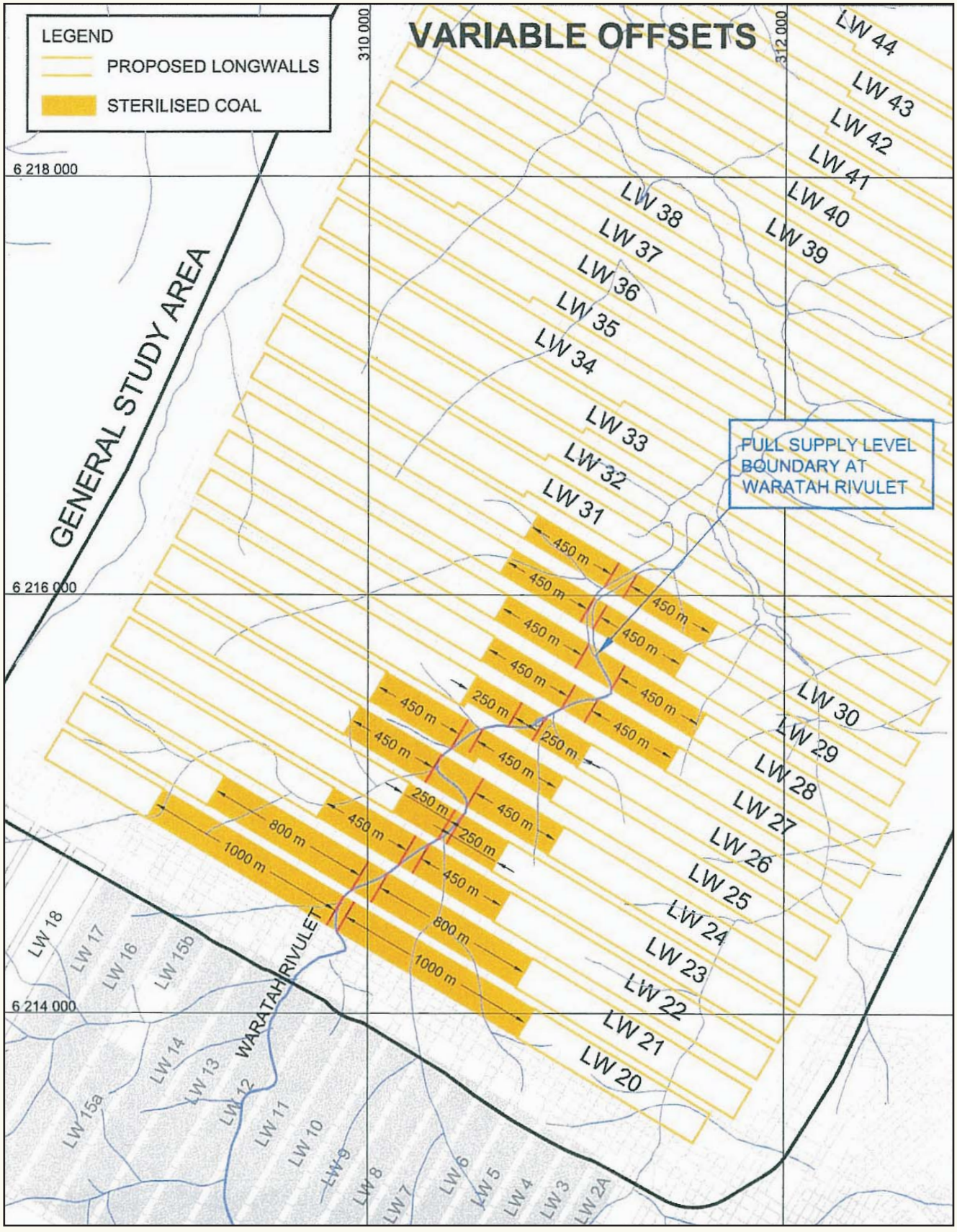
Case 3 was therefore not considered further.

Case 10c – Realignment of Underground Main Roads (Preferred Project)

The key component of this case is the establishment of a large contiguous coal pillar (or “island”) below both the Waratah Rivulet and the Eastern Tributary, facilitated by a realignment of the underground main roads (Figure 6a). The development of the Case 10c mine layout (Figure 6a) included consideration of various alternatives, including:

- realignment of the underground main roads either (i) parallel with Longwall 20, or (ii) at a more severe angle;
- economic considerations (i.e. avoidance of mine closure scenarios); and
- reduction in valley closure along the majority of the remaining reach of the Waratah Rivulet to below the threshold 200 mm value.

The initial two alternatives reviewed were full extraction of Longwalls 20 to 23 (Case 8, Figure 10) and a variation in the main roads to establishment an alternative large coal pillar (Case 9, Figure 11).



Source: MSEC (2008)

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FIGURE 7
Case 1 General Arrangement - Variable Stand-offs

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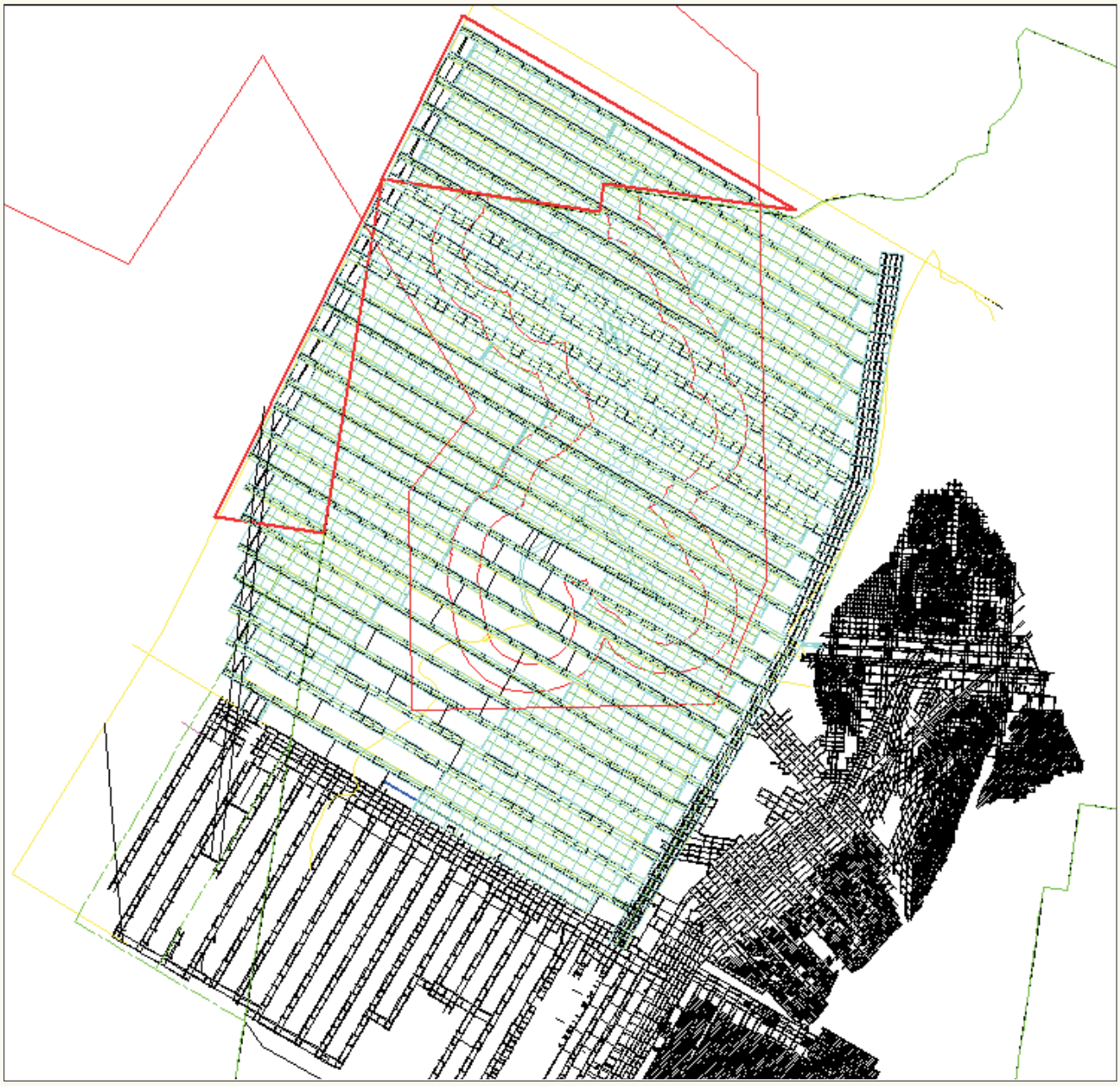

Source: HCPL (2009)

METROPOLITAN COAL PROJECT

FIGURE 8
Case 2 General Arrangement
500m Stand-off

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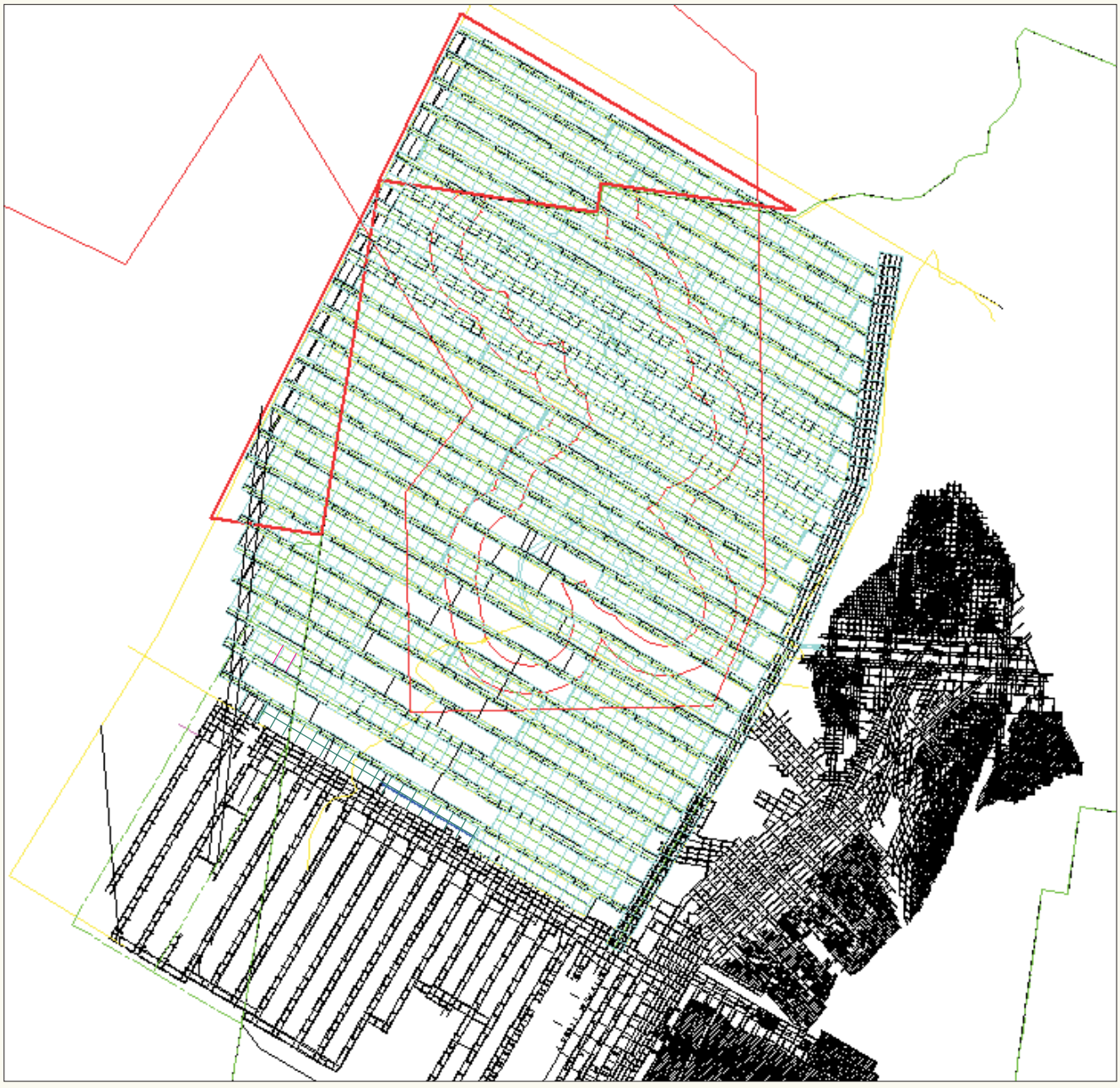
MET-08-AD7 _ 008A



Source: HCPL (2009)

METROPOLITAN COAL PROJECT

FIGURE 9
Case 3 General Arrangement - Extraction of Longwalls 20,22, 25 and 28

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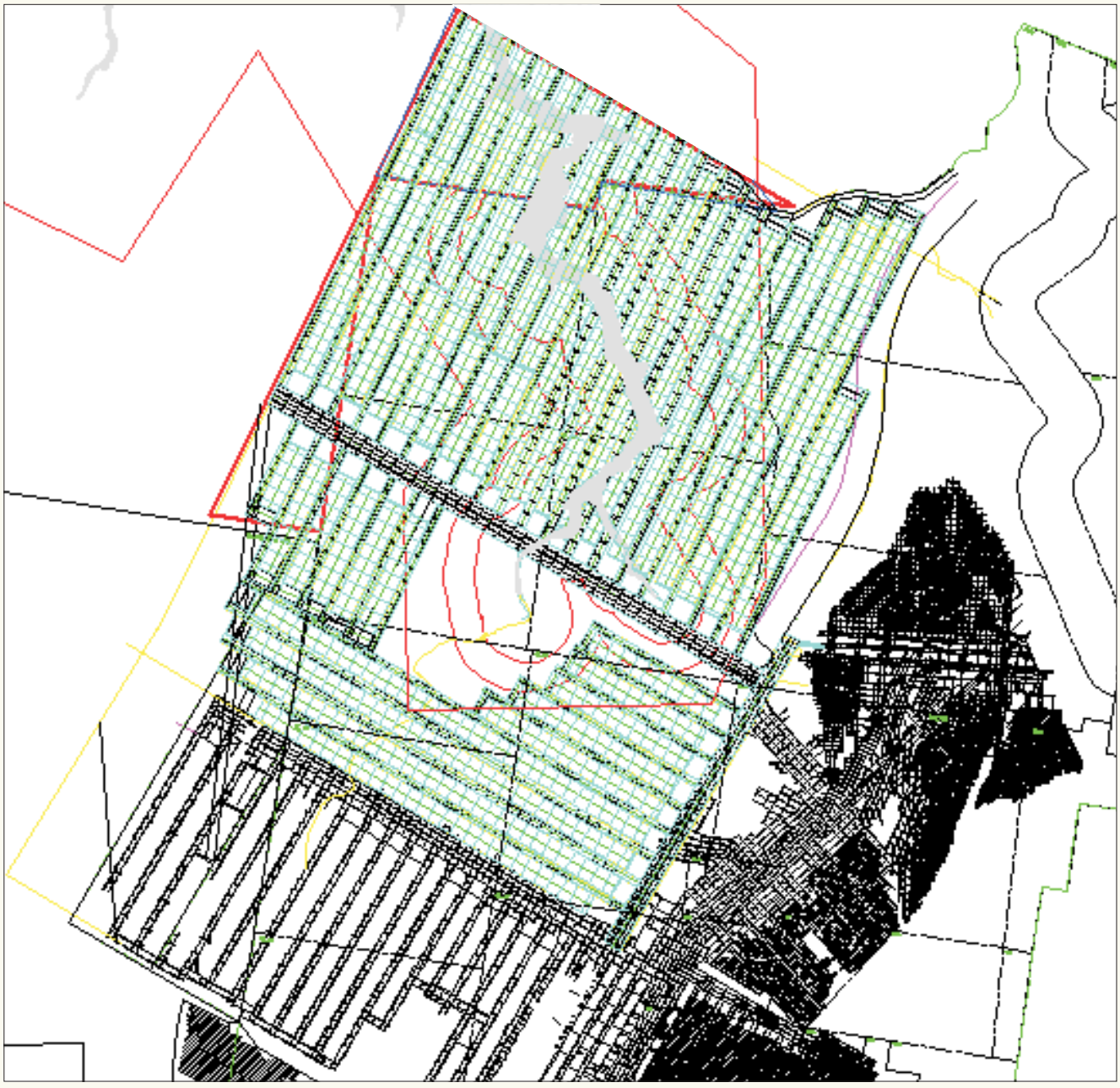

Source: HCPL (2009)

METROPOLITAN COAL PROJECT

FIGURE 10
Case 8 General Arrangement - Realignment of Underground Main Roads (Preliminary Alternative)

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MET-08-AD7 _004C

Source: HCPL (2009)

METROPOLITAN COAL PROJECT

FIGURE 11
Case 9 General Arrangement - Realignment of Underground Main Roads (Preliminary Alternative)

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MET-08-AD7 _ 009A

It was considered that both of the initial two alternatives would not meet the Preferred Project objectives (Section 5.1), given the predicted valley closure would significantly exceed the desired values over the reach of the Waratah Rivulet above Longwalls 22 and 23. Based on these reviews, it was determined that Longwalls 22 and 23 would also require stand-offs from the Waratah Rivulet.

The layout for Case 10a shown in Figure 12 was developed as a preliminary layout that included stand-offs in Longwalls 22 and 23. The stand-offs were determined on the basis of practical and economic mining considerations that would reasonably allow transition from full extraction to the stand-off scenario. Stand-off distances of 252 m and 359 m in Longwalls 22 and 23 were determined following a review of the maximum stand-off that would avoid longwall discontinuity (i.e. that would avoid mine closure). The layout was analysed by Mine Subsidence Engineering Consultants (MSEC) to determine the predicted valley closure along the Waratah Rivulet and Eastern Tributary.

The results indicated that the potential for subsidence impacts from Longwall 22 onwards was significantly reduced for Case 10a. The predicted cumulative valley closure was approximately 400 mm over the edge of Longwall 22, reducing to less than 200 mm over Longwall 24 and remained below 200 mm over the remaining reach of the Waratah Rivulet to the full supply level of the Woronora Reservoir. In comparison, the predicted valley closure for the original Project mine plan (i.e. full extraction, also shown on Figure 13) varied from 600 mm to over 900 mm over the same reach.

Given the significant reduction in potential subsidence effect over both the Waratah Rivulet and Eastern Tributary, such that either avoidance of impact or significantly minimised impact would be achieved in the subject reaches, and given the economic viability (although at a significant economic and social cost) of the layout, the general approach of this case was considered viable.

The mine layout was subsequently refined to increase resource recovery (by lengthening Longwalls 25 and 26) whilst still achieving the Preferred Project objectives (Section 5.1). MSEC was commissioned to determine the incremental length that could be added to Longwalls 25 and 26 whilst maintaining predicted valley closure to below 200 mm as in the previous case (Figures 13 and 14). This resulted in the final Case 10c mine layout (Figure 6a).

It was concluded that the development of this case would provide the following benefits:

- achievement of the objectives outlined in Section 5.1;
- maximises resource recovery by allowing extraction of longwalls parallel to the lease boundary;
- provides for underground main roads pillar stability, given the development of longwalls on only one side of the underground main roads (the north side) rather than both north and south; and
- minimises barrier pillar requirements, thereby reducing impacts on the length of Longwall 27.

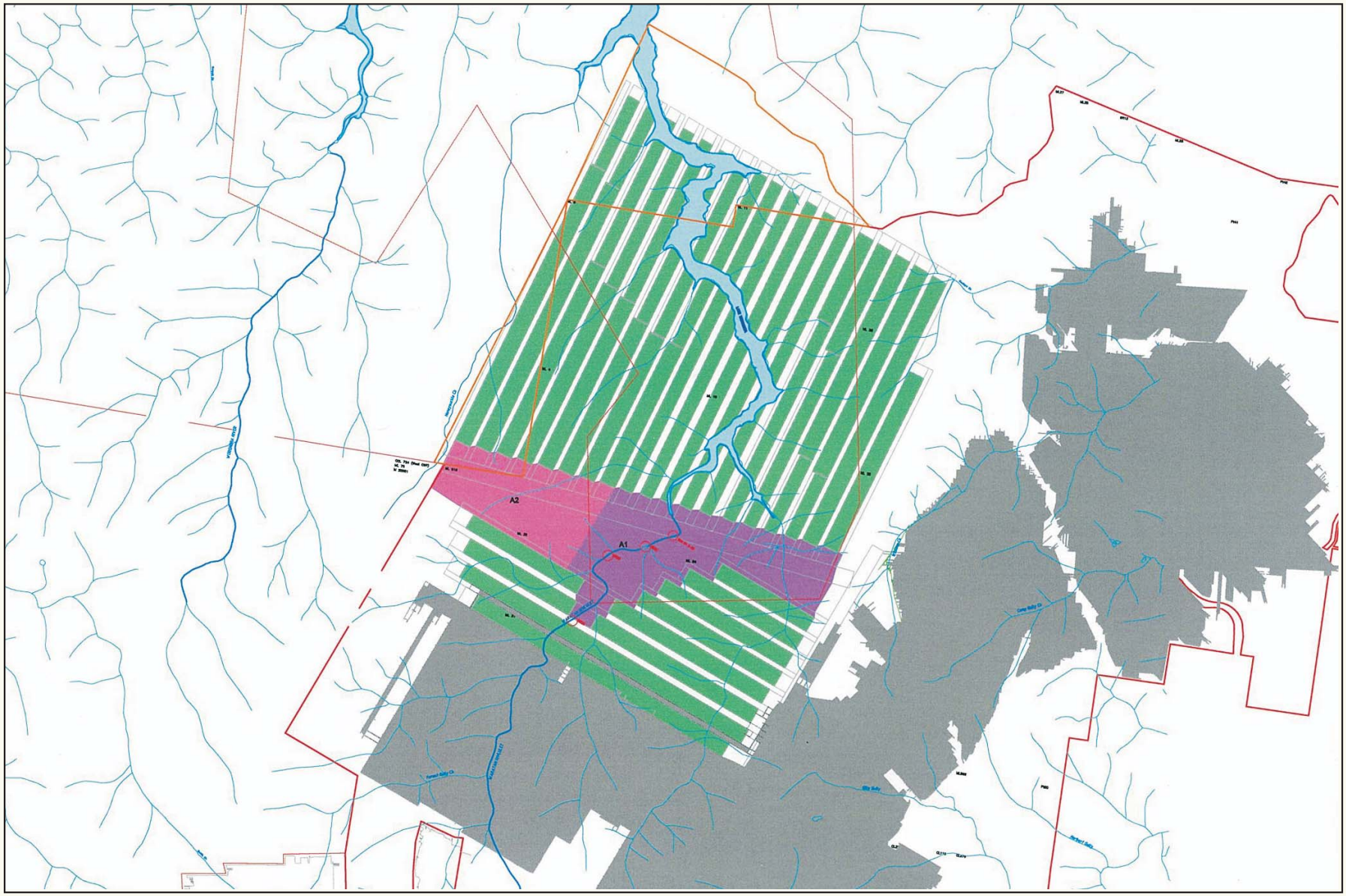
Whilst Case 10c would be economically sub-optimal and would fail to maximise the beneficial utilisation of the resource, this case would achieve the Preferred Project objective (Section 5.1). **Case 10c has therefore been selected as the basis for the Preferred Project (Figures 6a and 6b).**

5.3 PREFERRED PROJECT DESCRIPTION

The general arrangement for the Preferred Project longwalls is shown on Figure 6a. Tables 3 and 4 present a summary of the Preferred Project longwall dimensions and chain pillar dimensions, respectively. Table 5 provides a summary snapshot of the Preferred Project as compared with a summary of the existing Metropolitan Coal operations and the original Project as described in the EA.

Compared to the original Project, the Preferred Project leaves a very large intact coal pillar under reaches of the Waratah Rivulet and Eastern Tributary.

The Preferred Project would incorporate a coal pillar below the Waratah Rivulet for Longwalls 22 to 27. The geometry of the modified Longwalls 22 to 27 relative to the Waratah Rivulet is shown on Figures 6a and 6b. Table 6 presents the total length of the coal pillar relative to each longwall and the stand-off distances to the Waratah Rivulet on both the east and west sides of the Waratah Rivulet. The stand-off distances to the Waratah Rivulet are shown diagrammatically on Figure 6b.



METROPOLITAN COAL PROJECT

FIGURE 12
Case 10a General Arrangement - Realignment of Underground Main Roads (Preliminary Alternative)

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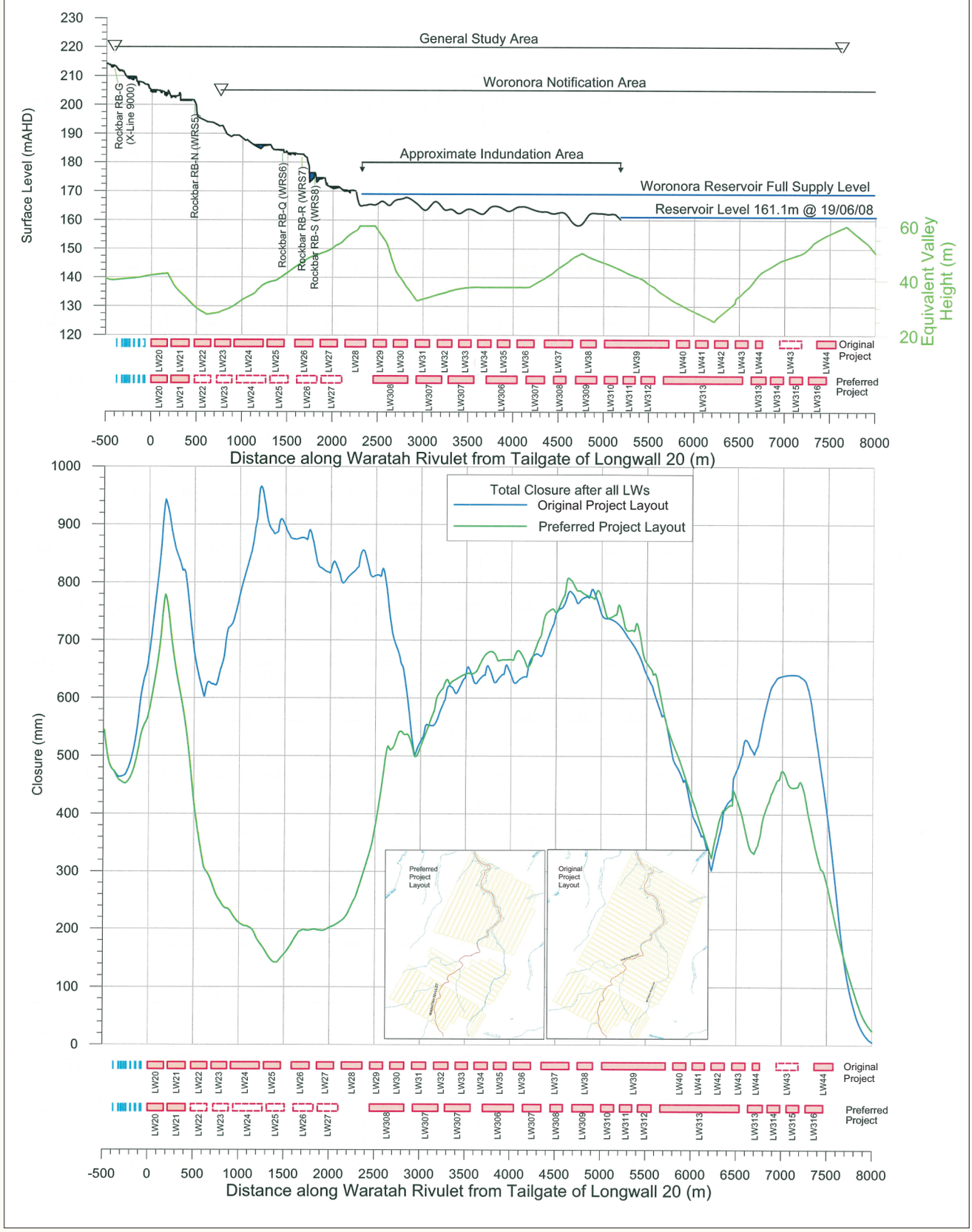
Source: HCPL (2009)

MET-08-AD7 _010A



Source: MSEC (2009)

METROPOLITAN COAL PROJECT

FIGURE 13

Waratah Rivulet Predicted Profiles of Closure for Original Project and Preferred Project

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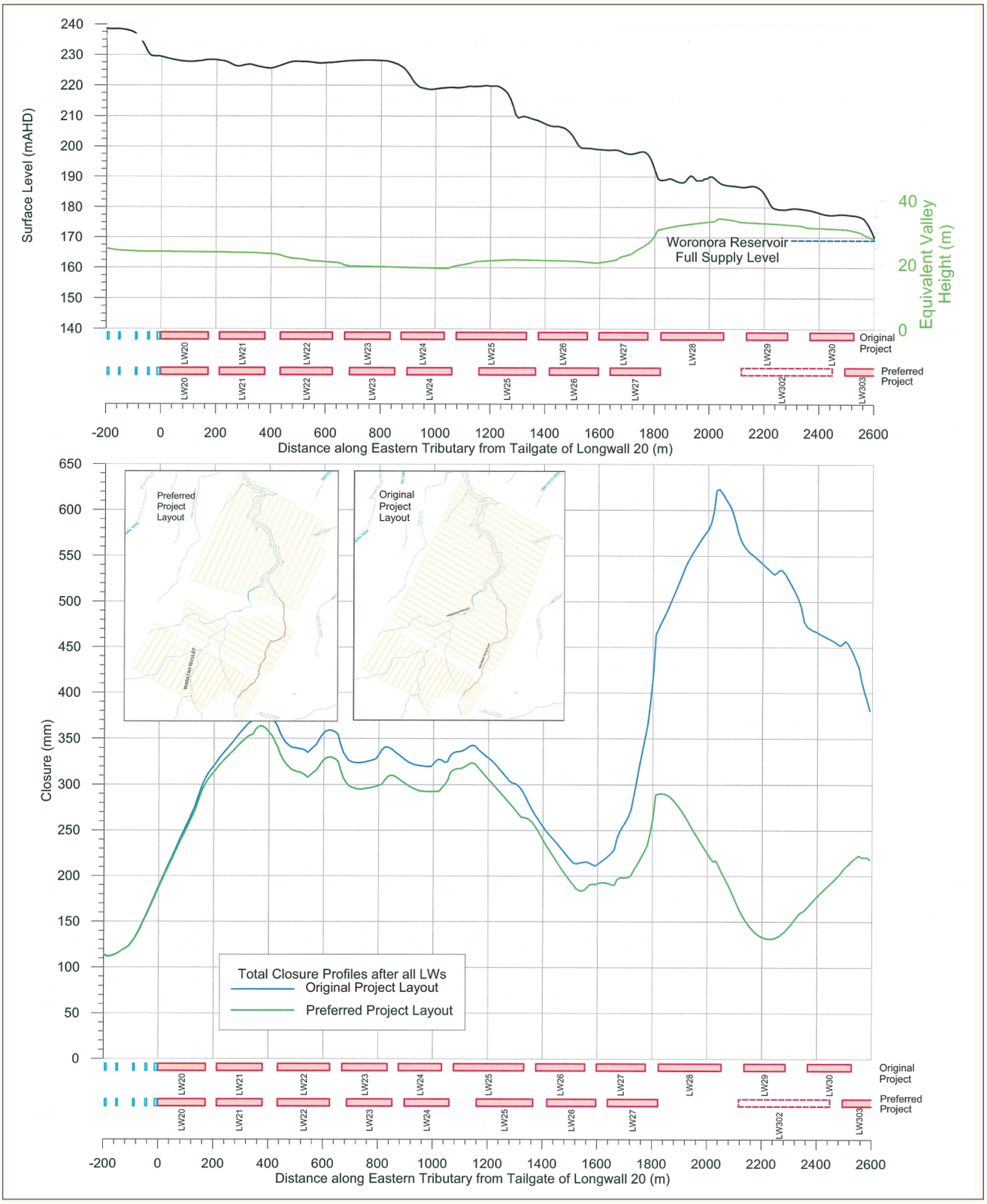
MET-08-AD7 _015B



Source: MSEC (2009)

METROPOLITAN COAL PROJECT

FIGURE 14
Eastern Tributary Predicted Profiles of Closure for Original Project and Preferred Project

HELENSBURGH COAL PTY LTD

MET-08-AD7 _014B

Table 3
Preferred Project Longwall Dimensions

Longwall	Centre Width (m)	Block Length (m)	Void Width (m)	Void Length (m)
LW 20	158	2,802	163	2,807
LW 21	158	3,125	163	3,130
LW 22A	158	1,177	163	1,182
LW 22B	158	1,789	163	1,794
LW 23A	158	1,232	163	1,237
LW 23B	158	1,722	163	1,727
LW 24	158	1,533	163	1,538
LW 25	158	1,630	163	1,635
LW 26	158	1,287	163	1,292
LW 27	158	1,014	163	1,019
LW 301	158	1,594	163	1,599
	133	455	138	457.5
LW 302	158	2,029	163	2,034
	133	621	138	623.5
LW 303	158	1,136	163	1,141
	133	1,648	138	1,651
LW 304	158	1,141	163	1,146
	133	1,826	138	1,829
LW 305	158	905	163	910
	133	2,094	138	2,097
LW 306	158	773	163	778
	133	2,256	138	2,259
LW 307	158	601	163	606
	133	2,460	138	2,463
LW 308	125	3,189	130	3,194
LW 309	125	3,220	130	3,225
LW 310	125	3,251	130	3,256
LW 311	125	3,332	130	3,337
LW 312	133	1,859	138	1,864
	158	1,500	163	1,503
LW 313	133	1,807	138	1,812
	158	1,584	163	1,587
LW 314	133	1,716	138	1,721
	158	1,757	163	1,760
LW 315	133	1,676	138	1,681
	158	1,830	163	1,833
LW 316	133	1,604	138	1,609
	158	1,984	163	1,987
LW 317	133	906	138	911
	158	2,714	163	2,717

Table 4
Preferred Project Chain Pillar Dimensions

Longwall	Chain Pillar (Solid) Width (m)	
	Wide Section	Narrow Section
LW 20	40	N/A
LW 21	55	N/A
LW 22	57	N/A
LW 23	45	N/A
LW 24	45	N/A
LW 25	50	N/A
LW 26	40	N/A
LW 27	40	N/A
LW 301	65	40
LW 302	65	40
LW 303	65	40
LW 304	65	40
LW 305	65	40
LW 306	65	40
LW 307	65	N/A
LW 308	65	N/A
LW 309	65	N/A
LW 310	65	N/A
LW 311	65	40
LW 312	65	40
LW 313	65	40
LW 314	65	40
LW 315	65	40
LW 316	65	40
LW 317	65	40

Table 5
Preferred Project Snapshot

Project Component	Summary of Existing Metropolitan Colliery Operations	Summary of Original Project (as described in the EA)	Summary of Preferred Project (compared to the Original Project)
Underground Mining and ROM Coal Production	• Production of approximately 1.8 Mtpa of ROM coal.	• Production of up to approximately 3.2 Mtpa of ROM coal.	• No change.
CHPP	• The CHPP has a washing capacity of approximately 400 tph.	• The CHPP and associated material handling systems would be upgraded to increase CHPP throughput up to approximately 600 tph. • Installation of a beneficiation circuit in the CHPP.	• No change.
Product Coal	• Production of approximately 1.5 Mtpa of hard coking and semi-hard coking coal for export and domestic markets. • Product coal is transported by train to the Port Kembla Coal Terminal and by truck to the Corrimal and Coalcliff Coke Works.	• Production of approximately 2.8 Mtpa of hard coking and semi-hard coking coal (including minor quantities of thermal coal) for export and domestic markets. • Continued product coal transport by train to the Port Kembla Coal Terminal with increased rail movements in line with increased coal production. • Trucking of product coal to the Corrimal and Coalcliff Coke Works would continue at the existing maximum rate of annual road movements.	• No change.
Coal Reject Management	• Coal reject is produced at the CHPP, stockpiled temporarily and then transported by truck to the Glenlee Washery. • No coal reject emplacement is currently undertaken at the existing Metropolitan Colliery Major Surface Facilities Area.[1]	• Coal reject would continue to be produced, with production to increase in line with increased ROM coal production. • Trucking of coal reject to Glenlee Washery would continue at the existing maximum rate of annual road movements. • Construction of a coal reject paste plant and associated infrastructure to facilitate underground backfilling of the mine void by goaf injection. • In the event that the quantity of coal reject is greater than anticipated or commissioning of the underground goaf injection technique is delayed, emplacement may take place into the old underground workings via Ventilation Shaft No. 1.	• No change.

