Jorge Van Den Brande

From: [redacted]
[redacted] Wednesday, 11 July 2018 3:26 PM
To: IPCN Enquiries Mailbox; [redacted]
Cc: [redacted]
Subject: Mt Pleasant Coal Mine Modification 3 - Muswellbrook Shire Council - Written Submissions
Attachments: Attachments.html

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2012-2013-0161-Thoma20Mitchell20Drive20.......pdf	5.8 MB
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Attention: Commissioners
Independent Planning Commission: Level 3, 201 Elizabeth Street, Sydney, NSW 2000, Phone: (02) 9383 2100,
Email: ipcn@ipcn.nsw.gov.au.

Dear Commissioners,

Council refers to the above matter and in particular to Council's meeting with the Commissioners of the IPC on 3 July.

Please find **attached** Council's written submissions, including Minute of Proposed Conditions of Consent, for your consideration.

Further **attached** is evidence supporting Council's submissions.

Do not hesitate to contact Council should you have any further queries.

Kind regards

Joshua Brown
Executive Services Coordinator

Direct: [redacted]
Mobile: [redacted]
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Department of Planning and Environment

Thomas Mitchell Drive

Contributions Study

May 2015

Executive summary

This study has been commissioned by the NSW Department of Planning and Environment (DP&E) to establish a contributions framework and allocate funding to the upgrade and ongoing maintenance of Thomas Mitchell Drive. The study has not been commissioned to establish whether or not contributions should be made, and if that premise exists.

GHD utilised recent and past traffic data to establish the use of Thomas Mitchell Drive by each of the Mangoola, Bengalla, Mount Arthur and Drayton mines. This data was used to develop a contributions framework that logically established a basis for allocating whole of life funding contributions.

User pays and baseline models (referencing standards) were developed with all models presenting varying degrees of relevance in application. On balance and in consideration of a variety of factors, we believe a hybrid model outlined in Section 3.5 is the most appropriate to be applied. Our basis for this is as follows:

- This is *most* consistent with current road funding models in that the road network is primarily provided to facilitate transport and economic activity. The road network is indirectly funded through general road user access charges (e.g. registration) and general revenues (e.g. rates, taxation, royalties, etc.).
- The mines are operating entities. It is most reasonable to seek direct funding for public (off-site) infrastructure at the time of project approval and construction.
- The mines contribute to general revenue through rates, taxes, royalties, VPAs, etc.
- The employees and businesses that live and operate within the LGA contribute to general revenues. We acknowledge not all traffic is generated from within the LGA.
- We fully acknowledge that Council revenue sources (both internal and external) may not be adequate to fully cover the impact of mining activity on the road network within MSC.
- Precedent applied on Ulan Road as developed by ARRB.
- The addition of pavement depth helps account for the direct impact of mine traffic.

Although there were a range of contributions calculated by each model, the outcomes were reasonably consistent on average. The allocation to the mines was estimated to be 39.1% of capital and recurrent costs. This was based on:

- Reference to a baseline standard of road cross section that would be provided with and without mining activity.
- Estimated pavement depth required to accommodate mine traffic as part of the whole upgrade pavement design.
- Equivalent Standard Axles kilometres travelled to establish use by each mine and other traffic. This accounts for traffic composition and distance travelled.

In 2013 dollar terms, the proposed allocations to each mine are as follows:

	Contribution (%)	Upgrade ($M)	Reseal (x2) ($M)	Rehabilitation ($M)	Total ($M)
Mangoola	2.8	0.57	0.06	0.21	0.84
Bengalla	6.2	1.24	0.14	0.46	1.84
Mount Arthur	25.4	5.05	0.59	1.88	7.53
Drayton	4.7	0.93	0.11	0.35	1.39
Total	*39.1*	*7.79*	*0.91*	*2.90*	*11.60*

It is proposed contributions be made at the time works are to be undertaken. This means:

- Work is correctly funded, rather than attempting to estimate future works in 2013 dollars
- New developments, expanded or ceased operations can be included in the contributions model
- Funding is used for the intended purpose

The above figures do not consider current or past funding agreements for Thomas Mitchell Drive or other Council assets.

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1. Introduction

1.1 Purpose of this report

This study has been commissioned by the NSW Department of Planning and Environment (DP&E) to establish a contributions framework and allocate funding to the upgrade and ongoing maintenance of Thomas Mitchell Drive. Specifically, the study has been tasked with establishing contributions by the Drayton, Mount Arthur, Bengalla and Mangoola mines, who are the primary mines who utilise Thomas Mitchell Drive for access.

The study has not been commissioned to establish whether or not contributions should be made, and if that premise exists.

1.2 Status

This report is currently at **final draft** and is issued for final consideration by DP&E and with stakeholders.

Revisions from previous versions include:

- Updated (higher) traffic volumes for Mount Arthur Coal have been incorporated to the modelling from the previous revision.
- Recalculation of the cross section using minimum cross sections as the basis for the hybrid model. This was done in consideration of previous Muswellbrook Shire Council approvals of road upgrades relating to mining projects.
- Incorporation of existing pavement assets to the project cost, in recognition that the existing pavement material contributes cost savings to the pavement upgrade.
- Minor adjustment of ESAkm calculations following identification of a calculation error.

1.3 Background

In 2013, GHD completed the upgrade design for Thomas Mitchell Drive. Our client for this work was Mount Arthur Coal (MAC) but the design was commissioned on behalf of Muswellbrook Shire Council (MSC). MSC were involved in the review and approval of the works.

The upgrade was undertaken in accordance with Austroads standards with minor geometric non-compliances required to satisfy the site's environmental and topographical constraints. All were deemed acceptable under the extended design domains allowed under Austroads.

The pavement was designed to accommodate accepted growth rates anticipated for the road network. The pavement predominantly comprised rehabilitation of the existing pavement with new pavement for shoulders and areas where the existing pavement had completely deteriorated and was deemed unsuitable for reuse. The rehabilitated pavement incorporates modified road materials in accordance with accepted industry practice.

1.4 Site description

Thomas Mitchell Drive connects the New England Highway to Denman Road and is located within Muswellbrook Shire. It is approximately 10.6 km long and has a sign posted speed of 100 km/h, with 80 km/h through the industrial area. The road is shown in Figure 1-1.

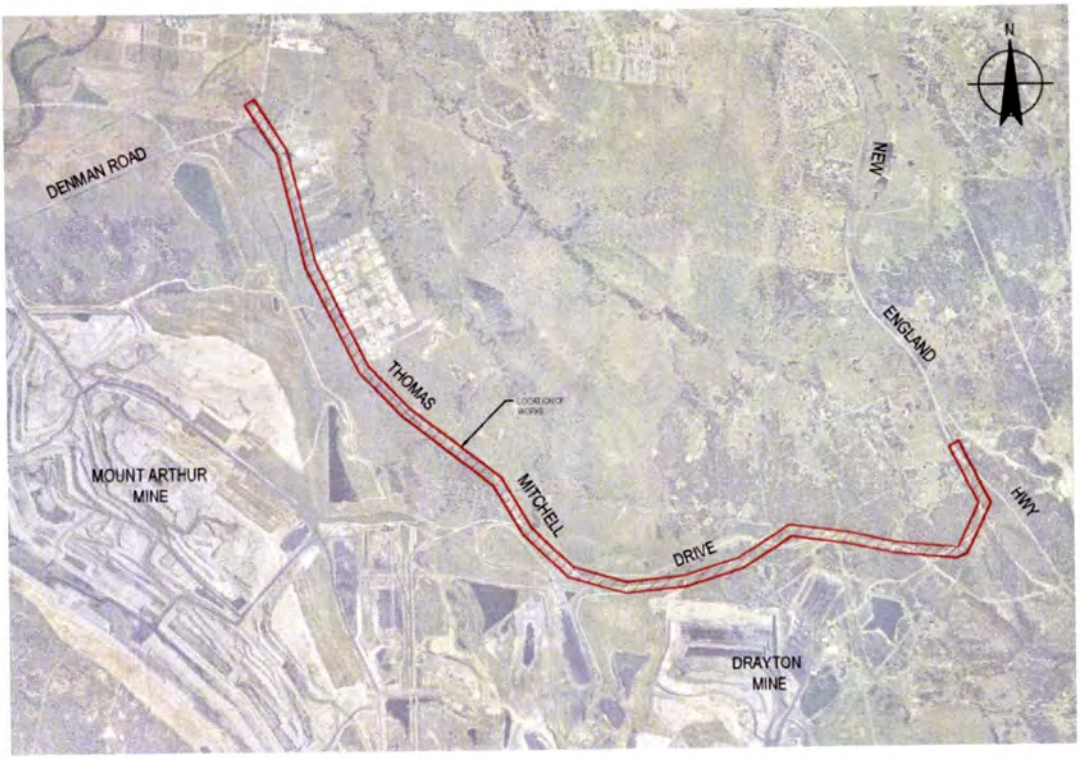

Figure 1-1 Locality plan

1.5 Stakeholders

The stakeholders related to this study include:

- DP&E as commissioner of the study
- MSC as asset owner
- Drayton mine
- Mount Arthur mine
- Bengalla mine
- Mangoola mine

2. Traffic modelling

2.1 September 2013 survey data

Survey data was collected by Northern Transport Planning & Engineering (NTPE) between 18 September and 25 September 2013. Specifically, the surveys consisted of:

Turning counts surveys on 18 September 2013, between 06:00 and 17:30 at the following locations:

1. Drayton Mine Access
2. Mount Arthur Mine Access *
3. Bengalla Mine Access
4. Mangoola Mine Access

* - note that the Mt Arthur Coal Mine survey was not complete on Wednesday 18 September and was repeated on Thursday 19 September.

Automatic Traffic Count (ATC) survey between 18 September and 25 September at the following location:

- Thomas Mitchell Drive between Denman Road and the Industrial Estate

Origin-destination surveys for traffic entering and leaving the Bengalla and Mangoola mines in order to understand the proportion of mine traffic using Thomas Mitchell Drive, specifically traffic coming from and going to:

- Thomas Mitchell Drive Industrial Estate
- The New England Highway via Thomas Mitchell Drive

The locations of the surveys are shown in Figure 2-1.

Figure 2-1 September 2013 survey locations

Mapping source: Google Maps

Roadworks are currently underway on two sections of Thomas Mitchell Drive, both south (east) of the Mount Arthur entrance. The sections of roadworks are controlled with traffic signals. Thomas Mitchell Drive was driven on Tuesday 15 October and stop signals were encountered at both locations. The time to drive the road was measured at 17 minutes under these conditions which would be considered a worst case. The normal travel time for the length of Thomas Mitchell Drive is 8 minutes.

An alternative route along the New England Highway and Denman Road is available. This travel time was measured at 11 minutes. Therefore, it is expected that a large portion of Mangoola and Bengalla traffic may not be using Thomas Mitchell Drive at the time of the traffic surveys. This may also affect traffic to Drayton and the industrial area.

Our modelling considers this issue and is considered to be suitable for assessment of contributions for upgrade costs. Should new or expanded mine activity occur in the future, it is recommended new surveys and traffic modelling be undertaken at that time to establish ongoing contributions for recurrent costs such as resealing.

2.2 Historical survey data

A series of data collected for previous studies has also been used in developing the traffic forecasts. These include the most recent planning applications to DP&E made by each of the four mines.

Turning count surveys at the following locations were collected on 13 October 2011, between 06:00-09:00 and 16:00-19:00:

1. Denman Road/Thomas Mitchell Drive
2. New England Highway/Thomas Mitchell Drive

Turning count surveys at the following locations were collected on 18 October 2011, between 06:00-09:00 and 16:00-19:00:

1. Denman Road/Thomas Mitchell Drive
2. Blakefield Road/Thomas Mitchell Drive (Industrial Estate)
3. Carramere Road/Thomas Mitchell Drive (Industrial Estate)
4. Glen Munro Road/Thomas Mitchell Drive (Industrial Estate)

Automatic Traffic Count (ATC) surveys have been collected for a full week in October 2011 and again in February 2013 at the following location:

- Thomas Mitchell Drive between the Industrial Estate and Mt Arthur Coal Mine

The locations of these surveys are shown in Figure 2-2.

Figure 2-2 Historical survey locations

Mapping source: Google Maps

Automatic Traffic Count (ATC) surveys were also collected for a full week from 27 March 2012 to 2 April 2012 on the MAC access road.

2.3 Baseline traffic modelling

2.3.1 Methodology

The available survey data, as described in Section 2.1 was used to develop an understanding of traffic flows along the length of Thomas Mitchell Drive, between the New England Highway to the east and Denman Road to the west.

This was carried out for the 'Daytime' period, defined as 06:00 – 17:30. This was the time period for which the origin-destination and turning count surveys were carried out.

The traffic flows were segmented by light and heavy vehicles.

The following steps were undertaken for both light and heavy vehicles to achieve an assessment of the baseline traffic conditions:

1. Summarise daytime traffic flow data (Appendix A Figures A-1 to A-3)
2. Comparison of traffic count data with historical count data
3. Amalgamation of historical and September 2013 surveys (Appendix A Figures A-4 to A-6) to:
   a. Provide the fullest possible picture of traffic movements in the study area
   b. Ameliorate the effect of roadworks being undertaken during the September 2013 surveys
   c. Normalisation of traffic flows (matching flows between entry and exit from the link)

4. Calculation of mine traffic (Appendix A Figures A-7 to A-9), including:

    a. Adjusting to account for the roadworks being undertaken during the September 2013 surveys

5. Calculation of the proportion of overall traffic flows that are attributable to each of the four mines (Appendix A, Tables A-10 to A-13).

2.3.2 Assumptions

The methodology outlined in Section 2.3.1 necessitated a series of assumptions to provide a consistent traffic flow 'baseline' along the length of Thomas Mitchell Drive:

Vehicle categorisation

The ATC data is broken down into 13 vehicle categories. It has been assumed that vehicle types 1, 2 and 13 are light vehicles. The rest are heavy vehicles. This is based on Austroads vehicle categorisation (with 13 assumed to be motorcycle/bicycle).

Further, it is assumed that this categorisation is consistent with the categorisation used in the turning count survey results.

ATC data 24 hour to daytime conversion

The ATC data is presented in hourly segments. Therefore, in order to produce 'daytime' flows it is assumed that the traffic flow is uniform between 17:00 and 18:00. This enables the ATC daytime flow to be calculated in the following way:

$$ATC\_Flow_{daytime} = ATC\_Flow_{06:00-17:00} + ATC\_Flow_{17:00-18:00}/2$$

Baseline traffic calculation

A comparison of the October 2011 and February 2013 ATC count data south of the Industrial Estate revealed no substantial difference in traffic flows between these dates, as shown in Figure 2-3 which compares the hourly traffic volumes for an average weekday.

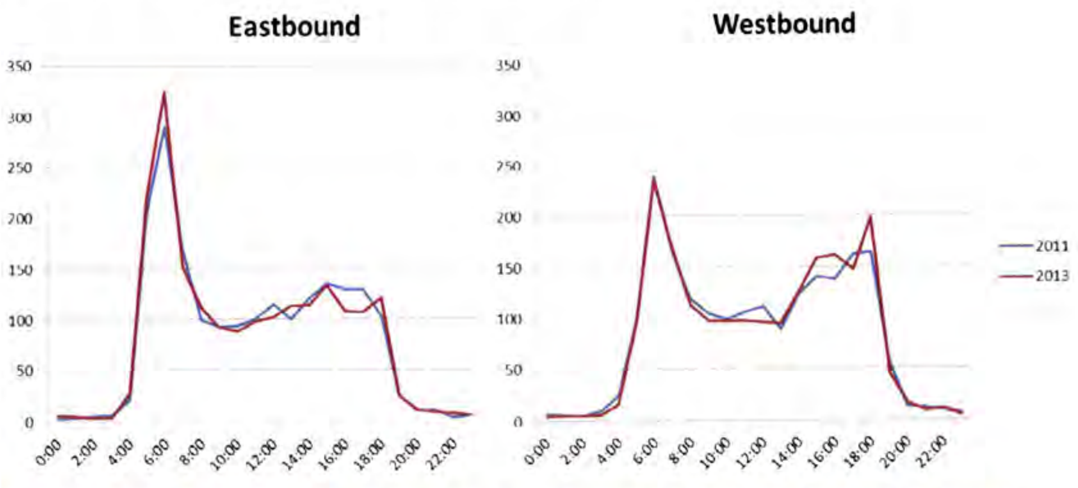

Figure 2-3 Comparison of October 2011 and February 2013 ATC survey

This analysis suggests that it is a valid approach to amalgamate the traffic survey data collected in October 2011 with the data collected in February and September 2013 for the purposes of producing a robust estimate of traffic flows as possible. This approach also provides an opportunity to explore the difference in flow caused by the current roadworks and produce a baseline that effectively removes the impact of the roadworks on traffic flows.

The analysis estimates that the approximate reduction in vehicle kilometres on Thomas Mitchell Drive attributable to the roadworks is 10,000 veh-km (29%), per day (06:00 – 17:30).

A number of steps were undertaken to produce the robust baseline traffic flows:

Factoring of October 2011 peak period counts to represent 06:00 – 17:30 for consistency with September 2013 counts, using ATC count profile:

1. Summation of total movements in and out of the Industrial estate (October 2011 surveys)
2. Comparison with the turn counts at Denman Rd, the New England Highway and the ATC counts (October 2011)
3. Adjustment of trips in and out of the Industrial estate for consistency with the turn counts at Denman Rd, the New England Highway and the ATC counts (October 2011). This is carried out on the basis that:
   a. Intra-Industrial estate movements that use Thomas Mitchell Drive
   b. The factoring from peak periods to daytime is likely to overestimate the proportion of turning vehicles
4. Calculation of Thomas Mitchell Drive traffic by section, using the mine traffic associated with the Mt Arthur and Drayton Mine Accesses

Mine traffic

The following assumptions have been made to adjust the observed mine traffic movements to account for the roadworks:

- For Mt Arthur and Drayton the roadworks will have no effect.
- The proportions of mine traffic from the respective EIS for Mangoola (16.2%) and Bengalla (27%) that use Thomas Mitchell Drive are applied to the turning counts observed at these sites.
- The trips to/from the industrial estate as recorded in the September 2013 OD surveys for Mangoola and Bengalla mines are additional to the EIS proportions, on the basis that the EIS proportions were calculated based on the home location of employees and therefore would not account for trips to and from the Industrial Estate.

2.3.3 Outcomes

Table 2-1 provides a summary of the calculated proportion of the total traffic on Thomas Mitchell Drive that is attributable to each of the mines in the vicinity. This calculation is based on the calculation of vehicle km for four sections of Thomas Mitchell Drive.

Table 2-1 Proportion of traffic volume attributable to each mine (Baseline)

	Total traffic (veh-km)	Mangoola	Bengalla	Mount Arthur	Drayton	Total Mine Traffic
Lights	33,728	3%	6%	32%	4%	45%
Heavies	3,862	3%	7%	37%	8%	55%
All	37,589	3%	6%	33%	4%	46%

The data in Table 2-1 and Appendix A (Tables A-10 (specifically) to A-13) show that:

- Approximately 46% of all traffic on Thomas Mitchell Drive is attributable to the mines. The proportion of heavy vehicles on Thomas Mitchell Drive that is attributable to the mines is higher (55%).
  It should be noted, however, that due to road works, the model under-represents the total number and proportion of heavy vehicles when compared to the pavement design. This exaggerates the heavy vehicle attributable to the mines. This anomaly is outlined further in Section 2.5 and is addressed in Section 3.
- The most heavily trafficked part of Thomas Mitchell Drive is to the west of the Industrial estate.
- The section of Thomas Mitchell Drive with the highest proportion of mine traffic is between the Industrial Estate and Mt Arthur Mine.
- Of all the mines, Mount Arthur contributes most traffic volumes to Thomas Mitchell Drive. This is partly because this mine produces more traffic than each of the other mines and partly because its location near the centre of Thomas Mitchell Drive means that vehicles to/from the mine must travel further on Thomas Mitchell Drive, whereas other mines have alternative routes available.

2.4 Growth scenarios

2.4.1 Assumptions

A forecast scenario for 2018 was developed to assess the proportion of traffic volume attributable to each mine once operations have increased.

The analysis is founded on the baseline traffic volumes and assumptions as described in Section 2.3. In addition the growth assumptions are based on a review of the relevant EIS documents for each mine operation. The following assumptions were used in the forecast assessment:

- Background traffic growth (non-mine traffic) is assumed to be 1.5% per annum from 2013 to 2018. This is consistent with the RMS regional traffic model and has been approved by RMS. Note, current EIS submissions have used 2.5% and the pavement design used 2%.
- Drayton mine - no growth (the new mine is replacing existing facility like for like)[1]
- Mt Arthur - This assessment has assumed that daily volumes will all occur within the 'Daytime' - so is likely to be overestimating the change. However, the increase is very small, as most of the increase in vehicle movements is projected to use Edderton Road instead of Thomas Mitchell Drive. The expected change has been interpreted as a 2-way flow[2].
- Bengalla -increase of a factor of 1.3375 in traffic - in direct proportion to the increase from 8 to 10.7mtpa[3].
- Mangoola - increase of a factor of 1.5 in traffic - in direct proportion to the increase from 300 to 450 full time workers[4].

Traffic volumes for the 2018 scenario are shown in Appendix A, Tables A-10 and A-11.

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[1] Drayton South Coal Project - Traffic and Transport Impact Assessment (August 2012)

[2] Mt Arthur Coal - Appendix K - Road Transport Assessment, Table 5.2 (December 2012)

[3] Bengalla Mining Company Pty Limited - Continuation of Mining Project - Traffic and Transport Impact Assessment (September 2013)

[4] Mangoola Coal Project Modification 6 - Traffic and Transport Assessment (May 2013)

2.4.2 Outcomes

Table 2-2 provides a summary of the calculated proportion of the total traffic on Thomas Mitchell Drive that is attributable to each of the mines in the vicinity incorporating the growth assumptions is Section 2.4.1. This calculation is based on the calculation of vehicle km for four sections of Thomas Mitchell Drive and is based on *7-day average traffic volumes.*

Table 2-2 Proportion of traffic volume attributable to each mine (2018 Forecast)

	Total traffic (veh-km)	Mangoola	Bengalla	Mount Arthur	Drayton	Total Mine Traffic
Lights	36,334	3%	7%	28%	4%	42%
Heavies	4,160	4%	9%	38%	7%	58%
All	40,494	3%	8%	29%	4%	44%

The data in Table 2-2 and Appendix A (Tables A-10 to A-13) shows that:

- 44% of traffic on Thomas Mitchell Drive is attributable to the mines, which is a reduction from 46% for the baseline scenario. This reduction occurs because the assumed background growth of 1.5% per annum is greater than the assumed traffic impacts of an increase in the scale of each mine operation.
- The overall observations for the baseline remain true for the 2018 forecast, namely:
  - The most heavily trafficked part of Thomas Mitchell Drive is to the west of the Industrial estate.
  - The section of Thomas Mitchell Drive with the highest proportion of mine traffic is between the Industrial Estate and Mt Arthur Mine.
  - Of all the mines, Mount Arthur contributes most traffic volumes to Thomas Mitchell Drive.

2.5 Future data requirements

The above findings are based on traffic surveys supplemented with previously published information. This is appropriate to be used for estimating contributions for upgrade costs. To accurately establish future contributions from each mine, new traffic surveys should be undertaken at the time of assessment.

As mentioned in Section 2.1, current road works at the time of modelling are likely to direct Mangoola, Bengalla and Industrial Area traffic through Muswellbrook, rather than along Thomas Mitchell Drive. This may misrepresent traffic distribution. Specifically, the following has been identified:

- The % of heavy vehicles from the 2013 traffic surveys is in the order of 9%. Traffic surveys undertaken in 2011 for the pavement design identified % heavy vehicles of around 18%. This does effect calculation of ESA and ESAkm for Model 2 in Section 3.3.3, however it does not change the outcome as:
  - The model references the pavement design ESA and ESAkm and this is not affected by the road works. That is, uses the 18% proportion.
  - Heavy vehicles proportions for the mines is consistent with historical values being approximately 12% for each mine.

- There is a high proportion (25%) of heavy vehicles within Drayton's traffic from the west, which generates relatively high levels of ESA. This seems consistent with Drayton's access being primarily from the New England Highway, and heavy vehicles from the industrial area simply being a higher proportion of relatively low traffic from the west.

Should re-assessment of this model be required prior to a new mining project assessment being submitted, an appropriate timing for new traffic counts would be approximately 3 months after completion of road works on Thomas Mitchell Drive.

2.6 Classification

Thomas Mitchell Drive is classified as a local road, being funded and managed by MSC. We suggest discussions be commenced with RMS for the road to be classified as a state road in accordance with the Roads Act, 1993, or declared as a regional road. This is on the basis that:

- The high traffic volumes and high proportion of heavy vehicles is unusual for a rural local road.
- There is anecdotal evidence that the Thomas Mitchell Drive/Bengalla link Road/Wybong Rd route is attracting inter-regional traffic and hence may be operating as an arterial road.
- The importance of the road in supporting the mining industry, with its direct benefits to the State economy.

In essence it would seem the function of Thomas Mitchell Drive is inconsistent with Council's ability to fund the road from direct revenue sources available to it, i.e. their rate base.

Road classifications are re-assessed on a state-wide basis. The timing of the next road classification review has not been set, however based on past timing RMS estimate the next review would be undertaken in 4 to 5 years' time.

3. Contributions framework

This section considers the basis to establish funding contributions for the upgrade and ongoing costs associated with Thomas Mitchell Drive.

3.1 Traffic sources

There are six primary groups associated with traffic use on Thomas Mitchell Drive. These are:

- General Muswellbrook Shire Council traffic including residents, through traffic and other traffic not associated with the mines
- The Thomas Mitchell Drive Industrial Area
- Mangoola Mine
- Bengalla Mine
- Mount Arthur Coal
- Drayton

3.1.1 Industrial area

The Department of Planning and Environment (DP&E) has indicated Council's position that the Industrial Area is mining focused and traffic generated from it should be attributed to each mine. The Industrial Area is a significant traffic generator as indicated by the volume of traffic at the western (north) end of Thomas Mitchell Drive.

There is a mix of mining and non-mining related businesses in the Industrial Area. It is not considered feasible to attribute Industrial Area activity to any particular mine, nor the mix of mining or non-mining services without significantly extensive traffic and business surveys. It is assumed the businesses within the Industrial Area would have been subject to a development consent, and are subject to land rates. Council has a suitable mechanism allowing for appropriate contributions and/or infrastructure upgrades to be made at the development consent stage, with ongoing funding via the rates system. Therefore, we believe for the purposes of funding contributions, the Industrial Estate should be considered independent of mines, even though they may be servicing the four mines nominated for this study, whether in part, or full.

It is acknowledged that the Industrial Area may not exist, either at all or on its current scale, if mining activity was not present in the locality.

3.1.2 Accounting for future development

Accounting for future development, especially new mine or other development is difficult, especially in consideration of immediate funding needs. To adjust findings in the future would require re-allocation of funding already paid by various parties. In consideration of the cost for the construction of the current upgrade, this would require as yet undeveloped mines to retrospectively pay existing mines either directly or through some indirect system. This is not considered feasible.

Therefore, any allocation model can only be based on existing or confirmed proposed development. On this basis, current costs relating to the construction of the currently underway upgrade should only be allocated to the four mines nominated as part of this study. Future costs associated with maintenance (reseals, rehabilitation) or further upgrade can be allocated against the mines or other developments operating at the time of that work being undertaken.

3.2 Contribution models

There are two broad philosophies in establishing the contributions framework:

- **User pays**: where each road user pays based on use. The most obvious user pays model is a toll road.
- **Baseline standard**: where the nexus between baseline and then the addition of mine generated traffic is considered in terms of requirements, referenced to road design standards and/or practice. This method can account for the position that public infrastructure acts to facilitate economic activity.

Both models have merit depending on any particular situation. Obviously the different parties involved will have reasonably clear preferences. A hybrid model combining the two can also be developed. These models are expanded on below.

All models presented below are based on 7-day average traffic volumes, as this better represents total traffic from the various sources.

3.3 User pays model

Under a user pays model, contribution by each party would be allocated in direct relation to use of the road. The most equitable distribution of use would be an allocation of total costs based a combination of:

- Road pavement to accommodate the volume and mix of light and heavy vehicles. This is measured by Equivalent Standard Axles (ESA), which is an industry standard parameter for the design of pavements.
- Vehicle kilometres travelled. This accounts for length of road used.

Therefore, this model would seek to estimate *ESA kilometres travelled* by the baseline traffic and each of the mines. ESA kilometres is considered more accurate as it takes into account the greater impact on a road pavement by heavy vehicles compared to light vehicles.

It is usual to base estimation of ESA on 7-day averages from traffic surveys, however as this study is only using ESA to allocate proportions, it is considered suitable for application.

3.3.1 User pays models

Using the information available, we have assessed user pays allocation in two ways. These are described and graphically represented below:

1. **Current (2013) mine traffic compared to ultimate (2043) design traffic**: This model does not account for development of new mines, expansion of existing mines beyond current proposals or other traffic generating development. 2043 represents the design life (30 years) of the pavement.
2. **Current mine traffic compared to current road traffic**: This assumes current mines will continue to generate traffic in the same proportion to current baseline traffic, regardless of baseline traffic growth. This is not considered realistic as it assumes the existing mines will continue to increase traffic over time, regardless of the number and/or extent of expansions, efficiency increases in production or technology improvements.

Each of the above models can also be assessed for sensitivity in consideration of known development plans in relation to design traffic: This at least accounts for known mine development in the foreseeable horizon.

Throughout this study, there were several discussions with Council about the sensitivity of the outcomes in relation to changes in traffic, growth rates and % heavy vehicles. The results of this sensitivity testing lie within the bounds of models 1 and 2 above and are presented in Appendix D.

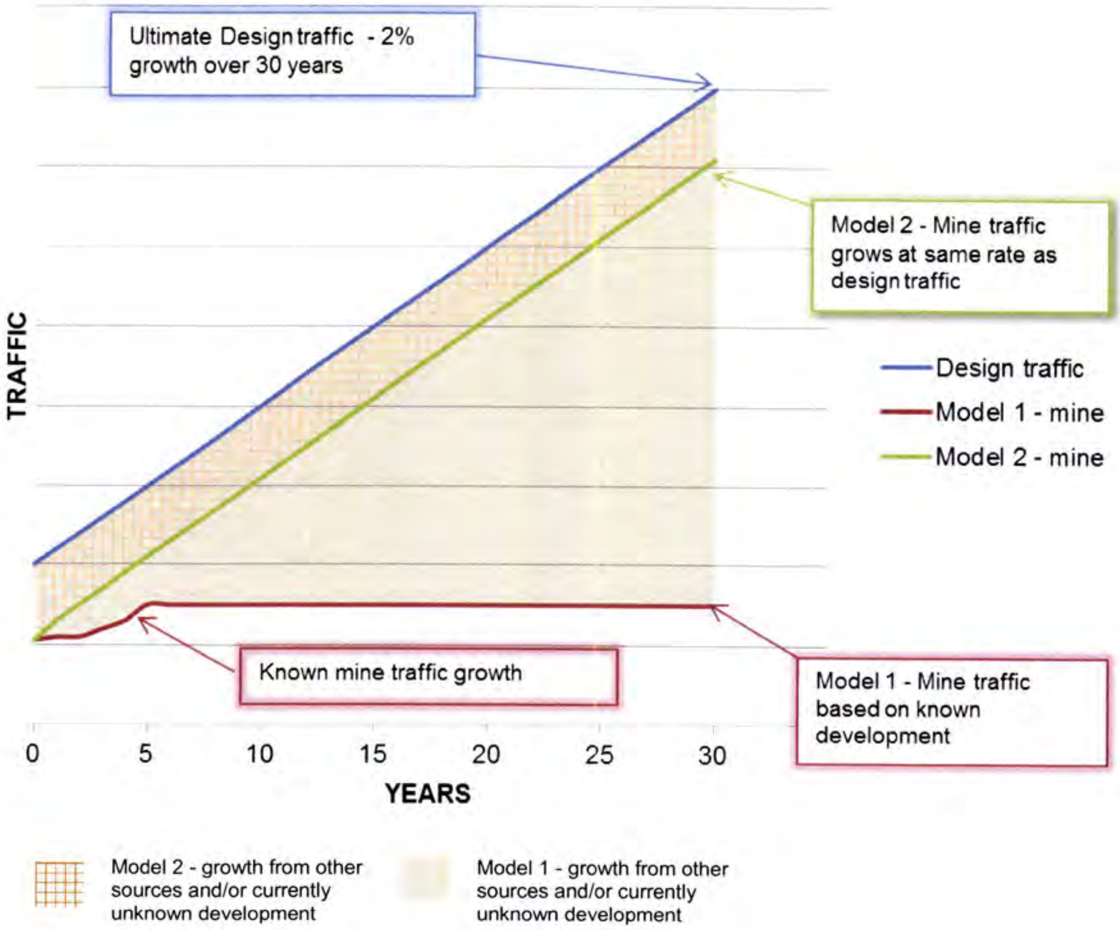


Figure 3-1 Graphical depiction of user pays models (not to scale)

Preferred model

The design of pavements incorporates traffic growth to account for a range of traffic generators including intra and inter-regional traffic as well as specific developments, e.g. mines and broader land release areas, e.g. residential, industrial or other land development.

In this context, the four subject mines are unlikely to generate a large proportion of the traffic growth accommodated within the pavement design. Therefore **Model 1**, where current traffic is compared to ultimate traffic, is more appropriate for implementation if a user pays model is adopted.

Discussion on both models is developed below. The numbers presented are based on a growth rate of 1.5%, where early report revisions used 2.5% growth.

3.3.2 Model 1 – Current (2013) mine traffic to ultimate (2043) design traffic

On the basis of traffic data presented in Section 2, we have estimated ESAs over a 30 year timeframe for each party as shown in Table 3-1. Detailed information and full calculations to support the generation of the ESA kilometres (ESAkm) travelled are attached in Appendix B.

Table 3-1 Model 1 – Current (2013) traffic to ultimate design traffic (2043)

Source	ESA	ESA km	Proportion
Non-mine	47,139,587	126,070,296	81.2%
Mangoola	606,514	1,609,997	1.0%
Bengalla	1,489,702	3,942,789	2.5%
Mount Arthur	7,595,538	19,650,143	12.7%
Drayton	1,668,660	3,982,776	2.6%
Subtotal mine	*11,360,413*	*29,185,704*	*18.8%*
TOTAL	**58,500,000**	**155,256,000**	**100%**

This finds that the four mines identified in this study should contribute 18.8% of total cost for the upgrade of Thomas Mitchell Drive.

To test the sensitivity of this finding relative to the known growth of the mines, the ESAkm were calculated utilising the traffic estimated in each of the mines current modification submissions for traffic volumes as at 2018. The summary findings are presented below.

Table 3-2 Model 1 Sensitivity – Projected (2018) mine growth traffic to ultimate design traffic (2043)

Source	ESA	ESA km	Proportion
Non-mine	45,559,802	122,011,829	78.6%
Mangoola	909,771	2,414,995	1.5%
Bengalla	1,992,476	5,273,480	3.4%
Mount Arthur	8,369,291	21,572,920	13.9%
Drayton	1,668,660	3,982,776	2.6%
Subtotal mine	*12,940,198*	*33,244,171*	*21.4%*
TOTAL	**58,500,000**	**155,256,000**	**100%**

The incorporation of mine growth (modifications submitted to DP&E) shows a slight increase to 21.4% from 18.8%.

If this model was chosen, a contribution of 21.4% would be considered appropriate.

3.3.3 Model 2 – Current (2013) mine traffic to current (2013) "design" traffic

In consideration of current mine traffic relative to current non-mine traffic over a 30 year pavement design life, the following position was established:

Table 3-3 Model 2 – Current (2013) traffic to ultimate design traffic (2013)

Source	ESA	ESA km	Proportion
Non-mine	11,715,791	31,341,601	46.2%
Mangoola	757,824	2,011,652	3.0%
Bengalla	1,861,347	4,926,419	7.3%
Mount Arthur	9,490,442	24,552,381	36.2%
Drayton	2,084,950	4,976,383	7.3%
Subtotal mine	*14,194,563*	*36,466,835*	*53.8%*
TOTAL	**25,910,354**	**67,808,436**	**100%**

With mine traffic estimated at 54%, this is higher than the 18% to 19% established from Model 1.

When the current development proposals from the mines are incorporated to the model, the following occurs:

Table 3-4 Model 2 Sensitivity – Projected (2018) mine growth traffic to ultimate design traffic (2018)

Source	ESA	ESA km	Proportion
Non-mine	12,438,658	33,328,201	44.5%
Mangoola	1,136,737	3,017,479	4.0%
Bengalla	2,489,551	6,589,086	8.8%
Mount Arthur	10,457,228	26,954,844	36.0%
Drayton	2,084,950	4,976,383	6.7%
Subtotal mine	*16,168,466*	*41,537,792*	*55.5%*
TOTAL	**28,607,124**	**74,865,993**	**100%**

The consideration of the growth scenario realises a slight increase of the mines' contributions to the overall traffic distribution.

If Model 2 was to be adopted under a user pays scenario, a proportion of 55.5% would seem reasonable.

Note, overall ESA and ESAkm are shown lower than in Model 1 results. This is due to these being calculated on traffic survey data that has a lower %HV than the surveys undertaken at the time of the pavement design. See Section 2.5. Model 1 is compared against design ESA and ESAkm. There is no inconsistency in the resultant proportion.

3.3.4 Future development

Future development can be readily incorporated to the User Pays model. When a new mine or other development occurs, or an existing mine expands, the ESAkm can be calculated and proportional contribution made.

The challenge with this is consistent application. Are all developments subject to this or only mining? Are there thresholds where assessment commences?

3.4 Baseline standard

The baseline standard scenario is founded on the philosophy that public infrastructure, such as roads, play a role in facilitating and supporting economic development. This does mean the public purse may not directly realise financial benefit but does indirectly through the broader taxation system. This model is the basis for the current provision of the Australia's road network, with the exception of high volume toll roads in some capital cities.

This model recognises that "payment" for use of the road occurs indirectly through rates, levies, royalties and voluntary planning agreement (VPA) that users may pay. Whether this completely accounts for use is open to conjecture and is not the subject of this study.

Under this model, allocation would be established on the basis of:

- Minimum road cross section required to meet the requirement of baseline traffic. This would be the non-mine allocation.
- Additional road cross section required to accommodate the addition of mine traffic.

This was the model adopted for capital cost for allocations on Ulan Road, which was undertaken by ARRB. This model does not directly account for the pavement depth required to accommodate the mine traffic as would the user pays model. It is a simplistic model that provides for a wider pavement cross section.

Austroads standards were used in the design of Thomas Mitchell Drive and therefore are the basis for this assessment.

3.4.1 Traffic segments

Thomas Mitchell Drive comprises approximately 7.9 km of rural road and 2.7 km of semi-urbanised road through the industrial estate. The rural section of the road can be quite simply assessed against standards to establish the baseline and mine incorporated arrangements (lane and shoulder widths). The industrial area is less clear cut due to the wider road being provided to accommodate the turning of larger vehicles to properties and also the provision of parking along the shoulder on one side.

For these reasons, it seems reasonable to calculate the allocations based on the rural section of the road.

3.4.2 Road standards

Austroads Guide to Road Design: Part 3 outlines the cross sectional requirement for roads. As a comparator, the RMS's Road Design Guide was also considered to establish any variation to these standards, noting it has been broadly superseded by Austroads. On the basis of AADT of 2000 vehicles, the following cross sections are appropriate:

Table 3-5 Road standards

Source	AADT	Lane width (m)	Shoulder width (m)
Austroads	500-1,000	3.1 to 3.5	1.5
	1,000-3,000	3.5	2.0
Road Design Guide	<500	3.0	1.0 to 2.0
	500 to 2,000	3.0 to 3.5	2.0 to 3.0

The Austroads guidelines allow for reductions to the desirable standards where budget or other constraints exist. Although not desirable, there are instances of new roads and road improvements where shoulders and verges are provided at reduced width, even though this is lower than the Austroads standard. Recent examples of these within the region include the Wybong Road upgrade associated with Mangoola with 1.0 m shoulders. There are other examples on the Golden Highway (RMS) and on Broke Road (Cessnock City Council). Further, the Thomas Mitchell Drive upgrade used 2.0 m shoulders whereas the Austroads guidelines prefer 2.5 m shoulders based on traffic volumes. In light of this, and based on our experience, we also assessed a cross section incorporating a 1.0 m shoulder as a minimum.

3.4.3 Baseline traffic

Based on the traffic data outlined in Section 2, the proportion of traffic directly related to the mines has been estimated. Detailed information and figures are attached in Appendix A, specifically Figure A-6 that forms the basis of discussion below.

The traffic data, specifically Sections 2.3 and 2.4, indicates mine traffic accounting for approximately 44% to 46% of traffic along Thomas Mitchell Drive on a vehicle-kilometre basis. This is correct but heavily influenced by the high traffic volumes in the Industrial Area. When only traffic east (south) of the Industrial Area is assessed, the following traffic sources are established on a vehicle-kilometre basis for 2013 traffic:

- Mine: 50.4%
- Industrial Area: 22.2% at AADT 735 (average)
- MSC (public/other): 27.3% at AADT 900 (average)

These figures present a conundrum in the consideration of the baseline model. We stated in Section 3.1.1 that the Industrial Area was to some degree associated with mining activity but should not be attributed to the mines (individually or as a group) for the basis of cost allocation for road works.

For the Baseline Model, the baseline traffic is which MSC would need to provide should mining activity not be present. At its lowest, the baseline traffic would therefore be the MSC category above at 900 AADT, which assumes the Industrial Area would not exist.

Due to the uncertainty of estimating the mine servicing component of Industrial Area traffic we propose to use the baseline traffic as 900 AADT.

3.4.4 Cross section

On the basis of the above baseline traffic (900 AADT), the following cross sections were considered for the rural sections of Thomas Mitchell Drive.

Table 3-6 Comparison of standards to upgrade design

Condition	AADT	Lane width (m)	Shoulder width (m)	Total width (m)	% increase for TMD upgrade
Minimum (not to standard)	900	3.25	1.0	8.5	29.4%
Austroads	900	3.25	1.5	9.5	15.8%
RMS RDG (superseded)	900	3.25	2.0	10.5	5%
Upgrade design	2000	3.5	2.0	11.0	-

The cross section adopted for Thomas Mitchell Drive design is 3.5 m lanes with 2.0 m shoulders.

In consideration of the above, it is GHD's view that if Thomas Mitchell Drive was provided by MSC without mine or industrial area traffic, a cross section meeting the minimum, rather than the Austroads standards would have been provided.

On this basis, the addition of direct mine traffic required an additional 0.25 m of traffic lane and 1.0 m of shoulder width. Therefore, in relation to the upgraded pavement:

- Across the total pavement cross section, this results in a 29.4% increase above the baseline case.
- On travel lane this equates to 7.7% increase and a 100% increase of shoulder width.

3.4.5 Mine allocations

Based on the ESAkm generated in Section 3.3, the following allocations would apply to the road funding based on the current planned modifications to each mine (2018):

Table 3-7 Thomas Mitchell Drive traffic allocations

Traffic Source	ESAkm	% total traffic	% mine traffic	% of funding allocation
Non-mine (1)	122,011,829	78.6%	-	70.6
Mangoola	2,414,995	1.5%	7.3	2.1
Bengalla	5,273,480	3.4%	15.9	4.7
Mount Arthur	21,572,920	13.9%	64.9	19.1
Drayton	3,982,776	2.6%	12.0	3.5
Subtotal mine	33,244,171	21.4%	100.0	29.4

Note (1): Non-mine traffic includes the Industrial Area and baseline traffic. The ESAkm used for non-mine traffic is based on the pavement design used for the upgrade, however this does not influence the total allocation to the mines nor the proportioning between the mines.

Industrial area considerations

We have previously stated a view that the Industrial Area should be treated separate from mines when allocation of cost is considered. This position stands, even though the cross section assessment excluded Industrial Area traffic from the baseline traffic.

We acknowledge the potential inconsistency with this application but believe it logical for the funding reasons presented in Section 3.1.1.

3.4.6 Future development

Current and projected traffic, accounting for current mine proposals, puts traffic on Thomas Mitchell Drive to the cusp of 3,000 AADT. This is the guide limit in Austroads where wider shoulders than are currently designed is required.

Therefore, it could be expected that further mine development, new mines or other significant development could trigger requirement for a wider cross section.

In this instance, the assessment framework within this report could be used or reassessed to establish contributions from existing mines and new development in part or full to accommodate any change to the road that may be required.

3.5 Hybrid model

A gap in the baseline model is that it considers the cross section and not the depth of additional pavement required in other areas of the pavement to accommodate non-baseline traffic. The depth of pavement is shifting towards a user pays model, although not entirely.

Pavement design is essentially about stiffness, so, for example, a doubling of traffic does not require a doubling of pavement depth.

Figure 3-2 below outlines the principle of the hybrid model, combining the cross sectional widening and additional pavement depth required for each traffic group. Note, the figure is not to scale and shows the pavement in cross section.

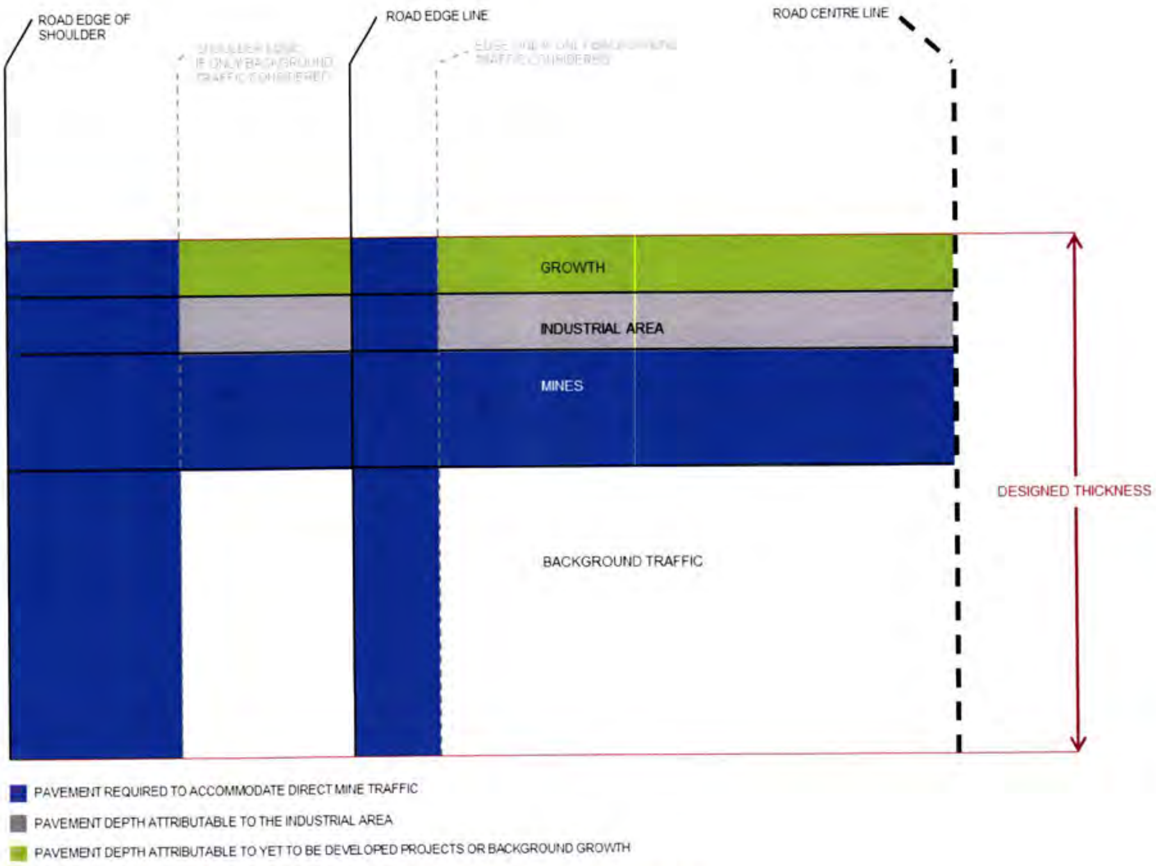


Figure 3-2 Pavement composition (not to scale)

3.5.1 Consumption

MSC presented the case for consumption of pavement to be considered rather than design. This would represent the pavement used by each party over the course of the 30 years of pavement. This model represents user pays arrangements and to apply it to this hybrid model would represent a double up in allocations to the mines. For this reason, consumption considerations were not considered appropriate.

Several consumption models using various parameters were considered and the outputs are shown in Appendix D.

3.5.2 Pavement treatments

The pavement treatments for the Thomas Mitchell Drive are complex due to the highly variable nature of the existing pavements and ground conditions. To attribute pavement depth to each traffic group, a selection of pavement treatments representing the majority of work through each segment of the road was used. Detailed calculations for the pavements attribution is enclosed in Appendix C. The pavement calculations attribute pavement depth to each group based only on the ESAkm estimates in Table 3-7 and do not account for construction tolerances such as minimum layer thickness etc. Further, for simplicity of calculation, heavy vehicle proportions were normalised across all the traffic groups. This is considered appropriate for this study.

On average, it was found that pavement depth could be broken down as follows:

Table 3-8 Average pavement depth breakdown

Source	Depth (mm)	Depth (%)
Background	270	80.6
Mines	46	13.7
Industrial Area	11	3.3
Growth	8	2.4
Total	335	100

With reference to Figure 3-2, to establish the portions attributable to each group, we need to determine the cross sectional area for each group by combining width and depth. There is some double up for the mine portion between the pavement width and depth. This is further clarified in the detailed calculations of Appendix C with outcomes confirmed below.

Table 3-9 Hybrid model allocations

Source	Allocation (%)
Background	56.9
Industrial Area	2.3
Mines	39.1
Mangoola	*2.8*
Bengalla	6.2
Mount Arthur	25.4
Drayton	4.7
Growth	1.7
Total	100

Therefore, the hybrid model estimates that 39.1% of cost be allocated to the four nominated mines, which is slightly higher than the baseline model at 29.4%. Based on the ESAkm from Table 3-7, the following allocations to each mine are determined:

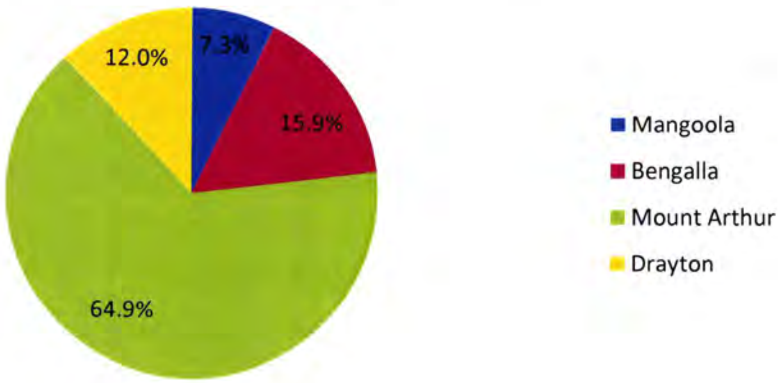


Figure 3-3 Mine allocations

Industrial area considerations

If Council's position of mines paying for the industrial traffic was adopted, the following allocations would be determined under the hybrid model:

Table 3-10 Hybrid model allocations (mines + industrial area)

Source	Allocation (%)
Background	56.9
Industrial Area	-
Mines	41.4
Mangoola	*3.0*
Bengalla	*6.6*
Mount Arthur	*26.9*
Drayton	*4.9*
Growth	1.9
Total	100

These allocations assume industrial area traffic is proportional to each mine's use of the road.

3.5.3 Future development

An advantage of the hybrid model is that it allows some consideration of future development based on direct traffic generated. In the event of a new development, the ESAkm could be established, and this used to allocate capital and maintenance funding from the *growth* group. This could apply to any expansion or new development, being mine related or not.

3.6 Preferred model

On balance and in consideration of a variety of factors, we believe the hybrid model outlined in Section 3.5 is the most appropriate to be applied. Our basis for this is as follows:

- This is *most* consistent with current road funding models in that the road network is primarily provided to facilitate transport and economic activity. The road network is indirectly funded through general road user access charges (e.g. registration) and general revenues (e.g. rates, taxation, royalties, etc.).
- The mines are operating entities. It is most reasonable to seek direct funding for public (off-site) infrastructure at the time of project approval and construction.
- The mines contribute to general revenue through rates, taxes, royalties, VPAs, etc.
- The employees and businesses that live and operate within the LGA contribute to general revenues. We acknowledge not all traffic is generated from within the LGA.
- We fully acknowledge that Council revenue sources (both internal and external) may not be adequate to fully cover the impact of mining activity on the road network within MSC.
- Precedent applied on Ulan Road as developed by ARRB.
- The addition of pavement depth helps account for the direct impact of mine traffic.

On this basis, we believe that should the mines contribute to the upgrade and ongoing maintenance of Thomas Mitchell Drive, then a reasonable proportion of costs to allocate 39.1% based on vehicle trip data and typical cross section treatments.

This proportion has been estimated on pavement width and depth. The proportion will apply to total upgrade costs and hence would include earthworks, pavements and road furniture such as barriers, signage, linemarking, etc. This reflects the fact that road features benefit all parties and is consistent with the consideration of AADT and cross section as, for example, the provision of barriers is determined in part by AADT and clear zone requirements.

We acknowledge potential inconsistencies with the baseline model upon which the hybrid model is built. However we believe it best represents the current form and function of the road network.

3.6.1 Future development

At some time in the future, it is possible there will be significant development proposals that will generate traffic on Thomas Mitchell Drive. To account for future development that has not yet commenced the formal planning process, we propose the following mechanism:

- A review of traffic data is undertaken to confirm the new development(s) is within the pavement design ESA and traffic is suitable for the current road cross section.
- If traffic is within design parameters, the future costs associated with any maintenance attributable to the mines would be allocated in proportion of ESAkm of all operating mines, at the time of assessment. The framework developed within this study would be applied with traffic data relevant to the time of assessment.

3.7 Denman Road intersection

The Denman Road and Thomas Mitchell Drive intersection requires upgrading. DP&E has requested the intersection be assessed to determine the contributions of each mine.

The assessment of intersection upgrades are typically completed on capacity rather than pavement, as was used above. In assessment of intersection capacity, the composition of light and heavy vehicles is accounted for in the calculation of queue lengths, which in turn leads to delay and then to a level of service (LoS).

The modelling of intersections is beyond the scope of this study; however assessment of AADT for each mine using the intersection will provide a guide to proportional use and hence proportional contribution from each mine.

The predominant capacity failure mode for the intersection will be turning traffic to/from Thomas Mitchell Drive, and intersection improvement works will focus on improving these turns. Therefore, when establishing the contribution of each mine to the upgrade, their traffic using Thomas Mitchell Drive at the intersection should be assessed. For the purposes of this study, we have used traffic west of the industrial estate as the traffic using the intersection.

The following allocations are established on the basis that each of the four mines are to pay for the entire upgrade of the intersection. Traffic is based on proposed mine modification currently under consideration by DP&E.

Table 3-11 Estimated Denman Road intersection use

Traffic Source	AADT west of Industrial Area	% total traffic (allocation)
Mangoola	180	8.9%
Bengalla	321	15.9%
Mount Arthur	1,437	71.3%
Drayton	78	3.9%
Total mine traffic	2,015	100%

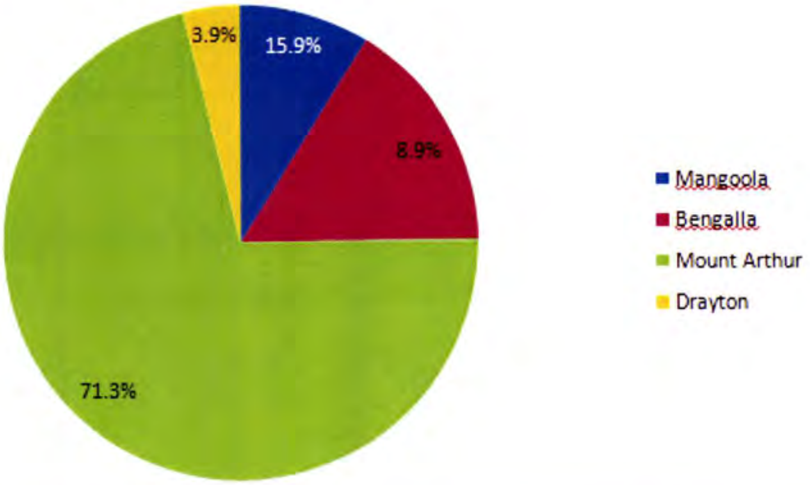


Figure 3-4 Denman Road intersection traffic distribution

It is noted that current operating conditions of the intersection are less than predicted. We recommend DP&E review timing of contributions to reflect actual timing of realised capacity constraints at the intersection

4. Apportionment

This section converts the allocations identified for each mine to dollars.

Estimates are based on figures provided by MSC, which they confirm are based on current tendered rates for Thomas Mitchell Drive road works currently underway. They include Council's management costs. GHD has not seen the detail of the estimate nor verified the headline number, however Council's confirmation is shown in Appendix F.

The contributions estimated below do not consider existing funding agreements or moneys previously paid for works on Thomas Mitchell Drive or elsewhere with MSC. Whether these should be accounted for and how is to be agreed between stakeholders and is not subject to this study.

4.1 Timing

The programme of the works is driven by:

- Upgrade construction: the availability of sufficient funding
- Maintenance: MSC pavement maintenance strategy

4.1.1 Upgrade construction

Construction has commenced on part of Thomas Mitchell Drive. For the purposes of this study we are assuming the upgrade will occur in entirety in the short-term and is therefore an immediate funding requirement.

MSC has confirmed an estimated cost for completion of the Thomas Mitchell Drive upgrade as $18.54M, broken down as follows:

- Work completed (New England Hwy to Mt Arthur entrance): $9.14M
- Work awarded (Mt Arthur entrance to Glen Munro Rd): $4.65M
- Work programmed (Glen Munro Rd to Denman Rd): $4.75M (estimated), which seems reasonable based on work undertaken to date

At the stakeholder meeting on 7 October 2014, there was discussion around initial payments made on known costs with part payment for Stage 4 costs, then final payment being made on conclusion of that work, when costs are known.

Within the upgrade costs, there exists a benefit to the project in the construction on, and the incorporation of existing pavement materials. For example, existing pavement:

- Subbase layers are functioning as a select layer
- Base layers are acting as subbase layers with the incorporation of lime modification

Following request by MSC, the opportunity cost of these existing layers was estimated on the basis that these existing layers provide a real saving to the project. This saving is estimated to be $1.375M and is added to the $18.54M above to provide a total capital cost estimate for the works of $19.915M. Calculations to support the $1.375M is included in Appendix E. The basis of our estimate is:

- The existing material reused being equivalent in cost to a material consistent with subbase and select material as outlined above.

Rates for subbase material being \$85/m^3 and for select being \$60/m^3. Appendix E contains a letter from KCE that confirms these rates as appropriate for the locality. KCE are an experienced roads constructor. MSC did request the residual value of the whole asset be used for the cost estimate; however GHD does not support this position. The incorporation of all the asset is not appropriate as the formation is an existing condition and would be required whether or not the road was to be upgraded, and whether mining traffic was present or not. The mines would not be expected to contribute to a public road that has always been needed, regardless of its presence.

4.1.2 Maintenance

Consistent with their Road Asset Management Plan, MSC have confirmed their expectation that the road will be subject to the following maintenance regime:

- Pavement resealed every eight years
- Possible pavement rehabilitation between 20 to 25 years. Rehabilitation would include pavement work to achieve the required design life and possible improvement to safety barriers, pavement drainage or other road infrastructure necessary to satisfy standards or safety requirements of the time.

Therefore, we would expect two reseals (Years 8 and 16) then one rehabilitation[5]. Following this, the pavement would be reconstructed or maintenance continues beyond the 30 year design life. The design life is consistent with the current planned horizon of mining operations and work beyond 30 years is therefore not considered as part of this study.

We propose each mine fund the maintenance works as they arise. This ensures:

- Funding is used for the maintenance of the road
- Work is correctly funded, rather than attempting to estimate future works in 2013 dollars
- New developments or expanded operations can be included in the contributions model
- Ceased operations would not be required to fund activity and obligations redistributed between remaining mines

Therefore, contributions to maintenance are made at the time of the works.

4.2 Costs

For the purposes of this report, guide cost estimates are provided in 2013 dollars. Contributions are estimated based on the allocations estimated in Section 3. For the purposes of comparison and sensitivity analysis, the preferred (baseline standard) and user pays models are presented below. Contributions are based on the following total guide costs:

- Upgrade: \$19.915 M. MSC estimate based on tendered costs, with the addition of savings realised by the incorporation of existing pavement materials.
- Reseal (x 2): \$2.3 M based on GHD guide estimate of \$10/m^2 and full shoulder seal provided as current design. This rate is consistent with industry rates and similar to the RMS estimate provided for the Thomas Mitchell Drive improvements undertaken in August 2010.

[5] NB: For the purposes of this study the term "maintenance" is restricted to these capitally intensive reseals and heavy rehabilitation works, which are necessary to achieve the design life of the road. This term does not extend to routine road maintenance (such as filling potholes) that would be undertaken irrespective of the road upgrade.

- Rehabilitation: $7.42 M based on GHD knowledge of RMS rehabilitation costs to be roughly $700,000 per km. This rate is consistent with the RMS estimate provided for the Thomas Mitchell Drive improvements undertaken in August 2010.

Table 4-1 Cost allocations for the preferred contributions model

	Contribution (%)	Upgrade ($M)	Reseal (x2) ($M)	Rehabilitation ($M)	Total ($M)
Mangoola	2.8	0.57	0.06	0.21	0.84
Bengalla	6.2	1.24	0.14	0.46	1.84
Mount Arthur	25.4	5.05	0.59	1.88	7.53
Drayton	4.7	0.93	0.11	0.35	1.39
Total	*39.1*	*7.79*	*0.91*	*2.90*	*11.60*

4.2.1 Model comparison

The table below shows a comparison of all the models developed in Section 3. Of note, the average of the user pays models and all the models combined are reasonably consistent with the preferred model. This might indicate that although there are inconsistencies and debatable points of difference within each model, the overall outcome could be consistent.

Table 4-2 Contribution comparison between models

	Preferred model (Hybrid)		Baseline		User Pays Model 1		User Pays Model 2		Average
	(%)	($M)	(%)	($M)	(%)	($M)	(%)	($M)	($M)
Mangoola	2.8	0.84	2.1	0.63	1.56	0.46	4.03	1.20	0.78
Bengalla	6.2	1.84	4.7	1.38	3.40	1.01	8.80	2.61	1.71
Mount Arthur	25.4	7.53	19.1	5.66	13.90	4.12	36.00	10.68	7.0
Drayton	4.7	1.39	3.5	1.05	2.57	0.76	6.65	1.97	1.29
Total	*39.1*	11.60	*29.4*	*8.72*	*21.41*	*6.35*	55.48	*16.46*	*10.78*

Note, there are small rounding errors in several figures above.

4.2.2 Industrial area

If the industrial area was paid for by the mines, the contributions under the hybrid model would be as follows:

Table 4-3 Contributions with mines paying for the industrial area

	Contribution (%)	Upgrade ($M)	Reseal (x2) ($M)	Rehabilitation ($M)	Total ($M)
Mangoola	3.0	0.60	0.07	0.22	0.89
Bengalla	6.6	1.31	0.15	0.49	1.95
Mount Arthur	26.9	5.35	0.63	1.99	7.97
Drayton	5.0	0.99	0.12	0.37	1.47
Total	*41.4*	*8.25*	*0.97*	*3.07*	*12.29*

4.3 Apportionment

On the basis that the mines will be asked to contribute to the upgrade and ongoing maintenance of Thomas Mitchell Drive, we believe the costs allocated in Table 4-1 should form the basis of those contributions. In summary:

- Initial contributions towards the upgrade works should be paid to Council as soon as practicable and by no later than 30 September 2015, unless otherwise advised by DP&E. The initial payment would include each mine's proportionate contribution towards:
  - All actual costs and awarded tenders for Stages 1, 2 and 3 that have been completed or are underway.
  - 50% of the estimated costs for Stage 4.
- Payment of remaining contributions to be made following completion of Stage 4 construction, and reconciliation of actual project delivery costs. This would constitute in the order of 50% of the estimated Stage 4 costs. These costs would be verified as actual and appropriate construction costs.
- Contributions for the maintenance activities (reseals and rehabilitation) be paid at the time of work. If appropriate, proportions are to be adjusted to account for new or expanded mining operations based on traffic volume and composition at the time of assessment.

4.3.1 Denman Road intersection

If each of the four mines are to contribute wholly to the upgrade of the Denman Road intersection, the total cost should be determined in accordance with Table 3-11.

5. Recommendation

Based on the traffic data and logic in developing a contributions framework, we recommend the hybrid model be adopted. This requires 39.1% of road funding to be provided by the mines with allocation to each mine based on ESAkm. On this basis, the allocations presented in Table 4-1 and shown below would apply through the life cycle of the Thomas Mitchell Drive pavement (30 years):

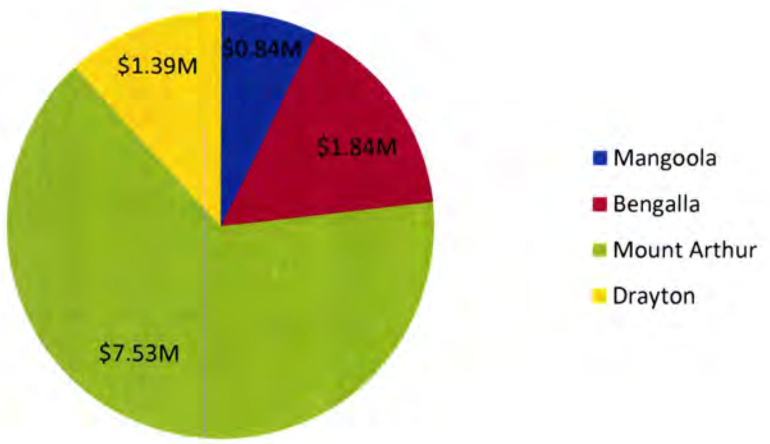


Figure 5-1 Estimated whole of life funding contribution by mine (2013 dollars)

Appendices

Appendix A – Traffic data

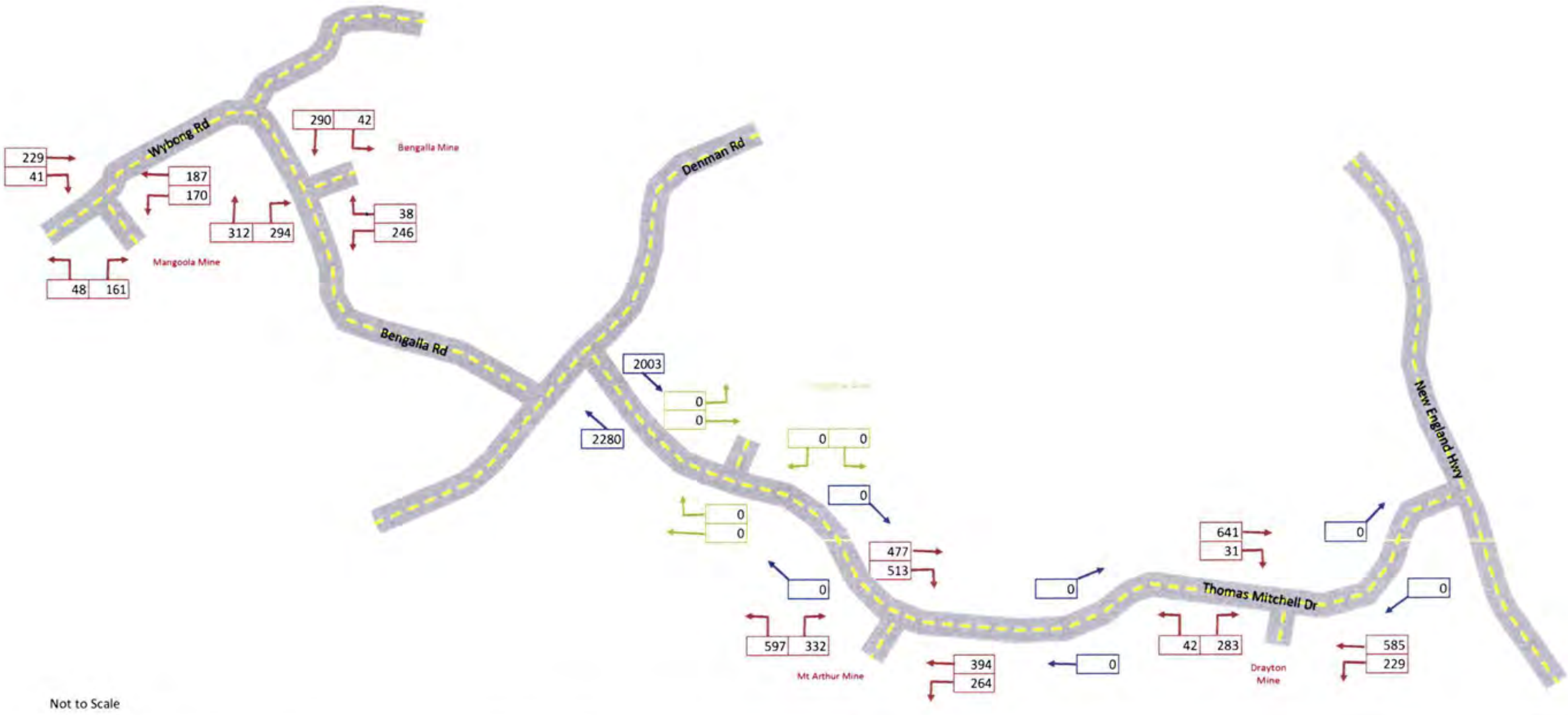


Figure A-1: Surveyed data - Light vehicles : Daytime

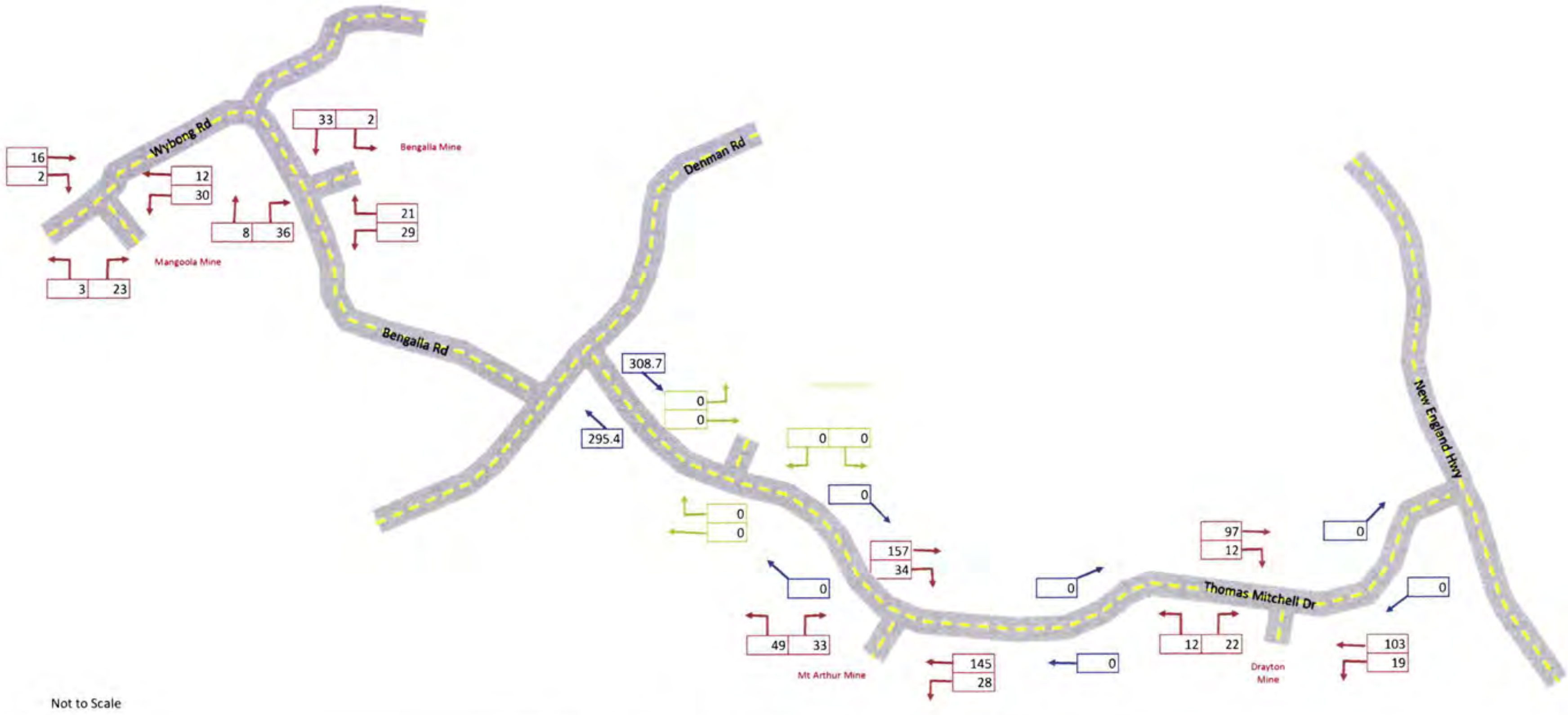


Figure A-2: Surveyed data - Heavy vehicles : Daytime

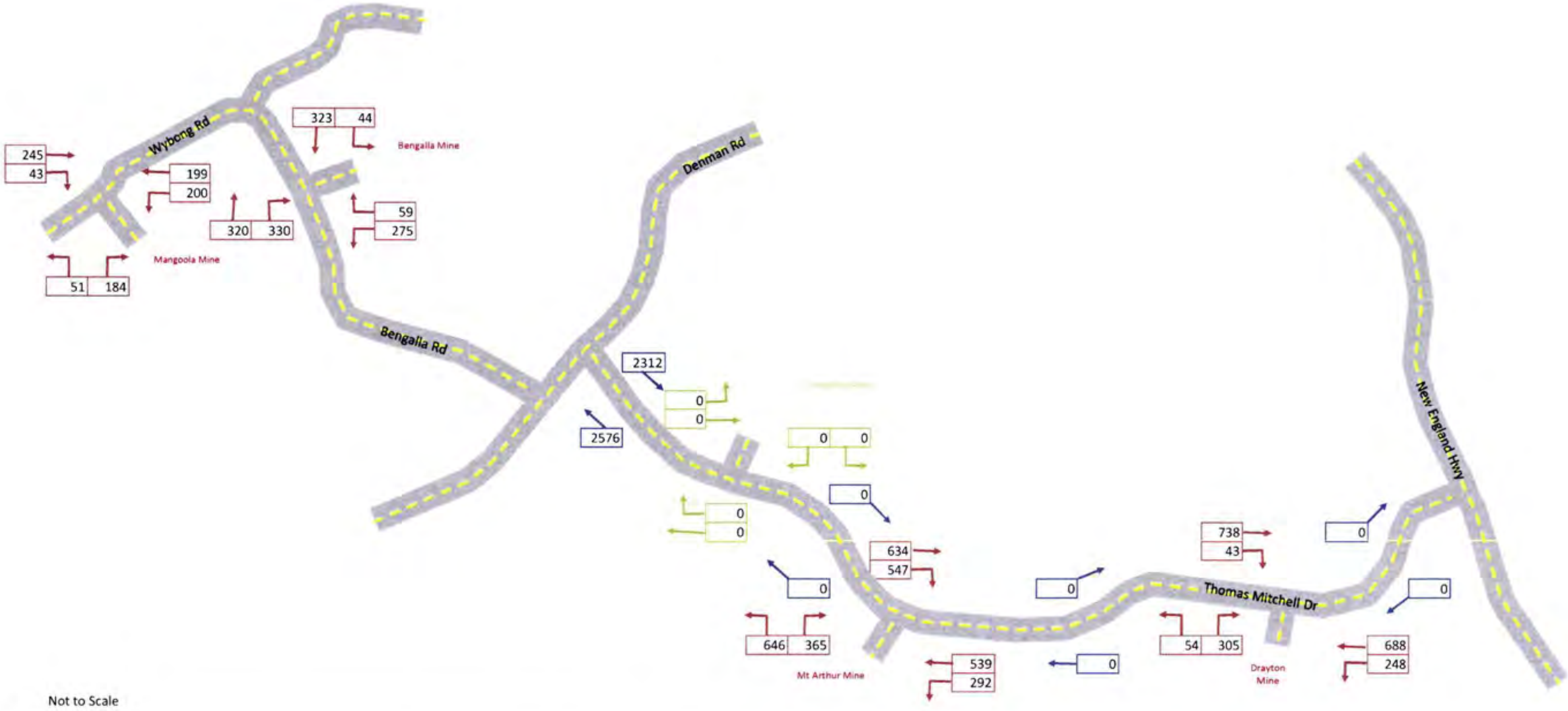
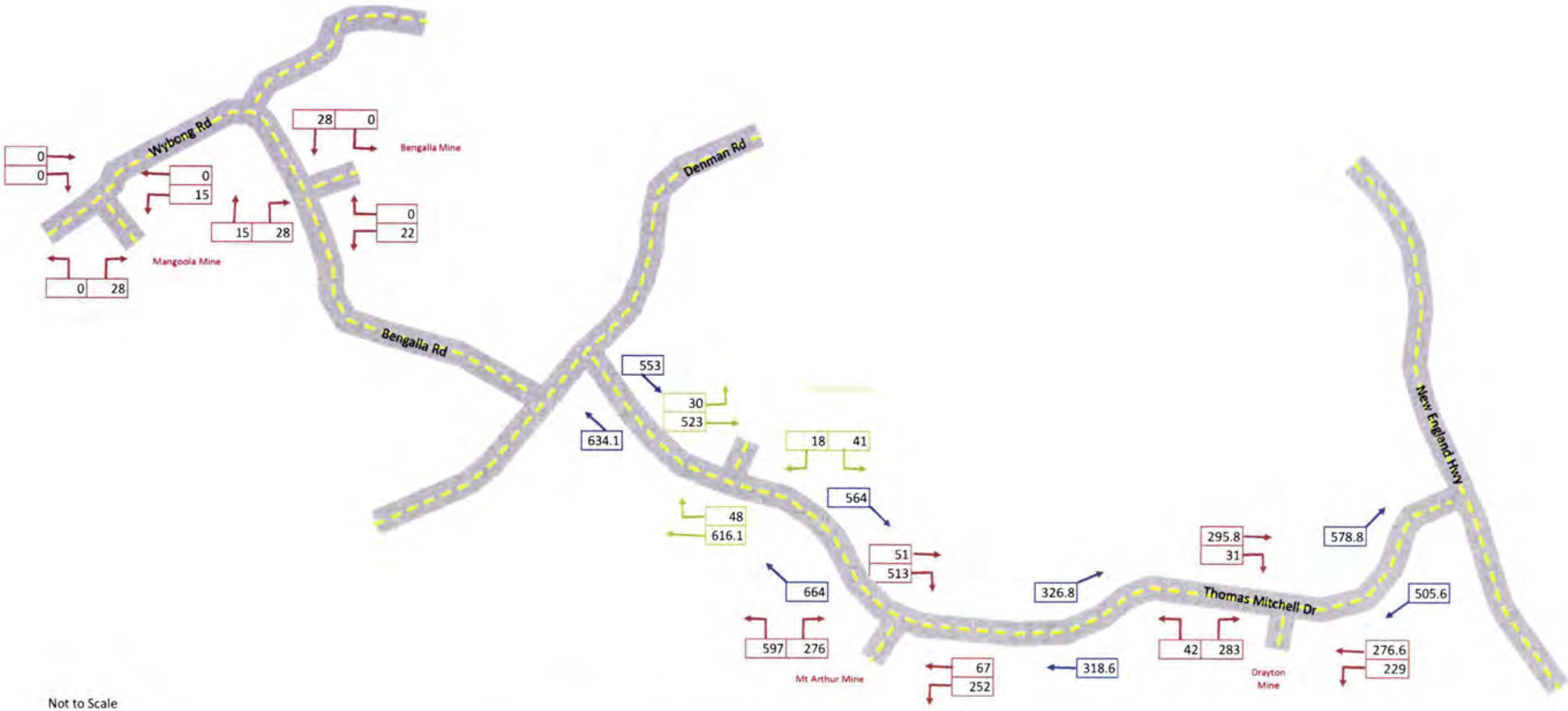


Figure A-3: Surveyed data - All vehicles : Daytime



Not to Scale

Figure A-4: All mine Traffic - Light Vehicles : Daytime

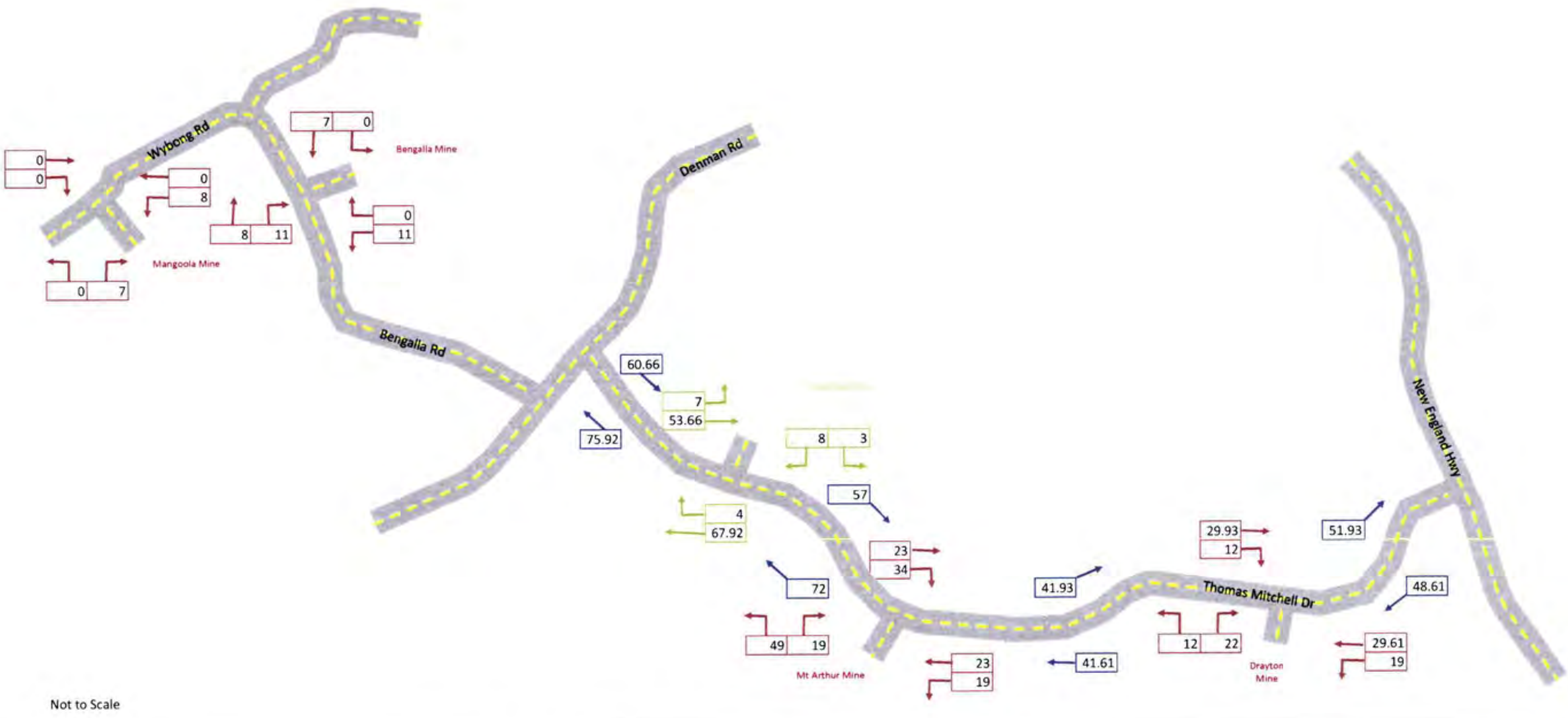
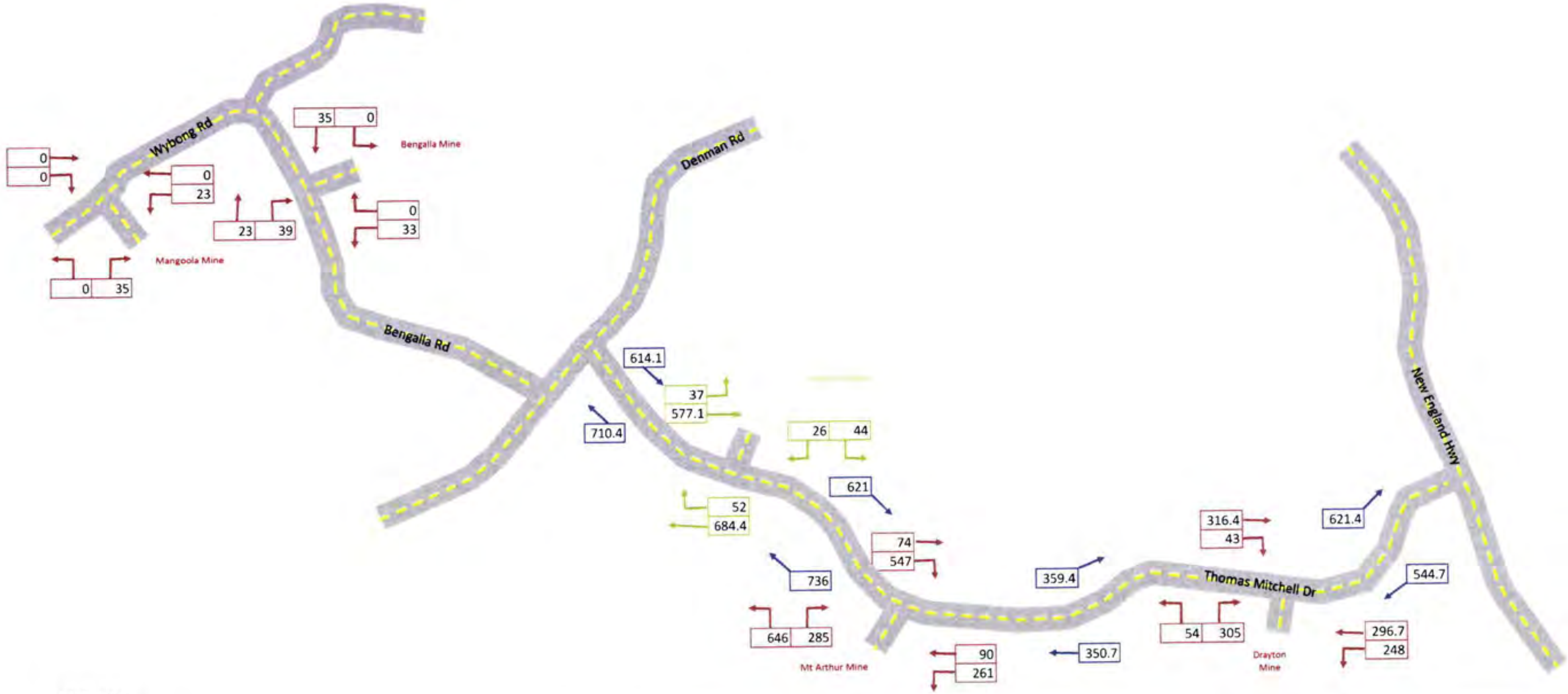
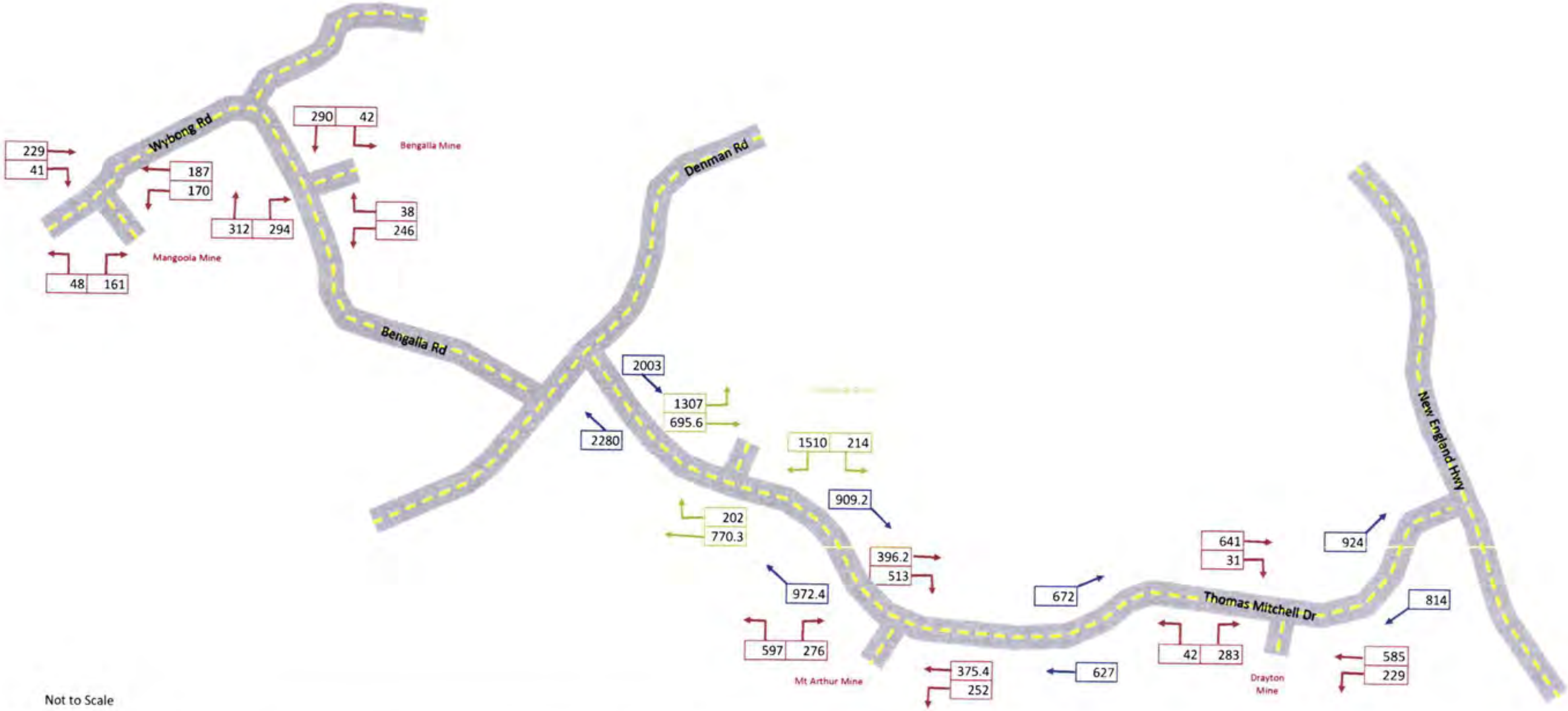


Figure A-5: All mine Traffic - Heavy Vehicles : Daytime



Not to Scale

Figure A-6: All mine Traffic - All Vehicles : Daytime



Not to Scale

Figure A-7: Final Baseline - Light Vehicles : Daytime

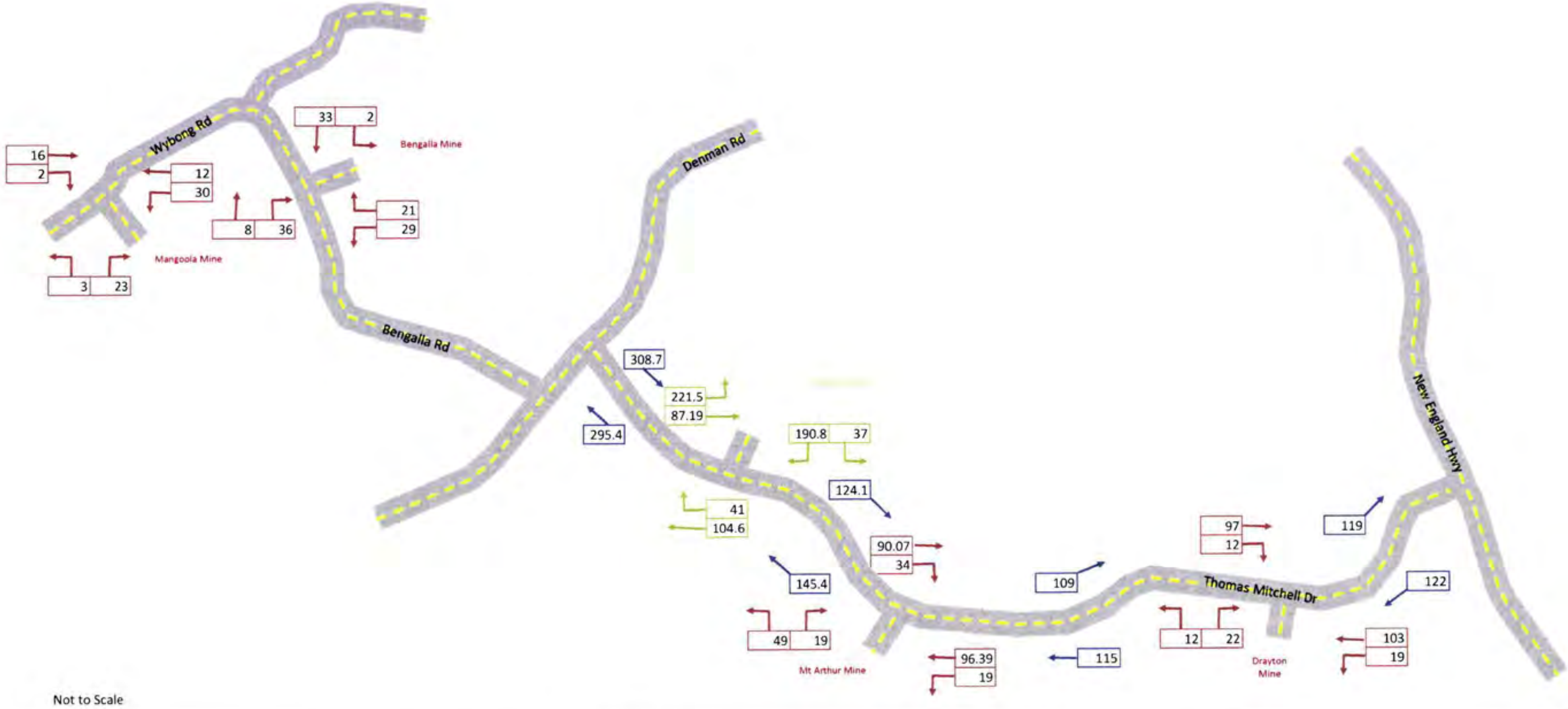
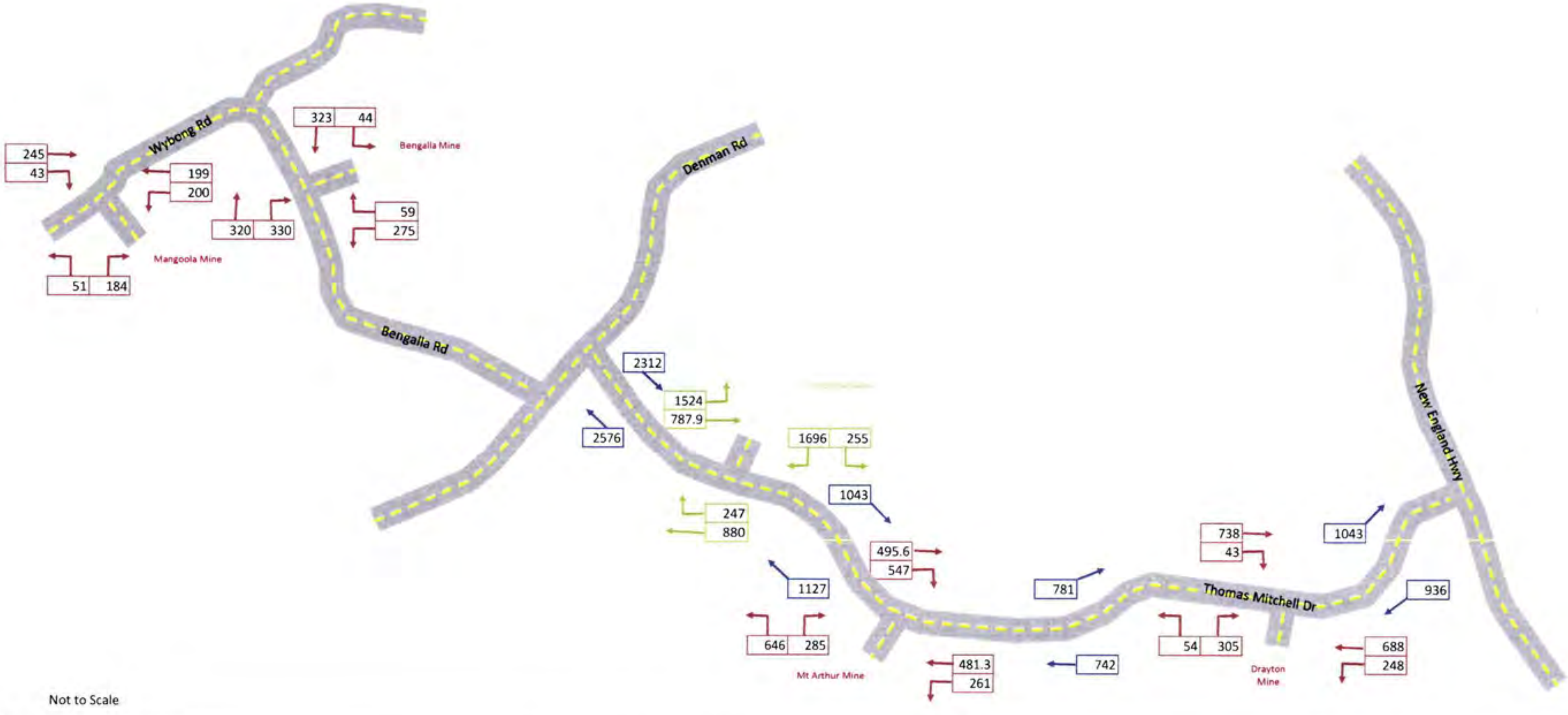


