WAMBO DEVELOPMENT PROJECT

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Noise and Blasting Assessment

RHA REPORT 10-2470-R1
Revision 2

Wambo Development Project Construction, Operating and Transportation Noise and Blasting Impact Assessment

Prepared for

Wambo Coal Pty Limited
Jerrys Plains Road
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23 June 2003

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Wambo Development Project
Construction, Operating and Transportation Noise and Blasting Impact Assessment

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This document has been prepared in accordance with the requirements of that System.

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1 INTRODUCTION

1.1 Assessment Requirements

Wambo Coal Pty Limited (WCPL) operates the existing Wambo Coal Mine (WCM) utilising open-cut mining methods with on-site processing to produce up to 3 million tonnes per annum (Mtpa) of saleable coal in accordance with Development Consent DA108/91 dated February 1992 and subsequent amendments. The WCM is located approximately 15 km west of Singleton, NSW near the village of Warkworth.

WCPL now proposes to increase open-cut and resume underground operations to extract up to 14.7 Mtpa of ROM coal processed through a two module Coal Handling and Preparation Plant (CHPP) with nominal capacity of 1,800 tonnes per hour (tph). Up to 11.3 Mtpa of product coal would be transported off-site by rail. The anticipated open-cut mine life is approximately 13 years and the underground operational mine life is in excess of 21 years.

Richard Heggie Associates Pty Ltd (RHA) has been engaged by WCPL to assess the noise and vibration impact associated with the Wambo Development Project (the Project).

This assessment has been guided by PlanningNSW Director General's Requirements (reference S02/02197) attached as **Appendix A1**, which includes the NSW Environment Protection Authority (EPA's) Requirements for Preparation of an EIS dated 19 December 2002, Singleton Shire Councils (SSC) Requirements for Preparation of an EIS dated 20 December 2002 as well as community submissions.

The major sources of noise and vibration emissions from the Project may be grouped in six distinct areas as described below for the purposes of noise and vibration impact assessment. The estimated timing of the Project activities described for each of these assessment areas is based on the planned development schedule. The actual timing of each activity would be based on actual mine production and progression.

On-Site Construction Noise

Construction Years 1 to 2: Existing (approved) mining operations are scheduled to coincide with the CHPP upgrade, rail spur/loop and train loading system daytime construction activities at the commencement of Year 2.

Box-Cut Extension: The Wollemi box-cut extension will utilise existing mining equipment commencing in Year 2.

On-Site Operating Noise

Operation Year 2: Representative of the nearest open-cut operations (with increased production) to Warkworth Village including Whybrow Seam underground, CHPP and train loading system operation (with train movement).

Operation Year 7: Representative of the nearest open-cut operations to Jerrys Plains village including Wambo Seam and Arrowfield Seam underground, CHPP and train loading system operations (with train movement).

Operation Year 9: Representative of the nearest open-cut operations to Bulga village including Wambo Seam and Arrowfield Seam underground, CHPP and train loading system operations (with train movement).

The above operating year scenarios utilised for noise modelling purposes are based on current open-cut mine planning. Should actual mine progression differ from the plan, then the predicted noise emissions and potential impacts for a given year may actually occur at a different time in the mine life.

On-Site Blast Emissions

Construction Years 4 to 5: Underground blasting to establish the Wambo Seam and Arrowfield/Bowfield Seam access drifts over an 18 month period.

Operation Years 1 to 14: Open-cut overburden blasting. Minor excavation blasting is also required to extend the Wollemi box-cut to provide access to the Whybrow Seam commencing in Year 2.

On-Site Operating Vibration

Operation Years 2 to 21: Representative of the nearest train movements along the rail spur and loop to Warkworth Village.

Off-Site Transportation Noise

Employee and Materials Road Traffic: Vehicle movements along on public roads in the vicinity of the site during Project construction and operation.

Product Coal Road Traffic: Product Coal is currently transported to the Mount Thorley Coal Loader (MTCL) under the existing consent. No increase in the 3 Mtpa road haulage is proposed, hence no further noise assessment is required. Moreover, product coal road transport will cease at the end of Year 2, after the construction of the rail spur and loop.

Product Coal Rail Traffic: The Project rail spur utilises sections of the previously consented rail spur (DA 235/97) and the Jerrys Plains Coal Terminal which awaits consent. No increase in the rail haulage above the consent limits is proposed; hence no further noise assessment is required.

Cumulative Mine Noise Effects

Cumulative Mine Operations: Review of existing and approved mines in the vicinity of the Project site.

1.2 Approval Requirements

Approved Wambo Coal Mine (WCM)

The existing WCM has consent to operate (with respect to noise and vibration emissions) in accordance with the following approvals:

- Singleton Shire Council Development Consent DA108/91 dated 17 February 1992 and Amendment dated 21 December 1998.
- Singleton Shire Council Development Consent DA 58/98 dated 17 July 1998.
- Singleton Shire Council Development Consent DA 239/97 dated 30 March 1998.
- EPA Environment Protection Licence (EPL) No 529 Review date 1 July 2002.

Proposed Wambo Development Project

The Project involves the continued development of open-cut and underground operations, and the construction of rail infrastructure to enable the direct rail of product coal to the Port of Newcastle. As shown on the Project Plan (**Appendix A2**) the proposed development would include:

- Continued development of open-cut mining operations within existing WCPL mining and coal leases and into MLA1 to the north-west and MLA2 within CL743.
- Selective auger mining of the Whybrow, Redbank Creek, Wambo and Whynot Seams up to 200 m beyond the open cut limits within WCPL owned land.

- Continued placement of waste rock and coarse rejects within mine waste rock emplacements.
- Placement of tailings within open-cut voids and capping with waste rock and coarse rejects.
- An extension to the existing Wollemi box-cut (within the limits of the proposed open-cut mining area) to provide direct access for three underground longwall panels in the Whybrow Seam.
- Underground mining of the Whybrow, Wambo, Arrowfield and Bowfield Seams.
- Upgrade of the existing CHPP to facilitate increased coal production.
- Development of a water control structure across North Wambo Creek at the north-western limit of the open-cut operation and a channel to allow the passage of flows to the lower reaches of North Wambo Creek around the open-cut development.
- Construction and operation of a rail spur, rail loop and train loading system to enable the transport of product coal by rail to market.
- Construction of a rail spur underpass beneath the Golden Highway.
- Realignment of the intersection between Wallaby Scrub Road and the Golden Highway.
- De-gazettal and physical closure of Pinegrove Road.
- Development of new access roads and internal haul roads, and
- Relocation of the administration area and site offices.

The Project hours of operation are presented in **Table 1.2.1**.

Table 1.2.1 Project Hours of Operation

Development	Construction		Operation
	Duration	Period	Period
Train Loading System	12 months	Generally daytime hours up to seven days per week	24 hours 7 days per week
Rail Spur/Loop	6 months		
CHPP	6 months		
Open-Cut Mining Box-Cut Extension	N/A		
Surface Blasting	Underground Access 0900 hours to 1700 hours Monday to Saturday[1]		Open-cut Overburden Box-Cut Extension 0900 hours to 1700 hours Monday to Saturday[1]
Underground Blasting	18 months	24 hours 7 days per week	N/A
Road Traffic (Employee & Materials)	Surface Works 0700 hours to 1800 hours - Monday to Friday 0800 hours to 1300 hours - Saturday Underground Works 24 hours 7 days per week		24 hours 7 days per week

Note 1: Surface blasting may be conducted outside of these periods in accordance with the applicable blast emission assessment criteria provided in the EPA's *Environmental Noise Control Manual* 1994 (see Table 6.1.2).

1.3 Noise and Vibration Assessment Procedures

The NSW EPA has regulatory responsibility for the control of noise from "scheduled premises" under the Protection of the Environment Operations Act 1997. In implementing the NSW Industrial Noise Policy (INP) 2000, the EPA has two broad objectives.

- Controlling intrusive noise impacts in the short term.
- Maintaining noise level amenity for particular land uses over the medium to long-term.

On-Site Construction Noise Emissions

The assessment of impact from on-site construction works remains according to the EPA's Environmental Noise Control Manual (ENCM) 1994 Chapter 171 Noise Control Guideline - Construction Site Noise.

On-Site Operating Noise Emissions

The NSW INP (2000) provides non-mandatory procedures for setting acceptable $L_{Aeq(15minute)}$ intrusive (and $L_{Aeq(period)}$) amenity noise levels for various receiver areas and guidelines for assessing noise impacts from on-site noise sources.

The assessment of sleep arousal from on-site operations remains according to the EPA's ENCM 1994 Chapter 19 – Noise Quality Objectives where the $L_{A1(60sec)}$ noise level from any specific noise source should not exceed the background noise level by more than 15 dBA.

On-Site Blast Emissions

Australian Standard AS 2187.2 1993 "*Explosives Storage, Transport and Use – Part 2: Use of Explosives*" provides guideline criteria for evaluating the effects of transient blast emissions on structures.

The NSW EPA currently adopts the Australia and New Zealand Environment Council Committee (ANZECC) "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration" dated September 1990 for assessing potential annoyance from blast emissions during daytime hours.

The assessment of blast emission impacts outside the hours advocated by ANZECC remains according to the EPA's Environmental Noise Control Manual (ENCM) 1994 Chapter 154 Noise Control Guideline – Blasting.

On-Site Operating Vibration Emissions

German Standard DIN 4150-3 1999 "*Structural Vibration Part 3: Effects of Vibration on Structures*" provides guideline criteria for evaluating the long-term effects of vibration on structures.

Off-Site Road Traffic Noise Emissions

The NSW EPA Environmental Criteria for Road Traffic Noise (1999) provides non-mandatory procedures for setting acceptable L_{Aeq} noise levels on arterial, collector and local roads and guidelines for assessing noise impacts from off-site road traffic.

Cumulative Mine Noise Emissions

The NSW INP (2000) also provides non-mandatory cumulative noise assessment guidelines that address existing and successive industrial development by setting acceptable (and maximum) cumulative $L_{Aeq(period)}$ amenity levels for all industrial (ie non-transport related) noise in an area. Note, the INP does not set acceptable cumulative $L_{Aeq(15minute)}$ intrusive criteria for all industrial noise sources in an area, but rather seeks to control cumulative noise via its amenity criteria.

2 PROJECT OVERVIEW

2.1 Land Ownership

The Land Ownership Plan (**Appendix B1)** identifies the nearest potentially affected dwellings beyond the proposed mine lease as summarised in **Table 2.1.1**.

Table 2.1.1 Nearest Potentially Affected Land Owners - Dwellings and Vacant Land

General Locality	Reference/ Land Owner	LEP Zoning	NSW INP (2000) Noise Amenity Area	ENM Dwelling Coordinates[1]		
				East (m)	North (m)	Elevation (m)
Wambo Road	WA Wambo Coal Pty Limited	1A Rural	Rural	13475	17025	70
	WB Wambo Coal Pty Limited			13875	17100	60
	WC Wambo Coal Pty Limited			13925	16950	60
	1 KM & CM Brosi			10960	13850	90
	2 W & D Lambkin			14700	13070	70
	3 HM Birrell			14800	12800	70
	4(B) IF & MA Circosta			14690	12490	70
	5 DS & DL Strachan			14750	12250	60
	6 HD Merrick			15000	12175	60
	7 DC & EM Maizey			14408	12057	80
	9 H Upward			Vacant 1and		
	25 RW Fenwick & AM Frost			11610	14210	83
	35 GJ Brosi			10230	13850	90
	63 Abrocuff Pty Ltd			14778	11830	70
	91 CL Bailey			14305	11895	89
	178 KJ & NL Smith			15085	11115	70
	246 RG & FS Bailey			14655	11571	70
Wallaby Scrub Road	8(A) Warkworth Mining Limited	1A Rural	Suburban	15290	13270	64
	8(B) Warkworth Mining Limited			17140	16330	110
	8(C,D,E) Warkworth Mining Limited			17440	15070	101
	8(G,F,H) Warkworth Mining Limited			17708	13814	85
Warkworth Village	WD Wambo Coal Pty Limited	1A Rural	Suburban	15840	19540	62
	WE Wambo Coal Pty Limited			15760	18930	60
	WF Wambo Coal Pty Limited			16230	18870	60
	11(E) Coal & Allied Pty Ltd			16010	19190	60
	14 S & J Keys			Vacant land		
	19(B,A) L Kelly			15810	18740	60
	20 Jerrys Plains Coal Terminal			15840	19170	60
	21(B) Coal & Allied			16670	19420	60
	21(A) Coal & Allied			16160	18730	60
	22 OJ Henderson			17270	18240	80
	23 HE Kannar			Vacant land		
	23(A) HE Kannar			16020	19030	60
	23(B) HE Kannar			16140	19150	60
	51 CM Hawkes Pty Ltd			15830	17360	60
	55 E & C Burley			Vacant land		
	56 K & L Haynes			16350	18660	65
	St Philips Anglican Church (Internal)		Place of Worship	16530	18530	65
	St Philips Anglican Church (External)		Passive/Active Recreation Area	16530	18530	65
Gouldsville	11(G) Coal & Allied Pty Ltd	1A Rural	Suburban	21810	18980	65
	23(C) H Kannar			20250	18250	65
Maison Dieu	11(F) Coal & Allied Pty Ltd	1A Rural	Suburban	18075	21800	60
	94 Curlewis Pastoral			19680	22035	80
	136 GJ & JG Ernst			Vacant land		
	254 RJ Algie			Vacant land		
	254(A) RJ Algie			19770	21620	79

Note 1: To convert to ISG coordinates add 286,000 m E and add 1,376,000 m N.

Table 2.1.1 Nearest Potentially Affected Land Owners - Dwellings and Vacant Land (Cont'd)

Locality	Reference/ Land Owner	LEP Zoning	NSW INP (2000) Noise Amenity Area	ENM Dwelling Coordinates[1]		
				East (m)	North (m)	Elevation (m)
Redmanvale/ Pinegrove Roads	13(C) DR Skinner	1A Rural	Rural	7734	20439	122
	15(B) L McGowen & AJ Caslick			6500	23400	124
	24 AJ Long			8589	19836	122
	30 CE & CN Williams			5890	23600	110
	33 DJ Thelander & JA O'Niell			6280	23990	129
	37 IA & JE Lawry			6468	23616	110
	45 R & PK Mansfield			Vacant land		
	46 RJ &CC Ball			Vacant land		
	48 SJL & LL Ponder			6130	23300	115
	49 WB & TM Oliver			5690	23550	113
	75 BA Barnes			5330	23350	125
	137 CW & K Woodruff			5370	23690	120
	163 JA Rodger & CM Williams			5156	23200	130
	188 LA & GI Fuller			4826	23520	135
Golden Highway	13B DR Skinner	1A Rural	Suburban	6986	25969	80
	16 MR & CE Cooper			7680	24480	102
	17 J & HJ Carter			7590	24710	88
	18 GJ Denney			7510	24000	90
	26 Amarina Systems			Vacant land		
	27 Birralee Feeds Pty Ltd			7420	25070	90
	28 C & M Garland			Vacant land		
	28(B,A) C & M Garland			7900	24370	80
	31(A,B,C,D) CM Fisher			8830	23560	98
	39 K & DL Northcote			7530	24260	140
	40 KM Muller			7720	24170	100
	43 ME & CM Carmody			7510	25060	80
	42 LM Redman			Vacant land		
	44 MR Skinner			6950	26030	80
	45 R & PIC Mansfield			Vacant land		
	46 RJ & CC Ball			Vacant land		
	50(B,A) WM, RF, RJ & RJ Nowland			7210	25530	80
	54 PW & BW Nichols			Vacant land		
	95 CW & RM Gee			Vacant land		
	262(A) RW Moses			8743	26615	158
	262(B) RW Moses			8759	26520	153
	262(C) RW Moses			8789	25772	105

Note 1: To convert to ISG coordinates add 286,000 m E and add 1,376,000 m N.

2.2 Provisional Development Schedule

The Provisional Development Schedule is attached as **Appendix B2**.

2.3 Open-Cut

Existing WCM

The existing WCM mobile surface equipment list is presented in **Table 2.3.1**.

Construction

Open-cut operations involve the continued development of existing mining activities with no definable construction period. The Wollemi box-cut extension will utilise the existing type of mining equipment commencing in Year 2.

Operation

The conceptual mine plans for open-cut operations for Years 2, 7 and 9 are shown in **Appendices B3** to **B5** respectively. The Project mobile surface equipment is presented in **Table 2.3.1**.

Table 2.3.1 Existing WCM and Project Mobile Surface Equipment Fleets

Mobile Equipment	Make and Model (or equivalent)	Existing (or typical)	Year 2	Years 7 & 9
Open-Cut/Box-Cut				
Excavators	Komatsu PC 5500 (500 t)	2	3	4
	Hitachi EX 2500 (250 t)	1	2	2
	Hitachi EX 1800 (180 t)	1	1	1
Haul Trucks	Komatsu 830 E (240 t)	8	12	16
	CAT 785 (150 t)	7	12	12
Dozers	CAT D10	2	4	4
	CAT D11	2	4	5
Graders	CAT G16	2	3	3
Water Trucks	CAT 773	2	4	4
Blast Hole Drills	DK 45/DK 55	2	3	3
Underground Surface				
Front-end Loader	CAT 992 (23 t)	-	-	1
B Doubles	Mack Bigfoot (140 t)	-	-	4
Coal Handling and Preparation Plant				
Front-end Loader	CAT 992 (23 t)	3	3	5
Dozers	CAT D11	2	3	3

Blasting

Up to 52 million bank cubic metres (MBCM) of overburden material is to be extracted annually requiring an average of five blasts per week with blast sizes typically in the range from 150,000 BCM up to 500,000 BCM. **Appendix A2** shows the perimeter of the open-cut extraction area.

2.4 Underground

Existing

The Wollemi underground mine is currently in a care and maintenance phase. The Project involves resumption of underground mining in the Whybrow and Wambo Seams and the introduction of underground operations in the Arrowfield and Bowfield Seams.

Construction Underground Blasting

Longwall mining of the Wambo Seam may require excavation blasting to develop drift access from the existing Wollemi portal. Similarly, underground mining of the Arrowfield and Bowfield Seams require excavation blasting to establish drift access in the vicinity of the CHPP. Note, any surface blasting required to establish portal(s) accesses would be confined to daytime.

Construction Surface Works

Relatively minor establishment works are required for power and ventilation.

Operation Surface Works

Surface haulage of the Whybrow and Wambo ROM coal will be via the existing Wollemi portal stack-out conveyor. A CAT 992 (or equivalent) front-end loader will load up to four (4) B Double (140 t) haul trucks to transport the material to the CHPP ROM stockpile adjacent to the dump hopper (refer **Table 2.3.1**).

ROM coal from the Arrowfield and Bowfield underground will be conveyed to the surface and stockpiled on the northern side of the CHPP. Surface ventilation systems include:

- Whybrow Longwall (**Appendix B3**) - Two (2) 60 m^3/s axial flow fans.
- Wambo Longwall (**Appendices B4 and B5**) - Existing 200 m^3/s system at Wollemi Portal.
- Arrowfield/Bowfield Longwall (**Appendices B4 and B5**) - Upcast 400 m^3/s fan system.

Gas drainage systems are also required for the Arrowfield/Bowfield Seams but are acoustically insignificant.

2.5 Coal Handling and Preparation Plant

Existing

The existing CHPP Module 2 has an average ROM coal throughput capacity of 900 tph.

Construction

The Project would require the commissioning of a second module within the footprint of the currently decommissioned Module 1. An additional capacity of 900 tph would be commissioned to match the expansion of operations.

Operation

ROM and product coal handling will involve the use of up to five CAT 992 front-end loaders (or equivalent) and up to three CAT D11 dozers (or equivalent, refer **Table 2.3.1**).

2.6 Train Loading System and Rail Spur/Loop

Construction

The proposed rail infrastructure including the Rail Spur/Loop Plan is shown as **Appendix B6**. The Train Loading System Layout is shown as **Appendix B7**.

The major construction equipment for the CHPP upgrade, train loading system and rail spur/loop are presented in **Table 2.6.1**.

Table 2.6.1 Major Construction Equipment Fleets

CHPP Upgrade	Train Loading System	Rail Spur/Loop
2 Cranes	Excavator	Dozer
2 Delivery Trucks	2 Cranes	Excavator
-	2 Delivery Trucks	Crane
-	-	Plate Compactor
-	-	Track Laying Machine

Operation

Up to 11.3 Mtpa of product coal will be transported off-site by rail and involve the use of nominal 8,600 t capacity trains requiring an average of approximately four train events (ie arrival and departure) per day.

3 EXISTING NOISE AND METEOROLOGICAL ENVIRONMENT

3.1 Noise Environment

Wambo Development Project December 2002

Ambient noise surveys to characterise and quantify the acoustical environment in the area surrounding the Project were conducted in December 2002. Eight unattended noise loggers were positioned at selected representative dwellings commencing Thursday 12 December 2002 for a period of 12 days.

WCPL maintained a detailed mine operating log throughout the 12 day monitoring period and is available upon request. Normal day and night shift operations were in progress including overburden and coal extraction and haulage as well as CHPP operation and product coal transport. Note however, that the objective of the monitoring programme was to establish background noise levels in the absence of any significant influence from the existing WCM mining activities.

In order to supplement the unattended logger measurements and to assist in identifying the character and duration of ambient noise sources, operator-attended daytime, night-time surveys were also conducted at all eight logging locations. The measurement methodology and analysis procedures are described in **Appendix C1**. The operator-attended measurement results are summarised in **Table 3.1.1**.

Table 3.1.1 Operator-Attended Ambient Noise Environment December 2002 (dBA re 20 μPa)

General Locality	Land Owner	LA90(15minute) Ambient Level			LAeq(15minute) Existing WCM			LAeq(15minute) Industrial Noise (Non WCM)		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Wambo Road	2 Lambkin (WCM Boundary)	31 31	32 31	32 34	Not discernible			Not discernible		
	25 Fenwick (Property)	27 27	34 36	30 33	N/D N/D	N/D <35	32 N/D	Not discernible		
Warkworth Village	19(A) Kelly (WCM Boundary)	56 38	43 45	39 45	<40 N/D	<35 N/D	38 46	Not discernible		
	51 Hawkes (WCM Boundary)	- 34	39 -	- -	- -	43 -	- -	Not discernible		
	56 Haynes (WCM Adjacent)	42 42	43 43	35 43	N/D N/D	N/D N/D	34 44	Not discernible		
Redmanvale/ Pinegrove Roads	15(B) McGowen/Caslick (Property)	36 35	31 41	30 -	Not discernible			Not discernible		
Golden Highway	31(D) Fisher (Property)	39 39	39 38	34 -	Not discernible			Not discernible		
	31(A,B,C,D) Fisher (20 m from Golden Highway)	37 40	47 37	36 -	Not discernible			Not discernible		

Note 1: N/D not discernible.

Note, noise emissions from the existing WCM were only detected by the operator at the nearest potentially affected receivers in Warkworth Village and to a lesser extent at 25 Fenwick. Furthermore, no significant industrial noise (ie non-transport related noise) from other mines (ie non-WCM sources) in the locality was detected at any of the monitoring locations.

The unattended ambient noise logger data from each monitoring location, together with the on-site weather conditions are presented graphically on a daily basis in **Appendices C2** to **C9**. The ambient noise data was then processed in accordance with the requirements of the NSW INP (2000) to derive the Monday to Sunday ambient noise levels presented in **Table 3.1.2**.

Table 3.1.2 Unattended Ambient Noise Environment December 2002 (dBA re 20 μPa)

General Locality	Land Owner	Rating Background Level[1,2] All Noise Sources including WCM at Warkworth			LAeq(period)[3] All Noise Sources including WCM at Warkworth			Estimated LAeq(period)[3] Industrial Noise Amenity (Non WCM)		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Wambo Road	2 Lambkin (WCM Boundary)	29	28	25	47	47	43	<44	<39	<34
	25 Fenwick (Property)	27	29	27	45	45	44	<44	<39	<34
Warkworth Village	19(A) Kelly (WCM Boundary)	38	38	35	57	49	47	<49	<39	<34
	51 Hawkes (WCM Boundary)	34	38	31	49	49	47	<49	<39	<34
	56 Haynes (WCM Adjacent)	36	37	31	48	48	47	<49	<39	<34
Redmanvale/ Pinegrove Roads	15(B) McGowen/ Caslick (Property)	28	31	27	47	45	45	<44	<39	<34
Golden Highway	31(D) Fisher (Property)	34	35	30	47	47	46	<49	<39	<34
	31(A,B,C,D) Fisher (20 m from road)	35	36	34	65	64	61	<49	<39	<34

Note 1: Measured noise levels less than 31 dBA may have a signal to noise ratio less than 5 dBA.
Note 2: In accordance with the NSW INP (2000), if the RBL is below 30 dBA, then 30 dBA shall be the assumed RBL.
Note 3: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours and Night-time 2200 hours to 0700 hours.

Based on the observations made during the operator-attended monitoring it is concluded that the Rating Background Levels presented in **Table 3.1.2** are representative of the non-WCM noise environment for all receiver areas except Warkworth Village. Historical background noise surveys were required to determine the non-WCM noise environment at Warkworth Village.

Wambo Coal Mine December 2000 to April 2001

Background noise surveys to characterise and quantify the acoustical environment in the area surrounding the existing Wambo Coal Mine were recorded by Egis Consulting during the period December 2000 to April 2001. Unattended noise loggers were positioned at selected representative dwellings in December 2000 (data discarded due to a period of prolonged bushfire emergency), March 2001 and April 2001.

The measurement methodology is described in the Wambo Mining Corporation "*Annual Environmental Management Report - July 2000 to June 2001*" prepared by Egis Consulting. The background noise data has been subsequently processed by RHA in accordance with the requirements of the NSW INP (2000) to determine the background noise levels as shown in **Table 3.1.3**.

Table 3.1.3 Unattended Background Noise Environment March and April 2001 (dBA re 20 µPa)

General Locality	Land Owner	Period	Rating Background Level[1,2] All Noise Sources excluding WCM			LAeq(period)[3] All Noise Sources excluding WCM			Estimated LAeq(period)[3] Industrial Noise Amenity (Non WCM)		
			Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Wambo Road	25 Fenwick	March April	- 30	- 30	- 30	- 38	- 43	- 52	- <44	- <39	- <34
Warkworth Village	19(B,A) Kelly	March April	35 -	33 -	33 -	47 -	49 -	42 -	<49 -	<39 -	<34 -
	51 Hawkes	March April	33 30	31 35	31 34	52 40	45 41	42 40	<49 <49	<39 <39	<34 <34
Redmanvale/ Pinegrove Roads	24 Long	March April	31 -	30 -	30 -	52 -	52 -	42 -	<44 -	<39 -	<34 -

Note 1: Measured noise levels less than 31 dBA may have a signal to noise ratio less than 5 dBA.
Note 2: In accordance with the NSW INP (2000), if the RBL is below 30 dBA, then 30 dBA shall be the assumed RBL.
Note 2: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours and Night-time 2200 hours to 0700 hours.

Gouldsville and Maison Dieu Localities

Background noise surveys to characterise and quantity the acoustical environment in Gouldsville were reported by Environmental Resources Management Australia (ERMA) in August 2002. The measurement methodology is described in the "*Warkworth Coal Mine Extension EIS Chapter - Noise and Vibration - August 2002*" prepared by ERMA.

Similarly, background noise surveys to characterise and quantify the acoustical environment in Maison Dieu were recorded by HLA Envirosciences Pty Ltd (HLA) in April 2000. The measurement methodology is described in the "*Jerrys Plains Coal Terminal Noise Impact Assessment*" dated November 2000 prepared by HLA.

In each case, the background noise data was processed (and reported by ERMA and HLA) in accordance with the requirements of the NSW INP (2000) to derive the Monday to Sunday ambient noise levels presented in **Table 3.1.4**.

Table 3.1.4 Unattended Ambient Noise Environment - Gouldsville August 2002 and Maison Dieu April 2000 (dBA re 20 μPa)

General Locality	Location	Rating Background Level[1,2] All Noise Sources excluding WCM			Estimated LAeq(period) Industrial Noise Amenity	Comments
		Day	Evening	Night		
Gouldsville[4]	N2 Gouldsville (Redbank Station)	33	33	33	35	Redbank Power Station audible and Warkworth Mine slightly audible
	N3 Gouldsville (Village)	30	30	30	33	
Maison Dieu	124 Bowman	33	33	33	33	Lemington Mine noise audible

Note 1: Measured noise levels less than 31 dBA may have a signal to noise ratio less than 5 dBA.
Note 2: In accordance with the NSW INP (2000), if the RBL is below 30 dBA, then 30 dBA shall be the assumed RBL.
Note 3: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours and Night-time 2200 hours to 0700 hours.
Note 4: Referenced to Warkworth Coal Mine Extension EIS Monitoring Locations.

Noise Environment for Project Assessment Purposes

For the purposes of assessing potential noise impacts from the Project, the ambient/background noise levels have been distilled into six distinct localities that are summarised in **Table 3.1.5**.

The Rating Background Levels (RBLs) adopted for assessment purposes are representative of the non-WCM noise environment, with RBLs ranging from 30 dBA at night to 35 dBA during the day. Furthermore, in the absence of the existing WCM, industrial noise amenity levels (ie non-transport related noise) from other mines in the locality are minimal at the nearest potentially affected receivers to the Project. At Gouldsville and Maison Dieu, mine noise is audible but generally low (refer **Table 3.1.5**).

Table 3.1.5 Noise Environment for Project Assessment Purposes (dBA re 20 µPA)

General Locality	Land Owner	Rating Background Level[1,2] All Noise Sources excluding WCM			LAeq(period)[3] All Noise Sources excluding WCM			Estimated LAeq(period)[3] Industrial Noise Amenity (Non WCM)		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Wambo Road (INP Rural)	2 Lambkin	30	30	30	47	47	43	<44	<39	<34
	25 Fenwick	30	30	30	45	45	44	<44	<39	<34
	Other Residential	30	30	30	46	46	43	<44	<39	<34
Warkworth Village (INP Suburban)	19(B,A) Kelly	35	33	33	47	49	42	<49	<39	<34
	51 Hawkes	33	31	31	52	45	42	<49	<39	<34
	56 Haynes	34	32	31	50	47	42	<49	<39	<34
	Other Residential	34	32	31	50	47	42	<49	<39	<34
Gouldsville (INP Suburban)	23(C) Kannar and Redbank Area	33	33	33	-	-	-	<49	<39	35
	Other Residential	30	30	30	-	-	-	<49	<39	<33
Maison Dieu (INP Suburban)	124 Bowman	33	33	33	-	-	-	<49	<39	<34
	Other Residential	33	33	33	-	-	-	<49	<39	<34
Redmanvale/ Pinegrove Roads (INP Rural)	15(B) McGowen/Caslick	30	31	30	47	45	45	<44	<39	<34
	24 Long	31	30	30	52	52	42	<44	<39	<34
	Other Residential	30	30	30	50	49	44	<44	<39	<34
Golden Highway (INP Suburban)	31(D) Fisher	34	35	30	47	47	46	<49	<39	<34
	Other Residential	34	35	30	47	47	46	<49	<39	<34

Note 1: Measured noise levels less than 31 dBA may have a signal to noise ratio less than 5 dBA.
Note 2: In accordance with the NSW INP (2000), if the RBL is below 30 dBA, then 30 dBA shall be the assumed RBL.
Note 2: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours and Night-time 2200 hours to 0700 hours.

3.2 Meteorological Environment

Project Meteorological Conditions

The NSW INP (2000) Section 5.3, Wind Effects, states:

> *"Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source to receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30 percent of the time or more in any assessment period in any season."*

An assessment of existing wind conditions has been prepared from the on-site meteorological data recorded at the WCM for the period September 2000 to August 2002. The dominant seasonal wind speeds and directions are presented as **Appendix C10** for daytime (0700 hours to 1800 hours), evening (1800 hours to 2200 hours) and night-time (2200 hours to 0700 hours).

The prevailing winds less than (or equal to) 3 m/s with a frequency of occurrence greater than (or equal to) 30% and considered to be relevant to the site in accordance with the NSW INP are presented in **Table 3.2.1**, where the dominant conditions are underlined.

Table 3.2.1 Project Prevailing Wind Conditions in accordance with NSW INP (2000)

Season	Winds ± 45^{o} £3 m/s with Frequency of Occurrence ‡ 30%		
	Daytime	Evening[1]	Night-time[1]
Annual	Nil	ESE (32%), SE (37%), SSE (33%)	SE (33%), SSE (32%)
Summer	Nil	E (32%), ESE (45%), SE (46%), SSE (38%)	E (31%), ESE (50%), SE (56%), SSE (50%), S (32%)
Autumn	Nil	ESE (38%), SE (44%), SSE (39%)	ESE (33%), SE (40%), SSE (39%)
Winter	Nil	W (31%), WNW (31%)	W (32%), WNW (32%)
Spring	Nil	SE (31%)	SE (32%), SSE (32%)

Note 1: The dominant seasonal wind speeds are underlined.

The NSW INP (2000) Section 5.2, Temperature Inversions, states:

> *"Assessment of impacts is confined to the night noise assessment period (10.00 pm to 7.00 am), as this is the time likely to have the greatest impact - that is, when temperature inversions usually occur and disturbance to sleep is possible."*
>
> *"Where inversion conditions are predicted for at least 30% (or approximately two nights per week) of total night-time in winter, then inversion effects are considered to be significant and should be taken into account in the noise assessment".*

An assessment of atmospheric stability conditions has also been prepared from the meteorological data set (described above). The winter evening and night-time frequency of occurrence of atmospheric stability classes are presented in **Table 3.2.2**, together with estimated Environmental Lapse Rates (ELR).

Table 3.2.2 Atmospheric Stability Frequency of Occurrence - Winter Evening and Winter Night-time

Stability Class	Occurrence Percentage	Estimated ELR[1] ^{o}C/100 m	Qualitative Description
A	0%	<-1.9	Lapse
B	0%	-1.9 to-1.7	Lapse
C	0%	-1.7 to-1.5	Lapse
D	51%	-1.5 to-0.5	Neutral
E	13%	-0.5 to 1.5	Weak Inversion
F	22%	1.5 to 4.0	Moderate Inversion
G	14%	>4.0	Strong Inversion

Note 1: ELR (Environmental Lapse Rate)

In accordance with the NSW INP (2000) the frequency of occurrence of moderate to strong (ie 1.5 to >4.0°C/100 m) winter temperature inversions is greater than 30% during the combined evening and night-time period and therefore requires assessment.

Environmental Noise Model (ENM) Meteorology

The ENM noise modelling meteorological parameters presented in **Table 3.2.3** are based on the default inversion and wind speeds presented in the NSW INP (2000) Section 5 Meteorological Conditions.

Table 3.2.3 Non-Adverse (Calm) and Adverse Noise Modelling Meteorological Parameters

Season	Period	Air Temp	Relative Humidity	Wind Velocity[1]	Temperature Gradient[1]
Non-Adverse Annual	Daytime	18°C	60%	0 m/s	0°C/100 m
Adverse Summer Autumn Spring	Evening and Night-time	12°C	75%	SE 3 m/s	0°C/100 m
Adverse Winter	Evening and Night-time	6°C	90%	W 2 m/s	3°C/100 m

Note 1: NSW INP (2000) default adverse wind speed 3 m/s and default inversion 3°C/100m plus 2 m/s wind.

4 MINE NOISE ASSESSMENT METHODOLOGY

4.1 Construction and Operating Assessment Criteria

Construction

The assessment of impact from on-site construction works remains according to the EPA's ENCM (1994) Chapter 171 Noise Control Guideline – Construction Site Noise (**Appendix D**). As the duration of the construction works is greater than 6 months the guideline suggests that the construction noise emissions should generally not exceed the background noise level by more than 5 dBA.

Operation

The NSW INP (2000) prescribes detailed calculation routines for establishing "project specific" $L_{Aeq(15minute)}$ intrusive criteria and $L_{Aeq(period)}$ amenity criteria for a development at potentially affected receivers.

In addition, "vacant land" is defined as a lot which is permitted to have (but does not yet have) a dwelling. Current PlanningNSW policy does not consider vacant land to be noise affected in the absence of a dwelling. In the event that the land owner establishes a dwelling, only then will it be considered as a noise sensitive receiver.

Sleep Disturbance

The EPA's ENCM (1994) suggests that the $L_{A1(60sec)}$ noise level from any specific noise should not exceed the background noise level by more than 15 dBA. However, the issue of potential sleep disturbance is complex and still poorly understood in the literature.

A review of noise events from comparable coal mining operations shows that the maximum or $L_{A1(60sec)}$ levels from mobile equipment (ie dozers, haul trucks, trains etc) are typically no greater than 10 dBA above the $L_{Aeq(15minute)}$ intrusive level. Hence, if the $L_{Aeq(15minute)}$ intrusive criteria (ie background plus 5 dBA) are achieved then the EPA's sleep disturbance criteria will also be met. This relationship enables the noise assessment process to focus on the setting of the appropriate INP-based criteria which aim to minimise annoyance reactions at various receiver locations.

Assessment Criteria

The INP-based intrusive and amenity noise assessment criteria at the six assessment localities are presented in **Table 4.1.1**. These criteria are nominated for the purposes of assessing potential noise impacts from the Project. Note, the $L_{Aeq(15minute)}$ intrusive criteria are the controlling noise limits at all residential receivers.

Table 4.1.1 NSW INP (2000) Project Specific Noise Assessment Criteria (dBA re 20 μPa)

Locality	Land Owner	Project Specific Assessment Criteria					
		Intrusive LAeq(15minute)			Amenity LAeq(period)[1]		
		Day	Evening	Night	Day	Evening	Night
Wambo Road (INP Rural)	2 Lambkin	35	35	35	50	45	40
	25 Fenwick	35	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Warkworth Village (INP Suburban)	19(B,A) Kelly	40	38	38	55	45	40
	51 Hawkes	38	36	36	55	45	40
	56 Haynes	39	37	36	55	45	40
	Other Residential	39	37	36	55	45	40
INP Place of Worship	St Philips Anglican Church (Internal)	Intrusive criteria apply only to residential receivers		Not in use	40	40	Not in use
INP Passive/Active Recreation Area	St Philips Anglican Church Grounds (External)				50-55	50-55	
Gouldsville (INP Suburban)	23(C) Kannar	38	38	38	55	45	38
	Other Residential	35	35	35	55	45	40

Table 4.1.1 NSW INP (2000) Project Specific Noise Assessment Criteria (dBA re 20 µPa) (Cont'd)

Locality	Land Owner	Project Specific Assessment Criteria					
		Intrusive LAeq(15minute)			Amenity LAeq(period)[1]		
		Day	Evening	Night	Day	Evening	Night
Maison Dieu (INP Suburban)	124 Bowman	38	38	38	55	45	40
	Other Residential	38	38	38	55	45	40
Redmanvale/ Pinegrove Roads (INP Rural)	15(B) McGowen/Caslick	35	36	35	50	45	40
	24 Long	36	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Golden Highway (INP Suburban)	31(D) Fisher	39	40	35	55	45	40
	Other Residential	39	40	35	55	45	40

Note 1: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours, Night-time 2200 hours to 0700 hours.

The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

In those cases where the INP project specific assessment criteria are not achieved, it does not automatically follow that all people exposed to the noise would find the noise unacceptable. In subjective terms, exceedances of the INP project specific assessment criteria can be generally described as follows:

- Negligible noise level increase <1 dBA
  (Not noticeable by all people)
- Marginal noise level increase 1 dBA to 2 dBA
  (Not noticeable by most people)
- Moderate noise level increase 3 dBA to 5 dBA
  (Not noticeable by some people but may be noticeable by others)
- Appreciable noise level increase >5 dBA
  (Noticeable by most people)

In view of the foregoing, **Table 4.1.2** presents the methodology for assessing noise levels which may exceed the INP project specific noise assessment criteria.

Table 4.1.2 Project Noise Impact Assessment Methodology

Assessment Criteria	Project Specific Criteria	Noise Management Zone		Noise Affectation Zone
		Marginal	Moderate	
Intrusive LAeq(15minute)	Rating background level plus 5 dBA	1 to 2 dBA above project specific criteria	3 to 5 dBA above project specific criteria	> 5 dBA above project specific criteria
Amenity LAeq(period)	INP based on existing industrial level			

For the purposes of assessing the potential noise impacts, the management and affectation criteria are further defined as follows:

Noise Management Zone

Depending on the degree of exceedance of the project specific criteria (1 dBA to 5 dBA) noise impacts could range from negligible to moderate. It is recommended that management procedures be implemented including:

- Noise monitoring on-site and within the community.
- Prompt response to any community issues of concern.
- Refinement of on-site noise mitigation measures and mine operating procedures where practicable.
- Discussions with relevant land owners to assess concerns.
- Consideration of acoustical mitigation at receivers where substantiated by monitoring results.
- Consideration of negotiated agreements with land owners.

Noise Affectation Zone

Exposure to noise levels corresponding to this zone may be considered unacceptable by some land owners particularly at night. It is recommended that WCPL explore the following:

- Discussions with relevant land owners to assess concerns and define responses.
- Implementation of acoustical mitigation at receivers.
- Negotiated agreements with land owners where required.

4.2 Mine Noise Mitigation Measures

The Noise Management Zone and Noise Affectation Zone procedures described in **Section 4.1** are in addition to ensuring that feasible noise controls, as included in predictive modelling, have been implemented for the Project including:

Noise Mitigation Investigations

During the initial assessment phase, a number of iterative steps were undertaken to ascertain potential unmitigated noise emissions and assess the feasibility and practicability of implementing noise management and mitigation measures to reduce Project noise emissions at receivers, including:

- Preliminary noise modelling of critical years to identify potential areas of affectation as well as investigating various noise mitigation and management measures to assess their relative effectiveness.
- Consideration of various combinations of noise mitigation and management measures to minimise the potential noise affectation zone, particularly towards Jerrys Plains.
- Adoption by WCPL of a range of noise mitigation and management measures that significantly reduce Project noise emissions from Year 5 to Year 13 (based on the planned production). The actual timing of the implementation of the noise controls would be dependent on the actual production and mine progression.

A brief discussion of the noise mitigation and management controls adopted is provided below.

Construction Noise Management Controls

All surface works (ie CHPP upgrade, Train Loading System and Rail Spur/Loop) construction activities will be confined to daytime hours in accordance with **Table 1.2.1**.

All underground works (ie excavation blasting to develop drift access to the Wambo, Arrowfield and Bowfield Seams) will be carried out to meet stringent criteria to ensure off-site blast emission impacts are negligible.

Mobile Equipment and Fixed Plant Source Noise Controls

The Project's fixed plant and mobile equipment (or equivalent) shall be commissioned to achieve the nominal overall L_{Aeq} sound power levels (SWLs) presented in **Table 4.2.1**.

The overall SWLs for mobile equipment are based on current "achievable" noise emission standards. Further reductions may be possible in the future. Initial cost estimates to install, maintain and service the "achievable" noise controls have been undertaken and included in the Project's operating budgets.

Subsequent detailed design studies may be required to refine individual SWLs and to prepare procurement specifications to ensure that the approved off-site environmental noise limits are achieved.

Table 4.2.1 Project Nominal Overall L_{Aeq} Sound Power Levels (dBA re 1pW)

Plant & Equipment	Make and Model (or equivalent)	Years 1 to 4	Year =5[1]
Open-Cut and Box-Cut (Component SWLs)			
Excavators	Komatsu PC 5500 (500 t)	121	116
	Hitachi EX 2500 (250 t)	118	113
	Hitachi EX 1800 (180 t)	117	112
Haul Trucks	Komatsu 830 E (240 t)	123	113
	CAT 785 (150 t)	123	113
Dozers	CAT D10	121	118
	CAT D11	123	120
Graders	CAT G16	115	110
Water Trucks	CAT 773	120	113
Blast Hole Drills	DK 55	118	113
	DK 45	116	111
Whybrow and Wambo Underground (Component SWLs)			
Whybrow Fans	60 m^3/s	99	99
Wambo Fans	200 m^3/s	-	104
Stackout Conveyor	2500 tph	110 dB/100 m, Drive 103	
Front-end Loader	CAT 992 (23 t)	117	112
B Doubles	Mack Bigfoot (140 t)	114	114
Arrowfield and Bowfield Underground (Component SWLs)			
Arrowfield Fans	350 m^3/s	-	107
Coal Preparation and Handling Plant (Module 1 or 2 Component SWLs)			
Receival Bin/Feeder	900 tph	111	111
Raw Coal Conveyor	900 tph	101 dB/100 m, Drive 100	
Secondary/Tertiary Crushers	900 tph	110	110
Enclosed Module 1 or 2	900 tph	107	107
Reject Bin and Drive	300 tph	100	100
Reject Conveyor	320 tph	97 dB/100 m	
Product Conveyor	640 tph	100 dB/100 m, Drive 100	
Front-end Loader	CAT 992 (23 t)	117	112
Dozers	CAT D11	123	120
Train Loading System (Component SWLs)			
Reclaim Conveyor	CV102-2500 tph	107 dB/100 m, Drive 107	
Train Loadout Conveyor	CV102-2500 tph	107 dB/100 m, Drive 107	
Train Loadout Bin	400 t	107	107
Locomotive Set	82 Class	111	111

Note 1: Or as determined by actual production/mine progression.

Open-Cut Operation Management Controls

Commencing in Year 5 (based on planned production/mine progression), waste rock dumping controls shall be implemented which place the following restrictions on evening and night-time overburden operations in the northern pit:

- Overburden haulage and dumping operations to be conducted on internal dump areas (ie no external dumping) and/or behind a minimum 10 m high bund wall or equivalent shielding mine landform.
- Alternatively, remote waste rock dumps in the southeast sections of the northern pit will be utilised for waste dumping.

In addition, overburden removal in areas on the top and outer sides of topographic ridges where bunding is not feasible would be restricted to daytime only.

Note that the implementation of these controls would be mine progression dependent, ie these controls need only be implemented as mining progresses into the areas described above in order to achieve the necessary potential impact mitigation in relation to noise emissions.

In addition to the above, WCPL will investigate the use of a real-time noise monitoring system that may assist in providing greater flexibility for operating the mine under favourable weather conditions.

Train Loading Management Controls

In order to minimise any residual noise impact at the St Philips Anglican Church from the rail transport of coal, WCPL will liaise with the rail service provider to minimise the potential impact of noise emissions on St. Philips Anglican Church (where practicable), particularly on Friday evenings (ie approximately 1800 hours to 2100 hours) and Sunday mornings (ie approximately 0900 hours to 1200 hours).

4.3 Mine Noise Modelling Procedure

The Project computer model was developed to incorporate the significant noise sources associated with the proposed development. Additional surrounding terrain and nearby receiver localities properties were also included in the model.

The Project computer model was prepared using RTA Software's Environmental Noise Model (ENM for Windows, Version 3.06), a commercial software system developed in conjunction with the NSW EPA. The acoustical algorithms utilised by this software have been endorsed by the Australian and New Zealand Environment and Conservation Council (ANZECC) and all State Environmental Authorities throughout Australia as representing one of the most appropriate predictive methodologies currently available.

The following scenarios were assessed (based on planned production/mine progression):

Construction Years 1 to 2: Existing (approved) mining operations are scheduled to coincide with the CHPP upgrade, Rail Spur/Loop and Train Loading System daytime construction activities at the commencement of Year 2.

Operation Year 2: Representative of the nearest open-cut operations to Warkworth Village including Whybrow Seam underground, CHPP and train loading system operation (with train movements).

Operation Year 7: Representative of the nearest open-cut operations to Jerrys Plains township including Wambo and Arrowfield Seam underground, CHPP and train loading system operations (with train movements).

Operation Year 9: Representative of the nearest open-cut operations to Bulga village including Wambo and Arrowfield Seam underground, CHPP and train loading system operations (with train movement).

Modelling of mining operations include all existing and proposed plant items operating concurrently to simulate the overall maximum energy equivalent (ie $L_{Aeq(15minute)}$) intrusive noise level. The model includes coal loading operations and train movement on the rail loop (as loading operations cease when the train is on the rail spur). A large proportion of the mobile equipment is operated in repeatable routines and a relatively smaller proportion of the emissions from continuous fixed plant items.

The L_{Aeq} sound power levels presented in **Table 4.2.1** for each item of mobile equipment do not include noise emissions which emanate from reversing alarms. In the event that reversing alarm noise is considered to be a source of disturbance, the alarm noise level should be checked against the appropriate Department of Mineral Resources requirements and the necessary mitigating action taken to achieve an acceptable noise reduction without compromising safety standards.

5 MINE NOISE IMPACT ASSESSMENT

5.1 Construction Years 1 to 2

Daytime construction activities associated with CHPP upgrade, Rail Spur/Loop and Train Loading System will be carried out simultaneously with existing (approved) mining operations over a 12 month period. The construction scenario comprises the following:

- The construction equipment presented in **Table 2.6.1**.
- The existing (approved) WCM equipment presented in **Table 2.3.1**.
- The existing (approved) WCM coal processing, handling and transportation system.

Construction activities will occur during the daytime only. As the duration of the construction activities are greater than 6 months, then the project specific assessment criteria presented in **Table 4.1.1** apply.

At the completion of the construction activity, mobile and fixed plant utilisation will increase towards the end of Year 2. Hence, the daytime noise impact arising from the expanded mining operation at the end of Year 2 is significantly greater in comparison to the daytime construction scenario.

The worst case Year 2 daytime noise impact is therefore presented in **Section 5.2**.

5.2 Operation Year 2

Impact Assessment at Noise Sensitive Receivers

The predicted $L_{Aeq(15minute)}$ intrusive noise emissions from Year 2 operation to the nearest affected noise sensitive receivers are presented in **Table 5.2.1** together with the project specific assessment criteria. The table includes all known dwellings where the project specific criteria are predicted to be exceeded and the St. Philips Anglican Church. An assessment of private vacant land is presented in **Table 5.2.2**.

Table 5.2.1 Year 2 Operation $L_{Aeq(15minute)}$ Intrusive Emissions (dBA re 20 mPa)

General Locality	Reference/ Land Owner	Non-Adverse Annual	Adverse SE Wind Summer, Autumn, Spring		Adverse Inversion W Wind Winter		Project Specific Criteria		
		Day	Evening	Night	Evening	Night	Day	Evening	Night
	WA WCPL	36[1]	34	34	43[3]	43[3]			
	WB WCPL	38[2]	36[1]	36[1]	45[3]	45[3]			
	WC WCPL	38[2]	36[1]	36[1]	45[3]	45[3]			
	1 Brosi	31	30	30	38[2]	38[2]			
	2 Lambkin	31	28	28	41[3]	41[3]			
	3 Birrell	30	27	27	40[2]	40[2]			
	4(B) Circosta	29	26	26	40[2]	40[2]			
Wambo Road	5 Strachan	29	26	26	39[2]	39[2]	35	35	35
	6 Merrick	28	25	25	39[2]	39[2]			
	7 Maizey	29	26	26	39[2]	39[2]			
	25 Fenwick	33	32	32	40[2]	40[2]			
	35 Brosi	29	29	29	34	34			
	63 Abrocuff	28	24	24	38[2]	38[2]			
	91 Bailey	29	27	27	38[2]	38[2]			
	178 Smith	27	23	23	36[1]	36[1]			
	246 Bailey	27	24	24	37[1]	37[1]			
	8(A) WML	31	28	28	41	41			
Wallaby Scrub Road	8(B) WML	39	36	36	50	50	Warkworth Mine Affectation Zone		
	8(C,D,E) WML	34	30	30	45	45			
	8(G,F,H) WML	29	25	25	42	42			
	WD WCPL	42[1]	48[3]	48[3]	53[3]	53[3]			
	WE WCPL	54[3]	57[3]	57[3]	59[3]	59[3]	39	37	36
	WF WCPL	52[3]	55[3]	55[3]	58[3]	58[3]			
	11(E) Coal & Allied	44[2]	47[3]	47[3]	55[3]	55[3]			
	19(B,A) Kelly	54[3]	57[3]	57[3]	59[3]	59[3]	40	38	38
	20 JPCT	46[3]	49[3]	49[3]	55[3]	55[3]			
	21(A) Coal & Allied	54[3]	56[3]	56[3]	59[3]	59[3]			
	21(B) Coal & Allied	40[1]	41[2]	41[2]	52[3]	52[3]	39	37	36
	22 Henderson	42[2]	40[2]	40[2]	53[3]	53[3]			
Warkworth Village	23(A) Kannar	49[3]	53[3]	53[3]	56[3]	56[3]			
	23(B) Kannar	47[3]	51[3]	51[3]	55[3]	55[3]			
	51 Hawkes	49[3]	44[3]	44[3]	59[3]	59[3]	38	36	36
	56 Haynes	52[3]	53[3]	53[3]	58[3]	58[3]	39	37	36
	St. Philips Anglican Church Internal[4] (with train loading)	38	37	Not in use	45[2]	Not in use	40	40	Not in use
	St. Philips Anglican Church Ground External[4] (with train loading)	48	47		55		50-55	50-55	

Table 5.2.1 Year 2 Operation $L_{Aeq(15minute)}$ Intrusive Emissions (dBA re 20 μPa) (Cont'd)

General Locality	Reference/ Land Owner	Non-Adverse Annual	Adverse SE Wind Summer, Autumn, Spring		Adverse Inversion W Wind Winter		Project Specific Criteria		
		Day	Evening	Night	Evening	Night	Day	Evening	Night
Warkworth Village (Cont'd)	St. Philips Anglican Church Internal[4] (without train loading)	28	26	Not in use	40	Not in use	40	40	Not in use
	St. Philips Anglican Church Ground External[4] (without train loading)	38	36		50		50-55	50-55	
Gouldsville	23(C) Kannar	22	19	19	40[1]	40[1]	38	38	38
	11(G) Coal & Allied	24	21	21	36[1]	36[1]	35	35	35
Maison Dieu	11(F) Coal & Allied	31	30	30	43[2]	43[2]	38	38	38
	94 Curlewis	29	29	29	41[2]	41[2]			
	254(A) Algie	29	28	28	40[1]	40[1]			
Redmanvale/ Pinegrove Roads	13(C) Skinner	32	44[3]	44[3]	32	32	35	35	35
	15(B) McGowen/ Caslick	19	35	35	18	18	35	36	35
	24 Long	37[1]	47[3]	47[3]	37[1]	37[1]	35	35	35
	30 Williams	17	34	34	17	17			
	33 Thelander/ O'Niell	19	35	35	19	19			
	37 Lawry	18	35	35	17	17			
	48 Ponder	18	35	35	18	18			
	49 Oliver	17	34	34	17	17			
	75 Barnes	18	34	34	18	18			
	137 Woodruff	18	34	34	18	18			
	163 Rodger/ Williams	19	35	35	19	19			
	188 Fuller	19	34	34	19	19			
Golden Highway	13(B) Skinner	19	36	36[1]	19	19	39	40	35
	16 Cooper	21	37	37[1]	22	22			
	17 Carter	20	37	37[1]	21	21			
	18 Denney	20	37	37[1]	20	20			
	27 Birralee Feeds	19	37	37[1]	20	20			
	28(B,A) Garland	20	38	38[2]	21	21			
	31(A,B,C,D) Fisher	22	40	40[2]	22	22			
	39 Northcote	22	38	38[2]	23	23			
	40 Muller	21	38	38[2]	21	21			
	43 Carmody	19	37	37[1]	20	20			
	44 Skinner	18	35	35	19	19			
	50(B,A) Nowland	19	36	36[1]	20	20			
	262(A) Moses	25	36	36[1]	27	27			
	262(B) Moses	25	36	36[1]	27	27			
	262(C) Moses	23	37	37[1]	25	25			

Note 1: Marginal Noise Management Zone 1 to 2 dBA above project specific criteria.
Note 2: Moderate Noise Management Zone 3 to 5 dBA above project specific criteria.
Note 3: Noise Affectation Zone >5 dBA above project specific criteria (shaded).

Winter Night-time Noise Contours

The Year 2 night-time $L_{Aeq(15minute)}$ intrusive noise contours under adverse inversion and west wind are presented as **Appendix E1.** Note, the contour diagram presents adverse noise emissions to the Wambo Road, Warkworth Village, Gouldsville and Maison Dieu receiver localities. (The calculation of the noise contours involves numerical interpolation of a noise level array with a graphical accuracy of up to approximately ±2.5 dBA.)

Private Vacant Land

PlanningNSW does not consider vacant land to be noise affected in the absence of a dwelling. For indicative purposes, however, based on the noise contours presented above, exceedances of the project specific criteria estimated over 25% of the vacant land area is summarised in **Table 5.2.2.** Note the land owner's entitlement to construct a dwelling is unknown.

Table 5.2.2 Year 2 Vacant Land with Project Specific Criteria Exceedances (>25% Land Area)

Locality	1 dBA to 2 dBA above Project Specific Criteria	3 dBA to 5 dBA above Project Specific Criteria	>5 dBA above Project Specific Criteria
Wambo Road	Nil	Nil	9 Upward
Warkworth Village	Nil	14 Keys	23 Kannar 55 Burley
Gouldsville	Nil	Nil	Nil
Maison Dieu	136 Ernst 254 Algie	Nil	Nil
Redmanvale/ Pinegrove Roads	Nil	Nil	Nil
Golden Highway	Nil	Nil	Nil

5.3 Operation Year 7

Impact Assessment at Noise Sensitive Receivers

The predicted $L_{Aeq(15minute)}$ intrusive noise emissions from Year 7 operation to the nearest affected noise sensitive receivers are presented in **Table 5.3.1** together with the project specific assessment criteria. The table includes all known dwellings where project specific criteria are predicted to be exceeded and the St. Philips Anglican Church. An assessment of private vacant land is presented in **Table 5.3.2**.

Table 5.3.1 Year 7 Operation LAeq(15minute) Intrusive Emissions (dBA re 20 µpa)

Locality	Reference/ Land owner	Non-Adverse Annual	Adverse SE Wind Summer, Autumn, Spring		Adverse Inversion W Wind Winter		Project Specific Criteria		
		Day	Evening	Night	Evening	Night	Day	Evening	Night
Wambo Road	WA WCPL	31	32	32	42[3]	42[3]	35	35	35
	WB WCPL	29	30	30	40[2]	40[2]			
	WC WCPL	27	28	28	38[2]	38[2]			
	1 Brosi	25	25	25	33	33			
	2 Lambkin	25	22	22	35	35			
	3 Birrell	24	21	21	34	34			
	4(B) Circosta	22	19	19	33	33			
	5 Strachan	22	19	19	33	33			
	6 Merrick	20	17	17	32	32			
	7 Maizey	23	21	21	32	32			
	25 Fenwick	28	28	28	35	35			
	63 Abrocuff	20	17	17	31	31			
	91 Bailey	22	19	19	32	32			
	178 Smith	18	15	15	30	30			
	246 Bailey	20	17	17	31	31			
Wallaby Scrub Road	8(A) WML	25	22	22	35	35	Warkworth Mine Affectation Zone		
	8(B) WML	33	31	31	46	46			
	8(C,D,E) WML	27	23	23	40	40			
	8(G,F,H) WML	21	18	18	34	34			
	WD WCPL	40[1]	45[3]	45[3]	47[3]	47[3]	39	37	36
	WE WCPL	53[3]	57[3]	57[3]	57[3]	57[3]			
	WF WCPL	52[3]	55[3]	55[3]	56[3]	56[3]			
	11(E) Coal & Allied	47[3]	51[3]	51[3]	52[3]	52[3]			
Warkworth Village	19(B,A) Kelly	53[3]	57[3]	57[3]	57[3]	57[3]	40	38	38
	20 JPCT	47[3]	52[3]	52[3]	52[3]	52[3]	39	37	36
	21(A) Coal & Allied	54[3]	56[3]	56[3]	58[3]	58[3]			
	21(B) Coal & Allied	38	40[2]	40[2]	46[3]	46[3]			
	22 Henderson	40[1]	38[1]	38[1]	51[3]	51[3]			
	23(A) Kannar	49[3]	53[3]	53[3]	53[3]	53[3]			
	23(B) Kannar	47[3]	51[3]	51[3]	52[3]	52[3]			
	51 Hawkes	49[3]	45[3]	45[3]	56[3]	56[3]	38	36	36
	56 Haynes	52[3]	53[3]	53[3]	57[3]	57[3]	39	37	36
	St. Philips Anglican Church Internal[4] (with train loading)	38	37	Not in use	44[2]	Not in Use	40	40	Not in Use
	St. Philips Anglican Church Ground External[4] (with train loading)	48	47		54		50-55	50-55	
	St. Philips Anglican Church Internal[4] (without train loading)	26	25	Not in use	34	Not in Use	40	40	Not in Use
	St. Philips Anglican Church Ground External[4] (without train loading)	36	35		44		50-55	50-55	
Gouldsville	23(C) Kannar	16	12	12	35	35	38	38	38
	11(G) Coal & Allied	16	13	13	32	32	35	35	35
Maison Dieu	11(F) Coal & Allied	22	24	24	35	35	38	38	38
	94 Curlewis	23	24	24	34	34			
	254(A) Algie	24	25	25	34	34			

Note 1: Marginal Noise Management Zone 1 to 2 dBA above project specific criteria.
Note 2: Moderate Noise Management Zone 3 to 5 dBA above project specific criteria.
Note 3: Noise Affectation Zone >5 dBA above project specific criteria (shaded).
Note 4: LAeq(period) noise amenity level and criteria.

Table 5.3.1 Year 7 Operation $L_{Aeq(15minute)}$ Intrusive Emissions (dBA re 20 μpa) (Cont'd)

Locality	Reference/ Land owner	Non-Adverse Annual	Adverse SE Wind Summer, Autumn, Spring		Adverse Inversion W Wind Winter		Project Specific Criteria		
		Day	Evening	Night	Evening	Night	Day	Evening	Night
Redmanvale/ Pinegrove Roads	13(C)Skinner	33	43[3]	43[3]	36[1]	36[1]	35	35	35
	15(B) McGowen/ Caslick	18	39[2]	39[2]	17	17	35	36	35
	24 Long	41[3]	47[3]	47[3]	45[3]	45[3]	35	35	35
	30 Williams	16	37[1]	37[1]	15	15			
	33 Thelander/ O'Niell	19	39[2]	39[2]	18	18			
	37 Lawry	19	38[2]	38[2]	15	15			
	48 Ponder	17	38[2]	38[2]	16	16			
	49 Oliver	17	36[1]	36[1]	15	15			
	75 Barnes	17	36[1]	36[1]	15	15			
	137 Woodruff	17	35	35	15	15			
	163 Rodger/ Williams	16	35	35	15	15			
	188 Fuller	16	34	34	15	15			
Golden Highway	13(B) Skinner	22	35	35	21	21	39	40	35
	16 Cooper	28	39	39[2]	22	22			
	17 Carter	26	38	38[2]	21	21			
	18 Denney	26	38	38[2]	21	21			
	27 Birralee Feeds	25	37	37[1]	21	21			
	28(B,A) Garland	26	40	40[2]	21	21			
	31(A,B,C,D) Fisher	33	43[3]	43[3]	27	27			
	39 Northcote	31	40	40[2]	25	25			
	40 Muller	27	40	40[2]	22	22			
	43 Carmody	24	37	37[1]	21	21			
	44 Skinner	22	34	34	21	21			
	50(B,A) Nowland	23	36	36[1]	21	21			
	262(A) Moses	26	34	34	31	31			
	262(B) Moses	27	34	34	32	32			
	262(C) Moses	25	36	36[1]	32	32			

Note 1: Marginal Noise Management Zone 1 to 2 dBA above project specific criteria.
Note 2: Moderate Noise Management Zone 3 to 5 dBA above project specific criteria.
Note 3: Noise Affectation Zone >5 dBA above project specific criteria (shaded).

Summer, Autumn and Spring Evening/Night-time Noise Contours

The Year 7 evening/night-time $L_{Aeq(15minute)}$ intrusive noise contours under adverse southeast wind are presented as **Appendix E2** Note, the contour diagram presents adverse noise emissions to the Redmanvale/Pinegrove Roads and Golden Highway localities. (The calculation of the noise contours involves numerical interpolation of a noise level array with a graphical accuracy of up to approximately ±2.5 dBA.)

Private Vacant Land

PlanningNSW does not consider vacant land to be noise affected in the absence of a dwelling. For indicative purposes, however, based on the noise contours presented above, exceedances of the project specific criteria estimated over 25% of the vacant land area is summarised in **Table 5.3.2.** Note, the land owners entitlement to construct a dwelling is unknown.

Table 5.3.2 Year 7 Vacant Land with Project Specific Criteria Exceedances (>25% Land Area)

Locality	1 dBA to 2 dBA above Project Specific Criteria	3 dBA to 5 dBA above Project Specific Criteria	>5 dBA above Project Specific Criteria
Wambo Road	Nil	Nil	Nil
Warkworth Village	Nil	14 Keys	23 Kannar 55 Burley
Gouldsville	Nil	Nil	Nil
Maison Dieu	Nil	Nil	Nil
Redmanvale/ Pinegrove Roads	46 Ball	Nil	Nil
Golden Highway	Nil	28 Garland	Nil

5.4 Operation Year 9

Impact Assessment at Noise Sensitive Receivers

The predicted $L_{Aeq(15minute)}$ intrusive noise emissions from Year 9 operation to the nearest affected noise sensitive receivers are presented in **Table 5.4.1** together with the project specific assessment criteria. The table includes all known dwellings where the project specific criteria are predicted to be exceeded and the St. Philips Anglican Church. An assessment of private vacant land is presented in **Table 5.4.2**.

Table 5.4.1 Year 9 $L_{Aeq(15minute)}$ Intrusive Emissions (dBA re 20 µpa)

Locality	Reference/ Land owner	Non-Adverse Annual	Adverse SE Wind Summer, Autumn, Spring		Adverse Inversion W Wind Winter		Project Specific Criteria		
		Day	Evening	Night	Evening	Night	Day	Evening	Night
Wambo Road	WA WCPL	35	33	33	43[3]	43[3]	35	35	35
	WB WCPL	34	32	32	42[3]	42[3]			
	WC WCPL	32	30	30	40[2]	40[2]			
	1 Brosi	25	26	26	33	33			
	2 Lambkin	25	21	21	35	35			
	3 Birrell	24	21	21	35	34			
	4(B) Circosta	22	19	19	34	33			
	5 Strachan	21	18	18	34	33			
	6 Merrick	21	18	18	32	32			
	7 Maizey	21	18	18	32	32			
	25 Fenwick	29	29	29	35	35			
	35 Brosi	22	24	24	29	29			
	63 Abrocuff	20	17	17	32	31			
	91 Bailey	22	20	20	32	32			
	178 Smith	18	15	15	31	29			
	246 Bailey	19	16	16	30	30			
Wallaby Scrub Road	8(A) WML	25	21	21	35	35	Warkworth Mine Affectation Zone		
	8(B) WML	33	30	30	46	46			
	8(C,D,E) WML	26	22	22	41	41			
	8(G,F,H) WML	21	17	17	35	35			
Warkworth Village Suburban	WD WCPL	40[1]	45[3]	45[3]	47[3]	47[3]	39	37	36
	WE WCPL	53[3]	57[3]	57[3]	56[3]	56[3]			
	WF WCPL	52[3]	55[3]	55[3]	56[3]	56[3]			
	11(E) Coal & Allied	47[3]	51[3]	51[3]	52[3]	52[3]			
	19(B,A) Kelly	53[3]	57[3]	57[3]	56[3]	56[3]	40	38	38
	20 Jerrys Plains Coal Terminal	47[3]	52[3]	52[3]	52[3]	52[3]	39	37	36
	21(A) Coal & Allied	54[3]	56[3]	56[3]	58[3]	58[3]			
	21(B) Coal & Allied	37	40[2]	40[2]	46[3]	46[3]			
	22 Henderson	40	38[1]	38[1]	50[3]	50[3]			
	23(A) Kannar	49[3]	53[3]	53[3]	53[3]	53[3]			
	23(B) Kannar	47[3]	51[3]	51[3]	52[3]	52[3]			
	51 Hawkes	49[3]	45[3]	45[3]	56[3]	56[3]	38	36	36
	56 Haynes	52[3]	53[3]	53[3]	57[3]	57[3]	39	37	36
	St. Philips Anglican Church Internal[4] (with train loading)	38	37	Not in use	44[2]	Not in use	40	40	Not in use
	St. Philips Anglican Church Ground External[4] (with train loading)	48	47		54		50-55	50-55	
	St. Philips Anglican Church Internal[4] (without train loading)	25	27	Not in use	34	Not in use	40	40	Not in use
	St. Philips Anglican Church Ground External[4] (without train loading)	35	37		44		50-55	50-55	
Gouldsville	23(C) Kannar	15	12	12	35	35	38	38	38
	11(G) Coal & Allied	15	12	12	31	31	35	35	35
Mason Dieu	11(F) Coal & Allied	22	24	24	33	33	38	38	38
	94 Curlewis	23	24	24	33	33			
	254(A) Algie	24	25	25	34	34			

Note 1: Marginal Noise Management Zone 1 to 2 dBA above project specific criteria.
Note 2: Moderate Noise Management Zone 3 to 5 dBA above project specific criteria.
Note 3: Noise Affectation Zone >5 dBA above project specific criteria (shaded).
Note 4: LAeq(period) noise amenity level and criteria.

Table 5.4.1 Year 9 $L_{Aeq(15minute)}$ Intrusive Emissions (dBA re 20 μpa) (Cont'd)

Locality	Reference/ Land Owner	Non-Adverse Annual	Adverse SE Wind Summer, Autumn, Spring		Adverse Inversion W Wind Winter		Project Specific Criteria		
		Day	Evening	Night	Evening	Night	Day	Evening	Night
Redmanvale/ Pinegrove Roads	13(C) Skinner	31	39[2]	39[2]	31	31	35	35	35
	15(B) McGowen/ Caslick	18	40[2]	40[2]	18	18	35	36	35
	24 Long	40[2]	44[3]	44[3]	41[3]	41[3]	35	35	35
	30 Williams	16	38[2]	38[2]	16	16			
	33 Thelander/ O'Niell	19	40[2]	40[2]	18	18			
	37 Lawry	17	39[2]	39[2]	16	16			
	48 Ponder	17	39[2]	39[2]	17	17			
	49 Oliver	16	38[2]	38[2]	16	16			
	75 Barnes	16	38[2]	38[2]	16	16			
	137 Woodruff	16	37[1]	37[1]	15	15			
	163 Rodger/ Williams	17	37[1]	37[1]	16	16			
	188 Fuller	16	36[1]	36[1]	15	15			
Golden Highway	13(B) Skinner	19	34	34	22	22	39	40	35
	16 Cooper	25	40	40[2]	25	25			
	17 Carter	23	36	36[1]	23	23			
	18 Denney	23	37	37[1]	23	23			
	27 Birralee Feeds	22	37	37[1]	23	23			
	28(B,A) Garland	24	37	37[1]	24	24			
	31(A,B,C,D) Fisher	29	37	37[1]	30	30			
	39 Northcote	27	40	40[2]	27	27			
	40 Muller	25	37	37[1]	25	25			
	43 Carmody	22	35	35	23	23			
	44 Skinner	19	34	34	22	22			
	50(B,A) Nowland	21	35	35	23	23			
	262(A) Moses	23	33	33	28	28			
	262(B) Moses	23	33	33	29	29			
	262(C) Moses	22	35	35	29	29			

Note 1: Marginal Noise Management Zone 1 to 2 dBA above project specific criteria.
Note 2: Moderate Noise Management Zone 3 to 5 dBA above project specific criteria.
Note 3: Noise Affectation Zone >5 dBA above project specific criteria (shaded).

Summer, Autumn and Spring Evening/Night-time Noise Contours

The Year 9 evening/night-time $L_{Aeq(15minute)}$ intrusive noise contours under adverse southeast wind are presented as **Appendix E3**. Note, the contour diagram presents adverse noise emissions to the Redmanvale/Pinegrove Roads and Golden Highway localities. (The calculation of the noise contours involves numerical interpolation of a noise level array with a graphical accuracy of up to approximately ±2.5 dBA.)

Private Vacant Land

PlanningNSW does not consider vacant land to be noise affected in the absence of a dwelling. For indicative purposes, however, based on the noise contour diagram presented above, exceedance of the project specific criteria estimated over 25% of the vacant land area is summarised in **Table 5.4.2**. Note, the land owners existing entitlement to construct a dwelling is unknown.

Table 5.4.2 Year 9 Private Vacant Land with Project Specific Criteria Exceedances (>25% Land Area)

Locality	1 dBA to 2 dBA above Project Specific Criteria	3 dBA to 5 dBA above Project Specific Criteria	>5 dBA above Project Specific Criteria
Wambo Road	Nil	Nil	Nil
Warkworth Village	Nil	14 Keys	23 Kannar 55 Burley
Gouldsville	Nil	Nil	Nil
Maison Dieu	Nil	Nil	Nil
Redmanvale/ Pinegrove Roads	42 Redman 45 Mansfield 54 Nichols 95 Gee	46 Ball	Nil
Golden Highway	28 Garland	Nil	Nil

6 BLASTING IMPACT ASSESSMENT

6.1 Assessment Criteria

Structural Damage Criteria

AS 2187.2-1993 *"Explosives – Storage, Transport and Use – Part 2: Use of Explosives"* nominates structural damage assessment criteria as presented in **Table 6.1.1**.

Table 6.1.1 Blast Emission Structural Damage Assessment Criteria (AS 2187)

Structure Type	PVS Vibration Level(1)	Airblast Level (dB re 20 µPa)
Sensitive (and Heritage)	5 mm/s	133 dB(Linear) Peak
Residential	10 mm/s	133 dB(Linear) Peak
Commercial/Industrial	25 mm/s	133 dB(Linear) Peak

Note 1: PVS - Peak Vector Sum vibration velocity.

Residential Disturbance Daytime Criteria

The ground vibration and airblast levels which cause concern or discomfort to residents are generally lower than the relevant building damage limits.

The NSW EPA advocates the use of the ANZECC guidelines for assessing potential residential disturbance arising from blast emissions. The ANZECC guidelines for control of blasting impact at residences are as follows:

- The recommended maximum level for airblast is 115 dB Linear.
- The level of 115 dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dB Linear at any time.
- The recommended maximum for ground vibration is 5 mm/s, Peak Vector Sum (PVS) vibration velocity. It is recommended however, that 2 mm/s (PVS) be considered as the long-term regulatory goal for the control of ground vibration.
- The PVS level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 0900 hrs to 1700 hrs Monday to Saturday. Blasting should not take place on Sundays and public holidays.
- Blasting should generally take place no more than once per day.

The Australian Standard 2187.2-1993 does not present human comfort criteria for ground vibration from blasting. It does however make mention of human comfort level for airblast in saying the "a limit of 120 dB for human comfort is commonly used". This is consistent with the ANZECC guidelines.

Residential Disturbance Evening and Night-time Criteria

The assessment of blast emission impacts outside the hours advocated by the ANZECC remains according to the EPA's Environmental Noise Control Manual 1994) Chapter 154 Noise Control Guidelines – Blasting presented in **Table 6.1.2**. Note, the suggested time of blasting has been modified to be consistent with the ANZECC guidelines.

Table 6.1.2 Evening and Night-time Blast Emission Assessment Criteria

Time of Blasting	5% Exceedance Airblast Level (dB Linear)	5% Exceedance PPV Ground Vibration (mm/s)
Monday to Saturday 9.00 am - 5.00 pm	115	5
Monday to Saturday 6.00 am - 9.00 am and 5.00 pm - 8.00 pm	105	2
Sunday, Public Holidays 6.00 am - 8.00 pm	95	1
Any Day 8.00 pm - 6.00 am	95	1

6.2 Open-Cut Overburden and Box-Cut Extension

6.2.1 Blasting Practices

On average, 1.0 MBCM of overburden material will be extracted weekly requiring an average of 5 blasts per week (or approximately 260 blasts per year) for a period of 13 years.

Assessment of the potential impacts of ground-borne vibration and airblast emissions arising from the overburden blasting has been based on the blast design parameters presented in **Table 6.2.1.1**.

Table 6.2.1.1 Provisional Overburden Blast Design Parameters

Parameter	Typical Ranges
Burden and Spacing	5 m to 7 m and 5 m to 10 m
Hole Diameter	200 mm
Bench Height	5 to 24 m
Holes per Delay	Typically 2 holes
Explosive Type	ANFO or Emulsion
Explosive Mass	25 kg/m or 38 kg/m
Maximum Instantaneous Charge	MIC 1600 kg
Powder Factor	Typically 0.50 kg/m^3

The Wollemi box-cut extension will involve the extraction of overburden material over a 6 month period. The potential for blast emission impacts arising from the above open-cut practices is appreciably greater by comparison with the box-cut blasting. Hence, no further assessment of minor box-cut blasting is necessary.

6.2.2 Predicted Blast Emissions

In order to determine emissions at the nearest representative receivers, recent measured ground vibration and airblast levels from the WCM open-cut blasting monitoring programme were collated. The available ground vibration and airblast data was processed to determine the 5% exceedance site laws. By adopting the suggested design levels of blast vibration and airblast can be predicted using the site specific formula in each case.

The site specific prediction formulae used are as follows:

$$PVS\ (5\%) = 28.5\ (R/Q^{1/2})^{-0.61}$$
$$SPL\ (5\%) = 156.4 - 17.3(\log_{10}R - 0.33\ \log_{10}Q)$$

where,

PVS (5%)	=	5% exceedance Peak Vector Sum vibration velocity (mm/s)
SPL (5%)	=	5% exceedance peak airblast noise level (dB Linear)
R	=	Distance between charge and receiver (m)
Q	=	Charge mass per delay (kg)

6.2.3 Blast Emissions Assessment

The site specific formulae have been used to predict ground vibration and airblast emissions at a selection of the nearest potentially affected dwellings as presented in **Table 6.2.3.1**.

Table 6.2.3.1 Predicted Open-Cut 5% Exceedance Blast Emissions (MIC 1600 kg)

General Locality	Reference/ Land Holder	Midpoint Distance to Dwellings[1] (m)	PVS Vibration	Peak Linear Airblast (dB re 20 µPa)
Wambo Road	2 Lambkin	Year 13 - 4,500 m	1.6 mm/s	112 dBL
	25 Fenwick	Year 13 - 3,300 m	1.9 mm/s	114 dBL
Warkworth Village	19(B,A) Kelly	Year 1 - 3,400 m	1.9 mm/s	114 dBL
	51 Hawkes	Year 1 - 4,050 m	1.7 mm/s	113 dBL
	St. Philips Anglican Church and Cemetery	Year 1 - 4,150 m	1.7 mm/s	112 dBL
Gouldsville	23(C) Kannar	Year 1 - 7,600 m	<0.1 mm/s	<90 dBL
Maison Dieu	254(A) Algie	Year 1 - 7,900 m	<0.1 mm/s	<90 dBL
Golden Highway	17 Carter	Year 7 - 2,900 m	2.1 mm/s	115 dBL
	28(B,A) Garland	Year 7 - 2,700 m	2.2 mm/s	116 dBL
	31(B) Fisher	Year 7 - 1,500 m	3.1 mm/s	120 dBL
	40 Muller	Year 7 - 2,600 m	2.2 mm/s	116 dBL
	39 Northcote	Year 7 - 2,800 m	2.1 mm/s	115 dBL
	Catholic Cemetery	Year 7 - 4,400 m	1.7 mm/s	112 dBL
	St. Philips Anglican Cemetery	Year 7 - 5,100 m	1.5 mm/s	111 dBL
Redmanvale/ Pinegrove Roads	13(B) Skinner	Year 13 - 1,000 m	4.0 mm/s	123 dBL
	15(B) McGowen/ Caslick	Year 8 - 2,900 m	2.1 mm/s	115 dBL
	24 Long	Year 13 - 600 m	5.4 mm/s	127 dBL
	33 Thelander/O'Niell	Year 8 - 3,000 m	2.0 mm/s	115 dBL
	37 Lawry	Year 8 - 3,100 m	2.0 mm/s	115 dBL

Note 1: Based on planned production/mine progression.