Table 5 (Continued)
Preferred Project Snapshot

Project Component	Summary of Existing Metropolitan Colliery Operations	Summary of Original Project (as described in the EA)	Summary of Preferred Project (compared to the Original Project)
General Surface Facilities and Supporting Infrastructure	• Existing general surface facilities include administration buildings, coal handling infrastructure, bath house, workshops, equipment service facilities, car park, washdown and fuel storage facilities. • Extensive supporting infrastructure including systems associated with: - underground drift access and conveyors; - electricity supply, reticulation and control; and - ventilation and gas management.	• The existing surface facilities would be utilised, however, the original Project would include the upgrade of some infrastructure and construction of additional components as required. • Supporting infrastructure systems would be extended and upgraded as required.	• No change.
Water Management	• A network of water storages is utilised to manage surface water that accumulates on-site. • Make-up water demand is met by sourcing stored water in historical workings, surface water runoff recovered from the existing Metropolitan Colliery Major Surface Facilities Area and purchase from Sydney Water as required. • Water treatment, reuse and off-site release in accordance with EPL No. 767.	• Continued use and (where required) upgrade and augmentation of existing water management infrastructure, including upgrade of underground water management systems. • Installation of an additional water tank.	• No change.
Life of Mine	• Longwalls 14 to 19A are currently scheduled for completion in 2010.	• An additional mine life of approximately 23 years.	• Reduction in additional mine life to approximately 20.2 years, which reflects the sterilisation of approximately 6.9 Mt of coal.
Employment	• HCPL currently has an operational workforce (staff and on-site contractors) of approximately 320 people.	• The operational workforce is expected to remain at approximately 320 people. • It is anticipated that a peak construction workforce of up to 50 employees would be required.	• No change.

[1] HCPL currently retains a WCC approval for development of a coal reject emplacement in Camp Gully (Section 2.8.5 and Figure 1-3 of the EA).

Table 6
Preferred Project Stand-off Distances to Waratah Rivulet

Longwall	Stand-off Distance to Waratah Rivulet		Total Pillar Length (m)
	Eastern Side of Waratah Rivulet (m)	Western Side of Waratah Rivulet (m)	
22	109	63	247
23	108	212	354
24	329	>211	>739
25	307	>245	>641
26	411	>439	>984
27	495	>610	>1,256

The pillar lengths presented in Table 4 and on Figure 6b extend to the boundary of Area A2 and therefore represent minimum pillar lengths relative to these longwalls. The pillar would reduce the cumulative predicted valley closure to less than 200 mm over Longwall 24 and remain below 200 mm over the remaining reach of the Waratah Rivulet to the full supply level of the Woronora Reservoir. The pillar also significantly reduces the predicted valley closure over Longwalls 20 to 23 (Figures 13 and 14).

Figure 6a shows the pillar areas within which coal would be sterilised (i.e. Areas A1, A2, and A3).

The Preferred Project excludes longwall extraction within Areas A1, A2, and A3.

Areas A1 and A2 were separately delineated on the basis of access and timing. Area A1 would be sterilised in the absence of further technological advances. Area A2 could only be accessed from the re-aligned main roads ('Mains 300', refer Figure 6a) and therefore activity in this area is at least 15 years into the future. Whilst Area A2 is excluded from the Preferred Project, it should be considered as a possible future mining area, potentially including non-longwall methods, subject to further environmental assessment and approval processes. Irrespective of technological advances, mining in Area A2 is considered unlikely to have an impact on the Waratah Rivulet or Eastern Tributary.

Area A3 is defined as a consequence of geological structure (specifically an igneous dyke). The location of the dyke system was confirmed by mine development and would truncate the longwall blocks as shown on Figure 6a.

Whilst the EA for the original Project assumed a maximum development scenario that included extraction through the dyke, extension of longwall panels through the dyke and Area A3 is no longer included as part of the Project (i.e. mining of longwalls within Area A3 is not part of the Preferred Project). Notwithstanding, Area A3 is identified as an area that may be extracted in the future if technological advances enable extraction in this dyke system.

Technological advances in the future may present the opportunity to recover some of the resource within Areas A1, A2 and A3 whilst still achieving the objective stated in Section 5.1 and such that the potential impacts described in the EA and Section 6 of this PPR are not exceeded.

Any such mining would be subject to future assessment and approval processes and does not form part of the Preferred Project.

Table 7 details the amount of coal that would be sterilised within Areas A1 and A2.

The sterilisation of approximately 6.9 Mt of coal would reduce the additional mine life by approximately 2.8 years.

The Preferred Project layout (Figure 6a) has been developed to reflect the optimal re-alignment of the mains roads. For clarity, the mains roads within the pillar area would comprise 'Mains 200', which would support Longwalls 20 to 27, and 'Mains 300' which would support Longwalls 301 to 317.

Table 7
Coal Sterilised for the Preferred Project

Area	Area A1	Area A2	Total
Project Longwall Resource Recovery	1,749,682	1,093,140	2,843,092
Extractable Resource (65%)	1,137,293	710,541	1,847,834
Coal Thickness (m)	3.2	3.2	3.2
Coal Volume (m^3)	3,639,338	2,273,731	5,913,069
Coal Density (t/m^3)	1.45	1.45	1.45
ROM Sterilised (t)	5,277,040	3,296,910	8,573,950
Average Yield	80%	80%	80%
Coal Product Sterilised (t)	**4,221,632**	**2,637,528**	**6,859,160**

m^3 = cubic metres

t/ m^3 = tonnes per cubic metre

Minor adjustments to the layout of the Preferred Project (Figure 6a) may be required following further detailed design and may include:

- variation to the angle of 'Mains 300' for optimal alignment with the lease boundary or other factors such as coal clearance, etc.;
- adjustment to the first workings required to form the connection between 'Mains 200', 'Mains 300' and the drift upgrade required for connection to facilitate coal clearance and ventilation;
- installing a bend in 'Mains 300' to facilitate coal clearance and optimise resource recovery; and
- lengthening (or shortening) of Longwalls 24 to 27 depending on advances in the knowledge of mining impacts on water courses and impact predictions.

Any adjustments to the first workings that would alter the area of secondary extraction, particularly in relation to the size and shape of the Area 1, would be subject to further environmental assessment and approval processes.

6 CONSEQUENTIAL ENVIRONMENTAL BENEFITS OF THE PREFERRED PROJECT

This PPR should be read in conjunction with: the EA prepared for the original Project; the responses to submissions provided to the DoP and the PAC; and other supplementary information provided to the DoP and the PAC.

The following sections describe the consequential environmental benefits for the Preferred Project (when compared to the original Project), including consideration of predicted subsidence effects and potential consequential environmental benefits to: groundwater resources; surface water; upland swamps; aquatic ecology; Aboriginal heritage; and economic efficiency.

The impact assessment findings presented in the EA for other environmental aspects potentially relevant to the modified Preferred Project have been reviewed. The assessment of potential impacts and proposed mitigation measures, management and monitoring outlined in the EA for these other environmental aspects are considered to be appropriate for the Preferred Project. Therefore, these other environmental aspects are not considered further in this PPR.

6.1 SUBSIDENCE

An assessment of the potential subsidence effects associated with the Preferred Project mine layout and particularly the longwall re-orientation within the area of Longwalls 301 to 317 has been conducted by MSEC and is presented in Attachment 4. The assessment included subsidence, tilt and compressive and tensile strain predictions (Attachment 4), including comparisons of these subsidence parameters for cliffs (refer below), infrastructure (refer below), upland swamps (refer to Section 6.4) and Aboriginal heritage sites (refer to Section 6.6).

In their assessment, MSEC concluded that the (Attachment 4):

> *The comparisons along the various natural features and items of surface infrastructure generally indicated that the Preferred Project Layout and the Base Case Layout result in subsidence parameters of similar magnitude where the series of longwall panel and pillar widths are the same, even though, the longwalls in the Preferred Project Layout are orientated approximately perpendicular to the longwalls in the Base Case Layout. The proposed sterilisation of a large coal pillar in the central area of the Preferred Project Layout would result in a significant reduction in subsidence effects to Waratah Rivulet (over Longwalls 22 to 27) and to lower reaches of the Eastern Tributary. Significant reductions in subsidence effects to features such as Aboriginal heritage sites and swamps in this area are also expected.*
>
> *In most locations the longwall widths of the Preferred Project Layout are similar to the longwall widths of the Base Case Layout. However, there are a few locations where the longwall width of the Preferred Project Layout is slightly wider than the longwall width of the Base Case Layout and these locations are shown on drawing No. MSEC403-101. Where the longwall widths of the Preferred Project Layout are greater than the longwall widths of the Base Case Layout, the predicted subsidence parameters are slightly higher for the Preferred Project Layout than for the Base Case Layout. However, this increase in predicted subsidence parameters is not significant and the assessed impacts to the natural features and items of surface infrastructure resulting from the extraction of the Preferred Project Layout at these locations are generally the same as was reported in the previous report MSEC285.*
>
> *As a result, expected impacts to the natural features and items of surface infrastructure resulting from the extraction of the Preferred Project Layout are generally expected to be similar to those assessed for the Base Case.*

Cliffs

MSEC's assessment (Attachment 4) included subsidence, tilt and compressive and tensile strain predictions for cliffs for the original Project and the Preferred Project. The prediction results are presented in Table 8. Negative results (shown in red) indicate where the predicted subsidence parameter for the Preferred Project layout is lower than that for the original Project layout.

With regard to potential impacts on cliffs resulting from the Preferred Project mine layout and particularly the longwall re-orientation within the area of Longwalls 301 to 317, MSEC stated that (Attachment 4):

> *the majority of predicted parameters for the Preferred Project Layout are less than or similar to those for the Base Case Layout.*

Infrastructure

With regard to potential impacts on infrastructure, MSEC stated that (Attachment 4):

> *The Statement of Commitments provided in the Environmental Assessment will limit impacts to structures within the Garrawarra Complex to Category A or B for tilt and Category 0 or 1 for strain. This would be achieved by adjustments to the longwall layout to limit impacts to the structures. HCPL advised that these same commitments would apply to the Preferred Project Layout…*

6.1.1 Adaptive Management

The Preferred Project represents a shift in the strategy to manage environmental impacts in relation to the Waratah Rivulet. The Preferred Project places a greater emphasis on avoidance where practically achievable and a greater emphasis on minimisation of impacts where avoidance cannot be practically achieved. Restoration will be used as a contingency measure for the subject reach of Waratah Rivulet where avoidance and/or minimisation cannot be achieved.

The proposed adaptive management approach, as outlined in detail in Section 5 of the EA, used restoration as a forward management tool to ensure that the nett environmental impact was recovered to an acceptable residual level. For example, if a reduction in surface flow during low flow conditions were to occur as a consequence of valley closure, then restoration would have restored pre-mining flow conditions. Where restoration was not achieved within a suitable timeframe or over a given length of the Waratah Rivulet, then modification to the mine plan was proposed.

The Preferred Project changes this strategy for the subject reach of Waratah Rivulet. The full extraction of Longwalls 20 and 21 is required to allow transition from the originally proposed mine plan to the Preferred Project mine plan involving substantial stand-offs that may otherwise not have been required. Similarly, whilst the Preferred Project includes a significant stand-off in Longwalls 22 and 23, the predicted valley closure is significantly reduced but above 200 mm in the overlying reach of the Rivulet (i.e. predicted to be in the range of 220 to 400 mm).

Table 8
Comparison of Predicted Systematic Subsidence Parameters for Cliffs

Site*	MGA Easting (m)	MGA Northing (m)	ID	Preferred Project Layout	Original Project Layout	Difference# (mm)	Preferred Project Layout	Original Project Layout	Difference# (mm)	Preferred Project Layout	Original Project Layout	Difference# (mm)	Preferred Project Layout	Original Project Layout	Difference# (mm)
				Total Subsidence After LW 317 (mm)	Total Subsidence After LW 44 (mm)		Maximum Total Tilt During or After LW 317 (mm/m)	Maximum Total Tilt During or After LW 44 (mm/m)		Maximum Predicted Tensile Strain During or After LW 317 (mm/m)	Maximum Predicted Tensile Strain During or After LW 44 (mm/m)		Maximum Predicted Compressive Strain During or After LW 317 (mm/m)	Maximum Predicted Compressive Strain During or After LW 44 (mm/m)	
COH1	Varies	Varies	1	458	493	-35	2.0	2.1	-0.2	0.2	0.4	-0.3	-0.3	-0.3	-0.0
COH2	Varies	Varies	2	684	748	-65	4.7	5.3	-0.6	1.3	1.3	0.0	-0.9	-0.9	0.0
COH3	Varies	Varies	3	13	1078	-1,065	0.1	3.6	-3.4	0.1	0.4	-0.4	0.0	-1.5	-1.5
COH4	Varies	Varies	4	10	1049	-1,039	0.1	3.8	-3.7	0.1	1.0	-0.9	0.0	-1.4	-1.4
COH5	Varies	Varies	5	5	400	-395	0.0	1.0	-1.0	0.0	1.1	-1.1	0.0	-0.3	-0.3
COH6	Varies	Varies	6	6	397	-391	0.1	1.2	-1.1	0.0	1.2	-1.2	0.0	-0.3	-0.3
COH7	Varies	Varies	7	6	393	-387	0.0	0.9	-0.9	0.0	0.5	-0.4	0.0	-1.1	-1.1
COH8	Varies	Varies	8	7	369	-362	0.0	1.9	-1.9	0.0	1.0	-1.0	0.0	-1.7	-1.7
COH9	Varies	Varies	9	45	363	-318	0.4	1.7	-1.2	0.1	1.1	-1.0	0.0	-0.3	-0.3
COH10	Varies	Varies	10	144	370	-226	1.8	0.9	0.9	0.3	0.5	-0.2	-0.2	-1.2	-0.9
COH11	Varies	Varies	11	404	347	56	0.4	1.6	-1.3	0.2	0.7	-0.5	-0.2	-1.7	-1.4
COH12	Varies	Varies	12	405	338	67	0.8	1.8	-0.9	0.3	1.3	-0.9	-0.7	-1.0	-0.3
COH13	Varies	Varies	13	404	370	34	0.7	1.1	-0.4	0.6	0.4	0.2	-0.4	-1.8	-1.4
COH14	Varies	Varies	14	132	1204	-1,071	1.4	2.2	-0.8	0.3	0.5	-0.2	-0.1	-0.9	-0.8
COH15	Varies	Varies	15	3	439	-437	0.0	1.0	-1.0	0.0	0.4	-0.4	0.0	-1.1	-1.1
COH16	Varies	Varies	16	15	381	-366	0.1	1.1	-0.9	0.1	0.5	-0.3	-0.1	-1.3	-1.3

Source: Attachment 4.

* Refer to Appendix A of the EA for cliff locations.

Negative results (shown in red) indicate where the predicted subsidence parameter for the Preferred Project layout is lower than that for the original Project layout.

mm/m= millimetres per metre

Whilst the likelihood of reduced surface flow is significantly minimised, it may still occur and require some restoration by HCPL.

Adaptive management involving modification to the mine plan in response to observed effects for Longwalls 20 to 23 is no longer a viable component of the Preferred Project. Notwithstanding, other aspects of adaptive management, such as development of the Waratah Rivulet Management Plan (WRMP) and associated Trigger Action Response Plan (TARP) would be implemented for the Preferred Project.

The WRMP and TARP would be based on the longwalls shown on Figures 6a and 6b (i.e. they would not include a step around Waratah Rivulet for Longwalls 20 and 21, nor an increase in the stand-off pillar within Longwalls 22 and 23) since the extraction of Longwalls 20 to 23 as shown are required to avoid mine closure. That is, sterilising more than the proposed amount (i.e. approximately 6.9 Mt) of premium coking coal within the centre of the reserve would result in a loss of continuity of mining operations and mine closure.

Adaptive management would be considered an appropriate management tool in relation to the environmental impact of Longwalls 24 to 27. In the case of Longwalls 24 to 27, an adaptive variation to the mine plan could **not** involve a step around the Waratah Rivulet given that the Preferred Project layout precludes mining on the western side of Waratah Rivulet in relation to Longwalls 24 to 27. Notwithstanding, other adaptive measures may be implemented as required (e.g. shortening of the next longwall would be considered by HCPL). These options would be detailed in the WRMP and associated TARP as required. The proposed contents of the WRMP for the Preferred Project is described in the Statement of Commitments (Attachment 1).

HCPL is committed to all aspects of adaptive management in relation to yield and quality of water in the Woronora Reservoir, as outlined in the EA. The development of the Preferred Project layout provides for further avoidance of impacts. The proposed sterilisation of coal within the pillar to further minimise potential impacts to the Waratah Rivulet from Longwall 24 to the full supply level of the reservoir is specifically designed to avoid the redirection of surface flow to underflow as a consequence of streambed cracking over that reach (i.e. from Longwall 24 to the full supply level).

6.2 GROUNDWATER

6.2.1 Potential Impacts of the Original Project

The potential impacts of the original Project on groundwater resources are described in Section 4.3.2 and Appendix B (Heritage Computing, 2008) of the EA and are summarised below.

Perched Groundwater Systems

Excess rainfall produces a permanent perched water table within swamp sediments and outcropping sandstone that is independent of the regional water table in the Hawkesbury Sandstone. As the swamps are essentially rainfall-fed, water levels within upland swamps fluctuate seasonally with climatic conditions.

Surface cracking resulting from mine subsidence within the upland swamps is not expected to result in an increase in the vertical movement of water from the perched water table into the regional aquifer as the sandstone bedrock is massive in structure and permeability decreases with depth.

It is expected that any surface cracking that may occur would be minor in nature (i.e. would be relatively shallow) and would terminate within the unsaturated part of the low permeability sandstone (Heritage Computing, 2008). In addition, due to the low hydraulic gradient of the water table within a swamp, lateral movement of water through the swamp towards a crack would be very small and very slow.

Any changes in swamp moisture as a result of cracking are expected to be minor and immeasurable when compared to natural variability (Heritage Computing, 2008). Notwithstanding this, HCPL has proposed an integrated swamp monitoring system including shallow and deeper piezometers. Contingency measures, in the case of unexpected outcomes, would include the use of polyurethane (PUR) grout injection technology.

Significant mine subsidence effects to upland swamps in elevated topography have not been observed at Metropolitan colliery nor in similar circumstances (i.e. depth of mining, mine geometry and topographical aspects) across the Southern Coalfield.

Shallow Groundwater Systems and Inflows to the Woronora Reservoir

Permanent mining-induced changes in the groundwater levels of shallow aquifers in connection with streams and ecosystems at the Metropolitan Colliery have not been observed to occur (Heritage Computing, 2008).

Stream beds at the Metropolitan Colliery have experienced cracking in response to subsidence effects. This has been observed to result in the diversion of a portion of surface water flows through fractures beneath the stream bed to move as underflow through the aquifer immediately beneath the stream, with emergence further downstream (Figure 15). This process is described further in Section 4.4 of the EA. There is no evidence that cracking in streambeds causes any net change in the overall water balance of a stream (Heritage Computing, 2008; Gilbert and Associates, 2008).

At the goaf hole drilled above Longwall 10 (which has already been mined by HCPL) the direction of shallow groundwater system flow (i.e. in the Hawkesbury Sandstone) has not been altered by mining, and the Waratah Rivulet is still gaining baseflow from the shallow groundwater aquifer (Heritage Computing, 2008).

The head difference between the shallow groundwater system at the Longwall 10 goaf hole and the Waratah Rivulet is about 30 m, and the horizontal hydraulic gradient is about 1:10. This gradient maintains horizontal flow through the Hawkesbury Sandstone to the Waratah Rivulet (Heritage Computing, 2008).

At the substantial depths of cover at the Project, the potential for connective cracking from the mined seam to the surface is not expected to occur (Heritage Computing, 2008).

The depressurisation effects described below for the deep groundwater system would not propagate to the Hawkesbury Sandstone where the shallow groundwater system is located (Heritage Computing, 2008). Hence no impacts on registered bores in the wider Project area and surrounds would be expected.

Based on the analysis of the conceptual groundwater system, there would be no loss of groundwater yield to the Woronora Reservoir. This is reinforced by the groundwater modelling which indicates negligible reduction in cumulative average inflows to the Woronora Reservoir (Heritage Computing, 2008).

Depressurisation of the Deep Groundwater System

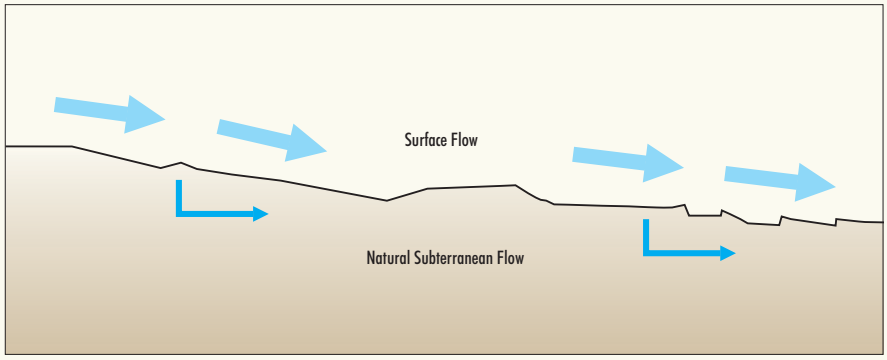
Immediately above a mined coal seam, rocks collapse into the void created by removal of the coal to form a caved zone and a fractured zone develops above the caved zone (Figure 16). This causes aquifer properties to change (e.g. permeability and porosity) and results in a higher vertical permeability as a result of mining.

Above goaf zones there would be substantial changes in fracture porosity and permeability, due to opening up of existing joints, new fractures and bed separation. Permeability increases would have accompanying reductions in hydraulic gradients, with associated changes in groundwater levels and pressures. Pronounced changes in groundwater levels can occur without any significant drainage into a mine, particularly from the Narrabeen Group sandstones (Heritage Computing, 2008).

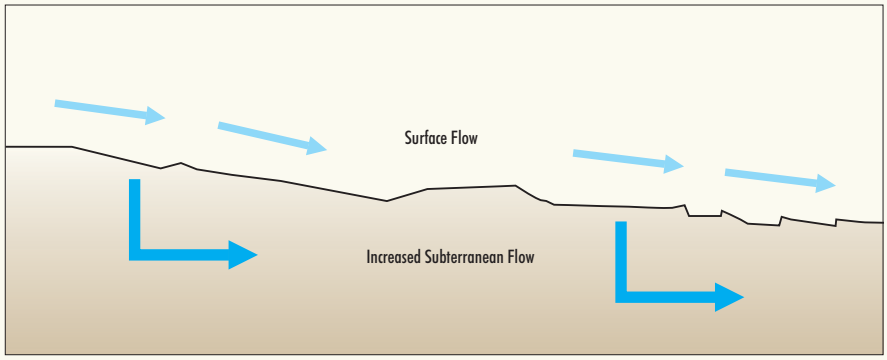
At the substantial depths of cover at the Metropolitan Colliery (Figure 16), no connective cracking from the ground surface to the mined coal seam is expected (Heritage Computing, 2008). Groundwater modelling for the original Project indicates that there is expected to be eventual recovery of deep groundwater system pressures over many decades following the cessation of mining (Heritage Computing, 2008).

Underground emplacement of coal wash material is proposed as part of the Project. Relative to other transmissive and storage properties of overburden rock, backfilling would have negligible influence on the groundwater resource (Heritage Computing, 2008).

Based on the data sets available at the time of publishing the EA, Heritage Computing (2008) concluded that no dewatering of swamps was expected and that there would be no loss of groundwater yield to the Woronora Reservoir. Groundwater modelling was also conducted by Heritage Computing (2008) which generally supported this position. Since the publication of the EA, improvements have been made to the groundwater modelling including the use of Modflow – SURFACT software and transient modelling. This model has also gone through a process of recalibration. It is considered that this model generally supports the conclusion stated above. Additional data continues to be obtained from the development of new deep boreholes. Heritage Computing has indicated to the PAC that this data also generally supports the conclusions stated above.

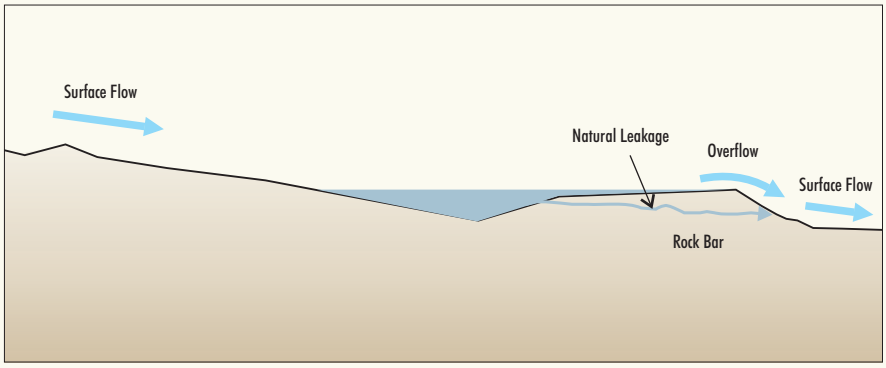


Prior to Mining

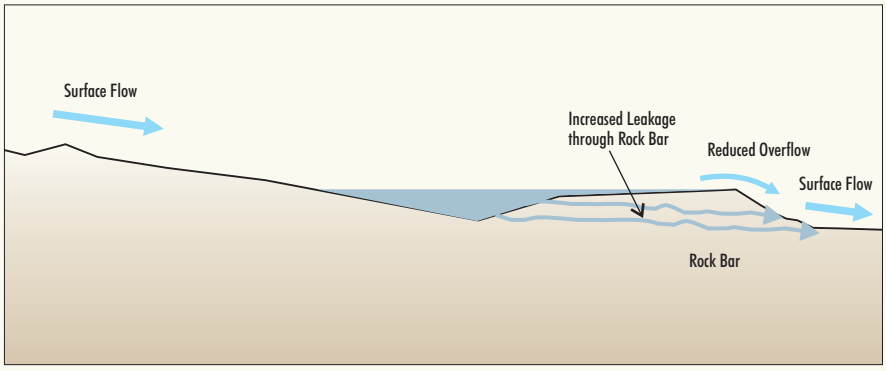


Following Mining

Diagrammatic Representation of Subterranean Flows



Prior to Mining



Following Mining

Diagrammatic Representation of Rock Bar Leakage

Source: After MSEC (2008)

METROPOLITAN COAL PROJECT

FIGURE 15
Diagrammatic Representation
of Subsidence Related Flow Diversion

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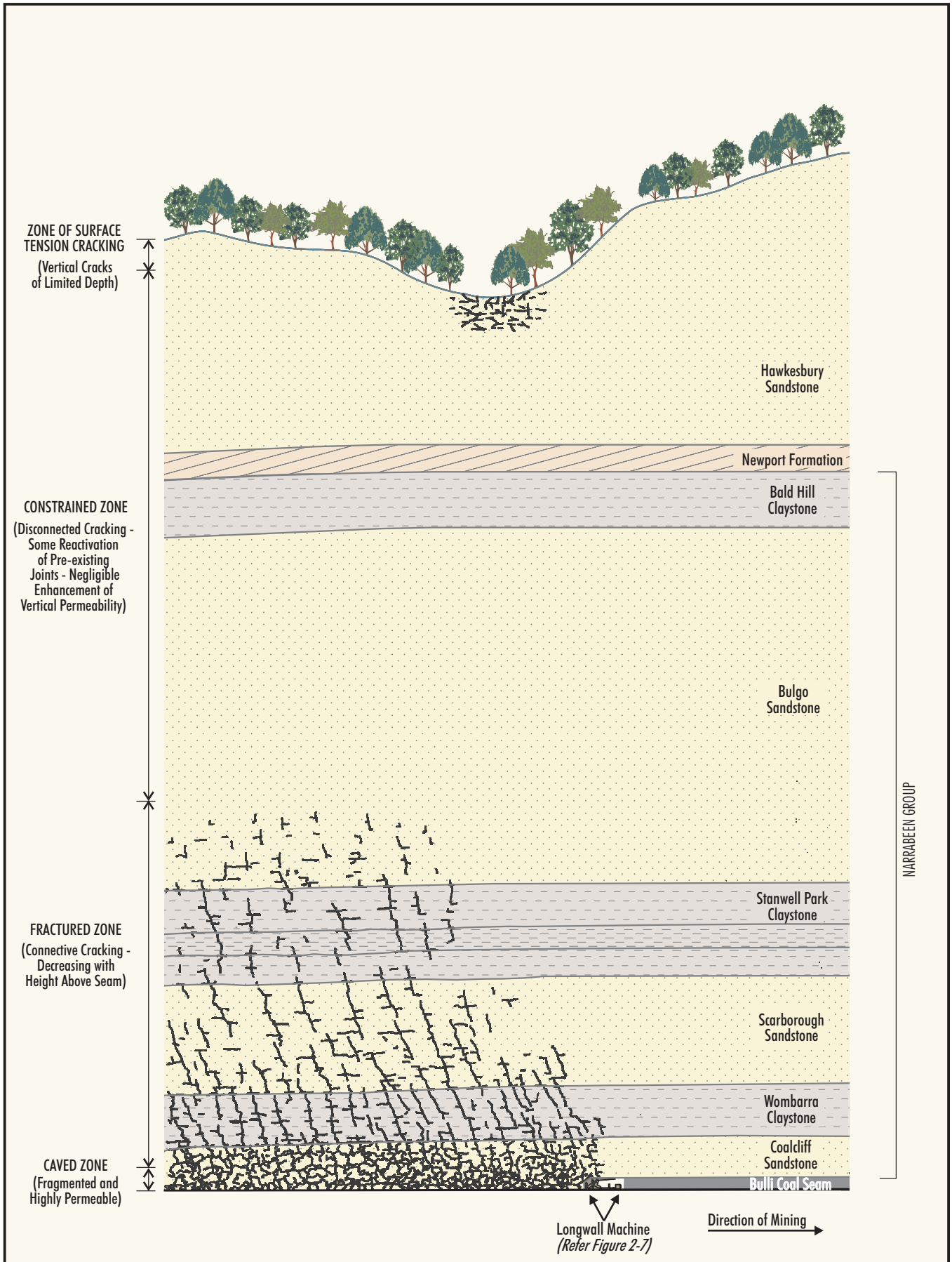

After: Geosensing Solutions (2008), Heritage Consulting (2008)

Not to Scale

METROPOLITAN COAL PROJECT

FIGURE 16
Schematic - Longwall Mining and Subsidence Profile

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Climate Change and Groundwater

Climate change and greenhouse gas emissions associated with the original Project are discussed in Section 3.8 of the EA including the potential groundwater impacts of the original Project in the context of global climate change.