Figure A-8: Final Baseline - Heavy Vehicles : Daytime



Not to Scale

Figure A-9: Final Baseline - All Vehicles : Daytime

Table A-10: Apportionment - 2018 Revised - 24 Hour 7 Days

		Eastbound				Westbound			
		A	B	C	D	A	B	C	D
	Section of Thomas Mitchell Drive	West of Industrial Estate	East of Industrial Estate and West of Mt Arthur Mine	East of Mt Arthur Mine and West of Drayton Mine	East of Drayton Mine	West of Industrial Estate	East of Industrial Estate and West of Mt Arthur Mine	East of Mt Arthur Mine and West of Drayton Mine	East of Drayton Mine
Approx Length (km)		2.1	2.9	4.6	1.1	2.1	2.9	4.6	1.1
All Vehicles	**Lights**	2,827	1,643	1,310	1,504	2,650	1,631	1,308	1,492
	Heavies	194	187	162	164	363	191	165	191
	All	**3,021**	**1,830**	**1,472**	**1,668**	**3,013**	**1,822**	**1,473**	**1,683**
All Mine Vehicles	**Lights**	802	801	548	824	925	949	542	746
	Heavies	142	141	88	99	146	149	82	89
	All	**944**	**943**	**636**	**923**	**1,071**	**1,098**	**623**	**836**
Proportion	**Lights**	*28%*	*49%*	*42%*	*55%*	*35%*	*58%*	*41%*	*50%*
	Heavies	*73%*	*76%*	*54%*	*60%*	*40%*	*78%*	*50%*	*47%*
	All	***31%***	***52%***	***43%***	***55%***	***36%***	***60%***	***42%***	***50%***

Mangoola Mine (GHD)

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	91	56	56	56	67	51	51	51
	Heavies	11	7	7	7	10	8	8	8
	All	**103**	**64**	**64**	**64**	**77**	**59**	**59**	**59**
Proportion	**Lights**	*3%*	*3%*	*4%*	*4%*	*3%*	*3%*	*4%*	*3%*
	Heavies	*6%*	*4%*	*4%*	*4%*	*3%*	*4%*	*5%*	*4%*
	All	***3%***	***3%***	***4%***	***4%***	***3%***	***3%***	***4%***	***3%***

Bengalla Mine

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	129	112	112	112	152	133	133	133
	Heavies	23	20	20	20	17	15	15	15
	All	**151**	**132**	**132**	**132**	**170**	**148**	**148**	**148**
Proportion	**Lights**	*5%*	*7%*	*9%*	*7%*	*6%*	*8%*	*10%*	*9%*
	Heavies	*12%*	*11%*	*12%*	*12%*	*5%*	*8%*	*9%*	*8%*
	All	***5%***	***7%***	***9%***	***8%***	***6%***	***8%***	***10%***	***9%***

Mt Arthur Mine (GHD - Daytime)

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	559	599	346	346	674	720	312	312
	Heavies	96	101	48	48	107	113	46	46
	All	**656**	**700**	**394**	**394**	**781**	**833**	**358**	**358**
Proportion	**Lights**	*20%*	*36%*	*26%*	*23%*	*25%*	*44%*	*24%*	*21%*
	Heavies	*50%*	*54%*	*30%*	*29%*	*30%*	*59%*	*28%*	*24%*
	All	***22%***	***38%***	***27%***	***24%***	***26%***	***46%***	***24%***	***21%***

Drayton Mine

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	23	34	34	310	32	46	46	251
	Heavies	12	13	13	24	12	13	13	21
	All	**34**	**47**	**47**	**334**	**43**	**59**	**59**	**271**
Proportion	**Lights**	*1%*	*2%*	*3%*	*21%*	*1%*	*3%*	*4%*	*17%*
	Heavies	*6%*	*7%*	*8%*	*15%*	*3%*	*7%*	*8%*	*11%*
	All	***1%***	***3%***	***3%***	***20%***	***1%***	***3%***	***4%***	***16%***

Table A-11: Apportionment - 2018 Revised - 24 Hour Weekday Assessment

		Eastbound				Westbound			
		A	B	C	D	A	B	C	D
	Section of Thomas Mitchell Drive	West of Industrial Estate	East of Industrial Estate and West of Mt Arthur Mine	East of Mt Arthur Mine and West of Drayton Mine	East of Drayton Mine	West of Industrial Estate	East of Industrial Estate and West of Mt Arthur Mine	East of Mt Arthur Mine and West of Drayton Mine	East of Drayton Mine
Approx Length (km)		2.1	2.9	4.6	1.1	2.1	2.9	4.6	1.1
All Vehicles	**Lights**	3,583	2,059	1,634	1,854	3,366	2,054	1,641	1,848
	Heavies	246	234	202	202	461	241	207	236
	All	3,829	2,293	1,836	2,056	3,827	2,294	1,847	2,085
All Mine Vehicles	**Lights**	988	987	675	1,012	1,119	1,151	652	902
	Heavies	175	174	111	124	179	183	101	110
	All	**1,163**	**1,161**	**786**	**1,136**	**1,298**	**1,333**	**752**	**1,011**
Proportion	**Lights**	*28%*	*48%*	*41%*	*55%*	*33%*	*56%*	*40%*	*49%*
	Heavies	*71%*	*74%*	*55%*	*61%*	*39%*	*76%*	*49%*	*47%*
	All	***30%***	***51%***	***43%***	***55%***	***34%***	***58%***	***41%***	***49%***
Mangoola Mine (GHD)									
All Mine Vehicles	**Lights**	112	69	69	69	82	63	63	63
	Heavies	14	9	9	9	12	10	10	10
	All	**126**	**78**	**78**	**78**	**95**	**72**	**72**	**72**
Proportion	**Lights**	*3%*	*3%*	*4%*	*4%*	*2%*	*3%*	*4%*	*3%*
	Heavies	*6%*	*4%*	*4%*	*4%*	*3%*	*4%*	*5%*	*4%*
	All	***3%***	***3%***	***4%***	***4%***	***2%***	***3%***	***4%***	***3%***
Bengalla Mine									
All Mine Vehicles	**Lights**	160	139	139	139	171	149	149	149
	Heavies	28	25	25	25	19	17	17	17
	All	**188**	**164**	**164**	**164**	**190**	**166**	**166**	**166**
Proportion	**Lights**	*4%*	*7%*	*9%*	*8%*	*5%*	*7%*	*9%*	*8%*
	Heavies	*11%*	*10%*	*12%*	*12%*	*4%*	*7%*	*8%*	*7%*
	All	***5%***	***7%***	***9%***	***8%***	***5%***	***7%***	***9%***	***8%***
Mt Arthur Mine (GHD - Daytime)									
All Mine Vehicles	**Lights**	689	737	425	425	828	883	384	384
	Heavies	118	125	61	61	133	140	58	58
	All	**807**	**862**	**487**	**487**	**961**	**1,023**	**442**	**442**
Proportion	**Lights**	*19%*	*36%*	*26%*	*23%*	*25%*	*43%*	*23%*	*21%*
	Heavies	*48%*	*53%*	*30%*	*30%*	*29%*	*58%*	*28%*	*25%*
	All	***21%***	***38%***	***27%***	***24%***	***25%***	***45%***	***24%***	***21%***
Drayton Mine									
All Mine Vehicles	**Lights**	28	41	41	378	39	56	56	306
	Heavies	14	16	16	29	14	16	16	25
	All	**42**	**57**	**57**	**407**	**53**	**72**	**72**	**331**
Proportion	**Lights**	*1%*	*2%*	*3%*	*20%*	*1%*	*3%*	*3%*	*17%*
	Heavies	*6%*	*7%*	*8%*	*15%*	*3%*	*7%*	*8%*	*11%*
	All	***1%***	***3%***	***3%***	***20%***	***1%***	***3%***	***4%***	***16%***

Table A-12: Apportionment - 2013 Revised - 24 Hour 7 Days

		Eastbound				Westbound			
		A	B	C	D	A	B	C	D
	Section of Thomas Mitchell Drive	West of Industrial Estate	East of Industrial Estate and West of Mt Arthur Mine	East of Mt Arthur Mine and West of Drayton Mine	East of Drayton Mine	West of Industrial Estate	East of Industrial Estate and West of Mt Arthur Mine	East of Mt Arthur Mine and West of Drayton Mine	East of Drayton Mine
Approx Length (km)		2.1	2.9	4.6	1.1	2.1	2.9	4.6	1.1
All Vehicles	**Lights**	2,624	1,525	1,216	1,396	2,460	1,514	1,214	1,385
	Heavies	180	173	150	152	337	178	153	177
	All	**2,804**	**1,699**	**1,367**	**1,548**	**2,797**	**1,692**	**1,367**	**1,563**
All Mine Vehicles	**Lights**	785	800	527	803	910	945	517	722
	Heavies	118	120	81	92	124	129	75	83
	All	**904**	**920**	**608**	**895**	**1,035**	**1,073**	**593**	**805**
Proportion	**Lights**	*30%*	*52%*	*43%*	*58%*	*37%*	*62%*	*43%*	*52%*
	Heavies	*66%*	*69%*	*54%*	*60%*	*37%*	*72%*	*49%*	*47%*
	All	***32%***	***54%***	***44%***	***58%***	***37%***	***63%***	***43%***	***52%***

Mangoola Mine (GHD)

All Mine Vehicles	**Lights**	61	38	38	38	45	34	34	34
	Heavies	8	5	5	5	7	5	5	5
	All	**68**	**42**	**42**	**42**	**51**	**39**	**39**	**39**
Proportion	**Lights**	*2%*	*2%*	*3%*	*3%*	*2%*	*2%*	*3%*	*2%*
	Heavies	*4%*	*3%*	*3%*	*3%*	*2%*	*3%*	*3%*	*3%*
	All	***2%***	***2%***	***3%***	***3%***	***2%***	***2%***	***3%***	***3%***

Bengalla Mine

All Mine Vehicles	**Lights**	96	84	84	84	114	99	99	99
	Heavies	17	15	15	15	13	11	11	11
	All	**113**	**99**	**99**	**99**	**127**	**110**	**110**	**110**
Proportion	**Lights**	*4%*	*5%*	*7%*	*6%*	*5%*	*7%*	*8%*	*7%*
	Heavies	*9%*	*9%*	*10%*	*10%*	*4%*	*6%*	*7%*	*6%*
	All	***4%***	***6%***	***7%***	***6%***	***5%***	***7%***	***8%***	***7%***

Mt Arthur Mine (GHD - Daytime)

All Mine Vehicles	**Lights**	605	645	372	372	720	766	338	338
	Heavies	82	87	48	48	93	99	46	46
	All	**688**	**732**	**420**	**420**	**813**	**865**	**384**	**384**
Proportion	**Lights**	*23%*	*42%*	*31%*	*27%*	*29%*	*51%*	*28%*	*24%*
	Heavies	*46%*	*50%*	*32%*	*32%*	*28%*	*56%*	*30%*	*26%*
	All	***25%***	***43%***	***31%***	***27%***	***29%***	***51%***	***28%***	***25%***

Drayton Mine

All Mine Vehicles	**Lights**	23	34	34	310	32	46	46	251
	Heavies	12	13	13	24	12	13	13	21
	All	**34**	**47**	**47**	**334**	**43**	**59**	**59**	**271**
Proportion	**Lights**	*1%*	*2%*	*3%*	*22%*	*1%*	*3%*	*4%*	*18%*
	Heavies	*7%*	*8%*	*9%*	*16%*	*3%*	*7%*	*9%*	*12%*
	All	***1%***	***3%***	***3%***	***22%***	***2%***	***3%***	***4%***	***17%***

Table A-13: Apportionment - 2013 Revised - 24 Hour Weekday Assessment

	Section of Thomas Mitchell Drive	Eastbound A: West of Industrial Estate	Eastbound B: East of Industrial Estate and West of Mt Arthur Mine	Eastbound C: East of Mt Arthur Mine and West of Drayton Mine	Eastbound D: East of Drayton Mine	Westbound A: West of Industrial Estate	Westbound B: East of Industrial Estate and West of Mt Arthur Mine	Westbound C: East of Mt Arthur Mine and West of Drayton Mine	Westbound D: East of Drayton Mine
Approx Length (km)		2.1	2.9	4.6	1.1	2.1	2.9	4.6	1.1
All Vehicles	**Lights**	3,326	1,912	1,517	1,721	3,124	1,906	1,523	1,716
	Heavies	228	217	187	188	428	224	192	219
	All	**3,555**	**2,129**	**1,704**	**1,908**	**3,552**	**2,130**	**1,715**	**1,935**
All Mine Vehicles	**Lights**	957	974	643	979	1,095	1,138	619	869
	Heavies	149	151	102	115	156	161	93	102
	All	**1,106**	**1,125**	**744**	**1,094**	**1,251**	**1,299**	**713**	**972**
Proportion	**Lights**	*29%*	*51%*	*42%*	*57%*	*35%*	*60%*	*41%*	*51%*
	Heavies	*65%*	*70%*	*54%*	*61%*	*36%*	*72%*	*49%*	*47%*
	All	***31%***	***53%***	***44%***	***57%***	***35%***	***61%***	***42%***	***50%***

Mangoola Mine (GHD)

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	74	46	46	46	55	42	42	42
	Heavies	9	6	6	6	8	6	6	6
	All	**84**	**52**	**52**	**52**	**63**	**48**	**48**	**48**
Proportion	**Lights**	*2%*	*2%*	*3%*	*3%*	*2%*	*2%*	*3%*	*2%*
	Heavies	*4%*	*3%*	*3%*	*3%*	*2%*	*3%*	*3%*	*3%*
	All	***2%***	***2%***	***3%***	***3%***	***2%***	***2%***	***3%***	***2%***

Bengalla Mine

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	120	104	104	104	128	111	111	111
	Heavies	21	18	18	18	14	13	13	13
	All	**141**	**123**	**123**	**123**	**142**	**124**	**124**	**124**
Proportion	**Lights**	*4%*	*5%*	*7%*	*6%*	*4%*	*6%*	*7%*	*6%*
	Heavies	*9%*	*8%*	*10%*	*10%*	*3%*	*6%*	*7%*	*6%*
	All	***4%***	***6%***	***7%***	***6%***	***4%***	***6%***	***7%***	***6%***

Mt Arthur Mine (GHD - Daytime)

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	735	783	451	451	874	929	410	410
	Heavies	104	111	61	61	119	126	58	58
	All	**839**	**894**	**513**	**513**	**993**	**1,055**	**468**	**468**
Proportion	**Lights**	*22%*	*41%*	*30%*	*26%*	*28%*	*49%*	*27%*	*24%*
	Heavies	*46%*	*51%*	*33%*	*33%*	*28%*	*57%*	*30%*	*27%*
	All	***24%***	***42%***	***30%***	***27%***	***28%***	***50%***	***27%***	***24%***

Drayton Mine

		EB A	EB B	EB C	EB D	WB A	WB B	WB C	WB D
All Mine Vehicles	**Lights**	28	41	41	378	39	56	56	306
	Heavies	14	16	16	29	14	16	16	25
	All	**42**	**57**	**57**	**407**	**53**	**72**	**72**	**331**
Proportion	**Lights**	*1%*	*2%*	*3%*	*22%*	*1%*	*3%*	*4%*	*18%*
	Heavies	*6%*	*7%*	*9%*	*16%*	*3%*	*7%*	*8%*	*12%*
	All	***1%***	***3%***	***3%***	***21%***	***1%***	***3%***	***4%***	***17%***

Appendix B – Pavement calculations (ESAkm)

Thomas Mitchell Dr - 2013 USER PAYS 1													
Traffic link	Segment	2013							DESA				
		AADT	%HV	Growth rate%	CGF	ESA/HV	Direction Factor (DF)	Lane Distribution Factor (LDF)	30	Years	Length (km)	ESA x km	
Pavement design	Denman Rd - Glen Munro								18,900,000		2.76	52,164,000	
	Glen Munro - MAC								13,200,000		2.21	29,172,000	
	MAC - Drayton								13,200,000		4.6	60,720,000	
	Drayton - NEH								13,200,000		1	13,200,000	
									58,500,000			155,256,000	
Mangoola	Denman - Glen Munro	120	12%	0.01%	30.04354	2.52	0.5	1	198,124		2.76	546,823	1.05%
	Glen Munro - MAC	82	12%	0.01%	30.04354	2.52	0.5	1	136,130		2.21	300,847	1.03%
	MAC - Drayton	82	12%	0.01%	30.04354	2.52	0.5	1	136,130		4.6	626,197	1.03%
	Drayton - NEH	82	12%	0.01%	30.04354	2.52	0.5	1	136,130		1	136,130	1.03%
									606,514			1,609,997	1.04%
Bengalla	Denman - Glen Munro	240	12%	0.01%	30.04354	2.52	0.5	1	412,328		2.76	1,138,026	2.18%
	Glen Munro - MAC	209	12%	0.01%	30.04354	2.52	0.5	1	359,125		2.21	793,665	2.72%
	MAC - Drayton	209	12%	0.01%	30.04354	2.52	0.5	1	359,125		4.6	1,651,973	2.72%
	Drayton - NEH	209	12%	0.01%	30.04354	2.52	0.5	1	359,125		1	359,125	2.72%
									1,489,702			3,942,789	2.54%
MAC	Denman - Glen Munro	1501	12%	0.01%	30.04354	2.52	0.5	1	2,422,075		2.76	6,684,928	12.82%
	Glen Munro - MAC	1597	12%	0.01%	30.04354	2.52	0.5	1	2,577,086		2.21	5,695,361	19.52%
	MAC - Drayton	804	12%	0.01%	30.04354	2.52	0.5	1	1,298,188		4.6	5,971,666	9.83%
	Drayton - NEH	804	12%	0.01%	30.04354	2.52	0.5	1	1,298,188		1	1,298,188	9.83%
									7,595,538			19,650,143	12.66%
Drayton	Denman - Glen Munro		30%	0.01%	30.04354	2.52	0.5	1	-		2.76	-	0.00%
	Glen Munro - MAC		25%	0.01%	30.04354	2.52	0.5	1	-		2.21	-	0.00%
	MAC - Drayton		25%	0.01%	30.04354	2.52	0.5	1	-		4.6	-	0.00%
	Drayton - NEH		7%	0.01%	30.04354	2.52	0.5	1	-		1	-	0.00%
									-			-	0.00%
	TOTAL MINE								9,691,754			25,202,928	16.23%

Thomas Mitchell Dr - 2018 USER PAYS 1														
Traffic link	Segment	2018							DESA					
		AADT	%HV	Growth rate%	CGF	ESA/HV	Direction Factor (DF)	Lane Distribution Factor (LDF)	30	Years	Length (km)	ESA x km	
Pavement design	Denman - Glen Munro								18,900,000		2.76	52,164,000	
	Glen Munro - MAC								13,200,000		2.21	29,172,000	
	MAC - Drayton								13,200,000		4.6	60,720,000	
	Drayton - NEH								13,200,000		1	13,200,000	
									58,500,000			155,256,000	
Mangoola	Denman - Glen Munro	180	12%	0.01%	30.04354	2.52	0.5	1	297,186		2.76	820,234	1.57%
	Glen Munro - MAC	122	12%	0.01%	30.04354	2.52	0.5	1	204,195		2.21	451,270	1.55%
	MAC - Drayton	122	12%	0.01%	30.04354	2.52	0.5	1	204,195		4.6	939,296	1.55%
	Drayton - NEH	122	12%	0.01%	30.04354	2.52	0.5	1	204,195		1	204,195	1.55%
									909,771			2,414,995	1.56%
Bengalla	Denman - Glen Munro	321	12%	0.01%	30.04354	2.52	0.5	1	551,489		2.76	1,522,110	2.92%
	Glen Munro - MAC	280	12%	0.01%	30.04354	2.52	0.5	1	480,329		2.21	1,061,527	3.64%
	MAC - Drayton	280	12%	0.01%	30.04354	2.52	0.5	1	480,329		4.6	2,209,514	3.64%
	Drayton - NEH	280	12%	0.01%	30.04354	2.52	0.5	1	480,329		1	480,329	3.64%
									1,992,476			5,273,480	3.40%
MAC	Denman - Glen Munro	1437	14%	0.01%	30.04354	2.52	0.5	1	2,808,952		2.76	7,752,707	14.86%
	Glen Munro - MAC	1533	14%	0.01%	30.04354	2.52	0.5	1	2,963,963		2.21	6,550,358	22.45%
	MAC - Drayton	752	12%	0.01%	30.04354	2.52	0.5	1	1,298,188		4.6	5,971,666	9.83%
	Drayton - NEH	752	12%	0.01%	30.04354	2.52	0.5	1	1,298,188		1	1,298,188	9.83%
									8,369,291			21,572,920	13.90%
Drayton	Denman - Glen Munro	78	30%	0.01%	30.04354	2.52	0.5	1	323,454		2.76	892,733	1.71%
	Glen Munro - MAC	106	25%	0.01%	30.04354	2.52	0.5	1	362,752		2.21	801,682	2.75%
	MAC - Drayton	106	25%	0.01%	30.04354	2.52	0.5	1	362,752		4.6	1,668,660	2.75%
	Drayton - NEH	605	7%	0.01%	30.04354	2.52	0.5	1	619,701		1	619,701	4.69%
									1,668,660			3,982,776	2.57%
	TOTAL MINE								12,940,198			33,244,171	21.41%

Thomas Mitchell Dr - 2013 USER PAYS 2													
Traffic link	Segment	2013							DESA				
		AADT	%HV	Growth rate%	CGF	ESA/HV	Direction Factor (DF)	Lane Distributio n Factor (LDF)	30	Years	Length (km)	ESA x km	%
All traffic	Denman - Glen Munro	5523	8.9%	1.50%	37.53868	2.52	0.5	1	8,523,695		2.76	23,525,399	
	Glen Munro - MAC	3284	9.9%	1.50%	37.53868	2.52	0.5	1	5,607,287		2.21	12,392,104	
	MAC - Drayton	2628	10.5%	1.50%	37.53868	2.52	0.5	1	4,783,369		4.6	22,003,497	
	Drayton - NEH	2505	11.4%	1.50%	37.53868	2.52	0.5	1	4,911,053		1	4,911,053	
									23,825,404			62,832,053	
Mangoola	Denman - Glen Munro	120	12%	1.50%	37.53868	2.52	0.5	1	247,552		2.76	683,242	2.90%
	Glen Munro - MAC	82	12%	1.50%	37.53868	2.52	0.5	1	170,091		2.21	375,901	3.03%
	MAC - Drayton	82	12%	1.50%	37.53868	2.52	0.5	1	170,091		4.6	782,418	3.56%
	Drayton - NEH	82	12%	1.50%	37.53868	2.52	0.5	1	170,091		1	170,091	3.46%
									757,824			2,011,652	3.20%
Bengalla	Denman - Glen Munro	240	12%	1.50%	37.53868	2.52	0.5	1	515,194		2.76	1,421,936	6.04%
	Glen Munro - MAC	209	12%	1.50%	37.53868	2.52	0.5	1	448,717		2.21	991,666	8.00%
	MAC - Drayton	209	12%	1.50%	37.53868	2.52	0.5	1	448,717		4.6	2,064,100	9.38%
	Drayton - NEH	209	12%	1.50%	37.53868	2.52	0.5	1	448,717		1	448,717	9.14%
									1,861,347			4,926,419	7.84%
MAC	Denman - Glen Munro	1501	12%	1.50%	37.53868	2.52	0.5	1	3,026,325		2.76	8,352,656	35.50%
	Glen Munro - MAC	1597	12%	1.50%	37.53868	2.52	0.5	1	3,220,007		2.21	7,116,216	57.43%
	MAC - Drayton	804	12%	1.50%	37.53868	2.52	0.5	1	1,622,055		4.6	7,461,453	33.91%
	Drayton - NEH	804	12%	1.50%	37.53868	2.52	0.5	1	1,622,055		1	1,622,055	33.03%
									9,490,442			24,552,381	39.08%
Drayton	Denman - Glen Munro		30%	1.50%	37.53868	2.52	0.5	1	-		2.76	-	0.00%
	Glen Munro - MAC		25%	1.50%	37.53868	2.52	0.5	1	-		2.21	-	0.00%
	MAC - Drayton		25%	1.50%	37.53868	2.52	0.5	1	-		4.6	-	0.00%
	Drayton - NEH		7%	1.50%	37.53868	2.52	0.5	1	-		1	-	0.00%
									-			-	0.00%
	MINE TOTAL								12,109,613	-	-	31,490,453	50.12%

Thomas Mitchell Dr - 2018 USER PAYS 2													
Traffic link	Description	2018							DESA				
		AADT	%HV	Growth rate%	CGF	ESA/HV	Direction Factor (DF)	Lane Distribution Factor (LDF)	30	Years	Length (km)	ESA x km	
Pavement design	Denman - Glen Munro	6184	9%	1.50%	37.53868	2.52	0.5	1	9,857,060		2.76	27,205,486	
	Glen Munro - MAC	3743	10%	1.50%	37.53868	2.52	0.5	1	6,691,323		2.21	14,787,823	
	MAC - Drayton	3018	11%	1.50%	37.53868	2.52	0.5	1	5,781,650		4.6	26,595,592	
	Drayton - NEH	3434	11%	1.50%	37.53868	2.52	0.5	1	6,277,091		1	6,277,091	
									28,607,124			74,865,993	
Mangoola	Denman - Glen Munro	180	12%	1.50%	37.53868	2.52	0.5	1	371,327		2.76	1,024,863	3.77%
	Glen Munro - MAC	122	12%	1.50%	37.53868	2.52	0.5	1	255,136		2.21	563,851	3.81%
	MAC - Drayton	122	12%	1.50%	37.53868	2.52	0.5	1	255,136		4.6	1,173,628	4.41%
	Drayton - NEH	122	12%	1.50%	37.53868	2.52	0.5	1	255,136		1	255,136	4.06%
									1,136,737			3,017,479	4.03%
Bengalla	Denman - Glen Munro	321	12%	1.50%	37.53868	2.52	0.5	1	689,072		2.76	1,901,839	6.99%
	Glen Munro - MAC	280	12%	1.50%	37.53868	2.52	0.5	1	600,160		2.21	1,326,353	8.97%
	MAC - Drayton	280	12%	1.50%	37.53868	2.52	0.5	1	600,160		4.6	2,760,734	10.38%
	Drayton - NEH	280	12%	1.50%	37.53868	2.52	0.5	1	600,160		1	600,160	9.56%
									2,489,551			6,589,086	8.80%
MAC	Denman - Glen Munro	1437	14%	1.50%	37.53868	2.52	0.5	1	3,509,718		2.76	9,686,821	35.61%
	Glen Munro - MAC	1533	14%	1.50%	37.53868	2.52	0.5	1	3,703,400		2.21	8,184,515	55.35%
	MAC - Drayton	752	12%	1.50%	37.53868	2.52	0.5	1	1,622,055		4.6	7,461,453	28.06%
	Drayton - NEH	752	12%	1.50%	37.53868	2.52	0.5	1	1,622,055		1	1,622,055	25.84%
									10,457,228			26,954,844	36.00%
Drayton	Denman - Glen Munro	78	30%	1.50%	37.53868	2.52	0.5	1	404,148		2.76	1,115,448	4.10%
	Glen Munro - MAC	106	25%	1.50%	37.53868	2.52	0.5	1	453,250		2.21	1,001,682	6.77%
	MAC - Drayton	106	25%	1.50%	37.53868	2.52	0.5	1	453,250		4.6	2,084,950	7.84%
	Drayton - NEH	605	7%	1.50%	37.53868	2.52	0.5	1	774,302		1	774,302	12.34%
									2,084,950			4,976,383	6.65%
	MINE TOTAL								16,168,466			41,537,792	55.48%

Appendix C – Pavement design

Equivalent pavement depth calculation

	Depth	Extra over background	% extra over	equivalent pavement depth	equivalent depth	% pavement
Background	270	0		270	270	80.60%
Background + mine		46	71%	46	316	13.73%
Background + IA		11	17%	11	327	3.28%
Background + growth		8	12%	8	335	2.39%
		65	100%			
TOTAL	335					

Pavement width (area related)						% from User pays 1 - 2018			Hybrid
Cross section									
width (m)	mine only (m)	Shared (m)	total(m)	% of total cross section pavement			ESAkm	%	% total $
11.0	3.24	7.8				Mangoola	2,414,995	7.3%	2.84%
	0	6.26	6.26	56.9%	Background	Bengalla	5,273,480	15.9%	6.20%
	3.24	1.07	4.30	39.1%	Mines	Mount Arthur	21,572,920	64.9%	25.38%
	0	0.25	0.25	2.3%	Industrial Area	Drayton	3,982,776	12.0%	4.68%
	0	0.19	0.19	1.7%	Growth		33,244,171		39.1%

GHD CLIENTS PEOPLE PERFORMANCE

Pavement Summary

Project:	Thomas Mitchell Drive Upgrade			
Job No:	22/17038			
Road:	Thomas Mitchell Drive			
Section:	All			
Date:	19-Nov-13			
Designed By:	H. Porter	**Date:**	19-Nov-13	19-Nov-13
Reviewed By	J. Grobler	**Date:**		

Pavement Type: Insitu lime modification and overlay	
Pavement Description:	**Granular overlay**
Direction:	-
Chainage (m):	**Traffic Block 1**
Project Reliability:	95.0%
DESA (ESA's): Background	9.50E+05
DESA (ESA's): Background + Mine	3.90E+06
DESA (ESA's): Background + Industrial + Mine	6.60E+06
DESA (ESA's): Background + Industrial + Mine + Growth	8.20E+06
Design Subgrade CBR (%):	2

Pavement Layer	**Pavement Material**	**Specification**	**Background**	**Background + Mine**	**Background + Industrial + Mine**	**Background + Industrial + Mine + Growth**
			Layer Thickness (mm)			
Surfacing Layer	14/7 mm double seal	n/a	15	15	15	15
Seal	Primerseal	n/a	-	-	-	-
Base Course	DGB20	n/a	125	195	210	220
Subbase Course	Insitu lime stabilise existing	n/a	200	200	200	200
Select Material Zone 1	Select fill (CBR 10%)	n/a	-	-	-	-
Select Material Zone 2	Select fill (CBR 5%)	n/a	-	-	-	-
Total Pavement Depth	-	-	325	395	410	420
Total Box Depth	-	-	340	410	425	435
Percentage pavement increase compared with background traffic only			-	22%	26%	29%

Pavement Type RC5 / HP5	
Pavement Description:	**Unbound granular re-construction**
Direction:	-
Chainage (m):	**Traffic Block 1**
Project Reliability:	95.0%
DESA (ESA's): Background	9.50E+05
DESA (ESA's): Background + Mine	3.90E+06
DESA (ESA's): Background + Industrial + Mine	6.60E+06
DESA (ESA's): Background + Industrial + Mine + Growth	8.20E+06
Design Subgrade CBR (%):	2

Pavement Layer	**Pavement Material**	**Specification**	**Background**	**Background + Mine**	**Background + Industrial + Mine**	**Background + Industrial + Mine + Growth**
			Layer Thickness (mm)			
Surfacing Layer	14/7 mm double seal	n/a	15	15	15	15
Seal	Primerseal	n/a	-	-	-	-
Base Course	DGB20	n/a	150	150	150	150
Subbase Course	DGS40	n/a	115	150	165	170
Select Material Zone 1	Select fill (CBR 10%)	n/a	180	180	180	180
Select Material Zone 2	Select fill (CBR 5%)	n/a	310	310	310	310
Total Pavement Depth	-	-	265	300	315	320
Total Box Depth	-	-	770	805	820	825
Percentage pavement increase compared with background traffic only			-	13%	19%	21%

Pavement Type: Insitu lime modification and overlay	
Pavement Description:	**Granular overlay**
Direction:	-
Chainage (m):	**Traffic Block 2**
Project Reliability:	95.0%
DESA (ESA's): Background	1.10E+06
DESA (ESA's): Background + Mine	4.00E+06
DESA (ESA's): Background + Industrial + Mine	5.00E+06
DESA (ESA's): Background + Industrial + Mine + Growth	6.20E+06
Design Subgrade CBR (%):	3

Pavement Layer	**Pavement Material**	**Specification**	**Background**	**Background + Mine**	**Background + Industrial + Mine**	**Background + Industrial + Mine + Growth**
			Layer Thickness (mm)			
Surfacing Layer	14/7 mm double seal	n/a	15	15	15	15
Seal	Primerseal	n/a	-	-	-	-
Base Course	DGB20	n/a	55	115	125	135
Subbase Course	Insitu lime stabilise existing	n/a	175	175	175	175
Select Material Zone 1	Select fill (CBR 10%)	n/a	-	-	-	-
Select Material Zone 2	Select fill (CBR 5%)	n/a	-	-	-	-
Total Pavement Depth	-	-	230	290	300	310
Total Box Depth	-	-	245	305	315	325
Percentage pavement increase compared with background traffic only			-	26%	30%	35%

Pavement Type HP1	
Pavement Description:	**Unbound granular re-construction**
Direction:	-
Chainage (m):	**Traffic Block 2**
Project Reliability:	95.0%
DESA (ESA's): Background	1.10E+06
DESA (ESA's): Background + Mine	4.00E+06
DESA (ESA's): Background + Industrial + Mine	5.00E+06
DESA (ESA's): Background + Industrial + Mine + Growth	6.20E+06
Design Subgrade CBR (%):	3

Background	**Background + Mine**	**Background + Industrial + Mine**	**Background + Industrial + Mine + Growth**

Pavement Layer	Pavement Material	Specification	Layer Thickness (mm)			
Surfacing Layer	14/7 mm double seal	n/a	15	15	15	15
Seal	Primerseal	n/a	-	-	-	-
Base Course	DGB20	n/a	150	150	150	150
Subbase Course	DGS40	n/a	120	150	155	165
Select Material Zone 1	Select fill (CBR 10%)	n/a	325	325	325	325
Select Material Zone 2	Select fill (CBR 5%)	n/a	-	-	-	-
Total Pavement Depth	-	-	270	300	305	315
Total Box Depth	-	-	610	640	645	655
Percentage pavement increase compared with background traffic only			-	11%	13%	17%

Pavement Type: Insitu lime modification and overlay	
Pavement Description:	Granular overlay
Direction:	-
Chainage (m):	Traffic Block 3
Project Reliability:	95.0%
DESA (ESA's): Background	1.10E+06
DESA (ESA's): Background + Mine	3.00E+06
DESA (ESA's): Background + Industrial + Mine	4.10E+06
DESA (ESA's): Background + Industrial + Mine + Growth	5.20E+06
Design Subgrade CBR (%):	2

Pavement Layer	Pavement Material	Specification	Background	Background + Mine	Background + Industrial + Mine	Background + Industrial + Mine + Growth
			Layer Thickness (mm)			
Surfacing Layer	14/7 mm double seal	n/a	15	15	15	15
Seal	Primerseal	n/a	-	-	-	-
Base Course	DGB20	n/a	50	95	110	115
Subbase Course	Insitu lime stabilise existing	n/a	180	180	180	180
Select Material Zone 1	Select fill (CBR 10%)	n/a	-	-	-	-
Select Material Zone 2	Select fill (CBR 5%)	n/a	-	-	-	-
Total Pavement Depth	-	-	230	275	290	295
Total Box Depth	-	-	245	290	305	310
Percentage pavement increase compared with background traffic only			-	20%	26%	28%

Pavement Type: Insitu lime modification and overlay	
Pavement Description:	Granular overlay
Direction:	-
Chainage (m):	Traffic Block 4
Project Reliability:	95.0%
DESA (ESA's): Background	1.10E+06
DESA (ESA's): Background + Mine	3.60E+06
DESA (ESA's): Background + Industrial + Mine	4.70E+06
DESA (ESA's): Background + Industrial + Mine + Growth	5.90E+06
Design Subgrade CBR (%):	2

Pavement Layer	Pavement Material	Specification	Background	Background + Mine	Background + Industrial + Mine	Background + Industrial + Mine + Growth
			Layer Thickness (mm)			
Surfacing Layer	14/7 mm double seal	n/a	15	15	15	15
Seal	Primerseal	n/a	-	-	-	-
Base Course	DGB20	n/a	120	175	185	195
Subbase Course	Insitu lime stabilise existing	n/a	180	180	180	180
Select Material Zone 1	Select fill (CBR 10%)	n/a	-	-	-	-
Select Material Zone 2	Select fill (CBR 5%)	n/a	-	-	-	-
Total Pavement Depth	-	-	300	355	365	375
Total Box Depth	-	-	315	370	380	390
Percentage pavement increase compared with background traffic only			-	18%	22%	25%

Pavement Type RC5	
Pavement Description:	Unbound granular re-construction
Direction:	-
Chainage (m):	Traffic Block 4
Project Reliability:	95.0%
DESA (ESA's): Background	1.10E+06
DESA (ESA's): Background + Mine	3.60E+06
DESA (ESA's): Background + Industrial + Mine	4.70E+06
DESA (ESA's): Background + Industrial + Mine + Growth	5.90E+06
Design Subgrade CBR (%):	2

Pavement Layer	Pavement Material	Specification	Background	Background + Mine	Background + Industrial + Mine	Background + Industrial + Mine + Growth
			Layer Thickness (mm)			
Surfacing Layer	14/7 mm double seal	n/a	15	15	15	15
Seal	Primerseal	n/a	-	-	-	-
Base Course	DGB20	n/a	150	150	150	150
Subbase Course	DGS40	n/a	120	150	155	160
Select Material Zone 1	Select fill (CBR 10%)	n/a	180	180	180	180
Select Material Zone 2	Select fill (CBR 5%)	n/a	310	310	310	310
Total Pavement Depth	-	-	270	300	305	310
Total Box Depth	-	-	775	805	810	815
Percentage pavement increase compared with background traffic only			-	11%	13%	15%

AVERAGE (%)		17%	21%	24%
AVERAGE depth (mm)	270	316	327	335
AVERAGE change (mm)		46	57	65
MAXIMUM (%)		26%	30%	35%
MAXIMUM depth (mm)	325	395	410	420
MAXIMUM change (mm)		70	85	95
MINIMUM (%)		11%	13%	15%
MINIMUM depth (mm)	230	275	290	295
MINIMUM change (mm)		45	60	65

Appendix D – Users pays sensitivity

	1 Measured traffic (2013), design HV (2012), 2% growth		2. Measured traffic (2013), design HV (2012), 1.11% growth		3. Measured traffic & %HV (2013), 2% growth		4. Measured traffic & %HV (2013), 1.11% growth		5. Measured traffic (2013), 18% HV (RFT), 2% growth		6. Measured traffic (2013), 18% HV, 1.11% growth		7. Design ESA (2012)		8. Calculated ESAs using design parameters & traffic (2013)	
Source	ESA km (M)	%	ESA km (M)	%	ESA km (M)	%	ESA km (M)	%	ESA km (M)	%	ESA km (M)	%	ESA km (M)	%	ESA km (M)	%
All traffic	117.5		102.5		73.3		63.9		129.8		113.1		155.3		130.8	
Mine	29.2	24.9%	29.2	28.5%	29.2	39.8%	29.2	45.7%	29.2	22.5%	29.2	25.8%	29.2	18.8%	29.2	22.3%
Non-mine (IA+base)	57.9	49.3%	57.9	56.5%	25.1	34.2%	25.1	39.3%	66.9	51.5%	66.9	59.2%	67.7	43.6%	67.7	51.8%
Growth	30.4	25.9%	15.4	15.0%	19	25.9%	9.6	15.0%	33.7	26.0%	17	15.0%	58.4	37.6%	33.9	25.9%
Comments	Represents observed traffic with the nominated pavement design growth rate		Represents the observed traffic with the RMS network growth rate		This scenarios are not appropriate as the %HV is not realistic and under represents total traffic ESAkm due to road works				Scenario's 5 and 6 are based on observed traffic with MSC %HV parameters for the design				These scenarios are based on design traffic agreed with MSC in 2012. Scenario 7 normalised ESAs over the non-IA sections at the highest estimated level. Scenario 8 represents design figures without that normalisation. 7 is actually USER PAYS 1.			

The above table shows various user pays models that were considered, incorporating the adjustment of % heavy vehicles, growth rate and/or traffic volumes. These models were not considered appropriate for adoption in this study.

Appendix E – Pavement material benefit

14-951CN

12 December, 2014

GHD Pty Ltd
Level 3, GHD Tower,
24 Honeysuckle Drive,
Newcastle NSW 2300

Attention: Paul Youman

Re: Budget Estimate for Pavement Material in Muswellbrook Area

Paul,

As requested we confirm that the below rates are estimate for works completed on road projects in the Muswellbrook area. We highlight that the actual rate will vary based on actual location, size and scope of works required

Supply and place subbase	$85/cu.m + GST
Supply and place select material	$60/cu.m+GST

If you have any questions please do not hesitate to contact me at our Beresfield office.

Yours faithfully
Keller Civil Engineers Pty Ltd

Clinton North

Hunter Valley Operations Manager

Ph: 49 22 5000
Fax: 49 22 5001

Chainage							Volume	Rate	Volume	Rate	
From	To	Traffic Lane	Initial treatment	Rehab Treatment	Lane Width (m)	Area (m2)	Re-used	($/m3)	Remaining	($/m3)	Value ($)
255	740	NB & SB	Mill existing seal (25mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	3395.0	679.0	$85	441.35	$60	$84,196
740	1110	NB & SB	Mill existing seal (25mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	6.71 / 3.5	3777.7	755.5	$85	491.101	$60	$93,687
1110	1322	NB & SB	Mill existing seal (25mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	1484.0	296.8	$85	192.92	$60	$36,803
1952	2656	SB	Mill existing seal (40mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	6.71	4723.8	944.8	$85	614.0992	$60	$117,151
1952	2117	NB	Mill existing seal (20mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	577.5	115.5	$85	75.075	$60	$14,322
2146	2656	NB	Mill existing seal (45mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	1785.0	357.0	$85	232.05	$60	$44,268
2785	3948	NB & SB	Mill existing seal (30mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 150MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	8141.0	1424.7	$85	1261.855	$60	$196,809
4050	4131	NB & SB	Mill existing seal (35mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 175MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	567.0	99.2	$85	87.885	$60	$13,707
5257	5632	NB & SB	Mill existing seal (30mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 175MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	2625.0	459.4	$85	406.875	$60	$63,459
5632	6160	NB & SB	Mill existing seal (25mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 150MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	3696.0	646.8	$85	572.88	$60	$89,351
6160	6480	NB & SB	Mill existing seal (40mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND 45MM AC14	3.5	2240.0	392.0	$85	347.2	$60	$54,152
6480	7435	SB	Mill existing seal (30mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	3342.5	668.5	$85	434.525	$60	$82,894
6480	6733	NB	Mill existing seal (30mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	885.5	177.1	$85	115.115	$60	$21,960
6774	7435	NB	Mill existing seal (30mm)	200MM INSITU MODIFIED STABILISATION WITH LIME AND 125MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	2313.5	462.7	$85	300.755	$60	$57,375
7435	7715	NB & SB	Mill existing seal (30mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 175MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	1960.0	343.0	$85	303.8	$60	$47,383
7984	8140	NB & SB	Mill existing seal (25mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 175MM DGB20 OVERLAY AND 45MM AC14	3.5	1092.0	191.1	$85	169.26	$60	$26,399
8140	9409	NB & SB	Mill existing seal (20mm)	180MM INSITU MODIFIED STABILISATION WITH LIME AND 180MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	8883.0	1598.9	$85	1332.45	$60	$215,857
9574	9760	NB & SB	Mill existing seal (30mm)	180MM INSITU MODIFIED STABILISATION WITH LIME AND 180MM DGB20 OVERLAY AND 45MM AC14	3.5	1302.0	234.4	$85	195.3	$60	$31,639
9760	9883	NB & SB	Mill existing seal (30mm)	180MM INSITU MODIFIED STABILISATION WITH LIME AND 150MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	861.0	155.0	$85	129.15	$60	$20,922
9951	10300	SB	Mill existing seal (25mm)	180MM INSITU MODIFIED STABILISATION WITH LIME AND 150MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	1221.5	219.9	$85	183.225	$60	$29,682
10185	10300	NB	Mill existing seal (25mm)	180MM INSITU MODIFIED STABILISATION WITH LIME AND 150MM DGB20 OVERLAY AND DOUBLE/DOUBLE SPRAY SEAL	3.5	402.5	72.5	$85	60.375	$60	$9,781
10371	10507	NB & SB	Mill existing seal (20mm)	175MM INSITU MODIFIED STABILISATION WITH LIME AND 175MM DGB20 OVERLAY AND 45MM AC14	3.5	952.0	166.6	$85	147.56	$60	$23,015
					Total	56227.5	10460.3	Total	8094.805	Total	$1,374,812
										SAY	$ 1,375,000

Appendix F – MSC cost summary

Payment Schedule for Thomas Mitchell Drive Upgrade Works

Thomas Mitchell Drive Upgrade Cost

Works Completed

Description	Amount ($)
Preliminary and geotechnical Investigation	$90,201
Design	$492,000
Construction of Stage 1 & 2 (From NE Hway to Mt Arthur Access Road)	$8,555,000
Sub Total	$9,137,201

Works in Progress (Contracts Awarded)

Description	Amount ($)
Construction of Stage 3 (From Mt Arthur Access Road to Glen Munro Road	$3,729,500
Installation of Stormwater Drainage along TMD at Industrial Estate	$920,000
Sub Total Contract awarded)	$4,649,500

Total Cost of Works Committed to date	**$13,786,701**
Cost savings due to existing pavement layers	**$1,800,000**
Total Project Cost to date	**$15,586,701**

Works Programed

Construction of Stage 4 (From Glen Munro Road to Denman Road)	$4,750,000

Contribution Plan as per Draft TMD Contribution Plan

Total Project Cost to date	$15,586,701
Total Contribution Due to date = 39.1% of Total Committed Works as per Executive Summary of Draft Thomas Mitchell Drive Contribution Study.	$6,094,400

Mine	Contribution Due Now	Remaining Contribution at Commencement of Stage 4 Works
Mangoola	$514,361	$156,750
Bengalla	$981,962	$299,250
Mt Arthur	$3,959,022	$1,206,500
Drayton	$639,055	$194,750
Total	$6,094,400	$1,857,250

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Respiratory and cardiovascular diseases and cancer among residents in the Hunter New England Area Health Service

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May 2010

Contents

Introduction

This report focuses on those diseases and causes of death that have been found to be associated with exposure to air pollutants. Analysis has also been undertaken on some diseases about which the community of the Hunter New England Area Health Service (HNEAHS) of New South Wales (NSW) has expressed a concern.

This report uses reliable, routinely collected health data to:

1) assess the health of the residents of the HNEAHS of NSW
2) to compare the health of the residents of the HNEAHS to the health of residents in other parts of NSW
3) examine variation in health within HNEAHS in relation to the distribution of coal mining and coal-powered electrical power generation activity within this area.

What do we know about air pollution and health?

Clean air is considered to be a basic requirement of human health and wellbeing (WHO 2005). The health effects of air pollution range from mild and temporary respiratory symptoms through to asthma, cardiovascular conditions, chronic lung disease, cancer and premature death. Both short-term and long-term exposure to air pollutants can cause disease as susceptibility to illness and disease depends on the duration and degree of exposure to the pollutant. Air pollutants are particularly harmful to the very young, elderly people and people with chronic respiratory or cardiovascular diseases (Australian Institute of Health and Welfare, 2008).

The six key air pollutants to which most Australians are exposed are particulate matter, ozone, carbon monoxide, nitrogen dioxide, sulphur dioxide and lead. Of these major air pollutants, ozone and particulate matter are of most concern in ambient air.

Dust from open-cut coal mining could contain a wide range of pollutants, but the one pollutant that is of most concern from a burden of disease perspective is particulate matter. The potential morbidity and mortality due to exposure to particulate matter far outweighs that attributable to other ambient air pollutants. Particulate matter from open-cut coal mining activities consists almost wholly of dust and particles from the earth above the coal, and does not contain much actual coal dust.

Particulate matter

Particulate matter can arise from various sources such as motor cars, mining activity, industrial processes, agricultural practices (amplified in drought conditions), wood burning (domestic heating), unflued gas heat ing and cooking, bushfires, wind-blown dust and tobacco smoke. Particulate matter can affect a person's health by aggravating respiratory diseases; irritating upper airways and eyes; increasing the risk of death from chronic respiratory and cardiovascular diseases (Pope et al, 2002).

There is strong evidence for the association between high levels of particulate matter and death, both soon and a long time after exposure. Where the particulate matter is less than 10 microns in diameter (PM_{10}) exposure can lead to hospital admissions for cardiovascular and respiratory disease, and is associated with increased symptoms of asthma and lung cancer deaths. Table 1 (Appendix A) shows the increased health risks associated with increasing levels of particulate matter.

How do we measure air quality?

The National Environment Protection and Heritage Council has set national air quality standards (National Environment Protection Measures) for the six key air pollutants. Since 2002, the standards are legally binding on all jurisdictions and require them to monitor air quality in order to identify potential air quality problems (Australian Government. Air Quality; http://www.environment.gov.au/atmosphere/airquality/publications/standards.html).

The air quality across NSW and the Hunter Valley is monitored by the NSW Department of the Environment, Climate Change and Water (DECCW). In the Hunter Valley, air quality monitors are positioned at industrial sites (mainly coal mines and power stations) for regulatory purposes.

There are no DECCW air quality monitors placed in the population centres in HNEAHS outside of Newcastle.

How do we measure health in NSW?

NSW Health has developed a sophisticated array of surveillance measures which actively monitor the health of the people of NSW on an ongoing basis. Statewide reports, including the biennial Report of the Chief Health Officer, on the outcomes of these surveillance measures are regularly updated and available at:
http://www.health.nsw.gov.au/publichealth/chorep/index.asp
http://www.health.nsw.gov.au/publichealth/surveys/index.asp
http://www.cancerinstitute.org.au/cancer_inst/statistics/index.html

A similar range of information describing the health of the population of HNEAHS is also available as an electronic resource (HHNE-e-R) at:
http://www.hnehealth.nsw.gov.au/hneph/healtheresource

These surveillance data are used to inform the public, health professionals and policy makers about changes in the health and wellbeing of the NSW population and to identify important influences that affect population health.

How were the health data collected?

In order to assess the possible impacts of mines and coal-powered power stations on the health of the people of HNEAHS, experts have collated routinely collected data and presented them in this report. Information is drawn from a range of reliable sources and includes data on the reasons people went to an emergency department, information on those admitted to hospital, notifications of cancer and information on the general health of the population. Data for cancer incidence and mortality, together with the most common cancers, causes of death and those conditions with the strongest links to particulate matter pollution are presented.

What other risk factors are associated with these diseases?

A person's health generally is determined by the interplay of social, environmental, socioeconomic, behavioural and biomedical factors. There are many factors that are associated with cardiopulmonary diseases and cancers including tobacco smoking, residential and occupational exposure to other pollutants, poor nutrition including a high intake of saturated fat and alcohol, overweight and obesity, high blood pressure and cholesterol levels and insufficient physical exercise. Determining the relative contribution of air pollution among these causes is difficult.

Presentation of data including data type, source and presentation

Data describing the health of the population of HNEAHS are presented in seven sections. The health conditions reviewed in these sections include those that have been documented in the research literature as being associated with exposure to ambient air pollution. There is also a section describing how drinking water is monitored in HNEAHS and Australian and state standards for water compliance. There has been some community concern about local drinking water quality being affected by air pollution.

A description of the methods used is presented at the beginning of each section. A complete set of data Tables and three Figures are found in Appendix D. A description of the limitations of the data is found in Appendix B.

Section 1 – The population of Hunter New England

This section describes the population of HNEAHS and the areas where they live. The location of coal mines and power stations have been mapped by location and type of mine (open-cut and underground).

Section 2 – Emergency department presentations for respiratory illness and asthma

The total number of people resident in HNEAHS who presented to emergency departments and who were assigned a diagnosis of any respiratory condition (including asthma) were obtained from the NSW Emergency Department Data Collection for the period 2007 to 2009 inclusive. Emergency department presentations are analysed by postcode area.

Section 3 – Hospital separations from respiratory diseases (including asthma) and cardiovascular diseases

This section details the number of people discharged from hospital, where the primary reason for their admission to hospital was diagnosed as respiratory disease, including asthma, and cardiovascular disease. This was obtained from the NSW Admitted Patients Data Collection. Separation rates are presented by local government area for all of HNEAHS and for NSW overall.

Section 4 – Self-reported data on overall health, asthma and smoking

Throughout the year the NSW Department of Health collects information on how people in NSW report their own health status (for children this is reported by a parent or guardian), their quality of life and a range of health issues including asthma and tobacco smoking. This section presents data from the NSW Population Health Survey. Data are presented by HNEAHS cluster.

Section 5 – Mortality

The latest available mortality data from people who were resident in HNEAHS at the time of their deaths are presented, including the causes of death that are considered most likely to be associated with air pollution. Data were provided by the Australian Bureau of Statistics. Rates are presented by HNEAHS cluster.

Section 6 – Cancer

The latest available cancer data on both the incidence of cancer (the number of new cases of a cancer diagnosed and reported in a given year) and the mortality from cancer (the number of people who died as a result of a cancer in a given year) are presented for the most common cancers experienced by residents of HNEAHS, as well as cancers with the strongest links to particulate matter pollution. Rates are presented by HNEAHS cluster. Cancer data were extracted from the NSW Central Cancer Registry, maintained by the NSW Cancer Institute.

Section 7 – Drinking water quality in the Hunter New England area

The NSW Health Drinking Water Monitoring Program specifies the minimum number of samples that should be taken based on the size and complexity of water supply systems, and in accordance with the National Health and Medical Research Council (NHMRC) *Australian Drinking Water Guidelines* (available at: http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm). In the Hunter Valley, the larger towns are tested for chemical quality each month and the smaller towns are tested every 6 months. The drinking water supplies are tested for a range of chemicals including aluminium, arsenic, barium, boron, cadmium, calcium, chloride, chromium, copper, cyanide, iodide, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, nitrite, selenium, silver, sodium, sulphate and zinc. NSW Health does not routinely monitor the quality of domestic rainwater tanks.

Description of findings in the report

Rates derived from the data are described as being either higher than or lower than a specified reference rate (such as the rate for the whole of NSW or the rate for all of NEAHS) when their 95% confidence intervals do not include the reference rate's value. This condition is approximately the same as there being less than a 5% probability that the difference between an observed rate and the reference rate could be a chance finding.

When the rates between one area and a comparison area are very different in magnitude but do not meet the above condition, they are discussed in this report as being different, but noted as not being "statistically significantly different" from the reference rate.

SECTION 1

The population of Hunter New England

Key points

- Hunter New England Area Health Service (HNEAHS) is one of eight area health services in NSW
- About 12% of the NSW population live in the HNEAHS
- Over one in five of the state's Aboriginal people live in the HNEAHS
- HNEAHS's population is ageing, with 16% 65 years or older, compared to 14% for NSW
- The Muswellbrook and Singleton local government areas contain the greatest concentration of open-cut coal mines and coal-fired power stations in the Upper Hunter and Lower Hunter.

This section provides information about the population of HNEAHS and where the people live in the region. The source of information is from the Australian Bureau of Statistics.

Throughout this report, three geographical categories within HNEAHS are considered:

- Clusters: administrative regions established by the HNEAHS for the purposes of delivering health services; each cluster consists of a number of local government areas
- Local government areas (LGAs): administrative divisions of NSW for which a local government (council) is responsible; each local government area consists of one or more postcodes
- Postcodes.

Local government areas are the smallest geographical area for which population health information is routinely collected.

Additional information supporting the findings presented in this section is contained in Appendix D, Tables 1-8.

Hunter New England Health Area Health Service

Hunter New England is one of eight area health services in NSW (Figure 1). It is one of four rural area health services and, of these, is the only one that includes a large city (Newcastle) within its boundaries. Newcastle has the second busiest harbour on the east coast and is the largest coal exporting port in the world. HNEAHS covers more than 130 000 square kilometres.

Figure 1. Area Health Services in NSW

In HNEAHS, there are 25 local government areas and these are grouped into eight administrative clusters. Table 2 shows the cluster populations by local government area.

Table 2. Hunter New England Area Health Service, NSW, estimated total residential population by cluster and local government area, 2009

HNEAHS cluster	Local government area	Population
Greater Newcastle	Lake Macquarie	195 479
	Newcastle	153 171
	Port Stephens	67 144
	TOTAL	**415 794**
Lower Hunter	Cessnock	49 751
	Dungog	8539
	Maitland	69 878
	Singleton	23 747
	TOTAL	**151 913**
Lower Mid North Coast	Gloucester	4995
	Greater Lakes	35 986
	Greater Taree	47 866
	TOTAL	**88 847**
McIntyre	Inverell	16 169
	Gwydir	5421
	TOTAL	**21 591**
Mehi	Moree Plain	14 427
	Narrabri	13 454
	TOTAL	**27 881**
Peel	Gunnedah	11 840
	Tamworth	57 066
	Walcha	3291
	TOTAL	**72 197**
Tablelands	Armidale Dumaresq	24 538
	Guyra	4404
	Tenterfield	6812
	Uralla	6008
	Glen Innes Severn	9065
	TOTAL	**50 827**
Upper Hunter	Muswellbrook	16 167
	Upper Hunter Shire	13 524
	Liverpool Plains	7825
	TOTAL	**37 516**
HNEAHS combined	**TOTAL**	**866 566**

Source: Australian Bureau of Statistics, ABS Estimated Resident Population

Who are the people who live within the boundaries of the Hunter New England Health Area Service?

The population of HNEAHS in 2009 was 866 566, representing approximately 12% of the population of NSW. The population lives in communities across the region, from the densely populated coastal zone to small rural townships (Table 2). Tables 3 to 8 in Appendix D provide more detail about the population at the local government area level by age, gender and Indigenous status.

HNEAHS has a diverse population. There are 32 889 Aboriginal people living in the Area, representing approximately 22% of the state's Aboriginal population, and 4% of the HNEAHS population (Table 6, Appendix D). The local government areas with the highest proportion of Aboriginal residents are Moree Plains (20.7%), Gunnedah (10.3%), Guyra (10.4%) and Narrabri (9.3%). There is also a higher proportion of older people (aged over 65 years) in HNEAHS, approximately 16% compared with 14% for the state (Table 8, Appendix D).

Socioeconomic disadvantage is found across HNEAHS, particularly where there is a higher Aboriginal population, public housing and lower employment. The most disadvantaged local government areas are: Inverell, Tenterfield, Glen Innes Severn, Guyra, Liverpool Plains, Gunnedah, Moree Plains, Cessnock and Greater Taree.

Mining in Hunter New England area

Over the past 30 years, there has been a six-fold increase in coal production through open-cut mining in the Hunter Valley. There are currently six coal-fired electrical power stations of which four lie within the HNEAHS and two fall outside the southern boundary (Figure 2). Operational coal mines are located in the Local Government Areas as described in Table 9 (also Appendix C).

Coal mining activities and coal-fired electrical power generation in the Hunter Valley are a source of air pollutants, including particulate matter. The level of exposure to air pollutants for the population living in the areas affected by these activities is not yet known. The Department of Environment, Climate Change and Water is currently planning to install an air quality monitoring array in the Hunter Valley.

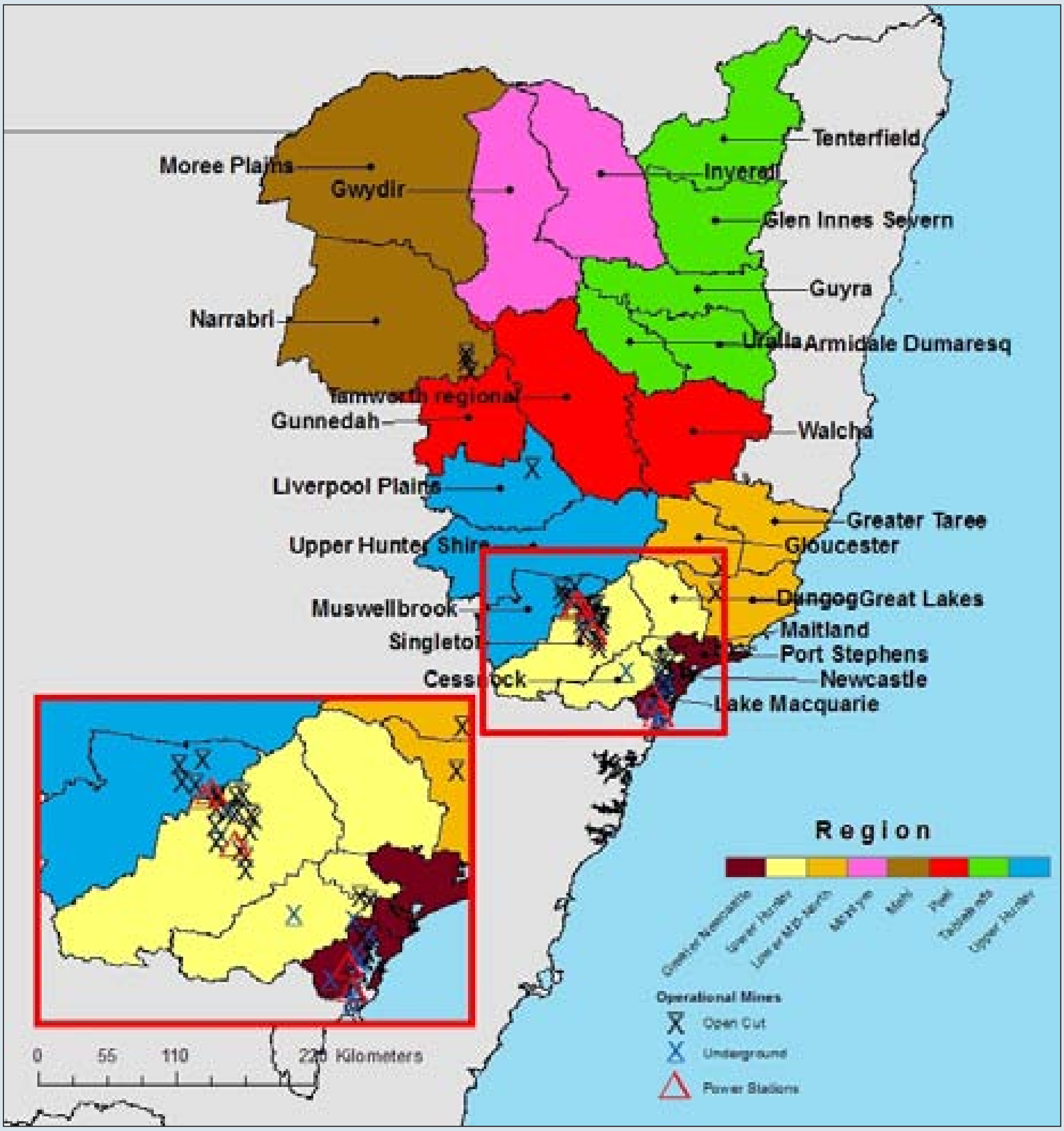
Table 9. Number of operating coal mines in the Hunter New England Area Health Service, April 2010

Local government area	Coal mines		
	Open-cut	Underground	Combined (open-cut and underground)
Singleton	11	2	4
Muswellbrook	5	-	1*
Cessnock	1	1	1
Lake Macquarie	1	5	-
Wyong**	-	2	-
Gloucester	1	-	-
Great Lakes	1	-	-
Gunnedah	3	-	-
Liverpool Plains	1	-	-
Narrabri	2	1	-
Total	**26**	**11**	**6**

*The combined open-cut and underground coal mine in Muswellbrook local government areas also falls across into boundary of Singleton local government areas. Not included in data set for Singleton local government areas.
**Wyong local government areas mine sites are located outside HNEAHS.
Source: Department of Environment, Climate Change and Water, Environment Protection and Regulation Division, Newcastle Office (April 2010)

The areas with the most intensive coal mining and power generation activities include the Upper and Lower Hunter clusters, and primarily the Muswellbrook and Singleton local government areas. There are a small number of open-cut coal mines in the Mehi cluster (Narrabri local government area), and the Peel cluster (Gunnedah local government area).

Figure 2. Location of coal mines and power stations in the Hunter New England Area Health Service by cluster and local government area, 2010



Emergency department presentations for respiratory illness and asthma

Key points

- The rates of presentation for all respiratory illnesses in Muswellbrook and Singleton postcodes ranked below those of Tamworth, Gunnedah and Cessnock in all age groups
- Muswellbrook area has high rates for emergency department presentation for asthma, but not the highest (Tamworth and Gunnedah) in Hunter New England Area Health Service (HNEAHS)
- Singleton also ranks highly for rates of emergency department presentations for asthma in those aged 15-64 years
- Muswellbrook and Singleton are equally highly ranked for rates of emergency department presentations for conditions unrelated to air pollution.

Methods

In this section, the rate of presentations to emergency departments (EDs) for respiratory illness including asthma in the Singleton and Muswellbrook postcode areas are compared with the remainder of HNEAHS and Sydney.

For the period 2007 to 2009 inclusive, data on the total number of emergency department presentations assigned a diagnosis of any respiratory condition, including asthma, were obtained from the NSW Emergency Department Data Collection. The analysis considered the postcode of the patient's place of residence and the patient's age group. The age groups reviewed were 0-14-years, 15-34-years, 35-64-years and 65-years and over.

Because the NSW Emergency Department Data Collection does not have complete coverage of the population of NSW, areas with good coverage of hospital attendances were selected as comparators. HNEAHS and the most populated part of the Sydney area both had good coverage over the analysis period. For Sydney, we included all postcodes in the following statistical subdivisions from the 2006 Australian Standard Geographic Classification (ASGC): Central Northern Sydney, Northern Beaches, Blacktown, Fairfield-Liverpool, St George-Sutherland, Lower North Sydney, Central Western Sydney, Canterbury-Bankstown, Inner Western Sydney, Eastern Suburbs and Inner Sydney.

Attendance rates at emergency departments per 100 000 resident population were calculated (ABS Estimated Resident Population). Two levels of analysis were undertaken: firstly, rates for each of the Singleton and Muswellbrook postcodes were compared with all remaining postcodes for HNEAHS combined and with the Sydney area; secondly, rates for postcodes in HNEAHS with populations of at least 10 000 were ranked according to rates of emergency department visits for respiratory problems and asthma.

Additional information supporting the findings presented in this section are contained in Appendix D, Table 10-14.

Findings

In the period 2007 to 2009, 0-35 year-old people resident in the Muswellbrook postcode had higher rates of emergency department presentations for both asthma and overall respiratory illness than the remainder of HNEAHS and Sydney.

Residents in the Singleton postcode had rates of presentation to emergency departments for asthma similar to residents in the rest of HNEAHS and Sydney. However, the overall emergency department presentation rate for respiratory illness was similar to that of Muswellbrook. Rates of asthma presentations for Singleton postcode in the 15-35-year-old age group were lower than Muswellbrook but still higher than Sydney and the rest of HNEAHS. Singleton postcode had the highest overall rate of respiratory illness in this age group (Table 10).

The 35-64-year-old residents in the Singleton and Muswellbrook postcodes had higher rates of presentations for both asthma and respiratory illness than Sydney or the rest of HNEAHS. Among those aged 65 years or more, Muswellbrook postcode had higher rates of presentations for both asthma and respiratory illness than Sydney or the rest of HNEAHS. In this age group, Singleton postcode had lower rates than the other postcodes for asthma and similar rates to the rest of HNEAHS for respiratory illness.

Respiratory illness presentations

For rates of overall respiratory illness presentations, Muswellbrook and Singleton postcodes ranked below those of Tamworth, Gunnedah and Cessnock in all age groups. Muswellbrook and Singleton postcodes ranked 6th and 7th highest in the 0-14-year age group, 7th and 4th highest in the 15-34-year age group, 6th and 5th highest in the 35-64-year age group, and 8th and 15th highest in those aged 65 years and over, respectively (Table 11).

Asthma presentations

For rates of asthma presentations, residents in the Muswellbrook postcode ranked highest among people aged less than 35 years of age, 7th highest in 35-64 year-olds, and 4th highest in those aged 65 years or more. Singleton postcode ranked 11th in 0-14 year-olds, 6th in 15-34 year-olds, 3rd in 35-64 year-olds and 25th in those aged 65 years and over. Moree and Tamworth postcodes ranked higher than both Singleton and Muswellbrook postcodes in people aged 35 years and over. Gunnedah ranked higher than both Singleton and Muswellbrook in those aged 65 years and over (Table 12).

Respiratory presentations to emergency departments

For overall respiratory presentations, Singleton postcode ranked 7th highest with a standardised incidence ratio (SIR) of 145, indicating that the rate in Singleton was 45% higher than HNEAHS. Muswellbrook postcode ranked 10th highest with an SIR of 137 (37% higher than HNEAHS overall), but the SIR was broadly similar to that of the Singleton postcode. Taking into account the statistical precision of these estimates, postal areas with higher rates than Singleton postcode included Tamworth, Cessnock, Abermain, Gunnedah and Kurri Kurri (Table 13). Those with broadly similar rates included Quirindi, Dundee, Inverell and Moree, as well as Muswellbrook postcodes.

Asthma presentations

For asthma presentations, Muswellbrook postcode ranked 5th highest with an SIR of 185 (85% higher than HNEAHS overall) and Singleton ranked 14th highest with an SIR of 120 (20% higher than HNEAHS overall). Taking into account the statistical precision of these estimates, Muswellbrook's

Table 10. Rates of emergency department presentations for all respiratory illness and asthma in residents of Singleton and Muswellbrook postcodes, the Hunter New England Area Health Service (HNEAHS) postcodes combined and Sydney postcodes, 2007.

Age years	Postcode	Population 2007	Asthma		All respiratory	
			n	Rate/ 100 000	n	Rate/ 100 000
0-14	Singleton	5095	193	1263	2026	13 255
	Muswellbrook	3254	223	2284	1305	13 368
	Remaining HNEAHS	158 921	5912	1240	41 983	8806
	Sydney*	639 539	21 507	1121	114 743	5981
15-34	Singleton	5746	115	667	1107	6422
	Muswellbrook	3827	132	1,150	639	5566
	Remaining HNEAHS	202 805	2534	416	20 962	3445
	Sydney*	1 062 379	5441	171	33 421	1049
35-64	Singleton	8396	94	373	758	3009
	Muswellbrook	5149	40	259	421	2725
	Remaining HNEAHS	321 941	2191	227	20 465	2119
	Sydney*	1 349 638	4709	116	36 023	890
65+	Singleton	2038	7	114	306	5005
	Muswellbrook	1380	15	362	235	5676
	Remaining HNEAHS	131 544	792	201	19 869	5035
	Sydney*	418 996	2258	180	49 868	3967

*Sydney area included postcodes in the following statistical subdivisions from the 2006 Australian Standard Geographic Classification (ASGC): Central Northern Sydney, Northern Beaches, Blacktown, Fairfield-Liverpool, St George-Sutherland, Lower North Sydney, Central Western Sydney, Canterbury-Bankstown, Inner Western Sydney, Eastern Suburbs and Inner Sydney.

Table 11. Hunter New England Area Health Service postcodes with populations greater than 10 000 ranked by rates of emergency department visits for respiratory illness, 2007-2009, from highest to lowest.

Rank	Age 0-14 years	Age 15-34 years	Age 35-64 years	Age 65+ years
1	2340, Tamworth area	2340, Tamworth area	2340, Tamworth area	2380, Gunnedah area
2	2380, Gunnedah area	2325, Cessnock area	2325, Cessnock area	2340, Tamworth area
3	2325, Cessnock area	2380, Gunnedah area	2380, Gunnedah area	2400, Moree area
4	2360, Inverell area	2330, Singleton area	2400, Moree area	2325, Cessnock area
5	2315, Nelson Bay area	2315, Nelson Bay area	2330, Singleton area	2304, Mayfield area
6	2333, Muswellbrook area	2360, Inverell area	2333, Muswellbrook area	2287, Wallsend area
7	2330, Singleton area	2333, Muswellbrook area	2315, Nelson Bay area	2281, Swansea area
8	2400, Moree area	2400, Moree area	2360, Inverell area	2333, Muswellbrook area
9	2320, Maitland area	2350, Armidale area	2320, Maitland area	2320, Maitland area
10	2304, Mayfield area	2320, Maitland area	2323, Mulbring area	2315, Nelson Bay area
11	2350, Armidale area	2323, Mulbring area	2350, Armidale area	2323, Mulbring area
12	2323, Mulbring area	2321, Berry Park area	2304, Mayfield area	2280, Belmont area
13	2321, Berry Park area	2430, Taree area	2322, Beresfield area	2321, Berry Park area
14	2299, Lambton area	2324, Hawks Nest area	2324, Hawks Nest area	2360, Inverell area
15	2430, Taree area	2322, Beresfield area	2430, Taree area	2330, Singleton area
16	2324, Hawks Nest area	2304, Mayfield area	2281, Swansea area	2299, Lambton area
17	2280, Belmont area	2299, Lambton area	2280, Belmont area	2284, Teralba area
18	2284, Teralba area	2264, Morisset area	2299, Lambton area	2290, Charlestown area
19	2281, Swansea area	2429, Wingham area	2264, Morisset area	2324, Hawks Nest area
20	2322, Beresfield area	2281, Swansea area	2321, Berry Park area	2322, Beresfield area
21	2287, Wallsend area	2284, Teralba area	2284, Teralba area	2285, Cardiff area
22	2285, Cardiff area	2287, Wallsend area	2287, Wallsend area	2350, Armidale area
23	2305, New Lambton area	2280, Belmont area	2429, Wingham area	2264, Morisset area
24	2429, Wingham area	2283, Toronto area	2283, Toronto area	2282, Warners Bay area
25	2264, Morisset area	2285, Cardiff area	2285, Cardiff area	2430, Taree area
26	2283, Toronto area	2318, Williamtown area	2290, Charlestown area	2305, New Lambton area
27	2282, Warners Bay area	2290, Charlestown area	2428, Forster area	2283, Toronto area
28	2290, Charlestown area	2305, New Lambton area	2305, New Lambton area	2289, Kotara area
29	2289, Kotara area	2282, Warners Bay area	2318, Williamtown area	2429, Wingham area
30	2318, Williamtown area	2428, Forster area	2289, Kotara area	2291, Merewether area
31	2291, Merewether area	2289, Kotara area	2282, Warners Bay area	2428, Forster area
32	2428, Forster area	2291, Merewether area	2291, Merewether area	2318, Williamtown area

rate was broadly similar to those of Quirindi, Glenbawn, Kurri Kurri, Tamworth, Cessnock, Narrabri, Abermain, Nelson Bay and Gunnedah postcodes (Table 14).

Limitations of the data

Emergency department diagnoses are recorded by busy emergency department staff and not by trained hospital information managers or coders. The HNEAHS uses a different computer program from the rest of the state for its emergency department patient management database. These factors may lead to variation in the coding of emergency department diagnoses within the state.

In 2009, in Australia the pandemic (H1N1) influenza virus caused dramatically increased rates of emergency department presentations for all types of respiratory illness in NSW. Rates of emergency department presentations diagnosed with asthma also increased somewhat during that time.

Rates of hospital admissions with confirmed pandemic influenza virus infection were higher in HNEAHS than in many parts of Sydney although rates in western and south-western Sydney were similar to those in HNEAHS.

Table 12. Hunter New England Area Health Service postcodes with populations greater than 10 000 ranked by rates of emergency department visits for asthma, 2007-2009, from highest to lowest in each age group.

Rank	Age 0-14 years	Age 15-34 years	Age 35-64 years	Age 65+ years
1	2333, Muswellbrook area	2333, Muswellbrook area	2400, Moree area	2400, Moree area
2	2340, Tamworth area	2340, Tamworth area	2340, Tamworth area	2380, Gunnedah area
3	2315, Nelson Bay area	2315, Nelson Bay area	2330, Singleton area	2340, Tamworth area
4	2304, Mayfield area	2325, Cessnock area	2325, Cessnock area	2333, Muswellbrook area
5	2325, Cessnock area	2360, Inverell area	2350, Armidale area	2350, Armidale area
6	2320, Maitland area	2330, Singleton area	2380, Gunnedah area	2321, Berry Park area
7	2380, Gunnedah area	2400, Moree area	2333, Muswellbrook area	2325, Cessnock area
8	2299, Lambton area	2380, Gunnedah area	2320, Maitland area	2281, Swansea area
9	2284, Teralba area	2320, Maitland area	2430, Taree area	2322, Beresfield area
10	2400, Moree area	2430, Taree area	2323, Mulbring area	2360, Inverell area
11	2330, Singleton area	2324, Hawks Nest area	2360, Inverell area	2284, Teralba area
12	2280, Belmont area	2350, Armidale area	2280, Belmont area	2285, Cardiff area
13	2305, New Lambton area	2323, Mulbring area	2304, Mayfield area	2315, Nelson Bay area
14	2323, Mulbring area	2304, Mayfield area	2315, Nelson Bay area	2283, Toronto area
15	2282, Warners Bay area	2281, Swansea area	2284, Teralba area	2282, Warners Bay area
16	2281, Swansea area	2299, Lambton area	2287, Wallsend area	2299, Lambton area
17	2291, Merewether area	2322, Beresfield area	2324, Hawks Nest area	2320, Maitland area
18	2429, Wingham area	2287, Wallsend area	2264, Morisset area	2323, Mulbring area
19	2321, Berry Park area	2285, Cardiff area	2281, Swansea area	2305, New Lambton area
20	2285, Cardiff area	2282, Warners Bay area	2285, Cardiff area	2287, Wallsend area
21	2324, Hawks Nest area	2280, Belmont area	2429, Wingham area	2280, Belmont area
22	2287, Wallsend area	2284, Teralba area	2290, Charlestown area	2264, Morisset area
23	2283, Toronto area	2429, Wingham area	2321, Berry Park area	2290, Charlestown area
24	2430, Taree area	2290, Charlestown area	2283, Toronto area	2324, Hawks Nest area
25	2350, Armidale area	2318, Williamtown area	2322, Beresfield area	2330, Singleton area
26	2289, Kotara area	2264, Morisset area	2428, Forster area	2430, Taree area
27	2290, Charlestown area	2283, Toronto area	2299, Lambton area	2429, Wingham area
28	2360, Inverell area	2428, Forster area	2291, Merewether area	2318, Williamtown area
29	2322, Beresfield area	2321, Berry Park area	2305, New Lambton area	2428, Forster area
30	2318, Williamtown area	2291, Merewether area	2282, Warners Bay area	2291, Merewether area
31	2264, Morisset area	2305, New Lambton area	2318, Williamtown area	2289, Kotara area
32	2428, Forster area	2289, Kotara area	2289, Kotara area	2304, Mayfield area

Rates of emergency department presentations may be strongly influenced by the availability of general practitioner services in an area.

Assessment of emergency department presentation ranking rates for other conditions

Because of the potentially large impact some of these limitations can have on interpreting the comparative analysis of emergency department presentation rates, further analyses of emergency department presentations in HNEAHS were conducted. As a comparison, conditions considered unlikely to be associated with air pollution were also assessed, and area rates of emergency department presentations were compared and ranked, similar to the data presented in Tables 11 and 12, and standardised incidence ratios (SIRs) were calculated, similar to those presented in Tables 13 and 14. The conditions assessed included injury, headache/migraine and gastrointestinal conditions. The results of the ranking exercise are presented in Tables 52 to 54 (Appendix D). These tables all show that Muswellbrook and Singleton postcodes are similarly highly ranked for emergency department presentation rates for these conditions as they are for asthma and respiratory diseases. The SIRs

Table 13. Hunter New England Area Health Service postcodes with populations greater than 5000 ranked by standardised incidence ratios (SIR) of emergency department visits for respiratory problems, 2007-2009, from highest to lowest

Postcode	Standardised incidence ratio (99% confidence interval)	Rank
2340, Tamworth	259 (253 – 266)	1
2325, Cessnock	208 (200 – 217)	2
2326, Abermain	196 (181 – 212)	3
2380, Gunnedah	194 (183 – 206)	4
2327, Kurri Kurri	184 (170 – 199)	5
2343, Quirindi area	161 (146 – 178)	6
2330, Singleton area	145 (138 – 153)	7
2370, Dundee area	143 (131 – 155)	8
2360, Inverell area	137 (129 – 146)	9
2333, Muswellbrook area	137 (129 – 146)	10
2400, Moree area	133 (123 – 143)	11
2315, Nelson Bay area	126 (117 – 135)	12
2337, Glenbawn area	119 (108 – 131)	13
2390, Narrabri area	107 (97 – 117)	14
2320, Maitland area	106 (100 – 111)	15
2295, Fern Bay area	103 (90 – 117)	16
2372, Tarban area	96 (84 – 109)	17
2335, Branxton area	94 (83 – 107)	18
2323, Mulbring area	93 (88 – 99)	19
2350, Armidale area	93 (88 – 99)	20
2422, Bowman area	93 (81 – 106)	21
2304, Mayfield area	90 (83 – 98)	22
2298, Georgetown area	84 (75 – 93)	23
2430, Taree area	80 (76 – 85)	24
2281, Swansea area	78 (71 – 85)	25
2420, Dungog area	77 (66 – 89)	26
2321, Berry Park area	77 (70 – 85)	27
2324, Hawks Nest area	76 (70 – 81)	28
2299, Lambton area	74 (66 – 81)	29
2280, Belmont area	70 (65 – 75)	30
2284, Teralba area	67 (60 – 74)	31
2319, Tanilba Bay area	67 (58 – 76)	32
2287, Wallsend area	66 (62 – 70)	33
2322, Beresfield area	66 (60 – 71)	34
2303, Hamilton	62 (55 – 70)	35
2264, Morisset area	61 (55 – 67)	36
2429, Wingham area	57 (51 – 64)	37
2283, Toronto area	56 (52 – 60)	38
2290, Charlestown area	56 (52 – 59)	39
2265, Martinsville area	55 (46 – 65)	40
2285, Cardiff area	55 (51 – 59)	41
2305, New Lambton area	54 (48 – 61)	42
2282, Warners Bay area	47 (42 – 53)	43
2289, Kotara area	46 (41 – 50)	44
2300, Newcastle area	44 (38 – 51)	45
2318, Williamtown area	40 (36 – 45)	46
2291, Merewether area	39 (34 – 44)	47
2428, Forster area	38 (34 – 41)	48

Table 14. Hunter New England Area Health Service postcodes with populations greater than 5000 ranked by standardised incidence ratios (SIR) of emergency department visits for asthma, 2007-2009, from highest to lowest

Postcode	Standardised incidence ratio (99% confidence interval)	Rank
2343, Quirindi	223 (173 – 283)	1
2337, Glenbawn	198 (159 – 243)	2
2327, Kurri Kurri	197 (158 – 242)	3
2340, Tamworth	193 (177 – 210)	4
2333, Muswellbrook	185 (158 – 216)	5
2325, Cessnock	155 (135 – 177)	6
2390, Narrabri area	148 (117 – 184)	7
2326, Abermain area	135 (102 – 176)	8
2400, Moree area	134 (108 – 164)	9
2315, Nelson Bay area	133 (107 – 164)	10
2380, Gunnedah area	130 (104 – 160)	11
2320, Maitland area	130 (112 – 149)	12
2370, Dundee area	126 (95 – 162)	13
2330, Singleton area	120 (102 – 140)	14
2304, Mayfield area	114 (92 – 139)	15
2360, Inverell area	106 (85 – 130)	16
2335, Branxton area	101 (70 – 141)	17
2420, Dungog area	101 (68 – 144)	18
2299, Lambton area	98 (75 – 127)	19
2350, Armidale area	97 (82 – 114)	20
2280, Belmont area	95 (80 – 113)	21
2281, Swansea area	95 (74 – 120)	22
2323, Mulbring area	93 (78 – 111)	23
2284, Teralba area	91 (68 – 119)	24
2430, Taree area	87 (74 – 101)	25
2422, Bowman area	83 (52 – 124)	26
2324, Hawks Nest area	81 (66 – 99)	27
2282, Warners Bay area	80 (62 – 102)	28
2295, Fern Bay area	79 (48 – 122)	29
2287, Wallsend area	77 (65 – 90)	30
2372, Tarban area	77 (48 – 116)	31
2285, Cardiff area	75 (63 – 90)	32
2298, Georgetown area	71 (50 – 99)	33
2321, Berry Park area	69 (51 – 91)	34
2305, New Lambton area	64 (46 – 87)	35
2265, Martinsville area	63 (38 – 98)	36
2429, Wingham area	61 (43 – 85)	37
2303, Hamilton	61 (40 – 87)	38
2290, Charlestown area	60 (50 – 72)	39
2283, Toronto area	59 (47 – 74)	40
2322, Beresfield area	58 (45 – 73)	41
2318, Williamtown area	58 (44 – 75)	42
2291, Merewether area	54 (39 – 74)	43
2264, Morisset area	52 (37 – 71)	44
2289, Kotara area	48 (36 – 63)	45
2428, Forster area	38 (28 – 51)	46
2300, Newcastle area	35 (20 – 55)	47
2319, Tanilba Bay area	34 (17 – 59)	48

were also of the same order of magnitude (data not shown). It is possible that the high emergency department presentation rates for asthma and all respiratory illness may be due to other factors such as lack of access to acute primary care services and not necessarily to exposure to air pollution.

Hospital separations from respiratory diseases, asthma and cardiovascular diseases

Key points

- Singleton and Muswellbrook local government areas have higher rates of cardiovascular disease hospital separations than all of Hunter New England Area Health Service (HNEAHS) or NSW
- Other local government areas in HNEAHS that do not have open-cut coal mining or power generation also have higher rates of separation from hospital for cardiovascular disease
- Muswellbrook has a higher separation rate for respiratory disease, whereas Singleton has a lower separation rate compared with NSW
- Asthma separation rates also show a mixed pattern, with higher rates in Muswellbrook and Narrabri, but lower rates in Cessnock and Singleton, compared with all of HNEAHS and NSW

Methods

People who are admitted to hospital have the reason for their admission, that is their diagnosis, recorded by NSW Health upon discharge. This information is know as a hospital separation. Hospital separations were classified using ICD-10-AM codes (ICD-10-AM: International statistical classification of diseases and related health problems, 10th revision, Australian modification). Separation rates are presented by local government area, for all of HNEAHS and for all of NSW for the time period 2004 to 2009.

Sources of data

NSW Admitted Patients Data Collection and the Population estimates were provided by the Centre for Epidemiology and Research, NSW Department.

Limitations

Data on hospital separations are often used as indicators of morbidity. However, they are imperfect measures as high rates may reflect not only serious morbidity but inadequate access to primary care (especially general practitioners in rural areas). Lower rates, on the other hand, may simply be the result of individual behaviours. In either event, the decision to hospitalise is often subjective and based on different perceptions of the need for hospital care on the part of individuals, doctors and health-care workers.

Additional information supporting the findings presented in this section are contained in Appendix D, Tables 15-20.

Causes of hospitalisation

The most common group of diagnoses assigned to patients at discharge for hospitals in the Hunter New England Area Health Service are included in the category ‘Factors influencing health’ which accounts for 65 425 hospitalisations each year or 22.2% of all hospitalisations. This proportion is less than the state average of 23.2%. Factors influencing health include admissions for dialysis, admission of live-born infants, symptoms without a specific cause, admissions for rehabilitation, nursing-home or respite care, surgery follow-up, fitting of prosthetic devices, supervision of high-risk pregnancies, in vitro fertilisation and admissions after contact with or exposure to communicable diseases..

Unintentional injuries (11.6%) and digestive system diseases (8.2%) are the second and third most common cause of hospitalisation in HNEAHS and are slightly different to the state averages (10.7% and 8.8% respectively).

Cardiovascular diseases account for 6.3% of hospital admissions in HNEAHS (6.1% in NSW). Chronic respiratory diseases, including asthma, account for 6973 hospitalisations each year or 2.4% of total hospitalisations in HNEAHS which is less than the NSW average of 2.7%.

Asthma on its own accounts for 0.5% (1337 hospitalisations each year) of all hospitalisations which is equal to the state average (Figures 3 and 4; Tables 15 and 16 in Appendix D).

Hospital separations for respiratory disease

Figure 5 is a simplified graphical representation of the more detailed data contained in Table 18 (Appendix D). Rates in Muswellbrook and Singleton are presented in red. Overall, the rate of hospital separations for respiratory disease in HNEAHS is lower than that for the rest of NSW. However, there is considerable variation by local government area. Many of the local government area with higher respiratory disease separation rates are in more rural areas, some of which also report higher tobacco smoking rates.

Of note is the considerable difference in rates between Muswellbrook and Singleton. Muswellbrook local government area has a higher separation rate for respiratory disease, but not the highest in the region, whereas Singleton local government area has a lower separation rate compared with NSW.

Figure 6 shows a map of the hospitalisation rates for respiratory disease for the local government areas within HNEAHS, including the location of mines (open-cut and underground) and power stations.

Hospital separations for asthma (adults)

Figure 7 is a simplified graphical representation of the more detailed data contained in Table 19 (Appendix D). Rates in Muswellbrook and Singleton are presented in red. Overall, the rate of hospital separations for asthma in HNEAHS is lower than that for the rest of NSW. However, there is considerable variation by local government area.

Many of those local government areas with high asthma separation rates are in more rural areas. There is a considerable difference in rates between Muswellbrook and Singleton. As for respiratory disease rates, Muswellbrook local government areas has a higher separation rate for asthma, whereas Singleton local government areas has a lower separation rate for asthma compared with NSW. Figure 8 shows a map of the hospitalisation rates for asthma for the local government areas within HNEAHS, including the location of open-cut and underground mines and power stations.

Hospital separations for asthma (children)

Figure 9 is a simplified graphical representation of the more detailed data contained in Table 20 (Appendix D). Rates in Muswellbrook and Singleton are presented in red. Overall, as for adults, the rate of hospital separations for asthma in HNEAHS is lower than that for the rest of NSW. Again, however, there is considerable variation by local government area. Many of those local government areas with higher asthma separation rates are in more rural areas. There is a notable difference in separation rates for asthma in children between Muswellbrook and Singleton.

Hospital separations for cardiovascular disease

Figure 10 is a simplified graphical representation of the more detailed data contained in Table 17 (Appendix D). Rates in Muswellbrook and Singleton are presented in red. Overall, the rate of hospital separations for cardiovascular disease in HNEAHS is comparable to that for the rest of NSW. However, there is variation by local government area.

Many of those local government areas with high cardiovascular disease separation rates are in the more rural areas, some of which also report higher tobacco smoking rates. Both Singleton and Muswellbrook local government areas have higher rates of cardiovascular disease separations than HNEAHS. Cessnock and Narrabri, two local government areas with several open-cut mines, also have higher cardiovascular disease separation rates than HNEAHS as a whole. Figure 11 is a map of the hospitalisation rates for cardiovascular disease for the local government areas within HNEAHS, including the location of open-cut and underground coal mines and power stations.