The following assessments are derived from the predicted (maximum) levels of blast emissions and the assessment criteria presented in **Table 6.2.3.1**.

Structural Damage Criteria

- The 5% exceedance emission levels are below the building damage criteria of 10 mm/s and 133 dB Linear at all dwellings.
- Similarly, all emission levels are well below the damage criteria for heritage structures of 5 mm/s and 133 dB Linear at churches and cemeteries.

Human Comfort Vibration Criteria

- The 5% exceedance PVS vibration velocities are below the 5 mm/s criteria at all dwellings, except at 24 Long where the predicted vibration level is 5.4 mm/s.
- The recommended long-term regulatory target of 2 mm/s is also generally achieved at all dwellings except at 31(B) Fisher, 13(B) Skinner and 24 Long where the predicted vibration level is 3.1 mm/s, 4.0 mm/s and 5.4 mm/s respectively.
- The target of 2 mm/s can be achieved at 31(B) Fisher by detonating single holes per delay with a charge weight of approximately 410 kg per hole. Changes to the blast design to achieve compliance at 13(B) Skinner and 24 Long are unlikely to be practicable.

Human Comfort Airblast Criteria

- The 5% exceedance airblast levels are below the 115 dBL criteria at all dwellings except 40 Muller, 28(B, A) Garland, 31(B) Fisher, 13(C) Skinner and 24 Long where the predicted airblast levels are 116 dBL, 116 dBL, 120 dBL, 123 dBL and 127 dBL respectively.
- The 115 dBL criteria can be achieved at 40 Muller, 28(B, A) Garland and 31(B) Fisher by detonating single holes per delay with a charge weight of approximately 260 kg per hole. Changes to the blast design to achieve compliance at 13(C) Skinner and 24 Long are unlikely to be practicable.

6.3 Underground Blasting

6.3.1 Blasting Practice

The Wambo Seam requires excavation blasting to develop drift access from the existing Wollemi portal. Similarly, the Arrowfield and Bowfield Seams require excavation blasting to establish drift access in the vicinity of the CHPP. Underground blasting will be conducted 24 hours per day over a cumulative period of approximately 18 months. Note, any surface blasting required to establish portal(s) would be confined to daytime.

Ground-borne vibration and airblast emissions arising from drift access (and portal) blasting has been based on the blast design parameters presented in **Table 6.3.1.1**.

Table 6.3.1.1 Provisional Portal and Drift Blast Design Parameters

Parameter	Typical Ranges
Face	6 m x 5 m
Pull	3 m
Holes per delay	Typically 8 holes
Hole Diameter	38 mm
Explosive Type	Packaged
Explosive Mass	1 kg/m
Maximum Instantaneous Charge	MIC 24 kg
Powder Factor	Typically 0.80 kg/m^3

6.3.2 Predicted Blast Emission Levels

By adopting the suggested design, the levels of blast vibration and airblast were predicted using the relevant vibration prediction formula in AS 2187.2-1993 (applicable heavily confined blasting) and the predictive airblast formula advocated by ICI Australia.

The relevant formulae used are as follows:

PVS (5%) = $5000\ (R/Q^{1/2})^{-1.60}$
SPL (5%) = $164.2 - 24(\log_{10}R - 0.33\ \log_{10}Q)$

where,

PVS (5%) = 5% exceedance Peak Vector Sum vibration velocity (mm/s)
SPL (5%) = 5% exceedance peak airblast noise level (dB Linear)
R = Distance between charge and receiver (m)
Q = Charge mass per delay (kg)

6.3.3 Blast Emissions Assessment

The standard formulae have been used to predict ground vibration and airblast emissions at a selection of the nearest potentially affected dwellings as presented in **Table 6.3.3.1**.

Table 6.3.3.1 Predicted Underground 5% Exceedance Blast Emissions (MIC 24 kg)

General Locality	Reference/ Land Holder	PVS Vibration (mm/s)		Peak Linear Airblast (dB re 20 µPa)			
		Arrowfield	Wambo	Arrowfield		Wambo	
		Portal/Drift	Portal/Drift	Portal	Drift[1]	Portal	Drift[1]
Wambo Road	2 Lambkin	<0.1	<0.1	<90	<90	<90	<90
	25 Fenwick	0.1	<0.1				
Warkworth Village	19(B,A) Kelly	0.9	0.1	102	92	<90	<90
	51 Hawkes	0.6	0.1	100	90		
	St. Philips Anglican Church/ Cemetery	0.4	0.1	97	<90		
Gouldsville	23(C) Kannar	<0.1	<0.1	<90	<90	<90	<90
Maison Dieu	254(A) Algie	<0.1	<0.1	<90	<90	<90	<90
Golden Highway	31(B) Fisher	<0.1	0.1	<90	<90	<90	<90
	40 Muller	<0.1	<0.1				
	Cemeteries	<0.1	<0.1				
Redmanvale/ Pinegrove Roads	13(C) Skinner	<0.1	<0.1	<90	<90	<90	<90
	15(B) McGowen/ Caslick	<0.1	<0.1				
	24 Long	0.1	<0.1				

Note 1: Predicted airblast following portal establishment and initial underground drift advance.

The following assessments are derived from the predicted (maximum) levels of blast emissions and the assessment criteria presented in **Table 6.3.3.1**.

Structural Damage Criteria

- The 5% exceedance emission levels are below the damage criteria of 10 mm/s and 133 dB Linear at all dwellings.
- Similarly, all emission levels are well below the damage criteria for heritage structures of 5 mm/s and 133 dB Linear at churches and cemeteries.

Human Comfort Vibration Criteria

- The 5% exceedance PVS vibration velocities are well below the 5mm/s criterion at all receivers during daytime portal and drift blasting.
- Similarly, vibration velocities are below the 1 mm/s criterion at all receivers during night-time drift blasting.

Human Comfort Airblast Criteria

- The 5% exceedance airblast levels are well below the 115 dB Linear criterion at all receivers during daytime portal and drift blasting.
- Similarly, airblast levels are below the 95 dB Linear criterion at all dwellings during night-time drift blasting following portal establishment and initial underground drift advance.

7 ROAD TRANSPORTATION ASSESSMENT

7.1 Traffic Noise Criteria

As presented in **Section 1.1**, WCPL has existing consent to transport coal along approved transportation routes to the MTCL. Moreover, project related product coal road transportation is expected to cease once the Train Loading System is operational (expected to be at the end of Year 2).

Based on the EPA's "*Environmental Criteria for Road Traffic Noise*" policy (ECRTN) dated May 1999, the Golden Highway is classified as an "arterial road". The applicable noise criteria are presented in **Table 7.1.1**.

Table 7.1.1 EPA Environmental Criteria for Road Traffic Noise

Road	Policy	Descriptor	Traffic Noise Goal
Golden Highway	Land use developments with the potential to create additional traffic existing on freeways/arterials	Daytime $L_{Aeq(15hour)}$	60 dBA
		Night-time $L_{Aeq(9hour)}$	55 dBA

Note, in all cases (where the nominated criteria are already exceeded), traffic associated with the development should not lead to an increase in the existing noise traffic levels of more than 2 dBA.

7.2 Traffic Noise Assessment Methodology

The nearest dwellings along the Golden Highway in the vicinity of the Project are presented in **Table 7.2.1**.

Table 7.2.1 Nearest Dwellings along the Golden Highway

Locality	Land Owner	Estimated Offset Distance (m)	Estimated Relative Elevation (m)
Warkworth Village	10 WCPL	25	0
	11(E) Coal & Allied	70	-10
	19(B,A) Kelly	80	+2
	20 Jerrys Plains Coal Terminal	20	0
	21(A) Coal & Allied	100	0
Golden Highway	13(A) Skinner	60	+12
	16 Cooper	+100	+15
	18 Denney	100	+8
	27 Birralee Feeds	25	10
	28(B,A) Garland	40	0
	31(D) Fisher	+100	+10 to +15
	43 Carmody	40	-5

In order to determine the existing traffic noise levels in the absence of (significant) existing WCM vehicles, traffic noise measurements were conducted at Location 31(A,B,C,D) Fisher at an offset distance of 20 m from the Golden Highway (refer **Section 3.1**). The unattended traffic noise data together with the on-site weather data and traffic counts are presented as **Appendix C9**. The traffic noise data was then processed in accordance with the requirements of the EPA's ECRTN to derive the Monday to Sunday traffic noise levels presented in **Table 7.2.2**.

Table 7.2.2 Golden Highway Traffic Noise Location 31(A,B,C,D) Fisher December 2002 (dBA re 20 μPa)

Locality	Land Owner	Daytime/Evening LAeq(15hour)	Night-time LAeq(9hour)
Golden Highway	31(A,B,C,D) Fisher (20 m from road)	67 dBA	64 dBA

Note 1: Noise levels include 2.5 dB correction from free field to facade.

It is concluded that existing traffic noise levels at the nearest dwellings (ie 20 m) to the Golden Highway in some cases already exceed the guideline criteria in the absence of significant existing WCM vehicles. Therefore, any increase in traffic noise due to the Project should be limited to a marginal 2dBA at the nearest properties to the Golden Highway and conservatively at all other dwellings. This requirement is achieved when the Project related percentage increase in existing light and heavy vehicle movements is no greater than 60%.

7.3 Traffic Noise Impact Assessment

The average annual daytime vehicle movements are presented in **Table 7.3.1**.

Table 7.3.1 Golden Highway Average Annual Daytime Traffic Movements

Locality	Traffic	Existing[1]	Project Year 1 to 2	Project Related Change	Project Year >2	Project Related Change
At Pinegrove Road	Light	1744	1754	0.6%	1764	1.2%
	Heavy	293	293	0.0%	293	0.0%
	Total	2037	2048	0.5%	2057	1.0%
West of WCM Access	Light	2405	2415	0.4%	2425	0.8%
	Heavy	982	982	0.0%	982	0.0%
	Total	3387	3398	0.3%	3407	0.6%
East of WCM Access Road	Light	2218	2313	4.3%	2399	8.2%
	Heavy	1169	1221	4.5%	783	-33.0%
	Total	3387	3534	4.3%	3182	-6.1%

Note 1: Further reductions in non-project heavy vehicle movements may occur with increased utilisation of the Jerrys Plains Coal Terminal.

As shown above, the daytime Project related percentage increase in vehicle movements is less than 60% in all cases and hence the resulting increase in traffic noise is below than 2 dBA.

The average annual night-time vehicle movements are presented in **Table 7.3.2**.

Table 7.3.2 Golden Highway Average Annual Night-time Traffic Movements

Locality	Traffic	Existing[1]	Project Year 1 to 2	Project Related Change	Project Year >2	Project Related Change
At Pinegrove Road	Light	213	223	5.0%	233	9.5%
	Heavy	50	50	0.0%	50	0.0%
	Total	263	273	4.0%	283	7.6%
West of WCM Access	Light	271	281	3.9%	291	7.4%
	Heavy	166	166	0.0%	166	0.0%
	Total	437	448	2.4%	457	4.6%
East of WCM Access Road	Light	636	731	14.9%	817	28.5%
	Heavy	433	441	1.8%	395	-8.8%
	Total	1069	1171	9.6%	1212	13.4%

Note 1: Further reductions in non-project heavy vehicle movements may occur with increased utilisation of the Jerrys Plains Coal Terminal.

Similarly, the night-time Project related percentage increases in vehicle movements are less than 60% in all cases and hence the resulting increase in traffic noise is well below 2 dBA.

8 RAIL TRANSPORTATION VIBRATION

8.1 Assessment Criteria and Train Movements

Structural Damage Criteria

German Standard DIN 4150-3 1999 "*Structural Vibration Part 3: Effects of Vibration on Structures*" provides criteria for evaluating the long-term (or continuous) effects of vibration on structures as presented in **Table 8.1.1**.

Table 8.1.1 Continuous Vibration Criteria for Long-term Effects on Structures (DIN 4150-3)

Line	Type of Structure	Vibration velocity in horizontal plane
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	10.0 mm/s
2	Dwellings and buildings of similar design and/or occupancy	5.0 mm/s
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (eg listed buildings under preservation order)	2.5 mm/s

Nearest Structures and Dwellings

As discussed in **Section 2.6**, product coal will be transported off-site using nominal 8,600 t capacity trains requiring an average of approximately four (4) train events (ie four arrivals and four departures) per day.

The Wambo Rail Spur/Loop Plan is shown in Appendix B6. The nearest potentially affected structures to the proposed rail line are presented in **Table 8.1.2**.

Table 8.1.2 Nearest Structures to the Rail Spur/Loop

Structure/Dwelling	Spur	Loop
St. Philips Anglican Church	400 m	300 m
22 Henderson (Dwelling)	100 m	600 m

8.2 Predicted Vibration Levels and Assessment

The vibration levels arising from locomotive powered freight trains can be predicted based on the "Generalized Ground Surface Vibration Curves" presented in the *"Transit Noise and Vibration Impact Assessment"* dated April 1995 prepared for the US Department of Transportation. It is noteworthy that the predicted levels of vibration using these curves compare favourably with the measured levels presented in United Collieries Extension EIS dated 2002.

The predicted peak vibration velocities are presented in **Table 8.2.1** together with the relevant assessment criteria.

Table 8.2.1 Predicted Train Generated Peak Component Vibration Levels

Structure/ Dwelling	Near Point Distance	Train Passby Speed		Vibration Criteria
		10 km/hr	30 km/hr	
St. Philips Anglican Church	300 m	<0.03 mm/s	<0.09 mm/s	2.5 mm/s
22 Henderson Dwelling	100 m	0.03 mm/s	0.09 mm/s	5.0 mm/s

Structural Damage Assessment

- The predicted peak component vibration levels are well below the most stringent damage criterion of 2.5 mm/s applicable to the church and its amenities.
- Similarly, the vibration levels are also well below the damage criterion of 5 mm/s applicable to dwellings.

9 CUMULATIVE MINE NOISE IMPACT ASSESSMENT

The Project Plan (**Appendix A2)** shows the extent of existing mining operations in the vicinity of the Project site. Existing and approved mining operations include the Warkworth Coal Mine, United Colliery and Hunter Valley operations. A summary of Development Consent Conditions with respect to noise is attached as **Appendix F**.

In order to assess any cumulative noise impacts, it is important to appreciate and distinguish between the INP's first and second environmental noise control objectives as follows:

Intrusive Noise Criteria $L_{Aeq(15minute)}$

The INP's first objective, that the intrusive noise emission from any single source does not exceed the background level by more than 5dBA, relates to individual industrial sites where the intrusive noise limit is generally specified in the Development Consent and/or Pollution Control Licence.

There is no established procedure (or regulatory requirement) to derive intrusive $L_{Aeq(15minute)}$ noise criteria for the cumulative operation of existing and/or approved industrial developments in a locality.

Noise Amenity Criteria $L_{Aeq(period)}$

The INP's second objective, that the $L_{Aeq(period)}$ amenity level (ie non-transport related) does not to exceed the specified "acceptable" or "maximum" noise level appropriate for the particular locality and land use, is aimed at restricting the potential cumulative increase in amenity noise levels otherwise known as "background creep".

The INP based acceptable and maximum noise amenity criteria for the six (6) assessment localities are summarised in **Table 9.1**.

Table 9.1 NSW INP (2000) Project Specific Noise Assessment Criteria (dBA re 20 µPa)

Locality	Land Use	Project Specific Assessment Criteria					
		Amenity $L_{Aeq(period)}$[1] Acceptable			Amenity $L_{Aeq(period)}$[1] Maximum		
		Day	Evening	Night	Day	Evening	Night
Wambo Road	Rural Residential	50	45	40	55	50	45
Warkworth Village	Suburban Residential	55	45	40	60	50	45
Gouldsville	Suburban Residential	55	45	40	60	50	45
Maison Dieu	Suburban Residential	55	45	40	60	50	45
Redmanvale/ Pinegrove Roads	Rural Residential	50	45	40	55	50	45
Golden Highway	Suburban Residential	55	45	40	60	50	45

Note 1: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours, Night-time 2200 hours to 0700 hours.

Cumulative Mine Noise Assessment

The potential for the simultaneous operation of adjoining mine developments to exceed the acceptable and maximum noise amenity criteria can be assessed on a worst case scenario basis by adding the anticipated intrusive noise limits from the Wambo Development Project and Warkworth mines, together with the approved noise limits from the United, Hunter Valley and Carrington Coal Mine Consents. The cumulative intrusive level is then adjusted to the equivalent amenity level for comparison with the criteria presented in **Table 9.1.** Note, this is clearly a worst case assessment as it assumes that all mines simultaneously emit their maximum noise emission to a common receiver locality during non-adverse or adverse weather conditions.

The cumulative mine noise amenity levels during non-adverse and adverse weather conditions are presented in **Tables 9.2 to 9.7** respectively for the six (6) assessment localities.

Table 9.2 Non-Adverse/Adverse Cumulative Noise Amenity - Wambo Road, Rural

General Locality	Operating Period	Project LAeq(15minute)	Warkworth[1] LAeq(15minute)	Other LAeq(15minute)	Cumulative LAeq(period) Amenity Level	Cumulative LAeq(period) Amenity Criteria
Wambo Road	Daytime	35/40	35/40	Nil	35/40	50-55
	Evening	35/40	36/40	Nil	35/40	45-50
	Night-time	35/40	35/40	Nil	35/40	40-45

Note 1: Anticipated noise limits under adverse conditions based on the Warkworth Coal Mine Extension EIS dated August 2002.

Table 9.3 Non-Adverse/Adverse Cumulative Noise Amenity - Warkworth Suburban

General Locality	Operating Period	Project LAeq(15minute)	Warkworth[1] LAeq(15minute)	United LAeq(15minute)	Cumulative LAeq(period) Amenity Level	Cumulative LAeq(period) Amenity Criteria
Warkworth Village	Daytime	39/44	35/40	35/40	38/43	55-60
	Evening	38/42	36/41	32/37	37/42	45-50
	Night-time	36/41	35/40	32/37	36/41	40-45

Note 1: Anticipated noise limits under adverse conditions based on the Warkworth Coal Mine Extension EIS dated August 2002.

Table 9.4 Non-Adverse/Adverse Cumulative Noise Amenity - Gouldsville Suburban

General Locality	Operating Period	Project LAeq(15minute)	Warkworth[1] LAeq(15minute)	United LAeq(15minute)	Cumulative LAeq(period) Amenity Level	Cumulative LAeq(period) Amenity Criteria
Gouldsville	Daytime	38/43	38/43	38/43	40/45	55-60
	Evening	38/43	38/43	38/43	40/45	45-50
	Night-time	38/43	38/43	38/43	39/44	40-45

Note 1: Anticipated noise limits under adverse conditions based on the Warkworth Coal Mine Extension EIS dated August 2002.

Table 9.5 Non-Adverse/Adverse Cumulative Noise Amenity - Maison Dieu Suburban

General Locality	Operating Period	Project LAeq(15minute)	Warkworth[1] LAeq(15minute)	United LAeq(15minute)	Cumulative LAeq(period) Amenity Level	Cumulative LAeq(period) Amenity Criteria
Maison Dieu	Daytime	38/43	35/40	38/43	39/44	55-60
	Evening	38/43	35/40	38/43	39/44	45-50
	Night-time	38/43	35/40	38/43	38/43	40-45

Note 1: Anticipated noise limits under adverse conditions based on the Warkworth Coal Mine Extension EIS dated August 2002.

Table 9.6 Non-Adverse/Adverse Cumulative Noise Amenity - Golden Highway Suburban

General Locality	Operating Period	Project LAeq(15minute)	Hunter Valley LAeq(15minute)	Carrington LAeq(15minute)	Cumulative LAeq(period) Amenity Level	Cumulative LAeq(period) Amenity Criteria
Golden Highway Suburban	Daytime	39/44	38/43	38/43	40/45	55-60
	Evening	40/45	38/43	38/43	40/45	50-55
	Night-time	35/40	33/38	33/38	35/40	40-45

Table 9.7 Non-Adverse/Adverse Cumulative Noise Amenity - Redmanvale and Pinegrove Roads Rural

General Locality	Operating Period	Project LAeq(15minute)	Hunter Valley LAeq(15minute)	Carrington LAeq(15minute)	Cumulative LAeq(period) Amenity Level	Cumulative LAeq(period) Amenity Criteria
Redmanvale/ Pinegrove Roads	Daytime	35/40	38/43	38/43	39/44	55-60
	Evening	35/40	38/43	38/43	39/44	50-55
	Night-time	35/40	33/38	33/38	35/40	40-45

At all six (6) assessment localities the non-adverse cumulative noise emissions from the Project and adjoining mines are below the relevant acceptable amenity criteria for industrial noise (ie non-transport related) during the daytime, evening and night-time.

Similarly, at all six (6) assessment localities the "worst case" adverse cumulative noise emissions from the Project and adjoining mines are below the relevant maximum amenity criteria for industrial noise. The likelihood that all mines simultaneously emit their maximum noise emissions under adverse weather conditions to any one receiver locality is minimal.

10 SUMMARY OF FINDINGS

10.1 Construction Noise Impact Assessment

Construction activities associated with CHPP upgrade, Rail Spur/Loop and Train Loading System will be carried out simultaneously with the existing (approved) mining operations over a 12 month period. Construction activities will occur during the daytime only. As the duration of the construction activities are greater than 6 months, the background noise level should generally not be exceeded by more than 5 dBA.

At the completion of the construction activity, mobile and fixed plant utilisation will increase towards the end of Year 2. Hence, the daytime noise impact arising from the expanded mining operation at the end of Year 2 is significantly greater in comparison to the daytime construction scenario.

10.2 Operating Noise Impact Assessment

Assessment Methodology and Criteria

The INP-based intrusive and amenity noise assessment criteria at the six (6) assessment localities are presented in **Table 10.2.1**. These criteria are nominated for the purposes of assessing potential noise impacts from the Project. Note, the $L_{Aeq(15minute)}$ intrusive criteria are the controlling noise limits at all residential receivers.

Table 10.2.1 NSW INP (2000) Project Specific Noise Assessment Criteria (dBA re 20 µPa)

Locality	Land Owner	Project Specific Assessment Criteria					
		Intrusive LAeq(15minute)			Amenity LAeq(period)[1]		
		Day	Evening	Night	Day	Evening	Night
Wambo Road (INP Rural)	2 Lambkin	35	35	35	50	45	40
	25 Fenwick	35	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Warkworth Village (INP Suburban)	19(B,A) Kelly	40	38	38	55	45	40
	51 Hawkes	38	36	36	55	45	40
	56 Haynes	39	37	36	55	45	40
	Other Residential	39	37	36	55	45	40
INP Place of Worship	St Philips Anglican Church (Internal)	Intrusive criteria apply only to residential receivers		Not in use	40	40	Not in use
INP Passive/Active Recreation Area	St Philips Anglican Church Grounds (External)				50-55	50-55	
Gouldsville[2] (INP Suburban)	23(C) Kannar and Redbank Area	38	38	38	55	45	38
	Other Residential	35	35	35	55	45	40
Maison Dieu (INP Suburban)	124 Bowman	38	38	38	55	45	40
	Other Residential	38	38	38	55	45	40
Redmanvale/ Pinegrove Roads (INP Rural)	15(B) McGowen/Caslick	35	36	35	50	45	40
	24 Long	36	35	35	50	45	40
	Other Residential	35	35	35	50	45	40
Golden Highway (INP Suburban)	31(D) Fisher	39	40	35	55	45	40
	Other Residential	39	40	35	55	45	40

Note 1: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours, Night-time 2200 hours to 0700 hours.
Note 2: Referenced to Warkworth Coal Mine Extension EIS Monitoring Locations.

In view of the foregoing, **Table 10.2.2** presents the methodology for assessing noise levels which may exceed the INP project specific noise assessment criteria.

Table 10.2.2 Project Noise Impact Assessment Methodology

Assessment Criteria	Project Specific Criteria	Noise Management Zone		Noise Affectation Zone
		Marginal	Moderate	
Intrusive LAeq(15minute)	Rating background level plus 5 dBA	1 to 2 dBA above project specific criteria	3 to 5 dBA above project specific criteria	>5 dBA above project specific criteria
Amenity LAeq(period)	INP based on existing industrial level			

Note 1: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours, Night-time 2200 hours to 0700 hours.
Note 2: Referenced to Warkworth Coal Mine Extension EIS Monitoring Locations.

Noise Impact Summary on Privately Owned Dwellings

Based on the predicted $L_{Aeq(15minute)}$ intrusive noise emissions for Years 2, 7 and 9, **Table 10.2.3** presents a summary of all known private dwellings where the project specific criteria are anticipated to be exceeded. An assessment of private vacant land is presented in **Table 10.2.5**.

Table 10.2.3 Private Dwellings within Noise Management and Affectation Zones

Locality	**Period**	**Noise Management Zone**		**Noise Affectation Zone**
		1 dBA to 2 dBA above Project Specific Criteria	**3 dBA to 5 dBA above Project Specific Criteria**	**>5 dBA above Project Specific Criteria**
Wambo Road	Non-Adverse[1] Annual Daytime	Nil	Nil	Nil
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	Nil	Nil	Nil
	Adverse W Wind and Inversion[3] Winter Evening/Night	35 Brosi 178 Smith 246 Bailey	1 Brosi 3 Birrell 4(B) Circosta 5 Strachan 6 Merrick 7 Maizey 25 Fenwick 63 Abrocuff 91 Bailey	2 Lambkin
Warkworth Village	Non-Adverse[1] Annual Daytime	Nil	22 Henderson	19(B,A) Kelly 23(A) Kannar 23(B) Kannar 51 Hawkes 56 Haynes
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	Nil	22 Henderson	19(B,A) Kelly 23(A) Kannar 23(B) Kannar 51 Hawkes 56 Haynes
	Adverse W Wind and Inversion[3] Winter Evening/Night	Nil	Nil	19(B,A) Kelly 22 Henderson 23(A) Kannar 23(B) Kannar 51 Hawkes 56 Haynes

Note 1: Non-adverse - Annual wind speed 0 m/s and temperature gradient 0°C/100 m.
Note 2: Adverse - Summer Autumn, Spring, wind speed 3 m/s southeast and temperature gradient 0°C/100 m.
Note 3: Adverse - Winter wind speed 2 m/s west and temperature gradient 3°C/100 m.

Table 10.2.3 Private Dwellings within Noise Management and Affectation Zones (Cont'd)

Locality	Period	Noise Management Zone: 1 dBA to 2 dBA above Project Specific Criteria	Noise Management Zone: 3 dBA to 5 dBA above Project Specific Criteria	Noise Affectation Zone: >5 dBA above Project Specific Criteria
Gouldsville	Non-Adverse[1] Annual Daytime	Nil	Nil	Nil
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	Nil	Nil	Nil
	Adverse W Wind & Inversion[3] Winter Evening/Night	23(C) Kannar	Nil	Nil
Maison Dieu	Non-Adverse[1] Annual Daytime	Nil	Nil	Nil
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	Nil	Nil	Nil
	Adverse W Wind & Inversion[3] Winter Evening/Night	254(A) Algie	94 Curlewis	Nil
Redmanvale/ Pinegrove Roads	Non-Adverse[1] Annual Daytime	Nil	Nil	24 Long
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	137 Woodruff 163 Rodger/Williams 188 Fuller	15(B)McGowen/Caslick 30 Williams 33 Thelander/O'Niell 37 Lawry 48 Ponder 49 Oliver 75 Barnes	13(C) Skinner 24 Long
	Adverse W Wind & Inversion[3] Winter Evening/Night	13(C) Skinner	Nil	24 Long
Golden Highway	Non-Adverse[1] Annual Daytime	Nil	Nil	Nil
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	13(B) Skinner 27 Birralee 43 Carmody 262(A) Moses 262(B) Moses 262(C) Moses	16 Cooper 17 Carter 18 Denney 28(B,A) Garland 39 Northcote 40 Muller 50(B,A) Nowland	31(A,B,C,D) Fisher
	Adverse W Wind & Inversion[3] Winter Evening/Night	Nil	Nil	Nil

Note 1: Non-adverse - Annual wind speed 0 m/s and temperature gradient 0°C/100 m.
Note 2: Adverse - Summer Autumn, Spring, wind speed 3 m/s southeast and temperature gradient 0°C/100 m.
Note 3: Adverse - Winter wind speed 2 m/s west and temperature gradient 3°C/100 m.

Noise Impact Summary on Mine Owned Dwellings

Based on the predicted $L_{Aeq(15minute)}$ intrusive noise emissions for Years 2, 7 and 9, **Table 10.2.4** presents a summary of all known mine owned dwellings where the project specific criteria are predicted to be exceeded.

Table 10.2.4 Mine Owned Dwellings within Noise Management and Affectation Zones

Locality	Period	Noise Management Zone		Noise Affectation Zone
		1 dBA to 2 dBA above Project Specific Criteria	3 dBA to 5 dBA above Project Specific Criteria	>5 dBA above Project Specific Criteria
Wambo Road	Non-Adverse[1] Annual Daytime	WA WCPL WB WCPL WC WCPL	Nil	Nil
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	WB WCPL WC WCPL	Nil	Nil
	Adverse W Wind and Inversion[3] Winter Evening/Night	Nil	Nil	Nil
Wallaby Scrub Road	Non-Adverse[1] Annual Daytime	Existing Warkworth Mine Affectation Zone. No project specific criteria have been established. Project noise emissions during the winter evening and night-time are predicted to be greater than 40 dBA at 8(A), 8(B), 8(C) 8(D), 8(E), 8(F), 8(G) and 8(H).		
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night			
	Adverse W Wind and Inversion[3] Winter Evening/Night			
Warkworth Village	Non-Adverse[1] Annual Daytime	WD WCPL 21(B) Coal & Allied	Nil	WE WCPL WF WCPL 11(E) Coal & Allied 20 JPCT 21(A) Coal & Allied
	Adverse SE Wind[2] Summer, Autumn, Spring Evening/Night	Nil	Nil	WD WCPL WE WCPL WF WCPL 11(E) Coal & Allied 20 JPCT 21(A) Coal & Allied 21(B) Coal & Allied
	Adverse W Wind and Inversion[3] Winter Evening/Night	Nil	Nil	WD WCPL WE WCPL WF WCPL 11(E) Coal & Allied 20 JPCT 21(A) Coal & Allied 21(B) Coal & Allied
Gouldsville	Adverse W Wind and Inversion[3] Winter Evening/Night	11(G) Coal & Allied	Nil	Nil
Maison Dieu	Adverse W Wind and Inversion[3] Winter Evening/Night	Nil	11(F) Coal & Allied	Nil

Note 1: Non-adverse - Annual wind speed 0 m/s and temperature gradient 0°C/100 m.
Note 2: Adverse - Summer Autumn, Spring, wind speed 3 m/s southeast and temperature gradient 0°C/100 m.
Note 3: Adverse - Winter wind speed 2 m/s west and temperature gradient 3°C/100 m.

Noise Impact Summary on Private Vacant Land

PlanningNSW does not consider vacant land to be noise affected in the absence of a dwelling. For indicative purposes however, based on the noise contours attached as **Appendices E1, E2 and E3**, **Table 10.2.5** presents a summary of private land owners where the project specific criteria are estimated to be exceeded over 25% of the vacant land area. Note, the land owner's current entitlement to construct a dwelling is unknown.

Table 10.2.5 Private Vacant Land within Noise Management and Affectation Zones (>25% Land Area)

Locality	1 dBA to 2 dBA above Project Specific Criteria	3 dBA to 5 dBA above Project Specific Criteria	>5 dBA above Project Specific Criteria
Wambo Road	Nil	Nil	9 Upward
Warkworth Village	Nil	14 Keys	23 Kannar 55 Burley
Gouldsville	Nil	Nil	Nil
Maison Dieu	136 Ernst 254 Algie	Nil	Nil
Redmanvale/ Pinegrove Roads	42 Redman 45 Mansfield 54 Nichols 95 Gee	46 Ball	Nil
Golden Highway	Nil	28 Garland	Nil

Procedure for General Terms of Approval

It is recommended noise limits for General Terms of Approval (GTA) be determined on a land owner by land owner basis according to the following procedure:

- Where the predicted noise emission is less than (or equal to) the project specific criteria then the project specific criteria is the GTA noise limit.
- Where the predicted noise emission is within the noise management zone then the predicted noise level is applied as the achievable GTA noise limit.
- Where the predicted noise emission is within the noise affectation zone then the upper limiting level applying to the noise management zone is the GTA noise limit.

Based on the above procedure the recommended GTA operating noise limits are presented in **Table 10.2.6**. The operating noise limits reflect the achievable noise emissions, including the noise mitigation measures, presented in this assessment.

Table 10.2.6 Nearest Potentially Affected Land Owners - Recommended Operating Noise Limits

General Locality	Reference/ Land Owner	NSW INP (2000) Noise Amenity Area	LAeq(15minute) Intrusive Noise Emission		
			Non-Adverse[2]	Adverse W Wind Inversion[3]	
			Daytime	Evening	Night
Wambo Road	WA WCPL	Rural	36	40	40
	WB WCPL		38	40	40
	WC WCPL		38	40	40
	1 KM & CM Brosi		35	38	38
	2 W & D Lambkin		35	40	40
	3 HM Birrell		35	40	40
	4(B) IF & MA Circosta		35	40	40
	5 DS & DL Strachan		35	39	39
	6 HD Merrick		35	39	39
	7 DC & EM Maizey		35	39	39
	25 RW Fenwick & AM Frost		35	40	40
	35 GJ Brosi		35	36	36
	63 Abrocuff Pty Ltd		35	38	38
	91 CL Bailey		35	38	38
	178 KJ & NL Smith		35	36	36
	246 RG & FS Bailey		35	37	37
	Other Residential		35	35	35
Wallaby Scrub Road	8(A) WML	Suburban	Warkworth Mine Affectation Zone		
	8(B) WML				
	8(C,D,E) WML				
	8(G,F,H) WML				
Warkworth Village	WD WCPL	Suburban	41	42	41
	WE WCPL		44	42	41
	WF WCPL		44	42	41
	11(E) Coal & Allied		44	42	41
	19(B,A) L Kelly		45	43	43
	20 JPCT		44	42	41
	21(A) Coal & Allied		44	42	41
	21(B) Coal & Allied		40	42	41
	22 OJ Henderson		42	42	41
	23(A) HE Kannar		44	42	41
	23(B) HE Kannar		44	42	41
	51 CM Hawkes Pty Ltd		43	41	41
	56 K & L Haynes		44	42	41
	Other Residential		39	37	36
	St Philips Anglican church[1] (Internal)	Place of Worship	40	40-45	Not in Use
	St Philips Anglican Church[1] (External)	Passive/Active Recreation Area	50-55	50-55	
Gouldsville	23(C) H Kannar		38	40	40
	11(G) Coal & Allied	Suburban	35	36	36
	Other Residential		35	35	35
Maison Dieu	11(F) Coal & Allied	Suburban	38	43	43
	94 Curlewis Pastoral		38	41	41
	254(A) RJ Algie		38	40	40
	Other Residential		38	38	38

Note 1: LAeq(period) noise amenity level criteria.

Note 2: Non-adverse - Annual wind speed = 0.5 m/s and temperature gradient = 0.5°C/100 m.

Note 3: Adverse - Winter wind speed = 2 m/s west (±45°) and temperature gradient= 3°C/100 m.

Table 10.2.6 Nearest Potentially Affected Land Owners - Recommended Operating Noise Limits (Cont'd)

General Locality	Reference/ Land Owner	NSW INP (2000) Noise Amenity Area	$L_{Aeq(15minute)}$ Intrusive Noise Emission		
			Non-Adverse[2]	Adverse SE Wind[3]	
			Daytime	Evening	Night
Redmanvale/ Pinegrove Roads	13(C) DR Skinner	Rural	35	40	40
	15(B) L McGowen & AJ Caslick		35	39	39
	24 AJ Long		40	40	40
	30 CE & CN Williams		35	37	37
	33 DJ Thelander & JA O'Niell		35	39	39
	37 IA & JE Lawry		35	38	38
	48 SJL & LL Ponder		35	38	38
	49 WB & TM Oliver		35	36	36
	75 BA Barnes		35	36	36
	137 CW & K Woodruff		35	35	35
	163 JA Rodger & CM Williams		35	37	37
	188 LA & GI Fuller		35	36	36
	Other Residential		35	35	35
Golden Highway	13(B) DR Skinner	Suburban	39	40	36
	16 MR & CE Cooper		39	40	39
	17 J & HJ Carter		39	40	38
	18 GJ Denney		39	40	38
	27 Birralee Feeds		39	40	37
	28(B,A) C & M Garland		39	40	40
	31(A,B,C,D) CM Fisher		39	43	40
	39 K & DL Northcote		39	40	40
	40 KM Muller		39	40	40
	43 ME & CM Carmody		39	40	37
	44 MR Skinner		39	40	35
	262(A) RW Moses		39	40	36
	262(B) RW Moses		39	40	36
	262(C) RW Moses		39	40	36
	Other Residential		39	40	35

Note 1: $L_{Aeq(period)}$ noise amenity level criteria.
Note 2: Non-adverse - Annual wind speed = 0.5 m/s and temperature gradient = 0.5°C/100 m.
Note 3: Adverse - Summer, Autumn, Spring, wind speed = 3 m/s southeast (± 45°) and temperature gradient = 0.5°C/100 m.

10.3 Blast Emission Impact Assessment

10.3.1 Assessment Methodology

Blast emission impacts have been assessed against the structural damage criteria presented in AS 2187.2-1993 and the human comfort criteria advocated by the NSW EPA (or ANZECC) during daytime and the night-time periods.

10.3.2 Open-Cut Overburden and Box-Cut Extension

Structural Damage Criteria

The 5% exceedance emission levels are below the building damage criteria of 10 mm/s and 133 dB Linear at all dwellings. Similarly, all emission levels are well below the damage criteria for heritage structures of 5 mm/s and 133 dB Linear at churches and cemeteries.

Human Comfort Vibration Criteria

The 5% exceedance PVS vibration velocities are below the 5 mm/s criterion at all dwellings, except at 24 Long where the predicted vibration level is 5.4 mm/s.

The recommended long-term regulatory target of 2 mm/s is also generally achieved at all dwellings except at 31(B) Fisher, 13(C) Skinner and 24 Long where the predicted vibration level is 3.1 mm/s, 4.0 mm/s and 5.4 mm/s respectively.

The target of 2 mm/s can be achieved at 31(B) Fisher by detonating single holes per delay with a charge weight of approximately 410 kg per hole. Changes to the blast design to achieve compliance at 13(C) Skinner and 24 Long are unlikely to be practicable.

Human Comfort Airblast Criteria

The 5% exceedance airblast levels are below the 115 dBL criteria at all dwellings except 40 Muller, 28(B,A) Garland, 31(B) Fisher, 13(C) Skinner and 24 Long where the predicted airblast levels are 116 dBL, 116 dBL, 120 dBL, 123 dBL and 127 dBL respectively.

The 115 dBL criteria can be achieved at 40 Muller, 28(B,A) Garland and 31(B) Fisher by detonating single holes per delay with a charge weight of approximately 260 kg per hole. Changes to the blast design to achieve compliance at 13(C) Skinner and 24 Long are unlikely to be practicable.

10.3.3 Underground Blasting

Structural Damage Criteria

The 5% exceedance emission levels are below the damage criterion of 10 mm/s and 133 dB Linear at all dwellings. Similarly, all emission levels are well below the damage criterion for heritage structures of 5mm/s and 133 dB Linear at churches and cemeteries.

Human Comfort Vibration Criteria

The 5% exceedance PVS vibration velocities are well below the 5 mm/s criterion at all receivers during daytime portal and drift blasting. Similarly, vibration velocities are below the 1 mm/s criterion at all receivers during night-time drift blasting.

Human Comfort Airblast Criteria

The 5% exceedance airblast levels are well below the 115 dB Linear criterion at all receivers during daytime portal and drift blasting. Similarly, airblast levels are below the 95 dB Linear criterion at all dwellings during night-time drift blasting following portal establishment and initial underground drift advance.

10.4 Traffic Noise Impact Assessment

WCPL has existing consent to transport coal along approved transportation routes to the MTCL. Moreover, product coal road transportation will cease once the Train Loading System is operational (expected to be at the end of Year 2). Project related traffic noise impacts have been assessed against the NSW EPA's ECRTN policy (1999), where traffic associated with the development should generally not lead to an increase in the existing noise levels of more than 2 dBA.

In all cases, the daytime and night-time Project related percentage increase in light and heavy vehicle movements is well less than 60% and hence the resulting increase in traffic noise is less than 2 dBA.

10.5 Rail Vibration Impact Assessment

Rail vibration impacts have been assessed in accordance with DIN 4150-3 1999 which provides guideline criteria for evaluating the long-term (or continuous) effects of vibration on structures.

In all cases, the predicted peak component vibration levels are well below the most stringent damage criterion of 2.5 mm/s applicable to the St. Philips Anglican Church and its Cemetery. Similarly, vibration levels are also well below the damage criterion of 5 mm/s applicable to dwellings.

10.6 Cumulative Mine Noise Impact Assessment

The NSW INP (2000) provides non-mandatory cumulative noise assessment guidelines that address existing and successive industrial development by setting acceptable (and maximum) cumulative $L_{Aeq(period)}$ amenity levels for all industrial (ie non-transport related) noise in an area. Note, that the INP does not set acceptable cumulative $L_{Aeq(15minute)}$ intrusive criteria for all industrial noise sources in an area, but rather seeks to control cumulative noise via its amenity criteria.

The potential for the simultaneous operation of the adjoining mine developments to exceed the acceptable and maximum noise amenity criteria can be assessed on a worst case scenario by adding the anticipated intrusive noise limits from the Wambo Development Project and Warkworth mines together with the approval noise limits from the United, Hunter Valley and Carrington Coal Mine Consents. The cumulative intrusive level is the adjustment to the equivalent amenity level for comparison with the acceptable and maximum noise amenity criteria.

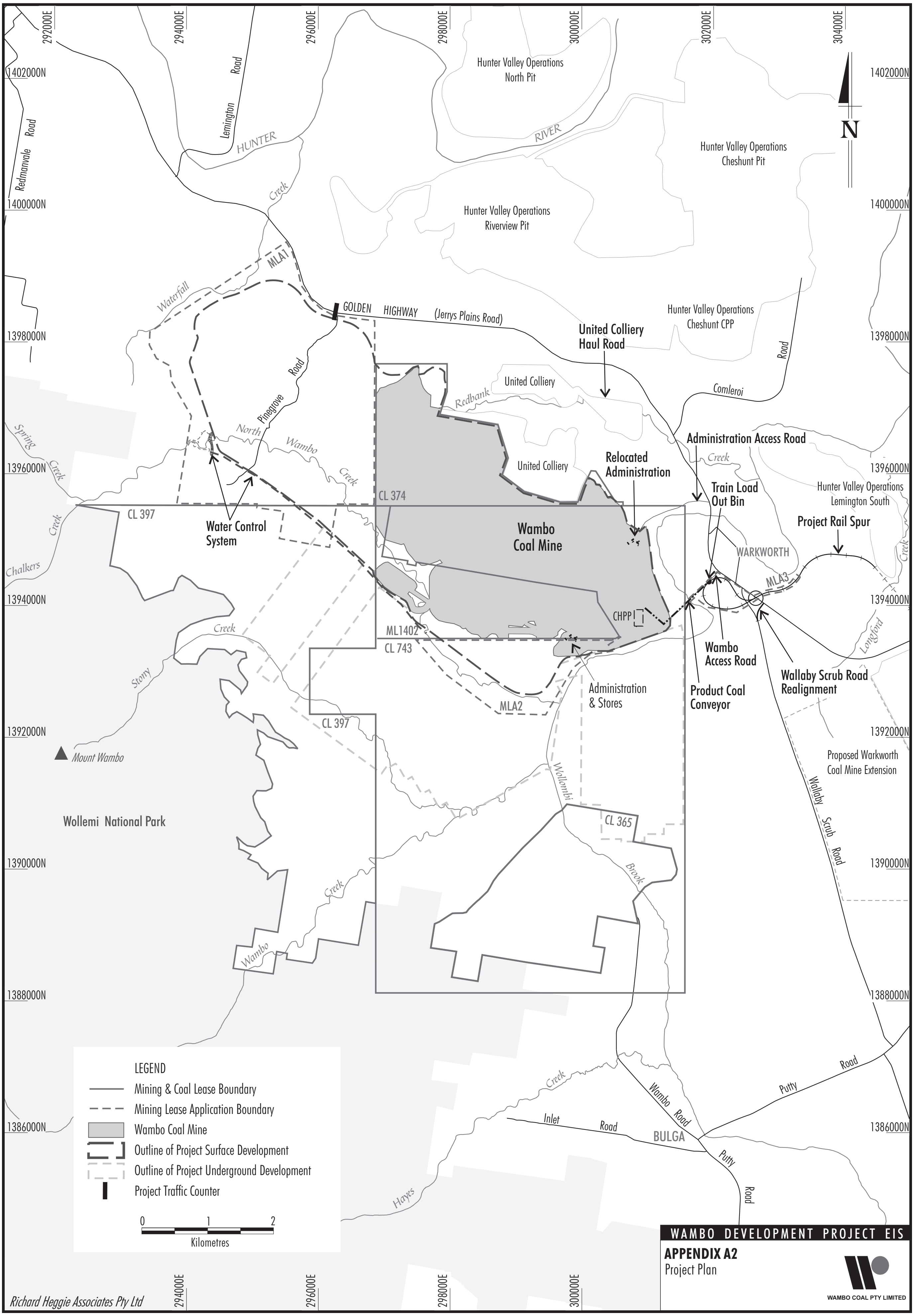
At all six (6) assessment localities the non-adverse cumulative noise emissions from the Project and adjoining mines are below the relevant acceptable amenity criteria for industrial noise (ie non-transport related) during the daytime, evening and night-time.

Similarly, at all six (6) assessment localities the "worst case" adverse cumulative noise emissions from the Project and adjoining mines are below the relevant maximum amenity criteria for industrial noise. The likelihood that all mines simultaneously emit their maximum noise emissions under adverse weather conditions to any one receiver locality is minimal.

Director General's Requirements

REFER ATTACHMENT 2 OF THE EIS

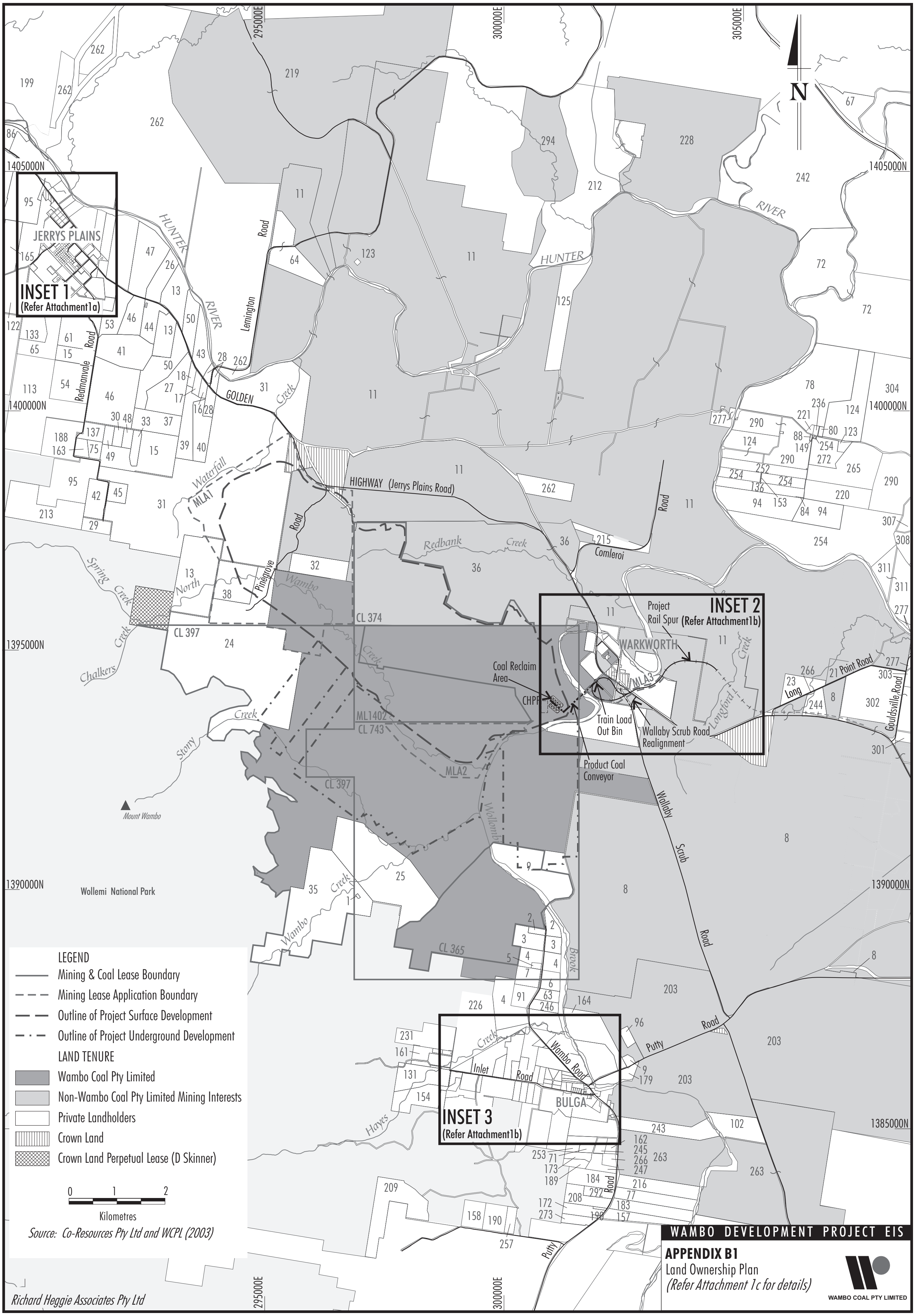
Project Plan



WAM-02-01-Noise_004I

Appendix B1

Land Ownership Plan



WAMBO DEVELOPMENT PROJECT EIS

APPENDIX B1
Land Ownership Plan
(Refer Attachment 1c for details)

WAM-02-01-Noise_006F

WAMBO DEVELOPMENT PROJECT EIS

ATTACHMENT 1b
Relevant Land Ownership
Warkworth and Bulga
(Refer Attachment 1c for details)

WAM-02-01-Noise_007H

1	KM & CM Brosi	64	AE & MJ Dallas	124	ES Bowman
2	W & D Lambkin	65	AF & HM Holt	125	Estate of the late JE Barry
3	HM Birrell	66	AJ Gallagher	126	Estate of the late TM Brown
4	IF & MA Circosta	67	White Mining	127	F & J Fameli
5	DS & DL Strachan	68	AL Tarrant	128	F H Turnbull
6	HD Merrick	69	AM & NM Renaud	129	FJ Carruthers
7	DC & EM Maizey	70	Anglican Church	130	G & JA Lee Wood
8	Warkworth Mining Limited	71	ARD & KM Spinks	131	G & SF O'Brien
9	H Upward	72	AS Bowman	132	G & T Carnevale
11	Coal & Allied Pty Ltd	73	AW & CA Louis	133	GA & GG Cross
13	DR Skinner	74	B Fogwell	134	GF Morley
14	S & G Keys	75	BA Barnes	135	GJ & BA Wild
15	L McGowen & AJ Caslick	76	Barrington Group of Companies	136	GJ & JG Ernst
16	MR & CE Cooper	77	BD Medhurst	137	GJ & K Woodruff
17	J & HJ Carter	78	BE & TA Moxey	138	GJ & TM Tlaskal
18	GJ Denney	79	BE Norton	139	GK & SR Grainger
19	L Kelly	80	BH & CJ Witchard	140	GL Turnbull
20	Jerry's Plains Coal Terminal	81	BJ & MG Anderson	141	Glendell Tenements
21	Coal & Allied Pty Ltd	82	BR McTaggart	142	GM Caban
22	O J Henderson	83	Bulga Community Centre	143	GR & JR Mumford
23	HE Kannar	84	BV Kbodler & ML Swain	144	GR Duff
24	AJ Long	85	C & PJ Reid	145	GW & ME Banks
25	RW Fenwick & AM Frost (Fenwick)	86	Calogo Bloodstock	146	GW Jennison
26	Amarina Systems	87	CG Wallace	147	GW McTaggart
27	Birralee Feeds Pty Ltd	88	CI Maskey	148	H & T & H Fotopoulos
28	C & M Garland	89	CJ & MB Cowlard	149	HJ Kauter
29	C Lowe	90	CL & L Price	150	IH & RA Moore
30	JE & CN Williams	91	CL Bailey	151	IK Mitchell
31	CM Fisher	92	Country Womens Association	152	IN & AM Batholomew
32	CM Moore	93	CS & EA Neville	153	Inchnuek
33	DJ Thelander & JA O'Niell	94	Curlewis Pastoral	154	Irene investments
35	GJ Brosi	95	CW & RM Gee	155	IV Farmer
36	Graham, Coates & Maitland	96	D & D Townsend	156	IW Killen
37	IA & JE Lawry	97	D & VM Saunders	157	J & D Vassallo
38	JV Clifton	98	D Macey	158	J & G Seiffhart
39	K & DL Northcote	99	D Vikas & SJ Mitchell	159	J & V Ferlito
40	KM Muller	100	DA Hodge	160	J Kladis
41	Jepolo Pty Ltd	101	DB Roser	161	J Leslie
42	LM Redman	102	DE Leslie	162	JA Pritchard
43	ME & CM Carmody	103	DE Morrow	163	JA Rodger & CM Williams
44	MR Skinner	104	Department of Education	164	JC Mullaly & PE McMaugh
45	R & PK Mansfield	105	DG & H Walton	165	JE Killin
46	RJ & CC Ball	106	DG & JC De Somer	166	Jerry Plains Cemetery
47	RJ Hayes	107	DJ & IB Birkett	167	Jerry's Plains Pony Club
48	SJL LL Ponder	108	DJ & VA Goldstein	168	JF Lannigan
49	WB TM Oliver	109	DJ Cassidy & AE Conley	169	JM & M Player
50	WM & RF & TJ & RJ Nowland	110	DK & AG Margery	170	JM Woodruff
51	C.M. Hawkes Pty Ltd	111	DK Partridge	171	JP & S Evans
52	KJ Bennett	112	DP & EJ Van Rensburg	172	JR & DC Lamb
53	TP & CM Old	113	DR & KG Nichols	173	JR & KA Wulff
54	PW & BN Nichols	114	DV & KN Cameron	174	JT & PJ Walmsley
55	E & C Burley	115	DW & JA Hadley	175	JT Lambkin
56	K & L Haynes	116	DW & SP Butler	176	Justice Dept
57	TJ & LM Bennett	117	E MacKenzie	177	JW & LM Clements
58	P & MD Cantrill	118	EA Quilan	178	KJ & NL Smith
59	GW & KM Merrick	119	EE McNaught	179	KJ & PD Slade
60	MJ Williams	120	EI & RC & DE Chapman & PA Salton	180	KJ Mitchell
61	LW Northgate	121	EJ & DL St John	181	KM Hunt
62	A Mitchell	122	EM Lannigan	182	KM Merrick
63	Abrocuff Pty Ltd	123	Energy Australia	183	KR & JM Dubois

Source: Co-Resources Pty Ltd and (WCPL 2003)

WAMBO DEVELOPMENT PROJECT EIS

ATTACHMENT 1c
Landholder Key
(Current as at 24 April 2003)
(Page 1 of 2)

WAMBO COAL PTY LIMITED

Richard Heggies Associates Pty Ltd

WAM-02-01-Noise_008H

184	KR & MJ Lobb
185	L & M Fletcher
186	L Edwards
187	L Farrugia
188	LA & GI Fuller
189	LC Krey
190	LJ & V Bodiam
191	LM & RB Caban
192	LM Crisp
193	LW & NR McLachlan
194	M & B Dragicevic
195	M & SE Bendall
196	M E Vidler
197	M G White
198	M N Killen
199	Macquarie Generation
200	MC & SJ Mitchell
201	MF & NV Chapman
202	MH & EJ Richards
203	Miller Pohang Coal
204	Minister for Education and Training
205	MJ & JG Bryan
206	MJ Dallas
207	MM & N Roser
208	MS & S Dawson
209	MV & SM Thompson
210	MV Ford
211	MW & P Charlton
212	N & L Holz
213	National Parks & Wildlife
214	ND Chalker & JR Spiller
215	Newcastle Gliding Club
216	Nippon Steel
217	NJ Barry
218	NO & RJ Cole
219	Novacoal Australia
220	NR & GJ Nelson
221	NR Bourke & EL White
222	NR Walters & TJ Barry
223	P Adamthwaite
224	PA & JA Cooke
225	Packtron Packaging
226	Paka Investments
227	PD Culbert
228	Peabody Resources
229	PF & FJ Ritchie
230	PG Gee
231	PJ & ER Hearse
232	PJ & GTL Magin
233	PJ & H Kolatchew
234	PJ Carlyon
235	PJ Keegan
236	PR & CM Burley
237	PT Jessop
238	PW & TA Harris
239	R McLauglin
240	RA & LJ Lannigan
241	RA Corino & PM Rayner
242	Raynest Pty Ltd
243	Recluse Pty Ltd
244	Redbank Project Pty Ltd
245	RG & A Godyn
246	RG & FS Bailey
247	RG & KL Caban
248	RG Nichols & SA Anderson
249	RGW Richardson
250	RI & JM Hedley
251	RJ & JA Evans
252	RJ & JS Wenham
253	RJ & KT Bridge
254	RJ Algie
255	RJ Farley & SJ Oldham
256	RJ Peel
257	RM Spencer
258	Roman Catholic Church
259	RP & L Newman
260	RW & HA Davis
261	RW & MA Cupitt
262	RW Moses
263	Saxonvale Coal Pty Ltd
264	School of Arts
265	SD Edwards & T Howard & JV Clifton
266	Singleton Council
267	SJ & L Pringle
268	SM & TA Gaunt
269	SM Franks & RA Harris
270	SM Gee
271	SPP & SJ Tamplin
272	TA & SA Mills
273	TC & SG Jackson
274	TE & BG Harrison
275	Telstra Corporation
276	TG Gale
277	The State of NSW
278	TJ Bennett
279	TJ BL Holstein
280	TP & S Mitchell
281	TR & SN & ML Cole
282	Transgrid
283	VE Gee
284	W Rienstra
285	W Riley
286	WB Harris & BL Guy
287	WG Barnett
288	WL & P Slaney
289	WT Clark
290	Wyoming Holsteins
291	YC Van Den Berg
292	D & JM Vikas
293	CA Dyson
294	CBS Explosives
295	Ian Headley
296	Singleton Shire Council
297	State Rail Authority
298	D & C Russell
299	C Russell
300	K Isaac
301	Pastures Protection Board
302	DB & P Stuart
303	R Thrift & Co
304	W Bowman, G Elder & A Bowman
305	Canravo Pty Ltd
306	Keith Heuston Pty Ltd
307	B New & A Knodler
308	N & E Riley
309	W & L Barry
310	HD & DR Hobden
311	HD Hobden
312	F & J Ventra
313	W & H Welsh
314	C & L Slade
315	L & R Gatt
316	RW Kannar
317	DM Clemson

Source: Co-Resources Pty Ltd and (WCPL 2003)

WAMBO DEVELOPMENT PROJECT EIS

ATTACHMENT 1c
Landholder Key
(Current as at 24 April 2003)
(Page 2 of 2)

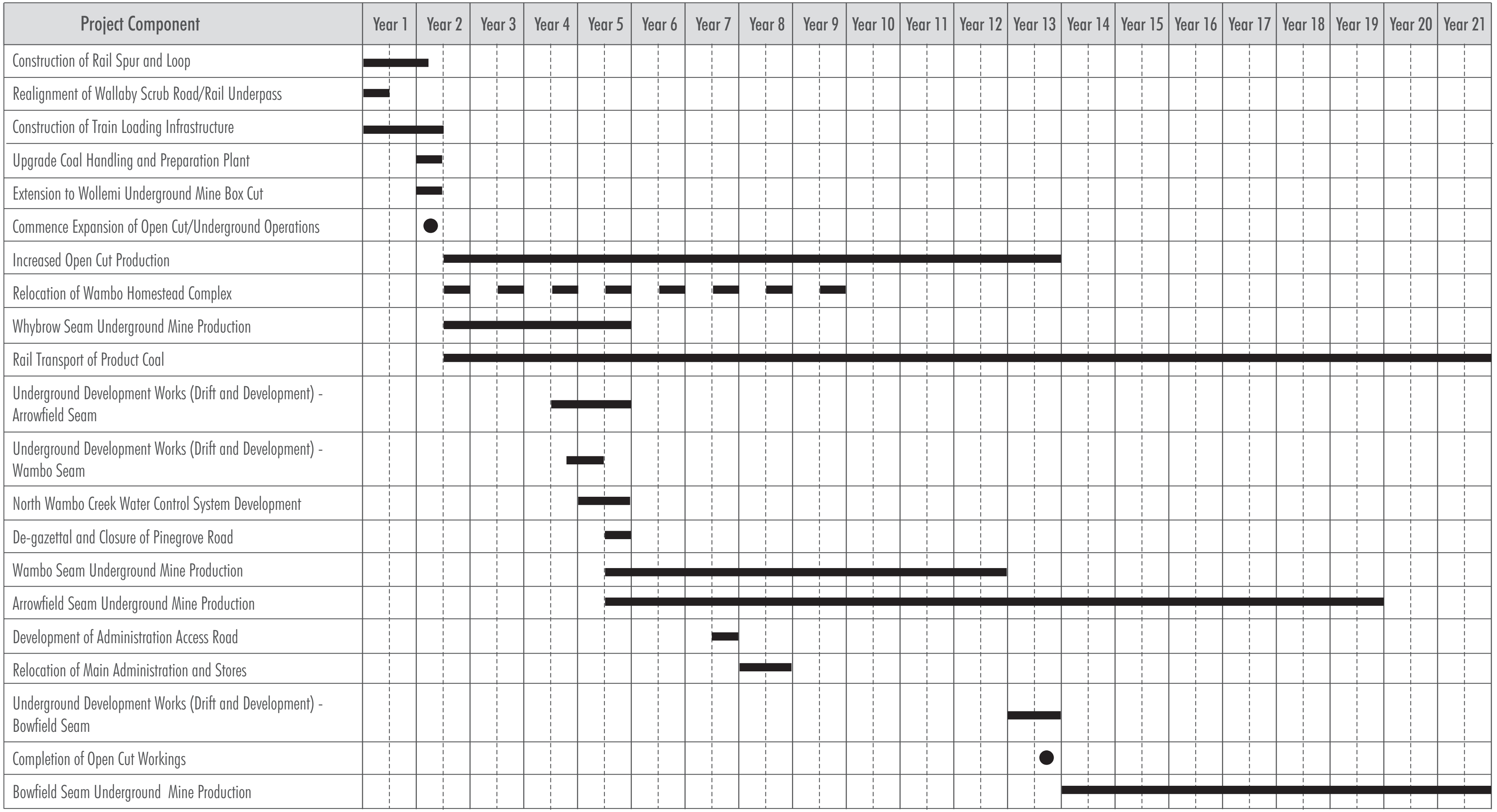
WAMBO COAL PTY LIMITED

Richard Heggies Associates Pty Ltd

WAM-02-01-Noise_008H

Provisional Development Schedule

Provisional Development Schedule



Source: WCPL 2003

WAMBO DEVELOPMENT PROJECT EIS

APPENDIX B2
Provisional Development Schedule

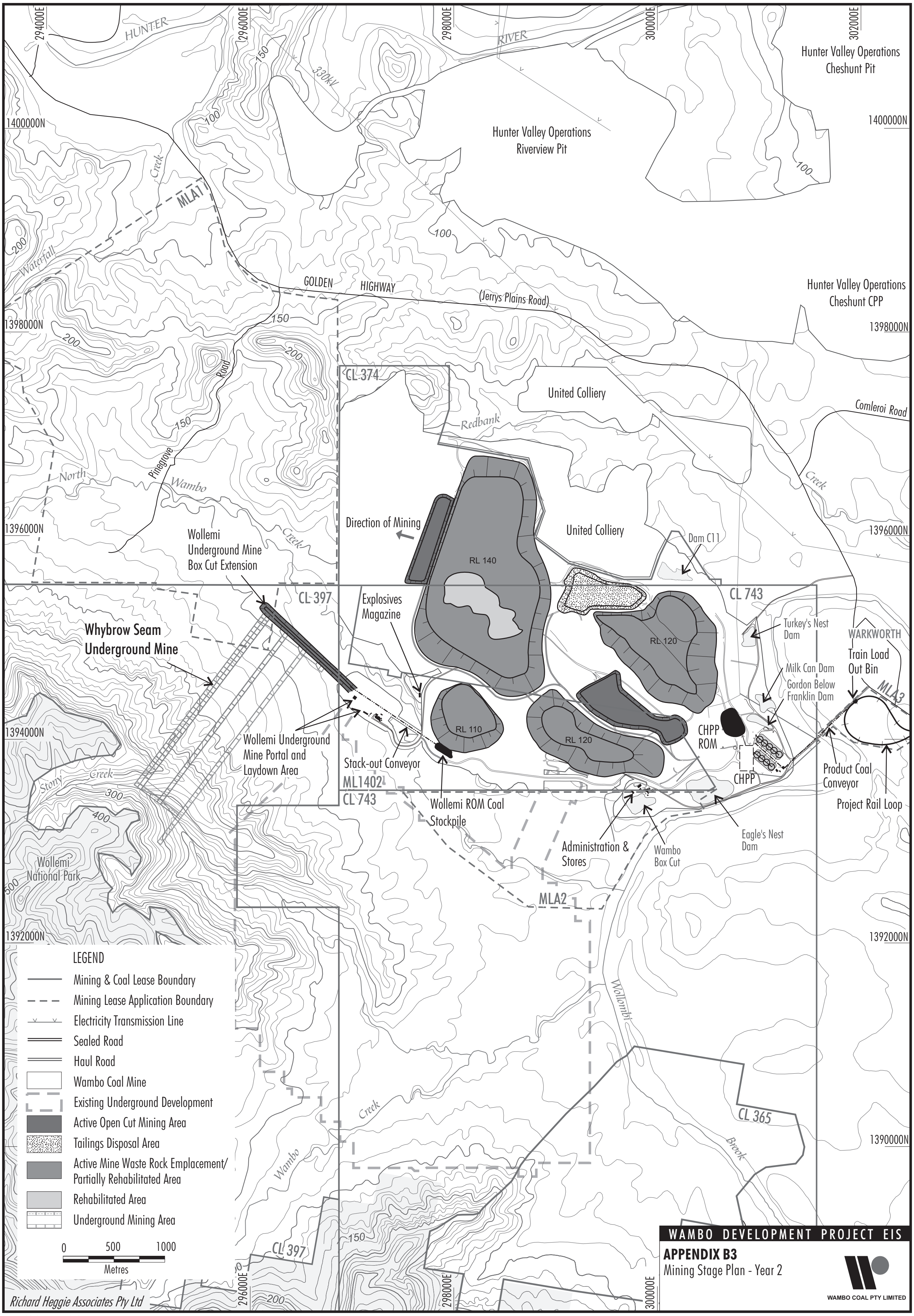
WAMBO COAL PTY LIMITED

Richard Heggie Associates Pty Ltd

Wam-02-01-Noise_009E

Appendix B3

Mining Stage Plan – Year 2

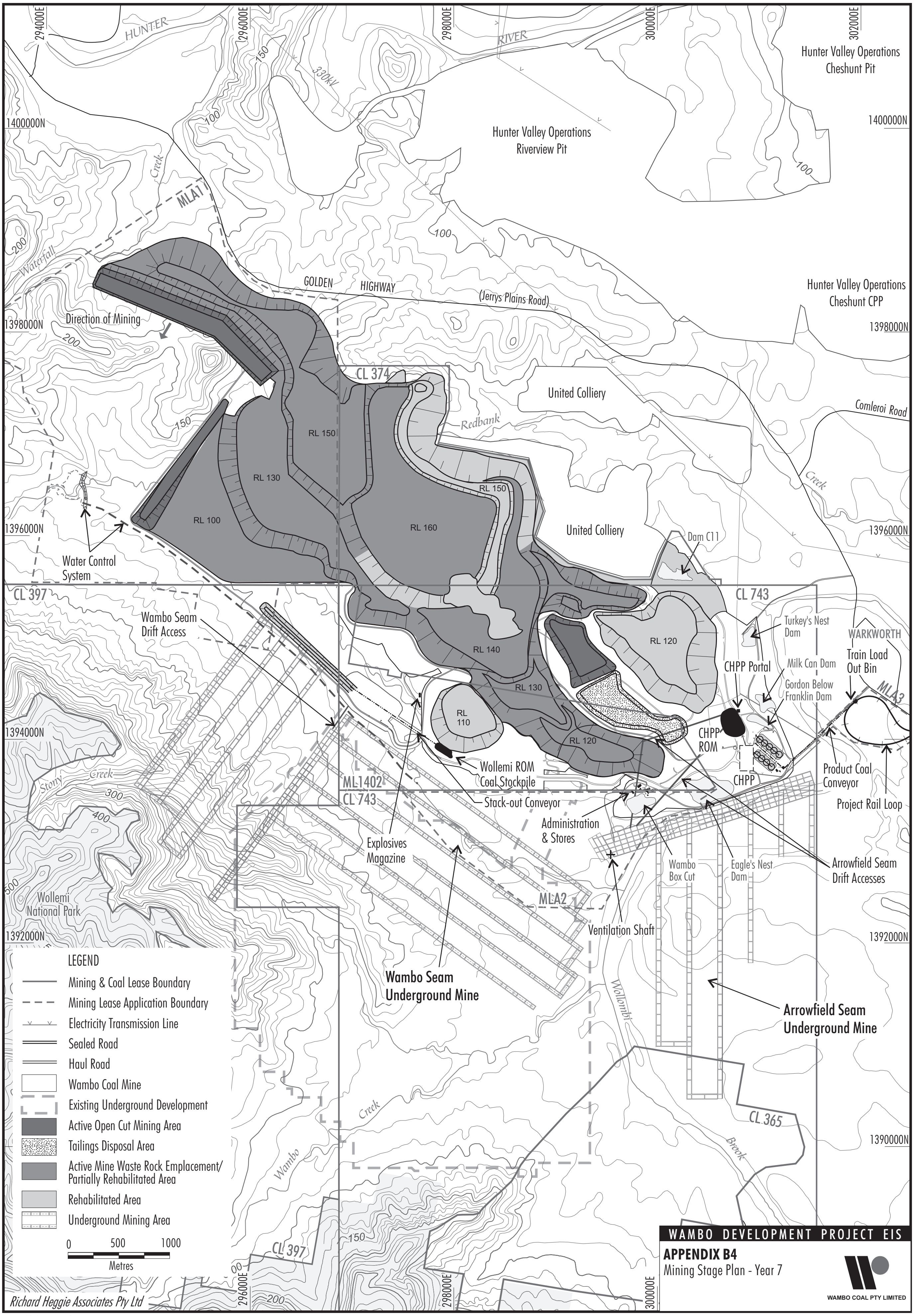


APPENDIX B3
Mining Stage Plan - Year 2

WAM-02-01-Noise_010H

Appendix B4

Mining Stage Plan - Year 7



WAMBO DEVELOPMENT PROJECT EIS

APPENDIX B4

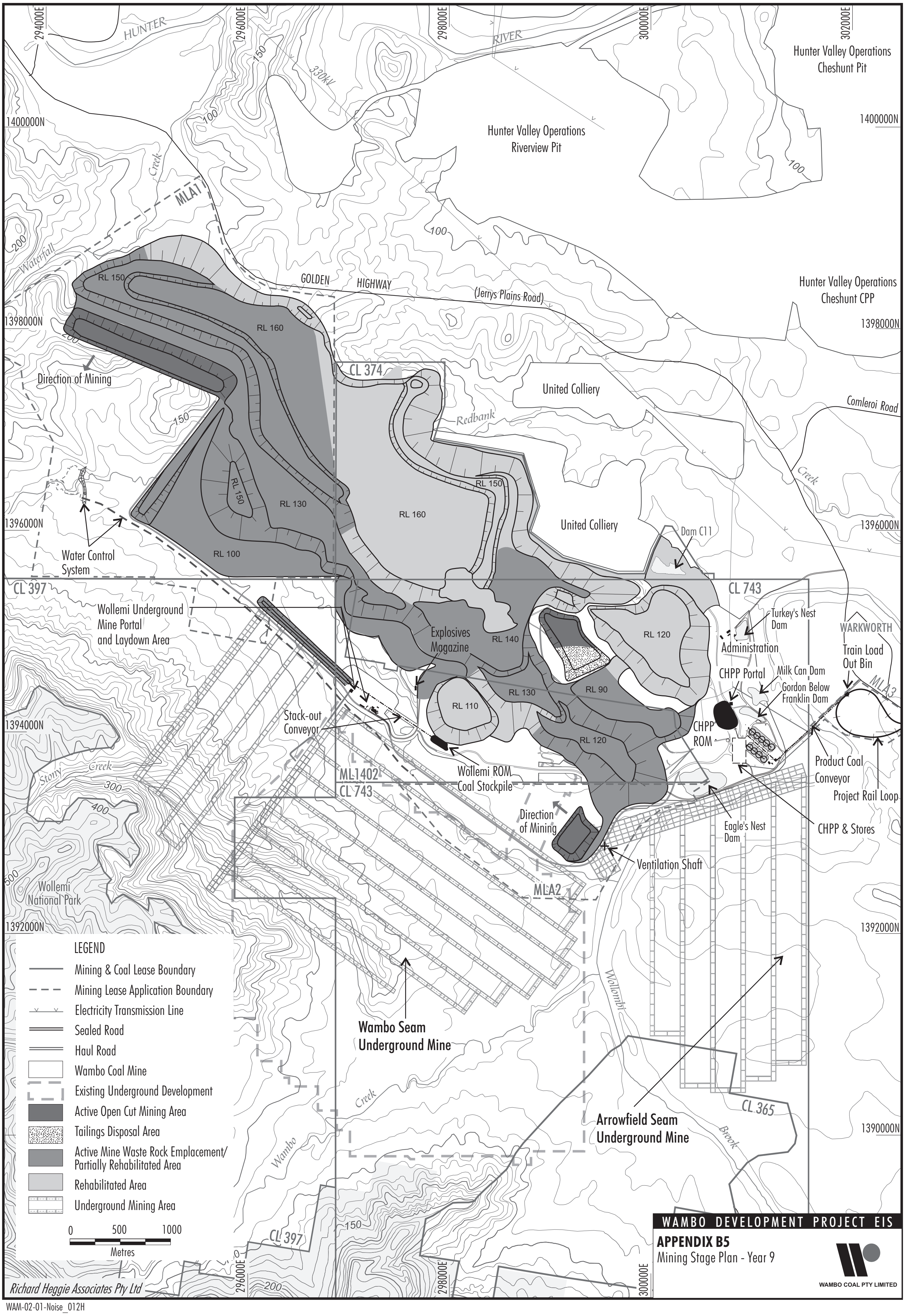
Mining Stage Plan - Year 7

WAMBO COAL PTY LIMITED

WAM-02-01-Noise_011H

Appendix B5

Mining Stage Plan - Year 9



APPENDIX B5
Mining Stage Plan - Year 9

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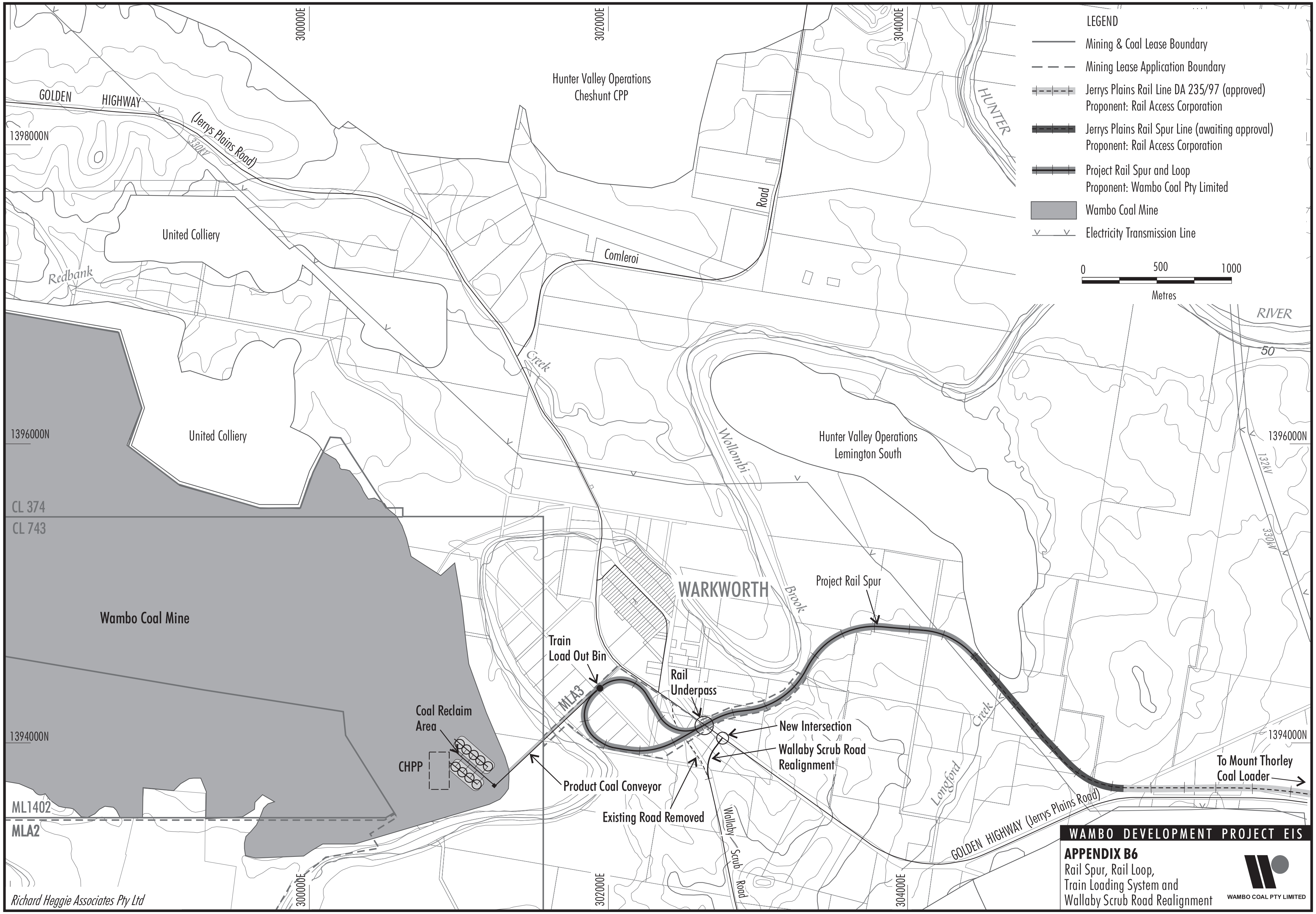
Appendix B6

Rail Spur/Loop Plan

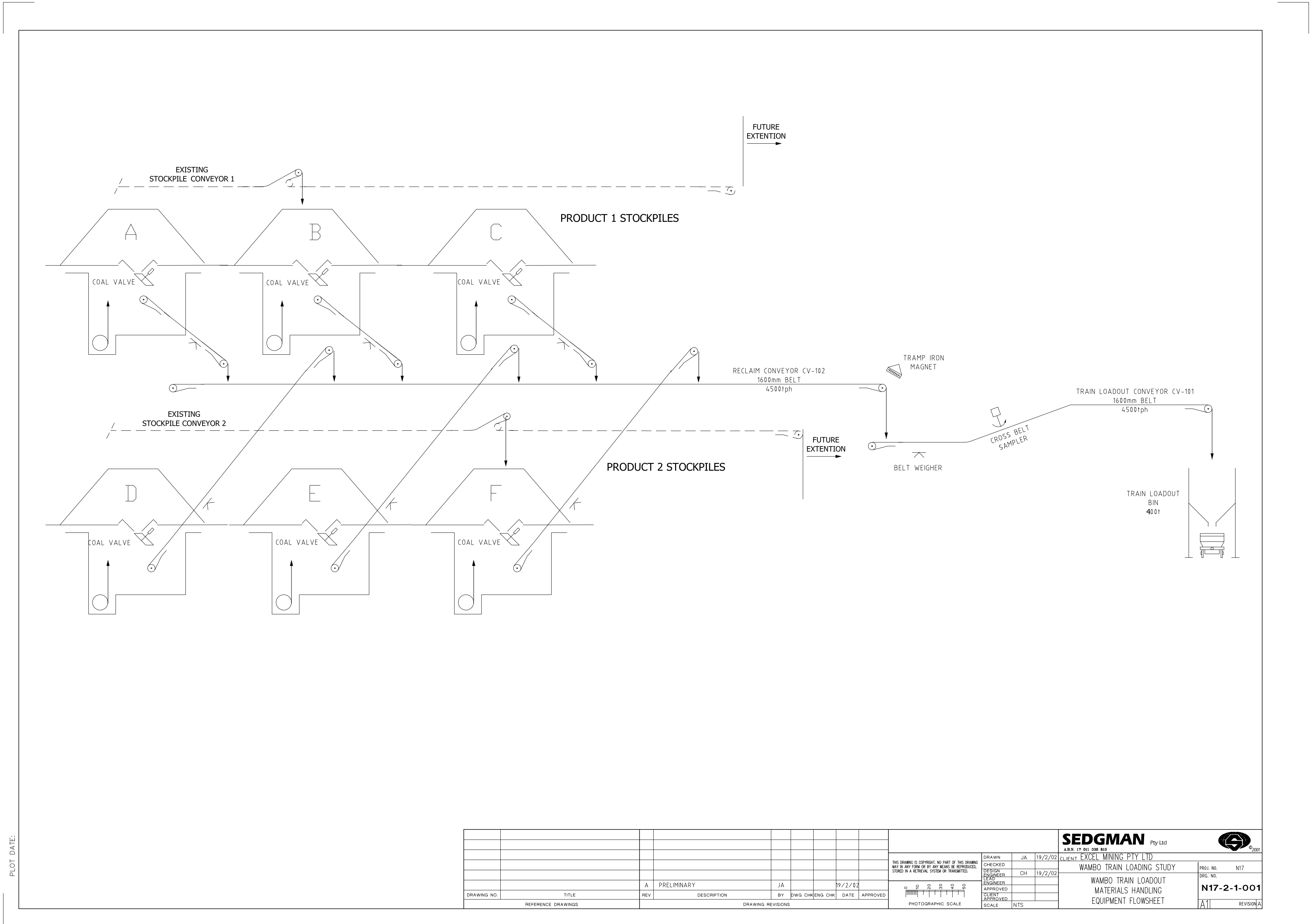


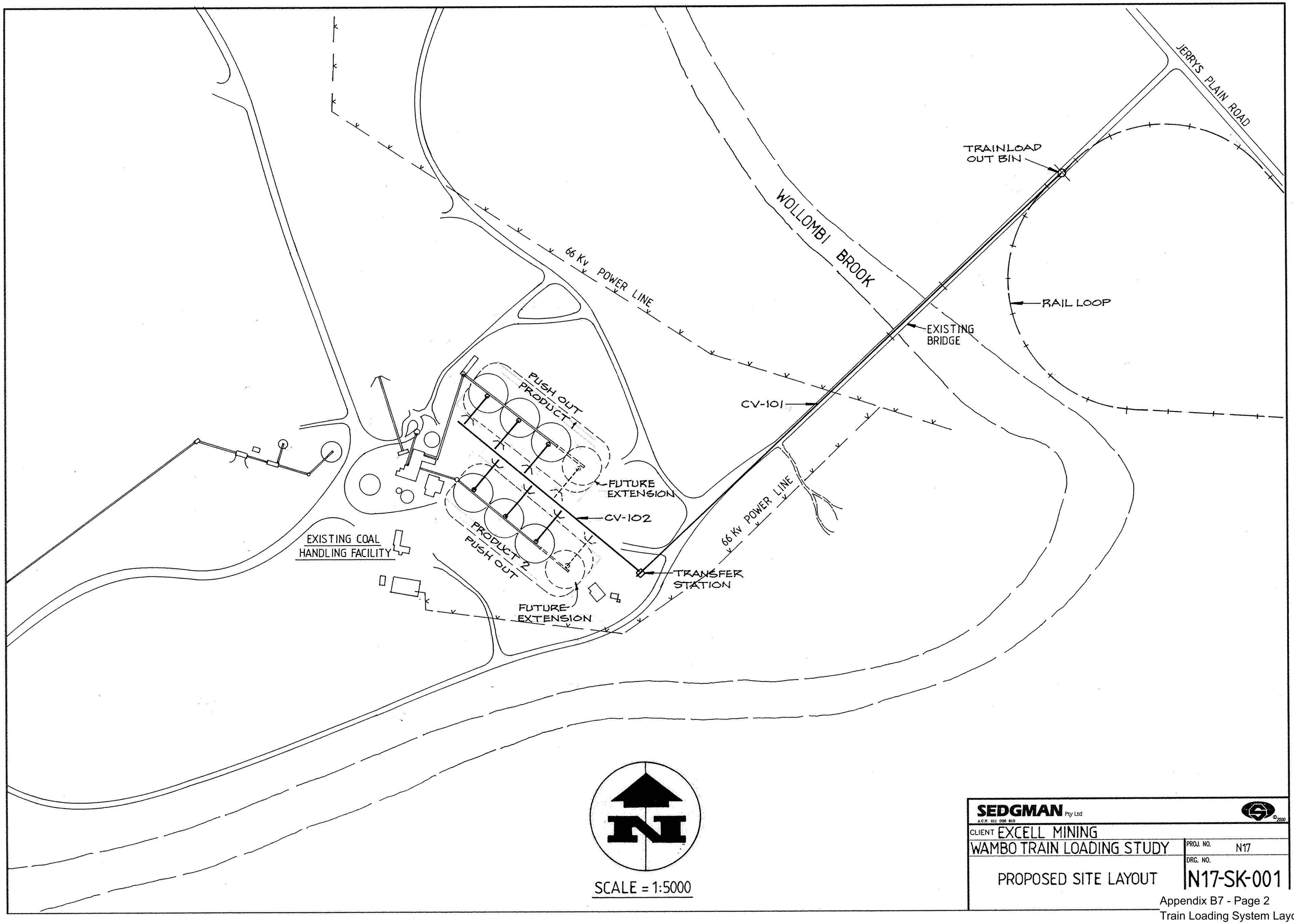
WAMBO DEVELOPMENT PROJECT EIS

APPENDIX B6
Rail Spur, Rail Loop,
Train Loading System and
Wallaby Scrub Road Realignment

WAM-02-01-Noise_013I

Train Loading System Layout


FUTURE EXTENTION
EXISTING STOCKPILE CONVEYOR 1
PRODUCT 1 STOCKPILES
A
B
C
COAL VALVE
COAL VALVE
COAL VALVE
TRAMP IRON MAGNET
RECLAIM CONVEYOR CV-102
1600mm BELT
4500tph
TRAIN LOADOUT CONVEYOR CV-101
1600mm BELT
4500tph
EXISTING STOCKPILE CONVEYOR 2
FUTURE EXTENTION
CROSS BELT SAMPLER
BELT WEIGHER
PRODUCT 2 STOCKPILES
D
E
F
TRAIN LOADOUT BIN
400t
COAL VALVE
COAL VALVE
COAL VALVE
PLOT DATE:
A
PRELIMINARY
JA
19/2/02
DRAWING NO.
TITLE
REFERENCE DRAWINGS
REV
DESCRIPTION
BY
DWG CHK
ENG CHK
DATE
APPROVED
DRAWING REVISIONS
THIS DRAWING IS COPYRIGHT. NO PART OF THIS DRAWING MAY IN ANY FORM OR BY ANY MEANS BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED.
PHOTOGRAPHIC SCALE
DRAWN JA 19/2/02
CHECKED
DESIGN ENGINEER CH 19/2/02
LEAD ENGINEER
APPROVED
CLIENT APPROVED
SCALE NTS
SEDGMAN Pty Ltd
A.B.N. 17 011 036 810
©2001
CLIENT EXCEL MINING PTY LTD
WAMBO TRAIN LOADING STUDY
PROJ. NO. N17
DRG. NO.
N17-2-1-001
WAMBO TRAIN LOADOUT
MATERIALS HANDLING
EQUIPMENT FLOWSHEET
A1
REVISION A


JERRYS PLAIN ROAD
TRAINLOAD OUT BIN
WOLLOMBI BROOK
66 Kv POWER LINE
RAIL LOOP
EXISTING BRIDGE
CV-101
PUSH OUT PRODUCT 1
FUTURE EXTENSION
CV-102
PRODUCT 2 PUSH OUT
EXISTING COAL HANDLING FACILITY
66 Kv POWER LINE
TRANSFER STATION
FUTURE EXTENSION
SCALE = 1:5000
SEDGMAN Pty Ltd
CLIENT EXCELL MINING
WAMBO TRAIN LOADING STUDY
PROJ. NO. N17
PROPOSED SITE LAYOUT
DRG. NO. N17-SK-001

3 EXISTING ACOUSTICAL ENVIRONMENT MEASUREMENT METHODOLOGY

3.1 Overview of Methodology

Ambient noise surveys to characterise and quantify the existing acoustical environment in the area surrounding the Project were conducted in December 2002. Eight (8) unattended noise loggers were positioned at selected representative dwellings for a period of 12 days commencing Thursday 12 December 2002.

