RPS

Environmental Assessment

Angus Place Colliery, NSW

Modification of Project Approval 06_0021 Under Section 75W, Part 3A

FINAL

Volume 2: Appendices

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APPENDIX 2.1

Schedule of land for the Project Approval

ANGUS PLACE COLLIERY

Schedule of Land

Lot	DP
7	751634
13a	751666
173	751666
40	751666
3	722335
34	751666
39	751666
33	751666
10d	751666
11c	751666
40	751666
7002	1026540
51	751636
49	751636
56	751636
50	751636
48	751636
56	751636
63	751636
62	751636
71	751636
72	751636
73	751636
74	751636
75	751636
76	751636
77	751636
78	751636
79	751636
60	751636
358	44086
24	751636
248	751636
1	751636
A	418163
B	418163
C	418163
26	751636
54	751636
55	751636
350	751636

Lot	DP
340	751636
1	542432
2	542432
3	542432
25	751636
2	751636
6	751636
15	751636
1	825667
2	825667
41	751636
20	827626
21	827626
22	827626
23	827626
24	827626
25	827626
26	827626
27	827626
4	751636
43	751636
34	751636
5	751636
354	751636
1	260621
2	260621
3	260621
4	260621
5	260621
31	751636
33	751636
28	751636
1	552422
2	552422
1	732199
2	732199
57	751636
32	751636
351	751636
1	65810
1	860363

Lot	DP
1	523671
2	523631
1	652799
406	751651
51	751651
15	751651
418	751651
419	751651
1	609683
2	609683
403	751651
404	751651
405	751651
176	751651
5	829137
16	855844
17	855844
12	864305
30	751651
173	666814
1	386554
2	386554
40	751651
43	751651
1	52865

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APPENDIX 2.2

Project Approval 2006
(including Statement of Commitments)

Project Approval

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

I, the Minister for Planning, approve the project referred to in schedule 1, subject to the conditions in schedules 2 to 5.

These conditions are required to:
- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the on-going environmental management of the project.

Frank Sartor MP
Minister for Planning

Signed by Minister Sartor 13 September 2006

Sydney 2006 File No: 9038493

SCHEDULE 1

Project Application:	06_0021
Proponent:	Centennial Angus Place Pty Limited
Approval Authority:	Minister for Planning
Land:	See Appendix 1
Project:	Angus Place Coal Project

DEFINITIONS

AEMR	Annual Environmental Management Report
Proponent	Centennial Angus Place Pty Limited, or its successors in title
BCA	Building Code of Australia
Bore	Any bore or well or excavation or other work connected or proposed to be connected with sources of sub-surface water, and used or proposed to be used or capable of being used to obtain supplies of such water whether the water flows naturally at all times or has to be raised whether wholly or at times by pumping or other artificial means
CCC	Community Consultative Committee
CEF	Community Enhancement Fund
Council	Council of the City of Lithgow
Day	Day is defined as the period from 7am to 6pm on Monday to Saturday, and 8am to 6pm on Sundays and public holidays
DEC	Department of Environment and Conservation
Department	Department of Planning
Director-General	Director-General of the Department of Planning, or delegate
DPI	Department of Primary Industries
EA	Environmental Assessment
SMP	Subsidence Management Plan
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
Evening	Evening is defined as the period from 6pm to 10pm
Land	Land means the whole of a lot in a current plan registered at the Land Titles Office at the date of this approval
Minister	Minister for Planning, or delegate
Night	Night is defined as the period from 10pm to 7am on Monday to Saturday, and 10pm to 8am on Sundays and public holidays
Privately-owned land	Land that is not owned by a public agency, or a mining company or its subsidiary
ROM	Run-of-mine
SCA	Sydney Catchment Authority
Site	Land to which the project application applies, including any land subject to an existing consent for the Angus Place Coal Mine.

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SCHEDULE 2
ADMINISTRATIVE CONDITIONS

Obligation to Minimise Harm to the Environment

1. The Proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.

Terms of Approval

2. The Proponent shall carry out the project generally in accordance with the:
   (a) Project Application 06_0021;
   (b) EA titled *Angus Place Colliery Proposed Mining and Coal Transport*, dated January 2006, and prepared by International Environmental Consultants Pty Limited; and
   (c) conditions of this approval.

   Note: The Angus Place Coal Project, including the existing workings and extension area, is shown on the plan in Appendix 2.

3. If there is any inconsistency between the above, the conditions of this approval shall prevail to the extent of the inconsistency.

4. The Proponent shall comply with any reasonable requirement/s of the Director-General arising from the Department's assessment of:
   (a) any reports, plans, programs or correspondence that are submitted in accordance with this approval; and
   (b) the implementation of any actions or measures contained in these reports, plans, programs or correspondence.

Limits on Approval

5. This approval lapses on 18 August 2024.

6. The Proponent shall not extract more than 3.5 million tonnes of ROM coal a year from the project by underground mining methods.

Surrender of Consents

7. Within 6 months of the date of this approval, the Proponent shall surrender all existing consents for the Angus Place Coal Mine to the satisfaction of the Director-General.

   Note: This approval will apply to all components of the Angus Place Coal Mine from the date of approval.

Structural Adequacy

8. The Proponent shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA.

   Notes:
   - *Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for any proposed building works.*
   - *Part 8 of the EP&A Regulation sets out the requirements for the certification of the project.*

Demolition

9. The Proponent shall ensure that all demolition work is carried out in accordance with *AS 2601-2001: The Demolition of Structures*, or its latest version.

Operation of Plant and Equipment

10. The Proponent shall ensure that all plant and equipment used at the site are:
    (a) maintained in a proper and efficient condition; and
    (b) operated in a proper and efficient manner.

Community Enhancement Contribution

11. Within 6 months of the date of this approval, and for 2 years thereafter, the Proponent shall pay Council $25,000 (ie. a total of $75,000), for improvements to Wolgan Road between the entrance of the mine and the old Castlereagh Highway at Lidsdale. If Council has not carried out these enhancement works within 2 years of final payment, the Proponent may retrieve the funds from Council.

12. Within 6 months of the date of this approval, the Proponent shall establish a Community Enhancement Fund of at least $30,000 to fund projects of benefit to the local community. The Proponent shall consult with Council and the CCC regarding distribution of monies from the fund.

SCHEDULE 3
SPECIFIC ENVIRONMENTAL CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from the landowner of the land listed in Table 1, the Proponent shall acquire the land in accordance with the procedures in conditions 7-9 of schedule 4:

Table 1: Land subject to acquisition upon request

Land
Mason (east)

Note: For more information on the references to land used in this condition, see the 'Property Details' figure of the EA.

2. While the land listed in condition 1 is privately-owned, the Proponent shall implement all practicable measures to ensure that the impacts of the project comply with the predictions in the EA, to the satisfaction of the Director-General.

Note: The noise predictions in the EA are 48dB(A) day time, 45dB(A) evening time and 37dB(A) night time, under the meteorological conditions specified in the notes to condition 17.

SUBSIDENCE

Note: The project will generally be regulated under the approval process for managing the impacts of coal mining subsidence under the Mining Act 1992.

Subsidence Management Plan

3. Before carrying out any underground mining operations that will potentially lead to subsidence of the land surface, the Proponent shall prepare a Subsidence Management Plan for those operations in accordance with the following DPI documents (or the most current and updated versions or replacements of these documents):
   - *New Approval Process for Management of Coal Mining Subsidence - Policy*; and
   - *Guideline for Applications for Subsidence Management Approvals,*

   to the satisfaction of the DPI.

4. Before carrying out any underground mining that will potentially lead to subsidence of the West Wolgan Swamp, the Proponent shall develop a Newnes Plateau Shrub Swamp Management Plan in consultation with the DEC and to the satisfaction of the Director-General and DPI.

SURFACE AND GROUND WATER

Pollution of Waters

5. Except as may be expressly provided by a DEC Environment Protection Licence, the Proponent shall comply with section 120 of the *Protection of the Environment Operations Act 1997* during the carrying out of the project.

Discharge Limits

6. Except as may be expressly provided by a DEC Environment Protection Licence, the Proponent shall ensure that the discharges from any licensed discharge points comply with the limits in Table 2:

Table 2: Discharge Limits

Pollutant	Units of measure	100 percentile concentration limit
pH	pH	6.5 ≤ pH ≤ 8.5
Non-filterable residue	mg/litre	NFR ≤ 30
Oil and Grease	mg/litre	10

Note: This condition does not authorise the pollution of waters by any other pollutants.

Water Resource Impacts

7. The Proponent shall ensure that the project does not result in any significant:
   (a) reduction in pumping yield in privately-owned groundwater bores;
   (b) reduction in surface flows and groundwater baseflow to upland swamps (Newnes Plateau Shrub Swamps) and wetlands; and
   (c) reduction in surface flows and groundwater baseflow to waterbodies including Kangaroo Creek, Wolgan River, Lambs Creek and Coxs River,

   to the satisfaction of the Director-General.

   Note: The respective sub-plans of the Site Water Management Plan (see condition 8 below) must include quantifiable impact assessment criteria for these water resource impacts, as well as measures to monitor, investigate and mitigate the impacts.

Site Water Management Plan

8. The Proponent shall prepare (and following approval implement) a Site Water Management Plan for the project, to the satisfaction of the Director-General. The Plan shall be prepared in consultation with DEC and SCA, and be submitted to the Director-General within 12 months of the date of this approval. The Plan must include:
   (a) a Water Balance;
   (b) an Erosion and Sediment Control Plan;
   (c) a Surface Water Monitoring Program;
   (d) a Ground Water Monitoring Program;
   (e) a Surface and Ground Water Response Plan; and
   (f) a strategy for decommissioning water management structures on the site.

9. The Water Balance shall:
   (a) include details of all water extracted, dewatered, transferred, used and/or discharged by the mine; and
   (b) provide for the annual re-calculation of the water balance and its reporting in the AEMR.

10. The Erosion and Sediment Control Plan shall:
    (a) be consistent with the requirements of the Department of Housing's *Managing Urban Stormwater: Soils and Construction* manual;
    (b) identify activities that could cause soil erosion and generate sediment;
    (c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters;
    (d) describe the location, function, and capacity of erosion and sediment control structures; and
    (e) describe what measures would be implemented to maintain the structures over time.

11. The Surface Water Monitoring Program shall include:
    (a) detailed baseline data on surface water flows (including ground water baseflows) and quality in waterbodies and wetlands above the mine;
    (b) surface water impact assessment criteria;
    (c) a program to monitor surface water flows (including ground water baseflows) and quality;
    (d) a protocol for the investigation, notification and mitigation of identified exceedances of the surface water impact assessment criteria; and
    (e) a program to monitor the effectiveness of the Erosion and Sediment Control Plan.

12. The Ground Water Monitoring Program shall include:
    (a) detailed baseline data on ground water levels and quality, based on statistical analysis;
    (b) ground water impact assessment criteria;
    (c) a program to monitor the volume and quality of ground water seeping into the underground mine workings;
    (d) a program to monitor regional ground water levels and quality; and
    (e) a protocol for the investigation, notification and mitigation of identified exceedances of the ground water impact assessment criteria.

13. The Surface and Ground Water Response Plan shall include:
    (a) the procedures that would be followed in the event of any exceedance of the surface or ground water impact assessment criteria, or other identified impact on surface or ground water; and
    (b) measures to mitigate, remediate and/or compensate any identified impacts.

AIR QUALITY

Impact Assessment Criteria

14. The Proponent shall ensure that the dust emissions generated by the project do not cause additional exceedances of the air quality criteria listed in Tables 3, 4, and 5 at any residence on, or more than 25 percent of, privately-owned land.

Table 3: Long term impact assessment criteria for particulate matter

Pollutant	Averaging period	Criterion
Total suspended particulate (TSP) matter	Annual	90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	30 µg/m^3

Table 4: Short term impact assessment criterion for particulate matter

Pollutant	Averaging period	Criterion
Particulate matter < 10 µm (PM_{10})	24 hour	50 µg/m^3

Table 5: Long term impact assessment criteria for deposited dust

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

Note: Deposited dust is assessed as insoluble solids as defined by Standards Australia, 2003, AS 3580.10.1-2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulates - Deposited Matter - Gravimetric Method.

Odour

15. Except as may be expressly provided by a DEC Environmental Protection Licence, the Proponent shall not cause or permit the emission of offensive odour beyond the site.

Air Quality Monitoring Program

16. The Proponent shall prepare (and following approval implement) an Air Quality Monitoring Program for the project, to the satisfaction of the Director-General. The program must include an air monitoring protocol for evaluating compliance with the air quality criteria in this approval. The program shall be prepared in consultation with DEC, and be submitted to the Director-General within 6 months of the date of this approval.

NOISE

Impact Assessment Criteria

17. From no later than 28 February 2007, the Proponent shall ensure that the noise generated by the project, including the Proponent's operation of the haul road to the Wallerawang power station, does not exceed the noise impact assessment criteria presented in Table 6 at any residence on privately-owned land.

Table 6: Noise impact assessment criteria dB(A) $L_{Aeq(15\ minute)}$

Land	Day	Evening	Night
Sharpe	42	38	36
Mason (West) and other Wolgan Road rural properties	41	37	35

Lidsdale village residents	44	40	35

Notes:
- *a) For more information on the references to land in this condition, see 'Property Details' figure of the EA.*
- *b) The noise criteria do not apply where the Proponent and the affected landowner have reached a negotiated agreement in regard to noise, and a copy of the agreement has been forwarded to the Director-General and DEC.*
- *c) Noise from the project is to be measured at the most affected point or within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the $L_{Aeq(15\ minute)}$ noise limits in the above table. Where it can be demonstrated that direct measurement of noise from the project is impractical, the DEC may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*
- *d) The noise emission limits identified in the above table apply under meteorological conditions of:*
  - *Wind speeds of up to 3 m/s at 10 metres above ground level; or*
  - *Temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.*

Land Acquisition Criteria

18. If, after 31 August 2007, the noise generated by the project, including the operation of the haul road to the Wallerawang power station, exceeds the criteria in Table 7, the Proponent shall, upon receiving a written request for acquisition from the landowner (excluding the landowners listed in Table 1), acquire the land in accordance with the procedures in conditions 7-9 of schedule 4.

Table 7: Land acquisition criteria dB(A) $L_{Aeq(15\ minute)}$

Land	Day	Evening	Night
Sharpe, Mason (West) and other Wolgan Road rural properties	44	40	40
Lidsdale village residents	47	43	43

Note: The notes under Table 6 also apply to Table 7.

Operating Hours – Wallerawang Power Station Haul Road

19. The Proponent shall not use the Wallerawang power station haul road at night.

Note: Night is defined as the period from 10pm to 7am on Monday to Saturday, and 10pm to 8am on Sundays and public holidays.

Additional Noise Mitigation Measures

20. Upon receiving a written request from a landowner in Table 8 (unless that landowner has acquisition rights and has requested acquisition), the Proponent shall implement additional noise mitigation measures such as double glazing, insulation, and/or air conditioning at any residence on the land in consultation with the landowner. These additional mitigation measures must be reasonable and feasible. If within 3 months of receiving this request from the landowner, the Proponent and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Director-General for resolution.

Table 8: Land subject to additional noise mitigation

Property
Mason (east)
Sharpe

Continuous Improvement

21. The Proponent shall:
    (a) implement all reasonable and feasible best practice noise mitigation measures;
    (b) investigate ways to reduce the noise generated by the project, including noise generated from use of the Wallerawang power station haul road; and
    (c) report on these investigations and the implementation and effectiveness of these measures in the AEMR,

to the satisfaction of the Director-General.

Noise Monitoring Program

22. The Proponent shall prepare (and following approval implement) a Noise Monitoring Program for the project, to the satisfaction of the Director-General. This program must include a combination of attended and unattended noise monitoring, and a noise monitoring protocol for evaluating compliance with the noise impact assessment criteria in this approval. The program shall be prepared in consultation with DEC, and be submitted to the Director-General within 6 months of the date of this approval.

METEOROLOGICAL MONITORING

23. Within 6 months of the date of this approval, the Proponent shall ensure that there is a suitable meteorological station operating in the vicinity of the project in accordance with the requirements in *Approved Methods for Sampling of Air Pollutants in New South Wales*, and to the satisfaction of the DEC and the Director-General.

FAUNA AND FLORA

Flora and Fauna Management Plan

24. The Proponent shall prepare (and following approval implement) a Flora and Fauna Management Plan for the project, to the satisfaction of the Director-General. The Plan shall be submitted to the Director-General within 12 months of the date of this approval. The Plan must include:
    (a) baseline data of the existing habitat on site;
    (b) detailed procedures to:
        - clear vegetation on site;
        - control weeds;
        - control access to environmentally sensitive areas on site;
        - manage any potential conflicts between flora and fauna and Aboriginal heritage;
    (c) a flora and fauna monitoring program; and
    (d) procedures for monitoring, reviewing, and implementing the plan.

TRAFFIC AND TRANSPORT

Transport of Coal

25. The Proponent shall not cause any coal truck movements on public roads, except in the event of emergencies with the prior approval of the Director-General, Council or DEC.

26. The Proponent shall maintain the surface of the haul road to Wallerawang power station to minimise the generation of noise and dust impacts, to the satisfaction of the Director-General.

Coal Conveyor

27. Within 18 months of the date of this approval, the Proponent shall provide the Director-General with a report on the feasibility of installing the previously approved conveyor from the coal mine to the Wallerawang power station. The report shall include:
    (a) cost-benefit analyses for both the conveyor and continued road haulage options, including analysis of economic, social and environmental considerations; and
    (b) a long term strategy for continued coal haulage, including detailed justification for the proposed coal haulage method/s.

Parking

28. The Proponent shall provide sufficient parking on-site for all project related traffic and visitors, in accordance with Council's parking codes, and to the satisfaction of the Director-General.

VISUAL IMPACT

Haul Road Landscaping

29. The Proponent shall prepare (and following approval implement) a Landscape Plan for the Wallerawang power station haul road, to the satisfaction of the Director-General. The Plan shall provide for the establishment and maintenance of reasonable and feasible landscaping measures to minimise the visual impacts of the haul road. The Plan shall be prepared in consultation with Council, and be submitted to the Director-General within 12 months of the date of this approval.

Note: The Landscaping Plan should focus on those areas of the haul road that are visible from residential and other public areas.

Lighting Emissions

30. The Proponent shall:
    (a) take all practicable measures to mitigate off-site lighting impacts from the project; and
    (b) ensure that all external lighting associated with the project complies with *Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*,

    to the satisfaction of the Director-General.

GREENHOUSE GAS

31. The Proponent shall:
    (a) monitor the greenhouse gas emissions generated by the project;
    (b) investigate ways to reduce greenhouse gas emissions generated by the project; and
    (c) report on these investigations in the AEMR,

    to the satisfaction of the Director-General.

WASTE MINIMISATION

32. The Proponent shall minimise the amount of waste generated by the project to the satisfaction of the Director-General.

HAZARDS MANAGEMENT

Spontaneous Combustion

33. The Proponent shall take the necessary measures to prevent, as far as is practical, spontaneous combustion on the site.

Dangerous Goods

34. The Proponent shall ensure that the storage, handling, and transport of dangerous goods is done in accordance with the relevant *Australian Standards*, particularly *AS1940* and *AS1596*, and the *Dangerous Goods Code*.

BUSHFIRE MANAGEMENT

35. The Proponent shall:
    (a) ensure that the project is suitably equipped to respond to any fires on-site; and
    (b) assist the Rural Fire Service, Forests NSW, and emergency services as much as possible if there is a fire on-site during the project.

MINE CLOSURE STRATEGY

36. The Proponent shall prepare a Mine Closure Strategy for the project, to the satisfaction of the Director-General. The Strategy shall be prepared in consultation with Council, DPI, SCA and DEC, and be submitted to the Director-General at least 3 years prior to the cessation of mining. The Plan must:
    (a) define the objectives and criteria for mine closure;
    (b) investigate options for the future use of the site, including the pit top and surface facilities area;
    (c) investigate ways to minimise the adverse socio-economic effects associated with mine closure, including reduction in local employment levels;
    (d) define a strategy for the ongoing management of water flow into the underground mine workings;
    (e) describe the measures that would be implemented to minimise or manage the ongoing environmental effects of the project; and
    (f) describe how the performance of these measures would be monitored over time.

SCHEDULE 4
ADDITIONAL PROCEDURES

NOTIFICATION OF LANDOWNERS

1. If the results of monitoring required in schedule 3 identify that impacts generated by the project are greater than the impact assessment criteria in schedule 3, except where this is predicted in the EA, then the Proponent shall notify the Director-General and the affected landowners and/or existing or future tenants (including tenants of mine-owned properties) accordingly, and provide quarterly monitoring results to each of these parties until the results show that the project is complying with the criteria in schedule 3.

INDEPENDENT REVIEW

2. If a landowner (excluding mine owned properties) considers the project to be exceeding the impact assessment criteria in schedule 3, except where this is predicted in the EA, then he/she may ask the Proponent in writing for an independent review of the impacts of the project on his/her land.

   If the Director-General is satisfied that an independent review is warranted, the Proponent shall within 3 months of the Director-General advising that an independent review is warranted:
   (a) consult with the landowner to determine his/her concerns;
   (b) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Director-General, to conduct monitoring on the land, to determine whether the project is complying with the relevant criteria in schedule 3, and identify the source(s) and scale of any impact on the land, and the project's contribution to this impact;
   (c) give the Director-General and landowner a copy of the independent review.

3. If the independent review determines that the project is complying with the relevant criteria in schedule 3, then the Proponent may discontinue the independent review with the approval of the Director-General.

4. If the independent review determines that the project is not complying with the criteria in schedule 3, and that the project is primarily responsible for this non-compliance, then the Proponent shall:
   (a) take all practicable measures, in consultation with the landowner, to ensure that the project complies with the relevant criteria; and
   (b) conduct further monitoring to determine whether these measures ensure compliance; or
   (c) secure a written agreement with the landowner to allow exceedances of the relevant criteria in schedule 3,

   to the satisfaction of the Director-General.

   If the additional monitoring referred to above subsequently determines that the project is complying with the relevant criteria in schedule 3, then the Proponent may discontinue the independent review with the approval of the Director-General.

   If the Proponent is unable to finalise an agreement with the landowner, then the Proponent or landowner may refer the matter to the Director-General for resolution.

   If the matter cannot be resolved within 21 days, the Director-General shall refer the matter to an Independent Dispute Resolution Process (see Appendix 3).

   If the measures referred to in (a) do not achieve compliance with the noise land acquisition criteria in schedule 3, and the Proponent cannot secure a written agreement with the landowner to allow these exceedances within 3 months, then the Proponent shall, upon receiving a written request from the landowner, acquire the landowner's land in accordance with the procedures in conditions 7-9 below.

5. If the independent review determines that the relevant criteria in schedule 3 are being exceeded, but that the project and another project/mine are responsible for this exceedance, then the Proponent shall, together with the relevant project/mine:
   (a) take all practicable measures, in consultation with the landowner, to ensure that the relevant criteria are complied with; and
   (b) conduct further monitoring to determine whether these measures ensure compliance; or
   (c) secure a written agreement with the landowner to allow exceedances of the relevant criteria in schedule 3,

   to the satisfaction of the Director-General.

   If the Proponent is unable to finalise an agreement with the landowner and/or other project/s, then the Proponent or landowner may refer the matter to the Director-General for resolution.

   If the matter cannot be resolved within 21 days, the Director-General shall refer the matter to an Independent Dispute Resolution Process (see Appendix 3).

6. If the landowner disputes the results of the independent review, either the Proponent or the landowner may refer the matter to the Director-General for resolution.

   If the matter cannot be resolved within 21 days, the Director-General shall refer the matter to an Independent Dispute Resolution Process.

LAND ACQUISITION

7. Within 3 months of receiving a written request from a landowner with acquisition rights, the Proponent shall make a binding written offer to the landowner based on:
   (a) the current market value of the landowner's interest in the property at the date of this written request, as if the property was unaffected by the project the subject of the project application, having regard to the:
       - existing and permissible use of the land, in accordance with the applicable planning instruments at the date of the written request; and
       - presence of improvements on the property and/or any approved building or structure which has been physically commenced at the date of the landowner's written request, and is due to be completed subsequent to that date, but excluding any improvements that have resulted from the implementation of the 'additional noise mitigation measures' in condition 20 of schedule 3;
   (b) the reasonable costs associated with:
       - relocating within the Lithgow local government area, or to any other local government area determined by the Director-General;
       - obtaining legal advice and expert advice for determining the acquisition price of the land, and the terms upon which it is required; and
   (c) reasonable compensation for any disturbance caused by the land acquisition process.

   However, if at the end of this period, the Proponent and landowner cannot agree on the acquisition price of the land, and/or the terms upon which the land is to be acquired, then either party may refer the matter to the Director-General for resolution.

   Upon receiving such a request, the Director-General shall request the President of the NSW Division of the Australian Property Institute to appoint a qualified independent valuer or Fellow of the Institute, to consider submissions from both parties, and determine a fair and reasonable acquisition price for the land, and/or terms upon which the land is to be acquired.

   Within 14 days of receiving the panel's determination, the Proponent shall make a written offer to purchase the land at a price not less than the panel's determination.

   If the landowner refuses to accept this offer within 6 months of the date of the Proponent's offer, the Proponent's obligations to acquire the land shall cease, unless otherwise agreed by the Director-General.

8. The Proponent shall bear the costs of any valuation or survey assessment requested by the independent valuer, or the Director-General and the costs of determination referred above.

9. If the Proponent and landowner agree that only part of the land shall be acquired, then the Proponent shall pay all reasonable costs associated with obtaining Council approval for any plan of subdivision (where permissible), and registration of the plan at the Office of the Registrar-General.

SCHEDULE 5
ENVIRONMENTAL MANAGEMENT, MONITORING, AUDITING & REPORTING

ENVIRONMENTAL MANAGEMENT STRATEGY

1. The Proponent shall prepare (and following approval implement) an Environmental Management Strategy for the project, to the satisfaction of the Director-General. The Strategy shall be submitted to the Director-General within 12 months of the date of this approval, and must:
   (a) provide the strategic context for environmental management of the project;
   (b) identify the statutory requirements that apply to the project;
   (c) describe in general how the environmental performance of the project would be monitored and managed during the project;
   (d) describe the procedures that would be implemented to:
   - keep the local community and relevant agencies informed about the operation and environmental performance of the project;
   - receive, handle, respond to, and record complaints;
   - resolve any disputes that may arise during the course of the project;
   - respond to any non-compliance;
   - manage cumulative impacts; and
   - respond to emergencies;

   (e) describe the role, responsibility, authority, and accountability of all the key personnel, involved in environmental management of the project;
   (f) be updated within 3 months of the completion of each Independent Environmental Audit.

ENVIRONMENTAL MONITORING PROGRAM

2. The Proponent shall prepare (and following approval implement) an Environmental Monitoring Program for the project, to the satisfaction of the Director-General. The Program must consolidate the various monitoring requirements in schedule 3 of this approval into a single document. The Program shall be prepared in consultation with the relevant agencies, and be submitted to the Director-General within 12 months of the date of this approval.

INCIDENT REPORTING

3. Within 7 days of detecting an exceedance of the limits/performance criteria in this approval, the Proponent shall report the exceedance to the Department, and any relevant agency. The report must:
   (a) describe the date, time, and nature of the exceedance;
   (b) identify the cause or likely cause of the exceedance;
   (c) describe what action has been taken to date; and
   (d) describe the proposed measures to address the exceedance.

   Note: The SCA shall be notified in the event of any spill or pollution incident with the potential to impact the Sydney drinking water catchment.

ANNUAL REPORTING

4. The Proponent shall prepare and submit an AEMR to the Director-General and the relevant agencies. This report must:
   (a) identify the standards and performance measures that apply to the project;
   (b) describe the works carried out in the last 12 months;
   (c) describe the works that will be carried out in the next 12 months;
   (d) include a summary of the complaints received during the past year, and compare this to the complaints received in the previous 5 years;
   (e) include a summary of the monitoring results on the project during the past year,
   (f) include an analysis of these monitoring results against the relevant:
   - impact assessment criteria;
   - monitoring results from previous years; and
   - predictions in the EA;

   (g) identify any trends in the monitoring over the life of the project;
   (h) identify any non-compliance during the previous year; and
   (i) describe what actions were, or are being, taken to ensure compliance.

   Note: The AEMR may also be prepared in accordance with any requirements of the DPI for an AEMR for the Mining Lease(s) associated with the project.

INDEPENDENT ENVIRONMENTAL AUDIT

5. Prior to 31 December 2007, and every 3 years thereafter, unless the Director-General directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must:
   (a) be conducted by a suitably qualified, experienced, and independent person whose appointment has been endorsed by the Director-General;
   (b) assess the environmental performance of the project, and its effects on the surrounding environment;
   (c) assess whether the project is complying with the relevant standards, performance measures, and statutory requirements;
   (d) review the adequacy of any strategy/plan/program required under this approval; and, if necessary,
   (e) recommend measures or actions to improve the environmental performance of the project, and/or any strategy/plan/program required under this approval.

6. Within 3 months of commissioning each Independent Environmental Audit, or as otherwise agreed by the Director-General, the Proponent shall submit a copy of the audit report to the Director-General, with a response to any of the recommendations contained in the audit report.

7. Following each Independent Environmental Audit, the Proponent shall review and if necessary revise each of the environmental management and monitoring strategies/plans/programs in schedules 3 and 5, to the satisfaction of the Director-General. The revised strategies/plans/programs shall be submitted to the Director-General within 6 months of commissioning the audit.

COMMUNITY CONSULTATIVE COMMITTEE

8. Within 3 months of this approval, the Proponent shall establish a Community Consultative Committee to provide a forum for open discussion between the Proponent, the community, the Council and other stakeholders on issues directly relating to the mine's operations and environmental performance, and to keep the community informed on these matters. The CCC shall:
   (a) be comprised of:
      - 2 representatives from the Proponent, including the person responsible for environmental management at the mine;
      - at least 1 representative from Council (if available); and
      - at least 1 representative from Forests NSW (if available); and
      - at least 3 representatives from the local community,

      whose appointment has been approved by the Director-General in consultation with the Council;
   (b) be chaired by an independent chairperson, or Council representative, whose appointment has been approved by the Director-General;
   (c) meet at least twice a year;
   (d) review the Proponent's performance with respect to environmental management and community relations;
   (e) undertake regular inspections of the mine operations;
   (f) review community concerns or complaints about the mine operations, and the Proponent's complaints handling procedures; and
   (g) provide feedback to:
      - the Proponent on improved environmental management and community relations, including the provision of information to the community and the identification of community initiatives to which the Proponent could contribute;
      - the Department regarding the conditions of this approval; and
      - the general community on the performance of the mine with respect to environmental management and community relations; and
   (h) be operated generally in accordance with any guidelines the Department may publish in regard to the operation of Community Consultative Committees for mining projects.

   Notes:
   a) The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval.
   b) The CCC may combine its function with other CCCs for mines operated by the Proponent in the Lidsdale / Blackmans Flat area.

9. The Proponent shall, at its own expense:
   (a) ensure that 2 of its representatives attend the Committee's meetings;
   (b) provide the Committee with regular information on the environmental performance and management of the project;
   (c) provide meeting facilities for the Committee;
   (d) arrange site inspections for the Committee, if necessary;
   (e) take minutes of the Committee's meetings;

(f) make these minutes available to the public;
(g) respond to any advice or recommendations the Committee may have in relation to the environmental management or performance of the project;
(h) forward a copy of the minutes of each Committee meeting, and any responses to the Committee's recommendations to the Director-General within a month of acceptance of the minutes by the Committee.

ACCESS TO INFORMATION

10. Within 3 months of the approval of any management plan/strategy or monitoring program required under this approval (or any subsequent revision of these management plans/strategies or monitoring programs), the completion of the Independent Environmental Audit required under this approval, or the completion of the AEMR, the Proponent shall:
    (a) provide a copy of the relevant document/s to the Council, relevant agencies and the CCC; and
    (b) put a copy of the relevant documents on the Proponent's website;

    to the satisfaction of the Director-General.

11. During the life of the project, the Proponent shall:
    (a) make a summary of monitoring results required under this approval publicly available on its website; and
    (b) update these results on a regular basis (at least every 6 months),

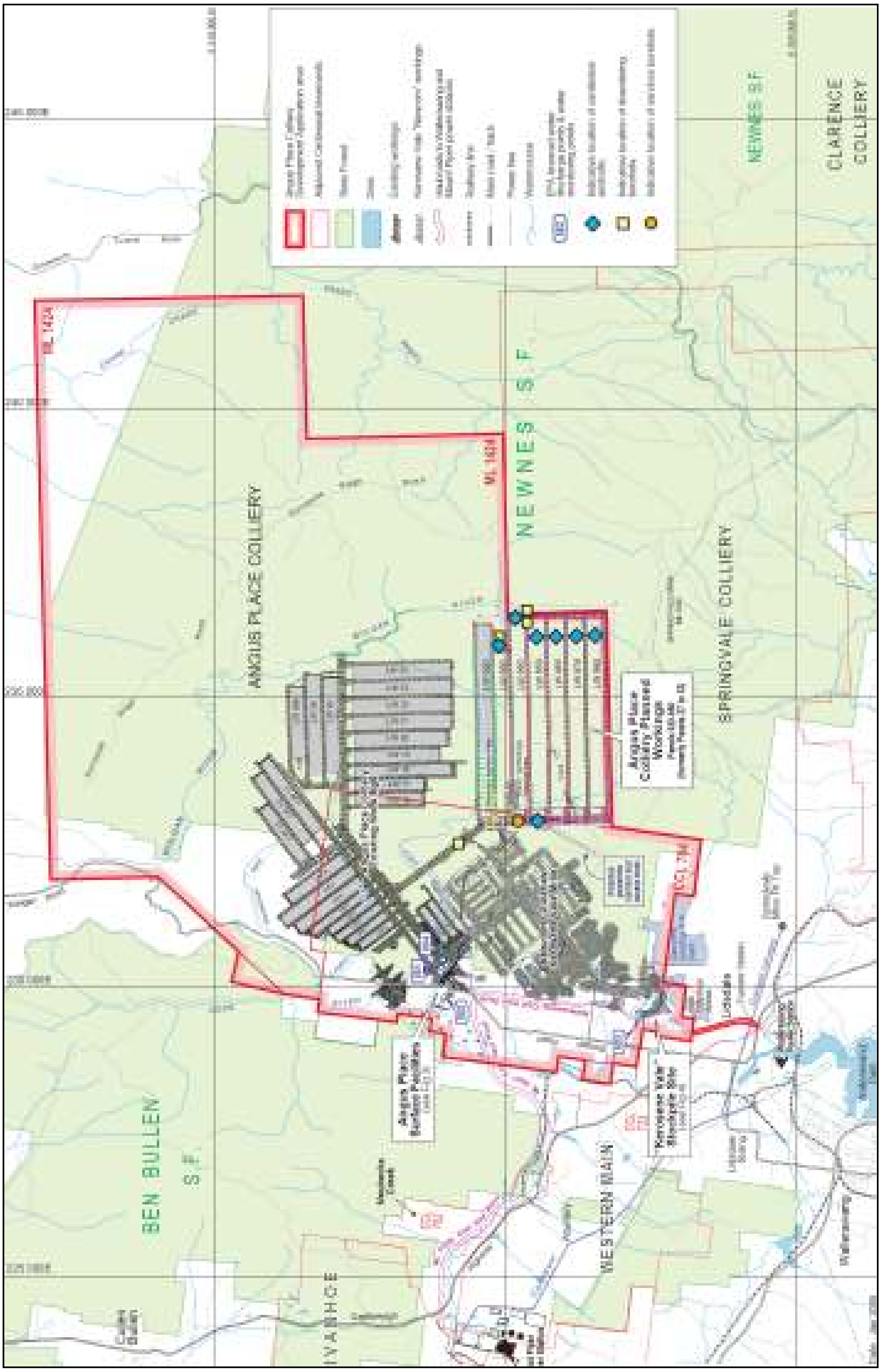
    to the satisfaction of the Director-General.