Figure 3. Cause of hospitalisation by category for people of all ages in NSW, 2003-2007

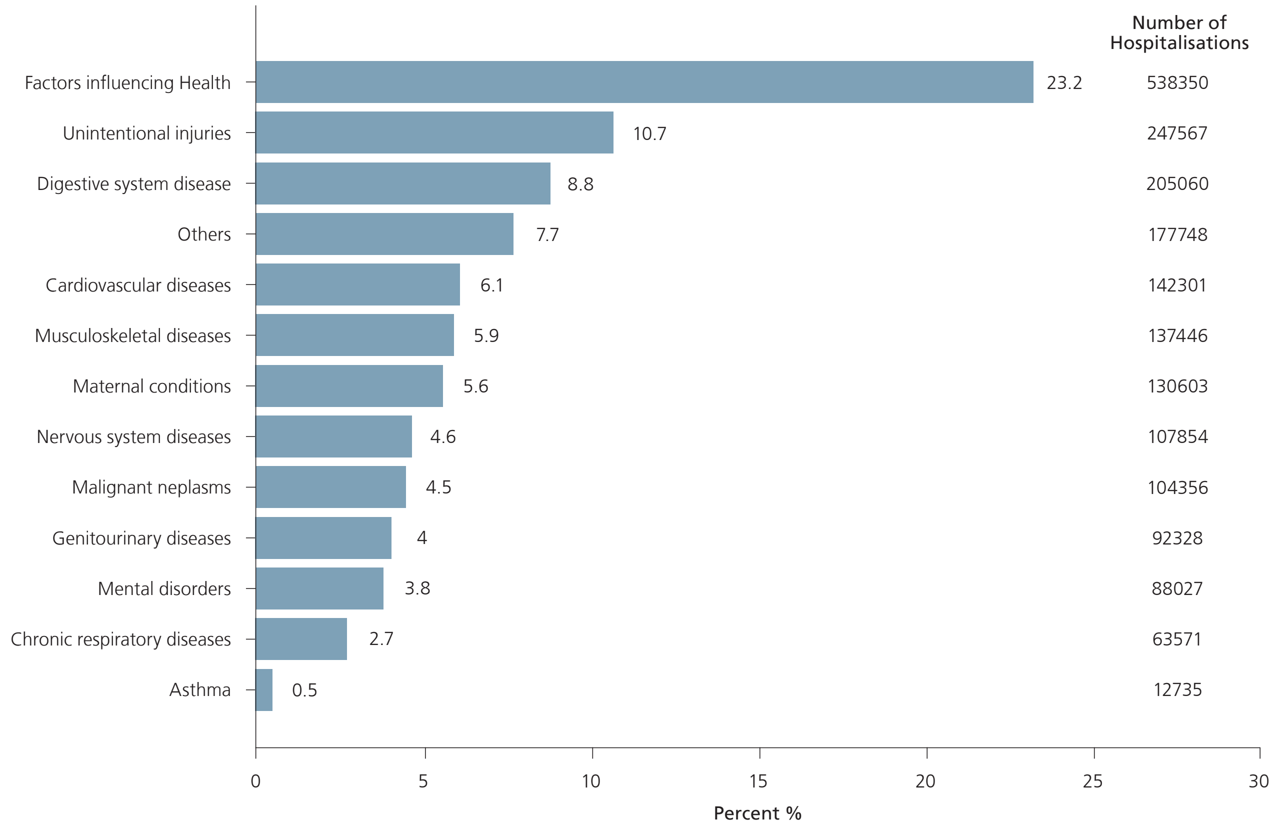


Figure 4. Cause of hospitalisation by category for people of all ages in Hunter New England Area Health Service, 2003-2007

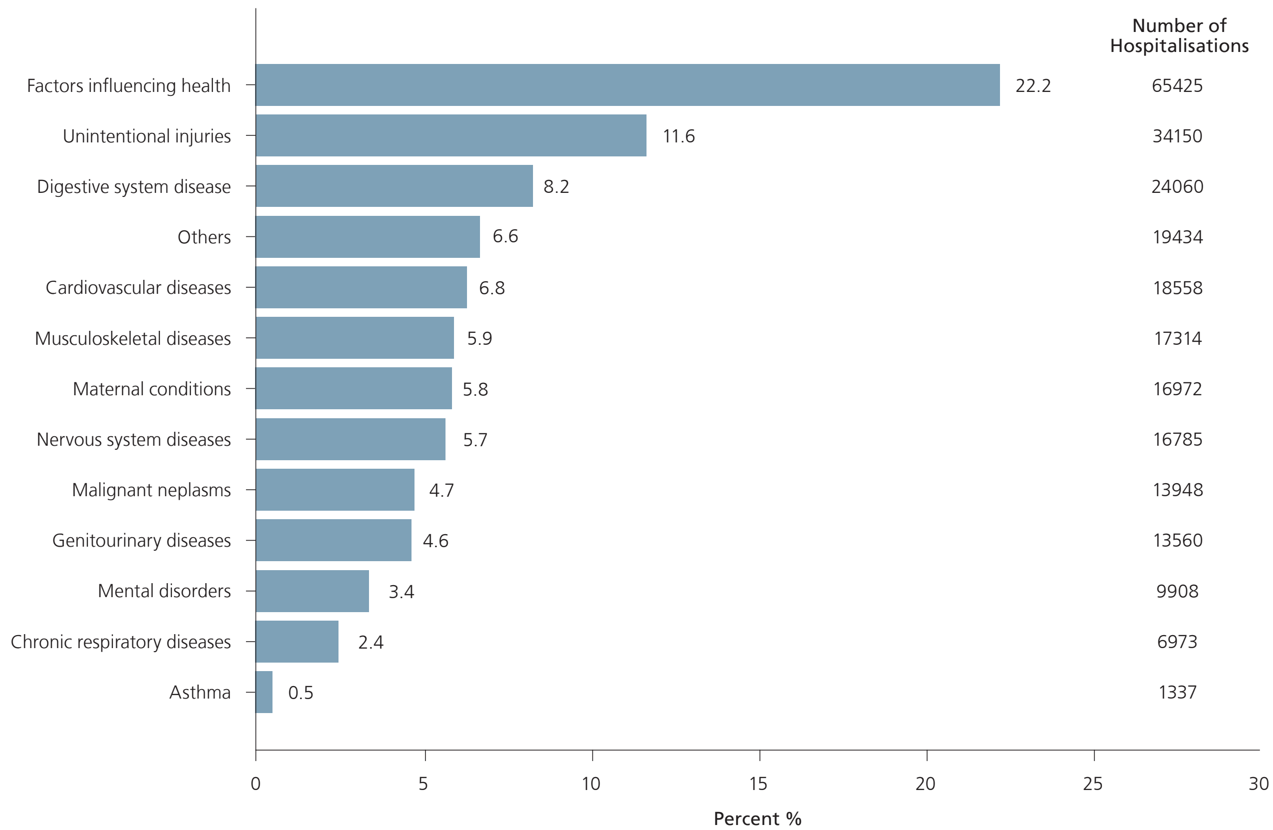


Figure 5. Rates for respiratory disease hospital separation by the 25 local government area in Hunter New England Health Area Health Service and NSW, 2004 – 2009

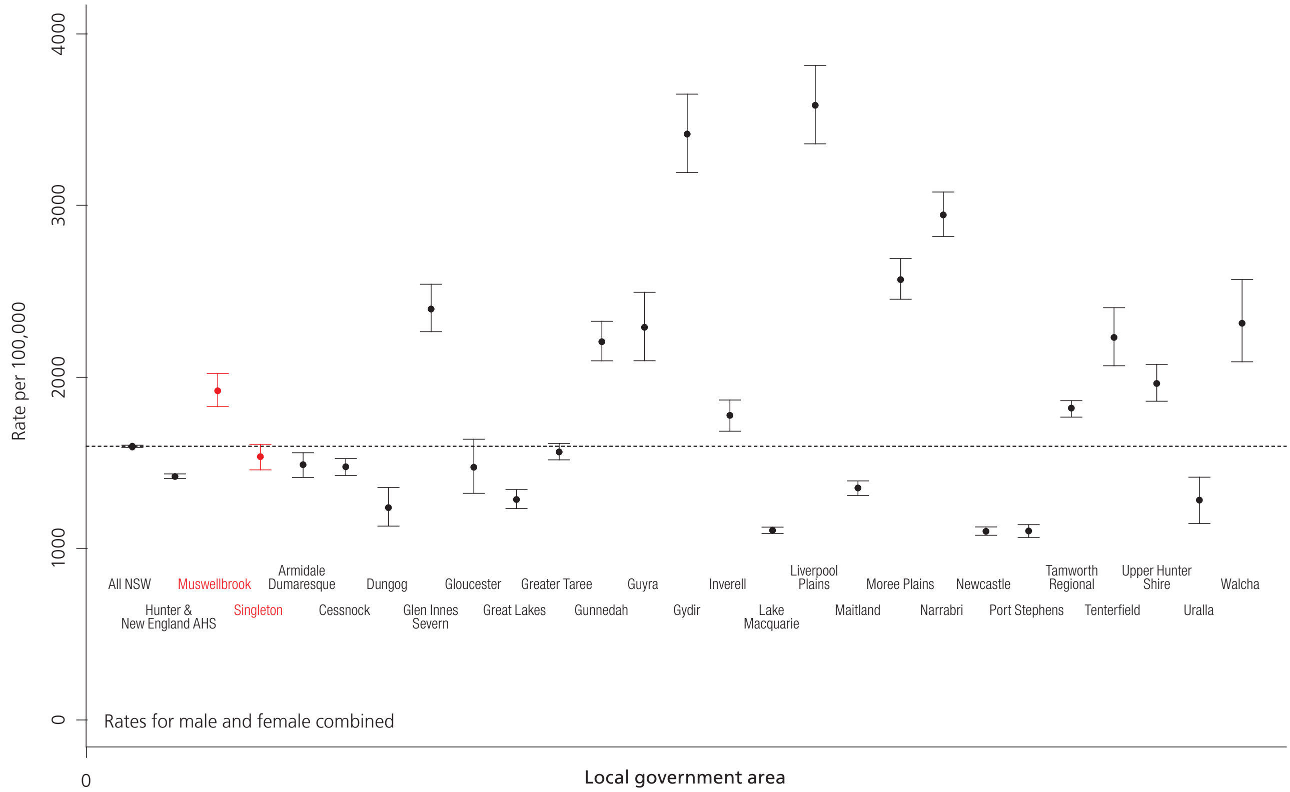


Figure 6. Rates for respiratory disease hospitalisations by the 25 local government areas in Hunter New England Area Health Service and the location of coal mines and power stations, 2004-2009

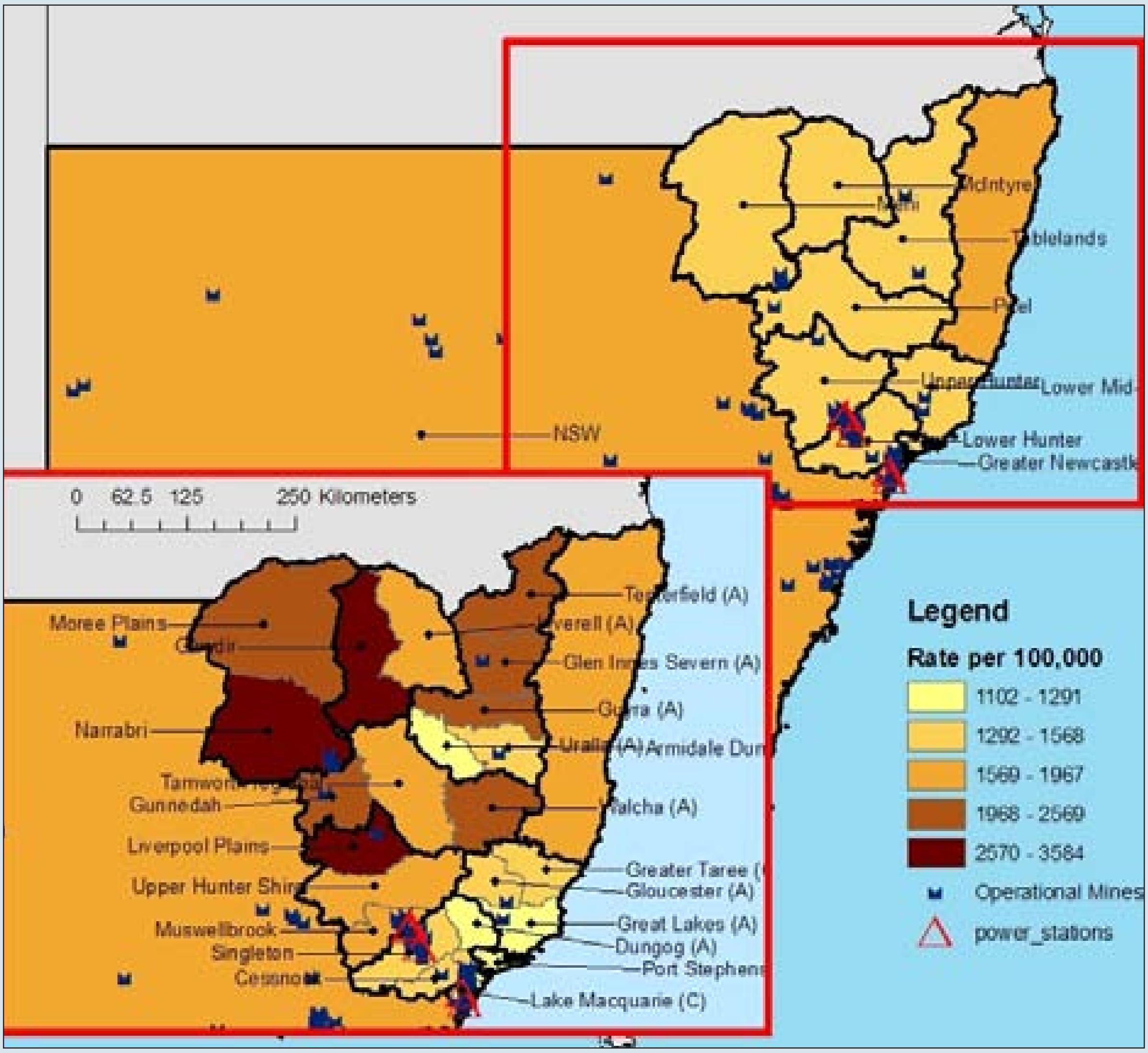


Figure 7. Rates of asthma hospital separation by local government area in Hunter New England Health Area Health Service and NSW, 2004 – 2009

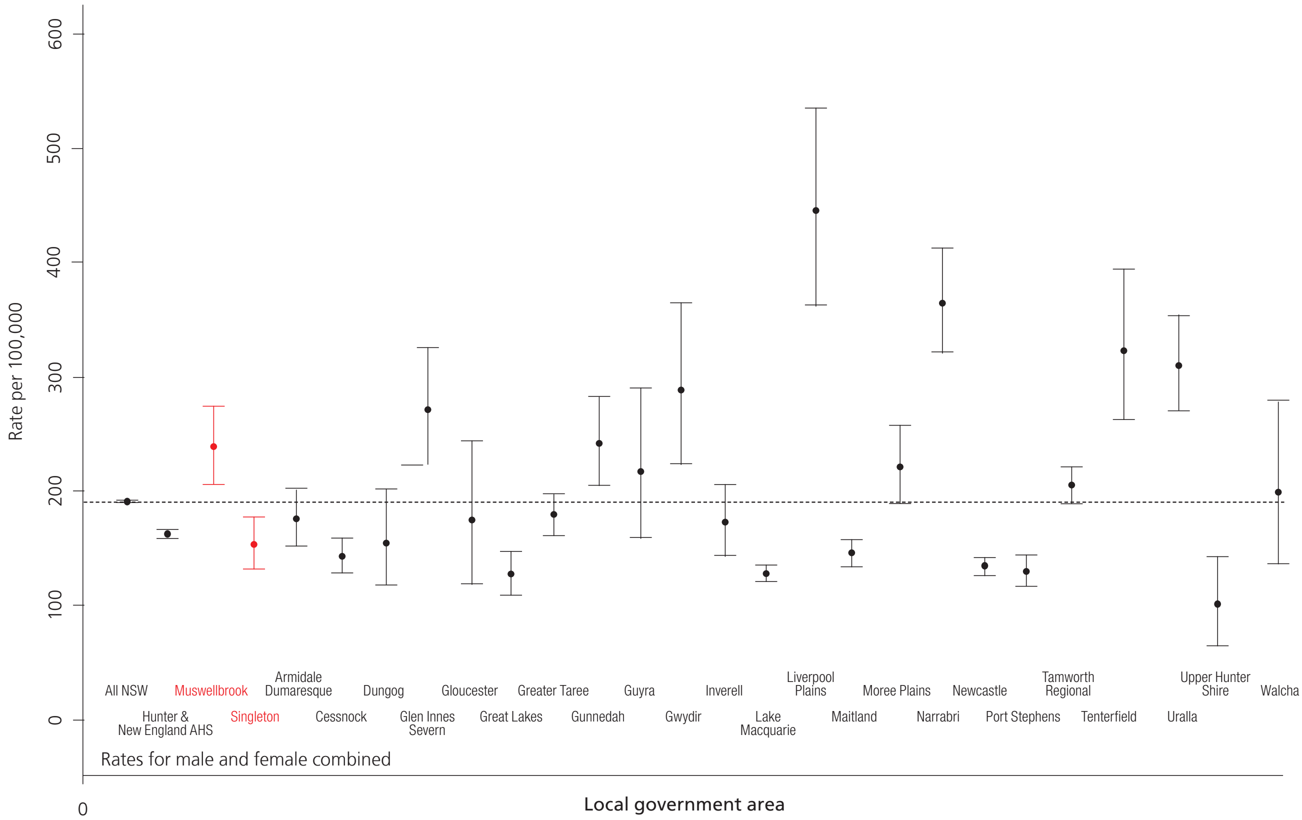


Figure 8. Rates of asthma hospitalisation by local government area in Hunter New England Health Area Health Service and the location of coal mines and power stations, 2004 – 2009

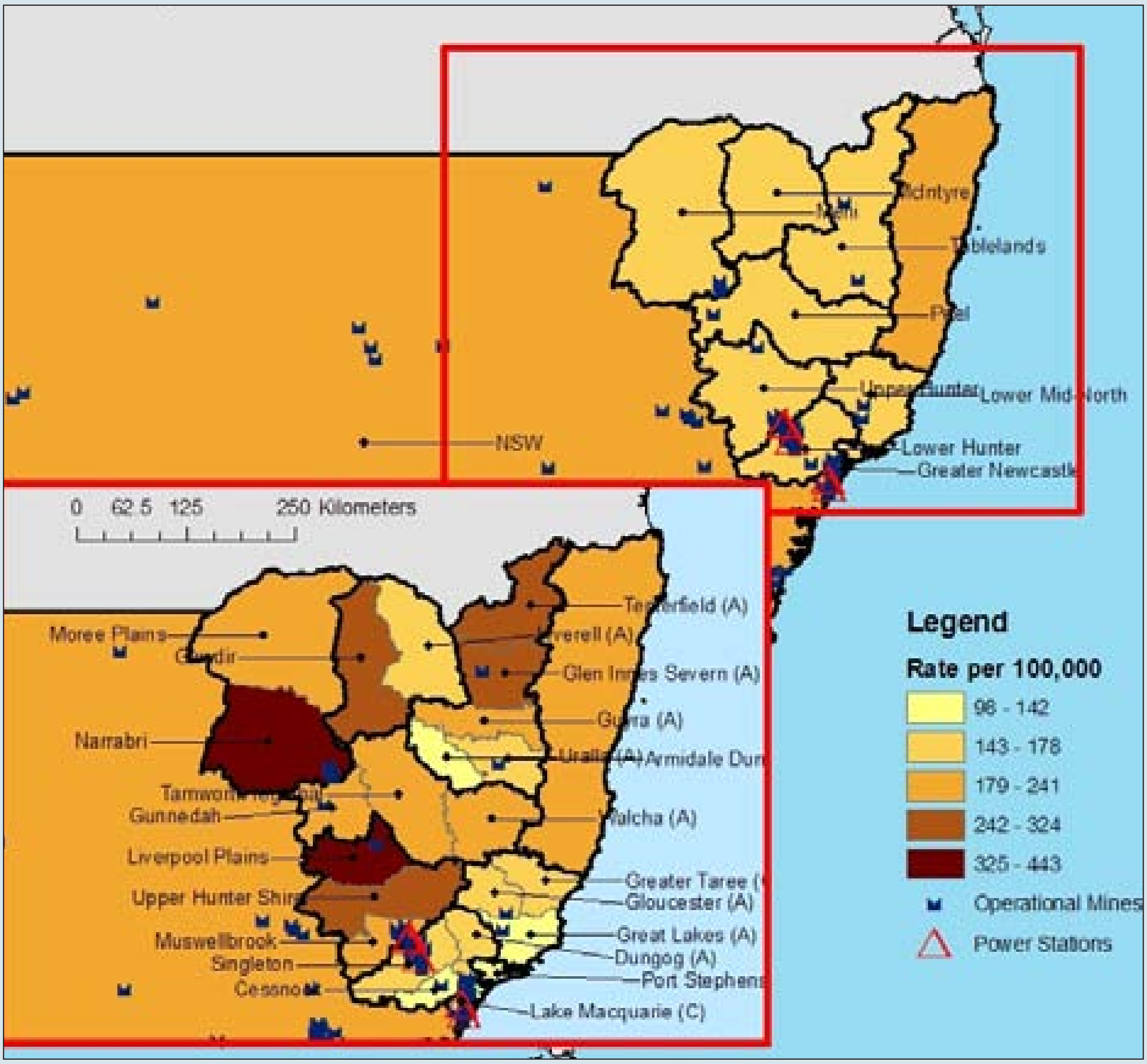


Figure 9. Rates of asthma hospital separation (children aged under 15 years) by local government area in Hunter New England Area Health Service and NSW, 2004 – 2009

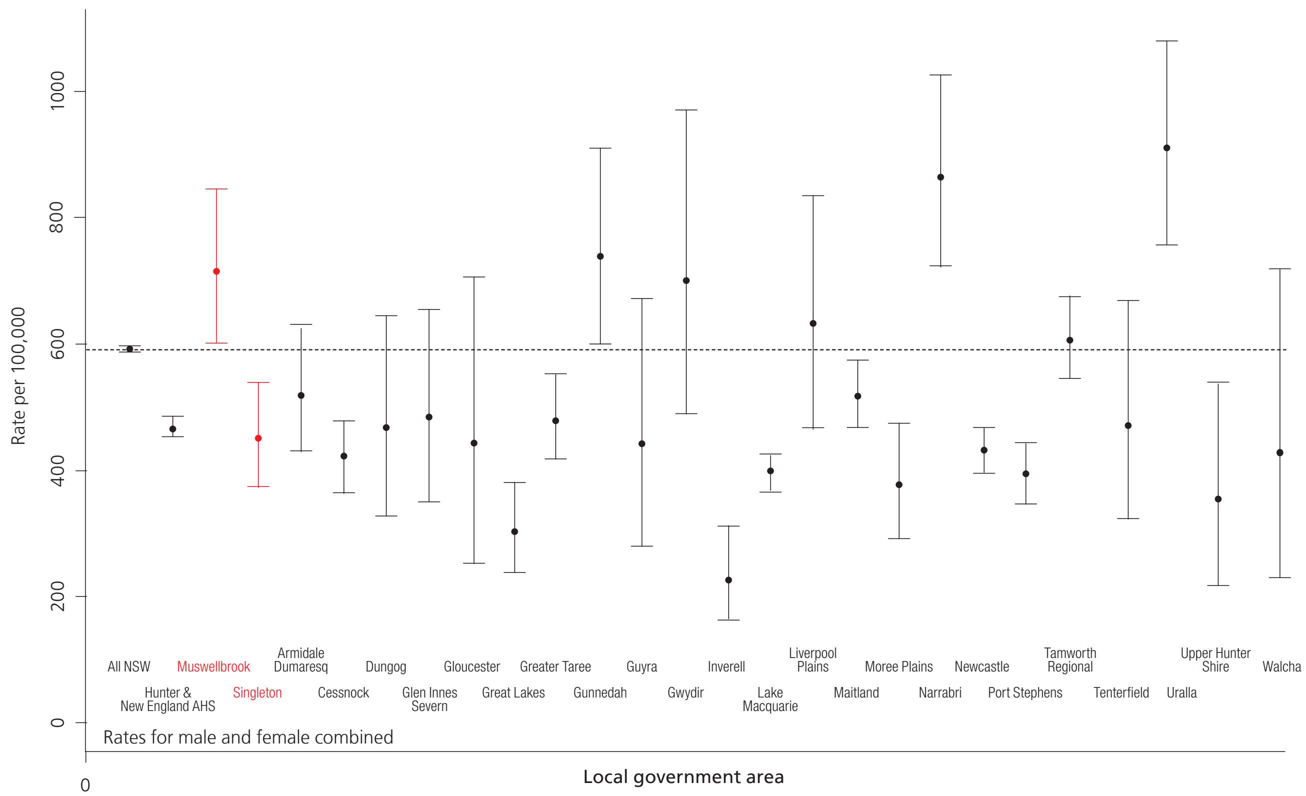


Figure 10. Rates for cardiovascular disease hospital separations by local government area in Hunter New England Area Health Service and NSW, 2004 – 2009

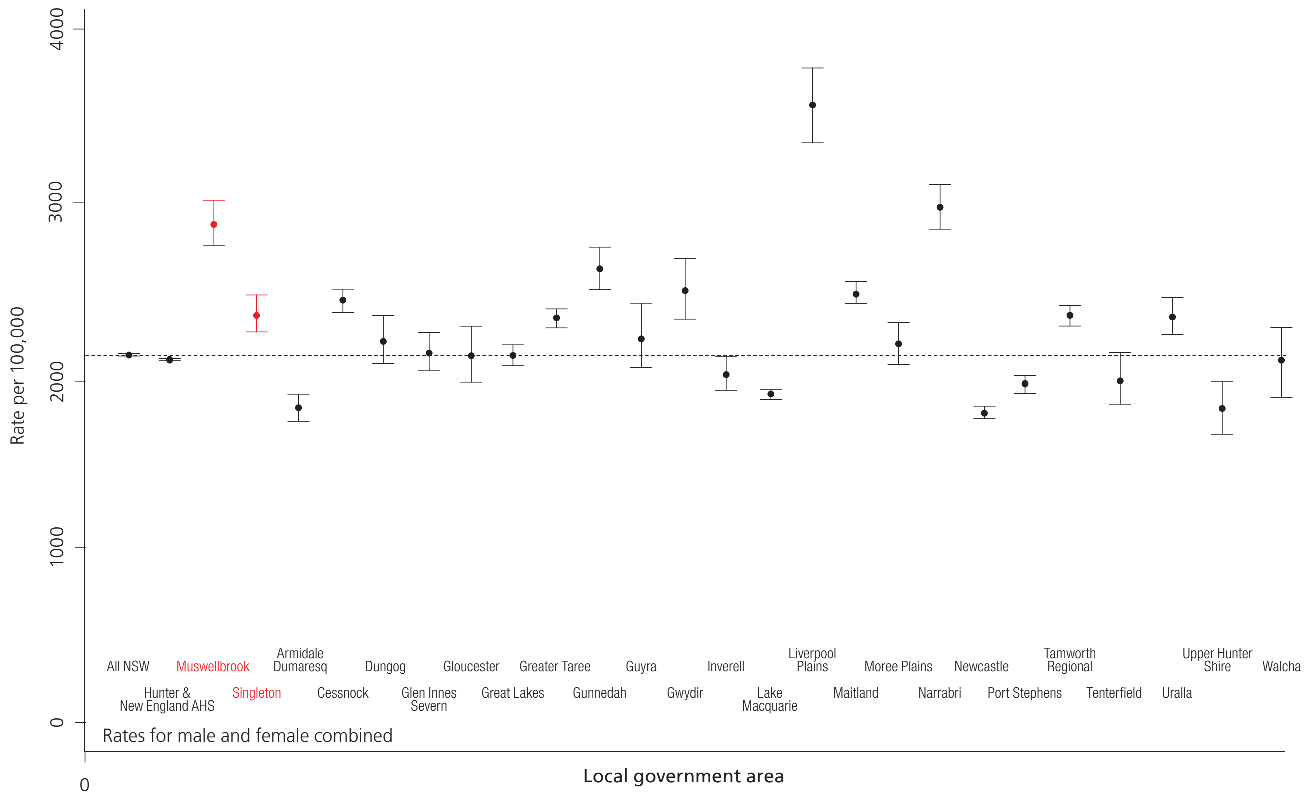
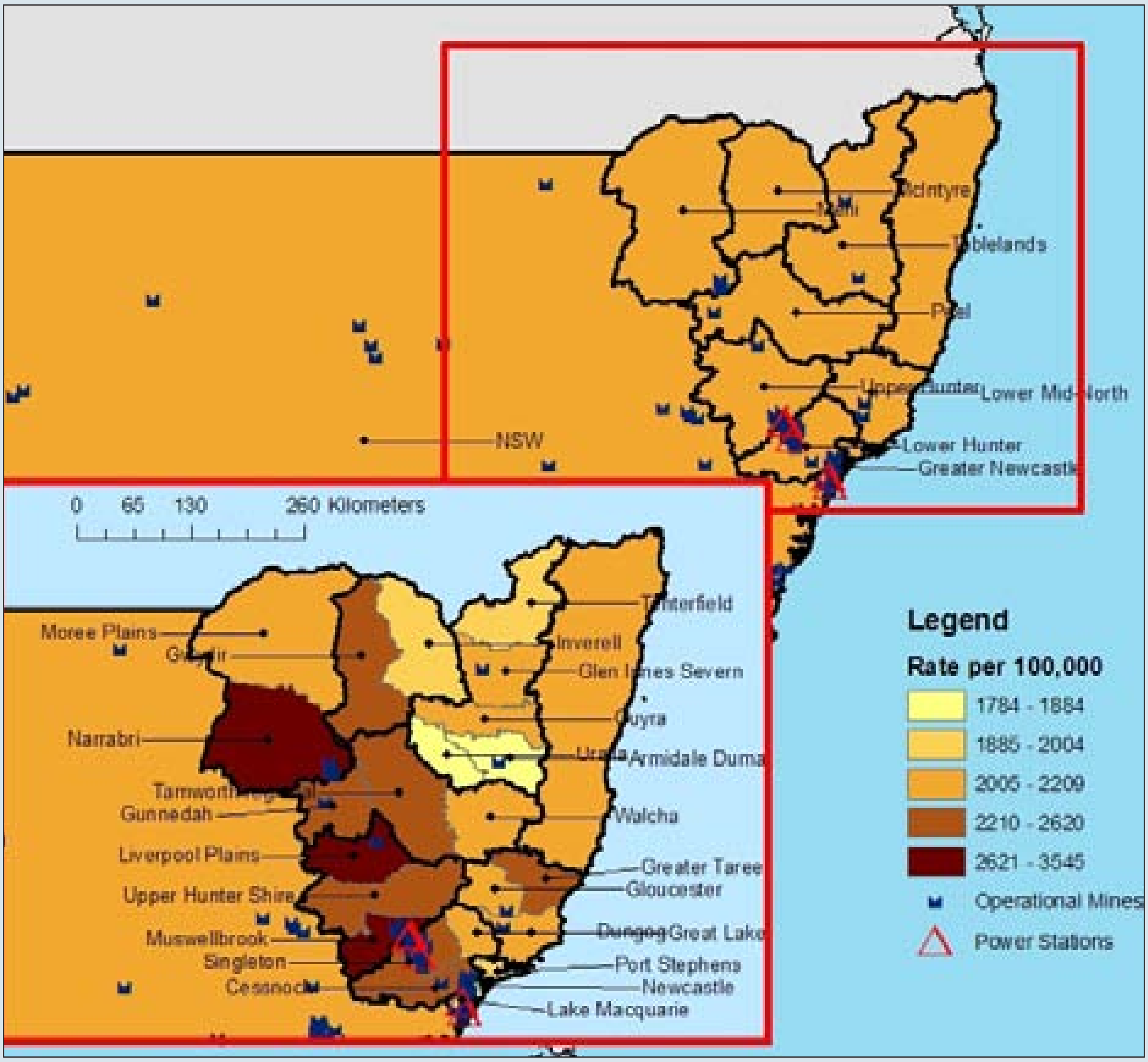


Figure 11. Rates of cardiovascular disease hospital separations by local government area in Hunter New England Health Area Health Service and the location of coal mines and power stations, 2004 – 2009



SECTION 4

Self-reported data on overall health, asthma and smoking

Key points

- There is no difference in self-reported health between residents of Hunter New England Area Health Service (HNEAHS) and the rest of NSW
- There is no difference in self-rated health between residents of any of the regions within HNEAHS
- The rate of parent/carer-reported asthma is similar in all regions of the HNEAHS and higher than that for the rest of NSW
- There is no statistically significant difference in self-reported asthma in adults in the HNEAHS compared to the rest of NSW
- The only areas of HNEAHS reporting statistically significant differences in asthma prevalence are Mehi and Peel
- The areas within the HNEAHS with smoking rates higher than NSW as a whole include Mehi, McIntyre and Upper Hunter, although these rates are not statistically significantly different from the rate for NSW.

Methods

Since 1997, the NSW Department of Health has used surveys as one way to monitor the health of the population of the state. Since 2002, one of the main mechanisms by which the Department monitors the risk behaviours and health status of the state's residents on an ongoing basis is the NSW Population Health Survey. This is a telephone survey that uses computer assisted telephone interviewing (CATI) to record how the people in NSW rate their health. The main aims of the survey are to provide information on the health of the people of NSW, and to inform the planning, implementation and evaluation of health services and programs in NSW. This section reports data collected from the Survey on self-reported (and for children, parent-reported) quality of life, asthma and tobacco smoking (see Appendix E for survey questions). Data in this section are presented by HNEAHS cluster.

New South Wales Population Health Survey

The Survey is conducted between February and December each year and covers the whole state. The target population is all state residents living in households with private telephones. The annual target sample is approximately 1500 people in each area health service (a total state sample of 12 000). The survey uses a nationally accepted method of random digit dialling to call people and then randomly selects a person within each house.

In the HNEAHS, 757 children participated in each of the 3 years from 2006 to 2008, and 5532 adults participated in the 5 years from 2004 to 2008.

Additional information supporting the findings presented in this section are contained in Appendix D, Tables 27-39.

Self-rated health of adults and children

Figures 14 and 15 present the self-rated health for adults and children, respectively, by cluster within HNEAHS compared with NSW. Both graphs show no difference in self-rated health between HNEAHS and NSW, or between areas within HNEAHS.

Parent/carer-reported asthma in children

Figures 16 and 17 show the rates of asthma reported by parents/carers. Rates in Lower and Upper Hunter, the areas with the greatest concentration of open-cut coal mines and power stations, are presented in red. Overall, the rate of parent/carer-reported asthma in HNEAHS is higher than the rest of NSW. Table 30 (Appendix D) shows that there is a reasonably consistent pattern of parent/carer-reported asthma across most of the local government areas in the HNEAHS. The higher asthma rates are reported in both those local government areas that contain the greatest concentration of open-cut coal mines and power stations, and also in local government areas containing few or no such industries.

Tables 31 and 32 (Appendix D) provide some indication of the severity of asthma reported. Children with reported asthma in HNEAHS have similar measures for both the presence of written asthma management plans and for reported interference with daily living as do children living in the rest of NSW.

The number of people with asthma who were interviewed is very small, however, and no local government areas or cluster-specific interpretations can be made.

Self-reported asthma in adults

Figure 18 and Tables 33-35 (Appendix D) show no differences in self-reported asthma among adults in HNEAHS compared with the rest of NSW. The only areas reporting differences in asthma prevalence are Mehi and Peel, which both report higher asthma prevalence. Neither of these regions is exposed to extensive open-cut coal mining or power generation industries.

Self-reported smoking rate

The overall self-reported smoking rate for HNEAHS (19.3%) is similar to that for NSW (19.2%) (Table 36, Appendix D; Figure 19). There is no significant difference in smoking rates across Hunter New England

Figure 12. Self-rated health status (excellent, very good, or good) by area health service, people aged 16 years and over, NSW, 2008

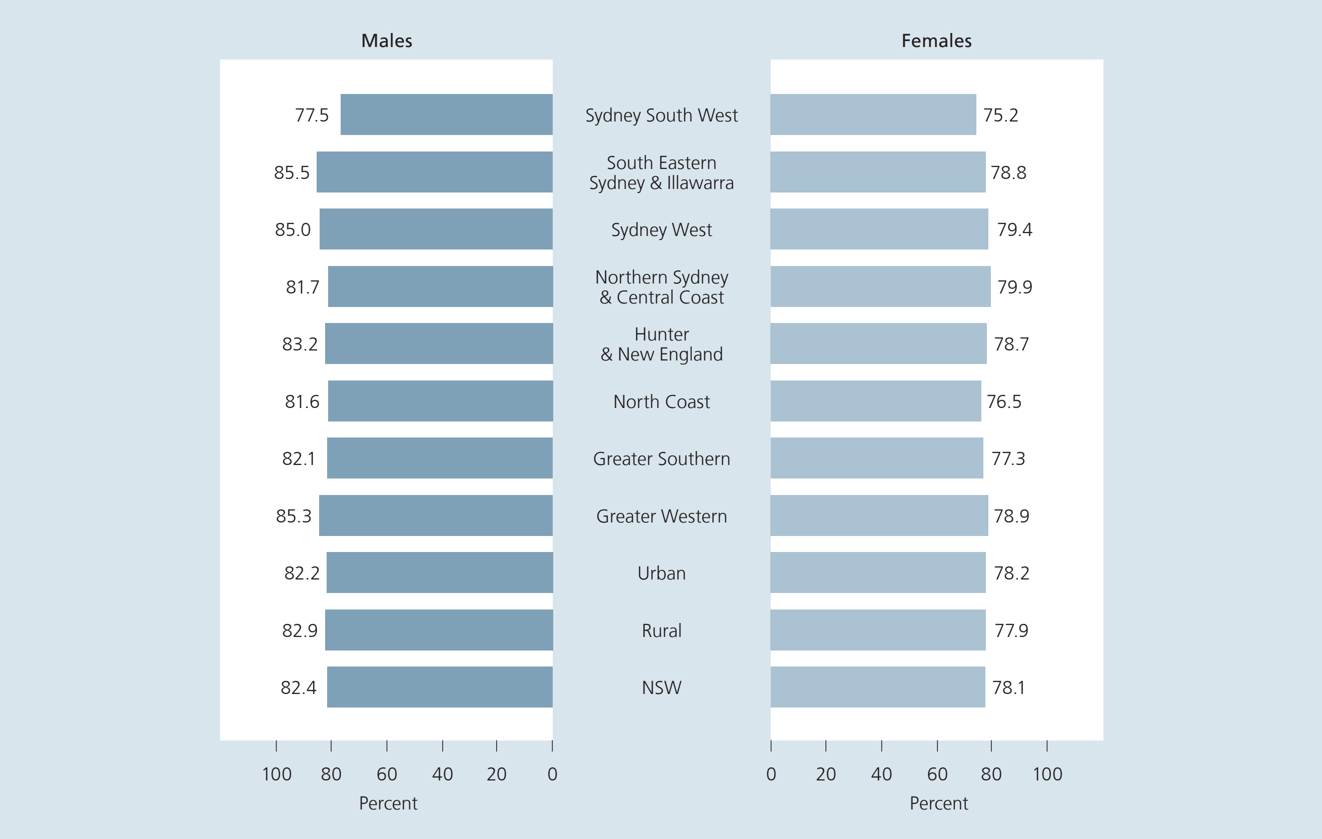


Figure 13. Self-rated health status by area health service (children 5-15 years old) and NSW, 2007-2008

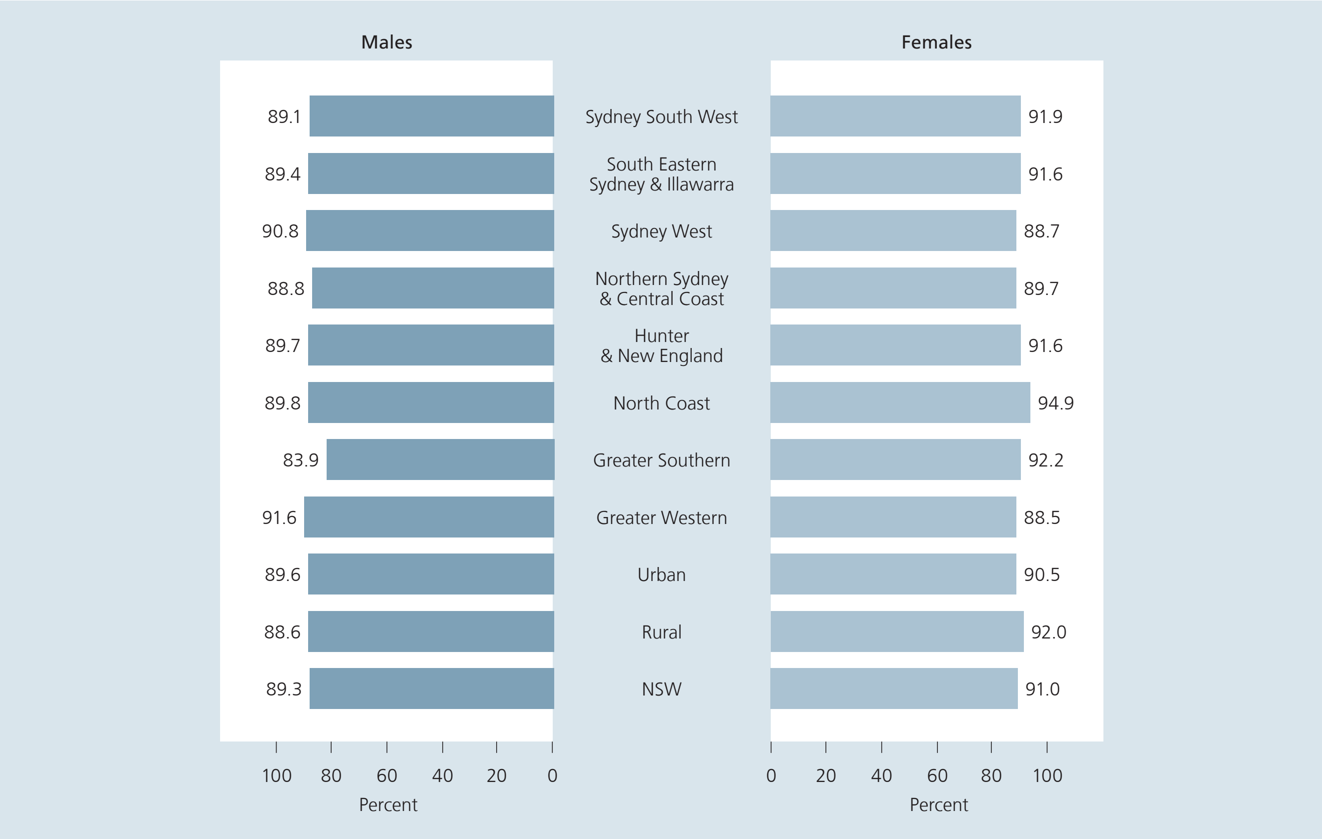


Figure 14. Self-rated heath status (16 years or older) by Hunter New England Area Health Service clusters in Hunter New England Area Health Service, 2008.

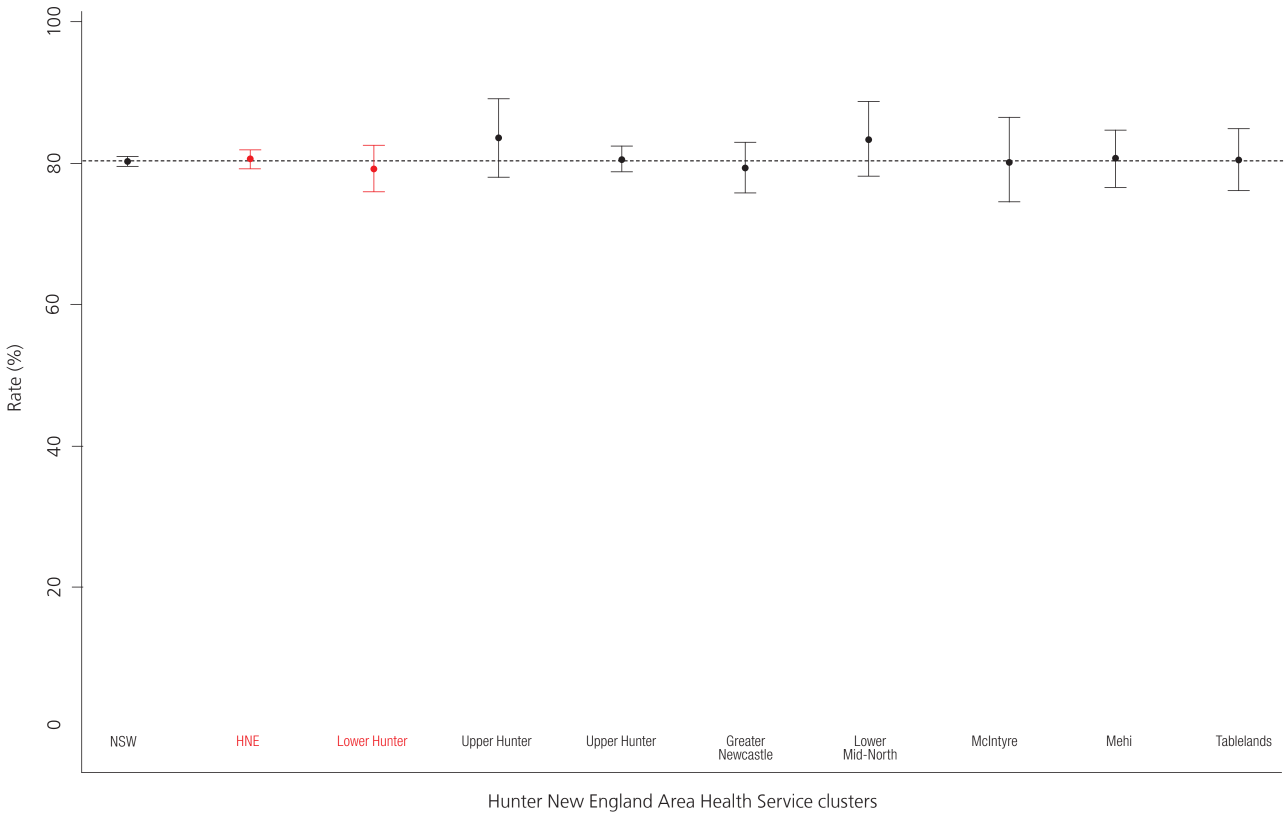


Figure 15. Self-rated health status (children 5-15 years of age) by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2007 – 2008.

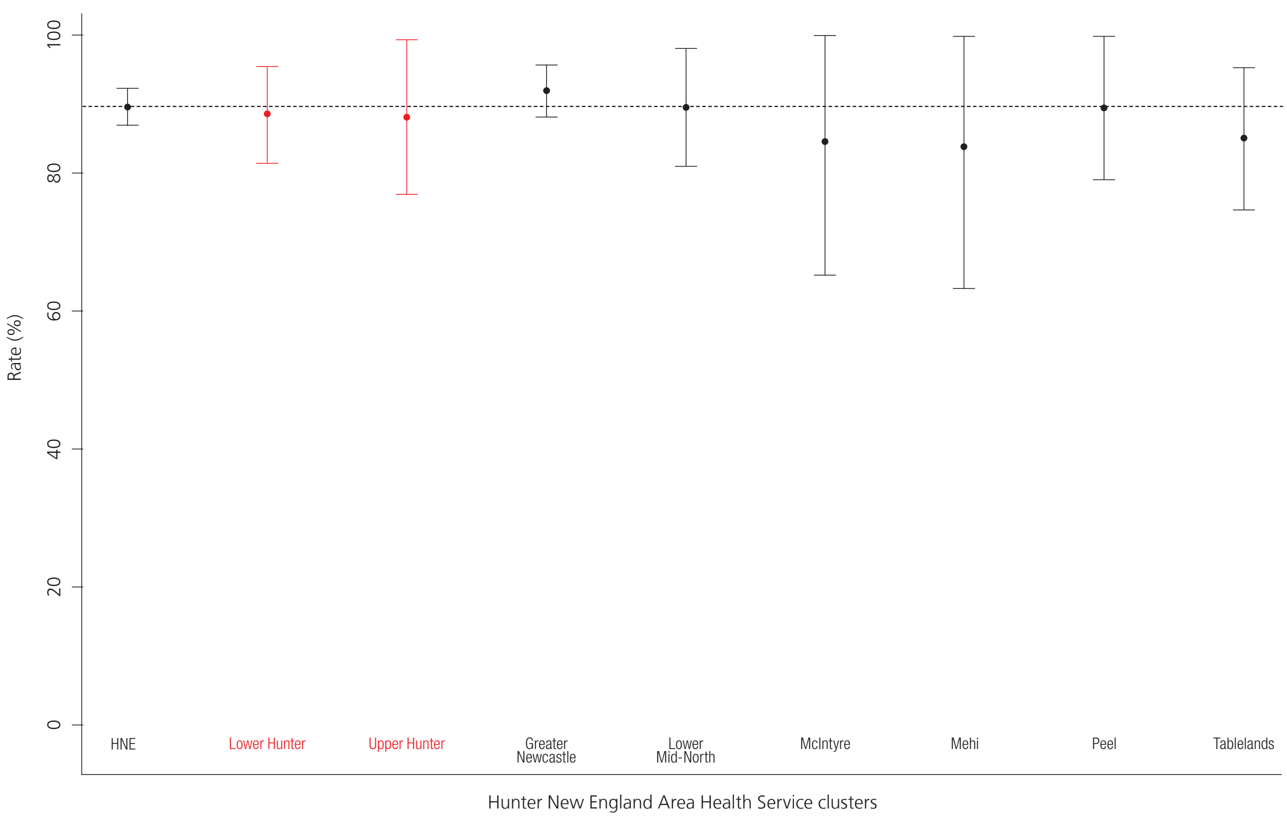


Figure 16. Parent/carer-reported current asthma by area health service (children 2-15 years) and NSW, 2007-2008

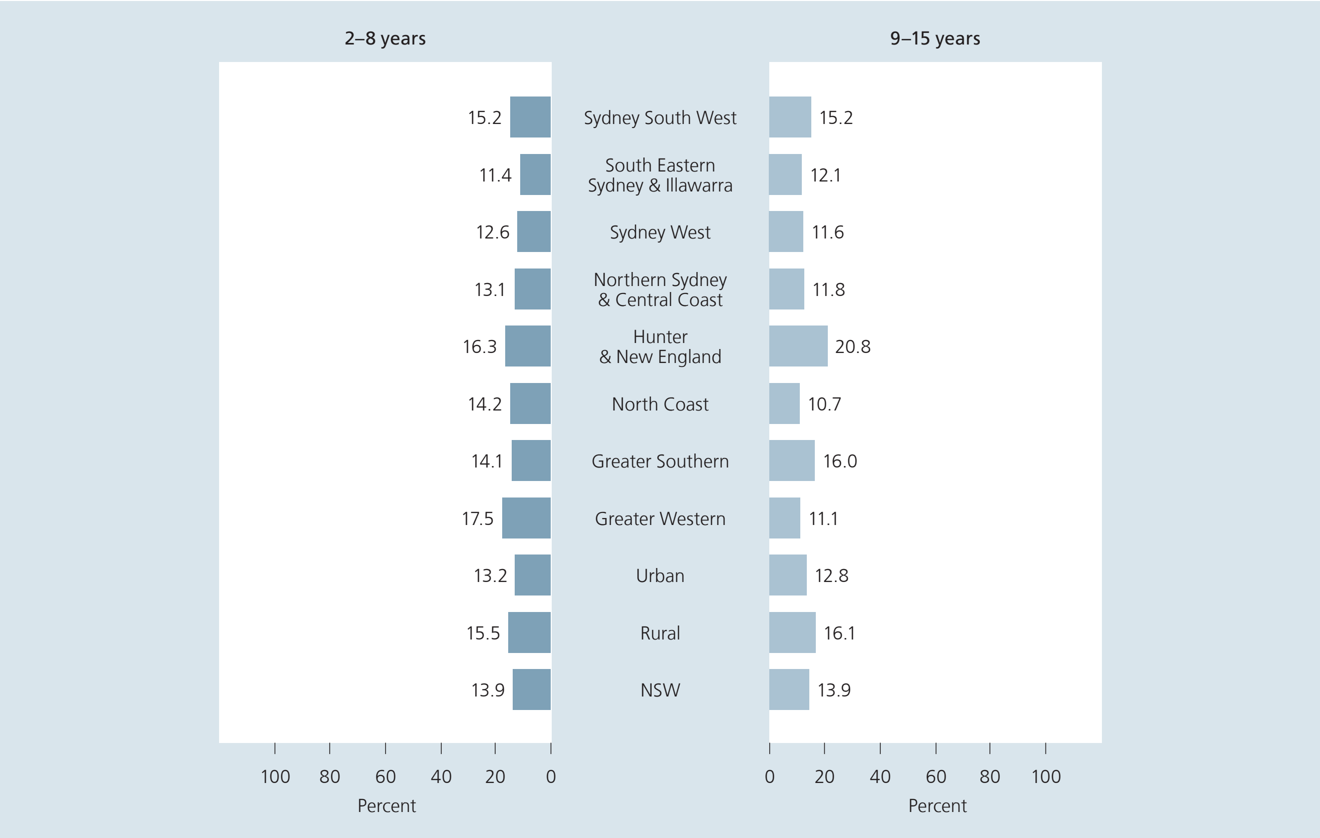


Figure 17. Parent/carer-reported current asthma rates for children (≤ 15 years of age) by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2006-2008

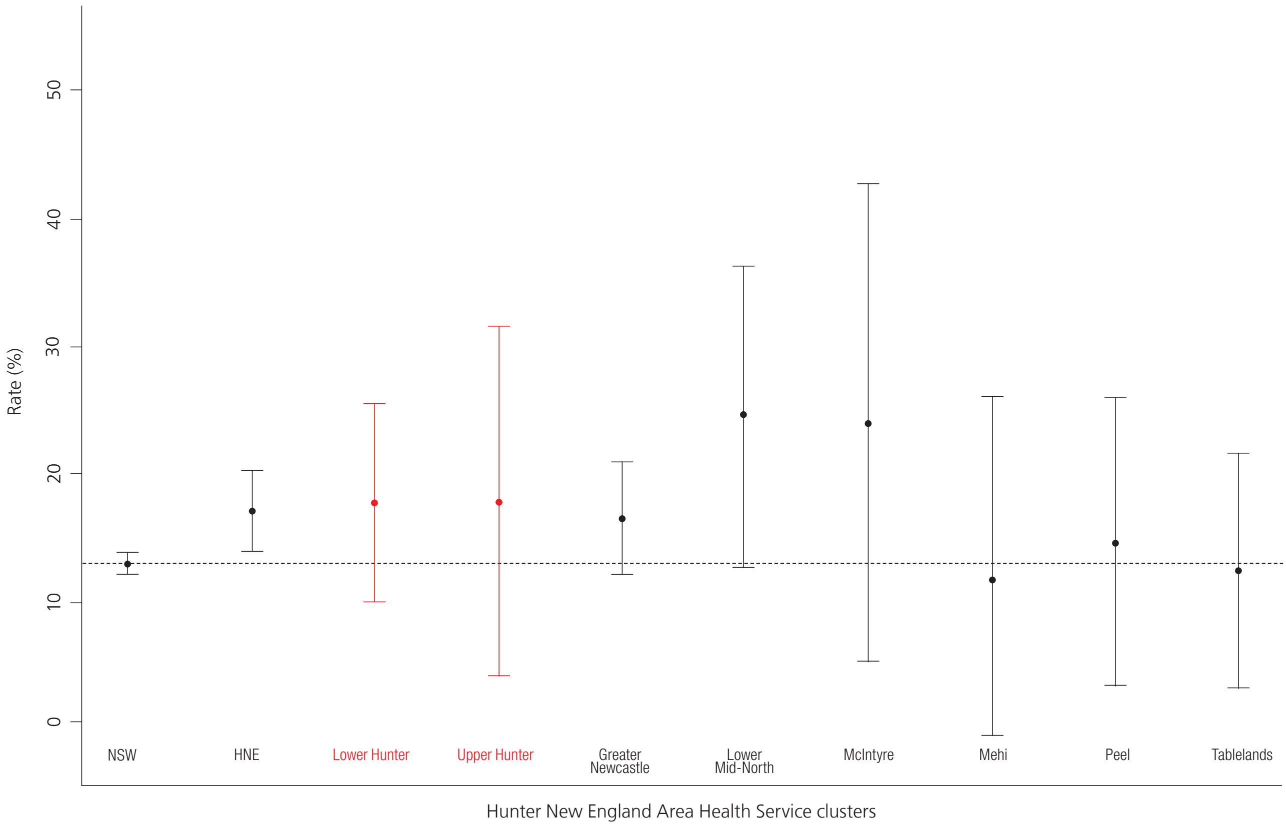


Figure 18. Self-reported current asthma rates for adults (> 15 years of age) by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2006-2008

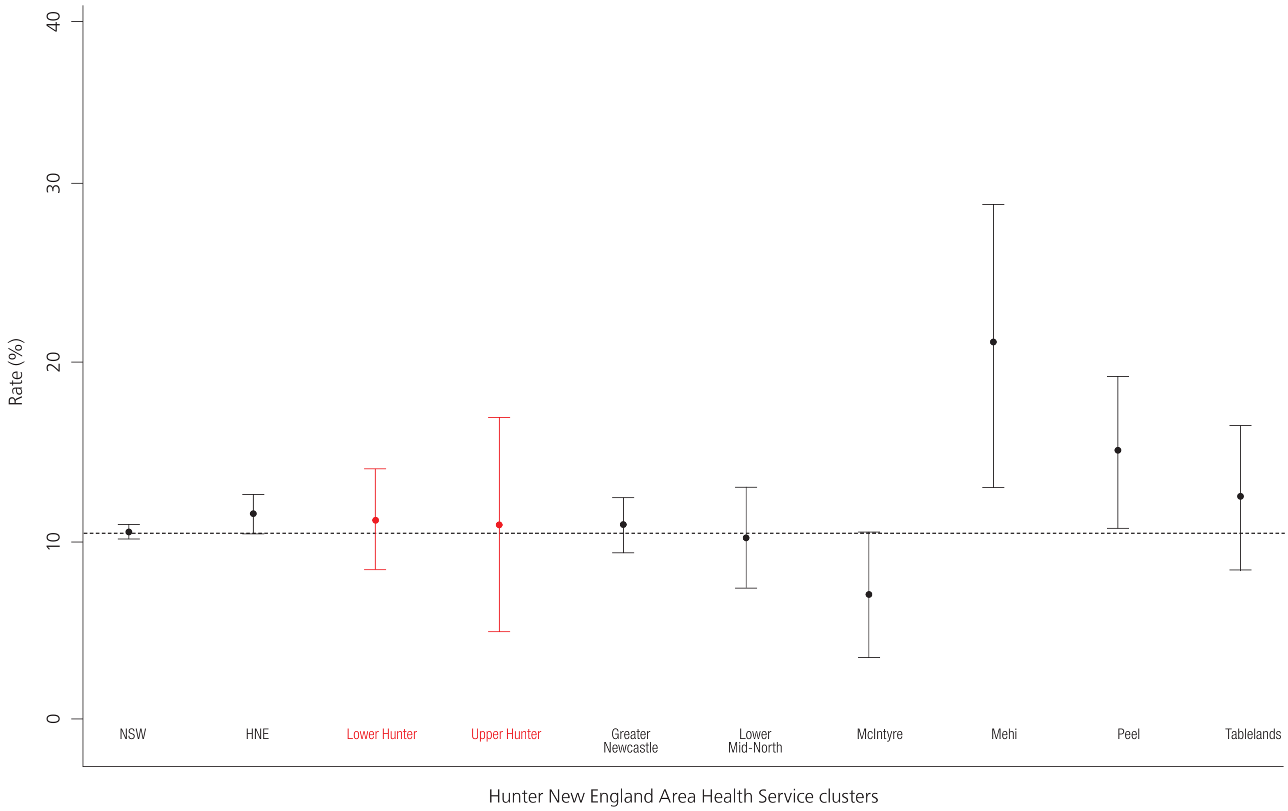


Figure 20. Self-reported current smoking rates for males by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2004-2008

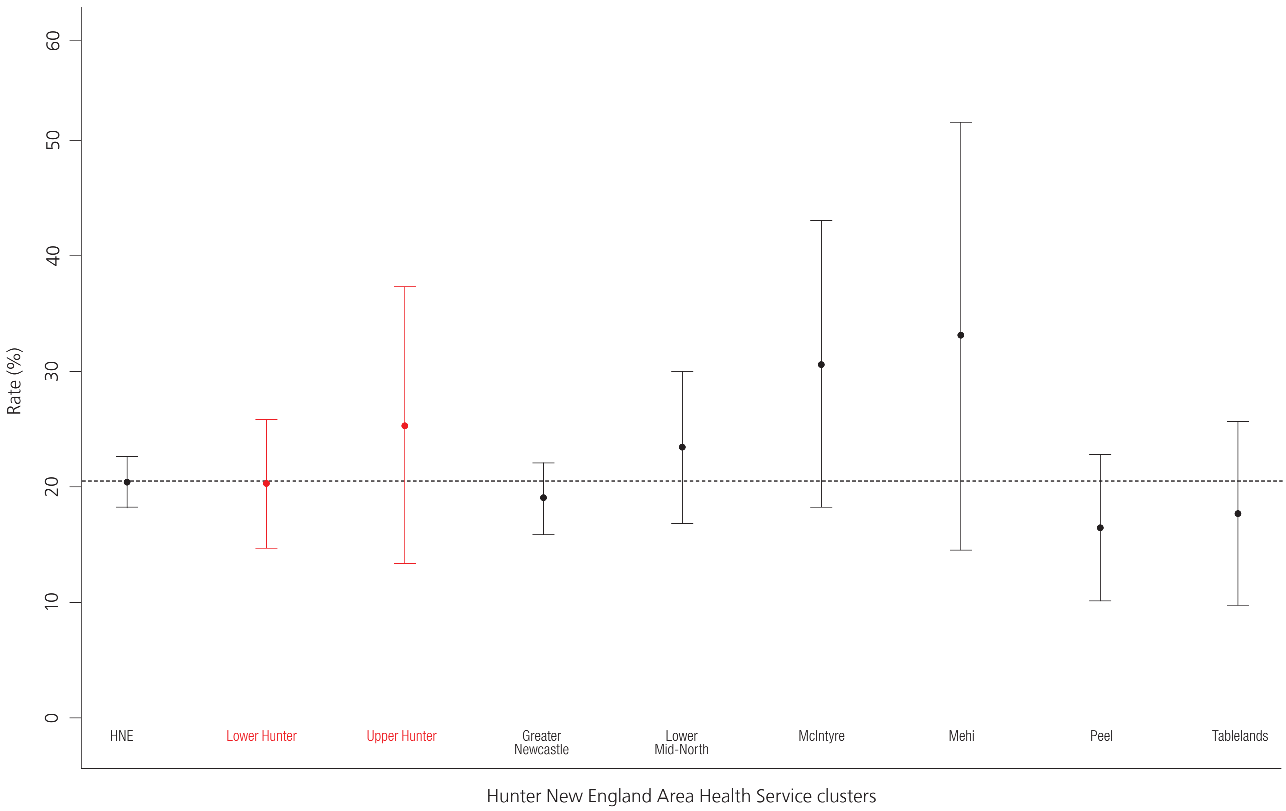


Figure 19. Self-reported current smoking rates for males by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2004-2008

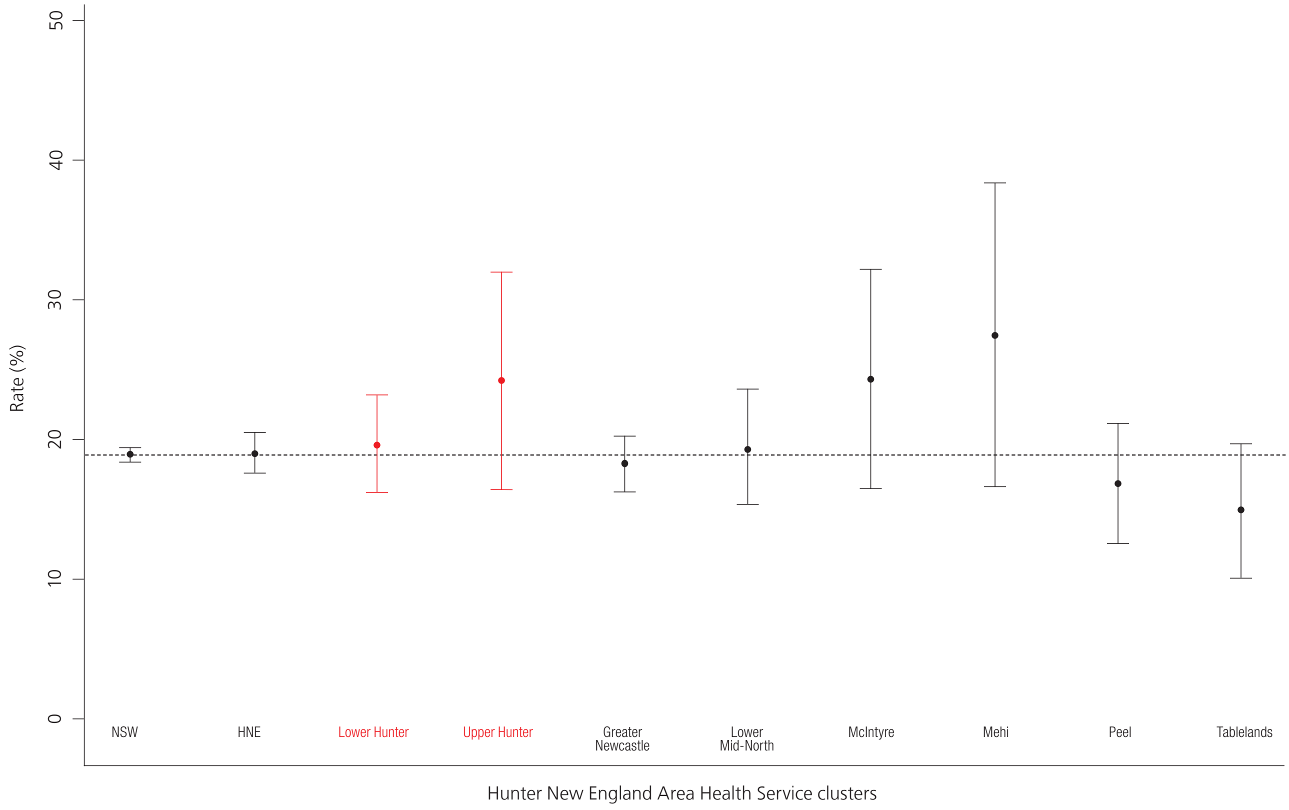
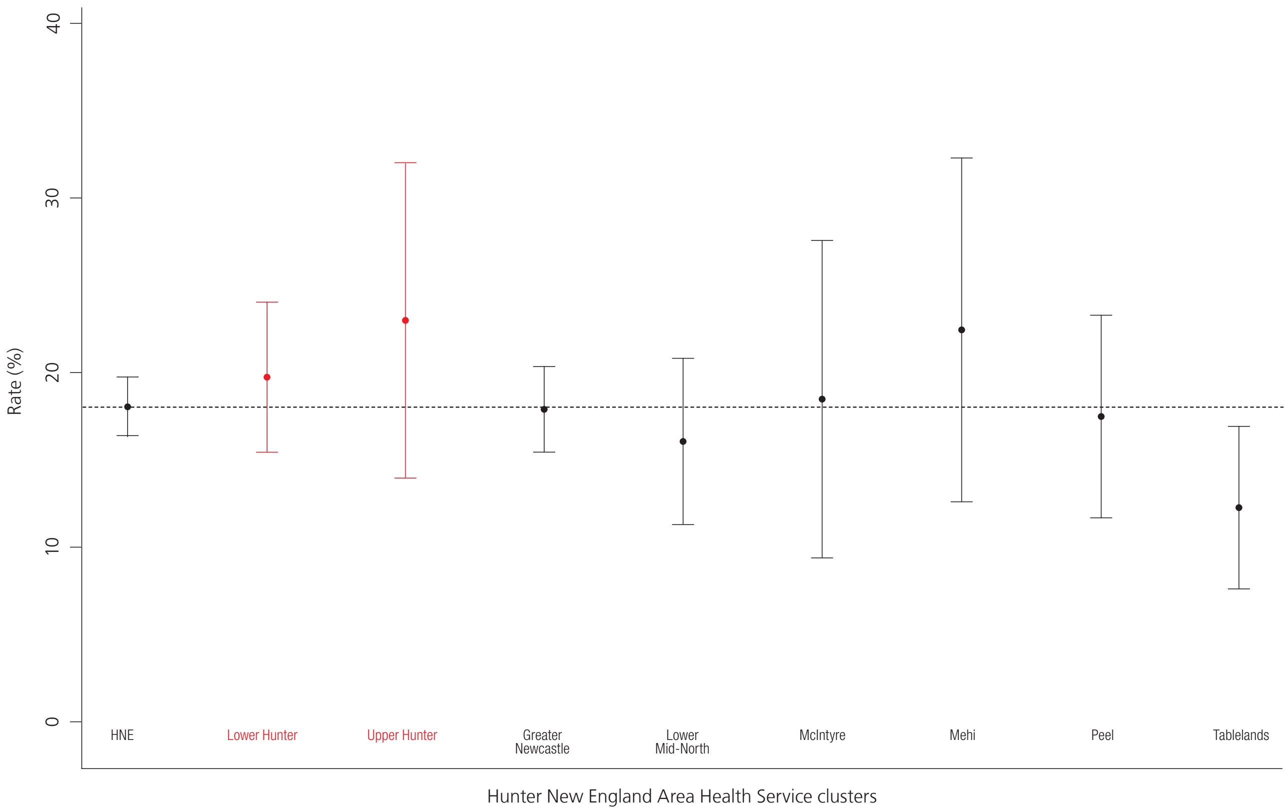


Figure 21. Self-reported current smoking rates for females by Hunter New England Area Health Service clusters in Hunter New England Area Health Service and NSW, 2004-2008



SECTION 5

Mortality

Key points

- The death rate from all causes is higher in the Hunter New England Area Health Service (HNEAHS) than for NSW, but varies across HNEAHS clusters
- The rate is higher in the Lower Hunter cluster but lower in the Upper Hunter cluster (the two clusters with extensive open-cut mining and power generation activities) than the death rate for NSW
- The cardiovascular disease death rate is higher for HNEAHS than for NSW, and differs between those clusters with extensive open-cut mining and power generation activities
- Deaths due to chronic respiratory conditions and asthma are lower in HNEAHS than in NSW.

Methods

Deaths were classified using ICD-10-AM codes (ICD-10-AM: International statistical classification of diseases and related health problems, 10th revision, Australian modification).

Rates were age-adjusted using the Australian population at 30 June 2001. 95% confidence intervals were calculated. Rates in this section are presented by HNEAHS cluster.

Sources of data

The NSW Admitted Patients Data Collection and the Population estimates were provided by the Centre for Epidemiology and Research, NSW Department of Health.

This section reports on overall deaths and deaths from respiratory and cardiovascular diseases. Cancer deaths are presented in Section 6.

Additional information supporting the findings presented in this section are contained in Appendix D, Table 21-26.

Deaths from all causes

Figure 22 shows that the death rate from all causes in HNEAHS is higher than the rate for NSW combined for both males and females. For death rates, HNEAHS ranks higher than five other area health services, approximately the same as those for the Greater Southern Area Health Service, but lower than that for the Greater Western Area Health Service (data not shown).

The death rate from all causes varies across HNEAHS clusters. It is higher in the Lower Hunter cluster, but lower in the Upper Hunter cluster (the two clusters with extensive open-cut mining and power generation activities) than the death rate for NSW as a whole (Figure 22). Within HNEAHS, the death rate from all causes is highest in the Mehi cluster. Mehi also has a higher proportion of Aboriginal residents.

Figure 23 (Appendix D) shows a steady decline in the death rates from all causes in HNEAHS over the past 15 years.

Leading causes of death

Across HNEAHS, the most common cause of death is cardiovascular disease, accounting for 2543 deaths each year or 37.1% of all deaths. This proportion is similar to the state average of 36.7%. Malignant neoplasms (cancers) are the second most common cause of death accounting for 1940 deaths each year or 28.3% of all deaths in HNEAHS. This rate is the same as that for NSW (28.3%). Chronic respiratory disease including asthma accounts for 425 deaths each year (6.2%) which is less than the state average of 6.6% while asthma on its own accounts for 0.2% of all deaths (17 deaths each year) which is again less than the state average of 0.3% (Figures 24 and 25; Tables 22 and 23 Appendix D).

Deaths from respiratory disease

The death rate from respiratory disease for HNEAHS is not different from that for NSW as a whole (Figure 26). However, there are clusters within HNEAHS with higher rates, most evident in the Mehi and McIntyre clusters among males.

The clusters with extensive open-cut mining and power generation activities, the Upper and Lower Hunter clusters, have rates of death from respiratory disease that are similar to and lower than that for the HNEAHS as a whole, respectively. The cluster with the highest death rate from respiratory diseases, Mehi, also has the highest overall death rate in HNEAHS and a higher proportion of Aboriginal residents.

Deaths from asthma

The death rate from asthma is very low. Consequently, a detailed analysis comparing rates of death from asthma by cluster is not meaningful.

Deaths from cardiovascular disease

The death rate from cardiovascular disease is higher in HNEAHS than for NSW (Figure 27). The highest rates occur in the Mehi cluster and the Lower Hunter cluster for both males and females. It is notable that the higher rates in Mehi are consistent with the (non statistically significant) higher smoking rates in that cluster. Also of note is that while the Lower Hunter cluster has a higher rate of cardiovascular disease deaths, the Upper Hunter cluster has a lower rate of cardiovascular disease deaths than that for NSW as a whole.

Hospitalisations from smoking

Table 26 (Appendix D) shows the smoking-attributable hospitalisations by local government area in HNEAHS in the period 2005-2006. The Cessnock, Moree Plains, Muswellbrook and Narrabri lower government areas had higher rates of smoking-attributable hospitalisations than the state average.

Figure 22. Deaths from all causes in males and in females by Hunter New England Area Health cluster, Hunter New England Area Health Service and NSW, 2002 – 2007

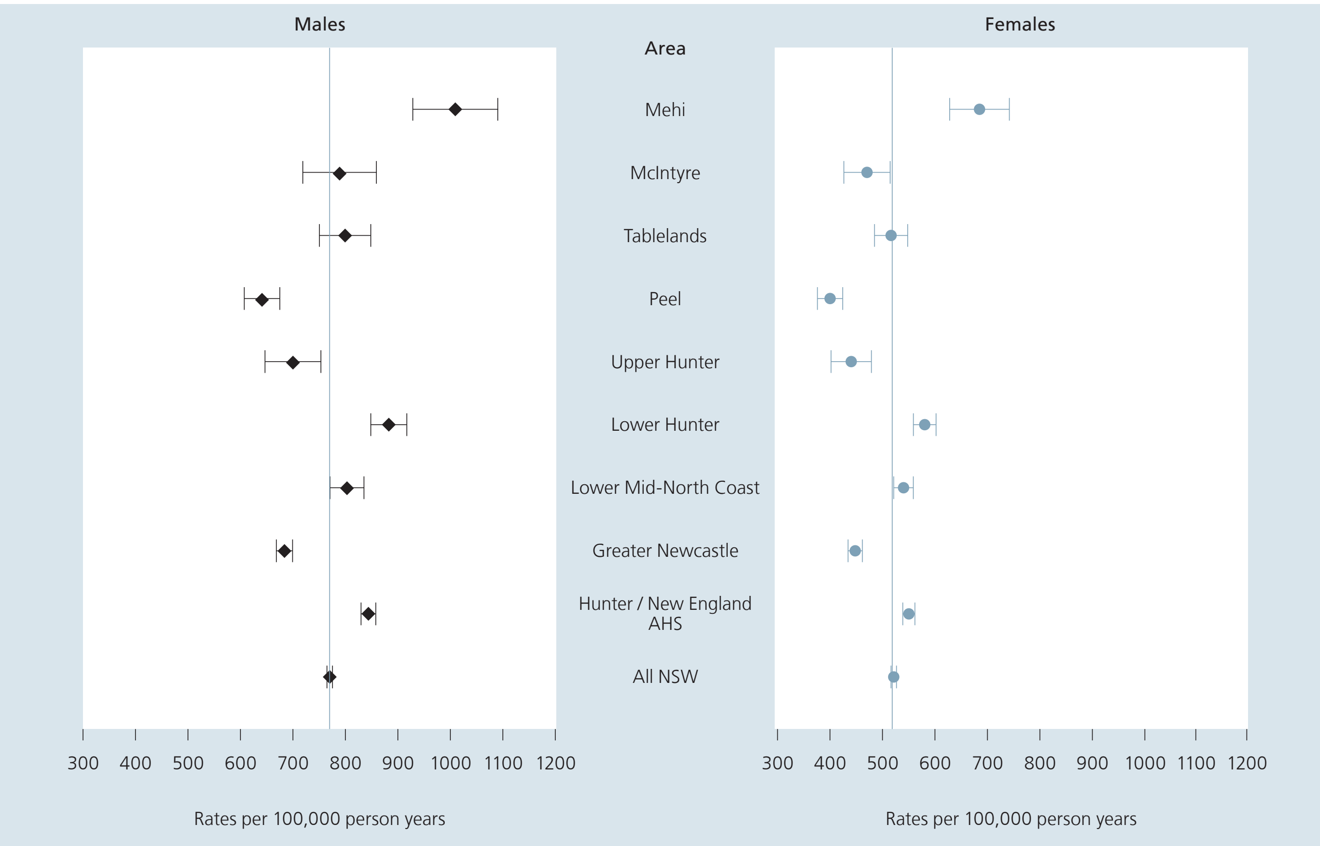


Figure 24. Cause of deaths by category, people of all ages in NSW, 2003 – 2007

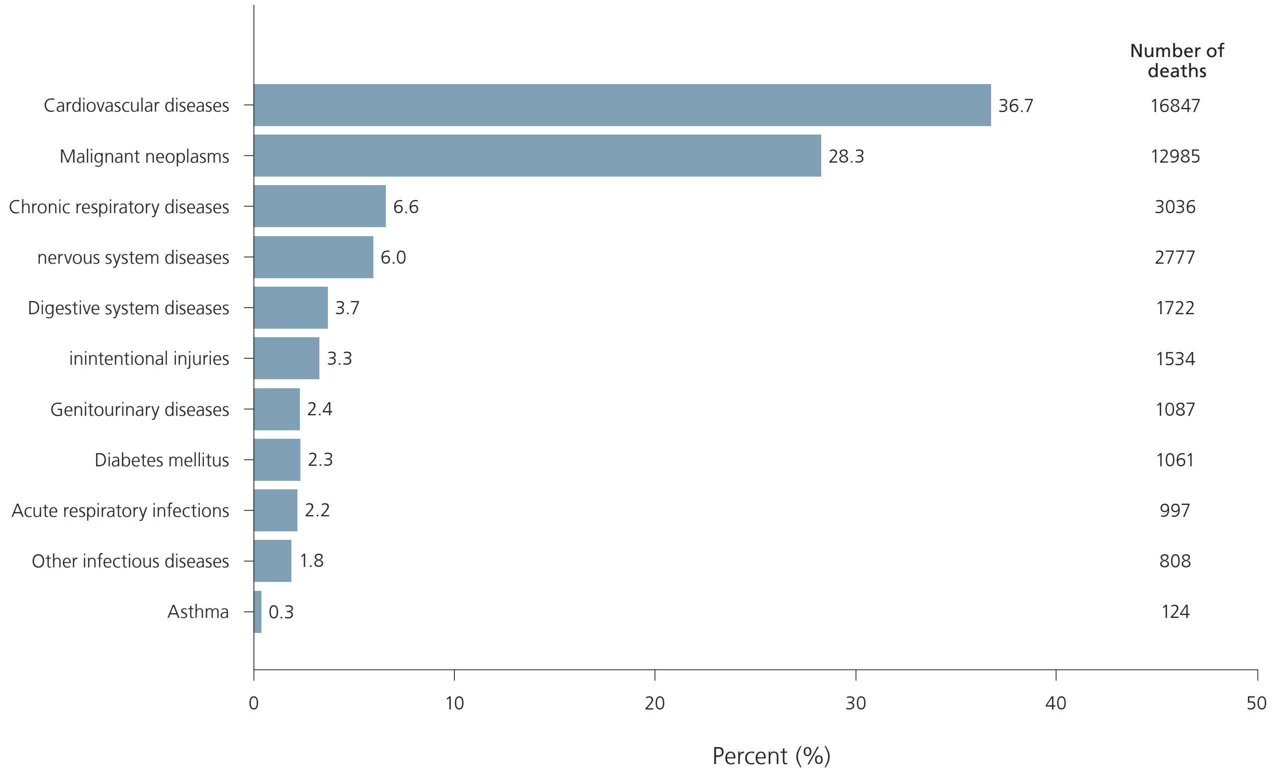


Figure 25. Cause of deaths by category, people of all ages in Hunter New England Area Health Service, 2003 – 2007

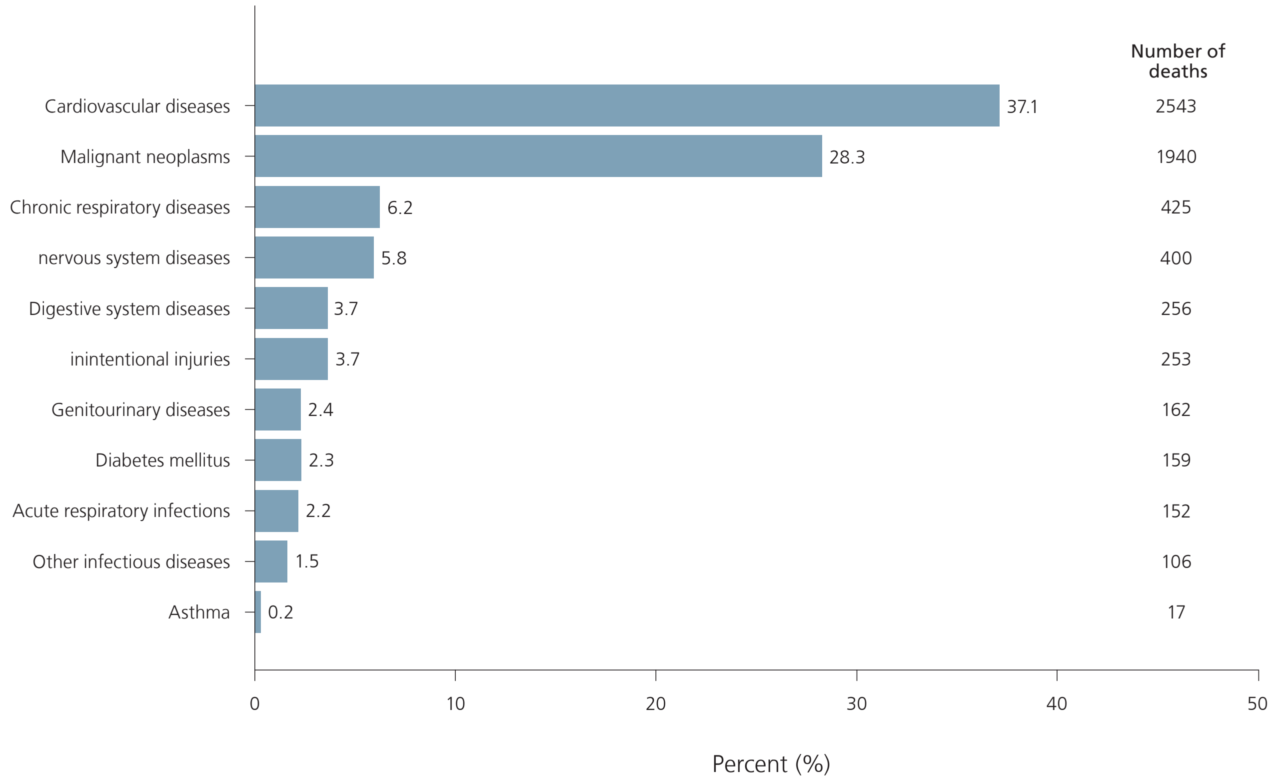


Figure 26. Deaths from all respiratory disease in males and in females by Hunter New England Area Health cluster, Hunter New England Area Health Service and NSW, 2002 – 2007

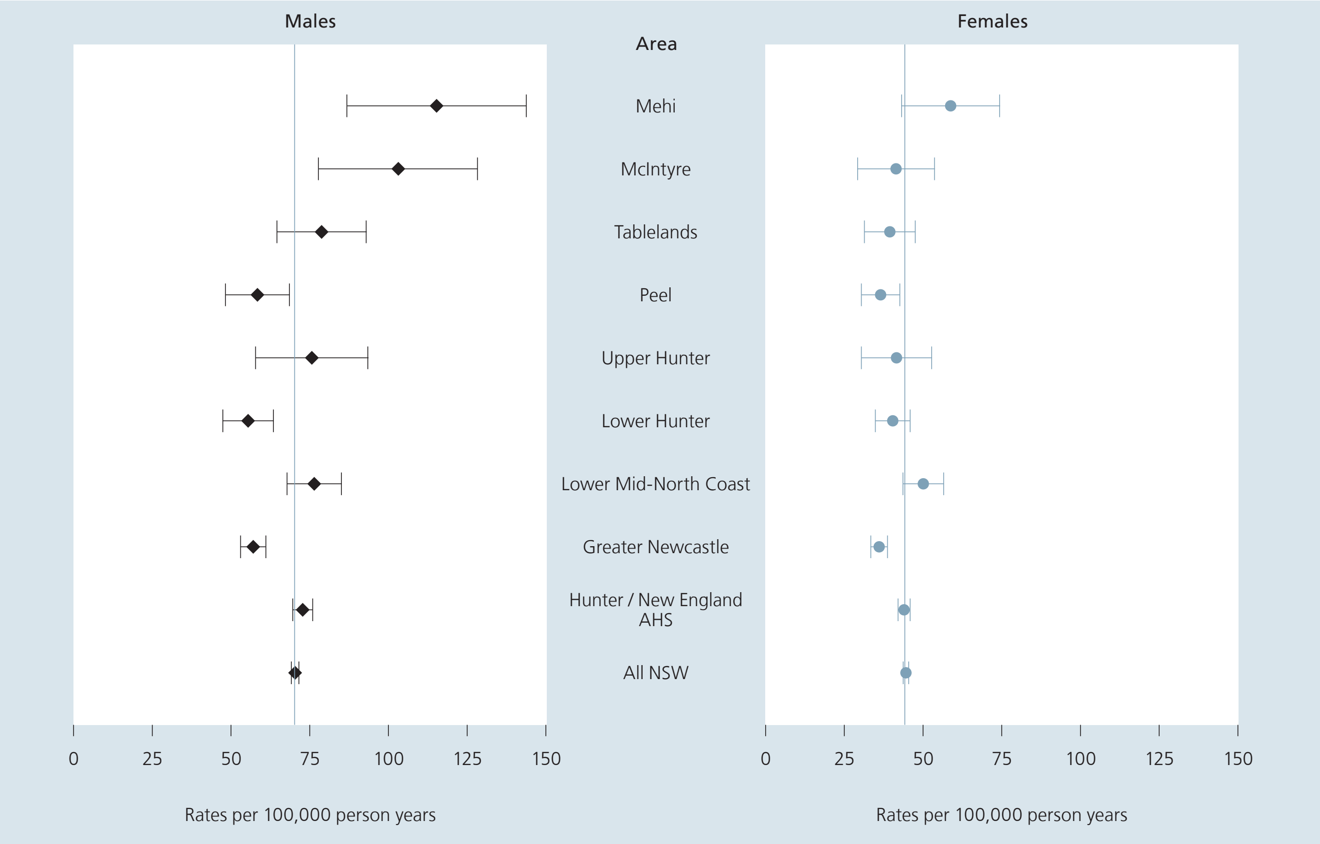
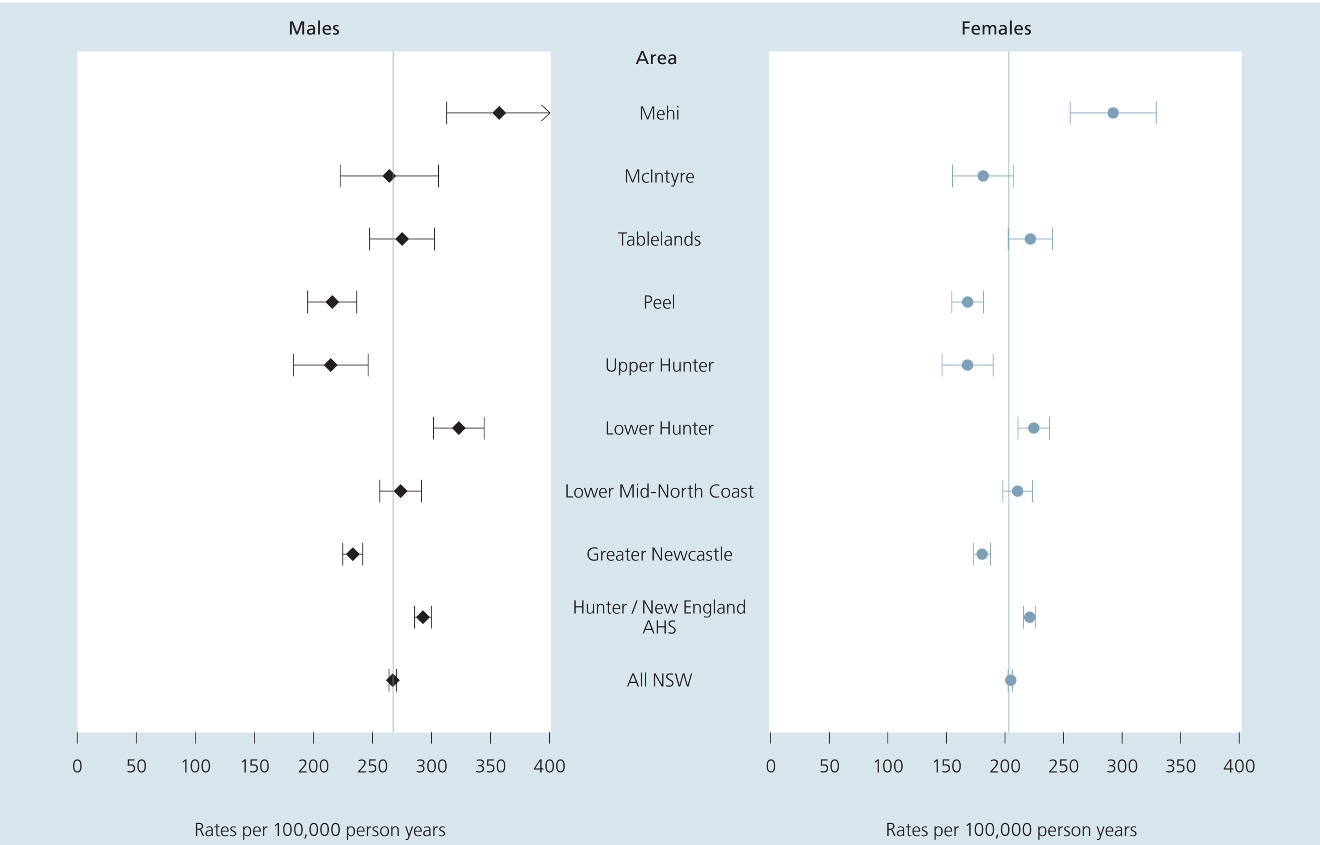


Figure 27. Deaths from cardiovascular diseases in males and in females by Hunter New England Area Health cluster, Hunter New England Area Health Service and NSW, 2002 – 2007



SECTION 6

Cancer

Key points

- Hunter New England Area Health Service (HNEAHS) has a higher cancer incidence and a higher rate of death from cancer than NSW, most notably among males
- The higher rates are for cancers not known to be associated with air pollution, including colorectal and prostate cancers, and melanoma
- The lung cancer rate is not higher in HNEAHS compared with NSW, and is not higher in any of the areas with extensive open-cut mining and power generation activities.

Methods

Deaths were classified using ICD-10-AM codes (ICD-10-AM: International statistical classification of diseases and related health problems, 10th revision, Australian modification).

Rates were age-adjusted using the Australian population at 30 June 2001. 95% confidence intervals were calculated. Rates in this section are presented by HNEAHS cluster.

Sources of data

NSW Admitted Patients Data Collection and the Population estimates were provided by the Centre for Epidemiology and Research, NSW Department of Health. Cancer incidence and mortality data were obtained through the NSW Central Cancer Registry, managed by the NSW Cancer Institute.

Additional information supporting the findings presented in this section are contained in Appendix D, Table 40-51.

Incidence and death rates from cancer of all types

Both the incidence of cancer and the death rate from cancer in HNEAHS are higher than for NSW (Figure 29). The higher cancer rates are found in the Mehi, McIntyre and Upper Hunter clusters (Figure 30, Table 41, Appendix D), and these rates are higher for males than for females. The death rate for both males and females has not changed over the past 10 years for both males and females in HNEAHS (Figure 31 Appendix D).

Cancer is a term covering different malignant neoplsams with very different causes. Cancers in this report are examined by specific type according to where they are found in the body. Figure 32 presents the most common body sites for cancer in HNEAHS from 2003 to 2007.

Leading causes of death from cancer

Figures 32 to 35 show the leading causes of death from cancer, and the leading diagnoses of new cancers. Overall, the leading causes of cancer in HNEAHS are prostate, melanoma, breast, colorectal and lung cancers.

Breast cancer

Table 46 (Appendix D) shows very similar breast cancer rates for HNEAHS compared with those for NSW. No cluster within HNEAHS shows any difference in incidence or death rates from breast cancer compared to that for HNEAHS or NSW as a whole. Breast cancer is not known to be associated with air pollution.

Lung cancer

Figures 36 and 37; Table 47 (Appendix D) show that the lung cancer rate for HNEAHS is similar to the rate for NSW. Within HNEAHS, the lung cancer rate for the Mehi cluster |is higher than for other clusters, consistent with the higher (but not statistically significantly higher) smoking rates reported in the Mehi cluster. The incidence rate in men in the Upper Hunter is also higher (but not statistically significantly higher) than that for men in NSW, but this is not true for men in Lower Hunter, the other cluster with extensive open-cut mining activities, nor for women in either of these clusters. Figure 38 shows a map of the incidence of lung cancer for the clusters within HNEAHS, including the location of open-cut and underground coal mines and coal-fired electrical power stations.

Figure 39 and Table 48 (Appendix D) show a slow decline from 1997 to 2008 in lung cancer rates among males in HNEAHS.

Colorectal cancer

HNEAHS has a higher rate of colorectal cancer than does NSW as a whole (Figure 40; Table 49 Appendix D). The incidence is highest in the Upper Hunter and Lower Hunter clusters, and the death rate is highest in these two clusters and the Mehi cluster (Figure 40). Colorectal cancer is not known to be associated with air pollution.

Prostate cancer

HNEAHS has a higher rate of prostate cancer than does NSW as a whole (Figure 41; Table 50 Appendix D). The incidence rates are consistently higher in all HNEAHS clusters with the exception of Greater Newcastle and Lower Hunter clusters, and the death rate is consistently higher across all clusters, compared with the incidence and death rates for NSW as a whole, respectively (Figure 41). Prostate cancer is not known to be associated with air pollution.

Melanoma

Figure 42 and Table 51 (Appendix D) show that the incidence and death rates for melanoma in HNEAHS is higher than those for NSW as a whole. The incidence is consistently higher in all clusters apart from the Tablelands and Peel clusters. Melanoma is not known to be associated with air pollution.

Cancer cluster investigation in Singleton

Five cases of brain cancer were reported occurring within two streets in Singleton. These cases were diagnosed between 1979 and 2008. A cancer cluster investigation was undertaken, and the results of the cluster investigation have been reviewed by Professor Bruce Armstrong, a cancer cluster expert. Professor Armstrong concluded that the geographical location of these brain tumour cases is most likely to be a chance occurrence. He has based this opinion on the lack of any increase in brain tumour rates in the Singleton local government area as a whole, the lack of any specific environmental hazard in the part of Singleton in which the cases lived that might be linked with brain tumour occurrence and the reasonable probability that the geographical grouping could have occurred by chance alone. A report of the cluster investigation can be found at: http://www.health.nsw.gov.au/resources/news/singleton_cancer_pdf.asp.