In order to supplement the unattended noise logger measurements and to assist in identifying the character and duration of ambient noise sources, operator-attended daytime, evening and night-time surveys were also conducted at all eight logging locations.

The ambient noise monitoring programme was implemented in accordance with AS 1055-1989, "Acoustics-Description and Measurement of Environmental Noise" and the NSW Industrial Noise Policy (INP) 2000.

3.2 Instrumentation and Measurement Parameters

Unattended Monitoring and Operator-Attended Surveys

All acoustic instrumentation employed throughout the noise monitoring programme has been designed to comply with the requirements of AS 1259.2-1990, "Sound Level Meters" and carries current NATA or manufacturer calibration certificates.

A description of instrumentation, designated type and serial numbers is shown in **Table 3.2.1**.

Table 3.2.1 Acoustic Instrumentation Schedule

Locality	Land Owner	Logger Position	Instrumentation	Class
Bulga Village Rural	2 Lambkin	WCM Boundary	ARL EL316 16-302-482	Type 1
	25 Fenwick	Property	ARL EL316 16-301-473	Type 1
Warkworth Village Suburban	19(A) Kelly	WCM Boundary	ARL EL215 194471	Type 2
	56 Haynes	WCM Adjacent	ARL EL215 194528	Type 2
	51 Hawkes	WCM Boundary	ARL EL215 194471	Type 2
Jerrys Plains Rural	15(B) McGowen/Caslick	Property	ARL EL316 16-301-471	Type 1
Jerrys Plains Suburban	31(D) Fisher	Property	ARL EL215 194525	Type 2
	31(A,B,C,D) Fisher	20 m from Jerrys Plains Road	ARL EL215 194536	Type 2

All instrumentation was programmed to record continuously the noise exceedance levels in 15 minute intervals including the L_{Amax}, L_{A1}, L_{A5}, L_{A10}, L_{A50}, L_{A90}, L_{A95}, L_{A99}, L_{Amin} and the L_{Aeq}.

Instrument calibration was conducted before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

Weather Monitoring Station and Traffic Counts

Meteorological data was obtained from the permanent automatic weather station located at the Wambo Coal Mine. In addition, a traffic counter was placed by CFE Information Technologies on the corner of Jerrys Plains and Pine Grove Roads commencing Thursday 12 December for a period of 19 days.

3.3 Unattended Ambient Noise Monitoring Results

The unattended ambient noise data from each location, together with the weather conditions are presented graphically on a daily basis in **Appendices C2** to **C9. Appendix C9** also includes traffic counts.

The statistical noise exceedance levels (LAN) are the levels exceeded for N% of the interval period. The LA90 represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The LA10 is the level exceeded for 10% of the time and is usually referred to as the average maximum noise level. The LAeq is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period.

Prior to further analysis, the ambient noise data from each location which correlated with periods of unstable weather (eg rainfall greater than 0.5 mm or wind speed greater than 5 m/s) were discarded. The acceptable ambient noise data was then processed in accordance with the NSW INP (2000) "Appendix B - Applying the Background Noise Policy" to derive the Monday to Sunday ambient noise levels presented in **Table 3.3.1**.

Table 3.3.1 Unattended Ambient Noise Environment December 2002 (dBA re 20 mPa)

Locality	Land Owner	Rating Background Level[1,2] All Noise Sources including WCM at Warkworth			LAeq(period)[3] All Noise Sources including WCM at Warkworth			Estimated LAeq(period)[3] Industrial Noise Amenity (Non WCM)		
		Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Bulga Village Rural	2 Lambkin (WCM Boundary)	29	28	25	47	47	43	<44	<39	<34
	25 Fenwick (Property)	27	29	27	45	45	44	<44	<39	<34
Warkworth Village Suburban	19(A) Kelly (WCM Boundary)	38	38	35	57	49	47	<49	<39	<34
	56 Haynes (WCM Adjacent)	36	37	31	48	48	47	<49	<39	<34
	51 Hawkes (WCM Boundary)	34	38	31	49	49	47	<49	<39	<34
Jerrys Plains Rural	15(B) McGowen/ Caslick	28	31	27	47	45	45	<44	<39	<34
Jerrys Plains Suburban	31(D) Fisher (Property)	34	35	30	47	47	46	<49	<39	<34
	31(A,B,C,D) Fisher (20 m from road)	35	36	34	65	64	61	<49	<39	<34

Note 1: Measured noise levels less than 31 dBA may have a signal to noise ratio less than 5 dBA.
Note 2: In accordance with the NSW INP (2000), if the RBL is below 30 dBA, then 30 dBA shall be the assumed RBL.
Note 3: Daytime 0700 hours to 1800 hours, Evening 1800 hours to 2200 hours and Night-time 2200 hours to 0700 hours.

3.4 Operator-Attended Ambient Noise Survey Results

Operator-attended noise surveys of 15 minutes duration were conducted with a precision integrating sound level meter in order to qualify the results obtained with the unattended noise loggers. During attended noise surveys, the operator identified the character and duration of acoustically significant ambient noise sources. Wherever possible the operator quantified local traffic flow and made a qualitative assessment of the prevailing weather conditions.

The daytime, evening and night-time operator-attended noise survey results are presented below:

Bulga Rural

Location – 2 Lambkin (WCM Boundary)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 09:30 Day	W-0.5m/s NW Temp=26°C	Ambient	54	46	40	31	37	Insects/Birds up to 46
15/12/02 18:30 Evening	W=1 – 3m/s NW Temp=32°C	Ambient	50	47	38	32	38	Pump or Generator from nearby houses 32 Birds 39-48
16/12/02 00:30 Night	W=still Temp=20°C	Ambient	51	45	41	32	37	Insects 34-47

Location – 25 Fenwick (Property)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 10:00 Day	W=0.5-1m/s NW Temp=26°C	Ambient	52	48	36	27	35	Insects/Birds up to 46 Noticeably less insect activity
15/12/02 18:00 Evening	W=2.5 – 3m/s NW Temp=33°C	Ambient	50	48	42	34	40	Birds 43-46
16/12/02 00:30 Night	W=Still Temp=20°C	Ambient	49	42	35	30	34	Wambo fan or mechanical noise 32
		Wambo	Estimated LAeq(15minute) – 32 dBA					

Warkworth Suburban

Location – 19A Kelly (WCM Boundary)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 10:30 Day	W=3 – 4m/s NW Temp=29°C	Ambient	67	62	60	56	58	Truck on bridge 61 Insects 54 – 57 Excavator tracking audible
		Wambo	Estimated LAeq(15minute) - <40 dBA					
15/12/02 20:00 Evening	W=1 – 3m/s NW Temp=24°C	Ambient	61	57	54	43	50	Truck on bridge 56 Wambo reverse beeper 40
		Wambo	Estimated LAeq(15minute) - <35 dBA					
15/12/02 23:30 Night	W=0.5 – 1m/s NW Temp=20°C	Ambient	58	56	51	39	47	Car 49 Truck on bridge 58 Wambo Washery 38 Reverse Beeper 34-35 Insects 38 – 40
		Wambo	Estimated LAeq(15minute) – 38 dBA					

Location – 56 Haynes (WCM Adjacent)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 10:50 Day	W=2 –3.5m/s NW Temp=29°C	Ambient	72	54	51	42	48	Truck on bridge 52-54 Truck passby on Hwy 46-47 Wind in trees 45
15/12/02 19:35 Evening	W=1.5 – 3m/s NW Temp=26°C	Ambient	64	61	56	43	52	Truck on bridge 62 Insects 42
15/12/02 23:50 Night	W=Still Temp=20°C	Ambient	59	54	45	35	42	Car 41 Truck on bridge 54 Wambo Washery or Fan 34
		Wambo	Estimated LAeq(15minute) – 34 dBA					

Location – 51 Hawkes (WCM Boundary)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 10:50 Day	W=2–3.5m/s NW Temp=°C	Ambient	-	-	-	-	-	Data not accessible
15/12/02 19:00 Evening	W=2.5 – 3m/s NW Temp=28°C	Ambient	52	49	46	39	43	Truck noise from Wambo Washery 44-46 wind in trees 41 Reverse beeper up to 47
		Wambo	Estimated LAeq(15minute) – 43 dBA					
15/12/02 23:50 Night	W=Still Temp=20°C	Ambient	-	-	-	-	-	Data not accessible

Jerrys Plains Rural

Location – 15(B) McGowen/Caslick (Dwelling)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 12:20 Day	W = 3 – 4 m/s NW Temp=33°C	Ambient	63	49	45	36	41	Insects 42-48 Plane to 54 Horse 55 Bird to 57
15/12/02 21:30 Evening	W=1.5 – 2 m/s NW Temp=22°C	Ambient	49	44	39	31	36	Wind in trees 33-35 Plane fly-over 35-45
15/12/02 22:00 Night	W=1 – 1.5 m/s NW Temp=20°C	Ambient	44	37	34	30	33	Insects 30-32 Plane 35

Jerrys Plains Suburban

Location – 31D Fisher (Dwelling)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 11:20 Day	W=4– 4.5m/s NW Temp=31°C	Ambient	62	55	50	39	45	Car 48 Truck 56 - 58
15/12/02 20:50 Evening	W=1 – 2m/s NW Temp=23°C	Ambient	61	58	54	39	50	Car 52 – 59 Motorcycle 54 Intermittent Insects 4 - 46
15/12/02 22:50 Night	W=0.5 – 1m/s NW Temp=20°C	Ambient	60	58	53	34	48	Car 52 Truck 57 Intermittent Insects 33 – 40

Location – 31(A,B,C,D) Fisher (20m from Jerrys Plains Road)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
16/12/02 11:40 Day	W=3–4.5m/s NW Temp=30°C	Ambient	87	79	65	37	67	Car 80 Truck 84 Frogs 55
15/12/02 20:30 Evening	W=1 – 2m/s NW Temp=23°C	Ambient	81	79	66	47	65	Car 77 – 82 Insects 46-48 Cow 50
15/12/02 22:30 Night	W=0.5 –1m/s NW Temp=20°C	Ambient	85	78	57	36	63	Car 84 Insects 38 - 42

Bulga Rural

Location – 2 Lambkin (WCM Boundary)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
23/12/02 11:00 Day	W= 2m/s SE Temp=25°C	Ambient	60	47	40	31	39	Insects/Birds 37 - 46
2212/02 21:20 Evening	W=1 m/s SE Temp=26°C	Ambient	49	44	35	31	35	Insects 31-32
22/12/02 22:25 Night	W=3.5 – 4m/s SE Temp=20°C	Ambient	49	45	42	34	39	Insects 35-47

Location – 25 Fenwick (Dwelling)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
23/12/02 11:30 Day	W= 2.5-3m/s SE Temp=25°C	Ambient	50	47	38	27	36	Insects 33 Birds 34 - 37
22/12/02 21:45 Evening	W=0.5 m/s SE Temp=33°C	Ambient	64	59	46	36	46	Insects Thunder 46 – 56 Wambo mine truck 38 – 42 (single event)
		Wambo	Estimated LAeq(15minute) - <35 dBA					
22/12/02 22:00 Night	W=0.5 m/s SE Temp=20°C	Ambient	52	41	39	33	37	Crickets 34 - 36

Warkworth Suburban

Location 19A Kelly (WCM Boundary)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax dBA
			LAmax	LA1	LA10	LA90	LAeq	
23/12/02 12:20 Day	W = 1-1.5m/s SE Temp=26°C	Ambient	61	55	49	38	49	Truck on bridge 57 Car on bridge 45 Insects 39 Birds 43
22/12/02 19:20 Evening	W=Still Temp=30°C	Ambient	58	57	54	45	51	Truck on bridge 58 Car on Hwy 50 Far Traffic 43-45 Insects 46 - 48
22/12/02 23:45 Night	W=2.5 –3m/s SE Temp=25°C	Ambient	57	54	52	45	49	Car 49 Truck on bridge 56 Wambo mine truck 49 Wambo dozer tracking 51
		Wambo	Estimated LAeq(15minute) – 46 dBA					

Location – 56 Haynes (WCM Adjacent)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
23/12/02 12:00 Day	W=2.5m/s SE Temp=26°C	Ambient	60	55	50	42	47	Far Traffic 39 Truck passby on Hwy 50 Car on Hwy 47 Birds 42
22/12/02 19:45 Evening	W=1m/s SE Temp=30°C	Ambient	72	62	54	43	51	Truck on Hwy 46-55 Thunder 45 Dog 67
22/12/02 23:25 Night	W=1.5 - 2m/s SE Temp=26°C	Ambient	63	55	52	43	49	Car on Hwy 46 Truck on Hwy 52 Wambo Mine Truck 47 – 49 Insects 41
		Wambo	Estimated LAeq(15minute) – 44 dBA					

Location – 51 Hawkes (WCM Boundary)

Date/Start Time	Weather	Measurement Description	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax – dBA
			LAmax	LA1	LA10	LA90	LAeq	
23/12/02 10:30 Day	W= 0.5–1m/s SE Temp=°C	Ambient	57	46	40	34	38	Birds 40-42 Far Traffic 37
15/12/02 19:00 Evening	W=2.5 – 3m/s NW Temp=28°C	Ambient	-	-	-	-	-	No data, not accessible
15/12/02 23:50 Night	W=Still Temp=20°C	Ambient	-	-	-	-	-	No data, not accessible

Jerrys Plains Rural

Location – 15(B) McGowen/Caslick (Dwelling)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax dBA
			LAmax	LA1	LA10	LA90	LAeq	
23 /12/02 14:20 Day	W=2 -2.5m/s SE Temp=28°C	Ambient	62	50	44	35	41	Horse 49 Bird to 43
22/12/02 18:00 Evening	W=1 - 1.5m/s SE Temp=31°C	Ambient	62	48	46	41	44	Insects 39-40 Birds 43 Dog 50
22/12/02 22:00 Night	W= m/s NW Temp=°C	Ambient	-	-	-	-	-	No data – storm and rain

Jerrys Plains Suburban

Location – 31D Fisher (Dwelling)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax dBA
			LAmax	LA1	LA10	LA90	LAeq	
23/12/02 13:50 Day	W = 2m/s SE Temp=29°C	Ambient	66	61	47	39	48	Far Traffic 43
22/12/02 18:50 Evening	W=1m/s SE Temp=29°C	Ambient	60	59	54	38	50	Car 51 – 58 Insects 42- 44
15/12/02 22:50 Night	W=m/s NW Temp=°C	Ambient	-	-	-	-		No data – storm and rain

Location – 31(A,B,C,D) Fisher (20m from Jerrys Plains Road)

Date/Start Time	Weather	Contribution	Primary Noise Descriptor (dBA re 20 µPa)					Emission and Typical Maximum Levels LAmax dBA
			LAmax	LA1	LA10	LA90	LAeq	
23/12/02 13:30 Day	W= 2m/s SE Temp=30°C	Ambient	79	77	73	40	67	Car 76 Truck 79
22/12/02 18:30 Evening	W=1 m/s NW Temp=31°C	Ambient	90	82	68	37	68	Car 75 Truck 82 Thunder 55
15/12/02 22:30 Night	W=m/s NW Temp=°C	Ambient	-	-	-	-	-	No data – storm and rain

Statistical Ambient Noise Levels Charts
Available On Request

WAMBO DEVELOPMENT PROJECT

SITE SPECIFIC WIND CONDITIONS – SEPTEMBER 2000 TO AUGUST 2002

Table 1 Seasonal Frequency of Occurrence Wind Speed Intervals - Daytime

Period	Calm (<0.5 m/s)	Wind Direction ±(45°)	Wind Speed		
			0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Annual	**4%**	**ESE**	**10%**	**9%**	**20%**
Summer	2%	ESE	12%	13%	25%
Autumn	6%	ESE	15%	13%	28%
Winter	6%	WNW	14%	9%	24%
Spring	2%	ESE	7%	8%	15%

Table 2 Seasonal Frequency of Occurrence Wind Speed Intervals - Evening

Period	Calm (<0.5 m/s)	Wind Direction ±(45°)	Wind Speed		
			0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Annual	4%	SE	23%	14%	37%
Summer	1%	SE	22%	24%	46%
Autumn	5%	SE	29%	15%	44%
Winter	5%	W	16%	15%	31%
Spring	3%	SE	16%	16%	31%

Table 3 Seasonal Frequency of Occurrence Wind Speed Intervals - Night-time

Period	Calm (<0.5 m/s)	Wind Direction ±(45°)	Wind Speed		
			0.5 to 2 m/s	2 to 3 m/s	0.5 to 3 m/s
Annual	12%	SE	23%	10%	33%
Summer	8%	SE	35%	21%	56%
Autumn	13%	SE	29%	11%	40%
Winter	14%	W	21%	11%	32%
Spring	13%	SSE	22%	10%	32%

SITE SPECIFIC ATMOSPHERIC STABILITY CONDITIONS – SEPTEMBER 2000 TO AUGUST 2002

Table 4 Frequency of Occurrence of Atmospheric Stability Classes - Daytime

Stability Class	Frequency of Occurrence	Estimated ELR °C/100 m	Qualitative Description
	Winter		
A	21%	<-1.9	Lapse
B	17%	-1.9 to -1.7	Lapse
C	45%	-1.7 to -1.5	Lapse
D	13%	-1.5 to -0.5	Neutral
E	3.0%	-0.5 to 1.5	Weak Inversion
F	0.4%	1.5 to 4	Moderate Inversion
G	0.8%	>4.0	Strong Inversion

Note: ELR (Environmental Lapse Rate)

Table 5 Frequency of Occurrence of Atmospheric Stability Classes - Evening and Night-time

Stability Class	Frequency of Occurrence	Estimated ELR °C/100 m	Qualitative Description
	Winter		
A	0%	<-1.9	Lapse
B	0%	-1.9 to -1.7	Lapse
C	0%	-1.7 to -1.5	Lapse
D	51%	-1.5 to -0.5	Neutral
E	13%	-0.5 to 1.5	Weak Inversion
F	22%	1.5 to 4	Moderate Inversion
G	14%	>4.0	Strong Inversion

Note: ELR (Environmental Lapse Rate

CHAPTER 171

NOISE CONTROL GUIDELINE

CONSTRUCTION SITE NOISE

Where there is likelihood of annoyance due to noise from construction sites, conditions such as the following may be specified in a development consent or building application.

This applies particularly to non-scheduled premises such as commercial buildings where a long construction time is not likely.

The criteria may not be applicable to long-term construction such as coal mines which may take several years.

Variations should be made according to local conditions.

Level Restrictions

i. Construction period of 4 weeks and under.

   The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dBA.

ii Construction period greater than 4 weeks and not exceeding 26 weeks.

   The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dBA.

Time Restrictions

Monday to Friday 7.00 am to 6.00 pm

Saturday 7.00 am to 1.00 pm if inaudible on residential premises, otherwise 8.00 am to 1.00 pm

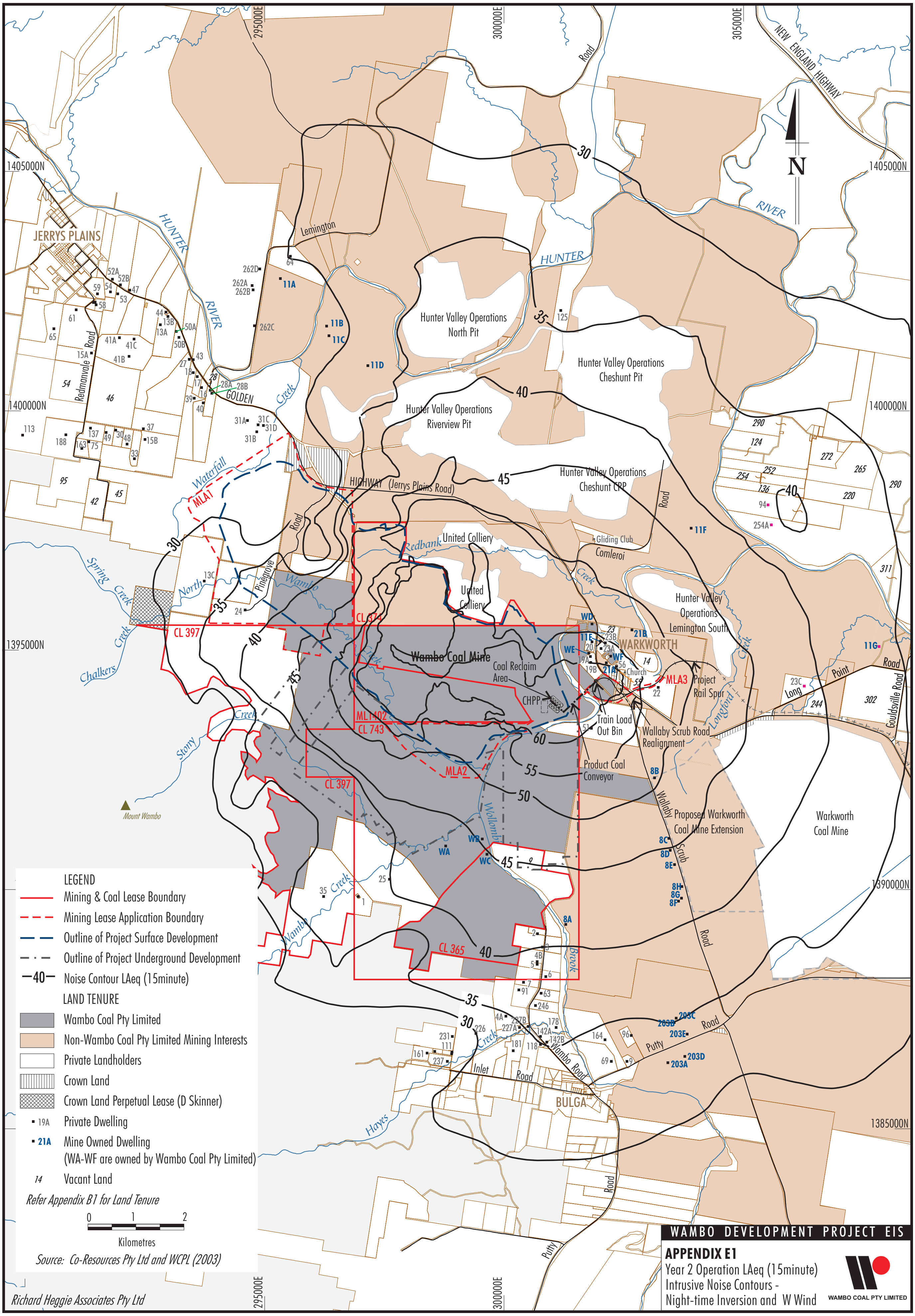
No construction work to take place on Sunday or Public Holidays.

Silencing

All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment should be used on road or rail works where 24 hour operation is necessary.

Appendix E1

Report 10-2470-R1
Page 1 of 2
Year 2 Operation $L_{Aeq(15minute)}$ Intrusive Noise Contours
Night-time Inversion and W Wind



WAMBO DEVELOPMENT PROJECT EIS

APPENDIX E1

Year 2 Operation LAeq (15minute) Intrusive Noise Contours - Night-time Inversion and W Wind

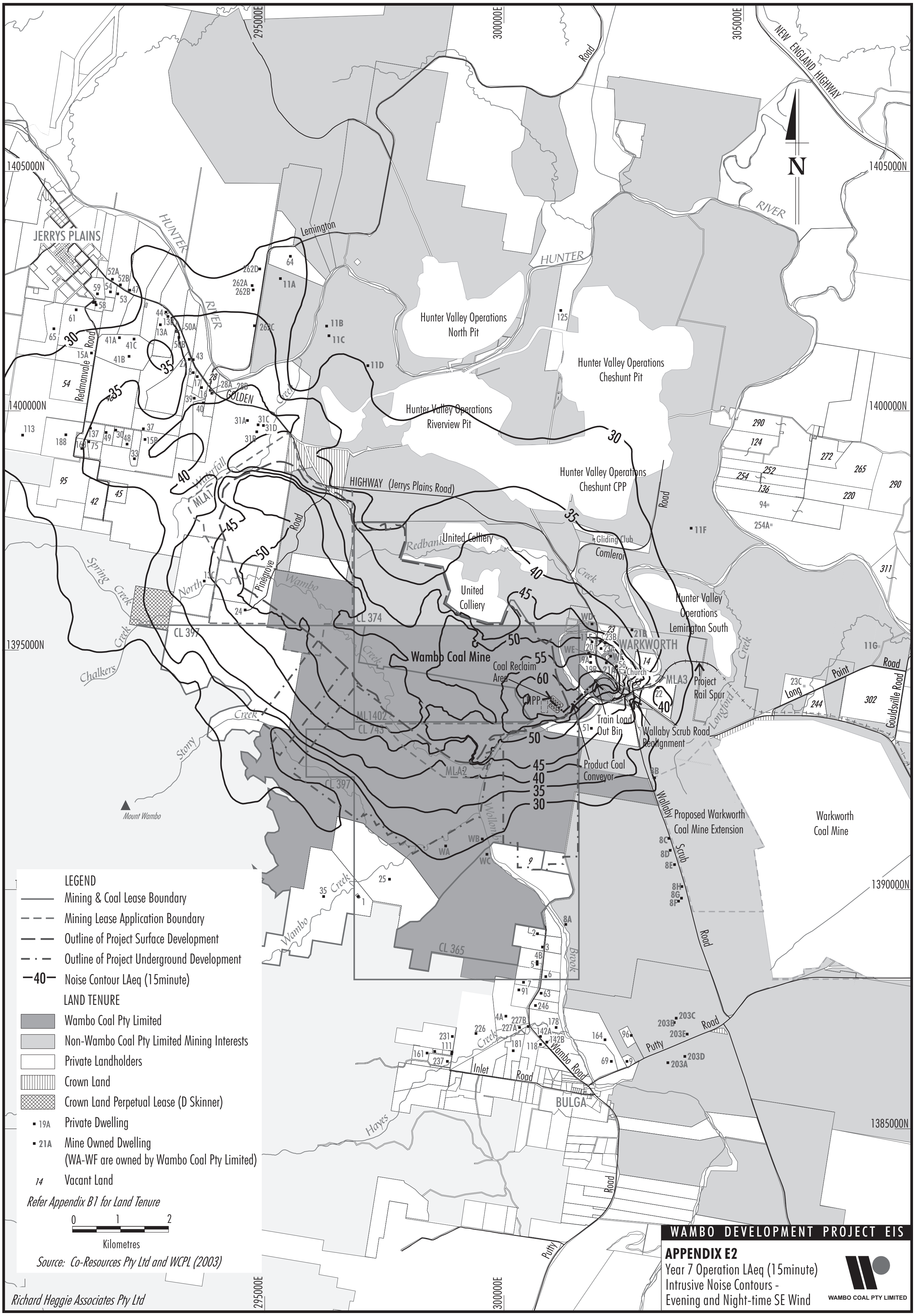
WAMBO COAL PTY LIMITED

WAM-02-01-Noise_001P

Appendix E2

Report 10-2470-R1

Year 7 Operation $L_{Aeq(15minute)}$ Intrusive Noise Contours
Evening and Night-time SE Wind



WAMBO DEVELOPMENT PROJECT EIS

APPENDIX E2

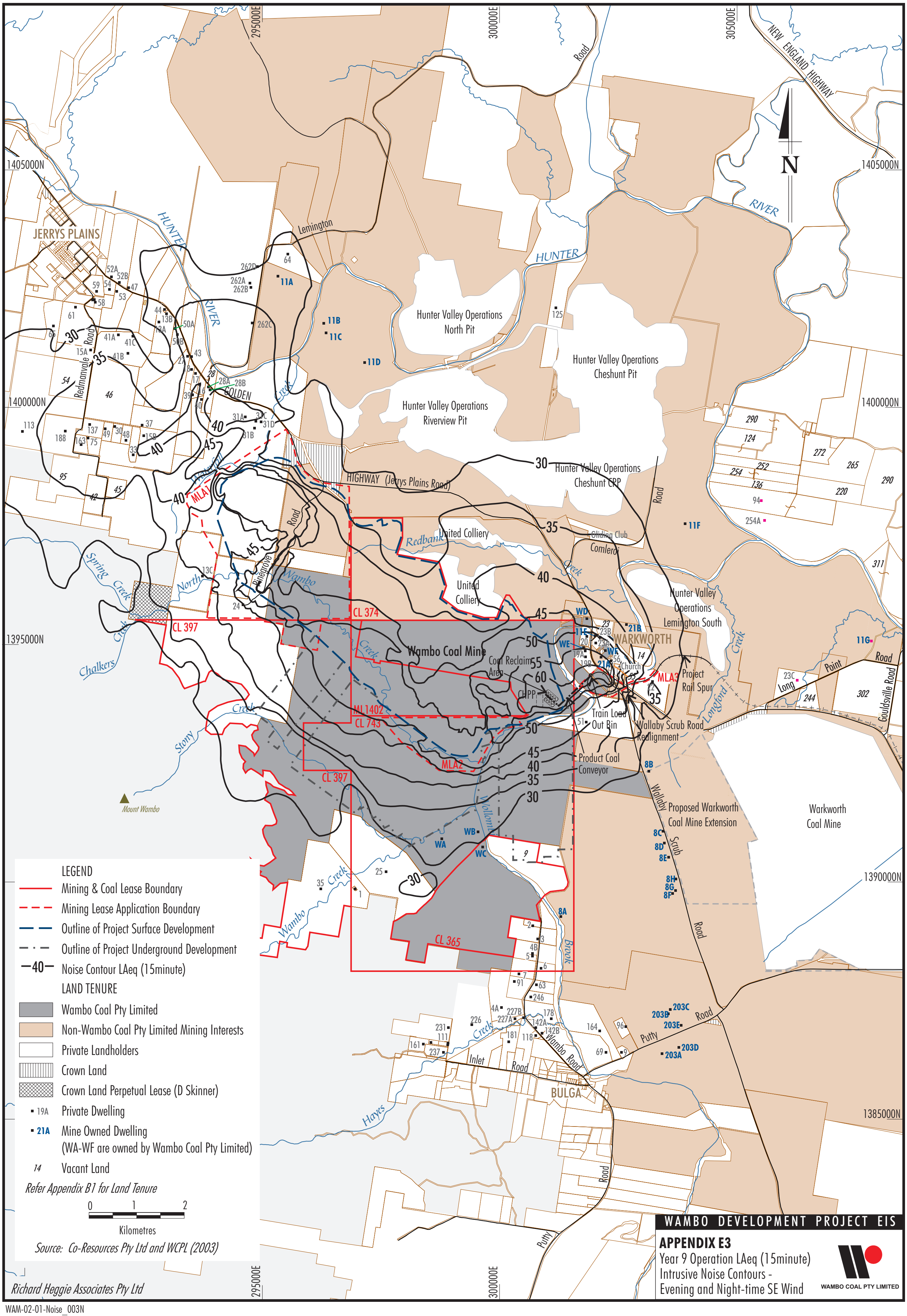
Year 7 Operation LAeq (15minute) Intrusive Noise Contours - Evening and Night-time SE Wind

Appendix E3

Report 10-2470-R1

Year 9 Operation $L_{Aeq(15minute)}$ Intrusive Noise Contours

Evening and Night-time SE Wind



WAMBO DEVELOPMENT PROJECT EIS

APPENDIX E3

Year 9 Operation LAeq (15minute) Intrusive Noise Contours - Evening and Night-time SE Wind

WAMBO COAL PTY LIMITED

MINE: Warkworth Coal Mine

CONSENT: DA 20/95 dated 14 December 1995

AMENDMENT: N91/00077 dated 2002
N91/00077 dated 28 September 2001
N91/00077 dated 26 June 2000

NOISE CRITERIA: Condition 10 Noise Levels

Location	EIS Affectation Non-Adverse		Operating Affectation Non-Adverse		Operating Affectation Adverse	
	Daytime LA10(15minute)	Night-time LA10(15minute)	Daytime LA10(15minute)	Night-time LA10(15minute)	Daytime LA10(15minute)	Night-time LA10(15minute)
Non-mine owned dwelling	-	-	35	33	-	-

Note: "Non-adverse" relates to average conditions (neutral atmosphere) that is calm winds and the absence of temperature inversion, or as otherwise determined by the EPA.

NOISE MANAGEMENT PLAN: Condition 11 Noise and Vibration Monitoring and Management

CUMULATIVE REQUIREMENTS: N/A

MINE: United Colliery

CONSENT: DA 81/174 dated 20 March 1984

AMENDMENT: N91/00456 dated 12 November 1990
N91/00456 dated 5 June 1995
N91/00456 dated 22 July 1998
N91/00456 dated 16 October 1999
N91/00456 dated 12 March 2002

NOISE CRITERIA: Condition 16(iii) Noise Emissions

Location	EIS Affectation Non-adverse			Operating Affectation Non-Adverse			Operating Affection - Adverse		
	Daytime LAeq (15minute)	Evening LAeq (15minute)	Night-time LAeq (15minute)	Daytime LAeq (15minute)	Evening LAeq (15minute)	Night-time LAeq (15minute)	Daytime LAeq (15minute)	Evening LAeq (15minute)	Night-time LAeq (15minute)
Warkworth Roadhouse	-	-	-	-	-	-	42	39	39

Note: "Adverse" weather conditions is defined as all atmospheric conditions.

NOISE MANAGEMENT PLAN: N/A

CUMULATIVE REQUIREMENTS: N/A

MINE: Carrington Coal Mine

CONSENT: DA 106-6-99 dated 15 August 2000

NOISE CRITERIA: Condition 6.3 Noise Controls, Noise Levels, Parts a,b,c

Location	EIS Affectation Non-Adverse		Operating Noise Limits Adverse		Operating Affectation			
					Adverse		Non -Adverse	
	Daytime LA10 (15minute)	Night-time LA1 (15minute)	Daytime LA10 (15minute)	Night-time LA1 (15minute)	Daytime LA10 (15minute)	Night-time LA10 (15minute)	Daytime LA10 (15minute)	Night-time LA10 (15minute)
Non-Mine Owned Dwellings	40	35	40	35-37	45	40	40	35

Note: "Non-adverse" conditions means calm conditions with winds less than 0.1 m/s and in the absence of temperature inversion.
"Adverse" weather conditions mean the presence of winds up to 3 m/s, and or temperature inversions of up to 4^oC/100 m.

NOISE MANAGEMENT PLAN: Condition 6.3 Noise Control, Noise Management Plan Parts h.i.

CUMULATIVE REQUIREMENTS: Condition 11.2 Cumulative Impact Assessment, Parts a,b,c,d as follows:

"*(a) In the event that the cumulative impact of dust or noise contributed by the operation of the Carrington Mine development and other nearby coal mining activities at residences in the vicinity of the mine is in excess of the noise or dust criteria contained in these conditions of consent, the Applicant shall negotiate with the other mining companies appropriate arrangements to contribute to the amelioration of the impacts of the exceedances of dust emissions or noise.*

(b) If such cumulative impacts cannot be satisfactorily ameliorated, then the Applicant shall contribute towards the acquisition of the subject affected properties, in proportion to the amount of dust or noise impact.

(c) The provisions of subclause (b) of this condition specifically apply to cumulative impact associated with the operation of the Carrington Mine development and future coal mining activities in the area operating under future consents.

(d) If agreement on appropriate contributions towards acquisition cannot be reached, then the Director-General may appoint an independent panel to resolve the matter. The membership of the independent panel shall be as determined by the Director-General. The independent panel shall determine the responsibilities of each of the mining companies. The decision of the independent panel shall be final and binding on all parties. The responsibilities of the mining companies and the land owner as described in Condition 11.1 will apply."

MINE: Hunter Valley Nos 1 and 2

CONSENT: DA 114-12-98 dated 2000

AMENDMENT: N91/00792 dated 2 November 2001
N91/00792 dated 11 March 2002

NOISE CRITERIA: Condition 6.3.1 Noise Levels Parts a,b,c.

Location	EIS Affectation Non-Adverse		Operating Noise Limits Adverse		Operating Affectation			
					Adverse		Non-Adverse	
	Daytime LA10 (15minute)	Night-time LA10 (15minute)	Daytime LA10 (15minute)	Night-time LA10 (15minute)	Daytime LA10 (15minute)	Night-time LA10 (15minute)	Daytime LA10 (15minute)	Night-time LA10 (15minute)
Non-mine owned dwellings	40	35	40	35-40	45	40	40	35

Note: "Non-adverse" conditions means calm conditions and in the absence of temperature inversions.
"Adverse" weather conditions mean the presence of winds up to 3 m/s and/or inversions of up to $4^{o}C/100$ m.

NOISE MANAGEMENT PLAN: Condition 6.4.3 Noise Management Plan

CUMULATIVE REQUIREMENTS: Condition 11.2 Cumulative Impact Assessment Parts a,b,c,d as follows:

"*(a) In the event that the cumulative impact of dust or noise contributed by the operation of the Hunter Valley Mine development and other nearby coal mining activities at residences in the vicinity of the mine is in excess of the noise or dust criteria contained in these conditions of consent, the Applicant shall negotiate with the other mining companies appropriate arrangements to contribute to the amelioration of the impacts of the exceedances of dust emissions or noise.*

(e) If such cumulative impacts cannot be satisfactorily ameliorated, then the Applicant shall contribute towards the acquisition of the subject affected properties, in proportion to the amount of dust or noise impact.

(f) The provisions of subclause (b) of this condition specifically apply to cumulative impact associated with the operation of the Hunter Valley Mine development and future coal mining activities in the area operating under future consents.

(g) If agreement on appropriate contributions towards acquisition cannot be reached, then the Director-General may appoint an independent panel to resolve the matter. The membership of the independent panel shall be as determined by the Director-General. The independent panel shall determine the responsibilities of each of the mining companies. The decision of the independent panel shall be final and binding on all parties. The responsibilities of the mining companies and the land owner as described in Condition 11.1 will apply."

WAMBO DEVELOPMENT PROJECT

APPENDIX B

Air Quality Assessment

AIR QUALITY IMPACT ASSESSMENT:

WAMBO DEVELOPMENT PROJECT

April 2003

Prepared
for
Wambo Coal Pty Limited

by

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FIGURES

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TABLES

1. INTRODUCTION

This report has been prepared by Holmes Air Sciences for Wambo Coal Pty Limited. It provides an assessment of the air quality impacts of the Wambo Development Project (the Project). The Project involves the continued development of open cut and underground mining operations at the existing Wambo Coal Mine. The proposed mining area is located near the village of Warkworth approximately 15 km west of Singleton, New South Wales (NSW). The assessment deals with a 21-year period during which run-of-mine (ROM) coal is planned to be mined at a rate of between 4.0 and 14.7 Mtpa from combined open cut and underground operations.

The Project area and nearby residences are shown on **Figure 1**. **Figure 2** shows the locations of air quality monitoring sites.

The assessment follows the New South Wales Environment Protection Authority's (EPA) guidelines for the use of models in the assessment of air quality impacts (**NSW EPA, 2001**). It uses a computer-based dispersion model, with local meteorological data and estimates of dust emissions, to predict the concentration and deposition rate of particulate matter from the Project and other mines expected to be operating concurrently during the life of the Project. Some modifications to the assessment approach presented in the EPA guidelines have been made (for example the use of the ISCST3 model instead of AUSPLUME and other modifications to the assessment approach). The EPA has previously been consulted regarding these modifications.

In summary the report provides information on the following:

- The way in which mining is to be undertaken with a focus on describing those aspects that will assist in understanding how the mine will affect air quality.
- The surrounding mines that are currently expected to operate during the life of the Project.
- The existing air quality conditions in the area around the proposed mine.
- Air quality goals that need to be met to protect air quality.
- Meteorological conditions in the area.
- The methods used to estimate dust emissions and the way in which dust emissions from the proposal will disperse and fallout.
- The expected dispersion and dust fallout patterns due to the Project and other mines and a comparison between the predicted dust concentration and fallout levels and the relevant air quality criteria.
- The emissions of greenhouse gases from the Project.
- The emissions of odour from the mine.
- The likely impacts of construction.
- The control methods to be used by the mine to reduce dust impacts.

2. AIR QUALITY ASSESSMENT METHODS AND CRITERIA

In managing air quality the EPA attempts to achieve compliance with the National Environment Protect Measures for Ambient Air Quality (referred to as the Ambient Air-NEPMs (see **NEPC, 1998**)). To do this the EPA specifies air quality assessment criteria relevant for assessing impacts from mining. These are summarised in **Tables 1**, **2** and **3**.

Although the EPA's assessment criteria are expressed in a different form from the Ambient Air-NEPMs, the criteria are such that the resulting ambient air quality is consistent with the Ambient Air-NEPMs.

Table 1. Impact assessment criteria for pollutants (for use in modelling)

Pollutant	Averaging period	Concentration	
		pphm	**µg/m³**
PM_{10}	1-day	-	50*
	annual	-	30
SO_2	10 minutes	25	712
	1-hour	20	570
	1-day	8	228
	1-year	2	60
NO_2	1-hour	12	246
	1-year	3	62
		ppm	**mg/m³**
CO	15 minutes	87	100
	1-hour	25	30
	8-hours	9	10

* Non cumulative for purposes of impact assessment (refer Section 4.4)

In addition, the guidelines provide the criteria for total suspended particulate matter (see **Table 2**) and for the insoluble component of deposited dust (see **Table 3**).

Table 2. NSW EPA amenity based criteria for dust fallout - TSP

Pollutant	Averaging period	Concentration
TSP	Annual	90 µg/m³

Table 3. NSW EPA amenity based criteria for dust fallout – deposited dust

Pollutant	Averaging period	Maximum increase in deposited	Maximum total dust deposition
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

The National Environmental Protection Council (NEPC) is in the process of developing an advisory National Environmental Protection Measure (NEPM) for $PM_{2.5}$. The numerical values for proposed NEPM are:

1. 8 µg/m³ – annual average
2. 25 µg/m³ – maximum 1-day average.

At this stage, the proposed advisory $PM_{2.5}$ standard is not part of the NSW EPA assessment criteria. Predictions as to the likely contribution that emissions from the Project will make to ambient $PM_{2.5}$ concentrations have been undertaken, however, these predictions have not been used to assess impacts against the proposed advisory standard. Predictions of $PM_{2.5}$ concentrations are provided in **Appendix A**.

The sulfur content of Australian diesel is too low and mining equipment is too widely dispersed over mine sites to cause sulfur dioxide goals to be exceeded even in mines that use large quantities of diesel. For this reason no detailed study is required to demonstrate that emissions of SO_2 from the mine will not significantly affect ambient SO_2 concentrations. In addition NO_x and CO emissions are too small and too widely dispersed to require a detailed modelling assessment.

Thus the main focus of the study is on the potential effects of particulate matter (PM) emissions. Particulate matter has the capacity to affect human health and to cause nuisance effects.

To assist in interpreting the significance of predicted concentration and deposition levels some background discussion on the potential harmful effects is provided below.

Particulate matter can be categorised by size and/or by chemical composition. The potential harmful effects depend on both.

The human respiratory system has in-built defensive systems that prevent particles larger than approximately 10 µm from reaching the more sensitive parts of the respiratory system. Particles with aerodynamic diameters less than 10 µm are referred to as PM_{10}. Particles larger than 10 µm, while not able to affect health, can soil materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air. This is referred to as Total Suspended Particulate matter (TSP). In practice particles larger than 30 to 50 µm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 µm. TSP includes PM_{10}.

3. METEOROLOGICAL CONDITIONS

The discussion in this section provides information on climatic conditions in the Project area, in particular on those climate elements that are relevant for estimating dust emissions. In addition, information is presented on dispersion conditions.

The Project site lies approximately 17 km west of the Bureau of Meteorology's observation station at Singleton (Army Base) and 15 km southeast of the observation station at Jerrys Plains. Data from both sites and from the Wambo Coal Mine environmental monitoring program are discussed in this review.

3.1 Dispersion meteorology

The computer-based dispersion model ISCST3 has been used in this study. This model requires data on wind speed, wind direction, atmospheric stability[1] class and mixed-layer height[2].

[1] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme (as used in this study) there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

Data is available from a number of different sites including a meteorological station operated as part of the Wambo Coal Mine environmental monitoring program (see **Figure 2** for location). The data set used in the modelling covers a period from 1 June 2001 to 31 May 2002. This data set is representative of the area and has 95.2% valid data. The annual average wind speed was 2.54 m/s. **Appendix B** provides tables of the joint frequency of occurrence of wind speed, wind direction and stability conditions. These data show that 6.7% of hourly average wind speeds exceeded 5.4 m/s during the period 1 June 2001 to 31 May 2002.[3]

The data provides hourly information on wind speed, wind direction, and other parameters required for dispersion modelling. **Figure 3** shows annual and seasonal windroses prepared from the data set used in the modelling.

The windroses show that over a year the prevailing winds are aligned along a northwest - southeast axis, which is common for much of the Hunter Valley.

3.2 Temperature and humidity

Temperature and humidity data for Singleton and Jerrys Plains are presented in **Table 4** and **5** respectively. The annual average temperature at Jerrys Plains (JP) is 0.9^{o}C warmer than at Singleton (S). January is the warmest month experiencing a mean monthly maximum temperature of 30.6^{o}C (Singleton) and 31.7^{o}C (Jerrys Plains). July is the coolest experiencing a mean monthly minimum temperature of 5.2^{o}C (S) and 3.7^{o}C (JP).

Singleton experiences slightly higher relative humidity than JP with annual average readings being 72% (S) and 69% (JP). Annual average 3 pm readings are 48% (S) and 47% (JP).

3.3 Rainfall and evaporation

Rainfall data is presented in **Table 4** and **5**. Mean annual rainfall has been 723.7 mm (S) and 640.2 mm (JP). January is the wettest months (in terms of average, but not median rainfall amounts) at both sites and July and August are the months with lowest average rainfall at S and JP respectively. Singleton records on average 112.6 raindays per year and JP records 86.

Evaporation data is available from the "Climatic Atlas of Australia" (**Bureau of Meteorology, 1988**). Evaporation rates for Singleton for January, April, July and October are approximately 225, 125, 75, and 175 mm respectively. Thus, evaporation is well above the expected rainfall amount for all the months of the year.

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[2] The term mixed-layer height, refers to the height above the ground through which ground-based emissions will eventually be dispersed once a plume has been thoroughly mixed. An elevated plume, initially above the mixed-layer height will remain isolated from the ground until such time as the mixed-layer height reaches the height of the plume. In general the mixed-layer height will increase during the day as the sun causes convection to deepen the turbulent layer of the atmosphere close to the ground. Mixed-layer height will also increase if the wind speed increases because higher wind speeds will increase turbulence as the wind blows over the rough ground.

[3] The threshold of 5.4 m/s is the wind speed at which dust emissions from wind erosion sources is initiated.

Table 4. Climate averages for Station: 061275 SINGLETON ARMY Commenced: 1969; Last record: 1990; Latitude (deg S):-32.6133; Longitude (deg E): 151.1717; State: NSW (Source: Bureau of Meteorology web site)

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.	No. of years	% complete
Mean daily maximum temperature - deg C	30.6	29.5	28.2	24.9	21	17.8	17.0	19.2	22.2	25.5	27.5	30.4	24.3	18.5	87
Mean no. of days where Max Temp >= 40.0 deg C	0.8	0.7	0.1	0	0	0	0	0	0	0.1	0.2	0.8	2.7	18.8	89
Mean no. of days where Max Temp >= 35.0 deg C	5.9	3.5	1.8	0.1	0	0	0	0	0.1	0.8	1.7	6.3	20.2	18.8	89
Mean no. of days where Max Temp >= 30.0 deg C	16.6	12.1	9.2	1.7	0	0	0	0	1.1	4.8	9.2	16.3	70.9	18.8	89
Highest daily Max Temp - deg C	42.2	43	40	37.5	28.5	24.3	26	28.5	36.1	41	42.5	44	44	20.3	96
Mean daily minimum temperature - deg C	17.7	17.9	16.1	12.6	9.5	6.8	5.2	6.3	8.8	11.8	14.2	16.7	11.6	18	85
Mean no. of days where Min Temp <= 2.0 deg C	0	0	0	0	0.4	1.5	4.8	2	0.2	0	0	0	8.8	18.8	89
Mean no. of days where Min Temp <= 0.0 deg C	0	0	0	0	0	0.1	0.7	0.1	0	0	0	0	0.9	18.8	89
Lowest daily Min Temp - deg C	7.1	8.5	8	3	1	0	-3.4	-0.5	0.5	4	5.5	8.5	-3.4	20.2	94
Mean 9am air temp - deg C	22.6	22.1	21.2	17.6	13.8	10.6	9.4	11.4	15.5	18.9	20.2	22.8	17	15.1	71
Mean 9am wet bulb temp - deg C	19.4	19.5	18.3	15.1	12.1	9.1	7.7	8.9	12	14.6	16.3	18.4	14.1	14.2	69
Mean 9am dew point - deg C	17.3	17.8	16.3	13.1	10.5	7.5	5.5	6.2	8.7	10.7	13.1	15.3	11.7	14.3	69
Mean 9am relative humidity - %	72	77	74	75	80	81	77	71	64	61	66	63	72	14.3	69
Mean 9am wind speed - km/h	5.5	5.5	6.4	6.3	6.3	6.7	7.9	7	7.6	7.7	6.8	6.5	6.7	14	66
Mean 3pm air temp - deg C	28.5	28	26.5	23.5	19.8	16.6	16.1	18.3	21.1	23.8	26.1	29.2	22.9	14.9	70
Mean 3pm wet bulb temp - deg C	20.8	21.2	19.8	17	14.8	12.2	11.2	11.9	14.1	16.1	18.1	20	16.3	14	68
Mean 3pm dew point - deg C	16.1	17	15.3	12.1	10.4	7.8	5.9	5	7.6	9.6	12	13.8	11	14.1	68
Mean 3pm relative humidity - %	49	52	51	49	56	56	52	42	42	42	43	40	48	14.1	68
Mean 3pm wind speed - km/h	10.8	11.3	10.2	9.1	8.3	8.1	9.7	9.7	9.7	11.1	11.9	11.7	10.1	14	66
Mean monthly rainfall - mm	94.3	88.9	72.7	58.4	59.7	37.9	29.4	37.1	45.3	69.1	67.9	63	723.7	20.8	98
Median (5th decile) monthly rainfall - mm	83	49.3	72.4	46.1	51	23.4	27.4	19.9	34.1	56.9	63	57.8	735.1	19	
9th decile of monthly rainfall - mm	210.3	212.4	176.6	143.5	131.3	103.8	58.7	100.8	96.9	178.1	137	137.8	919.7	19	
1st decile of monthly rainfall - mm	18.7	14.7	5.3	1.3	17.6	8.8	1	3.5	11.9	17.3	19.3	14.8	526	19	
Mean no. of raindays	10.8	10.3	10.5	9.4	9.7	9.5	8	7.8	8.4	10	10.3	7.9	112.6	19.3	91
Highest monthly rainfall - mm	226.3	340.4	264.3	172.2	314.3	288.4	231.6	206.9	156.1	170	217.8	233.1		115.5	99
Lowest monthly rainfall - mm	0	0	0	0	0	2.3	0.3	0	0	1.4	1	0		115.5	99
Highest recorded daily rainfall – mm	97.3	139.7	132.1	86.6	99.1	190.8	137.2	65.3	67.3	68.6	67.1	108	190.8	115.3	99
Mean no. of clear days	7	5.4	7.3	9.3	8.6	8.4	10.7	12	10.5	8.2	7.2	7.8	102.3	42.2	95
Mean no. of cloudy days	12.3	12.2	11.4	9.7	11	11.4	8.7	8.4	8.6	11.4	11.2	11.7	128	42.2	95

Table 5. Climate averages for Station: 061086 JERRYS PLAINS POST OFFICE Commenced: 1884; Last record: 2001; Latitude (deg S):-32.4983; Longitude (deg E): 150.9083; State: NSW (Source: Bureau of Meteorology web site)

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.	No. of years	% complete
Mean daily maximum temperature - deg C	31.7	30.9	29	25.3	21.2	17.9	17.3	19.4	22.8	26.2	29.3	31.4	25.2	89.5	95
Mean no. of days where Max Temp >= 40.0 deg C	1.3	0.6	0.1	0	0	0	0	0	0	0	0.4	0.9	3.3	39.8	90
Mean no. of days where Max Temp >= 35.0 deg C	6.9	4.2	2	0.1	0	0	0	0	0.1	0.6	3.3	6.3	23.4	39.8	90
Mean no. of days where Max Temp >= 30.0 deg C	16.7	13.3	10	2.9	0	0	0	0.1	1.1	4.8	10.4	16.4	75.8	39.8	90
Highest daily Max Temp - deg C	44.4	45.3	42.8	38.9	30	26.1	25.6	31	36.2	38	44.9	45.6	45.6	39.9	90
Mean daily minimum temperature - deg C	17.1	17	15	10.8	7.3	5.2	3.7	4.4	6.9	10.2	13.1	15.7	10.5	89.8	95
Mean no. of days where Min Temp <= 2.0 deg C	0	0	0	0.2	1.8	6.2	11.4	8.9	2.3	0.1	0	0	30.9	39.9	90
Mean no. of days where Min Temp <= 0.0 deg C	0	0	0	0	0.4	1.8	5.2	2.9	0.3	0	0	0	10.5	39.9	90
Lowest daily Min Temp - deg C	7.8	8.7	4.5	0.6	-1.6	-2.8	-4.5	-3	-0.6	1	4.4	5	-4.5	39.9	90
Mean 9am air temp - deg C	23.3	22.7	21.4	17.9	13.5	10.5	9.2	11.2	15	18.8	21.1	23.1	17.3	57.4	95
Mean 9am wet bulb temp - deg C	19.2	19.3	17.9	14.8	11.5	8.9	7.5	8.9	11.7	14.4	16.2	18	13.9	52.8	87
Mean 9am dew point - deg C	16.7	17.2	15.5	12.5	9.5	7	5.4	6.2	8.1	10.7	12.4	14.5	11.3	37	84
Mean 9am relative humidity - %	67	72	71	71	77	79	78	72	65	60	59	60	69	51.8	85
Mean 9am wind speed - km/h	10.5	9.7	9.6	9.3	9.4	9.8	11.2	11.3	12.3	11.5	11	10.5	10.5	39.7	90
Mean 3pm air temp - deg C	29.5	28.8	27.1	24.2	20	17	16.3	18.1	20.9	23.8	26.7	28.9	23.4	42.8	96
Mean 3pm wet bulb temp - deg C	21	21	19.6	17	14.5	12.1	11	12	13.9	16.1	17.8	19.5	16.2	38.1	85
Mean 3pm dew point - deg C	15.5	16.2	14.3	11.2	9.2	7	5.2	5.3	6.8	9.5	10.7	12.9	10.3	37.9	86
Mean 3pm relative humidity - %	47	50	50	47	52	54	50	45	43	44	41	42	47	37.3	85
Mean 3pm wind speed - km/h	14.1	14	13.3	12.3	12.1	12	14	14.9	15.6	14.6	15.2	14.8	13.9	39.6	89
Mean monthly rainfall - mm	78.9	70	58.6	45.3	41.6	46.2	44.7	36.5	41.8	51.9	57.9	66.8	640.2	115.5	99
Median (5th decile) monthly rainfall - mm	65.6	43.6	46	32.6	28.7	30.7	37.2	30.6	33.8	47.2	48.6	54.7	643.9	113	
9th decile of monthly rainfall - mm	160.9	177.9	121	101	88.9	100.8	95.4	73.2	86.2	97.3	118.9	137.7	825.8	113	
1st decile of monthly rainfall - mm	24.1	6.3	8.7	4.8	5.5	8.8	8.1	6.3	8.6	10.4	10.9	15.1	418.2	113	
Mean no. of raindays	7.9	7.2	7.3	6.3	6.5	7.4	7	7	6.6	7.5	7.6	7.5	86	115.3	99
Highest monthly rainfall – mm	226.3	340.4	264.3	172.2	314.3	288.4	231.6	206.9	156.1	170	217.8	233.1		115.5	99
Lowest monthly rainfall - mm	0	0	0	0	0	2.3	0.3	0	0	1.4	1	0		115.5	99
Highest recorded daily rainfall – mm	97.3	139.7	132.1	86.6	99.1	190.8	137.2	65.3	67.3	68.6	67.1	108	190.8	115.3	99
Mean no. of clear days	7	5.4	7.3	9.3	8.6	8.4	10.7	12	10.5	8.2	7.2	7.8	102.3	42.2	95
Mean no. of cloudy days	12.3	12.2	11.4	9.7	11	11.4	8.7	8.4	8.6	11.4	11.2	11.7	128	42.2	95

3.4 Mixing-height and stability class

Information on hourly mixing height and stability class are required as input to the dispersion model. Intensive sonde studies of the upper atmosphere around the Liddell power plant have been undertaken on behalf of the Electricity Commission of NSW (now Pacific Power) by **Malfroy (1989)** and **Malfroy (1992)**. However, no long-term direct measurements on mixing height are available for the area and theoretically derived values have been used. The theoretical values in the day have been estimated by assuming that the maximum mixing height reached during the day was 1500 m, 1200 m, 1000 m and 1200 m for summer, autumn, winter and spring respectively. At night theoretical values based on wind speed and stability have been derived. These give mixing height values which are consistent with the values reported by Malfroy.

Stability class is used by dispersion models to determine the rate at which the plume grows by the process of turbulent mixing. Each stability class is associated with a dispersion curve, which is used by the model to calculate the plume dimension and dust concentration at points downwind of the source. In the model used here, the Pasquill-Gifford dispersion curves have been used.

The frequency of occurrence of particular stability classes in the 1 June 2001 to 31 May 2002 data set, which was used in the dispersion model, is shown in **Table 6**.

Table 6. Frequency of occurrence of stability classes

Stability	Frequency of occurrence in percent
A	11.6
B	6.4
C	13.8
D	45.5
E	11.9
F	10.8

4. EXISTING AIR QUALITY

4.1 Monitoring networks

Wambo Coal Mine has operated a TSP monitor on a six-day cycle at the site marked as W-HV01 on **Figure 2** and has recently (27 November 2002) installed a PM_{10} monitor at the same location. In addition, TSP and PM_{10} monitoring data collected by Coal & Allied in Bulga, and published in the Warkworth Mine EIS (**ERM, 2002**), are also referred to in this discussion (see C&A-HV01 on **Figure 2**).

Measurements of monthly dust deposition (insoluble solids) are available from up to thirteen Wambo Coal Mine sites. The data collected since 2001 is reviewed in this report. Many of the sites have been operated to assist with on-site management of dust and are not relevant for determining existing deposition levels at off-site receptors. Only data from sites that represent off-site air quality have been included in the review. The proposed mine will expand the mining area to the northwest of its current location and into areas not covered by the existing monitoring network. Dust deposition data from Coal & Allied monitoring programs for mines to the north have been used to provide information on conditions in these areas. These gauges have been marked with the pre-fix C&A on **Figure 2**.

In addition to the data collected by mining companies as part of their environmental monitoring requirements, PM_{10} measurements have been collected as part of an ACARP study (**Holmes Air Sciences, 1999**). The ACARP monitoring site is marked as “W-HV01” on **Figure 2**.

In interpreting the distribution of PM_{10} concentrations and deposition levels it is relevant to note that there are often very sharp gradients in the levels measured especially near sources of dust. For deposition, levels can vary very significantly over a few hundred metres or so. For TSP and PM_{10} the gradients are generally gentler than for deposition, but modelling data (see later) suggests that the concentrations due to a specific source (e.g. the existing operations at Wambo) can vary by a factor of two from one side of Warkworth to the other. There are a number of significant sources of dust in the area. This raises several issues that affect the assessment of impacts due to the Project as follows.

- Because concentration gradients vary spatially it is not possible to characterise the existing air quality using a single background level to represent the entire area that might be affected by emissions from the Project.
- Some residential areas are already impacted (or predicted to be impacted) by mining operations other than the Project. Examples (**Figure 2**) are residences 8B to 8H along Wallaby Scrub Road, which are (or will be) primarily affected by the Warkworth Mine and residences 11B, 11C and 11D, which are (or are predicted to be) affected by Hunter Valley Operations to the north.

4.2 Particulate matter concentrations

Monitoring data from areas in the Hunter Valley where co-located TSP and PM_{10} monitors have been operated for reasonably long periods of time indicate that long-term average PM_{10} concentrations are approximately 40% of the corresponding long-term TSP concentration. Ten 24-hour measurements made at two co-located samplers at the Wambo monitoring site (W-HV01) (see **Figure 2**) between 27 November 2002 and 26 January 2003 showed PM_{10}:TSP ratios of between 25:100 and 50:100 with an average of 38:100. Caution should be adopted when applying this relationship to short-term averages, but in the absence of direct measurements of PM_{10} this ratio (40:100) has been used to assess the likely long-term PM_{10} concentrations that have applied at the Wambo monitoring site.

4.2.1 TSP

Figures 4 and **5** show the 24-hour averages and the moving annual averages for TSP and inferred PM_{10} (and directly measured PM_{10} concentrations) respectively. The measurement site is marked as W-HV01 on **Figure 2**. W-HV01 is located near the mine access road from Warkworth. It is thus likely to experience the effects of dust emissions from trucks hauling product coal to the Mt Thorley Coal Loader (MTCL) and from the mining operations to the west. Thus, the location is representative of mine-site air quality and almost certainly over estimates the concentrations that would be experienced in the residential areas of Warkworth and other residences that surround the mine. Further, the proposed mine development involves the construction of a balloon rail loop which will allow product coal to be exported from the mine by rail. This will eliminate the need for truck transport and reduce this current source of dust emissions in the Warkworth area.

The maximum recorded TSP concentration (24-hour average) was 247 µg/m^3 (27 November 2002). The second highest measured concentration was recorded six days later on 3 December 2002. These measurements and the fourth highest measurement recorded on 9 December 2002 were all affected by bushfire smoke from fires in the Hunter Valley during November and December 2002. Apart from the bushfire-affected measurements, in the three years (approximately) since December 1999, there have been no exceedances of the old US EPA 24-hour TSP Primary Standard of 260 µg/m^3 and one exceedance (16 July 2000) of the old US EPA Secondary Standard of 150 µg/m^3. (Note: reference is made to these old standards because no new standards for 24-hour TSP concentrations were developed after the TSP standards were replaced in 1997 by the standards for PM_{10}. The US EPA replaced the TSP standards with standards for PM_{10} when it was recognised that PM_{10} concentrations were a more relevant indicator of health impacts than concentrations of TSP).

It is not clear what caused the elevated TSP concentrations on the 16 July 2000. Winds were light generally with 10-minute average wind speeds less than 4 m/s and the wind direction was mostly from the west and south.

Table 7 summarises the TSP measurements presented in **Figure 4**. It can be seen that annual average TSP concentrations have all complied with the EPA's 90 µg/m^3 criterion. The significant increase in TSP concentrations that has occurred in 2002 appears to be largely attributable to the bushfires that affected the region in November and December. If the November and December measurements are excluded, then the annual average TSP concentration is 58.4 µg/m^3, which is 8 µg/m^3 higher than the annual average for the two previous years. This increase is almost certainly attributable to the drought conditions that have prevailed in 2002. This has raised general dust levels and made dust control on mines significantly more difficult.

Table 7. Summary of TSP monitoring data from W-HV01 (measured every sixth day) - µg/m^3

Year	Maximum	Minimum	Average	Number of Measurements
2000	188.0	6.8	50.0	57
2001	125.3	10.4	50.1	58
2002	247.0	2.5	72.7	51
2003	Insufficient data collected to date			

TSP concentrations are made at the site labelled C&A-HV01 (see **Figure 2**). The long-term average TSP concentrations at this monitoring site indicate that annual average TSP concentrations are likely to be approximately 32.0 µg/m^3.

There is no TSP to the northwest of the Project area and this level has been taken to represent conditions in the area to the northwest of the mine, where land use is similar.

4.2.2 PM_{10}

As discussed above, annual average PM_{10} concentrations can be inferred from TSP measurements by assuming that PM_{10} is 40% of the TSP.

The long-term inferred and measured average PM_{10} concentration at the monitoring site W-HV01 is presented in **Figure 5**. Annual average PM_{10} concentrations have been between 18.1 and 29.9 µg/m^3 over the period 18 December 1999 to 26 January 2003. The higher values are those affected by bushfires (see later discussion).

Table 8 summarises the PM_{10} data based on inferred data up to 16 November 2002 and on the measurements thereafter.

Table 8. Summary of inferred and measured PM_{10} monitoring data from W-HV01 (measured every sixth day) - µg/m^3

Year	Maximum	Minimum	Average	Number of measurements
2000	75.2	2.7	20.0	57
2001	50.1	4.2	20.0	58
2002	98.8	1.2	29.1 22.2 (excluding bushfires)	51
2003	Insufficient data collected to date			

Maximum 24-hour PM_{10} concentrations have exceeded the NEPM criterion of 50 µg/m^3 (five allowable exceedances per year) on occasions, particularly at times when bushfire smoke affects the area. The data for 2002 are clearly influenced by the bushfires that affected air quality in the area in November and December of 2002. The concentrations are below the NSW EPA annual average criterion of 30 µg/m^3, but based on the most recent year of data (2002) it would appear that little additional PM_{10} could be accepted in the area near the monitor. It is considered that the increase is due to the effects of drought and bushfires.

The Bureau of Meteorology Annual Climate Summary for 2002 (**Bureau of Meteorology, 2003**) stated the following. “The 10-months from March to December, which includes Australia’s main crop and pasture growing season (April-October), saw 61% of the area of Australia with rainfall below the 10th percentile, an area second only to the 10-month period of November-August 1901-02. March to December 2002 also saw 97% of the continent experience below median rainfall, with dry conditions exacerbated by the high temperatures. Although many individual regions had experienced more severe rainfall deficiencies on one or more previous occasions, the immense expanse of this dry event set it aside from most, if not all, dry periods since high quality records began in 1900.” Thus the climatic conditions that applied during the monitoring period were not typical. Further, PM_{10} concentrations were elevated because of the presence of bushfire smoke on a large number of days during the monitoring.

Other mine operated monitoring sites in the Hunter Valley show similar increases in particulate matter concentrations when 2002 data is compared with 2001, with annual average particulate matter concentration increasing between 10 and 20% as a result of the dry conditions.

It is relatively easy to exclude the effects of bush fires from the Wambo data, but because the drought applied throughout the monitoring period, it is not possible to exclude its effects from the data base. When the effects of the bushfires are excluded the annual average PM_{10} concentration for 2002 is 22.2 µg/m^3 which would allow an increase of 7.8 µg/m^3 before the EPA's annual average PM_{10} criterion of 30 µg/m^3 would be exceeded.

In addition, the annual average PM_{10} calculated from readings collected from the W-HV01 (see **Figure 2**) when the relative humidity was less than 80% was 14.4 µg/m^3. (Excluding data collected when the humidity was greater than 80% safeguards against mist or fog being recorded as particulate matter). The data relates to monitoring that took place over the period August 1997 to July 1998 and thus does not cover the recent very dry conditions experienced in 2002.

Finally long-term average PM_{10} concentration at the monitoring site labelled C&A-HV01 near Bulga (see **Figure 2**) was 13.3 µg/m^3. This site also recorded high concentrations during times when bushfire smoke was present.

The collected data suggest that a conservative estimate of annual average PM_{10} concentrations in the Warkworth area in "normal" dry conditions (without bushfires) is likely to be approximately 22 µg/m^3. In the areas further from current mining (for example to the northwest of the proposed Wambo Mine) annual average concentrations are in the order of 13 µg/m^3.

4.3 Deposition

Dust deposition data for the two-year period January 2001 and 2002 has been reviewed for this study. The current Wambo Coal Mine monitoring network includes 13 gauges. The network was set up to measure existing dust deposition rates in the vicinity of the mine and deposition levels due to emissions from mining activities. Only a few of the Wambo gauges provide data that represents conditions in residential areas. Coal & Allied also operate monitoring programs for its mines to the north of Jerrys Plains Road. Data for relevant gauges has been provided by Coal & Allied for this EIS. The locations of the Wambo and Coal & Allied gauges for the last two years are shown in **Figure 2**.

Data from Gauge D03 represents conditions in Warkworth and data from C&A102, 103 and 104 has been taken to represent conditions for the residences to the northwest.

Table 9 summarises the data, showing annual averages since 2001 for D03 and the selected relevant Coal & Allied monitors.

Dust gauge D03 unfortunately is prone to contamination from bird droppings and insect as well as plant material on occasions. After the contaminated results have been excluded, all gauges have recorded annual average dust deposition (insoluble solids) levels of less than 4 g/m^2/month. The levels recorded by the gauges to the north indicate that the area could accept increases in deposition level of 2 g/m^2/month (annual average) and the Warkworth area to the southwest could accept an increase of 1.9 g/m^2/month and would still be within EPA guidelines (Section 2).