APPENDIX 1
SCHEDULE OF LAND

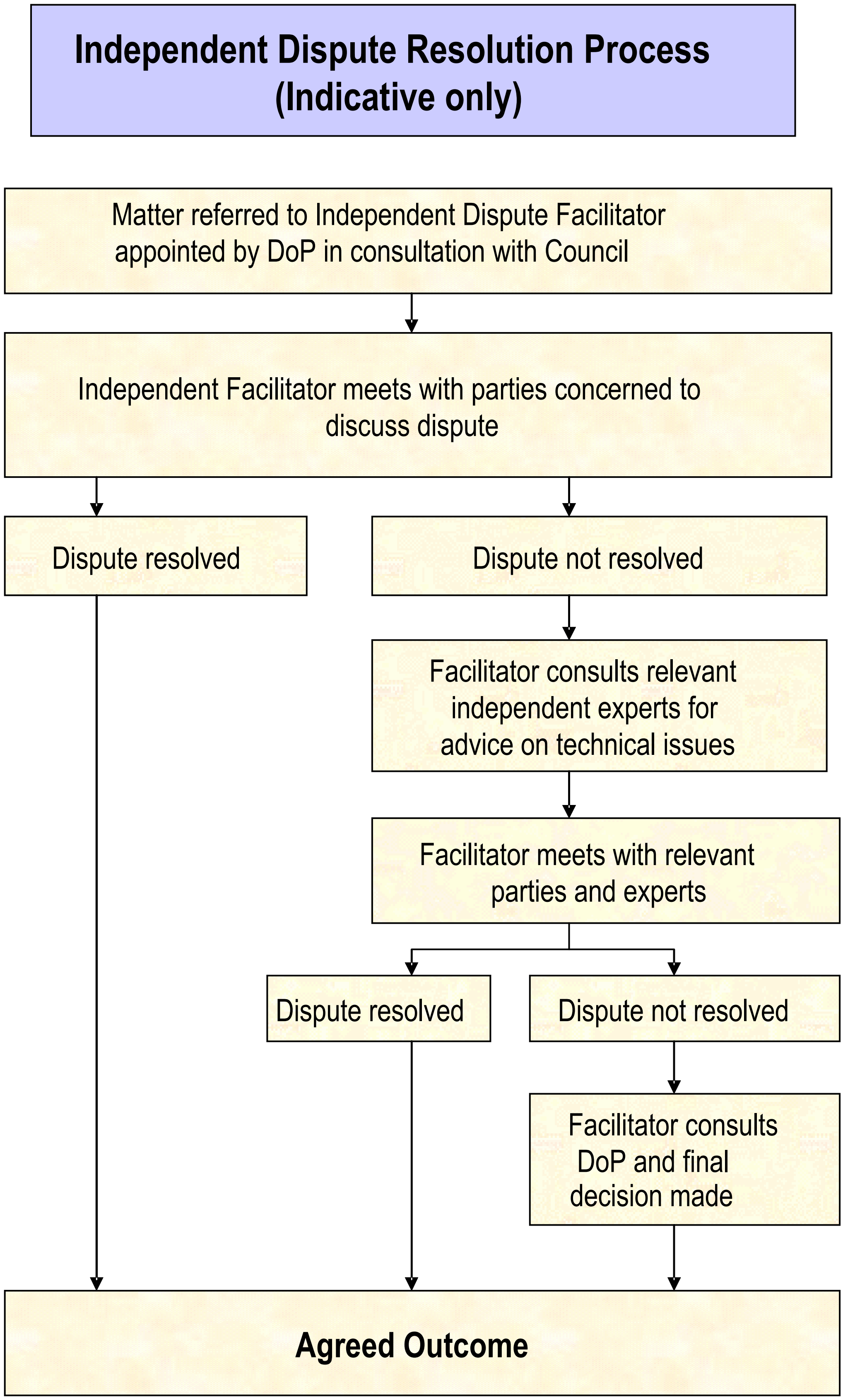
Lot	DP	County	Parish
7	751634	Cook	Cook
13a	751666	Cook	Wolgan
173	751666	Cook	Wolgan
40	751666	Cook	Wolgan
3	722335	Cook	Wolgan
34	751666	Cook	Wolgan
39	751666	Cook	Wolgan
33	751666	Cook	Wolgan
10d	751666	Cook	Wolgan
11c	751666	Cook	Wolgan
40	751636	Cook	Cox
7002	1026540	Cook	Cox
51	751636	Cook	Cox
56	751636	Cook	Cox
63	751636	Cook	Cox
62	751636	Cook	Cox
71	751636	Cook	Cox
72	751636	Cook	Cox
73	751636	Cook	Cox
74	751636	Cook	Cox
75	751636	Cook	Cox
76	751636	Cook	Cox
77	751636	Cook	Cox
78	751636	Cook	Cox
79	751636	Cook	Cox
60	751636	Cook	Cox
358	44086	Cook	Cox
24	751636	Cook	Cox
248	751636	Cook	Cox
1	751636	Cook	Cox
A	418163	Cook	Cox
B	418163	Cook	Cox
C	418163	Cook	Cox
26	751636	Cook	Cox
54	751636	Cook	Cox
55	751636	Cook	Cox
350	751636	Cook	Cox
340	751636	Cook	Cox
1	542432	Cook	Cox
2	542432	Cook	Cox
3	542432	Cook	Cox
25	751636	Cook	Cox
2	751636	Cook	Cox
6	751636	Cook	Cox
15	751636	Cook	Cox
1	825887	Cook	Cox
2	825887	Cook	Cox
41	751636	Cook	Cox
20	827626	Cook	Cox
21	827626	Cook	Cox
22	827626	Cook	Cox
23	827626	Cook	Cox
24	827626	Cook	Cox
25	827626	Cook	Cox
26	827626	Cook	Cox
27	827626	Cook	Cox
4	751636	Cook	Cox
43	751636	Cook	Cox
34	751636	Cook	Cox
5	751636	Cook	Cox
354	751636	Cook	Cox
1	260621	Cook	Cox
2	260621	Cook	Cox
3	260621	Cook	Cox
4	260621	Cook	Cox

Lot	DP	County	Parish
5	260621	Cook	Cox
31	751636	Cook	Cox
33	751636	Cook	Cox
28	751636	Cook	Cox
1	552422	Cook	Cox
2	552422	Cook	Cox
1	732119	Cook	Cox
2	732119	Cook	Cox
57	751636	Cook	Cox
32	751636	Cook	Cox
351	751636	Cook	Cox
1	65810	Cook	Lidsdale
1	860363	Cook	Cox
101	1033592	Cook	Cox
100	1033592	Cook	Cox
2	860363	Cook	Lidsdale
1	568265	Cook	Lidsdale
11	864305	Cook	Lidsdale
16	855844	Cook	Lidsdale
5	115922	Cook	Wolgan
1	523671	Cook	Lidsdale
2	523671	Cook	Lidsdale
1	652799	Cook	Lidsdale
406	751651	Cook	Lidsdale
51	751651	Cook	Lidsdale
15	751651	Cook	Lidsdale
418	751651	Cook	Lidsdale
419	751651	Cook	Lidsdale
2	609683	Cook	Lidsdale
403	751651	Cook	Lidsdale
404	751651	Cook	Lidsdale
405	751651	Cook	Lidsdale
176	751651	Cook	Lidsdale
5	829137	Cook	Lidsdale
16	855844	Cook	Lidsdale
17	855844	Cook	Lidsdale
12	864305	Cook	Lidsdale
30	751651	Cook	Lidsdale
173	666814	Cook	Lidsdale
1	386554	Cook	Lidsdale
2	386554	Cook	Lidsdale
40	751651	Cook	Lidsdale
43	751651	Cook	Lidsdale
1	52865	Cook	Lidsdale
2541-3090		Cook	Cox
1	651723	Cook	Cox
359	44086	Cook	Cox
2	722335	Cook	Wolgan
7003	1026540	Cook	Cox
Newnes State Forest		Cook	Cook

APPENDIX 2
ANGUS PLACE COAL PROJECT PLAN



APPENDIX 3
INDEPENDENT DISPUTE RESOLUTION PROCESS



Angus Place Colliery
Lease Extension Project
Statement of Commitments

Acronyms and Abbreviations

CCC	Community Consultative Committee
CCP	Community Consultation Process
CEF	Community Enhancement Fund
DEC	Department of Environment and Conservation
DoP	Department of Planning
DPI	Department of Primary Industries (Mineral Resources)

Commitment

Centennial Angus Place Pty Ltd ("the Mine") commits to the following measures to minimize impacts on the environment (including community) as a result of its Lease Extension Project:

Community

1. The Mine will establish a Community Consultation Process. A part of this will be the establishment of a Community Consultative Committee. The mine will invite community representatives to participate in mid panel and end of panel meetings.
2. The Mine will develop and distribute 6 Monthly Newsletters to the Community as a part of the CCP
3. The Mine will contribute $25,000 per annum for 3 years to Lithgow City Council for improvements to Wolgan Road between the entrance of the Mine and the (old) Castlereagh Highway at Lidsdale.
4. The Mine will establish a Community Enhancement Fund (CEF) of $30,000 over 5 years for projects that will benefit the local community
5. The Mine will seek to establish an Advisory Committee for the distribution of the CEF, comprised of local community, Council and Mine representatives.
6. The Mine will establish a charter for the Advisory Committee in consultation with the CCC.

Subsidence

7. Before carrying out any underground mining operations that will potentially lead to subsidence of the land surface, the Applicant will prepare a Subsidence Management Plan for those operations in accordance with the following DPI documents (or the most current and updated versions of these documents):

(a) *New Approval Process for Management of Coal Mining Subsidence - Policy*; and

(b) *Guideline for Applications for Subsidence Management Approvals*,

to the satisfaction of the Director-General of DPI.

8. The Mine will undertake subsidence monitoring as presented in the approved SMP or as required by DPI.
9. A summary of the results from subsidence monitoring will be provided to DoP and DPI in an annual report and to the community as a part of the CCP.
10. The Mine will undertake subsidence mitigation works in consultation with DPI.
11. Photographic surveys of each longwall will be undertaken 4 months prior to extraction to determine rock features. Any rock formations found will be monitored following longwall mining in accordance with Angus Place SMP commitments.
12. Where monitoring reveals cracking that had not been predicted, DPI will be contacted and where necessary, appropriate mitigation works will be undertaken to the satisfaction of the DPI – Mineral Resources, Director – Environmental Sustainability

Surface Water

13. The Mine will comply with the surface water quality and quantity limits of its Environmental Protection Licence
14. The Mine will monitor surface water quantity and quality at locations as required by its Environmental Protection Licence
15. The Mine will monitor surface water quantity and quality at locations up and downstream of its surface operations
16. The Mine will monitor stream flows within the Wolgan River tributary containing East Wolgan Swamp, the Wolgan River tributary containing Narrow Swamp and Kangaroo Creek relative to its mining area
17. A summary of the results from surface water monitoring will be included in the Annual Report.

Groundwater

18. The Mine will implement a Groundwater Monitoring Programme.
19. The Mine will develop and implement a Newnes Plateau Shrub Swamp Management and Monitoring Plan in consultation with DEC and DPI.
20. A summary of the results of all groundwater and Shrub Swamp monitoring will be included in the Annual Report.

Noise

21. The Mine will conduct noise monitoring and/or modeling annually in accordance with the Industrial Noise Policy or as may be replaced by another Guideline.

22. A summary of the results from the noise monitoring will be included in the Annual Report.

Air Quality

23. The Mine will adopt a maximum depositional dust limit of $4g/m^2/mth$ at its boundary.

24. The Mine will conduct depositional dust monitoring in accordance with AS3580.10.1 – 1991 or as may be replaced by another Australian Standard or DEC requirements.

25. Where results indicate depositional dust is $>4g/m^2/mth$, the Mine will undertake further analysis to determine composition. Where composition indicates the Mine is the primary source of dust, the Mine will investigate the cause and consult with the DEC.

26. A summary of the results from the air quality monitoring will be included in the Annual Report.

27. The Mine will monitor coal trucks to ensure all loads are appropriately covered.

Fauna and Flora

28. The mine will implement a Flora and Fauna Monitoring Programme as a part of the Newnes Plateau Shrub Swamp Management Plan

29. A summary of the results from the flora and fauna monitoring will be included in the Annual Report.

30. Any unforeseen impacts on flora and fauna from mining operations will be managed in consultation with DEC and to the satisfaction of DoP.

31. A weed management and eradication programme will be implemented along the Wallerawang Haul Road

Auditing and Reporting

32. The Mine will conduct an independent environmental audit each three years to assess its compliance and performance.

33. The Mine will complete an Annual Environmental Management Report each year within which all environmental monitoring results will be presented and analysed. The Mine will place the AEMR on a web site and will notify DoP, DPI, DEC, LCC, Forests NSW, SCA and CCC of its availability.

34. Within 6 months of the date of consent, the Mine will present an Environmental Monitoring Programme in consultation with relevant agencies and to the satisfaction of DoP. This will incorporate trigger points for further investigations.

Temporary Car Park (west of Wolgan Road)

35. The Mine will erect appropriate traffic safety signage on Wolgan Road.

36. The Mine will provide an appropriate sealing coat and drainage provisions on the temporary car park suitable to its ongoing use.

General

37. For any proposed new infrastructure or facilities (as indicated in the EA) or changes to current surface facilities and services, the Mine will conduct an Environmental Review to ensure it complies with the limits committed in this Statement and any subsequent development consent conditions.

38. Where the Review indicates compliance is not achievable, the Mine will consult with the DoP to determine any requirements for modification of the approval.

39. Where the Review indicates compliance is achievable, a summary of the Review will be included in the next AEMR.

APPENDIX 3.1

Subsidence Prediction and Impact Assessment

Ditton Geotechnical Services Pty Ltd
80 Roslyn Avenue Charlestown NSW 2290
PO Box 5100 Kahibah NSW 2290

Centennial Angus Place Colliery Pty Ltd

Subsidence Prediction and Impact Assessment for the Proposed Longwall Panels 910 and 900 West at Angus Place Colliery, Lidsdale

DgS Report No. ANP-002/1

Date: 11 October 2010

ABN 43 113 858 910 ACN 124 206 962
Ph: 02 4920 9798 Fax: 02 4920 9798
Mob: 0413 094074 Email: steve.dgs@westnet.com.au

11 October, 2010

Peter Corbett
Technical Services Manager
Centennial Angus Place Colliery Pty Ltd
PO Box 198
WALLERAWANG NSW 2845

Report No. ANP-002/1

Dear Peter,

Subject: Subsidence Prediction and Impact Assessment of LWs 910 and 900 West at the Centennial Angus Place Colliery, Lidsdale

This report has been prepared in accordance with the brief provided on the above project.

Please contact the undersigned if you have any questions regarding this matter.

For and on behalf of
Ditton Geotechnical Services Pty Ltd

Steven Ditton
Principal Engineer

Executive Summary

Centennial Angus Place Colliery (CAPC) received a development approval for the extraction of Longwalls 920 to 980 in 2006 under the provisions of Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

CAPC is now seeking a Project Modification Approval under Section 75W of Part 3A of the EP&A Act to extract a further two longwalls (LWs) 900W and 910 to the west and north of the abovementioned longwall panels.

Other relevant aspects of the project include the installation of a dewatering bore facility at the eastern end of LW 910, an access track to the facility from Blackfellows Hands Road, a powerline extension along the access tracks to supply electricity from the existing 930 and 940 dewatering bore power line, and a buried pipeline extension of the Springvale-Delta Water Transfer Scheme along the proposed dewatering bore access track.

LWs 910 and 900W will have extracted void widths of 210 m and 293 m respectively in the 3.25 m thick Lithgow Seam. Both the longwall mining and development heights in the gate roads will be equal to the seam thickness. The depth of cover ranges from 300 to 350 m, giving critical panel width/cover depth ratios from 0.84 to 0.98 for LW 900W and sub-critical width/cover depth ratios of 0.60 to 0.68 for LW910.

LW 900W will be extracted first and retreat towards the north. It is located to the west of existing main headings that are adjacent to LWs 950 and 980. The main headings pillars are 35 m wide x 32 to 118 m in length. LW 900W will encroach within the Centennial Springvale Colliery (CSVC) Holding within Mining Lease 1326 (ML1326) to the south of the study area. CAPC is currently in the process of creating a new mining lease with Industry and Investment NSW.

LW 910 will be extracted second and retreat towards the west. It is located north of the previously extracted LW920. The tailgate of LW 910 will consist of a row of 34 m wide x 96 m long chain pillars that were formed for the extraction of LW 920. The maingate for LW 910 will consist of 37 m wide by 95 m long chain pillars.

There is also a second mining layout option proposed for LW910, if it is decided to extend the mine to the north east of the current project area. The second option will have a reduced panel width to allow a further two access headings to be developed along the maingate (i.e. northern) side of the panel. The second option is likely to reduce the extent of subsidence impact compared to the first option and has therefore not been assessed further in this study.

The panels will be extracted below the Newnes State Forest, which is largely vegetated by eucalypt tree species and shrubs. The terrain is gently undulated with broad crested gullies associated with the drainage paths to the north and east of the area. Ground slopes are generally < 10^{o} with some bedrock exposures near drainage lines. A tributary or ephemeral drainage gully associated with the Wolgan River (West Wolgan Creek) will be undermined by LW 910 only.

The surface consists of a shallow residual or alluvial sandy soil cover to a depth 1 to 5 m overlying highly weathered sandstones of the Burralow Formation with low to very low strength (UCS <20 MPa). Massive, high strength sandstone units of the Narrabeen Group's Banks Wall and Burra-Moko Head Formations exist between depths of 50 to 200 m and are likely to reduce subsidence due to 'bridging' or 'natural 'arching' behaviour.

There are no major fault structures within the footprint of the proposed panels, although in-seam mapping and interpretation work indicates normal faulting exists with 80^o dip and striking NW-SE, N-S and NE-SW (in persistence order). Major Principal horizontal stress is generally aligned NW-SE across the panels.

Existing surface developments within the Design Angle of Draw (Design AoD) of 26.5^o from the proposed longwall extraction limits include several forest access tracks (Blackfellows Hands, Kangaroo Creek and Beecroft Trails) and a 66 kV suspended power line (Integral Energy) above LW 900W. It is proposed to install temporary power and welded PVC water supply lines in a shallow trench across LW 910 to the proposed mine de-watering bore. Similar installations have been subsided without incident after LWs 930 to 950 were extracted.

With the exception of several hanging swamps above LW920, which have already been undermined, there are no other sensitive features such as cliff lines > 20 m in height, rock features between 5 m and 20 m height or Aboriginal Heritage Sites within an Design AoD distance of 26.5^o (0.5 times the cover depth) of the proposed panels.

The closest rock formation (>5 m and < 20 m high) to LW 900W is located approximately 175 m to the south of the starting end of the longwall. The set back distance is equivalent to an angle of draw of 35^o, based on a cover depth of 310 m.

The closest rock formation to longwall 910 is located approximately 275 m west of the proposed finish position of the longwall. The set back distance is equivalent to an angle of draw of 42^o based on a cover depth of 310 m. When it was undermined by LW920 in August 2005, the feature comprised a 4 m high sandstone overhang that had been undercut by up to 1.5 m due to natural weathering of a 3 m thick unit of underlying shale.

The north-west facing overhang was subsided by up to 0.7 m after completion of LW920, with tilts of up to 6 mm/m and tensile / compressive strains of 1 to 2 mm/m. A rock fall of approximately 56 m^2 / 140 m^3 (4 m high x 14 m long x 1.5 m to 3 m deep) was identified in May 2010 by mine site representatives and subsequently reported to II NSW. Based on aerial photos of the area and field inspections, it was determined that the fall occurred sometime between April and August, 2009 (i.e. 4 years after first undermining).

Predictions of worst-case subsidence and potential impacts to existing and proposed surface features have been based on a review of the subsidence data for LWs 920 to 950, which have similar mining geometries to the proposed longwalls. The predicted maximum final subsidence for the proposed panels ranges from 0.69 to 1.47 m, depending on cover depth, and represents 21% to 45% of the assumed mining height of 3.25 m.

Based on supercritical longwall mining experience in the Western NSW Coalfields, maximum subsidence is very unlikely to exceed 60% of the mining height or 1.95 m. This scenario represents the 'non-bridging' case.

The subsidence above the 34 m wide chain pillars between LWs 920 and 910 is estimated to range from 0.65 m to 1.04 m. Goaf edge subsidence is estimated to range from 0.07 to 0.21 m around LW 900W and from 0.15 to 0.37 m for LW 910.

Maximum panel tilts are predicted to range from 5 to 16 mm/m with local increases up to 24 mm/m, if fault or other discontinuities affect subsidence trough development.

Tensile strains are predicted to range from 2 to 6 mm/m and compressive strains from 3 to 8 mm/m. Based on similar strain magnitudes over previous panels at CAPC, some minor cracking may occur where near surface rock exposures exist. If surface cracking does develop, the predicted strains could increase by up to two to three times and range from 4 to 16 mm/m.

The surface above the previously extracted longwalls 920 and 930 is expected to subside a further 0.15 m to 0.7 m due to compression of chain pillars caused by the extraction of longwall LW 910. The associated tilts and strains are not expected to increase by more than 10 %, and may decrease due to the reduction in differential subsidence.

The outcomes of the predicted subsidence may result in the following impacts:

- Based on the observations over LWs 920 to 950, minor surface cracking and shearing may develop within tensile and compressive strain zones above the extracted panels and range in width from 1 mm to 20 mm where deep soil profiles exist.

- Worst-case scenarios indicated by the predictions, suggest that where surface rock exposures exist, local strain concentrations could result in tapered vertical cracks of up to 90 mm width near tensile strain peaks or low angled shearing in compressive strain zones. Repairs may be required to some of the wider and deeper creeks and in the vicinity of roads and public access areas; however, it is considered unlikely that this will be necessary.

- Some remediation of dry creek beds may also be necessary if cracking causes instability or loss of ephemeral flows. This will need to be done in consultation with relevant stakeholders and government agencies.

- It is very unlikely that cracking of cliff lines will occur due to mine subsidence, as all known cliff lines exist outside the Design AoD of 26.5^{o}. Due to the recent rock fall above LW920, the proposed longwall panels 910 and 900W have been positioned well outside the Design Angle of Draw of 26.5^{o} to the above features (i.e. 42^{o} and 35^{o} respectively).

  For the case of the previously impacted low-level rock face above LW920, the finishing point for LW910 was moved east by 100 m (i.e. 1 chain pillar length) as a precautionary measure. It is anticipated that this will minimise any additional subsidence from chain pillar compression effects at the feature and the potential for further impact.

- The increase or decrease of surface gradients of up to 0.3^{o} (0.5%) along ephemeral watercourses or gullies that exist above the proposed longwall panels. There is also the potential for a minor increase in erosion and sedimentation along creek beds after several storm events or until a new equilibrium is reached. Post mining inspections over previously extracted longwall panels at CAPC has not identified any mining related erosion impact.

- Gully stormwater or groundwater seepage flows may be re-routed to below-surface pathways and re-surface down-stream of cracked areas where shallow surface rock is present. The temporary loss of surface water flows is unlikely to occur where deep alluvial soil profiles exist. Creek bed sediment is likely to infill any surface cracking during storm events.

- Ponding depths of < 0.1 m may develop along creeks and flatter areas beneath the proposed longwalls. Any increases of existing ponded areas or development of new ponds are likely to be in-channel and unlikely to cause significant impact to the existing environmental conditions.

- Direct hydraulic connection from the surface to the mine workings due to sub-surface fracturing is considered 'very unlikely'. Continuous fracturing is not expected to develop above massive sandstone units of the Narrabeen Formation, which exist between 110 and 250 m above the workings.

- Based on shallow piezometer and borehole extensometer monitoring results from the neighbouring Springvale mine, in-direct or discontinuous sub-surface fracturing is 'very unlikely' to interact with surface cracks or effect the near surface groundwater regime.

  The presence of 'plastic' shale beds and the Mount York Claystone unit, which exists between the massive Narrabeen Group sandstone units, is understood to provide protection from permanent drainage of surface aquifers through surface and subsurface fracture / joint interconnection.

- The forest access tracks above the proposed panels are managed by Forests NSW. These tracks are accessible to the public. The tracks are likely to be subsided by up to the maximum panel values presented earlier and may also be affected by vertical cracking or low angle compressive shearing. The typical crack widths are estimated to range between 1 mm and 20 mm where the tracks pass through the tensile and compressive strain zones above each longwall panel. Worst-case crack widths of up to 90 mm across the tracks may occur if surface rock exists near tensile strain peaks.

  Post mining inspections of Forests NSW roads over the previously extracted longwalls have only found 'hairline' cracking (<1 mm wide) which quickly self heal following a rainfall event or re-grading activity.

A worst case assessment predicts that approximately 50 m to 100 m of the road above each longwall may be impacted by cracking. Any necessary repairs to tensile cracking or compressive shear failures through the road after mining of each panel is completed will be carried out in consultation with Forests NSW. It is recommended that appropriate warning signage be erected adjacent to the roads where they enter/exit an area that will be subsided.

- The poles of the existing suspended Integral 66 kV powerline above LW 900W may be subject to subsidence of between 0.5 m to 1.0 m, tilts of up to 8 mm/m and tensile or compressive strains of up to 4 mm/m. The conductor catenary clearance may be decreased by up to 0.6 m after mining is completed.

  Regular visual inspections and surveys of the poles and conductors during subsidence development along the easement will be required to enable prompt repair or adjustment of the line if necessary.

  Potential mitigation works to minimise damage due to subsidence impacts to the power poles and conductors would be to provide appropriate flexible sheaving on the poles to control the tension in the conductors during/after mining impacts. If this is required, it will be completed in consultation with Integral Energy. An Infrastructure Management Plan will be developed to manage impacts of this nature.

- The proposed buried PVC mine de-watering pipeline and pumping station power supply above LW910, is likely to be subsided by up to 0.7 m with longitudinal tilts of 4 mm/m, tensile and compressive strains of approximately 2 mm/m, and horizontal displacements of 60 mm to 100 mm.

  The predicted deformations should be considered in the design of flexible couplings, pipe joint strengths, trench backfill depth and strain transfer characteristics of protective sheathing.

  Regular visual inspections and monitoring of pipeline discharge/power supply will be required during subsidence development with management plans determined to ensure suitable responses to mine subsidence damage if it occurs.

Surface monitoring lines should be installed at relevant locations to provide accurate measurement of subsidence, tilt and strain and to enable the review of the measured values versus subsidence predictions for impact management assessment purposes.

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Glossary of Terms

Angle of Draw (AoD) The angle to the vertical from the sides or ends of an extracted longwall block and the line drawn from the limits of extraction at seam level to the 20 mm subsidence contour at the surface. The 20 mm subsidence contour is an industry defined limit and represents the practical measurable limit of subsidence.

Chain Pillar The pillar of coal left between adjacent longwall panels. This forms a barrier that allows the goaf to be sealed off and facilitates tailgate roof stability.

Cliff Line Refers to sub-vertical rock slopes with heights > 20 m in the context of the CAPC Mining Lease. They are also usually longer than their height (see also **Rock Formations**).

Compressive Strain A decrease in the distance between two points on the surface. Compressive strains may cause shear cracking or steps at the surface if > 3 mm/m and are usually associated with concave curvatures near the middle of the panels.

Confidence Limits A term used to define the level of confidence in a predicted subsidence impact parameter and based on a database of previously measured values above geometrically similar mining layouts.

Cover Depth The depth from the surface to the mine workings.

Critical Longwall Panels Longwall panels that are almost as deep (H) as they are wide (W) (ie 0.9 <W/H < 1.4) and is the point where yielding of the overburden starts to occur and maximum subsidence is likely to develop if the panel widths are increased.

Curvature The rate of change of tilt between three points (A, B and C), measured at set distances apart (usually 10 m). The curvature is plotted at the middle point or point B and is usually concave in the middle of the panel and convex near the panel edges.

i.e. curvature = (tilt between points A and B - tilt between points B and C)/(average distance between points A to B and B to C) and usually expressed in 1/km.

Radius of curvature is the reciprocal of the curvature is usually measured in km (i.e. radius = 1/curvature). The curvature is a measure of surface ‘bending’ and is generally associated with cracking.

CWC Values The Credible Worst-Case (CWC) prediction for the predicted impact parameter and normally based on the Upper 95% Confidence Limit line determined from measured data and the line of 'best fit' used to calculate the mean value. The CWC values are typically 1.5 to 2 times the mean values.

Design Angle of Draw (Design AoD)	The 'practical' angle of draw used to define minimum or allowable distances from the sides and ends of an extracted longwall block to sensitive surface features. It is considered to be an effective impact management tool in which to minimise impact from differential subsidence parameters such as tilt, curvature and strain, which may cause cracking or instability. Subsidence by itself (i.e. with very low tilt and strain) does not cause damage outside longwall extraction limits. A Design angle of draw of 26.5^{o} has been used with negligible impact to surface features at CAPC (and CSVC Coal) to-date.
Development Height	The height at which the first workings (i.e. the main headings and gateroads) are driven; usually equal to or less than the extraction height on the longwall face.
Extraction Height	The height at which the seam is mined or extracted across a longwall face by the longwall shearer.
Factor of Safety (FoS)	The ratio between the strength of a structure divided by the load applied to the structure. Commonly used to design underground coal mine pillars.
Far-Field Displacement	Horizontal displacement outside of the angle of draw, associated with movement are due to horizontal stress relief above an extracted panel of coal. The strains due to these movements are usually < 0.5 mm/m and do not cause damage directly. Such displacements have been associated with differential movement between bridge abutments and dam walls in the Southern Coalfield, but generally have not caused significant damage in the Western Coalfield.
First Workings	The tunnels or roadways driven by a continuous mining machine to provide access to the longwall panels in a mine (i.e. main headings and gate roads). The roof of the roadways is generally supported by high strength steel rock bolts encapsulated in chemical resin. Subsidence above first workings pillars and roadways is generally < 20 mm.
Gate Roads	The tunnels or roadways driven down both sides of the longwall block (usually in pairs), to provide airways and access for men, materials, and the coal conveyor to the longwall face. The conveyor side of the block is called the 'maingate' and dust laden air and coal seam gases are exhausted on the opposite side (called the 'tailgate').

Goaf The extracted area that the immediate roof or overburden collapses into, following the extraction of the coal. The overburden above the 'goaf' sags, resulting in a subsidence 'trough' at the surface.

Horizontal Displacement Horizontal displacement of a point after subsidence has occurred above an underground mining area within the angle of draw. It can be predicted by multiplying the tilt by a factor derived for the near surface lithology at a site (e.g. a factor of around 15 is normally applied in the Western Coalfield).

Inbye An underground coal mining term used to describe the relative position of some feature or location in the mine that is closer to the coal face than the reference location.

Inflexion Point The point above a subsided area where tensile strain changes to compressive strain along the deflected surface. It is also the point where maximum tilt occurs above an extracted longwall panel. It is typically located between 0.25 and 0.4 x cover depth from the panel sides, depending on panel W/H ratio.

Longitudinal Subsidence Profile Subsidence measured (or predicted) along a longwall panel or centre line.

Longwall The method of extracting a wide block of coal using a coal shearer and armoured face conveyor. Hydraulic shields provide roof support across the face and protect the shearer and mine workers.

The longwall equipment is installed along the full width of the block in an 8 to 10 m wide installation road at the start of the block before retreating back to the finishing end of the block. The shields are progressively advanced across the full width of the face, as shearing continues in a sequence of backwards and forwards motions across the face.

Depending on the geological conditions and longwall performance, the longwall retreats at a typical rate of about 50 to 100 m/week.

Maingate Refers to the tunnels or roadways down the side of a longwall block which provides access for mine operations personnel, power, materials and clean air to the longwall face. It is usually located on the side of the longwall panel adjacent to unmined panels or solid coal.

Mean Values The average value of a given impact parameter value (i.e. of subsidence, tilt and strain) predicted using a line of 'best fit' through a set of measured data points against key independent variables (e.g. panel width, cover depth, extraction height). The mean values are typically two-thirds to half of the credible worst-case values and sometimes lower.

Mining Height Refers to the height or thickness of coal extracted along a longwall face.

Outbye An underground coal mining term used to describe the relative position of some feature or location in the mine that is closer to the mine entry point than the reference location.

Outlier A data point well outside the rest of the observations, representing an anomaly (e.g. a measurement related to a structural discontinuity or fault in the overburden that causes a compressive strain concentration at the surface, in an otherwise tensile strain field).