Figure 28. All cancers: incidence rates by local government areas within Hunter New England Area Health Service and NSW, 2003-2007

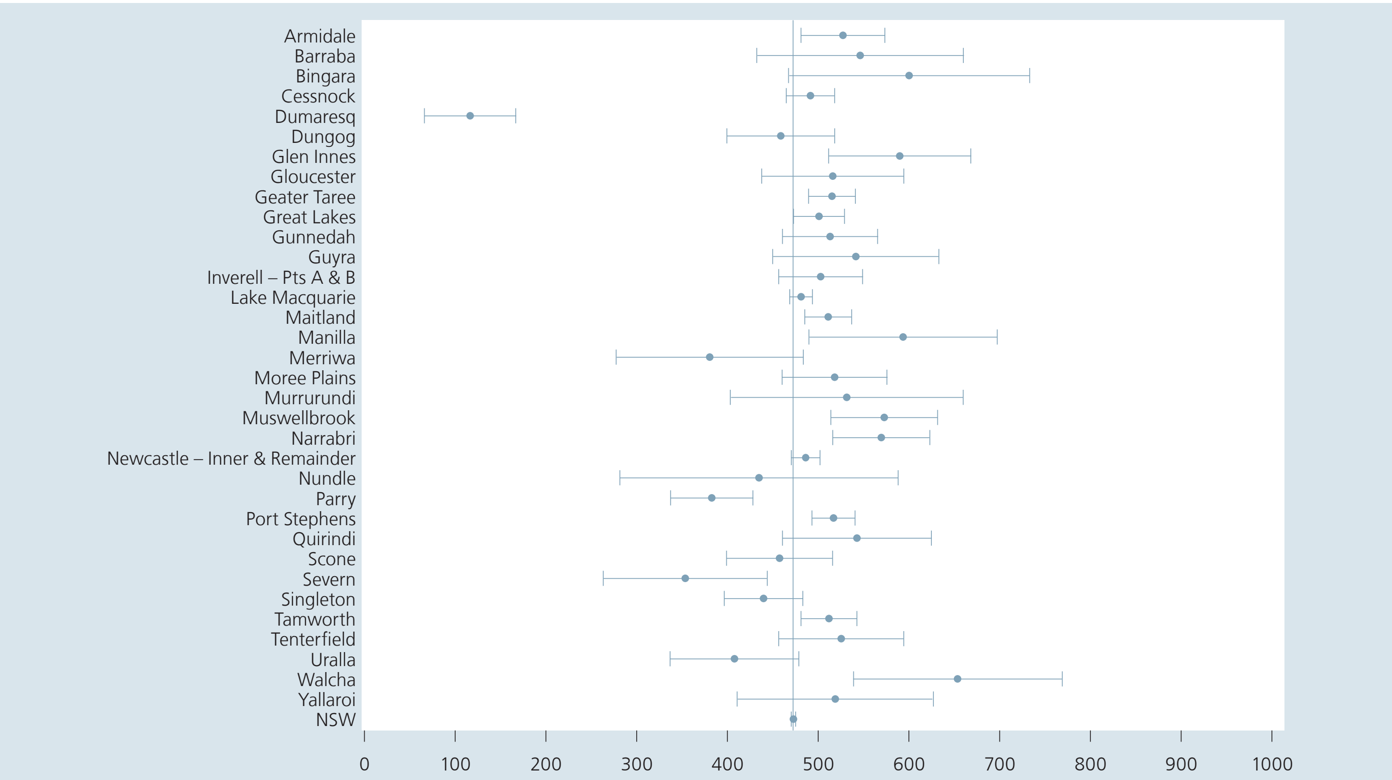


Figure 29. All cancers: incidence rates (2004-2008) and death rates (2003-2007) by Hunter New England Area Health Service cluster, Hunter New England Area Health Service and NSW

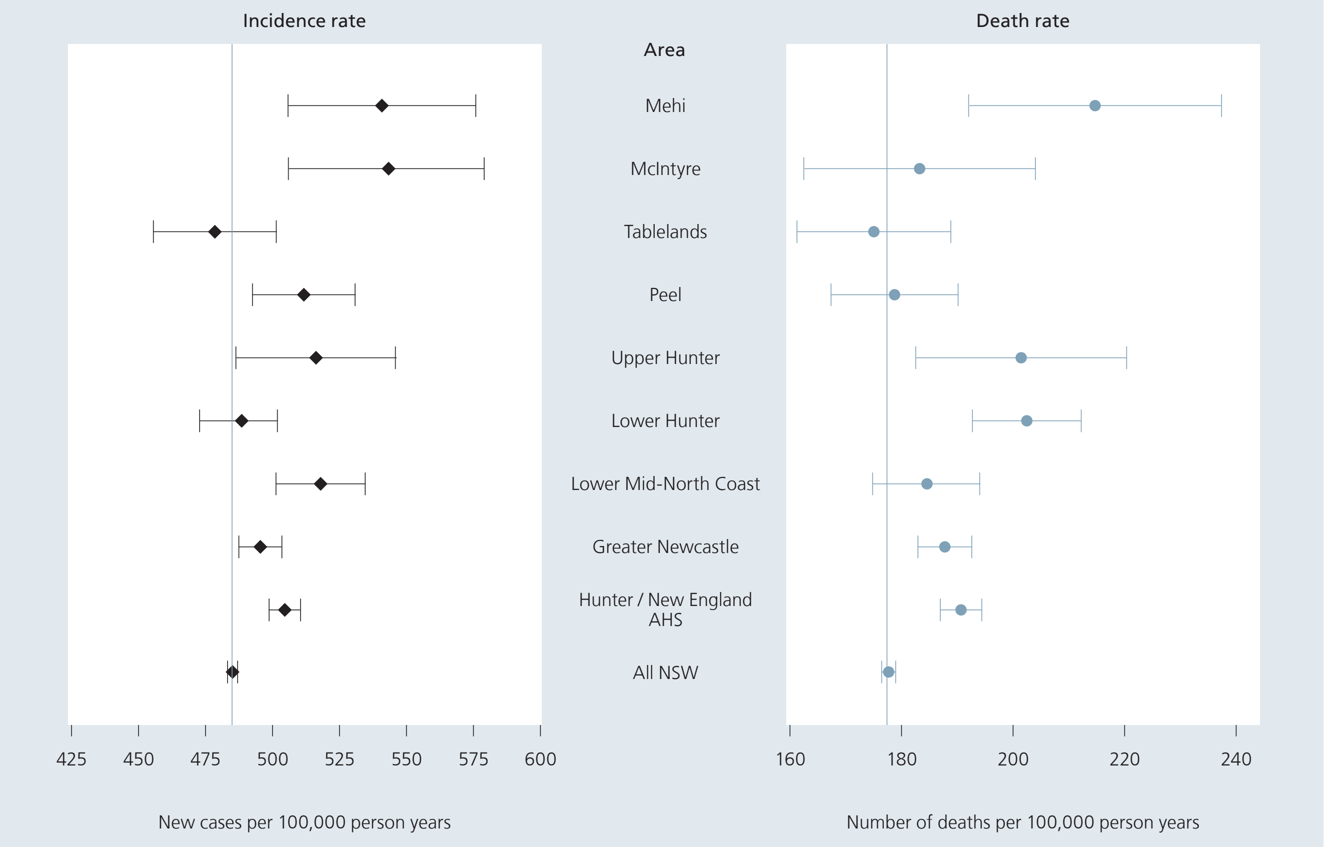


Figure 30. All cancers: incidence rates (2004-2008) in males and in females by Hunter New England Area Health Service cluster, Hunter New England Area Health Service and NSW

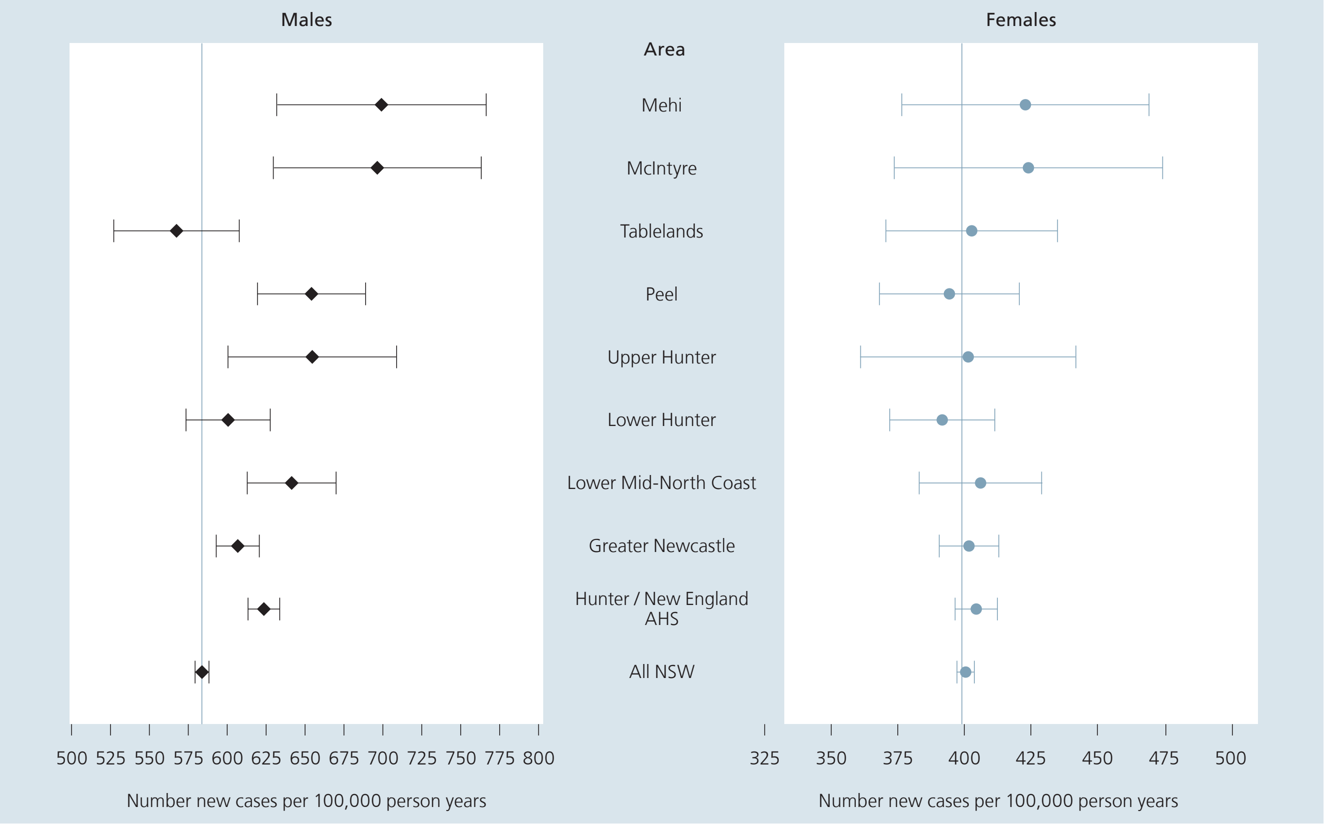


Figure 32. Cancer incidence by site (people) in Hunter New England Area Health Service, 2003-2007

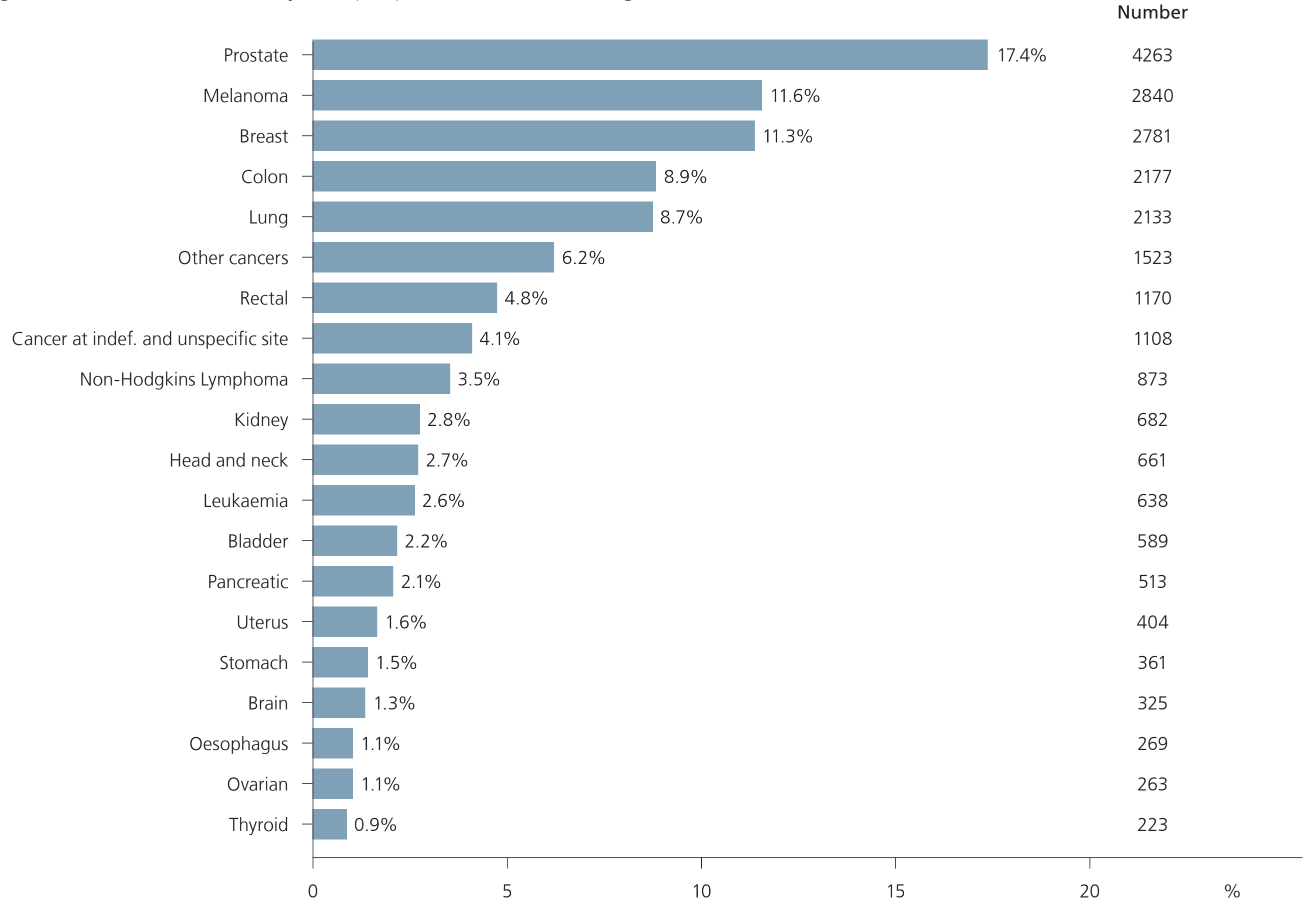


Figure 33. Cancer incidence by site (males) in Hunter New England Area Health Service, 2003 – 2007

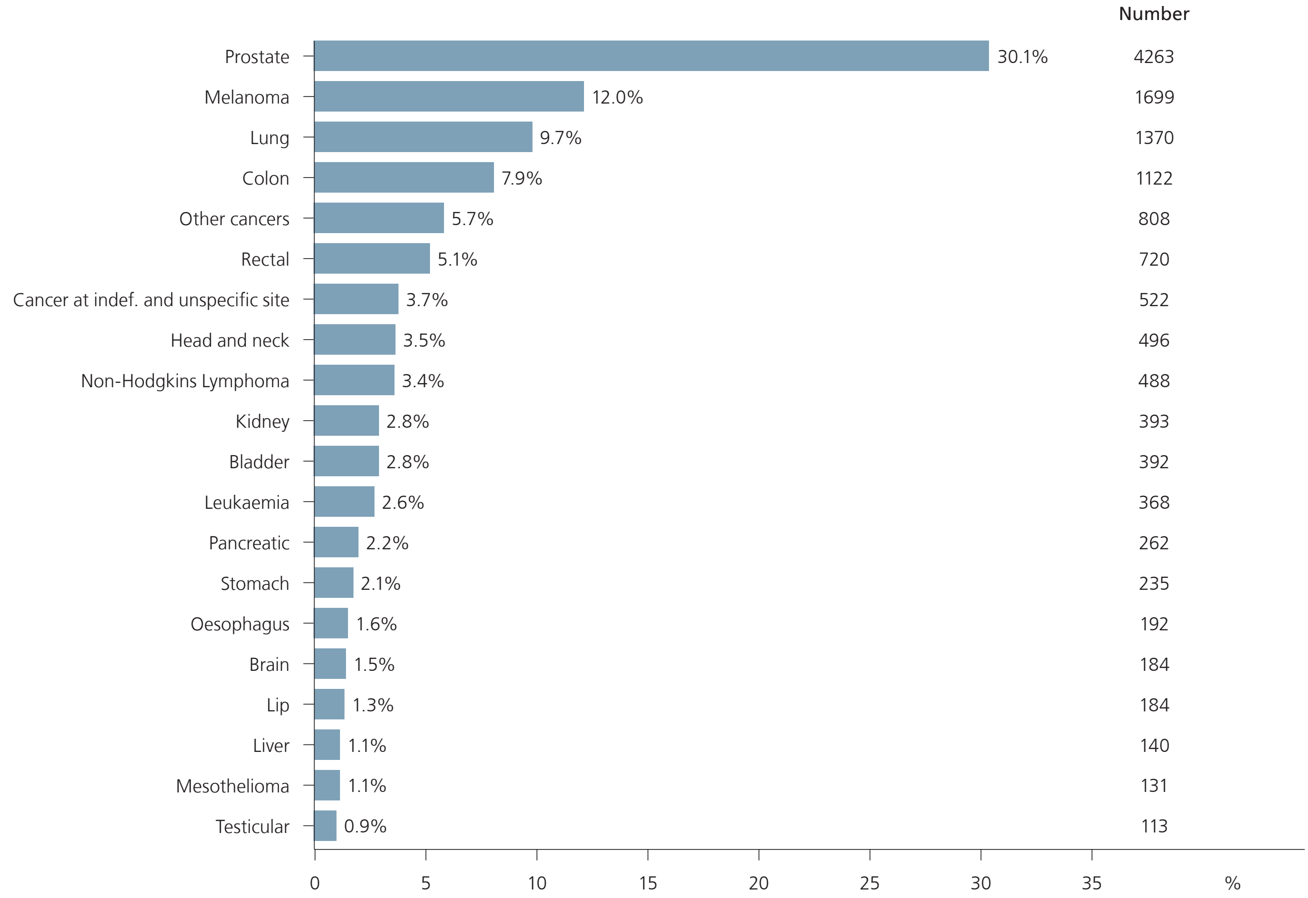


Figure 34. Cancer incidence by site (females) in Hunter New England Area Health Service, 2003 – 2007

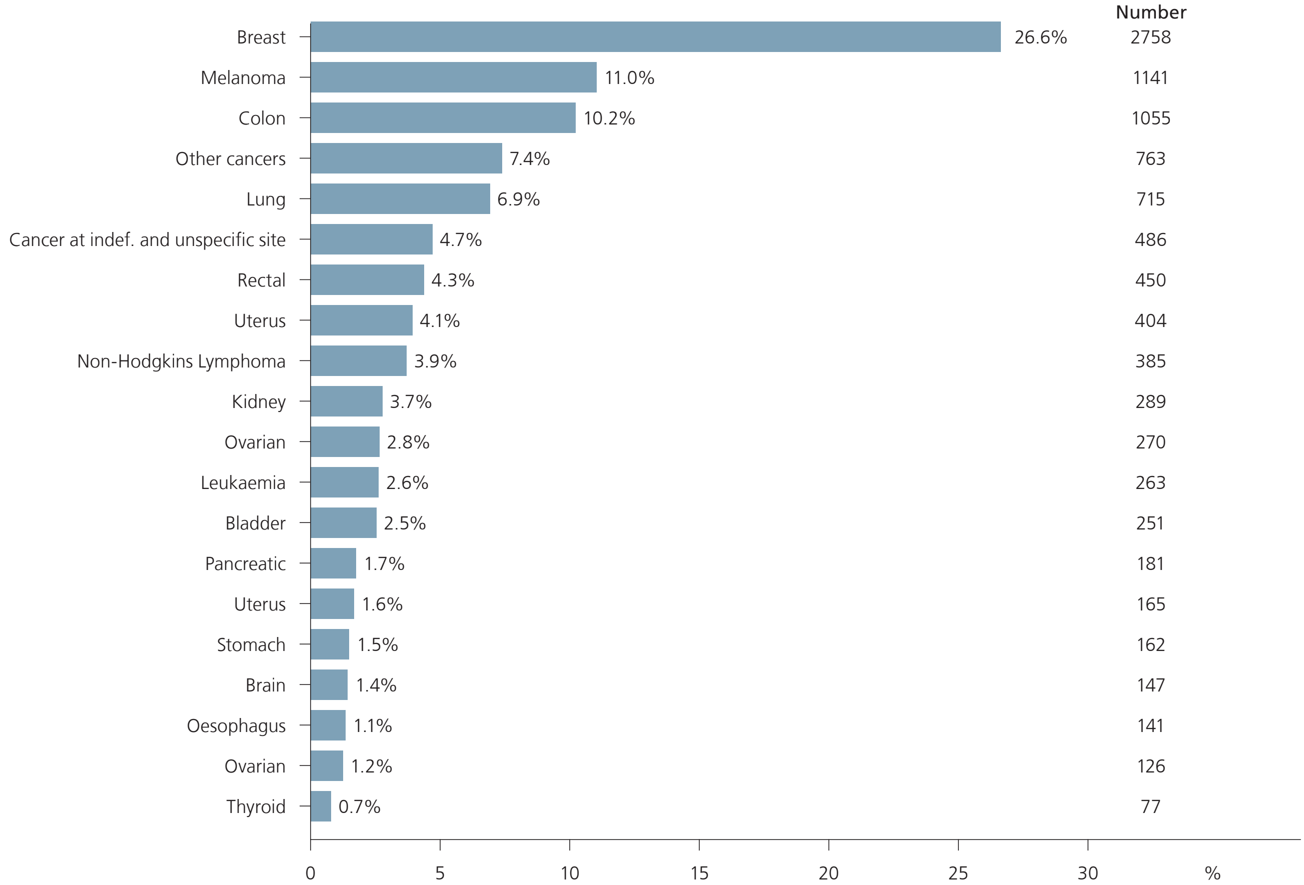


Figure 35. Cancer deaths by site (all people) in Hunter New England Area Health Service, 2003 – 2007

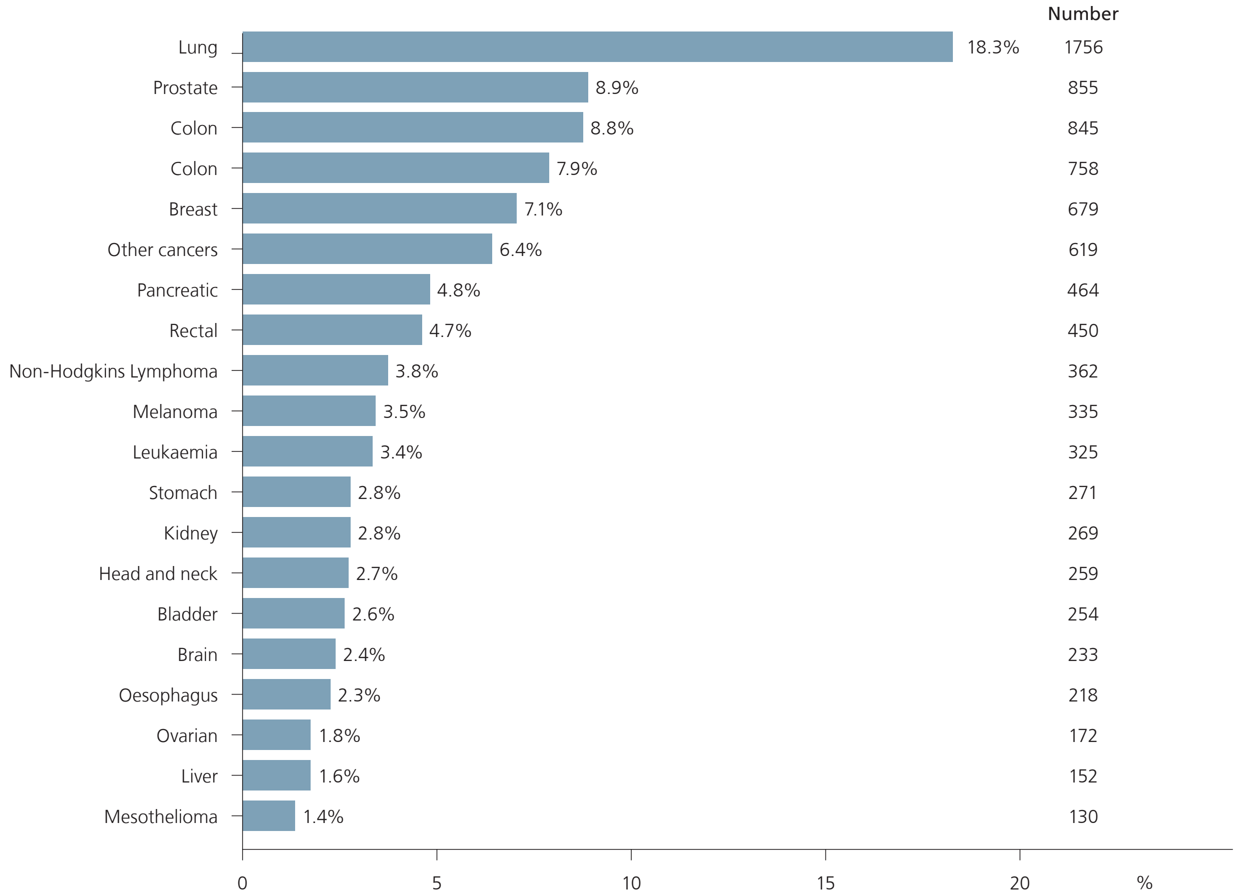


Figure 36. Lung cancer incidence rates (2004-2008) and death rates (2003-2007) by Hunter New England Area Health Service and Hunter New England Area Health Service clusters and NSW 2007

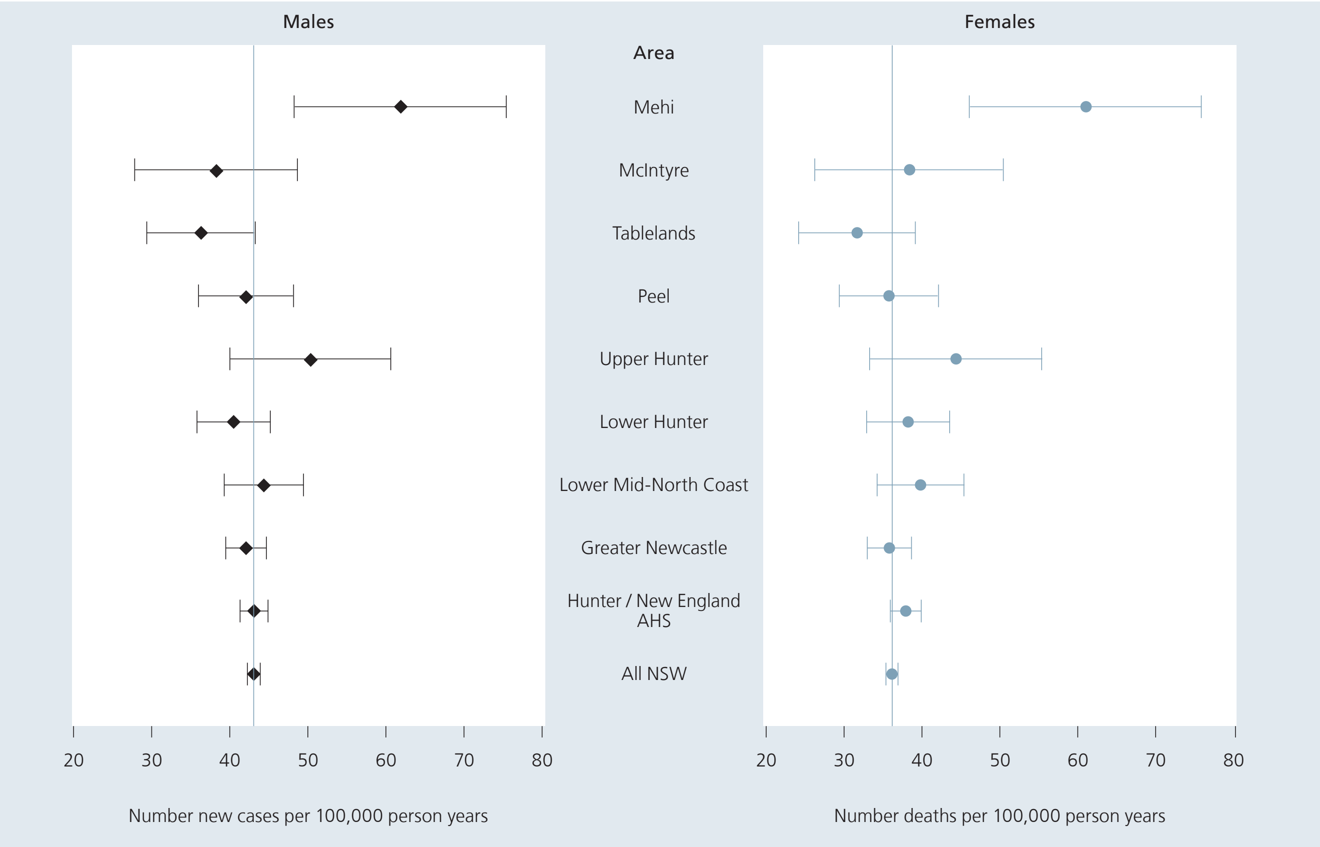


Figure 37 Number of new cases of lung cancer by NSW, Hunter New England Area Health Service and Hunter New England Area Health Service clusters and sex, 2004-2008

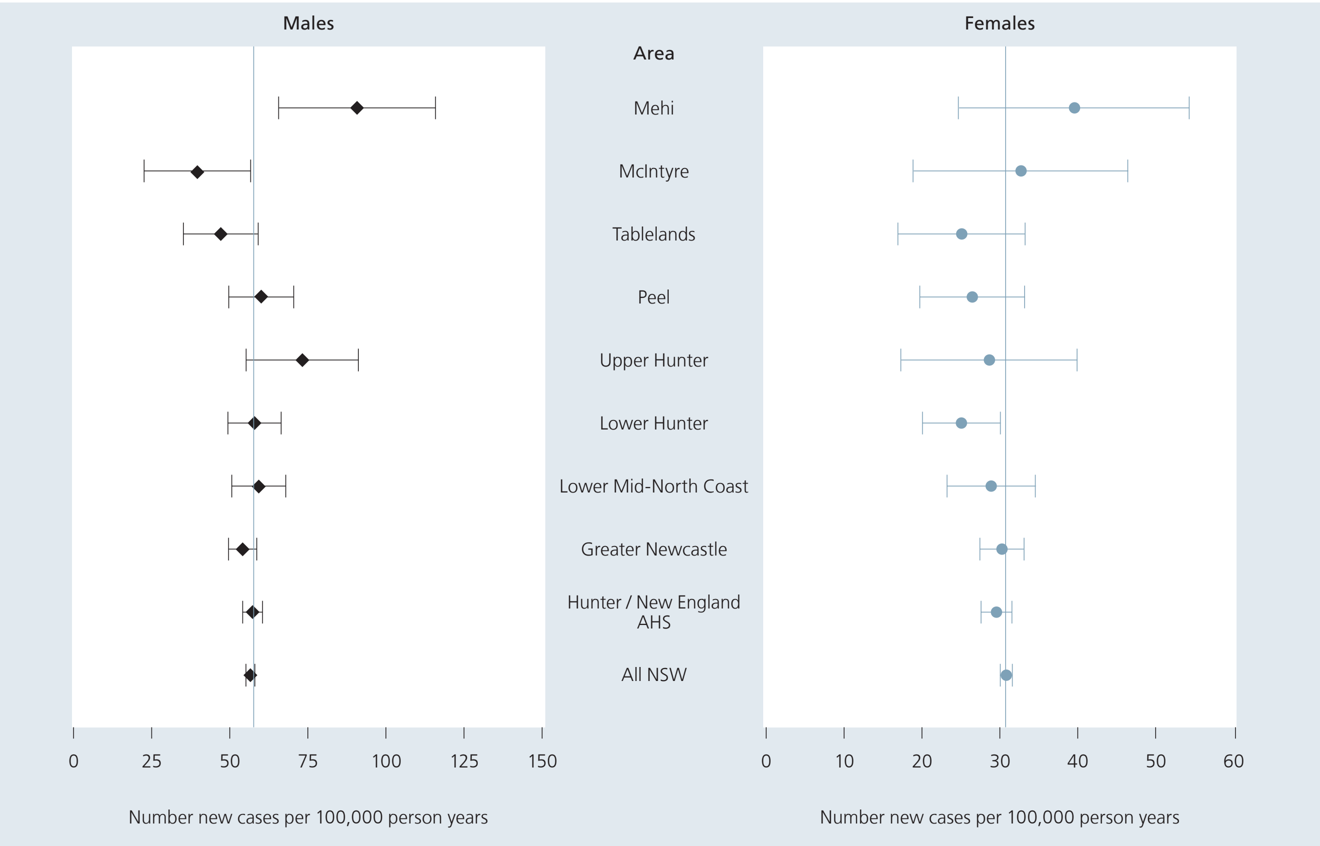


Figure 38. Location of coal mining and power stations and incidence of lung cancer by Hunter New England Area Health Service cluster, 2004-2008

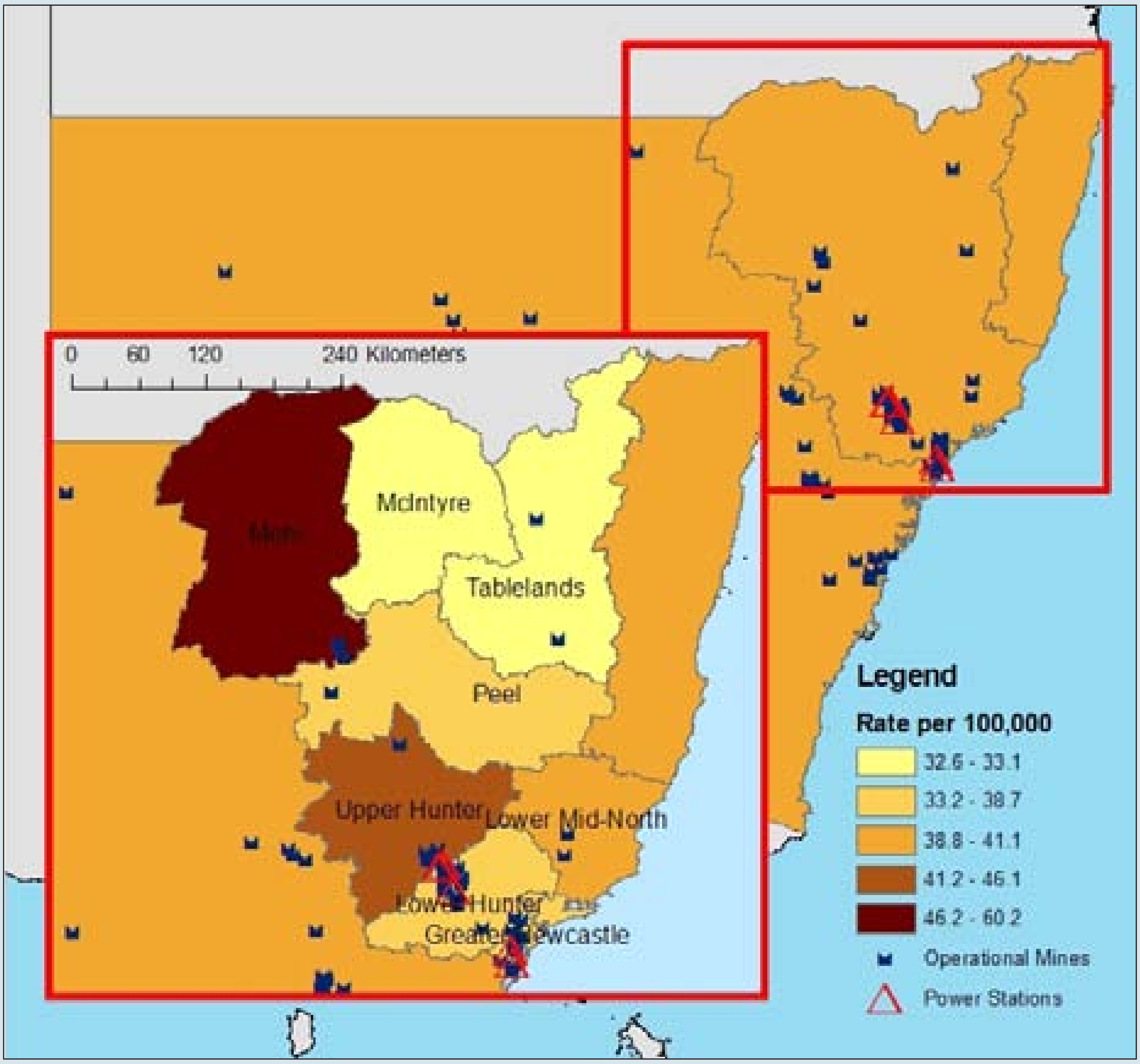


Figure 40. Colorectal cancer: incidence rates (2004-2008) and death rates (2003-2007) by NSW, Hunter New England Area Health Service and Hunter New England Area Health Service clusters

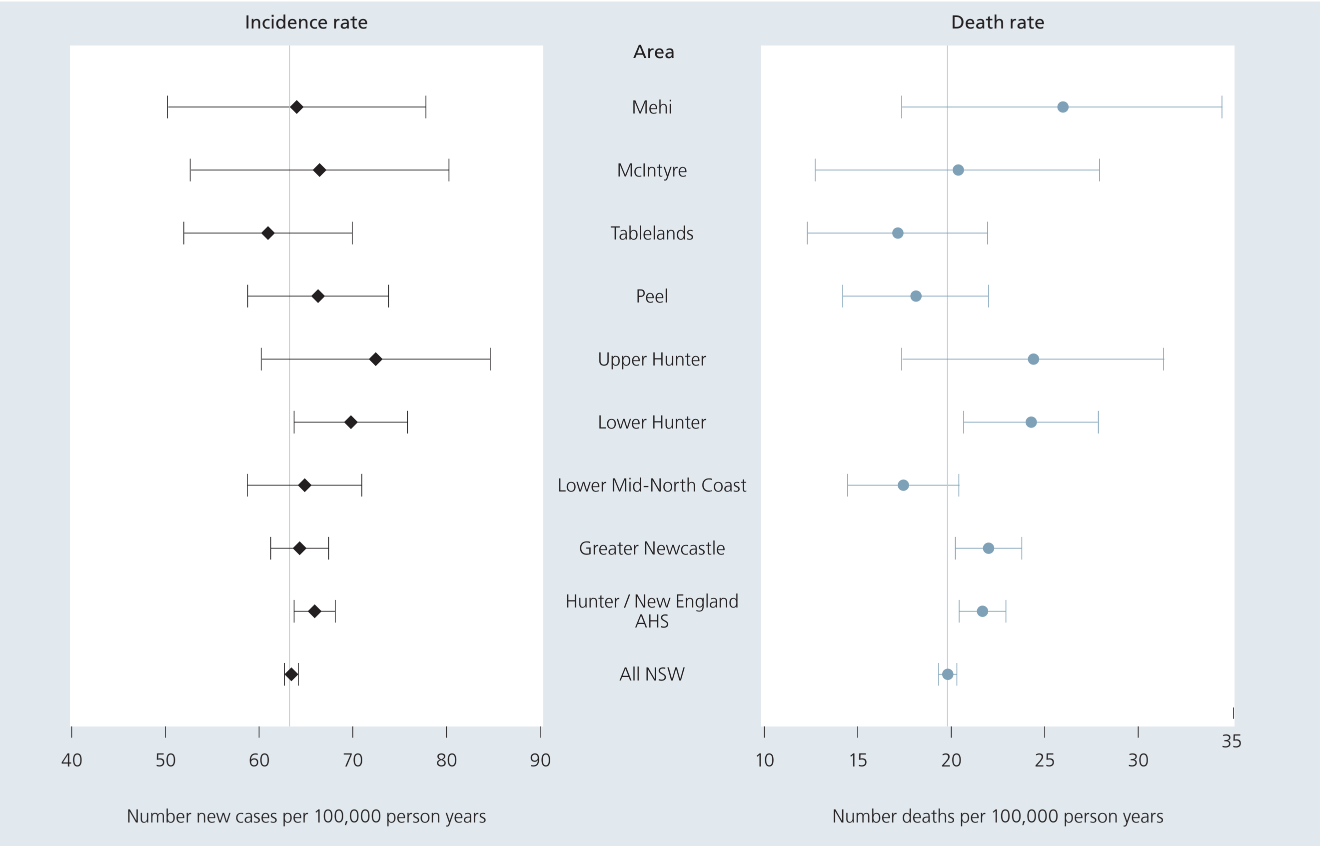


Figure 41. Prostate cancer: incidence rates (2004-2008) and death rates (2003-2007) by NSW, Hunter New England Area Health Service and Hunter New England Area Health Service clusters 2007

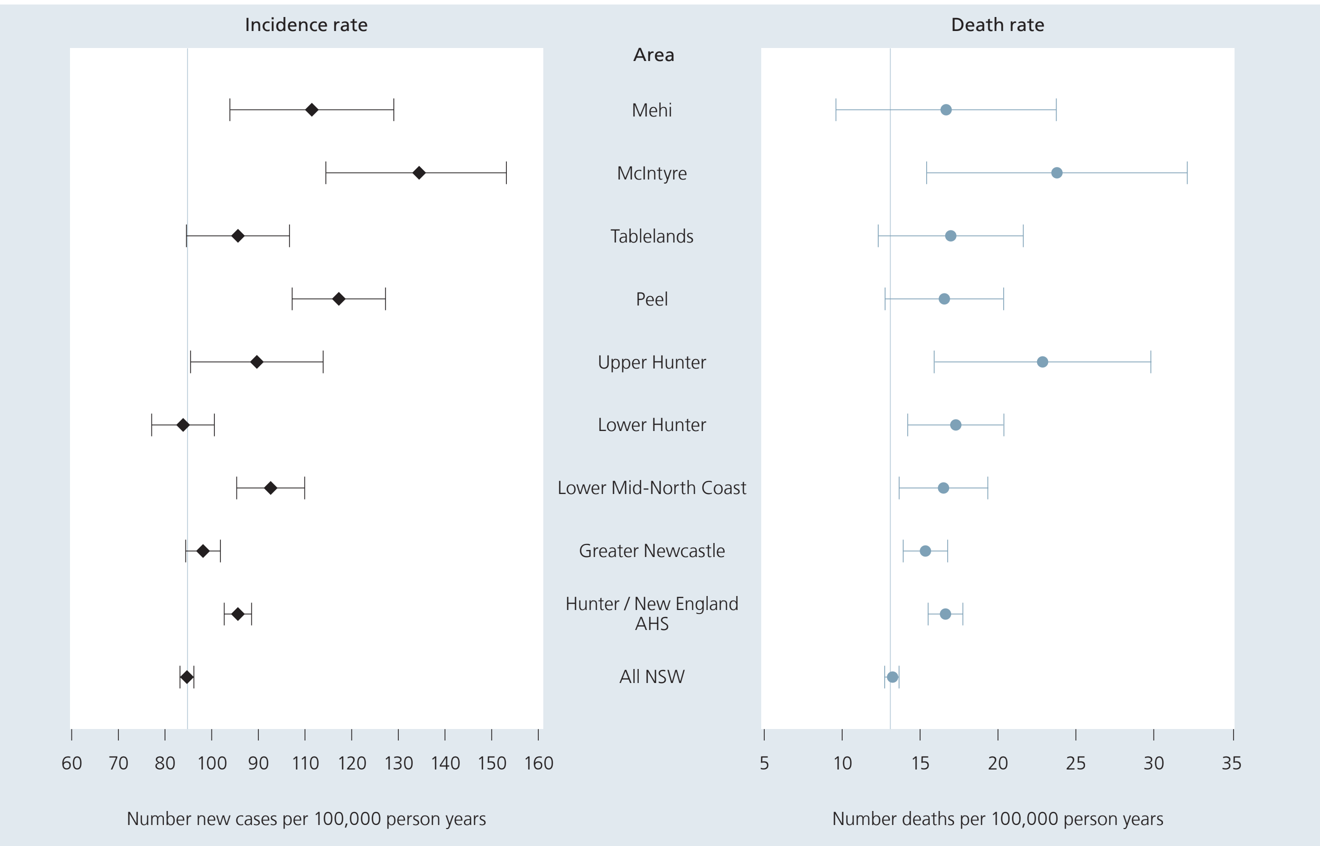
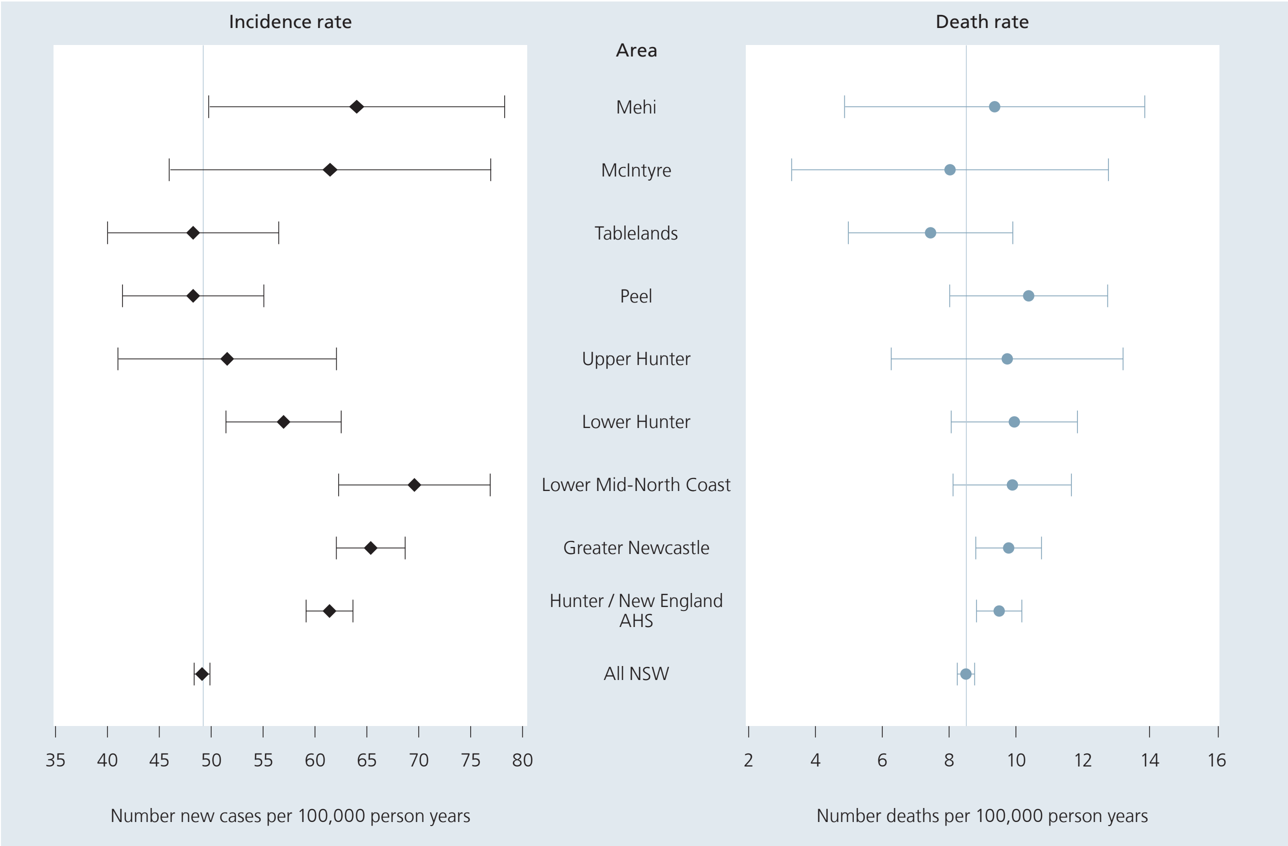


Figure 42. Melanoma: incidence rates (2003-2007) and death rates (2002-2006) by NSW, Hunter New England Area Health Service and Hunter New England Area Health Service clusters



SECTION 7

Drinking water quality

Key point

- The drinking water supplies for the towns near extensive open-cut mining and power generation activities are of comparable quality to that of other rural town water supplies.

Background

Water utilities in the Hunter Valley monitor the quality of public drinking water supplies under programs approved by NSW Health. Hunter Water Corporation (which in the Hunter Valley supplies the Maitland, Cessnock and Dungog local government areas) monitors drinking water for a comprehensive range of microbial and chemical characteristics as a requirement of the Operating Licence and Memoranda of Understanding with NSW Health.

In the Muswellbrook, Singleton and Upper Hunter local government areas, local Councils are responsible for the public drinking water supplies. NSW Health oversees these water supplies through the NSW Health Drinking Water Monitoring Program.

The *Australian Drinking Water Guidelines* published by the National Health and Medical Research Council (NHMRC) serve as the model of best practice for all water utilities in NSW. The guidelines provide a risk management framework for drinking water supply systems, which includes a multiple barrier catchment-to-tap approach. They include guideline values for microbiological, physical and chemical characteristics that affect health or the quality of drinking water, and recommend that drinking water supplies be monitored regularly for *Escherichia coli* bacteria, which is an indicator of faecal contamination. The *NSW Health Drinking Water Monitoring Program* specifies the minimum numbers of samples that should be taken based on the size and complexity of water supply systems, and in accordance with the NHMRC guidelines. In the Hunter Valley, the larger towns are tested for chemical quality each month and the smaller towns are tested every 6 months. Tests are carried out by accredited laboratories.

The drinking water supplies are tested for a range of chemicals including aluminium, arsenic, barium, boron, cadmium, calcium, chloride, chromium, copper, cyanide, iodide, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, nitrite, selenium, silver, sodium, sulphate and zinc.

Findings

In the Maitland, Cessnock and Dungog local government areas (supplied by Hunter Water Corporation), the drinking water supplies regularly comply with the *Australian Drinking Water Guidelines* for health-related chemicals.

In the Muswellbrook, Singleton and Upper Hunter local government areas, the towns that are monitored are Muswellbrook, Denman, Sandy Hollow, Singleton/Mount Thorley, Jerrys Plains, Scone, Aberdeen, Cassilis, Merriwa and Murrurundi.

An examination of test results since 2001 demonstrates that the monitored towns in the Muswellbrook, Singleton and Upper Hunter local government areas comply with the *Australian Drinking Water Guidelines* for health-related chemicals. Over this period, in 2001 one sample (out of 109) from Singleton was found to contain moderately elevated nitrate. This may have been due to a natural occurrence in the source water. In 2005 and 2006, two samples (out of 13) from Jerrys Plains were found to contain elevated lead. This is most likely to due to corrosion of domestic plumbing. In 2002, one sample (out of 20) from Sandy Hollow was found to contain elevated manganese. This was most likely due to a natural occurrence in the source water. All subsequent samples have complied with the guidelines.

These findings are consistent with statewide trends. A recent review of drinking water quality across regional NSW found that, over a 7 year period, 20.5% of public water supply systems (66/322) had at least one health-related chemical characteristic with 95th percentile test results greater than the guideline values. The majority of the non-compliant supply systems had only one non-compliant health-related characteristic.

NSW Health does not routinely monitor the quality of domestic rainwater tanks.

Commentary

Evidence of health effects of air pollution from the published literature

There is convincing evidence from the literature for a link between exposure to particulate matter and adverse health outcomes. Particulate air pollution is consistently and independently related to serious health effects, including lung cancer and other cardiopulmonary mortality (Cohen, 2005). Findings from the WHO global burden of disease comparative risk assessment estimate that ambient air pollution, in terms of fine particulate air pollution (PM2.5 – particulate matter less than 2.5 microns in diameter), causes about 3% of mortality from cardiopulmonary disease and about 5% of mortality from cancer of the trachea, bronchus and lung (Cohen, 2005). It is estimated that each 10-µg/m3 elevation in fine particulate air pollution has been associated with approximately a 6% increased risk of lung cancer mortality (Pope, 2002).

Table 1, *Health effects of particulate matter*, presented in Appendix A, summarises the magnitude of these health effects. The concentration response functions (a measure of increased risk for a given increase in exposure) for $PM_{2.5}$ and long-term deaths are from Pope et al (Pope et al, 2002). These concentration response functions have been used in recent reports (US EPA, 2004; AEA Technology Environment, 2005; UK DEFRA, 2006),and are also recommended by the US Environmental Protection Agency (US EPA, 2006) for use in a cost-benefit analysis and by the UK Department of Health (UK Department of Health, 2009).

There are no published Australian cohort studies on the association between particulate matter and long-term deaths.

Association between $PM_{2.5}$ and cardiovascular disease hospital admissions

The risk estimates presented are from Moolgavkar et al (1.4% increase for 18-64 years and 1.6% increase for 65+ years for a 10 µg/m3 increase in $PM_{2.5}$) (Moolgavkar, 2000; Moolgavkar, 2003). The risk estimates from the study of short-term health effects of air pollution on daily mortality in four Australian cities (Brisbane, Melbourne, Perth and Sydney) (5.1% increase for a 10-µg/m3 increase in $PM_{2.5}$) (Simpson et al, 2005) and the study of the associations between outdoor air pollution and cardiovascular hospital admissions for elderly people living in seven cities in New Zealand and Australia (13.7% increase for a 10-µg/m3 increase in $PM_{2.5}$) (Barnett et al, 2006) are considerably higher than those of Moolgavkar et al. The authors of the four cities study considered their results indicative only, due to the small number of cities included in the analysis (Simpson et al, 2005).

Effects of PM_{10} and hospital admissions for respiratory disease

The WHO concentration response functions are presented (RR = 1.008%, 95%CI = 1.0048-1.0112; all ages, for a 10-µg/m3 increase in PM_{10}) (World Health Organization, 2000). In a previously published cost-benefit analysis of air pollution, the percentage change in respiratory hospital admissions for a 10-µg/m3 change in PM_{10} has ranged from 0.8% (NSW DEC, 2005; UK DEFRA, 2006) to 2.28% (Fisher et al, 2005).

In Australia, the four cities study reported an increase in respiratory disease admissions in those 65 years and over of 2.9% and the authors considered the results indicative only (Simpson et al, 2005), whereas Morgan et al in a recent study reported a 1% increase in respiratory disease hospital admissions for all ages for a 10-µg/m3 increase in PM_{10} (Morgan et al, 2010).

This report: Hunter New England Area Health Service

This report contains the most current, available, routinely collected health information about the residents of the Hunter Valley who may be exposed to air pollution from coal-mining activities or power station emissions. It contains information about respiratory diseases, asthma, cardiovascular diseases incidence and deaths and cancer incidence and deaths for the Hunter New England Area Health Service (HNEAHS), by smaller geographical category (HNEAHS clusters, local government areas or postcode areas) where available. It is not possible for this report to assess the health effects of exposure to pollutants, as the pollutant exposure levels for the population are not available. This report provides information about relevant health outcomes by geographical category only, at the level of HNEAHS cluster, local government area and postcode.

Findings

Respiratory disease including asthma

The death rate from respiratory disease for HNEAHS is no different from that for NSW. However, there are parts of HNEAHS with higher rates, most evident among males in Mehi and McIntyre. Neither cluster is exposed to significant coal mine and power generation emissions, but both clusters have (not statistically significant) higher smoking rates.

The death rate from asthma in the HNEAHS is comparable to that for NSW, while the rate of hospital separations for asthma in HNEAHS is lower than that for the rest of NSW. However, there is variation by local government area. There is a difference in asthma separation rates between Muswellbrook and Singleton, the two local government areas that contain the greatest concentration of open-cut coal mines and coal-fired power stations.

While Muswellbrook local government area has higher asthma separation rates, Singleton local government area has lower asthma separation rates than NSW. Emergency department presentations for asthma and respiratory disease are higher in Muswellbrook for all age groups. In Singleton, asthma presentations for children aged less than 15 years and adults aged over 65 years were similar to those for NSW, although respiratory disease presentation rates for all ages and asthma presentation rates for those aged 15 to 64 years were higher than those for NSW. However, emergency department presentations for conditions not known to be associated with air pollution are also high for both Singleton and Muswellbrook local government areas.

The self-reported asthma rate among adults is similar in HNEAHS to that for NSW. HNEAHS has a higher rate of asthma reported by parents/carers of children aged less than 15 years than that reported by parents and carers of children less than 15 years in NSW. This reported asthma rate is higher both in those local government areas that contain the greatest concentration of open-cut coal mines and power stations, and also in local government areas containing few or no such industries.

Cardiovascular disease

The death rate from cardiovascular disease is higher in HNEAHS than it is in NSW . The highest rates occur in Mehi and the Lower Hunter for both males and females. The higher rates of cardiovascular disease deaths in Mehi are consistent with the higher smoking rates reported in that cluster. This cluster has the highest proportion of Aboriginal residents, and the Narrabri local government area contains several open-cut mines. However, the cardiovascular disease death rate differs between those clusters with extensive open-cut mining and power generation activities, being higher in the Lower Hunter cluster and lower in the Upper Hunter cluster than the cardiovascular disease death rate for NSW.

Overall, the rate of hospital separations for cardiovascular disease in HNEAHS is comparable with that for the rest of NSW. Singleton and Muswellbrook, the local government areas with extensive open-cut mining and power generation activities, and the Cessnock and Narrabri local government areas with some open-cut mining activity, have higher rates of cardiovascular disease separations from hospital than HNEAHS or NSW as a whole.

Cancer

Cancer incidence and mortality are higher in HNEAHS than for NSW. The higher rates are primarily due to higher rates of prostate cancer, colorectal cancer and melanoma in HNEAHS compared with the whole of NSW. None of these cancers is known to be associated with air pollution. The higher rates for these cancers are distributed across most of the clusters in HNEAHS, including clusters both with and without open-cut mining or power generation activities.

The only cancer known to be associated with air pollution, lung cancer, has incidence and death rates in HNEAHS similar to those for NSW. The only part of HNEAHS with higher incidence and death rates for lung cancer is Mehi. This cluster has higher (but not statistically significantly) smoking rates than HNEAHS overall, but relatively little coal mining or power generation activity. There was, though, a higher (but not statistically significantly higher) rate of lung cancer in men in Upper Hunter, but this was not present in women in Upper Hunter or in men or women in Lower Hunter.

While the open-cut mining activity had expanded six-fold during the thirty years to 2008, there was no evidence of an increasing lung cancer death rate in HNEAHS from 2000 to 2008.

Self-reported health

Self-reported health has been found to be a valid indicator of an individual's overall health. There is no difference in self-rated health between residents of HNEAHS and NSW, or between residents in any of the areas within HNEAHS.

Overall deaths

The death rate from all causes in HNEAHS is higher than NSW. This is primarily a result of higher rates of cancer and cardiovascular disease.

Conclusions from the data

Compared to the rest of NSW, one or both of Upper Hunter and Lower Hunter, the geographical regions of HNEAHS that are most affected by open-cut coal mining and power generation activities, have higher rates of:

- emergency department attendance for asthma and respiratory disease (but also for all other conditions, which may indicate a general tendency to greater use of emergency departments in these regions),
- hospital admission for all respiratory conditions together and for asthma (Upper Hunter Only)
- hospital admission for cardiovascular disease and
- death from all causes and cardiovascular disease (lower Hunter only).

These data may indicate an adverse health effect due to exposure to coal mining or coal-fired power generation activities in HNEAHS, or may be due to other factors (such as smoking, for example, which is higher in adults in Upper Hunter, although not statistically significantly higher). Thus they do not establish that these adverse health effects are attributable to air pollution or to any other specific exposure.

Further investigation is required to determine the role of pollutant exposures. Once the level and distribution of exposure to pollutants from coal mining and power generation is established, any health effects resulting from these pollutant exposures can be assessed. Other recognised disease risk factors, such as smoking, poor diet, lack of exercise, occupational hazards and lack of effective use of self-management strategies should also be considered as possible contributors to the poorer health of residents of some areas of HNEAHS.

Next steps

The review of the data presented in this report highlights certain areas where recommendations can be made to improve the type of information available and more accurately assess the potential risks for those living close to open-cut coal mines and power stations.

Most notably, there is an urgent need to establish appropriate air quality monitoring in population centres to more accurately assess the community's cumulative exposures to pollutants from coal mines and coal-powered electrical power stations. NSW Health will work with the Department of Environment, Climate Change and Water (DECCW) to ensure the monitoring is appropriate for assessing health risks to most of the population living around these coal and power-generation industries. Given the already established risks for health with increased exposure to particulate matter, an estimate of the burden of disease for those living in these areas can be reasonably made once the exposure information is available. Given the already established risks for health with increased exposure to particulate matter, an estimate of the burden of disease for those living in these areas can be reasonably made once the exposure information is available.

NSW Health is convening an independent panel to provide advice on health issues associated with air pollution. Professor Guy Marks from the Woolcock Institute will lead this initiative. The panel will consist of scientists from the fields of medicine, epidemiology and toxicology with other experts from air modelling and other related fields to be included when required. This report will be considered by the panel and will inform some of the panel's consideration on health issues associated with air pollution.

Companion report

The Department of Environment, Climate Change and Water (DECCW) has prepared a detailed compendium of the air pollution measures obtained from individual mine monitors in the Hunter Valley, which will be released in conjunction with this report.

References

AEA Technology Environment. *Service contract for carrying out cost-benefit analysis of air quality related issues, in particular in the clean air for Europe (CAFE) Programme.* Oxon, UK: AEA Technology Environment, 2005.

Altman DG, Machin D, Bryant T, Gardner S, editors. *Statistics with confidence: confidence intervals and statistical guidelines*, 2nd Edition. London: Br Med J Books, 2000.

Australian Institute of Health and Welfare. *Australia's health* 2008. Cat. no. AUS 99. Canberra: AIHW, 2008. Available at: http://www.aihw.gov.au/publications/index.cfm/title/10585 (accessed 20 April 2010).

Australian Government. *Air quality standards.* Available at: http://www.environment.gov.au/atmosphere/airquality/standards.html (accessed 20 April 2010).

Barnett AG, Williams GM, Schwartz J, Best TL, Neller AH, Petroeschevsky AL, et al. *The effects of air pollution on hospitalisations for cardiovascular disease in elderly people in Australian and New Zealand cities.* EnvironHealth Persp 2006;114:1018-23.

Cohen AJ, Ross Anderson H, Ostro B, Pandey KD, Krzyzanowski M, Künzli N, et al. *The global burden of disease due to outdoor air pollution.* J Toxicol Environ Health A. 2005;68(13-14):1301-7.

Fisher G, Kjellstrom T, Woodward A, Hales S, I. Town I, Sturman A, et al. *Health and Air Pollution in New Zealand: Christchurch Pilot Study, Health Research Council, Ministry for the Environment, Ministry of Transport, New Zealand,* 2005. Available at: http://www.hapinz.org.nz/HAPINZ%20Report%20-%201%20Sept%202005.pdf (accessed 26 April 2010).

Moolgavkar SH. *Air pollution and hospital admissions for diseases of the circulatory system in three U.S. metropolitan areas.* J Air Waste Manag Assoc 2000;50(7):1199-206.

Moolgavkar SH. *Air pollution and daily deaths and hospital admissions in Los Angeles and Cook counties. Revised analyses of time-series studies of air pollution and health.* Special report. Boston: Health Effects Institute, 2003.

Morgan G, Sheppeard V, Khalaj B, Ayyar A, Lincoln D, Jalaludin B, et al. *The effects of bushfire smoke on daily mortality and hospital admissions in Sydney, Australia, 1994 to 2002*. Epidemiology 2010;21:47-55.

National Health and Medical Research Council. *Australian Drinking Water Guidelines 6*, 2004. Available at: http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/adwg_11_06.pdf (accessed 2 April 2010).

NSW Department of Environment and Conservation. *Air pollution economics: health costs of air pollution in the greater Sydney metropolitan region.* Sydney, Department of Environment and Conservation, 2005.

NSW Health. *The health of the people of New South Wales. Report of the NSW Chief Health Officer.* Sydney, Department of Health, 2008. Available at: http://www.health.nsw.gov.au/publichealth/chorep/toc/choindex.asp (accessed 20 April 2010).

Pope CA III, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, et al. *Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution.* J Am Med Assoc 2002;87(9):1132-41.

Simpson R, Williams G, Petroeschevsky A, Best T, Morgan G, Denison L, et al. *The short-term effects of air pollution on daily mortality in four Australian cities.* Aust NZ J Pub Health 2005;29:205–12.

Simpson R, Williams GM, Petroeschevsky A, Best T, Morgan G, Denison L, et al. *The short-term effects of air pollution on hospital admissions in four Australian cities.* Aust NZ J Pub Health 2005;29(3):213-21.

Spix C, Anderson HR, Schwartz J, Vigotti MA, LeTertre A, Vonk JM, et al. *Short-term effects of air pollution on hospital admissions of respiratory diseases in Europe: a quantitative summary of APHEA study results. Air Pollution and Health: a European Approach.* Arch Environ Health 1998;53(1):54-64.

Touloumi G, Katsouyanni K, Zmirou D, Schwartz J, Spix C, de Leon AP, et al. *Short-term effects of ambient oxidant exposure on mortality: a combined analysis within the APHEA project. Air Pollution and Health: a European Approach.* Am J Epidemiol 1997;146(2):177-85.

UK Department for Environment, Food and Rural Affairs. *An economic analysis to inform the air quality strategy review consultation.* London: Department for Environment, Food and Rural Affair, 2006.

United Kingdom Department of Health. *Committee on the medical effects of air pollutants. Long-term exposure to air pollution: effect on mortality.* London: Department of Health, 2009.

United States Environmental Protection Agency. *Final regulatory analysis: control of emissions from nonroad diesel engines.* Washington, DC: United States Environmental Protection Agency, 2004.

United States Environmental Protection Agency. *Regulatory impact analysis. National Ambient Air Quality Standards for particle pollution.* North Carolina: Research Triangle Park, 2006.

World Health Organization. *Air quality guidelines for Europe*, Second edition. Copenhagen: World Health Organization Regional Office for Europe, 2000.

World Health Organization. *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide.* Global update 2005. Summary of risk assessment. Available at: http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf (accessed 20 April 2010).

Glossary of terms

The Admitted Patient Data Collection (APDC)	The Admitted Patient Data Collection (APDC) formerly the Inpatient Statistics Collection) is administered by the NSW Department of Health. It is a census of all admitted patient services provided by NSW Public and Private Hospitals. The purpose of the collection is to plan health services, track indicators of health status, and provide statistical information to monitor the use of NSW hospital services.
Age-adjusted or age-standardised rates	A commonly used procedure for adjusting rates, e.g. death rates. This minimises the effects of differences in age. Taking into account different age groups of a population allows valid comparison of data between two communities.
Ambient air pollition	This term relates to outdoor air pollution.
CATI	Computer Assisted Telephone Interviewing
Cluster	Service delivery administrative regions within Hunter New England Area Health Service
Confidence interval (CI)	An indication of the precision of an estimate. A 95% CI is typical; it is the range of values within which, 95% of the time, the true value would fall. Wider intervals indicate lesser precision; narrow intervals indicate greater precision (see Presentation of data including data type, source and presentation p 5).
Concentration response function (CRF)	A measure of increased risk for a given increase in exposure
ED	Emergency department
Hospital separations	The number of people who leave a hospital either through a completed procedure, discharge or death
HNEAHS	Hunter New England Area Health Service
Incidence	The number of new cases of disease occurring during a defined time period
ICD-10-AM codes	The international statistical classification of diseases and related health problems, 10th revision, Australian modification
Local government area	An administrative division of NSW for which a local government is responsible
Morbidity	Illness from a particular disease
Mortality	Death from a particular disease or injury

Particulate matter	Fine particles of solid or liquid matter that are suspended, in this instance, in the air. Sources of particulate matter can be manmade or natural.
$PM_{2.5}$	Particulate matter less than 2.5 microns in diameter
PM_{10}	Particulate matter less than 10 microns in diameter
Prevalence	The rate at which existing cases are found at a given point or time period
Standardised incidence ratio (SIR)	The number of cases of the disease in the particular population of interest, divided by the number that would have been expected if the rate of disease was the same as the rate in the general population
Statistical significance	A judgement of whether a finding is sufficiently unexpected statistically that it is unlikely to be due to chance alone. The most common cut-off is 5%, that is, if this result would occur by chance only one in twenty times, it would be considered to be significant.

APPENDIX A

Evidence supporting a link between particulate matter and risk to health

(Introduction)

Table 1. Health effects of particulate matter

Health endpoint	ICD-10 codes*	Concentration response function (for 10 µg/m³ increase in air pollutant) Relative risk (95% confidence interval)		
		PM_{10}	$PM_{2.5}$	Ozone
Deaths				
Long-term deaths** (age 30+ years)	All ICD-10 codes A00-Z99		1.06 (1.02-1.11) (Pope et al, 2002)	
Short-term all non-trauma deaths*** (all ages)	A00-R99			1.0046 (1.0028-1.0066) (Touloumi et al, 1997)
Hospitalisations				
Cardiovascular disease (age 15-64 years)	I00-I52		1.0141 (1.0074-1.0208) (Moolgavkar 2000)	
Cardiovascular disease (age 65+ years)	I00-I52		1.0159 (1.0092-1.0227) (Moolgavkar 2003)	
All respiratory disease (all ages)	J00-J99	1.008 (1.0048-1.0112) (World Health Organization 2000)		
All respiratory disease (age 15-64 years)	J00-J99			1.0038 (1.001-1.0066) (Spix et al, 1998)
All respiratory disease (age 65+ years)	J00-J99			1.0062 (1.003-1.0094) (Spix et al, 1998)

*All Concentration response functions (CRFs) are default values from AirQ except PM2.5 health impacts.
**Annual average of particulate matter used for long-term deaths.
***24-h average of particulate matter used for short-term deaths

Limitations of the available data presented in the report

(Presentation of data)

This report provides health information for geographical regions of HNEAHS by clusters, local government areas and postcodes and does not directly compare those living close to coal mining and power generation industries with those living elsewhere in HNEAHS or the state. There are a number of other limitations to the findings presented in this report:

- Data for air pollution levels in most of HNEAHS are unavailable.
- Data regarding exposure to air pollution in the workplace or the home environment are unavailable.
- Smoking rates are by cluster, and while it is known that smoking is associated with a range of health outcomes, the health outcomes for a whole cluster cannot be directly attributed to smoking rates alone.
- Associations between geographical location and health outcomes may be due to a number of individual-related factors, not necessarily environmental factors.
- Data on hospital separations are often used as indicators of morbidity. However, they are imperfect measures as higher and lower rates may reflect not only morbidity but also patterns of health service use.
- While this report does include self-reported data on smoking and asthma, there may be systematic differences in self-reporting, and there may be people who have an undiagnosed condition or choose not to report they smoke.
- Emergency department diagnoses are recorded by busy emergency department staff and not by trained hospital information managers or coders. HNEAHS uses a different computer program from the rest of the state for emergency department patient management database. These factors may lead to variation in the coding of emergency department diagnoses.
- Private hospital emergency departments in Wahroonga and Baulkham Hills within the northern Sydney area do not participate in the NSW Emergency Department Data Collection. Some western Sydney hospitals had reduced diagnosis completeness during the period studied. These factors could reduce the overall Sydney rates by a small but important percentage.
- In 2009, there was an epidemic in Australia caused by the pandemic (H1N1) 2009 influenza virus. This epidemic caused dramatically increased rates of emergency department presentations in NSW for that year. Rates of influenza varied by region. Rates of hospital admissions with confirmed pandemic influenza virus infection were higher in HNEAHS than many parts of Sydney, although rates in western and south western Sydney were similar to HNEAHS. Rates of emergency department presentations for asthma also increased somewhat during that time.
- Rates of emergency department presentations may be strongly influenced by availability of general practitioner services in an area.
- Statistically, many of the health outcomes assessed in this report are uncommon, and the populations being assessed in areas exposed to coal mining and power generation activities are small. These two characteristics will affect conclusions being drawn about whether differences in health outcomes between regions of HNEAHS and between HNEAHS and the state are significant.

Mining in the Hunter New England Area

(Section 1)

Table 9. Number of operating coal mines in the Hunter New England Area, April 2010

Local government area	Coal mines		
	Open-cut	Underground	Combined (open-cut and underground)
Singleton	11	2	4
Muswellbrook	5	-	1*
Cessnock	1	1	1
Lake Macquarie	1	5	-
Wyong**	-	2	-
Gloucester	1	-	-
Great Lakes	1	-	-
Gunnedah	3	-	-
Liverpool Plains	1	-	-
Narrabri	2	1	-
Total	**26**	**11**	**6**

*The combined open-cut and underground coal mine in Muswellbrook local government areas also falls across into boundary of Singleton local government areas. Not included in data set for Singleton local government areas.
**Wyong local government areas mine sites are located outside HNEAHS.
Source: Department of Environment, Climate Change and Water, Environment Protection and Regulation Division, Newcastle Office (April 2010)

APPENDIX D

Supporting tables and figures

(Sections 1-6)

Table 1 appears in Appenxix A.

Table 2. Hunter New England Area Health Service, NSW, estimated total residential population for each cluster and local government area, 2009.

HNEAHS cluster	Local government area	Population
Greater Newcastle	Lake Macquarie	195 479
	Newcastle	153 171
	Port Stephens	67 144
	TOTAL	**415 794**
Lower Hunter	Cessnock	49 751
	Dungog	8 539
	Maitland	69 878
	Singleton	23 747
	TOTAL	**151 913**
Lower Mid North Coast	Gloucester	4 995
	Greater Lakes	35 986
	Greater Taree	47 866
	TOTAL	**88 847**
McIntyre	Inverell	16 169
	Gwydir	5 421
	TOTAL	**21 591**
Mehi	Moree Plain	14 427
	Narrabri	13 454
	TOTAL	**27 881**
Peel	Gunnedah	11 840
	Tamworth	57 066
	Walcha	3 291
	TOTAL	**72 197**
Tablelands	Armidale Dumaresq	24 538
	Guyra	4 404
	Tenterfield	6 812
	Uralla	6 008
	Glen Innes Severn	9 065
	TOTAL	**50 827**
Upper Hunter	Muswellbrook	16 167
	Upper Hunter Shire	13 524
	Liverpool Plains	7 825
	TOTAL	**37 516**
HNEAHS combined	**TOTAL**	**866 566**

Source: Australian Bureau of Statistics, ABS Estimated Resident Population

Table 3. Total estimated residential population by local government area in Hunter New England Area Health Service, 2009.

Local Government Area	Years																	
	00-04	05-09	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 & over	All ages
Cessnock	3244	3462	3649	3507	2859	3074	3100	3380	3346	3346	3575	3285	3074	2131	1561	1300	1017	841	49751
Dungog	534	552	606	633	363	351	434	529	625	666	695	624	573	458	360	217	172	146	8539
Glen Innes Severn	559	594	623	544	366	416	424	494	557	664	657	624	693	554	465	344	266	219	9065
Gloucester	254	261	330	301	168	174	207	271	325	357	377	369	442	348	266	245	180	121	4995
Greater Lakes	1729	1754	1987	2010	1256	1274	1408	1805	2047	2367	2513	2633	3088	2863	2531	1928	1565	1228	35986
Greater Taree	2634	2965	3430	3263	2051	2044	2109	2570	2949	3451	3616	3457	3659	2975	2372	1826	1384	1112	47866
Gunnedah	755	815	945	840	562	599	560	703	748	836	879	792	724	605	541	427	279	228	11840
Guyra	304	336	333	289	207	202	228	250	303	293	313	271	319	242	175	147	114	77	4404
Gwydir	336	370	349	279	203	253	269	341	389	412	362	344	428	332	285	196	148	126	5421
Inverell	1041	1145	1249	1083	763	819	829	1014	1037	1076	1076	1006	1055	860	770	532	418	398	16169
Lake Macquarie	11611	11808	13282	13780	11166	10497	10731	12774	13060	13783	13931	12903	12539	9694	7739	6489	5315	4377	195479
Liverpool Plains	479	530	487	460	319	347	365	455	524	532	595	591	606	485	353	305	217	176	7825
Maitland	5093	5145	5152	5005	4403	4855	4819	5072	4750	4781	4691	4144	3620	2529	1915	1588	1251	1064	69878
Moree Plain	1183	1158	1067	899	929	978	989	1050	1008	1014	958	844	786	556	433	265	187	122	14427
Muswellbrook	1286	1262	1197	1161	1014	1141	1149	1157	1158	1210	1018	891	787	568	404	348	234	181	16167
Narrabri	947	1010	999	853	735	778	795	880	889	988	963	801	804	643	506	388	272	203	13454
Newcastle	9296	8252	8210	9858	13831	11759	10738	10538	10060	10485	10125	8965	7695	5954	4984	4509	4102	3809	153171
Port Stephens	4038	4386	4702	4497	3458	3246	3598	4358	4498	4798	4458	4429	4718	3758	2968	2204	1695	1332	67144
Singleton	1772	1839	1896	1886	1433	1522	1644	1824	1794	1755	1605	1372	1141	697	532	435	326	274	23747
Tamworth	3658	3814	4235	4420	3266	3202	3136	3563	3670	3979	3975	3681	3409	2663	2239	1700	1321	1134	57066
Tenterfield	401	447	461	394	260	265	334	399	405	462	569	579	537	384	331	250	178	153	6812
Upper Hunter Shire	906	895	892	801	787	840	802	875	869	995	988	907	789	671	513	401	322	273	13524
Uralla	371	409	471	404	278	280	292	350	427	471	480	470	455	285	223	163	103	76	6008
Walcha	200	209	238	196	140	130	159	203	231	231	227	271	232	221	134	99	89	81	3291
All Hunter New England	54062	54843	58540	60060	53601	50355	50256	56177	57141	60628	60231	55701	53417	41439	33394	26908	21646	18163	866565
All NSW	464968	435903	456170	470952	488194	490645	485690	511954	492818	498921	468800	419927	382385	283941	230903	185777	151022	132079	7051050

Table 4: Total estimated residential male population by local government area in Hunter New England Area Health Service, 2009.

Local Government Area	Years																	
	00-04	05-09	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 & over	All ages
Cessnock	1668	1789	1857	1811	1442	1556	1599	1724	1724	1640	1782	1648	1542	1102	768	565	407	248	24873
Dungog	272	281	304	338	187	184	214	251	308	336	358	314	297	260	184	124	67	46	4327
Glen Innes Severn	280	281	332	272	190	218	214	246	274	332	359	296	362	290	218	162	111	65	4502
Gloucester	128	127	161	159	91	87	99	135	158	183	192	188	212	178	137	101	81	43	2462
Greater Lakes	880	891	1034	1012	673	643	701	884	1011	1183	1220	1305	1535	1444	1254	965	744	461	17840
Greater Taree	1367	1538	1731	1684	1013	1063	1003	1243	1395	1675	1745	1719	1809	1501	1201	886	624	395	23594
Gunnedah	386	422	507	429	289	303	266	338	360	427	426	422	371	308	269	202	119	80	5923
Guyra	157	175	180	170	104	100	113	123	150	156	151	151	165	126	85	76	56	24	2261
Gwydir	170	187	194	142	103	129	131	165	204	215	194	172	223	176	155	103	62	36	2761
Inverell	534	590	640	555	374	412	412	495	510	546	553	527	534	435	359	260	179	118	8033
Lake Macquarie	5969	6123	6823	7164	5777	5236	5261	6300	6479	6733	6926	6277	6166	4749	3625	3039	2268	1471	96387
Liverpool Plains	245	272	248	230	173	169	184	224	263	255	304	311	306	236	174	146	102	70	3911
Maitland	2606	2615	2608	2506	2248	2412	2391	2499	2340	2371	2295	2087	1755	1292	888	719	508	353	34493
Moree Plain	604	586	547	462	487	487	484	548	539	523	538	453	399	314	230	128	74	43	7446
Muswellbrook	661	663	595	585	530	608	613	608	622	655	521	480	409	304	198	158	93	61	8365
Narrabri	479	500	542	424	383	382	400	433	457	491	492	411	430	340	233	191	119	70	6776
Newcastle	4760	4221	4254	4905	7000	6034	5438	5317	5140	5263	4996	4537	3799	2858	2340	1938	1624	1230	75652
Port Stephens	2075	2262	2387	2353	1858	1637	1772	2121	2186	2422	2184	2157	2295	1883	1496	1027	778	483	33376
Singleton	905	943	974	1000	819	821	852	945	912	909	852	724	629	366	257	188	119	89	12303
Tamworth	1873	1948	2175	2289	1694	1589	1510	1755	1797	1904	1949	1843	1687	1291	1051	799	520	344	28018
Tenterfield	205	223	222	216	135	122	163	195	202	243	277	312	289	193	173	126	68	58	3423
Upper Hunter Shire	462	456	456	419	447	423	394	451	454	501	524	473	423	337	250	185	143	90	6889
Uralla	189	201	233	205	141	141	148	166	206	211	253	239	250	144	109	76	38	26	2976
Walcha	104	109	111	111	74	69	74	97	118	131	121	136	120	117	71	49	39	27	1679
All Hunter New England	27712	28124	29989	30717	27546	25478	24997	27893	28529	30117	29959	27926	26621	20703	16109	12480	9138	6068	430107
All NSW	238693	223722	233378	241569	248395	245429	240473	253012	244272	247695	231337	208462	190781	140293	110853	85585	63764	44082	3491795

Table 5: Total estimated residential female population by local government area in Hunter New England Area Health Service, 2009.

Local Government Area	Years																	
	00-04	05-09	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 & over	All ages
Armidale Dumaresq	699	701	876	1426	1471	653	577	693	755	862	839	706	626	504	409	335	297	274	12702
Cessnock	1576	1673	1792	1696	1417	1518	1501	1655	1622	1706	1793	1637	1532	1029	793	735	610	593	24878
Dungog	262	271	302	295	176	167	220	277	317	330	337	310	277	198	176	93	106	99	4212
Glen Innes Severn	279	313	291	271	176	198	210	249	283	332	298	327	331	265	248	182	154	154	4563
Gloucester	125	134	169	143	76	87	108	136	166	173	185	181	229	169	129	144	99	77	2533
Greater Lakes	849	863	953	998	583	631	707	921	1036	1184	1293	1328	1553	1419	1276	962	821	767	18146
Greater Taree	1267	1427	1699	1579	1037	982	1105	1327	1554	1776	1870	1738	1850	1474	1171	940	759	717	24272
Gunnedah	368	393	438	411	273	296	294	365	388	410	453	369	353	297	273	225	161	149	5916
Guyra	148	161	153	119	103	103	114	126	153	137	162	120	154	116	91	71	58	54	2143
Gwydir	165	183	155	137	100	124	138	176	185	196	168	172	205	155	130	93	85	91	2660
Inverell	507	556	608	527	388	407	417	519	527	530	523	479	521	425	410	273	239	280	8137
Lake Macquarie	5642	5685	6459	6616	5389	5261	5470	6474	6581	7051	7005	6625	6373	4945	4114	3449	3047	2907	99092
Liverpool Plains	233	258	240	230	146	178	181	231	261	277	291	280	300	248	179	159	115	106	3913
Maitland	2486	2530	2543	2498	2154	2444	2428	2573	2409	2411	2396	2057	1866	1238	1027	870	743	711	35385
Moree Plain	579	572	519	436	443	491	506	502	469	491	420	391	387	242	203	137	114	79	6981
Muswellbrook	624	599	602	576	484	533	535	549	536	555	498	411	379	264	206	190	140	121	7802
Narrabri	469	510	457	428	352	396	395	447	432	497	471	390	374	303	272	197	153	133	6678
Newcastle	4535	4031	3956	4953	6831	5724	5300	5221	4920	5222	5129	4428	3896	3096	2644	2571	2479	2579	77519
Port Stephens	1963	2124	2316	2144	1601	1609	1826	2237	2312	2376	2274	2272	2423	1875	1473	1177	918	848	33767
Singleton	867	896	921	886	614	701	792	879	882	846	753	648	513	331	275	247	207	185	11443
Tamworth	1785	1866	2060	2131	1572	1613	1626	1808	1872	2076	2026	1838	1722	1372	1189	901	801	789	29048
Tenterfield	196	223	239	178	126	143	171	204	203	219	292	267	248	192	158	124	110	95	3388
Upper Hunter Shire	444	439	435	382	339	417	407	424	415	494	464	434	366	334	263	216	179	183	6636
Uralla	183	208	239	198	137	139	144	184	221	260	227	231	205	141	114	86	65	50	3032
Walcha	96	100	127	85	66	61	85	106	113	100	105	134	112	104	63	50	50	55	1612
All Hunter New England	26350	26719	28551	29343	26055	24877	25259	28284	28612	30511	30272	27775	26796	20736	17286	14428	12509	12096	436458
All NSW	226275	212182	222792	229383	239799	245215	245218	258942	248546	251225	237462	211465	191604	143648	120051	100192	87258	87997	3559255

Table 6: Distribution of Indigenous residents by local government area in Hunter New England Area Health Service, 2009.

Local government area	Indigenous Total	Non-Indigenous Total	Population Total	Percentage of total population
Armidale Dumaresq	1357	23176	24533	5.5
Cessnock	1700	46565	48265	3.5
Dungog	186	8246	8432	2.2
Glen Innes Severn	494	8601	9095	5.4
Gloucester	179	4806	4985	3.6
Great Lakes	1055	32927	33982	3.1
Greater Taree	2028	44951	46979	4.3
Gunnedah	1228	10738	11966	10.3
Guyra	456	3946	4402	10.4
Gwydir	137	5379	5516	2.5
Inverell	867	15285	16152	5.4
Lake Macquarie	4553	187402	191955	2.4
Liverpool Plains	769	7080	7849	9.8
Maitland	1715	63078	64793	2.6
Moree Plains	3024	11556	14580	20.7
Muswellbrook	775	15169	15944	4.9
Narrabri	1274	12406	13680	9.3
Newcastle	3234	145841	149075	2.2
Port Stephens	1866	61542	63408	2.9
Singleton	619	22386	23005	2.7
Tamworth Regional	3935	51964	55899	7
Tenterfield	476	6311	6787	7
Upper Hunter Shire	421	13188	13609	3.1
Uralla	350	5639	5989	5.8
Walcha	191	3136	3327	5.7
Hunter New England Total	32889	811318	844207	3.9
NSW Total	150772	6830593	6981365	2.2

Table 7. Gender percentages by local government area in Hunter New England Area Health Service, 2009.

Local government area	Male		Female		Population
	Total	Percent	Total	Percent	Total
Armidale Dumaresq	11836	48.2	12702	51.8	24538
Cessnock	24873	50	24878	50	49751
Dungog	4327	50.7	4212	49.3	8539
Glen Innes Severn	4502	49.7	4563	50.3	9065
Gloucester	2462	49.3	2533	50.7	4995
Greater Lakes	17840	49.6	18146	50.4	35986
Greater Taree	23594	49.3	24272	50.7	47866
Gunnedah	5923	50	5916	50	11840
Guyra	2261	51.3	2143	48.7	4404
Gwydir	2761	50.9	2660	49.1	5421
Inverell	8033	49.7	8137	50.3	16169
Lake Macquarie	96387	49.3	99092	50.7	195479
Liverpool Plains	3911	50	3913	50	7825
Maitland	34493	49.4	35385	50.6	69878
Moree Plain	7446	51.6	6981	48.4	14427
Muswellbrook	8365	51.7	7802	48.3	16167
Narrabri	6776	50.4	6678	49.6	13454
Newcastle	75652	49.4	77519	50.6	153171
Port Stephens	33376	49.7	33767	50.3	67144
Singleton	12303	51.8	11443	48.2	23747
Tamworth	28018	49.1	29048	50.9	57066
Tenterfield	3423	50.2	3388	49.7	6812
Upper Hunter Shire	6889	50.9	6636	49.1	13524
Uralla	2976	49.5	3032	50.5	6008
Walcha	1679	51	1612	49	3291
Hunter New England Total	430107	49.6	436458	50.4	866565
All NSW	3491795	49.5	3559255	50.5	7051050

Table 8. Age percentages by local government area in Hunter New England Area Health Service, 2009.

Local Government Area	Years						
	00-04	05-14	15-24	25-44	45-64	65 and over	All ages
Armidale Dumaresq	5.8	12.9	22.3	21.4	24.3	13.3	24538
Cessnock	6.5	14.3	12.8	25.9	26.7	13.8	49751
Dungog	6.3	13.6	11.7	22.7	30	15.8	8539
Glen Innes Severn	6.2	13.4	10	20.9	29.1	20.4	9065
Gloucester	5.1	11.8	9.4	19.6	30.9	23.2	4995
Greater Lakes	4.8	10.4	9.1	18.2	29.5	28.1	35986
Greater Taree	5.5	13.4	11.1	20.2	29.6	20.2	47866
Gunnedah	6.4	14.9	11.8	22	27.3	17.6	11840
Guyra	6.9	15.2	11.3	22.3	27.2	17.1	4404
Gwydir	6.2	13.3	8.9	23.1	28.5	20.1	5421
Inverell	6.4	14.8	11.4	22.9	26.1	18.4	16169
Lake Macquarie	5.9	12.8	12.8	24.1	27.2	17.2	195479
Liverpool Plains	6.1	13	10	21.6	29.7	19.6	7825
Maitland	7.3	14.7	13.5	27.9	24.7	11.9	69878
Moree Plain	8.2	15.4	12.7	27.9	25	10.8	14427
Muswellbrook	8	15.2	13.5	28.5	24.2	10.7	16167
Narrabri	7	14.9	11.8	24.8	26.4	15	13454
Newcastle	6.1	10.7	15.5	28.1	24.3	15.2	153171
Port Stephens	6	13.5	11.8	23.4	27.4	17.8	67144
Singleton	7.5	15.7	14	28.6	24.7	9.5	23747
Tamworth	6.4	14.1	13.5	23.8	26.4	15.9	57066
Tenterfield	5.9	13.3	9.6	20.6	31.5	19	6812
Upper Hunter Shire	6.7	13.2	11.7	25	27.2	16.1	13524
Uralla	6.2	14.6	11.4	22.5	31.2	14.1	6008
Walcha	6.1	13.6	10.2	22	29.2	19	3291
Hunter New England	6.2	13.1	13.1	24.7	26.5	16.3	866565
NSW	6.6	12.7	13.6	28.1	25.1	14	7051050
Hunter New England – Total	54062	113383	113661	213929	229977	141550	866565
NSW – Total	464968	892073	959146	1981107	1770033	983722	7051050

Table 9 appears in Section 1 on page 9 of this report and in Appendix C.

Table 10. Rates of emergency department presentations for all respiratory illness and asthma in residents of Singleton and Muswellbrook postcodes, the Hunter New England Area Health Service (HNEAHS) postcodes combined and Sydney postcodes, 2007.

Age years	Postcode	Population 2007	Asthma		All respiratory	
			n	Rate/ 100 000	n	Rate/ 100 000
0-14	Singleton	5095	193	1263	2026	13 255
	Muswellbrook	3254	223	2284	1305	13 368
	Remaining HNEAHS	158 921	5912	1240	41 983	8806
	Sydney*	639 539	21 507	1121	114 743	5981
15-34	Singleton	5746	115	667	1107	6422
	Muswellbrook	3827	132	1,150	639	5566
	Remaining HNEAHS	202 805	2534	416	20 962	3445
	Sydney*	1 062 379	5441	171	33 421	1049
35-64	Singleton	8396	94	373	758	3009
	Muswellbrook	5149	40	259	421	2725
	Remaining HNEAHS	321 941	2191	227	20 465	2119
	Sydney*	1 349 638	4709	116	36 023	890
65+	Singleton	2038	7	114	306	5005
	Muswellbrook	1380	15	362	235	5676
	Remaining HNEAHS	131 544	792	201	19 869	5035
	Sydney*	418 996	2258	180	49 868	3967

*Sydney area included postcodes in the following statistical subdivisions from the 2006 Australian Standard Geographic Classification (ASGC): Central Northern Sydney, Northern Beaches, Blacktown, Fairfield-Liverpool, St George-Sutherland, Lower North Sydney, Central Western Sydney, Canterbury-Bankstown, Inner Western Sydney, Eastern Suburbs and Inner Sydney.

Table 11. Hunter New England Area Health Service postcodes with populations greater than 10 000 ranked by rates of emergency department visits for respiratory illness, 2007-2009, from highest to lowest.

Rank	Age 0-14 years	Age 15-34 years	Age 35-64 years	Age 65+ years
1	2340, Tamworth area	2340, Tamworth area	2340, Tamworth area	2380, Gunnedah area
2	2380, Gunnedah area	2325, Cessnock area	2325, Cessnock area	2340, Tamworth area
3	2325, Cessnock area	2380, Gunnedah area	2380, Gunnedah area	2400, Moree area
4	2360, Inverell area	2330, Singleton area	2400, Moree area	2325, Cessnock area
5	2315, Nelson Bay area	2315, Nelson Bay area	2330, Singleton area	2304, Mayfield area
6	2333, Muswellbrook area	2360, Inverell area	2333, Muswellbrook area	2287, Wallsend area
7	2330, Singleton area	2333, Muswellbrook area	2315, Nelson Bay area	2281, Swansea area
8	2400, Moree area	2400, Moree area	2360, Inverell area	2333, Muswellbrook area
9	2320, Maitland area	2350, Armidale area	2320, Maitland area	2320, Maitland area
10	2304, Mayfield area	2320, Maitland area	2323, Mulbring area	2315, Nelson Bay area
11	2350, Armidale area	2323, Mulbring area	2350, Armidale area	2323, Mulbring area
12	2323, Mulbring area	2321, Berry Park area	2304, Mayfield area	2280, Belmont area
13	2321, Berry Park area	2430, Taree area	2322, Beresfield area	2321, Berry Park area
14	2299, Lambton area	2324, Hawks Nest area	2324, Hawks Nest area	2360, Inverell area
15	2430, Taree area	2322, Beresfield area	2430, Taree area	2330, Singleton area
16	2324, Hawks Nest area	2304, Mayfield area	2281, Swansea area	2299, Lambton area
17	2280, Belmont area	2299, Lambton area	2280, Belmont area	2284, Teralba area
18	2284, Teralba area	2264, Morisset area	2299, Lambton area	2290, Charlestown area
19	2281, Swansea area	2429, Wingham area	2264, Morisset area	2324, Hawks Nest area
20	2322, Beresfield area	2281, Swansea area	2321, Berry Park area	2322, Beresfield area
21	2287, Wallsend area	2284, Teralba area	2284, Teralba area	2285, Cardiff area
22	2285, Cardiff area	2287, Wallsend area	2287, Wallsend area	2350, Armidale area
23	2305, New Lambton area	2280, Belmont area	2429, Wingham area	2264, Morisset area
24	2429, Wingham area	2283, Toronto area	2283, Toronto area	2282, Warners Bay area
25	2264, Morisset area	2285, Cardiff area	2285, Cardiff area	2430, Taree area
26	2283, Toronto area	2318, Williamtown area	2290, Charlestown area	2305, New Lambton area
27	2282, Warners Bay area	2290, Charlestown area	2428, Forster area	2283, Toronto area
28	2290, Charlestown area	2305, New Lambton area	2305, New Lambton area	2289, Kotara area
29	2289, Kotara area	2282, Warners Bay area	2318, Williamtown area	2429, Wingham area
30	2318, Williamtown area	2428, Forster area	2289, Kotara area	2291, Merewether area
31	2291, Merewether area	2289, Kotara area	2282, Warners Bay area	2428, Forster area
32	2428, Forster area	2291, Merewether area	2291, Merewether area	2318, Williamtown area

Table 12. Hunter New England Area Health Service postcodes with populations greater than 10 000 ranked by rates of emergency department visits for asthma, 2007-2009, from highest to lowest in each age group.