Table 9 Annual Average Insoluble Solids Dust Deposition Rate for relevant gauges from Wambo Mine and Coal & Allied monitoring networks - g/m^2/month

Annual 2001	C&A101	C&A103	C&A104	D03
Jan	0.5	0.5	0.2	2.9
Feb	0.3	0.3	0.5	5.7
Mar	0.9	0.9	0.9	17.7[4]
Apr	0.5	0.5	0.9	1.8
May	0.2	0.2	0.5	1.4
Jun	1.3	1.3	0.4	14.3[4]
Jul	0.7	0.7	0.5	2.1
Aug	1.1	1.1	0.5	1.2
Sep	0.6	0.6	0.6	1.2
Oct	0.9	0.9	1.1	1.2
Nov	1.0	1.0	0.8	1.8
Dec	1.1	1.1	1.6	1.9
Annual 2002	**0.8**	**0.8**	**0.7**	**4.4 (2.0*)**
Jan	0.9	0.9	0.4	11.2[4]
Feb	1.6	1.6	1.8	1.9
Mar	0.8	0.8	1.4	2.4
Apr	0.6	0.6	1.2	7.1[5]
May	0.9	0.9	1.4	1.1
Jun	1.1	1.1	0.7	1.3
Jul	0.6	0.6	0.8	3.5
Aug	1.1	1.1	1.2	2.5
Sep	1.0	1.0	1.6	
Oct	1.6	1.6	2.3	
Nov	2.4	2.4	2.6	
Annual	**1.1**	**1.1**	**1.4**	**3.9 (2.1*)**

* Excluding contaminated samples.

4.4 Assessment criteria

One of the main reasons for analysing monitoring data is to determine existing air quality so that the assessment criteria can be determined in accordance with the EPA's modelling guidelines (**NSW EPA, 2001**). Using the guidelines the following criteria are determined:

- An acceptable increase in the Warkworth area for annual average PM_{10} is 8 µg/m^3 (30 - 22 µg/m^3) and an acceptable increase in the north-western area is 17 µg/m^3 (30 – 13 µg/m^3).
- An acceptable increase in annual average TSP is 32 µg/m^3 (90 – 58 µg/m^3) in the Warkworth area and 58 µg/m^3 (90 – 32 µg/m^3) in the north-west.
- An acceptable increase in annual deposition (insoluble solids) is 1.9 g/m^2/month for the Warkworth area and 2.0 g/m^2/month in the area to the northwest.

4 Contaminated with insects, bird dropping and plant material
5 Contaminated with bird droppings and insects

The use of these “acceptable increases” is complicated by the fact that the monitoring results include the effects of existing operations at Wambo, which form an integral part of the proposed operations.

The EPA guidelines also requires an assessment against 24-hour PM_{10} concentrations. The preferred approach is to add model predictions of predicted PM_{10} to measured PM_{10} concentrations for the same meteorological conditions. To do this requires contemporaneous monitoring and meteorological data so that the predicted concentrations for particular meteorological conditions can be matched to ambient concentrations that occur with those meteorological conditions.

The objective is that the sum of the predicted concentration from the Project being assessed and the background should not exceed the criterion. Alternatively, the assessment criterion can be that the Project should not cause additional exceedances.

The requirement to match ambient concentrations with the corresponding meteorological conditions used for the model prediction is based on the assumption that meteorological conditions and background concentrations are correlated. In some cases this may be true, but in the presence of bushfires or other unpredictable emissions this is not the case. A further requirement is that a database of continuous 24-hour PM_{10} concentrations is available along with the corresponding meteorological data. This is not the case for this study.

In view of the above the EPA also allows the assessment test to be that the predicted 24-hour average PM_{10} concentration from the development should be less than 50 $\mu g/m^3$. This is the approach that has been adopted here.

5. ESTIMATED EMISSIONS

5.1 Pre-amble

The model requires estimates of particulate matter emission rates for each activity associated with the mining operation. The operations and sources will include:

- Removing top-soil.
- Drilling overburden.
- Blasting overburden.
- Shaping and other bulldozer work on overburden.
- Excavator handling of overburden.
- Loading overburden to trucks.
- Hauling overburden to waste dumps.
- Unloading overburden at waste dumps.
- Loading coal to trucks.
- Hauling coal to dump hopper or ROM stockpile.
- Unloading coal to dump hopper or ROM stockpile.
- Rehandle of coal from the ROM stockpiles to the dump hopper.
- Handling coal at the Coal Handling and Preparation Plant (CHPP).
- Loading coal to product stockpiles.
- Loading coal to trains.
- Graders on roads.
- Emissions from underground mine ventilation shafts.

In addition there will be dust emissions due to wind erosion from exposed working areas (including pits and dumps) and also from coal stockpiles.

Emissions from all these sources have been determined in accordance with emission factors developed in the US (**US EPA, 1985** and revisions) and in Australia (**NERDDC, 1988 and SPCC, 1983**).

5.2 Approach to modelling

This section outlines the way in which the ISCST3 (Version 02035 – February 2002) model has been used to model the dispersion of dust from the mine.

The generation of dust from sources such as wind erosion and loading operations, depends on meteorological conditions. This means that emissions must be provided to the model in a way that reflects the hour-by-hour changes in the emission rates, which occur as meteorological conditions change. Time-varying emission rates have been used in the current study for wind erosion sources and for the loading and unloading of coal and overburden.

5.3 Controls

The controls that are available for the mine can be summarised in three broad categories:

1. Engineering controls.
2. Planning controls which related mostly to the separation between dust emission sources on the mine and sensitive areas.
3. Operational controls which vary mining activities when adverse meteorological conditions occur.

Engineering controls involve measures such as shielding conveyors, selection of appropriate stockpile stacking and reclaim systems, maintaining dust loadings on trafficked areas at low levels by watering and using agglomerating agents, and installation of sprinkler systems on coal handling areas.

Planning controls include the maintenance of adequate buffer distances between dust sources and receptors and progressive rehabilitation of mined areas to minimize the area susceptible to wind erosion. They may involve the acquisition of impacted properties or limiting the extent of mining.

Operational controls involve curtailing dust-generating activities when wind speeds, or more significantly, wind directions would take dust from its source to a sensitive area. Watering of roads and stockpiles with water trucks can also be considered in this category of controls as well as under the heading of Engineering controls.

The dust control measures that will be incorporated into the Project and which have been taken into account in the modelling are listed below:

- Dust suppression systems to be fitted on drill rigs.
- Watering of trafficked areas, active work areas and coal handling areas.
- Minimising exposed land susceptible to wind erosion.
- Progressive rehabilitation of areas disturbed by mining activities.
- Water sprays on stockpiles.

For the model runs allowance has been made for all these controls. The model assumes 85% control on haul roads due to dust suppression watering. Up to 90% control may be achieved on haul roads (see **Buonicore and Davis, 1992**) with watering. However typically watering of haul roads in the Hunter Valley is assumed to achieve between 50 and 75% control. The higher than average control for the Project has been used to account for the fact that a fixed irrigation system and/or suppressants will be used to control dust generation from select permanent (trunk) haul roads. Water carts will be used for the majority of the haul roads.

The model runs do not take into account the effect of real-time control measures, which can have a significant effect on reducing short-term (24-hour) impacts on specific areas. Real-time controls are unlikely to significantly affect the long-term averages.

5.4 *Estimated emissions from Wambo Mine*

Appendix C provides details as to how dust emissions from each dust producing activity have been calculated including the effect of dust controls and the assumptions that have been made in estimating these emissions. **Table 10** summarises the estimated TSP emission rates.

Table 10. Summary of estimated TSP dust emission from Wambo Mine (kg/yr)

	TSP Emission per year (kg)		
	Year 2	**Year 7**	**Year 9**
OPERATIONS ON OVERBURDEN			
Stripping top-soil			
- Northwest Pit	8,960	8,960	8,960
- Southeast Pit	8,960	8,960	8,960
Drilling O/B			
- Northwest Pit	31,070	40,881	40,881
- Southeast Pit	24,529	24,529	24,529
Blasting			
- Northwest Pit	112,944	148,610	148,610
- Southeast Pit	89,166	89,166	89,166
Shovel/Excavators/FELs Loading O/B			
- Northwest Pit	88,115	115,940	115,940
- Southeast Pit	69,564	69,564	69,564
Hauling O/B to emplacement area			
- from Northwest Pit	444,600	585,000	585,000
- from Southeast Pit	351,000	351,000	351,000
Emplacing O/B at dumps			
- Northwest Pit	88,115	115,940	115,940
- Southeast Pit	69,564	69,564	69,564
Dozers on O/B			
- Northwest Pit	365,500	411,187	411,187
- Southeast Pit	219,300	246,712	246,712
Dragline			
- Northwest Pit	-	-	-
- Southeast Pit	-	-	-
OPERATIONS ON OPEN CUT COAL			
Drilling coal			
- Northwest	-	-	-
- Southeast Pit	-	-	-
Blasting coal			
- Northwest	-	-	-
- Southeast Pit	-	-	-
Dozers ripping coal			
- Northwest	145,524	163,714	163,714
- Southeast Pit	87,314	98,228	98,228
Loading ROM Coal to trucks			
- Northwest	256,702	337,766	337,766
- Southeast Pit	202,660	202,660	202,660
Hauling ROM coal to dump hopper			
- Northwest	152,000	340,000	340,000
- Southeast Pit	36,000	72,000	72,000
Unloading ROM coal at hopper/stockpile			
- From all O/C pits	68,000	80,000	80,000

Table 10. Summary of estimated TSP dust emission from Wambo Mine (kg/yr) (Continued)

	TSP Emission per year (kg)		
	Year 2	Year 7	Year 9
ROM coal rehandle from stockpile to hopper (FEL)			
- From all O/C pits	20,400	24,000	24,000
Handling coal at CHPP			
- All O/C coal	11,327	13,326	13,326
Dozers pushing ROM coal			
- O/C coal in stockpiles	174,628	196,457	196,457
Dozers pushing product coal			
- O/C coal in stockpiles	65,348	73,517	73,517
Loading rejects (too wet to make dust)			
- Loading rejects to trucks	-	-	-
Transporting rejects (accounted for by return coal trucks)			
- Hauling rejects to Southeast Pit open cut	-	-	-
Unloading rejects (too wet to make dust)			
- Unload rejects in Southeast Pit	-	-	-
Loading product coal stockpile			
- Product coal from O/C	751	884	884
Wind erosion			
- Overburden dumps Northwest Pit	27,066	38,468	21,683
- Overburden dumps Southeast Pit	24,430	21,947	17,158
- Northwest Pit	3,845	14,873	9,996
- Southeast Pit	7,030	5,712	6,129
- ROM stockpiles	604	604	604
- Product stockpiles	448	448	483
Loading coal to trains			
- Product coal from O/C	787	926	926
Graders			
- Grading all roads	36,928	36,928	36,928
OPERATIONS ASSOCIATED WITH U/G MINING			
Loading ROM coal to stockpiles			
- At Wollemi box cut entrance to U/G	133	866	866
Loading ROM coal to stockpiles			
- At CHPP/Arrowfield	-	833	1,366
Loading ROM to 140-t B-doubles			
- At Wollemi box cut	4,000	26,000	26,000
Unloading ROM coal from 140 t B-doubles to ROM stockpile at CHPP			
- CHPP ROM stockpile	46	301	301
Transferring U/G ROM to hopper at CHPP			
- At CHPP	4,000	51,000	67,000
Dozers pushing ROM coal			
- U/G coal in stockpiles at CHPP	-	-	-
Dozers pushing product coal			
- U/G coal in stockpiles at CHPP	-	-	-
Loading trains			
- Product coal from U/G	95	1,206	1,585

Table 10. Summary of estimated TSP dust emission from Wambo Mine (kg/yr) (Continued)

	TSP Emission per year (kg)		
	Year 2	Year 7	Year 9
Transporting coal from Wollemi ROM stockpile to CHPP			
- 140 t B-doubles	13,714	89,143	89,143
U/G ventilation air			
- Ventilation air (Wollemi)	3,784	6,307	6,307
U/G ventilation air			
- Ventilation air (Arrowfield)	-	11,038	11,038
Total	**3,318,951**	**4,195,167**	**4,186,080**

Years 2, 7 and 9 have been selected as the critical assessment periods based on the current planned production schedule.

Year 2 has been selected as it represents the critical period for sensitive receptors to the east of the Project, particularly Warkworth and immediate surrounds. At the completion of construction, ROM coal production and waste handling activities will increase and would not have yet moved to the northwest away from these receptors.

Year 7 is considered to represent the critical scenario for receptors to the north and northwest. In Year 7 the Project would be at its northern most extent (and at its maximum open cut ROM coal production rate), thereafter moving in a southerly direction along the western limit of the open cut development.

Year 9 is considered to represent the critical scenario for sensitive receptors to the south (including Bulga and surrounds) as the open cut at the south western limit of the development would have commenced.

5.5 Estimated emissions from other local mines

The approach used to assess cumulative impacts has been to determine the planned ROM coal production and dust emission rates for each neighbouring mine expected to be operating in the area for each of the years for which modelling of Wambo Mine has been undertaken, namely Years 2, 7 and 9. Apart from the Project, the mines expected to be operating are: Warkworth Mine to the southeast, United to the north and the Coal & Allied pits know as Hunter Valley North Pit, Hunter Valley Riverview Pit, Hunter Valley Operations Cheshunt Pit and the Hunter Valley Cheshunt CPP, which are all located to the north.

Figure 1 shows the locations of each of the mining areas included in the cumulative assessment. Information is available on ROM production and TSP emissions for selected years in the life of these mines. Ideally, estimates of TSP emissions for each mine for the years corresponding to the Project's Years 2, 7 and 9 would be available. Unfortunately, data for matching years are not available in all cases.

Warkworth Mine has recently completed an EIS (**Holmes Air Sciences, 2002**), and detailed information on its emissions for its Years 2, 5, 10, 15 and 18 are available. For assessment purposes, emissions for Year 2 at Warkworth Mine have been matched with the Year 2 emissions for the Project. In Warkworth Mine's Year 2, it is estimated that mining will generate 5,385,361 kg of TSP while producing 10 Mt of ROM coal. For the Project in Years 7 and 9, the model assumes that Warkworth Mine is operating as it would for its Year 10, which is its "worst-case" year in which it is estimated to generate 9,255,169 kg of dust while producing 17,880,795 t of ROM coal. This gives a generic emission rate of 0.52 to 0.54 kg/t of ROM coal.

United operations have also recently completed an EIS (**HLA-Envirosciences, 2002**). In the worst-case scenario assessed, United was estimated to generate 1,026,264 kg of TSP. This is the figure assumed to apply for all years of the Project.

The Coal & Allied operations to the north are collectively approved to produce 12.4 Mtpa of ROM coal. To estimate the quantity of dust emission it has been assumed that 0.52 kg of TSP is produced for each tonne of ROM coal produced. This is the same figure that was estimated to apply to Warkworth Mine (**Holmes Air Sciences, 2002**), which is operated by the same company in the same environment using similar mining techniques. This generic emission factor is at the lower end of 0.5 to 2 kg/t of ROM estimated by the NSW SPCC in a review of air quality effects of mining in the Hunter Valley (**SPCC, 1983**) and is consistent with the figures reported in many recent EIS's. Given the use of large trucks, which allow reduced VKTs (vehicle kilometres travelled) for the same quantity of material handled and the higher level of effort that is applied to dust control, compared with practices in 1983, it is not unreasonable to adopt a figure towards the lower end of the 1983 range.

It should be noted the above approach makes conservative assumptions when dealing with the scheduling of mine development.

Table 11 shows the ROM production for each mine and the estimated TSP emission for each mine.

Table 11. ROM production and estimated dust emissions for cumulative impact assessment

Wambo Mine Year	Period
Warkworth Mine (from EIS) - ROM production - Estimated annual TSP - Location of sources (ISG coordinates - ROM production - Estimated annual TSP - Location of sources (ISG coordinates)	**Year 2** 10,000,000 t 5,385,361 kg 305200 mE 1392000 mN 306200 mE1390000 mN 307200 mE 1390800 mN **Years 7 and 9** 17,880,795 t 9,255,169 kg 304544 mE, 1391808 mN, 304605 mE, 1390274 mN, 304818 mE, 138927 mN.
United Colliery (from EIS) - ROM production - Estimated annual TSP - Location of sources (ISG coordinates)	**All years** 3,600,000 t 1,026,264 kg 299362 mE, 1397345 mN
Hunter Valley Operations (from Conditions of Consent) Hunter Valley North Pit, Hunter Valley Riverview Pit, Hunter Valley Operations Cheshunt Pit and the Hunter Valley Cheshunt CPP - ROM production - Estimated annual TSP - Location of sources (ISG coordinates)	**All years** 12,800,000 t 6,656,000 kg 298619 mE,1399623 mN Riverview 299444 mE,1399112 mN Riverview 300452 mE,1398484 mN Riverview 298734 mE,1401638 mN HVONP 301839 mE,1401704 mN Cheshunt 301756 mE,1400449 mN Cheshunt 301888 mE,1398451 mN Cheshunt CPP

In the cumulative modelling work, each neighbouring mine has been treated as a number of volume sources. These have been located at the apparent points of major emission as estimated from the known locations of the pits and or major dust sources on the mine or facility.

Sources have been considered in three classes:

1. Wind erosion sources where emissions vary with the hourly average wind speed according to the cube of the wind speed;
2. Loading and dumping operations where emissions vary as wind speed raised to the power 1.3; and
3. All other sources where emissions are assumed to be independent of wind speed.

For neighbouring mines the proportions of emissions in each of these categories has been assumed to be the same as applies at the Project, namely:

- 0.732 for emissions independent of wind speed;
- 0.135 for emissions that depend on wind speed (such as loading and dumping); and
- 0.133 for wind erosion sources.

Other mines and other sources, in addition to those identified above, will of course contribute to $PM_{2.5}$, PM_{10}, TSP concentrations and to dust deposition. In other assessments, a small allowance has been made to account for background particulate matter contributed by these more distant sources that are not directly included in the model. The nominal background levels set have been set at 5 µg/m^3 for PM_{10}, 10 µg/m^3 for TSP and 0.5 g/m^2/month for deposited dust. For the current assessment these levels have been set to zero. The reason for this is that a comparison of predicted TSP and PM_{10} levels at the W-HV01 monitoring site (see **Figure 2**) for Year 2, which is similar to current operations, indicates that the model is already over-predicting the levels that occur. The extent of the over prediction can be seen by examining the appropriate figures showing the predicted cumulative annual average PM_{10}, TSP and deposition levels. (These are discussed in some detail later). The predicted levels for Year 2 and the current measured levels are as follows:

Predicted		**Monitored**
Annual average PM_{10}	40 µg/m^3	22/29 µg/m^3 (without/with bushfires)
Annual average TSP	60 µg/m^3	61/73 µg/m^3 (without/with bushfires)
Annual average Deposition	2.4 g/m^2/month	2.1 g/m^2/month

Since the model does not include emissions from bushfires, the appropriate predicted value above should be compared with the prediction that excludes the effect of bushfires. Given the level of conservatism already in the predictions, adding any additional allowance to the predicted levels to account for sources not included in the model is not considered to be appropriate.

Some monitoring of $PM_{2.5}$ concentrations has been undertaken by the Australian Nuclear Science and Technology Organisation (ANSTO) on behalf of the Muswellbrook Council and as part of an ACARP funded study. The data suggest that long-term average $PM_{2.5}$ concentrations in the Muswellbrook area are approximately 7 µg/m^3. This level includes the effect of existing mining. At this stage there is insufficient experience with $PM_{2.5}$ concentrations in the Hunter Valley to provide a reliable estimate of background $PM_{2.5}$ concentrations in the area around the Project.

No allowance for non-mining $PM_{2.5}$ background has been added to model predictions and predictions of concentrations of $PM_{2.5}$ are provided for information rather than as a key component of the assessment (**Appendix A**).

6. ASSESSMENT METHODOLOGY

The short-term industrial source complex model (ISC3-ST - Version 02035) has been used in this study. The model is an advanced Gaussian dispersion model approved by the US EPA for use in regulatory assessments undertaken within the US. It is one of the most widely used regulatory models in the world. The model is accepted by the NSW EPA for assessing the dispersion of dust. A complete description of the model is provided in US EPA publications (**US EPA 1995A** and **1995B**). These two volumes provide user instructions (Volume 1) and a comprehensive technical description of the algorithms used in the model (Volume 2). For convenience, a very brief description of the model is provided below.

The model uses the Gaussian dispersion equation to simulate the dispersion of a plume from either, point, area, or volume sources. The model takes account of dry and wet deposition and includes algorithms to account for retention of dust within an open pit and includes mechanisms for determining the effect of terrain on plume dispersion. The model works on an hourly time step. This means that it requires a meteorological file that provides wind speed, wind direction and other dispersion parameters on an hourly basis. For each hour the dispersion of plumes is determined using the conventional Gaussian model assumptions. These model assumptions have some limitations and it is worth noting some of these at this point.

One of the most significant limitations of the Gaussian model is that it assumes that a steady state dispersion condition is reached instantaneously. That is, if one were to imagine that the plume is simulating for a particular hour, one would see each source of dust producing a plume that extends indefinitely in the downwind direction to the edge of the prediction grid. In reality, under very light wind conditions, this is an inappropriate assumption.

Consider for example a condition where the wind speed is 0.5 m/s. At the end of one hour any emission that occurred at the beginning of the hour will have travelled approximately 1.8 km from the source (0.5 m/s x 3,600 s). Thus, under these light wind conditions, the dust will have travelled 1.8 km from the source. The model assumes the dust will have travelled to the edge of the prediction grid that in this case may be up to 10 km from the source. In the next hour the meteorological conditions may remain the same or, more likely, the wind direction will change and the light wind condition may still persist. The model then assumes that a new equilibrium is established instantaneously and the plume travels in the new downwind direction at the new wind speed.

Because for surface sources the worst-case dispersion conditions are associated with light winds, the model has the potential to significantly overstate impacts at long distances downwind from the source. Since this problem leads to an overstatement of impacts rather than an understatement of impacts, this does not create a significant problem for environmental impact assessment. However, it should be borne in mind that there is a potential to overstate impacts at more distant receptors.

The ISC model also has the capacity to take into account emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on mining operations where wind speed is an important factor in determining the rate at which dust is generated.

For the current study, the mine was represented by a series of 25 to 32 volume sources depending on which year was being simulated. Each volume source was a combination of all dust emissions from activities taking place in the neighbourhood of the source. Estimates of emissions for each volume were developed on an hourly time step. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of mining activity and the wind speed. It is important to do this in the ISC model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds in a mining area correspond to periods of low dust generation (because wind erosion and other wind dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

The data sets that allow the accuracy of model predictions of 24-hour PM_{10} concentrations to be determined are rare and generally and none are entirely satisfactory. The reasons for this are that episodic conditions are unusual and this coupled with the fact that monitoring of particulate matter is normally undertaken on a six-day basis makes it difficult to find days when high concentrations are measured and where suitable meteorological and mine operating data are available. The use of TEOMS at some monitoring sites close to mines will allow continuous monitoring and this will increase the probability that suitable data sets are created.

A calibration study was undertaken as part of the Warkworth Mine EIS (**Holmes Air Sciences, 2002**). This was done by comparing the predicted maximum 24-hour average PM_{10} concentrations in the period 1 November 2000 to 31 October 2001 at the Warkworth Mine monitors at HV1 and HV2 and at the Mount Thorley Operations monitors at Lot 543 and Bulga (see **Holmes Air Sciences, 2002** for details). The maximum measured PM_{10} concentration at the Bulga monitoring site and the maximum measured TSP concentrations at all four sites over the same period were then determined by inspection of the monitoring data records. (Note, PM_{10} concentrations are only measured at the Bulga monitoring site, the other sites measure TSP only). The TSP concentrations have been converted to equivalent PM_{10} concentrations assuming that PM_{10} constitutes 40% of the TSP in this area.

The results are shown in **Table 12.**

Table 12. Comparison of maximum measured (or inferred) and maximum predicted 24-hour PM_{10} concentrations (1 Nov 2000 to 31 Oct 2001)

Site	Maximum predicted 24-hour PM_{10}	Maximum measured or inferred 24-hour PM_{10}	Ratio of predicted to measured concentration
HV1	100	170 x 0.4 = 68	1.5
HV2	140	140 x 0.4 = 56	2.5
Bulga PM_{10}	160	44 (direct measurement)	3.6
Bulga TSP	160	102 x 0.4 = 41	3.9
Lot 543	95	138 x 0.4 = 55	1.7
Average			2.64

The average extent of over prediction was a factor of 2.64, that is unadjusted model predictions appear to over predict 24-hour PM_{10} concentrations by 264%. (This over prediction applied even before including an allowance for remote sources not in the model). This factor was used to adjust the model predictions for the Warkworth Mine EIS downwards to obtain a calibrated prediction of the worst-case 24-hour PM_{10} concentrations for all five years that were assessed. This same factor has been used for the current assessment

The numerical value of the calibration factor would be expected to vary from one site to the next. Individual calibration factors would be expected to depend on a number of factors including distance from the most significant sources, the types of sources, the nature of the intervening vegetation and terrain. The calibration factor is applied for all receptors but is of course most important for those receptors that are sufficiently close to the mine that mine emissions have the potential to cause the EPA assessment criterion to be exceeded. In practical terms, this means residences within a few kilometres of active working areas of the mine, that is residences to the northwest of Wambo in the later years and in Warkworth.

In view of the above, it is reasonable to ask if the calibration factor developed above is relevant for the closest residences to Wambo. The five data sets used to develop the calibration factor for Warkworth Mine were collected from sites located from just under 1 km to approximately 3 km from the main mine-site dust sources that would have influenced air quality at the monitors. The intervening terrain was variable, but generally flat to gently undulating, and the vegetation varied from open grassland to a mixture of grassland and medium density bushland. The mining equipment used was similar although the influence of draglines would be marginally greater for the Warkworth calibration factors than for Wambo. The soils, overburden characteristics and coal types, from the perspective of emissions, are directly comparable. Given these considerations, the calibration factors used for Warkworth Mine are considered to be appropriate for this assessment.

7. ASSESSMENT OF IMPACTS DUE TO DUST EMISSION

7.1 Pre-amble

Dispersion model simulations have been undertaken for Years 2, 7, and 9. This section provides an interpretation of the predicted contours of dust concentration (PM_{10}, and TSP) and dust deposition produced by these simulations. In presenting the assessment, firstly contours have been provided showing the predicted effects of the Project considered in isolation. These are then followed by predictions that represent the Project considered cumulatively with other neighbouring mines. Thus for each of the three years, isopleth diagrams have been produced showing the following:

1. The predicted maximum 24-hour average PM_{10} concentration for the Project alone;
2. The predicted maximum 24-hour average PM_{10} concentration for the Project with other sources of PM;
3. The predicted annual average PM_{10} concentration for the Project;
4. The predicted annual average PM_{10} concentration for the Project with other sources of PM;
5. The predicted annual average TSP concentration for the Project;
6. The predicted annual average TSP concentration for the Project with other sources of PM;
7. The predicted annual average dust deposition for the Project, and;

8. The predicted annual average dust deposition for the Project with other sources of PM.

Similar predictions for 24-hour and annual average $PM_{2.5}$ concentrations for the Project by itself and the Project considered with the effects of other mines are provided in **Appendix A**.

The air quality criteria used for deciding which properties are likely to experience air quality impacts are those specified in the EPA's modelling guidelines as interpreted by recent conditions of consent for mines in the Hunter Valley (see **Table 1**, **2**, and **3** and the discussion below). The criteria are:

- 50 $\mu g/m^3$ for 24-hour PM_{10} for the Project considered alone;
- 150$\mu g/m^3$ for 24-hour PM_{10} for the Project considered with the contributions of other sources;
- 30 $\mu g/m^3$ for annual average PM_{10} due to the Project and other sources;
- 90 $\mu g/m^3$ for annual TSP concentrations due to the Project and other sources;
- 2 g/m^2/month for annual average deposition (insoluble solids) due to the Project considered alone; and
- 4 g/m^2/month for annual predicted cumulative deposition (insoluble solids) due to the Project and other sources levels.

Following practice established in recent conditions of consent, with the exception of the 2 g/m^2/month criterion and the 24-hour PM_{10} criterion, the criteria are interpreted to be cumulative criteria.

The 24-hour PM_{10} criterion of 50 $\mu g/m^3$ is interpreted as being as applicable to the Project when considered in isolation and the US EPA 24-hour PM_{10} standard of 150 $\mu g/m^3$ has been taken to be the cumulative criterion. Coupled with this is that any development that shows a 24-hour PM_{10} concentration due to the project plus background that exceeds 50 $\mu g/m^3$ at sensitive areas must demonstrate that it is using best practice controls to minimise emissions of dust.

Most mines in the Hunter Valley operate under reactive control strategies to manage air quality in the short-term. The effect of these strategies cannot be included in the cumulative modelling.

If these strategies work, and based on monitoring data collected near Bengalla and Bayswater, both of which operate real-time control strategies, they do appear to be working, then mines should not be significant contributors to PM_{10} concentrations when short-term PM_{10} concentrations are above the EPA's criteria.

In assessing air quality impacts, three categories of dust sensitive areas have been considered to include, (1) private residences, (2) community facilities such as the St Philips Church in Warkworth etc. and (3) Residences owned by Wambo Mine and other mines.

In assessing impacts the approach has been to first show the predicted effects for the Project considered in isolation and then to consider the effects of the Project with other mines. It useful to bear in mind, that because of the prevailing winds, the main areas where impacts would be expected are to the southeast and northwest of the dust sources, which are generally associated with the active mining areas.

In most cases impacts are the consequence of several sources of dust including other mines and non-mining sources, but in most cases one source can be seen to be responsible for the majority of the effect.

Only in the case of the residences to the northwest of the Project are the impacts clearly due mainly to Project operations. Other residences such as 11D, 11F are impacted more because of operations associated with the Hunter Valley operations to the north and Residences 8B, 8C, 8D, 8E, 8F, 8G, 8H and 8F, which are affected mostly by activities at Warkworth Mine and have been dealt with under Warkworth Mine's environmental assessment.

Finally, for each year the assessment results are summarised in tabular form at the end of the section.

7.2 Year 2

7.2.1 Predicted maximum 24-hour average PM_{10} concentrations

Figure 7 shows the predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project alone in Year 2. The relevant assessment 24-hour standard is 50 µg/m^3. No residences are predicted to experience 24-hour PM_{10} concentrations above the criterion.

Figure 8 shows the predicted maximum 24-hour PM_{10} concentrations due to emissions from the Project and other mines. No residences are predicted to experience 24-hour PM_{10} concentrations above 150 µg/m^3.

7.2.2 Predicted annual average PM_{10} concentrations

Figure 9 shows the predicted annual average PM_{10} concentrations due to emissions from the Project alone in Year 2. Since the 30 µg/m^3 criterion takes account of all sources of PM_{10} the figure is provided for information only. **Figure 10** shows the predicted annual PM_{10} concentrations from the Project and other mines. Residences predicted to experience annual PM_{10} concentrations above 30 µg/m^3 are the mine owned residences 8B, 8C, 8D, 8E, 8F, 8G, 8H, 11F, 11D and Residences 22, 51 and 125. **Figure 10** shows that each of these residences, except 51, are predominately affected by other mining operations. The tabular information (**Table 13**) presented at the end of the discussion for Year 2 shows the Project contribution relative to other mines.

7.2.3 Predicted annual average TSP concentrations

Figure 11 shows the predicted annual average TSP concentrations due to emissions from the Project alone in Year 2. The assessment criterion of 90 µg/m^3 and is based on cumulative effects so the figure is provided for information only. **Figure 12** shows the predicted annual average TSP concentrations for the Project and other mines. No residences are predicted to experience annual TSP concentrations above 90 µg/m^3.

7.2.4 Predicted annual average dust deposition (insoluble solids)

Figure 13 shows the predicted annual average dust deposition rate for Year 2 for the Project alone. The assessment criterion is 2 g/m^2/month (annual average). No residences are predicted to experience dust deposition levels due to the Project that are above this level.

Figure 14 shows the predicted annual average dust deposition rate for Year 2 for the Project considered with other mines. The assessment criterion is 4 g/m^2/month (annual average). No residences are predicted to experience dust deposition levels due to the Project that are above this level.

7.2.5 Summary for Year 2

Table 13 provides a tabulated summary of the PM and dust deposition levels predicted to occur in Year 2 at properties surrounding the Project. Predicted concentrations or deposition levels above the relevant EPA assessment criteria are identified with italicised bold print.

All other predicted concentrations comply with the assessment limits described in Section 4.4.

The only criterion predicted to be exceeded is the annual average PM_{10} criterion which is predicted to be exceeded at 12 properties due to cumulative effects. Eleven of these properties are predominately affected by other mining operations.

Table 13. Summary of contribution from the Project and cumulative effects for Year 2 for all assessment criteria - µg/m³

Properties			Project only				Project and other mines			
x - ISG coordinate	y - ISG coordinate	ID	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month
296953	1389843	1	5.9	0.9	1.0	0.01	13.5	4.3	4.7	0.10
300681	1389061	2	7.0	0.9	1.0	0.01	20.1	6.2	7.2	0.21
300798	1388805	3	6.8	0.9	0.9	0.01	18.0	5.9	6.8	0.19
300692	1388474	4	6.4	0.8	0.9	0.01	16.1	5.5	6.2	0.16
300692	1388410	5	6.3	0.8	0.9	0.01	16.4	5.4	6.1	0.15
300863	1388164	6	6.0	0.8	0.8	0.01	16.7	5.1	5.8	0.13
300404	1388047	7	5.7	0.8	0.8	0.01	19.2	5.1	5.6	0.11
301278	1389277	8A	7.2	0.9	1.0	0.01	18.3	6.9	8.2	0.28
303124	1392308	8B	20.5	8.4	8.9	0.18	74.7	**55.2**	69.6	2.42
303403	1391070	8C	13.5	2.9	3.1	0.03	98.2	**59.8**	78.7	2.83
303446	1390803	8D	13.0	2.5	2.6	0.03	89.2	**57.2**	76.2	2.94
303521	1390504	8E	12.6	2.0	2.1	0.02	77.2	**55.2**	76.0	3.37
303628	1389736	8F	10.2	1.4	1.5	0.01	75.8	**41.2**	60.4	2.82
303681	1389821	8G	10.2	1.5	1.6	0.01	83.2	**45.7**	67.6	3.24
303703	1390035	8H	10.6	1.6	1.7	0.02	91.0	**50.6**	74.4	3.64
302564	1386393	9	4.0	0.5	0.5	0.00	10.3	2.7	3.0	0.03
301828	1395536	10	17.7	9.9	11.4	0.44	25.7	24.0	27.6	0.83
301977	1395181	11E	18.1	10.6	12.2	0.48	25.4	25.1	28.9	0.88
303910	1397543	11F	5.8	1.8	1.9	0.03	48.5	**31.5**	38.4	2.15
301828	1395160	20	18.8	10.9	12.6	0.51	25.0	25.4	29.2	0.89
301786	1394723	19B	22.1	13.2	16.1	0.63	28.0	28.5	33.7	1.04
301796	1394851	19A	20.8	12.3	14.7	0.59	26.4	27.4	31.9	0.99
301753	1394925	WE	20.3	11.9	14.0	0.57	25.7	26.7	31.0	0.95
302106	1394733	21A	19.6	11.9	13.9	0.54	27.0	27.7	32.1	0.99
302660	1395398	21B	15.4	8.3	9.3	0.30	31.9	22.3	25.3	0.76
303227	1394210	22	31.9	16.1	17.5	0.51	50.2	**37.2**	42.1	1.19
302010	1395011	23A	18.4	11.1	12.8	0.52	24.7	25.9	29.8	0.92
302212	1394883	WF	18.4	11.0	12.7	0.48	27.2	26.3	30.3	0.93
302341	1394648	56	19.8	11.6	13.3	0.48	28.5	27.8	32.1	0.98
302501	1394530	Church	20.7	11.6	13.0	0.45	29.1	28.3	32.8	0.99
301798	1393367	51	43.0	24.1	29.1	1.24	52.0	**43.5**	51.8	1.80
305502	1398012	94	5.0	1.4	1.5	0.02	27.8	17.8	20.0	0.76
305577	1397607	254	5.4	1.6	1.7	0.02	27.0	18.2	20.5	0.82
302108	1395160	23B	17.6	10.3	11.8	0.46	26.4	24.9	28.6	0.87
301840	1397297	215	8.0	2.7	2.9	0.06	31.6	24.9	32.7	1.52
301174	1402084	125	4.7	0.8	0.9	0.01	63.6	**33.8**	44.2	1.76
297146	1400921	11D	10.2	3.7	3.9	0.06	60.7	**38.4**	47.2	1.47
296345	1401550	11C	9.4	4.0	4.2	0.06	39.6	28.1	31.5	0.74
296292	1401753	11B	9.1	3.8	4.0	0.06	38.3	27.6	30.9	0.72
295320	1402756	11A	8.3	3.6	3.7	0.05	29.5	21.1	22.8	0.39
293722	1396443	13C	10.4	5.1	5.5	0.11	18.5	10.8	11.6	0.21
294730	1402617	262A	8.6	4.0	4.2	0.05	27.1	18.9	20.3	0.33
294744	1402500	262B	8.8	4.2	4.3	0.05	27.3	19.0	20.4	0.33
294893	1402938	262D	8.3	3.6	3.8	0.04	27.4	19.3	20.7	0.33
294605	1399797	31A	17.0	8.7	9.2	0.12	30.6	19.6	21.2	0.40
294832	1399552	31B	18.3	9.6	10.2	0.13	31.7	21.1	22.8	0.43
294949	1399691	31C	17.6	9.4	10.0	0.13	30.7	21.3	23.1	0.44
294864	1399712	31D	17.5	9.2	9.8	0.13	30.7	20.9	22.6	0.43
294777	1401753	262C	9.8	5.0	5.3	0.06	26.5	19.4	21.0	0.36
291806	1402735	52A	9.1	3.8	3.9	0.04	19.2	11.2	11.8	0.15
291967	1402607	52B	9.3	3.9	4.1	0.04	19.5	11.5	12.1	0.16
292159	1402511	47	9.4	4.1	4.2	0.04	19.7	11.9	12.5	0.17
291913	1402447	53	9.5	4.0	4.1	0.04	19.8	11.5	12.0	0.16
291753	1402479	54	9.5	3.9	4.0	0.04	19.8	11.2	11.8	0.16
291495	1402436	59	9.5	3.8	3.9	0.04	19.8	10.8	11.3	0.15
291452	1402201	58	9.7	3.8	4.0	0.04	19.7	10.6	11.2	0.15
291378	1401198	15A	10.7	3.9	4.0	0.04	19.3	10.1	10.6	0.15
291946	1401508	41A	11.0	4.3	4.5	0.04	20.0	11.4	12.0	0.17

Table 13. Summary of contribution from the Project and cumulative effects for Year 2 for all assessment criteria - µg/m³ (Continued)

Properties			Project only				Project and other mines			
x - ISG coordinate	y - ISG coordinate	ID	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month
292149	1401113	41B	11.8	4.5	4.7	0.05	20.5	11.6	12.3	0.19
292234	1401486	41C	11.3	4.5	4.7	0.05	20.2	12.0	12.7	0.18
292928	1402009	44	10.2	4.6	4.8	0.05	19.8	13.6	14.4	0.21
292800	1401785	13A	10.8	4.7	4.9	0.05	19.9	13.3	14.0	0.21
292970	1401966	13B	10.2	4.7	4.9	0.05	19.8	13.7	14.5	0.21
293141	1401636	50A	11.0	5.0	5.2	0.06	19.7	14.0	14.9	0.22
293205	1401518	50B	11.2	5.1	5.3	0.06	19.6	14.2	15.1	0.23
293398	1401081	27	12.5	5.6	5.8	0.07	20.4	14.6	15.6	0.25
293494	1401059	43	12.6	5.7	5.9	0.07	20.4	14.9	15.9	0.26
293462	1400792	18	13.1	5.9	6.2	0.07	22.5	14.8	15.8	0.26
293548	1400696	17	13.2	6.1	6.4	0.07	23.6	15.1	16.2	0.27
293665	1400472	16	13.6	6.5	6.7	0.08	25.9	15.6	16.7	0.29
293708	1400171	40	14.7	6.8	7.1	0.08	28.1	15.8	17.0	0.29
293505	1400259	39	14.3	6.4	6.7	0.08	26.7	15.1	16.1	0.28
292460	1399595	37	13.0	4.8	5.0	0.05	22.3	11.3	12.1	0.20
292492	1399402	15B	12.7	4.8	5.0	0.05	22.2	11.2	12.0	0.20
292258	1398997	33	11.4	4.3	4.5	0.05	20.6	10.2	10.9	0.18
291884	1399595	30	11.1	4.0	4.2	0.04	19.9	9.8	10.5	0.17
292119	1399306	48	11.5	4.2	4.4	0.05	20.5	10.1	10.8	0.18
291660	1399541	49	10.3	3.8	3.9	0.04	18.9	9.3	9.9	0.16
291316	1399349	75	9.3	3.4	3.5	0.04	17.5	8.5	9.1	0.15
291337	1399616	137	9.6	3.5	3.6	0.04	17.9	8.8	9.3	0.15
296227	1389843	35	8.4	1.0	1.1	0.01	16.5	3.9	4.3	0.09
297604	1390205	25	6.0	1.1	1.2	0.01	13.6	4.9	5.5	0.12
298780	1390881	WA	9.4	1.4	1.5	0.01	15.5	6.5	7.2	0.17
299548	1391041	WB	9.5	1.5	1.6	0.01	17.8	7.5	8.5	0.22
299633	1390731	WC	8.9	1.4	1.5	0.01	17.6	7.2	8.2	0.22
298378	1386585	161	4.0	0.5	0.6	0.00	10.6	3.0	3.3	0.05
298911	1386937	231	5.3	0.6	0.6	0.01	12.0	3.4	3.7	0.05
298538	1386606	111	4.2	0.5	0.6	0.00	10.7	3.0	3.3	0.05
298879	1386574	111 east	4.8	0.5	0.6	0.00	10.9	3.1	3.4	0.05
298815	1386393	237	4.6	0.5	0.5	0.00	10.4	3.0	3.2	0.04
299413	1386990	226	6.5	0.6	0.6	0.01	12.4	3.6	3.9	0.06
300021	1387353	4A	5.6	0.7	0.7	0.01	14.4	4.2	4.6	0.07
300298	1387898	91	5.7	0.7	0.8	0.01	18.5	4.9	5.4	0.10
300330	1387108	227A	4.9	0.6	0.7	0.01	12.6	3.7	4.1	0.06
300480	1387129	227B	4.7	0.6	0.6	0.01	12.5	3.7	4.1	0.06
300203	1386638	181	4.8	0.6	0.6	0.01	11.8	3.3	3.6	0.05
300736	1386756	118	4.3	0.6	0.6	0.01	11.6	3.3	3.6	0.05
300767	1387823	63	5.4	0.7	0.8	0.01	16.5	4.7	5.2	0.10
300650	1387567	246	5.0	0.7	0.7	0.01	15.2	4.4	4.9	0.08
301067	1387108	178	4.2	0.6	0.6	0.01	12.2	3.6	3.9	0.06
300757	1386926	142A	4.3	0.6	0.6	0.01	11.7	3.4	3.7	0.05
300896	1386798	142B	4.2	0.5	0.6	0.01	11.7	3.3	3.6	0.05
302105	1386852	164	3.8	0.5	0.6	0.01	11.5	3.1	3.4	0.04
302222	1386393	69	3.6	0.5	0.5	0.00	10.3	2.7	3.0	0.03
302649	1386937	96	4.9	0.6	0.6	0.01	12.0	3.3	3.6	0.04
303407	1386361	203A	4.6	0.5	0.5	0.00	15.1	2.9	3.3	0.03
303545	1387204	203B	5.2	0.6	0.6	0.01	18.8	3.8	4.1	0.02
303577	1387289	203C	5.3	0.6	0.6	0.01	19.8	3.8	4.1	0.00
303823	1386958	203E	5.0	0.5	0.6	0.01	19.0	3.3	3.4	0.00
303770	1386500	203D	4.6	0.5	0.6	0.00	17.3	3.0	3.2	0.00
301270	1389288	1A	7.2	0.9	1.0	0.01	18.4	6.9	8.2	0.28
294598	1395832	24	15.3	6.4	7.1	0.16	24.5	12.4	13.5	0.26
293847	1400440	28A	13.6	6.7	7.0	0.08	26.6	16.2	17.4	0.30
293868	1400363	28B	13.9	6.8	7.1	0.08	27.3	16.3	17.5	0.30

7.3 Year 7

7.3.1 Predicted maximum 24-hour average PM_{10} concentrations

Figure 15 shows the predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project alone in Year 7. The relevant assessment 24-hour standard is 50 µg/m^3. No residences are predicted to experience 24-hour PM_{10} concentrations above the criterion.

Figure 16 shows the predicted maximum 24-hour PM_{10} concentrations due to emissions from the Project and other mines. Residences 8C, 8D, 8G and 8H are predicted to experience 24-hour PM_{10} concentrations above 150 µg/m^3 due to emissions from the Warkworth Mine. These residences have been assessed in the Warkworth Mine EIS.

7.3.2 Predicted annual average PM_{10} concentrations

Figure 17 shows the predicted annual average PM_{10} concentrations due to emissions from the Project alone in Year 7. Since the 30 µg/m^3 criterion takes account of all sources of PM_{10} the figure is provided for information only. **Figure 18** shows the predicted annual PM_{10} concentrations from the Project and other mines. A total of 28 sensitive receptors are predicted to experience annual PM_{10} concentrations above 30 µg/m^3 (see Section 7.3.5), of these 11 are predominately affected by other mining operations (properties 8B to 8H, 11F, 215, 125 and 11D).

7.3.3 Predicted annual average TSP concentrations

Figure 19 shows the predicted annual average TSP concentrations due to emissions from the Project alone in Year 7. The assessment criterion of 90 µg/m^3 is based on cumulative effects so the figure is provided for information only. **Figure 20** shows the predicted annual average TSP concentrations due to the Project and other mines. Residences predicted to experience annual TSP concentrations above 90 µg/m^3 are the mine owned residences 8B, 8C, 8D, 8E, 8F, 8G and 8H. These exceedances are due to the development of the Warkworth Mine. As noted before these residences have been considered under the Warkworth Mine EIS.

7.3.4 Predicted annual average dust deposition (insoluble solids)

Figure 21 shows the predicted annual average dust deposition rate for Year 7 for the Project alone. The assessment criterion is 2 g/m^2/month (annual average). No residences are predicted to experience dust deposition levels due to the Project that are above this level.

Figure 22 shows the predicted annual average dust deposition rate for Year 7 for the Project considered with other mines. The assessment criterion is 4 g/m^2/month (annual average). Mine owned residences 8C, 8D, 8E, 8F, 8G and 8H are predicted to experience dust deposition levels above this level due to the development of the Warkworth Mine. These residences have been assessed as impacted in the Warkworth Mine EIS.

7.3.5 Summary for Year 7

Table 14 provides a tabulated summary of the PM and dust deposition levels predicted to occur in Year 7 at properties surrounding the Project. Predicted concentrations or deposition levels above the relevant EPA assessment criteria are identified with bold italicised print.

All other predicted concentrations or deposition levels comply with the assessment limits described in Section 4.4.

Table 14. Summary of contribution from the Project and cumulative effects for Year 7 for all assessment criteria

Properties			Project only				Project and other mines			
x - ISG coordinate	y - ISG coordinate	ID	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month
296953	1389843	1	4.4	1.0	1.1	0.01	17.0	6.3	7.0	0.16
300681	1389061	2	5.0	0.9	0.9	0.01	34.7	9.8	11.3	0.35
300798	1388805	3	4.6	0.8	0.9	0.01	30.7	9.3	10.7	0.32
300692	1388474	4	4.2	0.8	0.8	0.01	27.0	8.5	9.7	0.25
300692	1388410	5	4.2	0.8	0.8	0.01	27.6	8.5	9.6	0.24
300863	1388164	6	3.9	0.7	0.8	0.01	28.2	8.0	9.0	0.21
300404	1388047	7	4.0	0.7	0.8	0.01	33.4	8.0	8.9	0.18
301278	1389277	8A	5.1	0.9	1.0	0.01	30.7	11.1	13.1	0.47
303124	1392308	8B	19.3	7.6	8.1	0.16	133.9	**92.7**	**117.0**	3.99
303403	1391070	8C	15.0	2.6	2.8	0.03	**183.5**	**109.5**	**141.8**	**4.83**
303446	1390803	8D	13.5	2.2	2.4	0.02	**166.0**	**105.3**	**137.8**	**5.03**
303521	1390504	8E	11.0	1.8	2.0	0.02	142.9	**102.5**	**138.1**	**5.76**
303628	1389736	8F	9.2	1.4	1.5	0.01	140.8	**76.6**	**109.4**	**4.84**
303681	1389821	8G	9.2	1.4	1.5	0.01	**155.1**	**85.1**	**122.7**	**5.55**
303703	1390035	8H	9.4	1.6	1.7	0.02	**170.1**	**94.2**	**135.0**	**6.24**
302564	1386393	9	3.2	0.5	0.5	0.00	16.4	3.9	4.4	0.05
301828	1395536	10	11.9	7.2	8.3	0.29	34.8	28.8	32.9	0.87
301977	1395181	11E	14.2	8.3	9.8	0.36	35.7	**31.4**	36.1	0.99
303910	1397543	11F	6.5	3.2	3.4	0.07	56.3	**34.2**	41.2	2.21
301828	1395160	20	14.5	8.8	10.4	0.39	35.1	**31.9**	36.7	1.00
301786	1394723	19B	21.5	13.9	17.7	0.81	40.3	**39.2**	46.7	1.48
301796	1394851	19A	18.8	11.9	14.8	0.64	37.9	**36.5**	42.9	1.29
301753	1394925	WE	17.3	10.9	13.4	0.56	36.5	**35.1**	40.9	1.19
302106	1394733	21A	19.8	12.2	14.5	0.61	39.3	**37.8**	44.1	1.35
302660	1395398	21B	11.4	6.8	7.6	0.24	42.2	27.1	31.1	0.92
303227	1394210	22	30.9	16.0	17.4	0.52	72.6	**49.5**	56.9	1.67
302010	1395011	23A	15.8	9.0	10.6	0.39	35.8	**32.9**	38.0	1.05
302212	1394883	WF	16.9	10.1	11.8	0.45	38.7	**34.6**	40.0	1.17
302341	1394648	56	19.6	12.2	14.2	0.56	41.6	**38.4**	44.8	1.38
302501	1394530	Church	19.9	12.5	14.3	0.54	43.4	**39.7**	46.4	1.43
301798	1393367	51	43.3	18.7	22.7	0.85	60.1	**52.6**	62.1	1.81
305502	1398012	94	5.2	2.2	2.3	0.04	29.7	19.1	21.5	0.80
305577	1397607	254	5.4	2.5	2.7	0.05	29.2	19.6	22.1	0.85
302108	1395160	23B	14.1	8.2	9.6	0.34	36.7	**31.2**	35.9	0.99
301840	1397297	215	10.2	5.0	5.6	0.16	38.1	**31.5**	39.9	1.72
301174	1402084	125	4.6	1.0	1.1	0.01	66.5	**35.5**	46.0	1.79
297146	1400921	11D	7.4	3.3	3.6	0.06	63.1	**40.6**	49.7	1.49
296345	1401550	11C	6.7	3.3	3.6	0.06	40.1	29.9	33.5	0.76
296292	1401753	11B	6.5	3.2	3.4	0.06	39.1	29.4	32.9	0.74
295320	1402756	11A	7.2	3.5	3.7	0.05	31.9	23.1	25.0	0.42
293722	1396443	13C	13.9	7.1	7.9	0.15	25.3	14.8	16.1	0.28
294730	1402617	262A	8.2	4.4	4.7	0.07	30.0	21.5	23.0	0.37
294744	1402500	262B	8.2	4.5	4.8	0.07	30.3	21.6	23.2	0.38
294893	1402938	262D	8.1	3.9	4.1	0.06	29.8	21.7	23.2	0.37
294605	1399797	31A	30.9	20.5	26.3	0.88	46.6	**33.9**	40.9	1.18
294832	1399552	31B	30.9	21.2	28.6	1.04	46.7	**35.3**	44.0	1.36
294949	1399691	31C	22.7	15.5	21.4	0.80	39.9	**30.1**	37.3	1.14
294864	1399712	31D	25.2	17.1	23.0	0.83	42.1	**31.4**	38.6	1.16
294777	1401753	262C	8.6	5.2	5.7	0.11	30.3	21.9	23.8	0.44
291806	1402735	52A	15.0	6.9	7.3	0.09	25.9	16.0	16.8	0.23
291967	1402607	52B	15.5	7.2	7.6	0.10	26.3	16.4	17.4	0.24
292159	1402511	47	15.5	7.3	7.8	0.10	26.3	16.9	17.9	0.25
291913	1402447	53	16.5	7.5	7.9	0.10	27.4	16.7	17.6	0.24
291753	1402479	54	16.7	7.4	7.8	0.10	27.7	16.4	17.3	0.24
291495	1402436	59	17.3	7.4	7.8	0.10	28.6	16.0	16.9	0.22
291452	1402201	58	17.8	7.6	8.0	0.10	29.0	16.0	16.9	0.23
291378	1401198	15A	19.8	7.8	8.3	0.10	32.0	15.7	16.6	0.23

Table 14. Summary of contribution from the Project and cumulative effects for Year 7 for all assessment criteria (Continued)

Properties			Project only				Project and other mines			
x - ISG coordinate	y - ISG coordinate	ID	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month
291946	1401508	41A	20.3	8.7	9.2	0.13	31.3	17.5	18.6	0.27
292149	1401113	41B	22.0	9.2	9.9	0.15	33.7	18.1	19.4	0.31
292234	1401486	41C	20.3	9.1	9.7	0.14	30.7	18.3	19.5	0.30
292928	1402009	44	15.5	8.1	8.8	0.14	25.8	19.0	20.3	0.32
292800	1401785	13A	17.3	8.7	9.4	0.15	27.1	19.1	20.5	0.33
292970	1401966	13B	15.6	8.2	8.8	0.14	25.8	19.1	20.4	0.33
293141	1401636	50A	16.3	8.7	9.6	0.17	26.5	19.8	21.3	0.36
293205	1401518	50B	16.5	8.9	9.8	0.18	26.7	20.0	21.6	0.38
293398	1401081	27	18.3	10.2	11.5	0.25	28.7	21.3	23.4	0.46
293494	1401059	43	17.8	10.2	11.6	0.26	28.2	21.5	23.7	0.47
293462	1400792	18	21.7	11.8	13.5	0.30	32.7	22.8	25.3	0.52
293548	1400696	17	22.7	12.4	14.2	0.33	34.2	23.6	26.3	0.55
293665	1400472	16	25.6	14.0	16.2	0.39	38.2	25.3	28.4	0.62
293708	1400171	40	32.6	17.8	20.7	0.50	46.7	29.1	32.8	0.73
293505	1400259	39	31.5	16.2	18.6	0.42	44.7	27.0	30.2	0.64
292460	1399595	37	24.8	10.1	11.2	0.21	38.4	18.5	20.2	0.38
292492	1399402	15B	23.4	10.1	11.2	0.22	36.8	18.3	20.0	0.39
292258	1398997	33	16.4	8.5	9.4	0.20	29.6	16.2	17.6	0.36
291884	1399595	30	18.9	7.8	8.5	0.15	30.9	15.3	16.5	0.30
292119	1399306	48	18.1	8.4	9.2	0.18	31.1	16.0	17.4	0.33
291660	1399541	49	17.2	7.0	7.6	0.13	28.1	14.2	15.3	0.27
291316	1399349	75	14.8	6.0	6.4	0.10	25.4	12.7	13.6	0.23
291337	1399616	137	16.2	6.3	6.8	0.10	26.6	13.2	14.1	0.23
296227	1389843	35	4.4	1.0	1.0	0.01	15.7	5.6	6.2	0.14
297604	1390205	25	5.2	1.2	1.2	0.01	17.3	7.3	8.1	0.20
298780	1390881	WA	5.6	1.3	1.4	0.01	18.0	9.5	10.7	0.28
299548	1391041	WB	7.2	1.4	1.5	0.01	21.9	11.3	12.9	0.35
299633	1390731	WC	6.8	1.3	1.4	0.01	23.0	11.0	12.6	0.36
298378	1386585	161	3.1	0.6	0.6	0.01	15.9	4.6	5.0	0.07
298911	1386937	231	3.4	0.6	0.7	0.01	19.5	5.2	5.7	0.09
298538	1386606	111	3.1	0.6	0.6	0.01	16.2	4.7	5.1	0.07
298879	1386574	111east	3.2	0.6	0.6	0.01	17.1	4.8	5.2	0.07
298815	1386393	237	3.1	0.6	0.6	0.01	16.1	4.6	4.9	0.06
299413	1386990	226	3.8	0.6	0.6	0.01	20.7	5.6	6.1	0.09
300021	1387353	4A	4.3	0.7	0.7	0.01	24.8	6.6	7.1	0.11
300298	1387898	91	4.1	0.7	0.7	0.01	32.2	7.7	8.5	0.17
300330	1387108	227A	3.6	0.6	0.6	0.01	21.2	5.7	6.2	0.09
300480	1387129	227B	3.4	0.6	0.6	0.01	21.1	5.6	6.2	0.10
300203	1386638	181	3.5	0.5	0.6	0.01	19.6	4.9	5.3	0.07
300736	1386756	118	3.2	0.5	0.6	0.01	19.4	4.9	5.4	0.07
300767	1387823	63	3.6	0.7	0.7	0.01	28.4	7.4	8.2	0.16
300650	1387567	246	3.5	0.6	0.7	0.01	26.3	6.9	7.5	0.13
301067	1387108	178	3.1	0.6	0.6	0.01	20.5	5.4	6.0	0.09
300757	1386926	142A	3.2	0.5	0.6	0.01	19.5	5.1	5.6	0.08
300896	1386798	142B	3.1	0.5	0.6	0.01	19.5	4.9	5.4	0.07
302105	1386852	164	3.1	0.5	0.6	0.01	19.1	4.5	5.0	0.06
302222	1386393	69	2.9	0.5	0.5	0.00	17.1	3.9	4.3	0.05
302649	1386937	96	3.8	0.5	0.6	0.01	18.6	4.8	5.3	0.06
303407	1386361	203A	4.4	0.5	0.5	0.01	25.0	4.3	4.8	0.04
303545	1387204	203B	4.7	0.6	0.6	0.01	32.0	5.6	6.1	0.03
303577	1387289	203C	4.8	0.6	0.6	0.01	33.9	5.7	6.1	0.00
303823	1386958	203E	4.6	0.5	0.6	0.01	32.6	4.8	5.0	0.04
303770	1386500	203D	4.6	0.5	0.5	0.01	29.3	4.4	4.7	0.01
301270	1389288	1A	5.1	0.9	1.0	0.01	30.8	11.1	13.1	0.47
294598	1395832	24	24.3	11.4	16.7	0.55	33.3	19.6	25.5	0.68
93847	1400440	28A	25.1	14.4	16.8	0.43	38.3	26.2	29.5	0.67
293868	1400363	28B	27.0	15.5	18.2	0.46	40.5	27.3	30.9	0.71

7.4 Year 9

7.4.1 Predicted maximum 24-hour average PM_{10} concentrations

Figure 23 shows the predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project alone in Year 9. The relevant assessment 24-hour standard is 50 µg/m^3. No residences are predicted to experience 24-hour PM_{10} concentrations above the criterion.

Figure 24 shows the predicted maximum 24-hour PM_{10} concentrations due to emissions from the Project and other mines. Four mine owned residence 8C, 8D, 8G and 8H are predicted to experience 24-hour PM_{10} concentrations above 150 µg/m^3 due to the development of the Warkworth Mine. These residences are assessed in the Warkworth Mine EIS.

7.4.2 Predicted annual average PM_{10} concentrations

Figure 25 shows the predicted annual average PM_{10} concentrations due to emissions from the Project alone in Year 9. Since the 30 µg/m^3 criterion takes account of all sources of PM_{10} the figure is provided for information only. **Figure 26** shows the predicted annual PM_{10} concentrations from the Project and other mines. A total of 21 properties (including mine owned residences, privately owned residences, the St Philips Church and the Newcastle Gliding Club) are predicted to experience annual PM_{10} concentrations above 30 µg/m^3 (see Section 7.4.5). Eleven of these properties (8B to 8H, 11D, 11F, 125 and 215) are predominantly affected by other mining operations.

7.4.3 Predicted annual average TSP concentrations

Figure 27 shows the predicted annual average TSP concentrations due to emissions from the Project alone in Year 9. The assessment criterion of 90 µg/m^3 is based on cumulative effects so the figure is provided for information only. **Figure 28** shows the predicted annual average TSP concentrations from the Project and other mines. Residences predicted to experience annual TSP concentrations above 90 µg/m^3 are the mine owned residences 8B, 8C, 8D, 8E, 8F, 8G and 8H, which are predominantly affected by Warkworth Mine and are assessed as affected properties in the Warkworth Mine EIS.

7.4.4 Predicted annual average dust deposition (insoluble solids)

Figure 29 shows the predicted annual average dust deposition rate for Year 9 for the Project alone. The assessment criterion is 2 g/m^2/month (annual average). No residences are predicted to experience dust deposition levels due to the Project that are above this level.

Figure 30 shows the predicted annual average dust deposition rate for Year 9 for the Project considered with other mines. The assessment criterion is 4 g/m^2/month (annual average). Mine owned residences 8C, 8D, 8E, 8F, 8G and 8H are predicted to experience dust deposition levels above this level due to the development of the Warkworth Mine. These residences have been assessed as affected properties in the Warkworth Mine EIS.

7.4.5 Summary for Year 9

Table 15 provides a tabulated summary of the PM and dust deposition levels predicted to occur in Year 9 at sensitive receptors surrounding the Project. Predicted concentrations or deposition levels above the relevant EPA assessment criteria are identified with bold italicised print.

All other predicted concentrations and deposition levels comply with the assessment limits described in Section 4.4.

Table 15. Summary of contribution from the Project and cumulative effects for Year 9 for all assessment criteria

Properties			Project only				Project and other mines			
x - ISG coordinate	y - ISG coordinate	ID	24-hour PM10 µg/m^3	Annual PM10 µg/m^3	Annual TSP µg/m^3	Annual dust deposition g/m^2/month	24-hour PM10 µg/m^3	Annual PM10 µg/m^3	Annual TSP µg/m^3	Annual dust deposition g/m^2/month
296953	1389843	1	10.0	1.2	1.3	0.01	19.6	6.5	7.1	0.16
300681	1389061	2	7.1	1.1	1.2	0.01	34.8	10.0	11.5	0.35
300798	1388805	3	6.6	1.1	1.1	0.01	30.8	9.5	10.9	0.32
300692	1388474	4	6.5	1.0	1.1	0.01	27.0	8.8	9.9	0.26
300692	1388410	5	6.4	1.0	1.1	0.01	27.7	8.7	9.8	0.25
300863	1388164	6	5.9	0.9	1.0	0.01	28.3	8.2	9.2	0.21
300404	1388047	7	6.0	0.9	1.0	0.01	33.5	8.2	9.1	0.19
301278	1389277	8A	8.0	1.2	1.3	0.01	31.4	11.4	13.4	0.47
303124	1392308	8B	27.4	15.1	16.2	0.41	136.1	***100.2***	***125.1***	***4.24***
303403	1391070	8C	12.8	5.8	6.2	0.13	***183.9***	***112.7***	***145.2***	***4.92***
303446	1390803	8D	12.3	4.5	4.8	0.09	***166.4***	***107.5***	***140.2***	***5.09***
303521	1390504	8E	12.7	3.2	3.4	0.05	143.3	***103.9***	***139.6***	***5.80***
303628	1389736	8F	11.5	2.0	2.2	0.02	141.1	***77.3***	***110.1***	***4.85***
303681	1389821	8G	11.6	2.1	2.3	0.03	***155.3***	***85.8***	***123.4***	***5.56***
303703	1390035	8H	11.9	2.4	2.6	0.03	***170.3***	***95.0***	***135.9***	***6.26***
302564	1386393	9	4.5	0.6	0.6	0.01	16.3	4.0	4.5	0.05
301828	1395536	10	13.1	5.7	6.2	0.18	34.4	27.3	30.8	0.77
301977	1395181	11E	15.3	6.0	6.6	0.19	35.6	29.0	32.9	0.82
303910	1397543	11F	6.5	2.6	2.7	0.05	55.8	***33.7***	40.6	2.19
301828	1395160	20	15.2	6.0	6.5	0.17	35.0	29.1	32.8	0.78
301786	1394723	19B	22.4	9.2	11.6	0.42	40.2	***34.5***	40.5	1.10
301796	1394851	19A	19.5	7.8	9.2	0.30	37.8	***32.4***	37.4	0.95
301753	1394925	WE	17.6	6.9	7.9	0.23	36.4	***31.1***	35.5	0.86
302106	1394733	21A	21.6	8.4	9.6	0.31	39.3	***34.0***	39.2	1.05
302660	1395398	21B	13.1	5.6	6.1	0.17	42.6	26.0	29.6	0.85
303227	1394210	22	26.9	12.6	13.6	0.37	73.3	***46.0***	53.1	1.51
302010	1395011	23A	16.9	6.3	6.9	0.19	35.8	***30.1***	34.3	0.85
302212	1394883	WF	18.7	7.1	7.9	0.22	38.7	***31.5***	36.1	0.94
302341	1394648	56	21.6	8.4	9.5	0.28	41.6	***34.6***	40.0	1.10
302501	1394530	Church	21.9	8.5	9.5	0.26	43.4	***35.8***	41.6	1.16
301798	1393367	51	49.5	27.5	32.5	1.13	60.8	***61.4***	71.9	2.09
305502	1398012	94	5.6	1.8	1.9	0.03	29.3	18.7	21.1	0.79
305577	1397607	254	6.0	2.2	2.3	0.04	28.5	19.2	21.7	0.84
302108	1395160	23B	15.4	6.0	6.6	0.18	36.7	28.9	32.9	0.83
301840	1397297	215	10.7	4.4	4.7	0.11	36.8	***30.8***	39.1	1.67
301174	1402084	125	4.5	0.9	1.0	0.01	66.5	***35.4***	45.9	1.79
297146	1400921	11D	6.4	2.7	2.9	0.05	62.7	***40.1***	49.0	1.48
296345	1401550	11C	5.3	2.7	2.8	0.04	39.5	29.2	32.7	0.75
296292	1401753	11B	5.2	2.6	2.7	0.04	38.5	28.7	32.1	0.73
295320	1402756	11A	6.4	2.6	2.7	0.04	31.2	22.3	24.1	0.41
293722	1396443	13C	17.3	7.6	8.6	0.15	27.4	15.3	16.8	0.28
294730	1402617	262A	7.7	3.2	3.4	0.05	29.3	20.3	21.8	0.35
294744	1402500	262B	7.6	3.3	3.4	0.05	29.6	20.4	21.9	0.36

Table 15. Summary of contribution from the Project and cumulative effects for Year 9 for all assessment criteria (Continued)

Properties			Project only				Project and other mines			
x – ISG coordinate	y – ISG coordinate	ID	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month	24-hour PM10 µg/m³	Annual PM10 µg/m³	Annual TSP µg/m³	Annual dust deposition g/m²/month
294893	1402938	262D	7.6	3.0	3.1	0.04	29.3	20.7	22.2	0.35
294605	1399797	31A	24.4	12.9	17.0	0.60	39.5	26.4	31.7	0.90
294832	1399552	31B	22.6	11.8	16.4	0.60	39.2	25.9	31.8	0.93
294949	1399691	31C	15.2	7.7	11.1	0.41	34.8	22.2	27.0	0.75
294864	1399712	31D	18.0	9.3	12.9	0.47	36.4	23.6	28.5	0.80
294777	1401753	262C	7.5	3.6	3.9	0.07	29.1	20.3	22.0	0.40
291806	1402735	52A	12.1	6.3	6.7	0.09	21.9	15.4	16.2	0.22
291967	1402607	52B	12.3	6.5	6.9	0.09	22.2	15.8	16.7	0.23
292159	1402511	47	12.4	6.6	7.0	0.10	22.4	16.2	17.1	0.24
291913	1402447	53	13.2	6.9	7.3	0.10	22.9	16.1	17.0	0.23
291753	1402479	54	13.3	6.9	7.3	0.09	22.9	15.9	16.8	0.23
291495	1402436	59	13.9	7.1	7.5	0.09	23.5	15.7	16.5	0.22
291452	1402201	58	15.3	7.4	7.8	0.10	25.0	15.8	16.7	0.22
291378	1401198	15A	21.4	8.4	8.9	0.12	33.2	16.3	17.3	0.25
291946	1401508	41A	19.2	8.6	9.2	0.14	29.5	17.4	18.5	0.28
292149	1401113	41B	21.9	9.3	10.1	0.17	33.1	18.1	19.6	0.33
292234	1401486	41C	18.4	8.6	9.3	0.15	28.1	17.9	19.2	0.30
292928	1402009	44	12.5	6.8	7.3	0.13	22.7	17.6	18.9	0.30
292800	1401785	13A	14.2	7.5	8.1	0.15	23.7	17.9	19.3	0.32
292970	1401966	13B	12.6	6.8	7.4	0.13	22.8	17.7	19.0	0.31
293141	1401636	50A	13.5	7.2	7.9	0.16	23.5	18.2	19.7	0.35
293205	1401518	50B	13.7	7.2	8.1	0.17	23.6	18.3	19.9	0.36
293398	1401081	27	15.6	8.1	9.5	0.23	24.7	19.2	21.3	0.44
293494	1401059	43	15.0	8.0	9.3	0.24	24.1	19.3	21.4	0.45
293462	1400792	18	18.5	9.6	11.3	0.29	27.4	20.6	23.2	0.51
293548	1400696	17	19.1	10.0	11.9	0.31	28.2	21.2	23.9	0.54
293665	1400472	16	21.4	11.2	13.5	0.37	30.9	22.5	25.7	0.60
293708	1400171	40	29.4	15.3	18.4	0.50	39.5	26.6	30.5	0.73
293505	1400259	39	28.9	14.6	17.4	0.45	38.6	25.4	29.0	0.68
292460	1399595	37	29.1	11.8	13.8	0.31	42.4	20.2	22.7	0.48
292492	1399402	15B	28.8	11.9	13.9	0.32	41.7	20.2	22.8	0.49
292258	1398997	33	23.1	10.4	11.9	0.26	34.7	18.1	20.0	0.42
291884	1399595	30	22.3	9.1	10.2	0.19	34.4	16.7	18.3	0.34
292119	1399306	48	23.2	10.0	11.3	0.23	35.2	17.6	19.5	0.39
291660	1399541	49	19.9	8.3	9.1	0.16	31.6	15.4	16.8	0.30
291316	1399349	75	16.8	7.1	7.6	0.11	28.1	13.8	14.7	0.24
291337	1399616	137	18.2	7.4	7.9	0.12	29.6	14.3	15.3	0.25
296227	1389843	35	8.1	1.3	1.4	0.01	17.5	6.0	6.6	0.14
297604	1390205	25	10.2	1.3	1.4	0.01	20.6	7.5	8.3	0.20
298780	1390881	WA	16.1	2.1	2.2	0.01	26.5	10.3	11.6	0.28
299548	1391041	WB	20.1	2.5	2.7	0.02	29.0	12.5	14.1	0.36
299633	1390731	WC	16.5	2.1	2.2	0.01	26.0	11.8	13.4	0.36
298378	1386585	161	4.2	0.7	0.7	0.01	16.0	4.7	5.1	0.07
298911	1386937	231	4.2	0.7	0.8	0.01	19.5	5.3	5.8	0.09
298538	1386606	111	4.2	0.7	0.7	0.01	16.3	4.8	5.2	0.07
298879	1386574	111 east	4.0	0.7	0.7	0.01	17.2	4.9	5.3	0.07
298815	1386393	237	3.9	0.6	0.7	0.01	16.1	4.7	5.0	0.06
299413	1386990	226	3.8	0.7	0.7	0.01	20.8	5.7	6.2	0.09
300021	1387353	4A	6.1	0.8	0.8	0.01	25.0	6.7	7.3	0.11
300298	1387898	91	6.0	0.9	1.0	0.01	32.4	7.9	8.7	0.17
300330	1387108	227A	5.3	0.7	0.8	0.01	21.5	5.8	6.3	0.09
300480	1387129	227B	5.1	0.7	0.8	0.01	21.4	5.8	6.3	0.10
300203	1386638	181	4.9	0.6	0.7	0.01	19.7	5.0	5.5	0.07
300736	1386756	118	4.4	0.7	0.7	0.01	19.6	5.0	5.5	0.07
300767	1387823	63	5.4	0.9	0.9	0.01	28.7	7.6	8.4	0.17

Table 15. Summary of contribution from the Project and cumulative effects for Year 9 for all assessment criteria (Continued)

Properties			Project only				Project and other mines			
x - ISG coordinate	y - ISG coordinate	ID	24-hour PM10 μg/m^3	Annual PM10 μg/m^3	Annual TSP μg/m^3	Annual dust deposition g/m^2/month	24-hour PM10 μg/m^3	Annual PM10 μg/m^3	Annual TSP μg/m^3	Annual dust deposition g/m^2/month
300650	1387567	246	5.1	0.8	0.9	0.01	26.6	7.0	7.7	0.13
301067	1387108	178	4.0	0.7	0.8	0.01	20.6	5.6	6.2	0.09
300757	1386926	142A	4.4	0.7	0.7	0.01	19.7	5.3	5.8	0.08
300896	1386798	142B	4.0	0.7	0.7	0.01	19.6	5.1	5.6	0.07
302105	1386852	164	4.4	0.7	0.7	0.01	19.0	4.7	5.2	0.06
302222	1386393	69	4.0	0.6	0.6	0.01	16.8	4.0	4.4	0.05
302649	1386937	96	4.9	0.7	0.7	0.01	18.8	4.9	5.4	0.06
303407	1386361	203A	5.3	0.6	0.6	0.01	25.0	4.4	4.9	0.05
303545	1387204	203B	6.1	0.7	0.8	0.01	32.2	5.7	6.3	0.04
303577	1387289	203C	6.3	0.7	0.8	0.01	34.0	5.8	6.2	0.01
303823	1386958	203E	5.9	0.7	0.7	0.01	32.8	5.0	5.1	0.03
303770	1386500	203D	5.4	0.6	0.6	0.01	29.4	4.5	4.8	0.00
301270	1389288	1A	8.0	1.2	1.3	0.01	31.5	11.4	13.5	0.47
294598	1395832	24	19.9	8.6	10.2	0.21	31.9	16.8	19.0	0.34
293847	1400440	28A	20.5	11.0	13.3	0.38	30.6	22.8	26.0	0.62
293868	1400363	28B	22.4	12.1	14.6	0.41	32.6	23.9	27.3	0.66

8. CONSTRUCTION

There will be a number of activities associated with the Project development that could be classed as construction. These will include modifications to the CHPP and coal handling system and the installation of ventilation shafts. These activities would not be expected to generate significant quantities of dust and dust emissions would be easily controlled using water sprays and standard dust control measures used on construction sites.

The construction of the rail loop will involve the clearing of vegetation and the placement of track. Earthworks will take place along a narrow corridor of varying width ranging from 100 or so metres to 25 m, within which the track will be laid. The construction work is expected to be completed over a 12-18 month period, however, construction of the Project spur and loop would only take a few months. Clearly dust emissions from works of this type have the capacity to cause nuisance impacts if not properly managed. In practice, it is not possible to realistically quantify impacts using dispersion modelling. To do so would require knowledge of weather conditions for the few weeks that work will be taking place in each location along the track.

Proper dust management will require the use of water carts, the defining of trafficked areas, the imposition of site vehicle speed limits and constraints on work under extreme unfavourable weather conditions.

9. ODOUR

Odour measurements undertaken on underground mines in the Hunter Valley have yielded odour emission levels of up to 170 odour units (ou) in mine ventilation air. Even with ventilation rates of up to 340 Am^3/s (equivalent to an odour emissions rate of 57,800 ou.m^3/s - see assessment Dartbrook by **Holmes Air Sciences (2003)**) this has not caused the EPA's odour goal of 7 ou (99-percentile for rural residential areas) to be exceeded.

Since the volume of ventilation air at Wambo will not exceed 350 m^3/s from any particular vent and the closest residences are significantly further away that at Dartbrook it can be concluded that odour impacts will not arise from the Project's emissions even if the high odour level of 170 ou were to apply to the Wambo ventilation air.

10. GREENHOUSE ISSUES

Coal mining results in the emission of carbon dioxide during the combustion of diesel fuel (used in diesel-powered equipment and in blasting) and indirectly in the use of electricity to power mining equipment. To assess emissions from these sources, the electrical and fuel requirement for existing mining operations have been used to determine energy usage for each tonne of coal handled by various parts of the mine. These estimates have then been used to estimate CO_2 emissions rates. In doing this it has been assumed that each MWh of electrical energy used results in the release of 1.06 t of CO_2 and that each litre of diesel fuel burnt (either in mobile plant or explosives) results in the release of 2.57 kg of CO_2. Using these assumptions and information supplied by the Wambo Coal Mine based on current operations it can be shown that:

- Coal through the CHPP results in 5.25 kg of CO_2/t (through the use of electrical power)
- Coal from the underground results in 11.51 kg of CO_2/t (through the use of electrical power)
- Coal from the open cut results in 17.91 kg of CO_2/t (through the use of diesel).

Table 16 summarises the estimated CO_2 emissions from the mine for each year using the above emissions factors for the CHPP, the underground and open cut.

Table 16. Summary of estimated CO_2 emissions

Year	Coal through CHPP - t	Coal from underground - t	ROM coal from open cut - t	Total CO_2 emission - t
1	3,000,000	-	4,300,000	92,741
2	5,100,000	400,000	6,800,000	153,129
3	6,800,000	2,300,000	7,200,000	191,071
4	7,600,000	2,500,000	8,000,000	211,896
5	7,600,000	2,500,000	8,000,000	211,896
6	8,200,000	3,000,000	8,000,000	215,044
7	9,900,000	5,100,000	8,000,000	229,716
8	11,300,000	6,700,000	8,000,000	261,223
9	11,300,000	6,700,000	8,000,000	279,631
10	11,300,000	6,700,000	8,000,000	279,631
11	11,200,000	6,500,000	8,000,000	279,106
12	10,200,000	5,400,000	8,000,000	271,558
13	9,000,000	4,000,000	8,000,000	252,606
14	6,500,000	7,500,000	-	80,126
15	6,500,000	7,500,000	-	120,393
16	6,500,000	7,500,000	-	120,393
17	6,500,000	7,500,000	-	120,393
18	6,000,000	7,000,000	-	117,770
19	6,000,000	7,000,000	-	112,017
20	3,400,000	4,000,000	-	98,375
21	3,400,000	4,000,000		
Total	157,300,000	103,800,000	98,300,000	3,698,714

In addition, mining will release methane to the atmosphere. Methane is a very “effective” greenhouse gas, with a warming potential of 21 compared with the warming potential for CO_2 of 1. It has a shorter life in the atmosphere (about 12 years compared with 50 to 200 years for CO_2 - see **Intergovernmental Panel on Climate Change (IPCC) (1996)**) before it is converted to carbon dioxide and water vapour. Methane emissions from open cut mining are not accurately known, but the equivalent CO_2 emitted via methane emissions is believed to be minor compared with the emissions from the combustion of the coal and the other sources considered above.