Panel Width The width of an extracted area between chain pillars.

Primary Subsidence The subsidence which occurs that is directly caused by longwall face retreat and the sagging of overburden or compression of chain pillars. Primary subsidence usually continues for three or four longwall panels at an exponential rate of decay after each longwall passes a given site.

Residual Subsidence The last 5% to 10% of subsidence that occurs after primary subsidence is complete. It is not directly linked to the retreating longwall face and is associated with the re-consolidation or re-compaction of goaf and overburden. It is unlikely that any further impact to features will occur due to residual subsidence.

Rock Formations Individual rock features > 5 m and < 20 m high which are not cliff lines. They are also known as sandstone pagodas or micro-buttes and are usually higher than their width (see also **Cliff Line**).

Shoving The shortening effect of compressive strains due to mine subsidence on surface terrain, which results in localised shearing movements of soils and rock.

Strain The change in horizontal distance between two points at the surface after mining, divided by the pre-mining distance between the points.

i.e. Strain = ((post-mining distance between A and B) - (pre-mining distance between A and B))/(pre-mining distance between A and B) and is usually expressed in mm/m.

Strain can be estimated by multiplying the curvature by a factor derived for the near surface lithology at a site (e.g. a factor of around 15 is normally applied in the Western Coalfield).

Discontinuous overburden behaviour however, can result in local strain and curvature concentrations at cracks, making accurate predictions difficult. A rule of thumb is normally applied to allow for these effects, which is to increase smooth profile strains (and curvatures) by 2 to 3 times at a given location. The increase in strain also usually develops at locations with shallow rock profiles, as opposed to areas with deep soil profiles.

Study Area The area which may be influenced by mine subsidence movements > 20 mm from the extraction of the proposed longwalls 910 and 900W.

Sub-critical Longwall Panels Longwall panels that are deeper than they are wide (W/H < 0.9 at CAPC) and cause lower magnitudes of subsidence than shallower panels due to natural arching of the overburden across the extracted coal seam.

Subsidence The difference between the pre-mining surface level and the post-mining surface level at a point, after it settles above an underground mining area.

Subsidence Control Reducing the impact of subsidence on a feature by modifying the mining layout and set back distances from the feature (normally applied to sensitive natural features that can't be protected by mitigation or amelioration works).

Subsidence Impact The effect that subsidence has on natural or man-made surface and sub-surface features above a mining area.

Subsidence Management Plan (SMP) Refers to the approval process for managing mine subsidence impacts, in accordance with the Department of Primary Industries (now known as Industry and Investment) Guidelines. The mine must prepare a Subsidence Management Plan to the satisfaction of the Director-General, before the commencement of operations that will potentially lead to subsidence of the land surface.

Subsidence Mitigation/ Amelioration Modifying or reducing the impact of subsidence on a feature, so that the impact is within safe, serviceable, and repairable limits (normally applied to moderately sensitive man-made features that can tolerate a certain amount of subsidence).

Subsidence Reduction Potential (SRP)
Refers to the potential reduction in subsidence due to massive strata in the overburden being able to either 'bridge' across an extracted panel or have a greater bulking volume when it collapses into the panel void (if close enough to seam level). The term was defined in an **ACARP, 2003** study into this phenomenon and is common in NSW Coalfields.

Super-Critical Longwall Panels
Longwall panels that are not as deep (H) as they are wide (W) (ie W/H > 1.4) and will cause complete failure of the overburden and maximum subsidence that is proportional to the mining height (i.e 0.5 to 0.6 T).

Tailgate
Refers to the tunnels or roadways down the side of a longwall block which provides a ventilation pathway for bad or dusty air away from the longwall face. It is usually located on the side of the longwall panel adjacent to previously extracted panels or goaf.

Tilt
The rate of change of subsidence between two points (A and B), measured at set distances apart (usually 10 m). Tilt is plotted at the mid-point between the points and is a measure of the amount of differential subsidence.

i.e. Tilt = (subsidence at point A - subsidence at point B)/(distance between the points) and is usually expressed in mm/m.

Tensile Strain
An increase in the distance between two points on the surface. Tensile strains are likely to cause cracking at the surface with shallow soil profiles over rock if > 2 mm/m and are usually associated with convex curvatures near the sides (or ends) of the panels. Tensile strain also usually develops above chain pillars.

Transverse Subsidence Profile
Subsidence measured (or predicted) across a longwall panel or cross line.

Valley Closure
The inward (or outward) movement of valley ridge crests due to subsidence trough deformations or changes to horizontal stress fields associated with longwall mining. Measured movements have ranged between 10 mm and 400 mm in the NSW Coalfields and are usually visually imperceptible.

Valley Uplift
The phenomenon of upward movements along the valley floors due to **Valley Closure** and buckling of sedimentary rock units. Measured movements have ranged between 10 mm and 400 mm in the NSW Coalfields and may cause surface cracking in exposed bedrock on the floor of the valley (or gorge).

1.0 Introduction

This report provides subsidence predictions and impact assessment for the proposed Longwalls 910 and 900 West at Centennial Angus Place Colliery (CAPC), Lidsdale.

CAPC received a development approval for the extraction of Longwalls 920 to 980 in 2006 under the provisions of Part 3A of the *Environmental Planning and Assessment* Act 1979 (EP&A Act). CAPC is now seeking a Project Modification Approval under Section 75W of Part 3A of the EP&A Act to extract two additional longwalls (LWs), one to the west (LW 900W) and one to the north (LW910) of the abovementioned longwalls.

The purpose of the report was to provide worst-case subsidence contour predictions and assess the potential impacts to existing natural and man-made features above the proposed longwalls. Recommendations for any necessary subsidence impact management strategies using mine planning and/or mitigation/hazard control techniques have also been provided.

The proposed longwalls will be located at 300 to 370 m depth beneath the Newnes State Forest in the 3.25 m thick Lithgow Seam. The LWs 900W and 910 will have extracted void widths of 293 m and 210 m respectively. Longwall 900W will be orientated north-south and located west of the existing north-south main headings and longwalls 920 to 980. Longwall 910 will be orientated east-west and located immediately to the north of the previously extracted LW920.

Longwall 900W will be extracted first and have a sub-critical panel width/cover depth ratio range of 0.56 to 0.65. Longwall 910 will have a critical panel width/cover depth ratio from 0.92 to 0.98.

There is also a second mining layout option proposed for LW910 if it is decided to extend the mine into an area located to the north east of the current project area. The second option will have a slightly reduced panel width to allow a further two access headings to be developed along the maingate (i.e. northern) side of the panel. The second option is likely to reduce the extent of subsidence impact compared to the first option and has therefore not been assessed further in this study.

Other relevant aspects of the project include:

- the installation of a dewatering bore facility at the eastern end of LW 910,
- an access track to the facility from Blackfellows Hands Track,
- a powerline extension along the access tracks to supply electricity from the existing 930 and 940 dewatering bore power line, and
- a buried pipeline extension of the Springvale-Delta Water Transfer Scheme along the proposed dewatering bore access track.

The following surface features are known to exist above the proposed longwalls:

- Gently undulating bushland with ground slopes < 10^o and broad drainage gullies.
- Several public-accessible forest tracks (Blackfellows Hands and Beecroft).
- A 66 kV suspended powerline (Integral Energy) above LW 900W.
- It is proposed to install temporary power and welded PVC water supply lines in a shallow trench across LW 910 to a mine de-watering bore.

There are no sensitive features such as sandstone cliff lines > 20 m high, rock formations > 5 m and < 20 m high or Aboriginal Heritage Sites within an angle of draw distance of 26.5^o (0.5 times the cover depth) of the proposed panels.

The closest significant rock feature to the limits of extraction for LWs 900W is located 175 m to the south of the panel's starting position, which is equivalent to an AoD of 29^o for a cover a depth of 310 m. The nearest significant rock feature to LW 910's extraction limits is located approximately 275 m west of the proposed finishing position of the panel.

Both features are therefore located outside of the design angle of draw of 26.5^o from the ends of the longwalls. Cliff lines > 20 m high exist to the north and west of the proposed panels and are outside the design angle of draw.

There are no Newnes Plateau hanging or shrub swamps above the proposed longwall extraction limits, however there are several of these features within the angle of draw to the 20 mm subsidence contour for LW910. To-date, most of the shrub and hanging swamps have been subsided by up to 1.4 m with without significant impact.

2.0 Method

CAPC have already completed longwalls 920 to 950. The proposed LW 900W is scheduled to be mined first after completion of LWs 960 to 980. LW910 will be located adjacent to the LW920 goaf.

To enable this assessment, the subsidence data for longwalls 920 to 950 was reviewed and an empirical model developed first (refer to **DgS, 2010**). This work was also required to assess the subsidence interaction between the existing approved longwalls (ie. 920 to 980) and the proposed longwalls (ie. 900W and 910).

The subsidence predictions presented in this study represent the credible worst-case scenarios for impact assessment and management strategy development. It is noted, that the subsidence review of the current mining area (ie. LWs 920 to 980) does not form part of the proposed project application area; rather, it provides valuable information to assess the subsidence interaction between the two areas.

The study methodology included the following work program:

(i) The development of a geotechnical model and description of surface and subsurface features for the study area.

(ii) A review of **DgS, 2010**, which contains predicted subsidence, tilt and strain profiles for LWs 950 to 980 based on survey data for LWs 920 to 940.

(iii) Prediction of maximum single and multiple panel subsidence impact parameters for LWs 910 and 900W, based on the range of geological conditions, proposed mining geometries, previous longwall survey data and the empirical model techniques described in **ACARP, 2003** and **DgS, 2010**.

(iv) Predictions of average (mean) and credible worst-case (Upper 95% Confidence Limit) subsidence, tilt and strain profiles for LWs 910 and 900W based on the outcomes of (iii) and cubic-spline interpolation software.

(v) Calibration of SDPS® 3-D influence function model for subsidence contour predictions, which include the surface topography and fault affected areas.

(vi) Predictions of surface impacts such as cracking and erosion/sedimentation due to strains and slope gradient changes after the extraction of all the longwalls applicable to this assessment (including LWs 920 to 980 for completion).

(vii) Predictions of sub-surface fracture heights above the longwalls in the study area for groundwater and surface water interaction impact assessment.

(viii) Recommendations for impact management plans and appropriate impact minimisation strategies.

3.0 Available Data

The following data was provided by CAPC representatives for the purposes of undertaking the stated assessment:

- Autocad drawings of the previous and proposed longwall panel layouts.
- Electronic copies of various interpreted contour plans of seam thickness, cover depth and surface topography over the previous and proposed longwall panel layouts.
- Geological and geophysical logs of four boreholes adjacent to the study area (CSVC's boreholes SPR 26, 32 and 39 and CAPC's boreholes ELN27, 29, 48 and 54).
- Subsidence data for several crosslines and centrelines above LWs 920 to 950.
- In-seam geological mapping and structure lineament definition over LWs 920 to 950.

The location of the longwall panels, surface features and survey lines are shown in **Figure 1**. Pre-mining surface level contours and slope gradients are presented in **Figure 2** with cover depth contours to the mine workings presented in **Figure 3**.

4.0 Mining Geometry

The location and mining geometries of the proposed longwalls are indicative, based on the available information at the time of completing this assessment. Typical mining geometries, as discussed within this section, have been used to complete this assessment.

The longwall panels 900W and 910 will have extracted nominal void widths of 293 m and 210 m respectively in the 3.25 m thick Lithgow Seam. Both the longwall mining and development heights in the panels will be equal to the seam thickness. The depth of cover ranges from 300 to 350 m, giving critical panel width/cover depth ratios from 0.84 to 0.98 for LW 900W and sub-critical width/cover depth ratios of 0.60 to 0.68 for LW910.

Longwall 900W will be extracted first and retreat towards the north. It will be located to the west of existing mains headings that are adjacent to LWs 950 and 980. The main headings pillars will typically be around 35 m wide x 32 to 118 m in length. LW 900W will also encroach within the Centennial Springvale Coal's (CSVC) lease to the south of the study area. CAPC is currently applying for a sub lease over the subject area.

Longwall 910 will be extracted second and retreat towards the west. It will have a tailgate with a row of chain pillars that are typically 34 m wide x 96 m long between it and LW 920. The maingate to be formed will typically consist of 37 m wide by 95 m long chain pillars. LW 910 will be extracted east to west.

There is also a second mining layout option proposed for LW910 if it is decided to extend the mine into an area located to the north east of the current project area. The second option will have a reduced panel width to allow a further two access headings to be developed along the maingate (i.e. northern) side of the panel. The second option is likely to reduce the extent of subsidence impact compared to the first option and has therefore not been assessed further in this study.

5.0 Study Area Conditions

5.1 Geological Setting

The geotechnical model of the overburden for the proposed panels is assumed to be similar to the model developed for LWs 920 to 980 in **DgS, 2010**. Extracts from the DgS report are provided below with a representative graphical log presented in **Figure 4**.

CAPC is situated within the southern portion of the Western Coalfield. The extracted and proposed longwall panels are located within the combined Lithgow/Lidsdale Seam of the Illawarra Coal Measures. Interpreted contours indicate that the total seam thickness ranges between 6.0 m and 7.2 m. The current and proposed workings are located within the Lithgow Seam (Unit 1), which forms the lower 3.0 to 3.3 m of the combined seam thickness.

The strata units (in ascending order) above the mine workings include:

- The Lidsdale and Lithgow Seams are immediately overlain by 4 to 6 m of the Long Swamp Formation, which consist of interbedded coal, shale and mudstone with low to moderate material strength (Unit 2).

- Approximately 31 m to 47 m of interbedded siltstone, sandstone and minor coal of the Newnes, Glen Davis and Denman Formations form the interburden (Units 2 and 3) up to the 7 to 16 m thick Gap Sandstone (Unit 4) and 10 m thick Katoomba / Little Riverdale Seams (Unit 1). Thinly bedded sandstone and siltstone of the Triassic Narrabeen Groups's Caley Formation (Unit 3) exist above the Katoomba Seam.

- The 74 to 79 m thick Burra-Moko Head Unit is thickly bedded to massive conglomeratic sandstone with minor shale beds (Unit 4) and overlys the thinly bedded strata some 114 m to 116 m above the workings.

- The Mount York Claystone is a 4 to 11 m thick unit of medium to high strength claystone (Unit 3) which separates the Burra-Moko Head Unit from the overlying Banks Wall Sandstone.

- The Banks Wall Sandstone (Unit 4) is 75 to 99 m thick and consists of thickly bedded to massive conglomeratic sandstone with minor shale beds and is 192 m to 206 m above the workings.

The first 50 to 60 m of overburden at the surface consists of a shallow residual or alluvial sandy soil cover to a depth 1 to 5 m overlying highly weathered sandstones of the Burralow Formation with low to very low strength (UCS <20 MPa).

Known regional geological structure in the study area consists of normal and reverse faulting. The structure is mid-angled to sub-vertical (i.e. dip angles from 35^o to 80^o) and strike NE:SW, N:S and NW:SE. No major structures or lineaments have been identified above the proposed panels. Major Principal horizontal stress is generally aligned NW-SE across the panels.

5.2 Surface Features

The panels will be extracted below the Newnes State Forest, which is vegetated by eucalypt tree species and shrubs. A tributary or ephemeral drainage gully associated with the Wolgan River (West Wolgan Creek) will be undermined by LW 910 only. There are no endangered ecological communities (EECs Species Act) identified above the proposed longwalls.

The terrain is gently undulated with broad crested gullies associated with the drainage paths to the north and east of the area. Ground slopes are generally < 10^o with some bedrock exposures near ephemeral drainage lines.

Existing surface developments within the angle of draw of the proposed longwalls include several forest access tracks and a 66 kV suspended power line (Integral Energy) above LW 900W. The power line consists of three conductors suspended between 15 m high timber poles at approximately 100 m spacing.

It is proposed to install temporary power and welded PVC water supply lines in a shallow trench across LW 910 to a mine de-watering bore. Similar installations have been subsided without incident for LWs 930 and 950.

With the exception of several hanging swamps above LW 920, there are no other sensitive features such as sandstone cliff lines > 20 m high, rock formations > 5 m to < 20 m high or Aboriginal Heritage Sites within the Design AoD of 26.5^o (0.5 times the cover depth) of the proposed panels.

The nearest rock formation to LW 900W is located 175 m to the south of its starting position at an equivalent AoD of 35^o. The nearest rock feature to LW 910 is 275 m to the west of its finishing point. Both rock features fall outside the Design AoD of 26.5°. Cliff lines exist to the north and west of the proposed panels also outside the design angle of draw (**Figure 2**).

The closest rock formation closest to longwall 910s finishing position was undermined by LW920 to the south in August 2005. When it was undermined by LW920 in August 2005, the feature comprised a 4 m high sandstone overhang that had been undercut by approximately 1.5 m due to natural weathering of a 3 m thick unit of underlying shale beds.

The north-west facing overhang was subsided by up to 0.6 m, with tilts of up to 9 mm/m and tensile / compressive strains of 2 to 3 mm/m. A rock fall of approximately 56 m^2 / 140 m^3 (4 m high x 14 m long x 1.5 m to 3 m deep) was identified in May 2010 by mine site representatives and subsequently reported to II NSW. Based on aerial photos of the area and field inspections, it was determined that the fall occurred sometime between April and August, 2009 (i.e. 4 years after first undermining).

5.3 Surface and Subsurface Groundwater Aquifers

The groundwater regime has been assessed and described in the CAPC SMP Application for LWs 930 to 980 (dated 30/05/05) and indicates that the following sub-surface aquifers (AQ1-5) exist above the proposed workings (in ascending order):

- AQ1 - The Lidsdale Seam
- AQ2 - Sandstone, coal and siltstones of the Farmers Creek Formation (includes the Gap Sandstone Member, Middle River and Katoomba Coal Seams)
- AQ3 - Conglomeratic Sandstone in Narrabeen Group's Burra-Moko Head Formation
- AQ4 - Conglomeratic Sandstone in lower Narrabeen Group's Banks Wall Sandstone
- AQ5 - Conglomeratic Sandstone in upper Narrabeen Group's Banks Wall Sandstone

Aquifers AQ1 to AQ4 are defined as confined aquifers with the AQ5 defined as an unconfined aquifer. The Mount York Claystone forms a semi-impermeable aquitard between the AQ4 and AQ5 aquifers, and is approximately 200 m above the Lithgow Seam. There are currently no privately owned groundwater extraction bores in the study area.

6.0 Description of Subsidence Development Mechanism

After the extraction of a single longwall panel, the immediate mine roof usually collapses into the void following extraction of the seam. The overlying strata or overburden then sags down onto the collapsed roof material, resulting in a subsidence trough developing at the surface.

The maximum subsidence occurs in the middle of the extracted panel and is dependent on the mining height, panel width, cover depth, overburden strata strength and stiffness and bulking characteristics of the collapsed strata. For the case of single seam mining, the maximum subsidence invariably does not exceed 60% of the mining height in the NSW and QLD Coalfields, and may be lower than this value due to the spanning or bridging capability of the strata above the collapsed ground (or the goaf).

The combination of the above factors determines whether a single longwall panel will be sub-critical, critical or supercritical in terms of maximum subsidence. In the Australian coalfields, sub-critical or (spanning) behaviour generally occurs when the panel width (W) is <0.6 times the cover depth (H). If relatively thick and strong massive strata exist, then sub-critical spanning behaviour can occur for panel W/H ratios up to 0.9 in the Western Coalfield (eg. CSVC, CAPC and Ulan Collieries). The maximum subsidence for this scenario is usually significantly < 60% of the longwall extraction height and could range between 10% and 30%.

Beyond the sub-critical range, the overburden is unable to span and starts to fail and sag down onto the collapsed or caved roof strata immediately above the extracted seam (i.e. the panel is critical or super-critical). Critical panels refer to panels with W/H ratios between 0.6 and 1.4 and where maximum subsidence is still a function of panel width. At CAPC and CSVC, the critical panel W/H ratios appear to range between 0.9 and 1.4.

Supercritical panels refer to panels with widths that cause complete collapse of the overburden and maximum panel subsidence does not usually continue to increase significantly with increasing panel width. The W/H ratio of supercritical panels is typically > 1.4 in Australian Coalfields.

The surface effect of extracting several adjacent longwall panels is dependent on the stiffness of the overburden and the chain pillars left between the panels. After mining of several longwall panels, additional subsidence usually occurs above a previously extracted panel and is caused primarily by the compression of the chain pillars and roof / floor strata due to load transfer via the deflecting strata above the extracted longwall panels.

A longwall chain pillar undergoes the majority of life-cycle compression when subject to double abutment loading (i.e. the formation of goaf on either side, after two adjacent panels have been extracted). Surface survey data indicates that an extracted panel can affect the chain pillars between three or four previously extracted panels. The stiffness of the overburden and chain pillar system will determine the extent of load transfer to the preceding chain pillars. If the chain pillars go into yield, the load on the pillars will be mitigated to some extent by load transfer to adjacent fallen roof material or goaf.

The surface subsidence trough usually extends outside the limits of extraction for a certain distance defined as the angle of draw (see **Glossary of Terms**). The angle of draw to 20 mm of vertical subsidence is normally assumed to be the practical limit of measureable mine subsidence. The angle of draw can also be affected significantly by other factors such as soil shrink/swell from climatic variation, regional horizontal stress relief affects and survey method accuracy.

The Department of Mineral Resources (now Industry and Investment) applies what is known as a "Design Angle of Draw" to provide appropriate set-back distances for longwall mining from sensitive surface features. In the NSW Coalfields, the practical or Design AoD from sensitive features is typically 26.5^{o} and has been applied successfully to cliff lines, waterways and sensitive archaeological sites. In some instances an additional buffer zone has been added to the design angle of draw to allow for uncertainties in final mining limits and geological and/or topographical factors.

It should be understood however, that surface features are generally only impacted by differential subsidence movements such as tilts, curvatures and strains once they exceed a certain tolerable value. The Design Angle of Draw is conservative and recognises the potential for variability in actual draw angles, but also recognises that this variability will probably result in negligible surface impacts outside the Design Angle of Draw. Design Angles of Draw therefore provide limits to the differential movements such as tilt, curvature and strain to tolerable magnitudes, rather than attempt to limit subsidence to 20 mm.

The effectiveness of the Design AoD of 26.5^{o} at CAPC can be demonstrated by reviewing the angles of draw to the key impact parameters of tilt, curvature and strain that have been measured to-date.

The subsidence prediction models used in this study consider the abovementioned processes and will be further described in **Section 7.0**.

7.0 Subsidence Impact Profile Prediction for Multiple Longwall Panels

7.1 General

Predictions of maximum subsidence impact parameters and post-mining subsidence profiles for multiple longwall panels require estimation of the following key parameters:

- maximum sag subsidence above a single longwall panel;
- chain pillar subsidence between adjacent longwall panels;
- inflexion point or maximum tilt location;
- maximum tensile strain or convex curvature location;
- maximum compressive strain or concave curvature location;
- goaf edge subsidence;
- angle of draw to the 20 mm subsidence contour.

A conceptual model of multiple longwall panel and chain pillar subsidence interaction mechanics with the key parameters described above is presented in **Figure 5a**.

Multiple-panel subsidence profiles are determined by adding a proportion of the chain pillar subsidence to the predicted single panel subsidence. Estimates of first and final subsidence above a given set of longwalls use this general approach. The definition of First and Final S_{max} is as follows:

First S_{max} = the total subsidence after the extraction of a longwall panel, including the effects of previously extracted longwall panels adjacent to the subject panel;

Final S_{max} = the total subsidence over an extracted longwall panel, after at least three more panels have been extracted, or when mining is completed.

In the Western Coalfield at CSVC and CAPC, where cover depths generally exceed 300 m, it has been found that First and Final S_{max} for a panel are predicted by adding 25% and 50% of the predicted subsidence over the respective chain pillars.

The subsidence above chain pillars has been defined in this study as follows:

First S_p = subsidence over chain pillars after longwall panels have been extracted on both sides of the pillar;

Final S_p = the total subsidence over a chain pillar, after at least another three more panels have been extracted, or when mining is completed.

The subsidence profiles have then been derived from the key profile points and cubic spline curve fitting techniques. The differential subsidence parameters of tilt, curvature and horizontal strain (which are the primary causes of impact) are estimated from the maximum subsidence and the typical panel geometry. The general location and relative magnitudes of the differential subsidence profiles is shown in **Figure 5b**.

Further details of the prediction methodology may be found in **DgS, 2010**.

7.2 Subsidence Reduction Potential of the Unit 4 Sandstone Units

The three massive Unit 4 sandstone strata units identified in the overburden were assessed for subsidence reduction potential (SRP) above the proposed panels.

The thickness and location of each unit above the proposed workings have been plotted with the SRP threshold limit lines for the appropriate cover depth category (i.e. H= 300 m +/- 50 m) as shown in **Figure 6**.

The outcomes of the assessment are summarised in **Table 2** and indicate that two of the massive conglomeratic sandstone units (Burra-Moko Head and Banks Wall Sandstone) have a thickness > 74 m and will have 'High' SRP above the 210 m and 293 m wide panels. The thinner Gap Sandstone unit is assessed to have a 'Low' SRP for the proposed panel geometries.

Table 2 – Summary of Significant Overburden Lithology Parameters

Formation	Unit	Panel Widths W (m)	Thickness, Range t (m)	Distance to Unit above the Workings, y (m)	Cover Depth H	Unit Location Ratio	Unit Subsidence Reduction Potential
Gap Sandstone	4	210 & 293	7 - 16	57 - 74	310-370	0.20 - 0.23	Low
Burra-Moko Head	4		74 - 79	114 - 116		0.31 - 0.36	High
Banks Wall Sandstone	4		99 - 75	192 - 206		0.52 - 0.60	High

7.3 Maximum Single Panel Subsidence

The maximum subsidence above a single longwall panel will depend upon the panel width, cover depth, seam thickness, and the SRP of the overburden.

Based on reference to the **ACARP, 2003** model, the SRP categories assessed above are then used to select the appropriate subsidence prediction lines from one of three given depth categories (100 m, 200 and 300 m +/- 50 m). The depth categories were developed in the **ACARP, 2003** study to cater for the influence of scale on the spanning behaviour of the massive lithological units above panels of a given geometry.

The predictions for single panels in the study area are based on the 300 m +/- 50 m cover depth curves shown in **Figure 7**. *Note: It is considered that the curves are suitable for cover depths > 350 m, based on comparisons between measured and predicted values at CAPC and CSVC.*

The maximum subsidence (S_{max}) for the single 210 and 293 m wide longwall panels at 300 to 370 m depth with 'High' SRP (typical Newnes Plateau) overburden is summarised in **Table 3** for the assumed average face extraction height of 3.25 m.

The maximum subsidence estimated for LWs 910 and 900W along XLs 1 to 7 (see **Figure 1** for their location) are summarised in **Table 3**.

Table 3 - Predicted Maximum Single Panel Subsidence for LWs 910 and 900 West

XL #	Panel Width W (m)	Cover Depth H (m)	W/H	Unit t (m)	Unit Location Above Workings y (m)	Unit Location Factor y/H	SRP	Single S_{max}/T* (m)		Single S_{max}* (m)	
								Mean	U95% CL	Mean	U95% CL
LW 910											
1	210	320	0.65	75	192	0.60	High	0.11	0.21	0.34	0.67
2	210	370	0.56	75	192	0.52	High	0.10	0.13	0.31	0.41
3	210	350	0.59	75	192	0.55	High	0.10	0.13	0.32	0.42
4	210	360	0.58	75	192	0.53	High	0.10	0.13	0.32	0.41
LW 900 West											
5	293	310	0.94	75	192	0.62	High	0.30	0.40	0.98	1.31
6	293	300	0.98	75	192	0.64	High	0.35	0.45	1.15	1.47
7	293	320	0.92	75	192	0.60	High	0.25	0.35	0.80	1.13

The results of the above assessment indicate that the maximum single panel subsidence is likely to range between 0.31 and 0.61 m (10% to 21% of the mining height) above LW 910 and between 0.80 and 1.47 m (25% to 45% of the mining height) above LW 900W.

The single panel subsidence predictions will be used with the chain pillar and goaf edge subsidence to estimate the multi-panel subsidence in **Section 7.8**.

7.4 Maximum Predicted Subsidence Above Chain Pillars

7.4.1 Model Development

The predicted subsidence values above the chain pillars have been estimated based on an empirical model of the roof-pillar-floor system.

The empirical model has been developed from measured subsidence data over chain pillars (S_p) divided by the mining height (T) v. the total pillar stress after longwall panel extraction on both sides.

The estimate of the total stress acting on the chain pillars on each side of the LW910 panel under double abutment loading conditions is based on the abutment angle concept described in **ACARP, 1998b**. The total stress acting on each pillar of a chain pillar pair after mining was estimated as follows:

σ = pillar load/area = $(P+A_1+A_2)/wl$

where:

P = full tributary area load of column of rock above each pillar;

= $(l+ r)(w + r).\rho.g.H$;

$A_{1,2}$ = total abutment load from each side of pillar in MN/m, and

= $(l+r)\rho g(0.5W'H - W'^2/8\tan\phi)$ (for sub-critical panel widths) or

= $(l+r)(\rho gH^2\tan\phi)/2$ (for super-critical panel widths);

w = pillar width (solid);

l = pillar length;

r = roadway width;

H = depth of cover;

ϕ = abutment angle (normally 21° adopted for cover depths < 370 m at CAPC);

W' = effective panel width (rib to rib distance minus the roadway width).

A panel is deemed sub-critical when $W'/2 < H\tan\phi$.

As presented in **ACARP, 1998a** the FoS of the chain pillars were based on the strength formula for 'squat' pillars with w/h ratios > 5 as follows:

$S = 27.63\Theta^{0.51}(0.29((w/5h)^{2.5} - 1) + 1)/(w^{0.22}h^{0.11})$

where:

h = pillar height;

Θ = a dimensionless 'aspect ratio' factor or w/h ratio in this case.

The FoS was calculated by dividing the pillar strength, S, with the pillar stress, σ.

A similar exercise was also completed for the first working pillars under single abutment load conditions due to the extraction of LW 900W.

The total stress acting on the mains pillars adjacent to the LW 900W goaf may be estimated as follows:

σ_{pillar} = pillar load/area = (P+RA)/wl

where:

P = Full tributary area load of column of rock above each pillar;

$= (w+ r)(l+r).\rho.g.H;$

RA = Single Abutment load due to cantilever action of overburden over goaf

$= 0.5\ u\ H^2 \tan(\theta)(l+r)$ (where u = unit weight of overburden 0.025 MPa/m
θ = abutment angle (normally taken as 21^o))

R = Proportion of abutment load acting on first row of pillars;

$= 1- [(D-w-r)/D]^3$ (where D = distance (m) that load distribution will extend from goaf edge according to **Peng & Chiang, 1986**: $D = 5.13\sqrt{H} = 90$ m)

$= 1 - [(90 - 35 - 4.8)/90]^3$

$= 0.83$

7.4.2 Chain Pillar Subsidence Model Outcomes

The Mean and Upper 95%CL chain pillar subsidence values for the proposed pillars between LWs 920 and 910 under double abutment loading conditions have been estimated after mining is completed using the methodology presented in **Section 7.4.1**.

The results are summarised in **Table 4** and presented graphically with the empirical model database in **Figure 8**.

The predicted subsidence and FoS for the main headings pillars under single abutment loading conditions after the extraction of LW 900W are also presented in **Table 4**. The assumed loading model used to estimate the single abutment loads on the main headings pillars is shown in **Figure 9a**.

Table 4 - Predicted Chain Pillar Subsidence for LW910 and Main Headings Pillar Subsidence under LW900W

XL* No.	Pillar w/h Ratio	Cover Depth H (m)	Pillar Stress (MPa)	Pillar FoS	Sp First (mean)	Sp First (U95%CL)	Sp Final (mean)	Sp Final (U95%CL)
34 m x 95 m chain pillars between LWs 920 and 910								
1	10.5	320	38.3	0.92	0.65	0.81	0.78	0.94
2	10.5	370	49.1	0.71	0.74	0.90	0.89	1.04
3	10.5	350	41.5	0.84	0.69	0.84	0.83	0.98
4	10.5	360	47.5	0.74	0.73	0.89	0.88	1.03
35 m x 119 m main headings pillars east of LW 900W								
5	10.8	300	19.51	1.92	*0.12*	*0.19*	*0.12*	*0.19*
35 m x 104 m main headings pillars east of LW 900W								
6	10.8	310	20.55	1.80	*0.13*	*0.20*	*0.13*	*0.20*
35 m x 95 m main headings pillars east of LW 900W								
7	10.8	320	21.58	1.69	*0.14*	*0.22*	*0.14*	*0.22*

Notes:
* - Pillar located on XL No. (as shown in **Figure 1**).
italics - Mean subsidence for mains heading pillars represents elastic behaviour range. U95%CL subsidence represents yielded pillar behaviour range.

The predicted first and final subsidence values over the chain pillars (First and Final S_p) between LWs 910 and 920 are estimated to range from 0.65 m to 1.05 m for total pillar stresses from 38.3 to 47.5 MPa. The FoS of the pillars range from 0.65 to 0.92, indicating the pillars are likely to go into yield after the extraction of LW910.

For LW 900W, the first row of mains headings pillars under single abutment loading will have FoS values ranging from 1.69 to 1.92 under pillar stresses from 21.6 MPa to 19.5 MPa.

*Note: The results based on **Figure 8** have been reduced by 50% to allow for the decreasing load acting on the adjacent pillars.*

Based on **ACARP, 1998a**, the probability that the pillars will yield under these conditions is < 1 in 1,000 (<0.1%). The predicted subsidence above the main headings pillars have been derived from **Figure 8** also and estimated to range between 0.12 m and 0.22 m.

Based on reference to **Figure 9b**, the pillar w/h ratios for the chain and main headings pillars range from 10.5 to 10.8. The pillars are therefore likely to exhibit strain hardening or 'squeezing' type yielding properties if overloaded during their service lives. This means that the pillars will still be able to support the applied loading with only a marginal increase in surface subsidence.

7.5 Inflexion Point and Peak Strain Locations

The subsidence development process causes tensile and compressive strains to develop above an extracted longwall panel, due to the sagging and bending of the overburden strata.