6.2.2 Consequential Reductions in Potential Impacts of the Preferred Original Project

As explained in Section 5.3 of this PPR, the Preferred Project comprises a significant reduction in the total area of longwall mining. As shown on Figure 6a, the extent of mining to the west and east would be reduced and a significant 'island' of intact coal would be left in the central portion of the proposed longwall mining area.

This means that the total area and volume of material that would experience the goafing effect described above, and therefore the consequential changes in hydraulic properties (i.e. increased permeability and porosity), would be significantly reduced. The life of mine would also be reduced by approximately 2.8 years. On this basis it is considered that the groundwater effects of the Preferred Project would be equal to or less than those predicted for the original Project (as summarised above). It is proposed that the groundwater model for the Preferred Project be developed and refined over time to inform the design of monitoring systems and to inform mine design.

The mitigation measures, management and monitoring relevant to groundwater resources described in Section 4.3.3 of the EA would be implemented for the Preferred Project.

6.3 SURFACE WATER

6.3.1 Potential Impacts of the Original Project

The potential impacts of the original Project on surface water resources are described in Section 4.4.2 and Appendix C (Gilbert and Associates, 2008) of the EA and are summarised below.

Woronora Reservoir Inflows

Based on the analysis of the effects of mining at the Metropolitan Colliery on inflows to the Woronora Reservoir, Gilbert and Associates (2008) concluded that:

- On the basis of recorded data from streamflow gauging stations in the area, streamflow patterns and magnitudes in the region are consistent.
- Recorded streamflow data from Waratah Rivulet indicates that there is no evidence of flow loss at low flows in periods of prolonged dry weather and flow recession as might be expected if flow were being affected by mining activity.
- The observed behaviour is consistent with no losses occurring from the catchment.
- There has been no discernable departure of streamflow model-predicted inflows to the Woronora Reservoir from those calculated using recorded reservoir data following commencement of mining.

Investigations undertaken by Gilbert and Associates (2008) show that subsidence induced underflow re-emerges downstream of the subsidence area with no evidence of flow loss to Woronora Reservoir. As described in Section 4.4.1 of the EA, this finding is supported by the Southern Coalfield Panel Report (SCPR) (DoP, 2008).

Based on the above and the Subsidence Assessment undertaken by MSEC (2008), the original Project is not expected to have an effect on catchment inflows to the Woronora Reservoir (Heritage Computing, 2008; Gilbert and Associates, 2008).

Stream Flows

Subsidence predictions for the original Project indicate that the maximum valley closure and upsidence movements at watercourses within the Project Underground Mining Area are within the range where fracturing of bedrock (and the consequent diversion of a portion of the total stream flow as underflow) could occur (MSEC, 2008).

However, subsidence movements associated with the Cawley's Creek and Wilson's Creek catchments would be relatively small, to the extent that fracturing of bedrock in these creeks is not expected (MSEC, 2008).

In Waratah Rivulet the amount of potential underflow as a result of the development of a fracture network has been conservatively estimated to increase the average frequency of no flow days as a result of the original Project from 2% to 15% and increase the average frequency of low flows (less than 2 megalitres per litre [ML/day]) from 36% to 40% of days (Gilbert and Associates, 2008). Mine subsidence associated with the original Project would have a negligible effect (less than 0.5%) on moderate (approximately 10 ML/day) and larger flows.

In summary, in the Project Underground Mining Area the effects of underflow would be most noticeable during periods of low flow and on the frequency of no flow, while the effects on the frequency and magnitude of high flows would be negligible (Gilbert and Associates, 2008).

Pool Water Levels and In-stream Connectivity

Underflow has been observed to result in lower water levels in pools as they become hydraulically connected with the fracture network.

Water Quality

As described in Section 4.4.1 of the EA, the overall water quality of most indicator parameters has not been noticeably affected by mine subsidence and water quality at all sites has been good with concentrations of most parameters being low relative to the Woronora Reservoir Bulk Water Supply Agreement Limits and Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) guidelines for the protection of aquatic ecosystems in upland rivers.

The effect of subsidence on water quality is expected to be similar to that already observed and described in Section 4.4.1 of the EA (i.e. transient pulses of iron, and to a lesser extent, manganese, aluminium and conductivity increases which would likely occur following any instances of fresh cracking of the creek bed) (Gilbert and Associates, 2008).

Project activities (e.g. on-going surface exploration activities, the upgrade and extension of surface infrastructure, access tracks, environmental monitoring and management activities, stream restoration activities and other minor Project-related surface activities) have the potential to increase soil erosion/sedimentation or result in water contamination (e.g. fuel leakages from equipment or uncontrolled spills). Appropriate management measures to minimise this risk are presented in Section 4.4.3 of the EA.

Water draining from coal reject stockpiled on-site at the Major Surface Facilities Area could result in the mobilisation of salt and sediments or the mobilisation of metals if the material was acid generating. As described in Section 4.4.1 of the EA, analysis of Metropolitan Colliery coal reject and at other mines in the Southern Coalfield indicates that coal reject is generally inert.

As water releases from the Major Surface Facilities Area to Camp Gully, which flows to the Hacking River would continue to be constrained by the existing EPL No. 767, it is expected there would be no material effect to downstream water quality (Gilbert and Associates, 2008).

Stream Gradients and Alignments

The anticipated changes in channel gradients predicted by MSEC (2008) would cause localised increases and decreases in flow energy/velocities (Gilbert and Associates, 2008). Increases in flow energy in steeper sections may in turn result in bed, or more likely, bank erosion. The extent of any erosion effects would depend principally on the strength of bank materials and the integrity of the riparian vegetation.

Based on observation of similar streams that have been affected by subsidence at the Metropolitan Colliery, it is expected that bank erosion would be relatively minor and comprise a slow retreat of the bank until a new dynamic equilibrium is reached (Gilbert and Associates, 2008).

The potential for changes in stream alignment due to mine subsidence is considered to be low (MSEC, 2008). The steep and incised nature of the local watercourses is such that alignment change is not a real possibility and it has not occurred to any significant degree in subsided areas at the Metropolitan Colliery to date (Gilbert and Associates, 2008).

Climate Change and Surface Water

Climate change and greenhouse gas emissions associated with the original Project are discussed in Section 3.8 of the EA. Consideration of the potential surface water impacts of the original Project in the context of global climate change is provided in Gilbert and Associates (2008) and Section 3.8 of the EA.

6.3.2 Consequential Reductions in Potential Impacts of the Preferred Project

As described in Section 5.3, the stand-offs for the Preferred Project would reduce the cumulative predicted valley closure to less than 200 mm over Longwall 24 and remain below 200 mm over the remaining reach of the Waratah Rivulet to the full supply level of the Woronora Reservoir.

Given these changes to predicted valley closure, the following changes to the potential impacts of the original Project on surface water resources would be expected as a result of the Preferred Project:

- avoidance of drainage of pools along the majority of the lower reach of the Waratah Rivulet;
- reduction in the potential for redirection of some surface flow into a shallow fracture network that may have developed as a consequence of cracking of the Waratah Rivulet stream bed;
- reduction in the potential for localised and transient impacts to water quality that may have occurred as a consequence of shallow cracking of the Waratah Rivulet and Eastern Tributary stream beds; and
- reduction in the potential extent of localised iron staining that would occur as a consequence of shallow cracking of the Waratah Rivulet and Eastern Tributary stream beds.

The mitigation measures, management and monitoring outlined in the EA for surface water resources are considered to be appropriate for the Preferred Project.

6.4 UPLAND SWAMPS

MSEC (2008) conservatively predicted for the original Project that the maximum total systematic tensile and compressive strains in headwater upland swamps within the proposed Project Underground Mining Area (Longwalls 20 to 44) and within the potential extent of mine subsidence effects are 1.4 mm/m and 1.7 mm/m, respectively. This means that cracking, buckling and/or dilating as a result of systematic compressive strains was not predicted to occur as a result of the cumulative subsidence from the extraction of Longwalls 1 to 44 (i.e. compressive strains less than the 2 mm/m threshold are predicted) (MSEC, 2008). The compressive strains would be expected to be reduced where coal is being sterilised as proposed by the Preferred Project.

Section 5.8.1 of Appendix A of the EA describes the predicted upsidence at headwater upland swamps:

> *Upsidence and closure movements also have the potential to result in cracking, buckling and/or dilating of the strata beneath the bedrock. However, as headwater upland swamps are generally located higher in the catchment topography in areas with relatively shallow relief (Appendix B of the Metropolitan Coal Project Environmental Assessment), headwater swamps would generally be subject to minimal valley related upsidence and closure movements. Predictions of valley related upsidence and closure movements were made for a number of headwater swamps located in those drainage lines with the steepest valley profiles. A maximum total closure strain of 8.9 mm/m is predicted, which occurs at Swamp S20.*
>
> *The soils in the swamps comprise mainly unconsolidated alluvial sediments and in most cases, the cracking that might occur at the rock surface may not appear at the surface of the swamps. Most of the swamps are also located in relatively level areas and not on steep slopes so the type of cracking resulting from downslope movements would not be expected to occur in the swamps.*
>
> *The most likely locations where cracking of surface soils may occur would be where the swamps are located over the edges of the mining area. However, given the depth of cover which is generally more than 420 metres, even on the edges of the mining area we would not expect much cracking in the surface soils. As indicated above, the headwater swamps would generally be subject to minimal valley related upsidence and closure movements.*

Predictions of valley related upsidence and closure movements within the inverts of valleys were made for a number of headwater swamps with the steepest valley profiles (i.e. those considered by MSEC to experience the highest potential subsidence effects). For the original Project, a maximum total closure strain of 8.9 mm/m was predicted. For the larger swamps, a maximum total closure strain of 4.3 mm/m was predicted at swamp 76, a maximum total closure strain of 7.8 mm/m was predicted at swamp 77 and a maximum total closure strain of 5.8 mm/m was predicted at swamp 92 (Table 9).

Table 9
Maximum Predicted Total Closure Strain for Upland Swamps

Swamp ID*	Original Project Maximum Predicted Total Closure Strain (mm/m)	Preferred Project Maximum Total Closure Strain (mm/m)
S14	6.1	3.4
S20	8.9	8.6
S22	2.2	2.2
S30	3.2	2.2
S31	2	2.1
S38	2.2	2.6
S52	3.7	5.7
S53	5.2	5.8
S57	3.8	3.8
S58	3.8	3.7
S74	2.2	2.3
S76	4.3	4.2
S77	7.8	7.7
S81	1.8	2.1
S82	5.3	5.8
S85	3.4	3.5
S90	1.8	1.6
S92	5.8	3.7
S93	1.2	0.2
S106	2.2	2.2
S128	6.5	5.4
S134	2.5	2.1

* Refer to Figure 17 for swamp locations.

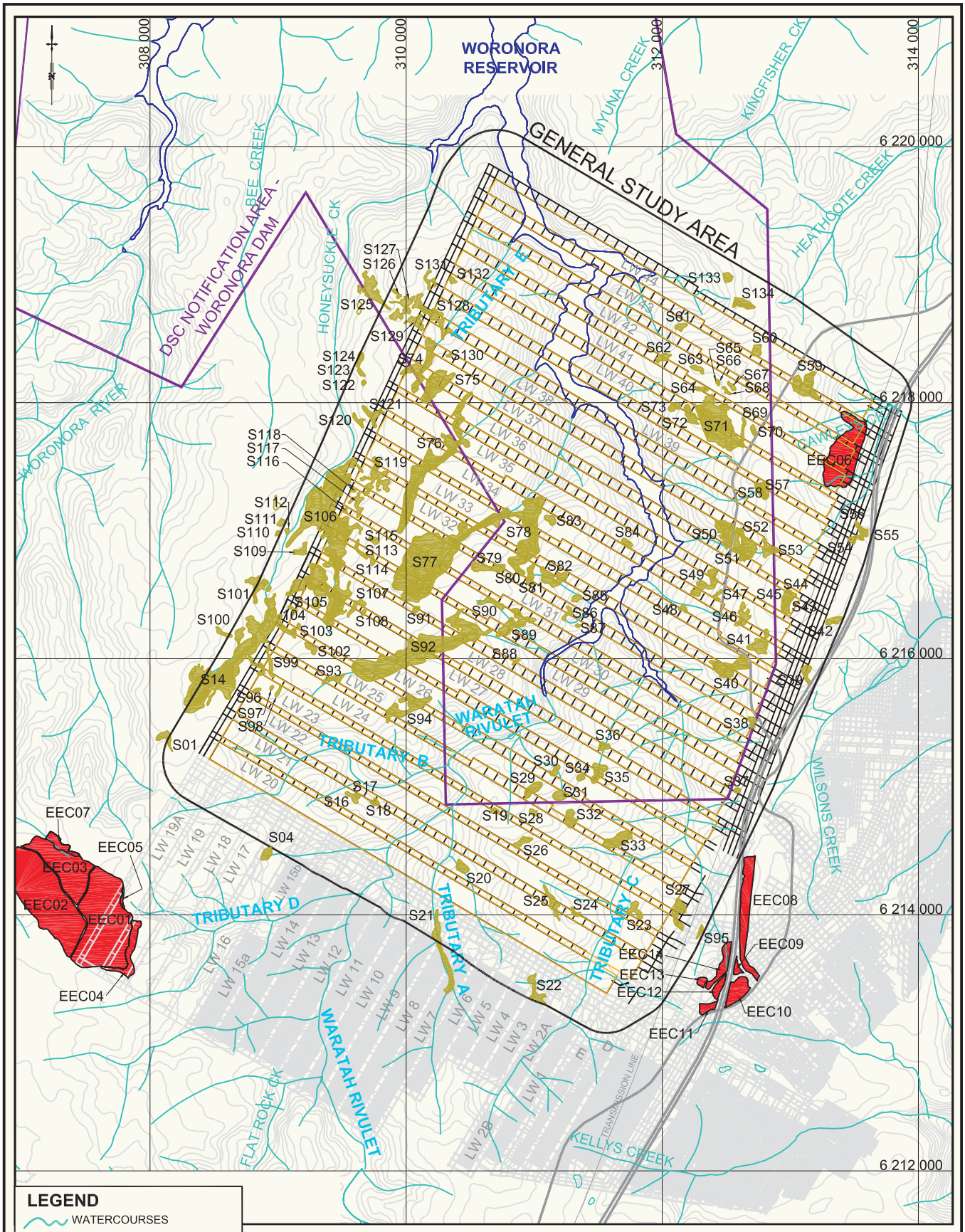
The maximum predicted total closure strains within the inverts of the valleys have been assessed for the Preferred Project and are also provided in Table 9. A maximum total closure strain of 4.2 mm/m is predicted at swamp 76, a maximum total closure strain of 7.7 mm/m is predicted at swamp 77 and a maximum total closure strain of 3.7 mm/m is predicted at swamp 92 (Table 9). The values of the closure strains at the lowest point of these swamps (i.e. where a rock outcrop may cause an obstacle for swamp soil migration) are 4.1 mm/m, 7.3 mm/m and 3.7 mm/m, respectively. The results for swamps 76 and 77 change only marginally from the previous mine layout, while the predicted closure strain for swamp 92 decreases from 5.8 mm/m to 3.7 mm/m (Table 9).

Given that negligible environmental impact to upland swamps was predicted for the original Project, negligible environmental impact would be expected in the case of upland swamps for the Preferred Project.

Further, as stated in Section 6.1, MSEC conducted an assessment of the potential subsidence effects on swamps 76, 77 and 92 associated with the Preferred Project mine layout and particularly the longwall re-orientation within the area of Longwalls 301 to 317 (Attachment 4). The assessment included subsidence, tilt and compressive and tensile strain predictions for swamps 76, 77 and 92 for the original Project and the Preferred Project.

With regard to potential impacts on swamps 76, 77 and 92, MSEC stated that (Attachment 4):

> *It can be noted that the predicted subsidence parameters for the Preferred Project Layout are generally less than or similar to predicted subsidence parameters for the Base Case Layout*



Source: MSEC (2008)

METROPOLITAN COAL PROJECT

FIGURE 17
Watercourses and Vegetation

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Given the above, the mitigation measures, management and monitoring outlined in the EA for upland swamps are considered to be appropriate for the Preferred Project.

6.5 AQUATIC ECOLOGY

The potential impacts of the original Project on aquatic ecology are described in Section 4.5.2 and Appendix D (BIO-ANALYSIS Pty Ltd, 2008) of the EA. Peer review was undertaken by Adjunct Professor David Goldney. Section 4.5.3 of the EA outlines the original Project aquatic ecology mitigation measures, management and monitoring. Section 4.5.4 of the EA describes compensatory measures and ecological initiatives.

As described in Section 5.3, the stand-offs for the Preferred Project would reduce the cumulative predicted valley closure to less than 200 mm over Longwall 24 and remain below 200 mm over the remaining reach of the Waratah Rivulet to the full supply level of Woronora Reservoir.

The resultant changes to the potential impacts of the original Project on surface water resources that would be expected as a result of the Preferred Project are described in Section 6.3.2. It is considered that these changes would further minimise the original Project's potential impacts on aquatic ecology.

The mitigation measures, management and monitoring outlined in the EA for aquatic ecology are considered to be appropriate for the Preferred Project.

6.6 ABORIGINAL HERITAGE

The potential impacts of the original Project on Aboriginal heritage are described in Section 4.8.2 and Appendix H (Kayandel Archaeological Services, 2008) of the EA. Peer review was undertaken by R.G. Gunn. Section 4.8.3 of the EA outlines the original Project Aboriginal heritage mitigation measures, management and monitoring.

Comparison of the area of coal sterilised by the Preferred Project with the mapped locations of the known Aboriginal heritage sites shown on Figure 4-18 of the EA indicates that of the 188 known sites mapped within the vicinity of the Project Underground Mining Area, approximately 26 sites would be located above sterilised coal in Areas A1 and A2.

Sites located above sterilised coal would be generally expected to experience some reduction in subsidence effects. The observed rate of subsidence effects to date is that up to 10% of sites experience an effect such as cracking, accelerated weathering or blockfall. Based on this, it is estimated that up to 3 sites may avoid potential impacts such as cracking, accelerated weathering or blockfall by sterilising areas A1 and A2.

As stated in Section 6.1, MSEC conducted an assessment of the potential subsidence effects on Aboriginal heritage sites associated with the Preferred Project mine layout and particularly the longwall re-orientation within the area of Longwalls 301 to 317 (Attachment 4). The assessment included subsidence, tilt and compressive and tensile strain predictions for Aboriginal heritage sites for the original Project and the Preferred Project. The prediction results are presented in Table 10. Negative results (shown in red) indicate where the predicted subsidence parameter for the Preferred Project layout is lower than that for the original Project layout.

With regard to potential impacts on known Aboriginal heritage sites resulting from the longwall re-orientation within the area of Longwalls 301 to 317, MSEC stated that (Attachment 4):

> *The majority of the results indicate that the parameters for the Preferred Project Layout are less than the predicted parameters for the Base Case Layout. Some results show an increase in the predicted parameters but as noted previously, the magnitudes are generally similar or significantly less than the Base Case Layout and hence the assessed impacts would be similar or less.*

Given the above, the mitigation measures, management and monitoring outlined in the EA for Aboriginal heritage are considered to be appropriate for the Preferred Project.

Table 10
Comparison of Predicted Systematic Subsidence Parameters for Aboriginal Heritage Sites

Site*	AHIMS Site No.	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)
		Total Subsidence after LW 317 (mm)	Total Subsidence after LW 44 (mm)		Maximum Total Tilt after LW 317 (mm/m)	Maximum Total Tilt after LW 44 (mm/m)		Maximum Predicted Tensile Strain during or after LW 317 (mm/m)	Maximum Predicted Tensile Strain during or after LW 44 (mm/m)		Maximum Predicted Compressive Strain during or after LW 317 (mm/m)	Maximum Predicted Compressive Strain during or after LW 44 (mm/m)	
FRC 105	52-2-0340	590	606	-16	4.1	4.2	-0.1	1.5	1.3	0.2	-0.2	-0.3	-0.0
FRC 113	52-2-0365	940	1038	-98	2.1	3.2	-1.1	0.1	0.5	-0.4	-1.4	-1.4	0.0
FRC 114	52-2-0725	36	34	2	0.4	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0
FRC 115	52-2-0726	108	107	1	1.1	1.1	0.0	0.2	0.2	0.0	-0.1	-0.1	-0.0
FRC 117	52-2-0739	325	408	-83	2.5	1.2	1.4	0.1	0.9	-0.8	-0.3	-0.4	-0.1
FRC 119	52-2-0196	379	606	-227	4.5	6.0	-1.4	0.8	0.8	-0.1	-0.1	-0.3	-0.2
FRC 124	52-2-0162	1074	1112	-38	1.9	2.1	-0.2	0.2	0.4	-0.2	-1.0	-1.0	0.0
FRC 125	52-2-0310	897	1037	-140	0.5	1.2	-0.7	0.3	0.3	0.0	-0.7	-0.7	-0.0
FRC 127	52-2-0203	36	406	-370	0.1	0.6	-0.4	0.0	0.5	-0.4	0.0	-1.2	-1.2
FRC 13	52-2-0125	292	294	-1	2.7	2.7	0.0	0.8	0.8	-0.0	0.0	0.0	0.0
FRC 14	52-2-0138	431	484	-54	1.8	2.2	-0.5	0.1	0.2	-0.0	-0.2	-0.2	0.0
FRC 15	52-2-0396	837	1126	-289	6.3	2.5	3.8	1.1	1.2	-0.0	-1.6	-1.7	-0.1
FRC 16.1	52-2-0120	364	402	-38	2.0	2.4	-0.3	0.1	0.1	-0.1	-0.3	-0.3	-0.0
FRC 16.2	52-2-120	316	344	-27	2.0	2.3	-0.3	0.4	0.4	-0.0	-0.2	-0.3	-0.0
FRC 160	52-2-0823	778	833	-55	3.6	3.5	0.1	0.2	0.4	-0.2	-0.4	-0.4	0.0
FRC 164	52-2-0171	81	378	-297	0.8	0.5	0.4	0.2	0.5	-0.4	0.0	-0.4	-0.4
FRC 168	52-2-0541	325	331	-6	2.3	2.3	-0.0	0.4	0.4	0.0	-0.2	-0.2	0.0
FRC 169	52-2-0747	763	813	-49	4.5	6.5	-2.0	0.1	0.8	-0.7	-1.2	-1.3	-0.1
FRC 17	52-2-0121	311	335	-25	2.1	2.4	-0.3	0.4	0.4	-0.0	-0.2	-0.2	0.0
FRC 171	52-2-0734	7	381	-375	0.1	0.9	-0.9	0.0	0.5	-0.4	0.0	-1.6	-1.6
FRC 172	52-2-0735	32	395	-363	0.3	1.1	-0.8	0.0	0.4	-0.4	-0.1	-0.6	-0.5

Table 10 (Continued)
Comparison of Predicted Systematic Subsidence Parameters for Aboriginal Heritage Sites

Site*	AHIMS Site No.	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm/m)	Preferred Project Layout	Original Project Layout	Difference[#] (mm/m)	Preferred Project Layout	Original Project Layout	Difference[#] (mm/m)
		Total Subsidence after LW 317 (mm)	Total Subsidence after LW 44 (mm)		Maximum Total Tilt after LW 317 (mm/m)	Maximum Total Tilt after LW 44 (mm/m)		Maximum Predicted Tensile Strain during or after LW 317 (mm/m)	Maximum Predicted Tensile Strain during or after LW 44 (mm/m)		Maximum Predicted Compressive Strain during or after LW 317 (mm/m)	Maximum Predicted Compressive Strain during or after LW 44 (mm/m)	
FRC 176	52-2-0826	931	1223	-292	0.3	0.8	-0.5	0.6	0.6	-0.0	-0.2	-0.7	-0.5
FRC 180	52-2-0828	214	389	-175	2.2	0.2	2.0	0.3	0.4	-0.1	-0.1	-0.5	-0.4
FRC 184	52-2-0222	418	361	58	1.2	1.0	0.2	0.7	0.4	0.3	-0.1	-1.1	-0.9
FRC 185	52-2-0223	413	363	50	0.4	0.3	0.1	0.1	0.8	-0.7	-0.3	-0.3	0.0
FRC 186	52-2-0224	430	364	66	0.4	0.7	-0.3	0.1	0.4	-0.3	-0.2	-1.0	-0.8
FRC 187	52-2-0225	434	372	62	0.4	0.4	-0.1	0.1	0.4	-0.3	-0.2	-0.4	-0.2
FRC 189	52-2-0180	391	340	50	0.3	0.5	-0.2	0.3	0.7	-0.4	-0.3	-0.4	-0.0
FRC 191	52-2-0183	424	360	65	1.0	0.6	0.5	0.3	0.8	-0.5	-0.9	-0.3	0.6
FRC 193	52-2-0144	40	970	-930	0.3	2.0	-1.7	0.0	0.6	-0.6	0.0	-0.7	-0.7
FRC 194	52-2-0263	59	356	-297	0.6	0.7	-0.2	0.1	0.9	-0.8	-0.1	-0.3	-0.2
FRC 195	52-2-0264	35	353	-318	0.3	1.4	-1.1	0.0	0.6	-0.5	0.0	-1.4	-1.3
FRC 198	52-2-0268	384	363	21	0.4	0.9	-0.6	0.1	0.6	-0.5	-0.3	-0.4	-0.1
FRC 199	52-2-0265	63	370	-306	0.7	0.7	-0.0	0.1	0.8	-0.7	0.0	-0.3	-0.3
FRC 20	52-2-0107	523	553	-30	2.3	2.4	-0.2	0.0	0.1	-0.1	-0.1	-0.1	-0.0
FRC 201	52-2-0267	321	349	-27	4.1	4.3	-0.2	0.5	0.6	-0.0	-0.2	-0.2	-0.0
FRC 21	52-2-0105	747	768	-21	4.8	5.0	-0.1	1.5	1.6	-0.1	-1.0	-1.1	-0.1
FRC 22	52-2-0145	84	1143	-1,060	0.4	1.1	-0.7	0.1	0.7	-0.6	0.0	-0.4	-0.4
FRC 23	52-2-0161	1078	1116	-38	1.5	1.7	-0.2	0.2	0.4	-0.2	-1.0	-1.0	0.0
FRC 24.1	52-2-159	386	1139	-754	3.4	0.8	2.6	0.2	0.4	-0.2	-0.5	-1.2	-0.7
FRC 24.2	52-2-0160	307	1074	-767	3.3	0.9	2.5	0.4	0.9	-0.5	-0.2	-0.3	-0.1
FRC 25	52-2-0129	817	1240	-423	1.4	1.8	-0.5	0.6	0.6	-0.0	-0.7	-1.0	-0.4

Table 10 (Continued)
Comparison of Predicted Systematic Subsidence Parameters for Aboriginal Heritage Sites

Site*	AHIMS Site No.	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)
		Total Subsidence after LW 317 (mm)	Total Subsidence after LW 44 (mm)		Maximum Total Tilt after LW 317 (mm/m)	Maximum Total Tilt after LW 44 (mm/m)		Maximum Predicted Tensile Strain during or after LW 317 (mm/m)	Maximum Predicted Tensile Strain during or after LW 44 (mm/m)		Maximum Predicted Compressive Strain during or after LW 317 (mm/m)	Maximum Predicted Compressive Strain during or after LW 44 (mm/m)	
FRC 253	52-2-0738	41	372	-331	0.2	1.0	-0.8	0.1	0.8	-0.8	0.0	-0.9	-0.9
FRC 254	52-2-0829	418	342	76	0.4	1.4	-1.0	0.3	1.0	-0.7	-0.2	-0.5	-0.2
FRC 26	52-2-0135	36	1145	-1,110	0.4	0.9	-0.4	0.1	0.8	-0.7	0.0	-0.7	-0.6
FRC 266	N/A	242	257	-15	1.6	1.7	-0.2	0.4	0.4	-0.0	0.0	0.0	-0.0
FRC 272	52-2-3074	1005	1094	-89	2.3	1.6	0.7	1.0	1.1	-0.1	-0.9	-0.9	-0.0
FRC 273	52-2-3075	1021	1100	-79	2.3	1.4	0.8	0.3	0.4	-0.1	-1.0	-1.0	0.0
FRC 274	N/A	525	1213	-688	3.0	1.1	1.9	0.1	0.4	-0.3	-0.4	-0.5	-0.1
FRC 275	N/A	640	1221	-581	2.7	1.3	1.4	0.4	0.6	-0.2	-0.5	-0.8	-0.4
FRC 276	52-2-3078	52	1156	-1,104	0.6	0.5	0.1	0.1	0.3	-0.2	0.0	-1.0	-0.9
FRC 277	52-2-3079	36	1169	-1,134	0.3	0.7	-0.4	0.0	0.6	-0.6	0.0	-0.2	-0.2
FRC 278	52-2-3080	352	357	-5	2.5	2.6	-0.1	0.5	0.5	-0.0	-0.2	-0.2	-0.0
FRC 279	52-2-3081	972	1002	-30	2.8	3.1	-0.2	0.4	0.4	0.0	-0.4	-0.4	-0.0
FRC 28	52-2-0154	31	399	-368	0.1	0.8	-0.6	0.1	0.5	-0.3	-0.1	-2.0	-1.9
FRC 280	52-2-3082	982	1059	-77	1.1	0.7	0.4	1.0	1.0	-0.0	0.0	-0.2	-0.2
FRC 281	52-2-3083	796	1041	-245	2.4	1.2	1.2	0.8	0.8	-0.0	-0.3	-0.3	0.1
FRC 283	52-2-3085	93	1172	-1,079	0.5	0.8	-0.3	0.1	0.7	-0.6	0.0	-0.4	-0.4
FRC 284	52-2-3086	217	1118	-901	1.6	1.8	-0.2	0.4	0.4	-0.0	0.0	-0.8	-0.8
FRC 285	52-2-3097	939	1120	-181	0.5	2.0	-1.5	0.2	0.5	-0.3	-0.4	-0.4	-0.0
FRC 29	52-2-0155	38	412	-374	0.2	1.0	-0.8	0.0	0.5	-0.4	0.0	-0.5	-0.5
FRC 30	52-2-0200	50	418	-368	0.3	0.8	-0.5	0.1	0.6	-0.5	0.0	-0.3	-0.3
FRC 301	N/A	963	1080	-117	1.7	2.5	-0.8	0.2	0.4	-0.2	-1.0	-1.4	-0.5

Table 10 (Continued)
Comparison of Predicted Systematic Subsidence Parameters for Aboriginal Heritage Sites

Site*	AHIMS Site No.	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)
		Total Subsidence after LW 317 (mm)	Total Subsidence after LW 44 (mm)		Maximum Total Tilt after LW 317 (mm/m)	Maximum Total Tilt after LW 44 (mm/m)		Maximum Predicted Tensile Strain during or after LW 317 (mm/m)	Maximum Predicted Tensile Strain during or after LW 44 (mm/m)		Maximum Predicted Compressive Strain during or after LW 317 (mm/m)	Maximum Predicted Compressive Strain during or after LW 44 (mm/m)	
FRC 302	N/A	13	15	-2	0.2	0.2	-0.0	0.0	0.0	-0.0	0.0	0.0	0.0
FRC 304	N/A	223	225	-3	1.3	1.3	-0.0	0.4	0.4	-0.0	-0.1	-0.1	-0.0
FRC 305	N/A	898	1086	-188	1.4	2.4	-1.0	0.4	0.4	-0.0	-0.4	-1.0	-0.6
FRC 306	N/A	925	1056	-130	1.8	1.6	0.2	1.1	1.1	-0.0	-0.2	-0.4	-0.1
FRC 307	N/A	24	378	-354	0.1	2.1	-2.0	0.1	1.0	-0.8	0.0	-2.0	-2.0
FRC 308	N/A	36	347	-311	0.5	3.9	-3.4	0.1	1.0	-0.9	0.0	-1.3	-1.3
FRC 309	N/A	451	381	70	0.7	0.8	-0.1	0.2	0.7	-0.5	-0.3	-0.9	-0.6
FRC 31	52-2-0722	39	409	-370	0.2	0.5	-0.3	0.0	0.4	-0.4	0.0	-0.9	-0.9
FRC 310	N/A	469	471	-3	0.5	0.6	-0.1	0.1	0.6	-0.5	-0.4	-0.5	-0.1
FRC 311	N/A	398	376	22	0.4	1.0	-0.6	0.4	0.4	0.0	-0.4	-0.9	-0.5
FRC 312	N/A	438	372	66	0.4	1.0	-0.7	0.1	0.5	-0.4	-0.2	-0.6	-0.4
FRC 313	N/A	448	532	-84	0.9	1.8	-0.9	0.6	0.5	0.1	-0.5	-0.2	0.4
FRC 314	N/A	444	400	43	0.4	0.6	-0.3	0.1	0.4	-0.3	-0.2	-0.3	-0.1
FRC 315	N/A	448	403	45	0.4	0.7	-0.3	0.1	0.4	-0.3	-0.1	-0.3	-0.2
FRC 317	N/A	456	414	42	0.4	1.0	-0.6	0.1	0.5	-0.4	-0.2	-0.8	-0.6
FRC 319	N/A	889	968	-78	1.0	0.6	0.4	0.8	0.5	0.3	0.0	-0.5	-0.5
FRC 32	52-2-0194	42	413	-372	0.1	0.2	-0.1	0.0	0.4	-0.4	0.0	-0.5	-0.5
FRC 320	N/A	74	396	-322	0.7	0.7	-0.0	0.2	0.6	-0.4	0.0	-0.3	-0.3
FRC 321	N/A	119	389	-270	1.4	0.5	0.9	0.3	0.4	-0.1	0.0	-1.4	-1.4
FRC 322	N/A	118	486	-368	1.5	0.5	1.0	0.2	0.4	-0.2	0.0	-0.3	-0.3
FRC 323	N/A	30	360	-329	0.3	1.4	-1.1	0.0	1.1	-1.1	0.0	-0.3	-0.3