Emissions from the underground operations can be estimated using data on the ventilation system and on the pre-mining gas drainage system. As an example, for the Whybrow seam it is estimated that approximately 120 m^3/s of ventilation air would be required and the methane content of the ventilation air would be 0.1% giving an annual emission rate of 3.78×10^6 m^3/year of methane [120 m^3/s x 365 day/year x 24 hour/day x 3600 seconds/hour x 0.001]. Assuming a temperature of 20^oC for the emitted air and a molecular weight of 16 kg/kmole for methane this would have a CO_2 equivalent of 52,800 t/y [21 x ((273 K /293 K) x 3.78×10^6/22.4) kmoles x 16 kg/kmole].

The ventilation rates for different parts of the Project will vary over the life of the mine. **Table 17** summarises the total annual equivalent CO_2 emission rate from all components of the Project’s ventilation and gas drainage systems.

The estimates in the table follow the same methodology as described above for the Whybrow example.

It should be noted that gas composition for the Arrowfield and Bowfield seams drainage is likely to vary over the life of the mine. The assumption that it will comprise 80% methane is a conservative assumption that covers the range of uncertainty. In practice, it is expected that approximately 10% of emissions are likely to be non-greenhouse gases and the remainder will be CO_2 or methane.

Table 17. Estimated CO_2 equivalent emission rate from the Project's ventilation systems

	Wollemi Portal		Homestead Portal		Whybrow longwall		Wambo longwall		Arrowfield/Bowfield longwall		Gas drainage for Arrowfield and Bowfield seams		Total CO2 equivalent - t/y
	Volume - m^3/s	Methane concentration (%)	Volume - m^3/s	Methane concentration (%)	Volume - m^3/s	Methane concentration (%)	Volume - m^3/s	Methane concentration (%)	Volume - m^3/s	Methane concentration (%)	Volume - m^3/s	Methane concentration (%)	
1	76	0.2	59	0.1									92,998
2	76	0.2			120	0.1							119,884
3	76	0.2			120	0.1							119,884
4	76	0.2			120	0.1							119,884
5					120	0.1	200	0.5	350	0.8	2	80	2,432,943
6							200	0.5	350	0.8	2	80	2,380,053
7							200	0.5	350	0.8	2	80	2,380,053
8							200	0.5	350	0.8	2	80	2,380,053
9							200	0.5	350	0.8	2	80	2,380,053
10							200	0.5	350	0.8	2	80	2,380,053
11							200	0.5	350	0.8	2	80	2,380,053
12							200	0.5	350	0.8	2	80	2,380,053
13							200	0.5	350	0.8	2	80	2,380,053
14									350	0.8	4	80	2,644,503
15									350	0.8	4	80	2,644,503
16									350	0.8	4	80	2,644,503
17									350	0.8	4	80	2,644,503
18									350	0.8	4	80	2,644,503
19									350	0.8	4	80	2,644,503
20									350	0.8	2	80	1,939,303
21									350	0.8	2	80	1,939,303
Total													41,671,645

The greenhouse warming potential due to emissions of methane from the Project's ventilation and gas drainage systems are more significant sources of greenhouse gases than the emissions from the use of fuel in mining.

The combustion of the product coal by customers will result in the release of carbon dioxide, which will add to the quantity of carbon dioxide in the atmosphere. This is of course the largest contributor to emissions that will occur as result of the Project. The mine has the capacity to add approximately up to 11.2 Mtpa[6] annually of carbon to the atmosphere as a result of combustion of the coal produced. It can be seen that this is the major source of carbon to the atmosphere from the Project.

The above figures can be compared with the estimated atmospheric reservoir of carbon of 2700 Gt. The annual production of carbon from the worldwide combustion of fossil fuels and cement production of 5.5 Gt (**IPCC, 1996**) of which Australia's contribution is approximately 0.11 Gt.

Over the 21-year life of the project it is estimated that 3,698,714 t of CO_2 will be emitted due to the consumption of electrical energy and diesel for mobile plant and blasting and 41,671,645 t of CO_2 equivalent will be released through the mine ventilation and gas drainage systems. This gives a total emission of 45,370,359 t (CO_2 equivalent) over the life of the mine or an average 2,160,493 t/y (CO_2 equivalent).

Clearly the mine's contribution to the global emissions is small, but coal mining and the use of coal as fuel is not compatible with reducing carbon dioxide concentrations in the atmosphere. The only practical measures that the development can take to minimise possible greenhouse effects is to ensure that the coal is mined in the most energy efficient manner.

11. MONITORING AND MITIGATION MEASURES

The modelling results are based on the assumption that the Project continues to apply existing dust control measures. The locations of the nearby residential areas in Warkworth are located north of the prevailing downwind direction for winter winds and are distant from the major dust sources associated with the mine (i.e. the open cuts). However, there will be a need to ensure that dust emissions are kept to the minimum practicable level to ensure that these areas are not impacted and that cumulative impacts with other mining projects are kept to acceptable levels. This section outlines procedures proposed for the management and control of dust emissions.

Proposed dust management and control procedures

The following procedures are proposed for the management of dust emissions from the mine. The aim of these procedures is to minimise the emission of dust. Dust can be generated from two primary sources, these being:

i) wind blown dust from exposed areas and from locations where there is no vegetation cover, and
ii) dust generated by mining activities.

Table 18 and **Table 19** list the different sources of wind blown and mining generated dust respectively, and their recommended control procedures.

6 Conservatively assumes that all the product coal is carbon.

Table 18. Control procedures for wind blown dust

Source	Control Procedures
Areas disturbed by mining	Disturb only the minimum area necessary for mining. Reshape, topsoil and rehabilitate completed overburden emplacement areas as soon as practicable after the completion of overburden tipping.
Coal handling areas	Maintain coal-handling areas in a moist condition using water carts to minimise wind blown and traffic generated dust.
Coal Product Stockpiles	Seal, or maintain water sprays on, product coal stockpiles and use sprays to reduce the risk of airborne dust.

Table 19. Mine generated dust and controls

Source	Control procedures
Haul Road Dust	Fixed irrigation and/or chemical dust suppressants would be used on select permanent (trunk) haul roads to minimise the generation of dust. All active roads and traffic areas will be watered using water carts to minimise the generation of dust. Active haul roads will be minimised and clearly defined. Obsolete roads will be rehabilitated.
Minor roads	Development of minor roads will be limited and the locations of these will be clearly defined. Minor roads used regularly for access etc will be constructed so as to minimise dust generation (well compacted select material) and watered as required. Obsolete roads will be rehabilitated.
Topsoil Stripping	Access tracks used by topsoil stripping equipment during their loading and unloading cycle will be watered.
Topsoil Stockpiling	On topsoil stockpiles, where the material is not planned to be used for over 6 months the material will be re-vegetated.
Drilling	Dust aprons will be lowered during drilling. Drill rigs will be equipped with dust suppression equipment and it will be operated whenever the potential for high levels of dust generation is identified.
Blasting	Stemming will be designed to provide optimum confinement of the blast charge.
Raw Coal Bins	Automatic sprays or other dust control mechanisms will be used when tipping raw coal generates excessive dust quantities.
Coal Preparation Plant	Spillage of material will be cleaned up to prevent dust. Dust suppression systems will be fitted at transfer points to prevent high dust levels where necessary.

It is envisaged that the monitoring program necessary to verify environmental performance will incorporate the following.

- One meteorological station at the existing location.
- Two high volume PM_{10} monitors one in the Warkworth area and one to the northwest (eg. towards Jerrys Plains).
- Deposition gauges would be added to the existing locations to provide adequate coverage further to the northwest.
- A real-time dust monitor will be installed to measure PM_{10} concentrations at a location agreed with the EPA.

- Real time monitoring of wind speed and wind direction will also be undertaken to allow real-time dust monitoring data to be interpreted and assist in the implementation of best practice management to minimise the effects of dust emissions.

12. CONCLUSIONS

This report has assessed the air quality impacts likely to arise due to operation of the Project open cut and underground mines for the next 21 years. The focus of the assessment has been on the effects of PM emissions. However, the assessment also provides a quantification of greenhouse gas emissions due to the Project and the potential for odour impacts associated with emissions of mine ventilation air. No odour impacts would be expected.

Impacts due to emissions of PM_{10}, TSP and deposited dust have been assessed for the Project in isolation and for the Project considered with other mines and other sources of PM.

A total of 28 residences are predicted to experience either PM or deposition levels above the EPA assessment criteria at some time over the life of the mine. These impacts are a consequence of cumulative effects. For seven of the residences (8B to 8H) the impacts are primarily due to mining operation proposed for the Warkworth Mine and are already dealt with in the Warkworth Mine EIS. Three mine owned residences (11D, 11E and 11F) are primarily affected by Hunter Valley Operations to the north and are already owned by Coal & Allied. Two residences (WE and WF) are already owned by Wambo Coal Mine.

The remaining residences that are predicted to be impacted are 20 (owned by Jerrys Plains Coal Terminal), 21A (owned by Coal & Allied), 19A, 19B, 22, 23A, 56, St Philips Church, 51, 23B, 215 (Newcastle Gliding Club), 125, 31A, 31B, 31C and 31D. These impacts are due to the cumulative effects of the Project and other mines.

Impacts due to dust emissions from construction of the rail loop and other development activities have also been considered. Normal dust controls applied during construction will need to be applied, but with these in place the EPA's criteria would be met.

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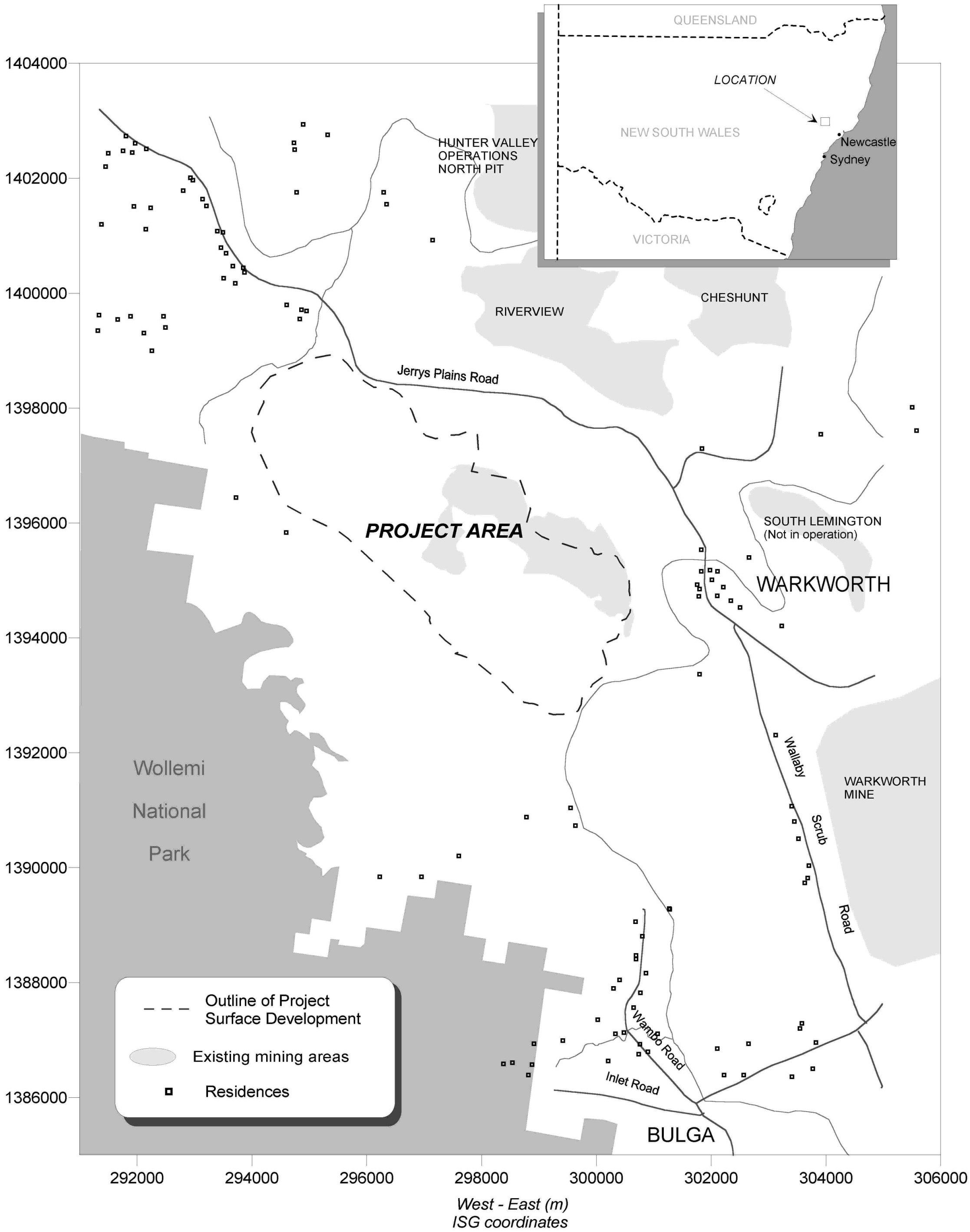
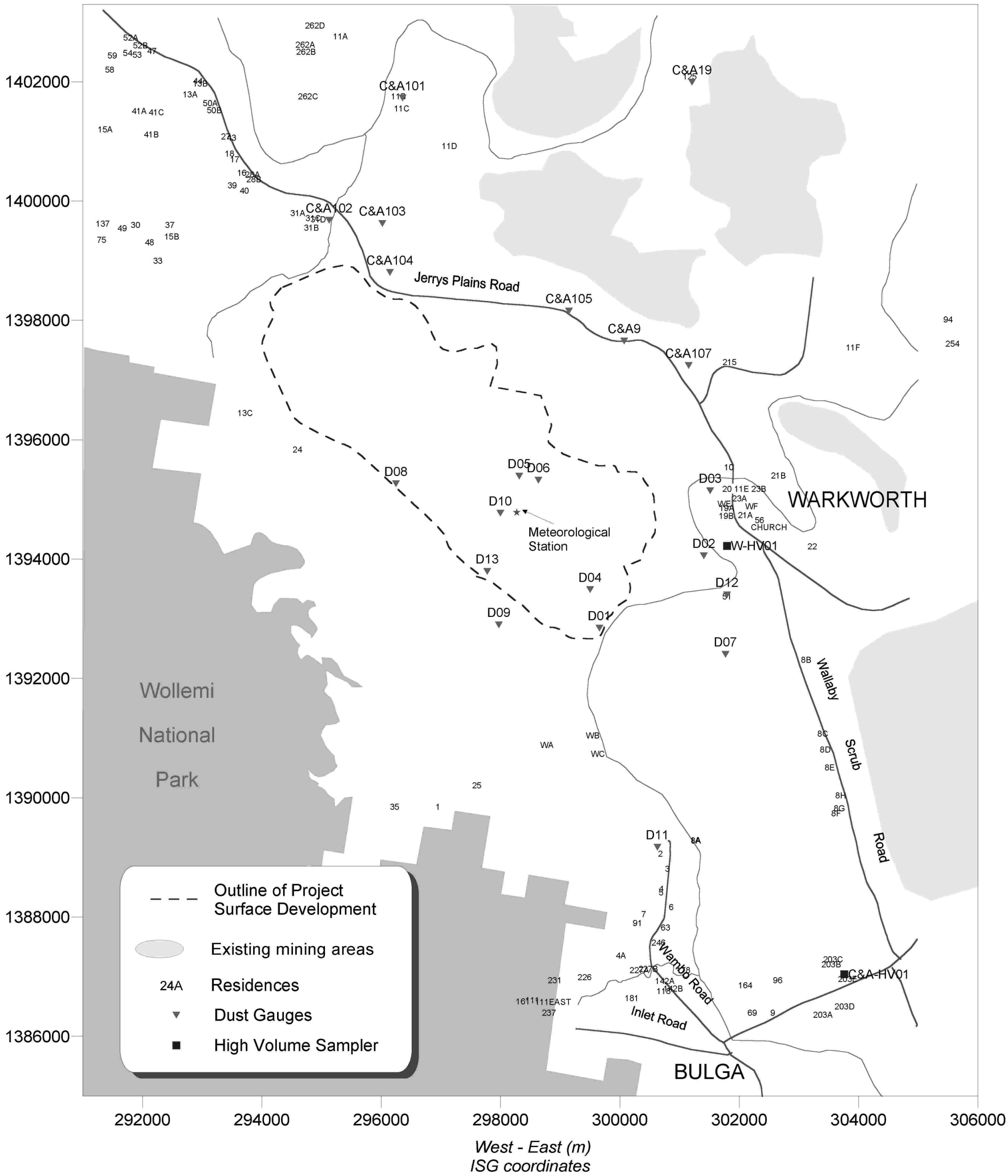
FIGURES



Location of study area

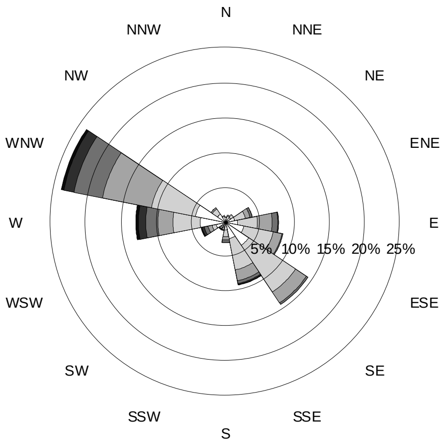
FIGURE 1



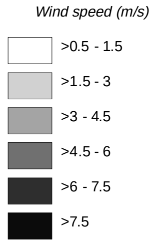
Location of dust and meteorological monitoring sites and residences

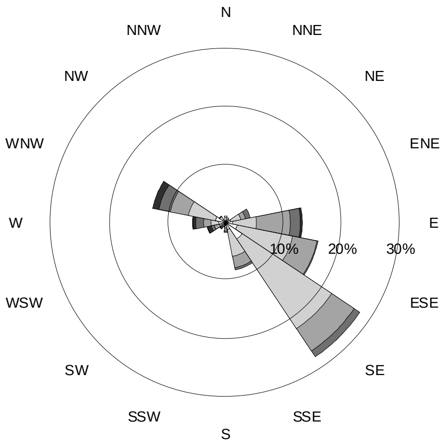
FIGURE 2

Annual and Seasonal Windroses for Wambo for 30 June 2001 to 31 May 2002

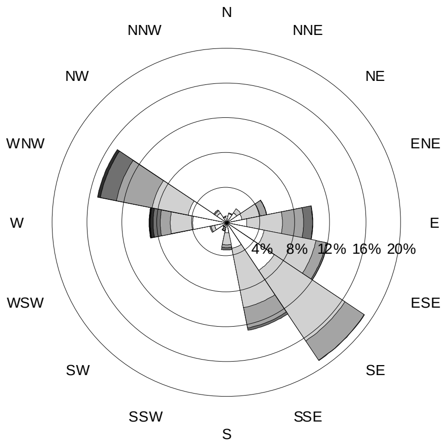


Annual
Calms = 4.5%

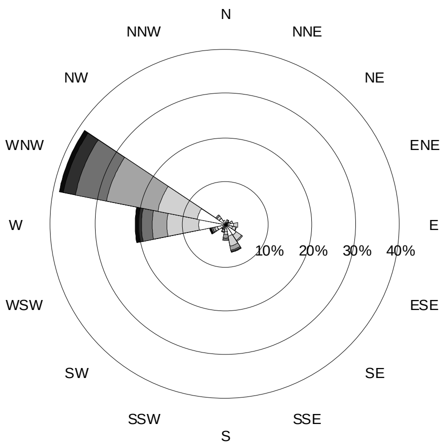




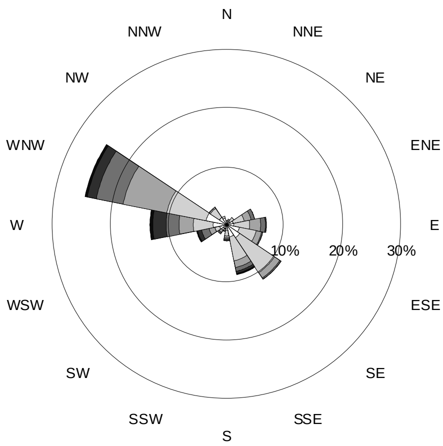
Summer
Calms = 0.7%



Autumn
Calms = 5.3%



Winter
Calms = 5.7%



Spring
Calms = 4.5%

FIGURE 3

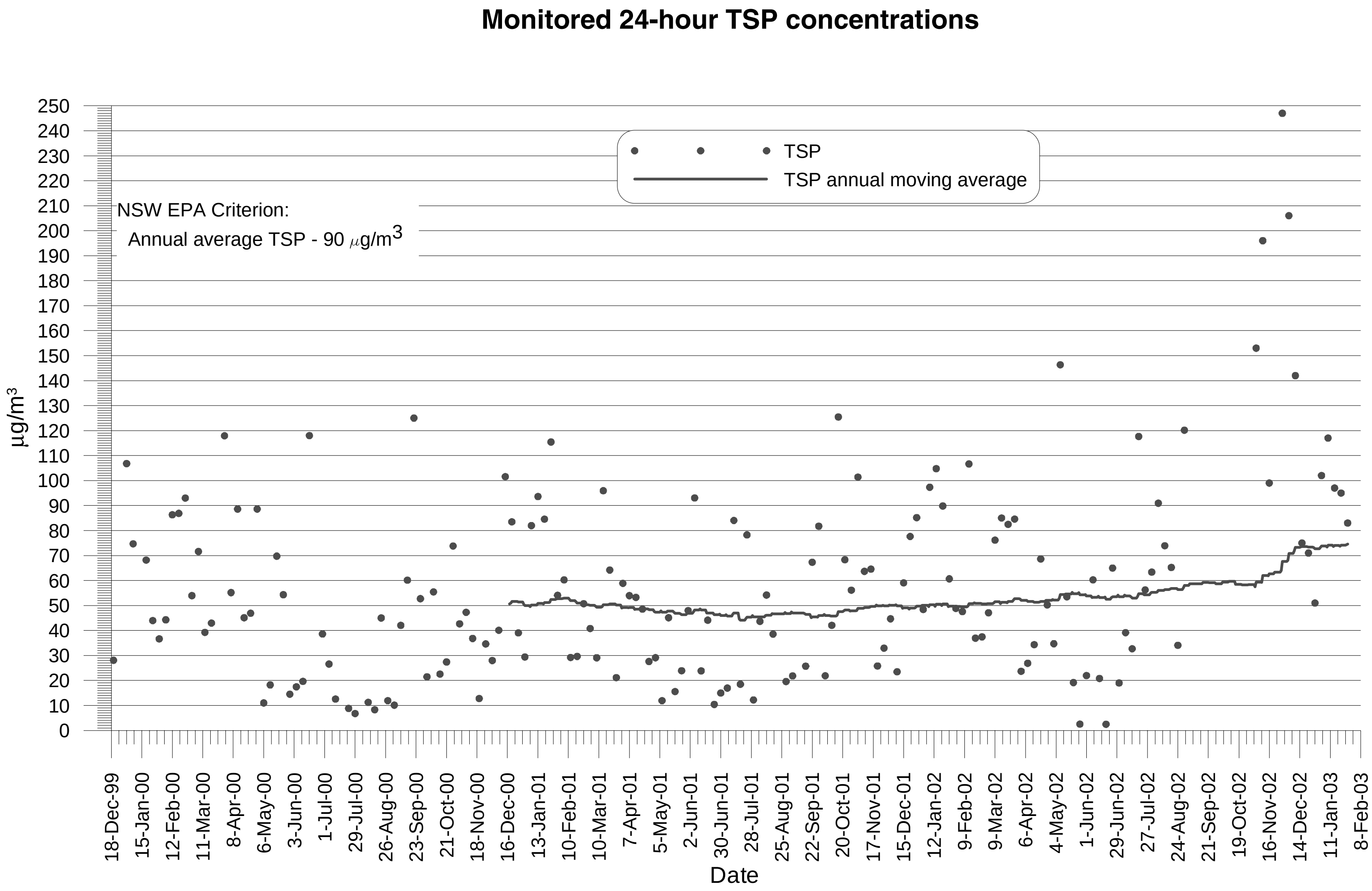

Monitored 24-hour TSP concentrations
TSP
TSP annual moving average
NSW EPA Criterion:
Annual average TSP - 90 μg/m3
μg/m3
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
18-Dec-99
15-Jan-00
12-Feb-00
11-Mar-00
8-Apr-00
6-May-00
3-Jun-00
1-Jul-00
29-Jul-00
26-Aug-00
23-Sep-00
21-Oct-00
18-Nov-00
16-Dec-00
13-Jan-01
10-Feb-01
10-Mar-01
7-Apr-01
5-May-01
2-Jun-01
30-Jun-01
28-Jul-01
25-Aug-01
22-Sep-01
20-Oct-01
17-Nov-01
15-Dec-01
12-Jan-02
9-Feb-02
9-Mar-02
6-Apr-02
4-May-02
1-Jun-02
29-Jun-02
27-Jul-02
24-Aug-02
21-Sep-02
19-Oct-02
16-Nov-02
14-Dec-02
11-Jan-03
8-Feb-03
Date

Figure 4

Monitored and inferred 24-hour PM_{10} concentrations

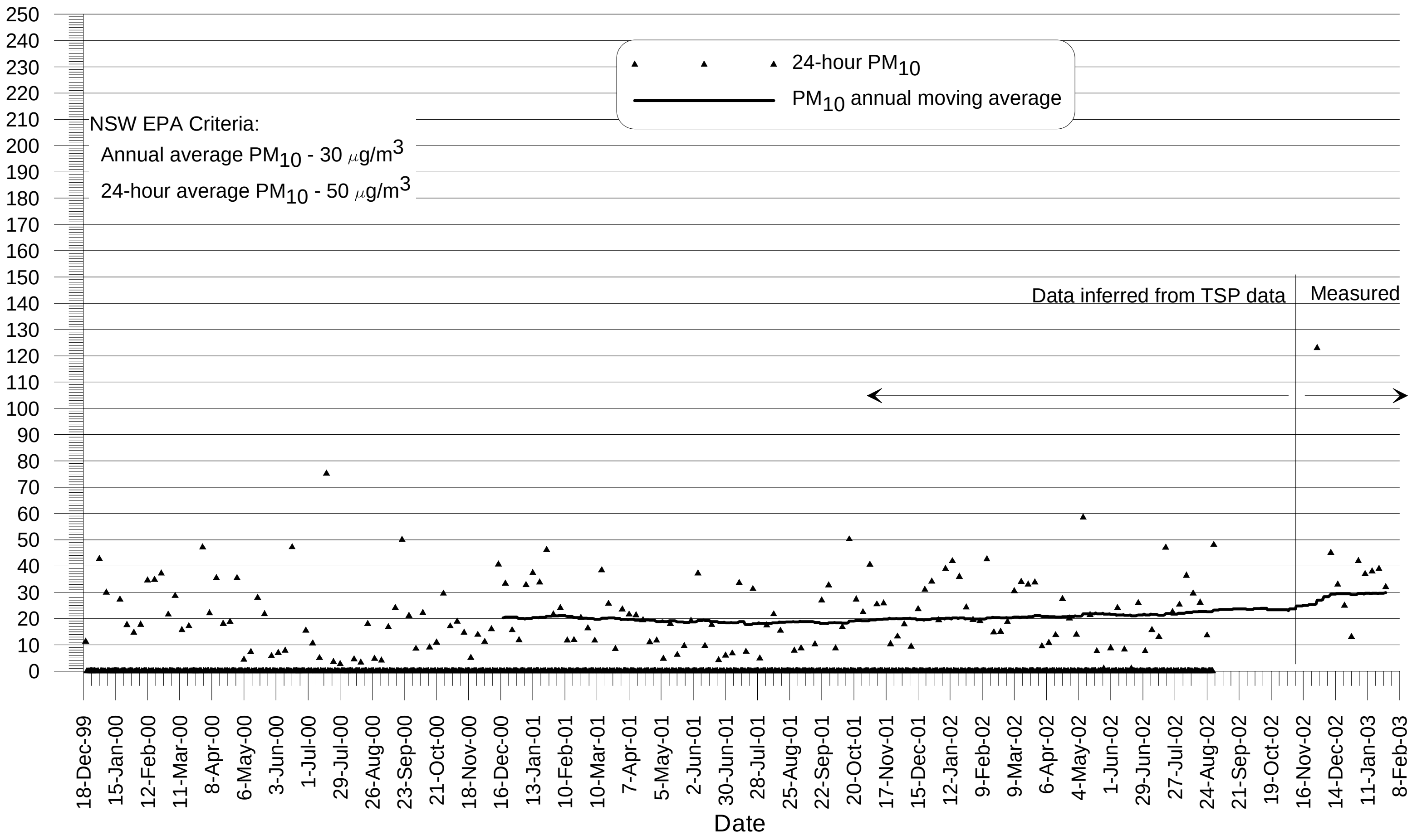
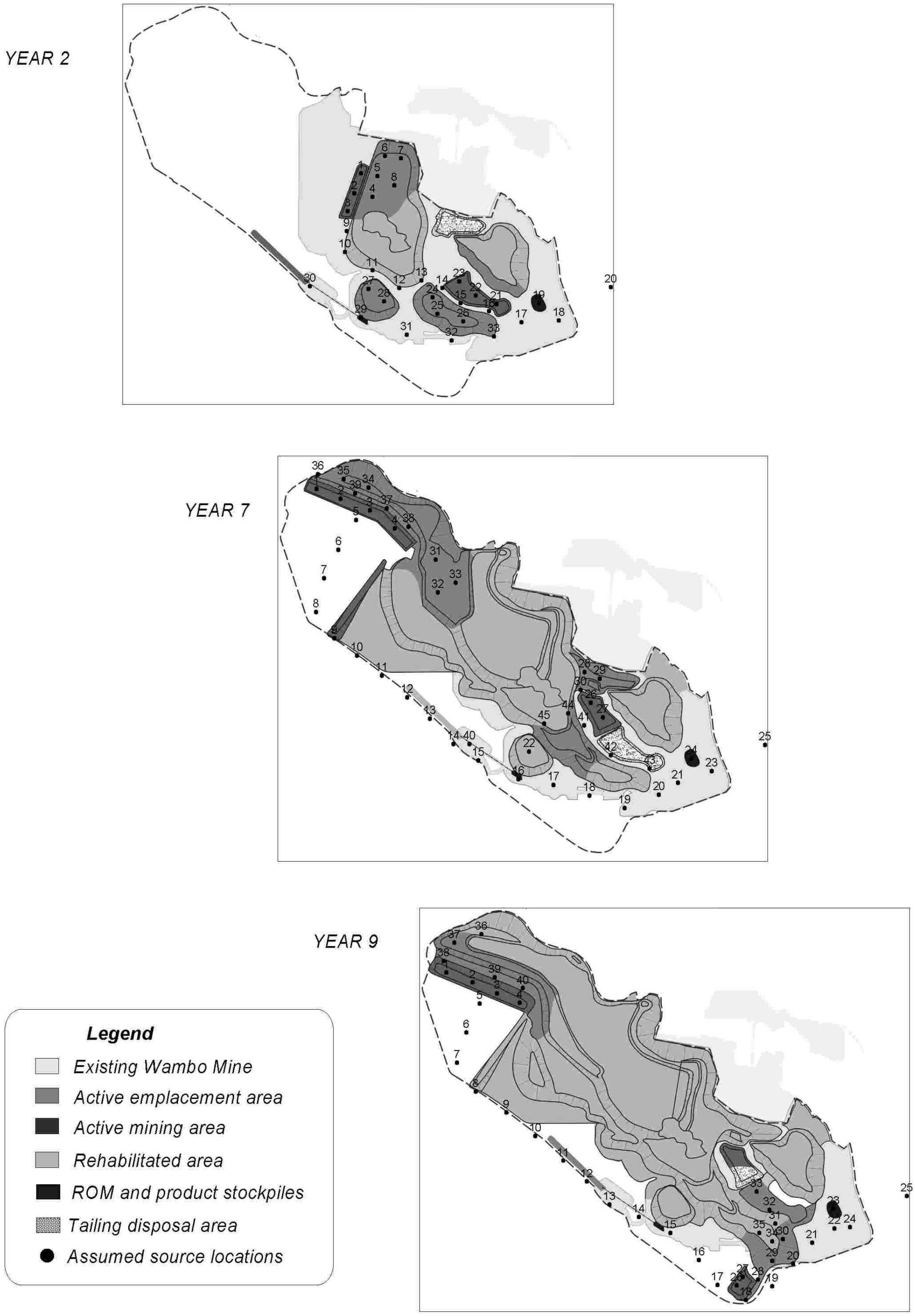
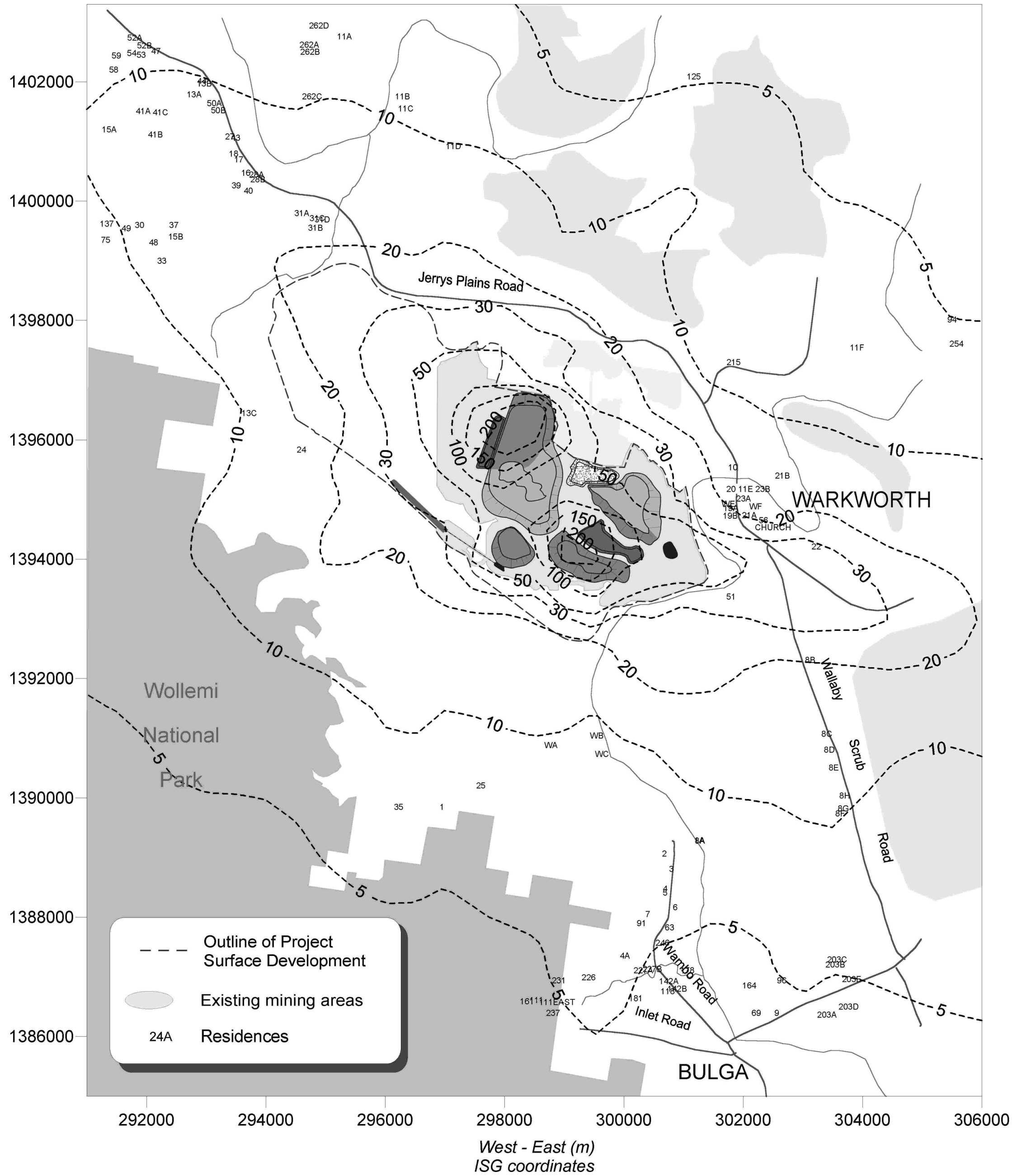


Figure 5



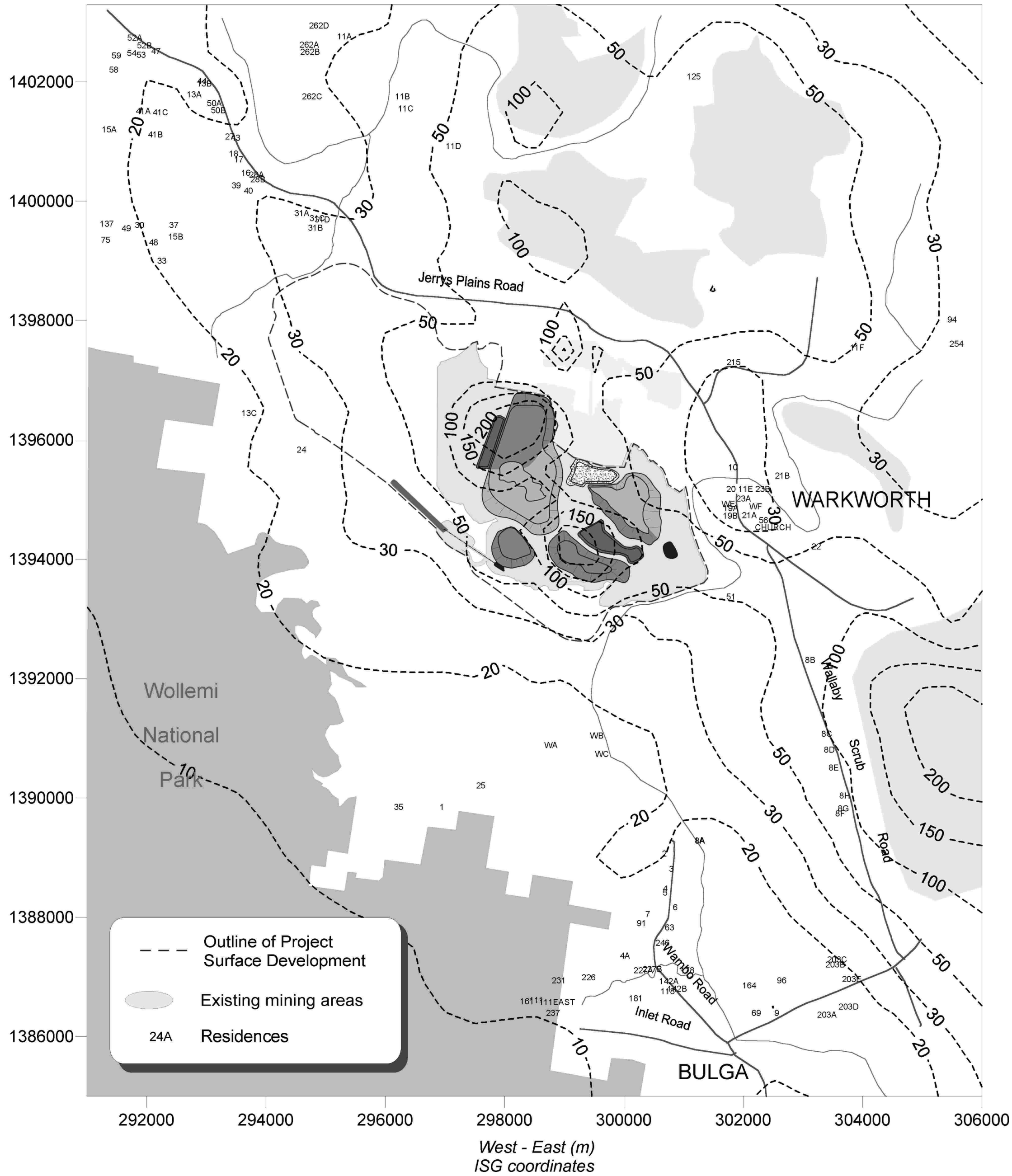
Sequence of mine development and assumed sources locations

FIGURE 6



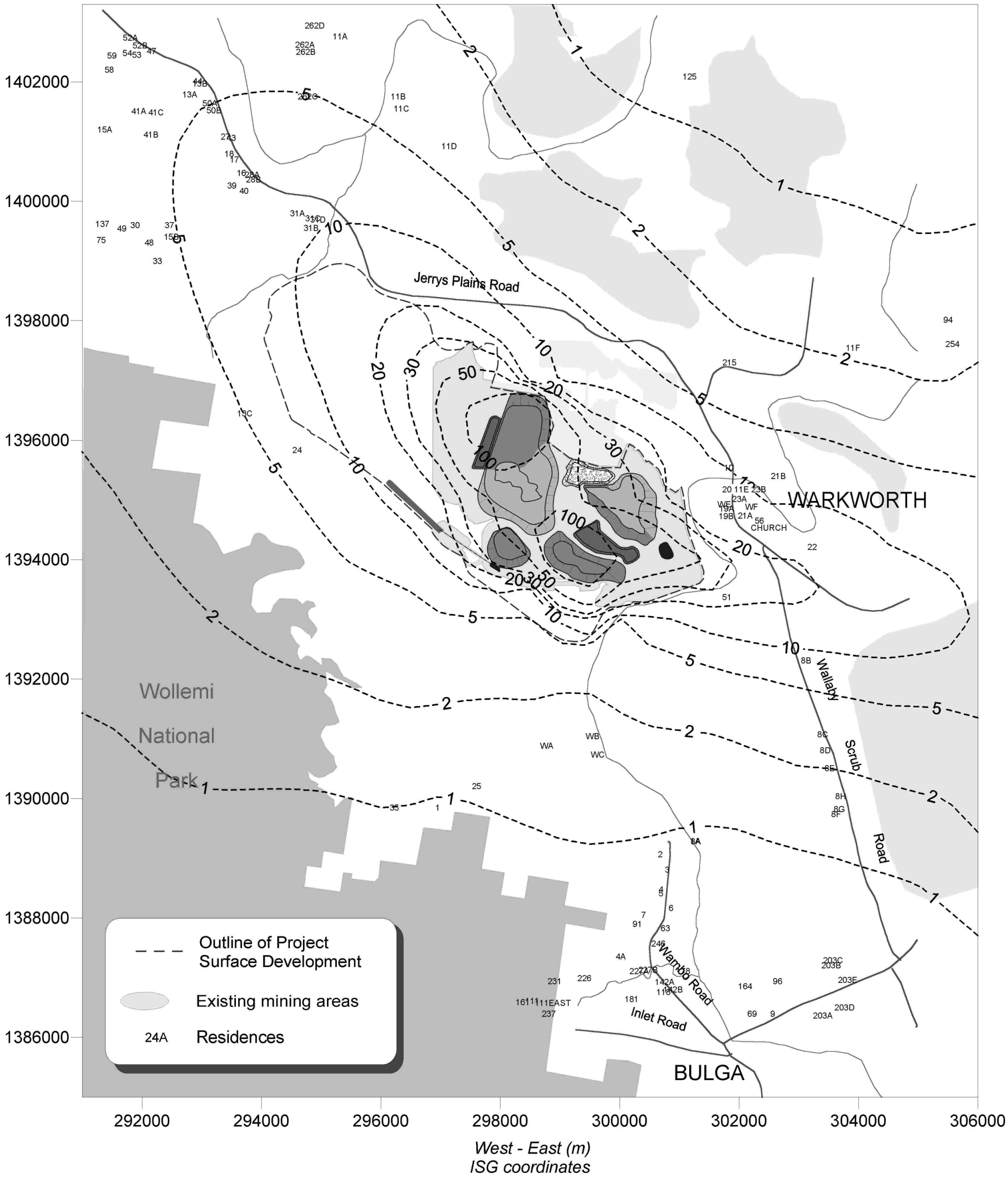
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project in Year 2 ($\mu g/m^3$)

FIGURE 7



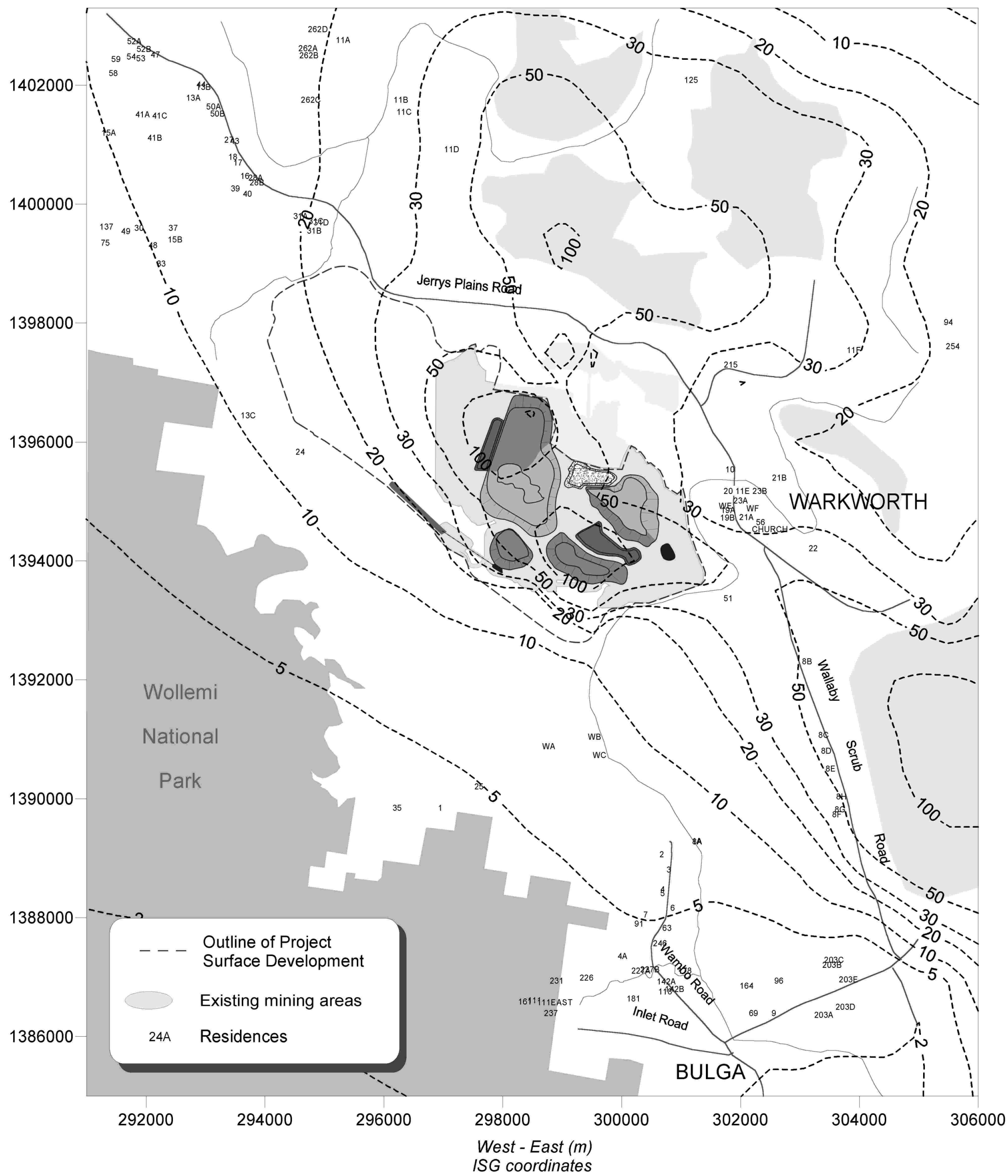
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project and other mines in Year 2 ($\mu g/m^3$)

FIGURE 8



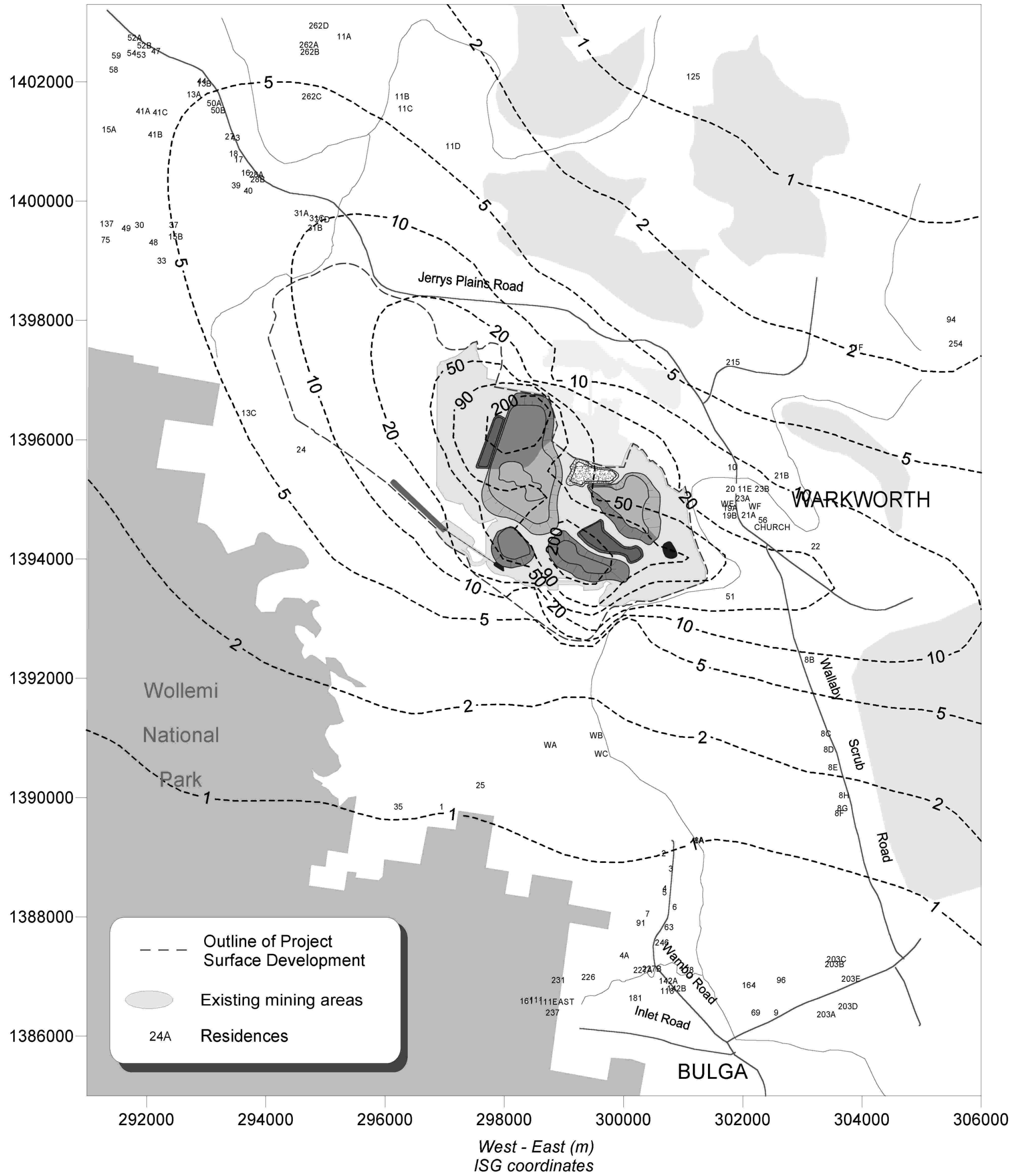
Predicted annual average PM_{10} concentrations due to emissions from the Project in Year 2 ($\mu g/m^3$)

FIGURE 9



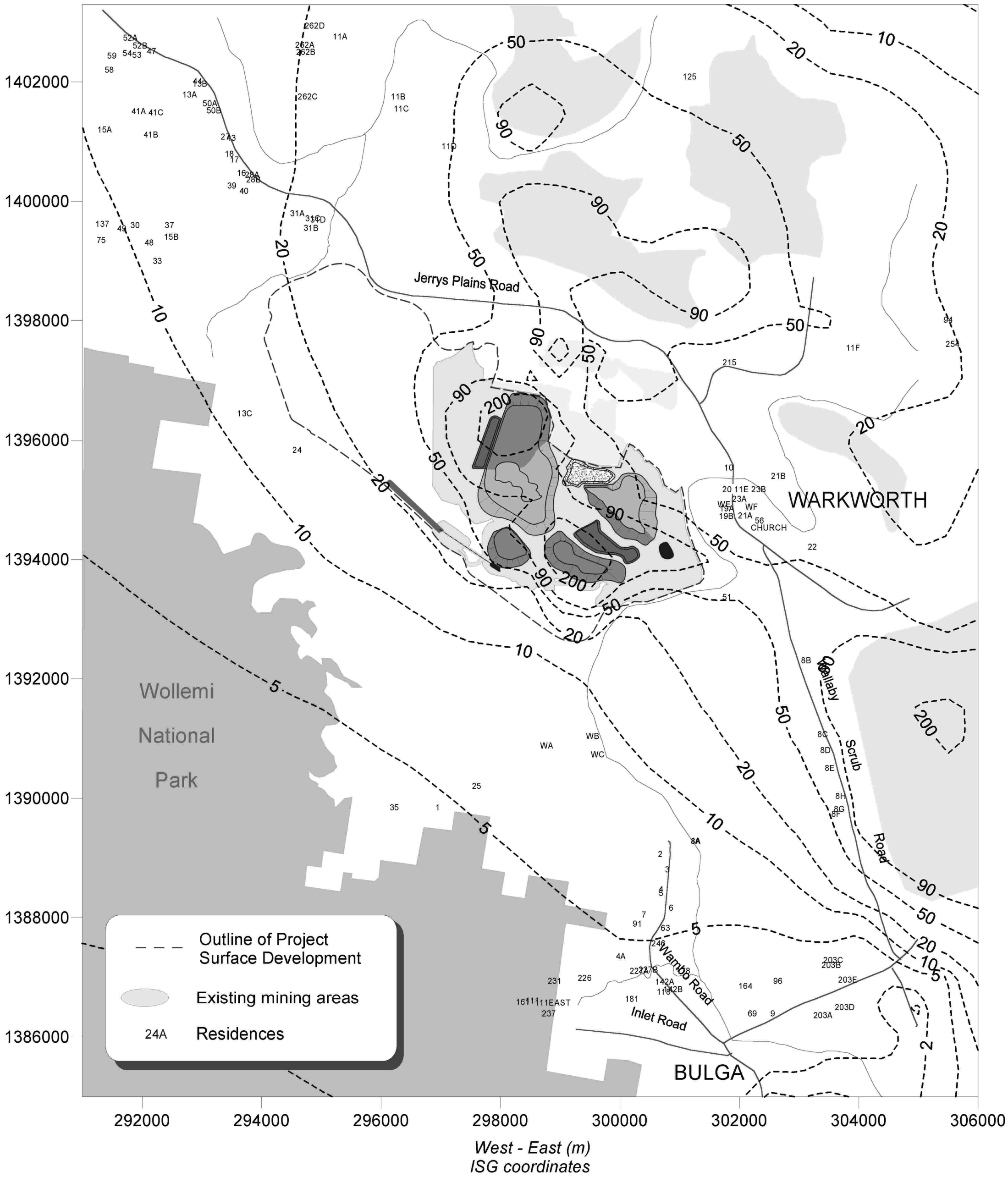
Predicted annual average PM_{10} concentrations due to emissions from the Project and other mines in Year 2 ($\mu g/m^3$)

FIGURE 10



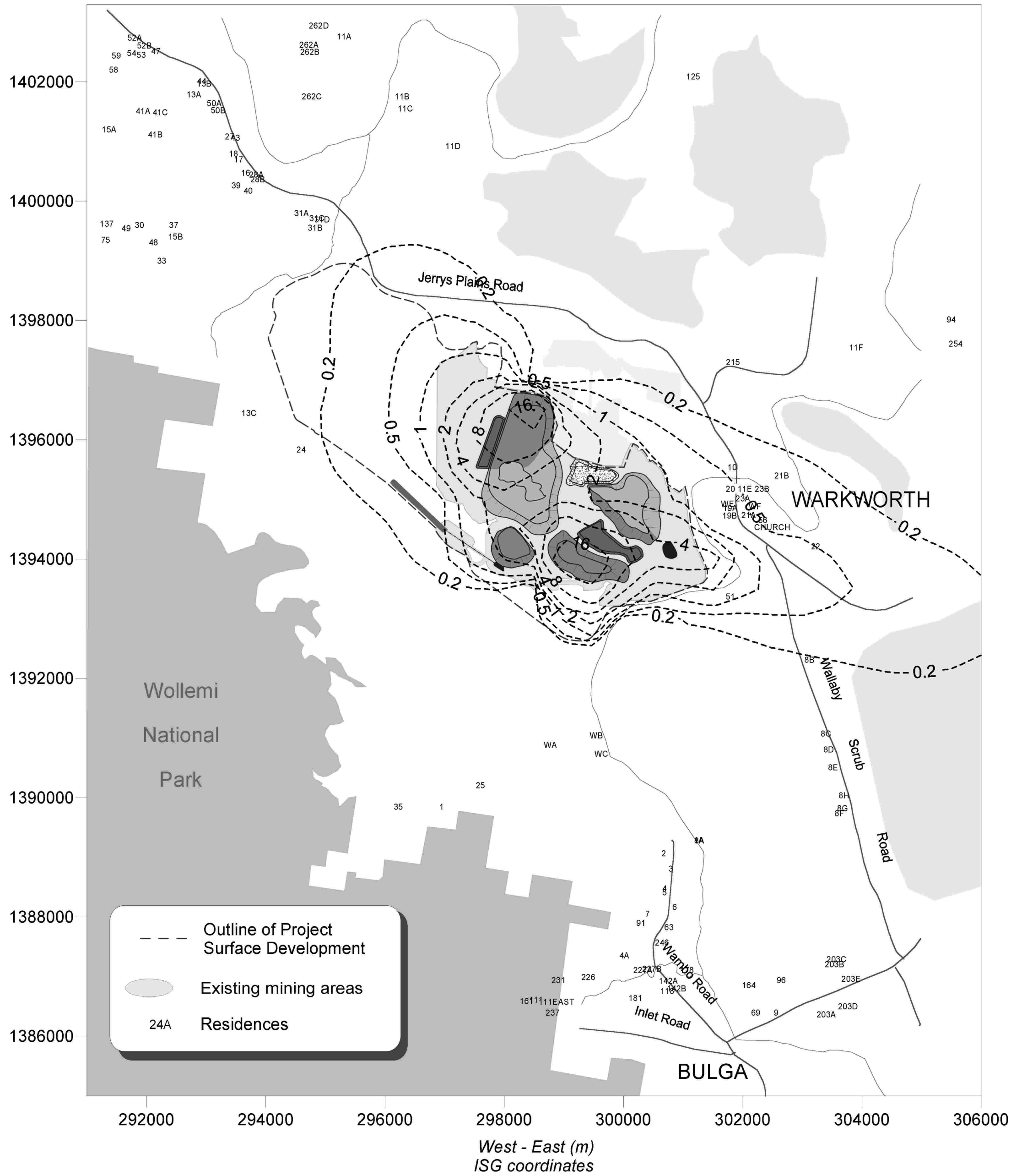
Predicted annual average TSP concentrations due to emissions from the Project in Year 2 (µg/m^3)

FIGURE 11



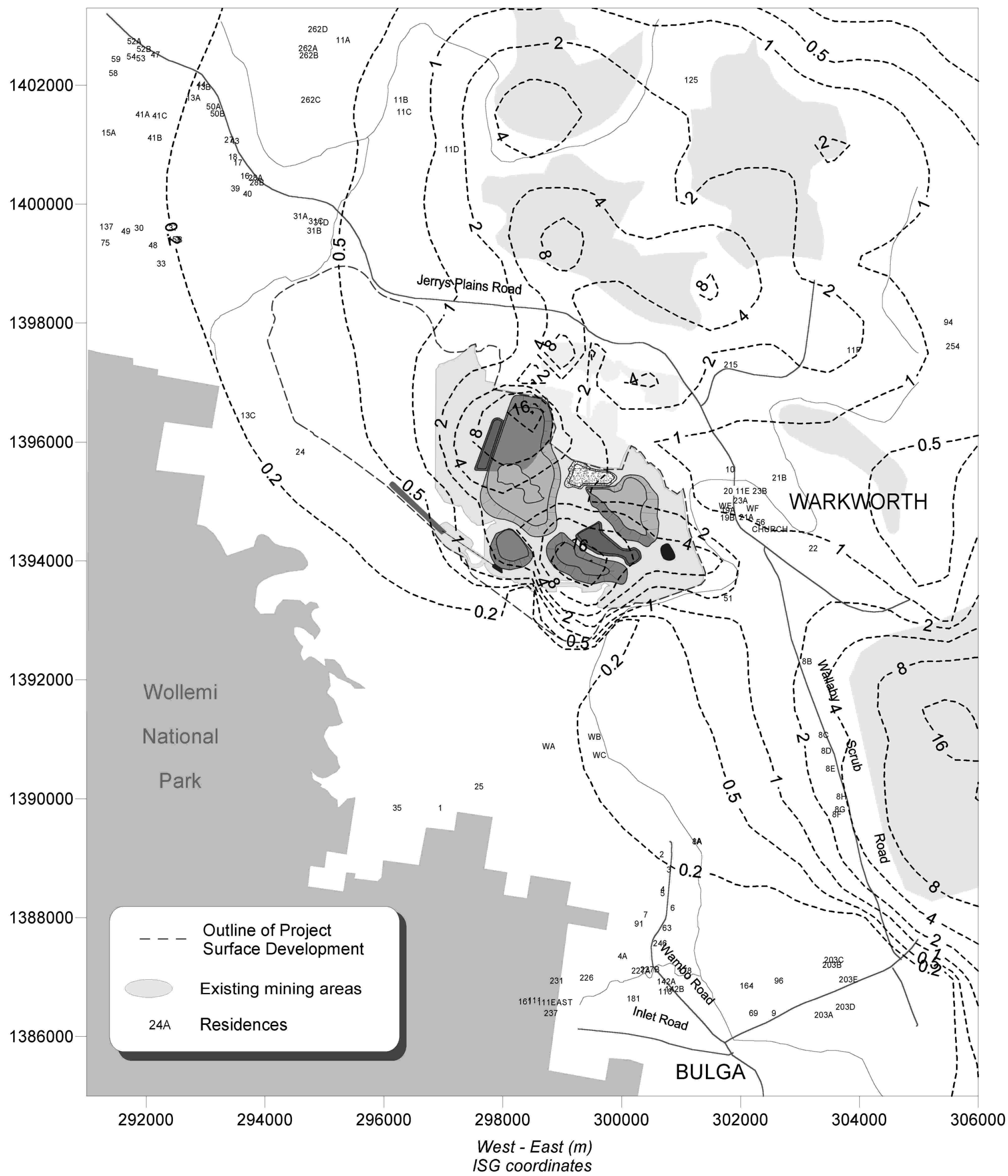
Predicted annual average TSP concentrations due to emissions from the Project and other mines in Year 2 (µg/m^3)

FIGURE 12



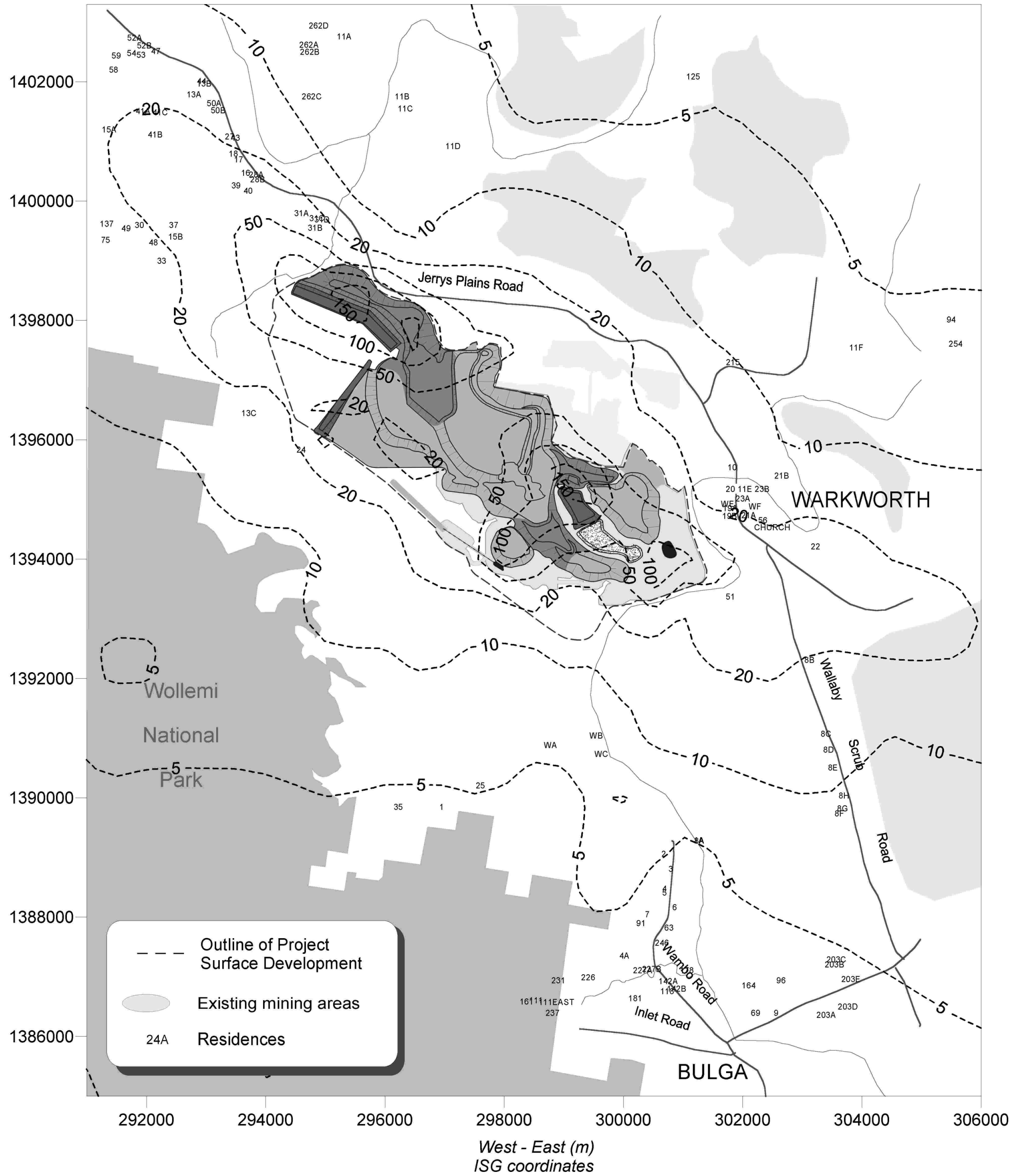
Predicted annual average dust deposition due to emissions from the Project in Year 2 (µg/m³)

FIGURE 13



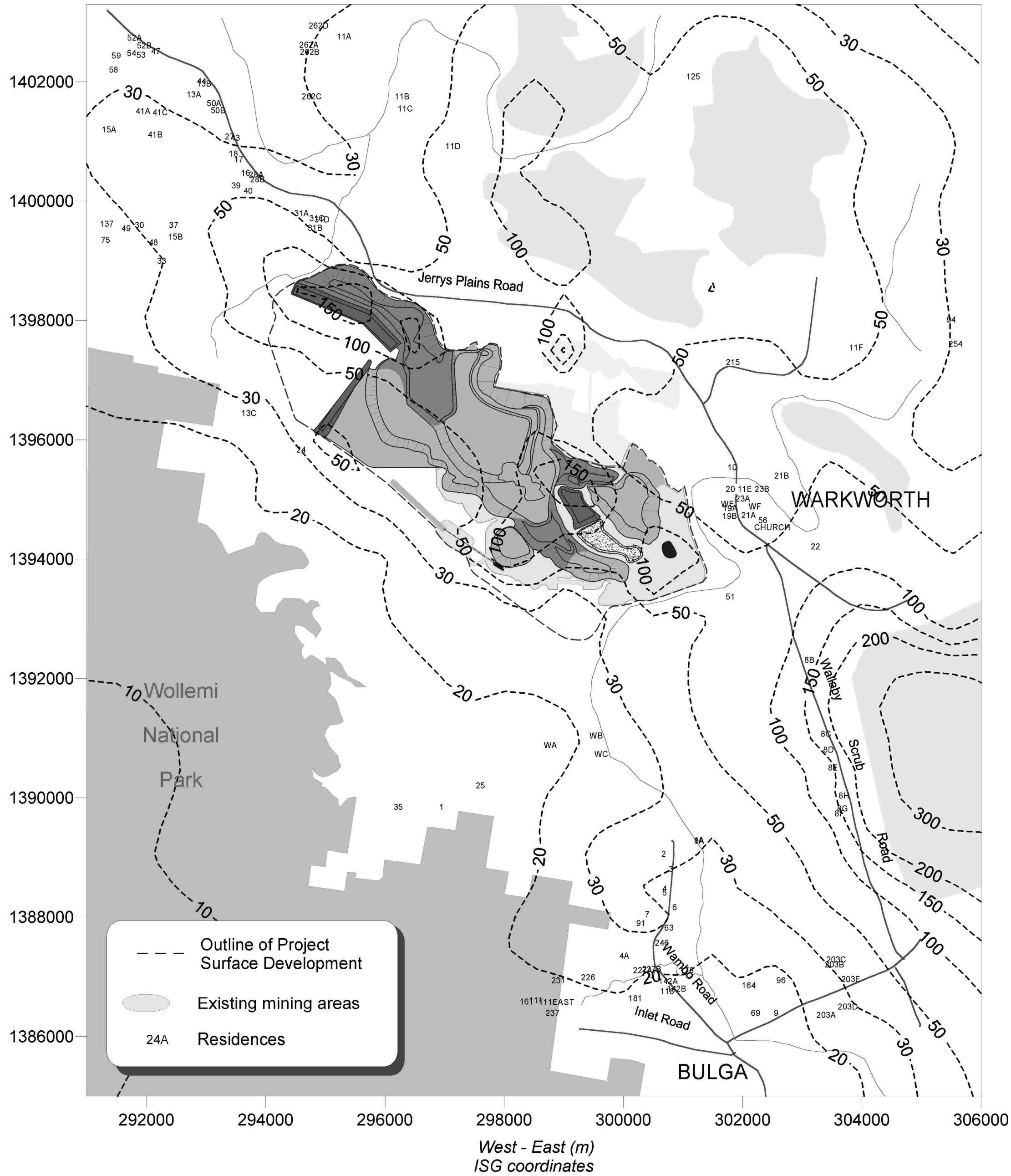
Predicted annual average dust deposition due to emissions from the Project and other mines in Year 2 (µg/m³)

FIGURE 14



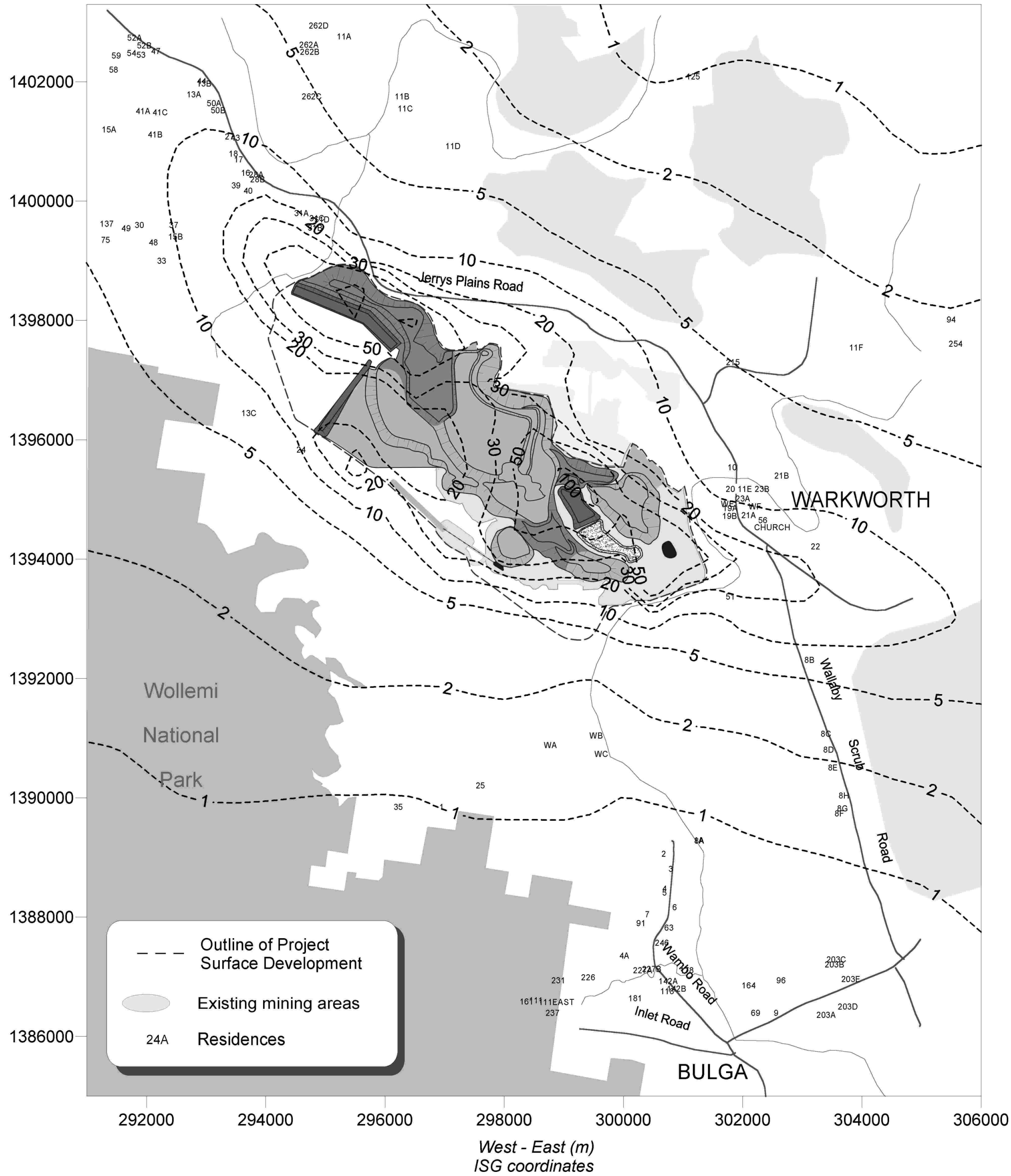
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project in Year 7 ($\mu g/m^3$)

FIGURE 15



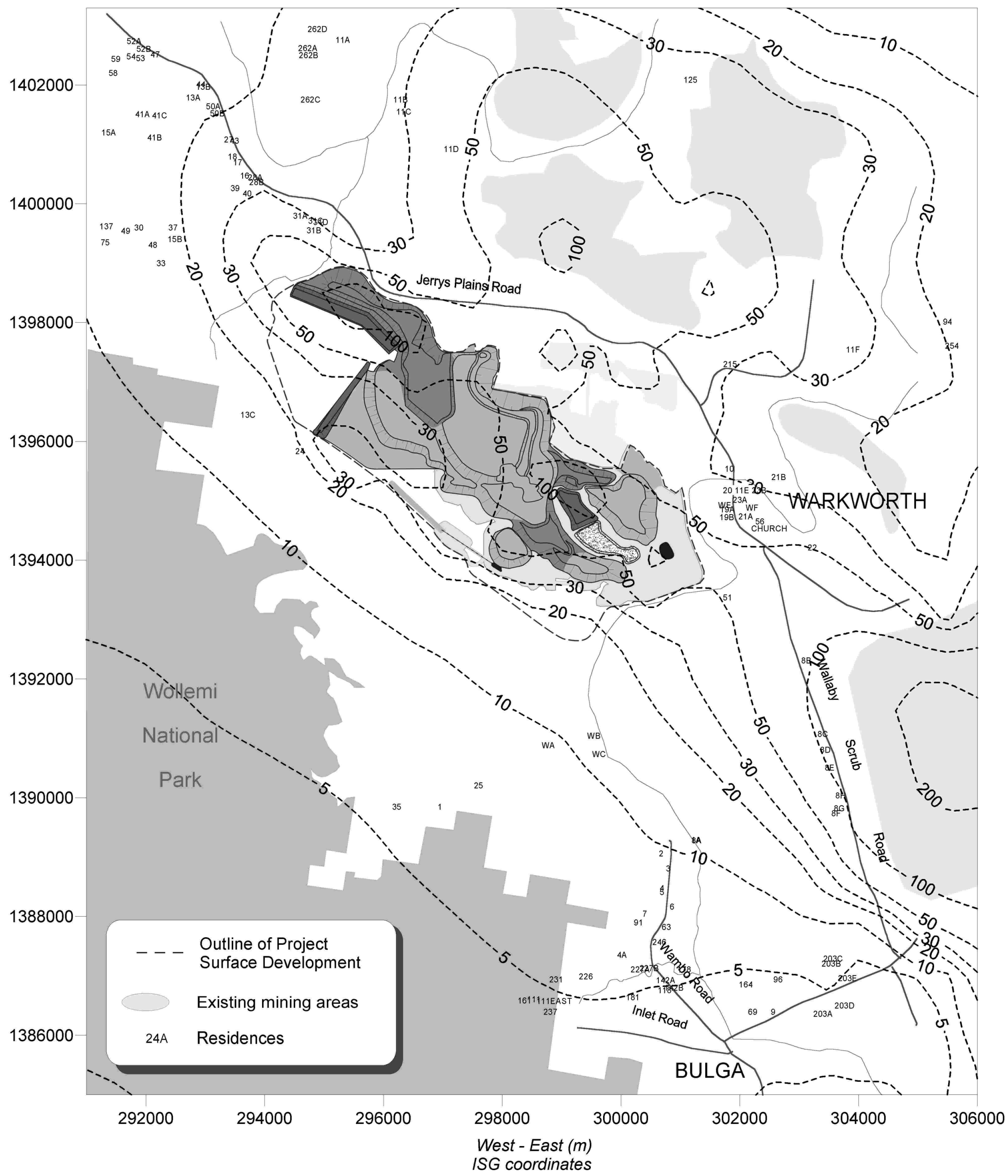
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project and other mines in Year 7 (µg/m^3)