Tensile strains are generally located in the outer third zone above an extracted longwall panel and the compressive strains will occur above the central or middle third area. The point where the tensile strains become compressive is called the inflexion point. The relative locations of the peak surface impact parameters above an extracted longwall panel are shown schematically in **Figure 5b**.

The Newcastle Coalfield database of longwall inflexion point and tensile/compressive strain or convex/concave curvature peak locations are shown in **Figure 10a** with the predicted values for the CAPC panels shown in **Figures 10b** to **10d**. The measured values for previous CAPC panels plot within the Newcastle database (see **DgS, 2010**).

The predicted locations of the above points for the proposed panels are given in **Table 5**.

Table 5 - Predicted Inflexion and Strain Peak Location Summary

XL* No.	Cover Depth H (m)	Panel W/H	Inflexion Point Location Factor d/H	Inflexion Point Location from Panel Rib, d	Tensile Strain Peak Location Factor d_t/H	Tensile Strain Peak Location From Panel Rib, d_t	Compressive Strain Peak Location Factor d_c/H	Compressive Strain Peak Location from Panel Rib, d_c
LW 910								
1+	320	0.66	0.21	66	0.21	44	0.27	88
2	330	0.64	0.20	66	0.20	43	0.27	88
3	350	0.60	0.18	65	0.18	40	0.25	88
4	360	0.58	0.18	64	0.18	39	0.25	89
LW 900 West								
5	310	0.94	0.30	92	0.21	65	0.38	118
6	300	0.98	0.30	91	0.22	65	0.39	117
7	320	0.92	0.29	92	0.21	66	0.37	118

Notes:
+ - Crossline moved further to east for prediction purposes.
* - Inflexion point for panel located on XL No. (as shown in **Figure 1**).

7.6 Goaf Edge Subsidence Prediction

The mean and U95%CL final goaf edge subsidence predictions for the proposed panels range from 0.15 m to 0.36 m for LW910 and from 0.07 m to 0.21 m for LW 900W.

The goaf edge predictions are based on DgS modified **ACARP, 2003** empirical prediction curves shown in **Figure 11** and the first or final maximum panel subsidence predictions (mean values) in **Section 7.8** (Table 7).

Measured goaf edge subsidence values for the previous CAPC and CSVC longwalls are presented in **DgS, 2010**.

7.7 Angle of Draw Prediction

Predictions of Angle of draw (AoD) to the 20 mm subsidence contour have been derived from the mean goaf edge subsidence predictions (see **Section 7.8**) and reference to the **ACARP, 2003** model for longwall panels in the Newcastle Coalfield. Predictions have also been provided based on the available data for CAPC, which generally indicates higher AoD values than the Newcastle Coalfield model. The results are summarised in **Table 6**.

It is noted here that the AoD to 20 mm subsidence is a highly variable parameter and has been found to range from 2^{o} to 56^{o} in the Southern Coalfields (**Holla and Barclay, 2000**) and from 10^{o} to 55^{o} in the Newcastle Coalfields (**DMR, 1987**) and the Western Coalfields (**DME, 1991**).

Whilst monitoring at Angus Place has shown subsidence to 20 mm extends outside of the Design AoD of 26.5^{o}, tilts, strains and curvature outside the Design AoD have been very small and not of sufficient magnitude to cause significant impact (ie. cracking and rockfalls). This is supported by inspections and subsidence survey results. It is important to note that when looking at impacts to surface features, it is the tilt, strain and curvature that are the most important effects.

AoD prediction curves for CAPC and CSVC have been developed from local data and are presented in **Figure 12a**. Details of the development of the curves are further discussed in **DgS, 2010**.

Table 6 - Predicted Angle of Draw to 20 mm Subsidence Summary

XL #	Cover Depth H (m)	Panel W/H	Mean Final S_{max} (m)	Mean Final Goaf Edge Subsidence (m)	Predicted AoD at CAPC (o)			
					Panel Side Model (mean)	Panel Side Model (U95%CL)	Panel End Model (mean)	Panel End Model (U95%CL)
LW 910								
1+	320	0.66	0.70	0.15	39	53	21	25
2	330	0.64	0.73	0.17	44	58	n.a.	n.a.
3	350	0.60	0.69	0.18	46	60	23	27
4	360	0.58	0.71	0.21	51	65	n.a.	n.a.
LW 900 West								
5	310	0.94	0.98	0.08	18	32	16	20
6	300	0.98	1.15	0.09	21	35	n.a.	n.a.
7	320	0.92	0.80	0.07	14	28	15	19

+ - crossline moved east for subsidence prediction purposes.

The predicted mean AoD to the 20 mm subsidence contour from the panels sides is estimated to range from 39^o to 51^o for the proposed LW 910 and from 14^o to 21^o for 900 West, based on reference to the CAPC / CSVC model (see **Figure 12b**). The U95%CL values range from 28^o to 65^o.

The predicted mean AoD from the panels ends are estimated to range from 21^o to 23^o for the proposed LW 910 and from 15^o to 16^o for 900W, based on reference to the CAPC / CSVC model (see also **Figure 12b**). The U95%CL values range from 19^o to 27^o.

Appropriate design angle of draw values from sensitive sites have been reviewed in **DgS, 2010** and discussed further in **Sections 6** and **9**.

7.8 Multiple Panel Subsidence Prediction Results

7.8.1 General

Based on the predicted maximum single panel, chain pillar and goaf edge subsidence values derived from the **ACARP, 2003** model, the empirically derived mean and U95%CL values of first and final maximum multi-panel subsidence and associated impact parameters are presented in **Table 7** for LWs 900W and LWs 910 to 930.

It may be assumed that there is a 5% probability that the U95%CL values in the table may be exceeded (i.e. one in twenty longwall panels with similar mining geometry and geological conditions).

The predictions for LWs 920 and 930 include the subsidence that has occurred to-date. The net values or increases due to LW910 are discussed in **Sections 8.2** and **9.0**.

Table 7 - Predicted First and Final Subsidence Parameters (Mean - U95%CL Values) for LWs 900 West and 910 to 930

XL No.	Panel Width W (m)	Cover Depth H (m)	Panel Width/ Cover (W/H)	Chain Pillar Width w_{cp} (m)	First Panel S_{max} (m)	Final Panel S_{max} (m)	First Pillar S_p (m)	Final Pillar S_p (m)	Final Tilt T_{max} (mm/m)	Final Comp Strain $-E_{max}$ (mm/m)	Final Tensile Strain $+E_{max}$ (mm/m)
LW 900W											
5	293	310	0.94	35	0.98 - 1.31	0.98 -1.31	*0.13* - 0.20	*0.13* - 0.20	7 - 13	4 - 5	3 - 4
6	293	300	0.98	35	1.15 - 1.47	1.15 - 1.47	*0.15* - 0.24	*0.15* - 0.24	8 - 16	4 - 6	3 - 5
7	293	320	0.92	35	0.80 - 1.13	0.80 - 1.13	*0.17* - 0.26	*0.17* - 0.26	6 - 12	3 - 4	2 - 4
LW 910											
1	210	320	0.65	34	0.34 - 0.70	0.69 - 1.06	0.65 - 0.81	0.78 - 0.94	6 - 12	5 - 8	4 - 6
2	210	370	0.56	34	0.31 - 0.50	0.71 - 0.89	0.74 - 0.90	0.89 - 1.04	7 - 12	5 - 8	4 - 6
3	210	350	0.59	34	0.32 - 0.51	0.69 - 0.87	0.69 - 0.84	0.83 - 0.98	9 - 12 **(18 - 24)**	5 - 8 **(10 - 16)**	4 - 6 **(8 - 12)**
4	210	360	0.58	34	0.32 - 0.50	0.71 - 0.89	0.73 - 0.89	0.88 - 1.03	7 - 11	5 - 8	4 - 6
LW 920											
1	261	310	0.84	35	0.41 - 0.78	0.79 - 1.15	0.66 - 0.81	0.79 - 0.94	6 - 8	4 - 5	3 - 4
2	261	365	0.72	35	0.69 - 1.05	1.08 - 1.44	0.74 - 0.90	0.89 - 1.05	9 - 12	5 - 8	4 - 6
3	261	310	0.84	337	1.65 - 1.89	1.66 - 1.89	0.11 - 0.18	0.13 - 0.21	16 - 22	8 - 12	6 - 9
4	261	360	0.73	35	0.71 - 1.07	1.09 - 1.45	0.73 - 0.89	0.87 - 1.03	9 - 12	5 - 8	4 - 6
LW 930											
1	261	330	0.79	40.2	0.70 - 1.06	1.03 - 1.39	0.63 - 0.78	0.75 - 0.91	8 - 11	5 - 7	4 - 6
2	261	370	0.71	40.2	0.70 - 1.06	1.07 - 1.43	0.72 - 0.88	0.86 - 1.02	9 - 12	5 - 7	4 - 6
3	262	330	0.79	40.1	1.35 - 1.71	1.65 - 1.89	0.64 - 0.80	0.77 - 0.93	15 - 22	8 - 11	6 - 9
4	261	350	0.75	40.2	0.71 - 1.07	1.07 - 1.43	0.68 - 0.84	0.82 - 0.97	9 - 12	5 - 7	4 - 6

Note:
italics - Mean subsidence values for mains heading pillars represents elastic behaviour range. U95%CL subsidence represents yielded pillar behaviour range.
* - Predicted tilt and strain values are for a surface with a deep soil cover and likely to have a 'smooth' profile. A surface with rock exposures may cause strain concentrations or a stepped subsidence profile to develop, which can result in measured strains that range between 2 and 4 x mean 'smooth' profile strains or 1.5 to 2 x mean 'smooth' profile tilts.
(Bold) - Possible fault effected values that may occur near the eastern end of panel.

7.8.2 Subsidence Prediction Summary

The predicted mean and U95%CL values for the **first maximum panel subsidence** after mining of LWs 910 and 900 West ranges from 0.31 m to 0.70 m and 0.80 to 1.47 m respectively (i.e. 10% to 45% of proposed extraction heights).

The predicted mean and U95%CL values for the **final maximum panel subsidence** after mining of LWs 910 and 900 West ranges from 0.69 m to 1.06 m and from 0.80 to 1.47 m respectively (i.e. 21% to 45% of proposed extraction heights).

Note: The predicted maximum panel subsidence at the centre of LW910 is lower than the predicted chain pillar subsidence in this case.

The predicted mean and U95%CL values for the **first chain pillar subsidence** after mining of LW 910 ranges from 0.38 m to 0.74 m and from 0.65 to 0.90 m respectively (i.e. 11% to 28% of proposed extraction heights).

The predicted mean and U95%CL values for the **final chain pillar subsidence** after mining of LWs 910 and 900, ranges from 0.78 m to 1.04 m and from 0.1 m to 0.2 m respectively (i.e. 3% to 28% of proposed extraction heights).

The predicted subsidence over the main headings pillars is estimated to range between 0.13 m and 0.26 m (i.e. 4% to 8%) of proposed extraction heights)after mining is completed.

The predicted mean and U95%CL values for the **final maximum panel tilt** after mining of LWs 910 and 900 West ranges from 6 to 12 mm/m and 7 to 16 mm/m respectively.

The predicted mean and U95%CL values for the **final maximum panel compressive strains** after mining of LWs 910 and 900 West, ranges from 5 to 8 mm/m and 3 to 6 mm/m respectively.

The predicted mean and U95%CL values for the **final maximum panel tensile strains** after mining of LWs 910 and 900 West ranges from 4 to 6 mm/m and 2 to 5 mm/m respectively.

The predicted mean and U95%CL values for the **final convex and concave curvatures** associated with the compressive strain zones after mining of LWs 910 and 900 West ranges from 0.13 to 0.38 and 0.19 to 0.50 km^{-1} respectively (i.e. curvature radii of 7.7 to 2 km).

Note: Discontinuous overburden behaviour such as cracking and shearing in tensile and compressive strain zones with shallow rock exposures, could increase the maximum predicted curvatures and strains by 2 to 4 times (i.e. the strains could range from 4 to 16 mm/m locally). Tilts could also be similarly affected and increase smooth profile values by 1.5 to 2 times (i.e. tilts could range from 12 mm/m to 24 mm/m locally).

The surface above the previously extracted longwalls 920 and 930 is expected to subside a further 0.15 m to 0.6 m due to compression of chain pillars caused by the extraction of longwall LW 910. The associated tilts and strains are not expected to increase by more than 10 % and may decrease due to the reduction in differential subsidence.

7.9 Subsidence Profile Predictions

Predictions of the credible worst-case subsidence, tilt, curvature and strain profiles for LWs 910 to 980 along XL 2 and LW 900W along XL 7 are shown in **Figures 13** and **14** respectively.

The figures show the profiles after each panel is extracted and after the completion of mining.

The predicted profiles were developed from the seven key points derived from modified **ACARP, 2003** empirical model and **Sigmaplot**® cubic-spline curves. Measured profiles for the B-Line are also presented with the XL 2 predictions. Further comparisons between measured and predicted subsidence, tilt and strain profiles are presented in **DgS, 2010**.

8.0 Prediction of Subsidence Impact Parameter Contours

8.1 Calibration of the SDPS® Model

The **SDPS®** model was then calibrated to the **ACARP, 2003** model profiles to derive predicted U95%CL subsidence contours. The outcome of the SDPS model calibration exercise is summarised in **Table 8**.

Table 8 - ACARP, 2003 and SDPS® Model Calibration Summary

Input Parameters	**Value**	**Model Database**
Panel No.s (refer to **Figure 1**)	LWs 910 & 900W	Includes CAPC & CSVC LWs
Panel Void Width, W (m)	210 & 293	34 - 292
Cover Depth, H (m)	300 - 380	71 - 516
Mining Height, T (m)	3.25	1.05 - 4.9
W/H range	0.56 - 0.98	0.2 - 2.0
Massive Strata Unit Thickness, t (m)	10 - 79	<5 - 80
Strata Unit Distance Above Workings, y (m)	57 - 206	1 - 350
SRP for Mining Area	Low to High	Low to High
Massive Strata Unit Location Ratio (y/H)	0.20 - 0.64	0.0 - 0.9
Maximum Final Panel Subsidence Range, S_{max} (m)	0.69 - 1.47	0.02 - 2.5
S_{max}/T Range for Panels	0.21 - 0.45	0.01 - 0.58
Chain Pillar Width (m)	34.2	18 - 49
Chain Pillar Lengths (m)	96	60 - 110
Development Road or Chain Pillar Height (m)	3.25	1.8 - 3.5
Gate road Heading and Cut-through Widths (m)	4.5 - 4.8	4.8 - 6.0
Chain Pillar Subsidence (m)	0.65 - 1.04	0.03 - 1.00
Theoretical Maximum Chain Pillar Stress (MPa)*	38 - 49	4.8 - 81
Chain Pillar FoS	0.73 - 2.92	0.56 - 9.40
Chain Pillar Width/Development Height	9.8 - 10.8	7.4 - 15.8
Modified ACARP, 2003 Inflection Point Location (d) from Rib-side/Cover Depth (H): d/H	0.17 - 0.30	0.03 - 0.50
Modified ACARP, 2003 Inflection Point Location from Rib-side, d (m)	62 - 92	5 - 99
Goaf Edge Subsidence (m)	0.07- 0.37	0.02 - 0.38
Angle of Draw from Sides of Panels (degrees)	14 - 67	10 - 62
Angle of Draw from Ends of Panels (degrees)	15 - 27	0 - 26.5
Calibration Results for Best Fit Solution to the Modified ACARP, 2003 Model Predictions^	**Optimum Value***	
Influence Angle (Tan(beta))	1.1 to 2	
Influence Angle (degrees)	48 to 63	
Supercritical Subsidence Factor for Panels and Pillars (S_{max}/T)	60	
Distance to Influence Inflexion Point from Internal Chain Pillar or Solid Rib-Sides (m)	62 - 92	

Notes:
^ - See SDPS manual extract in **Appendix A** in **DgS, 2010** for explanation of methodology and terms used.
* - These values provide best fit to the DgS Modified **ACARP, 2003** profiles only and are due to the effect of calibrating SDPS to multiple panels with compressing chain pillars (i.e. they should not be used for making predictions alone).

Based on reference to **Table 8**, the geometry and geology of the proposed longwall panels are generally within the limits of the current database.

The modified **ACARP, 2003** model and **SDPS®** model profiles of subsidence, tilt and strain have been compared in **Figures 15a** to **15c** along XL 2 and **Figures 16a** to **16c** along XL6.

The predicted **SDPS®** subsidence and tilt profiles were generally located within +/- 10 to 20% of the predicted modified **ACARP, 2003** models Upper 95% Confidence Limits. This outcome is considered a reasonable fit considering that the **ACARP, 2003** profiles represent measured tilt profiles that may be affected by 'skewed' or 'kinked' subsidence profiles.

The results of the analysis indicate that the majority of the predicted horizontal strains predicted by the **SDPS®** model would fall within +/- 50% of the modified **ACARP, 2003** model predictions. This result is also considered reasonable in the context that the **ACARP, 2003** model represents measured profile data that includes strain concentration effects such as cracking and shearing. As mentioned earlier, this 'discontinuous' type of overburden behaviour can increase 'smooth' profile strains by 2 to 4 times locally.

The predicted strain contours were subsequently derived in SDPS by multiplying the predicted curvatures by 24 instead of 16 (due to site specific data) to produce a reasonable correlation between the models (see **DgS, 2010** for further model calibration details).

8.2 Predicted Subsidence and Associated Impact Parameter Contours

Based on the calibrated SDPS® model, predictions of final cumulative subsidence contours for LWs 900W to 980 are presented in **Figure 17a**. The predicted worst-case increase in subsidence has then been determined by subtracting the contour predictions for the Approved Longwall Panels 920 to 980 (see **Figure 17b**) from the final cumulative contours. The net contours are shown in **Figure 17c**.

Figure 17c indicates that the rock features to the west of the proposed LW910 finishing point, are likely to be located well outside the 20 mm subsidence contour and therefore very unlikely to be further impacted by mining.

Associated subsidence impact parameter contours of principal tilt, horizontal strain and displacements have been subsequently derived using the calculus module provided in **Surfer8®** and the worst-case subsidence contours. The outcomes are shown in **Figures 18** to **20** respectively. **Figures 18** to **20** show the cumulative tilts, strains and displacement predictions after taking the extraction of LWs 920 to 980 into account.

It should be understood that the predicted tilts and strains will not change significantly if the minimum predicted chain pillar subsidence was to occur.

The pre and post mining topography have been generated from the aerial survey and the predicted subsidence contours. The results are given in **Figure 21**.

The above contours have been used to estimate the potential impacts to creeks and slopes in regards to cracking location, gradient changes and ponding on the subsided surface above the proposed extracted panels of LWs 910 and 900W.

9.0 Subsidence Impact Assessment

9.1 General

Based on the predicted maximum panel subsidence, tilt, horizontal displacement and strain values for the proposed longwall layout, expected and worst-case values for the following impact parameters have been estimated for the purpose of assessing appropriate management strategies for natural and man-made features in the study area:

- surface cracking zone location and potential width;
- height of sub-surface fracturing above the panels (direct and in-direct hydraulic connection zones above the workings);
- surface gradient changes;
- ponding potential;
- general slope stability and erosion;
- valley uplift and closure;
- far-field horizontal displacements and strains;

Due to the uncertainties associated with mine subsidence prediction and associated impacts for a given mining geometry and geology etc, a credible range of impact outcomes (based on probabilistic design methodologies) have been provided to assist with the review and development of effective subsidence impact management plans.

The mean and U95%CL values used in this report generally infer that the predictions will be exceeded by 50% and 5% of panels mined with similar geometry and geology etc. Using lower probability of exceedence values (i.e. <5% probability of exceedence) may result in potentially uneconomic or marginal mining layouts with a minimal gain in terms of impact reduction. The consequences of an exceedence will therefore need to be considered when selecting an appropriate probability of exceedence likelihood.

Discussions of likelihood of impact occurrence in the following sections generally refer to the qualitative measures of likelihood described in **Table 9**, and are based on terms used in **AGS, 2007** and **Vick, 2002**.

Table 9 - Qualitative Measures of Likelihood

Likelihood of Occurrence	**Event implication**	**Indicative relative probability of a single event**
Almost Certain	The event is expected to occur.	90-99%
Very Likely	The event is expected to occur, although not completely certain.	75-90%
Likely+	The event will probably occur under normal conditions.	50-75%
Possible	The event may occur under normal conditions.	10-50%
Unlikely*	The event is conceivable, but only if adverse conditions are present.	5-10%
Very Unlikely	The event probably will not occur, even if adverse conditions are present.	1-5%
Not Credible	The event is inconceivable or practically impossible, regardless of the conditions.	<1%

Notes:
+ - Equivalent to the mean or line-of-best fit regression lines for a given impact parameter presented in **ACARP, 2003**.
* - Equivalent to the credible worst-case or U95%CL subsidence impact parameter in **ACARP, 2003**.

The features of significance that will or may be subsided by longwall LW910 include:

- A section of West Wolgan Creek above LWs 910 to 920 and West Wolgan Shrub Swamp above LW930.

- The buried PVC pipeline and power supply above LWs 910 to 930, which connects to the proposed mine de-watering bore located to the north east of LW910's starting position.

- A 5 to 10 m high, north-south orientated rock formation exists approximately 275 m west of the finishing end of LW910. The cliff line is west-facing and outside the Design AoD of 26.5°.

- A forest access track (Blackfellows Hands Trail) that is accessible to the public.

The features of significance that will or may be subsided by longwall LW 900W include:

- A 66 kV Integral Energy power line with 3 conductors suspended on timber poles.

- Several forest access tracks (Kangaroo Creek and Beecroft Trails) that are accessible to the public.

- Moderate side slopes of 10^o to 15^o that are immediately above the nearest rock feature greater than 5 m in height. The feature is located 175 m to the south of the starting end of LW 900W outside the Design AoD of 26.5°.

It is very unlikely that cracking of major rock features due to mine subsidence will occur as they fall outside the Design AoD of 26.5°. The following sub-sections provide an assessment of the likely and worst-case subsidence impacts that could occur due to LWs 910 and 900W.

9.2 Surface Cracking and Erosion

9.2.1 Definition

Surface cracking can develop within the zone of influence of mine subsidence, and can occur during and after extraction of the longwall blocks. The type, width, length and location of the cracks is primarily due to the bending of the surface strata (i.e. curvature), the subsidence magnitude, mining geometry, surface geology and topographic relief.

Tensile fractures generally occur above longwalls between the panel ribs and the point of inflexion where convex (i.e. hogging) curvatures and tensile strains develop (see **Figure 5b**). The point of inflexion is assessed to be located 63 m for LW910 and 91 m from the panel ribs for LW 900W. The tensile strain peak is expected occur 40 m and 65 m in from the panel ribs for the respective longwalls. Tensile fractures can also occur above chain pillars that are located between extracted panels.

The surface cracks in the tensile strain zones if they occur, will probably be tapered and extend to depths ranging from 5 m to 20 m in near surface rocks. The location and frequency of surface cracking tends to occur within 10 m to 15 m from the tensile strain peaks and may consist of one to five cracks, depending on whether the near surface lithology comprises soil or bed rock. The cracks are likely to be < 1 mm wide below a depth of approximately 5 m.

Compressive shear fractures generally develop in the central area above a longwall panel and between the inflexion point locations (see **Figure 5b**). This zone is where concave (i.e. sagging) curvatures and compressive strains occur. Cracks within compressive strain zones are generally low-angle shear cracks caused by failure and shoving of near surface strata. Some tensile cracks can also be present, due to buckling and uplift of near surface bed rock in the base of gullies or man-made cuttings (see section on valley closure also).

Tensile cracks may also develop up to 30 m behind the advancing goaf edge of the longwall panels. The majority of these cracks generally close in the central, compressive strain areas of the longwall panels after the subsidence trough has fully developed.

Minor cracking may also occur above the chain pillars and just outside the limits of extraction (but within the 26.5^{o} angle of draw) if interaction with surface topography occurs. Cracking has not occurred in the steep terrain outside the 26.5^{o} angle of draw from the CAPC and CSVC longwalls to-date.

9.2.2 Observed Cracking Impacts for LWs 920 to 950

Surface cracks have generally occurred only where rock exposures exist along creeks and valley sides. Crack development has been limited or controlled on the plateau and swamp areas by the relatively deep alluvial or residual soil cover that is present. It is considered that the alluvial soils have 'absorbed' the high strains in the creeks and valleys that were recorded along the E and F Lines.

No significant impacts have been observed or measured to-date along the creeks or plateau after subsidence of up to 1.3 m and compressive strains of up to 15 mm/m. Some minor cracking occurred along the rocky side slopes of the drainage line associated with Narrow

Swamp where subsidence of up to 1.72 m developed above LW 940 (recorded along the F Line).

Minor cracking was also found along the rock bars within Kangaroo Creek after extraction of LW940. The high strain and subsidence results associated with the F and E Lines were most likely due to the existence and influence of a geological structure and valley 'stress notching' affects.

9.2.3 Predicted Worst-case Cracking Impacts for LWs 910 and 900W

Based on the predicted range of maximum transverse tensile strains from 2 to 6 mm/m for LWs 910 and 900W, surface cracking widths of between 1 mm and 20 mm may occur within the limits of extraction and up to 90 mm where competent rock is exposed near strain peaks. It is however considered unlikely that the cracks will occur as a single crack where deep soil or weathered surface rock exists, and likely to be several smaller width ones. Surface inspections have identified rock exposures along West Wolgan Creek, which are considered susceptible to cracking.

Predicted surface crack location zones associated with post-mining tensile and compressive strains are presented in **Figure 22**.

The change to surface gradients above each panel is estimated to range by up to +/- 0.7^{o} (or +/-1.2%). Minor terrain adjustment through erosion and sedimentation may occur where soils are exposed to stormwater runoff.

In regards to the creeks and watercourses above the proposed longwalls LW910 and 900W, the following credible worst case impacts due to mine subsidence are assessed:

- Minor transient surface cracking with widths < 20 mm may develop behind the retreating secondary extraction face and along and across creek beds or watercourses that are undermined.

- Final surface crack location zones shown in **Figure 22** are based on the strain contours shown in **Figure 19**. Further cracking is not expected to develop above LWs 920 and 930 after the extraction of 910.

- Cracks that occur within the drainage gullies or creek beds could result in sub-surface re-routing of surface flows during storm periods and particularly those areas that have bed-rock exposed. The impacts in most cases should be self-healing, due to sediment bed load that is likely to accumulate in the cracks after several storm events occur.

- The depth of surface cracking in alluvial soils along creek beds will be affected by the depth to rock and width of cracking at rock head. Where shallow rock or bedrock is exposed, the maximum crack depth may range could range between 3 and 20 m. The cracks however, are likely to taper to < 1 mm width at depths > 5 m below the surface.

- Based on **Figure 23**, the surface gradients along creek beds are estimated to increase by +/- 0.3^{o} (i.e. +/- 0.5%) after LW910 is extracted. The predicted pre and posting mining level profiles and gradient changes are presented in **Figure 24** for West Wolgan Creek above LW910.

Figure 24 also indicates that the surface gradients above LWs 920 and 930 are expected to increase by 0.1^o (0.2%) and 0.02^o (0.03%) after LW910.

It is possible that there will be a short term increase of existing pre-mining erosion rates along the creeks inside the up-stream ribs of the proposed longwall panels. It is noted however, that this has not previously been found during post mining inspections of the longwalls.

In regards to the worst-case scenario, the erosion rates would be expected to reach a new equilibrium after several storm events have occurred, with sediment likely to accumulate where net surface gradients have been decreased after mining.

9.2.4 Impact Management Strategies

In general, surface crack repair works are unlikely to be needed across the panels after mining, unless cracking develops across public access roads (see **Section 9.9**).

In regards to West Wolgan Creek, the following impact management strategy may be adopted:

- Undertake pre-mining and post-mining inspections along the creek, with the results of these inspections communicated to the respective stakeholders.

- Any observed impact caused by subsidence will be communicated to Forests NSW and any remediation required will be done so in accordance with them.

9.3 Sub-Surface Cracking

9.3.1 Sub-Surface Fracturing Zones

Fracturing above the goafed area varies considerably according to the geology, depth of cover; mine layout (panel width and chain pillar dimensions) and seam thickness extracted and is very site specific. The caving and subsidence development processes above a longwall or pillar extraction panel usually results in sub-surface fracturing and shearing of sedimentary strata in the overburden, see **Figure 25**.

Accurate predictions of continuous fracturing or hydraulic connection height above goafed areas require deep piezometer and borehole extensometer monitoring results. Emprically based models with data from other mines can be used, but the results must be interpreted with caution until local data can be obtained to validate the use of these models.

International and Australian research on longwall mining interaction with groundwater systems indicates that the overburden may be divided into essentially three or four zones of surface and subsurface fracturing. The zones are generally defined (in descending order) as:

- Surface Zone
- Continuous or Constrained Zone
- Fractured Zone
- Caved Zone

Starting from the seam level, the Caved Zone refers to the roof of the immediate mine workings above the extracted panel, which has collapsed into the void left after the coal seam has been extracted. The Caved Zone usually extends for 3 to 5 times the mining height above the roof of the mine workings.

The Fractured Zone has been affected by a high degree of bending deformation, resulting in significant fracturing and bedding parting separation and shearing. The Fractured Zone is supported by the collapsed material in The Caved Zone, which usually has a bulked volume equal to 1.2 to 1.5 times its undisturbed volume.

The Elastic or Constrained Zones refer to the section of overburden which has also been deformed by bending action, but to a lesser degree than the Fractured Zone below it. Bed separations and shearing of strata can occur in this zone, but fracturing tends to be discontinuous with underlying beds.

The Surface Zone includes the tensile and compressive surface cracking caused by mine subsidence and is assumed to extend to depths of 5 to 20 m in the Western Coalfield.

Based on reference to **Whittaker and Reddish, 1990** and **ACARP, 2003**, the impact of mining on the sub-surface aquifers and surface waters, requires an estimate of the '*Continuous*' and '*Discontinuous*' heights of fracturing or the A and B Zones - shown schematically in **Figure 25**.

Continuous sub-surface fracturing (A-Zone) refers to the zone of cracking above a longwall panel that is likely to result in a direct flow-path or hydraulic connection to the workings, if a sub-surface (or shallow surface) aquifer was intersected.

Discontinuous sub-surface fracturing (B-Zone) refers to the zone above the A-Zone where there could be a general increase in horizontal and vertical rock mass permeability, due to bending or curvature deformation of the overburden. This type of fracturing does not usually provide a direct flow path or connection to the mine workings like the A-Zone; however, it is possible that B-Zone fracturing may interact with surface cracks, joints, or faults. This type of fracturing can therefore result in an adjustment to surface and sub-surface flow paths, but may not result in a significant change to the groundwater or surface water resource in the long-term.

In regards to the general zones of fracturing mentioned earlier, the A-Zone may be assumed to include the Caved and Fractured Zones, and the B-Zone will develop in the Constrained Zone. Both A and B-Zones can extend to the Surface Zone and will depend on the mining height, cover depth, geology and panel width.

Two empirically-based models (**CSIRO, 2007** and **ACARP, 2003**) and have been used in this study to predict the A and B-Zone heights of sub-surface fracturing within the study area.

The **CSIRO, 2007** model was developed from deep multi-piezometer and extensometry data from subsided overburden at the CSVC mine and in-directly defines the A and B-Zones as a function of the mining height (the model refers to the A and B-Zones as the tops of the Fractured and Confined Zones respectively - see **Figure 26** for the **CSIRO, 2007** model fracture zone definitions).

The **CSIRO, 2007** model predicts that the height of the Fractured or A-Zone may generally reach 33 times the mining height (T) based on LW411 at CSVC. It is of interest to note that this value coincides with the **Forster, 1995** model that was developed in a similar manner for total extraction panels in the Newcastle-Central Coast Region.

The **ACARP, 2003** model was derived from the **Forster, 1995** Model data, and supplemented with drilling fluid loss records from surface to seam drilling logs in subsided, fractured overburden from the NSW Southern Coalfield and Oaky Creek Mine in the Bowen Basin.

The **ACARP, 2003** model includes several of the key parameters defined by **Whittaker and Reddish, 1989** and referred to in **Mark, 2007**. The additional parameters include the panel width, cover depth, maximum single panel subsidence and geological conditions (i.e. Subsidence Reduction Potential). The mining height is not applied directly, but indirectly through the subsidence prediction (further model development details may be found in **Appendix A** of **DgS, 2010**).

The measured data in **ACARP, 2003** has been plotted as the height of A or B-Zone fracturing /cover depth v. S_{max}/Effective Panel Width^2. A log-normal regression line has subsequently been derived to give predictions of mean and U95%CL values for both fracture zones.

9.3.2 Sub-Surface Fracture Height Predictions

The predicted values for the **ACARP, 2003** model's continuous and discontinuous sub-surface fracturing heights above the proposed longwall panels are summarised in **Table 10** and presented in **Figure 27** and **28**.

Table 10 - Summary of Measured CSVC and Predicted CAPC Sub-Surface Fracturing Heights above the Proposed Longwall Panels

Panel No.	Cover Depth, H (m)	Panel Width, W (m)	Average Mining Height, T (m)	Single Panel S_{max}* (mean) (m)	Single Panel S_{max}/W^2 (mean) (mm/m^2 or km^{-1})	Predicted Fracture Heights (m)			
						Continuous (A Horizon)		Discontinuous (B Horizon)	
						ACARP, 2003 Model (U95%CL)	**CSIRO, 2007^**	**ACARP, 2003** Model (U95%CL)	**CSIRO, 2007^**
CSVC Coal - Measured Data									
411	385	315	3.2	**0.88**	0.009	117	**106 (33T)**	287	**218 - 275 (68-86T)**
409	385	266	3.2	*0.36*	*0.005*	72	**-**	259	**250 (78T)**
CAPC - Predicted									
910	320	210	3.25	0.88	0.009	93	*75 (23T)*	235	*183 - 255 (56-78T)*
910	370	210	3.25	0.34	0.008	92		266	
910	350	210	3.25	0.31	0.007	99		254	
910	360	210	3.25	0.32	0.007	96		261	
900W	310	293	3.25	0.32	0.007	99	*101 (31T)*	247	*221 - 280 (63-86T*
900W	300	293	3.25	0.98	0.011	116		248	
900W	320	293	3.25	1.15	0.013	123		244	

Bold - Measured data; *italics* - estimated from measured data.
* - Single panel S_{max} is a measure of overburden bending and does not include chain pillar compression effects.
^ - Measured **CSIRO, 2007** data adjusted for panel width.