Rank	Age 0-14 years	Age 15-34 years	Age 35-64 years	Age 65+ years
1	2333, Muswellbrook area	2333, Muswellbrook area	2400, Moree area	2400, Moree area
2	2340, Tamworth area	2340, Tamworth area	2340, Tamworth area	2380, Gunnedah area
3	2315, Nelson Bay area	2315, Nelson Bay area	2330, Singleton area	2340, Tamworth area
4	2304, Mayfield area	2325, Cessnock area	2325, Cessnock area	2333, Muswellbrook area
5	2325, Cessnock area	2360, Inverell area	2350, Armidale area	2350, Armidale area
6	2320, Maitland area	2330, Singleton area	2380, Gunnedah area	2321, Berry Park area
7	2380, Gunnedah area	2400, Moree area	2333, Muswellbrook area	2325, Cessnock area
8	2299, Lambton area	2380, Gunnedah area	2320, Maitland area	2281, Swansea area
9	2284, Teralba area	2320, Maitland area	2430, Taree area	2322, Beresfield area
10	2400, Moree area	2430, Taree area	2323, Mulbring area	2360, Inverell area
11	2330, Singleton area	2324, Hawks Nest area	2360, Inverell area	2284, Teralba area
12	2280, Belmont area	2350, Armidale area	2280, Belmont area	2285, Cardiff area
13	2305, New Lambton area	2323, Mulbring area	2304, Mayfield area	2315, Nelson Bay area
14	2323, Mulbring area	2304, Mayfield area	2315, Nelson Bay area	2283, Toronto area
15	2282, Warners Bay area	2281, Swansea area	2284, Teralba area	2282, Warners Bay area
16	2281, Swansea area	2299, Lambton area	2287, Wallsend area	2299, Lambton area
17	2291, Merewether area	2322, Beresfield area	2324, Hawks Nest area	2320, Maitland area
18	2429, Wingham area	2287, Wallsend area	2264, Morisset area	2323, Mulbring area
19	2321, Berry Park area	2285, Cardiff area	2281, Swansea area	2305, New Lambton area
20	2285, Cardiff area	2282, Warners Bay area	2285, Cardiff area	2287, Wallsend area
21	2324, Hawks Nest area	2280, Belmont area	2429, Wingham area	2280, Belmont area
22	2287, Wallsend area	2284, Teralba area	2290, Charlestown area	2264, Morisset area
23	2283, Toronto area	2429, Wingham area	2321, Berry Park area	2290, Charlestown area
24	2430, Taree area	2290, Charlestown area	2283, Toronto area	2324, Hawks Nest area
25	2350, Armidale area	2318, Williamtown area	2322, Beresfield area	2330, Singleton area
26	2289, Kotara area	2264, Morisset area	2428, Forster area	2430, Taree area
27	2290, Charlestown area	2283, Toronto area	2299, Lambton area	2429, Wingham area
28	2360, Inverell area	2428, Forster area	2291, Merewether area	2318, Williamtown area
29	2322, Beresfield area	2321, Berry Park area	2305, New Lambton area	2428, Forster area
30	2318, Williamtown area	2291, Merewether area	2282, Warners Bay area	2291, Merewether area
31	2264, Morisset area	2305, New Lambton area	2318, Williamtown area	2289, Kotara area
32	2428, Forster area	2289, Kotara area	2289, Kotara area	2304, Mayfield area

Table 13. Hunter New England Area Health Service postcodes with populations greater than 5000 ranked by standardised incidence ratios (SIR) of emergency department visits for respiratory problems, 2007-2009, from highest to lowest

Postcode	Standardised incidence ratio (99% confidence interval)	Rank
2340, Tamworth	259 (253 – 266)	1
2325, Cessnock	208 (200 – 217)	2
2326, Abermain	196 (181 – 212)	3
2380, Gunnedah	194 (183 – 206)	4
2327, Kurri Kurri	184 (170 – 199)	5
2343, Quirindi area	161 (146 – 178)	6
2330, Singleton area	145 (138 – 153)	7
2370, Dundee area	143 (131 – 155)	8
2360, Inverell area	137 (129 – 146)	9
2333, Muswellbrook area	137 (129 – 146)	10
2400, Moree area	133 (123 – 143)	11
2315, Nelson Bay area	126 (117 – 135)	12
2337, Glenbawn area	119 (108 – 131)	13
2390, Narrabri area	107 (97 – 117)	14
2320, Maitland area	106 (100 – 111)	15
2295, Fern Bay area	103 (90 – 117)	16
2372, Tarban area	96 (84 – 109)	17
2335, Branxton area	94 (83 – 107)	18
2323, Mulbring area	93 (88 – 99)	19
2350, Armidale area	93 (88 – 99)	20
2422, Bowman area	93 (81 – 106)	21
2304, Mayfield area	90 (83 – 98)	22
2298, Georgetown area	84 (75 – 93)	23
2430, Taree area	80 (76 – 85)	24
2281, Swansea area	78 (71 – 85)	25
2420, Dungog area	77 (66 – 89)	26
2321, Berry Park area	77 (70 – 85)	27
2324, Hawks Nest area	76 (70 – 81)	28
2299, Lambton area	74 (66 – 81)	29
2280, Belmont area	70 (65 – 75)	30
2284, Teralba area	67 (60 – 74)	31
2319, Tanilba Bay area	67 (58 – 76)	32
2287, Wallsend area	66 (62 – 70)	33
2322, Beresfield area	66 (60 – 71)	34
2303, Hamilton	62 (55 – 70)	35
2264, Morisset area	61 (55 – 67)	36
2429, Wingham area	57 (51 – 64)	37
2283, Toronto area	56 (52 – 60)	38
2290, Charlestown area	56 (52 – 59)	39
2265, Martinsville area	55 (46 – 65)	40
2285, Cardiff area	55 (51 – 59)	41
2305, New Lambton area	54 (48 – 61)	42
2282, Warners Bay area	47 (42 – 53)	43
2289, Kotara area	46 (41 – 50)	44
2300, Newcastle area	44 (38 – 51)	45
2318, Williamtown area	40 (36 – 45)	46
2291, Merewether area	39 (34 – 44)	47
2428, Forster area	38 (34 – 41)	48

Table 14. Hunter New England Area Health Service postcodes with populations greater than 5000 ranked by standardised incidence ratios (SIR) of emergency department visits for asthma, 2007-2009, from highest to lowest

Postcode	Standardised incidence ratio (99% confidence interval)	Rank
2343, Quirindi	223 (173 – 283)	1
2337, Glenbawn	198 (159 – 243)	2
2327, Kurri Kurri	197 (158 – 242)	3
2340, Tamworth	193 (177 – 210)	4
2333, Muswellbrook	185 (158 – 216)	5
2325, Cessnock	155 (135 – 177)	6
2390, Narrabri area	148 (117 – 184)	7
2326, Abermain area	135 (102 – 176)	8
2400, Moree area	134 (108 – 164)	9
2315, Nelson Bay area	133 (107 – 164)	10
2380, Gunnedah area	130 (104 – 160)	11
2320, Maitland area	130 (112 – 149)	12
2370, Dundee area	126 (95 – 162)	13
2330, Singleton area	120 (102 – 140)	14
2304, Mayfield area	114 (92 – 139)	15
2360, Inverell area	106 (85 – 130)	16
2335, Branxton area	101 (70 – 141)	17
2420, Dungog area	101 (68 – 144)	18
2299, Lambton area	98 (75 – 127)	19
2350, Armidale area	97 (82 – 114)	20
2280, Belmont area	95 (80 – 113)	21
2281, Swansea area	95 (74 – 120)	22
2323, Mulbring area	93 (78 – 111)	23
2284, Teralba area	91 (68 – 119)	24
2430, Taree area	87 (74 – 101)	25
2422, Bowman area	83 (52 – 124)	26
2324, Hawks Nest area	81 (66 – 99)	27
2282, Warners Bay area	80 (62 – 102)	28
2295, Fern Bay area	79 (48 – 122)	29
2287, Wallsend area	77 (65 – 90)	30
2372, Tarban area	77 (48 – 116)	31
2285, Cardiff area	75 (63 – 90)	32
2298, Georgetown area	71 (50 – 99)	33
2321, Berry Park area	69 (51 – 91)	34
2305, New Lambton area	64 (46 – 87)	35
2265, Martinsville area	63 (38 – 98)	36
2429, Wingham area	61 (43 – 85)	37
2303, Hamilton	61 (40 – 87)	38
2290, Charlestown area	60 (50 – 72)	39
2283, Toronto area	59 (47 – 74)	40
2322, Beresfield area	58 (45 – 73)	41
2318, Williamtown area	58 (44 – 75)	42
2291, Merewether area	54 (39 – 74)	43
2264, Morisset area	52 (37 – 71)	44
2289, Kotara area	48 (36 – 63)	45
2428, Forster area	38 (28 – 51)	46
2300, Newcastle area	35 (20 – 55)	47
2319, Tanilba Bay area	34 (17 – 59)	48

Table 15. Cause of hospitalisations data by category, persons of all ages in NSW, 2004 -2009

Ranking	Category of causes	Number of Hospitalizations per year	Percent
1	Factors influencing health	538350	23.2
2	Unintentional injuries	247567	10.7
3	Digestive system diseases	205060	8.8
4	Others	177748	7.7
5	Maternal conditions	142301	6.1
6	Cardiovascular diseases	137446	5.9
7	Nervous system diseases	130603	5.6
8	Genitourinary diseases	107854	4.6
9	Musculoskeletal diseases	104353	4.5
10	Malignant neoplasms	92328	4.0
11	Mental disorders	88027	3.8
12	Chronic respiratory diseases	63571	2.7
22	Asthma	12735	0.5

Table 16. Cause of hospitalisations data by category, people of all ages in Hunter New England Area Health Service, 2004 -2009

Ranking	Category of causes	Number of Hospitalisations per year	Percent
1	Factors influencing health	538350	23.2
2	Unintentional injuries	247567	10.7
3	Digestive system diseases	205060	8.8
4	Others	177748	7.7
5	Maternal conditions	142301	6.1
6	Cardiovascular diseases	137446	5.9
7	Nervous system diseases	130603	5.6
8	Genitourinary diseases	107854	4.6
9	Musculoskeletal diseases	104353	4.5
10	Malignant neoplasms	92328	4.0
11	Mental disorders	88027	3.8
12	Chronic respiratory diseases	63571	2.7
22	Asthma	12735	0.5

Table 17. Cardiovascular disease hospital separations in males and in females, local government areas, Hunter New England Area Health Service and NSW, 2004/05-2008/09 combined

Local govt area	Gender	Number	Rate/100 000	LCL 95%	UCL 95%
All NSW	Males	447741	2620.8	2613.1	2628.5
	Females	334837	1641.1	1635.5	1646.8
	Persons	782677	2102.5	2097.9	2107.2
Hunter & New England AHS	Males	61730	2623.8	2602.9	2644.7
	Females	45425	1625.6	1610.3	1641.0
	Persons	107155	2096.3	2083.7	2109.0
Armidale Dumaresq	Males	1215	2212.6	2088.5	2342.1
	Females	985	1461.3	1370.3	1556.8
	Persons	2200	1804.3	1729.1	1881.9
Cessnock	Males	3713	3075.7	2975.6	3178.3
	Females	2707	1855.9	1785.3	1928.5
	Persons	6420	2431.2	2371.7	2491.8
Dungog	Males	634	2665.7	2454.8	2889.4
	Females	470	1798.4	1634.9	1973.6
	Persons	1104	2198.2	2068.3	2334.0
Glen Innes Severn	Males	769	2575.4	2392.4	2768.5
	Females	609	1764.7	1616.2	1922.5
	Persons	1378	2133.9	2018.6	2254.0
Gloucester	Males	473	2615.0	2374.1	2872.9
	Females	350	1662.5	1483.9	1855.8
	Persons	823	2113.2	1964.4	2270.0
Great Lakes	Males	3729	2505.2	2418.6	2593.9
	Females	2851	1746.9	1676.2	1819.6
	Persons	6580	2111.7	2056.1	2168.3
Greater Taree	Males	4464	2916.7	2828.9	3006.5
	Females	3091	1792.7	1727.7	1859.4
	Persons	7555	2323.7	2269.9	2378.3
Gunnedah	Males	1150	3303.0	3111.6	3502.9
	Females	780	1972.7	1834.6	2118.3
	Persons	1930	2619.9	2503.1	2740.7
Guyra	Males	349	2676.0	2395.3	2979.9
	Females	236	1717.1	1496.4	1960.3
	Persons	585	2209.1	2030.2	2399.4
Gwydir	Males	482	2924.6	2657.5	3210.3
	Females	409	2050.1	1847.2	2268.4
	Persons	891	2487.2	2322.1	2660.7
Inverell	Males	1114	2383.4	2243.4	2529.7
	Females	924	1682.6	1570.6	1800.2
	Persons	2038	2004.4	1916.3	2095.5
Lake Macquarie	Males	13442	2412.6	2371.6	2454.1
	Females	9483	1418.7	1389.6	1448.4
	Persons	22925	1884.1	1859.4	1908.9
Liverpool Plains	Males	665	4242.3	3916.4	4587.5
	Females	499	2872.8	2618.2	3144.8
	Persons	1164	3545.2	3338.5	3761.1
Maitland	Males	4520	3138.8	3046.8	3232.8
	Females	3281	1900.9	1835.8	1967.6
	Persons	7801	2474.1	2419.2	2529.9
Moree Plains	Males	794	2364.1	2192.7	2544.8
	Females	628	1958.6	1807.2	2119.1
	Persons	1422	2176.0	2061.8	2294.8
Muswellbrook	Males	1168	3305.9	3113.2	3507.2
	Females	868	2380.4	2224.1	2544.8
	Persons	2036	2869.6	2745.3	2998.1
Narrabri	Males	1241	3395.1	3205.8	3592.4
	Females	974	2516.2	2359.4	2680.6
	Persons	2215	2973.4	2850.2	3100.6
Newcastle	Males	9083	2318.8	2271.2	2367.2
	Females	6929	1339.6	1306.7	1373.1
	Persons	16012	1784.3	1756.2	1812.8
Port Stephens	Males	4635	2426.8	2356.0	2499.1
	Females	3125	1482.7	1430.2	1536.5
	Persons	7760	1936.5	1893.0	1980.8
Singleton	Males	1326	2919.1	2756.0	3088.9
	Females	950	1844.5	1728.1	1966.7
	Persons	2276	2347.7	2250.8	2447.7
Tamworth regional	Males	4556	2921.5	2836.2	3008.6
	Females	3547	1833.2	1771.9	1896.1
	Persons	8103	2341.2	2290.0	2393.3
Tenterfield	Males	459	2228.4	2020.8	2450.8
	Females	413	1781.0	1606.1	1969.0
	Persons	872	1973.3	1840.3	2113.1
Upper Hunter Shire	Males	1175	2862.2	2698.9	3032.7
	Females	856	1797.9	1676.2	1925.9
	Persons	2031	2329.6	2228.3	2434.2
Uralla	Males	331	2205.6	1962.5	2469.4
	Females	255	1469.8	1293.0	1663.9
	Persons	586	1801.9	1656.0	1956.9
Walcha	Males	243	2424.3	2119.2	2760.0
	Females	205	1803.3	1554.7	2079.2
	Persons	448	2070.9	1878.4	2277.5

Table 18. Respiratory disease hospital separations in males and in females for local government areas, Hunter New England Area Health Service and NSW, 2004/05-2008/09 combined

Local govt area	Gender	Number	Rate/100 000	LCL 95%	UCL 95%
All NSW	Males	302120	1801.6	1795.2	1808.1
	Females	261318	1429.1	1423.5	1434.7
	Persons	563508	1597.9	1593.7	1602.1
Hunter & New England AHS	Males	34805	1583.0	1566.2	1599.8
	Females	30793	1302.7	1287.8	1317.8
	Persons	65598	1424.9	1413.8	1436.0
Armidale Dumaresq	Males	930	1686.1	1577.8	1799.9
	Females	833	1325.7	1234.7	1421.5
	Persons	1763	1487.3	1417.4	1559.7
Cessnock	Males	1872	1578.9	1507.0	1653.3
	Females	1898	1433.2	1368.4	1500.2
	Persons	3770	1479.9	1432.8	1528.2
Dungog	Males	277	1307.4	1152.9	1476.4
	Females	257	1213.2	1062.1	1378.9
	Persons	534	1243.4	1136.3	1357.6
Glen Innes Severn	Males	665	2585.3	2386.4	2795.9
	Females	603	2268.5	2078.1	2470.8
	Persons	1268	2402.2	2265.6	2544.6
Gloucester	Males	228	1632.9	1409.1	1879.9
	Females	195	1362.6	1155.5	1593.0
	Persons	423	1478.0	1325.6	1641.7
Great Lakes	Males	1467	1292.8	1218.4	1370.2
	Females	1469	1310.2	1232.7	1390.7
	Persons	2936	1291.1	1237.4	1346.2
Greater Taree	Males	2238	1710.1	1637.0	1785.6
	Females	1941	1448.3	1380.5	1518.5
	Persons	4179	1568.1	1518.5	1619.0
Gunnedah	Males	837	2510.4	2340.0	2689.6
	Females	640	1968.9	1815.7	2131.4
	Persons	1477	2211.4	2098.1	2329.1
Guyra	Males	299	2507.1	2222.9	2816.9
	Females	251	2137.3	1871.0	2429.6
	Persons	550	2291.6	2098.7	2497.2
Gwydir	Males	525	3696.4	3373.2	4041.2
	Females	457	3273.8	2958.3	3611.9
	Persons	982	3420.9	3198.9	3653.7
Inverell	Males	820	1901.7	1771.5	2038.7
	Females	751	1694.8	1570.9	1825.5
	Persons	1571	1779.4	1690.2	1872.0
Lake Macquarie	Males	6354	1252.1	1221.2	1283.7
	Females	5500	1001.4	974.1	1029.3
	Persons	11854	1111.0	1090.6	1131.6
Liverpool Plains	Males	530	3745.0	3423.1	4088.3
	Females	476	3428.5	3111.2	3768.1
	Persons	1006	3583.5	3356.6	3821.2
Maitland	Males	2384	1564.5	1501.2	1629.7
	Females	2079	1199.8	1148.5	1252.9
	Persons	4463	1356.7	1317.0	1397.3
Moree Plains	Males	905	2444.9	2281.3	2616.6
	Females	952	2724.3	2551.9	2905.1
	Persons	1857	2569.3	2450.9	2691.8
Muswellbrook	Males	790	2170.6	2015.2	2334.5
	Females	678	1724.1	1595.8	1859.9
	Persons	1468	1923.6	1824.9	2026.3
Narrabri	Males	1069	3031.7	2850.5	3221.4
	Females	1036	2895.6	2720.0	3079.4
	Persons	2105	2950.4	2824.7	3080.2
Newcastle	Males	4779	1278.5	1242.2	1315.5
	Females	4112	969.8	939.1	1001.3
	Persons	8891	1102.4	1079.0	1126.1
Port Stephens	Males	2127	1238.1	1185.0	1293.0
	Females	1805	999.1	952.1	1047.6
	Persons	3932	1105.9	1070.9	1141.8
Singleton	Males	903	1712.2	1595.9	1834.3
	Females	777	1404.3	1306.2	1507.7
	Persons	1680	1535.8	1462.0	1612.4
Tamworth regional	Males	3067	2061.0	1988.0	2136.0
	Females	2628	1624.9	1561.7	1689.9
	Persons	5695	1820.9	1773.3	1869.5
Tenterfield	Males	397	2192.1	1971.8	2429.5
	Females	446	2300.8	2079.7	2537.9
	Persons	843	2237.8	2081.8	2402.0
Upper Hunter Shire	Males	888	2303.4	2152.9	2461.6
	Females	657	1680.4	1551.4	1817.2
	Persons	1545	1967.4	1869.2	2069.3
Uralla	Males	225	1560.0	1355.2	1786.0
	Females	162	1074.5	911.9	1257.3
	Persons	387	1286.8	1159.4	1424.3
Walcha	Males	229	2629.9	2290.3	3004.5
	Females	190	2077.9	1774.1	2416.2
	Persons	419	2322.9	2096.6	2566.2

Table 19. Asthma hospital separations in males and in females for local government areas, Hunter New England Area Health Service and NSW, 2004/05-2008/09 combined

Local govt area	Gender	Number	Rate/100 000	LCL 95%	UCL 95%
All NSW	Males	32665	194.0	191.9	196.1
	Females	31211	183.9	181.9	186.0
	Persons	63881	190.4	188.9	191.8
Hunter & New England AHS	Males	3249	156.8	151.5	162.3
	Females	3432	163.8	158.3	169.5
	Persons	6681	161.2	157.3	165.1
Armidale Dumaresq	Males	97	177.3	143.6	216.6
	Females	99	168.8	136.6	206.2
	Persons	196	175.3	151.4	202.0
Cessnock	Males	165	133.0	113.3	155.0
	Females	185	151.3	130.1	174.9
	Persons	350	142.1	127.5	157.8
Dungog	Males	27	137.3	89.5	201.2
	Females	32	171.7	116.6	243.5
	Persons	59	155.4	117.6	201.4
Glen Innes Severn	Males	43	181.2	130.1	245.3
	Females	78	362.7	283.7	456.2
	Persons	121	271.0	223.5	325.3
Gloucester	Males	20	182.7	108.5	286.5
	Females	18	168.1	90.7	278.5
	Persons	38	173.8	118.9	243.8
Great Lakes	Males	75	94.7	73.0	120.5
	Females	137	157.1	128.7	189.3
	Persons	212	126.3	108.2	146.4
Greater Taree	Males	197	181.3	156.3	209.0
	Females	192	171.1	146.8	198.2
	Persons	389	178.4	160.6	197.6
Gunnedah	Males	77	229.1	180.7	286.5
	Females	74	250.2	195.8	315.0
	Persons	151	241.2	203.9	283.3
Guyra	Males	26	222.0	143.4	327.5
	Females	22	212.6	130.0	326.3
	Persons	48	217.4	158.7	290.3
Gwydir	Males	36	293.9	204.6	408.6
	Females	35	288.6	198.0	405.3
	Persons	71	287.8	223.2	364.9
Inverell	Males	51	129.7	96.0	171.4
	Females	82	214.6	169.5	267.8
	Persons	133	172.7	144.0	205.4
Lake Macquarie	Males	547	120.1	110.2	130.6
	Females	613	132.9	122.4	144.1
	Persons	1160	127.3	120.0	134.9
Liverpool Plains	Males	55	424.4	317.7	554.9
	Females	56	457.5	342.0	598.5
	Persons	111	443.1	362.6	535.8
Maitland	Males	284	157.2	139.4	176.7
	Females	226	131.6	115.0	150.0
	Persons	510	145.5	133.1	158.8
Moree Plains	Males	68	164.3	126.9	209.2
	Females	97	279.8	226.3	342.0
	Persons	165	220.6	187.6	257.7
Muswellbrook	Males	87	192.1	152.7	238.3
	Females	115	279.0	230.0	335.3
	Persons	202	237.8	205.7	273.4
Narrabri	Males	129	357.5	298.1	425.2
	Females	132	369.3	308.3	438.6
	Persons	261	364.9	321.7	412.3
Newcastle	Males	477	138.5	126.3	151.6
	Females	438	125.9	114.2	138.5
	Persons	915	133.0	124.4	141.9
Port Stephens	Males	203	132.6	114.8	152.3
	Females	200	125.0	107.9	143.9
	Persons	403	129.4	116.9	142.8
Singleton	Males	107	168.2	137.5	203.6
	Females	80	139.0	109.9	173.3
	Total	187	153.3	132.0	177.1
Tamworth regional	Males	295	201.2	178.7	225.6
	Females	308	206.0	183.4	230.7
	Total	603	203.8	187.8	220.9
Tenterfield	Males	35	223.7	150.9	317.4
	Females	73	423.4	327.7	537.4
	Persons	108	323.5	262.4	394.1
Upper Hunter Shire	Males	117	316.4	261.4	379.6
	Females	107	303.2	247.8	367.1
	Persons	224	309.1	269.6	352.7
Uralla	Males	16	108.1	61.4	176.0
	Females	13	87.8	46.3	150.9
	Persons	29	97.7	65.2	140.7
Walcha	Males	15	186.1	103.1	308.4
	Females	20	217.5	130.7	339.1
	Persons	35	198.9	137.2	278.3

Table 20. Asthma hospital separations in boys and in girls aged under 15 years selected local government areas, Hunter New England Area Health Service and NSW, 2004/05 to 2008/09 combined

Local govt area	Gender	Number	Rate/100 000	LCL 95%	UCL 95%
All NSW	Males	25079	728.1	719.2	737.2
	Females	14578	446.8	439.6	454.1
	Total	39658	591.3	585.5	597.1
Hunter & New England AHS	Males	2370	560.6	538.3	583.7
	Females	1478	369.3	350.7	388.7
	Persons	3848	467.8	453.1	482.8
Armidale Dumaresq	Males	80	720.0	570.7	896.4
	Females	34	319.4	221.0	446.4
	Persons	114	522.9	431.2	628.4
Cessnock	Males	136	520.1	436.3	615.2
	Females	78	313.8	248.0	391.7
	Persons	214	420.2	365.8	480.5
Dungog	Males	18	434.3	256.6	687.6
	Females	19	501.2	300.8	783.9
	Persons	37	466.4	327.7	643.7
Glen Innes Severn	Males	18	409.1	242.3	646.8
	Females	25	560.5	362.7	827.5
	Persons	43	484.5	350.6	652.7
Gloucester	Males	13	677.3	358.6	1161.3
	Females	4	214.0	58.3	547.8
	Persons	17	440.0	255.5	705.7
Great Lakes	Males	38	293.7	207.7	403.4
	Females	39	312.3	222.0	427.1
	Persons	77	302.8	238.8	378.5
Greater Taree	Males	148	656.1	554.3	771.3
	Females	63	297.7	228.3	381.5
	Persons	211	481.8	418.7	551.8
Gunnedah	Males	58	854.0	648.3	1104.1
	Females	36	613.8	429.6	850.0
	Persons	94	743.0	600.3	909.4
Guyra	Males	17	641.5	373.5	1027.3
	Females	5	218.8	70.9	510.9
	Persons	22	444.4	278.5	672.9
Gwydir	Males	24	897.6	574.6	1336.1
	Females	12	491.4	253.9	858.5
	Persons	36	700.1	490.3	969.4
Inverell	Males	25	280.2	181.3	413.6
	Females	14	170.5	93.2	286.2
	Persons	39	227.7	161.9	311.3
Lake Macquarie	Males	408	443.4	401.4	488.6
	Females	295	343.5	305.4	385.1
	Persons	703	395.7	367.0	426.1
Liverpool Plains	Males	29	726.3	486.2	1043.4
	Females	20	527.8	322.3	815.4
	Persons	49	631.3	467.0	834.7
Maitland	Males	245	645.8	567.5	732.0
	Females	140	383.4	322.5	452.5
	Persons	385	517.2	466.9	571.6
Moree Plains	Males	47	499.7	366.9	664.8
	Females	22	246.1	154.0	373.0
	Persons	69	375.3	291.9	475.2
Muswellbrook	Males	71	703.1	548.9	887.2
	Females	67	720.7	558.5	915.3
	Persons	138	715.1	600.7	845.0
Narrabri	Males	83	1072.3	853.8	1329.6
	Females	50	649.9	482.3	856.9
	Persons	133	863.3	722.8	1023.1
Newcastle	Males	355	519.8	467.0	576.8
	Females	212	335.4	291.7	383.8
	Persons	567	430.5	395.7	467.5
Port Stephens	Males	151	473.2	400.7	555.0
	Females	94	307.7	248.6	376.6
	Persons	245	392.8	345.1	445.2
Singleton	Males	79	583.2	461.7	726.9
	Females	41	313.0	224.6	424.7
	Persons	120	450.5	373.5	538.7
Tamworth regional	Males	207	707.1	614.0	810.3
	Females	138	496.8	417.3	587.0
	Persons	345	605.2	542.9	672.6
Tenterfield	Males	12	360.9	186.4	630.6
	Females	20	593.0	362.1	916.0
	Persons	32	472.9	323.4	667.8
Upper Hunter Shire	Males	85	1215.0	970.4	1502.4
	Females	38	558.0	394.7	766.1
	Persons	123	887.1	737.2	1058.5
Uralla	Males	14	474.0	258.6	796.1
	Females	7	233.4	93.7	481.0
	Persons	21	352.4	217.9	538.9
Walcha	Males	9	531.4	242.8	1009.2
	Females	5	327.3	104.8	766.7
	Persons	14	428.0	233.4	718.9

Table 21. Deaths from all causes, for all ages in males and in females by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England Area Health Service and NSW, 2002-2007

HNEAHS cluster	Sex	Deaths n	Rate/100,000 Person years	LL 95% CI	UL 95% CI
Mehi	Male	710	1002.34	924.18	1084.96
	Female	604	681.92	628.49	738.67
	Persons	1314	832.74	787.76	879.60
McIntyre	Male	527	784.14	717.07	855.68
	Female	482	465.61	423.27	510.90
	Persons	1009	600.88	563.86	639.66
Tablelands	Male	1174	794.70	749.50	841.88
	Female	1082	511.21	480.36	543.48
	Persons	2256	635.32	609.12	662.34
Peel	Male	1392	635.22	601.86	669.93
	Female	1255	397.29	375.03	420.50
	Persons	2647	501.79	482.71	521.42
Upper Hunter	Male	675	694.78	642.79	749.81
	Female	571	438.47	402.48	476.77
	Persons	1246	555.96	525.35	587.89
Lower Hunter	Male	2990	879.05	846.95	912.03
	Female	2891	574.88	553.85	596.51
	Persons	5881	703.87	685.96	722.13
Lower Mid North Coast	Male	2872	799.03	768.86	830.04
	Female	2476	534.01	512.09	556.59
	Persons	5349	658.31	640.07	676.91
Greater Newcastle	Male	8660	678.47	664.12	693.04
	Female	8154	444.18	434.31	454.22
	Persons	16813	547.61	539.28	556.03
Hunter & New England AHS	Male	21365	838.53	827.17	850.00
	Female	19775	548.37	540.59	556.23
	Persons	41140	677.32	670.75	683.93
All NSW	Male	140934	766.72	762.68	770.77
	Female	134585	510.41	507.64	513.19
	Persons	275519	624.01	621.67	626.34

Table 22. Cause of deaths by health category, people of all ages in NSW, 2004 -2009

Ranking	Category of causes	Deaths per year n	Percent %
1	Cardiovascular diseases	16847	36.7
2	Malignant neoplasms	12985	28.3
3	Chronic respiratory diseases	3036	6.6
4	Nervous system diseases	2777	6.0
5	Unintentional injuries	1722	3.7
6	Digestive system diseases	1534	3.3
7	Genitourinary diseases	1087	2.4
8	Acute respiratory infections	1061	2.3
9	Diabetes mellitus	997	2.2
10	Other Infectious diseases	808	1.8
20	Asthma	124	0.3

Table 23. Cause of deaths by category, persons of all ages in Hunter New England Area Health Service, 2004 -2009

Ranking	Category of causes	Deaths per year n	Percent %
1	Cardiovascular diseases	2543	37.1
2	Malignant neoplasms	1940	28.3
3	Chronic respiratory diseases	425	6.2
4	Nervous system diseases	400	5.8
5	Digestive system diseases	256	3.7
6	Unintentional injuries	253	3.7
7	Genitourinary diseases	162	2.4
8	Diabetes mellitus	159	2.3
9	Acute respiratory infections	152	2.2
10	Other Infectious diseases	106	1.5
20	Asthma	17	0.2

Table 24. Deaths from all respiratory disease, for all ages in males and in females by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England Area Health Service and NSW, 2002-2007

HNEAHS cluster	Sex	Deaths n	Rate/100,000 Person years	LL 95% CI	UL 95% CI
Mehi	1	70	113.57	86.53	145.86
	2	50	56.38	41.81	74.36
	4	120	77.56	64.16	92.90
McIntyre	1	65	101.04	77.56	129.29
	2	42	38.52	27.30	52.66
	4	107	61.60	50.41	74.52
Tablelands	1	114	77.48	63.86	93.14
	2	83	37.30	29.48	46.50
	4	197	54.63	47.21	62.87
Peel	1	124	57.02	47.31	68.10
	2	110	34.02	27.87	41.10
	4	234	42.85	37.53	48.72
Upper Hunter	1	69	73.76	57.26	93.49
	2	53	39.45	29.32	51.88
	4	122	54.26	45.01	64.83
Lower Hunter	1	183	54.20	46.44	62.86
	2	193	38.73	33.38	44.67
	4	376	45.10	40.65	49.91
Lower Mid North Coast	1	281	75.51	66.74	85.08
	2	233	48.70	42.44	55.61
	4	515	60.61	55.39	66.19
Greater Newcastle	1	714	55.87	51.81	60.17
	2	640	34.31	31.65	37.13
	4	1354	42.65	40.40	44.99
Hunter & New England AHS	1	1831	72.44	69.11	75.88
	2	1564	42.77	40.64	44.97
	4	3394	54.67	52.84	56.55
All NSW	1	12487	70.15	68.91	71.41
	2	11597	43.23	42.43	44.03
	4	24084	53.98	53.30	54.67

Table 25. Deaths from cardiovascular diseases, in males and in females by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England Area Health Service and NSW, 2002 – 2007

HNEAHS area	Sex	Deaths n	Rate/100,000 Person years	LL 95% CI	UL 95% CI
Mehi	Male	238	360.13	312.37	412.71
	Female	241	272.51	239.15	309.22
	Persons	480	316.23	288.26	346.15
McIntyre	Male	174	263.32	224.85	306.36
	Female	186	167.16	143.22	193.87
	Persons	360	207.25	186.25	229.97
Tablelands	Male	398	275.63	249.03	304.29
	Female	469	206.74	188.11	226.69
	Persons	867	235.96	220.43	252.30
Peel	Male	471	218.94	199.36	239.91
	Female	532	154.95	141.83	168.93
	Persons	1003	184.02	172.77	195.81
Upper Hunter	Male	207	216.85	188.02	248.80
	Female	216	154.18	133.93	176.58
	Persons	423	184.84	167.57	203.41
Lower Hunter	Male	1035	322.74	302.82	343.59
	Female	1109	209.62	197.34	222.47
	Persons	2144	256.51	245.75	267.62
Lower Mid North Coast	Male	1008	275.58	258.45	293.54
	Female	990	197.21	184.88	210.14
	Persons	1998	233.31	223.05	243.91
Greater Newcastle	Male	2986	236.06	227.59	244.76
	Female	3366	168.07	162.33	173.95
	Persons	6351	198.92	194.03	203.90
Hunter & New England AHS	Male	7346	293.95	287.17	300.84
	Female	7981	206.49	201.92	211.13
	Persons	15327	245.83	241.94	249.76
All NSW	Male	48106	269.25	266.82	271.69
	Female	53473	190.55	188.92	192.19
	Persons	101579	226.45	225.06	227.85

Table 26. Smoking attributable hospitalisations by local government area, Hunter New England Area Health Service, 2005 -2006.

Local government area of residence	Smoothed number of separations per year	Smoothed rate per 100 000 population	Smoothed Estimate of Standardised Separation Ratio (SSR)	Lower 95% credible interval for sSSR	Upper 95% credible interval for sSSR	Significantly higher or lower than NSW
Armidale Dumaresq	56	245.8	82.2	68.9	97.2	-
Cessnock	183	371.9	124.4	112.3	137.0	++
Dungog	26	273.3	91.4	71.4	114.3	0
Glen Innes Severn	41	348.3	116.5	93.9	141.9	0
Gloucester	23	326.2	109.1	83.9	137.4	0
Great Lakes	162	288.3	96.4	86.4	107.1	0
Greater Taree	170	281.3	94.1	84.2	104.0	0
Gunnedah	48	350.1	117.1	95.1	139.9	0
Guyra	19	365.1	122.1	91.7	157.9	0
Gwydir	26	364.5	121.9	94.8	152.2	0
Inverell	54	285.9	95.6	79.7	113.7	0
Lake Macquarie	563	255.0	85.3	80.4	90.3	--
Liverpool Plains	35	342.6	114.6	92.5	139.7	0
Maitland	200	329.3	110.1	99.1	121.4	0
Moree Plains	48	371.0	124.1	101.7	147.9	+
Muswellbrook	59	423.9	141.8	118.3	167.4	++
Narrabri	70	486.3	162.6	139.0	189.0	++
Newcastle	400	254.0	84.9	79.1	90.9	--
Port Stephens	210	280.3	93.7	85.4	103.3	0
Singleton	59	306.6	102.5	86.1	120.9	0
Tamworth Regional	196	324.7	108.6	98.9	119.3	0
Tenterfield	26	298.9	100.0	77.8	126.7	0
Upper Hunter Shire	50	334.6	111.9	92.8	132.6	0
Uralla	18	274.2	91.7	69.4	119.7	0
Walcha	15	360.9	120.7	90.6	158.1	0

sSSR: smoothed Standardised Separation Ratio.
- lower than the state average at the 5% level of significance.
-- at 1%;
+ greater than the state average at the 5% level of significance.
++ at 1%

Table 27. Self-rated health status data for males and females by area health service for adults, NSW 2008

Area Health Service	Prevalence % (95% CI)		
	Males	Females	Persons
Sydney South West	77.5 (73.3-81.6)	75.2 (71.5-78.8)	76.3 (73.6-79.1)
South Eastern Sydney & Illawarra	85.5 (81.9-89.2)	78.8 (75.4-82.2)	82.1 (79.6-84.6)
Sydney West	85.0 (81.4-88.6)	79.4 (75.7-83.1)	82.2 (79.5-84.8)
Northern Sydney & Central Coast	81.7 (77.2-86.1)	79.9 (76.3-83.5)	80.8 (77.9-83.6)
Hunter & New England	83.2 (79.4-87.0)	78.7 (75.3-82.0)	80.9 (78.4-83.4)
North Coast	81.6 (77.3-86.0)	76.5 (72.8-80.2)	79.0 (76.2-81.9)
Greater Southern	82.1 (78.0-86.2)	77.3 (73.4-81.1)	79.7 (76.9-82.5)
Greater Western	85.3 (81.4-89.1)	78.9 (75.6-82.2)	82.1 (79.5-84.7)
Urban	82.2 (80.2-84.2)	78.2 (76.4-80.0)	80.2 (78.8-81.5)
Rural	82.9 (80.8-85.0)	77.9 (76.0-79.8)	80.4 (78.9-81.8)
NSW	82.4 (80.9-84.0)	78.1 (76.7-79.5)	80.2 (79.2-81.3)

Table 28. Self-rated health status data by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service, 2008.

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	2773	80.7	78.9	82.4
Lower Hunter	928	79.3	76.1	82.4
Lower Mid-North	793	79.4	75.8	83.0
McIntyre	221	83.5	78.1	88.8
Mehi	226	80.5	74.5	86.5
Peel	551	80.7	76.7	84.6
Tablelands	481	80.6	76.2	85.0
Upper Hunter	284	83.5	77.9	89.1
Hunter New England	6257	80.5	79.3	81.7
NSW	50598	80.4	79.9	80.9

Table 29. Self-rated health status data (children 5-15 years old) by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service, 2007-2008.

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	265	91.9402	88.3189	95.5614
Lower Hunter	104	88.4476	81.4808	95.4144
Lower Mid-North	55	89.6046	81.068	98.1412
McIntyre	17	84.7231	65.1571	100
Mehi	22	83.7828	63.1879	100
Peel	45	89.5258	79.1326	99.919
Tablelands	47	85.0393	74.8358	95.2427
Upper Hunter	36	88.2344	77.1223	99.3465
Hunter New England	591	89.6089	86.8541	92.3638

Table 30. Current asthma status for children (≤ 15 years of age) by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2006-2008

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	345	16.9	12.5	21.3
Lower Hunter	128	18.1	10.5	25.7
Lower Mid-North	67	24.7	13.0	36.3
McIntyre	23	24.2	5.7	42.8
Mehi	32	12.2	0.0	26.2
Peel	56	15.1	4.0	26.2
Tablelands	61	12.9	3.8	21.9
Upper Hunter	45	18.2	4.8	31.7
Hunter New England	757	17.5	14.4	20.5
NSW	8343	13.4	12.6	14.2

Table 31. Written Asthma Management Plan for children (≤ 15 years of age) by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2006-2008

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	55	58.7	44.2	73.1
Lower Hunter	20	65.5	43.5	87.5
Lower Mid-North	16	51.3	23.6	78.9
McIntyre	6	41.6	0.0	84.9
Mehi	4	0.0	0.0	0.0
Peel	7	47.0	5.9	88.2
Tablelands	7	44.0	6.4	81.7
Upper Hunter	7	51.0	9.0	92.9
Hunter New England	122	54.6	44.8	64.4
NSW	1158	54.8	51.5	58.1

Table 32. Asthma interference for children (≤ 15 years of age) by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2006-2008

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	4	13.0	0.0	26.7
Lower Hunter	12	12.6	0.0	35.8
Lower Mid-North	8	0.0	0.0	0.0
McIntyre	4	0.0	0.0	0.0
Mehi	3	0.0	0.0	0.0
Peel	6	22.6	0.0	62.0
Tablelands	4	0.0	0.0	0.0
Upper Hunter	4	19.7	0.0	56.6
Hunter New England	77	11.3	2.6	19.9
NSW	801	12.5	9.9	15.2

Table 33. Current asthma status for adults (>15 years of age) by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2004-2008

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	2429	10.9	9.4	12.5
Lower Hunter	828	11.2	8.4	14.0
Lower Mid-North	704	10.2	7.4	13.0
McIntyre	200	7.0	3.5	10.6
Mehi	207	21.0	13.0	28.9
Peel	480	15.0	10.7	19.2
Tablelands	434	12.5	8.4	16.5
Upper Hunter	250	10.9	5.0	16.9
Hunter New England	5532	11.5	10.4	12.6
NSW	44732	10.5	10.1	10.9

Table 34. Written Asthma Management Plan for adults (> 15 years of age) by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2004-2008

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	159	40.3	30.1	50.4
Lower Hunter	55	54.9	37.6	72.1
Lower Mid-North	33	39.9	20.9	58.9
McIntyre	8	45.3	7.3	83.3
Mehi	14	42.5	6.8	78.2
Peel	33	53.1	30.8	75.4
Tablelands	21	30.6	7.9	53.4
Upper Hunter	14	33.4	0.8	65.9
Hunter New England	337	42.7	35.6	49.8
NSW	2660	41.6	39.0	44.3

Table 35. Asthma interference for adults (>15 years of age) by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2004-2008

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	143	9.8	4.7	14.9
Lower Hunter	43	4.7	0.0	12.2
Lower Mid-North	37	4.4	0.0	10.8
McIntyre	4	56.2	6.9	100.0
Mehi	15	0.0	0.0	0.0
Peel	27	13.9	0.0	29.7
Tablelands	14	1.8	0.0	5.4
Upper Hunter	11	20.3	0.0	46.4
Hunter New England	294	9.1	5.5	12.6
NSW	2177	11.2	9.4	12.9

Table 36. Current smoking rates for adults by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2004 -2008

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	2500	18.5	16.5	20.5
Lower Hunter	829	20.0	16.5	23.5
Lower Mid-North	709	19.7	15.6	23.9
McIntyre	203	24.5	16.7	32.4
Mehi	194	27.7	16.9	38.5
Peel	500	17.1	12.8	21.4
Tablelands	439	15.2	10.4	20.0
Upper Hunter	249	24.4	16.6	32.2
Hunter New England	5623	19.3	17.9	20.7
NSW	45130	19.2	18.7	19.7

Table 37. Current smoking rates data for males by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2004 -2008.

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	993	19.1123	16.0159	22.2087
Lower Hunter	318	20.3356	14.7368	25.9345
Lower Mid-North	231	23.524	16.8373	30.2107
McIntyre	83	30.7139	18.2159	43.2119
Mehi	73	33.0631	14.5321	51.5941
Peel	190	16.5687	10.2308	22.9066
Tablelands	173	17.744	9.7751	25.7129
Upper Hunter	102	25.4064	13.3853	37.4275
Hunter New England	2218	20.5088	18.2762	22.7415

Table 38. Current smoking rates data for females by Hunter New England Area Health Service (HNEAHS) clusters in Hunter New England Area Health Service and NSW, 2004 -2008.

HNEAHS cluster	Total	Rate %	95% Confidence Limits	
			Lower	Upper
Greater Newcastle	1507	17.9038	15.4026	20.405
Lower hunter	511	19.7626	15.4149	24.1102
Lower mid-north	423	16.0352	11.2352	20.8352
McIntyre	120	18.5438	9.3464	27.7412
Mehi	121	22.4607	12.5148	32.4065
Peel	310	17.5349	11.6864	23.3834
Tablelands	266	12.2785	7.5904	16.9665
Upper hunter	147	23.0683	13.9092	32.2274
Hunter New England	3405	18.0554	16.3505	19.7603

Table 39. Smoking attributable deaths by local government area, Hunter New England Area Health Service, 2005-2006.

Local government area of residence	Smoothed number of separations per year	Smoothed rate per 100 000 population	Smoothed Estimate of SMR	Lower 95% credible interval for sSMR	Upper 95% credible interval for sSMR	Significantly higher or lower than NSW
Armidale Dumaresq	19	88.9	115.8	95.5	139.0	0
Cessnock	43	91.2	118.7	102.3	139.4	+
Dungog	8	80.5	104.8	85.5	127.4	0
Glen Innes Severn	10	80.3	104.6	81.9	129.2	0
Gloucester	6	83.1	108.1	85.5	134.2	0
Great Lakes	50	78.3	102.0	86.3	118.2	0
Greater Taree	56	88.7	115.4	99.6	133.0	0
Gunnedah	12	90.1	117.3	93.3	145.4	0
Guyra	*	89.1	116.0	91.5	143.6	0
Gwydir	7	97.7	127.2	101.6	158.0	+
Inverell	18	90.8	118.2	96.0	142.7	0
Lake Macquarie	169	74.0	96.3	86.9	106.8	0
Liverpool Plains	9	85.2	110.9	87.5	137.4	0
Maitland	42	76.5	99.6	85.3	115.4	0
Moree Plains	11	102.8	133.8	106.7	168.4	+
Muswellbrook	10	84.1	109.5	85.8	138.2	0
Narrabri	14	102.3	133.2	108.6	162.1	++
Newcastle	128	75.8	98.7	87.8	109.9	0
Port Stephens	58	78.6	102.3	87.8	118.3	0
Singleton	13	76.1	99.0	79.9	119.1	0
Tamworth Regional	53	88.0	114.5	98.9	132.0	0
Tenterfield	7	84.8	110.4	86.7	139.7	0
Upper Hunter Shire	12	80.1	104.3	86.1	124.7	0
Uralla	5	88.4	115.2	90.1	144.2	0
Walcha	*	86.9	113.1	90.7	137.6	0

0 result not statistically different than state average.
- Lower than the state average at the 5% level of significance.
-- at 1%.
+ Greater than the state average at the 5% level of significance.
++ at 1%.
Local Government Area boundaries defined in 2006. sSMR: Smoothed Standardised Mortality Ratio

Table 40. All cancer incidence data by local government areas within Hunter New England Area Health Service and NSW, 2003-2007

Local government area	Count	Crude rate per 100 000	Directly Standard Rate per 100 000	Lower 95% CI Directly Standard Rate	Upper 95% CI Directly Standard Rate
Armidale	525	504.9	525.3	480.8	572.7
Barraba	100	920.3	538.3	433	660.4
Bingara	92	908.7	588.7	467	730.9
Cessnock	1,296	534.1	490.4	463.9	517.9
Dumaresq	22	111.8	109.2	66.6	167.8
Dungog	238	556.8	455	398.3	517.5
Glen Innes	239	806.6	586.9	512.3	669
Gloucester	189	764	512.2	439	593.7
Greater Taree	1,609	703.3	514.1	488.5	540.6
Great Lakes	1,526	875.5	500.4	473.6	528.2
Gunnedah	382	623.9	511.1	460.6	565.6
Guyra	144	654.2	535.5	450	632.3
Inverell – Pts A & B	498	635.9	500.1	456.4	546.8
Lake Macquarie	5,662	591.7	480.9	468.3	493.8
Maitland	1,517	504.3	510	484.5	536.4
Manilla	139	839.3	587	490.5	696.4
Merriwa	56	480.3	370.7	277.8	484
Moree Plains	345	427.9	516.4	461.4	575.8
Murrurundi	73	690.5	520.9	403.6	660.5
Muswellbrook	393	517.4	570.4	514.8	630.3
Narrabri	438	620.9	567.4	515.2	623.3
Newcastle – Inner & Remainder	4,147	570.3	486.9	472	502.3
Nundle	35	528.9	415.6	281.2	588.8
Parry	290	441.2	380.4	337.2	427.6
Port Stephens	1,970	623.9	516.4	493.6	540.1
Quirindi	176	718.7	538	460.3	625
Scone	247	500.6	455.7	400.1	516.8
Severn	64	456.5	345.7	263.2	445
Singleton	431	394.2	438.8	397.8	482.7
Tamworth	1,083	579.5	512	481.7	543.7
Tenterfield	237	695.6	521.9	456.3	594.1
Uralla	135	441	403.2	336.7	478.8
Walcha	131	812.6	646.2	537.9	769.6
Yallaroi	94	603.1	511.8	412.1	627.9
NSW	173,494	507.2	473.3	471	475.5

Table 41. All cancers – new cases and deaths in males and in females by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England and NSW, incidence 2004 to 2008 and deaths 2003 to 2007 combined

HNEAHS cluster	Gender	New cases Number	Rate/100 000 person years	LL 95% CI	UL 95% CI	Deaths Number	Rate/100 000 person years	LL 95% CI	UL 95% CI
Mehi	Males	454	654.1	591.9	720.8	178	282.1	239.6	329.6
	Females	297	398.5	354.3	446.6	125	168.9	140.5	201.3
	Persons	751	513.4	476.9	551.9	303	218.1	194	244.4
McIntyre	Males	421	658.5	595.5	726.1	150	244	205.7	287.3
	Females	271	393	345.7	444.6	102	134	108.4	163.6
	Persons	692	512.5	474.3	552.9	252	183.3	161.1	207.6
Tablelands	Males	733	530.5	492.4	570.8	304	235.1	209.2	263.3
	Females	555	365.9	335.4	398.4	213	130.4	113.1	149.5
	Persons	1288	438.3	414.4	463.2	517	174.9	160	190.7
Peel	Males	1259	610.2	576.6	645.2	460	235.3	214	258.1
	Females	833	363.4	338.6	389.6	335	138.4	123.6	154.3
	Persons	2092	474	453.7	495	795	179.2	166.9	192.1
Upper Hunter	Males	560	623.6	572.3	678.1	235	280.4	245.2	319.1
	Females	357	372.5	334.4	413.8	147	147.7	124.5	173.9
	Persons	917	485.7	454.6	518.4	381	203.9	183.8	225.5
Lower Hunter	Males	1924	565.9	540.4	592.2	800	264.5	246	283.9
	Females	1378	355.1	336.4	374.6	658	163.6	151.2	176.8
	Persons	3302	449.5	434.2	465.1	1458	205.5	195.1	216.4
Lower Mid North Coast	Males	1991	601.7	574.5	629.9	775	234.6	218	252.1
	Females	1228	374.4	352.3	397.5	524	143.7	131.1	157.2
	Persons	3219	482.6	465.2	500.5	1300	185.6	175.3	196.2
Greater Newcastle	Males	6571	571.6	557.8	585.7	2714	243.4	234.3	252.8
	Females	4746	369.4	358.7	380.3	2084	149.4	142.9	156.1
	Persons	11317	460	451.5	468.7	4798	189.5	184.1	195
Hunter New England	Males	13913	587	577.2	596.9	5616	249.1	242.6	255.8
	Females	9665	372	364.4	379.6	4188	150.3	145.7	155
	Persons	23578	469.3	463.3	475.4	9804	192.8	188.9	196.6
All NSW	Males	93615	549.9	546.4	553.5	36633	228.2	225.9	230.6
	Females	71071	367.6	364.9	370.3	28680	141.3	139.7	143
	Persons	164686	448.9	.	451.1	65313	178.3	176.9	179.6

Table 42. Cancer incidence data by site (whole population) in Hunter New England Area Health Service, 2003 -2007

Cancer Site	Cases	Percent of total	Crude Rate per 100,000	Directly Std Rate per 100000	Lower 95% CI Dir Std Rate	Upper 95% CI Dir Std Rate
Prostate	4,263	17.4	101.7	83.4	80.9	86.0
Melanoma	2,840	11.6	67.8	60.4	58.2	62.7
Breast	2,781	11.3	66.4	58.3	56.2	60.6
Colon	2,177	8.9	51.9	43.0	41.2	44.8
Lung	2,133	8.7	50.9	42.1	40.4	44.0
Other Cancers	1,523	6.2	36.3	31.3	29.7	32.9
Rectal	1,170	4.8	27.9	23.5	22.2	24.9
Cancer at Indef & Unspec Site	1,008	4.1	24.1	19.7	18.5	21.0
Non-Hodgkins Lymphoma	873	3.6	20.8	17.8	16.7	19.1
Kidney	682	2.8	16.3	13.8	12.8	14.9
Head and Neck	661	2.7	15.8	13.4	12.4	14.5
Leukaemia	638	2.6	15.2	13.1	12.1	14.2
Bladder	539	2.2	12.9	10.4	9.5	11.3
Pancreatic	513	2.1	12.2	10.1	9.2	11.0
Uterus	404	1.6	9.6	8.2	7.4	9.0
Stomach	361	1.5	8.6	7.2	6.5	8.0
Brain	325	1.3	7.8	7.0	6.2	7.8
Oesophagus	269	1.1	6.4	5.3	4.7	6.0
Ovarian	263	1.1	6.3	5.4	4.7	6.1
Thyroid	223	0.9	5.3	5.1	4.4	5.8
Lip	221	0.9	5.3	4.8	4.2	5.5
Liver	216	0.9	5.2	4.3	3.8	5.0
Cervical	181	0.7	4.3	4.2	3.6	4.9
Mesothelioma	146	0.6	3.5	2.9	2.4	3.4
Testicular	113	0.5	2.7	3.0	2.5	3.6

Table 43. Cancer incidence data by site (males) in Hunter New England Area Health Service, 2003 -2007

Cancer Site	Cases	Percent of total	Crude Rate per 100,000	Directly Std Rate per 100000	Lower 95% CI Dir Std Rate	Upper 95% CI Dir Std Rate
Prostate	4,263	17.4	101.7	83.4	80.9	86.0
Melanoma	2,840	11.6	67.8	60.4	58.2	62.7
Breast	2,781	11.3	66.4	58.3	56.2	60.6
Colon	2,177	8.9	51.9	43.0	41.2	44.8
Lung	2,133	8.7	50.9	42.1	40.4	44.0
Other Cancers	1,523	6.2	36.3	31.3	29.7	32.9
Rectal	1,170	4.8	27.9	23.5	22.2	24.9
Cancer at Indef & Unspec Site	1,008	4.1	24.1	19.7	18.5	21.0
Non-Hodgkins Lymphoma	873	3.6	20.8	17.8	16.7	19.1
Kidney	682	2.8	16.3	13.8	12.8	14.9
Head and Neck	661	2.7	15.8	13.4	12.4	14.5
Leukaemia	638	2.6	15.2	13.1	12.1	14.2
Bladder	539	2.2	12.9	10.4	9.5	11.3
Pancreatic	513	2.1	12.2	10.1	9.2	11.0
Uterus	404	1.6	9.6	8.2	7.4	9.0
Stomach	361	1.5	8.6	7.2	6.5	8.0
Brain	325	1.3	7.8	7.0	6.2	7.8
Oesophagus	269	1.1	6.4	5.3	4.7	6.0
Ovarian	263	1.1	6.3	5.4	4.7	6.1
Thyroid	223	0.9	5.3	5.1	4.4	5.8
Lip	221	0.9	5.3	4.8	4.2	5.5
Liver	216	0.9	5.2	4.3	3.8	5.0
Cervical	181	0.7	4.3	4.2	3.6	4.9
Mesothelioma	146	0.6	3.5	2.9	2.4	3.4
Testicular	113	0.5	2.7	3.0	2.5	3.6

Table 44. Cancer incidence data by site (females) in Hunter New England Area Health Service, 2003 -2007

Cancer Site	Cases	Percent of total	Crude Rate per 100,000	Directly Std Rate per 100000	Lower 95% CI Dir Std Rate	Upper 95% CI Dir Std Rate
Breast	2,758	26.6	130.8	112.2	108.0	116.5
Melanoma	1,141	11.0	54.1	48.4	45.5	51.3
Colon	1,055	10.2	50.0	38.5	36.1	40.9
Lung	763	7.4	36.2	28.6	26.6	30.8
Other Cancers	715	6.9	33.9	27.3	25.3	29.4
Cancer at Indef & Unspec Site	486	4.7	23.0	16.9	15.4	18.5
Rectal	450	4.3	21.3	17.1	15.5	18.7
Uterus	404	3.9	19.2	15.7	14.2	17.3
Non-Hodgkins Lymphoma	385	3.7	18.3	14.9	13.4	16.5
Kidney	289	2.8	13.7	10.9	9.7	12.3
Leukaemia	270	2.6	12.8	10.3	9.1	11.7
Ovarian	263	2.5	12.5	10.2	8.9	11.5
Pancreatic	251	2.4	11.9	8.9	7.8	10.1
Cervical	181	1.7	8.6	8.2	7.0	9.5
Head and Neck	165	1.6	7.8	6.5	5.5	7.5
Thyroid	152	1.5	7.2	6.9	5.8	8.1
Bladder	147	1.4	7.0	5.0	4.2	5.9
Brain	141	1.4	6.7	6.0	5.1	7.2
Stomach	126	1.2	6.0	4.6	3.8	5.4
Oesophagus	77	0.7	3.7	2.7	2.1	3.3
Liver	76	0.7	3.6	2.7	2.1	3.4
Lip	57	0.5	2.7	2.2	1.7	2.9
Mesothelioma	15	0.1	0.7	0.5	0.3	0.8
Mesothelioma	146	0.6	3.5	2.9	2.4	3.4
Testicular	113	0.5	2.7	3.0	2.5	3.6

Table 45. Cancer mortality data by site (all population) in Hunter New England Area Health Service, 2003 -2007

Cancer Site	Cases	Percent of total	Crude Rate per 100,000	Directly Std Rate per 100,000	Lower 95% CI Dir Std Rate	Upper 95% CI Dir Std Rate
Lung	1,756	18.3	41.9	34.5	32.9	36.1
Prostate	855	8.9	20.4	16.2	15.2	17.4
Colon	845	8.8	20.2	16.5	15.4	17.6
Cancer at Indef & Unspec Site	758	7.9	18.1	14.7	13.7	15.8
Breast	679	7.1	16.2	13.8	12.8	14.9
Other Cancers	619	6.4	14.8	12.2	11.2	13.2
Pancreatic	464	4.8	11.1	9.1	8.3	9.9
Rectal	450	4.7	10.7	8.9	8.0	9.7
Non-Hodgkins Lymphoma	362	3.8	8.6	7.2	6.4	7.9
Melanoma	335	3.5	8.0	6.8	6.1	7.6
Leukaemia	325	3.4	7.8	6.4	5.7	7.2
Stomach	271	2.8	6.5	5.3	4.7	6.0
Kidney	269	2.8	6.4	5.3	4.7	6.0
Head and Neck	259	2.7	6.2	5.1	4.5	5.8
Bladder	254	2.6	6.1	4.9	4.3	5.5
Brain	233	2.4	5.6	4.9	4.3	5.6
Oesophagus	218	2.3	5.2	4.3	3.7	4.9
Ovarian	172	1.8	4.1	3.4	2.9	3.9
Liver	152	1.6	3.6	3.0	2.5	3.5
Mesothelioma	130	1.4	3.1	2.6	2.1	3.0
Uterus	95	1.0	2.3	1.9	1.5	2.3
Cervical	65	0.7	1.6	1.4	1.1	1.7
Thyroid	20	0.2	0.5	0.4	0.2	0.6
Lip	9	0.1	0.2	0.2	0.1	0.3
Testicular	5	0.1	0.1	0.1	0.0	0.3

Table 46. Breast cancer – incidence and death rates by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England Area Health Service and NSW, incidence 2004 to 2008 and deaths 2003 to 2007 combined

HNEAHS cluster	New cases n	Rate/100,000 person years	LL 95% CI	UL 95% CI	Deaths n	Rate/100,000 person years	LL 95% CI	UL 95% CI
Mehi	83	110.2	87.7	136.7	25	34.1	22	50.3
McIntyre	72	101.6	78.6	129	17	21.5	12.2	34.9
Tablelands	162	110.2	93.6	128.9	23	15.3	9.5	23.2
Peel	227	107.3	93.6	122.5	59	26.8	20.3	34.8
Upper Hunter	103	109	88.8	132.5	23	25.3	15.9	38.1
Lower Hunter	390	101.6	91.7	112.3	107	27	22.1	32.7
Lower Mid North Coast	308	102.3	90.6	115.1	73	21.3	16.5	27.1
Greater Newcastle	1262	102.4	96.8	108.4	348	26.4	23.6	29.4
Hunter New England	2607	104.4	100.4	108.6	676	25.5	23.6	27.6
All NSW	19671	105.1	103.6	106.6	4572	23.4	22.7	24.1

Table 47. Lung cancer – new cases and deaths in males and in females by Hunter New England Area Health Service cluster, Hunter New England Area Health Service and NSW, incidence 2004 to 2008 and deaths 2003 to 2007 combined

HNEAHS cluster	Gender	New cases n	Rate/100 000 person years	LL 95% CI	UL 95% CI	Deaths n	Rate/100 000 person years	LL 95% CI	UL 95% CI
Mehi	Males	63	90.8	68.7	117.5	54	81.1	60	106.9
	Females	25	33.5	21.6	49.5	21	29	17.9	44.4
	Persons	88	60.2	48.2	74.3	75	53.1	41.7	66.8
McIntyre	Males	23	34.9	21.8	52.8	26	40.8	26.4	60
	Females	24	31.7	19.9	47.7	21	27.7	16.7	42.9
	Persons	47	33.1	24.3	44.2	47	34.3	25.1	45.6
Tablelands	Males	62	45.1	34.5	58	55	41.2	31	53.8
	Females	37	22.7	15.9	31.5	32	20.5	14	29
	Persons	99	32.6	26.4	39.7	87	29.3	23.4	36.1
Peel	Males	114	54.5	44.9	65.5	97	47.5	38.4	58.1
	Females	61	25.3	19.3	32.6	50	20.9	15.5	27.6
	Persons	175	38.6	33	44.7	147	32.7	27.6	38.5
Upper Hunter	Males	62	69	52.7	88.8	53	60.5	45.1	79.3
	Females	26	26.9	17.6	39.5	22	22.4	14	34
	Persons	88	46.1	36.9	56.8	75	39.5	31	49.5
Lower Hunter	Males	187	55.4	47.6	64.1	167	52.2	44.5	60.9
	Females	88	22.4	18	27.7	82	21.8	17.3	27.1
	Persons	275	37.2	32.9	41.9	249	35.1	30.8	39.7
Lower Mid North Coast	Males	198	57.2	49.3	66	180	53	45.4	61.4
	Females	99	26.8	21.7	32.8	80	22.1	17.4	27.6
	Persons	297	41.1	36.5	46.2	260	36.4	32	41.1
Greater Newcastle	Males	604	51.6	47.5	55.9	524	46	42.2	50.2
	Females	377	28.2	25.4	31.2	313	22.8	20.3	25.5
	Persons	981	38.7	36.3	41.2	838	33.2	30.9	35.5
Hunter New England	Males	1313	54.8	51.8	57.8	1158	49.8	46.9	52.8
	Females	737	27.2	25.3	29.3	622	22.9	21.1	24.8
	Persons	2050	39.7	38	41.5	1779	34.9	33.3	36.6
All NSW	Males	9203	54.6	53.5	55.7	7750	47.4	46.4	48.5
	Females	5713	28.9	28.1	29.6	4461	22.6	21.9	23.2
	Persons	14916	40.3	39.7	41	12211	33.5	32.9	34.1

Table 48. Lung cancer – new cases (1997 to 2008) and deaths (1997 to 2007) in males and in females, Hunter New England Area Health Service

Year			1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number	New cases	Males	256	285	272	249	288	264	252	286	240	287	306	194
		Females	106	98	108	122	107	147	145	147	158	174	139	119
		Persons	362	383	380	371	395	411	397	433	398	461	445	313
	Deaths	Males	221	222	260	229	249	233	215	267	205	218	253	n/a
		Females	90	93	88	98	99	111	115	111	142	133	121	n/a
		Persons	311	315	348	327	348	344	330	378	347	351	373	n/a
Rate Per 100,000 population	New cases	Males	70.8	72.5	67.4	60.2	66.4	61	57.3	61.9	51.5	60.4	62.3	38.6
		Females	23.9	21.3	22.8	25.4	21.7	29.1	28.1	28.3	29.9	31.8	25.2	21.3
		Persons	43.3	44	42.6	40.9	42	43.1	40.8	43.7	39.5	44.7	42.1	29.2
	Deaths	Males	59.3	59.1	66.1	56	57.9	53.3	48.9	59.1	44.3	45.6	51.5	n/a
		Females	19.7	20.4	18.2	19.7	20.1	21.7	21.7	21.4	26.1	23.6	21.9	n/a
		Persons	36.6	36.4	39.1	35.7	37.1	36	33.7	38.1	34.1	33.5	35.4	n/a

n/a: not available.

Table 49. Colorectal cancer – incidence and death rates by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England Area Health Service and NSW, incidence 2004 to 2008 and deaths 2003 to 2007 combined

HNEAHS cluster	New cases Number	Rate/100,000 person years	LL 95% CI	UL 95% CI	Deaths Number	Rate/100,000 person years	LL 95% CI	UL 95% CI
Mehi	84	60.1	47.8	74.6	34	24.4	16.8	34.3
McIntyre	90	64.3	51.6	79.2	26	18.7	12.2	27.5
Tablelands	172	57.5	49.1	66.8	46	16.1	11.7	21.5
Peel	290	63.8	56.6	71.6	78	17.3	13.7	21.6
Upper Hunter	133	69.3	58	82.2	44	23.1	16.8	31.1
Lower Hunter	484	66	60.2	72.2	169	23.7	20.2	27.5
Lower Mid North Coast	436	61.6	55.8	67.9	110	15.5	12.7	18.7
Greater Newcastle	1538	60.9	57.9	64.1	512	20.3	18.5	22.1
Hunter New England	3227	62.7	60.5	64.9	1020	20	18.8	21.3
All NSW	22142	59.8	59	60.6	6654	18.1	17.7	18.6

Table 50. Prostate cancer – incidence and death rates by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England Area Health Service and NSW, incidence 2004 to 2008 and deaths 2003 to 2007 combined

HNEAHS cluster	New cases Number	Rate/100,000 person years	LL 95% CI	UL 95% CI	Deaths Number	Rate/100,000 person years	LL 95% CI	UL 95% CI
Mehi	152	102.3	86.5	120.2	20	15.3	9.3	23.8
McIntyre	183	128.9	110.7	149.2	31	22.6	15.4	32.1
Tablelands	270	88.3	78	99.5	50	16.3	12.1	21.5
Peel	488	106.1	96.8	115.9	73	16.1	12.6	20.2
Upper Hunter	182	94.5	81.2	109.4	42	21.9	15.8	29.6
Lower Hunter	588	79.2	72.9	85.9	120	17	14.1	20.3
Lower Mid North Coast	715	97.4	90.4	104.9	121	16.2	13.4	19.3
Greater Newcastle	2097	82.4	78.9	86	406	15.1	13.7	16.7
Hunter New England	4675	89.8	87.2	92.4	863	16.4	15.3	17.5
All NSW	29549	79.7	78.8	80.6	4830	12.9	12.5	13.3

Table 51. Melanoma – incidence and death rates by Hunter New England Area Health Service (HNEAHS) cluster, Hunter New England Area Health Service and NSW, persons all ages Incidence 2003 to 2007, Deaths 2002 to 2006 combined

HNEAHS cluster	New cases Number	Rate/100,000 person years	LL 95% CI	UL 95% CI	Deaths Number	Rate/100,000 person years	LL 95% CI	UL 95% CI
Mehi	89	60.8	48.7	74.9	11	7.5	3.7	13.4
McIntyre	70	56.6	43.7	72.0	6	5.3	1.8	11.9
Tablelands	133	48.4	40.4	57.5	13	4.6	2.4	7.9
Peel	199	48.2	41.6	55.5	32	8.0	5.4	11.3
Upper Hunter	96	53.0	42.9	64.8	12	6.6	3.4	11.5
Lower Hunter	401	56.7	51.2	62.5	49	7.2	5.3	9.5
Lower Mid North Coast	367	63.3	56.5	70.6	50	7.3	5.4	9.6
Greater Newcastle	1484	64.5	61.2	68.0	185	7.8	6.7	9.0
Hunter New England	2839	60.4	58.2	62.7	358	7.4	6.7	8.2
All NSW	17333	48.7	48.0	49.4	2178	6.1	5.9	6.4

Table 52. Postal areas for populations greater than 10,000 in the Hunter New England Area Health Service ranked by rate of emergency department visits for Injury (excluding poisoning)

Rank	Age 0-14 years	Age 15-34 years	Age 35-64 years	Age 65+ years
1	2325, Cessnock area	2340, Tamworth area	2340, Tamworth area	2380, Gunnedah area
2	2340, Tamworth area	2325, Cessnock area	2400, Moree area	2325, Cessnock area
3	2400, Moree area	2400, Moree area	2325, Cessnock area	2330, Singleton area
4	2360, Inverell area	2380, Gunnedah area	2333, Muswellbrook area	2340, Tamworth area
5	2330, Singleton area	2360, Inverell area	2380, Gunnedah area	2400, Moree area
6	2380, Gunnedah area	2330, Singleton area	2330, Singleton area	2333, Muswellbrook area
7	2333, Muswellbrook area	2333, Muswellbrook area	2360, Inverell area	2304, Mayfield area
8	2350, Armidale area	2315, Nelson Bay area	2350, Armidale area	2315, Nelson Bay area
9	2315, Nelson Bay area	2320, Maitland area	2320, Maitland area	2280, Belmont area
10	2320, Maitland area	2350, Armidale area	2304, Mayfield area	2360, Inverell area
11	2280, Belmont area	2281, Swansea area	2315, Nelson Bay area	2350, Armidale area
12	2304, Mayfield area	2280, Belmont area	2299, Lambton area	2287, Wallsend area
13	2323, Mulbring area	2324, Hawks Nest area	2323, Mulbring area	2320, Maitland area
14	2430, Taree area	2430, Taree area	2280, Belmont area	2281, Swansea area
15	2281, Swansea area	2323, Mulbring area	2281, Swansea area	2323, Mulbring area
16	2321, Berry Park area	2304, Mayfield area	2322, Beresfield area	2284, Teralba area
17	2324, Hawks Nest area	2321, Berry Park area	2324, Hawks Nest area	2299, Lambton area
18	2299, Lambton area	2322, Beresfield area	2284, Teralba area	2321, Berry Park area
19	2322, Beresfield area	2429, Wingham area	2430, Taree area	2305, New Lambton area
20	2282, Warners Bay area	2284, Teralba area	2321, Berry Park area	2290, Charlestown area
21	2429, Wingham area	2287, Wallsend area	2287, Wallsend area	2282, Warners Bay area
22	2305, New Lambton area	2299, Lambton area	2285, Cardiff area	2285, Cardiff area
23	2284, Teralba area	2282, Warners Bay area	2305, New Lambton area	2322, Beresfield area
24	2287, Wallsend area	2285, Cardiff area	2429, Wingham area	2430, Taree area
25	2285, Cardiff area	2305, New Lambton area	2290, Charlestown area	2291, Merewether area
26	2264, Morisset area	2290, Charlestown area	2282, Warners Bay area	2289, Kotara area
27	2290, Charlestown area	2283, Toronto area	2264, Morisset area	2283, Toronto area
28	2289, Kotara area	2264, Morisset area	2289, Kotara area	2324, Hawks Nest area
29	2318, Williamtown area	2318, Williamtown area	2283, Toronto area	2264, Morisset area
30	2283, Toronto area	2289, Kotara area	2291, Merewether area	2429, Wingham area
31	2291, Merewether area	2291, Merewether area	2318, Williamtown area	2318, Williamtown area
32	2428, Forster area	2428, Forster area	2428, Forster area	2428, Forster area

Table 53. Postal areas for populations greater than 10 000 in the Hunter New England Area Health Service ranked by rate of emergency department visits for headache/migraine.

Rank	Age 0-14 years	Age 15-34 years	Age 35-64 years	Age 65+ years
1	2380, Gunnedah area	2340, Tamworth area	2400, Moree area	2333, Muswellbrook area
2	2340, Tamworth area	2400, Moree area	2360, Inverell area	2299, Lambton area
3	2360, Inverell area	2325, Cessnock area	2340, Tamworth area	2360, Inverell area
4	2325, Cessnock area	2360, Inverell area	2325, Cessnock area	2400, Moree area
5	2400, Moree area	2330, Singleton area	2333, Muswellbrook area	2323, Mulbring area
6	2284, Teralba area	2380, Gunnedah area	2330, Singleton area	2287, Wallsend area
7	2333, Muswellbrook area	2333, Muswellbrook area	2380, Gunnedah area	2280, Belmont area
8	2281, Swansea area	2320, Maitland area	2315, Nelson Bay area	2281, Swansea area
9	2304, Mayfield area	2280, Belmont area	2320, Maitland area	2290, Charlestown area
10	2320, Maitland area	2323, Mulbring area	2322, Beresfield area	2380, Gunnedah area
11	2280, Belmont area	2350, Armidale area	2323, Mulbring area	2285, Cardiff area
12	2315, Nelson Bay area	2430, Taree area	2287, Wallsend area	2264, Morisset area
13	2430, Taree area	2315, Nelson Bay area	2304, Mayfield area	2330, Singleton area
14	2282, Warners Bay area	2324, Hawks Nest area	2430, Taree area	2429, Wingham area
15	2324, Hawks Nest area	2304, Mayfield area	2324, Hawks Nest area	2289, Kotara area
16	2299, Lambton area	2299, Lambton area	2350, Armidale area	2283, Toronto area
17	2323, Mulbring area	2321, Berry Park area	2280, Belmont area	2340, Tamworth area
18	2330, Singleton area	2322, Beresfield area	2299, Lambton area	2282, Warners Bay area
19	2287, Wallsend area	2284, Teralba area	2284, Teralba area	2304, Mayfield area
20	2321, Berry Park area	2287, Wallsend area	2321, Berry Park area	2321, Berry Park area
21	2350, Armidale area	2281, Swansea area	2283, Toronto area	2325, Cessnock area
22	2291, Merewether area	2285, Cardiff area	2285, Cardiff area	2320, Maitland area
23	2290, Charlestown area	2264, Morisset area	2264, Morisset area	2430, Taree area
24	2322, Beresfield area	2305, New Lambton area	2429, Wingham area	2284, Teralba area
25	2305, New Lambton area	2283, Toronto area	2289, Kotara area	2324, Hawks Nest area
26	2429, Wingham area	2290, Charlestown area	2281, Swansea area	2315, Nelson Bay area
27	2289, Kotara area	2429, Wingham area	2318, Williamtown area	2350, Armidale area
28	2285, Cardiff area	2289, Kotara area	2305, New Lambton area	2322, Beresfield area
29	2283, Toronto area	2282, Warners Bay area	2290, Charlestown area	2305, New Lambton area
30	2318, Williamtown area	2318, Williamtown area	2282, Warners Bay area	2291, Merewether area
31	2428, Forster area	2291, Merewether area	2291, Merewether area	2428, Forster area
32	2264, Morisset area	2428, Forster area	2428, Forster area	2318, Williamtown area

Table 54. Postal areas for populations greater than 10 000 in the Hunter New England Area Health Service ranked by rate of emergency department visits for gastrointestinal problems

Rank	Age 0-14 years	Age 15-34 years	Age 35-64 years	Age 65+ years
1	2340, Tamworth area	2340, Tamworth area	2340, Tamworth area	2360, Inverell area
2	2400, Moree area	2325, Cessnock area	2400, Moree area	2380, Gunnedah area
3	2380, Gunnedah area	2330, Singleton area	2325, Cessnock area	2333, Muswellbrook area
4	2325, Cessnock area	2380, Gunnedah area	2360, Inverell area	2330, Singleton area
5	2360, Inverell area	2360, Inverell area	2380, Gunnedah area	2340, Tamworth area
6	2330, Singleton area	2400, Moree area	2330, Singleton area	2325, Cessnock area
7	2333, Muswellbrook area	2315, Nelson Bay area	2333, Muswellbrook area	2320, Maitland area
8	2315, Nelson Bay area	2333, Muswellbrook area	2320, Maitland area	2400, Moree area
9	2320, Maitland area	2320, Maitland area	2315, Nelson Bay area	2323, Mulbring area
10	2304, Mayfield area	2350, Armidale area	2323, Mulbring area	2287, Wallsend area
11	2323, Mulbring area	2323, Mulbring area	2350, Armidale area	2315, Nelson Bay area
12	2299, Lambton area	2430, Taree area	2322, Beresfield area	2321, Berry Park area
13	2350, Armidale area	2321, Berry Park area	2304, Mayfield area	2284, Teralba area
14	2287, Wallsend area	2324, Hawks Nest area	2324, Hawks Nest area	2281, Swansea area
15	2284, Teralba area	2322, Beresfield area	2284, Teralba area	2299, Lambton area
16	2324, Hawks Nest area	2304, Mayfield area	2321, Berry Park area	2322, Beresfield area
17	2285, Cardiff area	2429, Wingham area	2430, Taree area	2304, Mayfield area
18	2321, Berry Park area	2281, Swansea area	2280, Belmont area	2285, Cardiff area
19	2322, Beresfield area	2280, Belmont area	2287, Wallsend area	2350, Armidale area
20	2430, Taree area	2264, Morisset area	2299, Lambton area	2280, Belmont area
21	2280, Belmont area	2283, Toronto area	2283, Toronto area	2324, Hawks Nest area
22	2305, New Lambton area	2284, Teralba area	2264, Morisset area	2282, Warners Bay area
23	2289, Kotara area	2287, Wallsend area	2281, Swansea area	2305, New Lambton area
24	2283, Toronto area	2299, Lambton area	2285, Cardiff area	2290, Charlestown area
25	2264, Morisset area	2305, New Lambton area	2290, Charlestown area	2289, Kotara area
26	2290, Charlestown area	2318, Williamtown area	2305, New Lambton area	2291, Merewether area
27	2281, Swansea area	2290, Charlestown area	2429, Wingham area	2430, Taree area
28	2282, Warners Bay area	2285, Cardiff area	2318, Williamtown area	2283, Toronto area
29	2318, Williamtown area	2289, Kotara area	2282, Warners Bay area	2264, Morisset area
30	2291, Merewether area	2282, Warners Bay area	2289, Kotara area	2429, Wingham area
31	2429, Wingham area	2428, Forster area	2428, Forster area	2428, Forster area
32	2428, Forster area	2291, Merewether area	2291, Merewether area	2318, Williamtown area

Figure 23. Deaths from all causes (males and females) in Hunter New England Area Health Service, 1992-2006

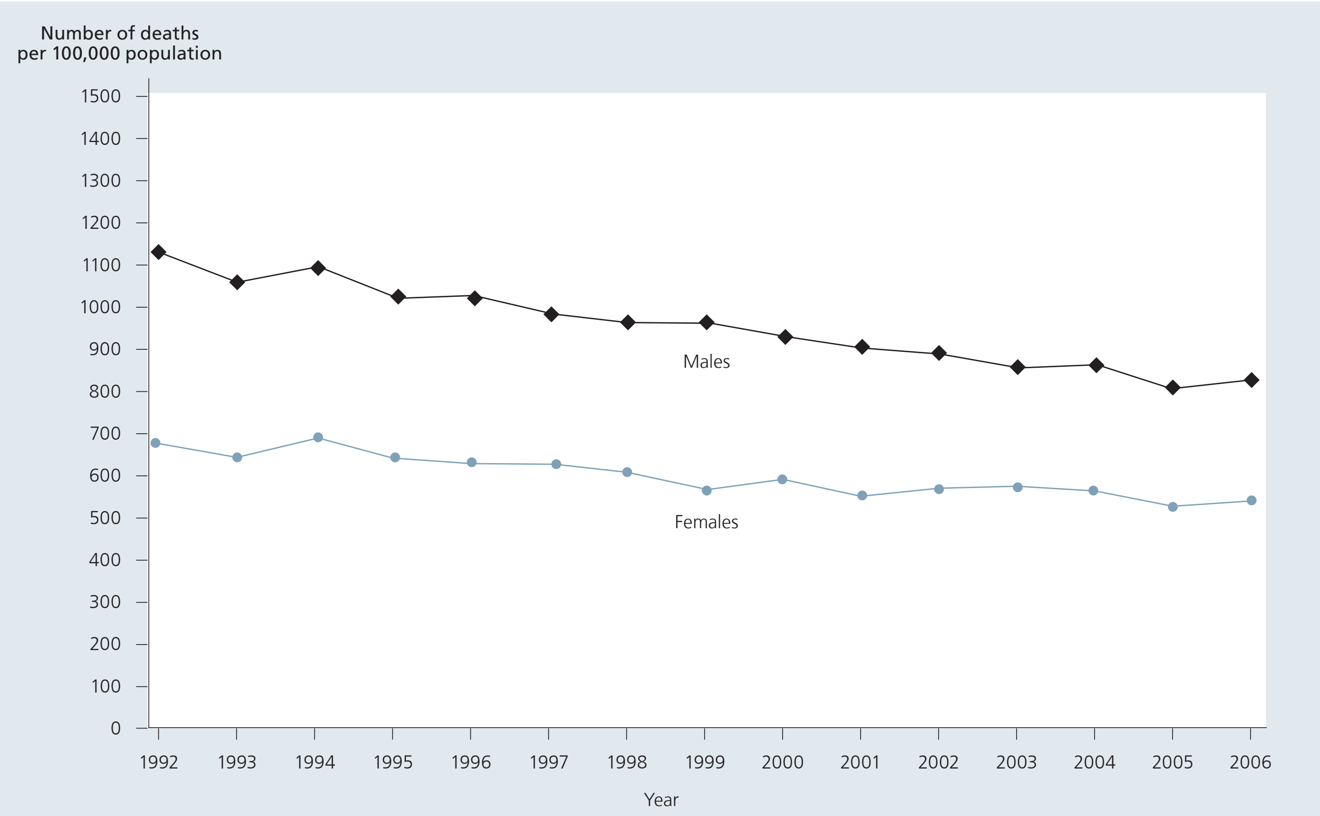


Figure 31. All cancers – new cases and deaths in Hunter New England Area Health Service

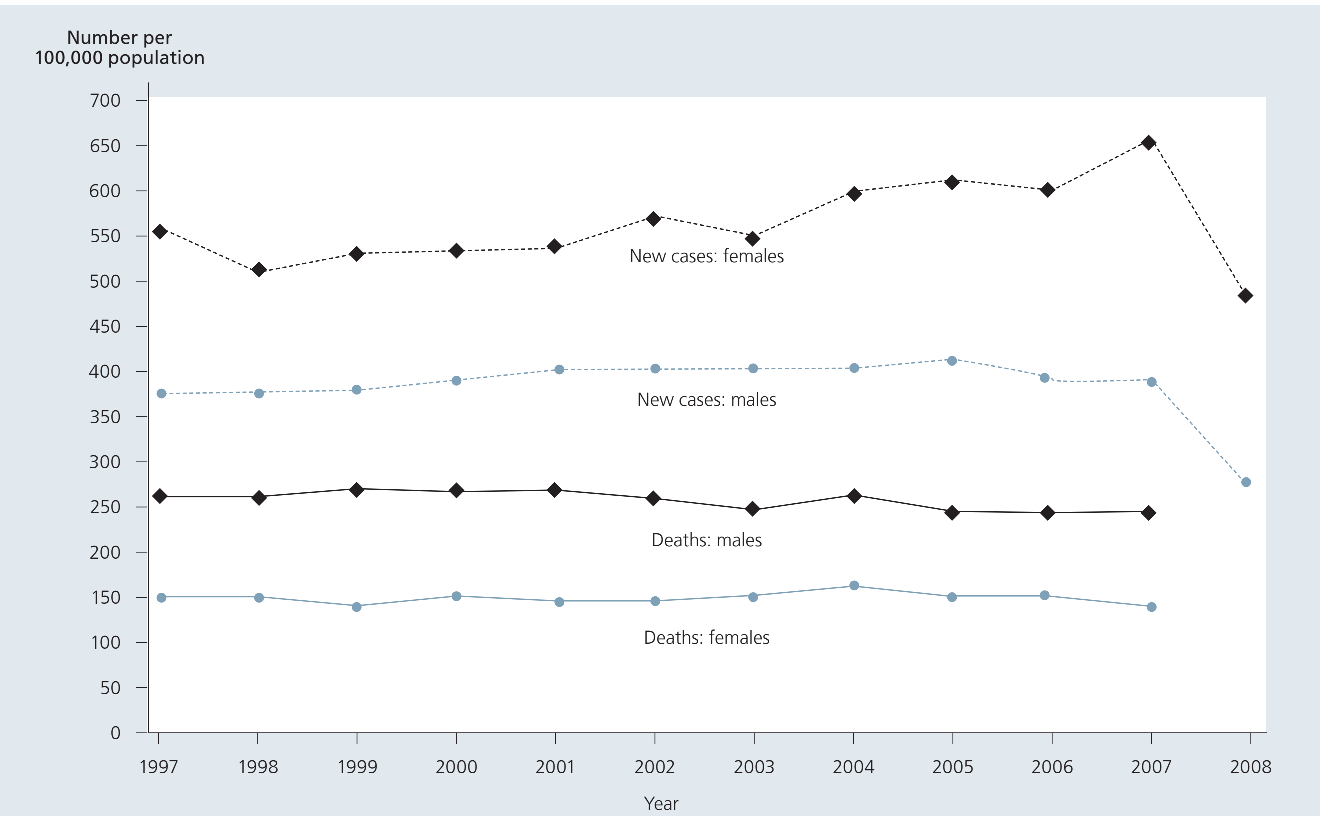
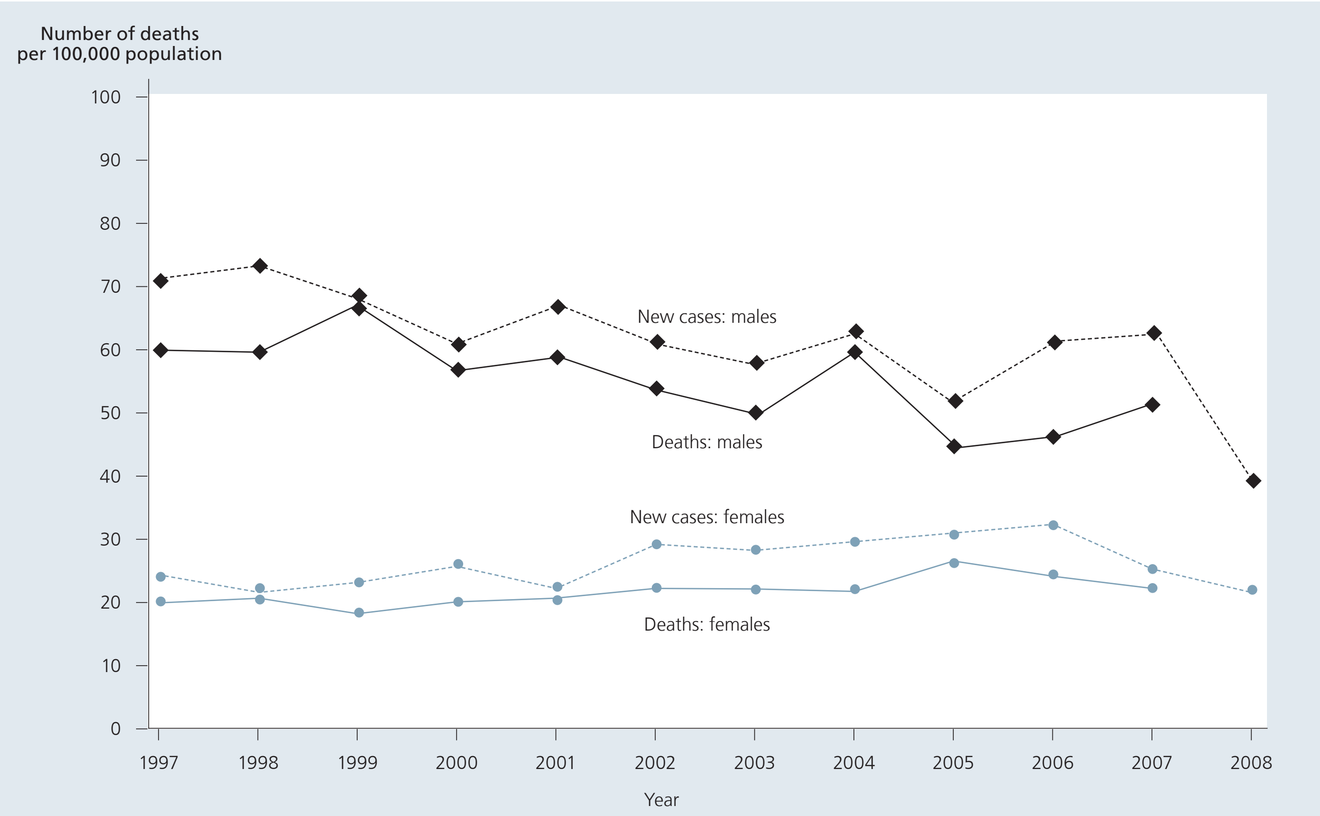


Figure 39. Lung cancer incidence and deaths in Hunter New England Area Health Service 1997-2008



Survey questions from the NSW Population Health Survey
(Section 4)

Methods used in the NSW Population Health Survey

Survey instrument

The content of the survey was developed by the NSW Health Survey Program in consultation with key stakeholders, area health services, other government departments, and a range of experts. The survey included questions used in previous surveys and new questions developed specifically for 2007 and 2008.

All new questions not previously used were submitted to NSW Health's Population and Health Services Research Ethics Committee for approval prior to use. New questions were also field-tested prior to inclusion in the survey.

Survey sample

In 2007 and 2008, the target population for the child component of the New South Wales Population Health Survey was all children aged 0-15 years living in households with private telephones. For each year, the target sample comprised approximately 475 children in each of the 8 area health services (total sample of 7,600 over 2 years). A total of 757 children participated in the Hunter New England Area Health Service in 2006-2008. Data is also available for 5532 adults interviewed between 2004-2008.

The sampling frame was developed as follows. Records from the Australia on Disk electronic white pages (phone book) were geo-coded using MapInfo mapping software. The geo-coded telephone numbers were assigned to statistical local areas and area health services. The proportion of numbers for each telephone prefix by area health service was calculated. All prefixes were expanded with suffixes ranging from 0000 to 9999. The resulting list was then matched back to the electronic phone book. All numbers that matched numbers in the electronic phone book were flagged and the number was assigned to the relevant geo-coded area health service. Unlisted numbers were assigned to the area health service containing the greatest proportion of numbers with that prefix. Numbers were then filtered to eliminate contiguous unused blocks of greater than 10 numbers. The remaining numbers were then checked against the business numbers in the electronic phone book to eliminate business numbers. Finally, numbers were randomly sorted. Households were contacted using random digit dialling. One person from the household was randomly selected for inclusion in the survey.

Interviews

In 2007 and 2008, interviews were carried out continuously between February and December. Selected households that had addresses in the electronic phone book were sent a letter describing the aims and methods of the survey 2 weeks prior to initial attempts at telephone contact. An 1800 freecall contact number was provided for potential respondents to verify the authenticity of the survey and to ask any questions regarding the survey. Trained interviewers at the Health Survey Program CATI facility carried out interviews.

Up to seven calls were made to establish initial contact with a household, and five calls were made in order to contact a selected respondent. If the selected respondent was a child under the age of 16 years, a parent or carer was selected as a proxy respondent.

Questions used from the health-related quality of life questionnaire

Children

Q1. Overall, how would you rate child's health during the last 4 weeks? [READ OUT] [ASKED IF CHILD AGED 5-15 YEARS]

1. Excellent
2. Very good
3. Good
4. Fair
5. Poor
6. Very poor

X Don't know
R Refused

Q2. During the last 4 weeks how much difficulty did child have doing his-her daily work or activities? [READ OUT] [ASKED IF CHILD AGED 5-15 YEARS]

1. No difficulty at all
2. A little bit of difficulty
3. Some difficulty
4. Much difficulty
5. Could not do work or activities

X Don't know
R Refused

Q3. During the last 4 weeks how much bodily pain has child generally had? [READ OUT] [ASKED IF CHILD AGED 5-15 YEARS]

1. None
2. Very mild
3. Mild
4. Moderate
5. Severe
6. Very severe

X Don't know
R Refused

Adults

Q1. Overall, how would you rate your health during the last 4 weeks? [READ OUT]

1. Excellent
2. Very good
3. Good
4. Fair
5. Poor
6. Very poor

X Don't know
R Refused

Q2. During the last 4 weeks how much difficulty did you have doing your daily work or activities? [READ OUT]

1. No difficulty at all
2. A little bit of difficulty
3. Some difficulty
4. Much difficulty
5. Could not do work or activities

X Don't know
R Refused

Q3. During the last 4 weeks how much bodily pain have you generally had? [READ OUT]

1. No pain
2. Very mild pain
3. Mild pain
4. Moderate pain
5. Severe pain

X Don't know
R Refused

Questions used from the asthma questionnaire

Q1. Has child ever been told by a doctor or hospital he-she has asthma? [ASKED IF CHILD AGED 2-15 YEARS]
1. Yes
2. No
X Don't know
R Refused

Q2. Has child had symptoms of asthma or taken treatment for asthma in the last 12 months? [ASKED IF CHILD AGED 2-15 YEARS]
1. Yes, symptoms
2. Yes, treatment
3. Yes, both
4. No
X Don't know
R Refused

Q3. During the last 4 weeks did child's asthma interfere with his-her ability to manage his-her day-to-day activities? [ASKED IF CHILD AGED 2-15 YEARS]
1. Yes
2. No ➞ Q6
X Don't know ➞ Q6
R Refused ➞ Q6

Q4. Did it interfere with these activities? [READ OUT] [ASKED IF CHILD AGED 2-15 YEARS]
1. A little bit
2. Moderately
3. Quite a bit
4. Extremely
X Don't know
R Refused

Q5. Does child have a written asthma management plan from his-her doctor on how to treat his-her asthma? [ASKED IF CHILD AGED 2-15 YEARS]
1. Yes
2. No
X Don't know
R Refused

Q6. What are the names or brands of all the medications child took for asthma in the last 12 months? [READ OUT] [ASKED IF CHILD AGED 2-15 YEARS]
1. _______ [SPECIFY]
X Don't know

R Refused

Questions used from the smoking questionnaire

Q1. Which of the following best describes your smoking status? This includes cigarettes, cigars and pipes. [READ OUT]
1. I smoke daily
2 I smoke occasionally
3. I don't smoke now, but I used to ➞ Q5
4. I've tried it a few times but never smoked regularly ➞ Q5
5. I've never smoked ➞ Q5
X Don't know ➞ Q5
R Refused ➞ Q5

Q2. Which of the following best describes how you feel about your smoking?[READ OUT]
1. I am not planning on quitting within the next 6 months
2. I am planning on quitting within the next 6 months
3. I am planning on quitting within the next month
4. I have not smoked in the last 24 hours but was smoking 6 months ago ➞ Q5
5. I have not been smoking in the last 6 months ➞ Q5
X Don't know ➞ Q5
R Refused ➞ Q5

Q3. How soon after you wake do you smoke your first cigarette? [READ OUT]
1. Less than or equal to 5 minutes
2. 6-30 minutes
3. 31-60 minutes
4. Longer than 60 minutes
X Don't know
R Refused

Q4. The last time you went to your general practitioner, did the doctor discuss your smoking and advise you to quit smoking?
1. Yes
2. No
X Don't know
R Refused

Q5. Which of the following best describes your home situation? [READ OUT]

1. My home is smoke-free (includes smoking is allowed outside only)
2. People occasionally smoke in the house
3. People frequently smoke in the house

X Don't know

R Refused

Q6. Are people allowed to smoke in your car?

1. Yes
2. No
3. Don't have a car

X Don't know

R Refused

Q7. If there was a total ban on smoking in hotels and licensed bars, would you be likely to go there: [READ OUT]

1. More often?
2. Less often?
3. It would make no difference

X Don't know

R Refused

Q8. If there was a total ban on smoking in outdoor dining areas, would you be likely to go there: [READ OUT]

1. More often?
2. Less often?
3. It would make no difference

X Don't know

R Refused

Q9. Do you support a regulation to ensure that, in shops, cigarettes are stored out of sight?

1. Yes
2. No

X Don't know

R Refused

SHPN (PHPP) 100110

Muswellbrook Mine Affected Roads

Stage 1 - Road Network Plan

81014003

Prepared for
Muswellbrook Shire Council

27 August 2015

muswellbrook shire council

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Shaping the Future

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Ver 1	Oct 2013	Draft	KHB/TKG		KDB	
Ver 2	March 2014	Draft	KHB/TKG		KDB	
Ver 3	May 2014	Draft	KHB/TKG		KDB	
Ver 4	June 2014	Draft	Initials		Initials	
Ver 6	July 2014	Draft	KHB/TKG		KDB	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
Ver 5	Draft for Review	KDB		26 June 2014
Ver 7	Revised Draft for Review	KDB		September 2014
Ver 9	Final Draft	KDB		19 January 2015
Ver 10	Final Draft with Steering Comm Comments	KDB		23/2/15
Ver 11	Final Draft (for Exhibition Purposes)	KDB		27/3/15
Ver 12	Final	KHB	K. Blackmore	4/8/15
Ver 13	Final (for Exhibition Purposes)	MSC		27/8/15

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Appendices

Tables

Figures

Executive Summary

Cardno (NSW/ACT) Pty Ltd have been engaged by Muswellbrook Shire Council to undertake an assessment of the impacts of mine related traffic on the local road network with the intention of ascertaining the proportion of mine related traffic using the roads as a basis for the subsequent preparation of a Developer Contributions Plan that would justify the imposition of contributions towards the provision and maintenance of road infrastructure in the medium (20 years) and long term (40 years).

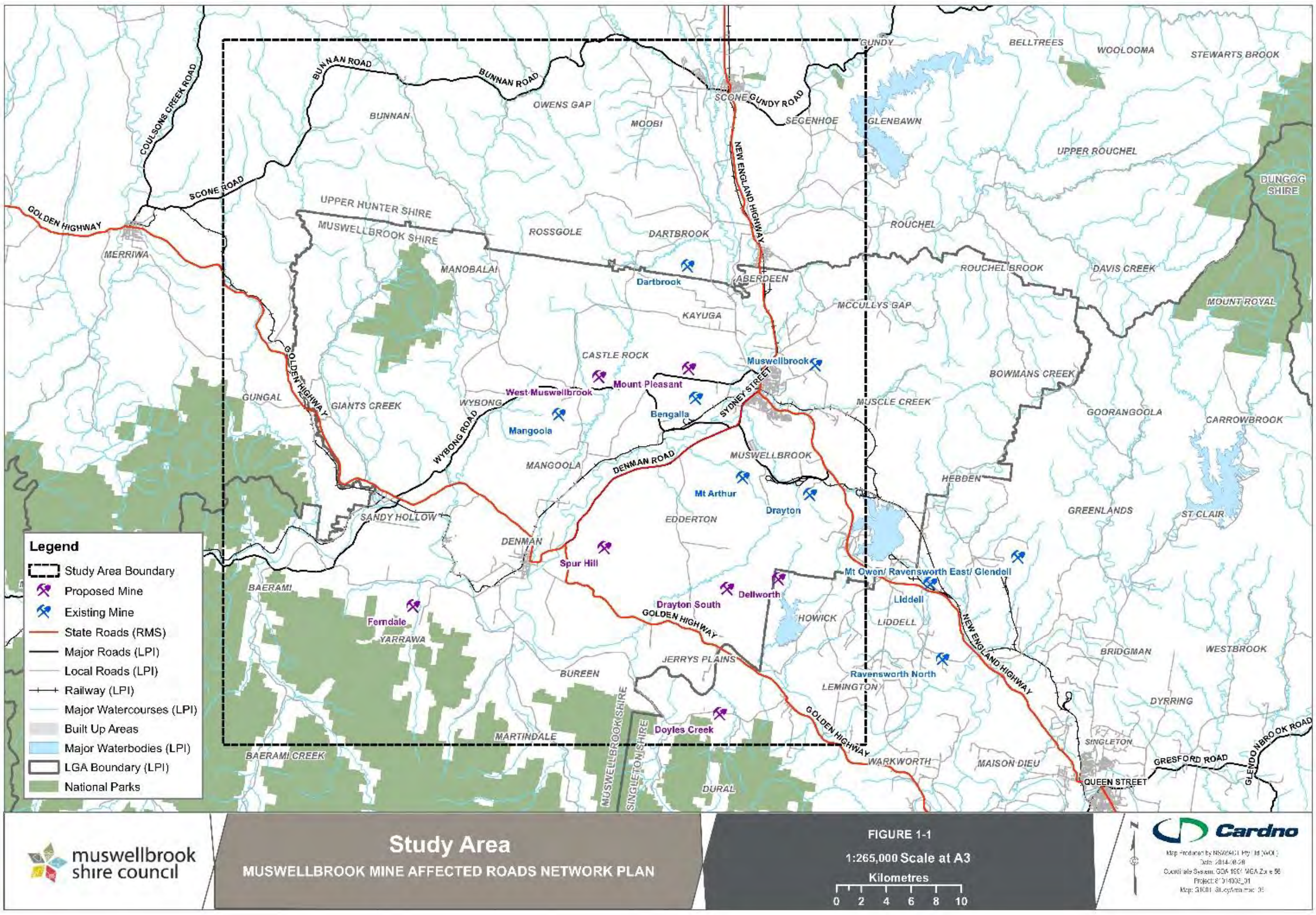


Figure 1-1 Study Area

The overall project involves:

STAGE 1 – Traffic Modelling and Network Planning

- Information gathering
- Traffic Modelling to determine the baseline
- Traffic forecasting in relation to 20 and 40 year growth scenarios
- Analysis of route options
- Preparation of a Road Network Plan

STAGE 2 – Implementation Strategy and Developer Contributions Plan

- Review of the financial management systems
- Works scheduling and cost apportionment (required upgrading and maintenance of local roads)
- Preparation of a Mine Contributions Strategy (based on the apportionment of traffic directly attributable to existing and future mining operations in the Shire).

Stage 1 Road Retwork Plan Findings and Recommendations

The strategies and recommendations of this Road Network Plan are based on the analysis of data from the November 2013 traffic survey, past surveys, and growth forecasts determined from the best available information in relation to mining proposals and known road network infrastructure initiatives. The main findings and recommendations of this Plan are as follows:

1. The Coal Mining Industry will remain the primary source of energy production for global electricity and steel production, with the demand for coal from the Upper Hunter to remain steady for the foreseeable future (>40 years).
2. An assessment of the existing road conditions identified that all road sections within the study area currently operate within the acceptable Level of Service (LoS) C, or within the designated network class average level of service, apart from Thomas Mitchell Drive (North) between Denman Road to the Industrial Area which was identified as having a deficient mid-block Level of Service of D and, as at November 2013, operates over its effective capacity by 124 veh/hr.
3. The majority of mine-related traffic generated by the four larger (most contributing) mines (being Mangoola, Bengalla, Mt Arthur and Drayton Mines) is currently concentrated on the route comprising Wybong Road, Bengalla Link Road, Denman Road and Thomas Mitchell Drive. Currently available alternatives to this route are convoluted and/or unsuitable for one or more reasons (ie. Kayuga Road via the bridge and Muswellbrook town centre, Roxburgh Road and Mangoola Road, Wybong Road (West) to Sandy Hollow and Edderton Road). As mine-related and local traffic increases, an option (or options) to better distribute the traffic will become critical for the safety of road users and the efficient movement of vehicles within the road network.
4. The following traffic related observations have been made in relation to mine growth forecasting:
    i. The existing larger mines are currently seeking to move in a westerly direction (exception being Mangoola).
    ii. As a consequence of the commencement of the currently proposed mine expansions and new mines up to the Year 2024 (ie. in the short term 0-10 years), there will likely be:
        - A potential increase in the number of full-time equivalent employees (fte's) at the Mangoola Mine for 15 years from 300 to 540 (depending on product demand); and,
        - More than a doubling of employee numbers at the Bengalla Mine from 2018 (400 fte's to 900 fte's) for 21 years; and,
        - An additional 256 fte's plus mining related traffic will be introduced to the road network from the proposed Mt Pleasant Mine starting 2018-2020 (assumed) for 21 years; and,
        - An additional 400 fte's plus mining related traffic will be introduced to the road network from the proposed Spur Hill Mine starting in 2019-2020 (assumed) for 25 years.
    iii. In the medium term (10-20 years) there may be a number of new mines commencing operations within the Shire, these being the West Muswellbrook Mine in the north and to the Ferndale Mine to the west. It is noted that the proposed West Muswellbrook Mine proposes the closure of a number of minor local rural roads within the North-west of the Study area and will also involve a rail line connection to the South that may cross some of the proposed new road network. The proposed road closures relate to minor roads only and do not affect the overarching strategy recommendations.
    iv. In the longer term (20-40+ years), there are likely to be a number of new mines further to the north-west (along Ridgelands Road and other locations within the North-West Crown Authority area) that will generate significant mine-related traffic movements in a location not immediately accessible to a suitable local or main arterial road.

v. On the assumption that demand for coal from the Hunter will remain steady for the foreseeable future, it is likely that new mines will only open as the established mines close down. Consequently, it is anticipated that with improved efficiencies in the coal industry, the amount of mine-related traffic on the local road network will remain relatively steady, albeit originating from changing locations over time.

5. In combination with the natural increase in background traffic growth of around 1% per annum, there will be a need for alternative travel routes to and from the mine locations connecting to the State Road Network (Denman Road, the Golden Highway and the New England Highway). These routes need to be of an appropriate standard to cater for the efficient and safe movement of both light and heavy vehicles to destinations within Muswellbrook LGA (the town centre, population centres and the industrial area) as well as destinations outside of the Shire (primarily south on the New England Highway and to a lesser degree north to Scone).
6. Given the constraints posed by the Hunter River floodplain, the coal haulage rail line, and the areas of coal extraction themselves, there are limited options for the location of new efficient travel paths. This Network Plan has considered a number of route options in relation to their benefits and costs, and also in relation to the likely timing of proposed new mines and expansion of existing mines.

The detailed analysis of the various options considered to address future demand is provided. The evaluation has determined that the following strategies offer the best solution in the short, medium and long term.

To improve the connectivity of Wybong Road to the New England Highway north of Muswellbrook:

1. Replace the Kayuga Bridge in its current location (Option 1C);
2. Upgrade Aberdeen Street from Kayuga Bridge to the New England Highway; and,
3. Upgrade Wybong Road (East) and Kayuga Road from the new southern Link Road to Kayuga Bridge.

To address the proposed closure of sections of Wybong Road and Castlerock Road to facilitate coal extraction by the Mt Pleasant Mine:

4. Construct a Southern Link Road connecting Wybong Road (East) via Overton Road to the Bengalla Link Road west of the Hunter River crossing (Option 2B) in lieu of the previously proposed Northern and Western Link Roads; and,
5. Connect Castlerock Road to Dorset Road (to local road standard) to facilitate access to properties on these roads;
6. Should Mt Pleasant Mine not proceed and Wybong Road not be closed in 2026, Wybong Road from the Bengalla Link Road to Kayuga Road will need to be upgraded to maintain a safe and efficient movement of vehicles over this section of road to a standard appropriate to accommodate anticipated traffic volumes from background growth and new mines proposed further west.

To improve connectivity to, and the functioning of, the Main Road Network:

7. Modify the proposed Bengalla Link Road Diversion (Option 3A) to facilitate a north-western extension in the longer term (funded by new mines in the west);
8. Upgrade Roxburgh Road and Wybong Road connections to the Bengalla Link Road;
9. Upgrade Wybong Road (West) (Option 3C) and Reedy Creek Road (Option 3D) in the long term;
10. Pursue the reclassification of Thomas Mitchell Drive as a Main Arterial Road under the care and control of NSW Roads and Maritime Services;
11. Examine opportunities to forego the temporary relocation of Edderton Road on the less efficient alignment (as proposed by Mt Arthur Mine and the proposed Drayton South Mine) in lieu of contributions for works to improve the safety and efficiency of Denman Road and the Golden Highway;

12. In the longer term, at completion of mining activity, the Road Authority prefers Edderton Road to be reconstructed in generally it's current more efficient alignment with upgraded intersections at Denman Road and the Golden Highway at design standards appropriate at the time and considering traffic growth over the period.
13. Consult with NSW Roads and Maritime Services in relation to options to avoid or rectify problems associated with the Golden Highway. In particular:
    - the Ogilvies Hill ascents;
    - the ability of the bridge crossing of the Hunter River near Denman to accommodate oversize vehicles;
    - potential mine subsidence impacts from proposed underground mining; and,
    - main road traffic within Denman township.

Figures 6-1 to 6-3 below show the specific initiatives that form the Road Network Plan recommendations above.