FIGURE 16



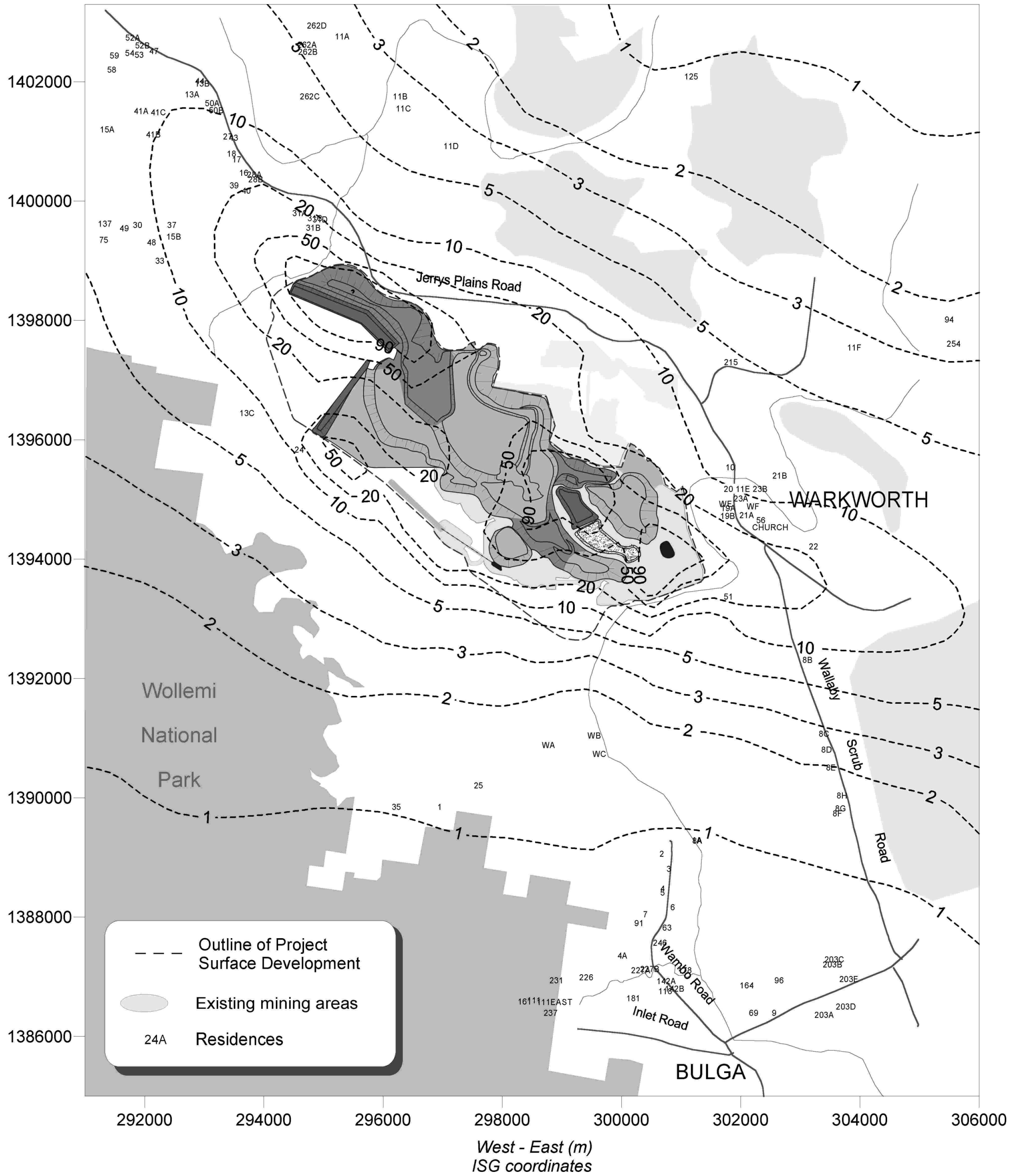
Predicted annual average PM_{10} concentrations due to emissions from the Project in Year 7 ($\mu g/m^3$)

FIGURE 17



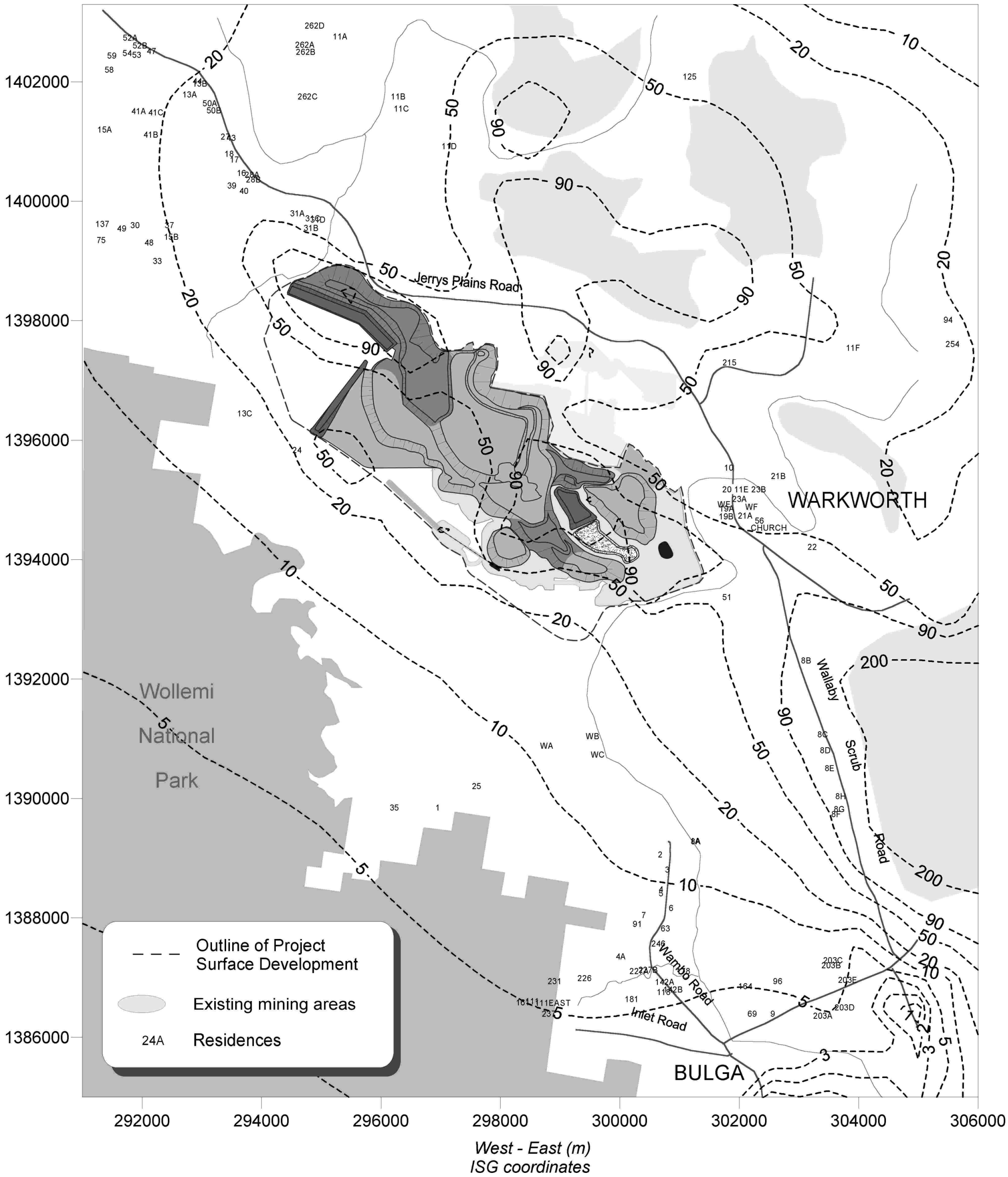
Predicted annual average PM_{10} concentrations due to emissions from the Project and other mines in Year 7 ($\mu g/m^3$)

FIGURE 18



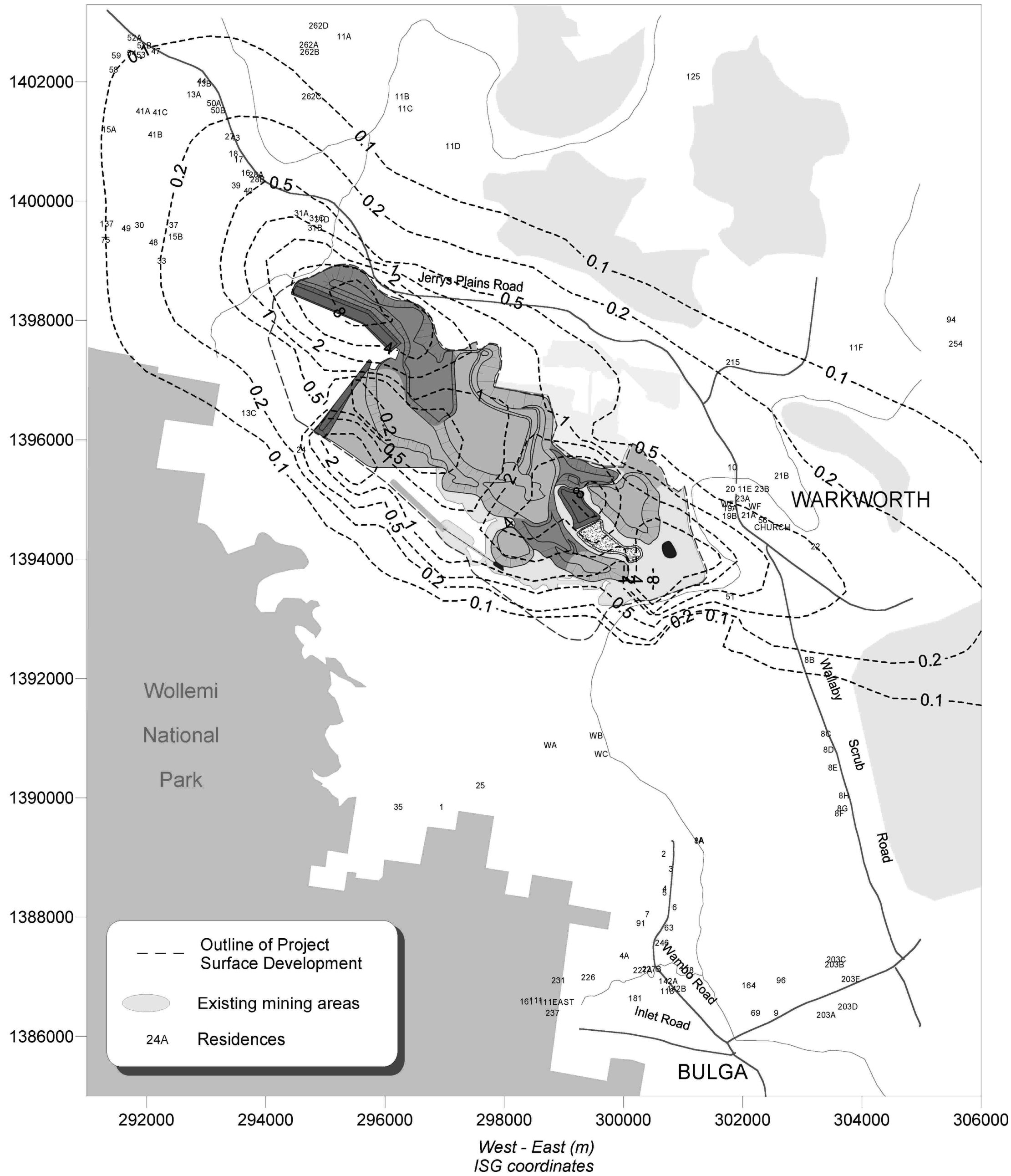
Predicted annual average TSP concentrations due to emissions from the Project in Year 7 (µg/m^3)

FIGURE 19



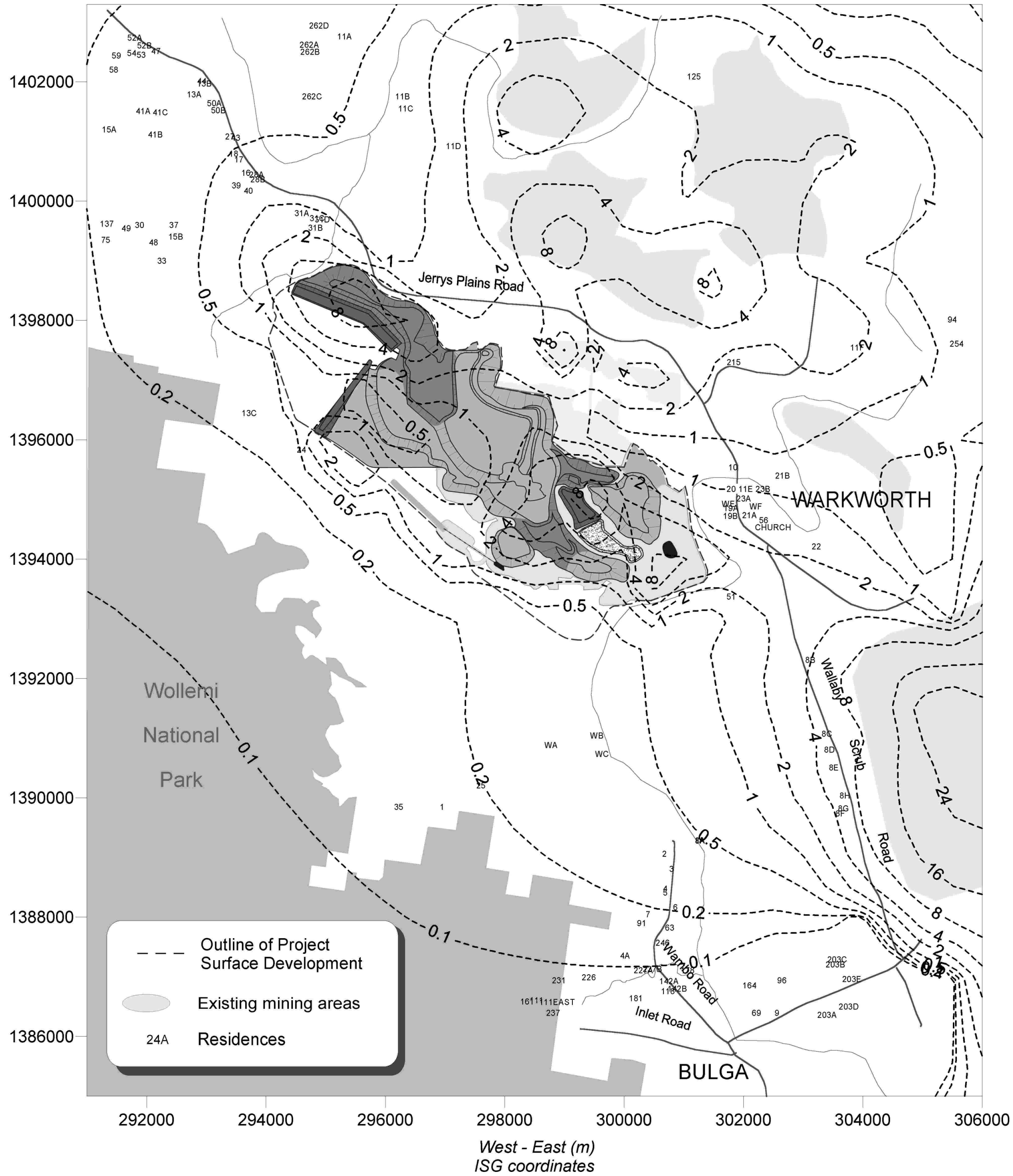
Predicted annual average TSP concentrations due to emissions from the Project and other mines in Year 7 (µg/m^3)

FIGURE 20



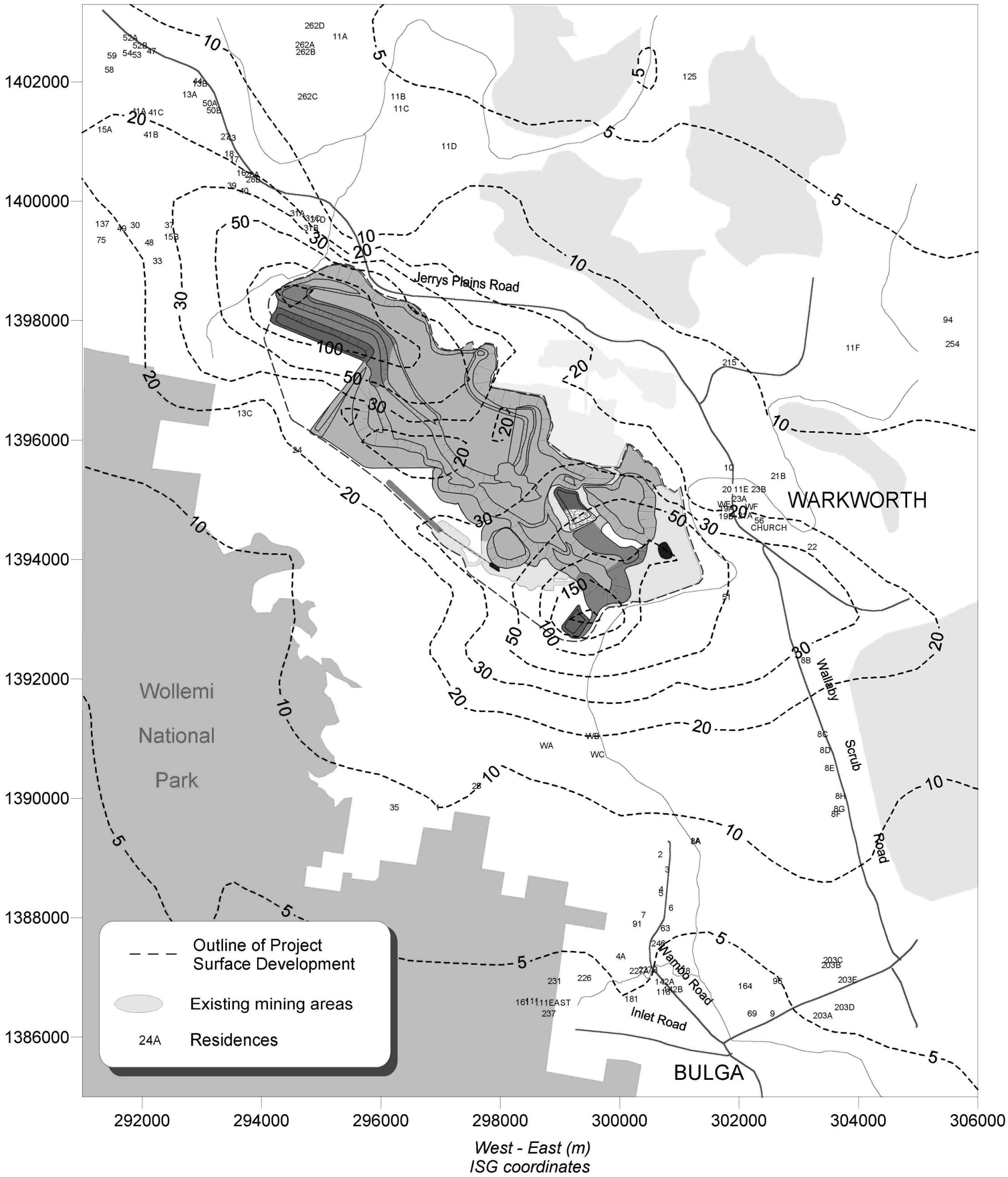
Predicted annual average dust deposition due to emissions from the Project in Year 7 (g/m^2/month)

FIGURE 21



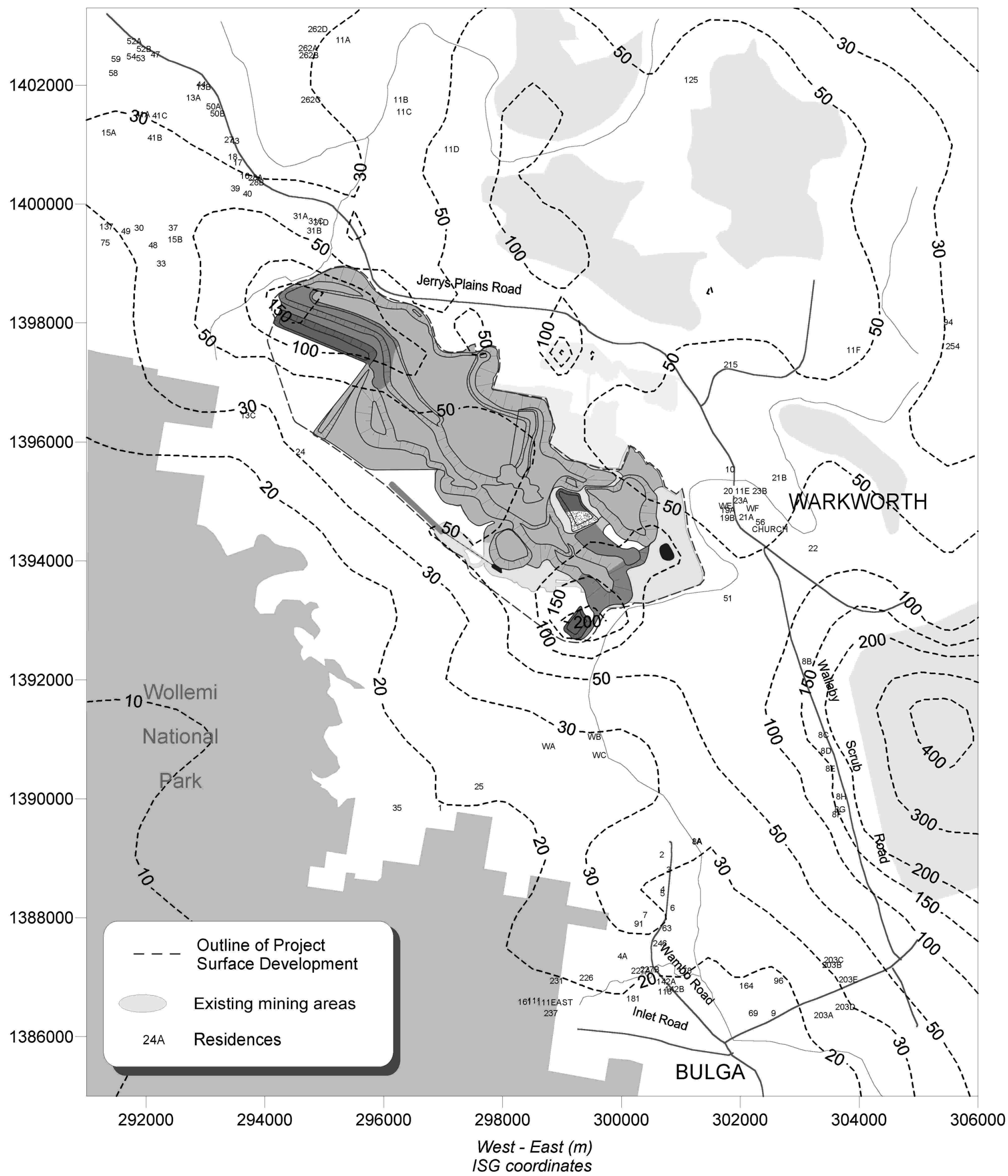
Predicted annual average dust deposition due to emissions from the Project and other mines in Year 7 (g/m²/month)

FIGURE 22



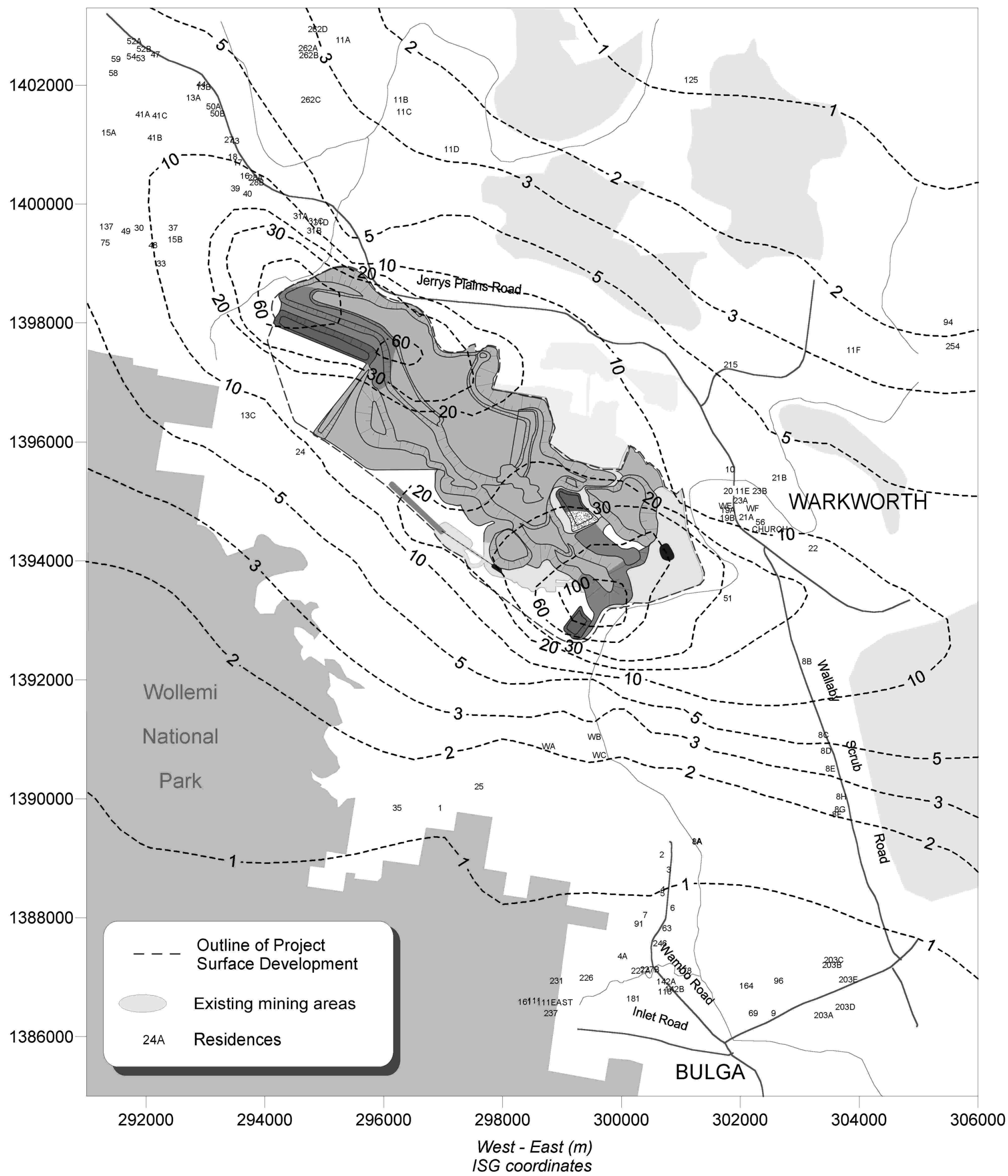
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project in Year 9 ($\mu g/m^3$)

FIGURE 23



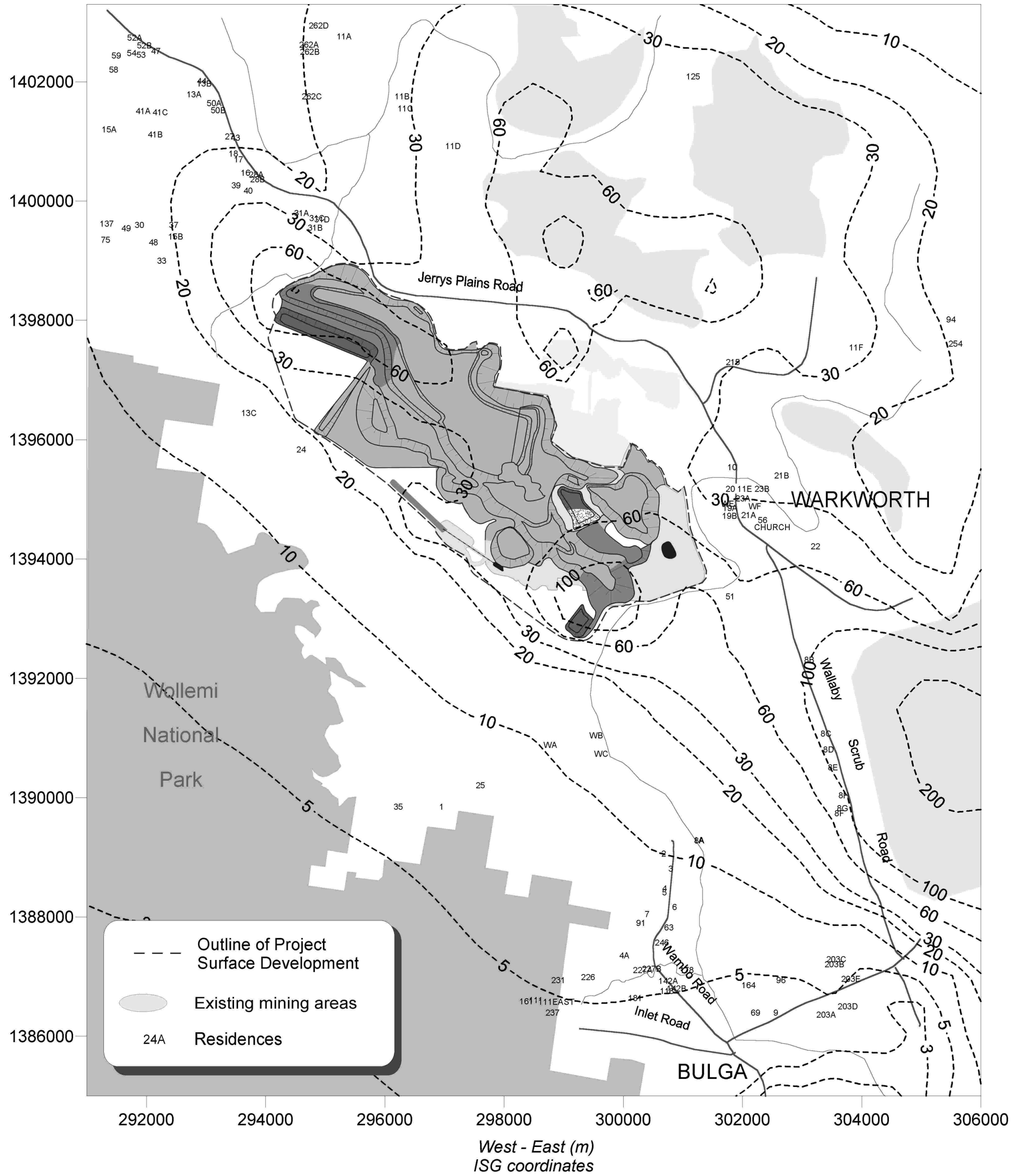
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the Project and other mines in Year 9 (µg/m^3)

FIGURE 24



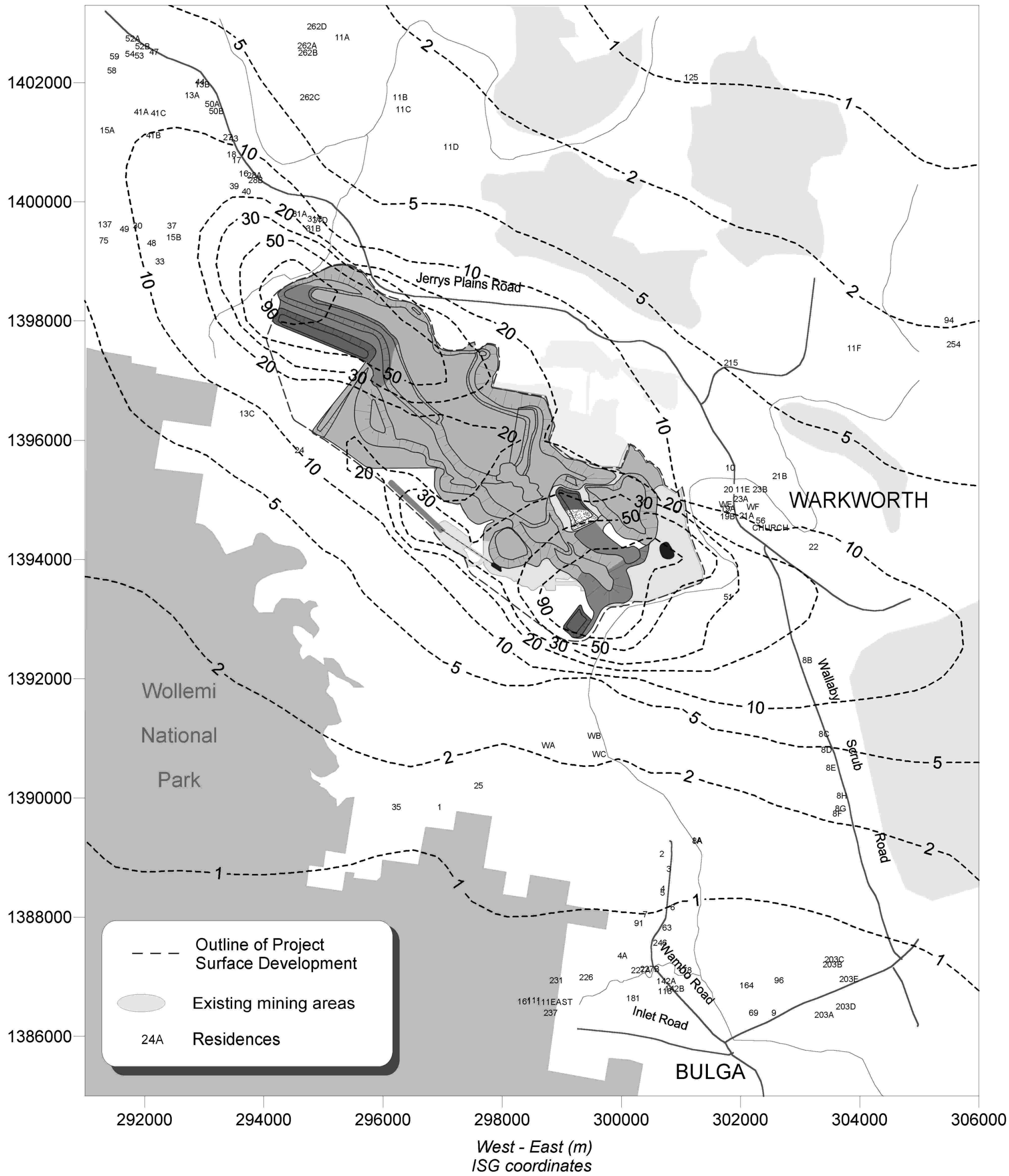
Predicted annual average PM_{10} concentrations due to emissions from the Project in Year 9 ($\mu g/m^3$)

FIGURE 25



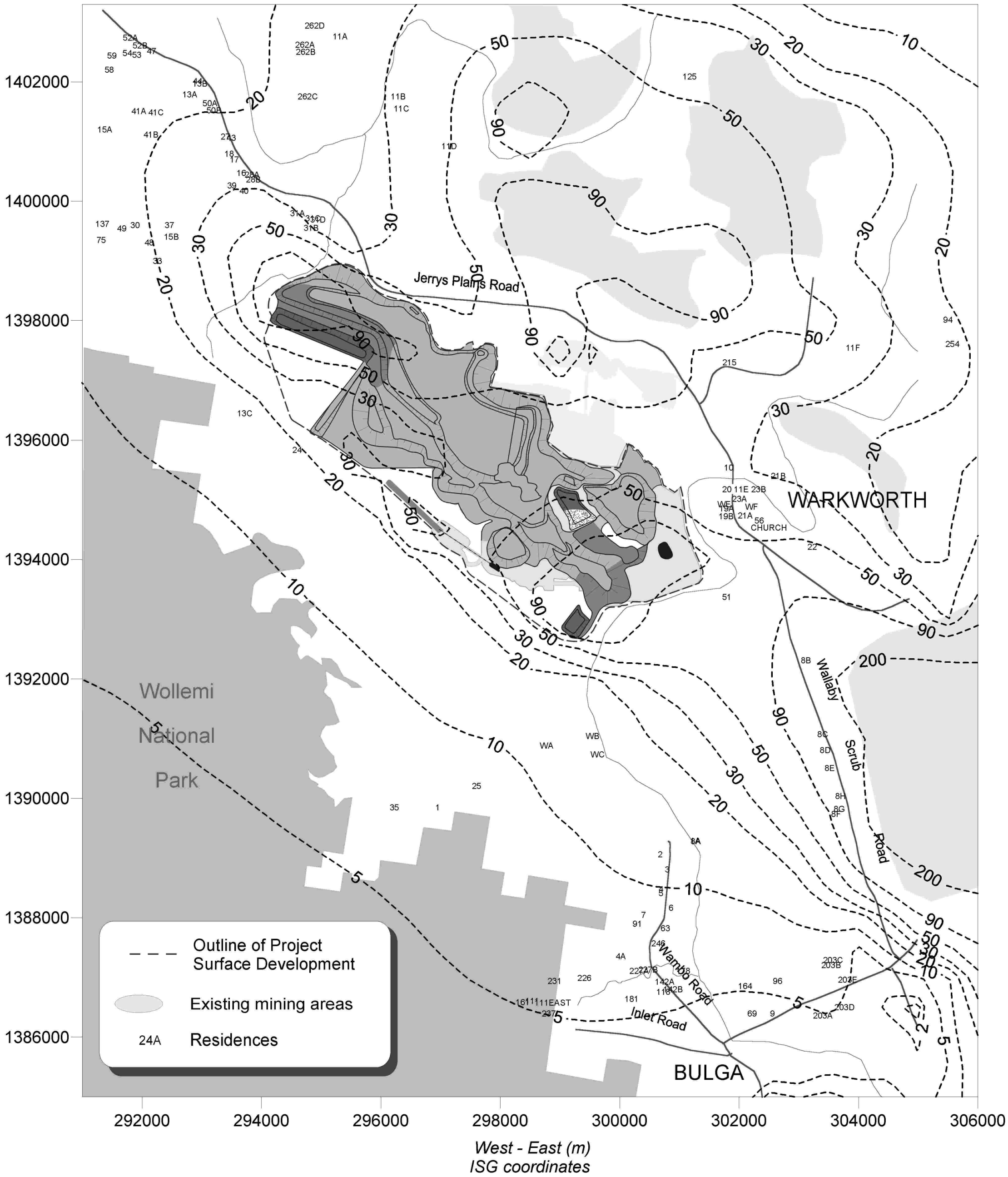
Predicted annual average PM_{10} concentrations due to emissions from the Project and other mines in Year 9 ($\mu g/m^3$)

FIGURE 26



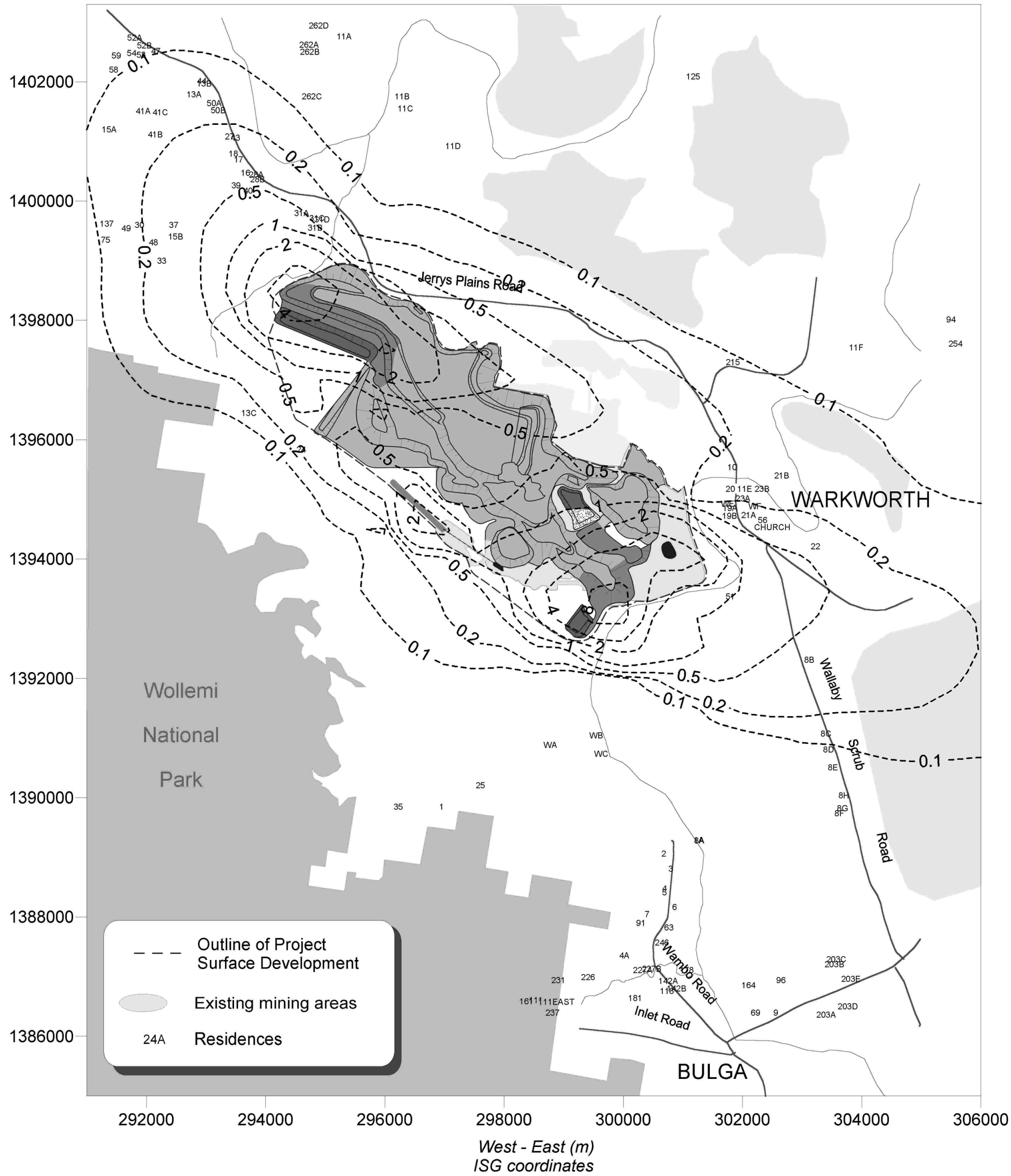
Predicted annual average TSP concentrations due to emissions from the Project in Year 9 (µg/m^3)

FIGURE 27



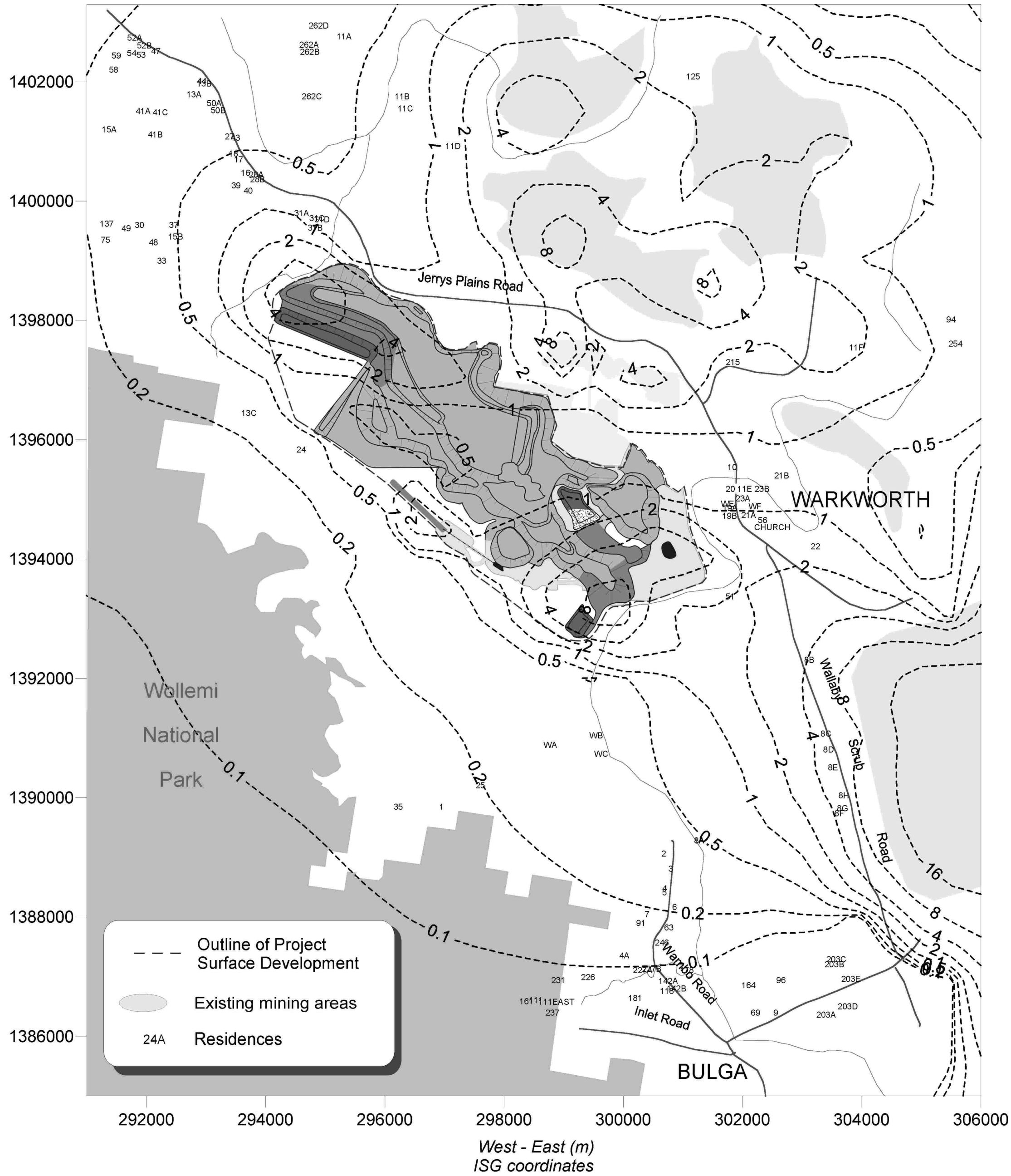
Predicted annual average TSP concentrations due to emissions from the Project and other mines in Year 9 ($\mu g/m^3$)

FIGURE 28



Predicted annual average dust deposition due to emissions from the Project in Year 9 (g/m²/month)

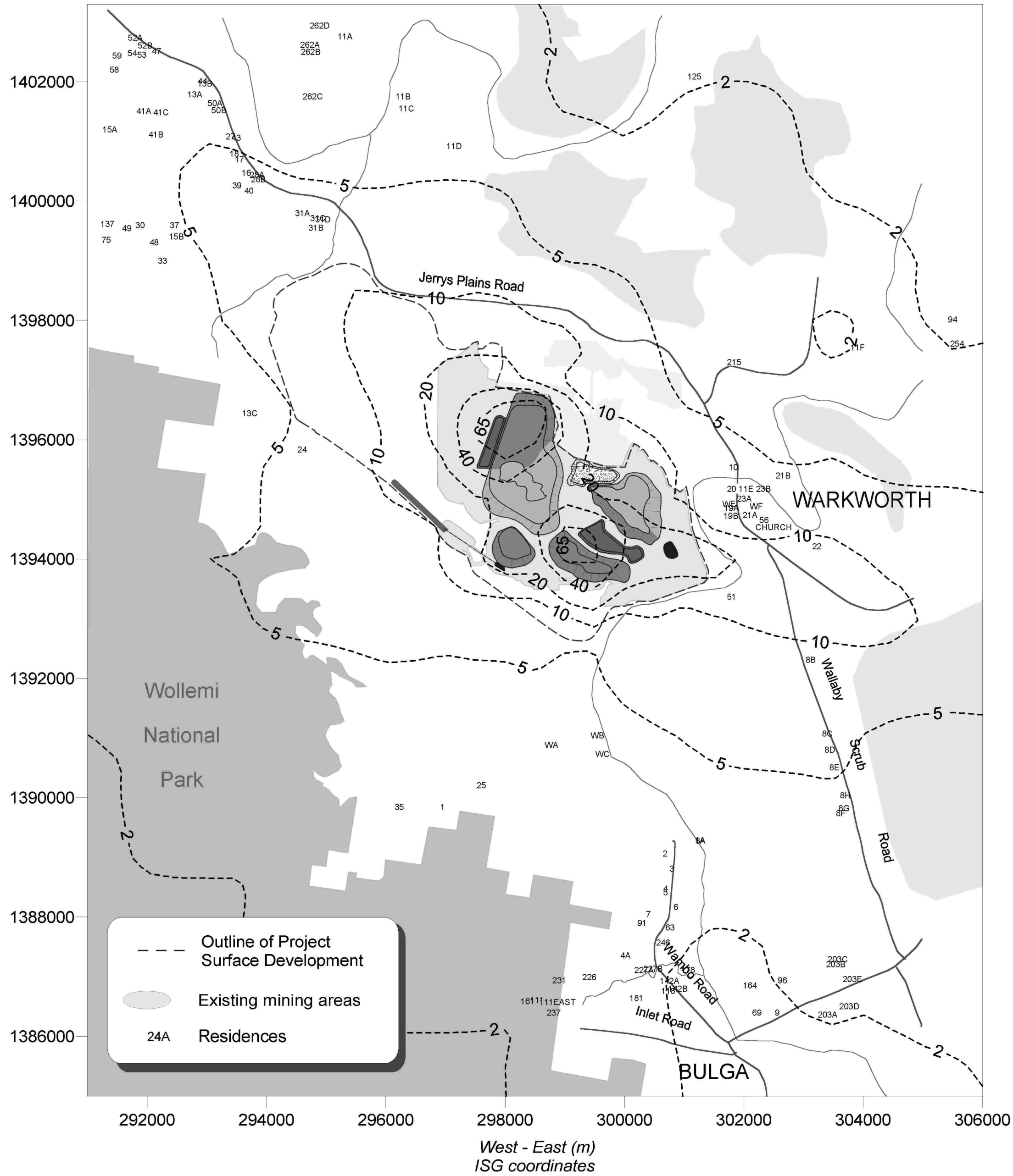
FIGURE 29



Predicted annual average dust deposition due to emissions from the Project and other mines in Year 9 (g/m²/month)

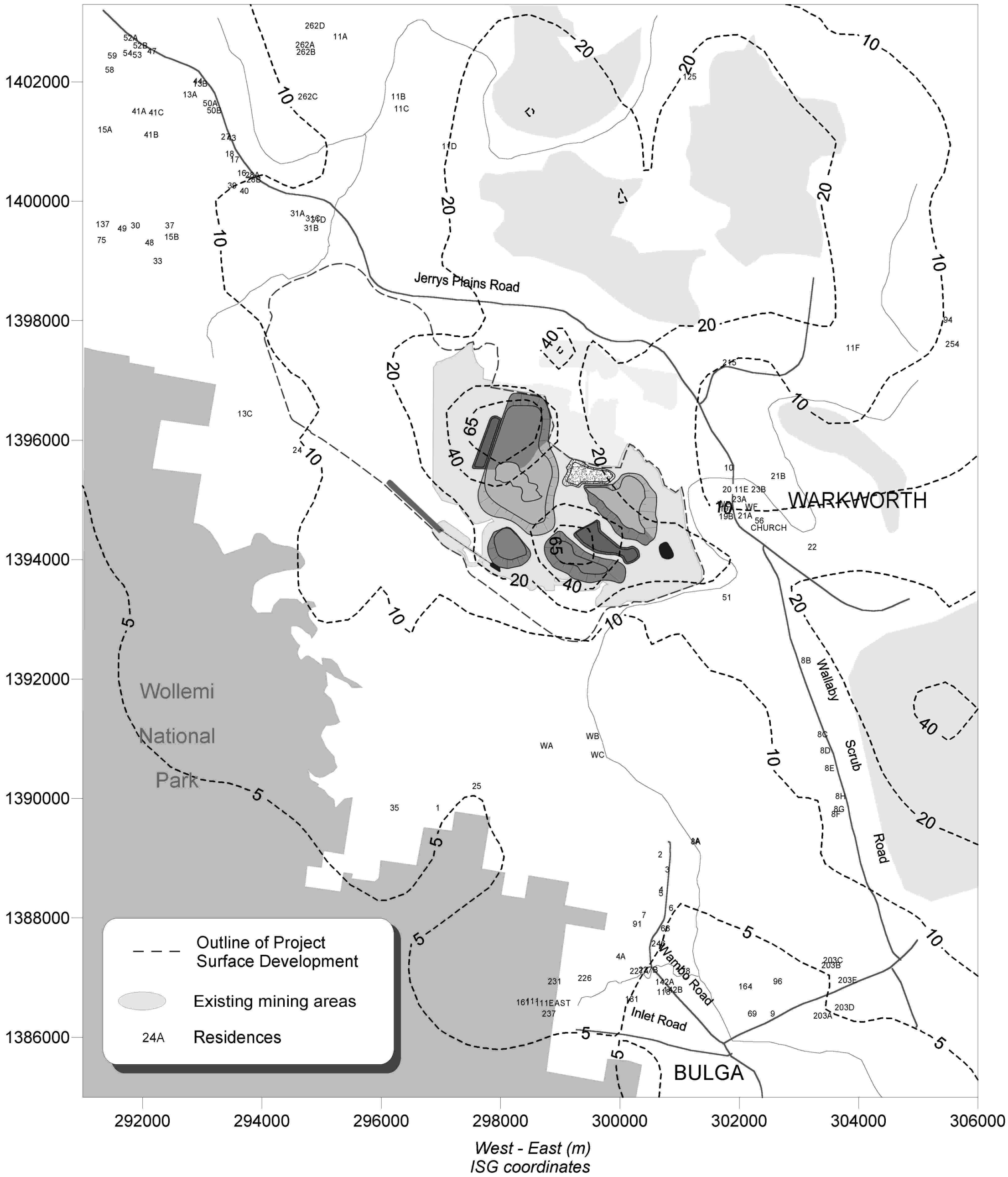
FIGURE 30

APPENDIX A
PREDICTED $PM_{2.5}$ CONCENTRATIONS



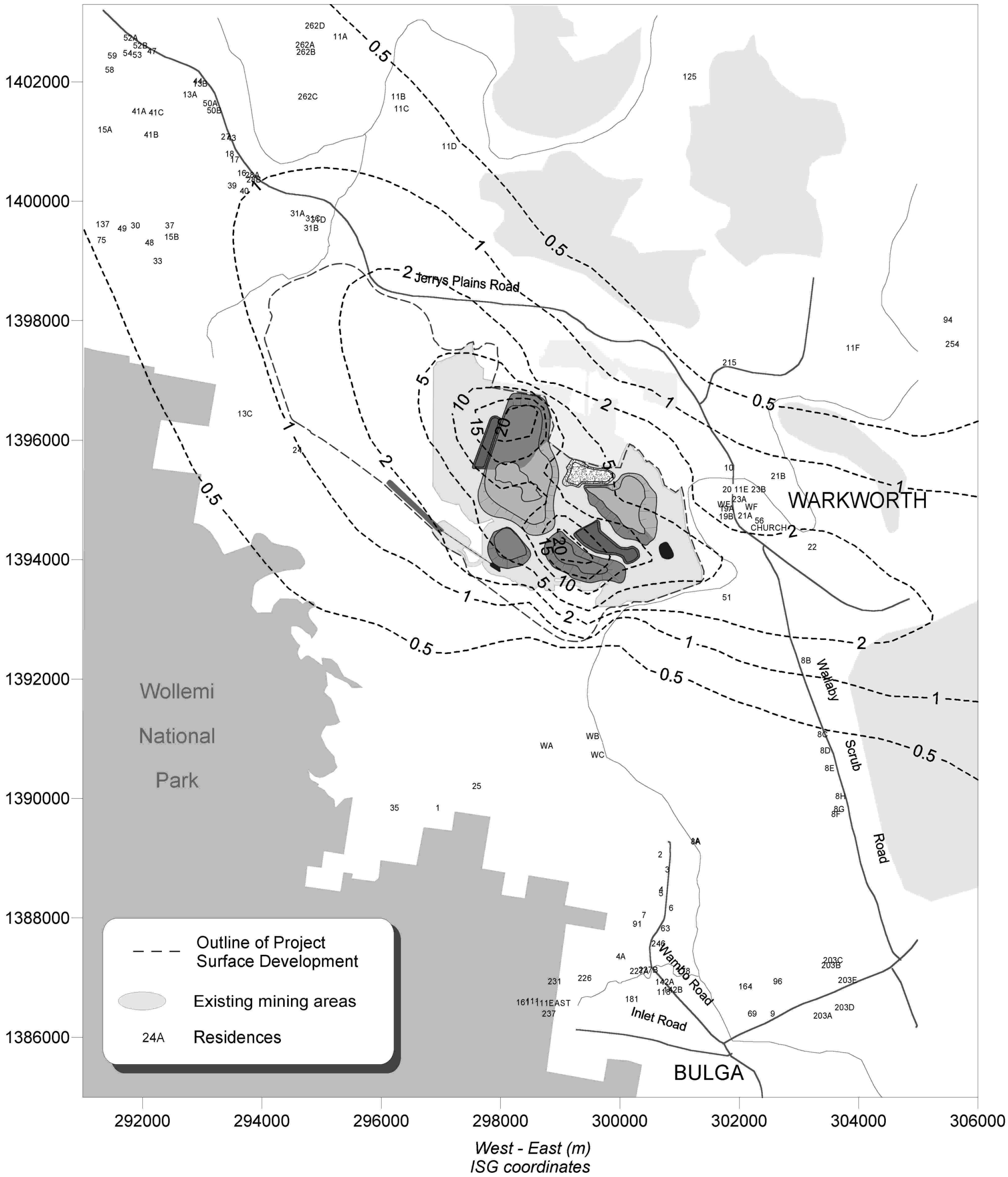
Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project in Year 2 ($\mu g/m^3$)

FIGURE A1



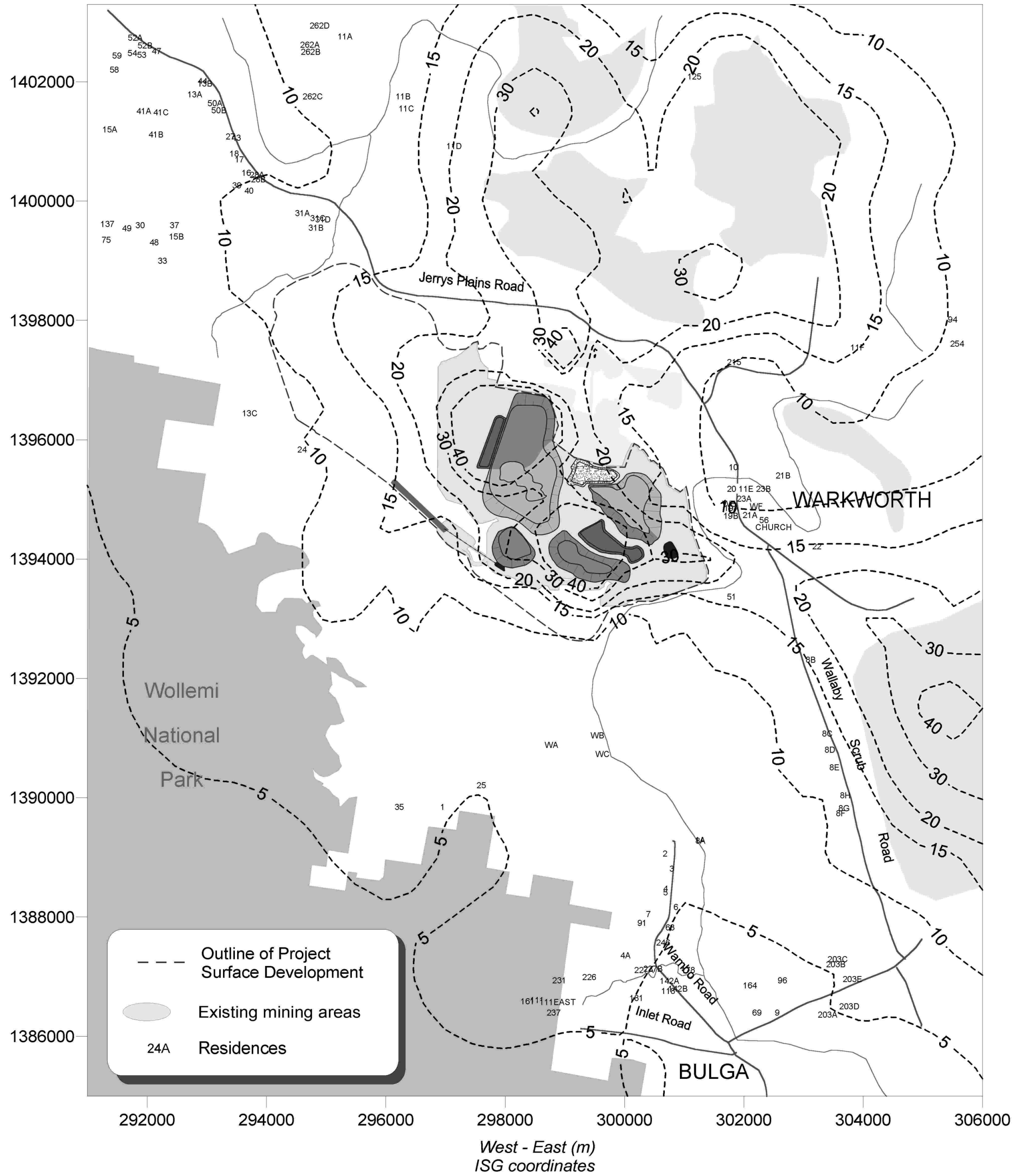
Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project and other mines in Year 2 ($\mu g/m^3$)

FIGURE A2



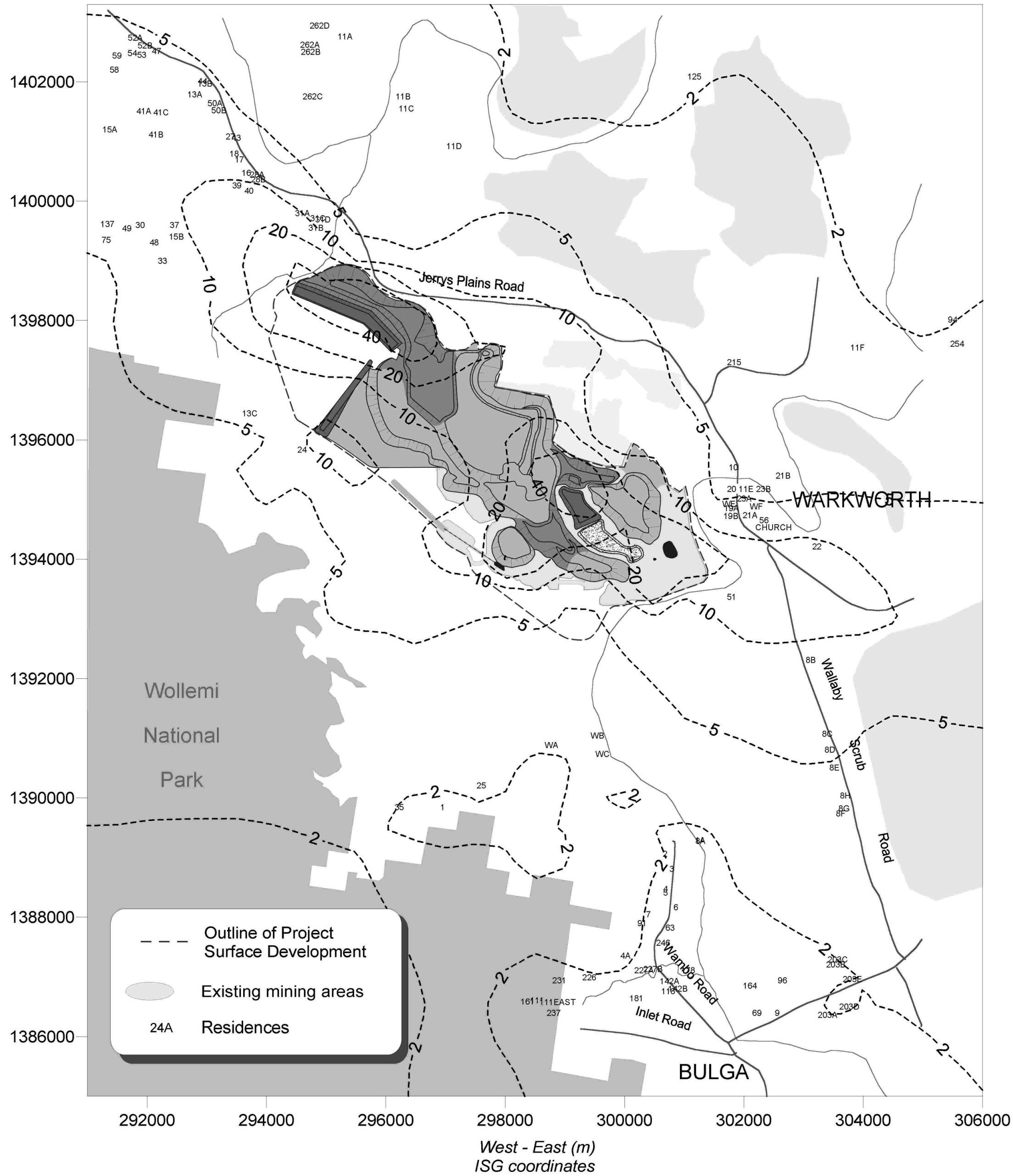
Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project in Year 2 ($\mu g/m^3$)

FIGURE A3



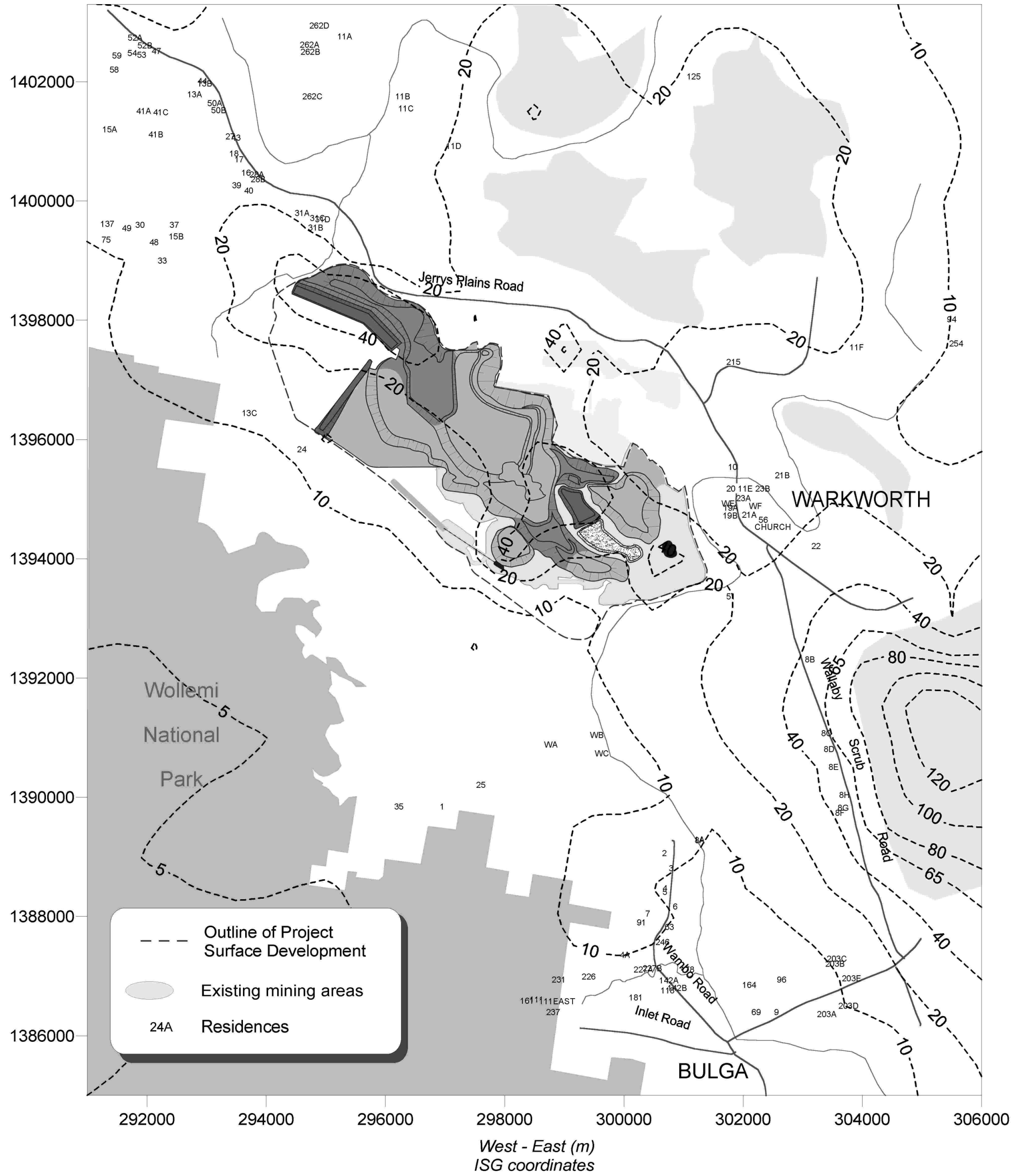
Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project and other mines in Year 2 ($\mu g/m^3$)

FIGURE A4



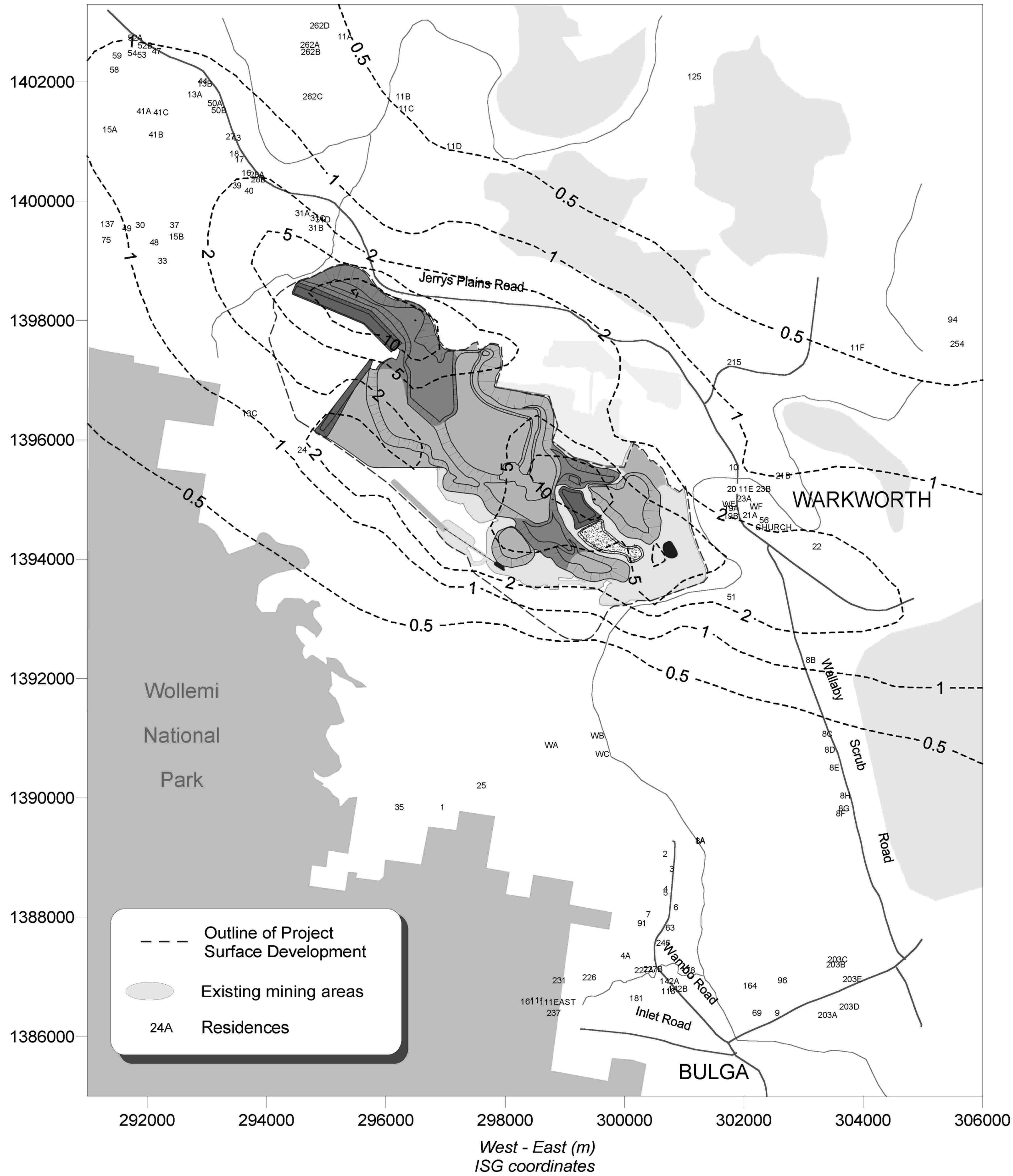
Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project in Year 7 ($\mu g/m^3$)

FIGURE A5



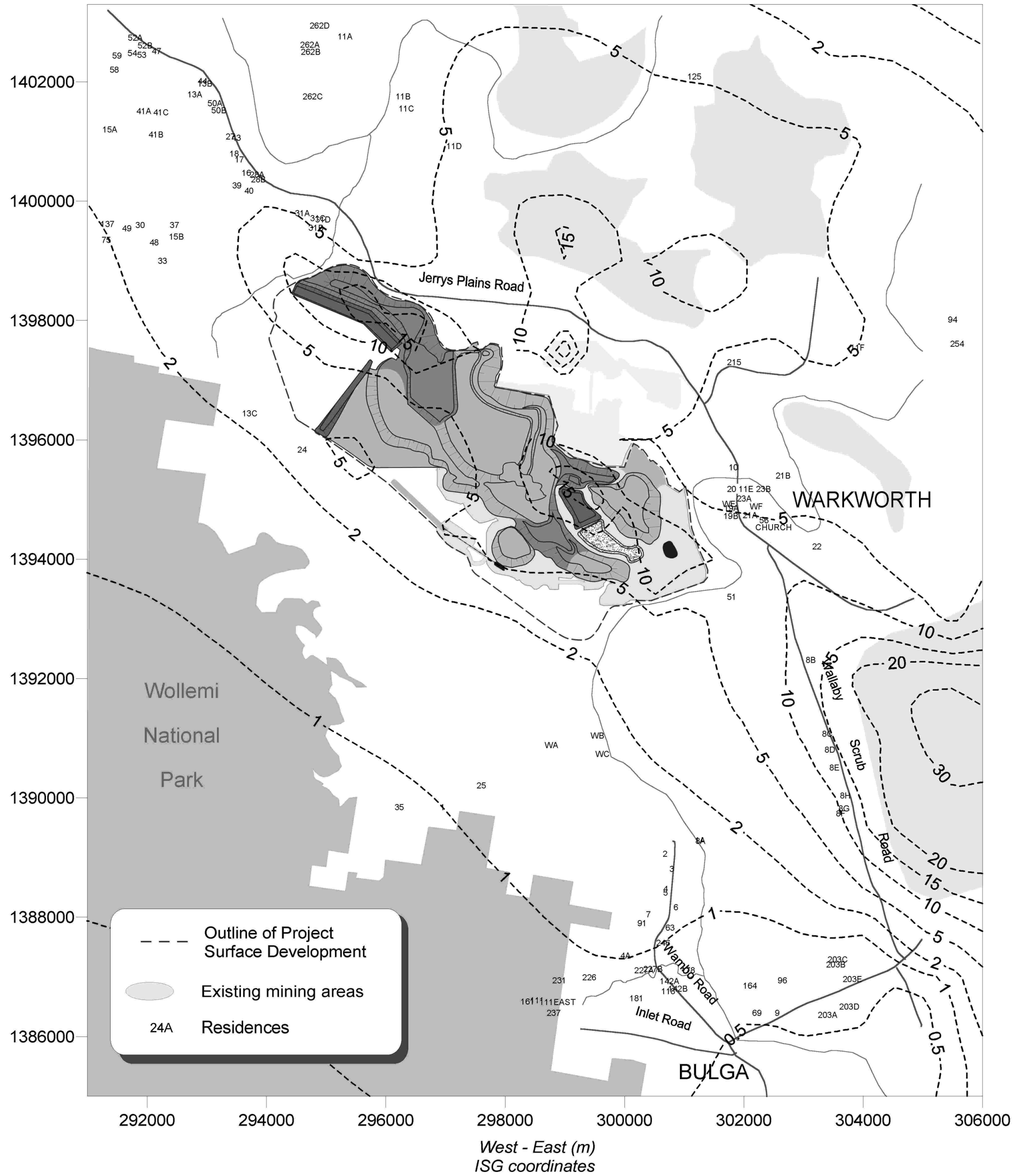
Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project and other mines in Year 7 ($\mu g/m^3$)

FIGURE A6



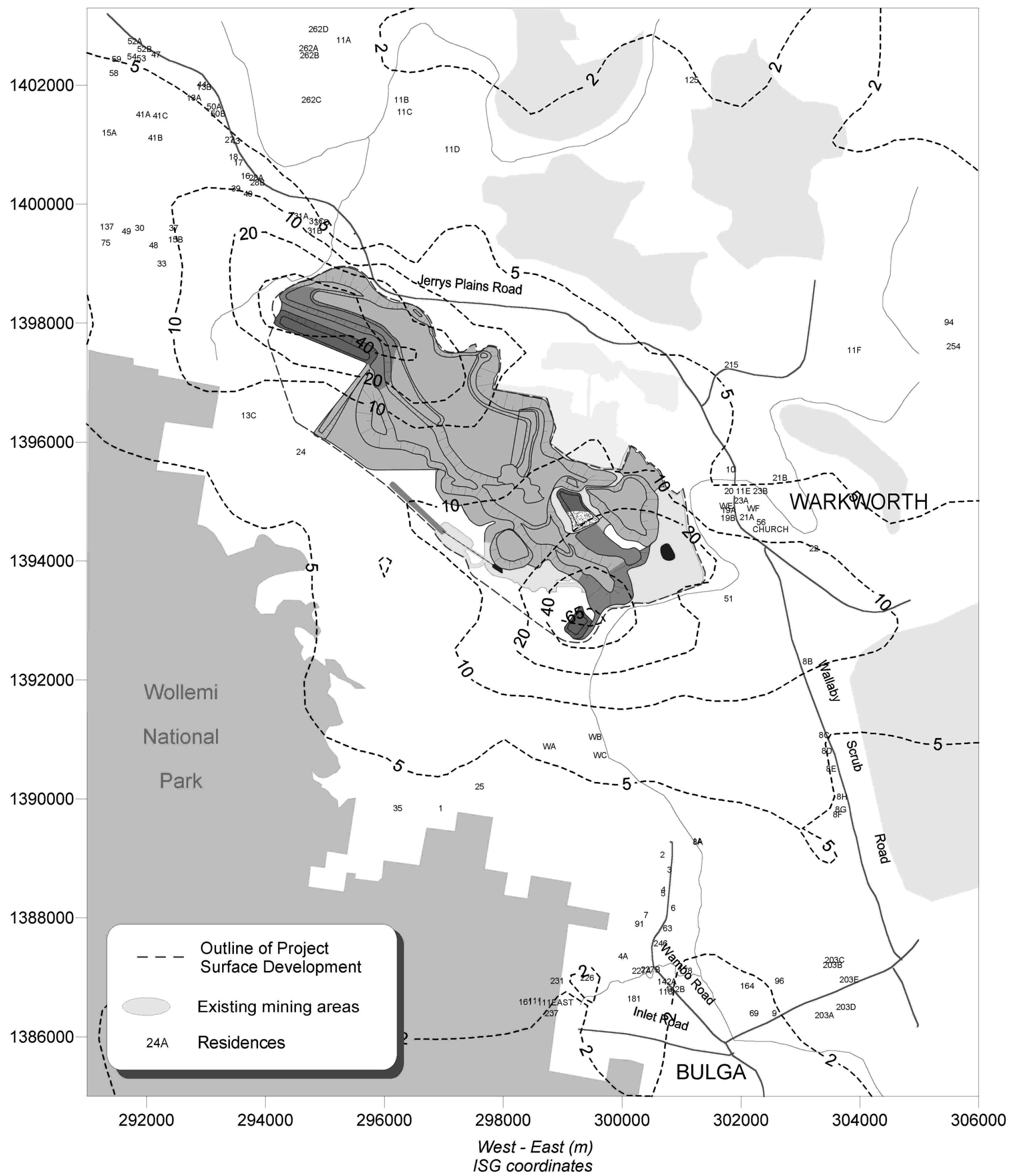
Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project in Year 7 ($\mu g/m^3$)