9.3.3 Discussion of A-Zone Horizon Model Predictions

The results for the **CSIRO, 2007** and **ACARP, 2003** models predict heights of continuous fracturing above the proposed longwalls range between 75 m and 123 m or 23 to 38 times the mining height (T). The predicted U95%CL A-Zone horizon values are also 177 m to 279 m below the surface for panel cover depths of between 300 m and 370 m respectively.

The **ACARP, 2003** model's predictions for the U95%CL A-Zone horizon above the proposed longwall panels are generally 10% to 30% higher than the **CSIRO, 2007** model indicates. In regards to the many uncertainties associated with continuous fracture height prediction, the results for both models are considered to correlate well (see **Figure 28**).

Continuous fracturing is therefore not expected to develop above massive sandstone units of the Narrabeen Formation, which exist between 110 and 250 m above the workings. Direct hydraulic connection from the surface to the mine workings due to sub-surface fracturing is considered 'very unlikely' to 'not credible'.

A similar US version of the **Forster, 1995** model indicates that the height of 'continuous' fracturing could range between 10T and 24T (i.e. 32 m and 77 m). A comment is made in a paper by **Mark, 2007**, that the “variation is also probably due to differences in geology and panel geometry”.

9.3.4 Discussion of B-Zone Horizon Model Predictions

The results for the **CSIRO, 2007** and **ACARP, 2003** models predict heights of 'discontinuous' fracturing above the proposed longwalls range between 183 m and 280 m or 56 to 86 times the mining height (T). The predicted U95%CL A-Zone horizon values are also 20 m to 104 m below the surface for panel cover depths of between 300 m and 370 m respectively. **Mark, 2007** indicates that the height of discontinuous fracturing could range between 24 T and 60T (i.e. 78 m and 195 m)

It is assessed that the results from the two models also correlate well for the prediction of the B-Zone Horizon (see **Figure 28**). It is therefore considered unlikely that B-Zone cracking will occur within 20 m of the surface for cover depths > 300 m above the proposed longwalls. It may be concluded that discontinuous sub-surface fracturing for these panels is 'very unlikely' to interact with surface cracking.

The presence of 'plastic' shale beds and the Mount York Claystone unit, which exists between the massive Narrabeen Group sandstone units, are also understood to provide protection from permanent drainage of surface aquifers through surface and subsurface fracture / joint interconnection.

9.3.5 Impacts to Rock Mass Permeability

In regards to changes to rock mass permeability, **Forster, 1995** and **CSIRO, 2007** indicates that horizontal permeabilities in the fractured zones above longwall mines (see **Figure 26**) could increase by 2 to 4 orders of magnitude (e.g. pre-mining $k_h = 10^{-9}$ to 10^{-10} m/s; post-mining $k_h = 10^{-7}$ to 10^{-6} m/s).

Vertical permeability's could not be measured directly from the boreholes but could be inferred by assuming complete pressure loss in the 'A-Zone', where direct hydraulic connection to the workings occurs. Only a slight increase in the 'B-Zone' or indirect / discontinuous fracturing develops (mainly due to increase in storage capacity) from bedding parting separation.

Discontinuous fracturing would be expected to increase rock mass storage capacity and horizontal permeability without direct hydraulic connection to the workings. Rock mass permeability is unlikely to increase significantly outside the limits of extraction. The **CSIRO, 2007** report indicates rock mass permeabilities are unlikely to be affected outside a distance of 20 m from the panel extraction limits.

9.3.6 Impact Management Strategies

It is very unlikely that surface cracks will interact with B-Zone cracks and that any re-directed surface flows due to minor surface cracking will be manageable and likely to 'self-heal'.

Furthermore, it is not credible to consider that the surface may be at risk to connective cracking to the surface due to the proposed mining extensions. Measurement of the A and B Zone horizons has been successful at CSVC and provides a reasonable level of confidence in the assessment provided herein.

9.4 Valley Closure and Uplift

9.4.1 Definition

As discussed in **ACARP, 2002**, when creeks and river valleys are subsided, the observed subsidence in the base of the creek or river is generally less than would normally be expected in flat terrain. This reduced subsidence is due to the floor rocks of a valley buckling upwards when subject to compressive stresses generated by surface deformation. In most cases in the Newcastle and Southern NSW Coalfields, the observed uplift has extended outside steep sided valleys and included the immediate cliff lines and the ground beyond them.

It should also be understood that these movements are strongly dependent on the level of 'locked-in' horizontal stress immediately below the floor of the gullies and more importantly the bedding thickness of the floor strata (i.e. thin to medium bedded sandstone is more likely to buckle than thicker, massive beds). The influence of the aspect ratio (i.e. valley width/depth) is also recognised as an important factor, with deep, narrow valleys having greater upsidence than broad, rounded ones, due to higher stress concentrations.

Valley closure and uplift movements can also occur along broader drainage gullies and man-made cuttings, where shallow, interbedded surface rock of moderate to high strength is present.

The development of upsidence or minor surface cracking may cause localised deviation of surface flows in rocky, ephemeral creek beds into sub-surface routes. The re-routed surface flows would be expected to re-surface downstream of the impacted area if it occurs.

9.4.2 Observed Closure and Uplift Impacts for LWs 920 to 950

To-date, uplift movements of between 30 mm and 50 mm have occurred along the C Line (located over Kangaroo Creek) and the F Line (located across Narrow Swamp). The uplift movements have resulted in minor cracking and shear displacements to rock bars and valley side walls.

9.4.3 Predicted Worst-case Closure and Uplift Impacts for LWs 910 and 900W

Valley 'closure' and 'upsidence' movements of similar magnitude could also occur above LWs 910 and 900W. However, as the valleys are wider in this area of the mine, the uplift and closure movements are likely to be lower than those observed to-date.

The impact of the movements, if they occur, are very unlikely to result in more damage than the minor cracking predicted for normal subsidence development of the near surface rocks.

9.4.4 Impact Management Strategy

The impact of valley uplift closure effects due to mine subsidence may be managed as follows:

- Install and monitor survey lines across representative drainage gullies where considered appropriate during and after undermining. Combine with visual inspections to locate damage (cracking, uplift).

- Review predictions of upsidence and valley crest movements after each panel is extracted.

- Assess and consult with the relevant government agencies on whether repairs to cracking (as a result of upsidence) or gully slope stabilisation works are required to minimise the likelihood of long-term degradation to the environment or risk to personnel and the general public should they occur.

9.5 Ponding

9.5.1 Definition

Ponding refers to the potential for closed-form depressions to develop at the surface above longwall panels. The actual ponding depths will depend upon several other factors, such as rain duration, effective percolation and evapo-transpiration rates.

Ponding increases could affect natural drainage patterns. Ponding locations are generally expected to occur along the creeks and tributaries above the proposed longwall panels with gentle slopes and low-lying areas.

9.5.2 Predicted Ponding Impacts

The potential ponding depths, inundation extent and ponded volumes have been estimated from the predicted post mining surface levels along the main creeks and general surface above LWs 910 to 930 and 900W.

The potential worst-case pond depths, affected area and volume along each creek or flat areas above the middle of proposed (and previous) panels, before and after mining, are summarised in **Table 11**.

Table 11 - Potential Worst-Case Ponding Assessment for LWs 900W and 910

Location (see **Figs 29 a,b**)	LW #	Pre-Mining Pond				Post-Mining Pond				Depth Inc. (m)	Ponded Area [Volume] Increase After Mining# (ha) [ML]
		Max Pond RL	**Max. Depth (m)**	**Size L x B**	**Area (ha) [Vol] (ML)**	**Max Pond RL**	**Max. Depth (m)**	**Size L x B (m^2)**	**Area (ha) [Vol] (ML)**		
-	900W	-	0	-	**-**	-	0	0	**0 [0]**	**0**	**0.0 [0.0]**
West Wolgan Creek	910	1098.4	0.67	39 x 12	**367 [123]**	1098.0	0.72	39 x 12	**367 [132]**	**0.05**	**0.00 [9.1]**
	920	1110.3	0	-	**-**	1108.8	0	0	**0 [0]**	**0.0**	**0.0 [0.0]**
	930	1122.7	0	-	**-**	1121.3	0	0	**0 [0]**	**0.0**	**0.0 [0.0]**

^ - Area = π x pond width x pond length/4;
* - Volume = Area x Maximum Pond Depth/2.
# - Net increase = Post-mining pond - pre-mining pond.

The predicted post-mining topography indicates that potential ponding depths above LW 910 to 930 and 900W are unlikely to exceed 0.1 m.

9.5.3 Impact Management Strategies

An appropriate ponding management strategy would include:

- The development of a suitable monitoring and mitigation response plan, based on consultation with the regulatory government authorities to ensure ponding impacts on existing vegetation do not result in long-term environmental degradation.

- The review and appraisal of changes to drainage paths and surface vegetation in areas of ponding development (if they occur), after each panel is extracted.

Overall, the impact of increased ponding along the creek beds is likely to be 'in-channel' and therefore, the effects on existing flora and fauna is likely to be minimal. Further assessment on the ponding impacts may be needed by specialist ecological consultants to confirm this assessment; however, local experience to-date suggests that ponding will not have a negative consequence.

9.6 Cliffs and Rock Formations

9.6.1 Previous and Potential Impacts

As discussed earlier, the closest rock formations (>5 m and < 20 m high) to the proposed longwalls are located approximately 175 m to the south of LW300W starting position and 275 m west of the proposed finish position of longwall 910 (see **Figure 1**). The set back distances are equivalent to angles of draw of 29^o and 42^o, based on a cover depth of 310 m at the ends of the longwalls (a conservative assumption as the cover depths at the features range between 250 and 270 m).

To-date, there has been no impact to sensitive cliff sites outside the 26.5^o Design AoD associated with the extraction of 920 to 950 (which includes the currently approved SMP application area 930 to 980) at CAPC. It is therefore expected that no impact will occur to the cliffs or rock features outside the 26.5^o Design AoD limit from LWs 910 and 900W.

The rock fall that occurred above LW920 affected approximately 6% of the total length of the 250 m length rock face, and occurred approximately 4 years after first undermining. At the time of the fall, the cliff had been affected by subsidence of approximately 0.7 m, with tilts of up to 10 mm/m and tensile and compressive strains of +/- 2 mm/m. A recent re-survey (8/06/10) of the C Line (which runs past the rock fall) indicates only marginal increase (8%) in maximum subsidence has occurred since 11/04/07.

Due to the rock fall above LW920, the proposed longwall panels 900W and 910 have been positioned well outside the Design Angle of Draw of 26.5^o to the nearest rock features (i.e. 29^o and 42^o respectively) as a precautionary measure. The proposed finishing point for LW910 has been moved one chain pillar length to the east (i.e 100 m) as a precautionary measure. It estimated that it is unlikely that >20 mm of additional subsidence will occur at the rockfall site due to chain pillar compression between LWs 910 and 920.

Despite the possibility that subsidence will exceed 20 mm at the 26.5^o Design AoD mark from the panel extraction limits, the measured tilts and strains outside this limit are typically both ≤ 1 mm/m respectively, based on CAPC and CSVC data. The AoD to 20 mm subsidence from the ends of the panels is likely to be < 26.5^o however.

Reference to **NERDDP, 1993** and **ACARP, 2002** indicate the following subsidence profile limits are appropriate for minimising impact to cliff lines and sensitive environmental features:

- Subsidence: 50 - 100 mm
- Tilt: 1.5 - 2 mm/m
- Curvature: 0.06 - 0.1 km^{-1} (radius of curvature > 10 km)
- Tensile Strain: 1.5 - 2 mm/m
- Compressive Strain: 2 - 2.5 mm/m

9.6.2 Impact Management Strategy

As it is not proposed to undermine any cliff lines, it is very unlikely that slope and cliff line instability or increased erosion will occur due to cracking or changes to drainage patterns after extraction of LWs 910 and 900W.

It is also considered very unlikely that the rock feature above LW920 will be impacted again by mine subsidence of up to 50 mm. However, the finishing point location has been conservatively located (i.e. 42^o AoD east of the cliff line) due to the impracticalities of applying an early-warning monitoring system and attempting to make unscheduled stops of the longwall face safely.

The management strategy for the cliff lines > 20 m high and rock formations < 20 m high is to monitor the features before and after mining to confirm that the Design AoD of 26.5^o is adequate for subsequent longwalls elsewhere on the CAPC mining lease. Some of the suggested approaches could include:

- Measurement of centreline and cross line angle of draw to 20 mm subsidence in the vicinity of the cliffs and rock formations.

- Pre and post-longwall extraction monitoring of surface slope and cliff lines (visual/photographic records and subsidence and strain monitoring at practical locations);

- On-going review of the angle of draw and appraisal of any significant changes to cliff lines, such as cracking along ridges, increased erosion down slopes, foot slope seepages and drainage path adjustments observed after each longwall is extracted

- In the unlikely event of mining related instability, it is recommended that any stabilisation works to creeks and vegetation affected by rock-falls or erosion should be based on consultation with the relevant government agencies.

9.7 Integral Energy 66 kV Power Line

9.7.1 Potential Impacts

The location of the Integral Energy power line corridor is shown in **Figure 1**. The timber power poles above LW 900W are approximately 15 m high and are 77 m to 266 m apart.

Predicted final subsidence, tilt, horizontal strain and displacement profiles along the power line corridor above LW 900W are presented in **Figures 30a** to **30d** and summarised in **Table 12**.

The poles of the existing suspended Integral 66 kV power line are likely to be subject to subsidence of between 0.0 m and 1.0 m, tilts of up to 8 mm/m and tensile or compressive strains of up to 2 mm/m. Power line conductor clearance is estimated to decrease from 0.0 to 0.69 m due to mine subsidence.

The power poles above the panels will be subject to transient movements towards the south as the face retreats towards the north, and then move back towards the east or west after full subsidence develops.

The poles will also be subject to tensile and compressive strains associated with the subsidence 'wave' as it passes underneath the poles. The transient tilts and strains could range from 50% to 70% of the final values, and will be dependent on face retreat rates.

The poles outside the mining limits and within the angle of draw will generally tilt towards the nearest panel rib side as subsidence develops.

Table 12 - Worst-Case Final Subsidence Predictions for Integral Energy 66 kV Power Poles

Pole No.	Easting	Northing	Final Subs S_{max} (m)	Final Tilt$^{+,\#}$ T_{max} (mm/m)		Final Tilt Direction (grid bearing) (o)	Final Ground Strain$^{\&}$ (mm/m)	Final HD$^{*,\#}$ Base (mm)		Conductor Clearance Loss (m)
				Princi -ple	In-line		Principle	Principle	In-line	
201	233367	6302160	0.00	0.0	0.0	-	0.0	0	0	0.00
202	233172	6302285	0.00	0.0	0.0	-	0.0	0	0	0.00
203	233065	6302353	0.00	0.0	0.0	300	0.0	0	0	0.00
204	232937	6302435	-0.03	0.3	0.3	319	0.0	5	5	0.03
205	232743	6302558	-0.72	8.3	6.5	278	-1	133	103	0.69
206	232648	6302619	-1.00	5.5	-2.0	087	-4	-88	-31	0.28
207	232569	6302712	-0.38	7.4	-5.7	089	2	-118	-91	0.62
208	232410	6302896	-0.04	0.4	-0.2	118	-0.1	-6	-4	0.34
209	232267	6303063	0.00	0.0	-0.0	084	0.0	0	0	0.03
210	232101	6303408	0.00	0.0	0.0	-	0.0	0	0	0.00
211	231978	6303461	0.00	0.0	0.0	-	0.0	0	0	0.00

Notes:
#- negative in-line tilts and horizontal displacements indicate movement in opposite direction to positive in-line values.
+ - Transient tilts due to travelling subsidence wave may be assumed to equal the final tilt magnitudes at a given location. Further analysis may be required if marginal conditions indicated.
& - Transient strains may be assumed to range from +/- Final values.
* - HD Base = Absolute horizontal displacement of pole at ground level.

9.7.2 Impact Management Strategies

Appropriate impact management strategies for the Integral Energy power line easement include:

- The development of a suitable monitoring and response plan based on consultation with Integral Energy to ensure the impacts on the poles and powerlines do not result in unsafe conditions or loss of serviceability during and after mining.

- Management of impacts would include replacement of damaged poles and preventing potential damage to conductors and/or providing an alternate supply of power (if possible) until subsidence has fully developed.

- Suitable responses to predicted subsidence impacts to the power poles and conductors would be to provide appropriate sheathing on the poles to control the tension in the conductors during/after mining impacts.

- Damage from subsidence (i.e. cracking and tilting) can manifest quickly after mining (i.e. within hours). The appropriate management plan will therefore need to consider the time required to respond to an impact such as signs of instability or pole tilting occurs in consultation with Integral Energy.

The impact management plan should also include the following activities:

- Measurement of the vertical distance from the ground to the conductor catenaries between each pole before, during and after subsidence development.

- Prepare and distribute results of each survey to relevant stakeholders.

- Review and implement Trigger Action Response Plan (TARP).

9.8 Mine De-Watering Bore Discharge Pipeline and Power Supply Line

9.8.1 Potential Impacts

The temporary welded PVC pipeline and power supply line will be buried in a shallow trench that traverses LWs 910, 920 and 930 (see **Figure 1**). The net worst-case subsidence impact parameter predictions along the pipeline corridor after mining LW 910 is completed are presented in **Table 13**.

Table 13 - Net Subsidence Predictions for the Temporary Mine De-Watering Pipeline

LW	Chain (Start/End) (m)		Final Net Subsidence S_{max} (m)	Final Net Tilt T_{max} (mm/m)	Final Net Curvature* C_{max} (km^{-1})		Final Net Ground Strain (mm/m)		Final Net Horiz. Displacement (mm)
					convex	concave	tensile	compressive	
910	328	539	0.30 - 0.85	5	0.077	0.085	2.2	2.5	89
920	570	847	0.17 - 0.70	4	0.047	0.067	1.1	1.6	63
930	891	1231	0.05 - 0.15	1	0.010	0.013	0.3	0.4	16

Note:
* - Lateral curvatures may be assumed to equal vertical curvature for pipe stress analysis.

Graphical representation of the final subsidence, tilt, curvature, horizontal displacement and strain profiles along the temporary pipeline corridor are presented in **Figures 31a** to **31e**.

Based on reference to **Ho and Dominish, 2004**, the impact of the predicted subsidence movements will be dependent on the tolerable limits of the PVC pipeline walls and welded joints to the induced bi-lateral curvatures and tensile/compressive strains acting along the pipeline. Both parameters are likely to increase or decrease the normal and shear stresses in the pipeline wall.

The generation of stress in the pipeline walls due to curvature in both the vertical and horizontal planes will be function of the pipe wall thickness, pipe diameter and Young's Modulus of the pipe material and internal operating pressures.

The transfer of strain (and stress) into the pipeline wall will also be dependent on the depth of backfill over the pipe and the coefficient of friction between the trench backfill and the pipe wall. A similar assessment will also be required for the protective sheathing around the power supply cable.

The deformed shape of the pipeline after mining should therefore be assessed by the mine in order to determine whether mitigation works are likely to be required during subsidence development.

The pipeline and power line installed for the purposes of dewatering CAPC mine, should be designed to withstand the predicted subsidence strains and tilts.

9.8.2 Impact Management Strategies

The proposed management strategies required to minimise impact on the pipeline due to subsidence are:

- Determine tolerable in-line and lateral pipeline deformation limits to be used for TARPs.
- Establish a practical pipeline break management plan to minimise disruption to underground operations.
- Utilise the existing B-Line and monitor the deformation of the ground surface along the pipeline.
- Uncover the pipeline sections where deformations and strains have exceeded the tolerable or agreed trigger action response limits.
- Re-align the pipeline and replace damaged sections and backfill if it is damaged during mining.

9.9 Forest Access Tracks

9.9.1 Potential Impacts

The predicted cumulative subsidence impact parameters for the forest access tracks above LWs 900W and 910 to 930 are summarised in **Table 14**.

Table 14 - Predicted Cumulative Subsidence Impact Parameters for the Forest Access Tracks

Longwall	XL	Panel Width (m)	Cover Depth (m)	Maximum Subsidence (m)	Maximum Tilt (m/m)	Maximum Compressive Strain (mm/m)	Maximum Tensile Strain (mm/m)
900W	6	293	300	1.15 - 1.47	8 - 12	4 - 6	3 - 5
	7	293	320	0.80 - 1.13	5 - 7	3 - 4	2 - 4
910	2	210	370	0.71 - 0.89	7 - 9	5 - 8	4 - 6
	4	210	360	0.71 - 0.89	7 - 9	5 - 8	4 - 6
920	*4*	*260*	*360*	*1.09 - 1.45*	*9 - 12*	*5 - 8*	*4 - 6*
930	*4*	*260*	*360*	*1.07 - 1.43*	*9 - 12*	*5 - 7*	*4 - 6*

* - Negative strains and crack widths indicate compression and shearing displacements respectively.
Italics - Predictions include subsidence to-date and LW910 effects.

Based on the predictions for maximum tensile and compressive strain, the worst case crack width across the tracks is estimated to range between 20 mm and 90 mm where it passes through the tensile and compressive strain zones above each longwall panel.

It is estimated that approximately 30 to 50 m long sections of the tracks above each longwall may require repairs to tensile cracking or compressive shear failures through the road after each panel is completed.

Some erosion damage may also occur due to changes in drainage paths along the sides of the tracks and the installation of new table drains or possibly culverts across the tracks may be necessary after mining or subsidence is completed.

9.9.2 Impact Management Strategies

Appropriate impact management strategies would be:

- The development of a suitable monitoring and response plan with stakeholders to ensure that any impacts to the roads do not result in unsafe conditions during and after the effects of mining.

- Management of impacts would include visual inspections of the road on a monthly basis just prior to and after undermining of the roads until 90% of subsidence has developed (usually occurs when the longwall face has retreated 1.4 x the cover depth past the road). The inspections should be completed above each panel and any impacts repaired promptly in accordance with the Infrastructure Management Plan to be developed.

- Erection of signage along the affected area which cautions drivers / riders of vehicles / motorbikes / mountain bikes of the hazards associated with mine subsidence. A contact phone number should be provided if subsidence impacts are encountered.

- Emergency response plans to close the tracks temporarily at short notice is also recommended if significant cracking affects the tracks.

It is understood that the mine has already developed a Public Safety Management Plan for previous longwall panels, which incorporates all of the above recommendations.

9.10 Potential Subsidence Interaction with Previously Extracted CSVC Longwalls

The proposed LW 900W will encroach within the CSVC mining lease. The proposed panel will be 252 m from the CSVC workings at its closest point (378 m between the proposed LW 900W and the existing CSVC LW1 goaf).

Based on the predicted worst case subsidence contours presented in **Figure 17c**, it is considered unlikely the predicted subsidence increases over the CSVC Goaf will exceed 20 mm.

The potential impacts of the CAPC Panels are therefore expected to be negligible over the CSVC panel area. No impact management strategy is considered necessary for the interaction effects between the mining leases.

10.0 Conclusions and Recommendations

10.1 Subsidence and Impact Predictions

Predictions of worst-case subsidence and potential impacts to existing and proposed surface features have been based on a review of the subsidence data for LWs 920 to 950, which have similar mining geometries.

The predicted maximum final subsidence for the proposed panels ranges from 0.69 m to 1.47 m, depending on cover depth, and is 21% to 45% of the assumed mining height of 3.25 m. These values indicate that the overburden will 'bridge' due to natural arching action for the proposed mining geometry.

Based on longwall mining experience at CAPC and CSVC, maximum subsidence is very unlikely to exceed 60% of the mining height or 1.95 m. This scenario represents super-critical or 'non-bridging' behaviour.

The subsidence above the 34 m wide chain pillars between LWs 920 and 910 is estimated to range from 0.64 to 1.04 m. Goaf edge subsidence is estimated to range from 0.07 to 0.21 m around LW 900W and from 0.15 to 0.37 m for LW 910.

Maximum panel tilts are predicted to range from 5 to 16 mm/m with tensile strains ranging from 2 to 6 mm/m and compressive from 3 to 8 mm/m. If surface cracking develops the predicted strains could increase up to two to three times where shallow rock exposures exist above strain peaks (i.e. from 4 to 16 mm/m). Tilts may also be increased locally to 24 mm/m should discontinuities or faulting effect subsidence development.

The surface above the previously extracted longwalls 920 and 930 is expected to subside a further 0.15 m to 0.7 m due to compression of chain pillars caused by the extraction of longwall LW 910. The associated tilts and strains are not expected to increase by more than 10 % and may decrease due to the reduction in differential subsidence.

The outcomes of the predicted subsidence may result in the following impacts:

- Minor surface cracking and shearing may develop within tensile and compressive strain zones above the extracted panels and range in width between 1 mm and 20 mm based on the observed cracking over LWs 920 to 950. Localised cracking of up to 90 mm wide is possible where near surface competent bed rock is exposed near the predicted strain peaks.

- It is however considered unlikely that the cracks will occur as a single crack where deep soil or weathered surface rock exists, and likely to consist of several smaller width ones.

- Repairs may be required to some of the wider and deeper creeks and in the vicinity of roads and public access areas. Should the worst case scenario eventuate, some remediation of dry creek beds may also be necessary and in consultation with relevant stakeholders and government agencies.

- It is very unlikely that further rock falls and mining related cracking of the rock formation located to the west of LW 910 will occur, due to the very low magnitudes of predicted tilts and strains of < 2 mm/m. Cliffs and rock formations are also located outside the Design AoD of 26.5^o from the ends of the proposed 900W and very unlikely to be impacted by tilting or strain.

- The increase or decrease of surface gradients of up to 0.5^o (1%) along ephemeral watercourses or gullies that exist above the proposed longwall panels. There is the potential for minor increases in erosion and sedimentation along creek beds after several storm events or until a new equilibrium is reached. This should be monitored both pre and post mining. There has been no erosion impact noted above the previously extracted CAPC longwalls however.

- Gully stormwater or groundwater seepage flows may be re-routed to below-surface pathways and re-surface down-stream of cracked areas where shallow surface rock is present. The temporary loss of surface water flows is unlikely to occur where deep alluvial soil profiles exist and creek bed sediment is expected to infill surface cracks after several storm events.

- Ponding depths of < 0.1 m may develop along creeks and flatter areas beneath the proposed longwalls. Any increases of existing ponded areas or development of new ponds are likely to be in-channel and unlikely to cause significant impact to the existing environmental conditions. The likelihood of ponding is dependent on a number of other factors including rainfall, soil moisture content and evapo-transpiration.

- Direct hydraulic connection from the surface to the mine workings due to sub-surface fracturing is considered 'very unlikely'. Continuous fracturing is not expected to develop above massive sandstone units of the Narrabeen Formation, which exist between 110 and 250 m above the workings.

- Based on shallow piezometer monitoring results above LWs 920 to 950, in-direct or 'discontinuous' sub-surface fracturing is 'very unlikely' to interact with surface cracks or effect the near surface groundwater regime.

- The presence of 'plastic' shale beds and the Mount York Claystone unit, which exists between the massive Narrabeen Group sandstone units, is understood to provide protection from permanent drainage of surface aquifers through surface and subsurface fracture / joint interconnection.

- The Blackfellows Hands, Kangaroo Creek and Beecroft Trails above the proposed panels are forest tracks that are accessible to the public. The tracks are likely to be subsided by up to the maximum panel values presented earlier and may also be affected by vertical cracking or low angle compressive shearing. The crack widths are estimated to range between 1 mm and 20 mm in the tensile and compressive strain zones above each longwall panel.

  Worst-case crack widths of up to 90 mm are estimated if there are near surface rock exposures present beneath the sections of track near tensile and compressive strain peaks.

- It is recommended that appropriate warning signage be erected adjacent to the tracks where they enter/exit an area that will be subsided. Any sign of cracking will be reported to Forests NSW and where necessary, remediation work will be carried out in consultation with Forests NSW.

- The poles suspending the existing Integral 66 kV powerlines may be subject to subsidence of between 0.5 m and 1 m, tilts of up to 8 mm/m and tensile or compressive strains of up to 4 mm/m. Power line conductor clearance is estimated to decrease from 0.0 to 0.69 m due to mine subsidence.

- Regular visual inspections and surveys of the poles and conductors during subsidence development along the powerline corridor will be required to enable prompt repair or adjustment of the line if necessary.

- Suitable mitigation works to minimise the poles from damage due subsidence impacts to the power poles and conductors will be carried out in consultation with Integral Energy as part of an Infrastructure Management Plan to be developed.

- The proposed buried PVC water supply and power supply to the mine de-watering pumping station is likely to be subsided by up to 0.85 m, with tilts of 1 to 5 mm/m, tensile and compressive strains of 0.3 to 2.5 mm/m, and horizontal displacements of 16 mm to 89 mm.

- The predicted deformations should be considered in the design of flexible couplings, pipe joint strengths, trench backfill depth and strain transfer characteristics of protective sheathing.

- Regular visual inspections and monitoring of pipeline discharge/power supply will be required during subsidence development with management plans determined to ensure suitable responses to mine subsidence damage if it occurs.

- Surface monitoring lines should be installed at relevant locations to provide accurate measurement of subsidence, tilt and strain and to enable the review of the measured values versus subsidence predictions for impact management assessment purposes.

10.2 Suggested Monitoring Requirements

The following subsidence and strain monitoring program is suggested for providing adequate information to monitor and implement appropriate subsidence impact management plans in the study area in consultation with the Principal Subsidence Engineer of DII:

- Continued surveys along the B-Line above LWs 930, 920 and 910 for monitoring of the de-watered pipeline. The extension of the B-Line should be considered to measure side panel angle of draw to 20 mm.

- Installation of a centreline at the finishing end of LW910 to measure 20 mm angle of draw in vicinity of Kangaroo Creek cliff line to the west.

- Installation of a centreline at the finishing end of LW970 and crossline for LW 900W to measure side panel angle of draw in vicinity of cliff lines to the west.

- Installation of a centreline at the starting end of LW 900W to measure 20 mm angle of draw in vicinity of the nearest rock feature and cliff lines to the south

- Monitoring of Integral Energy pole movements (X, Y, Z) and conductor clearances above LW 900W as part of the Infrastructure Management Plan.

The locations of the lines are shown in **Figure 32**.

The above monitoring program proposed is also intended to allow the comparison between predicted and measured subsidence parameters for a given feature. The following is suggested to ensure reasonable survey accuracy outcomes:

- Survey pegs should be spaced at a minimum of 10 m and a maximum of 15 m for reasonable tilt and curvature measurement accuracy. A minimum of two baseline surveys of subsidence and strain is recommended before mine subsidence effects occur.

- Survey frequency will be dependent upon mine management requirements for subsidence development data in order to implement subsidence and mine operation management plans.

- Subsidence and strains should be determined using Digital Level and standard steel tape.

- It is normally expected that level accuracy will be +/- 2 mm and +/- 3 mm for horizontal displacement (i.e. gives a strain measurement accuracy of +/- 0.2 mm/m strain over 15 m).

- Total station techniques may only be used determine 3-D coordinates, provided that the survey accuracy using EDM and traverse techniques from a terrestrial base line is acceptable. Accuracies of +/- 20 mm for level and +/- 10 to 20 mm for horizontal displacement (i.e. a strain measurement accuracy of +/- 1 to 1.5 mm/m over a 15 m bay-length) are typical.

- Total stations surveys will be utilised for monitoring of Integral Energy power pole surveys.