Table 10 (Continued)
Comparison of Predicted Systematic Subsidence Parameters for Aboriginal Heritage Sites

Site*	AHIMS Site No.	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)
		Total Subsidence after LW 317 (mm)	Total Subsidence after LW 44 (mm)		Maximum Total Tilt after LW 317 (mm/m)	Maximum Total Tilt after LW 44 (mm/m)		Maximum Predicted Tensile Strain during or after LW 317 (mm/m)	Maximum Predicted Tensile Strain during or after LW 44 (mm/m)		Maximum Predicted Compressive Strain during or after LW 317 (mm/m)	Maximum Predicted Compressive Strain during or after LW 44 (mm/m)	
FRC 324	N/A	21	361	-340	0.2	0.9	-0.7	0.0	0.7	-0.7	0.0	-1.1	-1.1
FRC 325	N/A	455	388	67	0.4	1.7	-1.3	0.4	1.3	-0.8	-0.1	-0.3	-0.1
FRC 33	52-2-0188	46	409	-363	0.4	0.3	0.1	0.1	0.7	-0.6	0.0	-0.3	-0.3
FRC 34	52-2-0195	43	361	-318	0.2	1.1	-0.8	0.1	1.0	-0.9	0.0	-0.3	-0.3
FRC 340	N/A	449	371	78	1.2	0.3	0.9	0.4	0.4	-0.1	-0.9	-0.4	0.6
FRC 342	N/A	66	1206	-1,139	0.5	0.6	-0.1	0.1	0.6	-0.5	0.0	-0.6	-0.6
FRC 343	N/A	70	296	-226	0.6	2.1	-1.5	0.1	0.4	-0.4	0.0	-0.1	-0.1
FRC 344	N/A	443	410	33	0.4	0.4	-0.1	0.1	0.4	-0.3	-0.1	-0.4	-0.3
FRC 345	N/A	438	411	27	0.4	0.8	-0.4	0.1	0.3	-0.2	-0.3	-0.2	0.1
FRC 40	52-2-0333	302	1257	-954	3.2	1.5	1.7	0.4	0.6	-0.2	0.0	-1.2	-1.2
FRC 44	52-2-0103	353	1236	-883	3.1	0.9	2.2	0.3	0.6	-0.3	-0.2	-1.2	-1.0
FRC 45	52-2-0102	277	1169	-892	2.7	0.6	2.1	0.3	0.4	-0.1	-0.1	-0.3	-0.2
FRC 46	52-2-0408	88	1100	-1,012	1.1	1.2	-0.1	0.1	0.4	-0.3	0.0	-1.3	-1.3
FRC 52	52-2-0257	22	1115	-1,093	0.2	0.5	-0.3	0.0	0.4	-0.3	0.0	-0.3	-0.3
FRC 57	52-2-258, 52-2-373*	604	605	-1	6.2	6.2	0.0	1.0	1.0	0.0	-0.6	-0.6	-0.0
FRC 60	52-2-0177	843	814	29	3.0	0.5	2.5	0.2	0.3	-0.1	-0.7	-0.9	-0.1
FRC 61	52-2-0152	37	664	-627	0.3	2.0	-1.7	0.0	0.6	-0.5	0.0	-0.8	-0.8
FRC 62	52-2-0168	26	452	-426	0.2	2.0	-1.8	0.0	0.5	-0.5	0.0	-0.6	-0.6
FRC 67	52-2-0185	439	382	57	1.2	0.9	0.3	0.3	0.5	-0.2	-0.5	-0.5	0.0
FRC 68	52-2-0186	454	382	72	0.9	0.7	0.2	0.3	0.4	-0.1	-0.7	-0.5	0.1

Table 10 (Continued)
Comparison of Predicted Systematic Subsidence Parameters for Aboriginal Heritage Sites

Site*	AHIMS Site No.	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)
		Total Subsidence after LW 317 (mm)	Total Subsidence after LW 44 (mm)		Maximum Total Tilt after LW 317 (mm/m)	Maximum Total Tilt after LW 44 (mm/m)		Maximum Predicted Tensile Strain during or after LW 317 (mm/m)	Maximum Predicted Tensile Strain during or after LW 44 (mm/m)		Maximum Predicted Compressive Strain during or after LW 317 (mm/m)	Maximum Predicted Compressive Strain during or after LW 44 (mm/m)	
FRC 70	52-2-0192	438	381	57	0.6	0.6	0.0	0.1	0.4	-0.3	-0.3	-1.1	-0.7
FRC 71	N/A	445	396	49	0.6	0.1	0.4	0.4	0.6	-0.2	-0.3	-0.5	-0.2
FRC 72	52-2-0199	69	608	-539	0.7	3.2	-2.5	0.1	1.2	-1.1	0.0	-1.5	-1.5
FRC 76	N/A	511	459	52	0.7	0.6	0.1	0.2	0.7	-0.5	-0.3	-0.3	-0.0
FRC 77	52-2-0330	500	459	41	0.5	0.5	0.1	0.2	0.3	-0.1	-0.7	-0.3	0.4
FRC 78	52-2-0885	497	455	42	0.6	0.4	0.1	0.2	0.4	-0.2	-0.2	-0.3	-0.1
FRC 87	52-2-0899	443	432	11	0.6	0.8	-0.2	0.5	0.6	-0.1	-0.1	-0.5	-0.4
FRC 93	52-2-0198	396	395	1	0.9	1.0	-0.1	0.7	0.3	0.4	-0.1	-0.8	-0.7
FRC 94	52-2-0873	418	401	18	0.3	0.5	-0.1	0.2	0.7	-0.5	-0.1	-0.3	-0.1
FRC 97	52-2-0220	425	352	73	0.4	0.6	-0.2	0.1	0.8	-0.7	-0.3	-0.3	0.0
MET 1	-	1052	1091	-40	1.8	2.0	-0.2	0.2	0.4	-0.2	-1.1	-1.1	0.0
NEW 1	N/A	433	418	15	0.5	0.9	-0.4	0.6	0.4	0.3	-0.4	-0.2	0.2
NEW 15	N/A	11	9	2	0.1	0.2	-0.1	0.0	0.1	-0.0	0.0	0.0	-0.0
NEW 16	N/A	15	12	3	0.1	0.2	-0.1	0.0	0.0	-0.0	0.0	0.0	-0.0
NEW 17	-	78	70	7	0.8	1.8	-1.0	0.2	0.3	-0.2	0.0	-0.1	-0.0
NEW 18	N/A	18	16	2	0.2	0.3	-0.2	0.0	0.0	-0.0	0.0	0.0	0.0
NEW 19	N/A	160	165	-6	1.9	3.9	-2.0	0.3	0.5	-0.2	0.0	-0.1	-0.1
NEW 2	N/A	466	385	81	1.1	0.9	0.2	0.4	0.6	-0.2	-0.9	-0.2	0.7
NEW 20	N/A	12	15	-3	0.1	0.4	-0.2	0.0	0.1	-0.1	0.0	0.0	-0.0
NEW 9	N/A	15	12	3	0.1	0.2	-0.1	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 19	N/A	463	344	119	0.5	1.0	-0.5	0.3	0.3	-0.0	-0.8	-0.6	0.1

Table 10 (Continued)
Comparison of Predicted Systematic Subsidence Parameters for Aboriginal Heritage Sites

Site*	AHIMS Site No.	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)	Preferred Project Layout	Original Project Layout	Difference[#] (mm)
		Total Subsidence after LW 317 (mm)	Total Subsidence after LW 44 (mm)		Maximum Total Tilt after LW 317 (mm/m)	Maximum Total Tilt after LW 44 (mm/m)		Maximum Predicted Tensile Strain during or after LW 317 (mm/m)	Maximum Predicted Tensile Strain during or after LW 44 (mm/m)		Maximum Predicted Compressive Strain during or after LW 317 (mm/m)	Maximum Predicted Compressive Strain during or after LW 44 (mm/m)	
NT 3	N/A	471	391	80	0.8	0.7	0.1	0.4	0.7	-0.3	-0.8	-0.3	0.5
NT 78	N/A	438	346	92	0.8	0.4	0.5	0.5	0.7	-0.2	-0.3	-0.4	-0.1
NT 79	N/A	434	371	63	0.8	0.3	0.5	0.5	0.6	-0.0	-0.3	-0.3	-0.0
NT 8	N/A	475	389	86	0.8	0.7	0.2	0.4	0.3	0.1	-0.8	-0.5	0.3
NT 80	N/A	454	390	64	1.1	0.4	0.7	0.5	0.5	0.0	-0.2	-0.3	-0.1
NT 81	N/A	471	379	93	0.4	0.5	-0.1	0.1	0.5	-0.4	-0.1	-0.3	-0.2
NT 9	N/A	469	385	84	0.9	0.3	0.6	0.4	0.5	-0.1	-0.4	-0.2	0.2
PAD 2	N/A	641	661	-19	4.5	4.7	-0.2	1.5	1.6	-0.1	-0.3	-0.3	-0.0
NT 10	52-2-625	61	264	-203	0.5	2.9	-2.4	0.1	0.5	-0.5	0.0	0.0	-0.0
NT 12	52-2-753	57	246	-189	0.4	2.7	-2.2	0.1	0.5	-0.5	0.0	0.0	-0.0
NT 18	52-2-751	400	368	33	1.0	0.7	0.3	0.3	0.2	0.1	-0.7	-0.5	0.2
NT 22	52-2-758	1	8	-8	0.0	0.2	-0.2	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 23	52-2-631	0	6	-6	0.0	0.2	-0.2	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 52	52-2-652	4	38	-34	0.0	0.3	-0.3	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 53	52-2-371	9	45	-36	0.1	0.4	-0.3	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 54	52-2-374	10	55	-45	0.1	0.5	-0.4	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 74	52-2-658	334	361	-27	1.6	1.5	0.1	0.1	0.5	-0.4	-0.3	-0.3	-0.0
NT 75	52-2-659	363	364	-1	1.3	1.2	0.1	0.1	0.4	-0.3	-0.1	-0.3	-0.2
NT 76	52-2-660	0	0	-0	0.0	0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 85	N/A	366	355	11	1.3	1.1	0.2	0.1	0.3	-0.2	-0.1	-0.5	-0.4
NT 86	N/A	5	16	-11	0.0	0.3	-0.3	0.0	0.0	-0.0	0.0	0.0	-0.0

Source: Attachment 4.

* Refer to Figure 4-18 of the EA for Aboriginal Heritage site locations.

[#] Negative results (shown in red) indicate where the predicted subsidence parameter for the Preferred Project layout is lower than that for the original Project layout.

6.7 ECONOMIC EFFICIENCY

HCPL has conducted further analysis of the relative costs and benefits of the Preferred Project compared to the original Project.[2]

The summary of estimated incremental costs and benefits of the Preferred Project is presented in Table 11. In addition, for comparative purposes, estimated incremental costs and benefits of sterilising only Area A1 have also been provided.

The estimated net production costs relate to additional longwall machine moves (e.g. relocation around blocks of sterilised coal), changes in revenues and mining costs associated with sterilised coal, changes in timing of decommissioning of plant and realisation of residual value of capital and land.

The environmental benefits of these scenarios with respect to reduced environmental impacts have also been estimated.

For Waratah Rivulet approximately 1 km of the stream would no longer be subjected to valley closure effects above 200 mm with the Preferred Project (Figure 13). This environmental benefit would be similar if Area A2 was mined, as Area A2 is located to the west of the Rivulet.

Comparison of the area of coal sterilised by the Preferred Project with the mapped locations of the known Aboriginal heritage sites shown on Figure 4-18 of the EA indicates that of the 188 known sites mapped within the vicinity of the Project Underground Mining Area, approximately 26 sites would be located above sterilised coal in Areas A1 and A2. Sites located above sterilised coal would be generally expected to experience some reduction in subsidence effects. The observed rate of subsidence effects to date is that up to 10% of sites experience an effect such as cracking, accelerated weathering or blockfall. Based on this, it is estimated that up to three sites may avoid potential impacts such as cracking, accelerated weathering or blockfall by sterilising areas A1 and A2.

There would also be some reduction in greenhouse gas emissions associated with the sterilised coal that would not be mined.

The community value of these environmental benefits has been estimated for the Preferred Project to be approximately $56 Million (M), using the results of the Choice Modelling Study and the assumed cost of carbon emissions. By comparison, if Area A2 was mined, the environmental benefits have been estimated at approximately $50M (i.e. sterilising Area A2 would provide an additional $6M benefit in addition to sterilising Area A1).

These estimates of environmental benefits in comparison to the original Project (i.e. full extraction) are conservative, given that they assume that no stream restoration is implemented for the original Project.

The social costs relate to reduced mine life for the Preferred Project is estimated at approximately $101M (approximately $64M if Area A2 was mined).

The relative net community cost of implementing the Preferred Project is approximately $150M, with the loss of approximately 6.9 Mt of product coal and a reduction in the mine life of approximately 2.8 years.

For comparison, if Area A2 was mined, the relative net community cost would be approximately $78M, with the loss of approximately 4.2 Mt of product coal and a reduction in the mine life of approximately 1.8 years.

The above analysis indicates that from a community economic efficiency perspective, mining of Area A2 would be the preferred outcome, as it would minimise net community costs. Notwithstanding, Area A2 contains some large swamps that would experience less subsidence effects if Area A2 is not mined and this may also be a consideration for the PAC, however, the environmental assessments conducted for the EA indicate that the swamps above the Project underground mining area would experience negligible environmental impact when compared to natural variations.

As stated in Section 5.3, the Preferred Project mine plan does not include longwall mining in Areas A1 or A2.

[2] Consistent with the responses to the PAC queries, the following analysis uses Macquarie Group 2009 predicted contract prices (e.g. US$110/t for hard coking coal and US$75/t for thermal coal) converted to Australian dollars using a conservative $US to $AUD conversion assumption of 0.75 and increasing in real terms by 1% per annum. In addition, mean implicit prices from the CL2 model have been used from the Choice Modelling Study.

Table 11
Incremental Costs and Benefits of the Preferred Project

Component	Incremental Difference to Original Project	
	Sterilise Area A1 Only	**Preferred Project (Sterilise Areas A1 and A2)**
Incremental Net Production Benefit/Cost	-$63M	-$105M
Incremental Estimated Environmental Benefit (Due to Reduced Potential Environmental Impacts)	$50M	$56M
Incremental Estimated Social Costs (Due to Reduced Mine Life)	-$64M	-$101M
Incremental Net Community Benefit/Cost	**-$78M**	**-$150M**

7 REFERENCES

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Gilbert and Associates (2008) *Metropolitan Coal Project Surface Water Assessment.* Report prepared for Helensburgh Coal Pty Ltd.

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Mine Subsidence Engineering Consultants (2008) *Metropolitan Colliery Longwalls 20-44 Subsidence Assessment.*

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ATTACHMENT 1

STATEMENT OF COMMITMENTS

STATEMENT OF COMMITMENTS

Environmental Management

Environmental management and mitigation measures to be implemented during the development and operation of the Metropolitan Coal Project (the Project) are described in the following sections of the Environmental Assessment:

- Land Resources, Climate and Bushfire Regime – Section 4.1.
- Subsidence – Section 4.2.
- Groundwater – Section 4.3.
- Surface Water – Section 4.4.
- Aquatic Ecology – Section 4.5.
- Terrestrial Flora – Section 4.6.
- Terrestrial Fauna – Section 4.7.
- Aboriginal Heritage – Section 4.8.
- Non-Aboriginal Heritage – Section 4.9.
- Noise – Section 4.10.
- Air Quality – Section 4.11.
- Transport – Section 4.12.
- Regional Economy – Section 4.13.
- Employment, Population and Community Infrastructure – Section 4.14.
- Hazard and Risk – Section 4.15.
- Visual Character – Section 4.16.

Helensburgh Coal Pty Ltd (HCPL) will prepare and implement a number of new environmental management plans for the Project, namely:

- Subsidence Management Plan(s) (SMP[s]) (for Longwalls 20 to 44 under the separate New South Wales [NSW] Department of Primary Industries-Mineral Resources [DPI-MR] approval process).
- Monitoring, management and response plan(s) for surface infrastructure (to be developed in conjunction with the SMPs).
- Waratah Rivulet Management Plan (WRMP).
- Flora and Fauna Management Plan (FFMP).
- Aboriginal Cultural Heritage Management Plan (ACHMP).
- Conservation Management Plan (CMP).
- Transport Management Plan (TMP).
- Mine Closure Plan (MCP).

In addition, a number of existing Metropolitan Colliery environmental management plans will be reviewed and updated to include Project-related activities, as appropriate:

- Bushfire Preparedness Plan.
- Surface Water Management Plan (SWMP).
- Water Savings Action Plan (WSAP).
- Energy Savings Action Plan (ESAP).
- Noise Pollution Reduction Programme(s) (PRP[s]).
- Air Quality PRP(s).

The abovementioned environmental management plans are described below.

Environmental management plans prepared in accordance with existing Metropolitan Colliery SMP approvals (*viz*. the *Metropolitan Colliery SMP Approval Conditions LW14-17* [DPI-MR, 2006a] and *Subsidence Management Plan Approval Metropolitan LW 18-19A* [DPI-MR, 2008]) for the Current Underground Mining Area will be reviewed, and where appropriate incorporated into the new environmental management plans described above.

HCPL also has a number of management plans relevant to occupational health and safety that will be reviewed and revised, where appropriate (e.g. the Underground Emergency Management Plan, Surface Emergency Management Plan, Fire and Explosion Control Management Plan, Underground Transport Management Plan, Stockpile Management Plan and Contractor Management Plan).

Subsidence Management Plans (SMPs)

HCPL will progressively prepare SMPs and obtain DPI-MR approval for the Project underground mining activities prior to mining being undertaken.

These applications will be prepared in accordance with the *Guideline for Applications for Subsidence Management Approvals* (NSW Department of Mineral Resources [DMR], 2003a) and *New Approval Process for the Management of Coal Mining Subsidence – Policy* (DMR, 2003b). These documents are collectively referred to as the SMP Guideline.

In accordance with the SMP Guideline, a number of SMPs will be required over the life of the Project, as SMP applications are limited to a mining area extending over a maximum of seven years.

The main areas to be addressed by an SMP application include (DMR, 2003a):

1. *The proposed mining system(s) and resource recovery;*
2. *Community consultation;*
3. *Statutory requirements that apply to the Application Area;*
4. *Expected subsidence and its potential impacts on public safety, the environment, community, land use, surface improvements and infrastructure; and*
5. *The proposed Subsidence Management Plan for the expected subsidence impacts.*

Where applicable, the SMP process provides the appropriate venue for the resolution of particular management issues pertaining to individual longwall panels or mining domains. For example, management of potential subsidence effects will be required at a number of structures on the F6 Southern Freeway. When the SMPs that apply to these structures are prepared, consultation with the NSW Roads and Traffic Authority (RTA) and the formulation of site-specific management measures to suitably manage potential subsidence effects on these structures to maintain public safety on the F6 Southern Freeway will be undertaken as a component of the SMP process.

Monitoring, Management and Response Plans

Monitoring, management and response plans will be prepared for:

- the Illawarra Railway to the satisfaction of RailCorp;
- F6 Southern Freeway including bridges to the satisfaction of the RTA;
- Princes Highway to the satisfaction of the Wollongong City Council (WCC);
- electrical services to the satisfaction of electrical services owners;
- optical fibre and copper telecommunications cables to the satisfaction of the cable owners;
- Sydney Water pipelines to the satisfaction of Sydney Water; and
- the Garrawarra Centre to the satisfaction of the Department of Health.

The monitoring, management and response plans will be prepared in conjunction with the relevant SMPs.

The mine design in the vicinity of the Garrawarra Centre will be constrained by performance criteria such that any impacts to the associated structures are negligible (i.e. would not require repair). Specific monitoring of the Garrawarra Centre will be included in relevant SMPs.

Waratah Rivulet Management Plan (WRMP)

A WRMP will be developed in consultation with the relevant authorities.

The WRMP will be developed to the satisfaction of the NSW Department of Planning (DoP).

The WRMP will be an operational document that will be reviewed and updated to reflect the status of longwall mining, revised subsidence predictions and any advances in stream restoration methods.

The WRMP will comprise the following elements:

- identification of evaluation zones where an adaptive management approach will be implemented;
- subsidence measurement for comparison with predictions;
- a Trigger Action Response Plan with trigger mechanisms that initiate a range of responses (e.g. a higher intensity of monitoring and/or the implementation of response measures) and that identify personnel responsible for implementation of the response measures;
- stream restoration phases over relevant reaches of the Waratah Rivulet;
- environmental monitoring, environmental control measures (e.g. vegetation management, erosion and sediment control, fuel management and polyurethane product management) and reporting for stream restoration works; and
- contingency measures in the event that observed subsidence effects are significantly greater than predicted.

Flora and Fauna Management Plan (FFMP)

A FFMP will be developed for the Project and will include the following management measures for aquatic and terrestrial ecology:

- measures to minimise impacts on aquatic ecology, terrestrial flora, terrestrial fauna, and their habitats;
- measures to be implemented in the event monitoring detects significant incidents or variations to the predicted subsidence impacts;
- environmental management of sites where vegetation removal is necessary;
- identification of areas in which specific surface works involving vegetation clearance will be avoided or limited;
- measures to avoid or minimise impacts to threatened flora and fauna;
- soil and weed management measures;
- bushfire management measures;
- natural regeneration and rehabilitation measures;
- *P. cinnamomi* management measures;
- Chytridiomycosis management measures;
- measures to minimise impacts on terrestrial fauna including those relating to fauna traps, vehicle strike and introduced pest species; and
- monitoring programmes for aquatic ecology, terrestrial flora and terrestrial fauna.

The FFMP will be developed in consultation with the NSW Fisheries, the NSW Department of Environment and Climate Change (DECC) and the Sydney Catchment Authority (SCA), and to the satisfaction of the DoP. The FFMP will be prepared prior to the extraction of Longwall 20.

Aboriginal Cultural Heritage Management Plan (ACHMP)

An ACHMP will be developed for the Project in consultation with the Aboriginal community.

The ACHMP will include:

- A protocol for consultation with the Aboriginal community.
- Statutory requirements.
- A protocol/programme for HCPL to sponsor existing or new Aboriginal community projects which benefit the wider Aboriginal community. These may include (for example): Aboriginal community field days; restoration of culturally significant buildings; rehabilitation/protection of areas with high cultural values; and/or potential employment/skill development opportunities. Any such sponsorship would be made available to the wider Aboriginal community with submissions presented to HCPL and projects selected by HCPL based on their individual merit and benefit to the wider Aboriginal community.
- A programme and scope for undertaking additional supplementary Aboriginal heritage fieldwork as part of future SMP applications.
- A programme for further investigation of potential Aboriginal heritage sites identified by members of the Aboriginal community (*viz*. two trees and a stone arrangement).
- A programme for updating site cards.
- Consideration of undertaking invasive recording techniques at select Aboriginal heritage sites.
- A programme for undertaking pre-clearance surveys for required Project surface infrastructure.
- A protocol for managing Aboriginal heritage sites located proximal to required surface disturbance works, including:
  - avoidance of impacts where practicable;
  - demarcation; and
  - developing a comprehensive record where avoidance is not practicable.
- A programme for further investigation of the artwork in sites FRC 93 and FRC 198 against the description of art provided on the Aboriginal Heritage Information Management System (AHIMS) site card.
- A monitoring programme for sites of moderate or high archaeological significance.
- A protocol for the development and implementation of management measure(s) at sites of moderate or high archaeological significance and/or mitigation measure(s) at sites of high archaeological significance.
- An access protocol for members of the Aboriginal community.

- A cultural awareness programme for HCPL staff and contractors as part of site inductions.
- A protocol for registering any new sites identified at the Project as well as updating and maintaining the existing record of Aboriginal heritage sites.
- A protocol that defines actions to be followed in the event that human skeletal material is encountered.

Conservation Management Plan (CMP)

A CMP will be developed for the Metropolitan Colliery to provide guidance for management of heritage items during the detailed design, construction and operational phases of the Project.

The CMP process will include:

1. Further detailed inspection of all items of heritage significance or potentially of heritage significance within the Major Surface Facilities Area and recording of these items.
2. Further literature and archival review to inform the CMP, where relevant.
3. Consultation with relevant agencies including the DoP (Heritage Office) regarding the detailed design of any heritage controls.
4. Consideration of heritage-related requirements of relevant planning instruments (e.g. the *Wollongong Local Environmental Plan, 1990* and *Illawarra Regional Environmental Plan No. 1*).
5. Consideration of contingency measures to address future (i.e. unforeseen) potential effects to heritage.

Noise Pollution Reduction Programmes (PRPs)

The existing and future PRPs for noise would inform the noise management measures for the Project. These include:

- applicable noise criteria from the Project Approval;
- noise monitoring to be undertaken for the Project (i.e. monitoring locations, frequencies, parameters and specifications);
- a description of the Project noise mitigation measures;
- a protocol for the on-going management of noise at the Metropolitan Colliery, including the PRP process;
- procedures to be followed in the event of an exceedance of Project Approval noise criteria, should they occur; and
- complaint response protocols.

Air Quality Pollution Reduction Programmes (PRPs)

The existing and future PRPs for air quality would inform the air quality management measures for the Project. These include:

- air quality monitoring to be undertaken for the Project;
- Project mitigation measures with respect to air quality;
- a protocol for the on-going management of air quality;
- procedures to be followed in the event of an exceedance of criteria should they occur; and
- complaint response protocols.

On-site stockpiles will continue to be managed to reduce the potential for the development of spontaneous combustion in accordance with the existing Stockpile Management Plan.

Transport Management Plan (TMP)

A TMP will be prepared for the Project and will include the following management measures:

- a cap on the Project public road haulage of coal reject at the existing Metropolitan Colliery maximum annual haulage levels;
- maintenance of the existing level of product coal haulage;
- maintenance of the existing Metropolitan Colliery heavy vehicle night-time curfew (i.e. large vehicle access to the site is restricted during night-time hours);
- measures to work with suppliers to minimise the use of heavy vehicles for the delivery of small items to the Major Surface Facilities Area that could be delivered via a light vehicle or van, where practicable;
- measures to encourage the mine operational workforce and Project construction workforce to car-pool and minimise workforce related light vehicle movements to the site;
- liaison with RailCorp to minimise Project night-time train movements as far as practicable within train scheduling restraints; and

- liaison with the Metropolitan Colliery Community Reference Group and RailCorp to facilitate the resolution of any particular rail noise or vibration issues (e.g. on-site train whistle noise) that may arise with respect to on-site or off-site rail haulage noise or vibration over the life of the Project, as required.

Access to the Woronora Special Area by HCPL staff and contractors will be undertaken in accordance with SCA requirements (e.g. conditions of entry, speed limits, etc.).

Mine Closure Plan (MCP)

Prior to the completion of mining operations, a MCP will be developed in consultation with relevant authorities and stakeholders including the WCC, the DoP and the Helensburgh community.

The MCP will describe:

- the final mine closure process;
- the long-term landuse for the Major Surface Facilities Area;
- the removal of infrastructure items;
- measures for landform stability and public safety;
- measures for non-Aboriginal heritage items;
- measures to maintain downstream water quality;
- final rehabilitation works, including the establishment of self-sustaining vegetation;
- post-closure maintenance and monitoring requirements;
- lease relinquishment/completion criteria; and
- mining and coal lease and other statutory requirements.

The MCP will be developed in consideration of relevant strategic landuse planning and resource management plans and policies, as well as rehabilitation and mine closure best practice documents (e.g. the Commonwealth of Australia [2006b] *Mine Rehabilitation* and Commonwealth of Australia [2006c] *Mine Closure and Completion*).

The MCP will also include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.

Bushfire Preparedness Plan

The existing Bushfire Preparedness Plan for Metropolitan Colliery activities in the Woronora Special Area will be reviewed and where required, revised to incorporate activities relevant to the Project.

The Bushfire Preparedness Plan includes fuel management and general housekeeping measures, procedures to minimise the risk of bushfire, response to bushfire in the Woronora Special Area and evacuation in case of an emergency.

Surface Water Management Plan (SWMP)

The Project water management system will generally be based on the existing water management system, however will be upgraded to address existing water treatment plant quantity limitations and augmented where necessary to address additional Project components.

The existing SWMP has been prepared to meet the requirements of PRP 7 in Environment Protection Licence (EPL) No. 767. The SWMP will be reviewed and where appropriate, revised to address Project-related activities.

Water Savings Action Plan (WSAP)

During 2006 and 2007, HCPL significantly upgraded the operational water management system to increase recycling and reduce make-up water demand from Sydney Water in accordance with the Metropolitan Colliery WSAP.

The Project will continue to build on the Metropolitan Colliery WSAP initiatives undertaken to date to increase the efficiency of water use and minimise the requirement for make-up water and off-site water releases. The WSAP will be reviewed and revised, where appropriate.

Energy Savings Action Plan (ESAP)

The existing Metropolitan Colliery ESAP will be reviewed and revised for the Project. The ESAP will include an Energy Plan to further improve energy performance and management systems for the Project, having regard to the *Guidelines for Energy Savings Action Plans* (NSW Department of Energy, Utilities and Sustainability, 2005).

Compensatory Measures and Other Ecological Initiatives

In addition to the environmental management and mitigation summarised above, compensatory measures and other ecological initiatives will be implemented for the Project and are summarised in Table SOC-1.

Environmental Monitoring

An overview of the environmental monitoring programmes developed for the Project is provided in Table SOC-2.

This section provides an outline of each component of the monitoring programme.

An Environmental Monitoring Programme (EMP) will be developed and documented for the Project. The monitoring components described below will be described in either the EMP or other relevant management plans (e.g. FFMP and ACHMP).

Meteorology

An automated meteorological monitoring station will be installed at the Project Major Surface Facilities Area to record temperature, relative humidity, net solar radiation, rainfall, wind speed, wind direction and sigma theta (the rate of change of wind direction). Meteorological data will be continuously monitored.

Subsidence

As described above, prior to the commencement of longwall mining and periodically during the life of the Project, SMPs will be developed in consultation with the relevant authorities. The SMPs will document the monitoring of potential subsidence impacts on key surface features.

Subsidence monitoring (subsidence survey lines and/or visual inspections) will be undertaken to quantify subsidence resulting from longwall mining.

Monitoring measures of relevance to potential subsidence impacts on groundwater, surface water, aquatic ecology, terrestrial flora and fauna, Aboriginal heritage, non-Aboriginal heritage and visual character are described in subsequent sections below. HCPL's proposed subsidence monitoring and adaptive management approach with respect to subsidence effects at the Waratah Rivulet are described in Section 5 of the EA.

Monitoring of infrastructure items will be undertaken as relevant Project longwalls are mined to confirm observed ground movements are consistent with the subsidence predictions and to identify potential impacts and required remedial measures.

Monitoring of infrastructure items if required would include the:

- Illawarra Railway;
- F6 Southern Freeway including bridges;
- Princes Highway;
- Garrawarra Centre;
- electrical services;
- optical fibre and copper telecommunications cables;
- Woronora Dam road, fire trails in the Woronora Special Area and other minor roads;
- Sydney Water pipelines;
- houses in close proximity to the Project Underground Mining Area; and
- rural buildings, tanks and farm dams.

Geological investigations will be undertaken progressively during the life of the Project and will inform subsidence prediction and the development of subsidence management measures where relevant. The geological investigations are described in the section below.

Groundwater

As described above, over the life of the Project SMPs will progressively be prepared. Project geological investigations, groundwater monitoring and response measures will be detailed in these SMPs, where relevant.