FIGURE A7



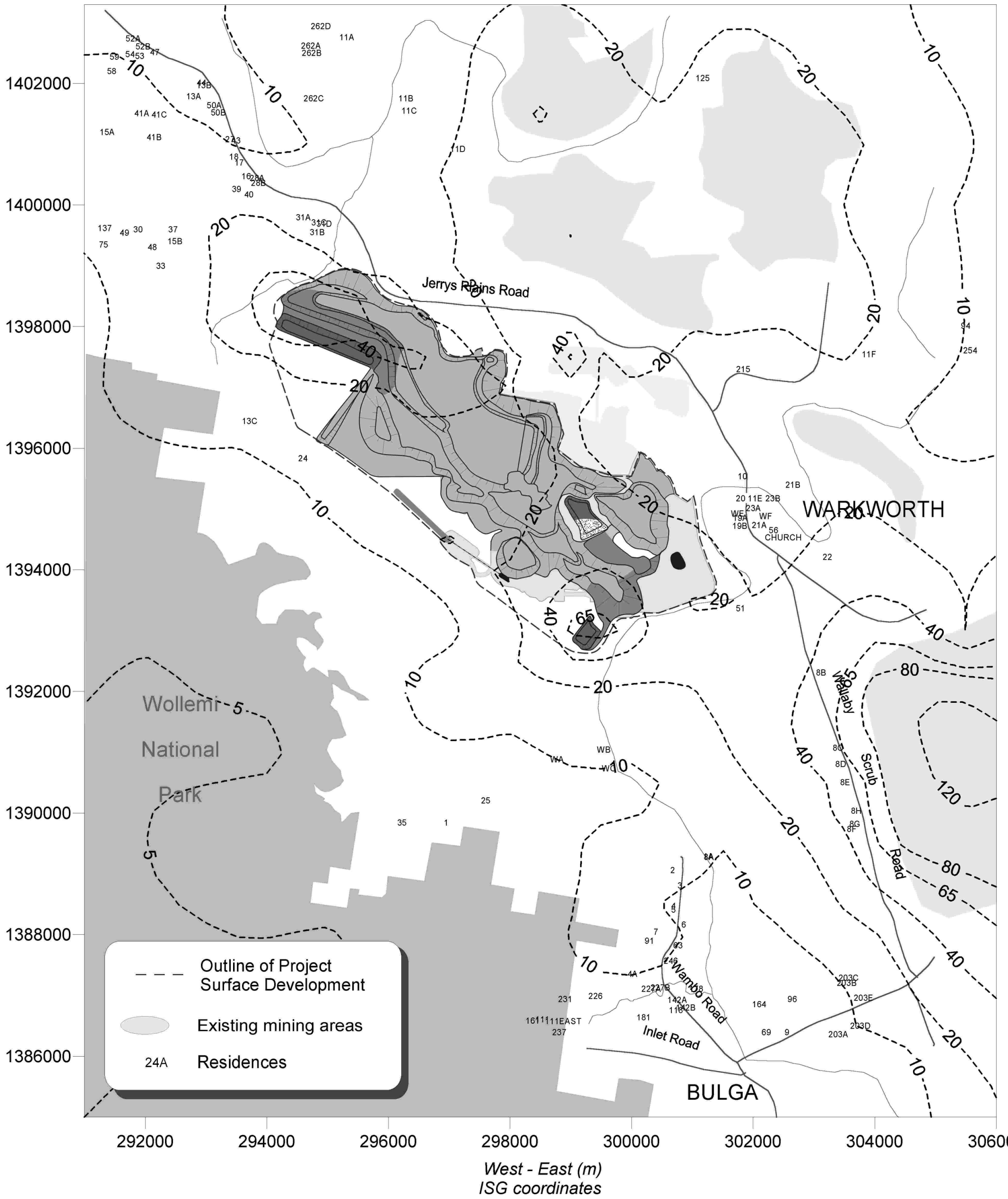
Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project and other mines in Year 7 ($\mu g/m^3$)

FIGURE A8



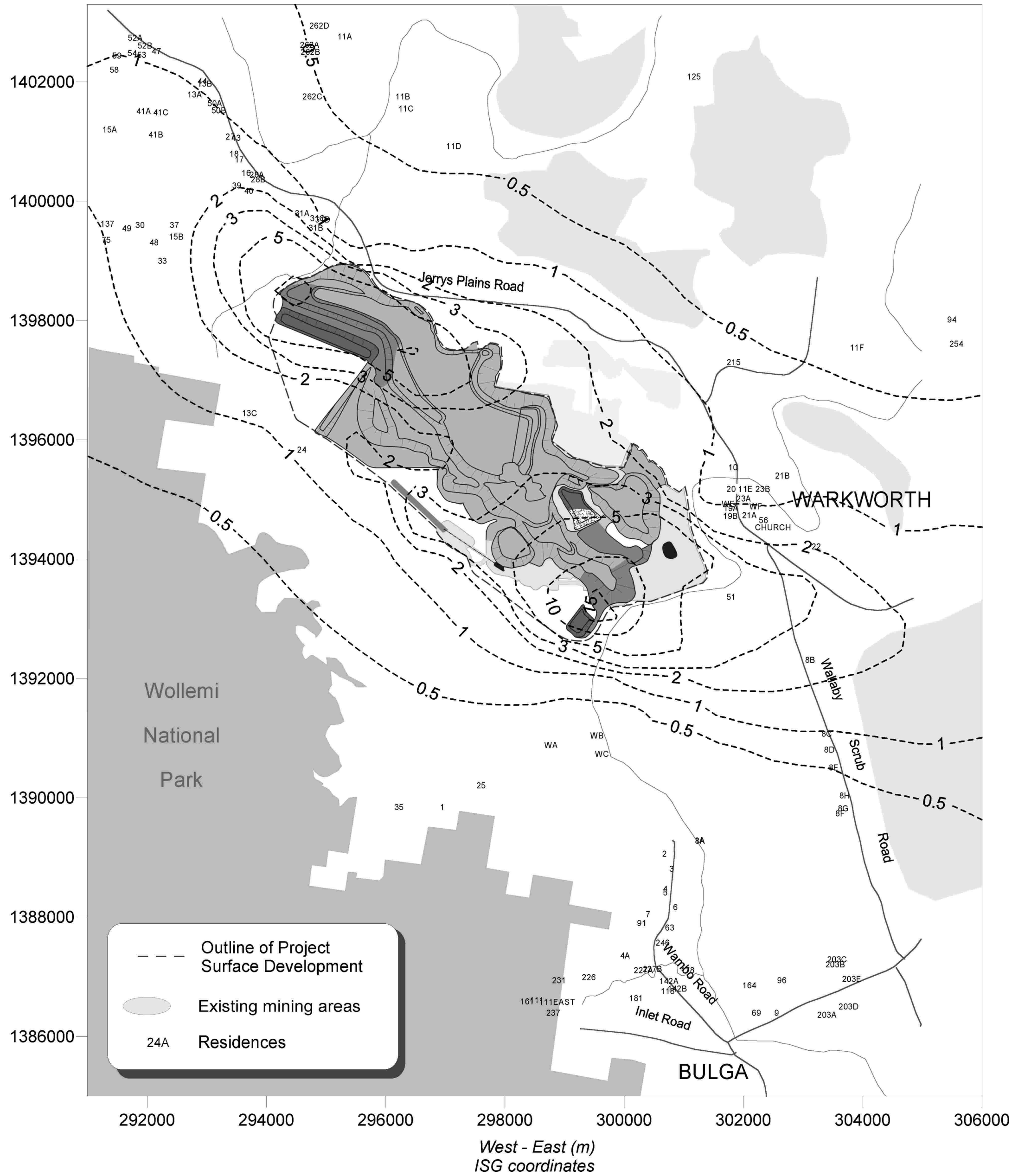
Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project in Year 9 ($\mu g/m^3$)

FIGURE A9



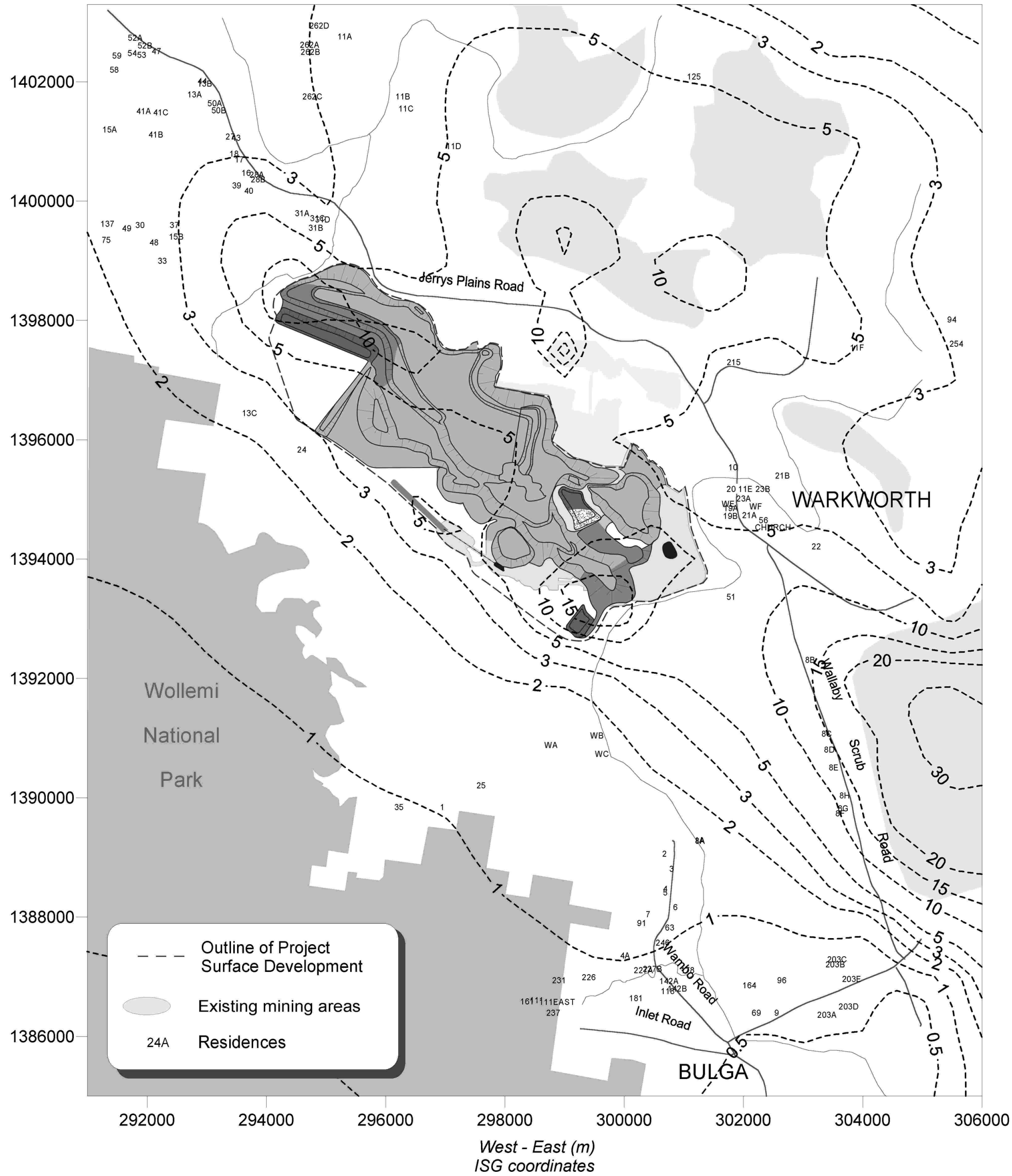
Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project and other mines in Year 9 ($\mu g/m^3$)

FIGURE A10



Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project in Year 9 ($\mu g/m^3$)

FIGURE A11



Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project and other mines in Year 9 ($\mu g/m^3$)

FIGURE A12

APPENDIX B
JOINT WIND SPEED, WIND DIRECTION AND STABILITY TABLES FOR WAMBO METEOROLOGICAL STATION FOR 1 JUNE 2001 TO 31 MAY 2002

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.51 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.009626	0.001872	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011497
NE	0.008155	0.005214	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.013369
ENE	0.013503	0.016845	0.006952	0.003209	0.000267	0.000000	0.000000	0.000000	0.040775
E	0.015775	0.028342	0.020588	0.007487	0.001070	0.000000	0.000000	0.000000	0.073262
ESE	0.026337	0.043984	0.013235	0.001738	0.000134	0.000000	0.000000	0.000000	0.085428
SE	0.037032	0.081016	0.018449	0.002406	0.000134	0.000000	0.000000	0.000000	0.139037
SSE	0.022995	0.048262	0.016578	0.004412	0.001604	0.000535	0.000134	0.000000	0.094519
S	0.010027	0.009759	0.004947	0.003476	0.000668	0.000000	0.000000	0.000000	0.028877
SSW	0.006551	0.002005	0.002807	0.001471	0.000000	0.000000	0.000000	0.000000	0.012834
SW	0.005615	0.002139	0.002540	0.001203	0.000267	0.000000	0.000000	0.000000	0.011765
WSW	0.014037	0.006684	0.006150	0.005615	0.003743	0.000802	0.000401	0.000134	0.037567
W	0.035294	0.038503	0.020722	0.016979	0.008824	0.003075	0.000668	0.000000	0.124064
WNW	0.043182	0.066310	0.071123	0.044118	0.015642	0.003209	0.000668	0.000000	0.244251
NW	0.013770	0.009225	0.002139	0.000000	0.000000	0.000000	0.000000	0.000000	0.025134
NNW	0.008957	0.001471	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010428
N	0.007353	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008289
CALM									0.038904
TOTAL	0.278209	0.362567	0.186230	0.092112	0.032353	0.007620	0.001872	0.000134	1.000000

MEAN WIND SPEED (m/s) = 2.54
NUMBER OF OBSERVATIONS = 7480

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 11.6%
B : 6.4%
C : 13.8%
D : 45.5%
E : 11.9%
F : 10.8%

STATISTICS FOR FILE: C:\Wambo\Met\wam01-02.isc
MONTHS: All
HOURS: All

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.51 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.005882	0.001337	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007219
NE	0.003743	0.002807	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006551
ENE	0.006150	0.006684	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012834
E	0.004545	0.006150	0.000401	0.000000	0.000000	0.000000	0.000000	0.000000	0.011096
ESE	0.003610	0.006016	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.009893
SE	0.002005	0.004011	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006016
SSE	0.000936	0.001738	0.000401	0.000000	0.000000	0.000000	0.000000	0.000000	0.003075
S	0.002273	0.001337	0.000134	0.000134	0.000000	0.000000	0.000000	0.000000	0.003877
SSW	0.000535	0.000535	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001070
SW	0.001203	0.000802	0.000000	0.000134	0.000000	0.000000	0.000000	0.000000	0.002139
WSW	0.001070	0.000535	0.000134	0.000267	0.000000	0.000000	0.000000	0.000000	0.002005
W	0.004545	0.001337	0.000535	0.000000	0.000000	0.000000	0.000000	0.000000	0.006417
WNW	0.007754	0.005882	0.001604	0.000000	0.000000	0.000000	0.000000	0.000000	0.015241
NW	0.006684	0.004144	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.011096
NNW	0.005214	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006150
N	0.004144	0.000535	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004679
CALM									0.006283
TOTAL	0.060294	0.044786	0.003743	0.000535	0.000000	0.000000	0.000000	0.000000	0.115642

MEAN WIND SPEED (m/s) = 1.49
NUMBER OF OBSERVATIONS = 865

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.51 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000535	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000668
NE	0.000401	0.000535	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000936
ENE	0.000668	0.003209	0.000936	0.000134	0.000000	0.000000	0.000000	0.000000	0.004947
E	0.001203	0.007219	0.003610	0.000000	0.000000	0.000000	0.000000	0.000000	0.012032
ESE	0.000535	0.007487	0.001604	0.000000	0.000000	0.000000	0.000000	0.000000	0.009626
SE	0.001337	0.004144	0.001203	0.000000	0.000000	0.000000	0.000000	0.000000	0.006684
SSE	0.000134	0.000802	0.000668	0.000000	0.000000	0.000000	0.000000	0.000000	0.001604
S	0.000134	0.000936	0.000668	0.000000	0.000000	0.000000	0.000000	0.000000	0.001738
SSW	0.000000	0.000000	0.000134	0.000134	0.000000	0.000000	0.000000	0.000000	0.000267
SW	0.000134	0.000267	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.000668
WSW	0.000267	0.000267	0.000802	0.000802	0.000000	0.000000	0.000000	0.000000	0.002139
W	0.002540	0.001738	0.002005	0.001471	0.000000	0.000000	0.000000	0.000000	0.007754
WNW	0.002406	0.004947	0.004144	0.000936	0.000000	0.000000	0.000000	0.000000	0.012433
NW	0.000668	0.000535	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.001471
NNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
N	0.000134	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000267
CALM									0.000936
TOTAL	0.011096	0.032353	0.016310	0.003476	0.000000	0.000000	0.000000	0.000000	0.064171

MEAN WIND SPEED (m/s) = 2.53
NUMBER OF OBSERVATIONS = 480

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.51 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000401	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000401
NE	0.000134	0.000401	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000535
ENE	0.000936	0.000535	0.002273	0.002005	0.000000	0.000000	0.000000	0.000000	0.005749
E	0.000401	0.003476	0.006283	0.003075	0.000000	0.000000	0.000000	0.000000	0.013235
ESE	0.002273	0.005214	0.003743	0.000802	0.000000	0.000000	0.000000	0.000000	0.012032
SE	0.001604	0.008556	0.006952	0.001471	0.000000	0.000000	0.000000	0.000000	0.018583
SSE	0.000535	0.002807	0.005214	0.002273	0.000000	0.000000	0.000000	0.000000	0.010829
S	0.000000	0.000668	0.001203	0.001471	0.000000	0.000000	0.000000	0.000000	0.003342
SSW	0.000000	0.000134	0.000668	0.000267	0.000000	0.000000	0.000000	0.000000	0.001070
SW	0.000134	0.000134	0.000535	0.000267	0.000000	0.000000	0.000000	0.000000	0.001070
WSW	0.000802	0.000267	0.001337	0.002941	0.000000	0.000000	0.000000	0.000000	0.005348
W	0.001738	0.006016	0.005214	0.008957	0.000000	0.000000	0.000000	0.000000	0.021925
WNW	0.002540	0.007353	0.017246	0.014706	0.000000	0.000000	0.000000	0.000000	0.041845
NW	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000134
NNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
N	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000134
CALM									0.001872
TOTAL	0.011765	0.035561	0.050668	0.038235	0.000000	0.000000	0.000000	0.000000	0.138102

MEAN WIND SPEED (m/s) = 3.50
NUMBER OF OBSERVATIONS = 1033

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.51 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000134	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000267
NE	0.000267	0.000535	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000802
ENE	0.001203	0.003610	0.003476	0.001070	0.000267	0.000000	0.000000	0.000000	0.009626
E	0.004545	0.007888	0.010294	0.004412	0.001070	0.000000	0.000000	0.000000	0.028209
ESE	0.012834	0.019519	0.007620	0.000936	0.000134	0.000000	0.000000	0.000000	0.041043
SE	0.019519	0.054947	0.010294	0.000936	0.000134	0.000000	0.000000	0.000000	0.085829
SSE	0.010160	0.034225	0.010294	0.002139	0.001604	0.000535	0.000134	0.000000	0.059091
S	0.002139	0.003743	0.002941	0.001872	0.000668	0.000000	0.000000	0.000000	0.011364
SSW	0.002139	0.000134	0.001872	0.001070	0.000000	0.000000	0.000000	0.000000	0.005214
SW	0.000936	0.000401	0.001738	0.000802	0.000267	0.000000	0.000000	0.000000	0.004144
WSW	0.003075	0.003075	0.003877	0.001604	0.003743	0.000802	0.000401	0.000134	0.016711
W	0.009091	0.016979	0.012701	0.006417	0.008824	0.003075	0.000668	0.000000	0.057754
WNW	0.005615	0.027139	0.046524	0.027941	0.015642	0.003209	0.000668	0.000000	0.126738
NW	0.000267	0.000401	0.001604	0.000000	0.000000	0.000000	0.000000	0.000000	0.002273
NNW	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000134
N	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALM									0.005615
TOTAL	0.072059	0.172727	0.113235	0.049198	0.032353	0.007620	0.001872	0.000134	0.454813

MEAN WIND SPEED (m/s) = 3.14
NUMBER OF OBSERVATIONS = 3402

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.51 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000134	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000267
NE	0.000802	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001070
ENE	0.001738	0.001738	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.003743
E	0.002273	0.003075	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005348
ESE	0.003342	0.005749	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009091
SE	0.007353	0.008422	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.015775
SSE	0.007487	0.008021	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.015508
S	0.003877	0.002139	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006016
SSW	0.001337	0.000668	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.002139
SW	0.000401	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000668
WSW	0.003075	0.001471	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004545
W	0.008824	0.008289	0.000267	0.000134	0.000000	0.000000	0.000000	0.000000	0.017513
WNW	0.009759	0.014305	0.001604	0.000535	0.000000	0.000000	0.000000	0.000000	0.026203
NW	0.001203	0.000802	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002005
NNW	0.000802	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000936
N	0.000134	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000401
CALM									0.007754
TOTAL	0.052540	0.055749	0.002273	0.000668	0.000000	0.000000	0.000000	0.000000	0.118984

MEAN WIND SPEED (m/s) = 1.51
NUMBER OF OBSERVATIONS = 890

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.51 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002540	0.000134	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002674
NE	0.002807	0.000668	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003476
ENE	0.002807	0.001070	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003877
E	0.002807	0.000535	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003342
ESE	0.003743	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003743
SE	0.005214	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006150
SSE	0.003743	0.000668	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004412
S	0.001604	0.000936	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002540
SSW	0.002540	0.000535	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003075
SW	0.002807	0.000267	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003075
WSW	0.005749	0.001070	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006818
W	0.008556	0.004144	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012701
WNW	0.015107	0.006684	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.021791
NW	0.004813	0.003342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008155
NNW	0.002807	0.000401	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003209
N	0.002807	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002807
CALM									0.016444
TOTAL	0.070455	0.021390	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.108289

MEAN WIND SPEED (m/s) = 1.07
NUMBER OF OBSERVATIONS = 810

APPENDIX C
WAMBO MINE – ESTIMATING DUST EMISSIONS AND OTHER TECHNICAL DATA

WAMBO OPEN CUT AND UNDERGROUND MINE OPERATIONS – ESTIMATED DUST EMISSIONS IN YEAR 2

Introduction

This appendix provides information on the way in which estimates of TSP emissions for Year 2 have been made.

Calculations are presented to an apparent accuracy of ±1 kg. There may appear to be minor discrepancies in the calculations – less than a fraction of 1%. These are due to rounding errors that arise because the emission factors displayed in the text of this appendix are not shown to the same precision as the emission factors actually used in the spreadsheets when the calculations are done.

For example, in the estimate of TSP emissions from loading overburden to trucks in the Northwest Pit (see below) it is stated that the activity will produce 88,115 kg/y of TSP [56,810,000 t/y x 0.00155 kg/t]. Checking this formula using the printed figures gives an estimate of 88,055 kg/y. However if the emission factor is written to greater precision eg (0.00155104 kg/t) the estimate becomes 88,114.6 kg/y, which then is written as 88,115 kg/y.

It is not intended to suggest the actual emissions can be estimated to the level of precision used in the calculations. The accuracy of individual estimates is not known precisely but validation tests performed in 1984 (**Dames & Moore, 1984**) indicate that model predictions of annual average dust deposition rates can be estimated with sufficient accuracy so that 80% of predicted annual average deposition rates lie within ±40% of the measured deposition value. This provides an indication as to the overall accuracy of the modelling system. It includes the effects of errors in the estimated emissions, the potential errors introduced by uncertainties in meteorological conditions and the dispersion modelling process.

In Year 2 mining will be taking place in the Southeast and Northwest Pits, which will collectively produce approximately 6,800,000 t of ROM coal. Underground mining will produce approximately 400,000 t of ROM coal.

Overburden will be drilled and blasted and then removed by truck and shovel.

Open cut ROM coal will be hauled by 150 t trucks to the ROM stockpile located near the CHPP and will then be transferred to the CHPP. Product coal will be stockpiled near the CHPP and transferred to the rail loading bin by conveyor.

Underground coal from the Wollemi mine will be transferred from the mine by conveyor and stacked onto stockpiles located near the underground portal and then transferred to the CHPP by 140 t B-Double trucks

The following sections describe each activity in the mining and coal handling processes that are likely to generate dust and provides estimates of the quantity of dust generated.

OPERATIONS ON OVERBURDEN

Stripping topsoil
Stripping topsoil will generate dust at the rate of approximately 14 kg/h (**SPCC, 1983**). Assuming that stripping topsoil takes approximately 640 h/y in each pit then the annual TSP emission rate will be 8,960 kg/y [640 h x 14.0 kg/ha/h] in both the Northwest and Southeast pits.

Drilling overburden
It is estimated that in Year 2, that 52,660 and 41,574 holes will be required for overburden blasting in the Northwest Pit and Southeast Pits respectively. Each hole is estimated to result in the generation of 0.59 kg of TSP **(US EPA, 1985)**, and so the total TSP emission from drilling holes for blasting overburden is estimated to be 31,070 kg/y [41,574 holes x 0.59 kg/hole] and 24,529 kg/y [41,574 kg/hole x 0.59 kg/hole] the Northwest Pit and Southeast Pits respectively.

Blasting overburden
TSP emissions from blasting can be estimated using the **US EPA (1985)** emission factor equation given in **Equation 1**.

Equation 1

$$E_{TSP} = 0.00022 \times A^{1.5} \qquad \text{kg/blast}$$

where :

A = area to be blasted in m^2

The area of a typical blast has been estimated to be 30000 m^2. The estimated emissions per blast will be 1143 kg/blast. Assuming that in Year 2 there will be 99 and 78 shots in the Northwest and Southeast Pits respectively, the emissions from each pit will be:

Northwest Pit – 112,944 kg/y
Southeast Pit - 89,166 kg/y.

Loading overburden to trucks
In Year 2, approximately 24,700,000 bcm will be handled by the truck and shovel in the Northwest Pit and 19,500,000 bcm in the Southeast Pit. Assuming a density of 2.3 t/bcm it is estimated that 56,810,000 t and 44,850,000 t will be loaded to trucks in the Northwest and Southeast Pits respectively.

Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. **Equation 2** shows the relationship between these variables.

Equation 2

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \quad \text{kg/t}$$

where,
$k = 0.74$
U = wind speed (m/s)
M = moisture content (%)
[where $0.25 \le M \le 4.8$]

For the Wambo meteorological data set used in the modelling the annual average value of $(u/2.2)^{1.3}$ is 1.31

Assuming moisture content of 2% for overburden, the equation can be written as;

$$E_{TSP} = 0.00118 \times \left(\frac{U}{2.2}\right)^{1.3}$$

where;
U = the wind speed in m/s.

The annual average emission factor for loading overburden to trucks will therefore be 0.00155 kg/t. Thus the annual TSP emissions from loading overburden to trucks in each pit will be as follows:

Northwest Pit - 88,115 kg/y [56,810,000 t/y x 0.00155 kg/t]
Southeast Pit - 69,564 kg/y [44,850,000 t/y x 0.00155 kg/t].

Hauling overburden to waste emplacement areas
In Year 2 approximately 24,700,000 bcm and 19,500,000 bcm of overburden will be hauled from the Northwest and Southeast Pits respectively to the overburden emplacement areas. This will be done using haul trucks with a capacity of 100 bcm. Assuming an emission factor of 1.0 kg/VKT (after the application of water) and an average haul distance of 3 km the total TSP emissions for Year 2 for each pit will be:

Northwest Pit - 741,000 kg/y [24,700,000 bcm/y / 100 bcm/trip x 3 km/trip x 1.0 kg/VKT]
Southeast Pit - 585,000 kg/y [19,500,000 bcm/y / 100 bcm/trip x 3 km/trip x 1.0 kg/VKT]

Unloading overburden to waste emplacement areas
In Year 2 approximately 56,810,000 t and 44,850,000 t of overburden will be dumped in the Northwest and Southeast waste emplacement areas respectively. The total TSP emissions for Year 2 for each pit will be:

Northwest Pit - 88,115 kg/y [56,810,000 t/y x 0.00155 kg/t]
Southeast Pit - 69,564 kg/y [44,850,000 t/y x 0.00155kg/t]

Dozers on overburden
The US EPA emission factor equation is given in **Equation 3**.

Equation 3

$$E_{TSP} = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \qquad \text{kg/hour}$$

where,
s = silt content (%), and
M = moisture content (%)

Taking M to be 2% and s to be 10%, the emission factor is estimated to be 16.7 kg/hour. In Year 2 it is estimated that dozers will spend approximately 21,840 and 13,104 hours in the Northwest and Southeast Pits respectively. The total TSP emission from the dozers working on overburden in each pit is:

> Northwest Pit and waste emplacement - 365,500 kg/y [21,840 h/y x 16.7 kg/h]
> Southeast Pit and waste emplacement - 219,300 kg/y [13,104 h/y x16.7kg/t]

OPERATIONS ON COAL

Drilling coal
There will be no drilling of coal.

Blasting coal
There will be no blasting of coal.

Dozers working on coal
The US EPA emission factor equation is given in **Equation 5**.

Equation 5

$$E_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}} \qquad \text{kg/hour}$$

where,
s = silt content (%), and
M = moisture content (%)

Taking M to be 6% and s to be 5%, the emission factor is estimated to be approximately 20.0 kg/hour.

In Year 2, it is estimated that dozers will work on coal for 7,280 and 4,368 hours respectively. The total TSP emission from dozers working on coal is therefore:

> Northwest – 145,524 kg/y [7,280 h/year x 20.0 kg/hour]
> Southeast - 87,314 kg/y [4,368 h/year x 20.0 kg/hour].

Loading coal to trucks
The emission factor used for this process is given by **Equation 6**:

Equation 6

$$E_{TSP} = \frac{0.580}{M^{1.2}} \quad \text{kg/t}$$

where,
M = moisture content (%)

Taking M to be 6%, the emission factor is estimated to be 0.06755 kg/t. In Year 2 approximately 3,800,000 and 3,000,000 t of ROM will be recovered from the Northwest and Southeast Pits respectively.

Northwest – 256,702 kg/y [3,800,000 t/year x0.06755 kg/t]
Southeast - 202,660 kg/y [3,000,000 t/year x0.06755kg/t].

Hauling coal to CHPP
It is estimated that in Year 2, 3,800,000 and 3,000,000 t of coal will be hauled from the Northwest and Southeast Pits respectively to the CHPP. This will be done using haul trucks with a capacity of 150 t. Assuming an emission factor of 1.0 kg/VKT (after application of water to the haul roads) and an average haul distance of 10 km and 3 km (return) for the Northwest and Southeast Pits respectively the total estimated TSP emissions for Year 2 is:

Northwest – 253,333 kg/y [3,800,000 t/year / 150 t/trip x 10 km/trip x 1.0 kg/VKT]
Southeast – 60,000 kg/y [3,000,000 t/year / 150 t/trip x 3 km/trip x 1.0 kg/VKT].

Unloading coal to hoppers
Open cut ROM coal will be unloaded at the CHPP dump hopper. In Year 2 it is estimated that 6,800,000 t of coal will be unloaded. Assuming an emission factor of 0.01kg/t the total estimated TSP emissions is 68,000 kg [6,800,000 t x 0.01 kg/t].

Rehandle of coal at CHPP
It is estimated that 2,040,000 t of open cut ROM coal will need to be re-handled at the CHPP. Assuming the same emission factor as above, namely 0.01 kg/t, the total TSP emission from this operation will be 20,400 kg/year.

Handling open cut coal within CHPP
Coal handling in the CHPP takes place in enclosed areas and under conditions were moisture levels are high. To account for the relatively minor emissions from this area it has been assumed that the emission is equivalent to five transfers each of which generates the same quantity of TSP as estimated by **Equation 2**. The estimated annual TSP emission is therefore 11,327 kg [6,800,000 t/y x 0.00167 kg/five transfers].

Dozers pushing open cut ROM coal at the CHPP stockpiles
The emission factor equation for dozers pushing coal at the ROM stockpile is the same as **Equation 5**. Assuming the same silt and moisture content is as for ROM coal used above the emission factor is 20.0 kg/h. In Year 2, 8,736 dozer hours will be devoted to this activity. Thus the annual TSP emission is estimated to be 174,628 kg/year [8,736 h/year x 20.0 kg/h].

Dozers pushing product coal to the reclaim conveyor
The emission factor equation for dozers pushing product coal at the stockpile is the same as **Equation 5**. Assuming 4% silt and10% moisture contents for the product coal the emission factor is 7.5 kg/h. In Year, 2 8,736 dozer hours will be devoted to this activity. Thus the annual TSP emissions is estimated to be 65,348 kg [8,736 h/year x 7.5 kg/h].

Loading open cut coal to trains
The emission factor for loading trains from the rail-loading bin is calculated using **Equation** 2 (see above) with moisture assumed to be 10%. The emission factor is 0.00016 kg/t and the annual production assuming 71% recovery after the CHPP plant is 4,828,000 t. The annual TSP emission is therefore 787 kg/y [4,828,000 t/y x 0.00016 kg/t].

Graders on roads
Estimates of TSP emissions from grading roads have been made using the **US EPA (1985)** emission factor equation (**Equation 7**).

Equation 7

$$E_{TSP} = 0.0034 \times S^{2.5} \qquad \text{kg/vkt}$$

where S = speed of the grader in km/h

Assuming an average speed of 8 km/h, the emission factor is 0.61547 kg/VKT. The distance travelled annually by the grader is estimated to be 60,000 km, which will result in an annual TSP emissions of 36,928 kg [60,000 km/y0.61547kg/km].

Handling rejects
Coarse rejects are returned to the open cuts for emplacement with overburden. This is done using the coal trucks on their return trips. Since the rejects have a high moisture level and no additional trips are generated by this operation it is assumed that the TSP emission are negligible.

WIND EROSION
The **US EPA (1985)** emission factor for wind erosion is shown as **Equation 8:**

Equation 8

$$E_{TSP} = 1.9 \times \left(\frac{s}{15}\right) \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \qquad \text{kg/ha/day}$$

where,
s = silt content (%)
p = number of raindays per year, and
f = percentage of the time wind speed is above 5.4 m/s (%)

For the Wambo area, the typical number of rain-days per year is 115 (taken from Bureau of Meteorology records for Singleton Station Number 061275, Lat 32 Degrees 37 Minutes South, Long 151 Degrees 10 Minutes and elevation 73.1 m). From the Wambo Meteorological data for 2001 the percentage of wind speeds above 5.4 m/s has been taken to be 6.7%. The estimated emissions and associated assumption for each of the major areas associated with wind erosion emissions are as follows:

Location	Area (ha)	Silt content (%)	Annual TSP emission)kg)
- Overburden dumps Northwest Pit	82	10	18,015
- Overburden dumps Southeast Pit	89	10	19,552
- Northwest Pit	18	10	3,954
- Southeast Pit	31	10	6,810
- ROM stockpiles	3	5	330
- Product stockpiles	3	4	264

OPERATIONS ASSOCIATED WITH UNDERGROUND MINING

Loading underground coal to ROM stockpiles at entrance to Wollemi
The emission factor is derived from **Equation 2**. Assuming a coal moisture content of 6% the emissions factor is 0.00033 kg/t. The total underground coal loaded to the ROM stockpile from the conveyor in Year 2 is 400,000 t/year. The total annual TSP emission is therefore 133 kg.

Loading underground coal from Arrowfield to ROM stockpiles at CHPP
The emission factor is derived from **Equation 2**. Assuming a coal moisture content of 6% the emissions factor is 0.00033 kg/t. The total underground coal loaded to the ROM stockpile from the conveyor in Year 2 is - t/year. The total annual TSP emission is therefore - kg.

Loading coal to B-Doubles at Wollemi
In Year 2 approximately 400,000 t of coal will be loaded. The emission factor for this operation is assumed to be 0.01 kg/t. The total annual TSP emission is therefore 4,000 kg.

Unloading underground coal from B-Doubles at CHPP stockpile
In Year 2 approximately 400,000 t of coal from the underground operations will be unloaded at the CHPP ROM stockpile. The emissions factor for this is derived from **Equation 2** and has the value 0.00016 kg/t. This gives and annual TSP emission of 65 kg.

Transferring underground ROM to CHPP
Approximately 400,000 t of coal will be transferred to the CHPP in Year 2. The emission factor for this is 0.01 kg/t, which gives an estimated annual TSP emission of 4,000 kg.

Dozers pushing underground coal in ROM and product stockpiles at the CHPP
The emissions from this have already be dealt with in the estimates for the open cut - see above.

Loading product coal from underground to trains
The emission factor for loading trains from the rail-loading bin is calculated using **Equation** 2 (see above) with moisture assumed to be 10%. The emission factor is 0.00016 kg/t and the annual production assuming 71% recovery after the CHPP plant is 4,828,000 t. The annual TSP emission is therefore 46 kg/y [284,000 t/y x 0.00016 kg/t].

Hauling coal from Wollemi to CHPP in 140 t B-Doubles
In Year 2 approximately 400,000 t of coal will be transported approximately 8 km (round trip) from the Wollemi stockpile to the CHPP. Assuming an emission factor of 1.0 kg/VKT and truck capacity of 140 t the estimated annual TSP emission is 22,857 kg.

Emissions from ventilation shaft(s)
Assume that the ventilation air is discharged at the rate of 76 Nm^3/s and that the TSP concentration is 0.1 mg/Nm^3. The annual TSP emissions will be 2,397 kg/year.

WAMBO OPEN CUT AND UNDERGROUND MINE OPERATIONS – ESTIMATED DUST EMISSIONS IN YEAR 7

Introduction
This appendix provides information on the way in which estimates of TSP emissions for Year 7 have been made.

Calculations are presented to an apparent accuracy of ±1 kg. There may appear to be minor discrepancies in the calculations – less than a fraction of 1%. These are due to rounding errors that arise because the emission factors displayed in the text of this appendix are not shown to the same precision as the emission factors actually used in the spreadsheets when the calculations are done.

For example, in the estimate of TSP emissions from loading overburden to trucks in the Northwest Pit (see below) it is stated that the activity will produce 115,940 kg/y of TSP [74,750,000 t/y x 0.00155 kg/t]. Checking this formula using the printed figures gives an estimate of 88,055 kg/y. However if the emission factor is written to greater precision eg (0.00155104 kg/t) the estimate becomes 88,114.6 kg/y, which then is written as 88,115 kg/y.

It is not intended to suggest the actual emissions can be estimated to the level of precision used in the calculations. The accuracy of individual estimates is not known precisely but validation tests performed in 1984 (**Dames & Moore, 1984**) indicate that model predictions of annual average dust deposition rates can be estimated with sufficient accuracy so that 80% of predicted annual average deposition rates lie within ±40% of the measured deposition value. This provides an indication as to the overall accuracy of the modelling system. It includes the effects of errors in the estimated emissions, the potential errors introduced by uncertainties in meteorological conditions and the dispersion modelling process.

In Year 7 mining will be taking place in the Southeast and Northwest Pits, which will collectively produce approximately 8,000,000 t of ROM coal. Underground mining will produce approximately 5,100,000 t of ROM coal.

Overburden will be drilled and blasted and then removed by truck and shovel.

Open cut ROM coal will be hauled by 150 t trucks to the ROM stockpile located near the CHPP and will then be transferred to the CHPP. Product coal will be stockpiled near the CHPP and transferred to the rail loading bin by conveyor.

Underground coal from the Wollemi mine will be transferred from the mine by conveyor and stacked onto stockpiles located near the underground portal and then transferred to the CHPP by 140 t B-Double trucks. Coal from the underground Arrowfield mine is transferred from the portal to the CHPP by conveyor.

The following sections describe each activity in the mining and coal handling processes that are likely to generate dust and provides estimates of the quantity of dust generated.

OPERATIONS ON OVERBURDEN

Stripping topsoil
Stripping topsoil will generate dust at the rate of approximately 14 kg/h (**SPCC, 1983**). Assuming that stripping topsoil takes approximately 640 h/y in each pit then the annual TSP emission rate will be 8,960 kg/y [640 h x 14.0 kg/ha/h] in both the Northwest and Southeast pits.

Drilling overburden
It is estimated that in Year 7, that 69,290 and 41,574 holes will be required for overburden blasting in the Northwest Pit and Southeast Pits respectively. Each hole is estimated to result in the generation of 0.59 kg of TSP **(US EPA, 1985)**, and so the total TSP emission from drilling holes for blasting overburden is estimated to be 40,881 kg/y [41,574 holes x 0.59 kg/hole] and 24,529 kg/y [41,574 kg/hole x 0.59 kg/hole] the Northwest Pit and Southeast Pits respectively.

Blasting overburden
TSP emissions from blasting can be estimated using the **US EPA (1985)** emission factor equation given in **Equation 1**.

Equation 1

$$E_{TSP} = 0.00022 \times A^{1.5} \qquad \text{kg/blast}$$

where :

A = area to be blasted in m^2

The area of a typical blast has been estimated to be 30000 m^2. The estimated emissions per blast will be 1143 kg/blast. Assuming that in Year 7 there will be 130 and 78 shots in the Northwest and Southeast Pits respectively, the emissions from each pit will be:

Northwest Pit – 148,610 kg/y
Southeast Pit - 89,166 kg/y.

Loading overburden to trucks
In Year 7, approximately 32,500,000 bcm will be handled by the truck and shovel in the Northwest Pit and 19,500,000 bcm in the Southeast Pit. Assuming a density of 2.3 t/bcm it is estimated that 74,750,000 t and 44,850,000 t will be loaded to trucks in the Northwest and Southeast Pits respectively.

Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. **Equation 2** shows the relationship between these variables.

Equation 2

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \quad \text{kg/t}$$

where,
$k = 0.74$
U = wind speed (m/s)
M = moisture content (%)
[where $0.25 \le M \le 4.8$]

For the Wambo meteorological data set used in the modelling the annual average value of $(u/2.2)^{1.3}$ is 1.31

Assuming moisture content of 2% for overburden, the equation can be written as;

$$E_{TSP} = 0.00118 \times \left(\frac{U}{2.2}\right)^{1.3}$$

where;
U = the wind speed in m/s.

The annual average emission factor for loading overburden to trucks will therefore be 0.00155 kg/t. Thus the annual TSP emissions from loading overburden to trucks in each pit will be as follows:

Northwest Pit - 115,940 kg/y [74,750,000 t/y x 0.00155 kg/t]
Southeast Pit - 69,564 kg/y [44,850,000 t/y x 0.00155 kg/t].

Hauling overburden to waste emplacement areas
In Year 7 approximately 32,500,000 bcm and 19,500,000 bcm of overburden will be hauled from the Northwest and Southeast Pits respectively to the overburden emplacement areas. This will be done using haul trucks with a capacity of 100 bcm. Assuming an emission factor of 1.0 kg/VKT (after the application of water) and an average haul distance of 3 km the total TSP emissions for Year 7 for each pit will be:

Northwest Pit - 975,000 kg/y [32,500,000 bcm/y / 100 bcm/trip x 3 km/trip x 1.0 kg/VKT]
Southeast Pit - 585,000 kg/y [19,500,000 bcm/y / 100 bcm/trip x 3 km/trip x 1.0 kg/VKT]

Unloading overburden to waste emplacement areas
In Year 7 approximately 74,750,000 t and 44,850,000 t of overburden will be dumped in the Northwest and Southeast waste emplacement areas respectively. The total TSP emissions for Year 7 for each pit will be:

Northwest Pit - 115,940 kg/y [74,750,000 t/y x 0.00155 kg/t]
Southeast Pit - 69,564 kg/y [44,850,000 t/y x 0.00155kg/t]

Dozers on overburden
The US EPA emission factor equation is given in **Equation 3**.

Equation 3

$$E_{TSP} = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \qquad \text{kg/hour}$$

where,
s = silt content (%), and
M = moisture content (%)

Taking M to be 2% and s to be 10%, the emission factor is estimated to be 16.7 kg/hour. In Year 7 it is estimated that dozers will spend approximately 24,570 and 14,742 hours in the Northwest and Southeast Pits respectively. The total TSP emission from the dozers working on overburden in each pit is:

> Northwest Pit and waste emplacement - 411,187 kg/y [24,570 h/y x 16.7 kg/h]
> Southeast Pit and waste emplacement - 246,712 kg/y [14,742 h/y x16.7kg/t]

OPERATIONS ON COAL

Drilling coal
There will be no drilling of coal.

Blasting coal
There will be no blasting of coal.

Dozers working on coal
The US EPA emission factor equation is given in **Equation 5**.

Equation 5

$$E_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}} \qquad \text{kg/hour}$$

where,
s = silt content (%), and
M = moisture content (%)

Taking M to be 6% and s to be 5%, the emission factor is estimated to be approximately 20.0 kg/hour.

In Year 7, it is estimated that dozers will work on coal for 8,190 and 4,914 hours respectively. The total TSP emission from dozers working on coal is therefore:

> Northwest – 163,714 kg/y [8,190 h/year x 20.0 kg/hour]
> Southeast - 98,228 kg/y [4,914 h/year x 20.0 kg/hour].

Loading coal to trucks
The emission factor used for this process is given by **Equation 6**:

Equation 6

$$E_{TSP} = \frac{0.580}{M^{1.2}} \quad \text{kg/t}$$

where,
M = moisture content (%)

Taking M to be 6%, the emission factor is estimated to be 0.06755 kg/t. In Year 7 approximately 5,000,000 and 3,000,000 t of ROM will be recovered from the Northwest and Southeast Pits respectively.

Northwest – 337,766 kg/y [5,000,000 t/year x0.06755 kg/t]
Southeast - 202,660 kg/y [3,000,000 t/year x0.06755kg/t].

Hauling coal to CHPP
It is estimated that in Year 7, 5,000,000 and 3,000,000 t of coal will be hauled from the Northwest and Southeast Pits respectively to the CHPP. This will be done using haul trucks with a capacity of 150 t. Assuming an emission factor of 1.0 kg/VKT (after application of water to the haul roads) and an average haul distance of 17 km and 6 km (return) for the Northwest and Southeast Pits respectively the total estimated TSP emissions for Year 7 is:

Northwest – 566,667 kg/y [5,000,000 t/year / 150 t/trip x 17 km/trip x 1.0 kg/VKT]
Southeast – 120,000 kg/y [3,000,000 t/year / 150 t/trip x 6 km/trip x 1.0 kg/VKT].

Unloading coal to hoppers
Open cut ROM coal will be unloaded at the CHPP dump hopper. In Year 7 it is estimated that 8,000,000 t of coal will be unloaded. Assuming an emission factor of 0.01kg/t the total estimated TSP emissions is 80,000 kg [8,000,000 t x 0.01 kg/t].

Rehandle of coal at CHPP
It is estimated that 2,400,000 t of open cut ROM coal will need to be re-handled at the CHPP. Assuming the same emission factor as above, namely 0.01000 kg/t, the total TSP emission from this operation will be 24,000 kg/year.

Handling open cut coal within CHPP
Coal handling in the CHPP takes place in enclosed areas and under conditions were moisture levels are high. To account for the relatively minor emissions from this area it has been assumed that the emission is equivalent to five transfers each of which generates the same quantity of TSP as estimated by **Equation 2**. The estimated annual TSP emission is therefore 13,326 kg [8,000,000 t/y x 0.00167 kg/five transfers].

Dozers pushing open cut ROM coal at the CHPP stockpiles
The emission factor equation for dozers pushing coal at the ROM stockpile is the same as **Equation 5**. Assuming the same silt and moisture content is as for ROM coal used above the emission factor is 20.0 kg/h. In Year 7, 9,828 dozer hours will be devoted to this activity. Thus the annual TSP emission is estimated to be 196,457 kg/year [9,828 h/year x 20.0 kg/h].

Dozers pushing product coal to the reclaim conveyor
The emission factor equation for dozers pushing product coal at the stockpile is the same as **Equation 5**. Assuming 4% silt and10% moisture contents for the product coal the emission factor is 7.5 kg/h. In Year, 2 9,828 dozer hours will be devoted to this activity. Thus the annual TSP emissions is estimated to be 73,517 kg [9,828 h/year x 7.5 kg/h].

Loading open cut coal to trains
The emission factor for loading trains from the rail-loading bin is calculated using **Equation** 2 (see above) with moisture assumed to be 10%. The emission factor is 0.00016 kg/t and the annual production assuming 71% recovery after the CHPP plant is 5,680,000 t. The annual TSP emission is therefore 926 kg/y [5,680,000 t/y x 0.00016 kg/t].

Graders on roads
Estimates of TSP emissions from grading roads have been made using the **US EPA (1985)** emission factor equation (**Equation 7**).

Equation 7

$$E_{TSP} = 0.0034 \times S^{2.5} \qquad \text{kg/vkt}$$

where S = speed of the grader in km/h

Assuming an average speed of 8 km/h, the emission factor is 0.61547 kg/VKT. The distance travelled annually by the grader is estimated to be 60,000 km, which will result in an annual TSP emissions of 36,928 kg [60,000 km/y0.61547kg/km].

Handling rejects
Coarse rejects are returned to the open cuts for emplacement with overburden. This is done using the coal trucks on their return trips. Since the rejects have a high moisture level and no additional trips are generated by this operation it is assumed that the TSP emission are negligible.

WIND EROSION
The **US EPA (1985)** emission factor for wind erosion is shown as **Equation 8:**

Equation 8

$$E_{TSP} = 1.9 \times \left(\frac{s}{15}\right) \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \qquad \text{kg/ha/day}$$

where,
s = silt content (%)
p = number of raindays per year, and
f = percentage of the time wind speed is above 5.4 m/s (%)

For the Wambo area, the typical number of rain-days per year is 115 (taken from Bureau of Meteorology records for Singleton Station Number 061275, Lat 32 Degrees 37 Minutes South, Long 151 Degrees 10 Minutes and elevation 73.1 m). From the Wambo Meteorological data for 2001 the percentage of wind speeds above 5.4 m/s has been taken to be 6.7%. The estimated emissions and associated assumption for each of the major areas associated with wind erosion emissions are as follows:

WAMBO DEVELOPMENT PROJECT

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX C

Non-Aboriginal Heritage Impact Statement

APPENDIX C

WAMBO DEVELOPMENT PROJECT

NON-ABORIGINAL HERITAGE IMPACT STATEMENT

PREPARED BY
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412 KING STREET, NEWCASTLE NSW 2300

MAY 2003
Document No. APPENDIX C-H.DOC

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C1 INTRODUCTION

C1.1 PURPOSE OF THE REPORT

This document assesses the Wambo Development Project for impacts to non-Aboriginal heritage in accordance with the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979 (EP&A Act)*.

The Wambo Development Project (the Project) is located approximately 15 kilometres (km) west of Singleton and 80km north-west of Newcastle in the Hunter valley, New South Wales (NSW) (Figure C-1).

This Project would include (Figure C-1) the:

- continued development of open cut operations within the existing Wambo Coal Pty Limited (WCPL) Mining and Coal Leases and into the Mining Lease Application area to the north-west;
- selective auger mining of the Whybrow, Redbank Creek, Wambo and Whynot Seams up to 200 m beyond the open cut limits within WCPL owned land;
- temporary stockpiling of soil from stripping campaigns;
- continued placement of overburden and coarse rejects within a combination of in-pit and out-of-pit emplacements;
- placement of tailings within mined-out open cut voids and capping with overburden and coarse rejects;
- an extension to the existing Wollemi Underground Mine Box Cut (within the limits of the proposed open cut mining area) to provide direct access for three underground longwall panels in the Whybrow seam;
- underground mining of the Whybrow, Wambo, Arrowfield and Bowfield seams;
- upgrade of the existing coal handling and preparation plant (CHPP) to facilitate increased coal production;
- development of a water control system including construction of a water control structure across North Wambo Creek to allow the passage of flows from the water control structure to the lower reaches of North Wambo Creek around the open cut development;
- construction of a rail spur, rail loop and train loading system to enable the transport of product coal by rail to market;
- re-alignment of Wallaby Scrub Road and Jerrys Plains Road intersection;
- de-gazettal and closure of Pinegrove Road;
- development of new access roads and internal haul roads; and
- relocation of the administration area and site offices.

A detailed description of the Project is provided in Section 2, Volume 1, of the Wambo Development Project Environmental Impact Statement (EIS).

C1.2 STRUCTURE OF THE REPORT

The structure of the report is as follows:

- Section C2 provides a current list of heritage items located within the region.
- Section C3 provides a written history and historical overview of the Project area.
- Section C4 provides an overview of the issues relating to the Wambo Homestead Complex (WHC). A regulatory overview of the legislative requirements in relation to the WHC is provided. In addition, Section C4 discusses the State significance of the WHC and details of the heritage impacts of the Project on the WHC. A discussion on the impact of retaining the WHC on Project coal reserves has been provided by WCPL and is presented in Attachment C-A.
- Section C5 provides the results of the non-Aboriginal survey for other items of non-Aboriginal heritage, assesses the significance of each heritage item and discusses the impacts of the Project on each.
- Section C6 provides a heritage impact statement for the Project.

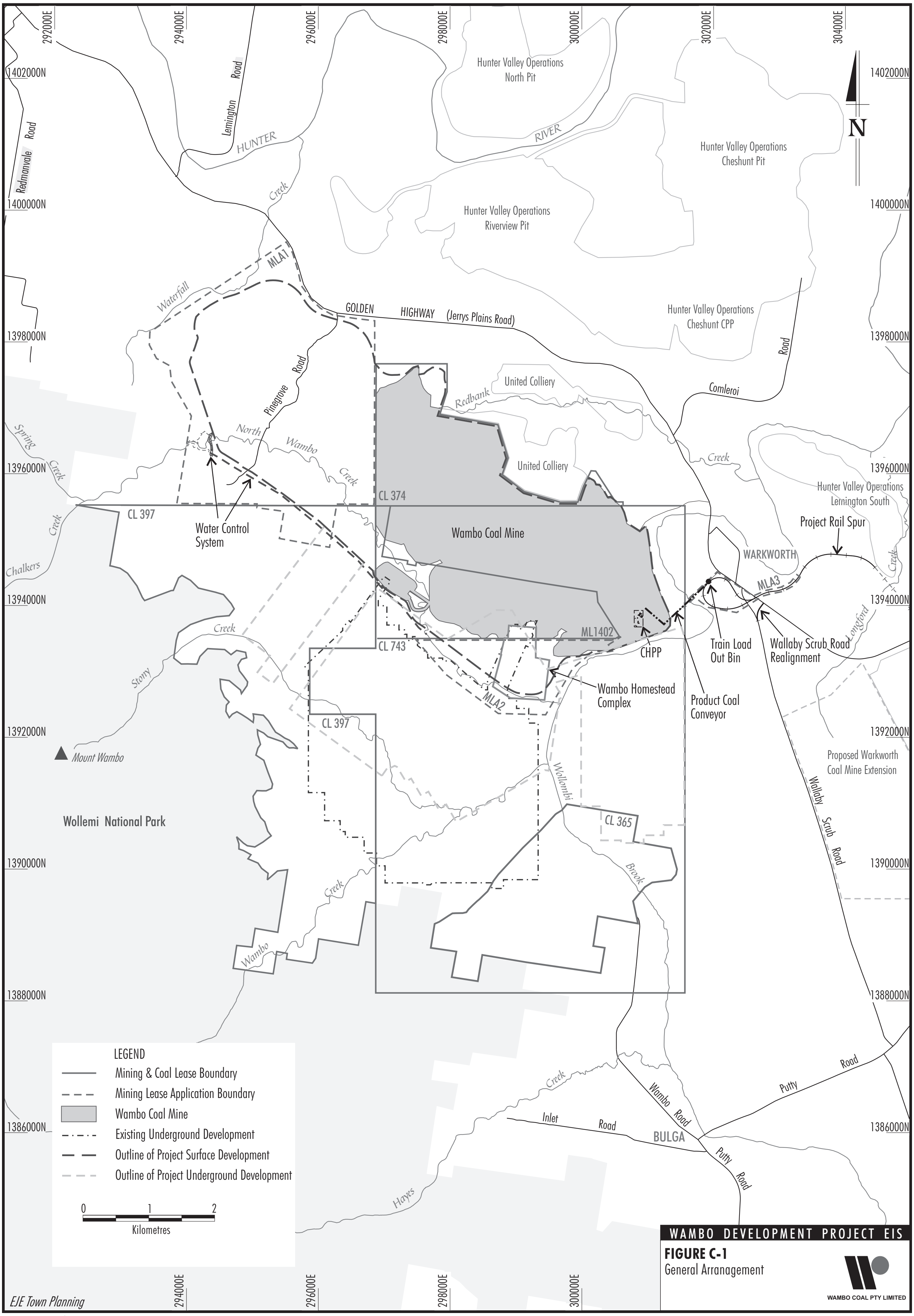


FIGURE C-1
General Arranagement

WAM-02-01-Non Aborg_001E

C2 STATUTORY HERITAGE LISTS

Heritage lists based on legislation have statutory standing in NSW. Heritage items with statutory protection include:

- Items of local heritage significance listed on schedules to Local Environmental Plans (LEPs).
- Items of special significance to the people of New South Wales listed on the State Heritage Register.
- Items in New South Wales on the Register of the National Estate (the Commonwealth has limited powers to restrict the actions of its agencies which affect these items).

Development Activities Requiring Approval under the Heritage Act

For an item listed on the State Heritage Register the following activities require an application to the Heritage Council:

- any demolition;
- damage to any part of the item;
- movement of a moveable object or archaeological relic;
- excavation for the purpose of exposing or moving a relic;
- development of land on which the building, work or relic is situated;
- alteration of the building, work, relic or movable object;
- display of any notice or advertisement on the place, building, work, relic, movable object or land, or in the precinct; and
- damage, destruction or removal or any tree or other vegetation from the place precinct or land.

In relation to items of State significance, the Heritage Council is a joint consent authority with the local council and other State agencies (for the purposes of this assessment, Planning NSW) for proposals that may affect the item's heritage significance.

C2.1 CURRENT HERITAGE LISTINGS

For the purposes for an assessment of non-Aboriginal heritage at Wambo, an investigation was undertaken into heritage items surrounding the site. Table C-1 provides details of listings from the Singleton Shire Council Local Environmental Plan (LEP) Heritage Schedule, NSW State Heritage Register, NSW State Heritage Inventory, and the Register of the National Estate Database.

Table C-1
Statutory Listed Heritage Items

Item Name	Address	Suburb	Listing - Status
Wambo Homestead and Outbuildings (WHC)	Wambo	Warkworth	NSW SHR - Gazetted
"Archerfield" Outbuildings	Archerfield Road	Warkworth	Singleton LEP - Regional Significance NSW SHI – Gazetted
St Phillips Church		Warkworth	Singleton LEP – Regional Significance NSW SHI – Gazetted
Clifford & Stafford Homestead Ruins	Long Point Road	Warkworth	Singleton LEP - Local Significance NSW SHI – Gazetted
Hotel Ruins		Warkworth	Singleton LEP - Local Significance NSW SHI – Gazetted
Queen Victoria Inn Ruins (former)	Jerry's Plains Road	Warkworth	Singleton LEP - Local Significance NSW SHI – Gazetted
Police Station	Doyle Street	Jerry's Plains	Singleton LEP – Regional Significance NSW SHI – Gazetted

Table C-1 (Continued)
Statutory Listed Heritage Items

Item Name	Address	Suburb	Listing - Status
Public School	Pagan Street	Jerry's Plains	Singleton LEP – Regional Significance NSW SHI – Gazetted
Old Anglican cemetery	Piribil Street	Jerry's Plains	Singleton LEP – Regional Significance NSW SHI – Gazetted
"Arrowfield"	Piribil Street	Jerry's Plains	Singleton LEP – Regional Significance NSW SHI – Gazetted
"Strowan"	Piribil Street	Jerry's Plains	Singleton LEP – Regional Significance NSW SHI – Gazetted
Post Office and Store	Pagan Street	Jerry's Plains	Singleton LEP - Local Significance NSW SHI – Gazetted
St James Anglican Church	Pagan Street	Jerry's Plains	Singleton LEP - Local Significance NSW SHI – Gazetted
Jerry's Plains Catholic Church	Pagan Street	Jerry's Plains	Singleton LEP - Local Significance NSW SHI – Gazetted
Wollemi National Park		Jerry's Plains	RNED - Registered
Indigenous Place		Jerry's Plains	RNED – Registered

(LEP – Local Environmental Plan) (SHR – State Heritage Register) (SHI – State Heritage Inventory) (RNED – Register of the National Estate Database)

The WHC is the only statutory listed heritage item located within the Project area. All other heritage items listed above are located outside the impact area for the Project (refer to Section 2 of the EIS for detailed Project description).

C3 HISTORICAL CONTEXT

C3.1 WRITTEN HISTORY

The following historical information is extrapolated from the history contained within "*Wambo Homestead – a Conservation Management Plan*" (Collins, 1994).

The Project area was originally explored by a party led by John Howe on or around St Patrick's Day, 17 of March 1819. On the 18th September 1820, John Howe was given permission to graze his flocks and herds at St Patrick's Plains. The land in question was first acquired under the Land Alienation Policies. Not all of the subject land was settled, and the two settlers within the subject land were Hindson and Maziere. (Figure C-2).

During the 1830's James Hale acquired Hindson's and Maziere's land. By 1842 Hale owned land to the south and east of the WHC. Land to the north was not settled until after 1842. The nearest other property owner of that time to the subject site was Smith. Smith's property was not within the subject area. The only major homestead within the subject land is the WHC. This ownership pattern can be seen in the 1837 land ownership map (Figure C-3).

Hale retained ownership of the majority of the site until his death in 1857 when the land transferred to his stepson, William Durham Jnr. In turn, Durham's sons, William James Hill Durham and Charles MacQuade Durham inherited in 1892. At which point in time it was sold to Charles Durham's father in law, Ben Richards.

In 1900 Richards sold the land to R C Allen and Frank McDonald. The property was subdivided in 1908 whereupon other properties must have been established.

In 1968 the majority of the subject land with the exception of the WHC was sold to the Wambo Mining Corporation (now Wambo Coal Pty Limited). Subsequently in circa 1983 Wambo Mining also purchased the WHC site.

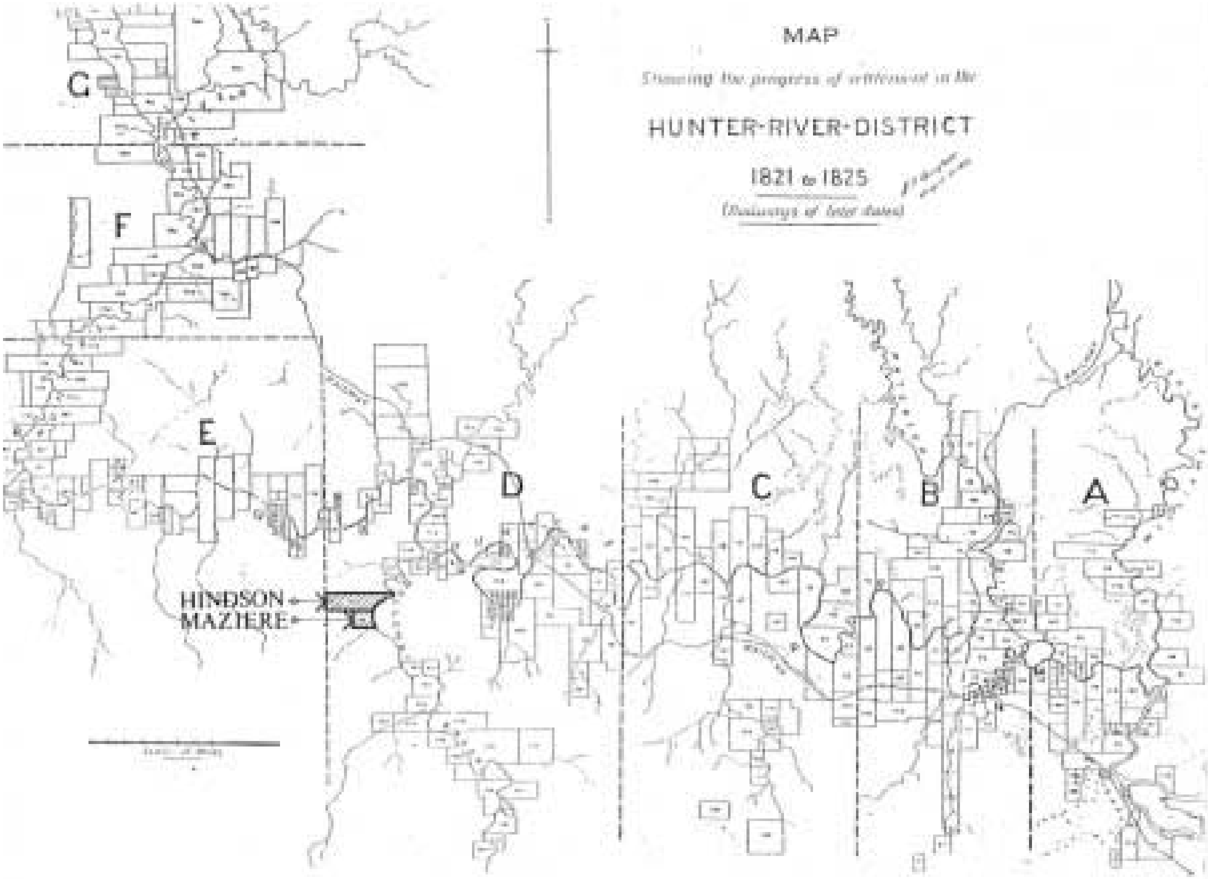


Figure C-2 – *Map by JT Cambell, 1825 (revised to show pertinent owners as cited in Green, "Pioneer Settlement of the Hunter Valley," University of Newcastle, 1975. p 205*

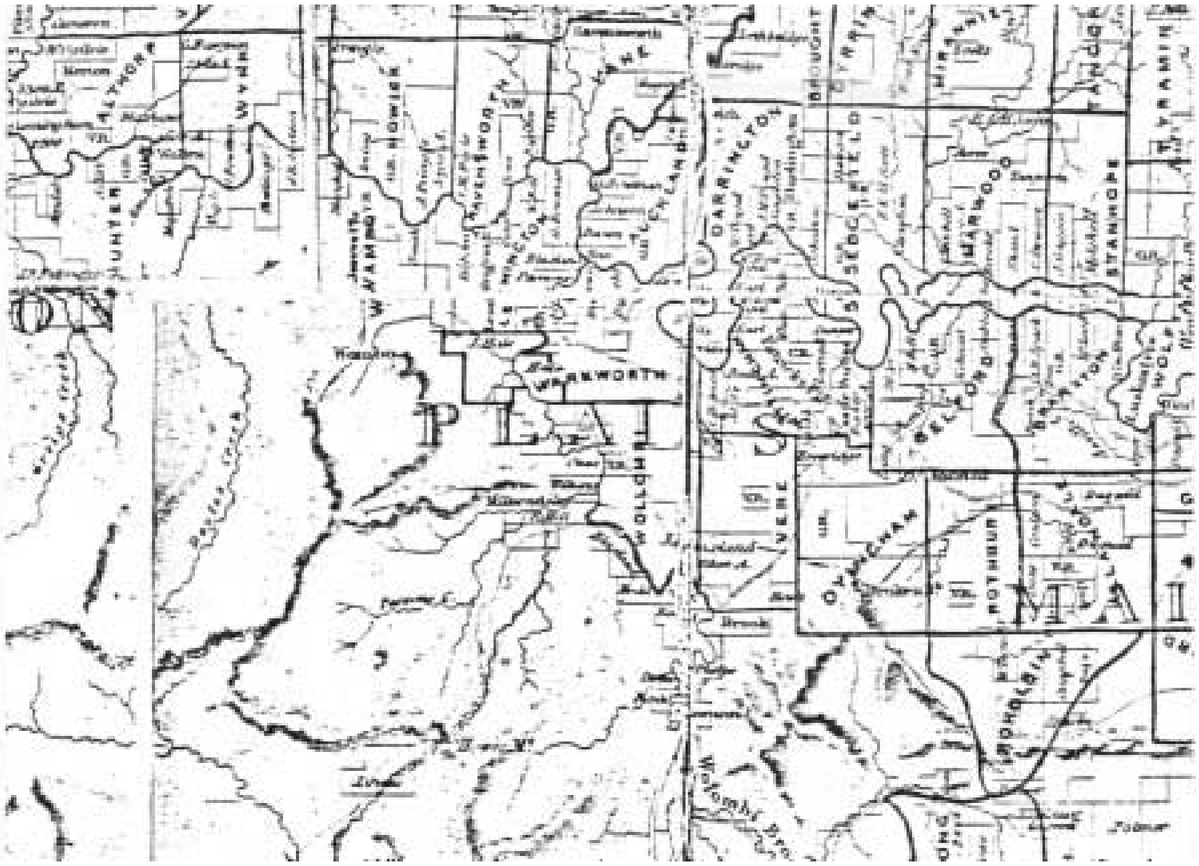


Figure C-3 – *1842 Revision of Robert Dixon's 1837 Map of the Colony of NSW*

C4 WAMBO HOMESTEAD COMPLEX

C4.1 REGULATORY OVERVIEW

The WHC is the subject of various statutory instruments which have an impact on the future uses and management of the site. These are discussed below.

C4.1.1 Heritage Listings

Relevant current listings for the WHC are:

- Listed as the 'Wambo & Outbuildings' under the *Heritage Act 1977*, on the *State Heritage Register (SHR No 00200).*
- Listed as 'Wambo & Outbuildings' on the Singleton Local Environmental Plan 1996 under Schedule 3 (Clauses 21-30) – Heritage Items as a Part 1 – Item classified as being of State Significance.

The inventory sheets for the WHC are provided in Attachment C-B.

C4.1.2 Heritage Act 1977

The *Heritage Act (NSW) 1977* is administered by the Minister for Planning on the advice of the Heritage Council of NSW. The *Heritage Act* creates opportunities for administration, control, protection, maintenance, preservation, restoration, enhancement and conservation of natural and built heritage in NSW. The Act is binding on all State Government agencies. Items of heritage significance are protected by means of interim Heritage Orders or by listing on the State Heritage Register.

The State Heritage Register

Items on the State Heritage Register are those items that have been identified as being of particular importance to the people of New South Wales, items that are of State significance or greater.

The WHC as a whole (not individual buildings) has been listed on the State Heritage Register. Copies of the State Heritage Register Listings are included in Attachment C-B.

Heritage Act Approvals

Listing protects and conserves items and places because approval for alteration, damage, demolition and development must be obtained from the Heritage Council under section 60 or section 140 of the *Heritage Act 1977*, before the commencement of any work.

The Minister may direct that an item be removed from the State Heritage Register if he considered that the item concerned is not of State significance and the Heritage Council recommends its removal. The procedure for removal of a listing is the same as the procedure for listing.

Proposals that involve modifications to heritage items or places must always be referred to the Heritage Council unless the works proposed fall within the type of work covered by the Standard exemptions (under Section 57 of the *Heritage Act*) or Specific exemptions, also under Section 57. The Minister for Planning can approve site specific exemptions, on the recommendation of the Heritage Council.

The Standard exemptions relate to *maintenance works, repairs, painting, excavation, restoration and conservation.* They are primarily intended to cover routine and periodic maintenance works rather than the adaptive re-use of buildings.

C4.1.3 Singleton Local Environmental Plan

Development in the Singleton Shire is controlled under Singleton Local Environmental Plan (LEP) 1996. Clauses 21-30 are the heritage clauses in the LEP. They are standard heritage provisions based on those applying at the time the plan was prepared.

Schedule 3, Heritage items Parts 1-3 lists the heritage of the council area protected under the LEP. The Wambo & Outbuildings complex is currently listed under Schedule 3 (Clauses 21-30) – Heritage Items as a Part 1 – Item classified as being of State Significance.

Development consent is required under clause 22(2) for a heritage item. However, Clause 23 (1) does not allow council to grant consent to a development application required by clause 22 in respect of a heritage item of State significance unless the concurrence of the Director is obtained. In this case, development application for the Project is being sought under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) (State Significant Development) and Planning NSW is the consent authority.

C4.2 STATEMENT OF SIGNIFICANCE

The WHC was listed on the State Heritage Register in April 1999.

The Statement of Significance on the State Heritage Register is as follows:

> *"Wambo Homestead is highly significant in the context of Australian pastoral activities and horse breeding in New South Wales. The use of Wambo relates directly to the economic climate and resource based needs of the Colony and State. It is an important group of homestead buildings which remain substantially intact and display the progressive architectural development of a typical Australian homestead."*

C4.2.1 Physical Description of the WHC

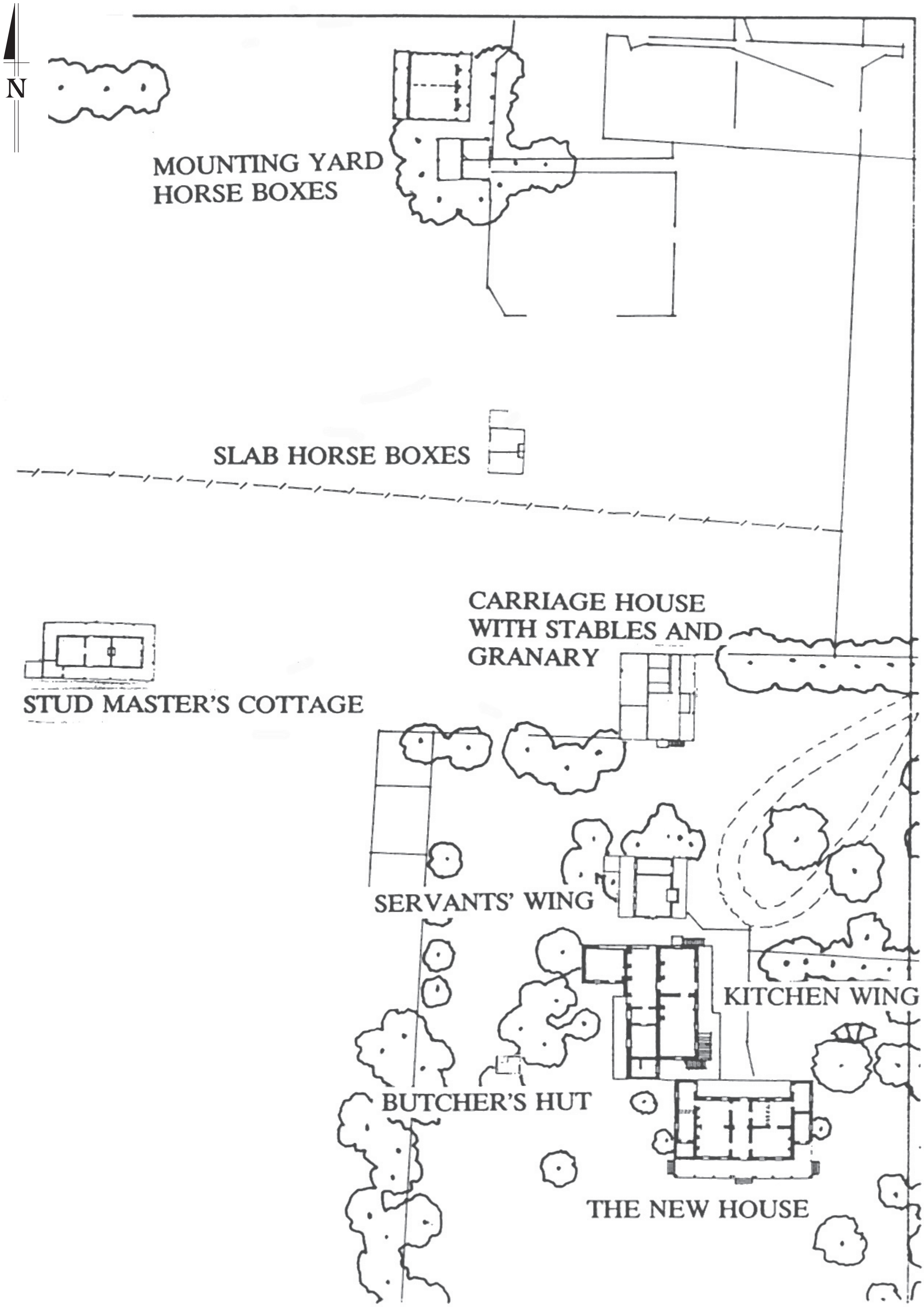
WHC Buildings

The WHC is presently comprised of eight buildings, the earliest being the kitchen wing. Originally this was a singly storey sandstone building with a cellar, to which a brick upper floor was wadded. A large brick laundry has also been added. Other buildings include the Stud Master's Cottage of three rooms and the brick servant's wing of three rooms also.

All are 'Old Colonial Georgian', the earliest European architectural style used in Australia. Around 1844, the 'Victorian Regency' New House was built. Its architectural style based on the Georgian vernacular. Other buildings which make up the Homestead are the Slab Carriage House with Stables, the timber slab/rammed earth Butcher's Hut and the Slab Horse Boxes. Other remote structures exist on the property including a large hay barn, silos and fences (State Heritage Register 2003; Collins, 1994). Figure C-1 shows the location of the curtilage of the WHC.

A description of the buildings (refer to Figure C-4) comprising the WHC adapted from Collins, 1994 is provided below:

- <u>Kitchen Wing (circa 1830) -</u> A two storey exposed sandstone and brick structure (refer to Figure C-4) with a basement and progressive additions. It is a conservatively balanced design of five bays with a symmetrical façade to the east. The roof, of galvanised iron over timber shingles, is of medium pitch with boxed eaves and the verandas are under separate roofs with slender posts. Veranda rooms and a modern laundry wing have been added to the west elevation. Access to the basement is via a set of steep sandstone stairs. The upper floor is reached by two separate single flight external timber and galvanised iron staircases at each end of the building.



Source: Collins (1994)

WAMBO DEVELOPMENT PROJECT EIS

FIGURE C-4
Wambo Homestead Complex

WAMBO COAL PTY LIMITED

EJE Town Planning

Not to Scale

- The New House (circa 1840) - A single storey, stuccoed brick structure (refer to Figure C-4) on an exposed sandstone plinth which appears as a platform. It is an elegant, refined symmetrical design or seven bays, and displays simplicity, subtlety and restraint. The stucco has been lined and painted to imitate quality stone work with simple classical projecting mouldings. The Victorian Regency design expresses crisp lines and classical proportions in the window and door treatments. The inclusion of timber jalousies typifies this style. The roof is timber shingles with a later covering of corrugated iron. The pitch is medium and the eaves are boxed. The verandas are under separate roofs supported on a colonnade of hardwood columns of the Tuscan Order. Veranda rooms flank the symmetrically planned house which consists of a central entry hall and four rooms. The New House is linked to the Kitchen Wing by a breezeway between the two buildings. The windows are double hung with timber sashes and twelve panels. The main entry doors are panelled with distinctive glazed fanlights to the main entry doors. Above the roof the chimneys are simply moulded at the top.