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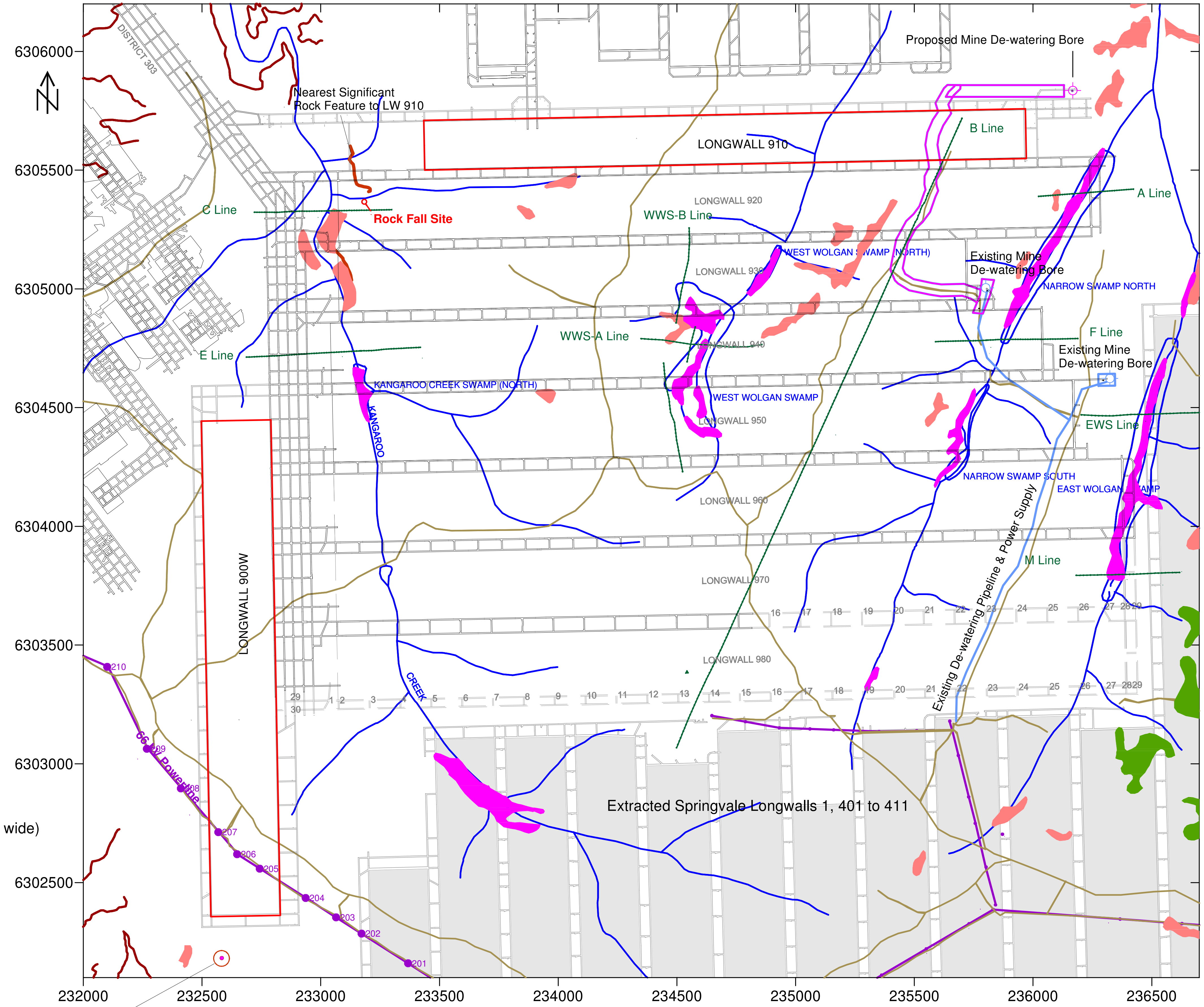


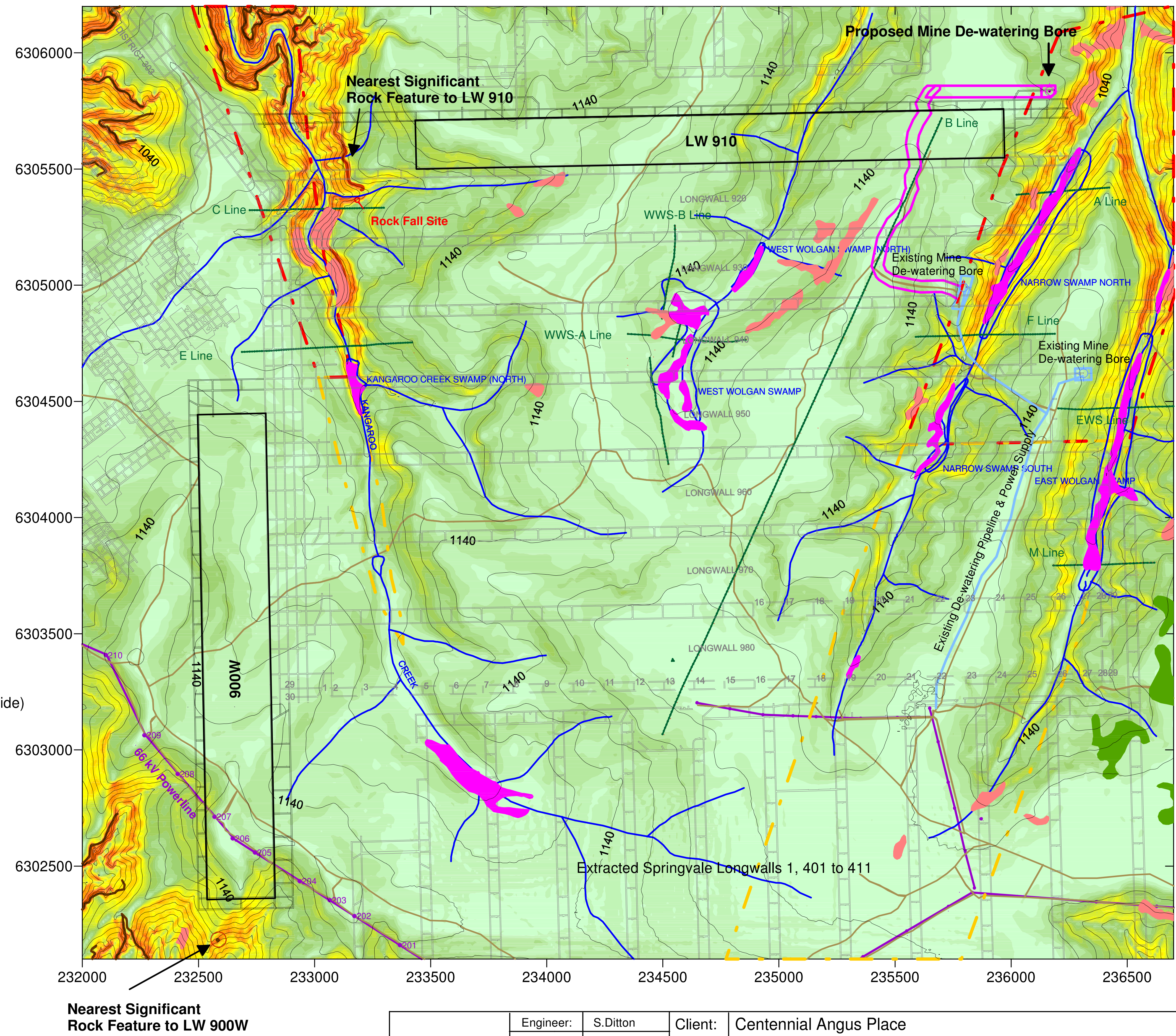
Key:

- Access Tracks
- Suspended Powerlines and Poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply to Mine Bores
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging swamps
- Cliff lines (>20 m high)
- Rock Formations (5 - 20 m)
- Extracted Longwall Blocks
- Proposed Longwalls
- Installed Subsidence Lines

DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton		
	Date:	14.08.10	Title:	Proposed Longwall Layout with Surface Features and Installed Subsidence Lines
Ditton Geotechnical Services Pty Ltd			Scale:	1:18,000 (A3) — Figure No: 1

Surface Gradient (o)

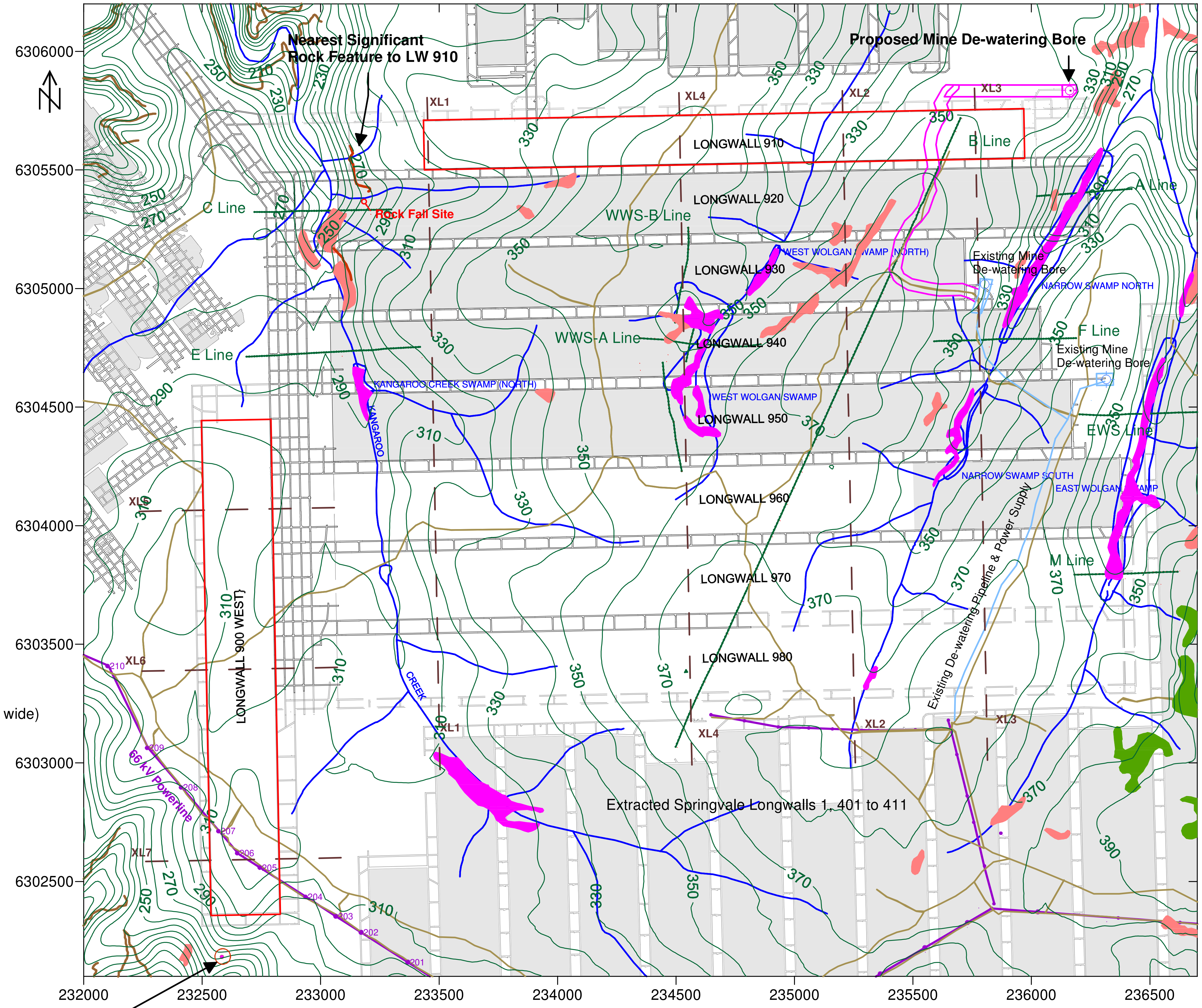
48
44
40
36
32
28
24
20
16
12
8
4
0



Key:

- Access Tracks
- Suspended Powerlines and Poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply to Mine Bores
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging swamps
- Newnes Plateau Wooded Heath
- Cliff lines (>20 m high)
- Rock Formations (5 - 20 m)
- Approved or Extracted Longwall Blocks
- Proposed Longwalls
- A Line — Installed Subsidence Lines
- High Fault Impact Potential Zone (refer to text)
- Moderate Fault Impact Potential Zone (refer to text)

DgS Ditton Geotechnical Services Pty Ltd	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton	Title:	Proposed Longwall Layout (900W & 910) & Approved Longwall (920 - 980) with Surface Level Contours, Slope Gradients and Surface Features
	Date:	14.03.10		
			Scale:	1:18,000 (A3) — Figure No: 2

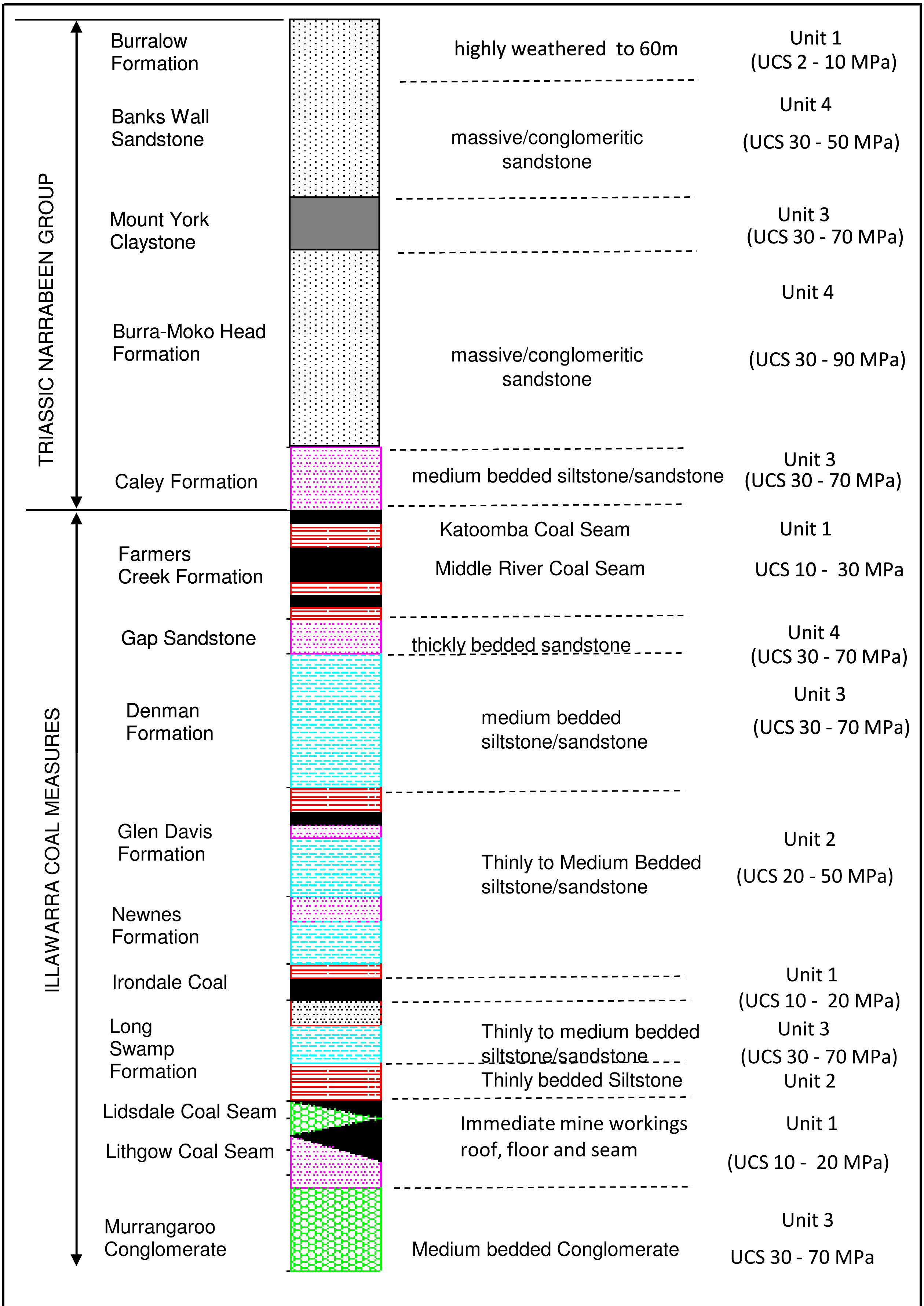


Nearest Significant Rock Feature to LW900W

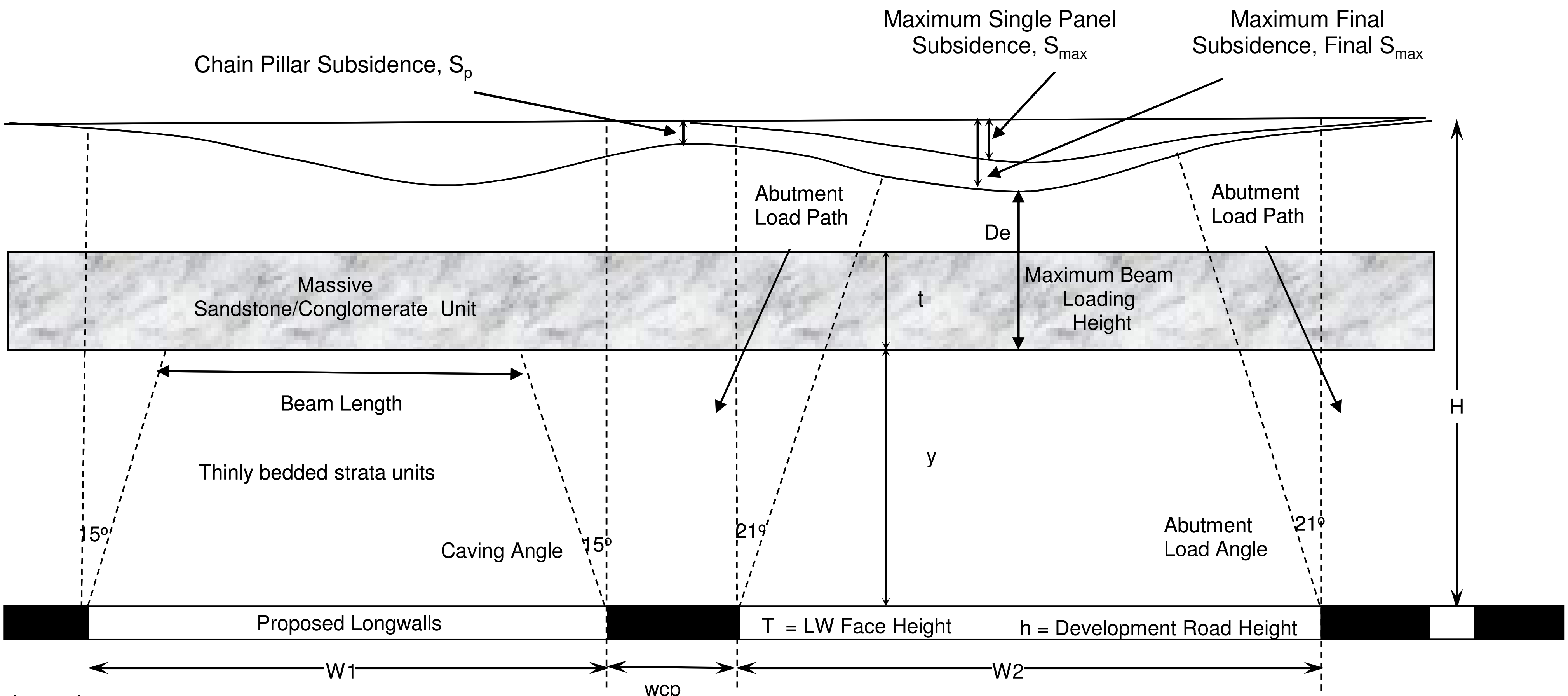
Key:

- Access Tracks
- Suspended Powerlines and Poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply to Mine Bores
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging swamps
- Newnes Plateau Wooded Heath
- Cliff lines (>20 m high)
- Rock Formations (5 - 20 m)
- Extracted Longwall Blocks
- Approved Longwall Blocks
- Proposed Longwalls
- A Line — Installed Subsidence Lines
- XL 1 — Subsidence Prediction Model Crosslines

DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton		
	Date:	14.08.10	Title:	Proposed Longwall Layout (900W - 910) and Approved Longwall Layout (920 - 980) with Cover Depth Contours, Surface Features and Installed Subsidence Survey Lines
Ditton Geotechnical Services Pty Ltd			Scale:	1:18,000 (A3) — Figure No: 3



DgS				
Engineer:	S.Ditton	Client:	Centennial Angus Place Coal Pty Ltd	
Drawn:	S.Ditton		ANP-002/1	
Date:	27.01.10	Title:	Typical Overburden Stratigraphy above the SMP Area	
Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 4



Legend

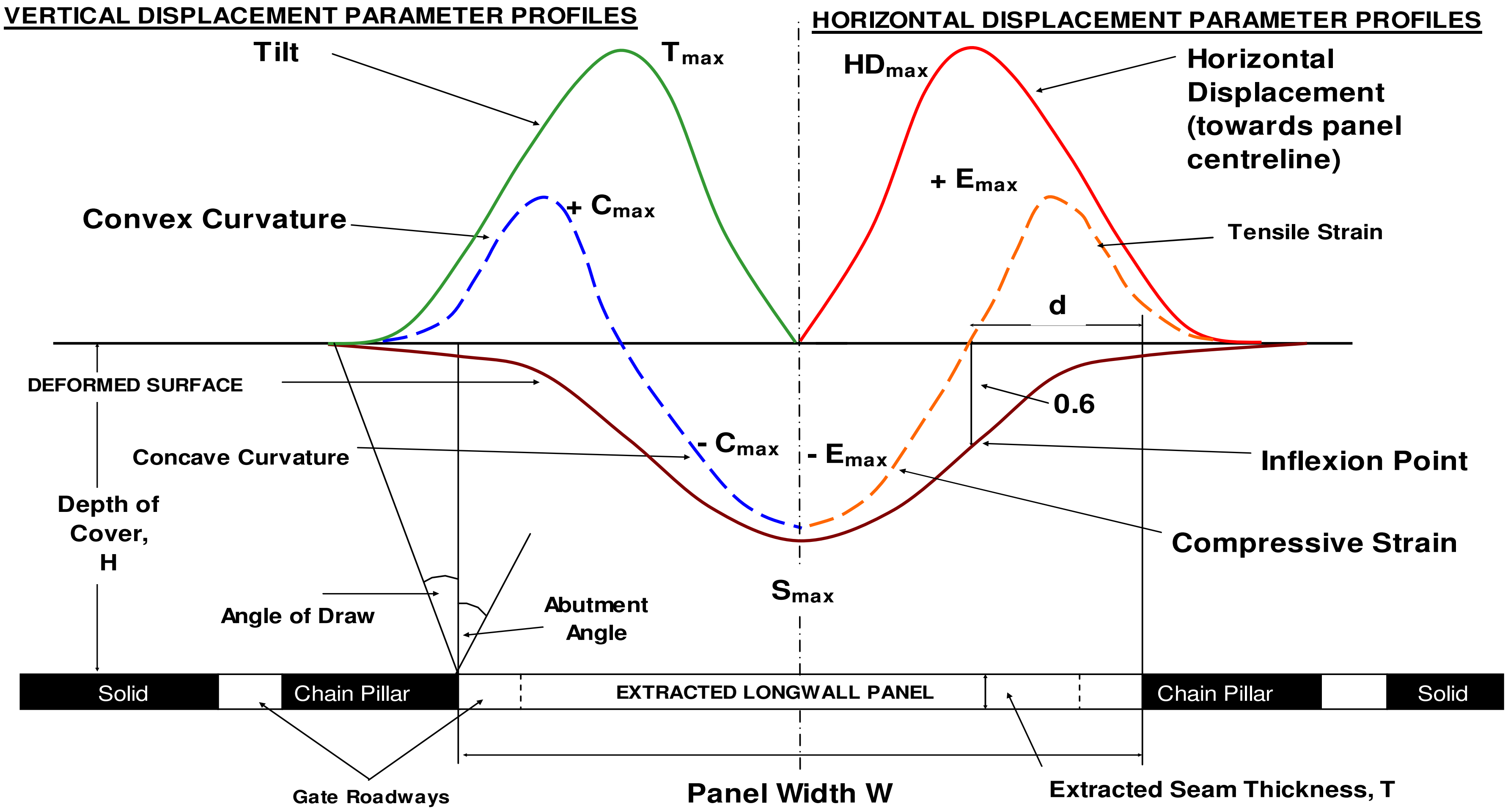
SRP - Subsidence Reduction Potential

Massive Unit

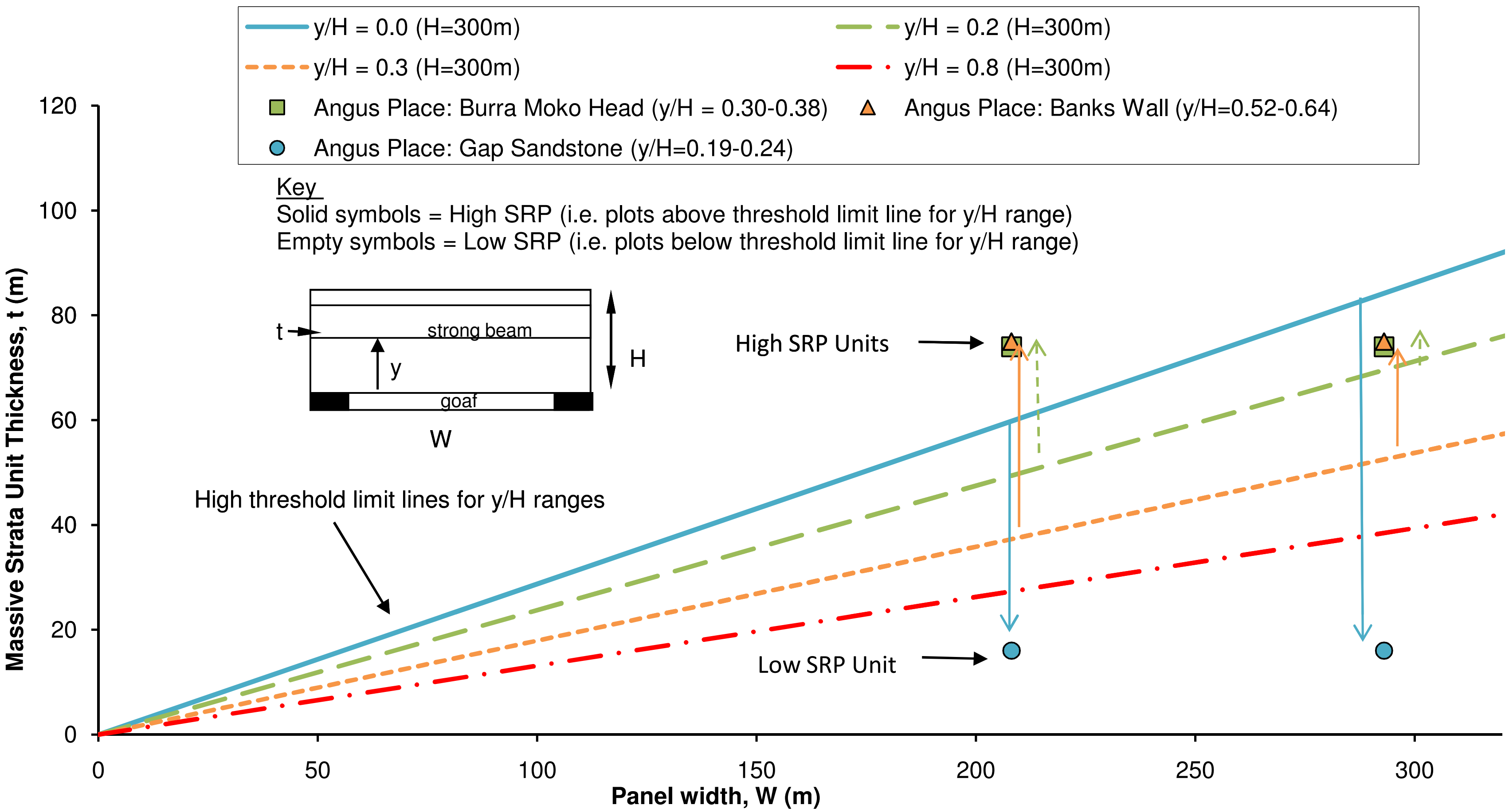
T - Seam Thickness

h - Development Road Height

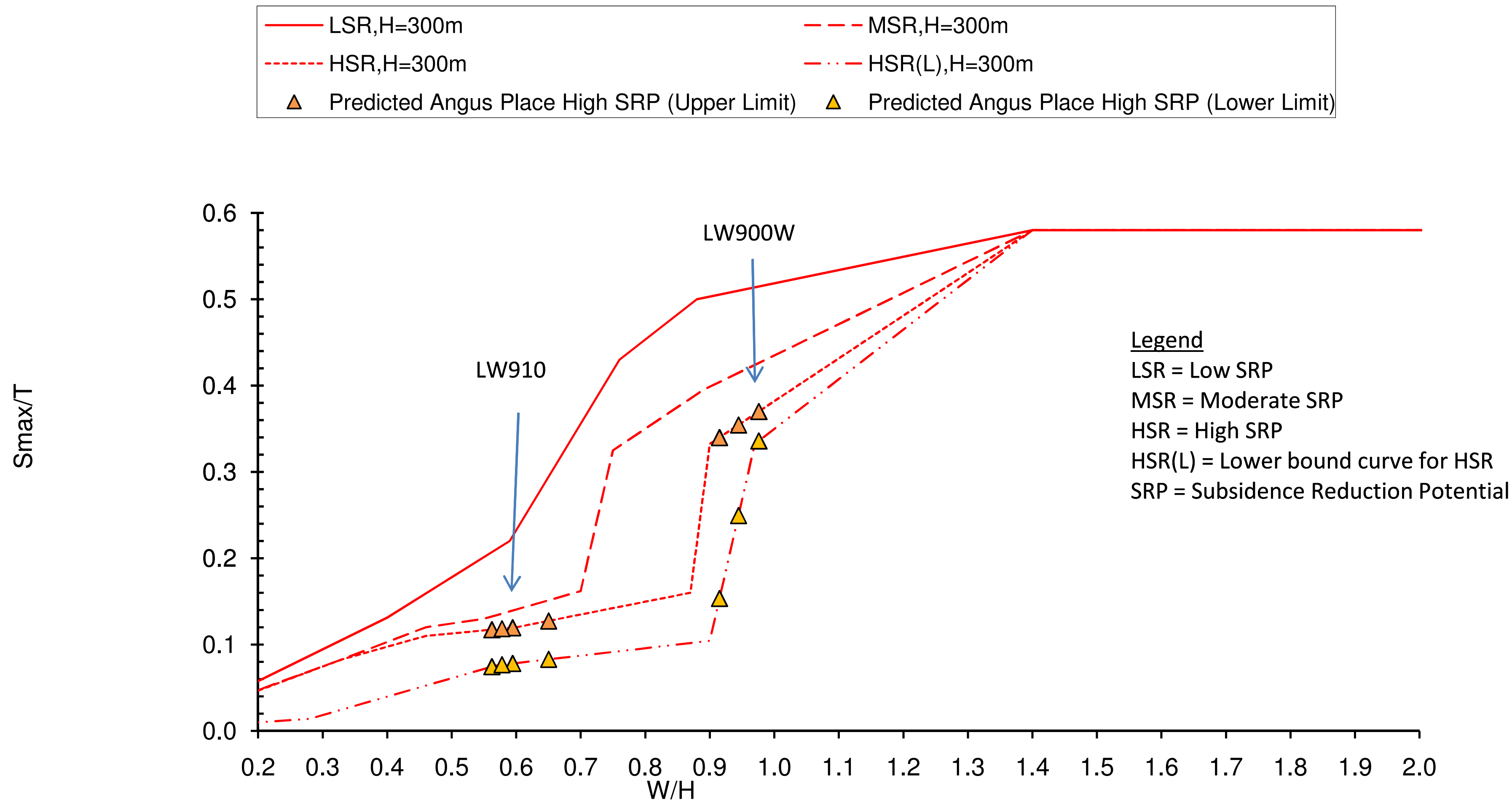
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Coal Pty Ltd ANP-002/1
	Drawn:	S.Ditton		
	Date:	01.02.10	Title:	Conceptual Model for Assessing Subsidence Reduction Potential of Massive Strata Units in Overburden
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS
			Figure No:	5a



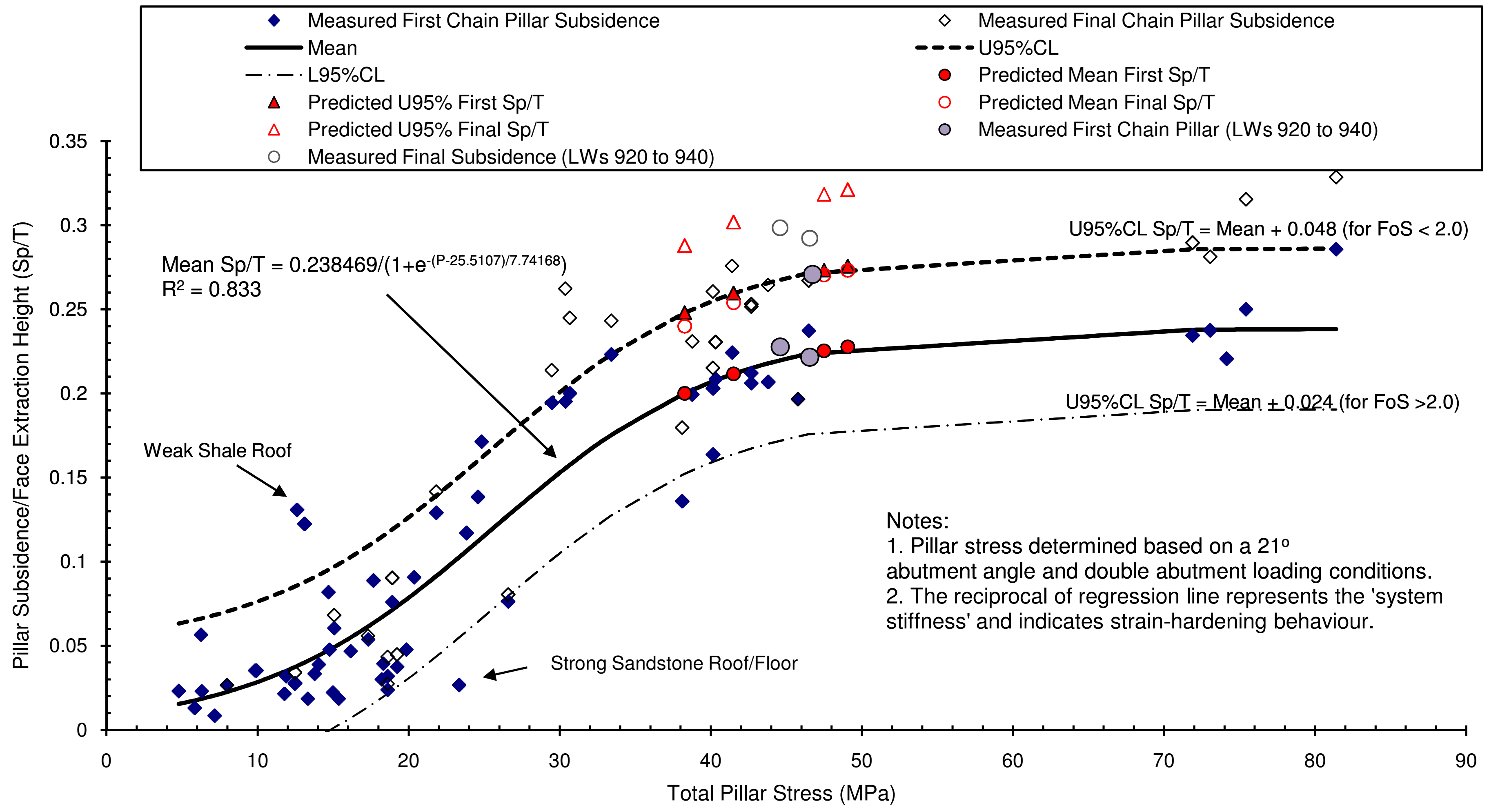
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Coal Pty Ltd ANP-002/1			
	Drawn:	S.Ditton					
	Date:	01.02.10	Title:	Mine Subsidence Trough Deformation Parameters (adapted from Holla, 1987)			
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS		Figure No:	5b