Table SOC-1
Metropolitan Coal Project Compensatory Measures and Ecological Initiatives

Compensatory Measure or Ecological Initiative	Comment	Financial Contribution
Research Programmes		$250,000
• Research into subsidence effects on streams and stored water.	Consistent with the Southern Coalfield Panel Report (SCPR).*	
• Research on techniques for remediating stream bed cracking, including:		
- crack network identification and monitoring techniques; and	Consistent with SCPR Recommendation 14.*	
- technical aspects of remediation, such as matters relating to environmental impacts of grouting operations and grout injection products, life spans of grouts, grouting beneath surfaces which cannot be accessed or disturbed, techniques for the remote placement of grout, cosmetic treatments of surface expressions of cracks and grouting boreholes.		
• Research comparing the outcomes of interventionist remediation with natural processes of remediation.	Consistent with SCPR.*	
• Research into the refinement of the prediction of non-conventional subsidence effects in the Southern Coalfield and the link to environmental effect. This will focus on valley closure and upsidence mechanisms.	Consistent with SCPR Recommendation 17.*	
	Sub-total Contribution	**$250,000**
Catchment Condition Work		
• Weed Control	Biodiversity initiative.	$100,000
- Financial contribution to weed control programmes for weeds such as Pampas Grass, African Love Grass, Lantana, African Boxthorn, Bridal Veil Creeper, Prickly Pear, Onion Grass and Blackberry within the Woronora catchment.		
	Subtotal Contribution	**$100,000**
Total HCPL Contribution		**$350,000**

* DoP (2008).

Table SOC-2
Overview of the Proposed Environmental Monitoring Programme

Monitoring Focus	EA Section	Monitoring Sites
Meteorology Automated meteorological station: • Temperature. • Relative humidity. • Net solar radiation. • Rainfall. • Wind speed. • Wind direction. • Sigma theta (the rate of change of wind direction).	4.1.3	Major Surface Facilities Area or nearby in Helensburgh.
Subsidence • Subsidence ground movements. • Visual inspections.	4.2.4	Natural surface features in the Project Underground Mining Area and surrounds. Infrastructure items in the Project Underground Mining Area and surrounds (Appendix A of the EA): • Illawarra Railway. • F6 Southern Freeway. • Princes Highway. • Bridges on the F6 Southern Freeway. • Garrawarra Centre. • Electrical services. • Optical fibre and copper telecommunication cables. • Woronora Dam road, fire trails in the Woronora Special Area and other minor roads. • Sydney Water pipelines. • Houses in close proximity to the Underground Mining Area. • Rural buildings, tanks and farm dams.
Geological Investigations • Long in-seam exploration boreholes. • Mapping of geological structures intersected by underground workings. • Surface mapping (ground-truthing) of geological characteristics. • Further analysis of geomorphic expressions.	4.3.3	Underground Mining Area and Surrounds (Appendix B of the EA).
Groundwater • Groundwater level.	4.3.3	WRGW1 to WRGW6. UTGW1 to UTGW3. FGGW1 to FGGW3. SWAMP1 to 3. 9EGW1. 9GGW1. 9HGW1. SWGW1 and SWGW2. RTGW1.

Table SOC-2 (Continued)
Overview of the Proposed Environmental Monitoring Programme

Monitoring Focus	EA Section	Monitoring Sites
• Groundwater quality – electrical conductivity, pH, total dissolved solids, turbidity, calcium, magnesium, sodium, flouride, potassium, chloride, sulphate, bicarbonate, total nitrogen, ammonium nitrogen, nitrate, total phosphorous, barium, strontium, manganese, iron, zinc, cobalt and aluminium.	4.3.3	WRGW1 to WRGW6. UTGW1 to UTGW3. FGGW1 to FGGW3. 9EGW1. 9GGW1. 9HGW1. RTGW1. (*Note: Monitoring site locations are shown in Appendix B and Figure 4-3 of the EA*).
Surface Water • Rainfall.	4.4.3	PV1 (Waratah Rivulet catchment). PV2 (Woronora River catchment).
• Evaporation.	4.4.3	At or near the Woronora Reservoir.
• Surface water flow.	4.4.3	GS2132102 (Waratah Rivulet) (SCA data). GS2132101 (Woronora River) (SCA data). GS213200 (O'Hares Creek) (NSW Department of Water and Energy data).
• Pool water level.	4.4.3	Pools A, B, C, E, F, G, G1, H and I. Major pools on Waratah Rivulet. Two representative pools on Woronora River. Selected pools in the lower reaches of the Eastern Tributary.
• Storage characteristics and cease to flow levels of monitored pools.	4.4.3	Pools A, B, C, E, F, G, G1, H and I. Major pools on Waratah Rivulet. Two representative pools on Woronora River. Selected pools in the lower reaches of the Eastern Tributary.
• Surface water quality - electrical conductivity, pH, redox potential, dissolved oxygen, turbidity, calcium, magnesium, sodium, potassium, chloride, sulphate, bicarbonate, total nitrogen, total phosphorous, nitrate, barium, strontium, manganese, iron, zinc, cobalt and aluminium.	4.4.3	WRWQ1 to 9. Eastern Tributary. Woronora River. Honeysuckle Creek. Bee Creek. Woronora Reservoir (SCA data). (*Note: Monitoring site locations are shown in Appendix C and Figure 4-6 of the EA*).
• Site water balance.	4.4.3	Major Surface Facilities Area and underground mining.
• Water releases.	4.4.3	Camp Gully.
Coal Reject Geochemical Testwork • Coal reject geochemistry.	4.4.3	Major Surface Facilities Area.
Erosion and Sediment Control • Stability. • Effectiveness.	4.1.3, 4.4.3 and 4.5.3	Sediment control structures.
Aquatic Ecology • Aquatic ecology.	4.5.3	Underground Mining Area and Surrounds.
Terrestrial Flora • Riparian vegetation. • Slope/ridgetop vegetation. • Upland swamp vegetation. • Weeds.	4.6.3	Underground Mining Area and Surrounds.

Table SOC-2 (Continued)
Overview of the Proposed Environmental Monitoring Programme

Monitoring Focus	EA Section	Monitoring Sites
Terrestrial Fauna • Sandstone habitats. • Amphibians. • Pests.	4.7.3	Underground Mining Area and Surrounds.
Aboriginal Heritage • Aboriginal heritage sites.	4.8.3	Underground Mining Area and Surrounds.
Non-Aboriginal Heritage • Non-Aboriginal heritage items.	4.9.3	Major Surface Facilities Area.
Noise • Attended and unattended noise monitoring.	4.10.3	Major Surface Facilities Area and Helensburgh (Appendix J and Figure 4-19 of the EA).
Air Quality • Real-time dust monitoring system. • Dust deposition. • High volume sampling (PM_{10}). • Greenhouse gas emissions and energy consumption.	4.11.3	Major Surface Facilities Area. Helensburgh. Helensburgh. Underground Mining Area and Major Surface Facilities Area. (*Note: Monitoring site locations are shown in Appendix K and Figure 4-19 of the EA*).
Rehabilitation • Erosion and Sediment Control • Revegetation. • Surface cracking (e.g. on fire trails or at Flat Rock Crossing). • Weed control. • Project Infrastructure. • Landform stability and public safety.	5.3, 5.4 and 5.5	Underground Mining Area and/or Major Surface Facilities Area.

Geological Investigation Programme

Geological investigations will be undertaken progressively during the life of the Project. Key components of the Project geological investigations will include:

- long in-seam exploration boreholes to identify any geological anomalies in advance of longwall mining;
- mapping of geological structures intersected by underground workings;
- surface mapping (ground-truthing) of geological characteristics; and
- further analysis of geomorphic expressions.

The above activities will focus on the identification of potential conduits (e.g. faults, dykes, joint seams) consistent with Recommendation 18 of the SCPR (DoP, 2008) and include extrapolation from areas external to the Project Underground Mining Area.

Groundwater Monitoring

The existing groundwater monitoring programme for Longwalls 14-17 at the Metropolitan Colliery will be augmented by the groundwater monitoring programme developed for Longwalls 18 to 19A in the Current Underground Mining Area which includes:

- three sets of deep multi-level piezometers to the Bulli Seam on ridgelines (i.e. in recharge areas) along Fire Roads 9E, 9G and 9H;
- three sets of deep multi-level groundwater sampling boreholes on ridgelines (i.e. in recharge areas) along Fire Roads 9E, 9G and 9H;
- paired bores at a swamp location (SWGW1 and SWGW2); and

- nested piezometers to approximately 60 m (near the base of the Hawkesbury Sandstone) immediately adjacent to a pool on a tributary stream (RTGW1).

The monitoring of groundwater levels (including those associated with upland swamps) and groundwater quality is described in Table SOC-2.

This groundwater monitoring programme and any supplementary components that may be required for the Project will be detailed in the Project EMP. The frequency, parameters and locations monitored as part of the groundwater quality monitoring programme will also be described in the Project EMP.

Surface Water

Surface Water Monitoring

The current Metropolitan Colliery surface water monitoring programme in the Completed and Current Underground Mining Areas has been developed by HCPL in consultation with the SCA. HCPL has already commenced some pre-mining data collection in the Project Underground Mining Area, however additional surface water monitoring will be conducted to assess localised impacts of the Project on surface water resources.

A surface water monitoring programme will be developed for the Project and detailed in the Project EMP. The frequency, parameters and locations monitored as part of the surface water quality monitoring programme will also be described in the Project EMP. However, it is anticipated that the following will be incorporated in the Project EMP:

- the existing pluviometer (rainfall measurement) network will be maintained over the life of the Project;
- an evaporation pan will be re-established at or near the Woronora Reservoir;
- stream flow gauging stations on Waratah Rivulet, Woronora River and O'Hares Creek will be maintained over the life of the Project;
- the existing water quality monitoring regime conducted by HCPL on Waratah Rivulet will continue and will be supplemented by on-going monitoring in the Eastern Tributary, Woronora River, Honeysuckle Creek and Bee Creek;
- water quality sampling in Woronora Reservoir will continue;
- water level monitoring of major pools on Waratah Rivulet will continue for the life of the Project;
- water levels in two representative pools on Woronora River and in selected pools that occur in the lower reaches of the Eastern Tributary will be monitored using continuous water level monitoring devices; and
- storage characteristics (volume versus level) and cease to flow levels of all monitored pools will be determined by survey.

HCPL's adaptive management approach for Waratah Rivulet and Woronora Reservoir monitoring is described in Section 5 of the EA.

Site Water Balance

The site water balance will be monitored and reviewed annually to optimise performance and validate predictions.

Water Releases – Camp Gully

Water releases from the Major Surface Facilities Area to Camp Gully will continue to be monitored in accordance with the requirements of EPL No. 767.

Coal Reject Geochemical Testwork

Periodically over the life of the Project, HCPL will test coal reject material that is produced to confirm that the coal reject geochemistry is generally consistent with that observed to date and does not require the implementation of any specific management measures with respect to reject disposal or surface water management.

Aquatic Ecology

Consistent with the SCPR recommendations, the aquatic ecology monitoring programme will be designed to:

(i) monitor subsidence-induced impacts on aquatic ecology; and

(ii) monitor the response of aquatic ecosystems to the implementation of stream restoration works.

The aquatic ecology monitoring programme will be described in detail in the FFMP to be developed for the Project.

Consistent with SCPR recommendations, the aquatic ecology monitoring programme will:

- include monitoring at an appropriate frequency and scale for a period prior to, during, and following the completion of mining;
- include monitoring at an appropriate frequency and scale prior to, during, and following the implementation of stream restoration activities;
- take into account the seasonality and inter-annual variability of the systems under study;
- target the collection of a minimum of two years pre-mining data, where practicable;
- include sites situated within the Project Underground Mining Area, as well as control sites situated in comparable unmined locations (the location of sampling sites will be determined in consideration of the aquatic habitat characteristics, their location relevant to the mine plan and access constraints);
- include the use of quantitative sampling techniques;
- be designed to comprise appropriate sampling replication;
- be designed consistent with best practice impact monitoring (e.g. the use of an experimental design that allows advanced statistical analyses techniques to be employed such as Before, After, Control, Impact designed studies);
- be co-ordinated with other monitoring programmes as practicable to assist with determinations of causal relationships (e.g. monitoring of pool water levels, stream flow, groundwater levels and subsidence);
- be developed in consideration of their potential contribution to regional and cumulative data sets on aquatic ecosystems consistent with Recommendation 21 of the SCPR; and
- be peer reviewed by an appropriately qualified specialist.

As described in the section above, surface water quality monitoring will be conducted to monitor subsidence-related impacts on surface water quality and will include parameters of relevance to aquatic ecology including dissolved oxygen, pH, electrical conductivity and turbidity.

Monitoring of subsidence effects on riparian vegetation are described in the section below.

Terrestrial Flora and Fauna

The terrestrial flora and fauna monitoring programmes will be described in detail in the FFMP to be developed for the Project.

Terrestrial flora and fauna will be monitored at an appropriate frequency and scale for a period prior to, during, and following the completion of mining. The monitoring programmes will target the collection of a minimum of two years pre-mining data, where practicable. The monitoring programmes will include sites situated within the Project Underground Mining Area, as well as control sites situated in comparable unmined locations and will be designed to comprise appropriate sampling replication.

The location of sampling sites will be determined in consideration of site characteristics, their location relevant to the Project Underground Mining Area, access and site inspection.

The vegetation and fauna monitoring components will be co-ordinated with other monitoring programmes where practicable to assist with determinations of causal relationships (e.g. monitoring of pool water levels in streams, groundwater levels, swamp gradients, visual monitoring [e.g. of scour pools and erosion features in upland swamps] and subsidence monitoring).

Terrestrial flora monitoring will include monitoring of riparian, upland swamp and slope/ridgetop vegetation. Riparian and slope/ridgetop vegetation will be monitored by visual observations, as well as quantitative sampling.

Monitoring of upland swamp vegetation will target the monitoring of the Sedgeland-Heath complex, as well as monitoring of the Cyperoid Heath/Tea Tree Thicket vegetation. Upland swamp vegetation will be monitored using transects and/or quadrats to obtain quantitative data on flora.

In consideration of the background ecological noise caused by recent wildfire in the Woronora Special Area, the monitoring of terrestrial fauna and their habitats will target specific Project potential impacts, namely, mine subsidence impacts on rocky habitats (e.g. rock fall) and the alteration of water availability.

The terrestrial fauna monitoring programme will include:

- Monitoring of sandstone habitats – monitoring of cliff faces and other sandstone habitats for terrestrial vertebrate fauna to assess the impact of subsidence on rocky habitats and usage by terrestrial vertebrate fauna.
- Monitoring of amphibian species – surveys for amphibians, including threatened species, with a focus on habitats of the Giant Burrowing Frog and Red-crowned Toadlet associated with tributaries.

Aboriginal Heritage

A monitoring programme will be developed in consultation with the Aboriginal community through the SMP process for sites of moderate or high archaeological significance to identify if subsidence has impacted Aboriginal heritage sites and to validate the predicted subsidence movements.

The monitoring programme will be described in the ACHMP and will include:

- the proposed monitoring team (including Aboriginal representation);
- particulars of any further recording of information prior to sites being subject to subsidence;
- tasks to be undertaken during each monitoring round, including:
  - comparison of the baseline record against the status of the site at the time of monitoring;
  - inspections of rock surfaces for cracking and/or exfoliation and/or blockfall;
  - inspection of art motifs for damage or deterioration;
  - subsidence monitoring within and around each site;
  - identification of natural deterioration process (such as fire, vegetation growth and water seepage); and
  - a description (including photos) of any changes noted.
- proposed monitoring schedule;
- proposed reporting requirements; and
- a strategy to undertake on-going consultation with the Aboriginal community.

Non-Aboriginal Heritage

The mine design in the vicinity of the Garrawarra Centre will be constrained by performance criteria developed by Mine Subsidence Engineering Consultants (MSEC) (2008) that result in impacts no greater than hairline cracks or fine cracks of buildings within the Garrawarra Centre which will not require repair. Specific monitoring of the Garrawarra Centre will be included in relevant SMPs.

The CMP to be developed for the Project will include further detailed inspection of all items of heritage significance or potentially of heritage significance within the Major Surface Facilities Area and recording of these items.

Noise

Noise monitoring will be conducted for the Project at the monitoring locations, frequencies, parameters and specifications described in the noise PRPs. Noise monitoring will be conducted in accordance with Australian Standard (AS) 1055 – 1997 *Acoustics – Description and Measurement of Environmental Noise* and the *NSW Noise Policy* (NSW Environment Protection Authority [EPA], 2000).

The results of the noise monitoring will be used to optimise noise controls and validate the noise modelling predictions.

HCPL will continue to maintain a complaints register as part of its environmental management and community relations protocol. The monitoring programme will incorporate mechanisms for responding to noise-related complaints.

Air Quality

Air quality monitoring will be conducted for the Project at the monitoring locations, frequencies, parameters and specifications described in the existing and future PRPs.

The air quality monitoring programme will include a real-time dust monitoring system, which will enable site operators to modify activities, as required to minimise dust emissions and off-site impacts during adverse conditions.

HCPL's current dust monitoring network includes one high volume sampler and six dust deposition gauges. An additional dust gauge has recently been installed at Old Station Road, and another two gauges will be installed at locations proximal to the nearest residences on Parkes Street and Oxley Place for the Project, to further augment the existing monitoring network.

The dust deposition gauges will be analysed for ash content and insoluble solids in accordance with AS 3580.10.1-1991 *Methods for Sampling and Analysis of Ambient Air – Determination of Particulates – Deposited Matter – Gravimetric Method.*

The high volume samplers will monitor particulate matter less than 10 microns in size (PM_{10}) over a six day continuous cycle in accordance with the *Approved Methods for the Sampling and Analysis of Air Pollution in New South Wales* (EPA, 2001).

The results of the air quality monitoring will be used to optimise air quality controls and validate the air quality modelling predictions.

As described above, HCPL will continue to maintain a complaints register as part of its environmental management and community relations protocol. The monitoring programme will incorporate mechanisms for responding to air quality-related complaints.

While no odour impacts are predicted from the Project ventilation shafts, in the event of an issue or complaint arising with respect odour, suitable complaint response and monitoring measures will be developed.

Reporting

Under the *Mining Act, 1992*, environmental protection and rehabilitation are regulated by conditions included in all mining leases, including requirements for the submission of a Mining Operations Plan (MOP) prior to the commencement of operation, and subsequent Annual Environmental Management Reports (AEMR).

Collectively, the MOP and AEMR constitute the *Guidelines to the Mining, Rehabilitation and Environmental Management Process* (MREMP Guidelines) (DPI-MR, 2006b) which has been developed by the DPI-MR.

The MREMP is a framework that aims to facilitate the development of mining in NSW in a safe manner such that operations are safe, the environment is protected, the resources are efficiently extracted and rehabilitation achieves a stable, satisfactory outcome (DPI-MR, 2006b). The structure and content of the Project MOP and AEMR will be developed in accordance with the MREMP Guidelines (DPI-MR, 2006b) and through consultation with various regulatory and advisory agencies including the DPI-MR, DECC, DoP, SCA and WCC.

Mining Operations Plan (MOP)

The existing MOP will be revised and updated as required to include Project-related operations.

The MOP will provide information in regard to the mining, processing and rehabilitation operations, relevant lease and development conditions, licences and other approvals.

The MOP will also describe:

- area(s) to be disturbed;
- mining, rehabilitation and remediation method(s) to be used and their sequence;
- existing surface infrastructure;
- progressive rehabilitation schedules;
- areas of particular environmental sensitivity;
- land and water management systems; and
- resource recovery.

The MOP will be revised periodically, and prior to any significant alteration to Project operations.

Annual Environmental Management Report (AEMR)

An AEMR will be prepared to report on the status of approvals, leases, licences and environmental risk management and environmental control strategies.

For the preceding 12 month period, the AEMR will provide a summary of community relations and liaison, mine development and rehabilitation in relation to the MOP. Project environmental performance in relation to the collective conditions of approvals, leases and licences for the previous 12 month period will also be reported.

The AEMR will also include a review and any proposed improvements in relation to environmental monitoring and management systems (including waste management) and environmental performance and will specify environmental and rehabilitation targets to be achieved during the ensuing 12 month period.

SMP Reporting

In accordance with Metropolitan Colliery's existing SMP approvals (DPI-MR, 2006a, 2008), HCPL will prepare and submit to relevant authorities a monthly Subsidence Management Status Report, which includes a summary of subsidence development, as well as measured and observed subsidence impacts. The outcomes of the monitoring and management programmes will also be reported in an End of Panel Report. A review process is currently incorporated into the monitoring and management programmes (typically at the completion of each longwall) to allow changes to be made to the programmes if required.

Other Licences and Approvals

HCPL will report to the relevant authorities in accordance with their licences and approvals (e.g. EPL No. 767 requirements, approvals issued by the SCA for surface activities within the Woronora Special Area and occupational health and safety requirements).

Greenhouse Gas Emissions

Greenhouse gas emissions and energy consumption will be reported in accordance with the *National Greenhouse and Energy Reporting Act, 2007* (NGER Act). The NGER Act makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds.

ATTACHMENT 2

DIRECTOR-GENERAL'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application Number	08_0149
Project	The Metropolitan Coal Project, which includes: • augmenting, upgrading and using the existing infrastructure at the mine; • extracting up to 3 million tonnes of run-of-mine coal a year from the Bulli coal seam for a period of 25 years using longwall mining methods; • processing run-of-mine coal at the mine; • transporting product coal and coal reject from the mine by road and/or rail; • disposing of coal rejects at the mine; and • rehabilitating the site.
Location	Approximately 30 kilometres northwest of Wollongong
Proponent	Helensburgh Coal Pty Ltd
Date of Issue	30 July 2008
General Requirements	The Environmental Assessment of the project must include: • an executive summary; • a detailed description of the following within the Metropolitan Colliery holdings and any associated reject disposal areas: - historical mining operations; - existing and approved mining operations/facilities, including any statutory approvals that apply to these operations/facilities; and - the existing environmental management and monitoring regime; • a detailed description of the project, including the: - need for the project; - alternatives considered, including a justification for the proposed mine plan/s and coal rejects disposal strategy on economic, social and environmental grounds; - likely staging of the project; and - plans of any proposed building works; • a risk assessment of the potential environmental impacts of the project, identifying the key issues for further assessment; • a detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment (see above), which includes: - a description of the existing environment, using sufficient baseline data; - an assessment of the potential impacts of all stages of the project, including any cumulative impacts, taking into consideration any relevant guidelines, policies, plans and statutory provisions (see below), and the findings and recommendations of the recent Southern Coalfield inquiry; - a description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate, monitor and/or offset the potential impacts of the project, including detailed contingency plans for managing any potentially significant risks to the environment; • a statement of commitments, outlining all the proposed environmental management and monitoring measures; • a conclusion justifying the project on economic, social and environmental grounds, taking into consideration whether the project is consistent with the objects of the *Environmental Planning & Assessment Act 1979*; • a signed statement from the author of the Environmental Assessment, certifying that the information contained within the document is neither false nor misleading.

Key Issues	• **Subsidence** – including: - accurate predictions of the potential subsidence effects of the proposed mine plan/s, and a sensitivity analysis of these predictions; and - a detailed assessment of the potential impacts of these subsidence effects on both the natural and built environment, paying particular attention to significant features of this environment; • **Soil & Water** – including: - a detailed assessment of the potential impacts of the project on the quantity, quality and long-term integrity of the surface and ground water resources in the project area, paying particular attention to the Waratah Rivulet and Lake Woronora; - site water balance, a detailed description of the measures that would be implemented on site to minimise the water use of the project; • **Biodiversity** – including: - accurate estimates of any vegetation clearing associated with the project; - a detailed assessment of the potential impacts of the project on any terrestrial and aquatic threatened species, populations, ecological communities or their habitats; and - a detailed description of the measures that would be implemented to maintain or improve the biodiversity values of the surrounding region in the medium to long term; • **Heritage** – including the potential Aboriginal and non-Aboriginal heritage impacts of the project; • **Noise** – including the potential construction, operational and on-site and off-site road and rail noise and vibration impacts; • **Air Quality**; • **Greenhouse Gas** – including: - a quantitative assessment of the potential scope 1, 2 and 3 greenhouse gas emissions of the project, and qualitative assessment of the potential impacts of these emissions on the environment; and - a detailed description of the measures that would be implemented on site to ensure that the project is energy efficient; • **Transport** - including a detailed assessment of the potential impacts of the project on the safety and performance of the road and rail network; • **Waste** – including: - robust estimates of the quantity and nature of the potential waste streams of the project; - a detailed description of the measures that would be implemented to minimise, reuse, recycle and dispose of any waste produced on site, including the proposed coal reject disposal strategy; • **Hazards** – paying particular attention to public safety; • **Rehabilitation** – including a detailed description of the proposed rehabilitation strategy for the mine, taking into consideration any relevant strategic land use planning or resource management plans or policies; • **Social & Economic**.
References	While not exhaustive, the following attachment contains a list of the guidelines, policies, and plans that may be relevant to the environmental assessment of the project.
Consultation	During the preparation of the Environmental Assessment, you should consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups or affected landowners. In particular you must consult with the: • Department of Environment and Climate Change; • Department of Primary Industries; • Department of Water and Energy; • Sydney Catchment Authority; • Dam Safety Committee; • Mine Subsidence Board; • Roads and Traffic Authority;

	• Department of Lands; and • Wollongong, Wollondilly and Campbelltown Council. The consultation process, and the issues raised during this process, must be described in the Environmental Assessment.
Deemed refusal period	120 days

Policies, Guidelines & Plans

Aspect	Policy /Methodology
Risk	
	AS/NZS 4360:2004 Risk Management (Standards Australia)
	HB 203: 203:2006 Environmental Risk Management – Principles & Process (Standards Australia)
	Risk Management Handbook for the Mining Industry (DPI)
	Risk Management Policy Framework for Dam Safety (Dam Safety Committee)
Subsidence	
	Guideline for Application for Subsidence Management Approvals (DMR)
Soil and Water	
	Rural Land Capability Mapping (DLWC)
	Agricultural Land Classification (DPI)
	Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC & NHMRC)
Soil	National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC)
	Draft Guidelines for the Assessment & Management if Groundwater Contamination (DECC)
	State Environmental Planning Policy No. 55 – Remediation of Land
	Managing Land Contamination – Planning Guidelines SEPP 55 – Remediation of Land (DOP)
	National Water Quality Management Strategy: Water quality management - an outline of the policies (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Policies and principles - a reference document (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Implementation guidelines (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ)
	Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC)
	State Water Management Outcomes Plan
	NSW Government Water Quality and River Flow Environmental Objectives (DECC)
Surface Water	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC)
	Drinking Water Catchments Regional Environmental Plan No. 1
	Managing Urban Stormwater: Soils & Construction (Landcom)
	Managing Urban Stormwater: Treatment Techniques (DECC)
	Managing Urban Stormwater: Source Control (DECC)
	Floodplain Management Manual (DNR)
	Floodplain Risk Management Guideline (DECC)
	A Rehabilitation Manual for Australian Streams (LWRRDC and CRCCH)
	Technical Guidelines: Bunding & Spill Management (DECC)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management (ARMCANZ/ANZECC)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC)
	Environmental Guidelines: Use of Effluent by Irrigation

Groundwater	National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC)
	NSW State Groundwater Policy Framework Document (DLWC)
	NSW State Groundwater Quality Protection Policy (DLWC)
	NSW State Groundwater Quantity Management Policy (DLWC) Draft
	Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report No 3 (MDBC)
	Murray-Darling Basin Commission. Groundwater Flow Modelling Guideline (Aquaterra Consulting Pty Ltd)
Flora and Fauna	
	Draft Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979* (DEC)
	NSW Groundwater Dependent Ecosystem Policy (DLWC)
	Policy & Guidelines - Aquatic Habitat Management and Fish Conservation (NSW Fisheries)
	Policy & Guidelines - Fish Friendly Waterway Crossings (NSW Fisheries)
	State Environmental Planning Policy No. 44 – Koala Habitat Protection
Heritage	
Aboriginal	Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC)
Non- Aboriginal	NSW Heritage Manual (NSW Heritage Office & DUAP)
	The Burra Charter (The Australia ICOMOS charter for places of cultural significance)
Noise	
	NSW Industrial Noise Policy (DECC)
	Environmental Criteria for Road Traffic Noise (NSW EPA)
	Environmental Noise Control Manual (DECC)
Air Quality	
	Protection of the Environment Operations (Clean Air) Regulation 2002
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC)
	Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC)
Greenhouse Gas	
	AGO Factors and Methods Workbook (AGO)
	Guidelines for Energy Savings Action Plans (DEUS, 2005)
Transport	
	Guide to Traffic Generating Development (RTA)
	Road Design Guide (RTA)
Waste	
	Waste Avoidance and Resource Recovery Strategy 2007 (DECC)
	Environmental Guidelines: Solid Waste Landfills (EPA)
	Environmental Guidelines: Assessment, Classification, and Management of Non-Liquid and Liquid Waste (EPA)
Hazards	
	State Environmental Planning Policy No. 33 – Hazardous and Offensive Development
	Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines (DUAP)
	Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis

Rehabilitation	
	Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth of Australia)
	Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth of Australia)
Social & Economic	
	Draft Economic Evaluation in Environmental Impact Assessment (DOP)
	Techniques for Effective Social Impact Assessment: A Practical Guide (Office of Social Policy, NSW Government Social Policy Directorate)
Strategic Plans	
	Illawarra Regional Strategy (DOP)
	Illawarra Regional Environmental Plan No. 1
	Special Areas Strategic Plan of Management 2007 (SCA & DEC)

ATTACHMENT 3

DIRECTION TO THE PLANNING ASSESSMENT COMMISSION

Direction to the Planning Assessment Commission

Metropolitan Coal Project

Section 23D(1)(b)(ii) & Schedule 3 of the *Environmental Planning and Assessment Act 1979*; & Part 16B of the *Environmental Planning and Assessment Regulation 2000*

I, the Minister for Planning:

1. Request the Planning Assessment Commission (the Commission) to:
   (a) carry out a review of the potential subsidence related impacts of the Metropolitan Coal Project on the values of Sydney's drinking water catchment, and in particular its potential impact on the Waratah Rivulet and Woronora Reservoir, taking into consideration the recommendations of the Southern Coalfield Inquiry;
   (b) advise on the significance and acceptability of these potential impacts, and to recommend appropriate measures to avoid, minimise, or offset these impacts; and
   (c) identify and comment on any other significant issues raised in submissions regarding the Metropolitan Coal Project or during the public hearings;

2. Direct that for the purposes of carrying out the review, the Commission is to be constituted of 5 members, being those members specified in Schedule 1; and

3. Direct the Commission to conduct public hearings as part of the review, in the Helensburgh area, commencing after 16 February 2009, and to provide its final report (under clause 268V of the *Environmental Planning and Assessment Regulation 2000*) by 16 March 2009.

The Hon Kristina Keneally MP
Minister for Planning

Sydney 14 November 2008

SCHEDULE 1

1. A member of the Commission, appointed under clause 2 of Schedule 3 of the *Environmental Planning and Assessment Act 1979*, as determined by the Chairperson of the Commission;
2. Professor Jeffrey Bennett;
3. Associate Professor Jim Galvin;
4. Mr Col Mackie; and
5. Mr John Tilleard.

ATTACHMENT 4

MSEC TECHNICAL NOTE '*MSEC403-METROPOLITAN COLLIERY – PREFERRED PROJECT LAYOUT (LONGWALLS 20 TO 27 AND 301 TO 317) TECHNICAL DISCUSSION ON PROPOSED MODIFICATION OF LONGWALL LAYOUT ORIENTATION*',

DATED 15 MAY 2009

MINE SUBSIDENCE ENGINEERING CONSULTANTS PTY LTD
Level 1, 228 Victoria Avenue Chatswood NSW 2067, PO Box 3047 Willoughby North NSW 2068

15 May 2009

Helensburgh Coal Pty Ltd
Metropolitan Colliery
PO Box 402
Helensburgh
NSW 2508

Attention: Greg Tarrant

MSEC403 - Metropolitan Colliery – Preferred Project Layout (Longwalls 20 to 27 and 301 to 317)
Technical Discussion on Proposed Modification of Longwall Layout Orientation

Dear Greg,

Introduction

Mine Subsidence Engineering Consultants (MSEC) was commissioned by Helensburgh Coal Pty Ltd (HCPL) to undertake subsidence predictions and impact assessments for proposed Longwalls 20 to 44, in support of an Environmental Assessment Application. Report No. MSEC285 (Revision C) was issued in August 2008 on completion of that work.

HCPL has proposed an alternative longwall layout named Preferred Project Layout (Drawing MSEC403-100). The longwall layout that was presented in the MSEC285 report is referred to as the Base Case. The Preferred Project Layout will be wholly contained within the Base Case Layout.

The Preferred Project Layout and the proposed Base Case Layout are presented in the attached Drawing MSEC403-100 and MSEC403-101. In the Preferred Project Layout Longwalls 20 to 27 are essentially identical in width to the Base Case Layout, however Longwalls 22 and 23 leave a barrier beneath Waratah Rivulet and Longwalls 24 to 27 have been significantly shortened. The remainder of the proposed longwalls are orientated approximately perpendicular to the previous longwall layout.