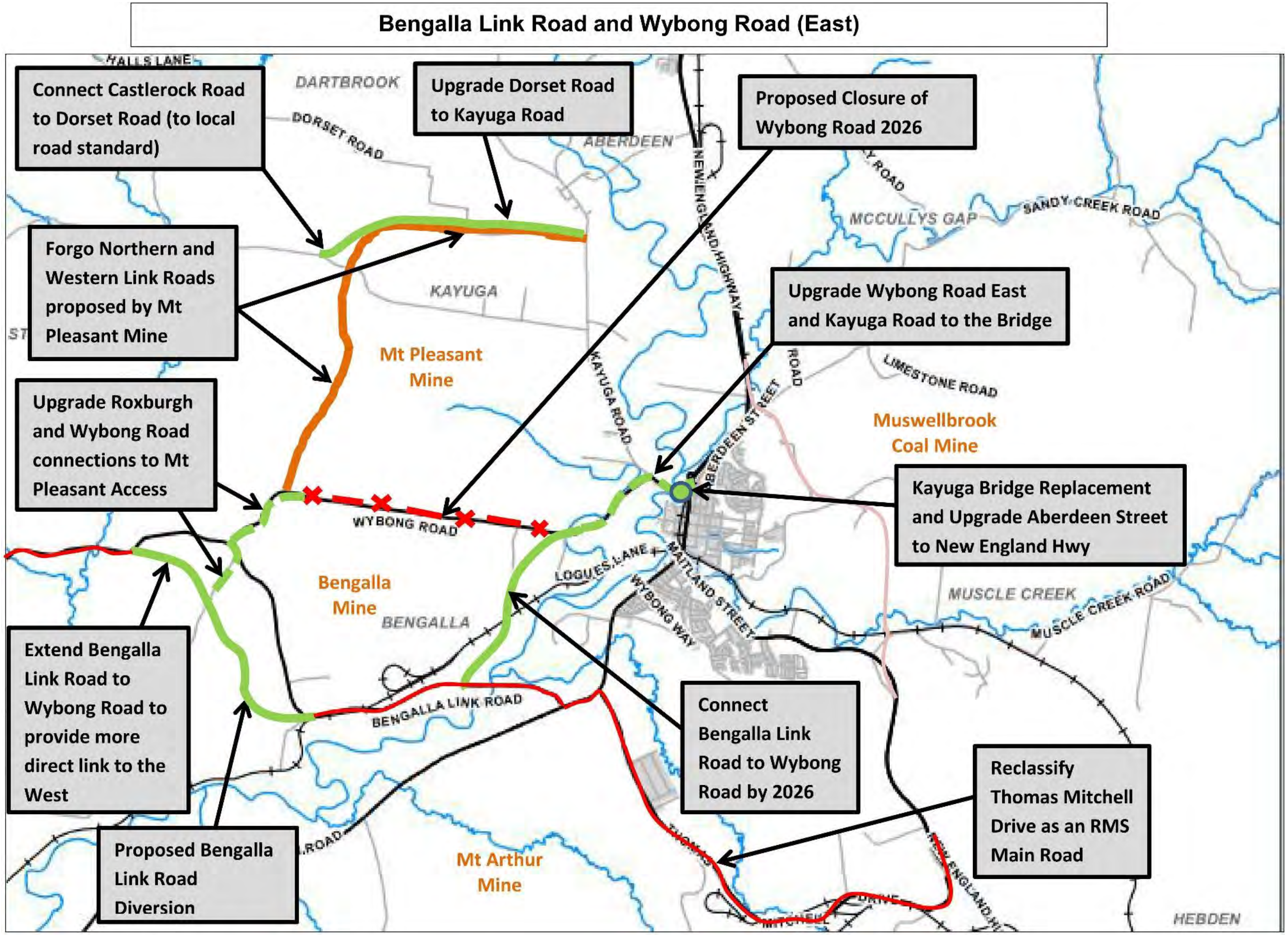


Figure 6-1 Road Network Plan (North-eastern Sector)

Edderton Road and Golden Highway

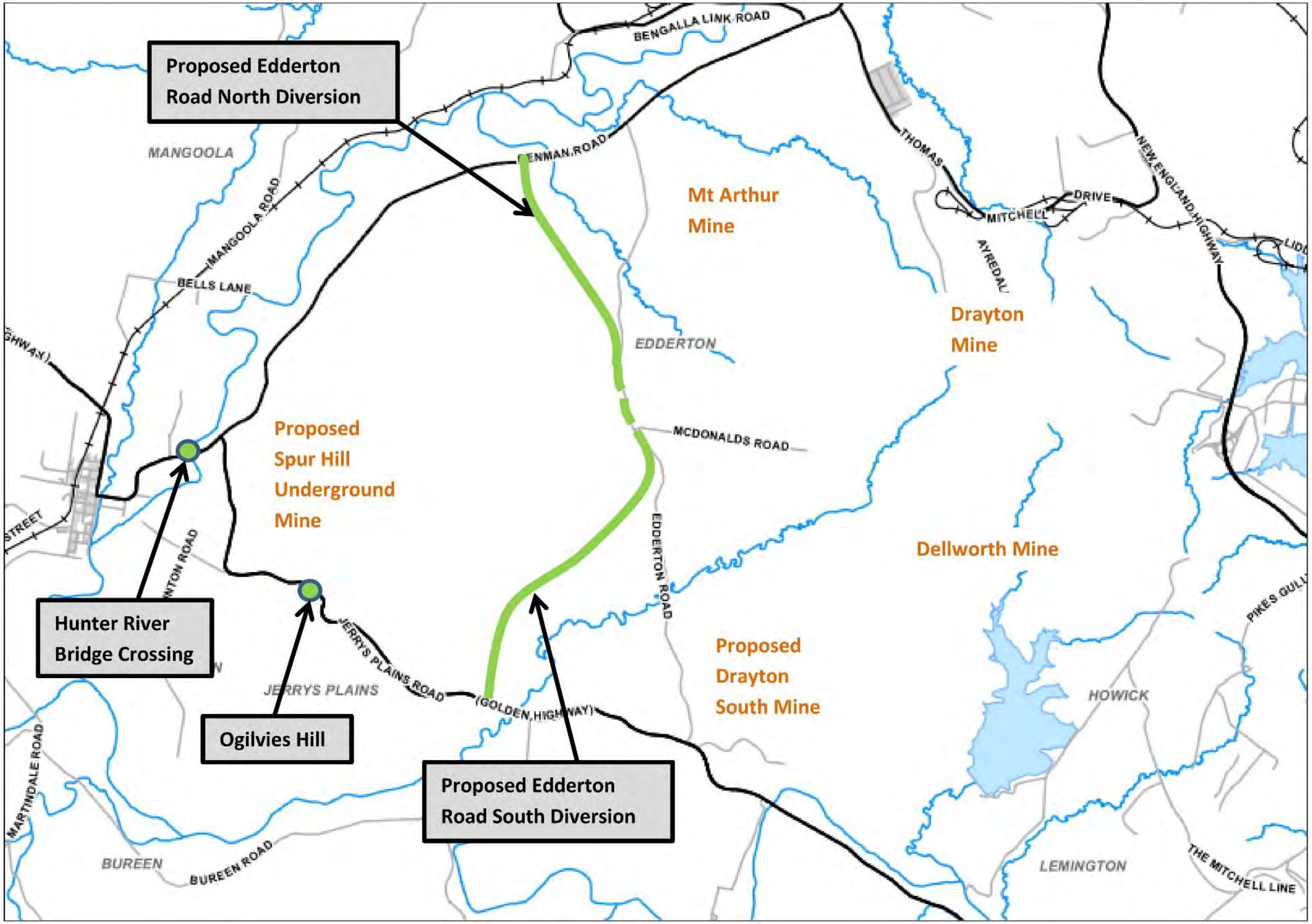


Figure 6-2 Road Network Plan (Southern Sector)

Wybong Road (West) and Reedy Creek Road

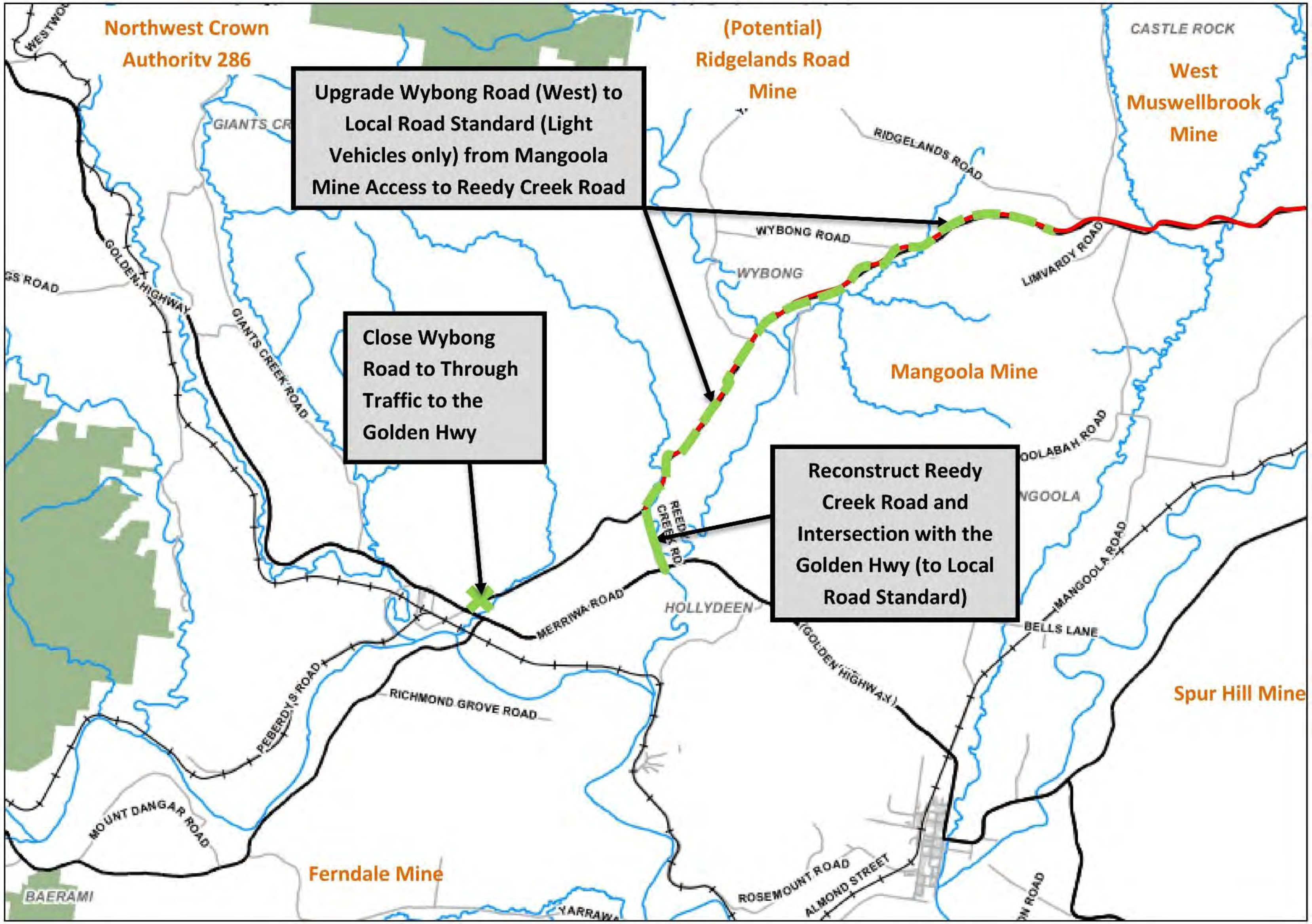


Figure 6-3 Road Network Plan (Western Sector)

1 Introduction

1.1 Background

Mines have been a major part of the Hunter Region's communities for more than 100 years. Many communities have been built from and around the economic activity generated by the minerals industry. The proximity of many mining operations to major population centres, particularly in the Upper Hunter, means that these Councils face different challenges to other more isolated mining areas. While Muswellbrook Shire Council (MSC) acknowledges the advantages associated with the coal industry in the form of both direct and indirect employment opportunities and increased expenditure, it is becoming increasingly evident that mine related traffic is having a significant impact on the local roads with correspondingly significant financial implications for the road authorities (Council and the NSW Roads and Maritime Services). The potential for new mines to be established in the area is likely to place additional demands on both the road network and on funding for maintenance and upgrades.

Council previously prepared a Strategy (1997) for the Western Roads which sought to manage the traffic demands on the local road network created by 3 mines (Mangoola, Bengalla and Mt Pleasant Mines). There are also a number of separate road maintenance agreements in place as conditions of consent. However, the contributions that are being received are not significant in the context of the broader road network and the overall impacts of mine related traffic movements from existing and proposed mines within Muswellbrook Shire and from surrounding Local Government Areas.

There is clearly a need to properly justify the proportional funding of the upgrading and maintenance of an integrated road network based on the nexus created by individual mines within Muswellbrook Shire. Consequently, Council is seeking the preparation of a Mine Affected Roads Network Plan, an Implementation and Funding Strategy and a Contributions Strategy.

Stage 1 of the project, involves the preparation of this Road Network Plan. This will enable Council to develop a broad understanding of the current performance of the network and also its future performance based on forecast demands.

1.2 Objectives

The Overall Project Objectives are to:

- Maintain the road network to retain value, quality and capacity;
- Provide a safer road environment for all road users;
- Optimise the efficiency and reliability of moving people and goods;
- Meet the needs of present and future land use development.

Stage 1 of this project involves the development of an appropriate arterial and collector Road Network Plan. This Plan is to be used to assist with the long term management of the road network and in the preparation of a Contributions Strategy related to Mine Affected Roads within the Muswellbrook LGA. In this regard, the Objectives for Stage 1 are to:

- Identify the extent to which roads within the local government area are being utilised by mining related vehicles;
- Based on the best available information, forecast the likely growth in traffic for 20 and 40 year time frames;
- Provide discussion in relation to the likely future demands on the road network and options to best meet the forecast demands;
- To establish a basis upon which justification for the introduction of a fair and equitable developer contributions plan specific to mining related traffic can occur.

1.3 Purpose

In preparing a Road Network Plan, it is most important to firstly identify what the Plan will be used for and who are the stakeholders involved.

1.3.1 Purpose of the Road Network Plan

The completed Plan will be used by relevant government agencies (local and state) to guide the development of priority safety, traffic, asset and infrastructure maintenance and improvements. It will also be used by industry and the community to understand proposed changes in the network over time that may influence their decisions.

1.3.2 Stakeholders

In relation to the Muswellbrook Road Network Plan, the stakeholders involved can be summarised as follows:

Table 1-1 List of Stakeholders

Stakeholder Group	Main Concerns	Vehicle Types Involved
Government Agencies (Muswellbrook Council and Roads and Maritime Services)	Asset management, safety, efficiency and maintenance and construction costs.	All
Coal Mines and Related Support Industries	Safety, efficiency, and maintenance and construction costs.	Mine related heavy vehicles, materials delivery and trade service vehicles and employee vehicles.
Other Industries (Thoroughbred Horse Industry, Other Primary Producers, Transport Industry, Manufacturing Industries, Service Providers, etc.)	Efficiency and safety.	Materials delivery and product transport vehicles, employees.
Tourism Industry (Vineyards, Recreation and National Parks etc.)	Efficiency and safety.	Tourist related traffic (from cars to caravans and coaches).
General Community	Efficiency and safety.	Domestic and public transport vehicles.

Factors that influence the operation of the road network include: road locations, construction standards, road maintenance, travel speeds and driver behaviour. A Road Network Plan should consider both stakeholder needs and the influencing factors in the formulation of options and preferred strategies. This is done through a weighted comparison of benefit to cost.

1.3.3 Monitoring and Review

Road Network Strategies contain recommendations based on the best information available at the time. However, Strategy recommendations will need to be monitored and regularly reviewed as priorities and demands change over time.

Once initiatives have been implemented, performance should be monitored and assessed to review their impact. Strategies will require updating to reflect and respond to consequent changes to performance.

1.4 Study Area

The study area includes the northern half of the Muswellbrook Local Government Area and the surrounding road network as shown in **Figure 1-1**. The identified mine locations included in this assessment are indicated in **Figure 1-2**.

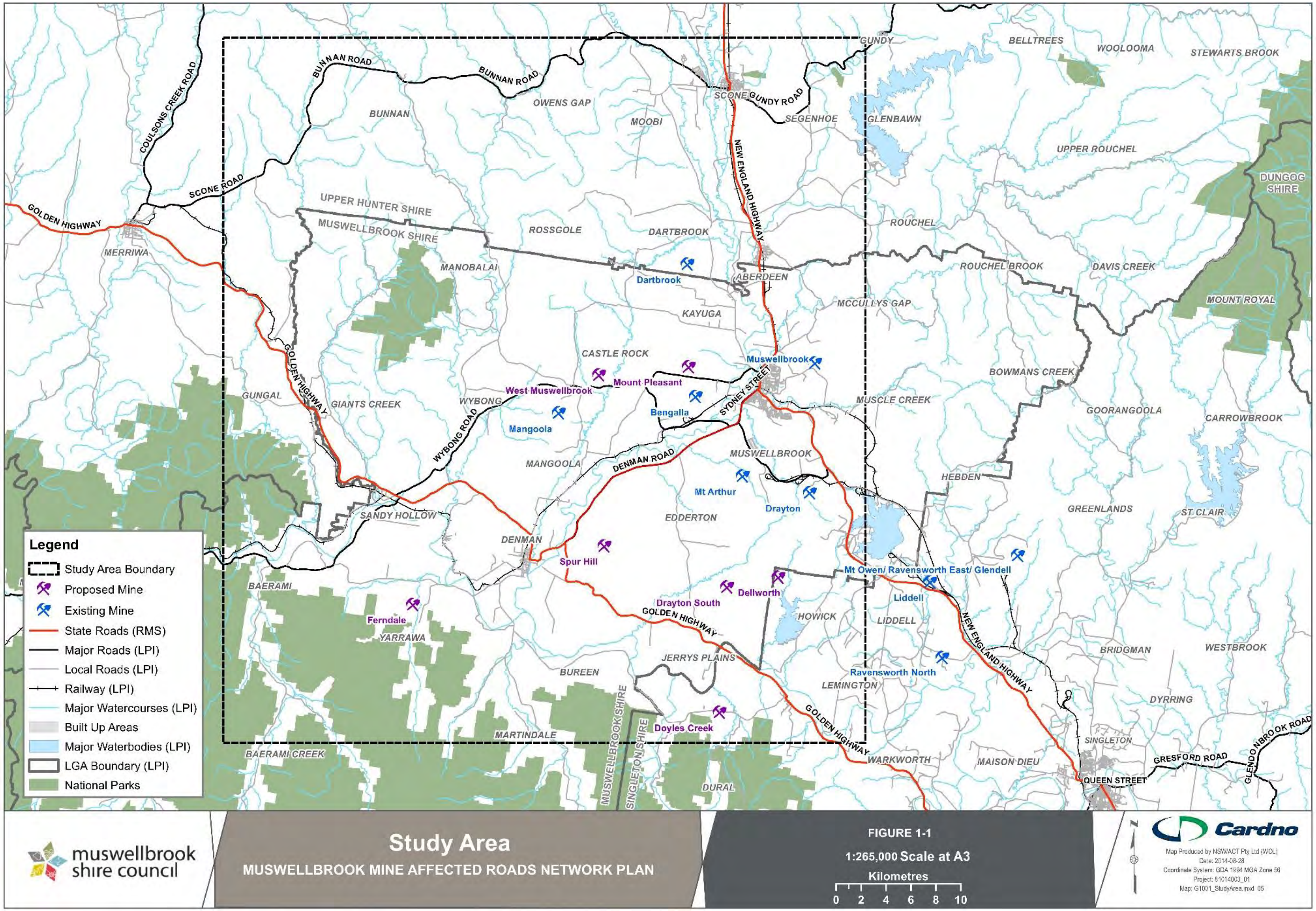


Figure 1-1 Study Area

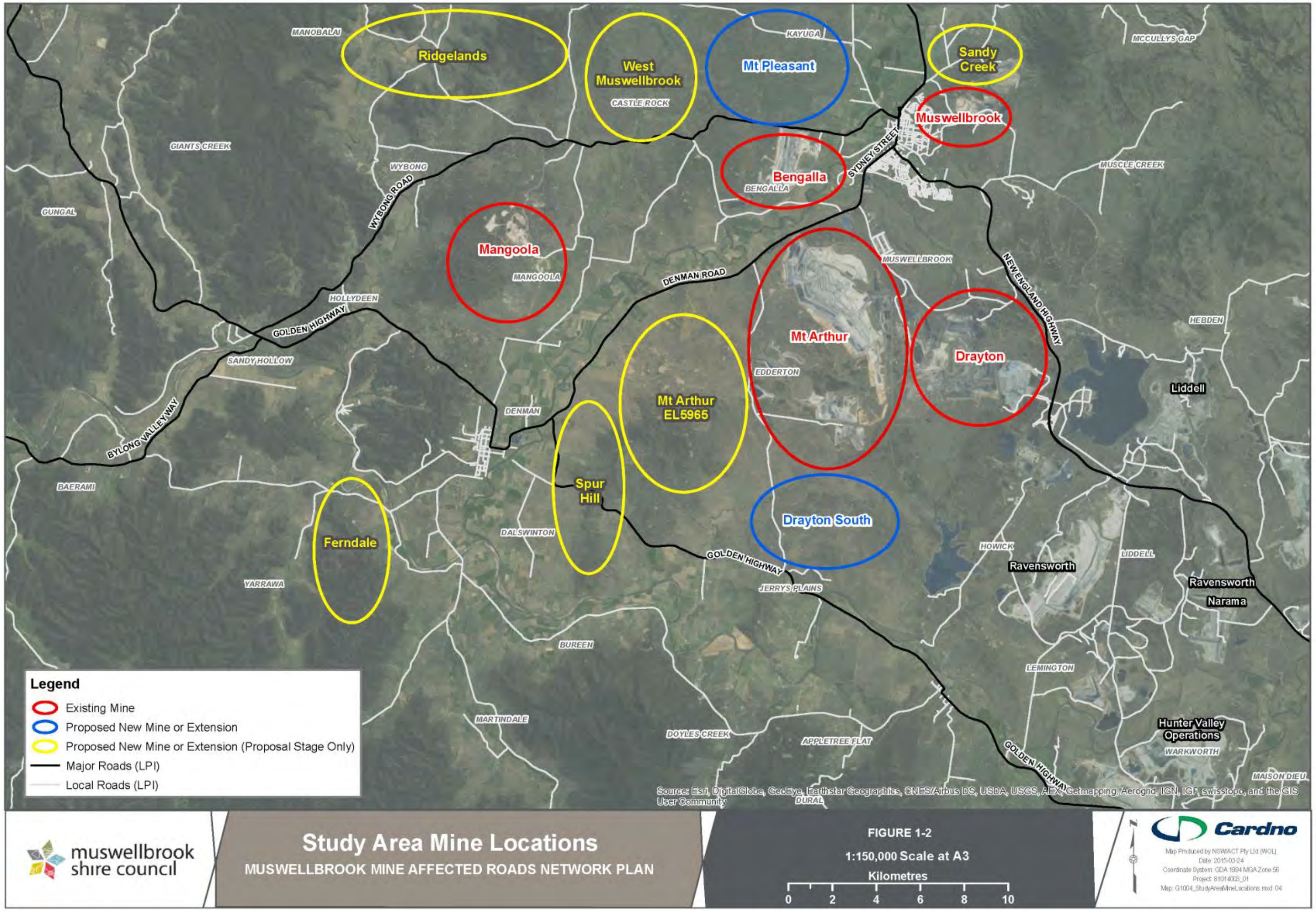


Figure 1-2 **Study Area Mine Locations**

2 Survey Methodology

In November 2013 SkyHigh Traffic Data undertook origin-destination surveys in the district around Muswellbrook. The survey was undertaken from 1:00am on Wednesday 6 November 2013 to 1:00am on Thursday 7 November 2013. The field method involved the use of video equipment to collect images of vehicles' numberplates at sixteen two-directional stations. Observations were classified into:

1. Non-heavy (light) vehicles
2. Heavy vehicles
3. B-doubles and larger vehicles

This analysis provides an indication of movements between observation stations as well as travel times. Vehicle number plates were observed within the study area over the course of the survey period, and these were processed and analysed for subsequent reporting. The locational map of the traffic count survey locations is included in **Figure 1-3**.

2.1 Thomas Mitchell Drive Reconstruction Work

It should be noted that road works occurring on Thomas Mitchell Drive would have affected the use of that route when the traffic surveys were conducted. It was determined from the origin-destination surveys that approximately 70% of east bound traffic on Denman Road continued past Thomas Mitchell Drive to the New England Highway at South Muswellbrook and then travelled to destinations further south. The traffic model has been adjusted accordingly to include those vehicles that would have normally travelled via Thomas Mitchell Drive to reach destinations south, but chose the alternative route to avoid the significant delays caused by the road works.

A summary of the modified results are presented in Section 3.2 of this report.

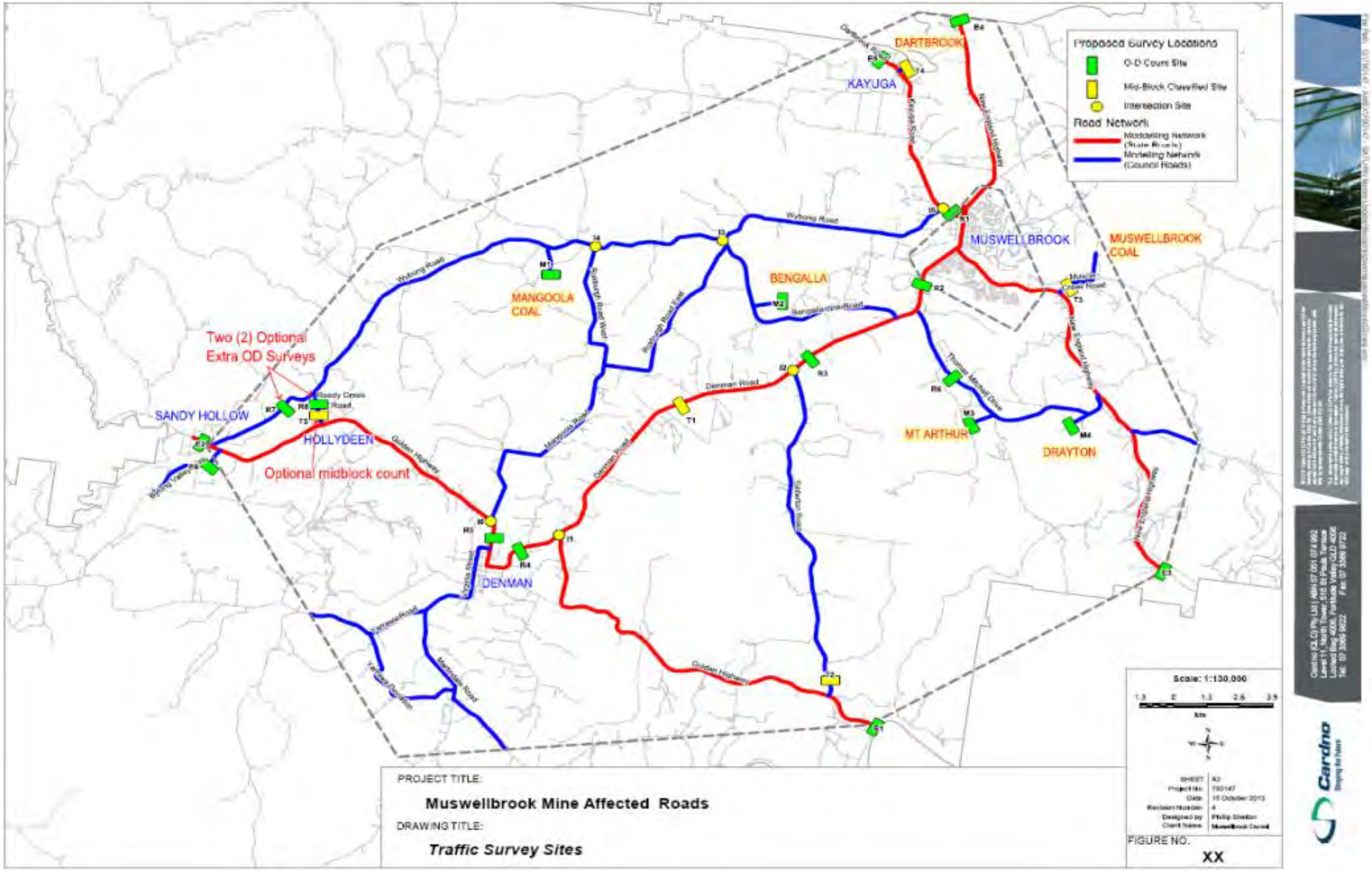


Figure 2-1 Traffic Count and O/D Survey Locations

3 Existing Road Network

3.1 Network Context

The Upper Hunter Strategic Regional Land Use Plan (UHSRLUP) outlines a range of key challenges facing the Upper Hunter Region and lists clear actions to address these challenges. Key infrastructure issues are identified, particularly those relating to the growth of the mining industry. These issues include road and rail capacity and increased demand for health and social services. A key action is the delivery of a fully costed infrastructure plan for the region.

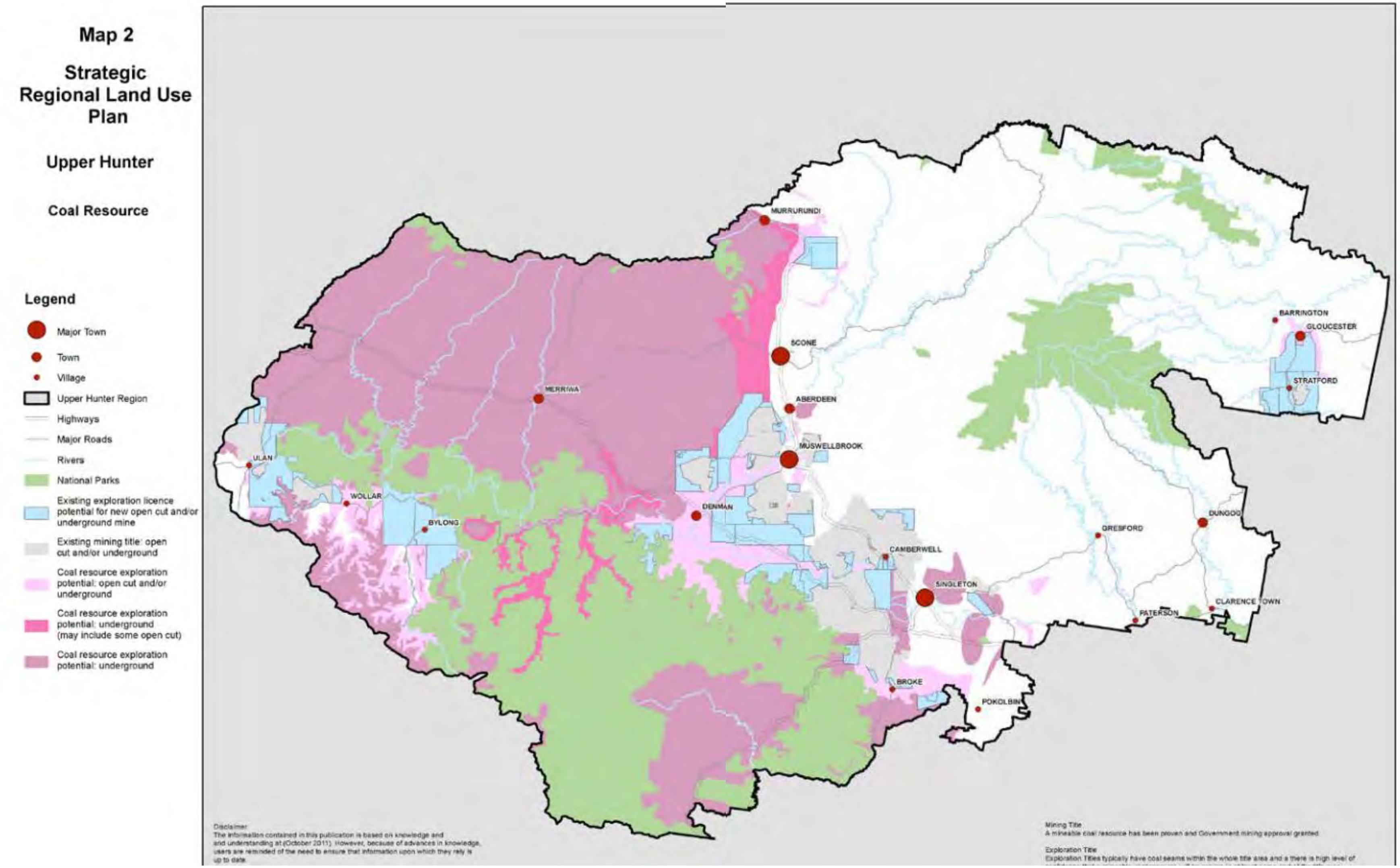
To support development in the region, a number of major new infrastructure investments are planned or underway, financed from a range of funding sources including:

- *Road upgrades including a new bridge over the Hunter River at Aberdeen to allow for higher mass limit vehicles between Muswellbrook and Tamworth and a new two lane bridge over the Great Northern Railway Line. (P. 32)*
- *The New England Highway is part of the National Land Transport Network and provides an inland north-south route for freight between Hexham and the Queensland Border. It performs a vital role in servicing the Hunter Valley coal mines and power stations, providing a means of regional freight distribution to the Northern Tablelands. (P.32)*

Consideration also needs to be given to the issue of road quality and maintenance requirements. The Government monitors the condition of the road surfaces on state roads in the Hunter Region to assist in identifying where improvements are required. The expansion of the mining industry will have an impact on the councils' local roads programs including additional maintenance, upgrades to roads and timber bridges, and sealing of some rural roads.

The UHRLUP and associated infrastructure plan will review the infrastructure requirements of the region and develop a package of local and regional infrastructure to include prioritisation, staging, timing and funding of infrastructure. The infrastructure plan will also include a methodology to predict the impacts of the coal and coal seam gas industries on local and regional infrastructure as well as a program to monitor resource development. Increased activity and population growth will impact on infrastructure provision in local communities. Issues such as road safety and accessibility for motorists (including heavy vehicles) and pedestrians will also require infrastructure investment to meet the demands generated by industry.

For the purposes of this Plan, **Figure 3.1**) represents the Network Context Area.



(Source: Upper Hunter SRLUP 2012)

Figure 3-1 Network Context Area

3.2 The Key Transport Elements

The key transport elements within the network context area include the:

New England Highway – The New England Highway is part of the AusLink National Network between Sydney and Brisbane, extending from the Pacific Highway at Hexham, via Muswellbrook and Tamworth, to the Queensland border near Tenterfield.

Golden Highway – The Golden Highway runs eastwards from Dubbo through Merriwa, Sandy Hollow, Denman, Jerry's Plains and Mount Thorley before joining the New England Highway at Belford, south of Singleton.

Denman Road (MR 209) – This road is likely to continue to be used by a significant proportion of mine traffic, particularly on the most eastern section between the Bengalla Link Road and Muswellbrook, and to a lesser degree by employee and trade vehicles to the west connecting to the Golden Highway (destinations west) and Denman township.

Upper Hunter Coal Rail Network - Coal is transported by rail from a series of mines and coal loaders strung out along the Hunter Valley, conveyed to the terminals at Port Waratah and Kooragang on the railway that runs between Muswellbrook and Newcastle. Coal also feeds onto this line from Ulan and the Gunnedah Basin, west and northwest of Muswellbrook respectively.

3.3 The Key Land Use Elements

(Source: Upper Hunter Strategic Regional Land Use Plan – Sept 2012)

The key land use elements include:

Open cut and underground coal mining - The greatest concentration of existing operating coal mines is between Singleton and Muswellbrook and a significant number of those mines are currently undergoing expansion supported by an increase in the export capacity of the Port of Newcastle.

Agricultural Industries – In particular, dairy and beef cattle and pasture production and associated service industries, and horse breeding. The thoroughbred horse breeding industry is focused around Scone in the Upper Hunter Shire and is supported by studs in Muswellbrook LGA. The region has grown to be one of the major horse breeding areas in the world.

Electricity production - Electricity generation is a major industry of the region making it the major supplier of energy to the NSW economy. Three of the Hunter's four power stations (Bayswater, Liddell, and Redbank coal fired power stations) are located within the Upper Hunter Region (Muswellbrook and Singleton LGAs) and together the Hunter power stations generate more than 60 per cent of all NSW electricity supply.

Tourism - Tourism is an important industry for the region. The proximity of Dungog and Gloucester to the world heritage listed Barrington Tops National Park, as well as the rural landscapes and wine industry, underpins tourism in the Upper Hunter.

Viticulture and wine making - The wine industry enjoys a strong and expanding base in the Singleton and Muswellbrook LGAs as a result of their suitability for wine making and the vineyard tourism market fuelled by the region's accessibility to Sydney.

National Parks and Reserves – The area is unique in the diversity of its vegetation and landscapes.

3.4 The Key Centres of Activity

Settlement is characterised by towns that have developed along the major river valleys initially in response to agricultural opportunities. Singleton is the largest of the towns along the valley with an estimated population of approximately 13,700 followed by Muswellbrook with a population of around 10,200. The remaining towns in the region are significantly smaller and include Scone (4,600), Gloucester (2,400 population), Dungog (2,100), Aberdeen (1,800), Denman (1,400), Merriwa (950) and Murrurundi (800) (ABS 2006)

The population of the region is estimated to have grown at an average rate of 1.2 per cent per annum between 2006 and 2011. However, growth rates vary significantly across the region. Strongest growth has occurred where mining is most prevalent – Singleton (1.4% p.a.) and Muswellbrook (1.3% p.a.).

3.5 The Major Geographical Constraints

The Hunter River is one of the largest river valleys on the NSW coast with a catchment of 2.2 million hectares. The Hunter River flows close to the townships of Aberdeen, Muswellbrook, Denman, Jerry's Plains and Singleton providing low lying floodplain areas most suited to agricultural pursuits. The river bisects the Corridor Study Area and is a major constraint to the creation of road links from areas in the north to desired destinations in the south.

3.6 Corridor Study Area

The Corridor Study Area (shown red in **Figure 4-2**) extends generally from the Muswellbrook Local Government Area boundary in the north to the national park areas in the south to Bunnan Road in the north-west, which connects the Golden Highway at Merriwa to the New England Highway at Scone. Bunnan Road generally runs parallel to the northern extent of Crown Authority 286 which represents the current extent of coal exploration in the Upper Hunter Coal Resource Area.

At a Corridor Study level, the major centres of activity include the townships of Muswellbrook, Scone, Denman and Merriwa. RMS Managed Roads include the New England Highway, the Golden Highway and Denman Road (shown coloured red). Other transport routes include the coal rail network (shown orange) and the local arterial feeder roads, with the main geographical constraint being the Hunter River (shown light blue) and its associated floodplain.

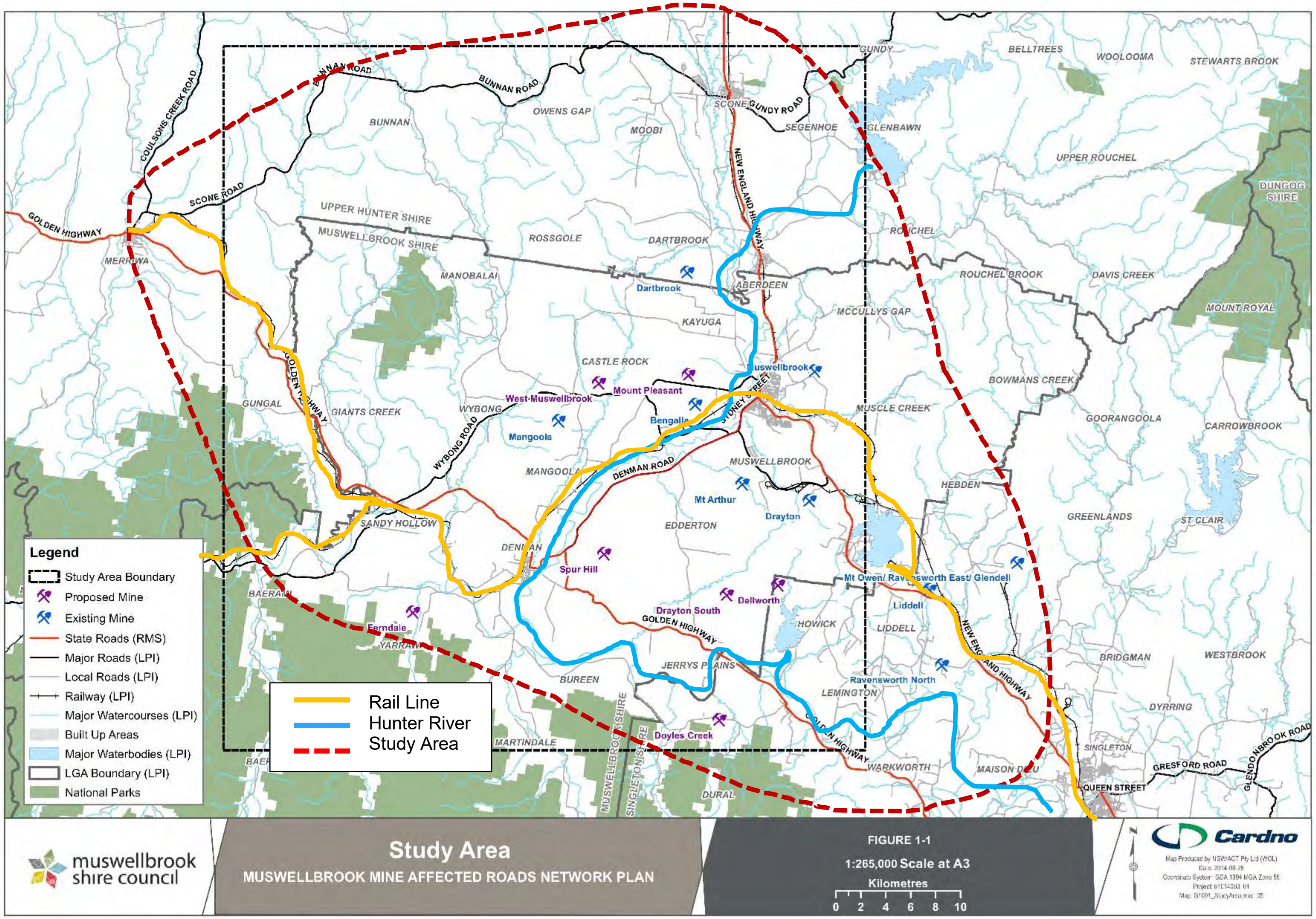


Figure 3-2 Corridor Study Area

As can be seen from the above map, the Hunter River and the Coal Rail Network bisect the corridor and present a major constraint to the movement of traffic from the north-west to south-east. The only locations where these constraints are traversed by roads are by the Golden Highway at Denman, the Bengalla Link Road, and the New England Highway at Muswellbrook and Aberdeen. The implications of these constraining features for the efficient movement of mine-related vehicles are discussed further below.

3.7 Road Hierarchy

The road hierarchy within the study area is identified in **Figure 3-3**, and includes the State controlled roads of The Golden Highway, New England Highway (in red) and Denman Road, Council controlled local distributor roads which connect to the State roads, and provide access to the mines. As such, most of these roads provide vital access and mobility functions within the region.

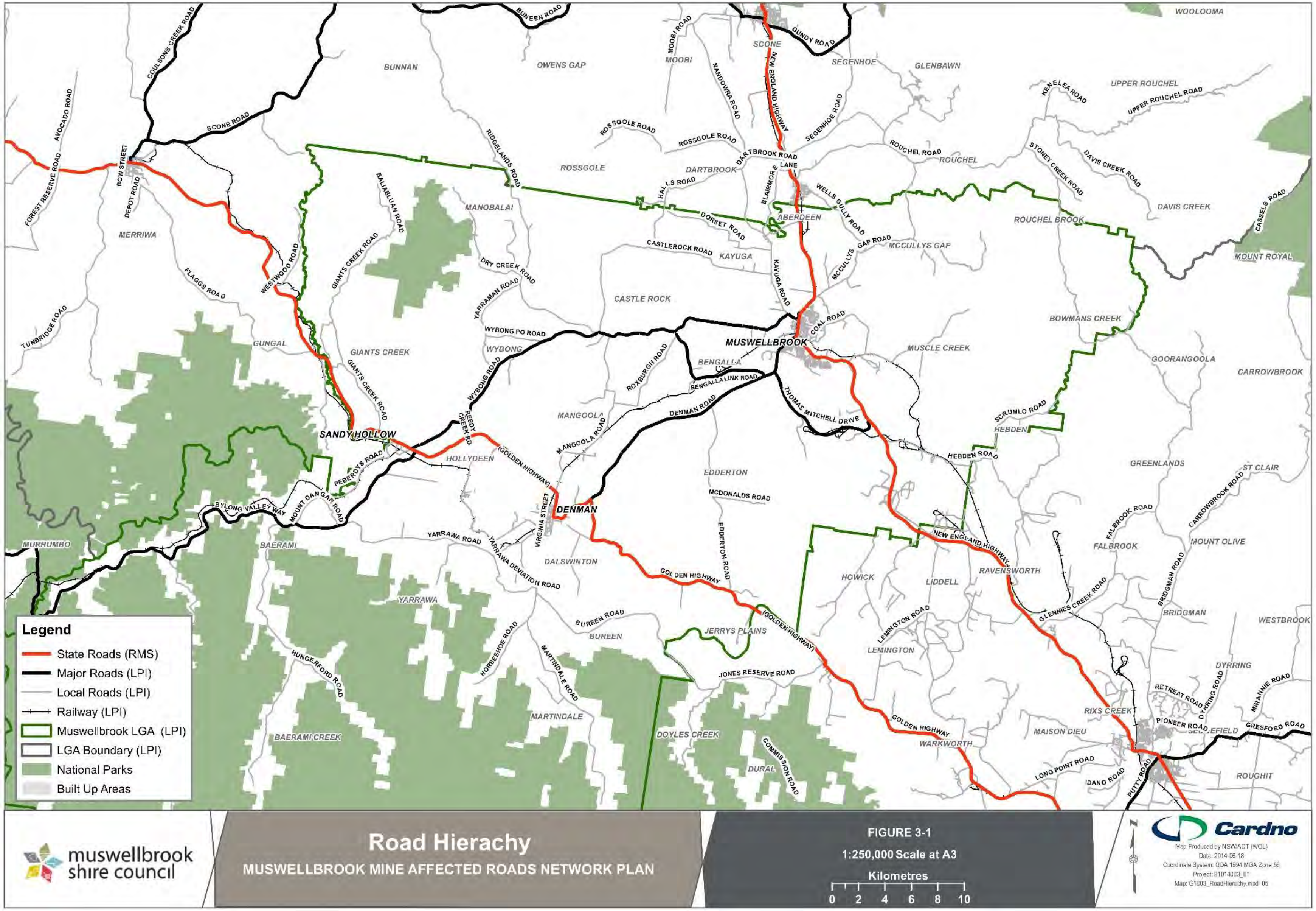


Figure 3-3 Road Hierarchy

3.8 State Highways and Main Roads

3.8.1 New England Highway (A 15)

This is a major state highway of a high standard in the rural areas passing through Muswellbrook which conveys local, regional and interstate traffic. A significant proportion of mine traffic from the region is expected to travel south via the New England Highway, which connects to Singleton, Maitland, Cessnock and the other regional towns.

3.8.2 Golden Highway (B84)

The Golden Highway is a designated State Highway (B84) and is not included in the assessment of local roads affected by mine-related traffic within Muswellbrook Shire. However, consideration must be given to any changes on arterial roads that may impact on the movement of mine-related traffic. It is noted that the current State government has recently announced their commitment to undertake a substantial upgrading of the Golden Highway to improve the levels of safety in certain locations.

3.8.3 Denman Road (MR 209)

This is a main road connecting the New England Highway at South Muswellbrook to the township of Denman. It is primarily a two lane highway with high standard rural intersections at Thomas Mitchell Drive and Edderton Road. The road is used by a significant proportion of mine traffic on the most eastern section between the Bengalla Link Road and Muswellbrook, and to a lesser degree by employee and trade vehicles to the west connecting to the Golden Highway (destinations west) and Denman Township.

3.9 Local Roads Most Utilized by Mine Related Traffic

The Muswellbrook Mine Affected Roads Map (**Figure 3-4**) identifies those locally controlled roads most affected by mining related traffic.

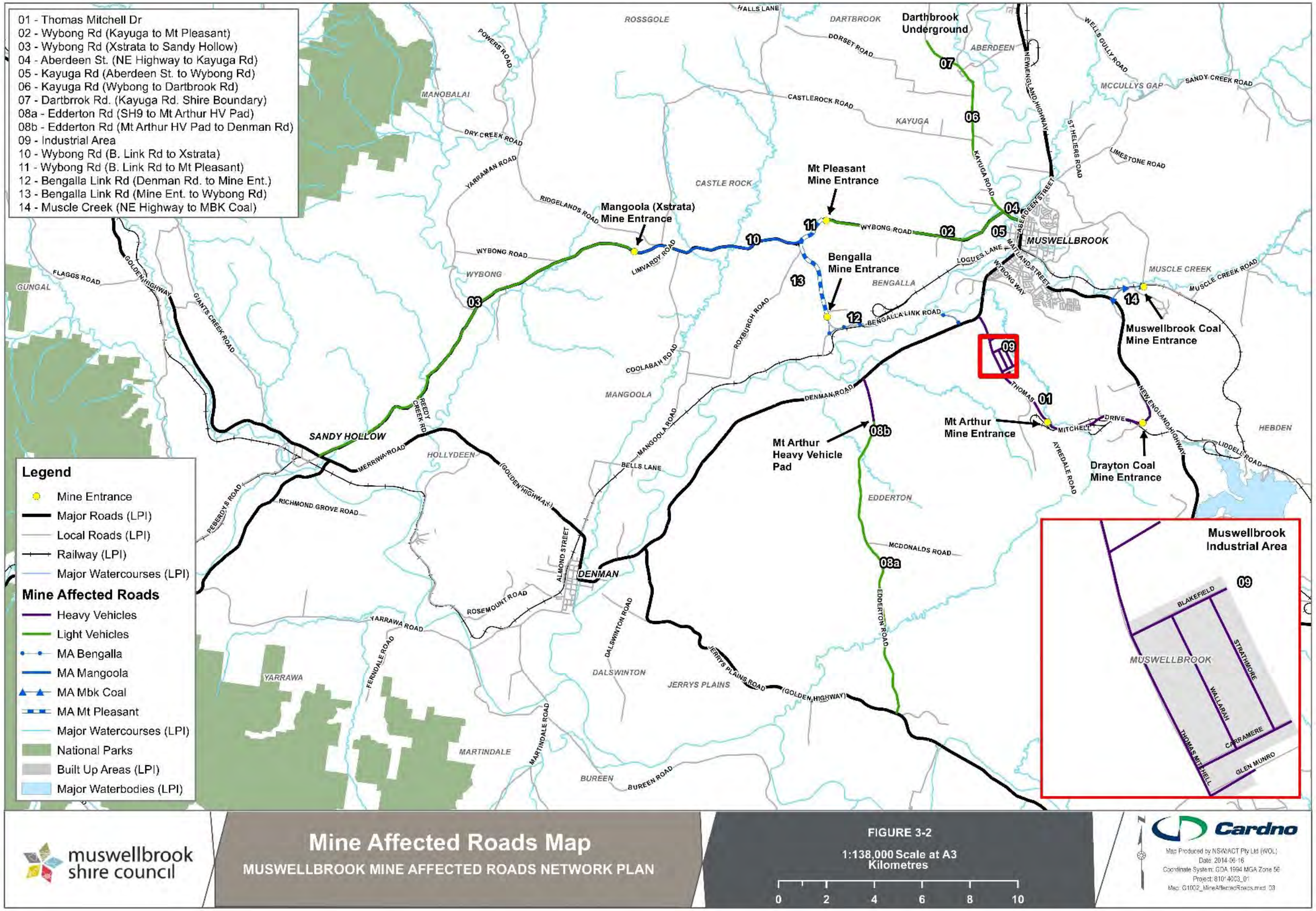


Figure 3-4 Mine Affected Roads Map

Each of the roads identified are discussed below in relation to their function within the existing road network.

3.9.1 Wybong Road

Wybong Road is currently the main access route between Muswellbrook township and the western rural areas of the Shire such as Sandy Hollow, Roxburgh, Mangoola, Wybong and Brogheda/Manobalai. The eastern section of Wybong Road (from Bengalla Link Road to Kayuga Road) does not carry a significant proportion of mine related traffic because all mine traffic is directed to use Bengalla Link Road when travelling to and from southern and eastern destinations. The central section of Wybong Road (between Mangoola Mine entrance and Bengalla Link Road) is the busiest section of the road with over 1,200 vpd. The western section of Wybong Road (from Sandy Hollow to Mangoola (Xstrata) Mine entrance) has less traffic with 425 vpd.

In year 9 of the new Mt Pleasant Mine, it is intended to close a section of Wybong Road (East) to permit mining of the boundary between the Mt Pleasant and Bengalla Mines. At that time, it is intended to construct the Mt Pleasant Western and Northern Link Roads to accommodate north bound traffic, and to direct south bound and Muswellbrook township traffic via the Bengalla Link Road. This matter is discussed further in later sections.

3.9.2 Kayuga Road, Kayuga Bridge and Aberdeen Street

Kayuga Road is a back road connecting Muswellbrook to Scone and providing access to rural properties and villages (Dartbrook and Kayuga areas). Only a small number of vehicles utilise the northern section of Kayuga Road (approx. 500 vpd). The majority of the traffic on the section of Kayuga Road between the bridge and Wybong Road intersection, turn at the Wybong Road intersection, as Wybong Road is the main access route between Muswellbrook and rural areas in the north west of the Shire.

In relation to heavy vehicles utilizing this route, Kayuga Bridge is not currently weight restricted; however it is a one lane timber structure of considerable age. Heavy vehicles utilise the bridge via Aberdeen Street and Kayuga Road, to access Wybong Road as a short cut to travel west along Wybong Road and beyond. These vehicles are most likely serving mining and agricultural activity in the northern and north-western localities, and possibly some Daracon Quarry vehicles (from Sandy Creek Road) and local bus services.

Notwithstanding any prohibition placed on mine related traffic utilising this route, it is apparent that this section of road (including Kayuga Bridge and Aberdeen Road) currently carries significant traffic volumes and these will continue to increase due to the efficiencies this route offers (for access to Wybong Road and beyond from the New England Highway and for access to the Muswellbrook town centre).

3.9.3 Bengalla Link Road

The Bengalla Link Road was specifically built to carry mine-related traffic between Wybong Road and Denman Road providing an alternative for south bound traffic to the New England Highway and then through Muswellbrook town centre. It provides a relatively efficient connection to Thomas Mitchell Drive and destinations south. This north-west to south-east connection currently meets the needs of the mining industry. However, with the advent of Mt Pleasant and other mines to the north-west in the longer term (West Muswellbrook and Ridgelands) it is unlikely that this road (and Wybong Road) will provide a satisfactory level of service and efficiency of movements for mine-related traffic travelling to south-east destinations.

3.9.4 Thomas Mitchell Drive (TMD)

This local road connects Denman Road to the New England Highway and provides the most direct and efficient route from the current areas of mining activity to the New England Highway and destinations south. The route effectively bypasses the longer and slower moving route via the New

England Highway and through South Muswellbrook. TMD has a two-way configuration with one lane in each direction and an approximately sealed width of 7 metres with 1 metre gravel shoulders, the exception being at the Muswellbrook Industrial Estate which allows for sealed roadside parking. The Industrial Estate is a significant traffic generator providing for the supply of materials and services to the mining industry, rural industries and also the local community. This road also provides direct access to the Mt Arthur and Drayton Mines.

3.9.5 Edderton Road

Edderton Road is a 15 km local road linking the Golden Highway in the south to Denman Road in the north. It is under the care and control of Muswellbrook Council. Edderton Road has a two-way configuration with one lane in each direction, and no line marking and no sealed shoulders. The sealed width is generally less than 6 metres and the pavement has significant patching. Saddlers Creek crosses the route as a cause-way approx. 3.5kms north of the Golden Highway. The road has a 14 tonne load limit to protect the pavement condition and in response to the substandard road alignment and width.

The Mt Arthur and Drayton South Mine proposals include the realignment of the northern and southern sections of the road to the west to facilitate proposed coal extraction in this location around 2020. It is envisaged that this route would not attract a significant volume of traffic from the north due to the fact that:

- Traffic heading towards Singleton would tend to use Thomas Mitchell Drive as a more direct route on a higher standard of road;
- Traffic heading to Denman and Merriwa and beyond would tend to use Denman Road; and
- The 14 tonne road limit would rule out heavy vehicle use.

3.10 Traffic Survey Results (in Summary)

As discussed in Section 2, traffic surveys were undertaken in November 2013 on different sections of the Muswellbrook Shire roads.

3.10.1 Total Traffic Volumes

The vehicles per day (vpd) and proportion of heavy vehicles for each road section is indicated in **Table 3.1**. As noted, sections of Thomas Mitchell Drive (east and west of the Mt Arthur access) were under reconstruction during the survey period, and as such the volumes have been redistributed to account for the impact construction had on the vehicle counts. Estimated typical traffic distribution patterns on the road network have been used. Higher traffic volumes have been highlighted for ease of reference.

- LV's – Light Vehicles (Cars and cars with trailers)
- HV's – Heavy Vehicles (trucks and buses up to B-Doubles)
- MCV's – Multi-combination Vehicles (B-Doubles and larger)

Table 3-1 Traffic Volumes and Proportion of Heavy Vehicles by Road Section

Road Section	Total Traffic Volumes Totals (vpd)	Total x Vehicle Types (vpd)		% HV of total vpd
Kayuga Road North (Shire Boundary to Wybong Road)	578	LV's	550	4.8%
		HV's & MCV's	28	
Kayuga Road East (Wybong Road to Kayuga Bridge)	**1,718**	LV's	1,625	5.4%
		HV's & MCV's	93	
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	804	LV's	749	6.8%
		HV's & MCV's	55	
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	**1,288**	LV's	1,198	6.9%
		HV's & MCV's	89	
Wybong Road East (Bengalla Link Road to Kayuga Road)	589	LV's	547	7.1%
		HV's & MCV's	42	
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	1,056	LV's	965	8.6%
		HV's & MCV's	91	
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	**2,030**	LV's	1,813	10.7%
		HV's & MCV's	**218**	
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	**8,801**	LV's	8,223	6.5%
		HV's & MCV's	**577**	
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	**4,702**	LV's	4,133	12%
		HV's & MCV's	**569**	
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	**3,789**	LV's	3,236	14.5%
		HV's & MCV's	**553**	
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	**4,146**	LV's	3,579	13.6%
		HV's & MCV's	**567**	
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	1,023	LV's	899	12%
		HV's & MCV's	**124**	
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	836	LV's	680	18.5%
		HV's & MCV's	**155**	

The following observations are made:

- Thomas Mitchell Drive carries the highest total traffic volumes (highlighted dark blue - between 3,789 and 8,801 vpd). This is followed by Bengalla Link Road South with 2,030 vpd, and Kayuga Road East (to the bridge) and the central section of Wybong Road (Mangoola Mine Entrance to Bengalla Link Road) which had over 1,200 vpd.
- Thomas Mitchell Drive carries the highest number of heavy vehicles (553 to 577 heavy vpd), with Bengalla Link Road South being the second busiest heavy vehicle route (218 heavy vpd).

- Edderton Road (a load limited road) carries a significant number of heavy vehicles (124 to 155vpd). (NB. It is noted from the following table, that only 48 of the 124 heavy vehicles recorded on Edderton Road North were local mine-related, while none of the 155 heavy vehicles recorded on the southern section of Edderton Road were identified as local mine-related).

3.10.2 Total Mine-related Traffic to Total Traffic

The proportion of mine-related traffic to total traffic volumes has been assessed to determine the roads that are impacted the most by the local mines. **Table 3.2** indicates the proportion of local mine-related traffic compared to total traffic, and the proportion of heavy vehicle (HV's) traffic (including Multi-Combination Vehicles) is shown for each road section. The highest numbers and proportions are again highlighted.

Table 3-2 Proportion of mine-related traffic on the local road network

Road Section	Daily Total Traffic Volumes	Daily Mine Related Traffic	Proportion of Mine-related Traffic	Daily Heavy Vehicle (HV) Volumes	Daily Mine Related HVs	Proportion of Mine-related HVs
Kayugah Road North (Shire Boundary to Wybong Road)	578	74	**12.8%**	28	2	**7.1%**
Kayuga Road East (Wybong Road to Kayuga Bridge)	1,718	246	**14.3%**	93	9	**9.7%**
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	804	231	**28.7%**	55	18	**32.7%**
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	1,288	726	**56.4%**	89	59	**66.3%**
Wybong Road East (Bengalla Link Road to Kayuga Road)	589	230	**39.0%**	42	19	**45.2%**
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	1,056	737	**69.8%**	91	63	**69.2%**
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	2,030	1,410	**69.5%**	218	141	**64.7%**
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	8,801	2,541	**28.9%**	577	124	**21.5%**
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	4,702	2,496	**53.1%**	569	147	**25.8%**
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	3,789	1,580	**41.7%**	553	112	**20.3%**
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	4,146	1,935	**46.7%**	567	138	**24.3%**
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	1,023	270	**26.4%**	124	48	**38.7%**
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	836	50	**6.0%**	155	0	**0.0%**

In decreasing order of magnitude, the following sections of road carry the most mine-related traffic:

1. **Thomas Mitchell Drive North** (Denman Road to the Industrial Area) – **2,541vpd** (but only represents 28.9% of the total traffic on this section of road)
2. **Thomas Mitchell Drive Central** (Industrial Area to Mt Arthur Mine Entrance) – **2,496vpd**
3. **Thomas Mitchell Drive East** (Drayton Mine Entrance to New England Hwy) – **1,935vpd**
4. **Thomas Mitchell Drive South** (Mt Arthur Mine Entrance to Drayton Mine Entrance) – **1,580vpd**
5. **Bengalla Link Road South** (Bengalla Mine Entrance to Denman Road) – **1,410vpd**
6. **Bengalla Link Road North** (Wybong Road to Bengalla Mine Entrance) – **737vpd**
7. **Wybong Road** (Mangoola Mine Entrance to Bengalla Link Road) – **726vpd**

In decreasing order of magnitude, the following sections of road carry the <u>most mine-related heavy vehicles</u>:

1. **Thomas Mitchell Drive Central** (Industrial Area to Mt Arthur Mine Entrance) – **147 heavy vpd**
2. **Bengalla Link Road South** (Bengalla Mine Entrance to Denman Road) – **141 heavy vpd**
3. **Thomas Mitchell Drive East** (Drayton Mine Entrance to New England Hwy) – **138 heavy vpd**
4. **Thomas Mitchell Drive North** (Denman Road to the Industrial Area) – **124 heavy vpd**
5. **Thomas Mitchell Drive South** (Mt Arthur Mine Entrance to Drayton Mine Entrance) – **112 heavy vpd**
6. **Bengalla Link Road North** (Wybong Road to Bengalla Mine Entrance) – **63 heavy vpd**
7. **Wybong Road** (Mangoola Mine Entrance to Bengalla Link Road) – **59 heavy vpd**
8. **Edderton Road North** (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad) – **48 heavy vpd**

The following observations are made:

- Almost 70% of the total traffic on Bengalla Link Road was recorded as being mine-related.
- Greater than 50% of the traffic on Wybong Road (between the Mangoola Mine Entrance to Bengalla Link Road) and the northern section of Thomas Mitchell Drive, was recorded as being mine-related.
- While the highest total numbers of mine-related heavy vehicles were recorded on Thomas Mitchell Drive, the highest proportions of mine-related heavy vehicles (>60% of the total heavy vehicles) were recorded on the central section of Wybong Road (between the Mangoola Mine Entrance and the Bengalla Link Road) and on the Bengalla Link Road.

3.10.3 <u>Comparison of Individual Mine Traffic to Total Mine-related Traffic</u>

The following mines within the study area are currently contributing significant amounts of traffic to the local road network:

- Mangoola Mine (M)
- Bengalla Mine (B)
- Mt Arthur Mine (MtA)
- Drayton Mine (D)

(Note: Muswellbrook Mine is accessed directly from the New England Highway and is responsible for the maintenance of Muscle Creek Road to and including the access road).

Figure 3-5 shows the number and proportion of the total traffic on each road section (excluding State roads) that is attributed to each of the four mines involved:

Daily Traffic Volumes x Proportion Mine Generated Traffic (No./%) x Local Road

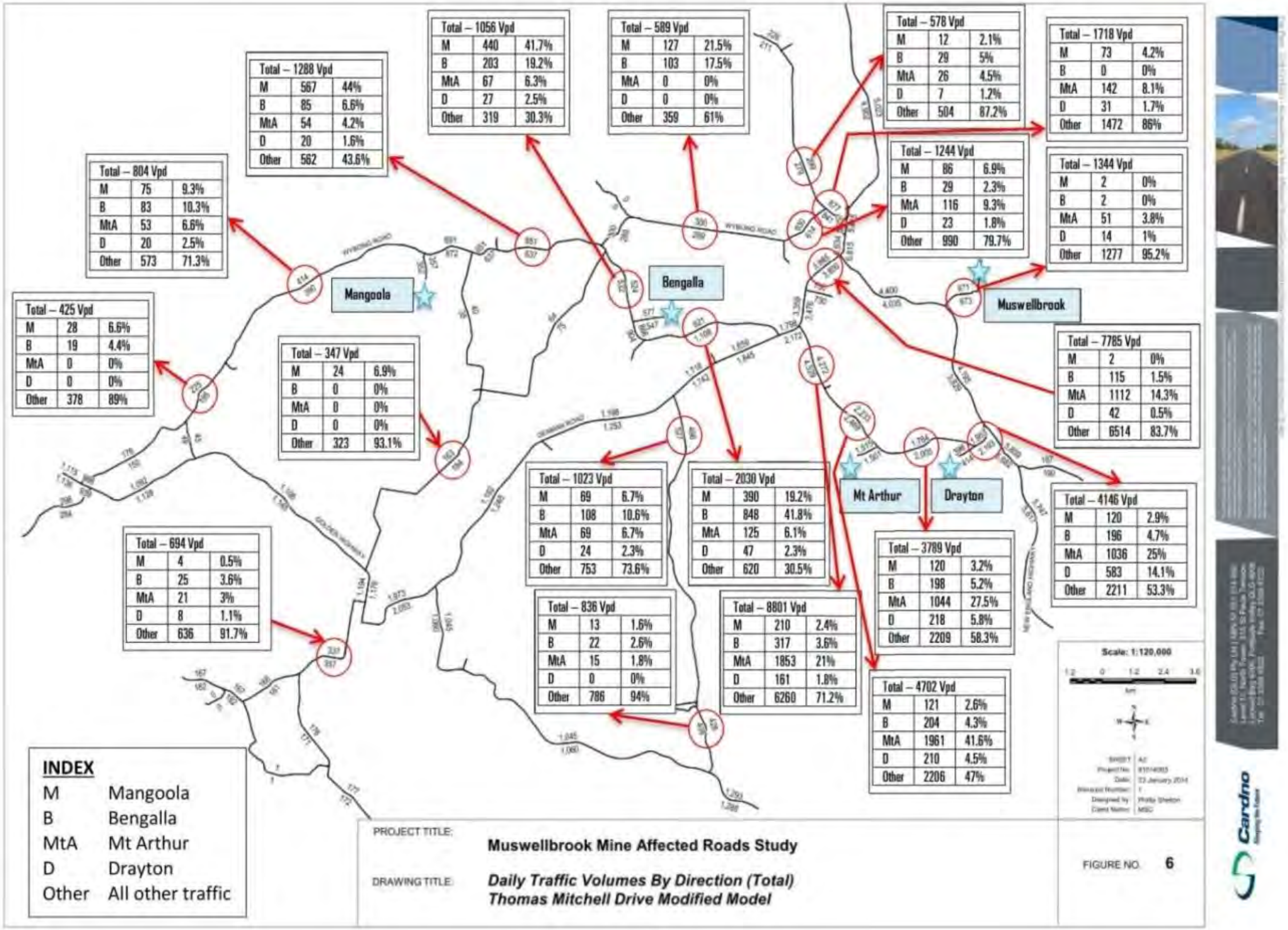


Figure 3-5 **Base Traffic Distribution Patterns**

3.11 Distributor Roads used by Mining Related Traffic

The traffic attributed to individual mines varies significantly across the network depending on proximity to origin and destination. Discussion in relation to each of the most used roads is provided in the following sections.

3.11.1 Thomas Mitchell Drive

The proportion of traffic attributed to each of the four mines varies significantly across the four sections of Thomas Mitchell Drive. For example, on the section of road between the Industrial Area and the Mt Arthur Mine entrance, the proportion of total traffic attributable to the Mt Arthur Mine was 41.6% due to proximity to the mine entry.

On average across the full length of Thomas Mitchell Drive, the following proportions apply:

- Mt Arthur Mine – Approx. 28.8%
- Drayton Mine – Approx. 6.5%
- Bengalla Mine – Approx. 4.5%
- Mangoola Mine – 2.8%
- Other – 57.4%

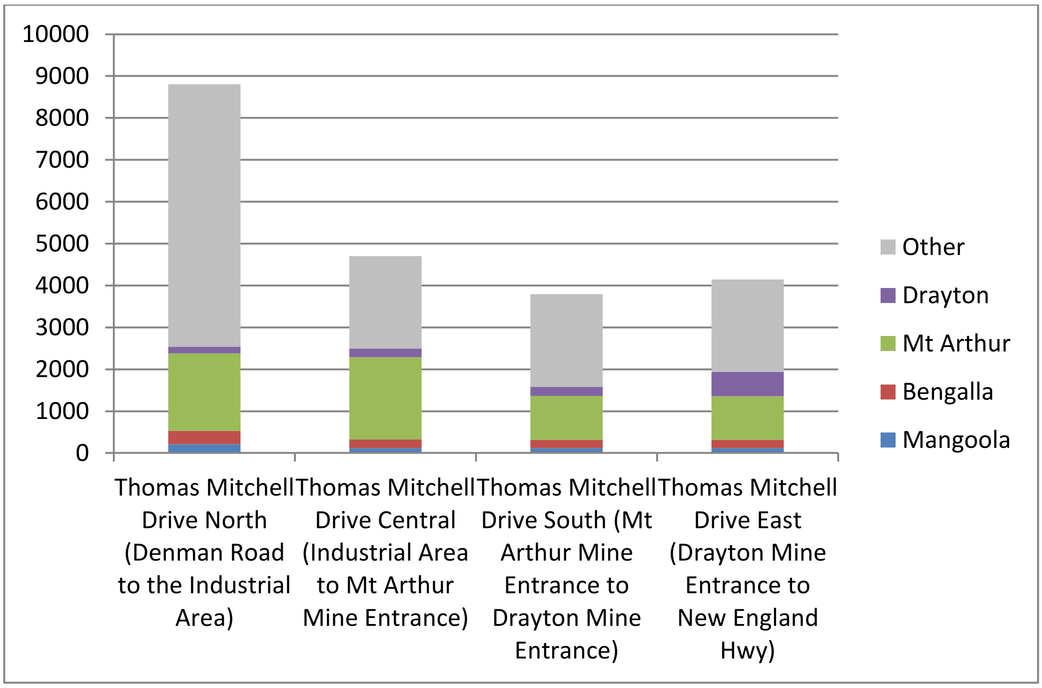


Figure 3-6 Distribution of traffic by mine on sections of Thomas Mitchell Drive

The following observations are made:

- The majority of the traffic (approx. 71%) on the northern section of Thomas Mitchell Drive (between the Industrial Area and Denman Road) is not directly linked to the local mines.
- The traffic related to the Mt Arthur Mine comprises the highest volume of mine related traffic on all four sections of Thomas Mitchell Drive.
- The traffic related to the Drayton Mine is higher on the eastern section of Thomas Mitchell Drive, which can be expected as the entrance to the mine is on this section of road.

3.11.2 Bengalla Link Road

The Bengalla Link Road was specifically built to carry mine-related traffic between Wybong Road and Denman Road providing a relatively efficient connection to Thomas Mitchell Drive, Muswellbrook Town Centre and destinations south. The results of the traffic survey indicate that 70% of all traffic on this road is directly generated by the local mines.

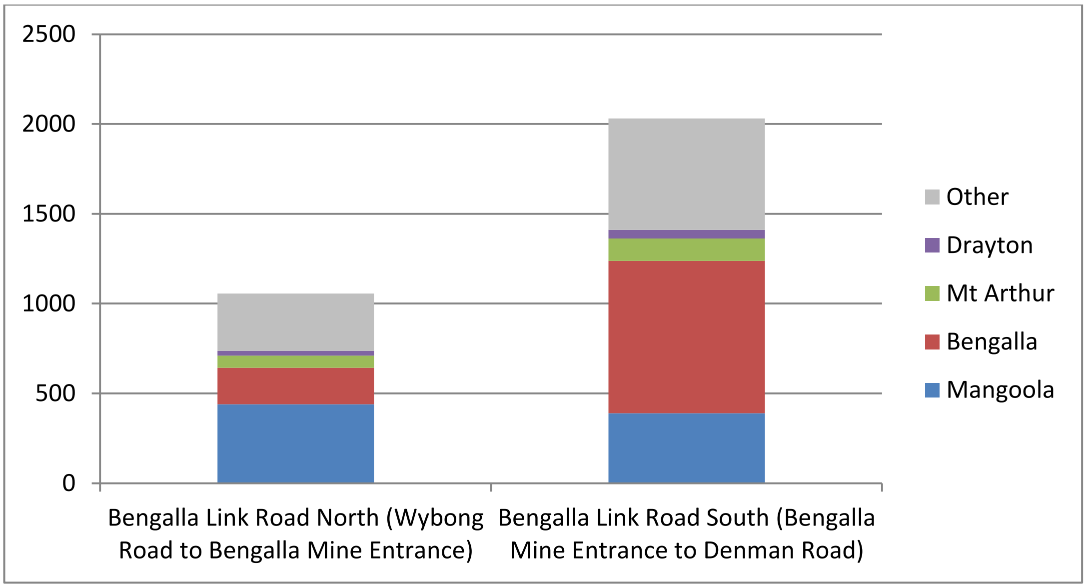


Figure 3-7 Distribution of traffic by mine on sections of Bengalla Link Road

A breakdown of traffic movements indicates a similar distribution of traffic on the two sections of road for the Mangoola Mine, which is expected, as traffic from this mine would continue along the full length of the Bengalla Link Road.

The following observations are made:

- Mangoola Mine related traffic (around 400 vpd) represents a significant proportion of the traffic using the Bengalla Link Road.
- The volume of traffic on the southern section of the Link Road doubles at the Bengalla Mine Access comprising 42% of all traffic on this section.

3.11.3 Wybong Road

The section of Wybong Road east of Bengalla Link Road (to Kayuga Road) does not carry a significant proportion of mine-related traffic because all mine traffic is directed to use Bengalla Link Road by condition of consent.

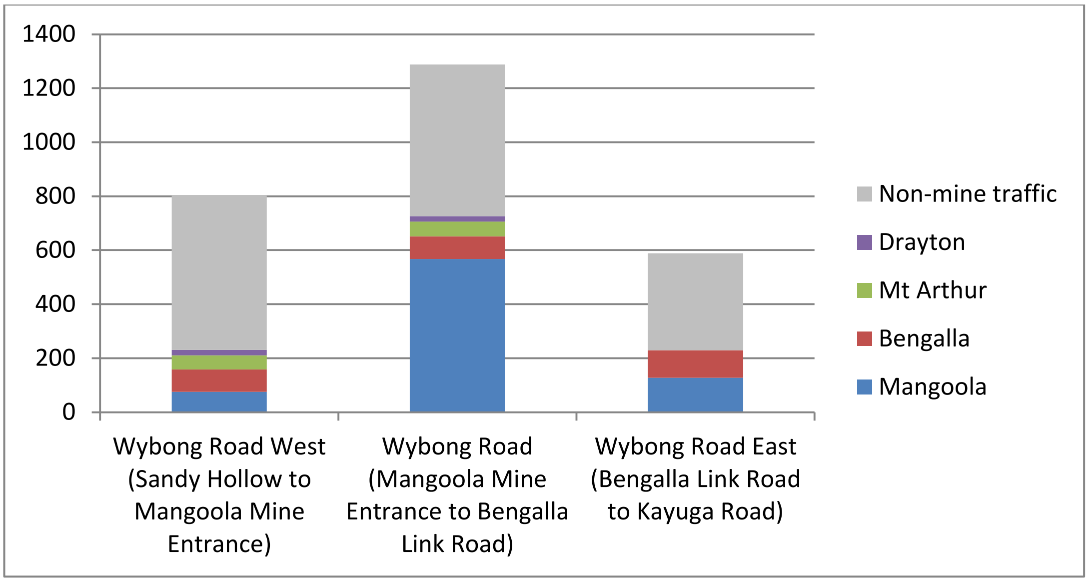


Figure 3-8 Distribution of traffic by mine on sections of Wybong Road

The following observations are made:

- Slightly more than 50% of the traffic utilising the central section of Wybong Road (between Mangoola Mine entrance and Bengalla Link Road) is mine related. Most mine-related traffic (44%) on this section of road is generated by the Mangoola Mine, with less than 10% generated by the other three mines.
- Similarly, 86% of the mine-related heavy vehicle traffic is from Mangoola Mine, with 14% from Bengalla Mine and nil from the other two mines.

3.11.4 Kayuga Road, Kayuga Bridge and Aberdeen Street

Kayuga Road is a back road connecting Muswellbrook to Scone and providing access to the properties and villages between (Dartbrook and Kayuga areas).

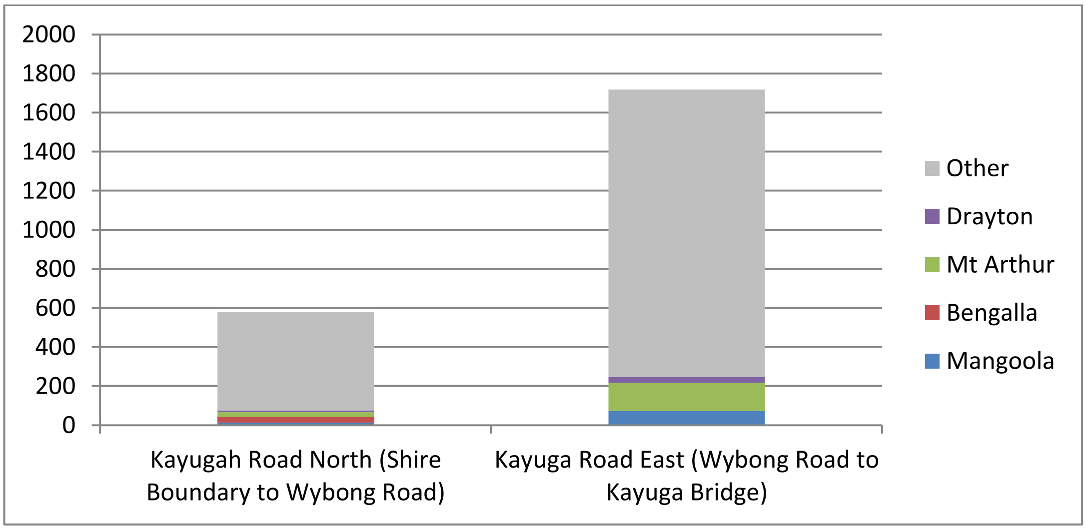


Figure 3-9 Distribution of traffic by mine on sections of Kayuga Road

The following observations are made:

- Only a small number of vehicles utilize the northern section of Kayuga Road (approx. 578vpd) and the small proportion of these that are mine related are light vehicles.
- Mine related traffic contributes only a small proportion (13%) of the total traffic movements (approx. 1,718vpd) on the more heavily used eastern section of Kayuga Road.
- It is assumed that the majority of the mine-related light vehicles identified will be employees travelling from Mangoola and Bengalla mines to and from their places of residence (in Aberdeen, Scone and northern areas of Muswellbrook) via the New England Highway.

3.11.5 Edderton Road

The northern section of Edderton Road leading off Denman Road has higher volumes of mine related traffic than the southern section of road for all mines. This reflects the movement of heavy vehicles and trade vehicles to the Mt Arthur Heavy Vehicle Assembly Pad. It is assumed that on the day of the survey, there was considerable activity at this facility.

The non-mine related traffic volumes are similar on both sections of road which indicates that a significant amount of non-mine related traffic (approx. 800 vpd) utilises this road to travel between Denman Road and the Golden Highway at Jerry's Plains.

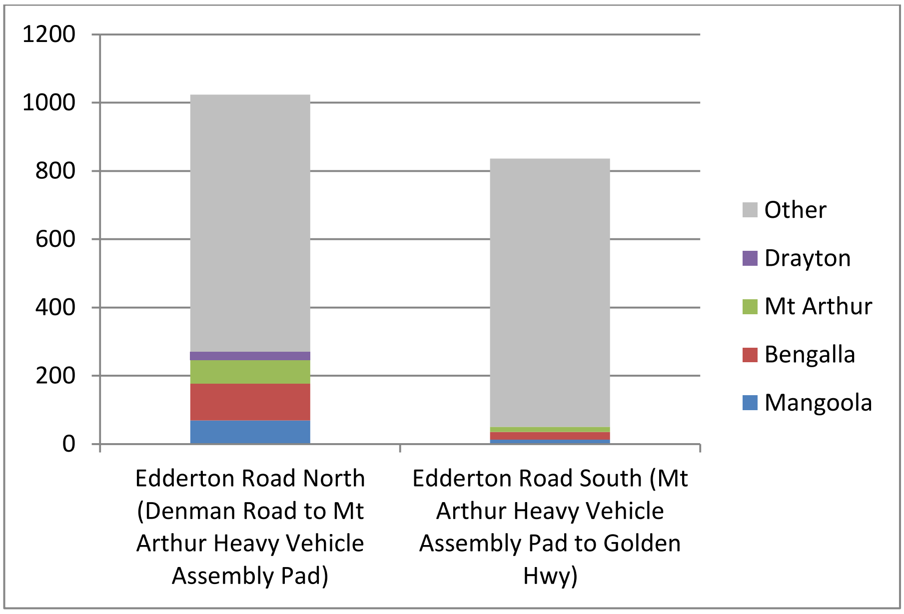


Figure 3-10 Distribution of traffic by mine on sections of Edderton Road

3.12 Minor Local Roads Impacted by Mine Related Activities

In addition to the local distributor roads discussed above, a number of minor local roads also carry mine-related traffic.

3.12.1 Mangoola Road and Roxburgh Road

Mangoola Road and Roxburgh Road connect Wybong Road and the Bengalla Link Road to Denman Road. The roads have narrow pavement widths and gravel shoulders, with moderate grades and sharp turns over undulating terrain in the northern sections, and involves three rail crossings in the southern sector. The traffic survey reveals that little or no traffic related to the Bengalla Mine utilize these roads (prohibited by condition of consent). It is assumed that the small mine related proportion (6.9%) of the total traffic using Mangoola Road is Mangoola Mine employees travelling to and from their places of residence in Denman or rural properties in the south.

3.12.2 Ridgelands Road / Wybong Post Office Road/Yarraman Road

These roads currently carry low traffic volumes and minimal mine related traffic, most likely made up of employees travelling to and from their place of residence on rural properties north of Wybong Road. However, with the establishment of new mines (West Muswellbrook and others to the north-west) it would be anticipated that these roads may well carry significant volumes of mine-related traffic in the longer term.

3.12.3 Reedy Creek Road

Reedy Creek Road provides a short cut for drivers seeking to gain access to Wybong Road (West) from the Golden Highway and vice versa. It is assumed that only drivers with local knowledge would use this shortcut. It is not a road significantly impacted by mine-related traffic. While the volumes of traffic utilizing this road are relatively low, there is some concern in relation to the adequacy and safety of the design of its intersection with the Golden Highway. Additional investigations are needed in relation to the geometrics of the road and the intersections, and the need to improve safety for drivers.

3.12.4 Muswellbrook Industrial Estate

The Muswellbrook Industrial Area offers a wide range of industrial manufacturing and support industries, and as a consequence generates a significant amount of mine-related and non-mine related traffic. The section of Thomas Mitchell Drive between the Industrial Area and Denman Road is the most heavily trafficked section of local road in the Shire. It is anticipated that the Muswellbrook Industrial Area will continue to provide services and products to the local community as well as the mining industry in the long term. With the potential opening of new mines to the north and west, it can be expected that the proportion of traffic related to the mining industry will increase on roads leading to/from and within the Industrial Area.

3.12.5 Castlerock Road / Dorset Road

Castlerock and Dorset Roads are narrow sealed rural roads that provide access to a number of farms north of Wybong Road. Castlerock Road extends west from Kayuga Road and turns south to link with Wybong Road near Ridgelands Road. Dorset Road also extends west from a point further north on Dartbrook Road and turns north, becoming a gravel access road. Both roads currently carry only low volumes of traffic. However, the Mt Pleasant Mine proposal involves the closure of the eastern section of Castlerock Road for mining purposes and construction of new link roads (‘western’ and ‘northern’) to circumvent the proposed mining operations. Farm access is to be provided by the new link roads which will also provide an alternative travel path for vehicles heading north when Wybong Road (East) is also closed for mining purposes.

3.13 Overview of Individual Mine-related Traffic

A breakdown of traffic per mine is shown in **Table 3.3.** Higher traffic volumes and percentages are highlighted.

Table 3-3 Summary of Mine-related Traffic

Road Section	Total Mine-related Vehicles			Mangoola Mine		Bengalla Mine		Mt Arthur Mine		Drayton Mine	
	Total Mine-related Traffic (vpd and %)	Vehicle Types (vpd)		% of Mine-related Traffic	Mine Traffic x Veh Type	% of Mine-related Traffic	Mine Traffic x Veh Type	% of Mine –related traffic	Mine Traffic x Veh Type	% of Mine-related Traffic	Mine Traffic x Veh Type
Kayugah Road North (Shire Boundary to Wybong Road)	**73** (12.8% of total traffic)	LV's	**71**	**16%**	12	**40%**	27	**34%**	25	**10%**	7
		HV's & MCV's	**2**		0		2		0		0
Kayuga Road East (Wybong Road to Kayuga Bridge)	**246** (14% of total traffic)	LV's	**238**	**30%**	70	**0%**	0	**57%**	138	**13%**	30
		HV's & MCV's	**9**		3		0		4		2
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	**231** (28.7% of total traffic)	LV's	**213**	**32%**	63	**36%**	77	**23%**	53	**9%**	20
		HV's & MCV's	**18**		12		6		0		0
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	**724** (56.4% of total traffic)	LV's	**665**	**78%**	514	**12%**	78	**7%**	53	**3%**	20
		HV's & MCV's	**59**		51		8		0		0
Wybong Road East (Bengalla Link Road to Kayuga Road)	**231** (39% of total traffic)	LV's	**209**	**55%**	117	**45%**	92	**0%**	0	**0%**	0
		HV's & MCV's	**19**		8		11		0		0
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	**734** (69.7% of total traffic)	LV's	**671**	**60%**	397	**28%**	183	**9%**	66	**3%**	25
		HV's & MCV's	**63**		43		20		0		0
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	**1,407** (69.4% of total traffic)	LV's	**1,266**	**28%**	352	**60%**	752	**9%**	119	**3%**	43
		HV's & MCV's	**141**		37		95		6		3
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	**2,541** (28.8% of total traffic)	LV's	**2,417**	**9%**	197	**12%**	301	**73%**	1,771	**6%**	148
		HV's & MCV's	**124**		14		16		80		13
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	**2,496** (53% of total traffic)	LV's	**2,349**	**5%**	109	**8%**	190	**79%**	1,867	**8%**	183
		HV's & MCV's	**147**		12		13		94		28
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	**1,580** (41.7% of total traffic)	LV's	**1,454**	**8%**	108	**12%**	189	**66%**	969	**14%**	188
		HV's & MCV's	**126**		12		8		76		30
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	**1,935** (46.7% of total traffic)	LV's	**1,797**	**6%**	108	**10%**	189	**54%**	964	**30%**	536
		HV's & MCV's	**138**		12		7		72		47
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	**270** (25.8% of total traffic)	LV's	**222**	**24%**	54	**41%**	80	**26%**	68	**9%**	20
		HV's & MCV's	**48**		12		29		3		4
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	**50** (6% of total traffic)	LV's	**50**	**26%**	13	**44%**	22	**30%**	15	**0%**	0
		HV's & MCV's	**0**		0		0		0		0

Traffic numbers of interest are shown highlighted and are discussed below.

(blue)	Local Roads with Higher Proportions of Mine Related Traffic Movements
(tan)	Higher Mine-related Traffic Numbers

In relation to each mine, the following observations are made:

3.13.1 Mangoola Mine

On the day of the traffic survey, Mangoola Mine accounted for:

- 3 heavy vehicles that used Kayuga Bridge (93 heavy vehicles per day in total but only 9 were generated by 3 of the subject mines).
- 12 heavy vehicle movements travelling on Wybong Road (West) between the Mine Entrance and Sandy Hollow.
- 78% of the mine-related traffic using Wybong Road between the Mine Entrance and Bengalla Link Road. This included 51 heavy vehicle movements per day.
- Just over half (55%) of the mine-related vehicles on Wybong Road (East) (to Kayuga Road).
- 60% of mine-related traffic on Bengalla Link Road (North) including 43 heavy vehicle movements.
- 37 of the mine-related heavy vehicle movements on Bengalla Link Road (South).

3.13.2 Bengalla Mine

On the day of the traffic survey, Bengalla Mine accounted for:

- 6 heavy vehicle movements travelling on Wybong Road (West) between the Mine Entrance and Sandy Hollow.
- 45% of the mine-related vehicles on Wybong Road (East) (to Kayuga Road).
- 20 mine-related heavy vehicle movements on Bengalla Link Road (North).
- 60% of the mine-related traffic on Bengalla Link Road (South) including 95 heavy vehicle movements.
- 29 of the 48 mine-related heavy vehicles using Edderton Road (North) on the day of the survey. This number appears unusually high suggesting that there was increased Bengalla Mine related activity at the Mt Arthur Heavy Vehicle Assembly Pad that day.

3.13.3 Mt Arthur Mine

On the day of the traffic survey, Mt Arthur Mine accounted for:

- 4 of the heavy vehicles that used Kayuga Bridge (93 heavy vehicles per day in total but only 9 were generated by 3 of the subject mines). There was also 138 light vehicle movements associated with Mt Arthur Mine using that route (approx. 60% of the mine-related light vehicles on that section of road).
- The majority (ranging from 54% to 79%) of the mine-related vehicles (including heavy vehicles) on the sections of Thomas Mitchell Drive.

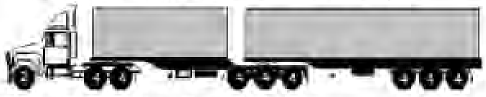
3.13.4 Drayton Mine

On the day of the traffic survey, Drayton Mine accounted for:

- 2 of the heavy vehicles that used Kayuga Bridge (93 heavy vehicles per day in total but only 9 were generated by 3 of the subject mines).
- A significant proportion of the mine-related heavy vehicles (ranging from 28 to 47 heavy vpd) using Thomas Mitchell Drive (primarily at the New England Highway end).

3.13.5 Multi-combination Vehicle (MCV's)

The traffic survey included counts for light vehicles (LV's), heavy vehicles (HV's) and multi-combination vehicles (MCV's). MCV's include B-Doubles and anything larger.

Restricted access vehicles: B–doubles		
• B–doubles ≤ 19 m and > 50 and ≤ 57 tonne mass • B–doubles > 19 m and ≤ 25m • B–doubles > 25m and ≤ 26m may operate under Class 3 26 Metre B–double Exemption Notice 2011  Class 2 B–doubles Notice 2010. The list of approved routes is regularly amended through the Gazette.	May operate on approved routes subject to meeting all access conditions listed in the Notice.	Route assessed and where appropriate approved by the access authority (RMS or council).

Source: NSW RMS

The following table identifies the numbers of MCV's counted on Thomas Mitchell Drive on the day of the traffic survey:

Table 3-4 Multi-combination Vehicles Thomas Mitchell Drive

Road Section	Total MCV's	Mangoola Mine	Bengalla Mine	Mt Arthur Mine	Drayton Mine
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	1	0	0	1	0
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	13	0	0	4	0
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	40	0	0	31	0
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	42	0	0	33	1

In relation to Thomas Mitchell Drive, the following occurred on the day of the survey:

- There were 9 MCV movements not related to the local mines on Thomas Mitchell Drive between the New England Highway and the Industrial Area.
- There were 31 and 33 MCV movements on Thomas Mitchell Drive between the New England Highway and Mt Arthur Coal Mine entrance.
- There were 4 MCV movements on Thomas Mitchell Drive between Mt Arthur Mine and the Industrial Area.

The following table identifies the numbers of MCV's counted on the Bengalla Link Road on the day of the traffic survey:

Table 3-5 Multi-combination Vehicles Bengalla Link Road

Road Section	Total MCV's	Mangoola Mine	Bengalla Mine	Mt Arthur Mine	Drayton Mine
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	3	0	0	0	0
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	14	0	4	0	0

In relation to Bengalla Link Road, the following occurred on the day of the survey:

- Survey data indicates that 13 of the MCV movements (3 from the north and 10 from the south) were generated by non-mine related rural industries off Bengalla Link Road.
- Bengalla Mine generated 4 MCV movements on the southern section of the Link Road.

3.13.6 Other Local Roads Carrying Multi-combination Vehicles (MCV's)

Survey data has been reviewed to identify other roads carrying significant numbers of MCV's. As anticipated, the state roads (New England Hwy, Golden Hwy and Denman Road) carry significant numbers of larger trucks and other large vehicles. It is also apparent that rural industries throughout the shire generate significant numbers of larger vehicle movements on the local arterial roads e.g. Rosemount Road (63 vpd) and Wybong Road (12 vpd).

3.14 Emergency By-pass and Overweight and Oversize Vehicle Routes

A vehicle or vehicle combination is considered to be oversize and/or overmass if it exceeds any general access mass or dimension limit. Typical examples of oversize and/or overmass vehicles include:

- Agricultural machines such as harvesters and grain augers.
- Vehicle combinations carrying large indivisible items such as mining and construction vehicles, bridge components or building infrastructure.
- Special purpose vehicles such as mobile cranes, concrete pump trucks and drilling rigs.

Oversize and overmass vehicles and loads are subject to operating and travel restrictions. Specific permits are required to operate on NSW roads. Within Muswellbrook Shire, there are a number of roads that are prohibited from carry overweight and oversize vehicles due to height and weight limits or physical constraints (e.g. bridge widths and heights, turning ability). Where restrictions or limitations exist, it is necessary to identify suitable alternative travel routes. The roads with these constraints are:

- **Hunter River Bridge near Denman** – Width limited. Alternative route via Wybong Road/Bengalla Link Road/Thomas Mitchell Drive to New England Highway.
- **New England Highway rail overpass in Muswellbrook** – Height limited. The alternative route is via Bell Street (also limited due to curve radii).
- **Golden Highway at Ogilvy Hill** – Steep grade with insufficient shoulder width to facilitate pull-off ability or safe passing. Alternative via Denman Road/Thomas Mitchell Drive to New England Highway.
- **Kayuga Road Bridge** – Width limited. Alternative is via Kayuga Road to travel north or via Wybong Road/Bengalla Link Road/Thomas Mitchell Drive to New England Highway to go south.

In formulating a Road Network Plan, it will be necessary to nominate the preferred alternative routes to facilitate permit applications.

3.15 Crash History

Crash data has been supplied by Muswellbrook Council for the study area for the five year period from 2008 to 2012. This data was used in a crash investigation of the existing road network. Generally crash data is categorised as tow-away, injury or fatality. These crash statistics along with traffic volume counts were used to calculate crash rates, casualty rates and fatality rates. The following definitions were used in these calculations:

- **Road Crash** - An apparent, unpremeditated event which results in death or injury to a person, or vehicle or property damage and is attributable to the movement of a road vehicle(s) on a public road.
- **Casualty Crash** - A road crash involving either an injury or a fatality.
- **Casualty Crash Rate** – The casualty crashes per km per year.

Figure 3.11 indicates the crashes on the mine-affected local roads and identifies them by definition (Fatal, Injury, or Tow Away). These crashes are also shown in **Table 3.6** which details the crashes by road section. Within the five year period, three fatal crashes and 34 injury crashes were recorded. The fatal crashes occurred on Edderton Road and Wybong Road West, and the roads with the most crashes are Wybong Road (21) and Thomas Mitchell Drive (20). The road sections with the highest casualty crash rate are highlighted in orange in **Table 3.6**.

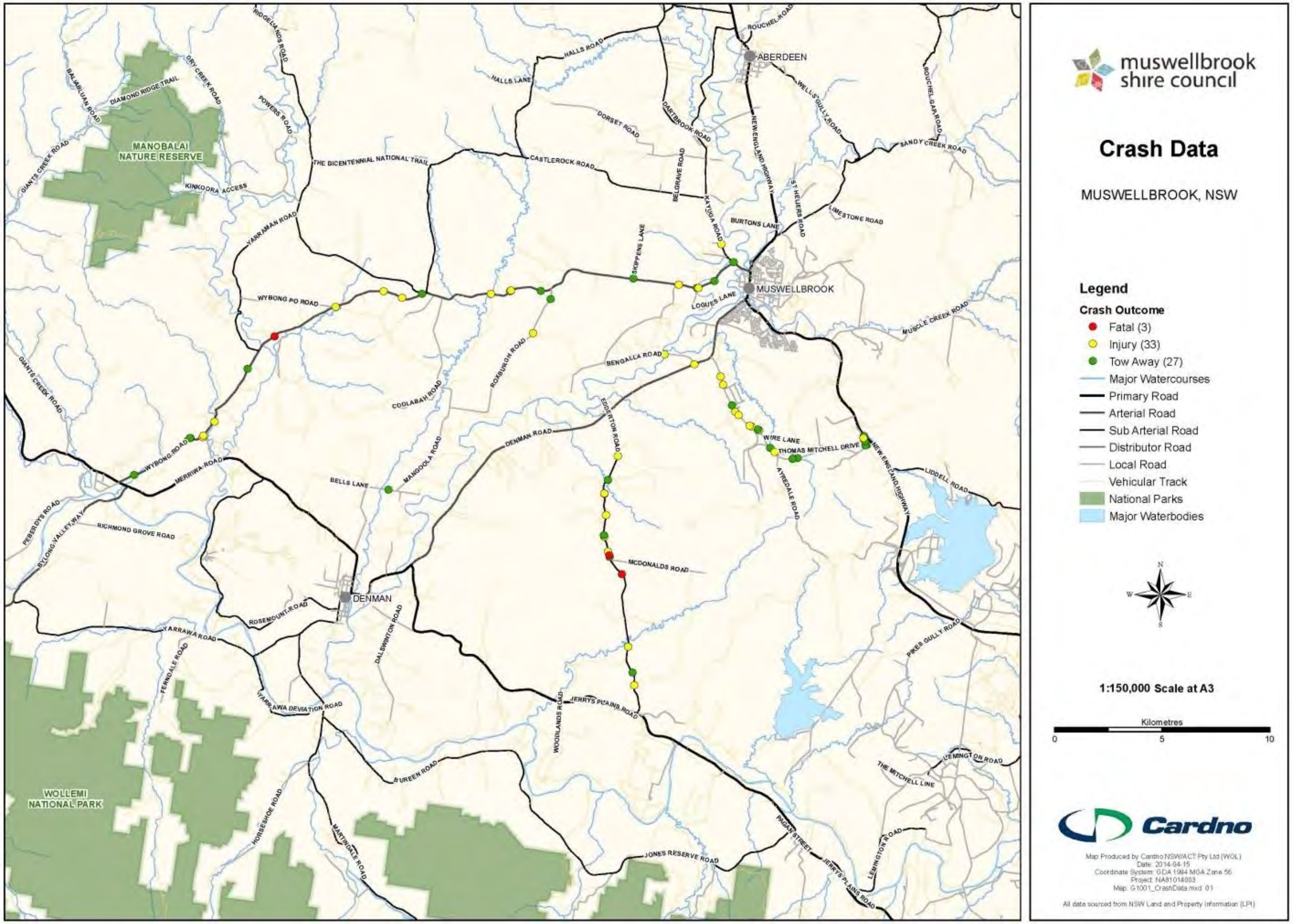


Figure 3-11 Crash Data for local mine-affected roads within Muswellbrook Shire

The proportion of heavy vehicle crashes was compared to the corresponding percentage of heavy vehicle movements. It is noted that the percentage of crashes involving heavy vehicles is significantly higher on every road section than the heavy vehicle proportion for the total traffic flows. This indicates that heavy vehicle crashes are over represented in the crash data. The road sections where heavy vehicles were involved in over 50% of crashes are highlighted in blue in **Table 3.6.**

Table 3-6 Crash Data by Road Section

Road Section	Length (km)	All vehicle crashes			% Crashes with HV's involved.	% HV of total traffic	Casualty crashes per km per year
		Tow Away	Injury	Fatal			
Kayugah Road North (Shire Boundary to Wybong Road)	2.3	1	1	-	**100%**	4.8%	0.09
Kayuga Road East (Wybong Road to Kayuga Bridge)	0.8	-	-	-	0%	5.4%	0.00
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	17.1	3	7	1	18%	6.8%	0.09
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	7.1	3	2	-	20%	6.9%	0.06
Wybong Road East (Bengalla Link Road to Kayuga Road)	9.6	3	2	-	20%	7.1%	0.04
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	3.2	-	1	-	**100%**	8.6%	0.06
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	6.3	-	2	-	50%	10.7%	0.06
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	2.7	1	2	-	**67%**	6.5%	0.15
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	2.3	2	5	-	**57%**	12%	0.43
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	1.9	2	1	-	33%	14.5%	0.11
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	3.8	6	1	-	**57%**	13.6%	0.05
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	7.3	3	7	1	45%	12%	0.22
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	7.5	1	2	1	**75%**	18.5%	0.08
Roxburgh Road	5.8	1	1	-	0%		0.03
Mangoola Road	9.4	1	-	-	0%		0.00
Total	**87.1**	**27**	**34**	**3**			**0.08**

The annual average casualty crash rate per kilometer was calculated at 0.08, which is below **the NSW state wide average annual casualty crash rate per kilometre of 0.4 for the same period**. This suggests that per length of road, the local roads are performing better than the state average. The annual casualty crash rate per kilometre does not however take into account the significant variations in traffic volumes along the road sections, and may therefore understate relatively high crash rates on particular lengths of road operating with significantly lower traffic volumes.