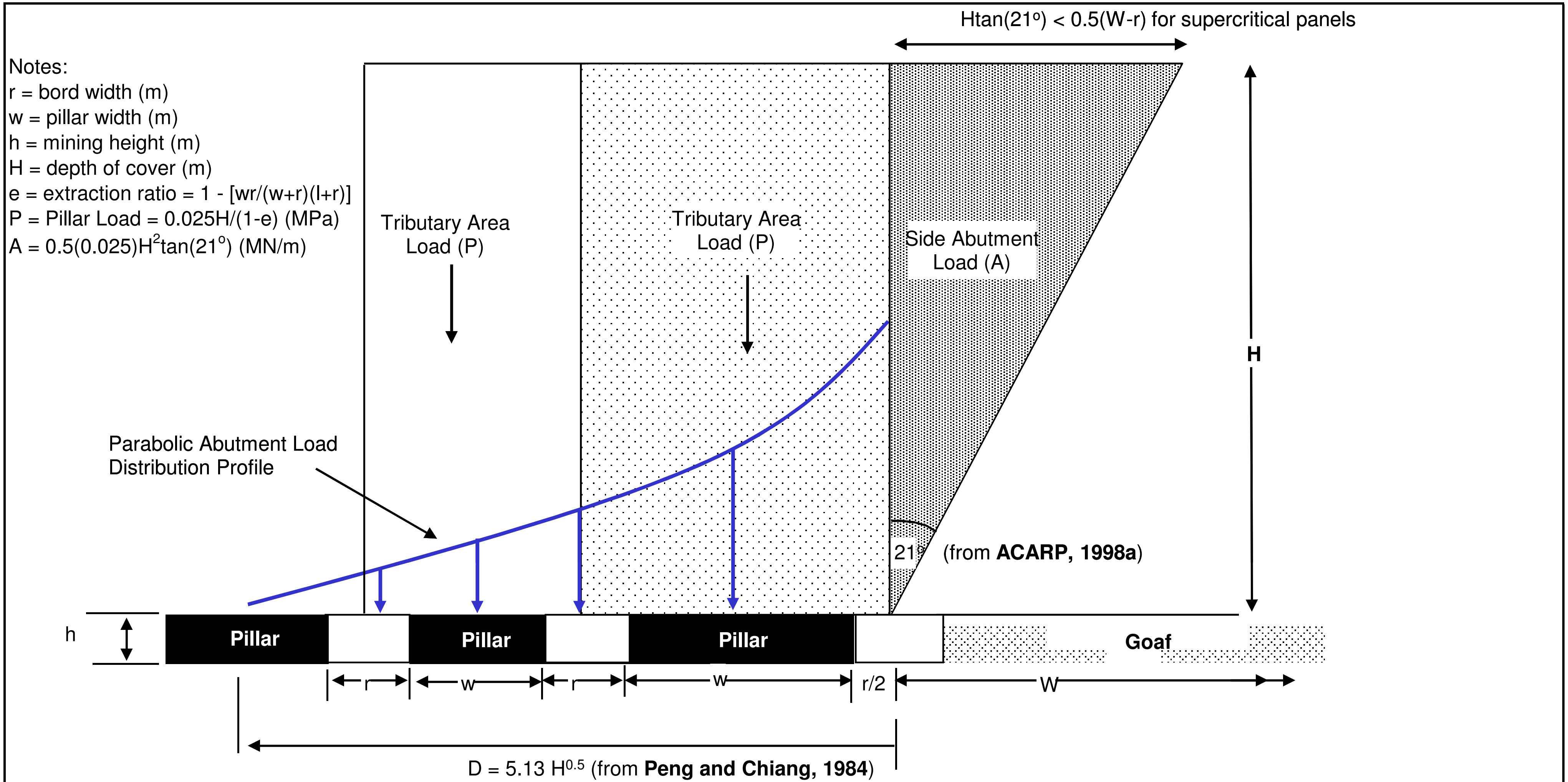
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1
	Drawn:	S.Ditton		
	Date:	01.02.10	Title:	Predicted Subsidence Reduction Potential of Sandstone Units Above the Proposed LWs 910 and 900W
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS — Figure No: 6



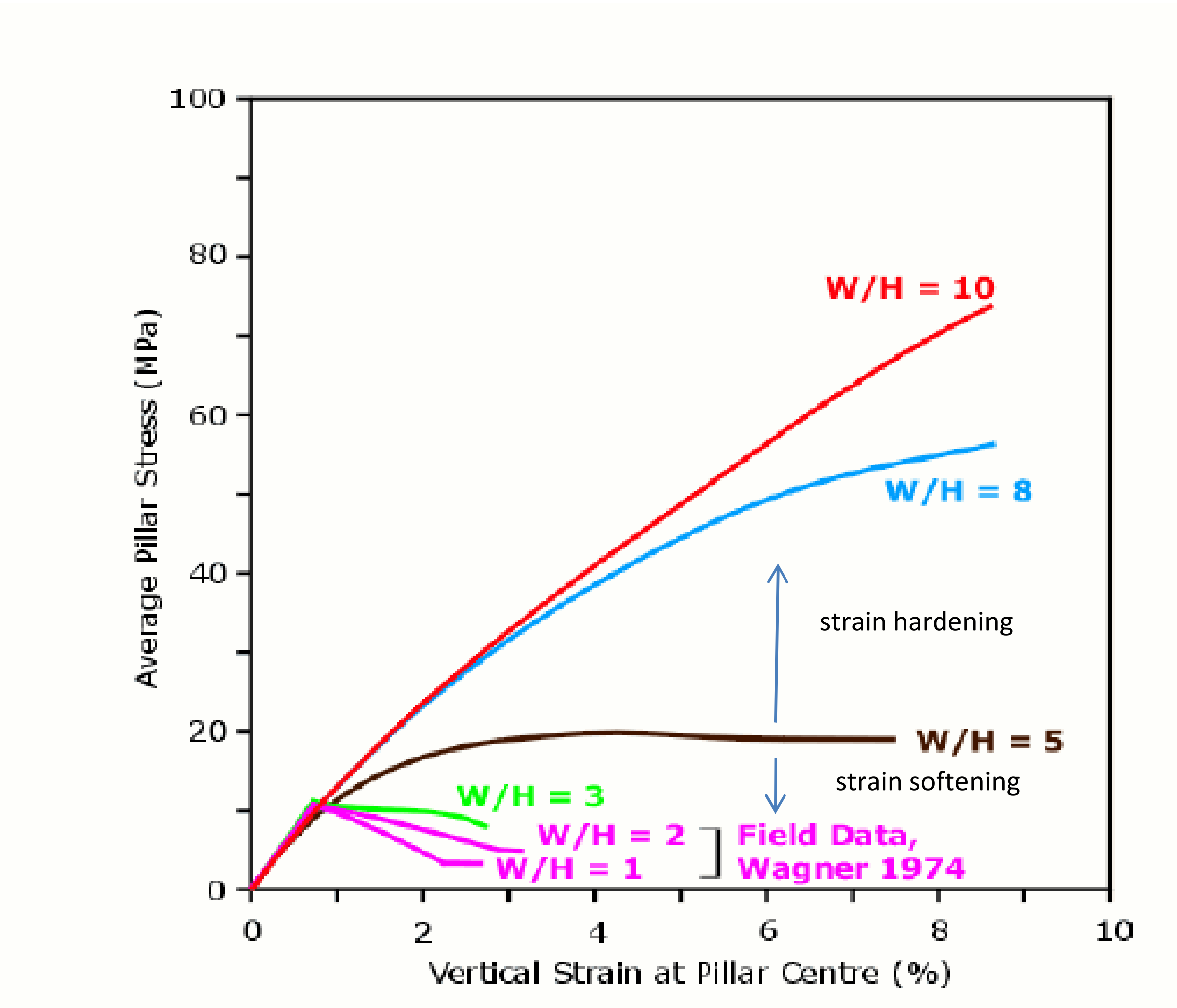
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1		
	Drawn:	S.Ditton				
	Date:	01.02.10	Title:	Predicted Maximum Single Panel Subsidence for Longwalls 910 and 900W in the Lithgow Seam with Cover Depths between 300 m and 370 m		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	7



DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1		
	Drawn:	S.Ditton				
	Date:	01.02.10	Title:	Empirical Chain Pillar Subsidence Prediction Model and the Predicted Outcomes for LW 910		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	8

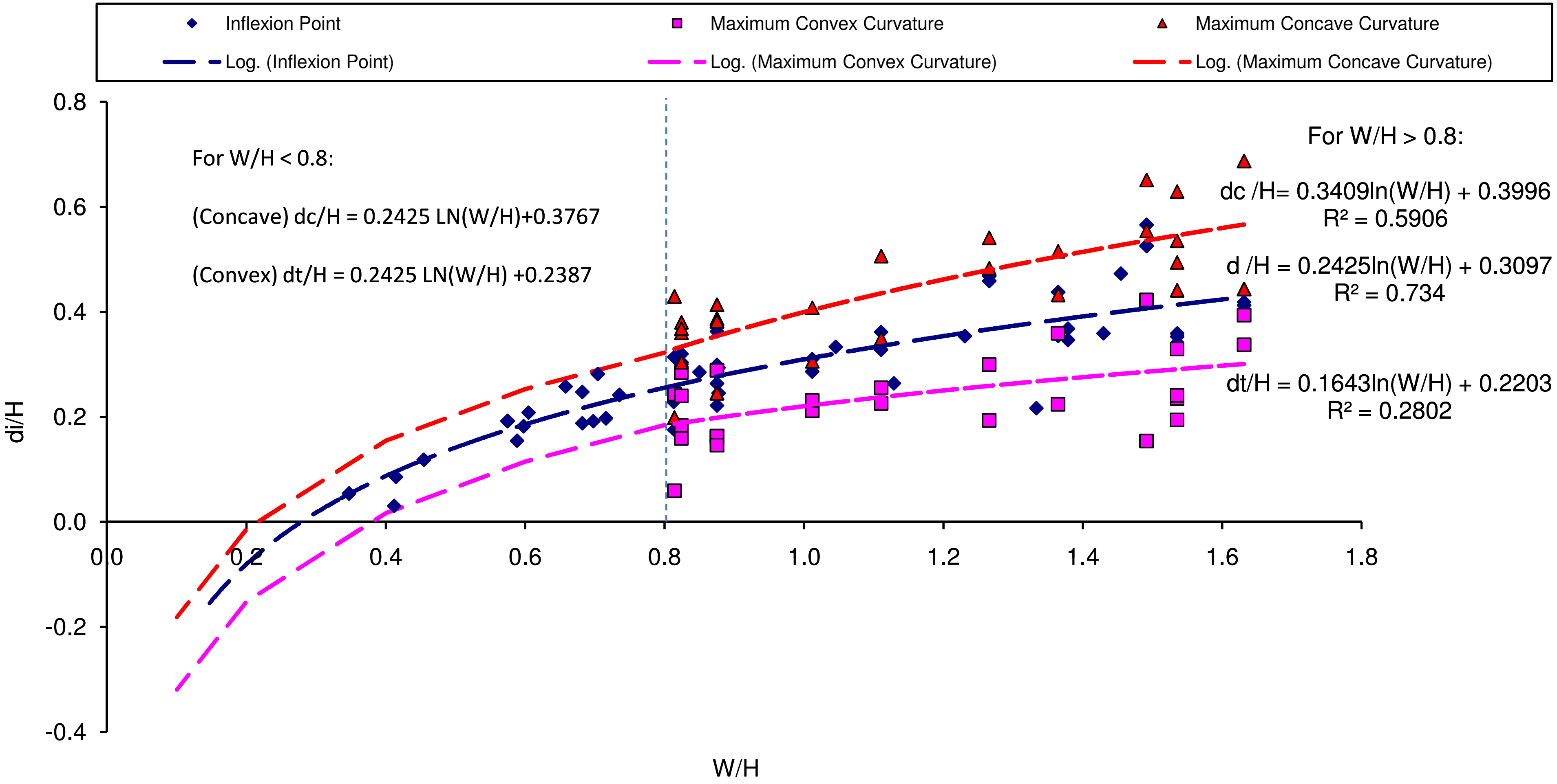


DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1		
	Drawn:	S.Ditton				
	Date:	11.03.10	Title:	Analytical Model for Calculating Abutment Load Acting on Main Headings Pillars Adjacent to 900 West		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	9a

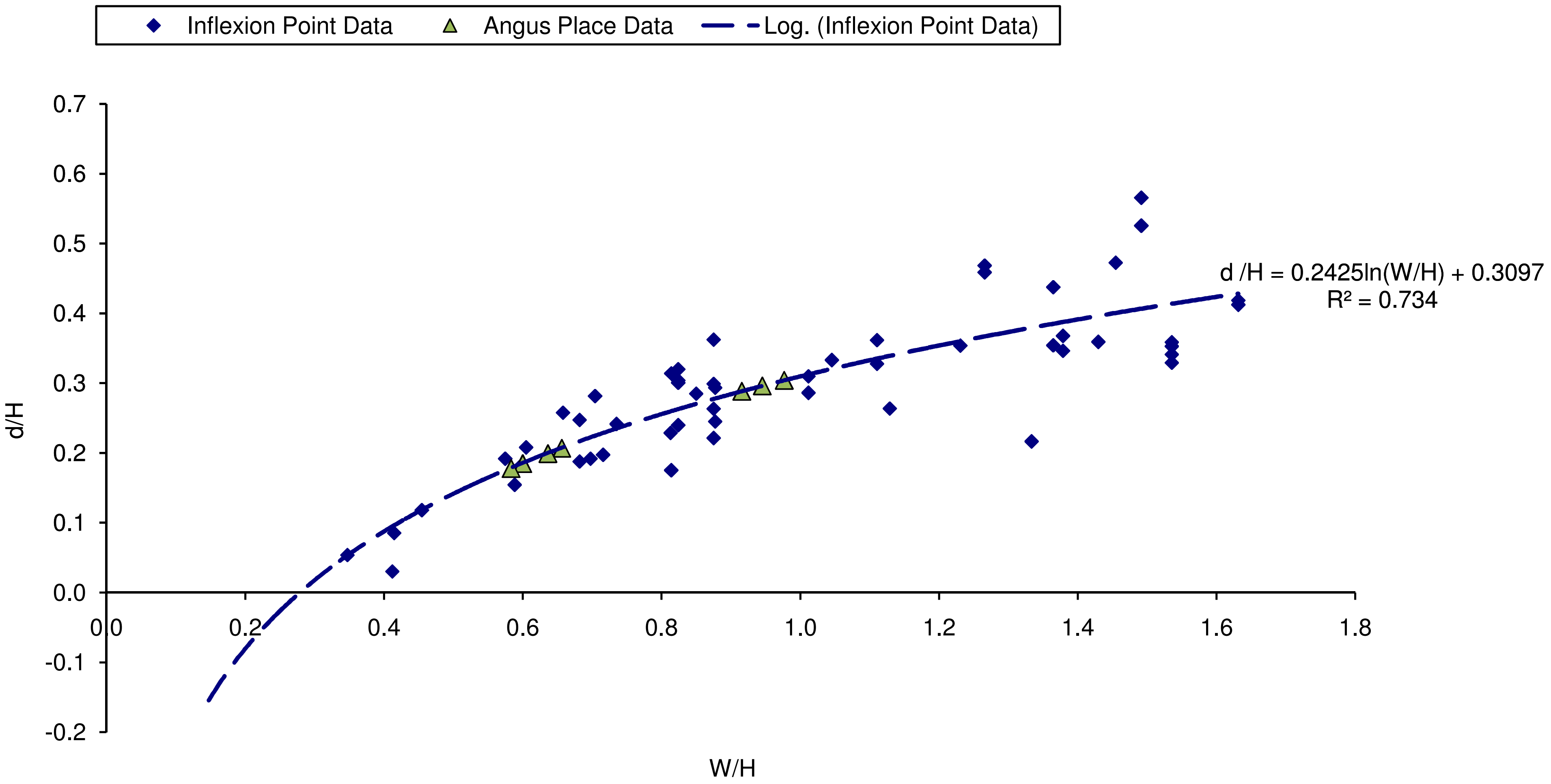


Source: **ACARP, 2005** (refer to text)

DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery		
	Drawn:	S.Ditton		ANP-002/1		
	Date:	01.02.10	Title:	In-situ Pillar Stress v. Strain Response for a Range of Pillar Width/Height Ratios		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	9b

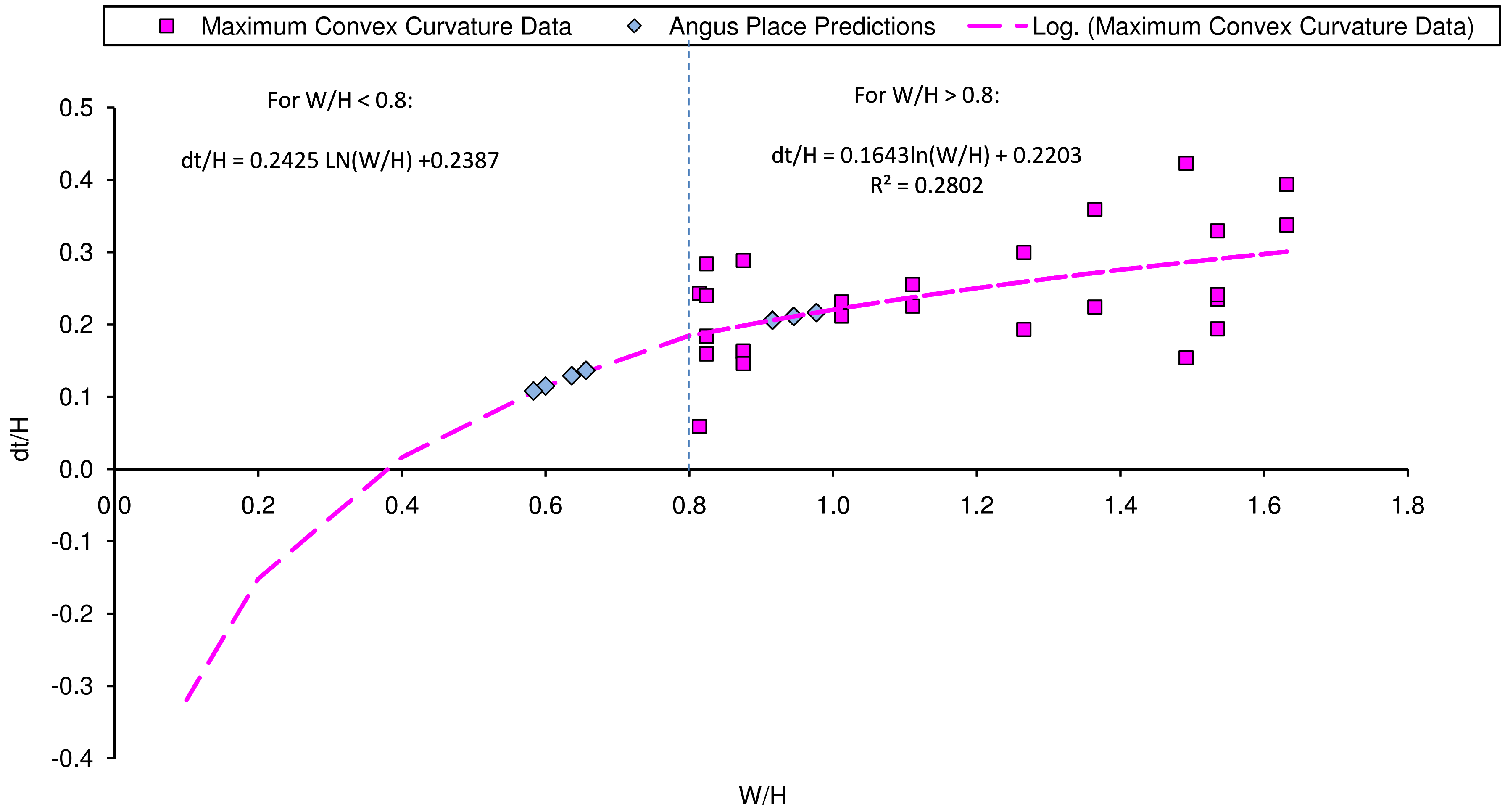


DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Coal Pty Ltd ANP-002/1
	Drawn:	S.Ditton		
	Date:	01.02.10	Title:	Empirical Model for Predicting the Location of Inflexion Points and Maximum Tensile and Compressive Strain Peaks above Longwall Panels in the Newcastle Coalfield
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS — Figure No: 10a

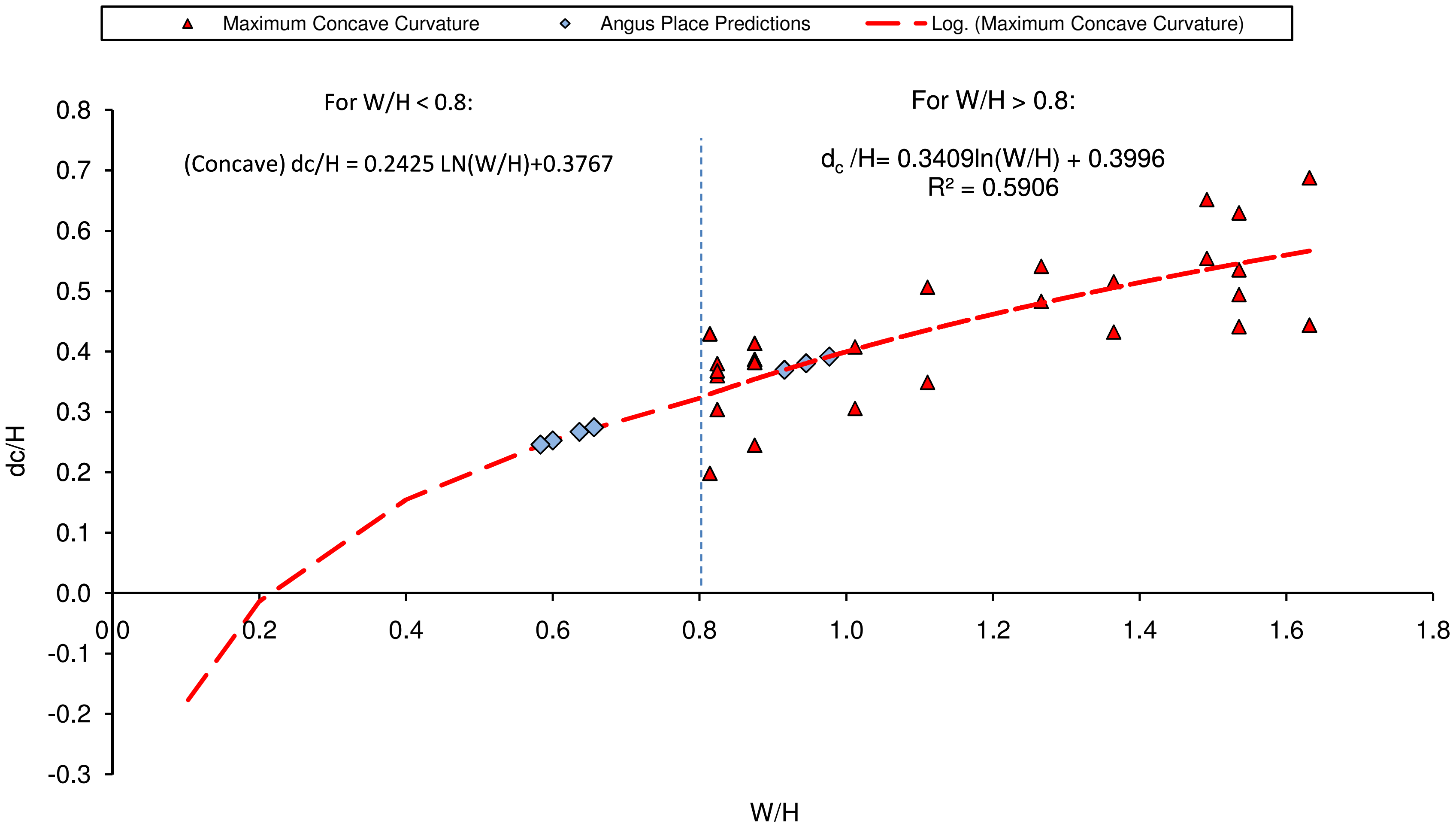


DgS

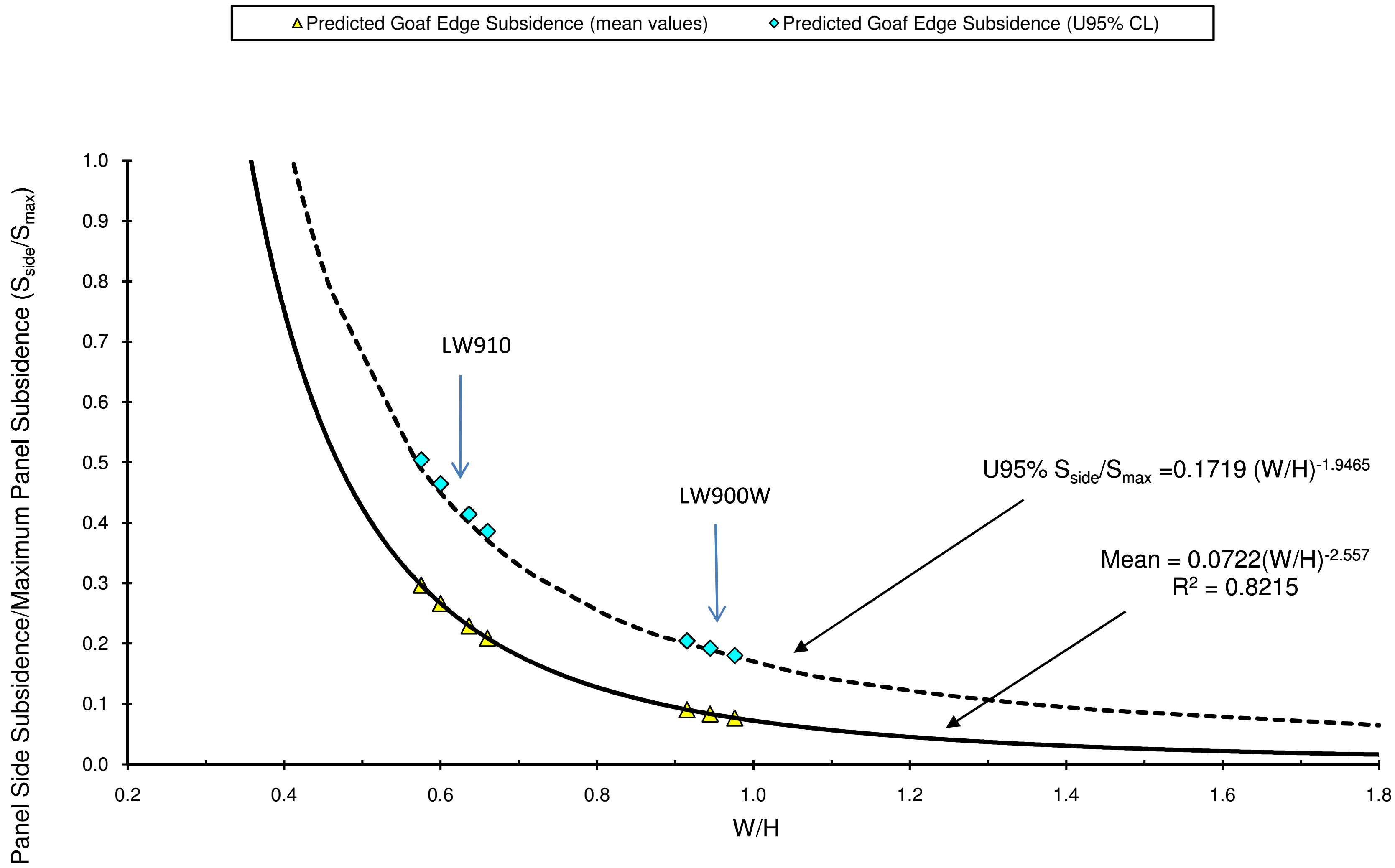
Engineer:	S.Ditton	Client:	Centennial Angus Place Coal Pty Ltd ANP-001/1
Drawn:	S.Ditton		
Date:	01.02.10	Title:	Empirical Model for Predicting the Location of the Inflexion Point or Maximum Tilt above Longwall Panels in the Newcastle Coalfield and Angus Place
Ditton Geotechnical Services Pty Ltd		Scale:	NTS
		Figure No:	10b



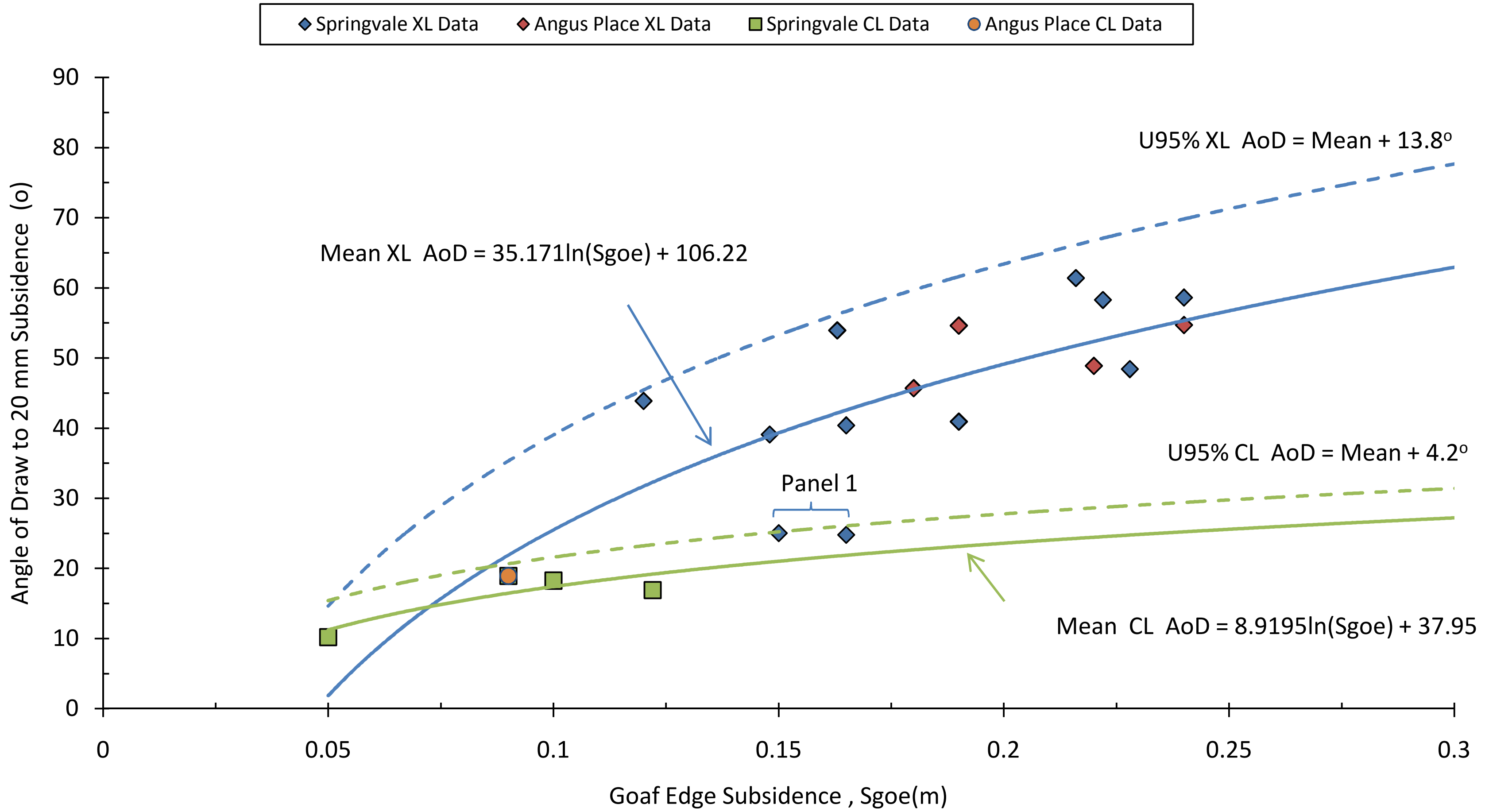
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Coal Pty Ltd ANP-001/1
	Drawn:	S.Ditton		
	Date:	01.02.10	Title:	Empirical Model for Predicting the Location of the Maximum Tensile Strain above Longwall Panels in the Newcastle Coalfield and Angus Place
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS
			Figure No:	10c