- Servants' Wing (circa 1840) - The format of this building suggests that it was originally built as a kitchen with servant's quarters above (refer to Figure C-4). It was probably part of the expansion of the Homestead in the 1840s. It would have superseded the kitchen in the single storey Kitchen Wing. The ground floor consists of two rooms: a large kitchen with open fireplace and bordered hearth, and a separate externally accessed store room. The upper floor is externally accessed and fits within the roof structure. The space is divided by a timber partition. The upper floor was previously linked to the upper of the Kitchen Wing by means of an open timber walkway. Externally the building is of face brick walls with gabled roof and separate verandas to the east and west. It is a symmetrical design of three bays. The brickwork has been laid in a crude combination of Flemish bond and English bond and windows have stone lintels and sills. The original roof covering of timber shingles still exists below corrugated iron which dates from the beginning of the 20th century. The veranda roofs are supported by octagonal timber columns and a large veranda beam laid on flat.

- Stud Master's Cottage (circa 1840) - "Old Colonial Georgian" in style and is a characteristic single storey verandaed country dwelling of the 1840s. Other style indicators which help classify this building include: symmetrical façade, exposed brick, medium pitched shingled roof with veranda under broken back roof, timber roof shingles, slender veranda posts, sash windows with small panes and flat arches, louvred shutters and simple chimney.

- Carriage House with Stables and Granary (circa 1844) - A crude building (refer to Figure C-4) of four bays and two storeys with a veranda under a simply pitched roof. This building is identical to a barn at Clarendon built by Lt William Cox for whom Hale worked as an overseer. A full length skillion has been added with its floor at a lower level. This building is a large timber structure, with two storey square ironbark columns. These columns take equally large ironbark upper floor beams bolted to the columns to form the structural frame.

- Slab Butcher's Hut (circa 1900) - Built in close proximity to the New House and Kitchen Wing (refer to Figure C-4) this building was used to prepare and dress meat for household consumption. It is of a traditional and interesting construction. The main frame is of vertical logs which have been dressed to take horizontal hardwood slabs internally and externally. Rammed earth has been packed into the space between the horizontal slabs. The floor is unreinforced concrete and the ceiling is of adzed slabs with a covering of earth supported by log beams. The interior was completely lined with a perforated zinc mesh. A butcher' cutting table, showing significant evidence of use, is located in the north-west corner of the room.

- Slab Horse Boxes (circa 1900) - The original structure consists of a pole frame construction with a cladding of vertical timber slabs and a timber shingled roof. Deterioration of the shingled roof has necessitated the installation of a corrugated iron roof. A half round eaves gutter has also been added to collect water and direct it to a galvanised storage tank on the northern elevation. The building is divided by a slab partition wall. A robust timber manger has been purpose built and is shared between the two horse boxes. Timber stable doors provide entry, and ventilation is increased by timber grille windows (refer to Figure C-4). A concrete floor has been poured inside the original construction. Nails used in construction and door hardware date from the beginning of the 20th Century.

- Mounting Yard Horse Boxes (circa 1906) -These buildings were constructed at the beginning of the 20th Century to be used in association with the mounting yards. The buildings are rectangular in shape with verandas along the longitudinal sides. The type of construction used is like no other timber building to be found within the homestead and consists of light timber framing clad with splayed weatherboards. The actual studs are simply stripped saplings. Internal partitions, used to form the horse stalls, have been lined with thicker, close fitting boards for greater strength and to provide protection to both studs and the horses they enclosed. The roofs to these buildings are simple gables with broken backs to form the verandas. The roof covering is corrugated iron with eaves gutters being used to collect roof water. This water was then held in tanks located between the two buildings (refer to Figure C-4). The floor of the larger building was made using log bearers covered by timber slabs thick enough to take the wear generated by the horses. In contrast, the smaller building has been constructed with an unreinforced concrete floor.

Original WHC Homestead Landscape and Setting

A description of the landscape and setting of the WHC in the early 1990s is provided below (from Collins (1994)). The landscape and setting of the WHC were integral to the listing of the WHC on the State Heritage Register.

The WHC presently occupies 81.5 acres (33 ha). Land surrounding the property is characterized by river flat, undulating pasture and woodland. The alluvial land on the north side of Wambo Creek has been used since the late 1820s for wheat growing, sheep and cattle grazing, a horse stud, dairy farms and presently coal mining. By the 1850s erosion problems and changes in agricultural emphasis in the area led to pastoral activities. During the second half of that century short horn cattle were grazed fro live export. Around the turn of the 20th century large quantities of excellent Lucerne were grown of the site and the property used as a thoroughbred horse stud. Later the property supported several dairy farms and continued to grow Lucerne.

The WHC is set on a "military crest": the point on a slope of a hill that will not allow any person or object (i.e. building) to be silhouetted against the horizon while allowing full view of a slope below. This location would have certainly given the best view of visitors approaching from the south while offering a degree of inconspicuousness to the passer-by. The area immediately around the Homestead is well treed, with remnant hedges defining the more formal areas. The WHC has been orientated to overlook the North Wambo Creek and its flood plain, and takes advantage of distant views to Mount Wambo and the Bulga Mountains.

Land surrounding the WHC is generally comprised of dissected ridges of low relief with rounded crests and gentle slopes. In the past the land has been used mainly for pastoral and to a lesser degree, agricultural purposes. These land uses resulted in the clearing of large areas fro the creation of pastures and cultivated fields for crops. Only scattered stands of remnant vegetation now remain. In some locations, areas of natural regeneration can be noticed which has resulted from the cessation of grazing.

It is thought prior to clearing for agriculture and grazing, the property was covered with a woodland community dominated by Eucalyptus crebra (Ironbark) and Casuarina luehmannii (Bull Oak). Other species present would have included Angophora floribunda (Rough Barked Apple), Brachychiton populneum (Kurrajong), Eucalyptus albens (White Box) and Eucalyptus mouccana (Grey Box). All of these trees are still present on the property albeit in reduced numbers.

C4.3 REVIEW OF STATE SIGNIFICANCE OF THE WHC

The following is the 'Statement of Cultural Significance' undertaken in the *Wambo Homestead: A Conservation Plan* (Collins, 1994).

Wambo Homestead is highly significant in the context of pastoral activities and horse breeding in New South Wales. Its contribution to the image of the Australian Homestead is important and the remaining buildings portray the developing aesthetic of Colonial/Victorian domestic architecture of the early 19th century in New South Wales. The combination and proximity of the buildings to each other and their setting on a military crest exemplify the evolution of early colonial homesteads.

Historically, Wambo Homestead is significant in New South Wales for its interpretation of the expanding pastoral activities of the infant colony and as evidence of the rise to wealth of a former convict James Hale. The homestead and surrounding estate documents the economic history of the Hunter Valley region from its agricultural beginnings to present day coal mining. The survival of early 20th century horse stud infrastructure is a rare contribution in both the Hunter Valley region and New South Wales. The division of Wambo into at least nine dairy farms after 1908 marks the decline of large estates in the Hunter Valley region.

The Homestead's association with James Hale, the Durham family, William Bede Dalley and the Allen and McDonald families is also of some historical importance.

Scientifically, the remaining structures provide insight into building design and the development of homestead complexes in colonial New South Wales. The buildings are rare evidence of the use of traditional skills and materials and of the construction technique practised by Georgian and Victorian builders and owners. As an archaeological resource the buildings and deposits of the Homestead are rare in the State.

Socially, Wambo Homestead demonstrates the opportunities that were available to energetic families of the early nineteenth century in New South Wales. As the home of William and Sophia Durham, Wambo has associative social significance as evidenced in the documents of the Homestead's visitors and employees in the late 19th century.

The design and location of the individual buildings reflects both the function and the social structure of the early homestead and estate. Further as a thoroughbred horse stud developed by the Allen and McDonald families Wambo represents the social and sporting aspirations of elite residents of Sydney at the turn of the 20th century.

Even after the estate was subdivided into smaller parcels the complex of homestead buildings remained a social focus for residents of the surrounding district up until the sale of the property by descendants of the McDonald family in the 1980s.

Since the above Statement of Cultural Significance was written in 1994, the land surrounding the WHC curtilage has been subject to further mining development. As a consequence, some components of the Statement of Cultural Significance no longer reflect the current Heritage status of the Wambo Homestead.

Changes to the heritage values of the WHC include:

- The site of the WHC no longer supports pastoral activities or horse breeding and has been significantly disturbed by mining activities. The historical significance of the WHC has been compromised as a result.

- Evidence relating to the occupation of James Hale (still retained in the buildings of the Homestead) is lost in terms of the subdivision of the estate (refer to section C3.1) and surrounding land use (mining activities) which have rendered the WHC irrelevant in terms of the recent and future economic development of the Hunter Valley. It still remains as a reminder of past economic activity; however given the impact of mining activities it has completely lost its context.

- The military crest on which the WHC was sited and which is considered to "exemplify the evolution of early colonial homesteads" has been modified by mining operations which have impacted the ridgeline behind the Homestead. The Homestead is no longer sited on a military crest.

- Due to the mining operations in the vicinity and the restricted access to the Homestead, the WHC no longer provides a social focus for the residents of the surrounding district.

- Although the Homestead complex is considered to be a rare example of construction technique and an archaeological resource and the evidence of the buildings still remain, access to the site and interpretation of the buildings has been significantly compromised due to the proximity of mining operations.

As stated previously there have been additional losses and changes to the physical integrity and setting of the WHC, however many of the individual buildings in the complex still retain some historic, social, aesthetic and technical importance. The ability to interpret the early history of these buildings has and continues to be compromised by the expansion of mining and natural deterioration due to ageing and environmental factors.

C4.4 IMPACTS OF THE PROJECT ON THE WHC

The impacts of the open cut section of the Project upon the cultural significance of the WHC are obvious and profound. Any heritage items in the open cut section will be destroyed unless they are relocated or fabric is salvaged. On the other hand retaining the WHC in its current location substantially impacts Project coal reserves (Attachment C-A).

If mining activities are restricted to areas outside the curtilage of the WHC as defined by the State Heritage listing, the retention of buildings is secured. However the impact on heritage value is still significant, given that access by the public and any future use will be severely restricted. In fact no use would be considered acceptable that close to the mining operation. Additionally, vibration and safety issues would exclude any practical use and increase expenditure with regard to maintenance and upkeep of the buildings and property. This effect of vibration is essentially more detrimental to masonry structures. Timber being a more ductile and forgiving construction material is not affected by mild vibration and only requires periodic maintenance to control this impact.

The impact on heritage items above the underground mine expansion area are confined to the effects of mine subsidence. Again, masonry structures are the most effected. Masonry buildings will crack and lose structural integrity. Some work with regard to minimising this risk has been carried out on the New House. Timber structures are again more likely to absorb minor subsidence without damage. However, they may be affected by severe subsidence by opening of joints which would destabilise the building and allow water entry to the structure.

Given that aesthetic value relates to the landscape setting, orientation of the building, its form, scale, colour, texture and material of the fabric, the smells and sounds associated with the place and its use, and the emotional response to these attributes, it will be very difficult to retain this value if a restricted mining proposal is approved. The proposal will significantly affect the setting and heritage significance of the WHC both in the short and long term; the buildings are particularly fragile due to their age and methods of construction. The buildings fragile condition and location adjacent to both the existing mining operation and proposed development area has and will further restrict access by users and the public due to safety requirements around the mining operations and the permanent landform modifications that result from open cut mining.

In addition, the rehabilitation programme proposed for the end of the mine's life comprises substantial areas of native woodland to enhance flora and fauna values in the surrounding area. The land in the vicinity of the WHC is proposed to form part of a future wildlife corridor between the Wollemi National Park and the vegetation remnants to the east. Rehabilitation works will therefore further erode the pastoral setting of the WHC which is a major component of its significance.

C4.5 RELOCATION OF THE WHC

Under section 63(2) of the *Heritage Act,* where a building or work is subject to a listing on the State Heritage Register, the Heritage Council can approve an application when a condition of approval is that the item be relocated to another site.

C4.5.1 Relocation Proposal

It is proposed to relocate the WHC to other locations both within the Singleton Shire and the wider Hunter Region. The form of relocation would be dependent on both the nature and characteristics of the element to be relocated and the relocation destination.

For a number of the individual elements/buildings in the WHC (Figure C-4) substantial relocation and re-erection is desirable and would be of benefit by simply retaining the physical and technical significance of the structure at another location where it can be available for public access and interpretation. In this regard it is proposed to substantially relocate the following items (refer to Attachment C-B for listing details):

- Stud Masters Cottage;
- Slab Horse Boxes;
- Butcher's Hut;

- Carriage House; and
- Mounting Yards.

Relocation sites would be selected through a consultative process with the Singleton Shire Council (SSC), Tourism Singleton, the local community and stakeholders in the Hunter Region. Interest has already been registered by members of the Wambo Development Project Community Consultative Committee (WDPCCC) in regard to relocating part of the WHC to Jerrys Plains.

For the remaining components of the WHC the relocation proposal would involve relocation of substantial elemental fabric i.e. all significant fabric which retains its integrity would be salvaged and used elsewhere for interpretation purposes (e.g. sandstone flagging, timber joinery, timber roof structures, and sandstone bricks can be used at other local historic sites to repair and reinstate lost elements with the addition of interpretative plaques and material to identify the material as originally from WHC). Additionally, this material could be used in conjunction with some of the relocated items to enhance their provenance or as fabric available for re-use on other Heritage listed properties (e.g. repair projects). The following components of the WHC would be relocated in this manner:

- Servants Wing (a significant amount of original fabric as already been lost due to environmental and decay factors);
- Kitchen Wing; and
- New House.

A consultative process as above would be followed in determining appropriate relocation sites and projects for interpretation purposes and for the re-use of fabric.

Native vegetation located within the WHC is unlikely to be feasibly relocated. It is envisaged that new planting relating to the original vegetation type would be planted in the relocation areas to give a level of context of the original landscape setting, design and character.

C4.5.2 Burra Charter Implications

> <u>Article 9.1 - Location</u>
> The physical location of a *place* is part of its *cultural significance.* A building, work or other component of a place should remain in its historical location. Relocation is unacceptable unless this is the sole practical means of ensuring its survival, or unless Article 9.2 applies.
>
> <u>Article 9.2 - Movable Structures</u>
> Some buildings, works or other components of *places* were designed to be readily removable or already have a history of relocation. Provided such buildings, works or other components do not have strong links with their present location, removal may be appropriate.
>
> If any building, work or other component is moved, it should be moved to an appropriate location and given an appropriate *use*. Such an action should not be to the detriment of any *place* of cultural *significance.*

Although Articles 9 and 10 of the Burra Charter state that removal of a building and its contents of cultural significance is unacceptable, except where removal is the sole means of ensuring its survival, the practice of moving historically significant buildings is widespread and the building is considered ‘saved’ when it is relocated. With the approval of the proposed mining operations, the relocation and salvage of some buildings and their fabric is the only option available.

If a building must be moved, the Burra Charter again provides guidance through Articles 24 to 32 on conservation practice. Most importantly the Articles highlight the need for professionally prepared studies to understand a place or building before any work is undertaken and that the existing fabric and use should be recorded before any changes are made. This has already been undertaken via the Conservation Management Plan for the WHC undertaken by Collins, 1994.

If relocation is approved the buildings will lose most of their former relationship with the land they are associated with. It is arguable however that this relationship with the land is already diminished due to the vicinity of mining operations to the WHC and the subsequent loss of the setting and landscape. With relocation a level of 'cultural significance' will be retained, in particular, the technical significance of the buildings, as examples of a range of early building methods.

There are building types that cannot be fully relocated and re-erected without losing integrity. These include the Servants Wing, Kitchen Wing and New House. By the time their components have been reassembled, original material (such as lime and shell mortar in an old brick building or textile/newspaper linings in slab huts) will be lost. A contemporary reconstruction of the original building is not the real thing.

The relocation proposal which provides for substantial relocation of five of the elements of the WHC and the recovery and relocation to other sites, significant fabric from the remaining elements, would allow use and access by the public that would otherwise be alienated. This would eliminate the risk that the majority of original fabric may well disappear through weather and deterioration. Additionally, the buildings would benefit from not being in the setting of an open cut mine.

C4.6 FINDINGS IN RELATION TO THE WHC

Future conservation of the WHC at its current location will require a significant commitment of resources and the loss of significant coal reserves (Attachment C-A) and will not improve the limited ability for use or public access, even if mining operations are restricted to areas outside the WHC and curtilage. After reviewing the State significance of the buildings in terms of their current condition and capacity to reveal heritage significance, the following conclusions have been drawn:

- Even if the proposal is modified and mining is restricted to areas outside the curtilage, deterioration due to environmental effects and lack of use will still occur and the aspect of the setting will be seriously and permanently modified. Mine rehabilitation programmes will further impact on the surrounding landscape and therefore the pastoral setting of the WHC.

- Relocation of some buildings, while achievable, will alter the historic significance because the evidence will not remain in situ. However, a level of 'cultural significance' will be retained, in particular, the technical significance of the buildings as examples of a range of early building methods will survive.

- Recovery of significant fabric from the group and its relocation to other sites may allow use and access by the public that would otherwise be alienated. This would eliminate the risk that the majority of original fabric may well disappear through weather, deterioration and as a result of general maintenance works.

Under the proposal outlined in Section C4.5, there can be a net heritage benefit with the relocation and retention of buildings and a significant amount of physical heritage fabric. If the mining proposal is modified the net heritage benefit is diminished due to the lack of public access and the restricted location of the WHC within a severely modified environment.

C5 OTHER NON-ABORIGINAL HERITAGE

In addition to the WHC, a number of other non-Aboriginal heritage items were recorded within the Project area.

C5.1 SURVEY OF THE ITEMS

Those items that were identified during field surveys as having heritage potential are shown in Figure C-5. Descriptions of these other non-Aboriginal heritage items are summarised in Table C-2.

Table C-2
Items of Non-Aboriginal Heritage Recorded within the Project Area

Site Number	Site Name	Description	Significance
Site 1	Grain Silo A	Located within the open cut mining footprint. The site includes a grain silo, hay shed and a low concrete tank. There are no significant moveable artefacts visible at the site, what remains are items such as sheets of corrugated iron and fencing wire.	No Significance
Site 2	Grain Silo B	Similar to Site 1, however lacks the low concrete tank.	No Significance
Site 3	Abandoned Homestead A	Located adjacent to Stony Creek within the underground mining footprint. The site consists of the remains of a cottage, four outbuildings and a pit mine. A number of moveable items are located at the site. The remains are ruins and therefore in very poor physical condition.	Minor Local Significance
Site 4	"Whynot" Homestead	Located to the southwest of the open cut footprint. The site is a federation period small farm site consisting of a weatherboard cottage and outbuildings. Overall the buildings are in sound condition.	Limited Local Significance
Site 5	Abandoned Homestead B	Located adjacent to Wollombi Brook in the vicinity of the Project rail loop. Homestead B consists of an abandoned cottage and shed. The physical condition of the buildings is poor.	Local Significance
Site 6	Piggery and Butcher's Hut	Located within the footprint of the Project rail loop. The Piggery and Butcher's Hut are dilapidated and beginning to fall apart.	Minor Local Significance
Site 7	Aerial Footing	Located 200 m north of Site 6. Site 7 consists of a base plate and four stay points for an aerial or other tall, thin structure.	No Significance
Site 8	"Montrose" Homestead	Located 400 m northwest of the open cut mine footprint. It consists of a brick and weatherboard homestead and a number of outbuildings including an old wool shed. The buildings are in good condition.	Slightly Significant
Site 9	Abandoned Tractor	The abandoned tractor is a Massey Ferguson circa 1955. The site is located within the open cut mine footprint.	No Significance
Site 10	Roman Catholic Cemetery	Old Roman Catholic Cemetery is located at Jerrys Plains.	Local Significance
Site 11	Old Anglican Cemetery	Old Anglican Cemetery is located at Jerrys Plains.	Regional Significance
Site 12	St Philips Anglican Church and Cemetery	St Phillips Anglican Church and Cemetery are located at Warkworth. The buildings and cemetery are in good condition.	Regional Significance

The survey results for the items in Table C-2 are presented in Attachment C-C.

A number of items of measurable historical interest have been located. In particular the piggery (Site Six) and the remnant homesteads at Sites Three and Five. The piggery has the potential to be disturbed by the rail loop, but careful location of the track should ensure the buildings remain untouched. The abandoned homestead at Site Three has archaeological interest and has the potential to reveal aspects of life in the late nineteenth and early twentieth centuries. In similar manner, the abandoned homestead at Site Five also has archaeological potential.

The effect upon these items, as with all the other items provided in Table C-2 is considered to be insignificant. Much of the other non-Aboriginal heritage within the locality can be either retained or is not significant enough to warrant retention.

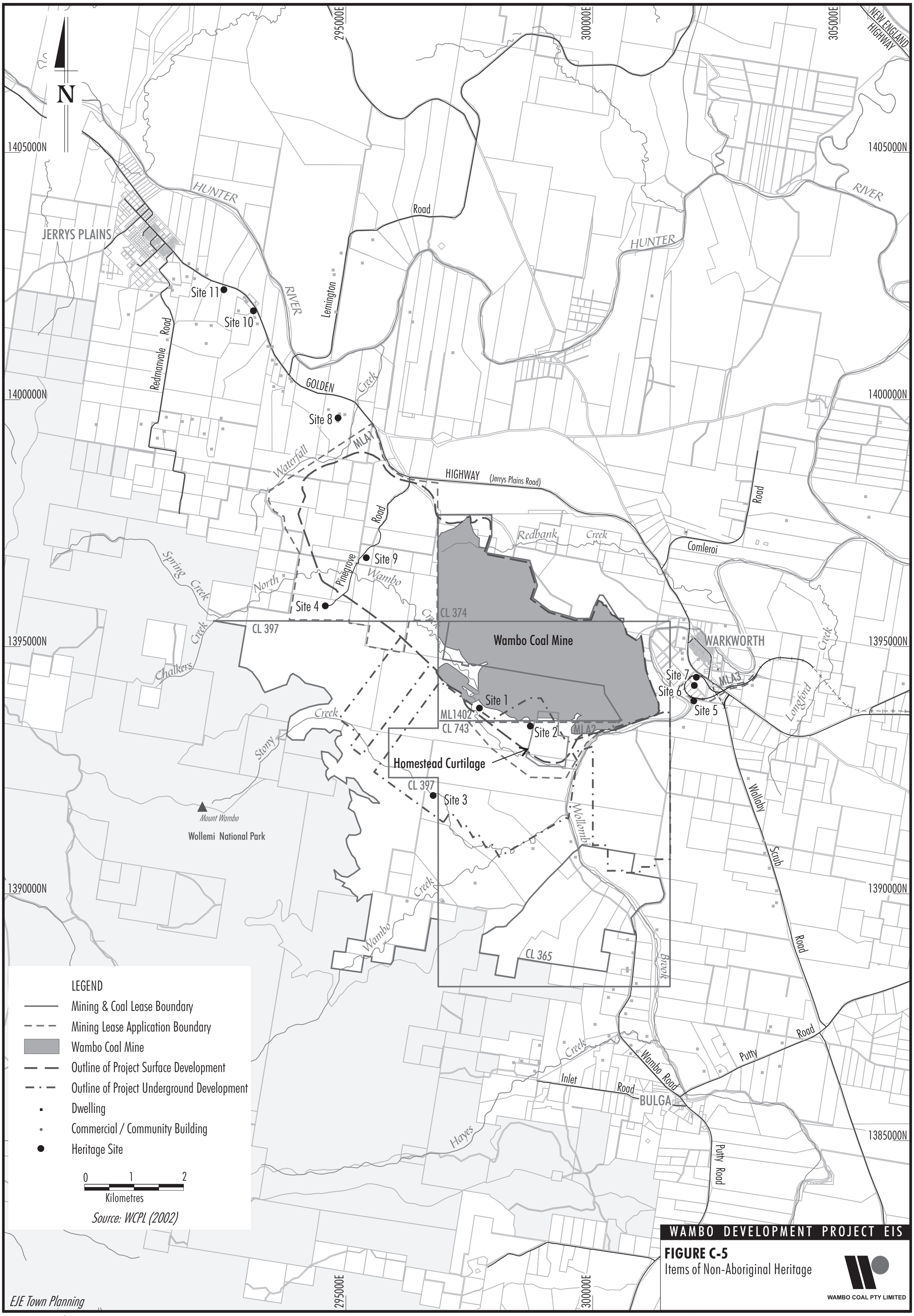


FIGURE C-5
Items of Non-Aboriginal Heritage

WAM-02-01-Non Aborg_003D

C6 HERITAGE IMPACT OF THE PROJECT

The heritage significance of the WHC is discussed in section C4 and the significance of other heritage items has been presented in section C5. The impact of the Project on items of non-Aboriginal heritage is discussed below.

The impacts of the open cut section of the proposal upon heritage items are obvious and profound. Any heritage items located within the open cut mining footprint will be destroyed.

The vibration impacts of the open cut mine may be expected to extend up to 500 metres from the edge of the open cut mining footprint. The effects of vibration would essentially be confined to masonry structures. Wood is a more forgiving construction material and is not affected by mild vibration. There are no locally or regionally significant heritage items or buildings within the subject study area that would be affected by vibration from the Project. The WHC would be subject to Project impacts from blasting and vibration prior to substantial relocation (refer to Attachment C-A).

The impact upon heritage items above the underground mining areas are confined to the affects of mine subsidence. Again, masonry structures are the most effected. Masonry buildings will crack and lose structural integrity. Wooden structures are again more likely to absorb minor subsidence without damage. However, they may be affected by severe subsidence by opening of joints which would destabilise the building. There are structures with minor local significance within the mine subsidence area that could be affected, however these structures are dilapidated and any effects from mine subsidence would not be readily detected. The WHC would be subject to the subsidence impacts described above prior to relocation.

C6.1 ASPECTS OF THE PROJECT WHICH WILL ENHANCE HERITAGE SIGNIFICANCE

The Project does not have any aspects that will significantly improve or enhance the heritage of the locality. However, by undertaking this assessment, a greater level of understanding of the local heritage has been obtained.

In addition, the recovery of significant fabric from the WHC and its relocation to other sites would allow use and access by the public that would otherwise be alienated by mining activities. The relocation of the WHC will ensure the retention of both cultural and technical significance as examples of a range of early building methods will survive. The relocation of the WHC would eliminate the risk that the majority of original fabric may well disappear through weather, deterioration and as a result of general maintenance works.

C6.2 ASPECTS OF THE PROJECT WHICH COULD IMPACT ON HERITAGE SIGNIFICANCE

The Project will involve the destruction of all visible local non-Aboriginal heritage within the open cut mining area. However, the proposal to substantially relocate the WHC (refer to section C4.5) would provide a net heritage benefit by ensuring the retention of the buildings.

Heritage items of local significance above the underground mining footprint would effectively remain undisturbed and available for future generations.

C6.3 MEASURES PROPOSED TO MITIGATE NEGATIVE IMPACTS

Measures proposed to mitigate Project impacts on items of non-Aboriginal heritage are discussed below.

WHC:

- Substantial relocation and re-erection of a number of the individual elements/buildings in the WHC, whereby retaining the physical and technical significance of the structure at another location where it can be available for public access and interpretation. The elements would include the Stud Masters Cottage, Slab Horse Boxes, Butchers Hut, Carriage House, and Circular Mounting Yards.

- Relocation of substantial elemental fabric from the Servants Wing, Kitchen Wing and New House. All significant fabric which retains its integrity would be salvaged and used elsewhere for interpretation purposes (e.g. sandstone flagging, timber joinery, timber roof structures, and sandstone bricks can be used at other local historic sites to repair and reinstate lost elements with the addition of interpretative plaques and material to identify the material as originally from WHC). Additionally, this material could be used in conjunction with some of the relocated items to enhance their provenance or as fabric available for re-use on other Heritage listed properties (e.g. repair projects).

Other items of non-Aboriginal Heritage:

- The fact that none of the heritage items above the underground section will be significantly affected by mine subsidence is a mitigating aspect of the Project.
- The heritage items located at Sites Five and Six in the vicinity of the proposed rail loop may be left unaffected by the development by designing the rail loop to ensure it does not impact those items.
- Items of moveable heritage, in particular, such items as are found within the open cut section of the proposal, can be relocated to a museum if desired.
- The impact of vibration upon masonry sections of heritage items can be mitigated by a program to ensure such damage, if it should occur, would be repaired.

C6.4 STATEMENT OF HERITAGE IMPACT

The impact of the Project open cut and underground mining areas and rail loop has been considered. A complete survey for of the effected lands has been undertaken.

The effect of the Project upon items of local heritage value (refer to Table C-2) is considered to be insignificant. Where items of local significance are to be disturbed, it is recommended that the items be recorded and that record kept in the Singleton Local Library and the NSW Library for posterity.

The proposal to relocate the WHC will provide a net heritage benefit enabling the retention of heritage values that would be otherwise diminished due to the Project.

This Heritage Impact Statement concludes that in relation to items of heritage significance, there is no reason why the proposal should not be granted consent. The proposal is therefore endorsed for approval.

C7 REFERENCES

Collins, B. (1994) *Wambo Homestead: A Conservation Plan*.

ATTACHMENT C-A

COAL RESERVES AFFECTED BY THE WAMBO HOMESTEAD

CA1 IMPACTS OF THE WHC ON THE PROJECT'S COAL RESERVES AND THE PROJECT'S ECONOMICS

CA1.1 OPEN CUT MINING

The Project proposes open cut mining through the land area occupied by the WHC and its curtilage. This is predicated on the approval of a relocation proposal for the WHC.

If the WHC is preserved, then the impact on the coal reserves is to restrict open cut mining to areas outside the curtilage. Due to the potential effects of blast vibration on the WHC's structures then open cut mining needs to be restricted to locations at some distance from the curtilage and the structures of the WHC. The full details of this impact are described in Section A2.3 below.

If the WHC is preserved in its current location then some 6.2 million tonnes of saleable coal will not be mined by open cut methods as proposed in the project. An additional 7 million tonnes of saleable coal will be more costly to mine.

CA1.2 UNDERGROUND MINING

Why Can't The 6.2 Million Tonnes Of Coal Be Mined By Underground Methods That Will Allow The WHC To Remain In Its Current Location?

Underground mining of these reserves is not practicable for the following reasons:

- Of the 4 coal seams that make up the 6.2 million tonnes of open cut coal, only the Whybrow and Wambo Seams have adequate thickness for underground mining. The Redbank Creek and Whynot Seams are too thin and contain non-coal partings which preclude underground mining.
- The available areas of these seams are limited due to the proximity of existing workings and proposed workings. As such, the available coal reserves would be limited in extent and insufficient to justify the capital investment required to open an underground mine.
- Underground mining of the Whybrow and Wambo Seams in the area beneath the WHC would not allow full extraction of the coal so as to prevent surface subsidence impacting on the WHC. Partial extraction methods for underground mining would be uneconomic for these limited reserves.

Underground mining is not a practical alternative to the proposed open cut mining to mine these coal reserves.

Other underground mining of the Wambo, Arrowfield, and Bowfield Seams is proposed by the Project. Some of these reserves will be sterilised by the preservation of the WHC. An analysis of these reserves is given in Section A2.2.1 below.

If the WHC is preserved in its current location then some 3.2 million tonnes of saleable coal will not be mined by underground methods as proposed in the Project.

CA1.3 ECONOMIC IMPACTS ON THE PROJECT OF PRESERVING THE WHC

- Some 9.4 million tonnes of coal will not be produced.
- A loss of A$450 million from the NSW economy.
- A loss to the NSW Government of A$16 million in royalty.
- A reduction in the project life of between 1 and 2 years, resulting in the loss of up to 370 jobs over that period.
- An additional 7 million tonnes of coal will be more expensive to produce and may be uneconomic depending on the market price of coal at the time.
- The reduced earnings to the company will be unavailable for investment in the mine (note that a major proportion of earnings are re-invested in the mine and other developments).

CA2 COAL RESERVES AFFECTED BY THE WAMBO HOMESTEAD COMPLEX

CA2.1 COAL SEAMS UNDERLYING THE WHC

Figure CA-1 shows a full stratigraphic column of the coal seams of the Wittingham Coal Measures underlying the Wambo Homestead Complex (WHC) and its curtilage. The Whybrow, Redbank Creek, Wambo and Wambo Riders, Whynot, Arrowfield, and Bowfield/Warkworth Seams are potentially economic coal reserves in this area. The Whynot Seam is the deepest seam with open cut mining potential.

Figure CA-2 shows a partial stratigraphic column showing the coal seams with open cut mining potential in this location. The Whybrow Seam has been previously mined by underground methods in the Homestead Colliery which mined the access roadways underneath the WHC curtilage circa 1978. The Wambo Seam which is also shown in this figure has underground mining potential and part of the area was mined by the original Wambo Colliery circa 1970.

Figure CA-3 shows a partial stratigraphic column showing the coal seams at greater depth which are proposed for underground mining in the Wambo Development Project, the Arrowfield and Bowfield Seams. The Bowfield Seam working section includes the upper plies of the underlying Warkworth Seam.

CA2.2 UNDERGROUND MINING RESERVES

Seams with underground mining potential are those where a “working section” is available which has a thickness of approximately 1.8 metres or greater. A working section may be defined as a contiguous section of the coal seam which when mined delivers an acceptable coal product after beneficiation. In the area of the WHC and curtilage, the Whybrow, Wambo, Arrowfield and Bowfield Seams have potential working sections for underground mining.

The Redbank Creek and Whynot Seams do not have a working section suitable for underground mining. They do however, have open cut mining potential and are considered in Section CA2.3 below.

To protect the WHC and its curtilage will require a mine plan which does not subside the surface of the curtilage area. Underground mining, provided it does not subside the land surface, should not have any other deleterious impact on the WHC and curtilage. Underground mining which will not subside the surface can only be “first workings” or “partial extraction”, and not longwall or total extraction.

The Wambo Development Project is proposing underground mining in the locality of the WHC and curtilage in the Wambo, Arrowfield and Bowfield Seams.

The other remaining reserves of the Whybrow and Wambo Seams within the curtilage area are proposed to be mined using open cut methods. Underground mining of these seams in this area is not economically feasible for the following reasons:

- Inadequate reserve to justify capital investment in new mine entries (noting that the Homestead Mine entries have been sealed as the roadways were no longer safe for access);
- The prior mining has reduced the available reserve and would require isolation or barrier pillars between these workings and any new workings, further limiting the available coal reserves; and
- Partial extraction of the coal, to prevent surface subsidence, will result in unacceptably high mining costs.

CA2.2.1 Economic Impact of Loss of Underground Mining Reserves

The preservation of the WHC and curtilage will sterilise reserves in the proposed Wambo Seam, the Arrowfield Seam and the Bowfield Seam Underground Mines. The coal sterilised is that in the longwall panels which if mined would cause subsidence of the curtilage area. The mine development or first workings could proceed underneath the curtilage without causing surface subsidence.

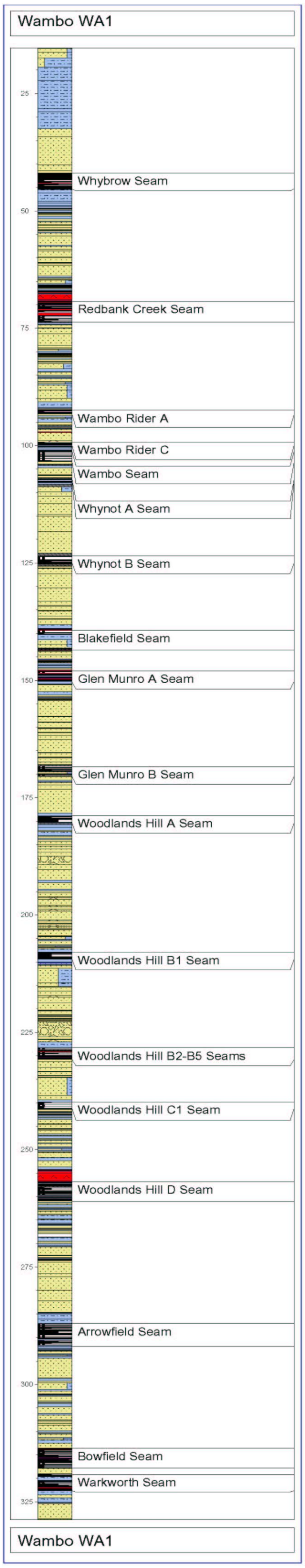


Figure CA-1: Full Stratigraphic Column

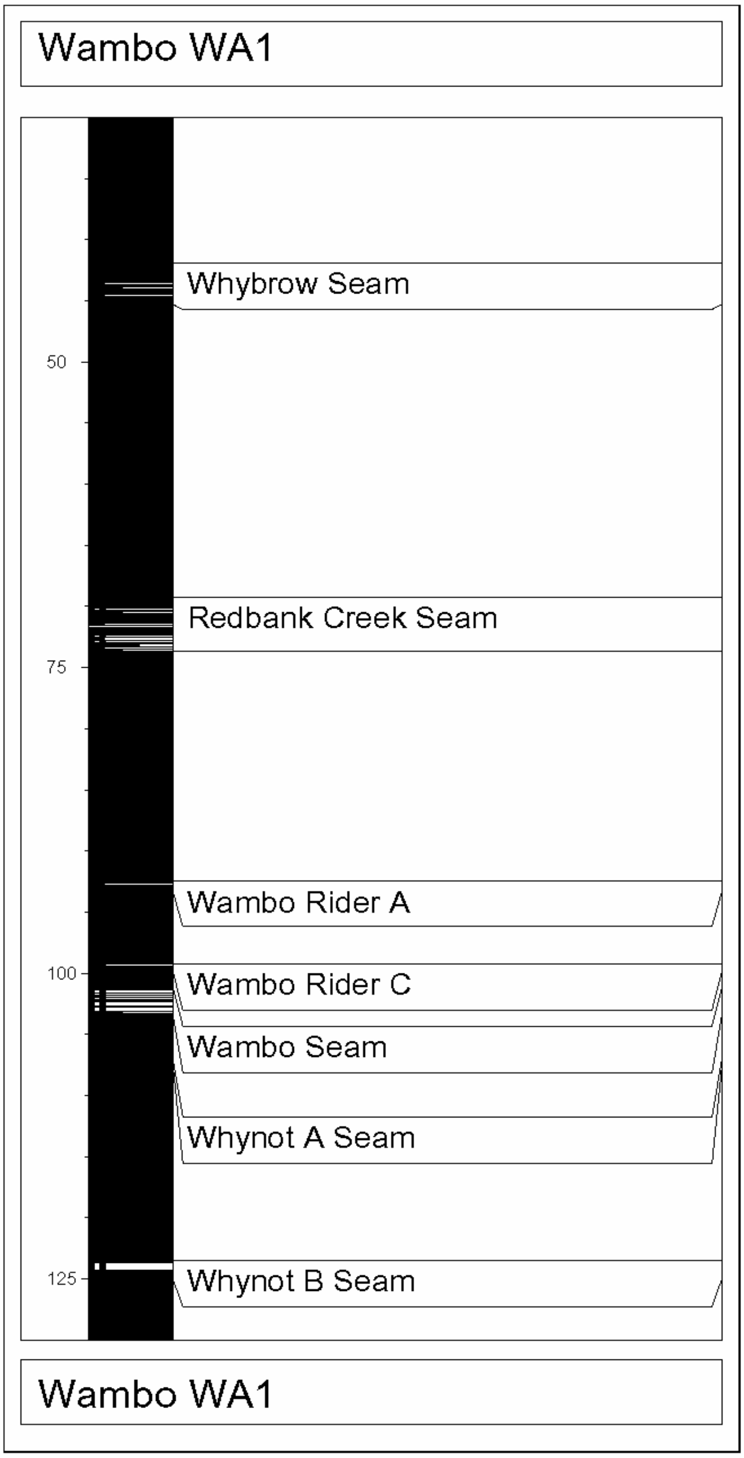


Figure CA-2: Stratigraphic Column showing Open Cut Seams

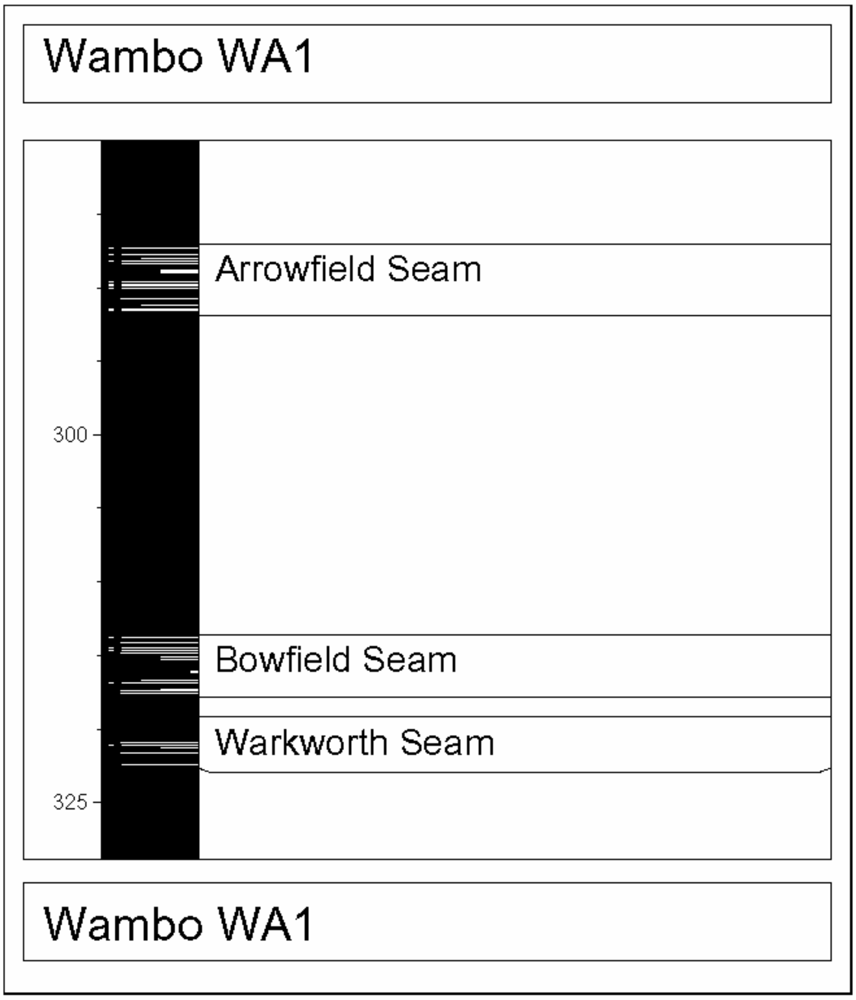


Figure CA-3: Stratigraphic Column showing Deep Underground Seams

The following table details the reserves sterilised in these three seams:

Table CA-1
Underground Coal Reserves Located within WHC Curtilage

Coal Seam	Saleable Tonnes ('000)
Wambo	440
Arrowfield	1210
Bowfield	1510
Total	**3160**

At a coal price of A$48[1] per tonne, not mining these reserves (some 3.165 million tonnes of coal) results in a loss to the NSW economy of A$152 million. The royalty payable to the NSW Government on this coal would equate to A$5.4 million.

CA2.3 OPEN CUT MINING RESERVES

Distinct from the underground mining situation, the open cut mining must stand back further from the WHC and its curtilage, due to the potential for deleterious effects caused by blasting during open cut mining. The following sections detail the loss of reserves in the proposed open cut caused by standing back from the WHC.

CA2.3.1 Blast Vibration Criteria

Australian Standard AS 2187.2-1993 "*Explosives – Storage, Transport and Use – Part 2: Use of Explosives"* (AS 2187.2-1993) nominates structural damage assessment criteria as presented in Table CA-2.

TableCA-2
Blast Emission Structural Damage Assessment Criteria (AS 2187)

Structure Type	PVS Vibration Level(1)	Airblast Level (dB re 20 µPa)
Sensitive (and Heritage)	5 mm/s	133 dB(Linear) Peak
Residential	10 mm/s	133 dB(Linear) Peak
Commercial/Industrial	25 mm/s	133 dB(Linear) Peak

Note 1: PVS - Peak Vector Sum vibration velocity.
Source: Richard Heggie Associates (2003).

For Sensitive and Heritage structures, AS 2187.2-1993 (Table CA-2) nominates a Peak Vector Sum (PVS) vibration velocity of 5 mm/s as the maximum vibration to which a structure can be subjected without causing damage.

CA2.3.2 Blast Design Parameters

Assessment of the potential impacts of ground-borne vibration at the Project, arising from overburden blasting has been based on the "typical" blast design parameters presented in Table CA-3.

[1] Based on historic and current contract coal prices (weighted average) and future market considerations (WCPL).

Table CA-3
Provisional Overburden Blast Design Parameters

Parameter	Typical Ranges
Burden and Spacing	5 m to 7 m and 5 m to 10 m
Hole Diameter	200 mm
Bench Height	5 to 24 m
Holes per Delay	Typically 2 holes
Explosive Type	ANFO or Emulsion
Explosive Mass	25 kg/m or 38 kg/m
Maximum Instantaneous Charge (MIC)	MIC 1600 kg
Powder Factor	Typically 0.50 kg/m^3

Source: Richard Heggie Associates (2003).

The Maximum Instantaneous Charge (MIC or “charge per delay”) of 1,600 kg is the standard blast design used at Wambo Coal Mine. However, it is considered that the MIC can be reduced in the vicinity of the WHC curtilage by way of changing parameters such as explosives type, holes per delay, bench height, and hole diameter. The practical minimum MIC blast design is however considered to be 400 kg.

Blasting designs for both MIC 1,600 kg and MIC 400 kg were considered when determining the size of blasting buffer zones required to isolate the WHC curtilage from blasting impacts.

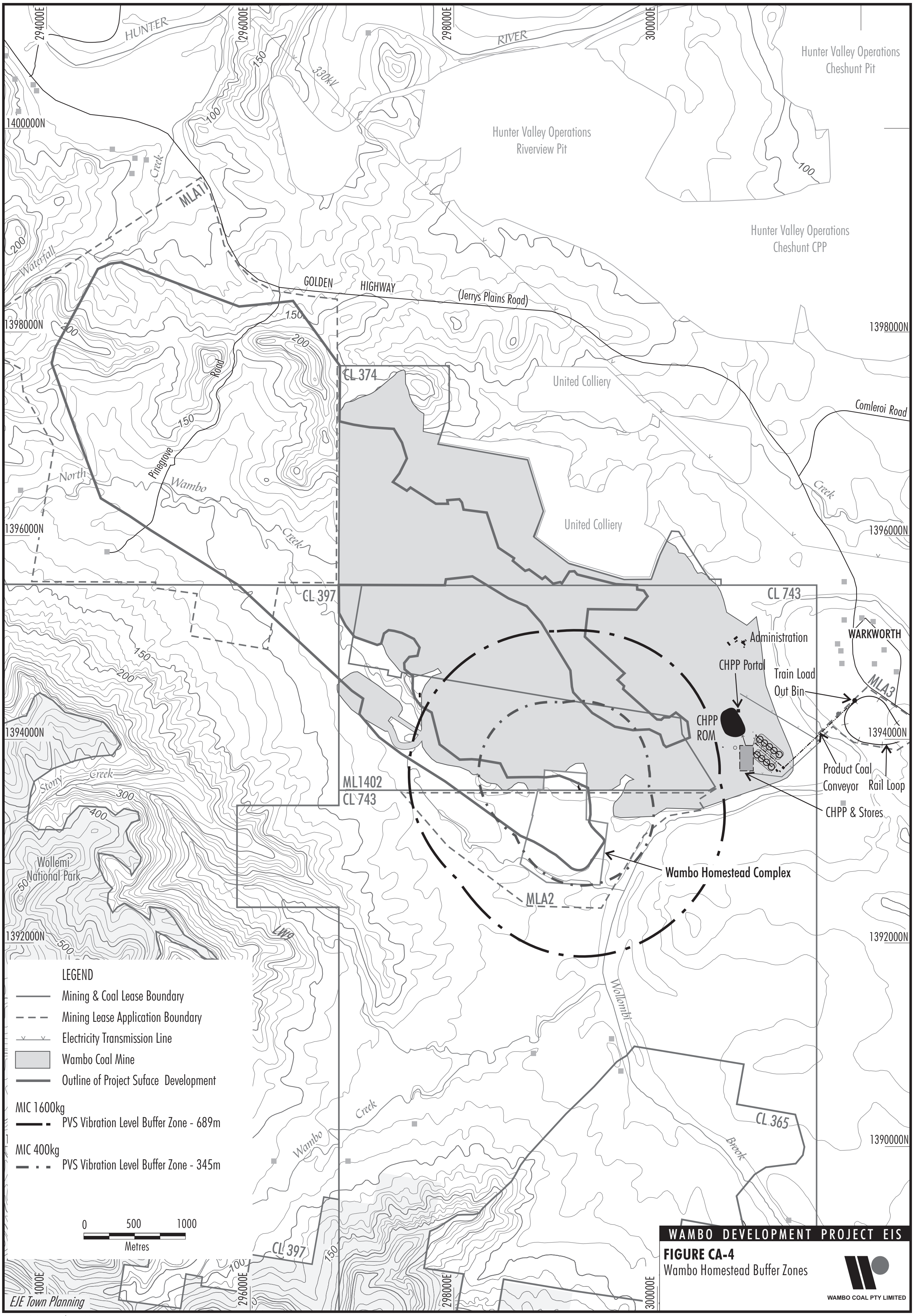
CA2.3.3 Blasting Buffer Zones

The WHC curtilage, the proposed open cut mine and buffer zones for MIC 1,600 kg and MIC 400 kg are shown on Figure CA-4. The buffer zones have been calculated as the minimum distances from the WHC where blasts can be fired and not exceed the 5mm/s PVS (Table CA-2) at the items. The larger (orange) zone is the calculated distance from the heritage items where a blast with a MIC of 1,600 kg can be fired without exceeding the 5 mm/s PVS at the heritage items. The smaller (yellow) zone is the calculated distance from the WHC where a blast with a MIC of 400kg can be fired without exceeding the 5 mm/s PVS at the heritage items.

As above, the practical minimum blast design is MIC 400 kg, therefore the coal located within the MIC 400 kg (yellow) zone would not be able to be mined using conventional open cut blasting techniques. The coal located outside the MIC 400 kg zone, but within the MIC 1,600 kg zone, would be able to be mined (using a modified blast design of nominal MIC 400 kg) but at an increase in drilling and blasting costs. These costs would add between $0.50 and $1.00 per saleable tonne.

CA2.3.4 Mining Within the Blasting Buffer Zones

The four target coal seams in the proposed open cut mine are the: Whybrow, Redbank Creek, Wambo, and Whynot Seams (Figure CA-2). Table CA-4 details the coal reserves within the two buffer zones.



WAMBO DEVELOPMENT PROJECT EIS

FIGURE CA-4
Wambo Homestead Buffer Zones

WAMBO COAL PTY LIMITED

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Table CA-4
Coal Reserves Located within Blasting Buffer Zones

	MIC 1,600 kg	**MIC 400 kg**
Coal Seam	**Saleable Tonnes ('000)**	**Saleable Tonnes ('000)**
Whybrow	2,440	1,660
Redbank Creek	3,820	1,730
Wambo	4,260	1,790
Whynot	2,720	1,030
Total	**13,240**	**6,210**

It is not considered feasible to mine these seams by methods other than conventional open cut techniques. The Redbank Creek, Wambo and Whynot seams do not have a working section of sufficient thickness to support an underground mining method and the Whybrow seam does not have a sufficient reserve to support an underground mine.

CA2.3.6 Economic Impact of Loss of Open Cut Mining Reserves

At a coal price of A$48 per tonne, not mining the area within the MIC 400 kg blasting zone (some 6.2 million tonnes of coal) results in a loss to the NSW economy of A$298 million. The royalty payable to the NSW Government on this coal would equate to A$10.6 million. A further (approximately) 7 million tonnes of coal (located between the buffer zones) would be more expensive to mine. The net effect of this would likely be that a portion of this 7 million tonnes of coal would be rendered uneconomic. The total actual loss to the NSW economy and reduction in State royalties would be slightly greater than the figures presented above.

CA2.4 ECONOMIC IMPACT OF LOSS OF MINING RESERVES

The total loss to the NSW economy and the loss of royalty is shown in Table CA-5.

Table CA-5
Economic Impact of Loss of Mining Reserves

Mining Method	**Loss to NSW Economy (A$M)**	**Loss of Royalty (A$M)**
Underground	152	5.4
Open Cut	298	10.6
Total	**450**	**16**

CA3 REFERENCES

Richard Heggie & Associates. (2003), Wambo Development Project Noise and Blasting Impact Assessment. Report Prepared for Wambo Coal Pty Limited.

ATTACHMENT C-B

WAMBO HOMESTEAD COMPLEX HERITAGE LISTING

NSW Heritage Office

Listing Heritage Items

State Heritage Register Search Results

Wambo & Outbuildings

Item

Name of Item: Wambo & Outbuildings
Type of Item: Area/Complex/Group
Group/Collection: Farming and Grazing
Category: Homestead Complex
Primary Address: Warkworth, NSW 2330
Local Govt. Area: Singleton
Property Description:

Lot/Volume Code	Lot/Volume Number	Section Number	Plan/Folio Code	Plan/Folio Number
LOT	82	-	DP	548749

All Addresses

Street Address	Suburb/Town	LGA	Parish	County	Type
	Warkworth	Singleton	Lemington	Hunter	Primary

Owner/s

Organisation Name	Owner Category	Date Ownership Updated
Wambo Mining Corporation Pty Ltd	Private	08 Apr 99

Statement of Significance

Wombo Homestead is highly significant in the context of Australian pastoral activities and horse breeding in New South Wales. The use of Wombo relates directly to the economic climate and resource based needs of the Colony and State. It is an important group of homestead buildings which remain substantially intact and display the progressive architectural development of a typical Australian homestead.
Date Significance Updated: 11 Dec 01
Note: There are incomplete details for a number of items listed on the State Heritage Register. The Heritage Office intends to develop or upgrade statements of significance for these items as resources become available.

Description

Construction Years: 1830 -

Physical Description: The Homestead is presently comprised of eight buildings, the earliest being the kitchen wing. Originally this was a single storey sandstone building with a cellar, to which a brick upper floor was added. A large brick laundry has also been added. Other buildings include the Stud Master's Cottage of three rooms and the brick servants wing of three rooms also. All are 'Old Colonial Georgian', the earliest European architectural style used in Australia. Around 1844, the 'Victorian Regency' New House was built. Its architectural style based on the Georgian vernacular. The New House was constructed of brick and render with a stone base. It contains four rooms off a central corridor under the main roof with four additional rooms under the main roof. Other

	buildings which make up the Homestead are the Slab Carriage House with Stables, the timber slab / rammed earth Butcher's Hut and the Slab Horse Boxes. Other remote structures exist on the property including a large hay barn, silos and fences.
Physical Condition and/or Archaeological Potential:	As a group of buildings, Wambo Homestead is rare in New South Wales in that many outbuildings still remain substantially intact allowing easy understanding of the development of a homestead complex. **Date Condition Updated:** 11 Dec 01
Modifications and Dates:	1830's - Single brick Stud Master's Cottage and Servants Wing constructed possibly while the brick upper floor to the kitchen wing was added. 1837 - Homestead was situated on 4480 acres and included a large brick structure with cellars. 1844 (circa) - The New House was constructed. The construction of the Carriage House and Stables would have been contemporary with the building of the New House.

Assessment of Significance

SHR Criteria a) [Historical Significance]	Wambo Homestead shows the development of pastoral activities in the Hunter Valley after J.T Bigge's reports on the state of the colony and its administration to the British Government. It specifically shows the pattern of selection by residents of Windsor via John Howe's newly established Bulga Road. Wambo provides evidence of the rise to wealth of James Hale, a former convict and important resident of Windsor. Wambo Homestead is a rare example which demonstrates the economic development of the Hunter Valley Region from an agricultural base through sheep, cattle and horse breeding to dairying and presently coal mining. The process involved in gaining the best economic opportunities from the property can be clearly seen.
SHR Criteria b) [Associative Significance]	As the creation of the convicted thief, James Hale, Wambo Estate demonstrates the enormous opportunities open to the pioneers of New South Wales. Within two decades a farm boy serving a seven year prison term had become wealthy and influential in two districts, the Hawkesbury and the Hunter Valley. In the Durham period, the property continued to yield affluence to its owners, allowing the children of convicts to control the circumstances of their lives and to live with some style.
SHR Criteria c) [Aesthetic Significance]	Wombo Homestead remains substantially intact and largely unaltered. The buildings follow the architectural vocabulary of vernacular Georgian England and are elementary in design, symmetrical and consist of the simplest combination of rooms. Interior finishes and furnishings reflect conditions on the frontier where isolation and poor roads necessitated local manufacture.
SHR Criteria d) [Social Significance]	Wambo Homestead demonstrates the opportunities available to energetic people who were transported to NSW in the early decades of the 19th century. Wambo Homestead is significant in terms of its distance from Hales place of residence, Windsor, and because of its position in the broadening agricultural enterprises of pioneer settlers. The group of buildings express the way farms were operated, with an emphasis on manual labour, and the use of the horse for work and transport. As the residence of William and Sophia Durham the homestead has associative social significance in the Hunter Valley. This is evident in the substantial development of the Homestead in the early years and the descriptions of lifestyle afforded by visiting commentators of the period. Further, the development of the Horse Stud infrastructure by the Allen and McDonald partnership provides physical evidence of the social and sporting aspirations of elite residents of Sydney at the turn of the 20th century.
SHR Criteria e) [Research Potential]	As an archaeological resource the buildings and surrounding grounds provided an opportunity to contribute to the knowledge regarding the expansion of the colony of New South Wales, its agricultural diversification and every day life on homestead properties from the 1820's till the 1890's.
SHR Criteria f) [Rarity]	As a group of buildings, Wambo Homestead is rare in New South Wales in that many outbuildings still remain substantially intact allowing easy understanding of the development of a homestead complex.
Assessment Criteria	Items are assessed against the **State Heritage Register (SHR) Criteria** to determine the level of significance. Refer to the Listings below for the level of statutory protection.

Listings

Heritage Listing	Listing Title	Listing Number	Gazette Date	Gazette Number	Gazette Page
Heritage Act - State Heritage Register		00200	02 Apr 99	27	1546
Heritage Act - Permanent Conservation Order - former		00200	03 Sep 82	116	4087
Local Environmental Plan		1996	05 Jul 96	081	3907

References

Type	Author	Year	Title
Management Plan	Bernard Collins	1994	*Wambo Homestead Near Warkworth, New South Wales, A conservation Study*
Written	Bernard Collins	1994	*Wambo Homestead Near Wakworth NSW: A Conservation Management Plan*

Procedures /Exemptions

Section of Act	Description	Title	Comments	Action Date
57(2)	Exemption to allow work	Standard Exemptions	The Schedule of new standard exemptions and notification form can be downloaded from the Heritage Office website.	Mar 7 2003

Source of information for this entry

Name: NSW Heritage Office
Email: watters@heritage.nsw.gov.au
Web Page: www.heritage.nsw.gov.au

Administration

Database Number: 5045018
File Number: S90/07120 & HC 30487,

Every effort has been made to ensure that information contained in the State Heritage Inventory is correct. If you find any errors or omissions please send your comments to the Database Manager.

ATTACHMENT C-C

RESULTS OF NON-ABORIGINAL HERITAGE SURVEY

C-C1 OTHER NON-ABORIGINAL HERITAGE

In addition to the Wambo Homestead Complex, a number of other non-Aboriginal heritage items were recorded within the Project area.

C-C1.1 SURVEY OF ITEMS

Those items that were identified during field surveys as having heritage potential are shown in Figure C-1 and are discussed below.

C-C1.1.1 Site One – Grain Silo A

Site one lies within the area of the proposed open cut mine. It includes a grain silo, hay shed and a low concrete tank which would have been used as a cattle trough. There are no significant moveable artefacts visible at the site, what remains are items such as sheets of corrugated iron and fencing wire.

Figure 1 – *Site One*

C-C1.1.1.1 Location

Site One is located within the area of the original Wambo Estate and was probably constructed after the subdivision of the land in 1900.

C-C1.1.1.2 Physical Condition

The physical condition of structures at Site One is poor. The timber of the hay shed is termite-damaged and no longer structurally sound. The roof sheeting is lifting and in places has been blown off. The circular cattle trough is broken on one side. The silo remains in reasonably good condition.

C-C1.1.1.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

The construction of the grain silo, hay shed and cattle trough almost certainly occurred after 1900 when Wambo was subdivided and used for dairy farming. The grain silo, hay shed and cattle trough are relatively common relics of farming communities. The use of concrete suggests that these items are no older than 60 to 70 years. The items have no significance in relation to this criterion.

Importance in Relation to a Person, or Group of Significance

The silo is within the area of the original Wambo estate owned by James Hale. However, the association with James Hale, his heirs and successors is not considered to be significant.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

The design and construction of the grain silo, hayshed and concrete tank are considered to be typical of their era and of no particular importance in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

Site one is considered to be of no importance in terms of a community or cultural group for spiritual, social or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

Site one is not considered to have the potential to yield any significant information that will contribute to cultural or natural history.

Exhibits Rare or Endangered Aspects Cultural/Natural History

Site one is not considered to exhibit any rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

The silo at Site One is typical of its type and therefore is representative of its class. However this type of silo is common within the locality and within NSW.

C-C1.1.1.4 Statement of Heritage Significance

The items at Site One are not considered to be significant.

C-C1.1.1.5 Mitigation and Management

Site one will be destroyed by the development of the open cut mine. Mitigation of this impact should be in the form of establishing a written description and photographic record.

C-C1.1.2 Site Two – Grain Silo B

Site Two is remarkably similar to Site One, lacking only the concrete water trough. Site Two also lies within the area of the proposed open cut mine and is closer to the site of the Wambo Homestead than Site One. It includes a grain silo and hay shed. There are no significant moveable artefacts visible at the site, what remains are items such as sheets of corrugated iron and fencing wire.

Figure 2 – *Site Two*

C-C1.1.2.1 Location

Site Two is located adjacent to the western side of the curtilage boundary of the Wambo Homestead group of buildings. It is located within the area of the original Wambo estate and was probably constructed after the subdivision of the land in 1900.

C-C1.1.2.2 Physical Condition

The physical condition of structures at Site Two is poor. As with Site One, the timber of the hay shed is termite-damaged and no longer structurally sound. The roof sheeting is lifting and in places has been blown off. The silo remains in reasonably good condition.

C-C1.1.2.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

The construction of the grain silo and hay shed almost certainly occurred after 1900 when Wambo was subdivided and used for dairy farming. The grain silo and hay shed are relatively common relics of farming communities. The use of concrete suggests that these items are no older than 60 to 70 years. The items have no significance in relation to this criterion.

Importance in Relation to a Person, or Group of Significance

The silo at Site Two is within the area of the original Wambo estate owned by James Hale. It is located closer to the Homestead than the silo located at Site One. However, the association with the estate, James Hale, or his heirs and successors is not considered to be significant.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

The design and construction of the grain silo, hayshed and concrete tank are considered to be typical of their era and of no particular importance in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

Site Two is considered to be of no importance in terms of a community or cultural group for spiritual, social or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

Site Two is not considered to have the potential to yield any significant information that will contribute to cultural or natural history.

Exhibits Rare or Endangered Aspects Cultural/Natural History

Site Two is not considered to exhibit any rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

The silo at Site Two is typical of its type and therefore is representative of its class. However this type of silo is common within the locality and within NSW.

C-C1.1.2.4 Statement of Heritage Significance

The items at Site Two are not considered to be significant.

C-C1.1.2.5 Mitigation and Management

Site Two will be destroyed by the development of the open cut mine. Mitigation of this impact should be in the form of establishing a written description and photographic record.

C-C1.1.3 Site Three – Abandoned Homestead A

Site Three is spread over several acres and includes the remains of a cottage, 4 outbuildings, and what appears to be a pit mine (Figure C-7). A number of moveable relics are located at Site Three, including a winch, which presumably was located above the mine opening that now lies to one side

Figure 3 – *Remains of cottage*

Figure 4 – *Remains of mine head*

Figure 5 - *Remains of outbuilding*

Figure 6 – *Remains of vehicle shed*

C-C1.1.3.1 Location

The location lies on Stony Creek just within the proposed underground mining area.

C-C1.1.3.2 Physical Condition

The remains are in ruins, and therefore in very poor condition given their relatively recent age.

C-C1.1.3.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

The Land upon which Site Three is located was part of the subdivision of the Wambo Estate in 1900 and was therefore settled some time after 1900. The buildings all appear to date from that period, or later and include such items as a tractor/vehicle shed (Figure C-9).

Importance in Relation to a Person, or Group of Significance

The association with the Wambo estate is limited to the fact that the parcel was divided from that estate. There is no significance derived from that linkage.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

Site Three is considered to have no particular importance in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

Site Three is considered to be of no importance in terms of a community or cultural group for spiritual, social or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

The site has the potential to yield cultural information concerning the buildings located upon it. The value of this information is limited in heritage terms but has a certain degree of interest in archaeological terms. The site may be considered to have limited local significance.

Exhibits Rare or Endangered Aspects Cultural/Natural History

The site exhibits no rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

The site is too dilapidated to have any representative value. Better examples of Federation period small Homestead sites are readily found within the locality and within NSW generally.

C-C1.1.3.4 Statement of Heritage Significance

Site Three is considered to have minor local significance based upon the potential to reveal archaeological information concerning federation period farm sites.

C-C1.1.3.5 Mitigation and Management

Site 3 is located within an existing subsidence area. Any further subsidence which results from the Project is unlikely to exacerbate the already severely dilapidated condition of the building. As a precaution against any further impacts a written description and photographic record of Site 3 should be established

C-C1.1.4 Site Four – "Whynot" Homestead

"Whynot" is a federation period small farm site that is currently occupied by the Long family. The land upon which it is located was part of Wambo Estate until 1900 when it was subdivided off and sold. The property remains as a functioning cattle property.

Figure 7 – *Vehicle shed*

Figure 8 – *Cottage*

Figure 9 – *Rear view of buidings*

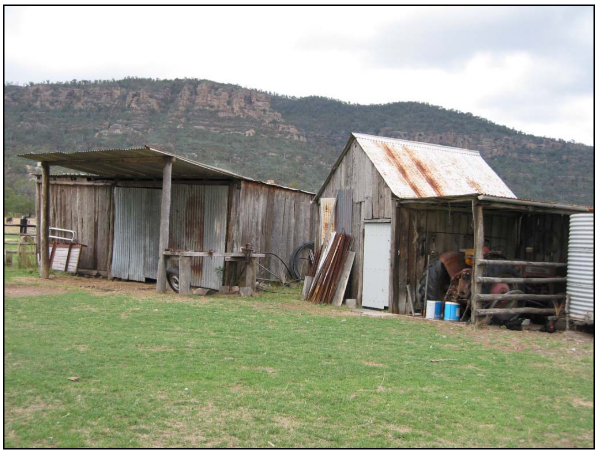

Figure 10 – *Out buildings*

C-C1.1.4.1 Location

"Whynot" is located west of the Wambo Homestead.

C-C1.1.4.2 Physical Condition

The cottage is weatherboard with a galvanized iron roof and brick chimney. The outbuildings are also of timber and galvanized iron construction. Some of the sheds are constructed using vertical wooden slab walls. Overall, the buildings are in generally sound condition.

C-C1.1.4.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

The land upon which Site Four is located was part of the Wambo estate until 1900 when the estate was subdivided. The Cottage and out building were built after that subdivision and have slight significance due to the fact that they reflect the change in agricultural practice from pastoral grazing to dairy farming and the break up of the Wambo Estate. It is worth noting that the agricultural use has now reverted back to pastoral cattle grazing.

Importance in Relation to a Person, or Group of Significance

The association of Site Four with the Wambo estate is limited to the fact that the parcel of land upon which it is situated was divided from that estate. There is no significance derived from that linkage.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

The design and construction of the cottage and outbuildings are considered to be typical of their era and of no particular importance in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

Site Four is considered to be of no importance in terms of a community or cultural group for spiritual, social or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

The cultural and natural historic value of Site Four is limited in heritage terms and is not considered significant.

Exhibits Rare or Endangered Aspects Cultural/Natural History

The site exhibits no rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

“Whynot” is representative of federation period small pastoral holdings. However, such holdings are common to the locality and NSW.

C-C1.1.4.4 Statement of Heritage Significance

Site Four is considered to have limited local significance based upon the manner in which it reflects the break-up and redevelopment of the original Wambo Estate after 1900.

C-C1.1.4.5 Mitigation and Management

The cottage and buildings of Site Four will not be directly affected by the proposal. There is the potential for indirect impacts in the form of vibration from blasting operations in the open cut mine. These indirect impacts are addressed by the Noise and Blast Vibration Assessment presented in the Environmental Impact Statement. No specific mitigation measures are considered necessary.

C-C1.1.5 Site Five – Abandoned Homestead B

Figure 11 – *Abandoned cottage*

Figure 12 – *Abandoned shed, with the abandoned cottage in the background*

C-C1.1.5.1 Location

This homestead is located is adjacent to Wollombi Brook. The proposed rail loop will pass just north of the homestead. The homestead is however located outside of the boundary of the proposed rail loop (see Figure C-1).

C-C1.1.5.2 Physical Condition

The physical condition of the building is poor. It appears to have been abandoned for approximately 50 years.

C-C1.1.5.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

The homestead building of Site Five appears to be of a style consistent with buildings of the Victorian style of architecture. It is considered to date from between 1860 and 1880. It has minor significance in this respect due to its age and the pattern of development of the locality.

Importance in Relation to a Person, or Group of Significance

The building's importance in terms of its relationship to a particular person or group of significance has not been able to be determined.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

Site Five has no importance in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

Site Five has no importance to the community or a cultural group for spiritual, cultural or social reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

The site is considered to have minor potential to yield technical information concerning the buildings located upon it.

Exhibits Rare or Endangered Aspects Cultural/Natural History

The site exhibits no rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

This building is representative of late nineteenth century farm cottages. Cottages of this type and period are not common in the local area. It is therefore considered to be of moderate significance in these terms.

C-C1.1.5.4 Statement of Heritage Significance

This site is not listed in any heritage study, but is considered to be of local heritage significance due to its architectural style and age.

C-C1.1.5.5 Mitigation and Management

This item will be unaffected by the proposal. The rail loop alignment will not encroach within the curtilage of Site Five.

C-C1.1.6 Site Six – Piggery and Butcher's Hut

Figure 13 – *Piggery - South yard*

Figure 14 – *Piggery – North yard*

Figure 15 – *Butchers shed*

Figure 16 – *Interior of Butchers shed*

C-C1.1.6.1 Location

The piggery and Butchers shed lie within the proposed Rail Loop. The piggery and shed appear to be both dating from circa 1900.

C-C1.1.6.2 Physical Condition

Both buildings are dilapidated and beginning to fall apart. The butcher's shed in particular is suffering form termite attack and is no longer sound.

C-C1.1.6.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

Prior to the widespread use of refrigeration, the piggery would have been an important facility for the locality of Warkworth in the early twentieth century. It is apparent that the piggery declined and appears to have been abandoned for some 50 years.

Importance in Relation to a Person, or Group of Significance

The site is not considered important in relation to a person or group of significance.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

The site is considered to be of minor local importance in terms of its technical characteristics, such as its ability to demonstrate the domestication and housing of farm animals.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

The site is not considered important to the community or a cultural group for social, spiritual or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

The piggery and butchers shed have minor potential to yield information concerning the practices of the domestication and housing of farm animals.

Exhibits Rare or Endangered Aspects Cultural/Natural History

The site exhibits no rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

The two buildings are representative of this type of small scale food production facility for smaller townships at the turn of the nineteenth century. The buildings are considered to be of minor significance for that reason.

C-C1.1.6.4 Statement of Heritage Significance

It is considered that the piggery and butchers shed together form an item of minor local significance as they clearly demonstrate a facet of life of the inhabitants of Warkworth at the time.

C-C1.1.6.5 Mitigation and Management

This item should remain unaffected by the proposal. Care should be taken to ensure that no harm comes to the structures by the laying of the rail loop. The piggery and butcher's shed will be clearly identified during construction to prevent accidental damage. No other measures are considered necessary.

C-C1.1.7 Site Seven – Aerial Footing

Site Seven contains the remains of what appears to be some sort of base plate and four stay points for what is assumed to be an aerial of other tall thin structure. This footing shown below, was found on land owned by Wambo Coal and is assumed to be work associated with part of the earlier mining operations.

Figure 17 – *Base plate (note the stay point to the top left of the photo)*

Figure 18 – *Typical stay point*

C-C1.1.7.1 Location

The base plate is located some 200 metres north of the piggery within the area of the proposed rail loop.

C-C1.1.7.2 Physical Condition

The structure does not appear to be that old and is considered to be circa 1970's vintage.

C-C1.1.7.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

The site is not considered important in the course or pattern of cultural / natural history.

Importance in Relation to a Person, or Group of Significance

The site is not considered important in relation to a person or group of significance.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

The site is not considered important in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

The site is not considered important to the community or a cultural group for social, spiritual or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

The site is not considered to have the potential to yield information that will contribute to cultural or natural history.

Exhibits Rare or Endangered Aspects Cultural/Natural History

The site exhibits no rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

The site is not considered to be representative of the principle characteristics of a cultural or natural class of items.

C-C1.1.7.4 Statement of Heritage Significance

This site has no heritage significance.

C-C1.1.7.5 Mitigation and Management

No measures are considered necessary.

C-C1.1.8 Site Eight – "Montrose" Homestead

Montrose is a brick and weatherboard building that has had many obvious alterations to the physical structure of the building. It has a number of out buildings, including an old wool shed some 400 metres to the north west, near the entry point to the Golden Highway. Montrose includes some more modern buildings as well, such as the manager's residence.

Figure 19 – *Montrose homestead*

Figure 20 – *Montrose homestead*

Figure 21 – *Montrose woolshed*

Figure 22 – *Montrose woolshed*

C-C1.1.8.1 Location

Montrose is located outside the proposed open cut mine and is approximately 500 metres from the edge of the proposed operations. As such it is only just within the scope of consideration under this assessment.

C-C1.1.8.2 Physical Condition

The buildings appear in reasonable condition. There have been numerous modern additions to the original building, which has also been modified in terms of replacement windows and other similar alterations.

C-C1.1.8.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

Montrose appears to be near to the edge of the original land grant to Smith, shown on Robert Dixon's 1837 map of the colony, but the buildings on the site by no means approach that vintage. Montrose appears to have been constructed in the Federation period, circa 1910.

Importance in Relation to a Person, or Group of Significance

The site is not considered to have importance in relation to a person or group of significance.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

The site is not considered important in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

The site is not considered to be important to the community or to a cultural group for social, spiritual or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

Montrose has the ability to yield information concerning the management and operation of post 1900 pastoral properties.

Exhibits Rare or Endangered Aspects Cultural/Natural History

The site exhibits no rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

The old woolshed is considered to be representative of its type.

C-C1.1.8.4 Statement of Heritage Significance

The woolshed in Site Eight is considered to be slightly significant in terms of its heritage and the ability to yield information that might contribute to the cultural history of the wool industry in the early part of the twentieth century.

C-C1.1.8.5 Mitigation and Management

The buildings of Site Eight will not be directly affected by the proposal. There is the potential for indirect impacts in the form of vibration from blasting operations in the open cut mine. These indirect impacts are addressed by the Noise and Blast Vibration Assessment presented in the Environmental Impact Statement. No specific mitigation measures are considered necessary.

C-C1.1.9 Site Nine – Moveable Heritage – An Abandoned Tractor

Figure 23 – *Abandoned Tractor*

Figure 24 - *Abandoned Tractor*

C-C1.1.9.1 Location

The site is located within the proposed open cut mine area on Portion 95. The site is described in Figure C-1 as "Site Nine."

C-C1.1.9.2 Physical Condition

The tractor appears to be a Massey Ferguson. It does not appear to be that old and is considered to be circa 1955's vintage. It is in poor condition with most components missing.

C-C1.1.9.3 Heritage Assessment Criteria

Importance in the Course or Pattern of Cultural/Natural History

The site is not considered important in the course or pattern of cultural / natural history.

Importance in Relation to a Person, or Group of Significance

The site is not considered important in relation to a person or group of significance.

Importance in Terms of Aesthetic/Technical/Creative Characteristics

The site is not considered important in terms of aesthetic, technical or creative characteristics.

Importance to a Community/Cultural Group for Social/Spiritual/Cultural Reasons

The site is not considered important to the community or a cultural group for social, spiritual or cultural reasons.

Potential to Yield Information that will Contribute to Cultural/Natural History

The site is not considered to have the potential to yield information that will contribute to cultural or natural history.

Exhibits Rare or Endangered Aspects Cultural/Natural History

The site exhibits no rare or endangered aspects of cultural or natural history.

Representative of Principle Characteristics of a Cultural/Natural Class of Items

The site is not considered to be representative of the principle characteristics of a cultural or natural class of items. The tractor is not considered representative as it has lost most of its components.

C-C1.1.9.4 Statement of Heritage Significance

The tractor and the site have no heritage significance.

C-C1.1.9.5 Mitigation and Management

No measures are considered necessary.

C-C1.1.10 Sites Ten and Eleven – Cemetery Sites

During the site survey, reference was made to two cemetery sites near Jerry's Plains that may be affected by the proposal. The names of the cemeteries at Jerrys Plains are:

- "Old Anglican Cemetery"
- "Old Roman Catholic Cemetery"

A search for these cemeteries was made and therefore reference to them is included in this assessment. The sites are shown as sites 10 and 11 located on the map in Figure C-1.

C-C1.1.10.1 Location

The sites of the cemeteries are well clear of the proposed mine, being located approximately 4 kilometres to the north-west.

C-C1.1.10.2 Physical Condition

The physical condition of the cemeteries was not inspected, as they are located well outside the survey area.

C-C1.1.10.3 Statement of Heritage Significance

No statement of significance is made for these items in this assessment.

C-C1.1.10.4 Heritage Impact

The importance of the cemeteries has not been assessed in this report as they are clearly outside the geographic parameters of this Heritage Assessment.

C-C1.1.10.5 Mitigation and Management

No measures are considered necessary.

C-C1.1.11 Site Twelve – St Philips Church and Cemetery, Warkworth

During the public submissions, reference was made to St Philips Church and Cemetery. The site is shown as Site 12 on Figure C-1.

C-C1.1.11.1 Location

The sites of the church and cemetery are located well clear of the proposed rail loop, being some 500 metres to the north of the proposed rail line.

C-C1.1.11.2 Physical Condition

The physical condition of the church and cemetery was inspected. However a complete assessment was not considered necessary, as they are located well outside the survey area.

C-C1.1.11.3 Statement of Heritage Significance

St Phillips Church and cemetery is listed on the Singleton LEP as having Regional Significance and is listed on the NSW State Heritage Inventory.

C-C1.1.11.4 Heritage Impact

It is not considered that the rail line impinges upon the visual curtilage of the church and cemetery, which are part of the village of Warkworth. While they are located upon the edge of the village and have a rural vista across the proposed rail loop, that vista is not considered to be a significant part of the heritage of the church and cemetery. Potential visual, noise, vibration and air quality impacts on the Church are assessed in the Project Environmental Impact Statement (EIS).

C-C1.1.11.5 Mitigation and Management

No measures are considered necessary.