MSEC has been commissioned by HCPL to undertake a brief assessment of the potential changes to impacts on the natural surface features and items of surface infrastructure resulting from the proposed extraction of the Preferred Project Layout. As requested the discussion in this letter will focus on the potential changes to impacts as a result of the change in orientation of the proposed longwalls.

A A Waddington, BEng, CPEng, MICE, MIE (Aust), RPEQ. D R Kay, BEng, MEngSc, CPEng, MIE (Aust)
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Modified Longwall Orientation

The general width of longwall panels and pillars for the Preferred Project Layout is generally similar to that previously used for the Base Case Layout. The panel width of approximately 163 metres and pillar width of 40 metres are unchanged.

The panel widths are narrowed and pillar widths are widened below the Woronora Reservoir in a similar fashion to the Base Case Layout. Panel widths vary from 130 metres to 138 metres and pillar widths are 65 metres for the Preferred Project Layout (previously 133 metres and 70 metres were used for the Base Case).

A layout plan showing the Preferred Project Layout in relation to the previous Base Case Layout is presented in Drawing MSEC403-101. Many of the longwalls in the Preferred Project Layout (i.e. Longwalls 301 to 317) are orientated approximately in a perpendicular direction to the longwalls in the Base Case Layout. In most areas, the Preferred Project Layout has approximately the same panel and pillar dimensions to the Base Case Layout, but, there are some locations where the width of the proposed longwalls and pillars do not match the Base Case Layout as the longwalls change from wide to narrow or vice versa. The attached Drawing MSEC403-101 indicates most of these areas with shaded patterns. The red shaded patterns indicate that the longwall width of the Preferred Project Layout is narrower than the longwall width of the Base Case Layout and the green shaded patterns indicate that the longwall width of the Preferred Project Layout is wider than the longwall width of the Base Case Layout.

Effects of the Change in Orientation on Predicted Subsidence Parameters and Impact Assessments

Aside from the minor differences noted above, the main change to the proposed longwall layout is the change in orientation. The main expected outcome of this change is that the orientation of subsidence parameters will change but they will generally be expected to be of similar magnitude to the previous Base Case Layout where the longwall widths and pillar widths are the same. This similarity is demonstrated in the attached Fig. A.101, which shows a comparison of the predicted profiles of subsidence, tilt and strain for prediction lines over each of the layouts. The locations of the prediction lines A and B are shown in the sketches on Fig. A.101.

It can be seen that the magnitudes of subsidence, tilt and strain over the wider panels in the Base Case Layout are similar to the magnitudes of subsidence, tilt and strain over the wider panels in the Preferred Project Layout. Similarly, the magnitudes of subsidence, tilt and strain over the narrower panels in the Base Case Layout are similar to the magnitudes of subsidence, tilt and strain over the narrower panels in the Preferred Project Layout. For the purpose of comparison, the profiles were adjusted over different horizontal scales, since the number of wide and narrow longwalls and the locations of the transitions from wide to narrow are not an exact match. The profiles show small variations as a result of variations in conditions across the longwall layouts, but, basically the shape and magnitudes of the predicted parameters are generally similar.

Comparisons were made between predictions for surface features located over the Preferred Project Layout and surface features located over the Base Case. These are discussed below.

Waratah Rivulet and Eastern Tributary

A comparison of the profiles of predicted total closure after extraction of all longwalls is presented for the Waratah Rivulet and the Eastern Tributary in the attached Fig. A.102 and Fig. A.103 respectively.

The total closure profiles for the Waratah Rivulet, shown in Fig. A.102, indicates that the section of the Waratah Rivulet that is located over the north-south orientated longwalls (i.e. Longwalls 301 t0 307) in the Preferred Project Layout has a very similar closure profile to that for the east-west-orientated longwalls in the Base Case Layout. The predicted total closures over the proposed Longwalls 24 to 27 of the Base Case Layout range from 800 to 900 mm, whilst the predicted total closures over the proposed Longwalls 24 to 27 of the Preferred Project Layout are significantly reduced, i.e. less than 200 mm.

Most of the Eastern Tributary is located over longwalls that have the same orientation for the Preferred Project Layout and the Base Case Layout, i.e. over Longwalls 20 to 27, and, as a result, the total closure profiles over these longwalls are similar. The predicted total closure profiles over the lower reaches of Eastern Tributary are significantly reduced. The predicted total closures over the Preferred Project Layout vary between 140 and 220 mm, whilst the predicted total closures over the Base Case Layout vary between 350 and 620 mm.

Archaeological Sites

A comparison table has been prepared for most of the archaeological sites that are located over the proposed longwalls at Metropolitan Colliery to show the differences in predicted subsidence parameters between the Preferred Project Layout and the Base Case Layout. The results are presented in the attached Table A.101. The table presents prediction results for total subsidence, tilt, tensile strain and compressive strain at each archaeological site for the Preferred Project Layout and the Base Case Layout and the difference between the two. All negative results in the differences column (shown in red) indicate that the predicted subsidence parameter for the Preferred Project Layout is lower that the result for the Base Case Layout.

The majority of the results indicate that the parameters for the Preferred Project Layout are less than the predicted parameters for the Base Case Layout. Some results show an increase in the predicted parameters but as noted previously, the magnitudes are generally similar or significantly less than the Base Case Layout and hence the assessed impacts would be similar or less.

Cliffs

A similar comparison of predicted subsidence parameters between the Preferred Project Layout and the Base Case Layout was prepared for the Cliff sites that are located over the proposed longwalls at Metropolitan Colliery. The comparisons are presented in the attached Table A.102 which shows a similar result to the Archaeological sites, in that the majority of predicted parameters for the Preferred Project Layout are less than or similar to those for the Base Case Layout.

Swamps

It can be noted that the predicted subsidence parameters for the Preferred Project Layout are generally less than or similar to predicted subsidence parameters for the Base Case Layout, regardless of which method is used for assessing the likely impact of subsidence ground movements at swamps. As a result the likely impacts at the swamps for the Preferred Project Layout will be generally less than or similar to the likely impacts for the Base Case Layout.

The technical note provided to HCPL on 15 May 2009 discusses the predictions for three key swamps, S76, S77 and S92 as a result of the Preferred Project Layout. This discussion was based on an updated approach to assessing strain parameters for the swamps and superseded the methods used in the previous report MSEC285. A copy of this technical note is attached to this letter for reference.

Structures

The Statement of Commitments provided in the Environmental Assessment will limit impacts to structures within the Garrawarra Complex to Category A or B for tilt and Category 0 or 1 for strain. This would be achieved by adjustments to the longwall layout to limit impacts to the structures. HCPL advised that these same commitments would apply to the Preferred Project Layout, therefore an assessment of prediction results was not carried out.

Summary

A comparison of predicted subsidence parameters has been made for several of the natural features and items of surface infrastructure that are located over the proposed longwalls at Metropolitan Colliery to review the potential effects of different longwall orientations of the Preferred Project Layout and the Base Case Layout.

The comparisons along the various natural features and items of surface infrastructure generally indicated that the Preferred Project Layout and the Base Case Layout result in subsidence parameters of similar magnitude where the series of longwall panel and pillar widths are the same, even though, the longwalls in the Preferred Project Layout are orientated approximately perpendicular to the longwalls in the Base Case Layout. The proposed sterilisation of a large coal pillar in the central area of the Preferred Project Layout would result in a significant reduction in subsidence effects to Waratah Rivulet (over Longwalls 22 to 27) and to lower reaches of the Eastern Tributary. Significant reductions in subsidence effects to features such as Aboriginal heritage sites and swamps in this area are also expected.

In most locations the longwall widths of the Preferred Project Layout are similar to the longwall widths of the Base Case Layout. However, there are a few locations where the longwall width of the Preferred Project Layout is slightly wider than the longwall width of the Base Case Layout and these locations are shown on drawing No. MSEC403-101. Where the longwall widths of the Preferred Project Layout are greater than the longwall widths of the Base Case Layout, the predicted subsidence parameters are slightly higher for the Preferred Project Layout than for the Base Case Layout. However, this increase in predicted subsidence parameters is not significant and the assessed impacts to the natural features and items of surface infrastructure resulting from the extraction of the Preferred Project Layout at these locations are generally the same as was reported in the previous report MSEC285.

As a result, expected impacts to the natural features and items of surface infrastructure resulting from the extraction of the Preferred Project Layout are generally expected to be similar to those assessed for the Base Case.

Yours sincerely,

Peter DeBono

Attachments:

Drawing Number MSEC403-100 – General Layout – Preferred Project Layout

Drawing Number MSEC403-101 – General Layout – Comparison of Preferred Project Layout and Base Case

Fig. A.101 Comparison of Predicted Profiles of Systematic Subsidence, Tilt and Strain along Prediction Lines for Base Case Layout and Preferred Project Layout

Fig. A.102 Metropolitan Colliery - Comparison of Predicted Closure Profiles along the Waratah Rivulet for Base Case Layout and Preferred Project Layout

Fig. A.103 Comparison of Predicted Closure Profiles along the Eastern Tributary for Base Case Layout and Preferred Project Layout

Table A.101 Metropolitan Colliery – Comparison of Predicted Systematic Subsidence Parameters for the Archaeological sites using Preferred Project Layout and Base Case

Table A.102 Metropolitan Colliery – Comparison of Predicted Systematic Subsidence Parameters for the Cliffs using Preferred Project Layout and Base Case

Technical Note: Metropolitan Colliery – Preferred Project Layout (Longwalls 20 to 27 and 301 to 317) Technical Discussion Systematic Tensile and compressive Strains and Closure Strains in Swamps S76, S77 and S92, dated 15 May 2009

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HELENSBURGH COAL

METROPOLITAN COLLIERY

LONGWALLS 20 TO 27 and 301 to 317
PREFERRED PROJECT GENERAL LAYOUT

DATE:	SCALE:	DRAWING No:	Rev No
15-May-2009	1:40000	MSEC403-100	

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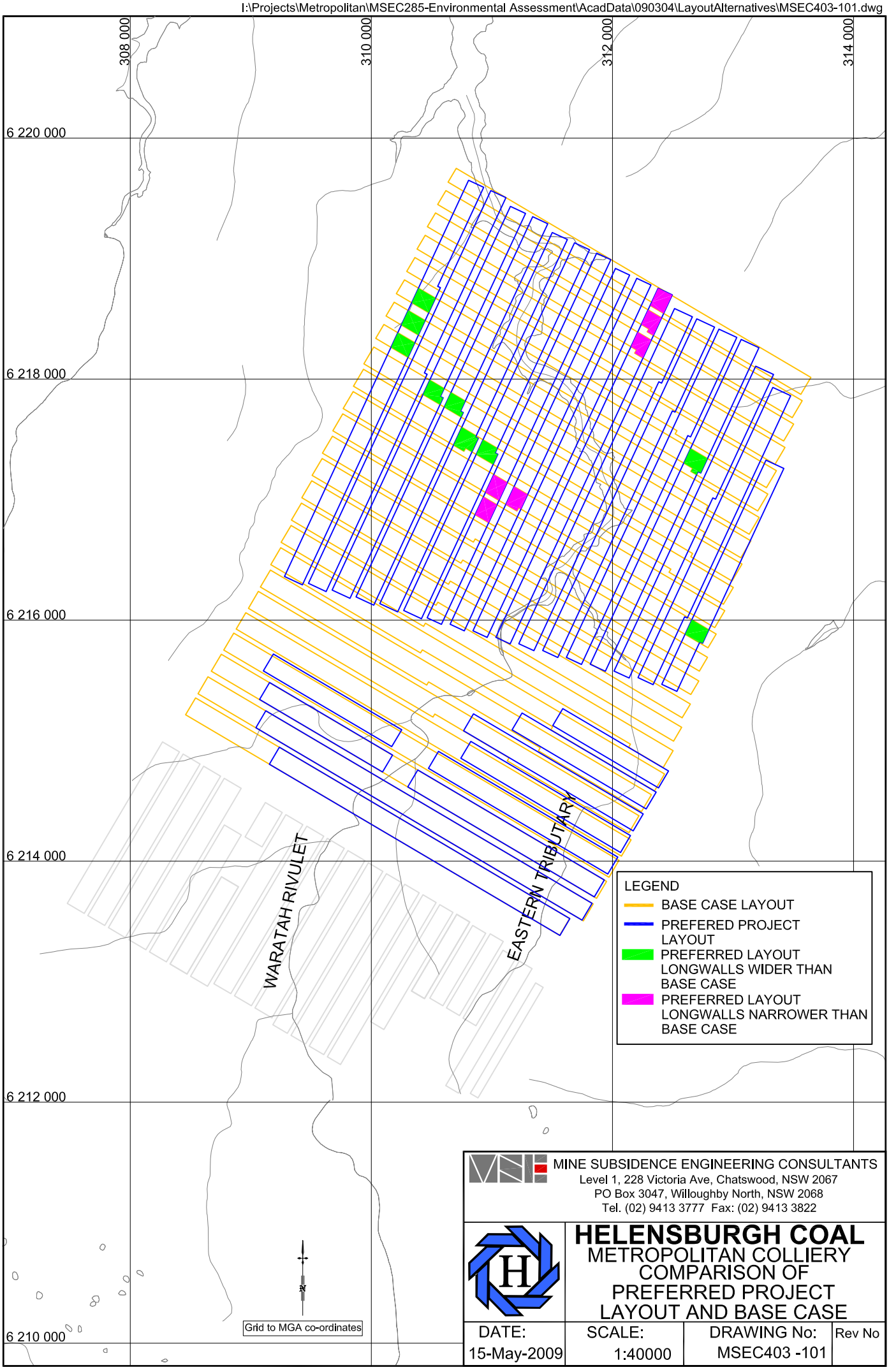

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COMPARISON OF PREFERRED PROJECT LAYOUT AND BASE CASE

DATE:	SCALE:	DRAWING No:	Rev No
15-May-2009	1:40000	MSEC403 -101	

Comparison of Predicted Profiles of Systematic Subsidence, Tilt and Strain along Prediction Lines for Base Case and Preferred Project Layout

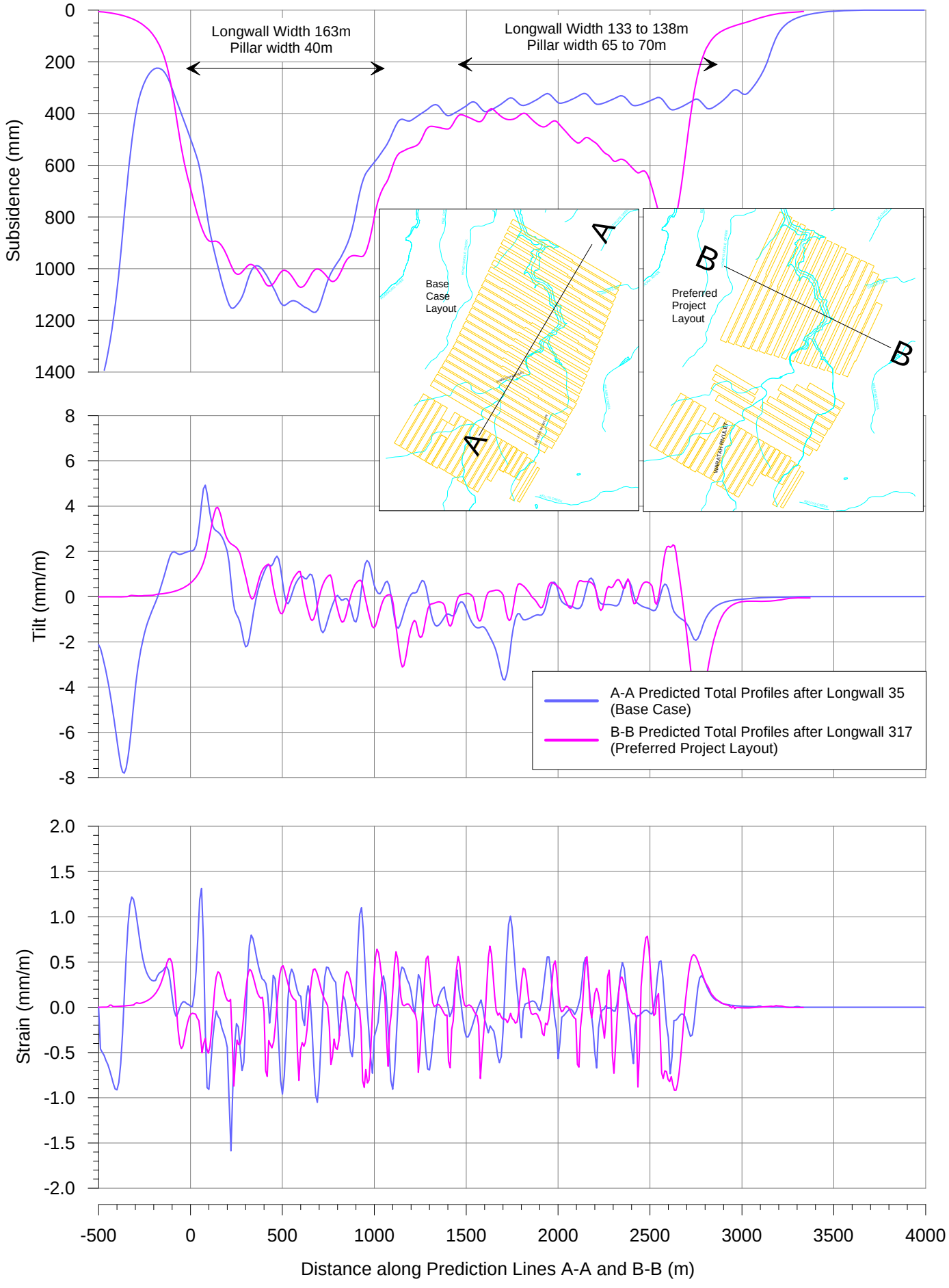

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Fig. A.101

Metropolitan Colliery - Comparison of Predicted Closure Profiles along the Waratah Rivulet for Base Case and Preferred Project Layouts

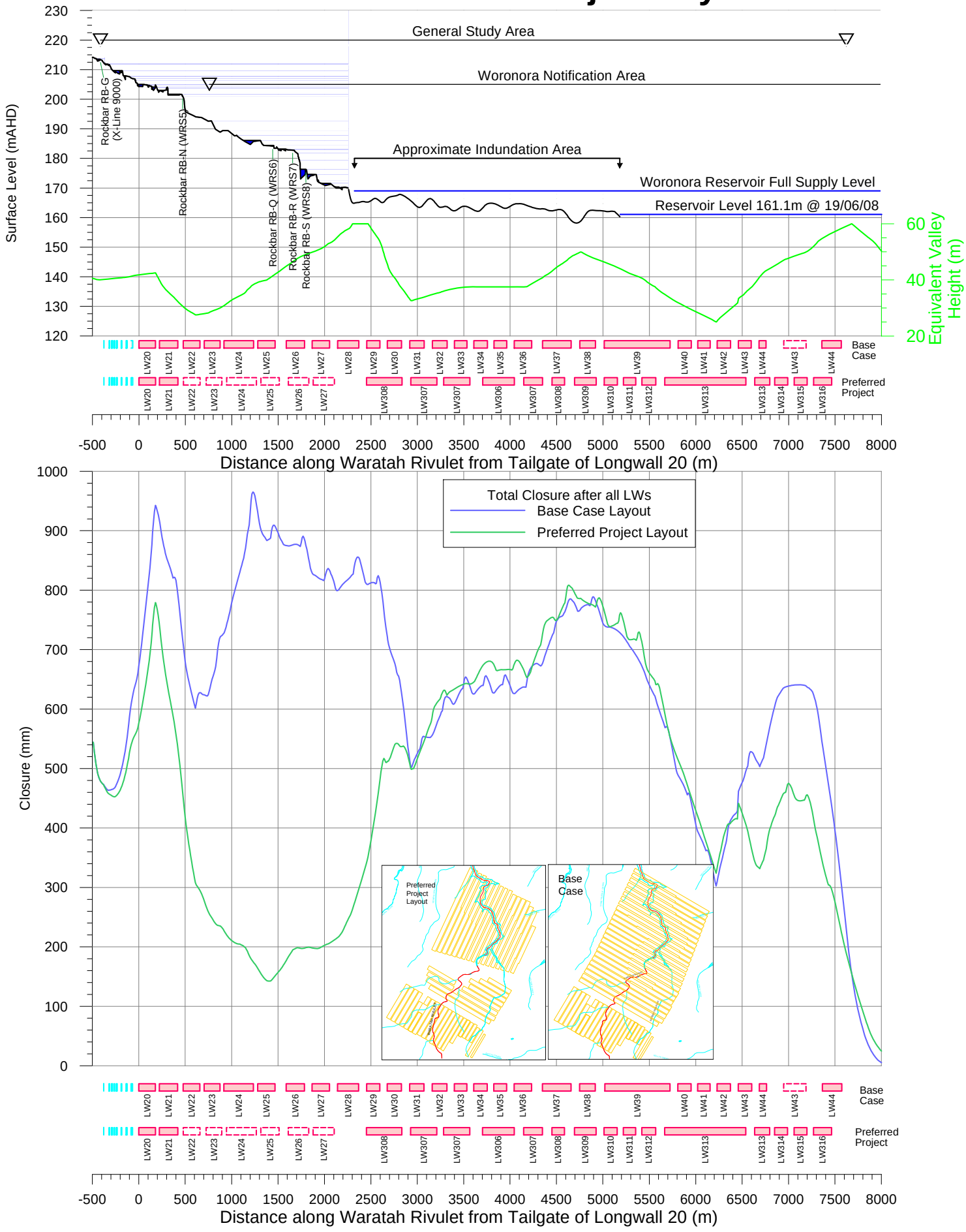
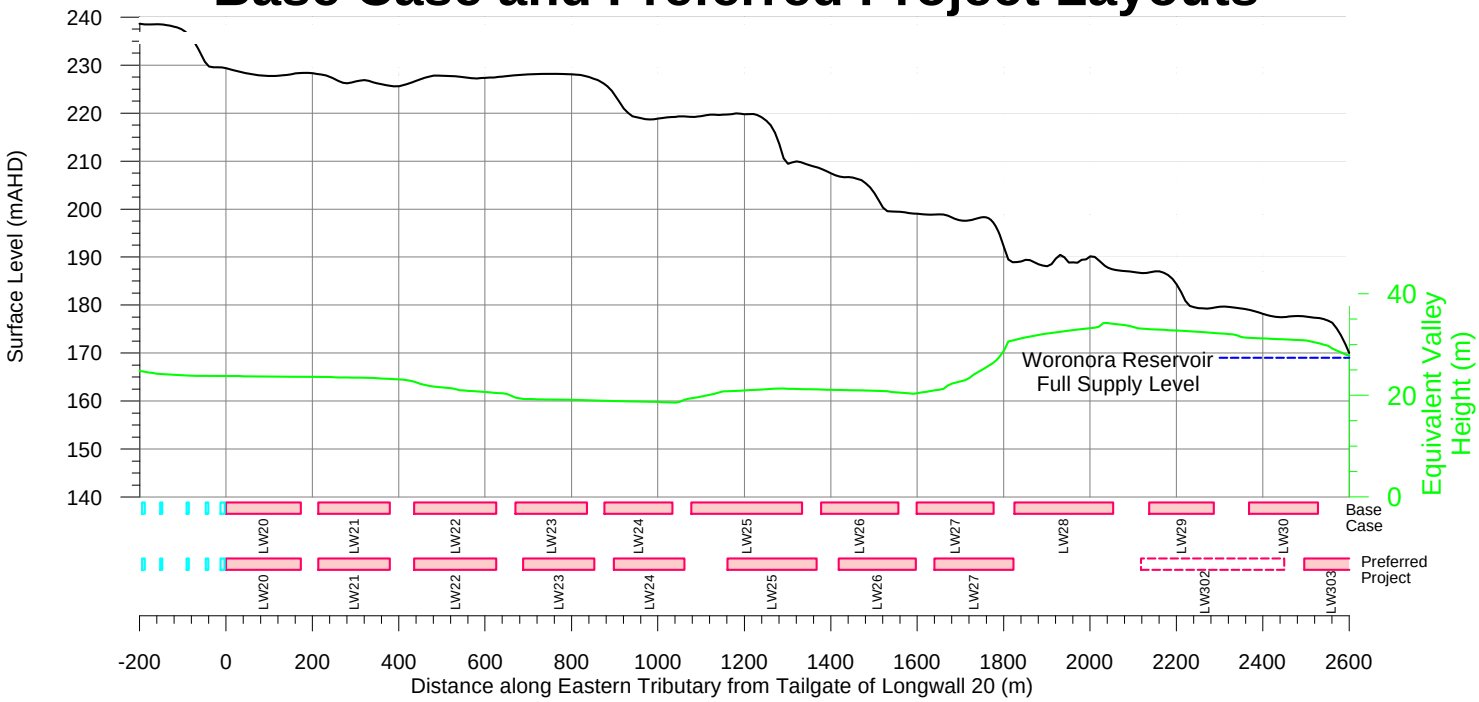


Fig. A.102

Metropolitan Colliery - Comparison of Predicted Closure Profiles along the Eastern Tributary for Base Case and Preferred Project Layouts



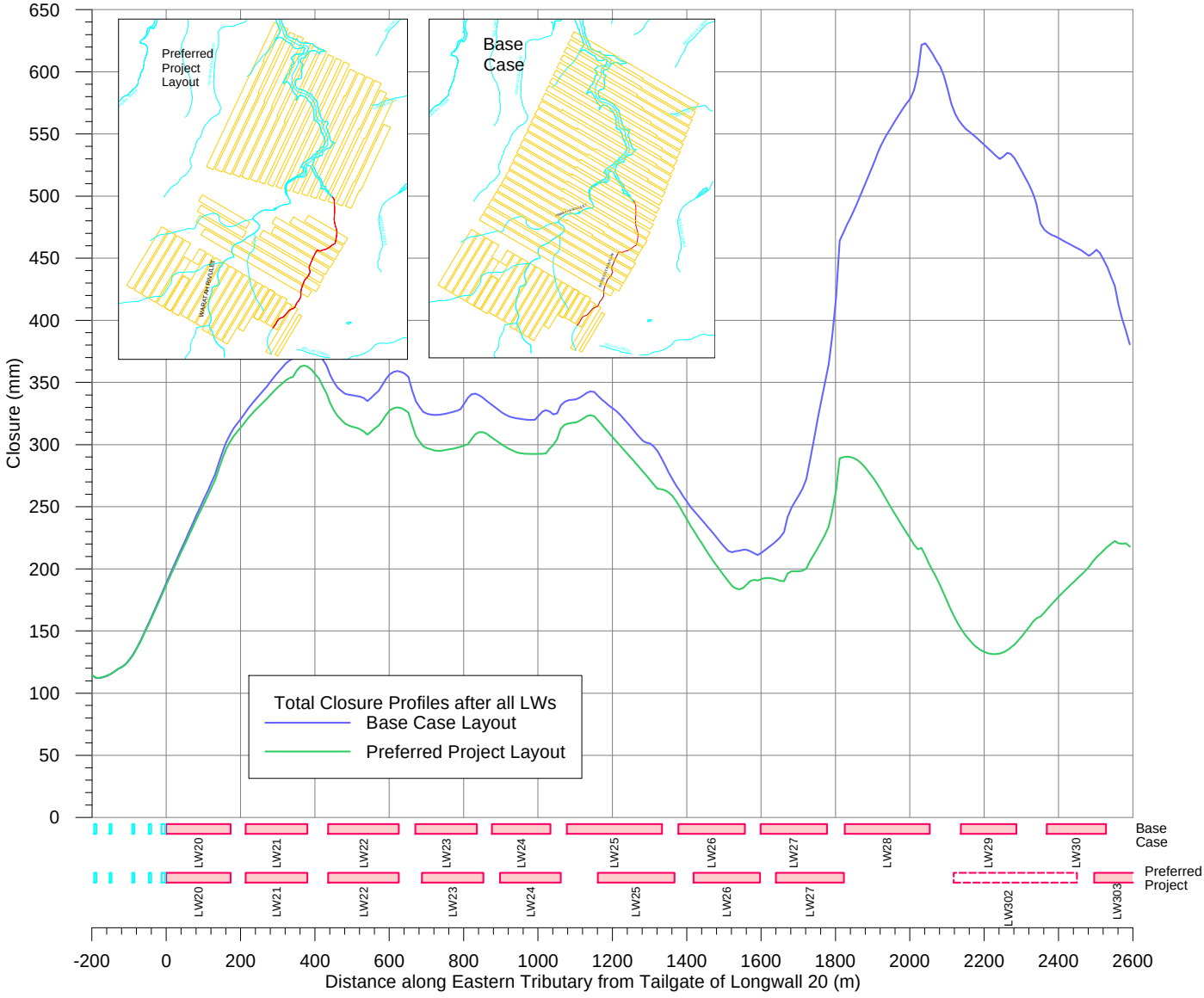


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Fig. A.103

Table A.101 - Metropolitan Colliery - Comparison of Predicted Systematic Subsidence Parameters for the Archaeological sites using Preferred Project Layout and Base Case