The cause of accidents is characterized by a Road User Movement (RUM) code used to attribute crashes to different categories. These categories are shown in **Figure 3.12** which shows the causes of accidents by road section. This shows that most crashes (70%) were caused by vehicles travelling “off path on curve” or “off path on straight”, suggesting that speed may have been a contributing factor.

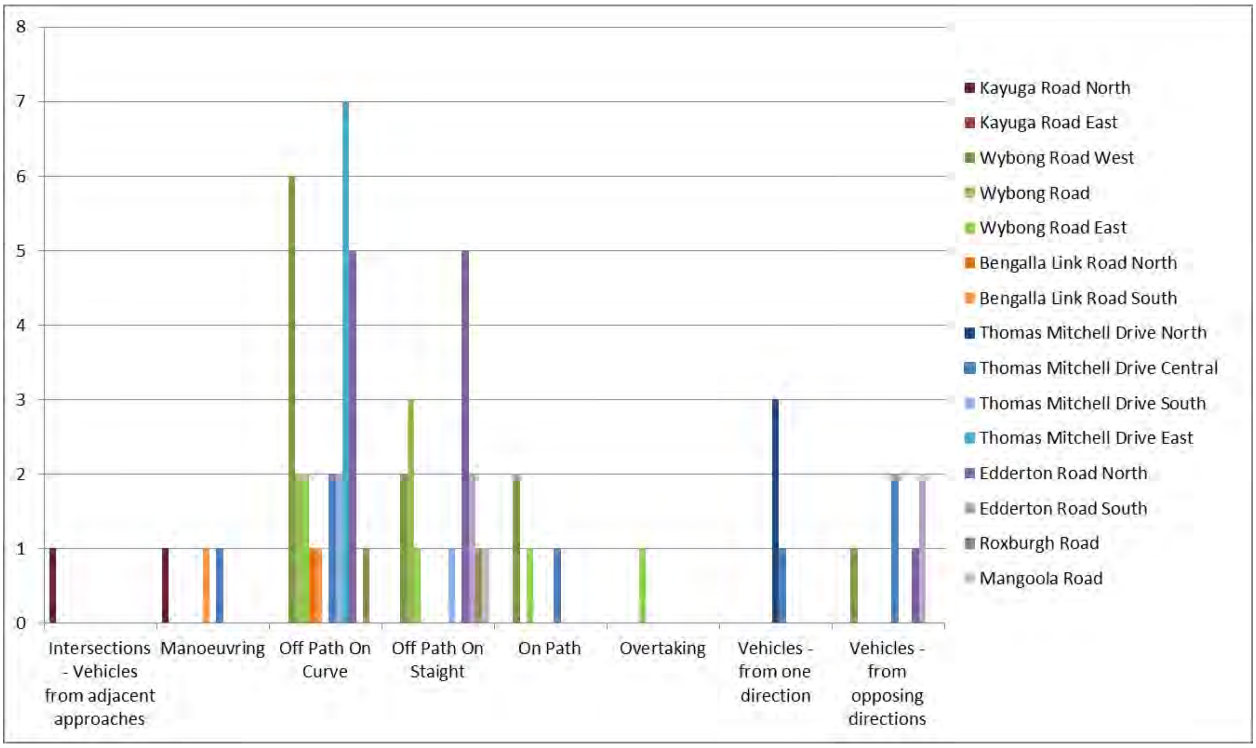


Figure 3-12 Crashes by code type and road section

3.16 Performance Assessment

Road Hierarchy

The Road Network Management Hierarchy is used by RMS to manage State Roads accordingly. Although this study excludes State Roads, the hierarchy can still be used to organise the mine affected local roads. The classification is based on traffic volumes, heavy vehicle volumes, speed posting and strategic factors, and are distinguished between Urban and Rural categories. **Table 3.7** lists the categories for the Rural Network Management Hierarchy as developed by the RTA (2008).

(Note: The RMS uses a road network hierarchy approach for the assessment of State Highways and Roads. While the RMS methodology is not directly applicable to local roads, it provides a useful reference as to how the local road network is performing)

Table 3-7 Road Network Management Hierarchy – Rural (as per RMS)

Class	Average Annual Daily Traffic	Heavy Vehicles (Average)	Speed Limit (km/h)
6R	12,000+	2,500	100-110
5R	12,000	1,200	80-110
4R	10,000	1,000	80-110
3R	4,500	500	60-110
2R	1,500	250	60-110
1R	500	50	60-110

Source: Network and Corridor Planning Practice Notes (RTA, 2008)

While the traffic volumes in **Table 3.7** indicate AADT and the traffic counts for the Muswellbrook roads are from a weekday count and so not directly comparable, **Table 3.8** has been used to differentiate between the different classes of road, to provide an estimated road hierarchy. As the traffic volumes differ between sections of the same road, the estimated hierarchy for each section of road is indicated in **Table 3.8**. Some of the road sections have values between 1R and 2R where the traffic volumes are close to the 2R category, but the heavy vehicle volumes are closer to 1R. In these cases the 2R category has been applied to more accurately reflect the overall traffic volumes.

Table 3-8 Estimated Road Hierarchy

Road Section	Daily Traffic Volumes	Daily Heavy Vehicles	Speed Limit (km/h)	Class
Kayugah Road North (Shire Boundary to Wybong Road)	**578**	**28**	70	1R
Kayuga Road East (Wybong Road to Kayuga Bridge)	**1,718**	**93**	70	2R
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	**804**	**55**	70	1R
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	**1,288**	**89**	80	2R
Wybong Road East (Bengalla Link Road to Kayuga Road)	**589**	**42**	80	1R
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	**1,056**	**91**	90	2R
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	**2,030**	**218**	90	2R
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	**8,801**	**577**	80	3R
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	**4,702**	**569**	80	3R
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	**3,789**	**553**	80	3R
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	**4,146**	**567**	80	3R
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	**1,023**	**124**	80	2R
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	**836**	**155**	80	2R

The identification of a road hierarchy categorises the road sections accordingly and enables performance of each road section to be assessed according to its category. The road sections are sorted by category in **Table 3.9**.

The definition and expected role of the Road Network Management Hierarchy – Rural categories, are described further as follows (Network and Corridor Planning, Practice Notes, 2008):

- **3R** – Class 3R roads provide a strategic freight function. They are typified by moderate levels of traffic volumes including freight, commercial vehicle and public transport travel. They provide an acceptable standard of travel and serve inter/intra-regional functions. Typically they have undivided carriageways with 2 lanes.
- **2R** – Class 2R roads provide inter-regional and intra-regional connectivity and the strategic needs of freight. They are typified by low levels of traffic volumes including freight, commercial vehicle and public transport travel. They provide a reasonable standard of travel and serve intra-regional and some-inter-regional functions. Typically they have undivided carriageways with 2 lanes.
- **1R** – Class 1R are typified by very low levels of traffic volumes including freight, commercial vehicle and public transport travel. They provide a varied but reasonable standard of travel and serve some intra-regional and inter-regional functions. Typically they have undivided carriageways with 2 lanes.

Table 3-9 Road sections by Class of Road Hierarchy

Class	Road Section
3R	**Thomas Mitchell Drive North** (Denman Road to the Industrial Area)
	Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)
	Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)
	Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)
2R	**Kayuga Road East** (Wybong Road to Kayuga Bridge)
	Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)
	Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)
	Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)
	Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)
	Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)
1R	**Wybong Road West** (Sandy Hollow to Mangoola Mine Entrance)
	Kayugah Road North (Shire Boundary to Wybong Road)
	Wybong Road East (Bengalla Link Road to Kayuga Road)

Performance benchmarks are primarily used by RMS when focusing on ensuring network objects are progressively met. Benchmarks are considered for each class type and are defined as *'the average value for each measure over all roads contained in that class'* (Network and Corridor Planning, Practice Notes, 2008). The network performances of the road sections within the study area have been assessed based on the transport and safety network class averages set out by the RTA/RMS for rural roads. **Table 3.10** outlines the average class performance levels set out by RTA/RMS.

Table 3-10 Network Class Averages – Rural Areas

	Safety Casualty Crashes per Kilometre per Year (2001-05)	Transport Daily mid-block level of service (2006)
6R	0.72	2.7
5R	0.72	2.4
4R	0.40	2.3
3R	0.37	2.2
2R	0.16	1.6
1R	0.05	1.1

where: LOS A = 0-1, LOS B = 1-2, LOS C = 2-3, LOC D = 3-4, LOS E = 4-5, LOS F = 5-6

Source: Network and Corridor Planning, Practice Notes, RTA, 2008 (Table 4.4)

3.17 Safety

The study of safety network performance standards undertaken, calculated and measured by length of road, number of injuries and number of fatalities, identified that a number of sections of roads within the study area exceed class averages set out by RTA/RMS. The following roads were identified to exceed safety network class averages set out by RTA/RMS, identifying that safety improvements are required within identified sections, with full findings of the study presented in **Table 3.11**:

- **Kayugah Road North** (Shire Boundary to Wybong Road);
- **Wybong Road West** (Sandy Hollow to Mangoola Mine Entrance);
- **Thomas Mitchell Drive Central** (Industrial Area to Mt Arthur Mine Entrance); and
- **Edderton Road North** (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)

Table 3-11 Results Summary of Network Class Averages – Rural Areas

Road Section	Casualty Crashes per km per year - Average Class Performance	Casualty Crashes per kilometre per year for each road section
Kayugah Road North (Shire Boundary to Wybong Road)	0.05	0.09*
Kayuga Road East (Wybong Road to Kayuga Bridge)	0.16	0.00
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	0.05	0.09*
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	0.16	0.06
Wybong Road East (Bengalla Link Road to Kayuga Road)	0.05	0.04
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	0.16	0.06
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	0.16	0.06
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	0.37	0.15
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	0.37	0.43*

Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	0.37	0.11
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	0.37	0.05
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	0.16	0.22*
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	0.16	0.08

** Exceeds acceptable casualty crashes per kilometre per year (2001-05) network class average for rural roads*

3.18 Road Capacity

The RMS mid-block level of service for rural roads is defined by a number of factors that contribute to the calculation of the actual level of service. The road mid-block level of service for the sections of roads within the study area was calculated primarily on the number of lanes in each direction, two directional light and heavy traffic volumes and lane, and shoulder widths. **Table 3.12** outlines the results of the mid-block level of service (LoS) as well as the additional capacity compared with network class averages. It should be noted that when assessing the mid-block capacity, level of service A to C is considered to be acceptable.

The following findings were noted:

- Kayuga Road, Wybong Road, the Bengalla Link Road and Edderton Road are all operating within their current theoretical capacity having a Level of Service (LoS) of either A or B for the various road sections.
- Thomas Mitchell Drive south of the Industrial Area is currently operating close to capacity with a LoS of C. While a mid-block LoS of C is generally considered acceptable, there is limited additional two-way capacity to accommodate any substantial increases in traffic on this section of Thomas Mitchell Drive (ranging from 243 to 316 vehicles per hour). Variations to peak hour traffic volumes and anticipated increases in base traffic volumes over time will see this road operating close to capacity at times, resulting in delays, slower traffic speeds and increased risks to road users.
- Thomas Mitchell Drive North between Denman Road and the Industrial Area has been identified as having a mid-block LoS of D and was operating over capacity by 124 veh/hr on the day of the traffic survey.

It is recommended that responsible authority carry out further mid-block counts in order to monitor performance over time. Should the road capacity be substantially exceeded, consideration will need to be given to additional road works to improve traffic flows.

Table 3-12 Mid-Block Level of Service Results Summary

Road Section	Lanes per direction	Two-way Traffic volumes (veh/hr)	Two-way HV volumes (veh/hr)	Road Management Hierarchy	LoS for each road section	Additional Two-way Capacity Against Daily Mid-block Network Class LOS C*
Kayugah Road North (Shire Boundary to Wybong Road)	1	58	3	1R	A	713
Kayuga Road East (Wybong Road to Kayuga Bridge)	1	172	10	2R	B	593
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	1	81	6	1R	A	673
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	1	129	9	2R	B	623
Wybong Road East (Bengalla Link Road to Kayuga Road)	1	59	5	1R	A	692
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	1	106	10	2R	B	632
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	1	203	22	2R	B	519
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	1	881	58	3R	D	-124
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	1	471	57	3R	C	243
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	1	379	55	3R	C	316
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	1	415	57	3R	C	286
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	1	103	13	2R	B	610
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	1	84	16	2R	A	583

**The additional two-way capacity has been compared against LOS C, considered as the acceptable peak hour capacity.*

Note 1: In the absence of mid-block hourly counts for all road sections listed, the two-way peak hour traffic volumes have been calculated at 10% of vehicles per day (as per RMS Practice Notes). Available mid-block traffic data suggest that the peak hour is more spread which would result in slightly greater capacity being available at peak times in some locations.

An assessment of the existing road conditions identified that all road sections within the study area operate well within the acceptable LoS C or higher, apart from Thomas Mitchell Drive North between Denman Road to the Industrial Area (identified as a mid-block Level of Service of D) and over capacity by 124 veh/hr.

It is recommended that the responsible authority carry out further mid-block counts in order to monitor performance over time. Should the road capacity be substantially exceeded, consideration will need to be given to additional road works to improve of traffic flows.

4 Future Demands on the Network

4.1 Specific Mine Proposals

The following map shows the location of current and proposed mining operations within the Study Area.

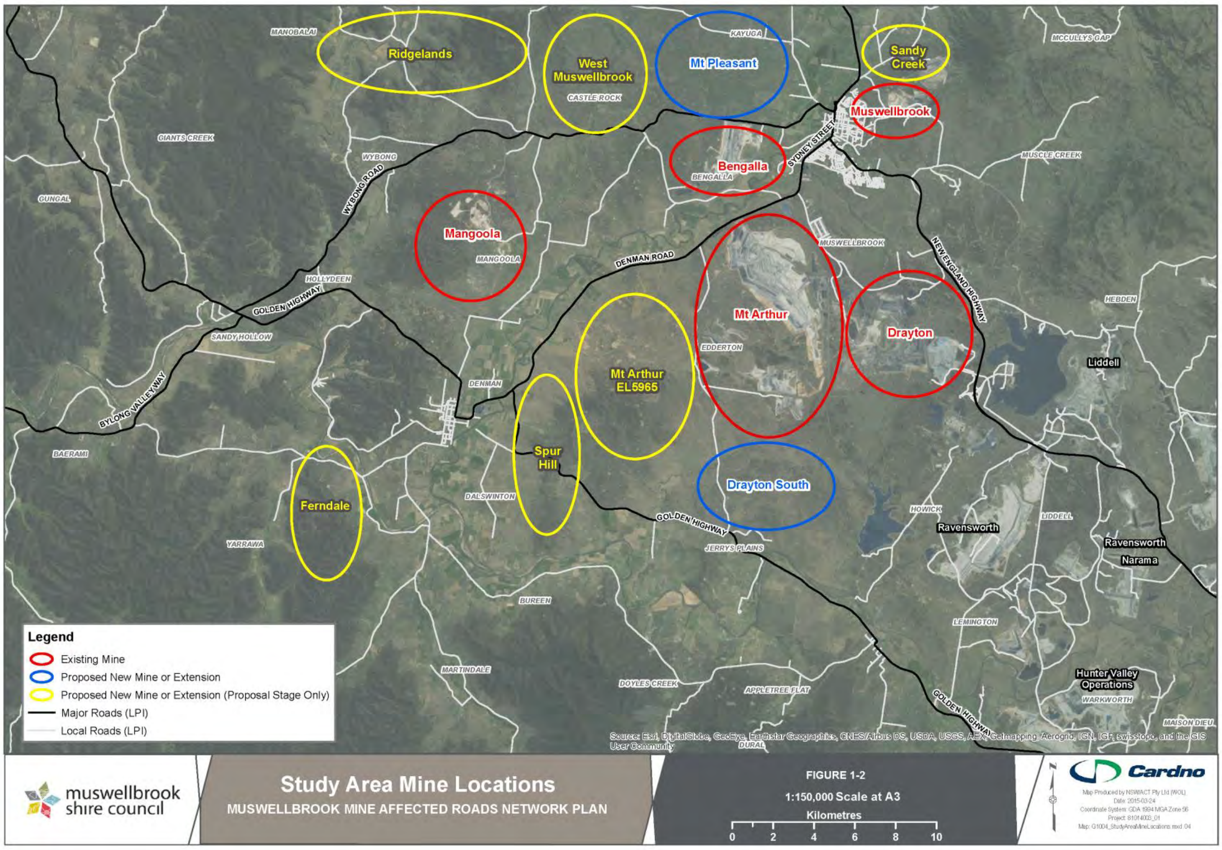


Figure 4-1 Mine Locations within the Study Area (Existing and Proposed)

Following a review of applications currently with the NSW Department of Planning and Infrastructure (DPI) and after direct consultation with the mine operators and proponents, the following mine life expectancies have been estimated (Refer to ***Figure 4.2***). It should be noted that there are many variables which will influence mine activity over the coming years. The following chart and subsequent comments reflect a 'best guess' from the information currently available.

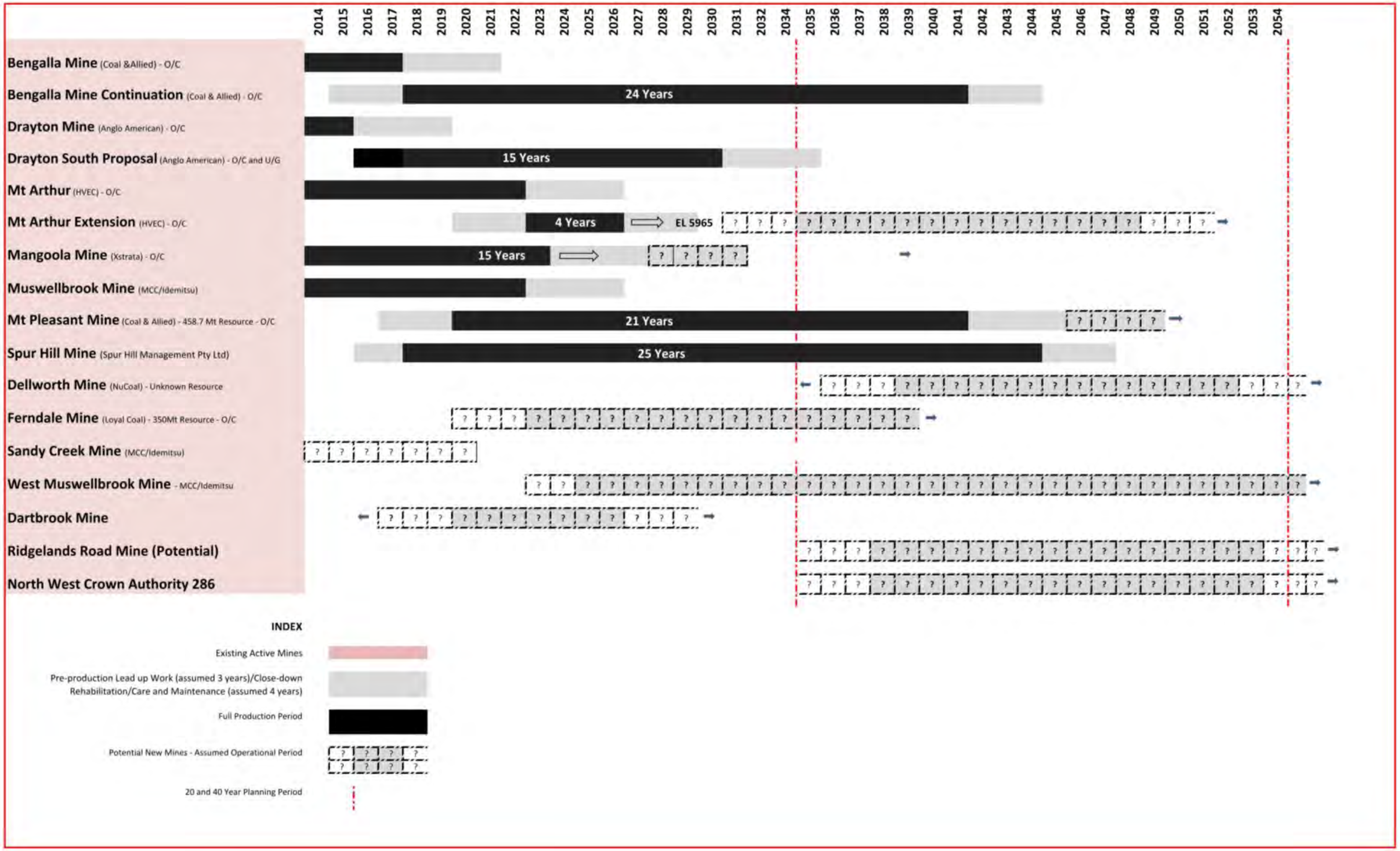


Figure 4-2 Estimated Mine Life Expectancy Chart

The following table summarises the anticipated mine activity over the next 20 and 40 years based on currently available information:

Table 4-1 Summary of Anticipated Mine Activity

Mine	Over the next 20 years (to 2034)	20 to 40 year time frame (2034 to 2054)
Bengalla Mine (Existing)	The consent for the current Bengalla Mine extraction area will lapse in 2017 and rehabilitation ('care and maintenance') will continue for a number of years thereafter. Currently 400 full-time equivalent employees (fte's) plus contractors work at the mine. Open cut coal extraction will continue in a westerly direction into a new resource area for a further 24 years (with 900 fte's plus contractors).	Coal extraction will continue in a westerly direction until approx. 2041. Potential exists for the open cut extraction to continue into new areas to the west and potentially into underground coal resources.
Drayton Mine (Existing) and Drayton South Mine (Proposal)	The existing Drayton Mine extraction area will cease operation at the end of 2015 and rehabilitation ('care and maintenance') will continue for a number of years thereafter. A new (reduced) Drayton South Mine will commence in 2015 continuing west for approx. 15 years (2030). (Existing 530 fte's to relocate to Drayton South extraction area).	Coal extraction will continue in a westerly direction until approx. 2030. Potential exists for extraction to continue into underground coal resources.
Mt Arthur Mine (Existing) plus Extension	The existing Mt Arthur Mine extraction area has a further 8 years of resource and with approval of the extension to the west, will cease operation in approx. 12 years (2026) after which rehabilitation ('care and maintenance') will continue for a number of years. (2,600 fte's plus contractors currently work at the mine). Further resources within EL 5965 will see the extraction area extend further west beyond the 20 year time frame.	Potential exists for the extraction of underground coal resources and new areas of additional open cut coal within EL 5965. Potential mine life span is unknown but is assumed will extend beyond 2054.
Mangoola Mine (Existing)	Increased extraction rates to see the existing Mangoola Mine resource to run out in 2023-2024 (300 fte's currently working at the mine to increase to 450 fte's plus up to 90 contractors).	Additional open cut resources exist to the west. Future underground resource also exists and may be pursued subject to viability assessment.
Muswellbrook Mine (Existing)	The existing Muswellbrook Mine extraction area will cease operation in the next 4 years (2018) and rehabilitation ('care and maintenance') will continue for a number of years thereafter.	
Mt Pleasant Mine (Approved)	Mine construction to commence in 2015 (256 fte's during construction) and coal extraction to commence in 2017 (320 fte's) and to continue for 21 years (to 2038).	Extraction to continue until approx. 2038 and rehabilitation ('care and maintenance') will occur for a number of years thereafter. Future underground resources exist. Viability of extraction depends on market prices and advances in technology.
Spur Hill Mine (Proposal)	EL 7429 (Spurhill) is known to contain estimated resources in the order of 154Mt. It is assumed that construction will commence in 2015 (400 fte's) and extraction to commence in 2017 (300 fte's) and continue for 25 years (2042).	Extraction to continue until around 2042. Future underground resources exist and may be pursued subject to viability assessment.

Dellworth Mine (Potential)	EL 6594 (Dellworth) – Unknown resources. Long term potential.	Potential to be acquired by adjoining mines (Drayton, Mt Arthur).
Ferndale Mine (Potential)	EL 7430 (Ferndale) is known to contain estimated resources in the order of 743Mt (up to 85Mt saleable). Assume construction in 2016 (250 fte's) and extraction to commence in 2018 (100 fte's) and continue for 25 years (2043).	Extraction to continue until around 2043. Existence and viability of additional resource extraction unknown.
Sandy Creek Mine (Potential)	Estimated 16.9Mt of marketable reserves. Existing consent lapses in 2020.	Potential long term resource.
West Muswellbrook Mine (Potential Mine)	EL 19 (West Muswellbrook) is known to contain estimated resources in the order of 460Mt (7Mtpa). Assuming viability, extraction to commence around 2025 and continue for at least 30 years until beyond 2055.	Extraction to continue beyond 2055.
Dartbrook Mine (Existing)	Ceased Operating (Jan 2007) – under Care and Maintenance. Future U/G resource unknown.	
Ridgelands Road Mine(s) (Potential)	EL 6047 (Ridgelands) is located north of Wybong Road – Yet to be explored to identify coal reserves.	Potential long term extraction.
North West Crown Authority 286	Auth 286 - Surrounding Manobalai National Reserve in the north-west of the coal corridor.	Potential exploration for coal resources and long term extraction.

The following traffic related observations can be made from the above forecasting:

- The proposed and potential mine operations identified will see mine activity continuing at an increased level within the Muswellbrook LGA for the foreseeable future.
- The existing larger mines are currently seeking to move in a westerly direction (exception being Mangoola).
- In the short and medium term (10-20 years) there are a number of new mines set to commence operations to the north of the current mine activity (Mt Pleasant), in the north-west (West Muswellbrook) and to the west (Spurhill).
- On commencement of the currently proposed mine expansions (2017-2020), there will be:
  - A potential increase in the number of full-time equivalent employees (fte's) at the Mangoola Mine from 300 to 540 (depending on product demand);
  - More than a doubling of employee numbers at the Bengalla Mine (400 fte's to 900 fte's);
  - an additional 256 fte's (during construction) increasing to 320 fte's (during operation) plus direct mine related traffic will be introduced to the road network from the proposed Mt Pleasant Mine; and,
  - an additional 400 fte's (during construction) reducing to 300 fte's (during operation) plus direct mine related traffic will be introduced to the road network from the proposed Spur Hill Mine.
- In the longer term (20-40+ years), there are likely to be a number of new mines further to the north-west (along Ridgelands Road and within the North-West Crown Authority area) that could generate significant mine-related traffic movements in a location not immediately accessible to the main arterial road network.

4.2 Industry Road Network Demands

What will the land uses be like in 20 years (to 2034) and in 40 years (to 2054)?

4.2.1 Mining Industry Generally

Cardno's research suggests that:

- Coal will remain the primary source of energy production for global electricity and steel production for the foreseeable future.
- While competition from emerging coal supplying nations will influence the rate of growth, the demand for coal from the Hunter will continue to grow, albeit at a lower rate than in the recent boom period.
- Coal industry forecasts suggest that demand for efficiently produced, high quality Australian coal should remain steady for the foreseeable future.
- The best-placed mines are those with existing, low-cost operations and the reserves available to expand.
- Coal mining projects at the planning stage face rising construction and operating costs which will reduce their financial viability. As such, the initiation of new mines is likely to be postponed until there is a greater level of confidence in the market (i.e. until long term returns in investment are assured).

(Sources: Various Coal Industry Web Sites)

The ***Upper Hunter Strategic Regional Land Use Strategy 2012 (SRLUP)*** states (in Chapter 5):

It is estimated that 63 per cent of the gross regional product comes from mining. Between 2006 and 2010, direct employment in mining in the region rose from 5,500 to more than 11,000. Mining support industries, such as engineering, construction, transport, logistics and human resources have also become well established in Singleton and Muswellbrook.

Mining activity has grown significantly in the last five years and this growth is expected to increase in the coming years, with strongest growth in export demand predicted to occur during the years 2012-2016. This degree of growth in export coal production is expected to generate a moderate increase in additional mining jobs in the region by 2020 with that level of mining employment likely to be maintained until at least 2025.

Over the period to 2036, the region's workforce is expected to grow by between 7,400 and 8,200 jobs. Much of this increase will be driven by the growth of the coal and coal seam gas industries and focused in the LGAs of Singleton, Muswellbrook and Upper Hunter. Efficiency improvements in the mining industry will also support growth, without the need for additional labour.

The ARTC's 2013-2022 Hunter Valley Corridor Capacity Strategy states that "*the currently contracted export coal volumes are around 158 mtpa in 2013 and may be as high as 188 mtpa in 2014 and 197 mtpa in 2015 where they approximately stabilize until increasing to around 204 mtpa in 2018 and 206 mtpa in 2019"*. It is noted that *"the actual unconditional contracted volume for 2013 is approximately 22 mtpa lower than contracted at the time of the 2012 Strategy."*

It can be concluded from the above observations that:

- The Coal Mining Industry will remain the primary source of energy production for global electricity and steel production for the foreseeable future (>40 years).
- Due to reduced coal prices, growth in the coal industry in the Upper Hunter will remain steady but cautious in the short to medium term, with the most efficient existing mines (and extensions thereto) likely to continue to be the primary suppliers of coal for local users and export purposes.
- The less efficient mines are likely to reduce production (or potentially cease production) to maintain viability or minimise losses until the market improves.
- Due to the substantial establishment costs, relatively low coal prices and limited markets, new mines are likely to be postponed until there is a greater level of confidence in the market or other mines deplete their resources and cease operation.
- Improvements in the efficiency in coal extraction will support growth in the industry, without the need for any substantial increase in labour. As a consequence, there are unlikely to be significant increases in traffic movements unless the demand for coal increases substantially and new mines are opened.

4.2.2 Impacts of the Current Mine Approvals and Applications

Approvals and applications for the expansion, intensification and/or relocation of existing mines (which are currently at various stages in the planning assessment process), are unlikely to result in increased traffic numbers of a size that will overload the current road network in the short term (with the exception of the northern section of Thomas Mitchell Drive which currently operates above its theoretical capacity at a Level of Service ‘D’).

The Traffic Assessment for the Mt Pleasant Mine states that as a result of that mine alone (should it proceed), traffic on routes to and from the south will be significant on only three sections of road, namely:

- The Bengalla Link Road (61% increase);
- Denman Road east of the Bengalla Link Road (10% increase); and,
- Thomas Mitchell Drive (10% increase).

(Source: Page 14.13 Mt Pleasant Proposal - Traffic Impacts 1997 by ERM Mitchell McCotter)

While the increases would generally not affect overall traffic flows and speeds on the Bengalla Link Road and the short section of Denman Road, the traffic increases on Thomas Mitchell Drive, being 10% for the Mt Pleasant Mine traffic and “about 18% for all current mine traffic”, will result in the road being subjected to traffic volumes in excess of the capacity of the road in its current formation.

The movement of coal extraction areas in a westerly direction will necessitate the removal of sections of existing roads to facilitate extraction of coal resources under and adjacent to the current road alignments (e.g. the northern section of Bengalla Link Road and the full length of Edderton Road). There will be significant expense in the relocation of these roads and potentially significant traffic flow interruptions associated with removal and reconstruction of pavements and intersections. In the case of Edderton Road the existing location is potentially more efficient and following mining operations the road could be reinstated in its current location and upgraded to standards current at the time.

Similarly, construction works associated with the approved Mt Pleasant Coal Mine will involve significant disruptions to traffic flows (e.g. bridging of the Bengalla Link Road over the proposed rail loop, construction of the Northern and Western Link Roads, closure of Wybong Road (East) and Castlerock Road, upgrading of Wybong Road between Bengalla Link Road and the new Mt Pleasant Mine Access, and the construction of the rail load-out conveyor over or under Wybong Road). A major concern will be the timing of each of these components (See **Figure 4.1** – Roads coloured pink).

Options to address these disruptive road works are discussed in **Section 5** of this report.

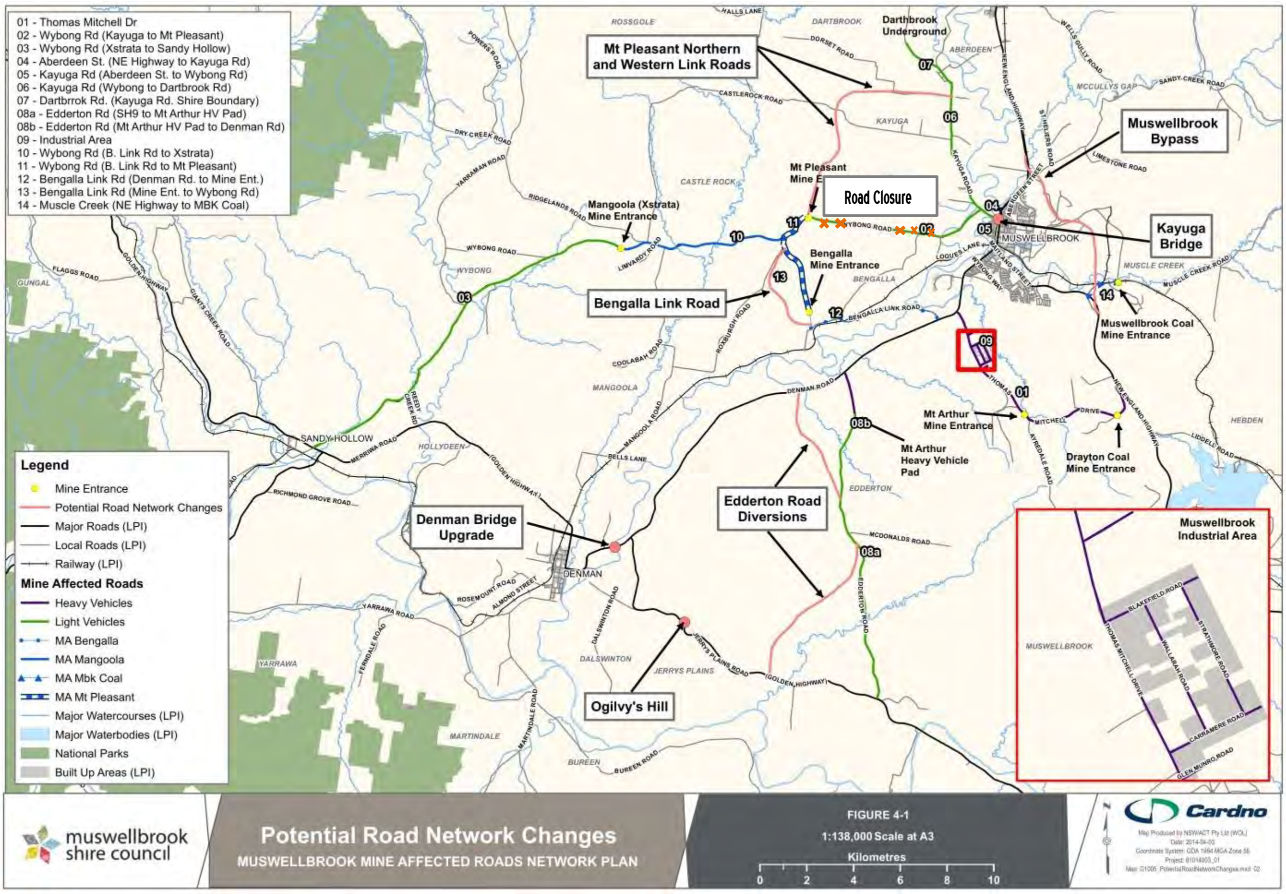


Figure 4-3 Proposed Road Network Changes and Existing Limitations

4.2.3 Background Traffic Growth

NSW Roads and Maritime Services (RMS) Assets Branch has advised that, in the absence of real data, a maximum of 1.5%pa growth in background traffic should apply to Council controlled regional roads. This is reinforced by the Hyder (2008) Muswellbrook Bypass report which states (on Page 66) that: *The marginal through traffic growth on the New England Highway should be calculated at 1.45% between 2007 and 2020 and 1% until 2037.* That is, a more logarithmic reduction in the growth rate rather than a flat rate.

Thomas Mitchell Drive is currently categorised as a local road, but carries traffic volumes and functions like a Regional Road in the network. On this basis, a background traffic growth rate for Thomas Mitchell Drive of 1.45% pa has been adopted for the next 20 years reducing to 1.00%pa for the 20-40 year period.

For local roads, RMS advice suggests that new dwellings and population growth figures are often a good indicator of the anticipated growth in background traffic for local roads within the urban areas of an LGA (NB. New dwellings and population growth in Muswellbrook LGA for the Census period 2006 to 2011 was 0.83%pa). On this basis, 1% pa growth in background traffic across the board has been adopted for the next 20 years and 0.9% pa for the 20 to 40 year time frame.

Assumed background traffic growth rates for modelling purposes:

- - Thomas Mitchell Drive – 1.45% pa for the next 20 years reducing to 1.00% pa for the 20-40 year period.
- - All Other Local Roads – 1% pa growth across the board for the next 20 years and 0.9% pa for the 20 to 40 year time frame.

4.2.4 Industrial Land Use

Muswellbrook has been experiencing a steady economic growth during the last two decades, due to the significant development in the coal and energy industries. The growth of the mining industry will demand more industrial land to accommodate its supportive services. Council's Industrial Land Use Strategy states that there is an adequate short term supply of industrial land in Muswellbrook and several candidate areas for future industrial development in the medium to long term have been identified subject to the further detailed investigations. Two of the candidate areas are located to the east and south of Muswellbrook Township. The other two candidate areas (A and B) are located to the north of and opposite the existing Thomas Mitchell Drive industrial area and include 100 hectares of land in total. This potential expansion of industrial activity on Thomas Mitchell Drive in the medium and long term will have implications for the roads capacity and safety, and the frequency of required road maintenance.

4.2.5 Other Land Uses

The Shire has a diverse economy with various rural, urban and service sectors. All of these are critically important to a balanced diverse economy, which will continue to exist post mining. Viticulture and horse breeding are significant rural activities. There is small scale tourist industry activities associated with these operations. These activities do not generate large numbers of vehicles; but they do have very specific issues.

It is important that the operational needs of all road users be considered and that the impacts on safety and efficiency of the overall rural road network as a result of mining activity be properly assessed and mitigated to an acceptable level.

The Hunter Thoroughbred Breeders Association (HTBA) has provided the following comments in relation to their vehicle movements and industry changes:

> Horses are transported to sales throughout the year. The transportation of horses by truck at any time causes stress on the animals. The movement of horses between studs increases during the breeding season which extends from July to December each year. A significant proportion of movement is between Jerrys Plains and the Scone studs. During the season, horses are moved from early morning throughout the day, potentially 3 trucks per stud per day. This primarily involves the transportation of mares for breeding purposes but also the movement of young foals. As such, it is highly desirable that the travel time and the number of stops is minimised, as confinement, the heat due to reduced air flow (particular during summer), and traffic noise causes discomfort and distress to the horses.

While the industry has generally plateaued in terms of the number of stud farms, the amount of stock will continue to increase. There are a considerable number of visits to studs by horse owners during the breeding season and at sale times. The number of vehicle movements generated by employees and material deliveries are not high. However, the number of coach tours to the horse studs is increasing. Upper Hunter Tours has advised that each of the larger studs has 1-2 coach tours per week and a similar number of mini-bus tours.

4.3 Local Roads

The expansion of existing mines and development of new mines is expected to increase mine related traffic on the following roads:

4.3.1 Wybong Road

The eastern section from Bengalla Link Road to Kayuga Road does not and will not carry a significant proportion of mine related traffic due to the limitations of the existing Kayuga Bridge. By condition of consent, all mine generated traffic (including the proposed Mt Pleasant Mine) must be controlled and directed to use Bengalla Link Road when travelling to and from southern and eastern destinations.

The Mt Pleasant Mine proposal requires that (in Year 9) a section of Wybong Road (East), adjacent to the Mt Pleasant and Bengalla Mines, will be closed to permit mining of the boundary land between the mines.

In the longer term, with the advent the proposed West Muswellbrook and Ridgelands Road Mines, the central section of Wybong Road (between Ridgeland Road and Bengalla Link Road) will experience significant additional mine-related traffic. This assumes that the primary access to both mines is gained via Wybong Road. Given that both of these mines will extend a considerable distance to the north (beyond the

LGA boundary) over the life of the projects, there is a possibility that access may be gained from the north and the south at different times or at the same time. It is not possible to accurately forecast the potential impacts on the road network at this early development approval stage and this will require monitoring and programming of works as information becomes available.

4.3.2 Kayuga Road, Kayuga Bridge and Aberdeen Street

The eastern section of Kayuga Road (including Kayuga Bridge and Aberdeen Street) carries significant traffic volumes (mostly non-mine related) and these will continue to increase due to the efficiencies this route offers (for access to Wybong Road and beyond), from destinations north via the New England Highway and south to the Muswellbrook town centre.In the longer term, the construction of the Muswellbrook Bypass offers some efficiency for vehicles to travel south from this location, as the minimal distance from Aberdeen Street via the New England Highway to the proposed McCullys Gap Road on-ramp makes it a feasible route. This option is discussed in later sections of this report, including the option of a new river crossing off the extension of Wybong Road to connect more directly to the New England Highway.

The function of Kayuga Road in the network is not likely to change significantly. The replacement of the existing single lane timber bridge and minor traffic flow improvements will assist in improving the level of safety and efficiency of travel in this location.

It is important to note that historically the Kayuga Road Bridge has great local significance as it is an indication as to the emerging significance of the town of Muswellbrook in the state context in the late 19th century. It symbolises the state’s commitment to the establishment of links with the more western Hunter Valley lands. Aesthetically the bridge has local significance as a rare use of an iron bridge design locally. Scientifically the bridge is typical of similar bridges of the late 19th Century throughout the region and state but ut is of local significance for its potential to reveal information which could contribute to an understanding of the local area skills base of the time and the freight and construction techniques used in its construction (Ref: Muswellbrook Heritage Study Inventory 1996). The historical significance of the bridge will be an important consideration in the assessment of impacts arising from its proposed replacement by the RMS.

4.3.3 Bengalla Link Road

This north-west to south-east connection currently meets the needs of the mining industry and local traffic. However, with the advent of Mt Pleasant and other mines to the north-west in the longer term (West Muswellbrook and the Ridgelands Road area) the level of service offered by Bengalla Link Road and Wybong Road will be reduced affecting the efficiency of movement for mine-related traffic travelling to south-east destinations.

4.3.4 Thomas Mitchell Drive

Thomas Mitchell Drive is currently the most heavily trafficked road in the local road network. The road has recently been upgraded to provide improved pavement depths and widths consistent with arterial road standards. With the addition of proposed industrial areas (100 hectares) in this location in the medium-long term, and increased mine activity in the north, it will require the construction of passing lanes to facilitate passing of slower vehicles. Existing and forecast traffic volumes suggest that Thomas Mitchell Drive should be recognised as a regional main road coming under the care and control of the RMS.

The following conclusions are drawn from the above discussions:

1. Bengalla Link Road and Thomas Mitchell Drive will continue to be the main thoroughfares for mine related traffic movements between the existing and proposed mines in Muswellbrook and the New England Highway. Future industrial areas to be developed off Denman Road and Thomas Mitchell Drive will attract further traffic volumes to this location.
2. Proposed mine-related road realignments and closures may cause significant interruptions to traffic flows if not properly managed in terms of timing and alternative routes.

5 Road Network Scenarios

What options are there to address the anticipated long term traffic generation issues associated with coal mining without compromising mine efficiency, public safety and convenience?

5.1 Potential Connections

As stated previously, Bengalla Link Road, Denman Road and Thomas Mitchell Drive currently play critical roles in accommodating traffic movements (most importantly heavy vehicles) to destinations in the south without travelling through Muswellbrook town centre. In the absence of a more efficient alternative, these roads are likely to continue to be an important travel path for the foreseeable future.

As a matter of due process, Cardno has investigated a number of options for the construction of a more efficient alternative route (or routes) that would better serve the demands created by the mining industry in the longer term. However, the Hunter River (and its floodplain) and the coal haulage rail line are major constraints, with any new road(s) connecting Wybong Road and Denman Road, involving the construction of at least one bridge and substantial new road construction within the flood plain and upgrades to existing roads and new intersections at some considerable cost.

Similarly, the existing and proposed mining (Mt Arthur expansion west and Drayton South) exclude options for any new road connection to the south from Denman Road to the Golden Highway in the short to medium term.

In assessing long term network improvement options, the following desired outcomes should be considered:

- Provide for the efficient movement of vehicles between destinations;
- Preferably direct traffic to the main road network (as the safest and most efficient travel route);
- In the absence of more efficient and viable options, increase the carrying capacity of the existing main travel paths;
- Where possible, provide for alternative travel paths in case of interruptions to traffic flows;
- Provide for the movement of oversize vehicles;
- Achieve favourable benefit to cost comparisons.

The main traffic generators are the mines themselves, support industries (in existing and proposed industrial areas), service providers (contractors travelling between mines) and employees travelling to and from work (primarily from and to the south but also west and north).

The following options have been identified and are examined in some detail in subsequent sections:

Options to Improve the Connectivity of Wybong Road to the New England Highway north of Muswellbrook

- **Option 1A** – Extend Wybong Road (at Kayuga Road) to the New England Highway (at McCullys Gap Road)
- **Option1B** – Extend Wybong Road (at Kayuga Road) to Aberdeen Street at the New England Highway
- **Option1C** – Replacement of the Kayuga Bridge in its current location

Options to Address Wybong Road Closure in 2026

- **Option 2A** – Connect Wybong Road (via Logues Lane) to Denman Road (at Skellatar Stock Route)
- **Option 2B** – Connect Wybong Road (via Overton Road) to Bengalla Link Road
- **Option 2C** – Construct the Northern and Western Link Roads (as proposed by Mt Pleasant Mine)

Options to Improve Connectivity from the North West Sector to the Main Road Network

- **Option 3A** – Modified Bengalla Link Road Diversion
- **Option 3B** – Connect Wybong Road (via Mangoola Road, Roxburgh Road and an existing crown road reserve) to Denman Road
- **Option 3C** – Upgrade Wybong Road (West)
- **Option 3D** – Upgrade Reedy Creek Road to the Golden Highway

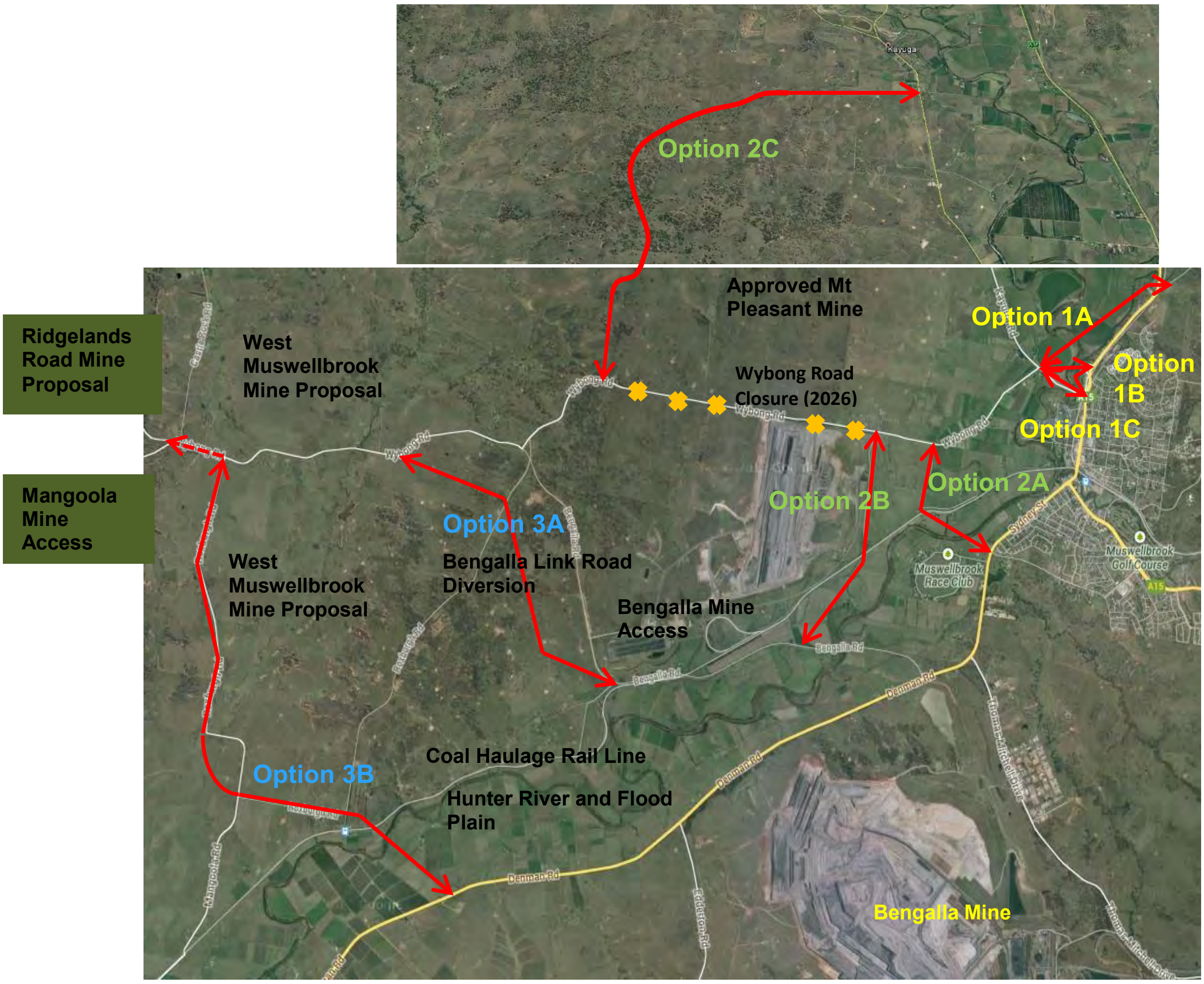


Figure 5-1 Options 1A to 3B

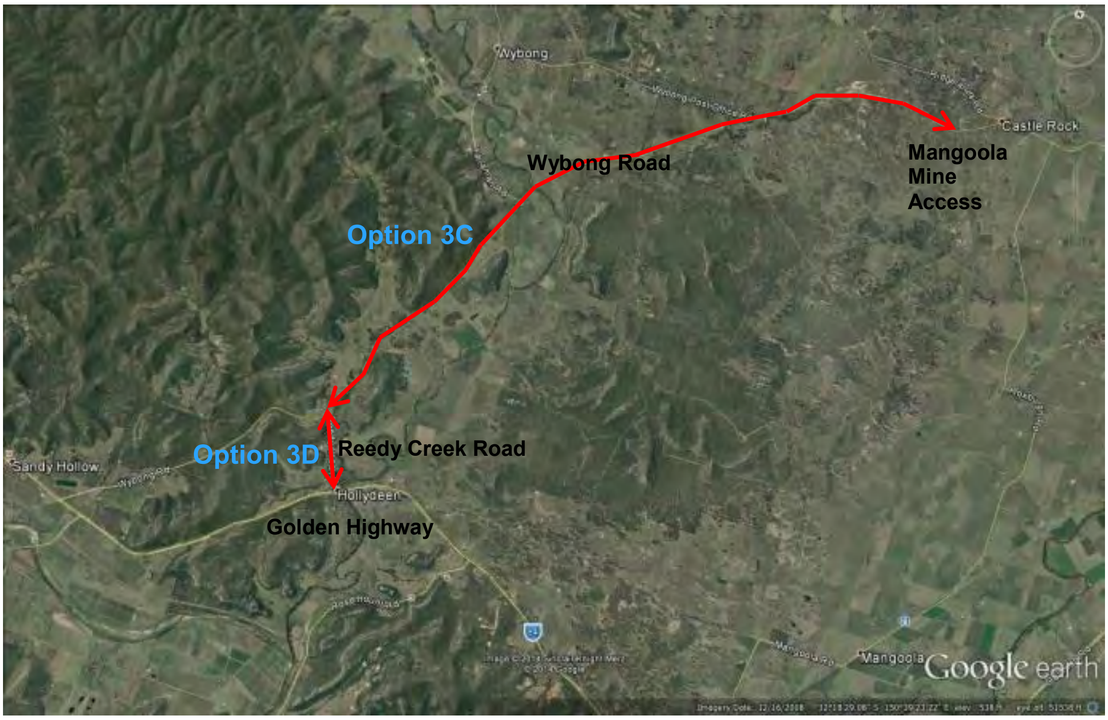


Figure 5-2 Options 3C and 3D

Each option offers different advantages in terms of road network improvements and efficiencies but also has corresponding costs as a result of the constraints. The following sections provide a qualitative summary of the strengths and weaknesses associated with options in terms of six elements:

- Land Ownership – The potential extent of land acquisition required.
- Terrain and Land Use – The nature of the topography and potential impacts upon existing land uses.
- Environmental Factors – The potential impact upon the existing environment and any known environmental constraints likely to affect design (e.g. flood extent).
- Intersections – The intersections potentially affected or required.
- Road and Traffic Benefits – Predicted likely benefits and weaknesses for local traffic flows and convenience over the medium and long term, and for both mine and non-mine related traffic.
- Costs – Estimated capital costs of option establishment.

5.2 Options to Improve the Connection of Kayuga Road to the New England Highway

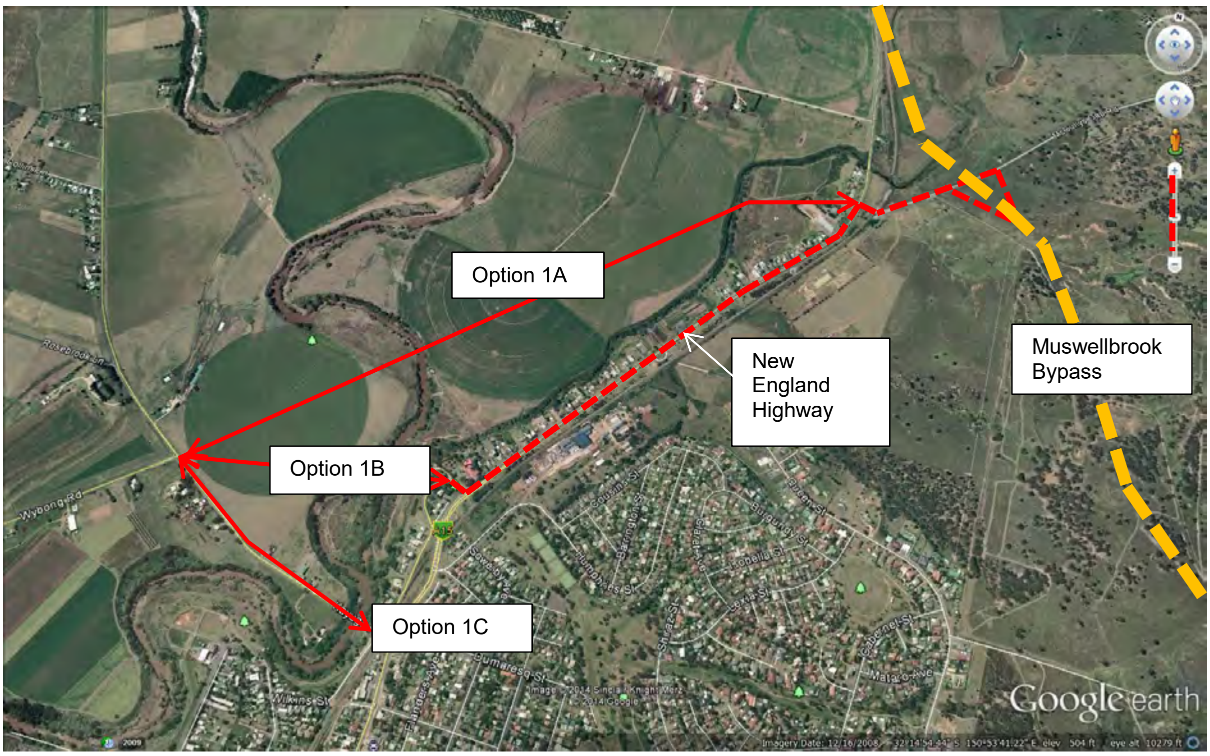


Figure 5-3 Options 1A, 1B and 1C

5.2.1 Option 1A – Extend Wybong Road (at Kayuga Road) to the New England Highway (at McCullys Gap Road)

Assumptions – Length 2.35kms (Approx.), two bridge crossings (50m and 100m long over creek and river) two major intersections, traffic control at intersections only.

- **Land Ownership** - Requires acquisition of privately owned farm land over the full length of the proposed road. Option would require the purchase and loss of productive agricultural land.
- **Terrain and Land Use** - Improved agricultural land on flood plain.
- **Environmental Factors** - Flood prone (1 in 100 Year Flood Level Approx. RL 148m AHD). This option involves construction within the flood plain and bridging over the Hunter River and Sandy Creek with potential to impact adversely on the flow of flood waters.
- **Intersections** – Roundabout at Kayuga Road, T-intersection at New England Highway
- **Road and Traffic Benefits**
  - Provides a direct connection from the extension of Wybong Road to the New England Highway for north bound traffic and to the McCullys Gap Road interchange on the proposed Muswellbrook Bypass for south bound traffic.
  - Provides an alternative to the Bengalla Link Road and Thomas Mitchell Drive route to gain access to the south without having to enter Muswellbrook CBD.
- **Road and Traffic Weaknesses**
  - The route is a duplication of the New England Highway north of Aberdeen Street.
  - As a single strategy, primarily serves the eastern areas of the Muswellbrook coal corridor and provides minimal benefit in terms of addressing the longer term mine-related traffic demands in the west and north-west of the corridor.

- **Cost** – **$42M** (includes 30% contingency costs added). Includes the construction of a new bridge over the Hunter River. Existing Kayuga Bridge would remain for weight limited local traffic only.

5.2.2 Option 1B – Extend Wybong Road (at Kayuga Road) to Aberdeen Street at the New England Highway (Refer to Figure 5.3 above)

Assumptions – Length 0.85kms (Approx.), one bridge crossing (100m length over river), two major intersections, traffic control at intersections only.

- **Land Ownership** - Requires acquisition of privately owned farm land over the full length of the proposed road.
- **Terrain and Land Use** - Improved agricultural land on flood plain. This option involves the purchase and loss of productive agricultural land.
- **Environmental Factors** - Flood prone (1 in 100 Year Flood Level Approx. RL 148m AHD). This option involves construction within the flood plain and bridging over the Hunter River with potential to impact adversely on flow of flood waters.
- **Intersections** – Roundabout at Wybong and Kayuga Road and intersection Aberdeen Street.
- **Road and Traffic Benefits**
  - Provides some improved convenience for north bound traffic.
- **Road and Traffic Weaknesses**
  - Duplicates the existing Kayuga Bridge/Aberdeen Street connection to the New England Highway.
  - Offers little advantage over the existing route.
- **Cost** – **$30M** (includes 30% contingency costs added). Includes the construction of a new bridge over the Hunter River north of the existing Kayuga Bridge.

5.2.3 Option 1C – Upgrade Kayuga Road and Aberdeen Street from Wybong Road to the New England Hwy, including Replacement of Kayuga Bridge (Refer to Figure 5.3 above)

Assumptions – Length 0.85kms (Approx.), replace existing bridge, two minor intersections, traffic control at intersections only.

- **Land Ownership** – Public road reserves.
- **Terrain and Land Use** – Existing public roads.
- **Environmental Factors** - Flood prone (1 in 100 Year Flood Level Approx. RL 148m AHD). This option involves construction within the flood plain and bridging over the Hunter River.
- **Intersections** – Roundabout at Wybong and Kayuga Road and intersection at Aberdeen Street.
- **Road and Traffic Benefits**
  - Provides some improved convenience and safety for north bound traffic.
- **Road and Traffic Weaknesses**
  - Existing route.
- **Cost** – **$13M** (includes 30% contingency costs added). Includes the construction of a new bridge over the Hunter River at the existing Kayuga Bridge location. The heritage significance of the existing Kayuga Road Bridge will need to be considered and addressed as part of the impact assessment process associated with these works.

Note: Funding sources to be determined in Stage 2

5.3 Options to Address Wybong Road Closure in 2026

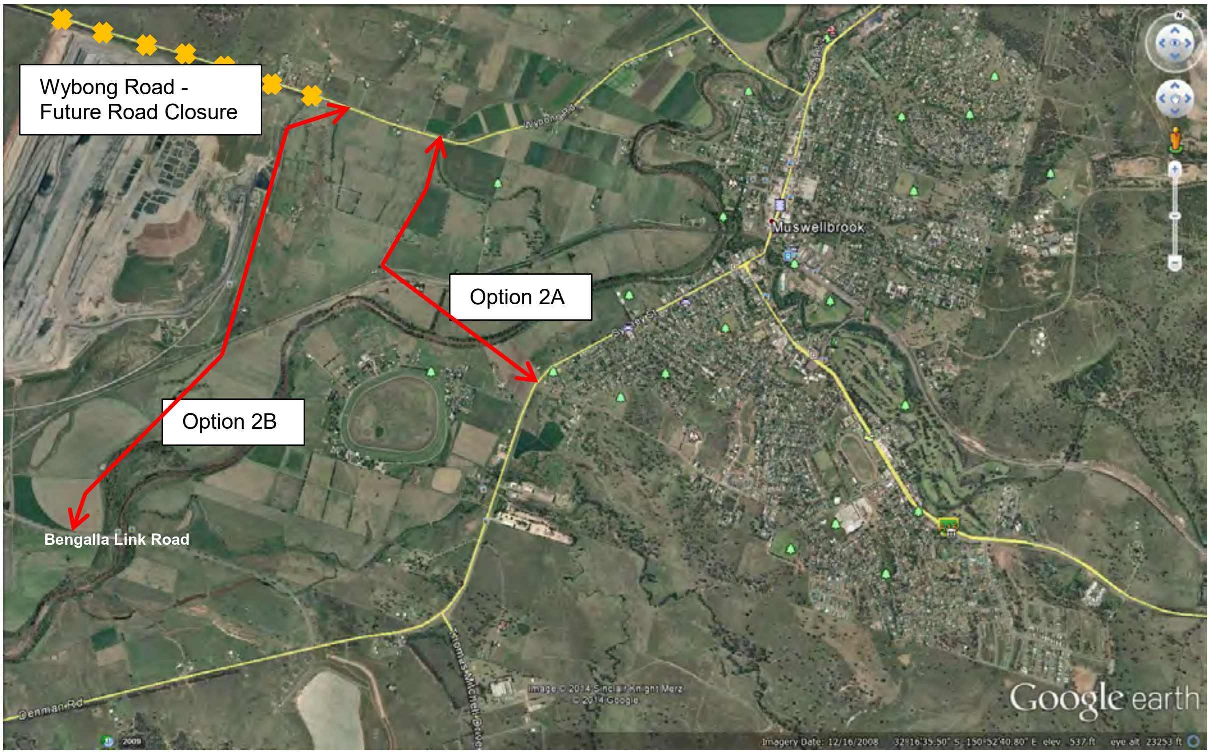


Figure 5-4 Options 2A and 2B

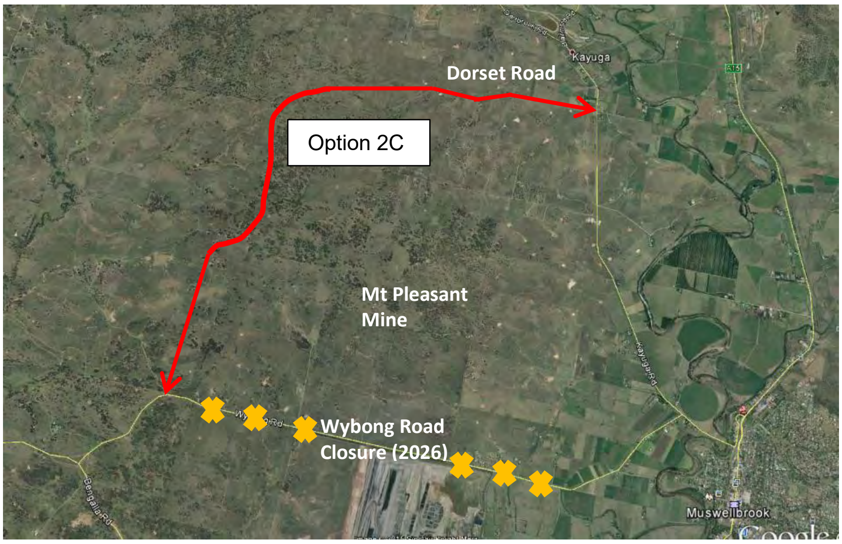


Figure 5-5 Option 2C Northern and Western Link Roads

5.3.2 Option 2A – Connect Wybong Road (via Logues Lane) to Denman Road (at Skellatar Stock Route)

Assumptions – Length 2.3kms (Approx.), two bridge crossings (40m over rail line and 100m over river).

- **Land Ownership** - Requires acquisition of privately owned farm land over the full length of the proposed road.
- **Terrain and Land Use -** Improved agricultural land on flood plain. This option involves the purchase and loss of productive agricultural land.

- **<u>Environmental Factors</u>** - Flood prone (1 in 100 Year Flood Level Approx. RL 146m AHD). This option involves construction within the extensive flood plain, bridging over the coal rail haulage line and bridging over the Hunter River with potential to impact adversely on flow of flood waters. Upstream urban areas may be affected.
- **<u>Intersections</u>** – At Wybong Road and Denman Road
- **<u>Road and Traffic Benefits</u>**
  - Utilises the existing Logues Lane alignment.
  - Provides a connection to South Muswellbrook residential areas.

<u>Road and Traffic Weaknesses</u>

  - Location provides little relief to anticipated mine-related traffic demands in the north-west.
  - Flood plain extends for full length including over Wybong Road and Denman Road.
  - Road subgrade and ramping on both sides of bridge within flood plain and floodway.
  - Potential flooding implications (involves a significant reduction in the width of the flood way - urban areas upstream may be affected). To avoid interruption of flood waters, bridge lengths may need to be extended at considerable additional cost.
  - Hunter River and the Coal Rail Line separation is significant (approx. 786 metres) likely to require one long bridge or two bridge spans.
  - Acquisition of privately owned farm land involved.
  - Potential opposition from residents at Skellatar Stock Route intersection and surrounds.
- **<u>Cost</u>** – **$37M** (includes 30% contingency costs added)

5.3.3 <u>Option 2B – Connect Wybong Road (via Overton Road) to Bengalla Link Road</u>

<u>Assumption</u> – Length 3.5kms (Approx.), one bridge crossing (40m over rail line), one major intersection, traffic control at intersection only.

- **<u>Land Ownership</u>** – Bengalla Mine.
- **<u>Terrain and Land Use</u> -** This option involves the loss of some productive agricultural land.
- **<u>Environmental Factors</u>** - Flood fringe (1 in 100 Year Flood Level Approx. RL 143m AHD). This option involves bridging over the coal haulage rail line and some construction within the edge of the flood plain.
- **<u>Intersections</u>** - At Wybong Road and Bengalla Link Road.
- **<u>Road and Traffic Benefits</u>**
  - Provides a direct link between Bengalla Link Road to Wybong Road offering access to Kayuga Road and the New England Highway.
  - Offers an alternative to the proposed Mt Pleasant Western and Northern Link Roads at potentially less cost.
  - Utilises the existing flood-free Overton Road alignment.
  - Avoids the need for an additional river crossing and development within the floodway.
- **<u>Road and Traffic Weaknesses</u>**
  - Road and bridge ramping within flood plain.
- **<u>Estimated Cost</u> - $23M** (includes 30% contingency costs). Could be funded by Mt Pleasant Mine as a cheaper alternative to the proposed Western and Northern Link Roads. It would be necessary to apply for a modification of the development consent to accommodate the change in approach to the bypassing the proposed closure of Wybong Road in 2026.

5.3.4 Option 2C – Western and Northern Link Roads (Mt Pleasant Mine)

Assumption – Length 10.3kms (Approx.), 6.8kms of new road and 3.5km of road upgrade to Dorset Road, , one major and one minor intersection, traffic control at intersections only.

- **Land Ownership** – Mt Pleasant Mine
- **Terrain and Land Use -** This option involves the loss of some grazing land.
- **Environmental Factors** – Undulating and cleared rural land.
- **Intersections** - At Wybong Road and Kayuga Road.
- **Road and Traffic Benefits**
  - Addresses the proposed closure of Wybong Road.
- **Road and Traffic Weaknesses**
  - Offers little advantage in terms of travel efficiency. Forecast traffic volumes in 2034 of 186 vpd.
  - Offers little advantage in terms of connectivity.
- **Estimated Cost - $47M** (includes 30% contingency costs).

5.4 Option 2D – Upgrade Wybong Road (from Bengalla Link Road to Kayuga Road) should Mt Pleasant Closure not Occur

Assumptions – Length 9.7kms (Approx.), 2 minor intersections, traffic control at intersectins only, nil property acquisition

- **Land Ownership** – Existing public road reserve.
- **Terrain and Land Use** – Public road.
- **Environmental Factors** – Minimal.
- **Intersections** - Existing
- **Road and Traffic Benefits**
  - Utilises the existing road reserve. No land acquisition involved.
- **Road and Traffic Weaknesses**
  - Nil
- **Cost – $13M** (includes 30% contingency costs)

This Option would only occur should Mt Pleasant Mine not proceed and Wybong Road not be closed in 2026, Wybong Road from the Bengalla Link Road to Kayuga Road will need to be upgraded to maintain a safe and efficient movement of vehicles over this section of road to a standard appropriate to accommodate anticipated traffic volumes from background growth and new mines proposed further west.

5.5 Option 3A – Modified Bengalla Link Road Diversion

(Refer to Figure 5-1 above)

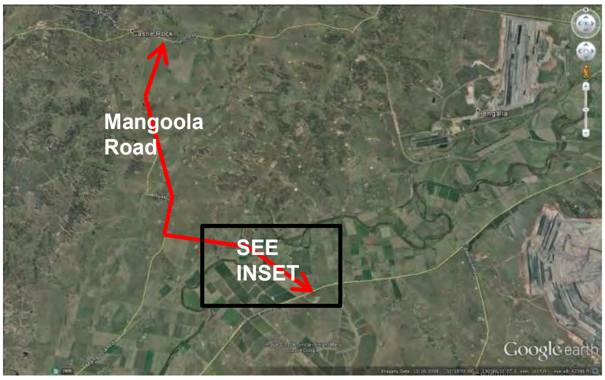
Assumptions – Length 5.2kms (Approx.), 2 major intersections, traffic control along route, nil property acquisition.

- **Land Ownership** – Existing public road reserve and mine controlled land.
- **Terrain and Land Use** – Public road. Proposed road alignment diversion passes within close proximity of an existing dwelling off Roxburgh Road. Consideration will need to be given to minimising impacts.
- **Environmental Factors** – Minimal.
- **Intersections** - Existing

- **Road and Traffic Benefits**
  - Utilises the existing road reserve. No land acquisition involved.
  - Crossings of the Hunter River and the Coal Rail Line are existing.
- **Road and Traffic Weaknesses**
  - Concentrates all traffic to a single travel corridor.
- **Cost** – **$33M** (includes 30% contingency costs)

This Option includes the western diversion of Bengalla Link Road as approved in the Mine Continuation of Bengalla Mine. However, it also seeks to have the road alignment and intersections in the north, located to best facilitate the future extension of the road to the north west to link with Wybong Road to provide a more direct travel path. The road extension and associated intersection with Wybong Road would be pursued in the longer term and would be funded by new mines in the north-west. A minor change in the road design plans to accommodate a future connection to the west should not require modification of the consent. Further consideration of the detailed design will be required to confirm this position.

5.6 Option 3B – Connect Wybong Road (via Mangoola Road, Roxburgh Road and an Existing Crown Road Reserve) to Denman Road



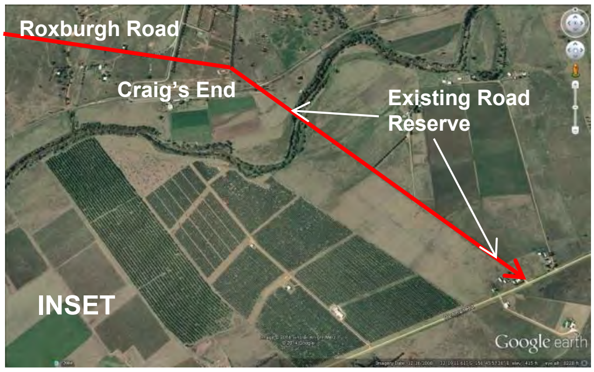


Figure 5-6 Option 3B

Assumptions – Length 9.58kms (Approx.), 3.5kms new road and 6.08kms upgrade of existing, one bridge crossing (100m over rail line and river), one multi-cell box culvert crossing (Mangoola Road), two major intersections and two minor intersections, traffic control along route and at intersections, limited property acquisition.

- **Land Ownership** – Public road reserve and privately owned farmland. Some land acquisition involved.
- **Terrain and Land Use** – Undulating existing road in the north. Flood prone improved agricultural land in the south. This option involves the purchase and loss of some productive agricultural land (near Craig's End) and some grazing land (to straighten Mangoola Road and for the bridge and approaches).
- **Environmental Factors** - Flood Level Approx. RL 128m AHD. No significant implications for flooding impacts from a reduction in the width of floodway and flood storage. The location is well downstream of any urban areas.
- **Intersections** – Upgrade existing intersection at Wybong Road, minor intersections at Roxburgh Road and major intersection at Denman Road.
- **Road and Traffic Benefits**
  - Intersects with Wybong Road in the vicinity of Ridgelands Road (Mangoola Mine entrance and future West Muswellbrook Mine) – Future mine-related traffic generators.
  - Utilises a significant section of the existing Mangoola Road and Roxburgh Road alignments.

- Elevated land on the north-western bridge approach reducing the extent of the bridge ramp on one side.
- Hunter River and the Coal Rail Line are reasonably adjacent to each other (approx. 300 metres).
- Existing road reserve south of the Hunter River connecting to Denman Road. Minimal land acquisition.
- Results in a better distribution of traffic by providing an alternative travel path to the Bengalla Link Road.
- Facilitates the efficient movement of vehicles to and from the south (alternative to Thomas Mitchell Drive) in the long term with the potential to connect to the Golden Highway by a realigned Edderton Road.

- **Road and Traffic Weaknesses**
  - Involves some vertical (levelling) and horizontal (straightening) adjustments to the existing road alignment.
  - Mangoola Road and Roxburgh Road are currently single lane width pavement designed for light traffic only. The sections of these roads affected would require complete reconstruction involving substantial cut/fill and associated drainage management.
  - May also conflict with the proposed rail access for the West Muswellbrook (WMB) Mine project which would have adverse cost implications should the rail access eventuate.
- **Cost** – **$63M** (includes 30% contingency costs added) – NB. This route lies partially within the Mangoola Mine EL area and the West Muswellbrook EL area. Opportunity may exist for conditional land dedication thereby reducing the estimated cost. The cost of an additional rail access crossing associated with the WMB Mine may need to be included in the above cost estimate.

5.7 Option 3C – Upgrade Wybong Road (West) from Mangoola Mine Access to Reedy Creek Road

(Refer to Figure 5-2 above)

Assumptions – Approx. Length 13.5kms, four minor intersections, one major intersection, traffic control along the route, nil property acquisition.

- **Land Ownership** – Existing road reserve.
- **Terrain and Land Use** – Undulating narrow road surrounded by unimproved rural land.
- **Environmental Factors** – Flooding at Pheenys Creek causeway.
- **Intersections** – One major intersection and four minor intersections.
- **Road and Traffic Benefits**
  - Utilises the existing Wybong Road alignment.
  - No land acquisition.
- **Road and Traffic Weaknesses**
  - Existing rural road would require reconstruction to widen and improve durability.
- **Cost** - - **$42M** (includes 30% contingency costs added). A significant proportion of the upgrading of Wybong Road could be justified as works-in-kind required from future mines in the north.

5.8 Option 3D – Upgrade Reedy Creek Road to the Golden Highway

(Refer to Figure 5.2 above)

Assumptions - Length 1.4kms (Approx.), one minor intersection at Wybong Road, one major intersection at Golden Hwy, traffic control along the route, nil property acquisition.

- **Land Ownership** – Existing road reserve.

- **Terrain and Land Use** – Undulating narrow road surrounded by rural land.
- **Environmental Factors** - Nil
- **Intersections** – One major intersection and one minor intersection.
- **Road and Traffic Benefits**
  - Utilises the existing Reedy Creek Road alignment.
  - No major flooding or environmental issues. However, the road would need to be constructed to be flood-free during a major storm event, particularly if the Wybong Road intersection with the Golden Highway at Sandy Hollow is closed.
  - No land acquisition.
- **Road and Traffic Weaknesses**
  - Major intersection improvements required at Reedy Creek Road and Golden Highway. Bridge approach and existing dwelling limit intersection design options at additional cost.
- **Cost** - - **$12M** (includes 30% contingency costs added). A significant proportion of the upgrading of Wybong Road could be justified as works-in-kind required from future mines in the north.

5.9 Other Road Infrastructure Issues

5.9.1 Kayuga Bridge Replacement

Kayuga Bridge currently provides the only crossing of the Hunter River to the north of Muswellbrook. The bridge is not currently weight restricted, however it is a one lane timber structure of considerable age. The traffic survey determined that on the day of the survey, Kayuga Bridge was carrying 172 vehicles per hour and was operating at a Level of Service B. Of the 172 vehicles per hour, ten (10) of these were heavy vehicles. Nine (9) of the ten (10) heavy vehicles were identified as being linked to mines.

Responsibility for the maintenance and or replacement of the Kayuga Bridge lies with the NSW Roads and Maritime Services (RMS) and it is understood that the RMS will review the recent traffic data to determine the need (urgency) for its replacement.

While the traffic volumes passing over the bridge are currently within acceptable limits, it is evident that these will continue to increase due to the efficiencies this route offers in terms of connection to the New England Highway and access to the Muswellbrook town centre. With increased traffic volumes (particularly the number of heavy vehicles) travelling on the bridge, the deterioration of the structure will accelerate.

5.9.2 Hunter River Bridge at Denman

The Hunter River Bridge at Denman is not currently load limited. However, the bridge superstructure is a barrier to the movement of oversize vehicles due to its limited width and height. In the absence of the widening of the bridge by the RMS, it will be necessary to ensure that a suitable alternative route is available. The current alternative route is via Wybong Road/Bengalla Link Road/Thomas Mitchell Drive to the New England Highway.

5.9.3 Ogilvy's Hill

The Golden Highway at Ogilvy's Hill is a single lane two-way road on a steep grade with insufficient pavement and shoulder width to facilitate the passing of slow vehicles. Past history records the blocking of traffic due to truck breakdown. While it is a rarely occurring event, the blocking of a heavily trafficked main highway on a narrow and steep section of road has potentially serious ramifications. As a State Government controlled road, the provision of up-hill passing lanes, widened shoulders or pull-off bays should be considered. The alternative route is via Denman Road and Edderton Road to the Golden Highway or via Thomas Mitchell Drive to the New England Highway.

5.9.4 Other Land Use Initiatives

The Upper Hunter Economic Diversification Report 2012 acknowledges that the mining and power generation industries will continue to remain a major source of employment within the Muswellbrook LGA.

The report also identifies a number of opportunities to consolidate and expand on existing employment generators including:

- Expansion of the equine industry in Muswellbrook and Upper Hunter LGA;
- Maintenance and development of the wine industry;
- More intensive agriculture (subject to availability of alluvial land);
- Investment in other power generation technologies (coal seam gas, clean coal) and growth of renewable energy sources;
- Expand on support activities (engineering, technical services, maintenance);
- Maintain and develop the tourist industry based on short breaks and events, and the wine sector and equine industry, resort style accommodation, improved skills and sub-regional integration (regional trails);

The report also identifies opportunities for the longer term (post coal mining) such as:

- Mine site rehabilitation and subsequent land uses including the beef industry, new crops and products;
- Forestry development on rehabilitated land (including carbon credits).

This Road Network Plan provides strategies for improved accessibility across the northern half of the LGA and the distribution of traffic to avoid congestion, delays and risks to road users. While the strategies are primarily targeting the foreseeable traffic demands of the coal industry, they will also facilitate growth in other industries, in both the short and long term.

5.9.5 Potential External Influences and Issues

In formulating the Road Network Plan, consideration has been given to a number of external factors that have the potential to influence traffic flows on the local road network in the immediate, short, medium and long term. These include:

The opening of the Hunter Expressway (M1 to Branxton) (March 2014)

The opening of the Hunter Expressway has dramatically reduced the travel time to and from Newcastle and Sydney. In terms of impacts on mine-related traffic, the expressway will mostly benefit employees and trade vehicles travelling from external destinations to and from Muswellbrook mines. In terms of general impacts on the Upper Hunter, the new expressway reduces travel times and costs, and improves accessibility which will assist in stimulating economic growth in the region.

Impacts on the local road network from mines external to Muswellbrook LGA

Currently, the industrial estate off Thomas Mitchell Drive offers a range of support services to the mining industry and as a consequence also attracts considerable traffic from sources external to the LGA. The traffic data indicates that only 50% (approximately) of the total traffic on Thomas Mitchell Drive is related to the local mines. It is logical to assume that a considerable amount of the remaining 50% of traffic comes from mines within Singleton LGA and beyond.

Council’s Industrial Land Use Strategy identifies two candidate areas (A and B) located to the north of and opposite the existing Thomas Mitchell Drive industrial area, which includes approximately 100 hectares of additional land in total. Several new mine extensions are proposed within the adjoining LGA. This potential expansion of nearby mining activity and the forecast increase in the area of developable industrial land on Thomas Mitchell Drive in the medium and long term, will likely result in considerable additional traffic on Thomas Mitchell Drive to that currently being experienced and will have implications for the roads capacity, safety, and the frequency of required road maintenance.

The proposed Muswellbrook By-pass

The Muswellbrook By-pass will remove through traffic from the New England Highway within Muswellbrook town centre and South Muswellbrook. The Hyder By-pass Traffic Study suggests that “the through traffic reduction is unlikely to reduce delays of local traffic entering the New England Highway” and “in the future, local traffic growth will dominate the traffic performance of key intersections within Muswellbrook town centre, even if the bypass is built”. As such, the construction of the by-pass is unlikely to have any significant impact on the local road network. However, should a direct link from Wybong Road to the New England Highway be constructed (Options 1A and 1B of this Plan), this route would offer some efficiencies for traffic coming from and travelling to destinations in the north of the Shire (including south bound through traffic connecting to the by-pass rather than using Bengalla Link Road and Thomas Mitchell Drive). In this case, the long term retention/reinstatement of Wybong Road would be beneficial in offering an alternative route for mine-related traffic in the north of the Shire.

Other proposed main road improvements

The proposed local road improvements contained in this Plan are designed to improve connectivity to the State and Regional Road Network and surrounding population centres. Improvements to the State controlled road network, including the recently announced funding for upgrades to the Golden Highway, will assist in facilitating the efficient and safe movement of vehicles into and out of the LGA. Hopefully, any proposed upgrades will address existing deficiencies in the regional network and reduce the reliance on the local road system for the provision of alternative emergency bypass and over-sized vehicle routes.

The strategies and recommendations of this Plan have considered the known and foreseeable external issues, and it has been determined that, other than those discussed above, they are unlikely to have any significant impacts on the local road network. Based on currently available information, it is considered that the proposed strategies and recommendations contained in this Plan respond to potential external influences and initiatives. Should a major traffic generator or network change arise in the future, Council may need to modify network strategies to respond accordingly.

5.10 Forecast Traffic

Consistent with the Project Objectives, this Network Plan seeks to identify strategies that will best meet the needs of present and future land uses. Based on best available information, Cardno has run traffic models for selected strategies to forecast likely traffic demands arising from future development over the 20 and 40 year time frames.

5.10.1 Assumptions

For the purposes of traffic modelling, the following assumptions have been made:

Background Local Traffic Growth

- Thomas Mitchell Drive – 1.45% pa for 20 years and 1% pa for 20-40 years
- All other Local Roads – 1% pa for 20 years and 0.9% pa for 20-40 years

In relation to Mine Growth

- Dartbrook Mine to cease care and maintenance in 3 years.
- Muswellbrook Mine to close down in 2018 and continue with care and maintenance for 4 years.
- Bengalla Mine – Mine expansion into new area – Same access – Existing 450 fte's to increase to 1,000 fte's – From 2017 (for 24 years until 2041).
- Drayton/Drayton South – New extraction area – Same access – Existing 530 fte's to relocate (no change in numbers) – From 2015 (for 15 years until 2027).
- Mt Arthur – Mine expansion – Same access - Existing 2,600 fte's (no change in numbers) – From 2014 (for 12 years until 2026).
- Mangoola Mine – Increased extraction rates – Same access – Existing 300 fte's to increase to 540 fte's – From 2015 (for 12 years until 2027).
- Mt Pleasant Mine – New mine – New access – New 320 full time equivalent employees (fte's) – To commence extraction 2017 (for 21 years until 2038).
- Spur Hill – New Mine – New access – New 300 fte's – From 2017 (for 25 years until 2042). Spur Hill Mine to have the same distribution of vehicle types and destinations as the current Mangoola

Mine except that those trips that were going south to the New England Highway are to go south via Denman Road and the Golden Highway.

- Doyles Creek Mine – New mine – New 300 fte's – From 2021 (for 21 years until 2042). New access directly to the Golden Hwy (via Buneen Road) will have the same distribution of vehicle types and destinations as Drayton Coal except that those trips that were travelling south on the local road network to the New England Highway or the Golden Highway, will not appear on the modelled network.
- Ferndale Mine – New mine – New access – New 100 fte's – From 2018 (for 25 years to 2043). Ferndale Mine to have same distribution of vehicle types and destinations as the current Mangoola Mine except that those trips that were going south to the New England Highway are to go south via the Golden Highway.
- West Muswellbrook – New mine – New access off Wybong Road – New 300 fte's – From 2030 (for 20 years until 2050).
- For new mine construction and the care and maintenance period of closing mines, a taper up and taper down period of 3 and 4 years respectively has been adopted. Adopted 50% fte's for three year construction period before full extraction, then 10% of fte's in the year after end of extraction dropping to 0% over the next 4 years.
- As established mines close, new mines will open. Mines assumed to start up in the long term (when the current mines are closing down after 2054) will include:
  - Dellworth Mine (300 fte's) - Will have the same distribution of vehicles types and destinations as Drayton South Mine.
  - Ridgelands Road and
  - North West Crown Authority land (could involve several mines west and north west of Ridgelands Road).
  - Ridgelands Road Mine (500 fte's) and North West Crown Authority mines (1,000 fte's) will have the same distribution of vehicle types and destinations as the current Mangoola Mine except that south bound and originating traffic will go via Wybong Road (West) and Reedy Creek Road to/from the Golden Hwy. These mines involve a new major intersection on Wybong Road between the Mangoola Mine access and Roxburgh Road.
  - Sandy Creek Mine

Assumed Infrastructure Improvements

- Replacement of Kayuga Bridge in 2017-18 (to Class 2R – undivided carriageway with 2 lanes – 60 kms/hr) – Open to Bengalla Mine and Mt Pleasant Mine traffic without restriction (currently Bengalla traffic prohibited from using this route).
- Permanent Closure of Wybong Road to occur in 2026. Alternative access to east via either Western and Northern Link Roads or a Wybong Road to Bengalla Link Road connection.
- Should Mt Pleasant Mine not proceed and Wybong Road not be closed in 2026, Wybong Road from the Bengalla Link Road to Kayuga Road will need to be upgraded to maintain a safe and efficient movement of vehicles over this section of road to a standard appropriate to accommodate anticipated traffic volumes from mines proposed further west. It is anticipated that an upgrade of Wybong Road (7 metre pavement with 1m gravel shoulders) for a distance of 9.7 kms would be in the order of $13M. (Refer to Appendix C Option 2D for Estimate Summary). Council will need to monitor approvals and undertake amendments to the Contributions Strategy as information becomes available to inform the determination of new mine applications.

5.10.2 Modelled Alternatives

The traffic impacts of the following specific road improvements have been modelled to allow comparison of the respective traffic benefits:

Comparative Model 1 – Wybong Road to Bengalla Link Road Connection (Option 2B) in lieu of Proposed Mt Pleasant Link Roads (Option 2C)

a) Construction of connection of Wybong Road (west of Kayuga Rd) to Bengalla Link Road (west of Hunter River crossing) (Class 2R – undivided carriageway with 2 lanes – 80 kms/hr) in 2026

Comparative Model 2 – Proposed Bengalla Link Road Diversion including North Western Deviation

a) Bengalla Link Road Diversion in 2032 (Class 2R – undivided carriageway with 2 lanes – 80 kms/hr)

and

b) Bengalla Link Road North West Deviation in 2032 (Class 2R – undivided carriageway with 2 lanes – 80 kms/hr)

5.10.3 Growth Comparisons

Note1: Modelling incorporates the Wybong Road to Bengalla Southern Link Road Connection (in lieu of the Western and Northern Link Roads) and the Bengalla Link Road North-western Deviation

Road Section	Daily Total Traffic Volumes 2014	Daily Total Traffic Volumes 2034 (Note: 1)	Daily Total Traffic Volumes 2054 (Note: 1)
Kayugah Road North (Shire Boundary to Wybong Road)	578	685	708
Kayuga Road East (Wybong Road to Kayuga Bridge)	1,718	1,323	2,127
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	804	709	920
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	1,288	1,056	2,338
Wybong Road East (Bengalla Link Road to Kayuga Road)	589	902	1,572
(Proposed Year 2026) Wybong Road to Bengalla Link Road Connection	N/A	1,155	851
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	1,056	1,716	1,258
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	2,030	3,684	2,831
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	8,801	6,142	10,224
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	4,702	4,364	4,121
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	3,789	4,364	4,122
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	4,146	4,439	4,122
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	1,023	1,491	1,351
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	836	1,539	1,213

The following observations are made:

- The closure of a section of Wybong Road (East) in 2026 will result in the redirection of traffic currently travelling on this section of road onto Bengalla Link Road. South bound and town centre bound traffic that previously used Kayuga Bridge will use Denman Road and Thomas Mitchell Drive resulting in an initial reduction of traffic on Kayuga Road. Growth in background traffic will ultimately see volumes on Kayuga Bridge increase. Should Mt Pleasant Mine and the closure of Wybong

Road not proceed, the existing Wybong Road from Bengalla Link Road to Kayuga Road will need to be upgraded to accommodate predicted growth in background and mine related traffic.

- Traffic volumes on Wybong Road West (Sandy Hollow to Mangoola Mine Entrance) will remain relatively steady until new mines in the west generate greater levels of activity on this section of road to gain access to the Golden Highway at Reedy Creek Road.
- Traffic volumes on roads currently most affected by mine-related traffic (eg. Bengalla Link Road and Thomas Mitchell Drive) will increase over the next 20 years as a result the commencement of new and expanded mines in that vicinity. However, as the established mines in the east cease operating in the longer term (Bengalla 2041, Drayton South 2030, Mt Pleasant 2038), the majority of mine related traffic movements will shift to the west resulting higher volumes on Wybong Road (West), Denman Road and the Golden Highway.
- Thomas Mitchell Drive North will continue to experience the highest traffic volumes due to the existing and proposed industrial areas.

5.11 Overall Assessment of Options

In assessing the overall performance of the road network over time, the following points need to be kept in mind:

1. The current road network will continue to function satisfactorily in the short term (0-10 years) until new mines and mine extensions result in traffic numbers approaching road capacity, and performance limits resulting in reduced levels of service at intersections and increased accident risks.
2. There is a significant cost to Mt Pleasant Mine associated with the closure of Wybong Road and the construction of the proposed Northern and Western Link Roads (Estimated at $47M) to provide a connection between Wybong Road and Kayuga Road (and the New England Highway beyond). A significant cost saving could result if efficient alternative solutions for connection to the New England Highway are feasible.
3. Options 1A, 1B, 2A, and 3B all involve the construction of new roads and bridges within the flood plain of the Hunter River. Consideration will need to be given to the upstream impacts on flood behaviour due to obstruction of flows (i.e. increased velocities and depths of water during major flood events).
4. Edderton Road currently provides little relief to traffic volumes due to load limitations, poor surface condition and alignment. The currently proposed diversion and reconstruction of Edderton Road to accommodate coal extraction by the Mt Arthur and Drayton South Mines, will result in a more convoluted and inefficient route. Consideration should be given to the need for Edderton Road to be reconstructed generally in its current location upon completion of mining. This should occur as soon as possible after mining operations.

A comparison of the costs and benefits associated with each of the options is provided in the following table.

Table 5-1 Cost/Benefit Analysis

Road Improvement Option	Estimated Cost ($M) includes 30% Contingency Costs	Potential Environmental and Land Use Impacts	Traffic Benefits	Comments
1A - Extend Wybong Road to NE Hwy (at McCullys Gap Road)	$42M	Significant	Good long term (with Muswellbrook Bypass)	Significant works within floodway. Loss of productive ag land. Excessive cost relative to traffic benefits gained.
1B - Extend Wybong Road to NE Hwy (at Aberdeen St)	$30M	Significant	Moderate	Significant works within floodway. Loss of some productive ag land. Excessive cost relative to traffic benefits gained.
1C – Replace Kayuga Bridge, upgrade Wybong Road (East) and Kayuga Road from the new southern Link Road to Kayuga Bridge, upgrade Aberdeen Street from the New England Hwy, to the new Kayuga Bridge	Replace Kayuga Bridge $7M Upgrade Wybong and Kayuga Rd $5M Upgrade Aberdeen St $6.4M	Minimal	Moderate	Most cost effective option to improve connectivity to the New England Hwy**(Recommended Option) NB. Heritage implications associated with the replacement of Kayuga Road bridge would need to be addressed.**
2A - Connect Wybong Road (via Logues Lane) to Denman Road (at Skellatar Stock Route)	$37M	Significant	Minimal	Significant works within floodway. Loss of productive ag land. Excessive cost relative to traffic benefits gained.
2B - Connect Wybong Road (via Overton Road) to Bengalla Link Road	$23M	Minimal	Good	Most cost effective option to address the proposed closure of Wybong Road **(Recommended Option)**
2C - Western and Northern Link Roads (Mt Pleasant Mine)	$47M	Moderate	Moderate	Significant costs involved in bypassing mine extraction area directing traffic to Dorset Road and Kayuga Road. Some loss of grazing land. Excessive cost relative to traffic benefits gained.
2D – Upgrade Wybong Road from Bengalla Link Road to Kayuga Road	$13M	Minimal	Good	Should Mt Pleasant Mine and the closure of Wybong Road not proceed, the existing Wybong Road from Bengalla Link Road to Kayuga Road will need to be upgraded to accommodate predicted growth in background and mine related traffic.
3A – Modified Bengalla Link Road Diversion	$33M (Modification of design would be at minimal additional cost)	Minimal	Moderate	Diversion proposed by Bengalla Mine to facilitate coal extraction. Proposed modification has minimal short term traffic benefits but some efficiency gains in the long term. **(Recommended Option)**
3B - Connect Wybong Road (via Mangoola Road, Roxburgh Road and an Existing Crown Road Reserve) to Denman Road	$63M	Significant	Moderate	Significant works within floodway. Loss of productive ag land. Excessive cost relative to traffic benefits gained.
3C - Upgrade Wybong Road (West) from Mangoola Mine Access to Reedy Creek Road	$42M	Minimal	Minimal (in short term) Good (in long term)	Works-in-kind from new mines in the north would make costs more acceptable. **(Recommended Option)**

3D - Upgrade Reedy Creek Road to the Golden Highway	$12M	Minimal	Good	Works-in-kind from new mines in the north would make costs more acceptable. **(Recommended Option)**

6 Road Network Plan

6.1 Project Objectives Revisited

Section 1.2 identifies the Overall Project Objectives as being to:

- Maintain the road network to retain value, quality and capacity;
- Provide a safer road environment for all road users;
- Optimise the efficiency and reliability of moving people and goods;
- Meet the needs of present and future land use development.

Additionally, Table 1-1 on Page 2 identifies the following stakeholders and their main issues of concern:

Table 1-1 List of Stakeholders

Stakeholder Group	Main Concerns	Vehicle Types Involved
Government Agencies (Muswellbrook Council and Roads and Maritime Services)	Asset management, safety, efficiency and maintenance and construction costs.	All
Coal Mines and Related Support Industries	Safety, efficiency, and maintenance and construction costs.	Mine related heavy vehicles, materials delivery and trade service vehicles and employee vehicles.
Other Industries (Thoroughbred Horse Industry, Other Primary Producers, Transport Industry, Manufacturing Industries, Service Providers, etc.)	Efficiency and safety.	Materials delivery and product transport vehicles, employees.
Tourism Industry (Vineyards, Recreation and National Parks etc.)	Efficiency and safety.	Tourist related traffic (from cars to caravans and coaches).
General Community	Efficiency and safety.	Domestic and public transport vehicles.