Label	AHIMS Site No.	Total Subs after LW317	Total Subs after LW44	Difference	Total Maximum Tilt after LW317	Total Tilt after LW44	Difference	Maximum Predicted Tensile Strain during or after LW317	Maximum Predicted Tensile Strain during or after LW44	Difference	Maximum Predicted Comp. Strain during or after LW317	Maximum Predicted Comp. Strain during or after LW44	Difference
		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout	
FRC 105	52-2-0340	590	606	-16	4.1	4.2	-0.1	1.5	1.3	0.2	-0.2	-0.3	-0.0
FRC 113	52-2-0365	940	1038	-98	2.1	3.2	-1.1	0.1	0.5	-0.4	-1.4	-1.4	0.0
FRC 114	52-2-0725	36	34	2	0.4	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0
FRC 115	52-2-0726	108	107	1	1.1	1.1	0.0	0.2	0.2	0.0	-0.1	-0.1	-0.0
FRC 117	52-2-0739	325	408	-83	2.5	1.2	1.4	0.1	0.9	-0.8	-0.3	-0.4	-0.1
FRC 119	52-2-0196	379	606	-227	4.5	6.0	-1.4	0.8	0.8	-0.1	-0.1	-0.3	-0.2
FRC 124	52-2-0162	1074	1112	-38	1.9	2.1	-0.2	0.2	0.4	-0.2	-1.0	-1.0	0.0
FRC 125	52-2-0310	897	1037	-140	0.5	1.2	-0.7	0.3	0.3	0.0	-0.7	-0.7	-0.0
FRC 127	52-2-0203	36	406	-370	0.1	0.6	-0.4	0.0	0.5	-0.4	0.0	-1.2	-1.2
FRC 13	52-2-0125	292	294	-1	2.7	2.7	0.0	0.8	0.8	-0.0	0.0	0.0	0.0
FRC 14	52-2-0138	431	484	-54	1.8	2.2	-0.5	0.1	0.2	-0.0	-0.2	-0.2	0.0
FRC 15	52-2-0396	837	1126	-289	6.3	2.5	3.8	1.1	1.2	-0.0	-1.6	-1.7	-0.1
FRC 16.1	52-2-0120	364	402	-38	2.0	2.4	-0.3	0.1	0.1	-0.1	-0.3	-0.3	-0.0
FRC 16.2	52-2-120	316	344	-27	2.0	2.3	-0.3	0.4	0.4	-0.0	-0.2	-0.3	-0.0
FRC 160	52-2-0823	778	833	-55	3.6	3.5	0.1	0.2	0.4	-0.2	-0.4	-0.4	0.0
FRC 164	52-2-0171	81	378	-297	0.8	0.5	0.4	0.2	0.5	-0.4	0.0	-0.4	-0.4
FRC 168	52-2-0541	325	331	-6	2.3	2.3	-0.0	0.4	0.4	0.0	-0.2	-0.2	0.0
FRC 169	52-2-0747	763	813	-49	4.5	6.5	-2.0	0.1	0.8	-0.7	-1.2	-1.3	-0.1
FRC 17	52-2-0121	311	335	-25	2.1	2.4	-0.3	0.4	0.4	-0.0	-0.2	-0.2	0.0
FRC 171	52-2-0734	7	381	-375	0.1	0.9	-0.9	0.0	0.5	-0.4	0.0	-1.6	-1.6
FRC 172	52-2-0735	32	395	-363	0.3	1.1	-0.8	0.0	0.4	-0.4	-0.1	-0.6	-0.5
FRC 176	52-2-0826	931	1223	-292	0.3	0.8	-0.5	0.6	0.6	-0.0	-0.2	-0.7	-0.5
FRC 180	52-2-0828	214	389	-175	2.2	0.2	2.0	0.3	0.4	-0.1	-0.1	-0.5	-0.4
FRC 184	52-2-0222	418	361	58	1.2	1.0	0.2	0.7	0.4	0.3	-0.1	-1.1	-0.9
FRC 185	52-2-0223	413	363	50	0.4	0.3	0.1	0.1	0.8	-0.7	-0.3	-0.3	0.0
FRC 186	52-2-0224	430	364	66	0.4	0.7	-0.3	0.1	0.4	-0.3	-0.2	-1.0	-0.8
FRC 187	52-2-0225	434	372	62	0.4	0.4	-0.1	0.1	0.4	-0.3	-0.2	-0.4	-0.2
FRC 189	52-2-0180	391	340	50	0.3	0.5	-0.2	0.3	0.7	-0.4	-0.3	-0.4	-0.0
FRC 191	52-2-0183	424	360	65	1.0	0.6	0.5	0.3	0.8	-0.5	-0.9	-0.3	0.6
FRC 193	52-2-0144	40	970	-930	0.3	2.0	-1.7	0.0	0.6	-0.6	0.0	-0.7	-0.7
FRC 194	52-2-0263	59	356	-297	0.6	0.7	-0.2	0.1	0.9	-0.8	-0.1	-0.3	-0.2
FRC 195	52-2-0264	35	353	-318	0.3	1.4	-1.1	0.0	0.6	-0.5	0.0	-1.4	-1.3
FRC 198	52-2-0268	384	363	21	0.4	0.9	-0.6	0.1	0.6	-0.5	-0.3	-0.4	-0.1
FRC 199	52-2-0265	63	370	-306	0.7	0.7	-0.0	0.1	0.8	-0.7	0.0	-0.3	-0.3
FRC 20	52-2-0107	523	553	-30	2.3	2.4	-0.2	0.0	0.1	-0.1	-0.1	-0.1	-0.0
FRC 201	52-2-0267	321	349	-27	4.1	4.3	-0.2	0.5	0.6	-0.0	-0.2	-0.2	-0.0
FRC 21	52-2-0105	747	768	-21	4.8	5.0	-0.1	1.5	1.6	-0.1	-1.0	-1.1	-0.1
FRC 22	52-2-0145	84	1143	-1,060	0.4	1.1	-0.7	0.1	0.7	-0.6	0.0	-0.4	-0.4
FRC 23	52-2-0161	1078	1116	-38	1.5	1.7	-0.2	0.2	0.4	-0.2	-1.0	-1.0	0.0
FRC 24.1	52-2-159	386	1139	-754	3.4	0.8	2.6	0.2	0.4	-0.2	-0.5	-1.2	-0.7
FRC 24.2	52-2-0160	307	1074	-767	3.3	0.9	2.5	0.4	0.9	-0.5	-0.2	-0.3	-0.1
FRC 25	52-2-0129	817	1240	-423	1.4	1.8	-0.5	0.6	0.6	-0.0	-0.7	-1.0	-0.4
FRC 253	52-2-0738	41	372	-331	0.2	1.0	-0.8	0.1	0.8	-0.8	0.0	-0.9	-0.9
FRC 254	52-2-0829	418	342	76	0.4	1.4	-1.0	0.3	1.0	-0.7	-0.2	-0.5	-0.2
FRC 26	52-2-0135	36	1145	-1,110	0.4	0.9	-0.4	0.1	0.8	-0.7	0.0	-0.7	-0.6
FRC 266	N/A	242	257	-15	1.6	1.7	-0.2	0.4	0.4	-0.0	0.0	0.0	-0.0
FRC 272	52-2-3074	1005	1094	-89	2.3	1.6	0.7	1.0	1.1	-0.1	-0.9	-0.9	-0.0
FRC 273	52-2-3075	1021	1100	-79	2.3	1.4	0.8	0.3	0.4	-0.1	-1.0	-1.0	0.0
FRC 274	N/A	525	1213	-688	3.0	1.1	1.9	0.1	0.4	-0.3	-0.4	-0.5	-0.1
FRC 275	N/A	640	1221	-581	2.7	1.3	1.4	0.4	0.6	-0.2	-0.5	-0.8	-0.4
FRC 276	52-2-3078	52	1156	-1,104	0.6	0.5	0.1	0.1	0.3	-0.2	0.0	-1.0	-0.9
FRC 277	52-2-3079	36	1169	-1,134	0.3	0.7	-0.4	0.0	0.6	-0.6	0.0	-0.2	-0.2
FRC 278	52-2-3080	352	357	-5	2.5	2.6	-0.1	0.5	0.5	-0.0	-0.2	-0.2	-0.0
FRC 279	52-2-3081	972	1002	-30	2.8	3.1	-0.2	0.4	0.4	0.0	-0.4	-0.4	-0.0
FRC 28	52-2-0154	31	399	-368	0.1	0.8	-0.6	0.1	0.5	-0.3	-0.1	-2.0	-1.9
FRC 280	52-2-3082	982	1059	-77	1.1	0.7	0.4	1.0	1.0	-0.0	0.0	-0.2	-0.2
FRC 281	52-2-3083	796	1041	-245	2.4	1.2	1.2	0.8	0.8	-0.0	-0.3	-0.3	0.1
FRC 283	52-2-3085	93	1172	-1,079	0.5	0.8	-0.3	0.1	0.7	-0.6	0.0	-0.4	-0.4
FRC 284	52-2-3086	217	1118	-901	1.6	1.8	-0.2	0.4	0.4	-0.0	0.0	-0.8	-0.8
FRC 285	52-2-3097	939	1120	-181	0.5	2.0	-1.5	0.2	0.5	-0.3	-0.4	-0.4	-0.0
FRC 29	52-2-0155	38	412	-374	0.2	1.0	-0.8	0.0	0.5	-0.4	0.0	-0.5	-0.5
FRC 30	52-2-0200	50	418	-368	0.3	0.8	-0.5	0.1	0.6	-0.5	0.0	-0.3	-0.3
FRC 301	N/A	963	1080	-117	1.7	2.5	-0.8	0.2	0.4	-0.2	-1.0	-1.4	-0.5
FRC 302	N/A	13	15	-2	0.2	0.2	-0.0	0.0	0.0	-0.0	0.0	0.0	0.0
FRC 304	N/A	223	225	-3	1.3	1.3	-0.0	0.4	0.4	-0.0	-0.1	-0.1	-0.0
FRC 305	N/A	898	1086	-188	1.4	2.4	-1.0	0.4	0.4	-0.0	-0.4	-1.0	-0.6
FRC 306	N/A	925	1056	-130	1.8	1.6	0.2	1.1	1.1	-0.0	-0.2	-0.4	-0.1
FRC 307	N/A	24	378	-354	0.1	2.1	-2.0	0.1	1.0	-0.8	0.0	-2.0	-2.0
FRC 308	N/A	36	347	-311	0.5	3.9	-3.4	0.1	1.0	-0.9	0.0	-1.3	-1.3
FRC 309	N/A	451	381	70	0.7	0.8	-0.1	0.2	0.7	-0.5	-0.3	-0.9	-0.6

Table A.101 - Metropolitan Colliery - Comparison of Predicted Systematic Subsidence Parameters for the Archaeological sites using Preferred Project Layout and Base Case

Label	AHIMS Site No.	Total Subs after LW317	Total Subs after LW44	Difference	Total Maximum Tilt after LW317	Total Tilt after LW44	Difference	Maximum Predicted Tensile Strain during or after LW317	Maximum Predicted Tensile Strain during or after LW44	Difference	Maximum Predicted Comp. Strain during or after LW317	Maximum Predicted Comp. Strain during or after LW44	Difference
		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout	
FRC 31	52-2-0722	39	409	-370	0.2	0.5	-0.3	0.0	0.4	-0.4	0.0	-0.9	-0.9
FRC 310	N/A	469	471	-3	0.5	0.6	-0.1	0.1	0.6	-0.5	-0.4	-0.5	-0.1
FRC 311	N/A	398	376	22	0.4	1.0	-0.6	0.4	0.4	0.0	-0.4	-0.9	-0.5
FRC 312	N/A	438	372	66	0.4	1.0	-0.7	0.1	0.5	-0.4	-0.2	-0.6	-0.4
FRC 313	N/A	448	532	-84	0.9	1.8	-0.9	0.6	0.5	0.1	-0.5	-0.2	0.4
FRC 314	N/A	444	400	43	0.4	0.6	-0.3	0.1	0.4	-0.3	-0.2	-0.3	-0.1
FRC 315	N/A	448	403	45	0.4	0.7	-0.3	0.1	0.4	-0.3	-0.1	-0.3	-0.2
FRC 317	N/A	456	414	42	0.4	1.0	-0.6	0.1	0.5	-0.4	-0.2	-0.8	-0.6
FRC 319	N/A	889	968	-78	1.0	0.6	0.4	0.8	0.5	0.3	0.0	-0.5	-0.5
FRC 32	52-2-0194	42	413	-372	0.1	0.2	-0.1	0.0	0.4	-0.4	0.0	-0.5	-0.5
FRC 320	N/A	74	396	-322	0.7	0.7	-0.0	0.2	0.6	-0.4	0.0	-0.3	-0.3
FRC 321	N/A	119	389	-270	1.4	0.5	0.9	0.3	0.4	-0.1	0.0	-1.4	-1.4
FRC 322	N/A	118	486	-368	1.5	0.5	1.0	0.2	0.4	-0.2	0.0	-0.3	-0.3
FRC 323	N/A	30	360	-329	0.3	1.4	-1.1	0.0	1.1	-1.1	0.0	-0.3	-0.3
FRC 324	N/A	21	361	-340	0.2	0.9	-0.7	0.0	0.7	-0.7	0.0	-1.1	-1.1
FRC 325	N/A	455	388	67	0.4	1.7	-1.3	0.4	1.3	-0.8	-0.1	-0.3	-0.1
FRC 33	52-2-0188	46	409	-363	0.4	0.3	0.1	0.1	0.7	-0.6	0.0	-0.3	-0.3
FRC 34	52-2-0195	43	361	-318	0.2	1.1	-0.8	0.1	1.0	-0.9	0.0	-0.3	-0.3
FRC 340	N/A	449	371	78	1.2	0.3	0.9	0.4	0.4	-0.1	-0.9	-0.4	0.6
FRC 342	N/A	66	1206	-1,139	0.5	0.6	-0.1	0.1	0.6	-0.5	0.0	-0.6	-0.6
FRC 343	N/A	70	296	-226	0.6	2.1	-1.5	0.1	0.4	-0.4	0.0	-0.1	-0.1
FRC 344	N/A	443	410	33	0.4	0.4	-0.1	0.1	0.4	-0.3	-0.1	-0.4	-0.3
FRC 345	N/A	438	411	27	0.4	0.8	-0.4	0.1	0.3	-0.2	-0.3	-0.2	0.1
FRC 40	52-2-0333	302	1257	-954	3.2	1.5	1.7	0.4	0.6	-0.2	0.0	-1.2	-1.2
FRC 44	52-2-0103	353	1236	-883	3.1	0.9	2.2	0.3	0.6	-0.3	-0.2	-1.2	-1.0
FRC 45	52-2-0102	277	1169	-892	2.7	0.6	2.1	0.3	0.4	-0.1	-0.1	-0.3	-0.2
FRC 46	52-2-0408	88	1100	-1,012	1.1	1.2	-0.1	0.1	0.4	-0.3	0.0	-1.3	-1.3
FRC 52	52-2-0257	22	1115	-1,093	0.2	0.5	-0.3	0.0	0.4	-0.3	0.0	-0.3	-0.3
FRC 57	2-258, 52-2-3	604	605	-1	6.2	6.2	0.0	1.0	1.0	0.0	-0.6	-0.6	-0.0
FRC 60	52-2-0177	843	814	29	3.0	0.5	2.5	0.2	0.3	-0.1	-0.7	-0.9	-0.1
FRC 61	52-2-0152	37	664	-627	0.3	2.0	-1.7	0.0	0.6	-0.5	0.0	-0.8	-0.8
FRC 62	52-2-0168	26	452	-426	0.2	2.0	-1.8	0.0	0.5	-0.5	0.0	-0.6	-0.6
FRC 67	52-2-0185	439	382	57	1.2	0.9	0.3	0.3	0.5	-0.2	-0.5	-0.5	0.0
FRC 68	52-2-0186	454	382	72	0.9	0.7	0.2	0.3	0.4	-0.1	-0.7	-0.5	0.1
FRC 70	52-2-0192	438	381	57	0.6	0.6	0.0	0.1	0.4	-0.3	-0.3	-1.1	-0.7
FRC 71	N/A	445	396	49	0.6	0.1	0.4	0.4	0.6	-0.2	-0.3	-0.5	-0.2
FRC 72	52-2-0199	69	608	-539	0.7	3.2	-2.5	0.1	1.2	-1.1	0.0	-1.5	-1.5
FRC 76	N/A	511	459	52	0.7	0.6	0.1	0.2	0.7	-0.5	-0.3	-0.3	-0.0
FRC 77	52-2-0330	500	459	41	0.5	0.5	0.1	0.2	0.3	-0.1	-0.7	-0.3	0.4
FRC 78	52-2-0885	497	455	42	0.6	0.4	0.1	0.2	0.4	-0.2	-0.2	-0.3	-0.1
FRC 87	52-2-0899	443	432	11	0.6	0.8	-0.2	0.5	0.6	-0.1	-0.1	-0.5	-0.4
FRC 93	52-2-0198	396	395	1	0.9	1.0	-0.1	0.7	0.3	0.4	-0.1	-0.8	-0.7
FRC 94	52-2-0873	418	401	18	0.3	0.5	-0.1	0.2	0.7	-0.5	-0.1	-0.3	-0.1
FRC 97	52-2-0220	425	352	73	0.4	0.6	-0.2	0.1	0.8	-0.7	-0.3	-0.3	0.0
MET 1	-	1052	1091	-40	1.8	2.0	-0.2	0.2	0.4	-0.2	-1.1	-1.1	0.0
NEW 1	N/A	433	418	15	0.5	0.9	-0.4	0.6	0.4	0.3	-0.4	-0.2	0.2
NEW 15	N/A	11	9	2	0.1	0.2	-0.1	0.0	0.1	-0.0	0.0	0.0	-0.0
NEW 16	N/A	15	12	3	0.1	0.2	-0.1	0.0	0.0	-0.0	0.0	0.0	-0.0
NEW 17	-	78	70	7	0.8	1.8	-1.0	0.2	0.3	-0.2	0.0	-0.1	-0.0
NEW 18	N/A	18	16	2	0.2	0.3	-0.2	0.0	0.0	-0.0	0.0	0.0	0.0
NEW 19	N/A	160	165	-6	1.9	3.9	-2.0	0.3	0.5	-0.2	0.0	-0.1	-0.1
NEW 2	N/A	466	385	81	1.1	0.9	0.2	0.4	0.6	-0.2	-0.9	-0.2	0.7
NEW 20	N/A	12	15	-3	0.1	0.4	-0.2	0.0	0.1	-0.1	0.0	0.0	-0.0
NEW 9	N/A	15	12	3	0.1	0.2	-0.1	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 19	N/A	463	344	119	0.5	1.0	-0.5	0.3	0.3	-0.0	-0.8	-0.6	0.1
NT 3	N/A	471	391	80	0.8	0.7	0.1	0.4	0.7	-0.3	-0.8	-0.3	0.5
NT 78	N/A	438	346	92	0.8	0.4	0.5	0.5	0.7	-0.2	-0.3	-0.4	-0.1
NT 79	N/A	434	371	63	0.8	0.3	0.5	0.5	0.6	-0.0	-0.3	-0.3	-0.0
NT 8	N/A	475	389	86	0.8	0.7	0.2	0.4	0.3	0.1	-0.8	-0.5	0.3
NT 80	N/A	454	390	64	1.1	0.4	0.7	0.5	0.5	0.0	-0.2	-0.3	-0.1
NT 81	N/A	471	379	93	0.4	0.5	-0.1	0.1	0.5	-0.4	-0.1	-0.3	-0.2
NT 9	N/A	469	385	84	0.9	0.3	0.6	0.4	0.5	-0.1	-0.4	-0.2	0.2
PAD 2	N/A	641	661	-19	4.5	4.7	-0.2	1.5	1.6	-0.1	-0.3	-0.3	-0.0
NT 10	52-2-625	61	264	-203	0.5	2.9	-2.4	0.1	0.5	-0.5	0.0	0.0	-0.0
NT 12	52-2-753	57	246	-189	0.4	2.7	-2.2	0.1	0.5	-0.5	0.0	0.0	-0.0
NT 18	52-2-751	400	368	33	1.0	0.7	0.3	0.3	0.2	0.1	-0.7	-0.5	0.2
NT 22	52-2-758	1	8	-8	0.0	0.2	-0.2	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 23	52-2-631	0	6	-6	0.0	0.2	-0.2	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 52	52-2-652	4	38	-34	0.0	0.3	-0.3	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 53	52-2-371	9	45	-36	0.1	0.4	-0.3	0.0	0.0	-0.0	0.0	0.0	-0.0

Table A.101 - Metropolitan Colliery - Comparison of Predicted Systematic Subsidence Parameters for the Archaeological sites using Preferred Project Layout and Base Case

Label	**AHIMS Site No.**	Total Subs after LW317	Total Subs after LW44	Difference	Total Maximum Tilt after LW317	Total Tilt after LW44	Difference	Maximum Predicted Tensile Strain during or after LW317	Maximum Predicted Tensile Strain during or after LW44	Difference	Maximum Predicted Comp. Strain during or after LW317	Maximum Predicted Comp. Strain during or after LW44	Difference
		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout	
NT 54	52-2-374	10	55	-45	0.1	0.5	-0.4	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 74	52-2-658	334	361	-27	1.6	1.5	0.1	0.1	0.5	-0.4	-0.3	-0.3	-0.0
NT 75	52-2-659	363	364	-1	1.3	1.2	0.1	0.1	0.4	-0.3	-0.1	-0.3	-0.2
NT 76	52-2-660	0	0	-0	0.0	0.0	-0.0	0.0	0.0	-0.0	0.0	0.0	-0.0
NT 85	N/A	366	355	11	1.3	1.1	0.2	0.1	0.3	-0.2	-0.1	-0.5	-0.4
NT 86	N/A	5	16	-11	0.0	0.3	-0.3	0.0	0.0	-0.0	0.0	0.0	-0.0

Table A.102 - Metropolitan Colliery - Comparison of Predicted Systematic Subsidence Parameters for the Cliffs using Preferred Project Layout and Base Case

Location	MGA Easting (m)	MGA Northing (m)	ID	Total Subs after LW317	Total Subs after LW44	Difference	Total Tilt during or after LW317	Total Tilt during or after LW44	Difference	Maximum Predicted Tensile Strain during or after LW317	Maximum Predicted Tensile Strain during or after LW44	Difference	Maximum Predicted Comp. Strain during or after LW317	Maximum Predicted Comp. Strain during or after LW44	Difference
				Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout		Preferred Project Layout	Base Case Layout	
COH1	Varies	Varies	1	458	493	-35	2.0	2.1	-0.2	0.2	0.4	-0.3	-0.3	-0.3	-0.0
COH2	Varies	Varies	2	684	748	-65	4.7	5.3	-0.6	1.3	1.3	0.0	-0.9	-0.9	0.0
COH3	Varies	Varies	3	13	1078	-1,065	0.1	3.6	-3.4	0.1	0.4	-0.4	0.0	-1.5	-1.5
COH4	Varies	Varies	4	10	1049	-1,039	0.1	3.8	-3.7	0.1	1.0	-0.9	0.0	-1.4	-1.4
COH5	Varies	Varies	5	5	400	-395	0.0	1.0	-1.0	0.0	1.1	-1.1	0.0	-0.3	-0.3
COH6	Varies	Varies	6	6	397	-391	0.1	1.2	-1.1	0.0	1.2	-1.2	0.0	-0.3	-0.3
COH7	Varies	Varies	7	6	393	-387	0.0	0.9	-0.9	0.0	0.5	-0.4	0.0	-1.1	-1.1
COH8	Varies	Varies	8	7	369	-362	0.0	1.9	-1.9	0.0	1.0	-1.0	0.0	-1.7	-1.7
COH9	Varies	Varies	9	45	363	-318	0.4	1.7	-1.2	0.1	1.1	-1.0	0.0	-0.3	-0.3
COH10	Varies	Varies	10	144	370	-226	1.8	0.9	0.9	0.3	0.5	-0.2	-0.2	-1.2	-0.9
COH11	Varies	Varies	11	404	347	56	0.4	1.6	-1.3	0.2	0.7	-0.5	-0.2	-1.7	-1.4
COH12	Varies	Varies	12	405	338	67	0.8	1.8	-0.9	0.3	1.3	-0.9	-0.7	-1.0	-0.3
COH13	Varies	Varies	13	404	370	34	0.7	1.1	-0.4	0.6	0.4	0.2	-0.4	-1.8	-1.4
COH14	Varies	Varies	14	132	1204	-1,071	1.4	2.2	-0.8	0.3	0.5	-0.2	-0.1	-0.9	-0.8
COH15	Varies	Varies	15	3	439	-437	0.0	1.0	-1.0	0.0	0.4	-0.4	0.0	-1.1	-1.1
COH16	Varies	Varies	16	15	381	-366	0.1	1.1	-0.9	0.1	0.5	-0.3	-0.1	-1.3	-1.3

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15 May 2009

Helensburgh Coal Pty Ltd
Metropolitan Colliery
PO Box 402
Helensburgh
NSW 2508

Attention: Greg Tarrant

Metropolitan Colliery – Preferred Project Layout (Longwalls 20 to 27 and 301 to 317)
Technical Discussion Systematic Tensile and compressive Strains and
Closure Strains in Swamps S76, S77 and S92

Dear Greg,

SYSTEMATIC TENSILE AND COMPRESSIVE STRAINS IN SWAMPS S76, S77 AND S92

Strain is the most difficult parameter to predict, as it is dependent on numerous factors including magnitude of ground curvature, magnitude of horizontal movement, the locations of joints at bedrock, the depths to bedrock, topographical features and local geology. Observed strain profiles, therefore, often appear to be quite irregular, that is, they have a saw toothed shape rather than a smooth shape.

The larger observed tensile strains tend to occur adjacent to the longwall goaf edges or chain pillars, in the locations of hogging (i.e.: convex) curvature, and the larger observed compressive strains tend to occur near the low point of the subsidence trough, in the locations of sagging (i.e.: concave) curvature.

In practice, however, the locations expected to experience tensile strain can also experience compressive strain, whilst the locations expected to experience compressive strain can also experience tensile strain. This is illustrated in Figure 1, which show a sample distribution of strain measured in locations of hogging curvature (left) and measured in the locations of sagging curvature (right).

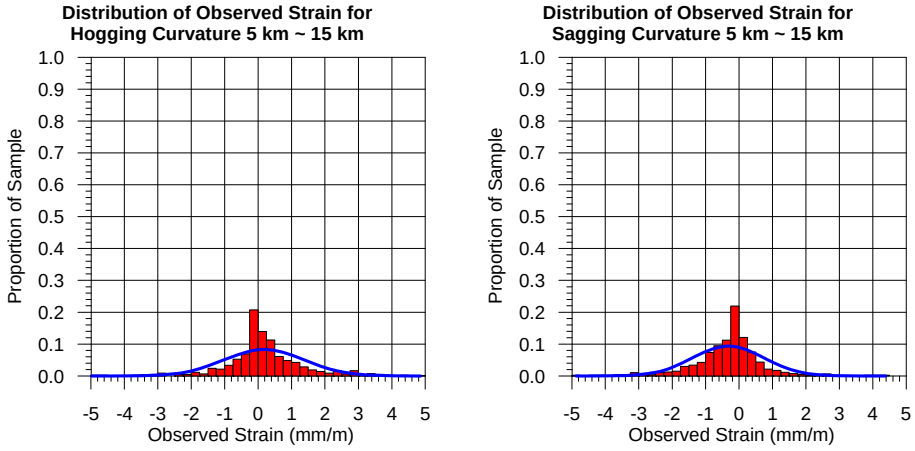

Figure 1 Distribution of Ground Strains Measured in Locations of Hogging Curvature (Left) and Measured in Locations of Sagging Curvature (Right)

It can be seen from the left graph, that locations of hogging curvature are more likely to experience tensile strains than compressive strains and, from the right graph, that locations of sagging curvature are more likely

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to experience compressive strains than tensile strains. However, it can also be seen from these graphs, that large tensile and compressive strains can occur in locations of both hogging curvature and sagging curvature. In this way, the locations of the maximum observed tensile and compressive strains can, in fact, occur anywhere above extracted longwalls. As a result of these observations, it is considered more appropriate to assess a probability of occurrence of strain rather than trying to attempt specific predictions of strain at a point.

The probabilities of exceedance of strain for the swamps have, therefore, been determined using measured strains anywhere above previously extracted longwalls and, therefore, the same probability has been adopted regardless of the position above the longwall. These probabilities will, in fact, be greater for some locations and less for other locations, but when considered for a continuous feature which crosses from the edge to the middle of a longwall, such as for the swamps, these probabilities average out.

Contour plots of predicted curvature for Swamps S76, S77 and S92 are shown in Figure 2, Figure 3, and Figure 4, respectively with the labels showing the magnitudes in units of 1/km. The contour plots show blue contours for sagging curvature (i.e. higher probabilities of compressive strain) and red contours for hogging curvature (i.e. higher probabilities of tensile strain). Some of the blue and red contour lines can be seen to overlap in Figure 3 and Figure 4. Where this occurs, it indicates that both sagging and hogging curvature are occurring at these locations but the directions are orthogonal (i.e. a geometric saddle-shape). The plots also show the drainage lines that pass through the swamps.

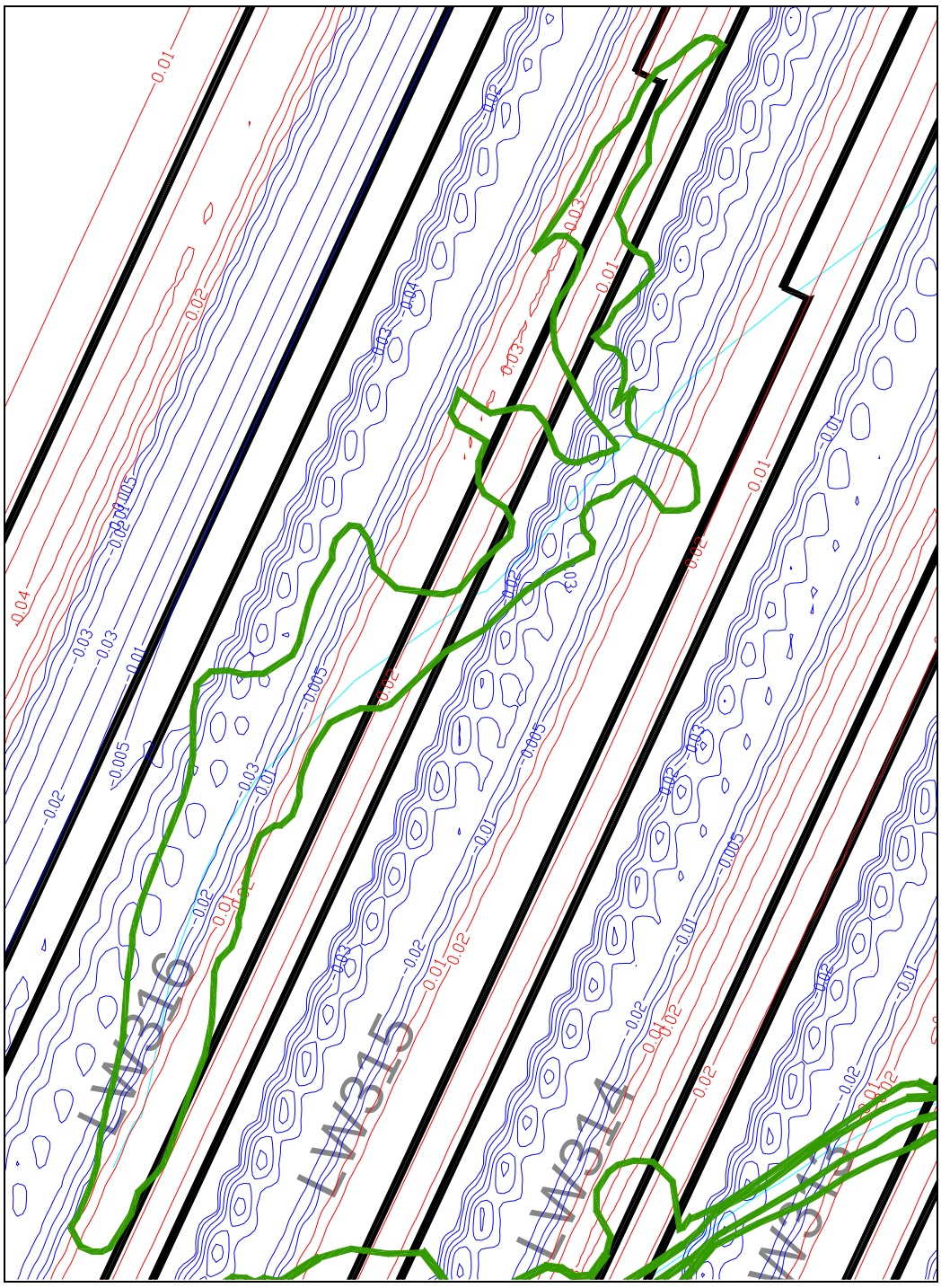

Figure 2 SWAMP S76 – Predicted Total Curvature Contours after the Extraction of all Longwalls

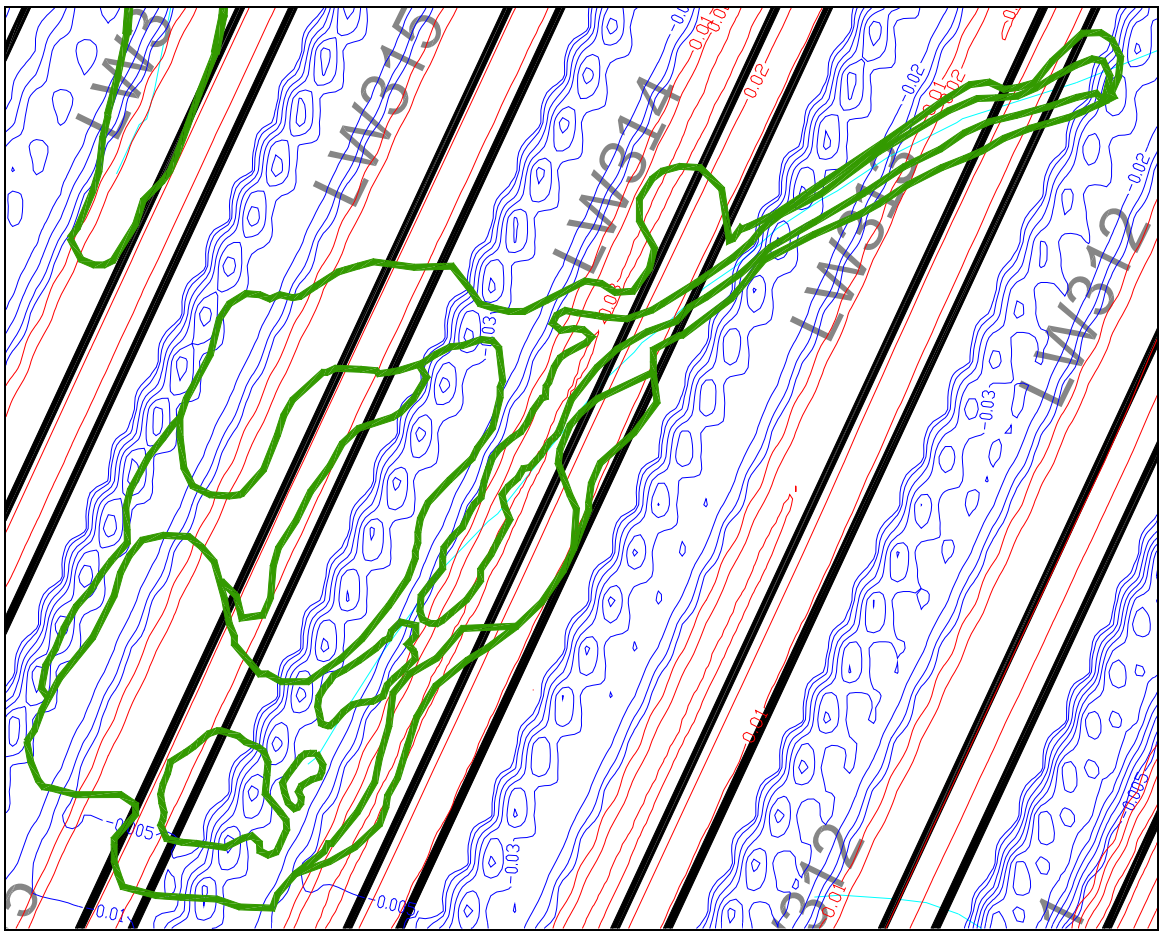

Figure 3 SWAMP S77 – Predicted Total Curvature Contours after the Extraction of all Longwalls

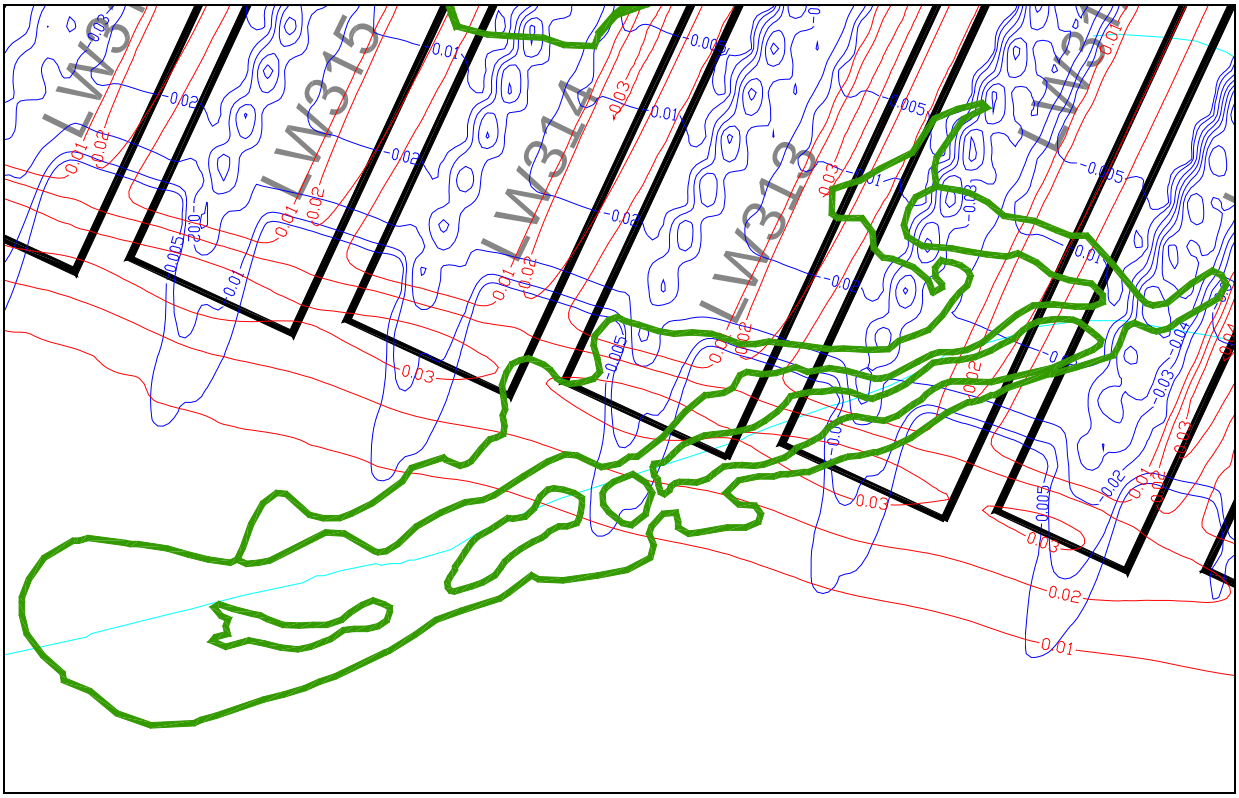

Figure 4 SWAMP S92 – Predicted Total Curvature Contours after the Extraction of all Longwalls

To assess the probability of exceedance of strain values for the swamps, a frequency analysis has been undertaken of observed strains along the D Line during the mining of Longwalls 8 to 15b.