The key words derived from the stated objectives and stakeholder issues of concern are:

- Costs (both construction and maintenance),
- Efficiency;
- Reliability (in terms of meeting the needs of the users); and,
- Safety

The Road Network Plan Study Area contains a wide range of constraining factors that limit the opportunities to dramatically improve on the existing road network. The limiting factors include:

1. The existing and proposed mine operations and associated infrastructure (extraction areas, coal handling and transport facilities) are mostly fixed in location and have to be circumvented;
2. Any additional crossings of the Hunter River and its associated floodplain involve major costs in bridging to manage environmental impacts;
3. Impacts on other critical land uses including crop and stock production must be avoided if possible; and
4. The need to connect traffic generating development to desired destinations via the existing main road transport corridors.

The strategies contained in the Road Network Plan, seek to provide for the most efficient and safe movement of vehicles within the limitations applying and at the least cost.

It is considered that the following strategies will address both short and long term issues arising from future growth and should form the basis of a Contributions Strategy to assist in funding the provision of road infrastructure needed to meet anticipated demand.

6.2 Proposed Strategies and Recommendations

The detailed analysis of the various options considered to address future demand is provided in the previous Chapters. The evaluation has determined that the following strategies offer the best solution in the short medium and long term:

To improve the connectivity of Wybong Road to the New England Highway north of Muswellbrook:

1. Replace the Kayuga Bridge in its current location (Option 1C);
2. Upgrade Aberdeen Street from Kayuga Bridge to the New England Highway; and,
3. Upgrade Wybong Road (East) and Kayuga Road from the new southern Link Road to Kayuga Bridge.

To address the proposed closure of sections of Wybong Road and Castlerock Road to facilitate coal extraction by the Mt Pleasant Mine:

4. Construct a Southern Link Road connecting Wybong Road (East) via Overton Road to the Bengalla Link Road west of the Hunter River crossing (Option 2B) in lieu of the previously proposed Northern and Western Link Roads; and,
5. Connect Castlerock Road to Dorset Road (to local road standard) to facilitate access to properties on these roads;
6. Should Mt Pleasant Mine not proceed and Wybong Road not be closed in 2026, Wybong Road from the Bengalla Link Road to Kayuga Road will need to be upgraded to maintain a safe and efficient movement of vehicles over this section of road to a standard appropriate to accommodate anticipated traffic volumes from background growth and new mines proposed further west.

To improve connectivity to, and the functioning of, the Main Road Network:

7. Modify the proposed Bengalla Link Road Diversion (Option 3A) to facilitate a north-western extension in the longer term (funded by new mines in the west);
8. Upgrade Roxburgh Road and Wybong Road connections to the Bengalla Link Road;
9. Upgrade Wybong Road (West) (Option 3C) and Reedy Creek Road (Option 3D) in the long term;
10. Pursue the reclassification of Thomas Mitchell Drive as a Main Arterial Road under the care and control of NSW Roads and Maritime Services;
11. Examine opportunities to forego the temporary relocation of Edderton Road on the less efficient alignment (as proposed by Mt Arthur Mine and the proposed Drayton South Mine) in lieu of contributions for works to improve the safety and efficiency of Denman Road and the Golden Highway;
12. In the longer term, at completion of mining activity, the Road Authority prefers Edderton Road to be reconstructed in generally it’s current more efficient alignment with upgraded intersections at Denman Road and the Golden Highway at design standards appropriate at the time and considering traffic growth over the period.
13. Consult with NSW Roads and Maritime Services in relation to options to avoid or rectify problems associated with the Golden Highway. In particular:
    - the Ogilvies Hill ascents;
    - the ability of the bridge crossing of the Hunter River near Denman to accommodate oversize vehicles; and
    - potential mine subsidence impacts from proposed underground mining; and,

- main road traffic within Denman township.

Figures 6-1 to 6-3 below show the specific initiatives that form the Road Network Plan recommendations above.

Note: All proposed roadworks will require approval under Section 138 of the Roads Act 1993.

Bengalla Link Road and Wybong Road (East)

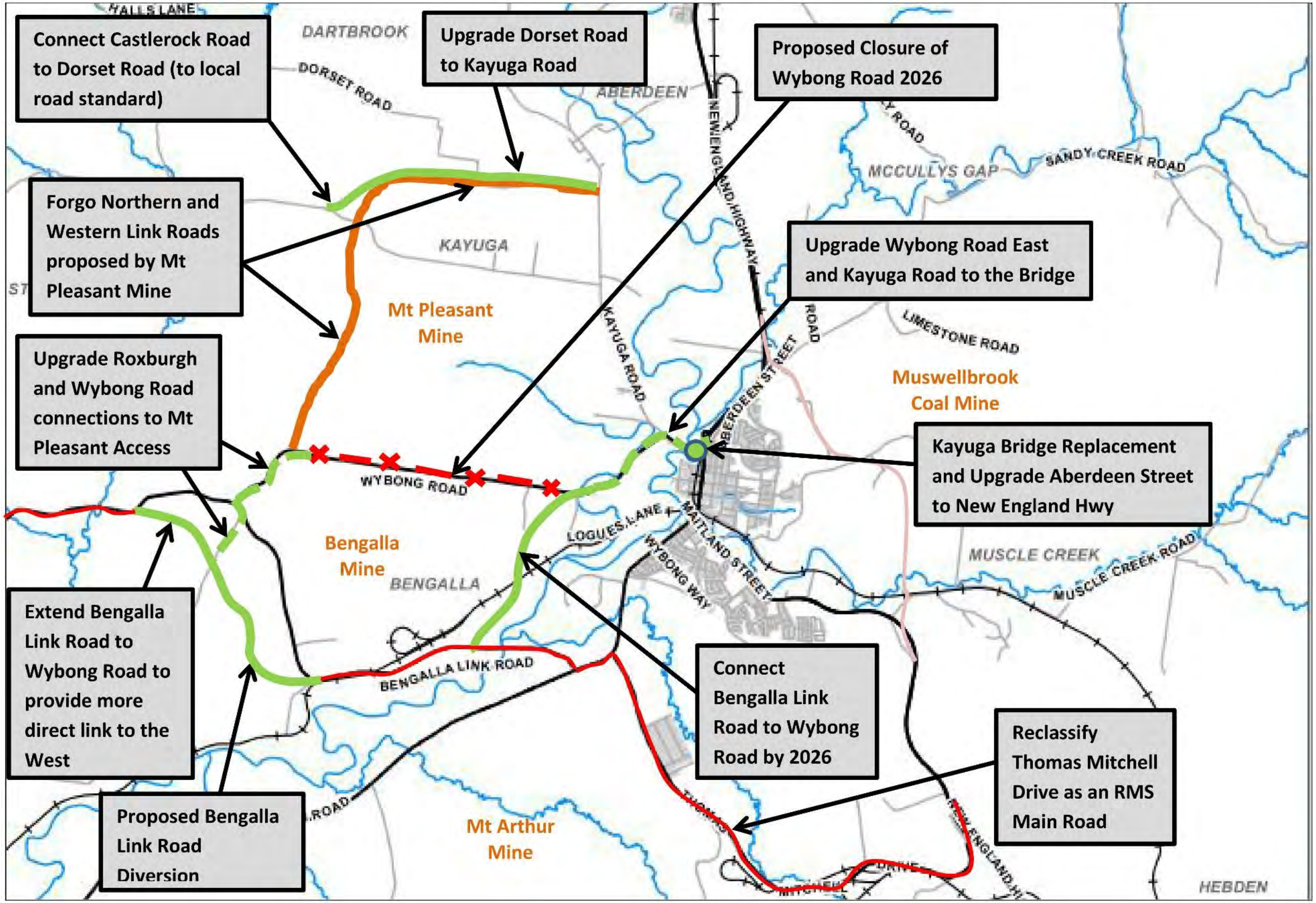


Figure 6-1 **Road Network Plan (North-eastern Sector)**

Edderton Road and Golden Highway

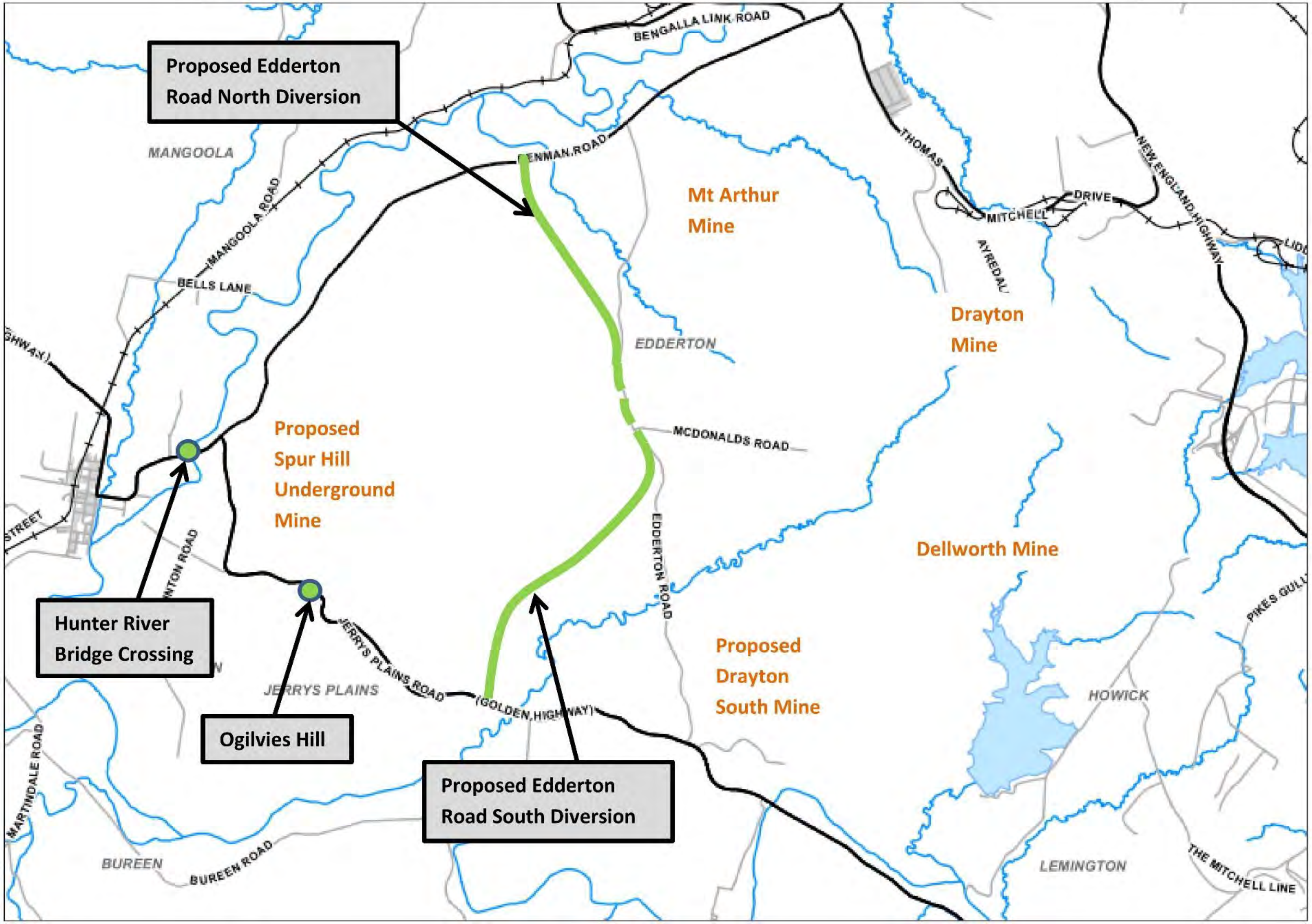


Figure 6-2 Road Network Plan (Southern Sector)

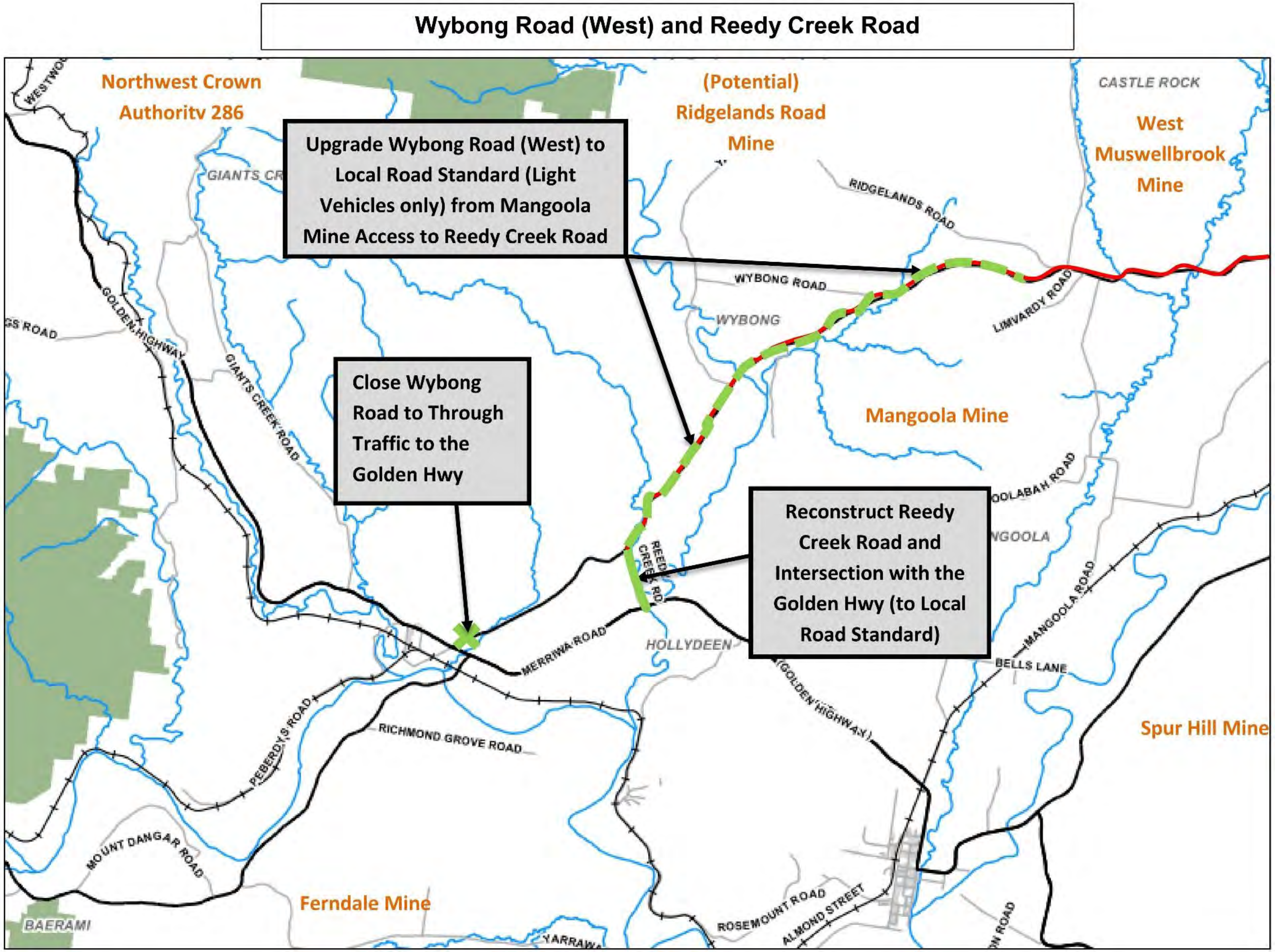


Figure 6-3 Road Network Plan (Western Sector)

6.3 Triggers and Priorities

The timing and responsibility for the implementation of the proposed road network improvements are directly linked to the various mine applications, approvals and government initiatives. The following table discusses the proposed network improvements in light of the current circumstances. Timing and responsibilities may change as a result of negotiations, and the timing and content of determinations of mining proposals.

Recommended Initiative	Comments	Priority/ Timing
Kayuga Bridge replacement	The replacement of the current one lane timber structure with a two lane concrete bridge able to carry larger vehicles, is considered critical to providing efficient access for both mine-related and local vehicles coming to and from the west in the short and long term. Responsibility for the replacement of the Kayuga Bridge lies with the RMS.	**High Priority/ Short Term**
Construct Southern Link Road (Wybong Road to Bengalla Link Road)	A pre-requisite to the closure of Wybong Road to facilitate coal extraction (in Year 9 of the Mt Pleasant Mine operation), will be the construction of the Southern Link Road. The construction of the proposed Southern Link Road would be in lieu of the proposed Northern and Western Link Roads previously proposed in the Mt Pleasant Mine application. The Southern Link offers travel efficiencies and significant cost savings to the mine. As such, this initiative should be taken up with Coal and Allied in relation to a Modification to the Consent. Construction of the Southern Link Road would remain the responsibility of Mt Pleasant Mine. Should the Mt Pleasant Mine not proceed, the closure of Wybong Road will not occur and the Southern Link Road would not be required. In this circumstance, Wybong Road from the Bengalla Link Road to Kayuga Road will need to be upgraded to maintain a safe and efficient movement of vehicles over this section of road to a standard appropriate to accommodate anticipated traffic volumes from background growth and new mines proposed further to the west.	**High Priority/ Medium Term**
Upgrade Wybong Road (East), Kayuga Road and Aberdeen Street	The construction of the Southern Link Road, in combination with the construction of a new Kayuga Bridge, will provide a relatively efficient route for vehicles to access the New England Highway. The construction of the proposed Muswellbrook Bypass will also see this route offering efficiencies in travel time to destinations south of Muswellbrook LGA. The costs associated with the upgrading of the roads leading to the bridge and New England Highway should be pursued via contributions and/or works-in-kind from new development proportional to their traffic generation.	**High Priority/ Medium Term**
Connect Castlerock to Dorset Road and upgrade to local standard	The connection and upgrading of Castlerock Road and Dorset Roads should be completed by Mt Pleasant Mine prior to the closure of the section of Castlerock Road within the extraction area. This initiative should be taken up with Coal and Allied in relation to a Modification to the Consent.	**High Priority/ Medium Term**
Modified Bengalla Link Road Diversion	The diversion of the Bengalla Link Road west to facilitate the continuation of mining is currently before the Sate Government for consideration. The modification of the diversion to better facilitate the efficient movement of vehicles from locations west along Wybong Road, is seen as being beneficial in the longer term. This initiative should be taken up with Bengalla Mining Company and the NSW Dept of Planning and Environment in relation to amendment to the current application or as a condition of approval should that be forthcoming. The construction of the diverted Bengalla Link Road on the modified alignment should be the responsibility of the Bengalla Mine. The northern road alignment and design of intersections to have regard tothe proposed extension of the Bengalla Link Road to the North-west to connect to Wybong Road in the longer term and to be funded by new mines in the west.	**High Priority/ Medium Term**
Upgrade Roxburgh and Wybong Road connections to Modified Bengalla Link Road alignment	Construction of the connecting roads to the modified Bengalla Link Road Diversion should be the responsibility of the Bengalla Mine.	**High Priority/ Medium Term**
Upgrade Wybong Road (west) to local road standard	The upgrading of Wybong Road (West) is required to improve travel efficiency and safety as traffic generating development in the west results in increased vehicle usage. Responsibility for the upgrading of this road should be linked to new and expanding mines in the north and west of the Shire and contributions or works should be proportional to the demand created by any new development in this area.	**Medium Priority/ Long Term**
Upgrade Reedy Creek Road and Golden Hwy intersection	Responsibility for the upgrading of this road and its intersection with the Golden Highway should be linked to new and expanding mines in the north and west of the Shire and contributions or works-in-kind should be proportional to the demand created by new development.	**Medium Priority/ Long Term**
Reclassify Thomas Mitchell Drive	Current and forecast traffic volumes indicate that Thomas Mitchell Drive will continue to operate as an important arterial road warranting State Government care and control.	**High Priority/ Short Term**
Edderton Road Temporary Replacement and final reconstruction.	Current and forecast traffic volumes on Edderton Road do not justify the upgrading of this road. However, the accident history is disproportionately high relative to the number of vehicles. The pavement width and road alignment are of significant concern in relation to road user safety. The cost of diverting the northern and southern sections of the road to facilitate coal extraction will be considerable and will result in a less efficient road alignment. Consideration should be given to the closure of the road and the redirection of funding (or works) to improve the arterial road network. This initiative should be taken up with the respective mines. The proposal by the mines should be considered a temporary solution to allow mining to proceed. The	**High Priority/ Medium and Long Term**

	long-term requirement preferred by the Road Authority is that the road be reconstructed generally in it's current location on completion of mining activity.	
Consultation with RMS on Golden Highway Improvements	Strategies to address current and potential problems associated with the Golden Highway need to be discussed at an early juncture to facilitate the long term planning of efficiencies, cost savings and safety improvements to the Golden Highway.	**High Priority/ Long Term**

7 Where to from here?

7.1 Stage 1 – Adoption of the Road Network Plan

Stage 1 of this project involved the development of an appropriate local Road Network Plan. This Plan is to be used to assist with the long term management of the road network and in the preparation of a Developer Contributions Strategy specifically related to Mine Affected Roads within the Muswellbrook LGA. In this regard, the Objectives for Stage 1 were to:

- Identify the extent to which roads within the local government area are being utilised by mining related vehicles;
- Based on the best available information, forecast the likely growth in traffic for 20 and 40 year time frames;
- Provide discussion in relation to the likely future demands on the road network and options to best meet the forecast demands;
- To establish a basis upon which justification for the introduction of a fair and equitable developer contributions plan specific to mining related traffic can occur.

The completed Plan will be used by relevant government agencies (local and state) to guide the development of priority safety, traffic, asset and infrastructure maintenance, and improvements. It will also be used by industry and the community to understand proposed changes in the network over time that may influence their decisions.

7.2 Monitoring and Review

The Stage 1 Road Network Plan will need to be a ‘dynamic document’ responding over time to the performance of the roads within the network, and to changing circumstances affecting the likely rate of growth in demand on the road network. Similarly, the related Contributions Strategy will need to be regularly reviewed to maintain consistency with the Road Network Plan. A five (5) year cycle of performance review is considered accepted practice consistent with State Government directives for Council’s to review their planning instruments to maintain currency. To ensure that contributions imposed on development are properly justified (ie. based on best available information), traffic surveys and analysis should be undertaken on a regular basis. As a matter of course, the findings of the five (5) yearly Road Network Plan review should carry over to the subsequent review of the related Contributions Plan.

Potential triggers for the review process other than on a 5 yearly cycle include:

- Changes to federal, state or Local government priorities;
- Proposed high-impact land use and/or transport changes within the local road network;
- Proposed changes outside the local road network that may significantly impact on the role and function of roads within the local network.

Contributions Plans should have a minor review annually. This annual review needs to include an examination of the variables affecting the contribution rate.

7.3 Stage 2 – Developer Contributions Strategy

Section 94 of the Environmental Planning and Assessment Act 1979 makes provision for a determining authority (either Council or State Government) to impose conditions of consent on new development that will impact on public infrastructure and services within a Local Government Area. This is done by way of a Development Contributions Plan (or Plans), or in the absence of a relevant Development Contributions Plan, via a negotiated Voluntary Planning Agreement (as has been the practice in the past).

Stage 2 of this Project involves the preparation of such a Development Contributions Strategy specifically related to the traffic generated by the coal mines with the Muswellbrook Local Government Area. Contributions (or works-in-kind in lieu of contributions) recommended by this Strategy are to be fully justified in terms of the nexus between the impacts of a particular development and the infrastructure needed to address the identified impacts.

Funds collected by a consent authority must be spent on the nominated infrastructure (or stages thereof) within a “timely period”. Consequently, any Contributions Strategy can only justify contributions for works needed within the short to medium term.

8 References

Upper Hunter Strategic Regional Land Use Plan 2012 – NSW Department of Planning and Infrastructure

Muswellbrook Shire Council Land Use Development Strategy

2013 NSW Coal Industry Profile – NSW Dept of Trade and Investment Resources and Energy

MSC Western Roads Strategic Traffic Study

Muswellbrook By-pass Report by Hyder

2010-2011- Parsons Brinkerhoff - Wybong Road Traffic Study

ARTC 2013 HV Strategy – Final

RTA Network and Corridor Planning Practice Note

Bengalla Continuation Project - EIS Main Report – Sept 2013

Dartbrook Mine Extension - Preliminary Planning Assessment 2001

Doyles Creek Proposed Mine - Preliminary Proposal March 2012

Drayton South Coal Project - Environmental Assessment – Main Report – November 2012

Mangoola Mine Mod 6 – Environmental Assessment

Mt Arthur Coal Open Cut - Mod 1 - Environmental Assessment

Spur Hill Project Description and Preliminary Environmental Assessment 2012

Mt Pleasant Project Modification – Environmental Assessment Report (Oct 2010)

Doyles Creek Underground Mine and Training School – Project Overview (March 2012)

VPA’s for Bengalla and Mangoola Mines

APPENDIX A

TRAFFIC SURVEY METHODOLOGY

TRAFFIC SURVEY METHODOLOGY

In November 2013 SkyHigh Traffic Data undertook origin-destination surveys in the district around Muswellbrook in the Hunter Valley of NSW. The survey was undertaken from 1:00am on Wednesday 6 November 2013 to 1:00am on Thursday 7 November 2013. The field method involved the use of video equipment to collect images of vehicles' numberplates at sixteen two-directional stations. Observations were classified into:

1. Non-heavy (light) vehicles
2. Other heavy trucks
3. B-doubles

This analysis provides an indication of movements between observation stations, as required by the brief, as well as travel times. Vehicle number plates were observed at twenty-six stations within the study area over the course of the survey period, and these were processed and analysed for subsequent reporting. The table below describes station locations.

Observation station locations

Mine Entrance Sites (M series)

- M1 Mangoola Coal access road off Wybong Road;
- M2 Bengalla Mine access road off Bengalla Link Road;
- M3 Mt Arthur Mine access road off Thomas Mitchell Drive;
- M4 Drayton Mine access road off Thomas Mitchell Drive.

External Link Sites (E series)

- E1 Golden Highway (south eastern Shire boundary east of Edderton Road);
- E2 Golden Highway (western Shire boundary west of Sandy Hollow);
- E3 New England Highway (eastern Shire boundary east of Pikes Gully Road intersection);
- E4 New England Highway (northern Shire boundary south of Aberdeen);
- E5 Dartbrook Road (northern Shire boundary west of Blairmore Road);
- E6 Bylong Valley Way (western Shire Boundary at Goulburn River Bridge).

Internal Route Sites (R series)

- R1 Kayuga Road between Wybong Road and Aberdeen Street;
- R2 Denman Road north of Thomas Mitchell Drive;
- R3 Denman Road north east of Edderton Road;
- R4 Golden Highway west of Denman Road (east of Denman township);
- R5 Golden Highway south of Mangoola Road (north of Denman township);
- R6 Thomas Mitchell Drive south of Glen Munro Road at Industrial Estate.

The locational map of the traffic count survey locations is included below:

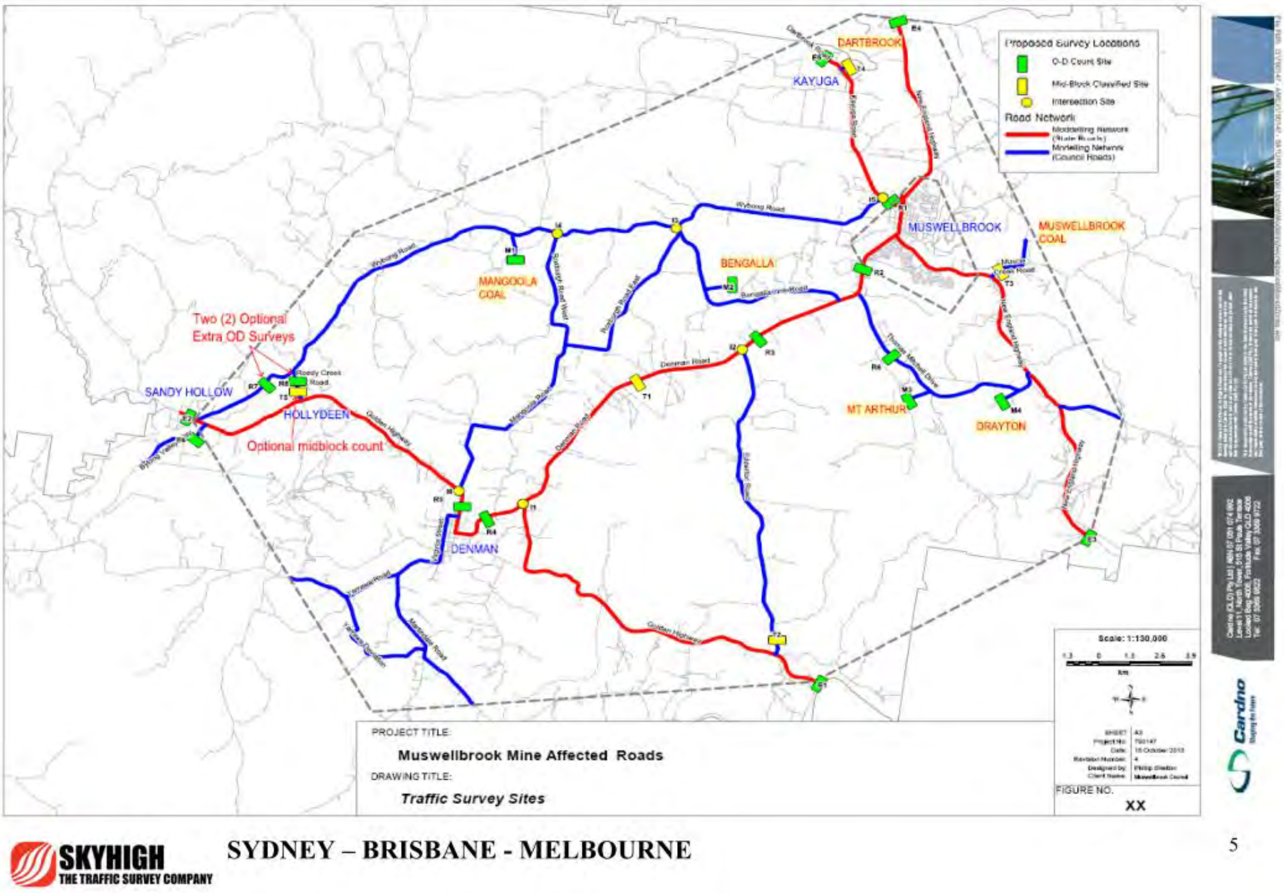


Figure 8-1 Traffic Count and O/D Survey Locations

Inter-station travel time

A general match of stations within the study area was undertaken for most feasible station pairs. This was undertaken using a relaxed travel time cut-off (minimum -60 minutes to maximum of 150 minutes). This provides a check on site labelling and time stamp synchronisation. From this analysis a set of travel time frequency distributions was prepared for each station pair. This was then reviewed to identify maximum travel time cut-offs, based on the shape of the distribution and with cognisance of the distances between stations. This was on an all-classes basis, and where there was a fragmented distribution toward the plausible maximum travel time, vehicle classes were examined to identify if there was a preponderance of heavy vehicles.

Our conclusion was that the all-vehicle travel time distributions were reasonably representative of travel times between stations, with some allowance for apparently high travel times.

Matching approaches

The study specification identified sets of matches to be undertaken. These are described below.

Mine to Mine

This matched all *mine station trips out* to all *mine station trips in*. The matching was undertaken with mine site-only data and trips were extracted if they were configured out-in and the match was within the travel time maximums described above.

Mine to External

This matched all *mine station trips out* to all *external trips out*. The matching was undertaken with mine site and external station-only data and trips were extracted if they were configured out-in and the match was within the travel time maximums described above.

External to Mine

This matched all *external station trips in* to *mine station trips in*. The matching was undertaken with mine site and external station-only data and trips were extracted if they were configured out-in and the match was within the travel time maximums described above.

External to External

This matched all *external station trips in* to all *external station trips out*. The matching was undertaken with external station-only data and trips were extracted if they were configured out-in and the match was within the travel time maximums described above.

Mine to Route, External to Route and Route to Route

This matching used replacement of data, so that the station pair frequencies reported are for the station pair only, irrespective of whether the vehicle was detected at an intermediate station or not.

Expansion process

Due to a range of factors associated with number plate surveys, some observations are incomplete.

Incomplete number plates

Where a character position or positions were not clear to the data recorder, then a dash ('-') was inserted. If at least one dash was in the recorded plate, then it was precluded from further matching analysis. In order to account for this in the results, a process of expansion was applied.

Expansion factors for each station were calculated using the following approach:

Expansion factor = total plates (including those with a '-')/good plates

This was undertaken by station, class and by 60-minute period. These expansion factors were applied multiplicatively for the first and last station observed. Five workbooks were produced for each frequency (count of matches and sum of missed plate expansion weights), each with hourly matching matrices over the 24-hour period and a 24-hour total matrix for each vehicle class and for all vehicles.

Thomas Mitchell Drive Reconstruction Work

It should be noted that road works occurring on Thomas Mitchell Drive would have affected the use of that route when the traffic surveys were conducted. It was determined from the origin-destination surveys that approximately 70% of east bound traffic on Denman Road at the Thomas Mitchell Drive intersection travelled via South Muswellbrook to access the New England Highway and then travel south. The traffic model has been adjusted accordingly to include those vehicles that would have normally travelled via Thomas Mitchell Drive to reach destinations south, but chose to travel via South Muswellbrook to avoid the significant delays caused by the road works.

Total Traffic and Mine-related Traffic by Vehicle Type

A summary table comparing total traffic and mine-related traffic by vehicle type on each section of local road is provided in **Table 0-1** below.

(yellow)	Local Roads with Highest Total Traffic Volumes
(blue)	Local Roads with Higher Proportions of Mine Related Traffic Movements
(orange)	Local Roads with High Heavy Vehicle Usage
(green)	Local Roads with Highest Numbers of Mine-related Heavy Vehicles

Table 0-1 – Total Traffic and Mine-related Traffic by Vehicle Type

(NOTE 1: Denman Road, Golden Hwy and New England Hwy are State Government controlled roads and are therefore excluded)

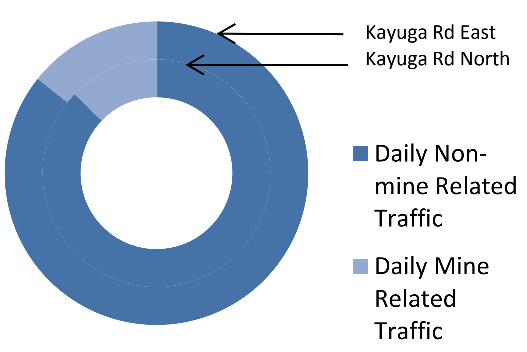
(NOTE: 2: The following table references Light Vehicles as 'LV's. Due to the small number of Multi-combination Vehicles (MCV's) involved, Heavy Vehicles (HV's) & Multi-combination Vehicles (MCV's) are added together. Those sections of road travelled by a more significant number of MCV's are discussed separately below).

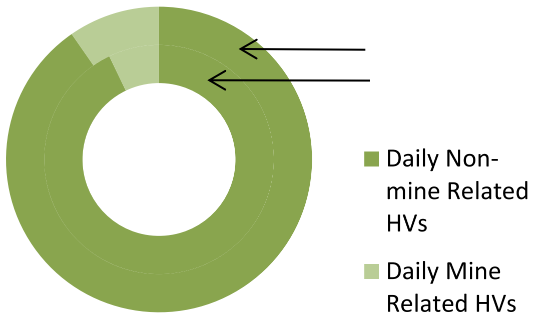
Road Section	Total Traffic Volumes			Total Mine-related Vehicles		
	Totals (vpd)	Total x Vehicle Types (vpd)		Totals (vpd and %)	Vehicle Types (vpd)	
Kayuga Road North (Shire Boundary to Wybong Road)	**578**	LV's	**550**	**73** (12.8% of total traffic)	LV's	**71**
		HV's & MCV's	**28**		HV's & MCV's	**2**
Kayuga Road East (Wybong Road to Kayuga Bridge)	**1,718**	LV's	**1,625**	**246** (14% of total traffic)	LV's	**238**
		HV's & MCV's	**93**		HV's & MCV's	**9**
Wybong Road West (Sandy Hollow to Mangoola Mine Entrance)	**804**	LV's	**749**	**231** (28.7% of total traffic)	LV's	**213**
		HV's & MCV's	**55**		HV's & MCV's	**18**
Wybong Road (Mangoola Mine Entrance to Bengalla Link Road)	**1,288**	LV's	**1,198**	**724** (56.4% of total traffic)	LV's	**665**
		HV's & MCV's	**89**		HV's & MCV's	**59**
Wybong Road East (Bengalla Link Road to Kayuga Road)	**589**	LV's	**547**	**228** (39% of total traffic)	LV's	**209**
		HV's & MCV's	**42**		HV's & MCV's	**19**
Bengalla Link Road North (Wybong Road to Bengalla Mine Entrance)	**1,056**	LV's	**965**	**734** (69.7% of total traffic)	LV's	**671**
		HV's & MCV's	**91**		HV's & MCV's	**63**
Bengalla Link Road South (Bengalla Mine Entrance to Denman Road)	**2,030**	LV's	**1,813**	**1,407** (69.4% of total traffic)	LV's	**1,266**
		HV's & MCV's	**218**		HV's & MCV's	**141**
Thomas Mitchell Drive North (Denman Road to the Industrial Area)	**8,801**	LV's	**8,223**	**2,541** (28.8% of total traffic)	LV's	**2,417**
		HV's & MCV's	**577**		HV's & MCV's	**124**
Thomas Mitchell Drive Central (Industrial Area to Mt Arthur Mine Entrance)	**4,702**	LV's	**4,133**	**2,496** (53% of total traffic)	LV's	**2,349**
		HV's & MCV's	**569**		HV's & MCV's	**147**
Thomas Mitchell Drive South (Mt Arthur Mine Entrance to Drayton Mine Entrance)	**3,789**	LV's	**3,236**	**1,566** (41.3% of total traffic)	LV's	**1,454**
		HV's & MCV's	**553**		HV's & MCV's	**112**
Thomas Mitchell Drive East (Drayton Mine Entrance to New England Hwy)	**4,146**	LV's	**3,579**	**1,935** (46.7% of total traffic)	LV's	**1,797**
		HV's & MCV's	**567**		HV's & MCV's	**138**
Edderton Road North (Denman Road to Mt Arthur Heavy Vehicle Assembly Pad)	**1,023**	LV's	**899**	**264** (25.8% of total traffic)	LV's	**216**
		HV's & MCV's	**124**		HV's & MCV's	**48**
Edderton Road South (Mt Arthur Heavy Vehicle Assembly Pad to Golden Hwy)	**836**	LV's	**680**	**50** (6% of total traffic)	LV's	**50**
		HV's & MCV's	**155**		HV's & MCV's	**0**

APPENDIX B

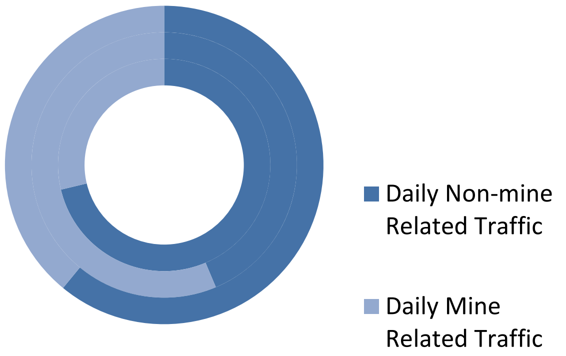
DIAGRAMMATIC REPRESENTATION OF TRAFFIC SURVEY RESULTS

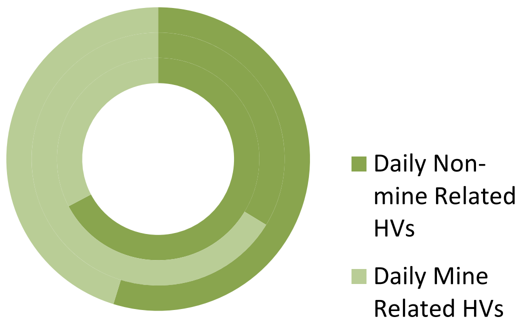
The following graphs provide an "at a glance" view of the proportion of daily non-mine related traffic compared to the daily mine related traffic on each of the affected roads.



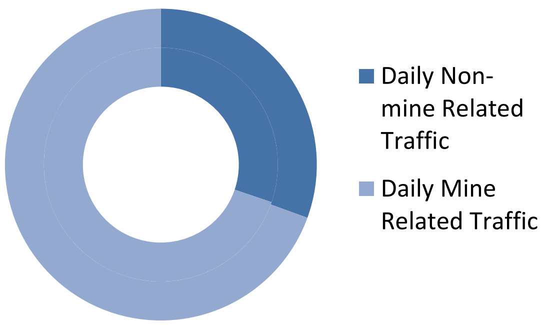


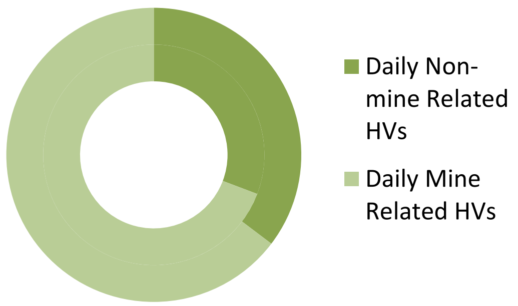
Kayuga Road



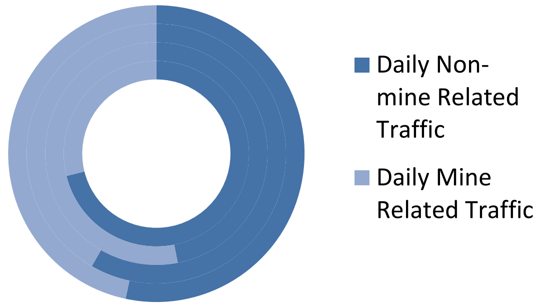


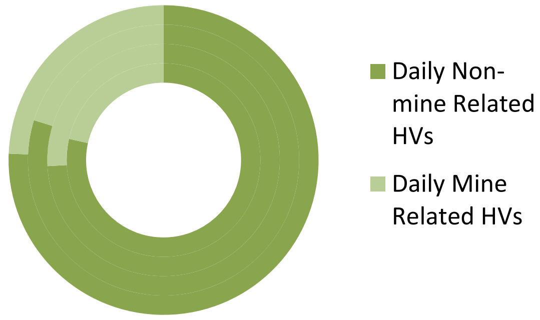
Wybong Road



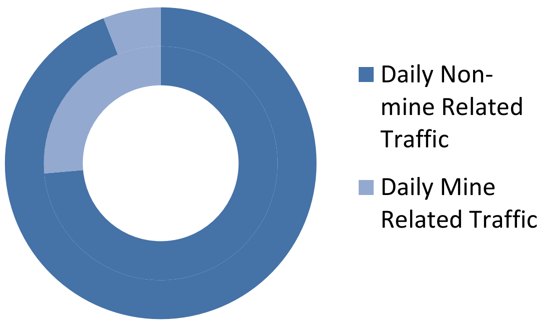


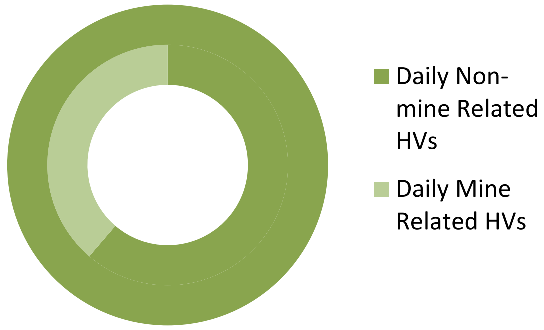
Bengalla Road





Thomas Mitchell Drive





Edderton Road

APPENDIX C
COST ESTIMATE SUMMARY SHEETS

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 1A Connect to McCully's Gap Rd Assumptions:

- 2.35 km Two Lane Road
- 2 Bridge Crossings - 50m and 100m river bridge
- 2 major intersections
- Traffic Control at Intersections only

	Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0	**Project Development**					
1.1	Route/Concept/EIS/Reps Report	$578,627.11	30%	$173,588.13	$752,215.25	
1.2	Project Management Services	$43,397.03	30%	$13,019.11	$56,416.14	
1.3	Client Representation	$4,339.70	30%	$1,301.91	$5,641.61	
	Sub Total	$626,363.85	30%	$187,909.15	$814,273.00	2.0%
2.0	**Investigation and Design**					
2.1	Investigation and Design	$578,627.11	30%	$173,588.13	$752,215.25	
2.2	Project Management Services	$43,397.03	30%	$13,019.11	$56,416.14	
2.3	Client Representation	$4,339.70	30%	$1,301.91	$5,641.61	
	Sub Total	$626,363.85	30%	$187,909.15	$814,273.00	2.0%
3.0	**Property Acquisitions**					
3.1	Profesional Services for property	$76,188.00	30%	$22,856.40	$99,044.40	
3.2	Property Acquisition Costs	$1,088,400.00	30%	$326,520.00	$1,414,920.00	
3.3	Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4	Project Management Services	$81,630.00	30%	$24,489.00	$106,119.00	
3.5	Client Representation	$8,163.00	30%	$2,448.90	$10,611.90	
	Sub Total	$1,254,381.00	30%	$376,314.30	$1,630,695.30	3.9%
4.0	**Public Utility Adjustments**					
4.1	Utility Adjustments	$144,656.78	30%	$43,397.03	$188,053.81	
4.2	Project Management Services	$10,849.26	30%	$3,254.78	$14,104.04	
4.3	Client Representation	$1,084.93	30%	$325.48	$1,410.40	
	Sub Total	$156,590.96	30%	$46,977.29	$203,568.25	0.5%
5.0	**Construction**					
5.1	Infrastructure - General	$650,000.00	30%	$195,000.00	$845,000.00	
5.2	Infrastructure - Environmental	$169,200.00	30%	$50,760.00	$219,960.00	
5.3	Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4	Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5	Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6	Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7	Infrastructure - Pavement	$6,750,000.00	30%	$2,025,000.00	$8,775,000.00	
5.8	Infrastructure - Structures	$13,000,000.00	30%	$3,900,000.00	$16,900,000.00	
5.9	Infrastructure - Local Roads/Intersections	$6,000,000.00	30%	$1,800,000.00	$7,800,000.00	
5.10	Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11	Infrastructure - Miscellaneous	$724,531.73	30%	$217,359.52	$941,891.24	
5.12	Infrastructure - Site Management	$136,468.66	30%	$40,940.60	$177,409.26	
5.13	Project Management Services	$1,364,686.59	30%	$409,405.98	$1,774,092.56	
5.14	Client Representation	$136,468.66	30%	$40,940.60	$177,409.26	
	Sub Total	$28,931,355.63	30%	$8,679,406.69	$37,610,762.32	90.7%
6.0	**Handover**					
6.1	Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2	Project Data and Performance	$289,313.56	30%	$86,794.07	$376,107.62	
6.3	Project Management Services	$22,073.52	30%	$6,622.06	$28,695.57	
6.4	Client Representation	$2,207.35	30%	$662.21	$2,869.56	
	Sub Total	$318,594.42	30%	$95,578.33	$414,172.75	1.0%
	TOTAL ESTIMATE	**$31,913,649.71**	**30%**	**$9,574,094.91**	**$41,487,744.63**	**100.0%**
	INDICATIVE COST ESTIMATE ($ million)				**$41.49**	

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 1B Connect to Aberdeen St Ass

- 0.85 km Two Lane Road
- 1 Bridge Crossings - 100m river bridge
- 2 major intersections
- Traffic Control at Intersections only

	Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0	**Project Development**					
1.1	Route/Concept/EIS/Reps Report	$437,126.01	30%	$131,137.80	$568,263.81	
1.2	Project Management Services	$32,784.45	30%	$9,835.34	$42,619.79	
1.3	Client Representation	$3,278.45	30%	$983.53	$4,261.98	
	Sub Total	$473,188.91	30%	$141,956.67	$615,145.58	2.0%
2.0	**Investigation and Design**					
2.1	Investigation and Design	$437,126.01	30%	$131,137.80	$568,263.81	
2.2	Project Management Services	$32,784.45	30%	$9,835.34	$42,619.79	
2.3	Client Representation	$3,278.45	30%	$983.53	$4,261.98	
	Sub Total	$473,188.91	30%	$141,956.67	$615,145.58	2.0%
3.0	**Property Acquisitions**					
3.1	Profesional Services for property	$7,000.00	30%	$2,100.00	$9,100.00	
3.2	Property Acquisition Costs	$100,000.00	30%	$30,000.00	$130,000.00	
3.3	Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4	Project Management Services	$7,500.00	30%	$2,250.00	$9,750.00	
3.5	Client Representation	$750.00	30%	$225.00	$975.00	
	Sub Total	$115,250.00	30%	$34,575.00	$149,825.00	0.5%
4.0	**Public Utility Adjustments**					
4.1	Utility Adjustments	$109,281.50	30%	$32,784.45	$142,065.95	
4.2	Project Management Services	$8,196.11	30%	$2,458.83	$10,654.95	
4.3	Client Representation	$819.61	30%	$245.88	$1,065.49	
	Sub Total	$118,297.23	30%	$35,489.17	$153,786.39	0.5%
5.0	**Construction**					
5.1	Infrastructure - General	$330,000.00	30%	$99,000.00	$429,000.00	
5.2	Infrastructure - Environmental	$61,200.00	30%	$18,360.00	$79,560.00	
5.3	Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4	Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5	Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6	Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7	Infrastructure - Pavement	$3,000,000.00	30%	$900,000.00	$3,900,000.00	
5.8	Infrastructure - Structures	$9,550,000.00	30%	$2,865,000.00	$12,415,000.00	
5.9	Infrastructure - Local Roads/Intersections	$7,200,000.00	30%	$2,160,000.00	$9,360,000.00	
5.10	Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11	Infrastructure - Miscellaneous	$477,951.48	30%	$143,385.44	$621,336.92	
5.12	Infrastructure - Site Management	$103,095.76	30%	$30,928.73	$134,024.48	
5.13	Project Management Services	$1,030,957.57	30%	$309,287.27	$1,340,244.85	
5.14	Client Representation	$103,095.76	30%	$30,928.73	$134,024.48	
	Sub Total	$21,856,300.56	30%	$6,556,890.17	$28,413,190.73	93.9%
6.0	**Handover**					
6.1	Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2	Project Data and Performance	$218,563.01	30%	$65,568.90	$284,131.91	
6.3	Project Management Services	$16,767.23	30%	$5,030.17	$21,797.39	
6.4	Client Representation	$1,676.72	30%	$503.02	$2,179.74	
	Sub Total	$242,006.95	30%	$72,602.09	$314,609.04	1.0%
	TOTAL ESTIMATE	**$23,278,232.56**	**30%**	**$6,983,469.77**	**$30,261,702.33**	**100.0%**
	INDICATIVE COST ESTIMATE ($ million)				**$30.26**	

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 1C Replace Kayuga Bridge Assumptions:

- 1.4 km Two Lane Road
- 1 Bridge Crossing - 100m river bridge
- 2 minor intersections
- Traffic Control at Intersections only

	Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0	**Project Development**					
1.1	Route/Concept/EIS/Reps Report	$187,847.82	30%	$56,354.35	$244,202.17	
1.2	Project Management Services	$14,088.59	30%	$4,226.58	$18,315.16	
1.3	Client Representation	$1,408.86	30%	$422.66	$1,831.52	
	Sub Total	$203,345.27	30%	$61,003.58	$264,348.85	2.0%
2.0	**Investigation and Design**					
2.1	Investigation and Design	$187,847.82	30%	$56,354.35	$244,202.17	
2.2	Project Management Services	$14,088.59	30%	$4,226.58	$18,315.16	
2.3	Client Representation	$1,408.86	30%	$422.66	$1,831.52	
	Sub Total	$203,345.27	30%	$61,003.58	$264,348.85	2.0%
3.0	**Property Acquisitions**					
3.1	Profesional Services for property	$0.00	30%	$0.00	$0.00	
3.2	Property Acquisition Costs	$0.00	30%	$0.00	$0.00	
3.3	Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4	Project Management Services	$0.00	30%	$0.00	$0.00	
3.5	Client Representation	$0.00	30%	$0.00	$0.00	
	Sub Total	$0.00	30%	$0.00	$0.00	0.0%
4.0	**Public Utility Adjustments**					
4.1	Utility Adjustments	$46,961.96	30%	$14,088.59	$61,050.54	
4.2	Project Management Services	$3,522.15	30%	$1,056.64	$4,578.79	
4.3	Client Representation	$352.21	30%	$105.66	$457.88	
	Sub Total	$50,836.32	30%	$15,250.90	$66,087.21	0.5%
5.0	**Construction**					
5.1	Infrastructure - General	$285,000.00	30%	$85,500.00	$370,500.00	
5.2	Infrastructure - Environmental	$54,000.00	30%	$16,200.00	$70,200.00	
5.3	Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4	Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5	Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6	Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7	Infrastructure - Pavement	$1,312,500.00	30%	$393,750.00	$1,706,250.00	
5.8	Infrastructure - Structures	$4,575,000.00	30%	$1,372,500.00	$5,947,500.00	
5.9	Infrastructure - Local Roads/Intersections	$2,400,000.00	30%	$720,000.00	$3,120,000.00	
5.10	Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11	Infrastructure - Miscellaneous	$234,246.38	30%	$70,273.91	$304,520.29	
5.12	Infrastructure - Site Management	$44,303.73	30%	$13,291.12	$57,594.85	
5.13	Project Management Services	$443,037.32	30%	$132,911.20	$575,948.51	
5.14	Client Representation	$44,303.73	30%	$13,291.12	$57,594.85	
	Sub Total	$9,392,391.16	30%	$2,817,717.35	$12,210,108.50	94.3%
6.0	**Handover**					
6.1	Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2	Project Data and Performance	$93,923.91	30%	$28,177.17	$122,101.09	
6.3	Project Management Services	$7,419.29	30%	$2,225.79	$9,645.08	
6.4	Client Representation	$741.93	30%	$222.58	$964.51	
	Sub Total	$107,085.13	30%	$32,125.54	$139,210.67	1.1%
	TOTAL ESTIMATE	**$9,957,003.15**	**30%**	**$2,987,100.94**	**$12,944,104.09**	**100.0%**
	INDICATIVE COST ESTIMATE ($ million)				**$12.94**	

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 2A Connect Wybong Rd to Denman Rd Assumptions:

- 2.3 km Two Lane Road
- 2 Bridge Crossings - 40m rail bridge and 100m river bridge
- 2 major intersections
- Traffic Control at Intersections only

Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0 Project Development					
1.1 Route/Concept/EIS/Reps Report	$522,001.79	30%	$156,600.54	$678,602.33	
1.2 Project Management Services	$39,150.13	30%	$11,745.04	$50,895.17	
1.3 Client Representation	$3,915.01	30%	$1,174.50	$5,089.52	
Sub Total	$565,066.94	30%	$169,520.08	$734,587.02	2.0%
2.0 Investigation and Design					
2.1 Investigation and Design	$522,001.79	30%	$156,600.54	$678,602.33	
2.2 Project Management Services	$39,150.13	30%	$11,745.04	$50,895.17	
2.3 Client Representation	$3,915.01	30%	$1,174.50	$5,089.52	
Sub Total	$565,066.94	30%	$169,520.08	$734,587.02	2.0%
3.0 Property Acquisitions					
3.1 Profesional Services for property	$26,908.00	30%	$8,072.40	$34,980.40	
3.2 Property Acquisition Costs	$384,400.00	30%	$115,320.00	$499,720.00	
3.3 Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4 Project Management Services	$28,830.00	30%	$8,649.00	$37,479.00	
3.5 Client Representation	$2,883.00	30%	$864.90	$3,747.90	
Sub Total	$443,021.00	30%	$132,906.30	$575,927.30	1.6%
4.0 Public Utility Adjustments					
4.1 Utility Adjustments	$130,500.45	30%	$39,150.13	$169,650.58	
4.2 Project Management Services	$9,787.53	30%	$2,936.26	$12,723.79	
4.3 Client Representation	$978.75	30%	$293.63	$1,272.38	
Sub Total	$141,266.74	30%	$42,380.02	$183,646.76	0.5%
5.0 Construction					
5.1 Infrastructure - General	$450,000.00	30%	$135,000.00	$585,000.00	
5.2 Infrastructure - Environmental	$165,600.00	30%	$49,680.00	$215,280.00	
5.3 Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4 Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5 Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6 Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7 Infrastructure - Pavement	$5,750,000.00	30%	$1,725,000.00	$7,475,000.00	
5.8 Infrastructure - Structures	$11,590,000.00	30%	$3,477,000.00	$15,067,000.00	
5.9 Infrastructure - Local Roads/Intersections	$6,000,000.00	30%	$1,800,000.00	$7,800,000.00	
5.10 Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11 Infrastructure - Miscellaneous	$667,126.05	30%	$200,137.82	$867,263.87	
5.12 Infrastructure - Site Management	$123,113.63	30%	$36,934.09	$160,047.72	
5.13 Project Management Services	$1,231,136.30	30%	$369,340.89	$1,600,477.19	
5.14 Client Representation	$123,113.63	30%	$36,934.09	$160,047.72	
Sub Total	$26,100,089.61	30%	$7,830,026.88	$33,930,116.50	92.9%
6.0 Handover					
6.1 Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2 Project Data and Performance	$261,000.90	30%	$78,300.27	$339,301.16	
6.3 Project Management Services	$19,950.07	30%	$5,985.02	$25,935.09	
6.4 Client Representation	$1,995.01	30%	$598.50	$2,593.51	
Sub Total	$287,945.97	30%	$86,383.79	$374,329.76	1.0%
TOTAL ESTIMATE	**$28,102,457.20**	**30%**	**$8,430,737.16**	**$36,533,194.36**	**100.0%**

INDICATIVE COST ESTIMATE ($ million)	**$36.53**

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 2B Wybong Rd to Bengalla Link Rd Assur

- 3.5 km Two Lane Road
- 1 Bridge Crossing - 40m bridge
- 1 major intersection
- Traffic Control at Intersection only

Item	Estimate ($) (excluding contingency)	Contingency		Estimate ($) (including contingency)	% of Total Estimate
		%	Amount ($)		
1.0 Project Development					
1.1 Route/Concept/EIS/Reps Report	$321,371.17	30%	$96,411.35	$417,782.52	
1.2 Project Management Services	$24,102.84	30%	$7,230.85	$31,333.69	
1.3 Client Representation	$2,410.28	30%	$723.09	$3,133.37	
Sub Total	$347,884.29	30%	$104,365.29	$452,249.57	2.0%
2.0 Investigation and Design					
2.1 Investigation and Design	$321,371.17	30%	$96,411.35	$417,782.52	
2.2 Project Management Services	$24,102.84	30%	$7,230.85	$31,333.69	
2.3 Client Representation	$2,410.28	30%	$723.09	$3,133.37	
Sub Total	$347,884.29	30%	$104,365.29	$452,249.57	2.0%
3.0 Property Acquisitions					
3.1 Profesional Services for property	$19,600.00	30%	$5,880.00	$25,480.00	
3.2 Property Acquisition Costs	$280,000.00	30%	$84,000.00	$364,000.00	
3.3 Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4 Project Management Services	$21,000.00	30%	$6,300.00	$27,300.00	
3.5 Client Representation	$2,100.00	30%	$630.00	$2,730.00	
Sub Total	$322,700.00	30%	$96,810.00	$419,510.00	1.9%
4.0 Public Utility Adjustments					
4.1 Utility Adjustments	$80,342.79	30%	$24,102.84	$104,445.63	
4.2 Project Management Services	$6,025.71	30%	$1,807.71	$7,833.42	
4.3 Client Representation	$602.57	30%	$180.77	$783.34	
Sub Total	$86,971.07	30%	$26,091.32	$113,062.39	0.5%
5.0 Construction					
5.1 Infrastructure - General	$390,000.00	30%	$117,000.00	$507,000.00	
5.2 Infrastructure - Environmental	$252,000.00	30%	$75,600.00	$327,600.00	
5.3 Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4 Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5 Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6 Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7 Infrastructure - Pavement	$8,750,000.00	30%	$2,625,000.00	$11,375,000.00	
5.8 Infrastructure - Structures	$2,200,000.00	30%	$660,000.00	$2,860,000.00	
5.9 Infrastructure - Local Roads/Intersections	$3,000,000.00	30%	$900,000.00	$3,900,000.00	
5.10 Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11 Infrastructure - Miscellaneous	$567,017.25	30%	$170,105.18	$737,122.43	
5.12 Infrastructure - Site Management	$75,795.09	30%	$22,738.53	$98,533.61	
5.13 Project Management Services	$757,950.86	30%	$227,385.26	$985,336.12	
5.14 Client Representation	$75,795.09	30%	$22,738.53	$98,533.61	
Sub Total	$16,068,558.29	30%	$4,820,567.49	$20,889,125.77	92.6%
6.0 Handover					
6.1 Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2 Project Data and Performance	$160,685.58	30%	$48,205.67	$208,891.26	
6.3 Project Management Services	$12,426.42	30%	$3,727.93	$16,154.34	
6.4 Client Representation	$1,242.64	30%	$372.79	$1,615.43	
Sub Total	$179,354.64	30%	$53,806.39	$233,161.04	1.0%
TOTAL ESTIMATE	**$17,353,352.57**	**30%**	**$5,206,005.77**	**$22,559,358.35**	**100.0%**

INDICATIVE COST ESTIMATE ($ million)	**$22.56**

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:
Assumptions
Option 2C Northern and Western Link Rds:

- 10.3 km Two Lane Road

- 1 major intersection
- Traffic Control at Intersections only

Item		Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0 Project Development						
1.1 Route/Concept/EIS/Reps Report		$680,784.02	30%	$204,235.21	$885,019.22	
1.2 Project Management Services		$51,058.80	30%	$15,317.64	$66,376.44	
1.3 Client Representation		$5,105.88	30%	$1,531.76	$6,637.64	
	Sub Total	$736,948.70	30%	$221,084.61	$958,033.31	2.0%
2.0 Investigation and Design						
2.1 Investigation and Design		$680,784.02	30%	$204,235.21	$885,019.22	
2.2 Project Management Services		$51,058.80	30%	$15,317.64	$66,376.44	
2.3 Client Representation		$5,105.88	30%	$1,531.76	$6,637.64	
	Sub Total	$736,948.70	30%	$221,084.61	$958,033.31	2.0%
3.0 Property Acquisitions						
3.1 Profesional Services for property		$20,468.00	30%	$6,140.40	$26,608.40	
3.2 Property Acquisition Costs		$292,400.00	30%	$87,720.00	$380,120.00	
3.3 Property Resale Credits		$0.00	30%	$0.00	$0.00	
3.4 Project Management Services		$21,930.00	30%	$6,579.00	$28,509.00	
3.5 Client Representation		$2,193.00	30%	$657.90	$2,850.90	
	Sub Total	$336,991.00	30%	$101,097.30	$438,088.30	0.9%
4.0 Public Utility Adjustments						
4.1 Utility Adjustments		$170,196.00	30%	$51,058.80	$221,254.81	
4.2 Project Management Services		$12,764.70	30%	$3,829.41	$16,594.11	
4.3 Client Representation		$1,276.47	30%	$382.94	$1,659.41	
	Sub Total	$184,237.17	30%	$55,271.15	$239,508.33	0.5%
5.0 Construction						
5.1 Infrastructure - General		$525,000.00	30%	$157,500.00	$682,500.00	
5.2 Infrastructure - Environmental		$741,600.00	30%	$222,480.00	$964,080.00	
5.3 Infrastructure - Noise Mitigation		$0.00	30%	$0.00	$0.00	
5.4 Infrastructure - Flood Mitigation		$0.00	30%	$0.00	$0.00	
5.5 Infrastructure - Earthworks		$0.00	30%	$0.00	$0.00	
5.6 Infrastructure - Drainage		$0.00	30%	$0.00	$0.00	
5.7 Infrastructure - Pavement		$25,750,000.00	30%	$7,725,000.00	$33,475,000.00	
5.8 Infrastructure - Structures		$30,000.00	30%	$9,000.00	$39,000.00	
5.9 Infrastructure - Local Roads/Intersections		$4,200,000.00	30%	$1,260,000.00	$5,460,000.00	
5.10 Infrastructure - Urban Design & Landscaping		$0.00	30%	$0.00	$0.00	
5.11 Infrastructure - Miscellaneous		$865,853.64	30%	$259,756.09	$1,125,609.73	
5.12 Infrastructure - Site Management		$160,562.27	30%	$48,168.68	$208,730.95	
5.13 Project Management Services		$1,605,622.68	30%	$481,686.80	$2,087,309.49	
5.14 Client Representation		$160,562.27	30%	$48,168.68	$208,730.95	
	Sub Total	$34,039,200.85	30%	$10,211,760.26	$44,250,961.11	93.5%
6.0 Handover						
6.1 Existing Signs		$5,000.00	30%	$1,500.00	$6,500.00	
6.2 Project Data and Performance		$340,392.01	30%	$102,117.60	$442,509.61	
6.3 Project Management Services		$25,904.40	30%	$7,771.32	$33,675.72	
6.4 Client Representation		$2,590.44	30%	$777.13	$3,367.57	
	Sub Total	$373,886.85	30%	$112,166.05	$486,052.90	1.0%
TOTAL ESTIMATE		**$36,408,213.28**	**30%**	**$10,922,463.98**	**$47,330,677.26**	**100.0%**

INDICATIVE COST ESTIMATE ($ million)	**$47.33**

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 2D Upgrade Wybong Rd from Bengalla Link Rd to Kayuga Road Assumptions:

- 9.7kms Two Lane Rural Road, 7m pavement, 1m gravel shoulde
- 2 minor intersections
-
- Traffic Control at intersections only

	Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0	**Project Development**					
1.1	Route/Concept/EIS/Reps Report	$194,043.49	30%	$58,213.05	$252,256.53	
1.2	Project Management Services	$14,553.26	30%	$4,365.98	$18,919.24	
1.3	Client Representation	$1,455.33	30%	$436.60	$1,891.92	
	Sub Total	$210,052.07	30%	$63,015.62	$273,067.70	2.0%
2.0	**Investigation and Design**					
2.1	Investigation and Design	$194,043.49	30%	$58,213.05	$252,256.53	
2.2	Project Management Services	$14,553.26	30%	$4,365.98	$18,919.24	
2.3	Client Representation	$1,455.33	30%	$436.60	$1,891.92	
	Sub Total	$210,052.07	30%	$63,015.62	$273,067.70	2.0%
3.0	**Property Acquisitions**					
3.1	Profesional Services for property	$0.00	30%	$0.00	$0.00	
3.2	Property Acquisition Costs	$0.00	30%	$0.00	$0.00	
3.3	Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4	Project Management Services	$0.00	30%	$0.00	$0.00	
3.5	Client Representation	$0.00	30%	$0.00	$0.00	
	Sub Total	$0.00	30%	$0.00	$0.00	0.0%
4.0	**Public Utility Adjustments**					
4.1	Utility Adjustments	$48,510.87	30%	$14,553.26	$63,064.13	
4.2	Project Management Services	$3,638.32	30%	$1,091.49	$4,729.81	
4.3	Client Representation	$363.83	30%	$109.15	$472.98	
	Sub Total	$52,513.02	30%	$15,753.91	$68,266.92	0.5%
5.0	**Construction**					
5.1	Infrastructure - General	$265,000.00	30%	$79,500.00	$344,500.00	
5.2	Infrastructure - Environmental	$698,400.00	30%	$209,520.00	$907,920.00	
5.3	Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4	Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5	Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6	Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7	Infrastructure - Pavement	$6,305,000.00	30%	$1,891,500.00	$8,196,500.00	
5.8	Infrastructure - Structures	$0.00	30%	$0.00	$0.00	
5.9	Infrastructure - Local Roads/Intersections	$1,700,000.00	30%	$510,000.00	$2,210,000.00	
5.10	Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11	Infrastructure - Miscellaneous	$184,594.61	30%	$55,378.38	$239,973.00	
5.12	Infrastructure - Site Management	$45,764.97	30%	$13,729.49	$59,494.46	
5.13	Project Management Services	$457,649.73	30%	$137,294.92	$594,944.65	
5.14	Client Representation	$45,764.97	30%	$13,729.49	$59,494.46	
	Sub Total	$9,702,174.29	30%	$2,910,652.29	$12,612,826.58	94.3%
6.0	**Handover**					
6.1	Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2	Project Data and Performance	$97,021.74	30%	$29,106.52	$126,128.27	
6.3	Project Management Services	$7,651.63	30%	$2,295.49	$9,947.12	
6.4	Client Representation	$765.16	30%	$229.55	$994.71	
	Sub Total	$110,438.54	30%	$33,131.56	$143,570.10	1.1%
	TOTAL ESTIMATE	**$10,285,229.99**	**30%**	**$3,085,569.00**	**$13,370,798.99**	**100.0%**
	INDICATIVE COST ESTIMATE ($ million)				**$13.37**	

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 3A Wybong Rd to Bengalla Link Rd

- 3.5 km Two Lane Road
- 1 Bridge Crossing - 40m bridge
- 1 major intersection
- Traffic Control at Intersection only

Item		Estimate ($) (excluding contingency)	Contingency		Estimate ($) (including contingency)	% of Total Estimate
			%	Amount ($)		
1.0	**Project Development**					
1.1	Route/Concept/EIS/Reps Report	$321,371.17	30%	$96,411.35	$417,782.52	
1.2	Project Management Services	$24,102.84	30%	$7,230.85	$31,333.69	
1.3	Client Representation	$2,410.28	30%	$723.09	$3,133.37	
	Sub Total	$347,884.29	30%	$104,365.29	$452,249.57	2.0%
2.0	**Investigation and Design**					
2.1	Investigation and Design	$321,371.17	30%	$96,411.35	$417,782.52	
2.2	Project Management Services	$24,102.84	30%	$7,230.85	$31,333.69	
2.3	Client Representation	$2,410.28	30%	$723.09	$3,133.37	
	Sub Total	$347,884.29	30%	$104,365.29	$452,249.57	2.0%
3.0	**Property Acquisitions**					
3.1	Profesional Services for property	$19,600.00	30%	$5,880.00	$25,480.00	
3.2	Property Acquisition Costs	$280,000.00	30%	$84,000.00	$364,000.00	
3.3	Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4	Project Management Services	$21,000.00	30%	$6,300.00	$27,300.00	
3.5	Client Representation	$2,100.00	30%	$630.00	$2,730.00	
	Sub Total	$322,700.00	30%	$96,810.00	$419,510.00	1.9%
4.0	**Public Utility Adjustments**					
4.1	Utility Adjustments	$80,342.79	30%	$24,102.84	$104,445.63	
4.2	Project Management Services	$6,025.71	30%	$1,807.71	$7,833.42	
4.3	Client Representation	$602.57	30%	$180.77	$783.34	
	Sub Total	$86,971.07	30%	$26,091.32	$113,062.39	0.5%
5.0	**Construction**					
5.1	Infrastructure - General	$390,000.00	30%	$117,000.00	$507,000.00	
5.2	Infrastructure - Environmental	$252,000.00	30%	$75,600.00	$327,600.00	
5.3	Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4	Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5	Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6	Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7	Infrastructure - Pavement	$8,750,000.00	30%	$2,625,000.00	$11,375,000.00	
5.8	Infrastructure - Structures	$2,200,000.00	30%	$660,000.00	$2,860,000.00	
5.9	Infrastructure - Local Roads/Intersections	$3,000,000.00	30%	$900,000.00	$3,900,000.00	
5.10	Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11	Infrastructure - Miscellaneous	$567,017.25	30%	$170,105.18	$737,122.43	
5.12	Infrastructure - Site Management	$75,795.09	30%	$22,738.53	$98,533.61	
5.13	Project Management Services	$757,950.86	30%	$227,385.26	$985,336.12	
5.14	Client Representation	$75,795.09	30%	$22,738.53	$98,533.61	
	Sub Total	$16,068,558.29	30%	$4,820,567.49	$20,889,125.77	92.6%
6.0	**Handover**					
6.1	Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2	Project Data and Performance	$160,685.58	30%	$48,205.67	$208,891.26	
6.3	Project Management Services	$12,426.42	30%	$3,727.93	$16,154.34	
6.4	Client Representation	$1,242.64	30%	$372.79	$1,615.43	
	Sub Total	$179,354.64	30%	$53,806.39	$233,161.04	1.0%
TOTAL ESTIMATE		**$17,353,352.57**	**30%**	**$5,206,005.77**	**$22,559,358.35**	**100.0%**
INDICATIVE COST ESTIMATE ($ million)					**$22.56**	

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:
Assumptions

Option 3B Northern and Western Link Rds:

- 10.3 km Two Lane Road
- 1 major intersection
- Traffic Control at Intersections only

	Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0	**Project Development**					
1.1	Route/Concept/EIS/Reps Report	$680,784.02	30%	$204,235.21	$885,019.22	
1.2	Project Management Services	$51,058.80	30%	$15,317.64	$66,376.44	
1.3	Client Representation	$5,105.88	30%	$1,531.76	$6,637.64	
	Sub Total	$736,948.70	30%	$221,084.61	$958,033.31	2.0%
2.0	**Investigation and Design**					
2.1	Investigation and Design	$680,784.02	30%	$204,235.21	$885,019.22	
2.2	Project Management Services	$51,058.80	30%	$15,317.64	$66,376.44	
2.3	Client Representation	$5,105.88	30%	$1,531.76	$6,637.64	
	Sub Total	$736,948.70	30%	$221,084.61	$958,033.31	2.0%
3.0	**Property Acquisitions**					
3.1	Profesional Services for property	$20,468.00	30%	$6,140.40	$26,608.40	
3.2	Property Acquisition Costs	$292,400.00	30%	$87,720.00	$380,120.00	
3.3	Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4	Project Management Services	$21,930.00	30%	$6,579.00	$28,509.00	
3.5	Client Representation	$2,193.00	30%	$657.90	$2,850.90	
	Sub Total	$336,991.00	30%	$101,097.30	$438,088.30	0.9%
4.0	**Public Utility Adjustments**					
4.1	Utility Adjustments	$170,196.00	30%	$51,058.80	$221,254.81	
4.2	Project Management Services	$12,764.70	30%	$3,829.41	$16,594.11	
4.3	Client Representation	$1,276.47	30%	$382.94	$1,659.41	
	Sub Total	$184,237.17	30%	$55,271.15	$239,508.33	0.5%
5.0	**Construction**					
5.1	Infrastructure - General	$525,000.00	30%	$157,500.00	$682,500.00	
5.2	Infrastructure - Environmental	$741,600.00	30%	$222,480.00	$964,080.00	
5.3	Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4	Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5	Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6	Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7	Infrastructure - Pavement	$25,750,000.00	30%	$7,725,000.00	$33,475,000.00	
5.8	Infrastructure - Structures	$30,000.00	30%	$9,000.00	$39,000.00	
5.9	Infrastructure - Local Roads/Intersections	$4,200,000.00	30%	$1,260,000.00	$5,460,000.00	
5.10	Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11	Infrastructure - Miscellaneous	$865,853.64	30%	$259,756.09	$1,125,609.73	
5.12	Infrastructure - Site Management	$160,562.27	30%	$48,168.68	$208,730.95	
5.13	Project Management Services	$1,605,622.68	30%	$481,686.80	$2,087,309.49	
5.14	Client Representation	$160,562.27	30%	$48,168.68	$208,730.95	
	Sub Total	$34,039,200.85	30%	$10,211,760.26	$44,250,961.11	93.5%
6.0	**Handover**					
6.1	Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2	Project Data and Performance	$340,392.01	30%	$102,117.60	$442,509.61	
6.3	Project Management Services	$25,904.40	30%	$7,771.32	$33,675.72	
6.4	Client Representation	$2,590.44	30%	$777.13	$3,367.57	
	Sub Total	$373,886.85	30%	$112,166.05	$486,052.90	1.0%
	TOTAL ESTIMATE	**$36,408,213.28**	**30%**	**$10,922,463.98**	**$47,330,677.26**	**100.0%**
	INDICATIVE COST ESTIMATE ($ million)				**$47.33**	

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 3C Upgrade Wybong Road (West) Assumptions:

- 13.5 km full upgrade of existing road
- 4 minor intersections
- 1 major intersections
- Traffic Control along the route
- Nil property acquisition

Item	Estimate ($) (excluding contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (including contingency)	% of Total Estimate
1.0 Project Development					
1.1 Route/Concept/EIS/Reps Report	$613,546.44	30%	$184,063.93	$797,610.37	
1.2 Project Management Services	$46,015.98	30%	$13,804.79	$59,820.78	
1.3 Client Representation	$4,601.60	30%	$1,380.48	$5,982.08	
Sub Total	$664,164.02	30%	$199,249.21	$863,413.23	2.0%
2.0 Investigation and Design					
2.1 Investigation and Design	$613,546.44	30%	$184,063.93	$797,610.37	
2.2 Project Management Services	$46,015.98	30%	$13,804.79	$59,820.78	
2.3 Client Representation	$4,601.60	30%	$1,380.48	$5,982.08	
Sub Total	$664,164.02	30%	$199,249.21	$863,413.23	2.0%
3.0 Property Acquisitions					
3.1 Profesional Services for property	$0.00	30%	$0.00	$0.00	
3.2 Property Acquisition Costs	$0.00	30%	$0.00	$0.00	
3.3 Property Resale Credits	$0.00	30%	$0.00	$0.00	
3.4 Project Management Services	$0.00	30%	$0.00	$0.00	
3.5 Client Representation	$0.00	30%	$0.00	$0.00	
Sub Total	$0.00	30%	$0.00	$0.00	0.0%
4.0 Public Utility Adjustments					
4.1 Utility Adjustments	$153,386.61	30%	$46,015.98	$199,402.59	
4.2 Project Management Services	$11,504.00	30%	$3,451.20	$14,955.19	
4.3 Client Representation	$1,150.40	30%	$345.12	$1,495.52	
Sub Total	$166,041.00	30%	$49,812.30	$215,853.31	0.5%
5.0 Construction					
5.1 Infrastructure - General	$4,590,000.00	30%	$1,377,000.00	$5,967,000.00	
5.2 Infrastructure - Environmental	$972,000.00	30%	$291,600.00	$1,263,600.00	
5.3 Infrastructure - Noise Mitigation	$0.00	30%	$0.00	$0.00	
5.4 Infrastructure - Flood Mitigation	$0.00	30%	$0.00	$0.00	
5.5 Infrastructure - Earthworks	$0.00	30%	$0.00	$0.00	
5.6 Infrastructure - Drainage	$0.00	30%	$0.00	$0.00	
5.7 Infrastructure - Pavement	$16,875,000.00	30%	$5,062,500.00	$21,937,500.00	
5.8 Infrastructure - Structures	$0.00	30%	$0.00	$0.00	
5.9 Infrastructure - Local Roads/Intersections	$4,800,000.00	30%	$1,440,000.00	$6,240,000.00	
5.10 Infrastructure - Urban Design & Landscaping	$0.00	30%	$0.00	$0.00	
5.11 Infrastructure - Miscellaneous	$1,703,869.75	30%	$511,160.93	$2,215,030.68	
5.12 Infrastructure - Site Management	$144,704.35	30%	$43,411.30	$188,115.65	
5.13 Project Management Services	$1,447,043.49	30%	$434,113.05	$1,881,156.53	
5.14 Client Representation	$144,704.35	30%	$43,411.30	$188,115.65	
Sub Total	$30,677,321.94	30%	$9,203,196.58	$39,880,518.52	94.4%
6.0 Handover					
6.1 Existing Signs	$5,000.00	30%	$1,500.00	$6,500.00	
6.2 Project Data and Performance	$306,773.22	30%	$92,031.97	$398,805.19	
6.3 Project Management Services	$23,382.99	30%	$7,014.90	$30,397.89	
6.4 Client Representation	$2,338.30	30%	$701.49	$3,039.79	
Sub Total	$337,494.51	30%	$101,248.35	$438,742.86	1.0%
TOTAL ESTIMATE	**$32,509,185.49**	**30%**	**$9,752,755.65**	**$42,261,941.14**	**100.0%**

INDICATIVE COST ESTIMATE ($ million)	**$42.26**

MUSWELLBROOK MINE AFFECTED ROAD NETWORK

SUMMARY OF COSTS:

Option 3D Upgrade Reedy Creek Road Assumptions:

- 1.4kms full upgrade of existing road
- 1 minor intersection
- 1 major intersections
- Traffic Control along the route
- Nil property acquisition

Item		Estimate ($) (excluding contingency)	Contingency		Estimate ($) (including contingency)	% of Total Estimate
			%	Amount ($)		
1.0 Project Development						
1.1 Route/Concept/EIS/Reps Report		$165,846.52	30%	$49,753.96	$215,600.47	
1.2 Project Management Services		$12,438.49	30%	$3,731.55	$16,170.04	
1.3 Client Representation		$1,243.85	30%	$373.15	$1,617.00	
	Sub Total	$179,528.85	30%	$53,858.66	$233,387.51	2.0%
2.0 Investigation and Design						
2.1 Investigation and Design		$165,846.52	30%	$49,753.96	$215,600.47	
2.2 Project Management Services		$12,438.49	30%	$3,731.55	$16,170.04	
2.3 Client Representation		$1,243.85	30%	$373.15	$1,617.00	
	Sub Total	$179,528.85	30%	$53,858.66	$233,387.51	2.0%
3.0 Property Acquisitions						
3.1 Profesional Services for property		$0.00	30%	$0.00	$0.00	
3.2 Property Acquisition Costs		$0.00	30%	$0.00	$0.00	
3.3 Property Resale Credits		$0.00	30%	$0.00	$0.00	
3.4 Project Management Services		$0.00	30%	$0.00	$0.00	
3.5 Client Representation		$0.00	30%	$0.00	$0.00	
	Sub Total	$0.00	30%	$0.00	$0.00	0.0%
4.0 Public Utility Adjustments						
4.1 Utility Adjustments		$41,461.63	30%	$12,438.49	$53,900.12	
4.2 Project Management Services		$3,109.62	30%	$932.89	$4,042.51	
4.3 Client Representation		$310.96	30%	$93.29	$404.25	
	Sub Total	$44,882.21	30%	$13,464.66	$58,346.88	0.5%
5.0 Construction						
5.1 Infrastructure - General		$700,000.00	30%	$210,000.00	$910,000.00	
5.2 Infrastructure - Environmental		$100,800.00	30%	$30,240.00	$131,040.00	
5.3 Infrastructure - Noise Mitigation		$0.00	30%	$0.00	$0.00	
5.4 Infrastructure - Flood Mitigation		$0.00	30%	$0.00	$0.00	
5.5 Infrastructure - Earthworks		$0.00	30%	$0.00	$0.00	
5.6 Infrastructure - Drainage		$0.00	30%	$0.00	$0.00	
5.7 Infrastructure - Pavement		$2,450,000.00	30%	$735,000.00	$3,185,000.00	
5.8 Infrastructure - Structures		$0.00	30%	$0.00	$0.00	
5.9 Infrastructure - Local Roads/Intersections		$4,200,000.00	30%	$1,260,000.00	$5,460,000.00	
5.10 Infrastructure - Urban Design & Landscaping		$0.00	30%	$0.00	$0.00	
5.11 Infrastructure - Miscellaneous		$372,148.90	30%	$111,644.67	$483,793.57	
5.12 Infrastructure - Site Management		$39,114.74	30%	$11,734.42	$50,849.17	
5.13 Project Management Services		$391,147.45	30%	$117,344.23	$508,491.68	
5.14 Client Representation		$39,114.74	30%	$11,734.42	$50,849.17	
	Sub Total	$8,292,325.83	30%	$2,487,697.75	$10,780,023.58	94.3%
6.0 Handover						
6.1 Existing Signs		$5,000.00	30%	$1,500.00	$6,500.00	
6.2 Project Data and Performance		$82,923.26	30%	$24,876.98	$107,800.24	
6.3 Project Management Services		$6,594.24	30%	$1,978.27	$8,572.52	
6.4 Client Representation		$659.42	30%	$197.83	$857.25	
	Sub Total	$95,176.93	30%	$28,553.08	$123,730.01	1.1%
TOTAL ESTIMATE		**$8,791,442.68**	**30%**	**$2,637,432.81**	**$11,428,875.49**	**100.0%**

INDICATIVE COST ESTIMATE ($ million)	**$11.43**

muswellbrook shire council

Enquiries
Please ask for
Direct
Our reference
Your reference

10 July 2018

Attention: Commissioners
Independent Planning Commission
Level 3, 201 Elizabeth Street
SYDNEY NSW 2000

Dear Commissioners,

Mt Pleasant Coal Mine Modification 3 – Written Submissions

Council refers to the above matter and to the meeting between the Independent Planning Commission (**IPC**) and Muswellbrook Shire Council representatives on 3 July 2018.

Council wishes to thank the members of the IPC and staff for their time on that date and for the opportunity to make the written submissions herein.

1. Extension of Mine Life in the Absence of a New State-Significant Development Application

1.1 The Applicant seeks to modify the conditions of a development application (DA 92/97) originally granted in 1999. Council notes that the Environmental Impact Statement, which formed the basis on which the consent was originally granted, was prepared in 1997.

1.2 Council submits that, when the development application was granted development consent, other mining operations within the Muswellbrook Local Government Area (**LGA**) were not contemplated. Such operations include the Mt Arthur consolidation extension and expansion, the Bengalla expansion and extension and the Mangoola mine expansion and extension. It also contemplated mining operations that were approved and were idled prematurely – such as the Dartbrook operation.

1.3 There is almost no similarity between the original project approval and the modified consolidated consent and extension now sought by Mt Pleasant. That part of the project that relates to an extension of the existing project approval should, for that reason, be refused and the applicant should seek that part of the project application by fresh SSD application.

1.4 In the alternative, Council submits that the IPC should impose a pre-condition to the consent to the effect that should the Applicant not submit a fresh SSD application within two (2) years (as the application has informally undertaken to do) the development consent lapses.

2. Thomas Mitchell Drive Contributions Study

2.1 The draft conditions proposed by the Department include a condition with respect to the use of the community's local road, Thomas Mitchell Drive. That condition essentially requires the Applicant to make the contribution required to be made in Council's Contributions Study (as amended). There is, however, no present requirement for Mt Pleasant to make any contribution under that Study.

2.2 That is because the Contributions Study, referred to in the consent, was predicated on the basis it would need to be reviewed if Mt Pleasant proceeded or if any of the assumptions of the plan significantly changed. One such significant change has already occurred in that the Drayton South mine has not proceeded as proposed.

2.3 In Council's submission, road impacts, both safety and financial impacts, are a fundamental part of the assessment process. In Council's submission it is not appropriate for the IPC to delegate the making of that assessment as an afterthought. The safety of mineworkers and the community on roads impacted upon by the development should be front and centre of the approvals process.

2.4 Council notes that the Contributions Study is presently underfunded as a result of the decision in relation to Drayton South by approximately $1,450,000. Council has provided bridging finance of approximately $450,000 to underwrite part of the expected mining contributions because of the need to construct the road in discrete stages.

2.5 It is Council's submission that, as a result of the foregoing, the Contributions Study must be reviewed and that the Applicant must bear the reasonable cost of such review.

2.6 To this end, Council proposes that a new condition of consent be inserted in the event that the IPC is minded to grant consent to the application notwithstanding the inadequacy of the present assessment insofar as traffic impact is concerned. The proposed condition is set out in the Minute.

3. Mining Affected Road Network Strategy

3.1 Council respectfully submits that the proposed conditions of consent and the Environmental Assessment Report do not consider Council's Mining Affected Roads - Road Network Plan (the **Plan**).

3.2 Condition 38(c) of the conditions of consent refer to "Council's Western Roads Strategy".

3.3 The Western Roads Strategy has been superseded by the Plan. The Western Roads Strategy underpinned almost all the traffic management arrangements originally assessed for the mine site. Key aspects of the Plan involve the Mt Pleasant mine.

3.4 The Applicant should pay for the Plan to be reviewed and for any upgrades necessitated by its impact on Council's roads infrastructure.

3.5 Council submits that it would be unreasonable for the broader community to bear the cost of road maintenance, repair and upgrade due to the Applicant's impact on the same in the course of its operation of the mine.

3.6 For these reasons, Council submits that the IPC include a condition to the effect of that proposed in the Minute.

4. Rehabilitation Standards & Objectives

4.1 Council submits that the consent conditions as currently drafted provide the Department with total discretion as to the Applicant's rehabilitation of the site.

4.2 Council relies on conditions 53-56 inclusive in that regard which impose obligations on the Applicant to rehabilitate the site in accordance with broad objectives and to prepare and implement a rehabilitation strategy and rehabilitation management plan to the satisfaction of the Department. The clauses refer to the satisfaction of the Secretary or the DRG.

4.3 Consequently, the conditions of consent are silent as to the standards the Applicant must meet in order to acquit its rehabilitation obligations.

4.4 Council submits that this would be extraordinary and is without precedent. It essentially relegates important issues around long-term rehabilitation and remediation to being second-class considerations. In Council's submission, the Parliament intended matters concerning environmental impacts, including remediation and rehabilitation, to be given equal weight to economic and social considerations. In Council's view, the IPC should set minimum standards consistent with best practice which might be improved upon in subordinate documents – including the Rehabilitation Strategy.

4.5 The town of Muswellbrook is the largest town in Australia to be entirely surrounded by mining operations – most of them large scale open cut operations. Final landforms and voids will impact the community in perpetuity and as such, are of particular significance to the community, its identity, its liveability, and its amenity. Council objects to the condition as presently proposed and notes it would be a remarkable departure from past best practice and set a troubling precedent for the future.

4.6 Council considers that, on the basis of the above, the IPC should set at least minimum standards and objectives and that improved design principles need to be included as a component of the revised consent to provide clarity to the community and with adequate detail should assessment against compliance be needed in the future.

4.7 To these ends, Council submits that the conditions of consent proposed in the Minute be included by the IPC if it assesses the application in the affirmative.

Definition of Natural Micro-Relief

4.8 The insertion of a definition of the term "natural micro-relief" is central to Council's proposed submissions and conditions of consent in respect of the rehabilitation standards and objectives of the development.

4.9 Council respectfully submits that, in the absence of a definition of the term "natural micro-relief", there is significant scope for ambiguity as to the measures that must be taken and the standards required to be met by the Applicant for it to discharge its obligations. That ambiguity has given and, in Council's submission, will continue to give, rise to litigation between Council, mining operations and the State Government.

4.10 A definition of the term "natural micro-relief" is essential for certainty and for assessing compliance with the relevant conditions of consent and enforcing compliance with same if necessary.

4.11 Consequently, Council proposes that the definition proposed in the Minute be inserted into the conditions of consent should the IPC grant approval for the development.

5. Air Quality & Dust

5.1 It is Council's submission that this project, if approved, will have significant impacts on the air quality of the LGA.

5.2 The key distinguishing feature of the proposed development in respect of other mines in the Muswellbrook Shire is that Mt Pleasant is located in the wind corridor directly upwind of the Muswellbrook township. Council joins in the submission from the Department of Health with respect to these issues.

5.3 As you are aware, there are generally conditions in mining consents requiring that all feasible and reasonable mitigation and avoidance measures are taken to ensure that dust emissions from the development do not exceed particular levels. These levels are typically averaged over a 24 hour period. Such a condition appears at condition 20 of the proposed conditions of consent to the development.

5.4 Council's view is that the 24 hour averaging period has the unintended consequence of obscuring issues of elevated dust levels at night as a result of surface temperature inversions. Council submits that the result of these inversions is to trap dust emitted from this and other mining developments in the Shire for sustained periods which, taken in isolation, are above the relevant standards or putative standards.

5.5 This causes the level of dust in the air to increase substantially at night, which is in turn obscured by the lower levels of dust in the air during the day. Consequently, the average over a 24 hour period does not result in a technical exceedance.

5.6 In the past, Council has submitted that air quality conditions of consent be predicated upon the differing levels of concentration of particulate matter in the air during the day and night respectively.

5.7 However, Council acknowledges that there is arguably insufficient empirical evidence as to the effect on human health of exposure to elevated levels of dust at night.

5.8 In light of this, Council submits that the IPC, if it is minded to approve the application, include a condition of consent which requires the applicant to provide, at its cost, a study into the effects to human health of exposure to night-time dust levels in the Upper Hunter. Council's proposed condition of consent in this regard is set out in the Minute.

5.9 This research is essential to improving the understanding of the consequences to human health, particularly respiratory and cardiovascular health, of exposure to night-time dust levels generated by mining. This research will inform efforts to promote the health of members of the community.

Your consideration of Council's submission and proposed conditions of consent is appreciated.

Yours faithfully

[redacted]

Fiona Plesman
GENERAL MANAGER

muswellbrook shire council

MT PLEASANT COAL MINE MODIFICATION 3

APPLICATION NUMBER: DA 92/97 MOD 3

MINUTE OF PROPOSED AMENDMENTS

DEFINITIONS

Natural micro-relief	Engineered micro-relief that emulates pre-mining small-scale topography variation encountered on surrounding pre-mining disturbance landforms.

SCHEDULE 3
ENVIRONMENTAL CONDITIONS – GENERAL

Air Quality Operating Conditions

"22. The Applicant must:

(a) implement best practice air quality management, including all reasonable and feasible measures to minimise the odour, fume and dust emissions of the development;

(b) minimise visible air pollution generated by the development;

(c) minimise, where reasonable and feasible, the extent of potential dust generating surfaces exposed on the site at any given point in time;

(d) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see Noted above under Tables 8-10);

(e) regularly assess the real-time air quality monitoring and meteorological forecasting data and relocate, modify and/or stop operations on site to ensure compliance with the relevant conditions of this consent; and

(f) co-ordinate the air quality management on site with the air quality management at nearby mines (including the Bengalla mine) to minimise cumulative air quality impacts from the mines,

(g) Utilise fixed and mobile cameras to monitor and manage visible air pollution.

to the satisfaction of the Secretary."

Air Quality and Greenhouse Gas Management Plan

"23. The Applicant must prepare an Air Quality and Greenhouse Gas Management Plan for the development to the satisfaction of the Secretary. This plan must:
(a) be submitted to the Secretary for approval prior to carrying out any development on site;
(b) describe the measures that would be implemented to ensure compliance with the relevant conditions of this consent, including a real-time air quality management system that employs reactive and proactive mitigation measures;
(c) include an air quality monitoring program that:
- uses a combination of real-time monitors and supplementary monitors to evaluate the performance of the development;
- includes PM2.5 monitoring (although this obligation could be satisfied by the regional air quality monitoring network if sufficient justification is provided);
- includes a protocol for determining exceedances of the relevant conditions of this consent; and

(d) include a protocol that has been prepared in consultation with the owners of nearby mines to minimise the cumulative air quality impacts of the mines.
(e) include a real time Air Quality Monitor on the north western perimeter of the mine site.

The Applicant must implement the approved management plan as approved from time to time by the Secretary."

"**Dust Study**

24A. Within twelve (12) months after the date on which consent is granted, the Applicant will, at its sole expense, fund a study (such study to be conducted by an appropriately qualified professional selected by the Chief Executive Officer of the Hunter New England Area Health Service) into the effects on human health of exposure to night-time dust levels in the Upper Hunter. The study must include:
(a) as large a sample size of the population of the Singleton and Muswellbrook Shire local government area townships as reasonably necessary to produce statistically relevant results;
(b) a comparison of emissions of particulate matter for the duration of the study clearly displaying averages of daytime and night-time dust levels;
(c) a detailed report and analysis of the effects to human health, particularly respiratory and cardiovascular health, of exposure to night-time dust levels;

to the satisfaction of the Chief Executive Officer of the Hunter New England Area Health Service."

Thomas Mitchell Drive

"41AA. The Applicant must pay the reasonable costs incurred by Council in reviewing the Thomas Mitchell Drive Contributions Study as it relates to or is impacted upon by the development."

Review of the Mining Affected Road Network Plan and Contributions

"41B. The Applicant must pay the reasonable costs incurred by Council in:
(a) Reviewing the Mining Affected Road Network Plan as it relates to or is impacted upon by the project;

(b) Designing a link road, in accordance with Council's Mining Affected Road Network Strategy from Denman Road to the New England Highway north of Muswellbrook.

41C. The Applicant pay the contribution, reasonably assessed to be payable pursuant to the Council's Resourcing Strategy for the Funding of Mining Affected Roads as amended from time to time or other funding or resource strategy approved by Council from time-to-time, for the construction, renewal, upgrade or maintenance of road infrastructure."

Rehabilitation Strategy

54. Prior to commencing any development on the site, the Applicant must prepare a Rehabilitation Strategy for the development to the satisfaction of the Secretary. This strategy must:

(a) be prepared in consultation with relevant stakeholders, including DRG, DoI Water, Council and the CCC;
(b) investigate options for the future use of the site upon the completion of mining and detail the measures to achieve and test these outcomes;
(c) describe and justify the proposed rehabilitation strategy for the site; and
(d) define the rehabilitation objectives for the area, as well as the proposed completion criteria for this rehabilitation.
(e) include plans for progressive rehabilitation and final landforms across the whole of the site with both macro-relief and natural micro-relief, and in sufficient detail in the descriptions to guide enforcement implementation requirements;
(f) include an outline of the closure objectives of the site and details of the measures by which the objectives will be progressively implemented to maximise early relinquishment of land no longer needed for mining purposes; and
(g) include an outline of the available and preferred options for a final void(s) for both the end of the Consent period and for the probable end of mine life. The outline must include details on void shape, depth and volume and the measures by which the design will minimise the size and volume of voids and optimise shape and the viable land use options for the final void(s) post mine closure.

The Applicant must implement the approved strategy as approved from time to time by the Secretary.

Closure Plan

54A. The Applicant shall prepare a Closure Plan to the satisfaction of the Secretary. The plan must:
(a) be prepared in consultation with Council;
(b) provide indicative post-mining land uses proposed for the mining land;
(c) a plan showing the topographic features of the completed landforms;
(d) provide a program that indicates what criteria will be used to assess land against for its early release for post-mining land uses;
(e) provide an indicative time table for the early release of land for post-mining land uses;
(f) provide an indication of potential employment generating developments that will be compatible with the completed landforms and sympathetic with existing

developments and maximise, to the extent possible, the labour intensity of post-mining land uses;

(g) describe what services are planned to be provided or available for the land, post-mining. This should include, but not limited to, the provision of:

I. Access, with the indicative location of existing and new roads;
II. Water, power and phone supplies;
III. Fencing based on land capability;
IV. An indication of lot layout;
IV. An indication of future limitations of the land for buildings and other built structures; and

(h) provide for regular reviews of the Closure Plan at reasonable intervals.