Frequency histograms of maximum measured total tensile and compressive strain for all survey bays when they were located directly above goaf are shown in Figure 5. The dataset has been collected in the following manner:

- The dataset includes the maximum tensile and compressive strain measured at any stage during mining when each survey bay was located directly above goaf.
- If a survey bay only recorded tensile strain, the maximum measured compressive strain is counted as zero. The same approach was undertaken for calculating maximum measured compressive strains.
- Clear and obvious survey errors have been removed from the analysis.
- Strains measured for survey bays located directly above Longwalls 4 to 7 were not included in the analysis as strain surveys first commenced when Longwall 8 was mined. Strains measured between pegs located above Longwalls 4 to 7 do not capture the total strains that occurred due to all mining.
- Strains measured at the bases of valleys have been included in the analysis.

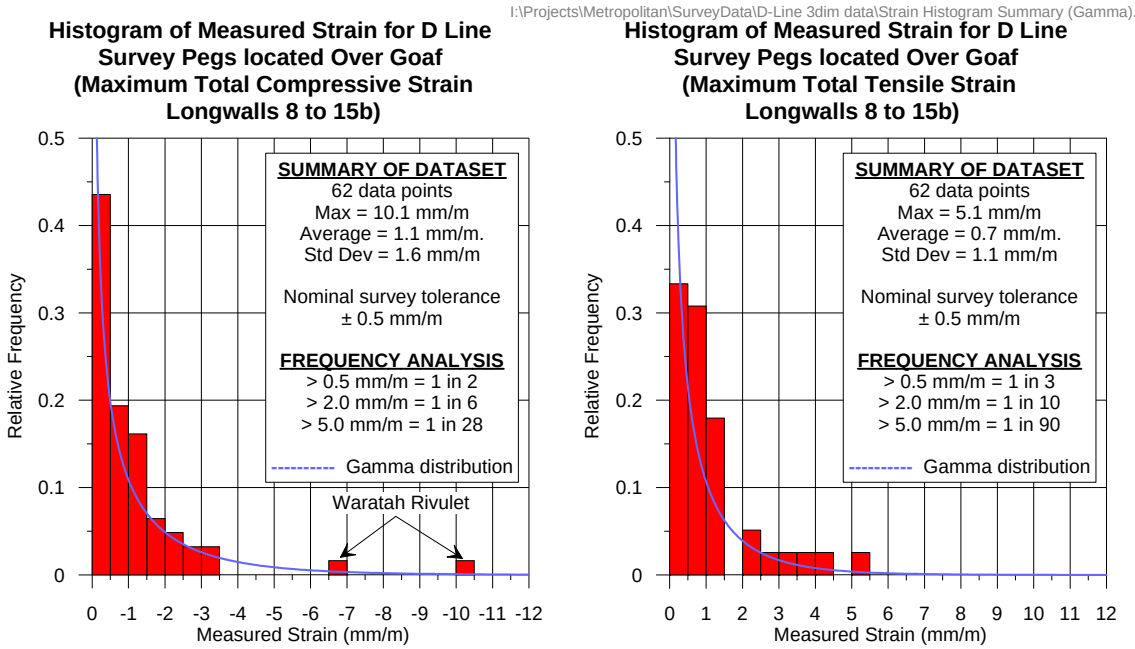

Figure 5 Frequency Histograms of Maximum Observed Strains for survey pegs located directly above goaf along D Line

It was observed that a number of the higher observed compressive strains were measured in the bases of valleys, as expected. These measurements were filtered from the dataset and a frequency histogram of measured compressive strains above goaf excluding pegs located in the bases of valleys is shown in Figure 6.

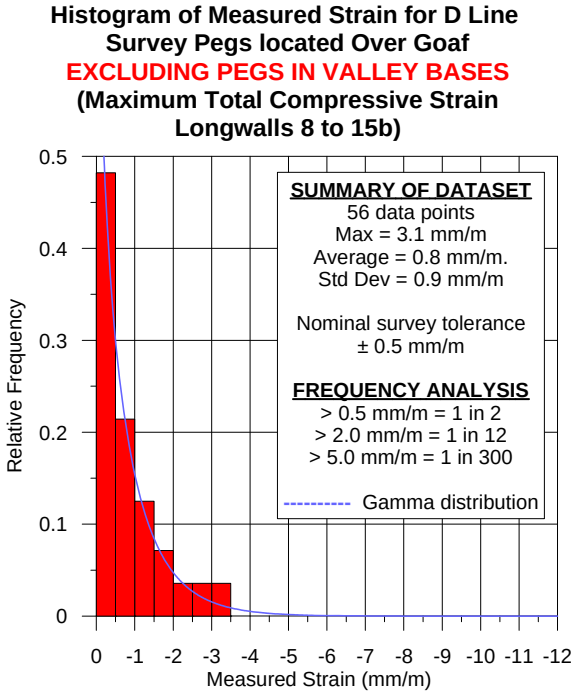

Figure 6 Frequency Histograms of Maximum Observed Compressive Strains for survey pegs located directly above goaf along D Line (excluding pegs in valleys)

It can be seen from Figure 5 and Figure 6 that the majority of maximum observed tensile and compressive strains were less than 2 mm/m. There were, however, a small proportion (i.e. 8% and 15%) of instances where observed strains exceeded 2 mm/m.

A similar frequency analysis was undertaken of maximum strains measured between survey pegs when they were located over solid coal. The dataset was limited to pegs located within 300 metres of the closest goaf edge, which approximates a 35º angle of draw line. The results are shown in Figure 7.

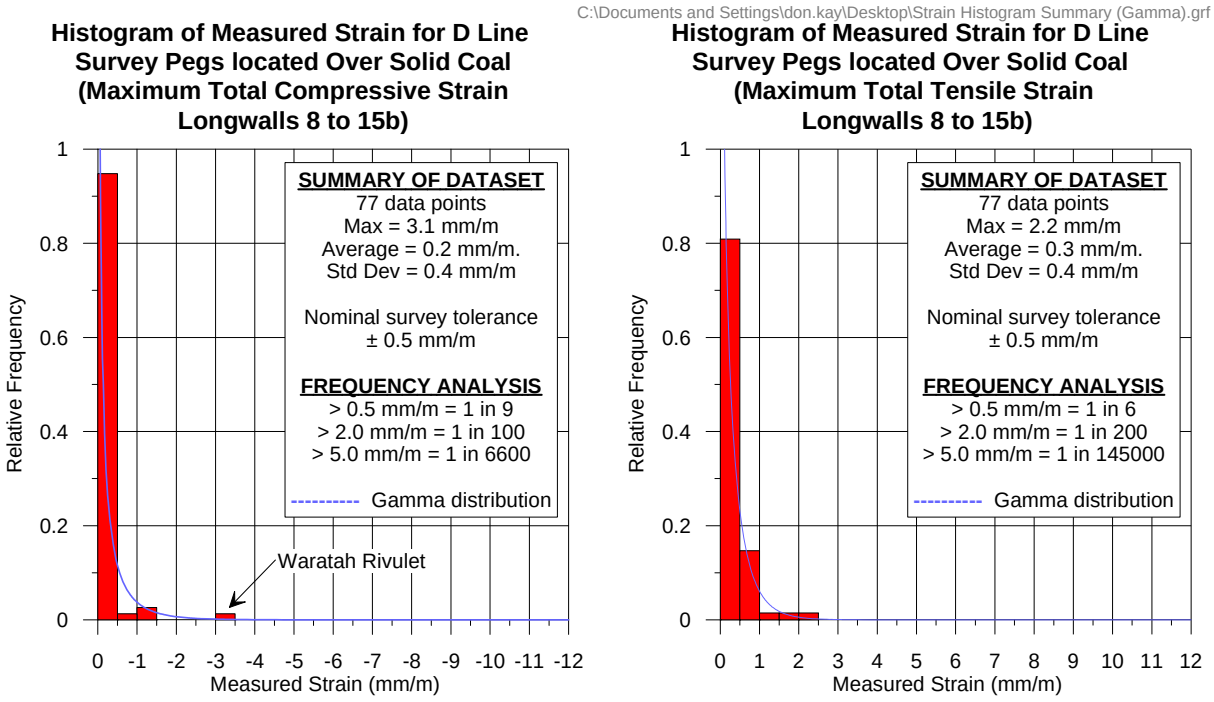

Figure 7 Frequency Histograms of Maximum Observed Strains for survey pegs located directly above solid coal along D Line

The reliability of strain predictions, as discussed in Report No. MSEC285 can be placed in context by the frequency analysis provided above.

The frequency analysis of observed strains along the D Line provides a reasonable indication of the strains that will occur during the mining of the proposed longwalls. The probabilities of exceeding strains are indicated in the plots shown in Figure 5, Figure 6, and Figure 7 and these can be used to assess the probabilities of strains in the swamps. Figure 5 and Figure 6 apply to swamps above longwalls. Specific locations of strain cannot be predicted but larger tensile strains are expected to occur in the regions of hogging curvature and larger compressive strains are expected to occur in regions of sagging curvature. For swamp S92, the probabilities in Figure 7 can be used to assess the regions of the swamp that are outside the longwall footprint. It is noted, however, that the analysis is based on the results recorded along one monitoring line only and as a result, the analysis is based on only a limited number of observations.

It can be seen in Figure 5 and Figure 7 that the largest compressive strains occur in the Waratah Rivulet. The valley profiles along the drainage lines through the swamps are much shallower than the Waratah Rivulet. It is expected that the largest potential strains in the swamps would occur near the bases of the drainage lines. Compressive strains due to valley closure are discussed below.

CLOSURE STRAINS IN SWAMPS S76, S77 AND S92

Drainage lines pass through each of the swamps S76, S77 and S92 as shown in Figure 2, Figure 3, and Figure 4. These swamps are located near the headwaters of the drainage lines and as a result have relatively shallow valley profiles.

The maximum predicted closure strains along the drainage lines have been determined from the predicted closures using the procedure that was developed during an ACARP funded study on upsidence and closure (2002) and this procedure is outlined in a document that is available on the MSEC website www.minesubsidence.com . The method uses an upper bound curve that was drawn over a plot of the then available observed closure versus observed strain. The method is recognised as being very conservative. The predicted strains are assessed for a 20m bay length. Plots of the predicted closures and predicted closure strains along the drainage lines through the three swamps are shown in Figure 8.

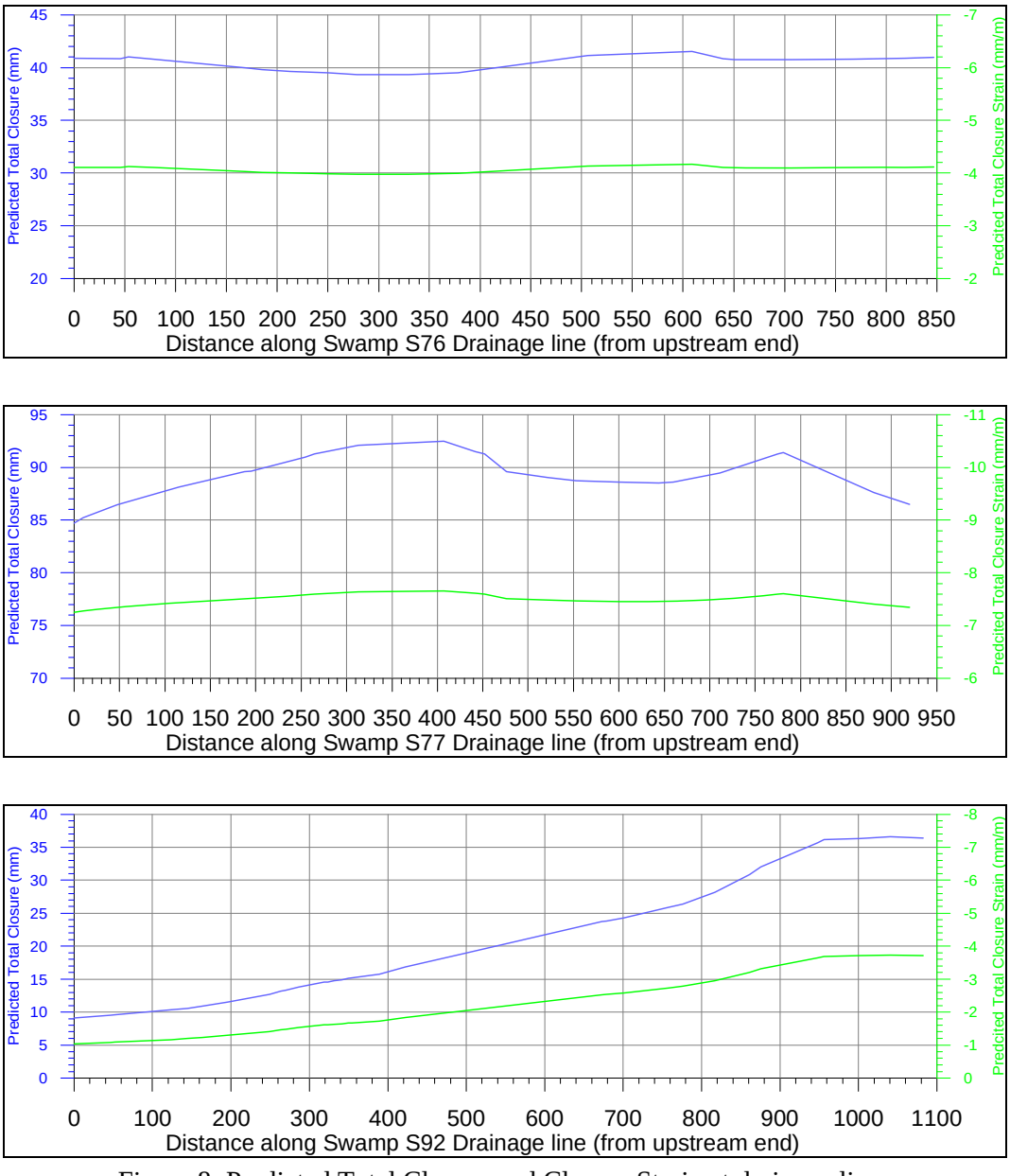

Figure 8 Predicted Total Closure and Closure Strain at drainage lines in Swamps S76, S77 and S92

The above predicted total closures for these drainage lines (blue lines) are relatively small when compared to the maximum predicted total closures of over 1200mm for the Waratah Rivulet, above the previously extracted longwalls.

It would be expected for these shallow valley shapes, with low predicted closures, that the predicted maximum closure strains should also be relatively low. However, as shown in the graphs above, with strains of 4 to 7 mm/m, this is not reflected using the existing method of closure strain prediction. The main drawback with the above method of predicting maximum closure strain is that only a single relationship is used, between closure and strain. In reality there are different factors that need to be taken into consideration when predicting closure strain. For example, a deep valley may experience a relatively high value of closure strain, when compared to a shallow valley, which is more likely to experience a lower value of closure strain. However the valley depth is not included in determining the maximum closure strains.

The shortcomings of the above method are recognised and some work has already been undertaken to improve the method of prediction of maximum closure strains following the recent collection of an increased number of maximum closure strain data points in MSEC's databases. A modified maximum closure strain prediction method has just been developed based on these observed raw maximum closure strains, without any adjustment for differences in the lengths of the bays that the strains were measured between. Further improvements to this method are expected to be made after collecting and assessing further data on the effects of geology on upsidence and closure as part of a programme of research under a new ACARP Research Project C18015. During this study it also is planned to develop a method to predict total maximum closure strains as well as incremental maximum closure strains and it is planned to also provide a probability of exceedance of the predicted maximum closure strains.

For the three swamps in question, MSEC has used this refined maximum closure strain prediction method, that is based on the latest updated database of raw observed maximum closure strains and current bay lengths, to prepare a prediction for maximum closure strains in these swamps. This method was not available during preparation of the subsidence assessment report MSEC285 Rev C (August 2008). It is recognised that this refined method is in its infancy, however, it is considered that the results obtained using this refined method are a considerable improvement over the existing method of predicting closure strains.

The refined method uses four factors to determine a maximum closure strain for the drainage lines in the swamps. The four factors include:

- Valley depth;
- Lateral distances from maingate edges of an incremental panel;
- Longitudinal distances from the end of an incremental panel;
- Maximum incremental subsidence for a panel.

This approach is similar to the method of prediction of valley related upsidence and closure movements that was published in ACARP Research Project No C9067, however, at present the method is based on raw observed incremental strains and not adjusted or normalised strain values.

The preliminary plots of the available observed maximum closure strain data for the above four factors are attached. The following points should be noted:

- Only raw maximum observed incremental closure strains have been plotted;
- The values have not been adjusted or normalised yet to allow for the varying multi-variant influence of the four factors;
- Relevant data labels have been attached to each raw observed strain that indicate the strain bay lengths and the valley heights;
- The graphs should be viewed as interim or draft as they will be adjusted further to allow for geological information as part of the current ACARP project.

It should be noted that preliminary prediction curves have been drawn over the observed raw maximum closure strains and that the largest raw maximum closure strains were measured over short bay lengths.

It is not possible to adjust the measured strains over varying bay lengths to a standardised bay length without making assumptions of on the distributions of strains within each bay length. Hence we can only plot the available strains and record what bay lengths they were measured over. For a given predicted maximum closure strain, we can note the bay length that this measurement was based on.

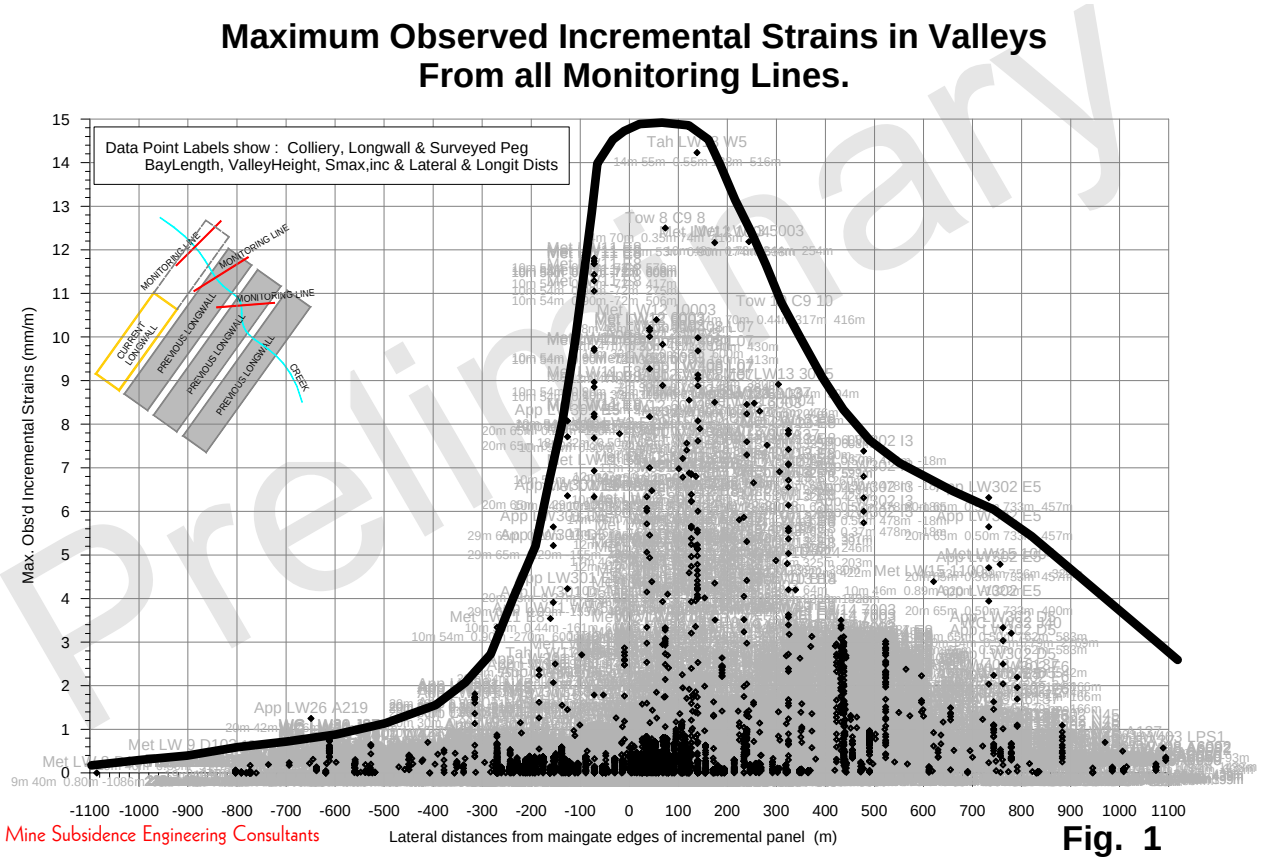

Fig. 1

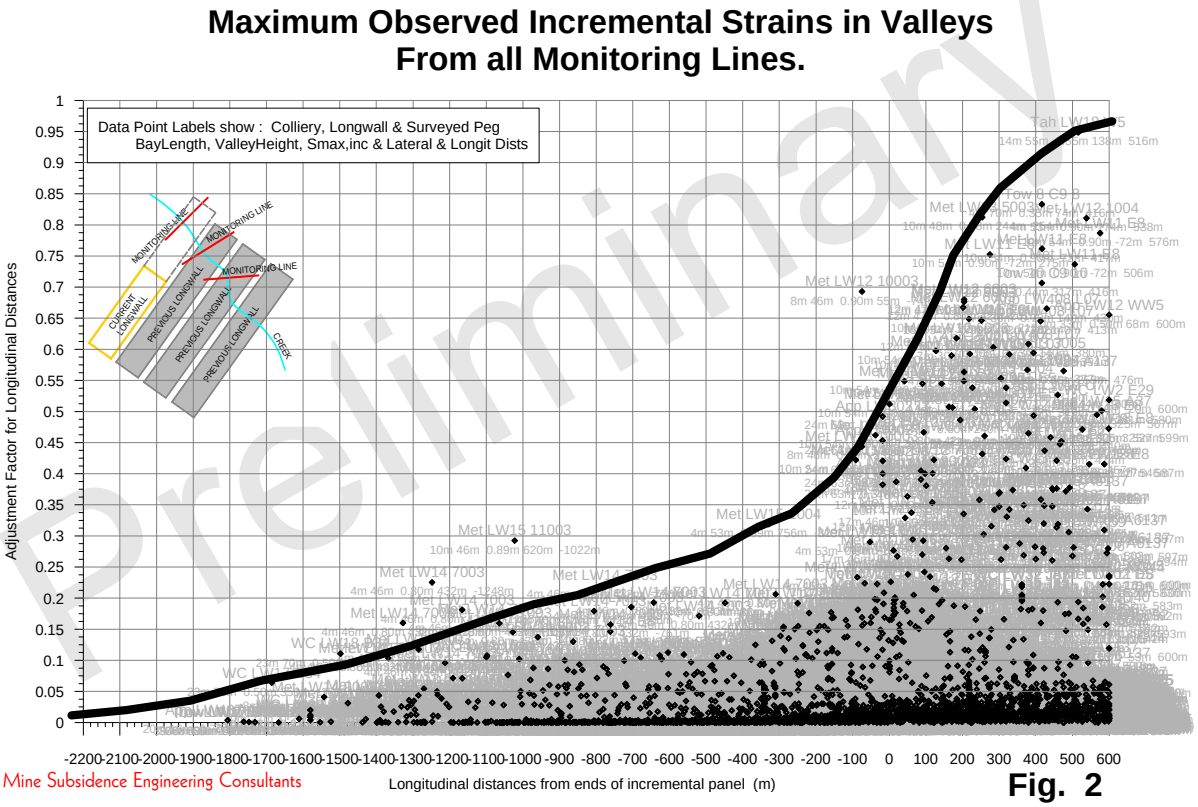

Fig. 2

Preliminary

Maximum Observed Incremental Strains in Valleys From all Monitoring Lines.

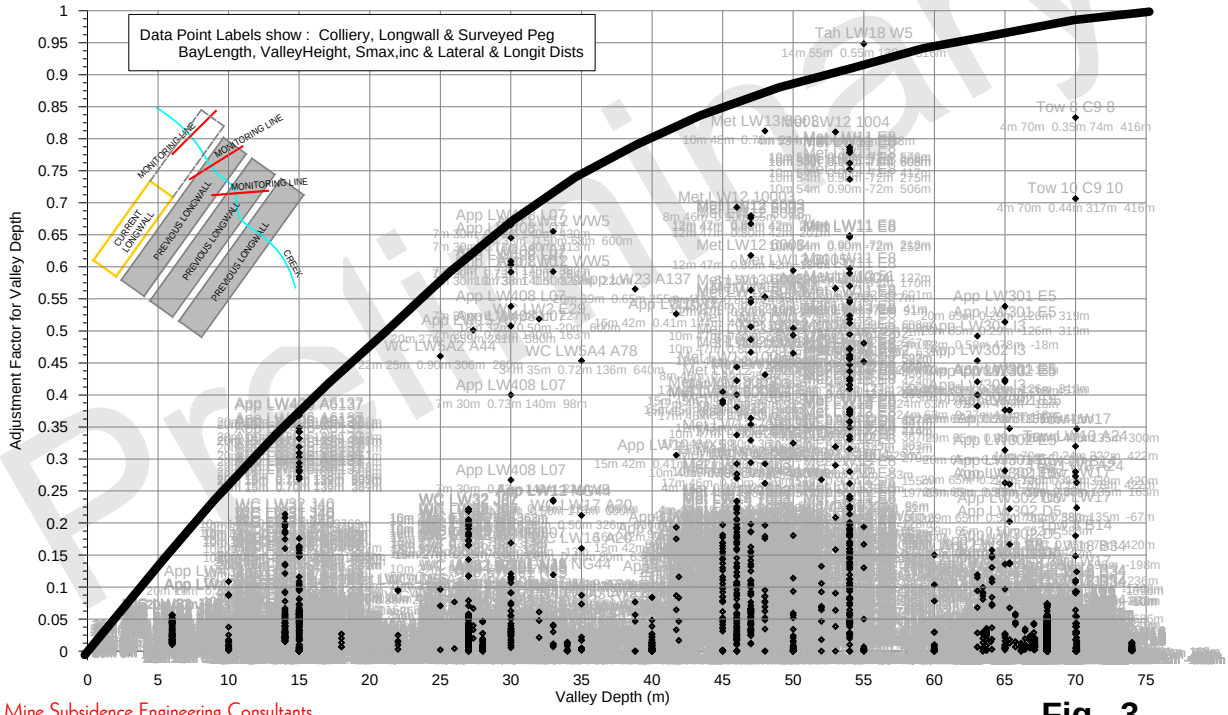

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Fig. 3

Maximum Observed Incremental Strains in Valleys From all Monitoring Lines.

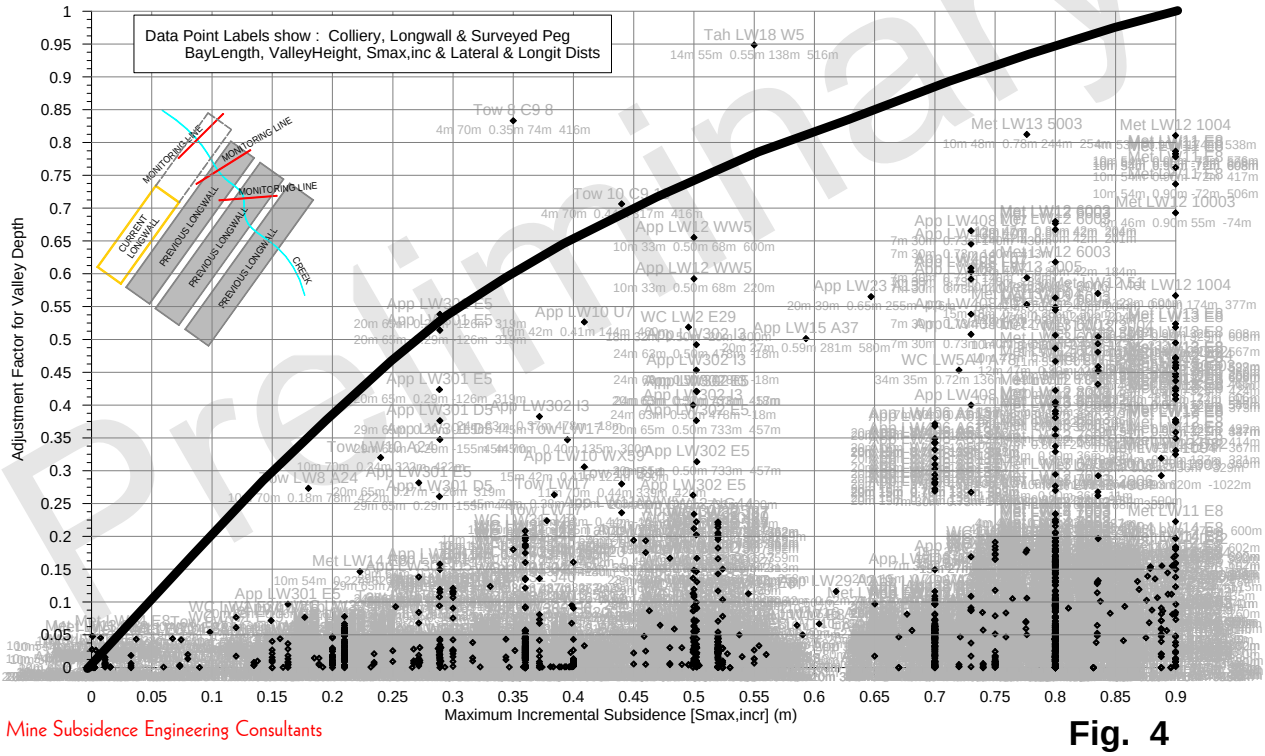

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Fig. 4

Preliminary

Using the above preliminary prediction plots, the predicted incremental maximum closure strains for the swamp drainage lines are as follows:

S76 – 1.0mm/m

S77 – 2.1mm/m

S92 – 0.4mm/m (over solid coal) to 0.8mm/m (over goaf)

These maximum closure strains results are based on incremental panel data. We currently do not have a revised prediction method for total strains. A method addressing total strains will be provided as part of the current ACARP project. It is noted that it is not considered suitable to add incremental results for each panel as the locations of the maximum increments for each longwall occur in different locations along the drainage line and the resulting total would be overly conservative.

These results are more consistent with what would be expected for a valley that approaches the headwaters of a drainage line with a shallow valley profile; i.e. that the predicted closures would be small (which they are), and predicted closure strains would also be small. These results are, however still considered to be very conservative due to high strains produced by short bay lengths in the data sets.