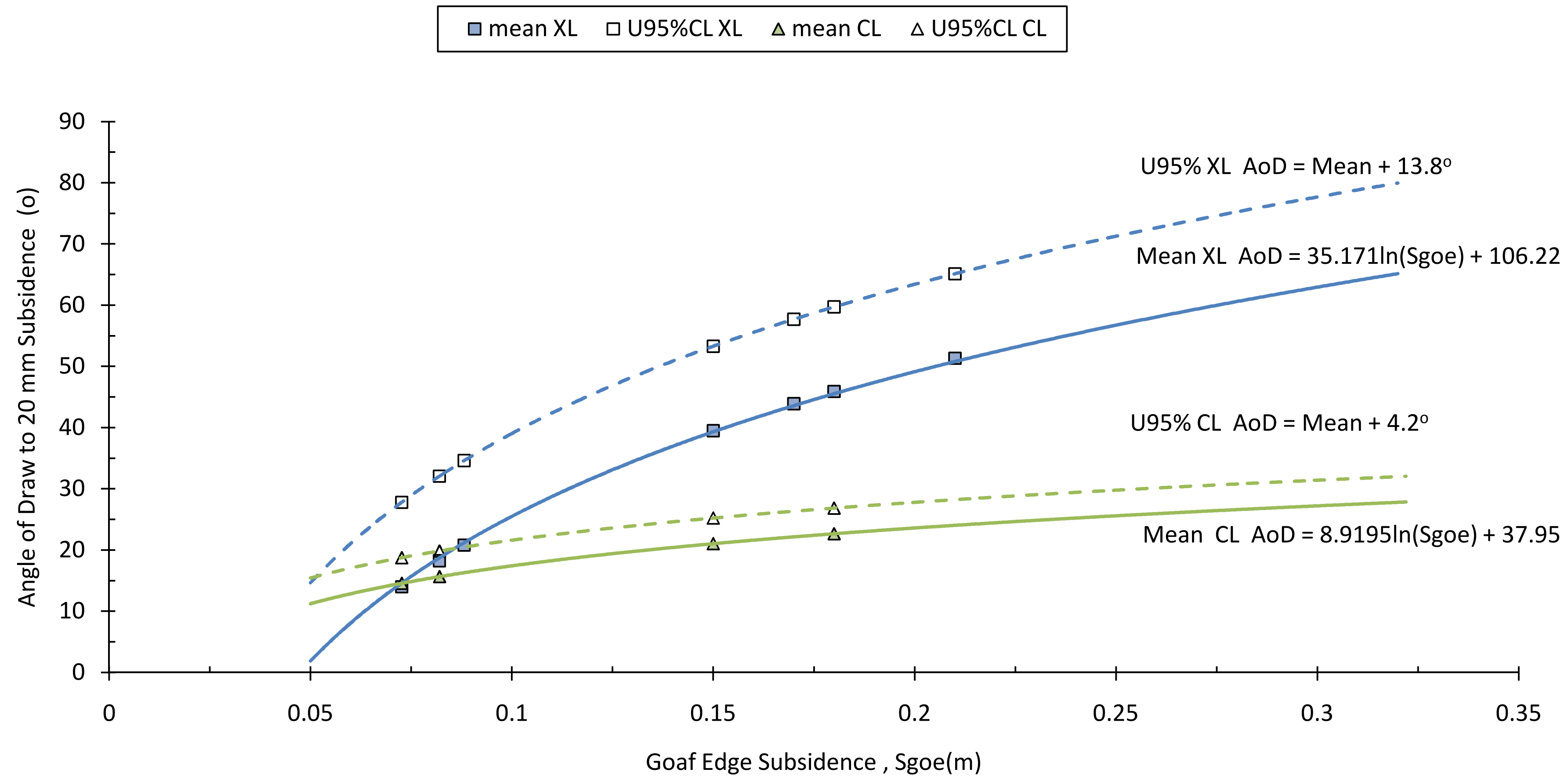
Engineer:	S.Ditton	Client:	Centennial Angus Place Coal Pty Ltd ANP-002/1	
Drawn:	S.Ditton			
Date:	01.02.10	Title:	Empirical Model for Predicting the Location of Maximum Compressive Strain above Longwall Panel Subsidence in the Newcastle Coalfield and Angus Place	
Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 10d



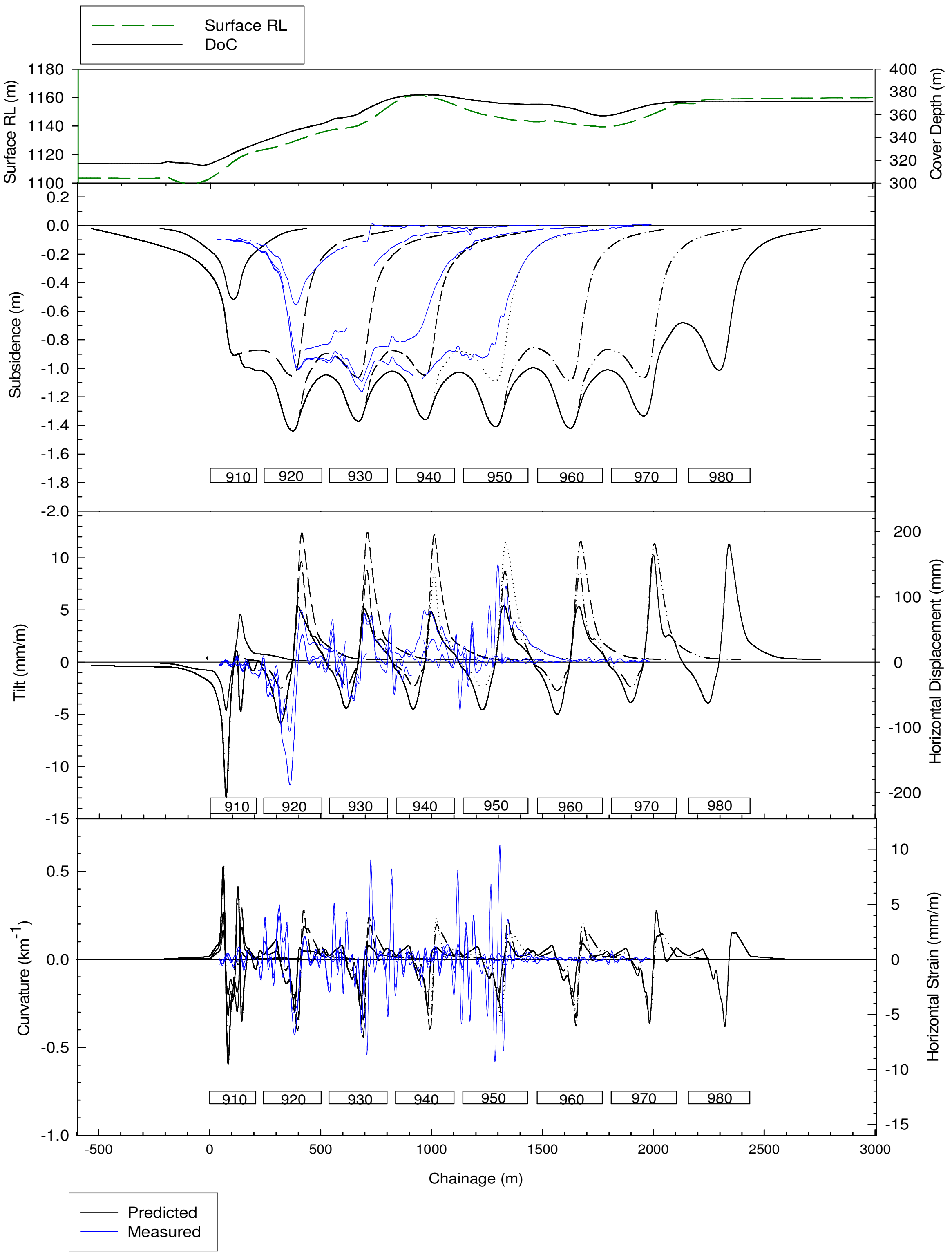
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1
	Drawn:	S.Ditton		
	Date:	01.02.10	Title:	Empirical Model for Goaf Edge Subsidence Prediction Above Longwall Panels in the Newcastle Coalfield and Angus Place Data
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS
			Figure No:	11



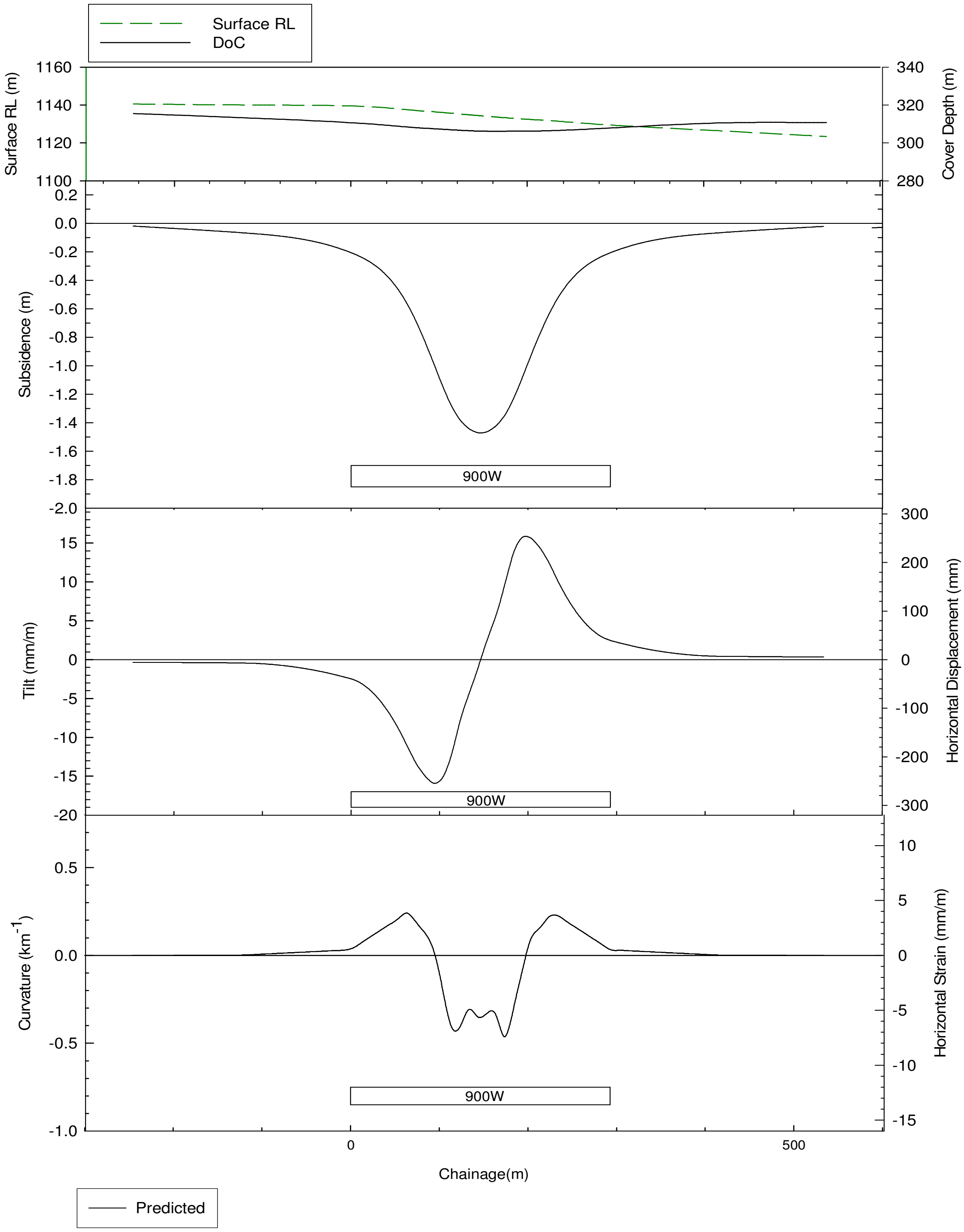
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-001/1		
	Drawn:	S.Ditton				
	Date:	20.02.10	Title:	Empirical Model for Predicting the Angle of Draw from Longwall Panel Limits based on Angus Place and Springvale Data		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	12a



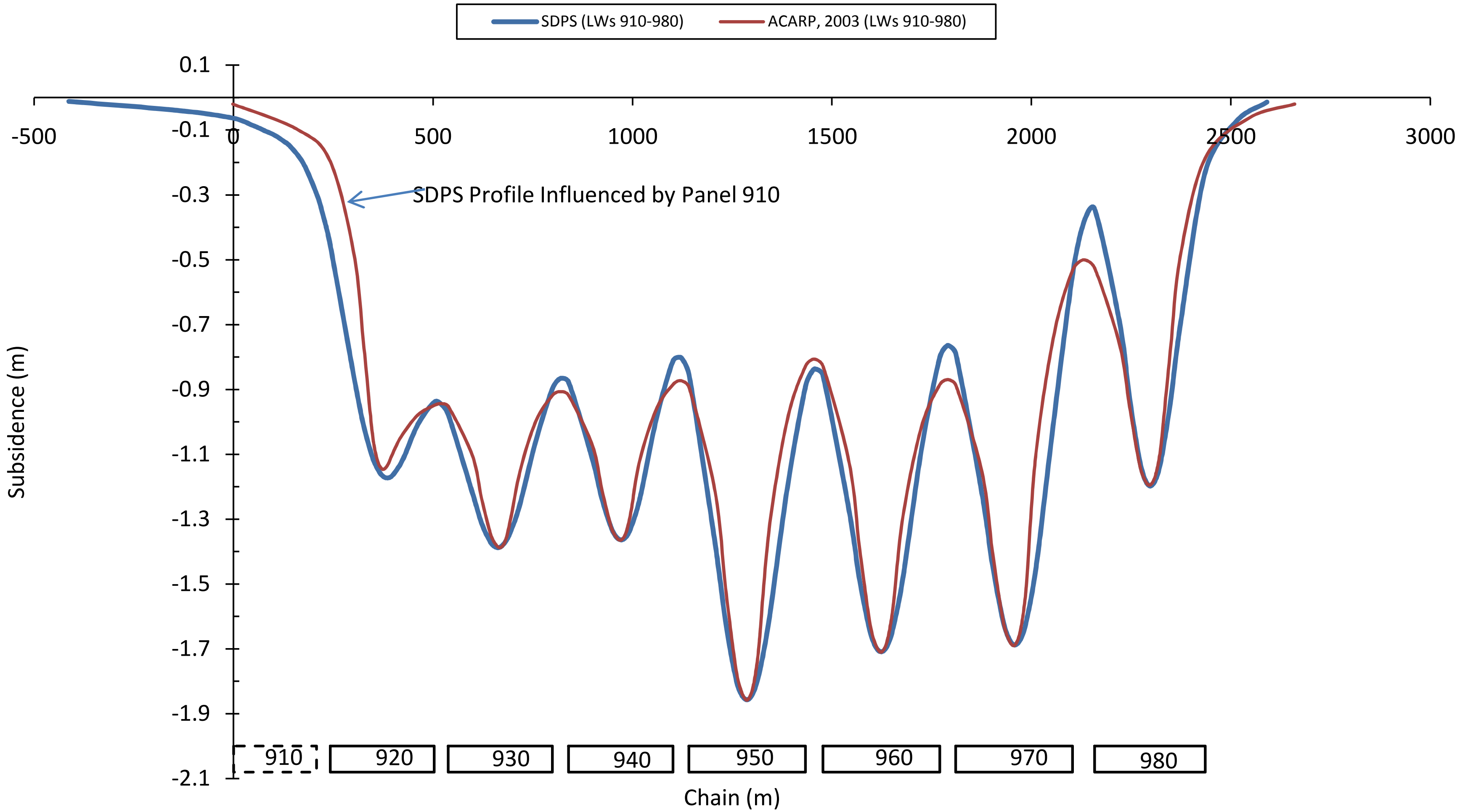
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1		
	Drawn:	S.Ditton				
	Date:	20.02.10	Title:	Predicted Angle of Draw from Longwall Panel Sides and Ends for LWs 910 and 900W		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	12b



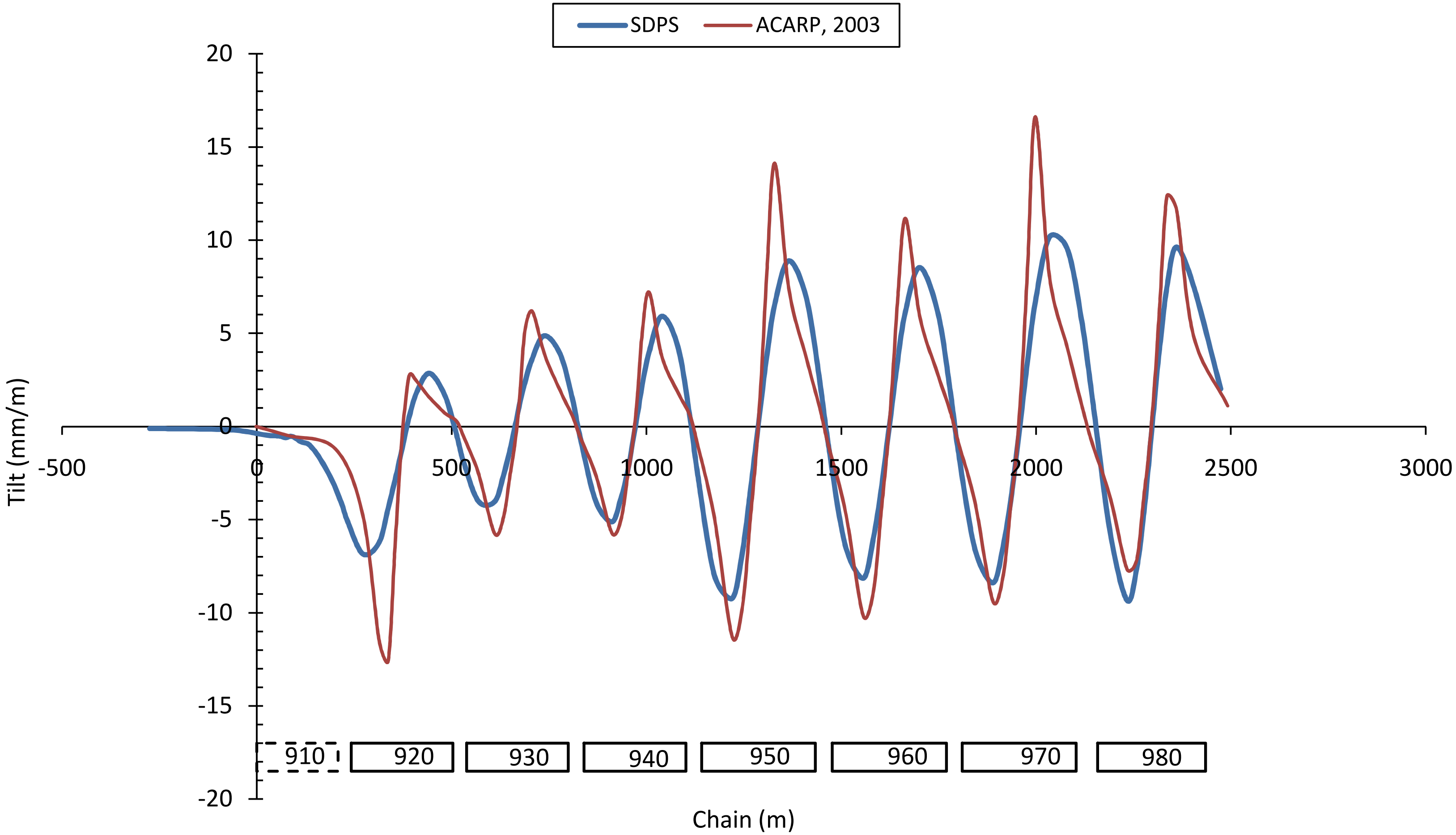
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery	
	Drawn:	S.Ditton		ANP-002/1	
	Date:	05.03.10	Title:	Measured Subsidence Data v. Predicted	
	Ditton Geotechnical Services Pty Ltd			U95%CL Profiles Along XL2 for LWs 910-980	
			Scale:	NTS	Figure No: 13



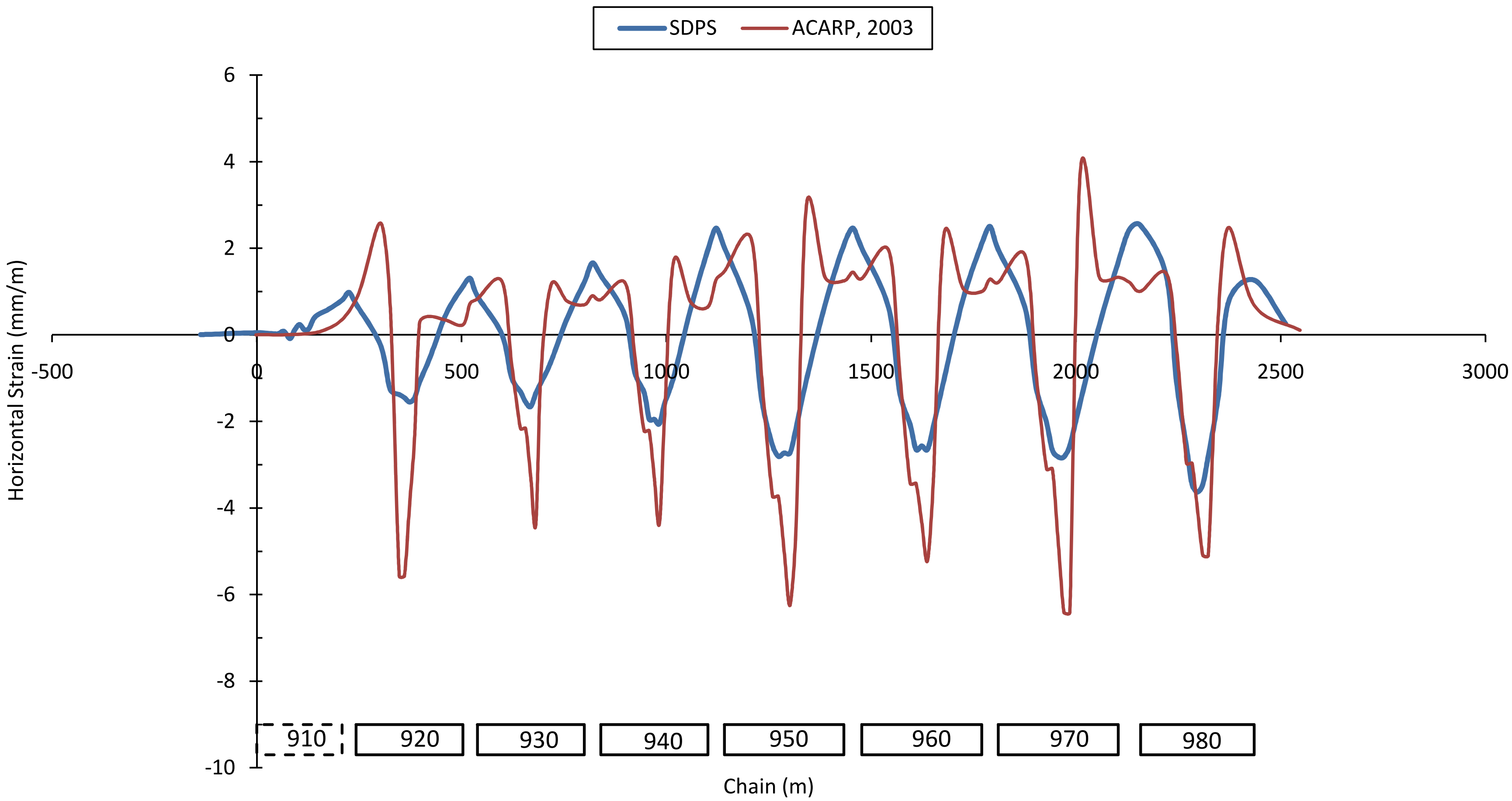
	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery	
DgS	Drawn:	S.Ditton		ANP-002/1	
	Date:	05.03.10	Title:	Predicted U95%CL Profiles along XL6 above the Proposed LW900West	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 14



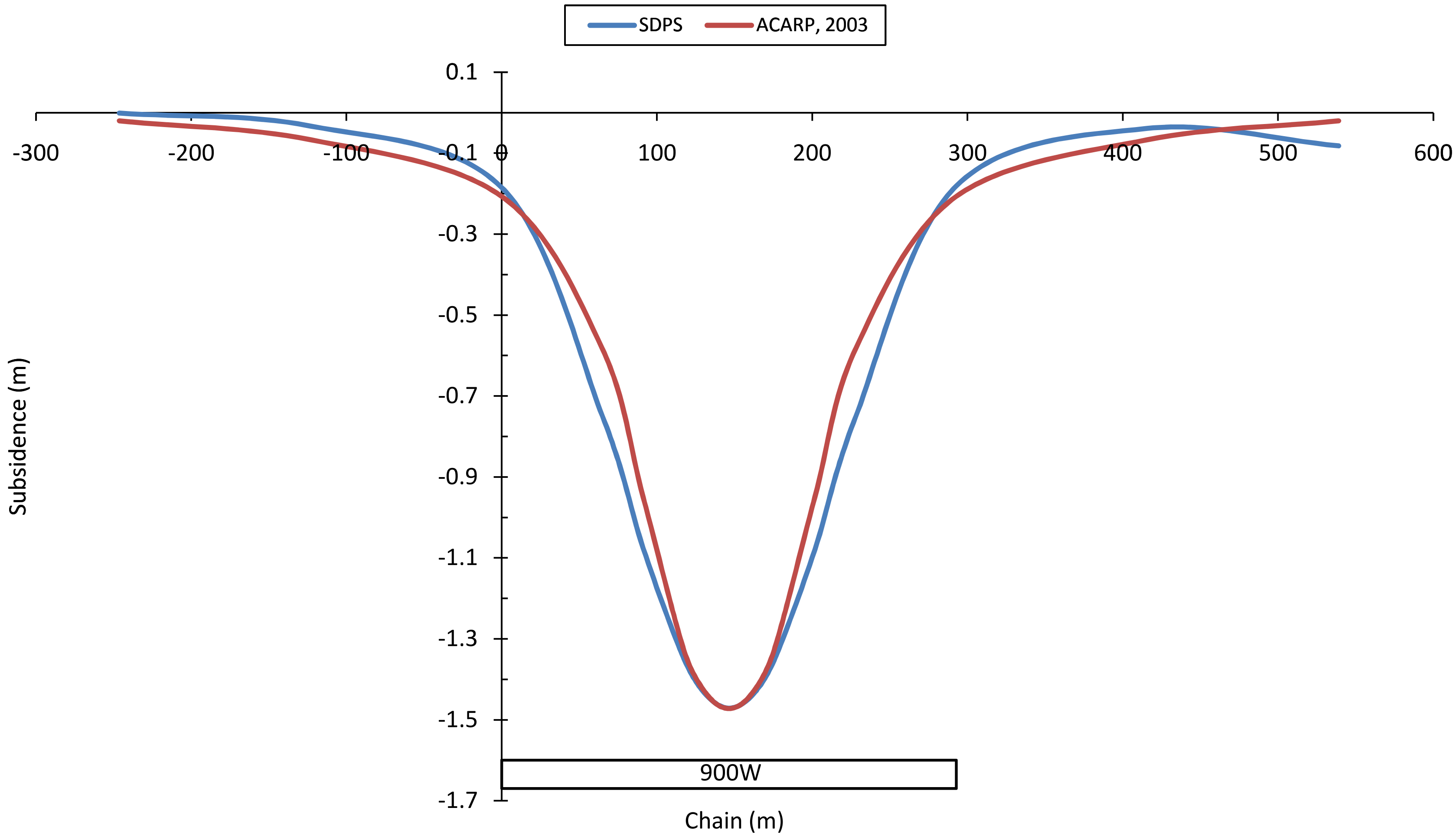
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1	
	Drawn:	S.Ditton			
	Date:	01.07.10	Title:	SDPS Model Calibration Results v. ACARP, 2003 Subsidence Profile (U95%CL) along XL 1 above the Angus Place Longwall Panels 910 to 980 - see Figure 1 for Location	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 15a



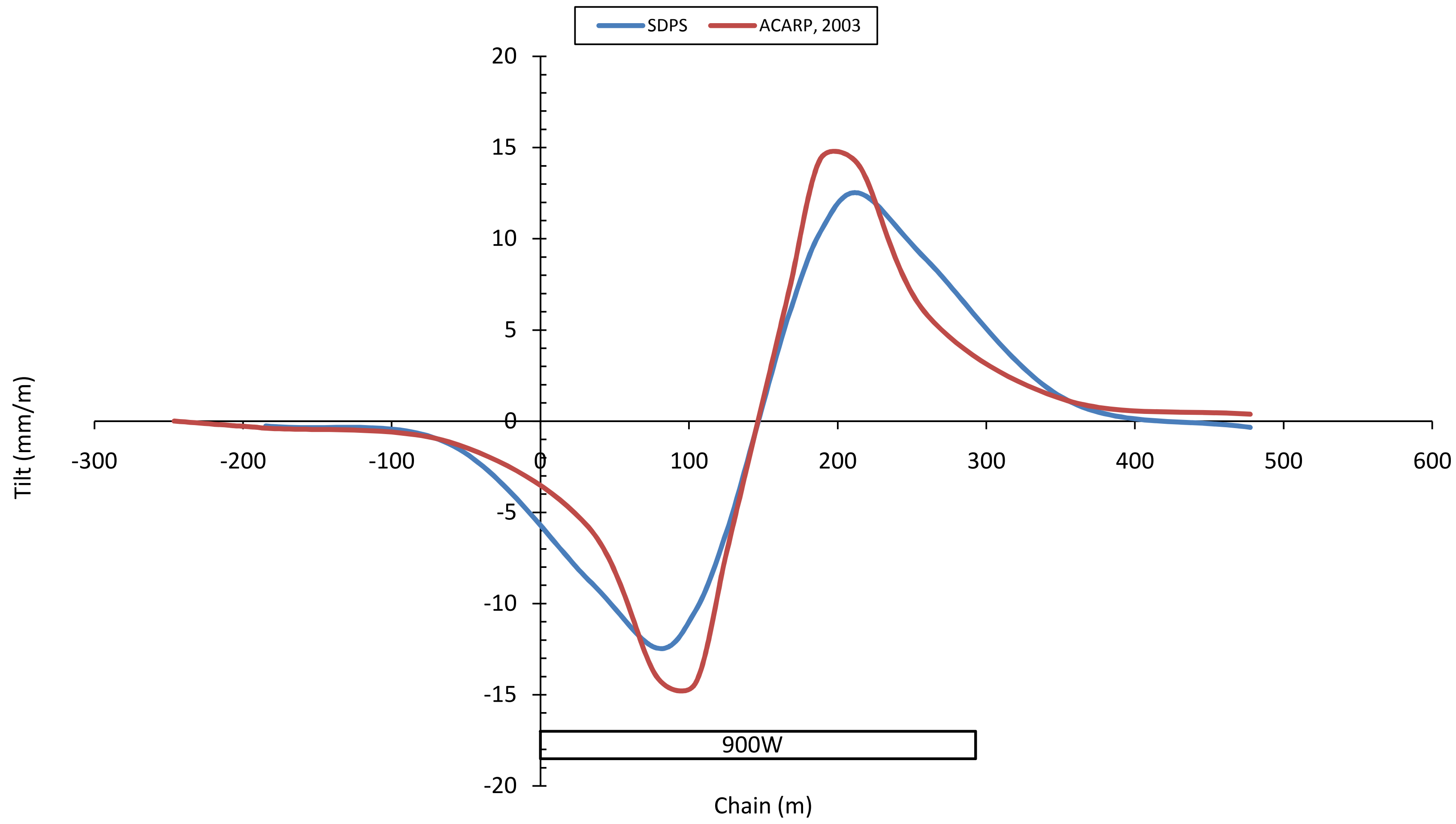
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1			
	Drawn:	S.Ditton					
	Date:	01.07.10	Title:	SDPS Model Calibration Results v. ACARP, 2003 Tilt Profile (U95%CL) along XL 1 above the Angus Place Longwall Panels 910 to 980 - see Figure 1 for Location			
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS		Figure No:	15b



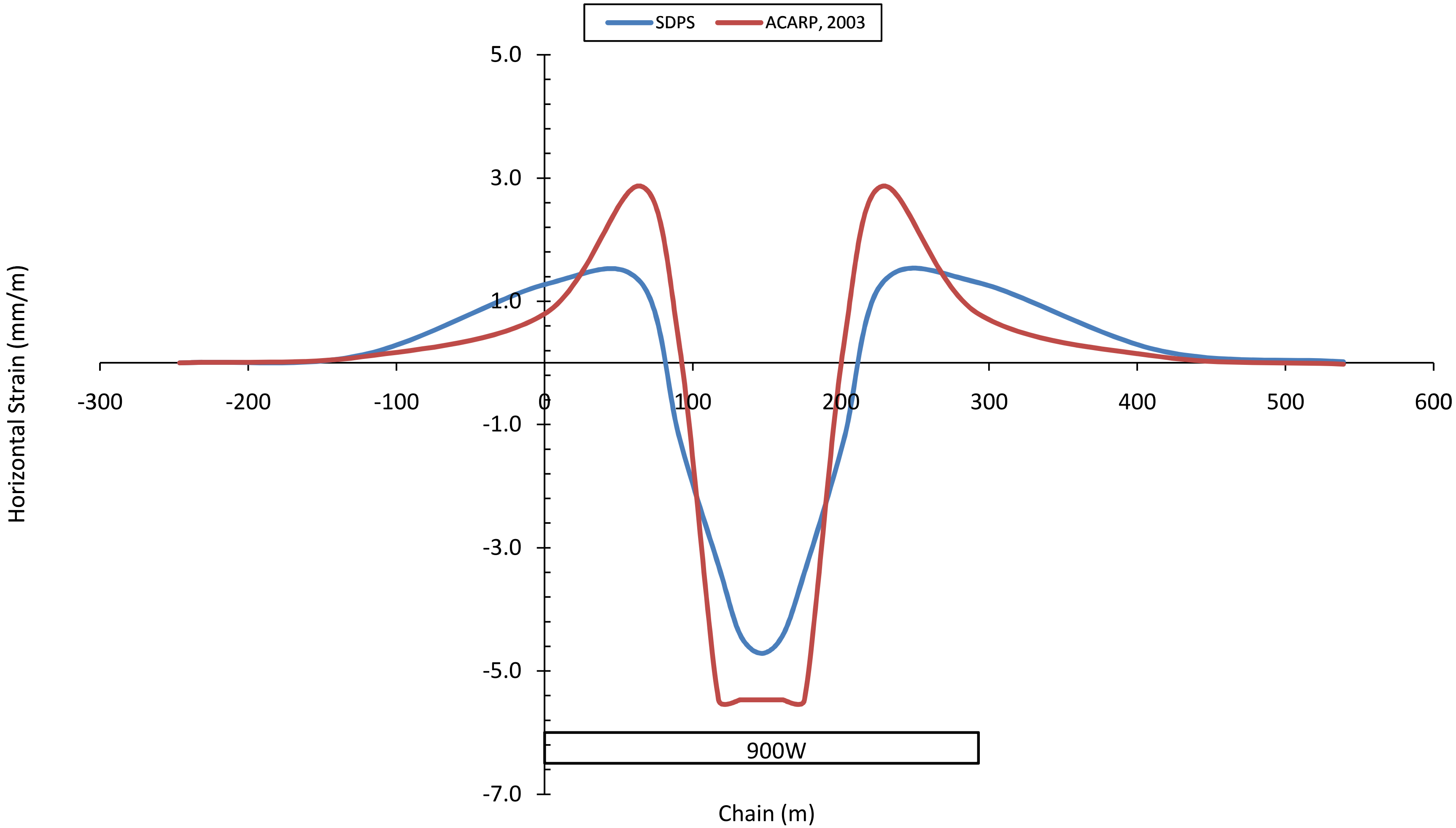
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1			
	Drawn:	S.Ditton					
	Date:	01.07.10	Title:	SDPS Model Calibration Results v. ACARP, 2003 Horizontal Strain Profile (U95%CL) along XL 1 above the Angus Place Longwalls 910 to 980 - see Figure 1 for Location			
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS		Figure No:	15c



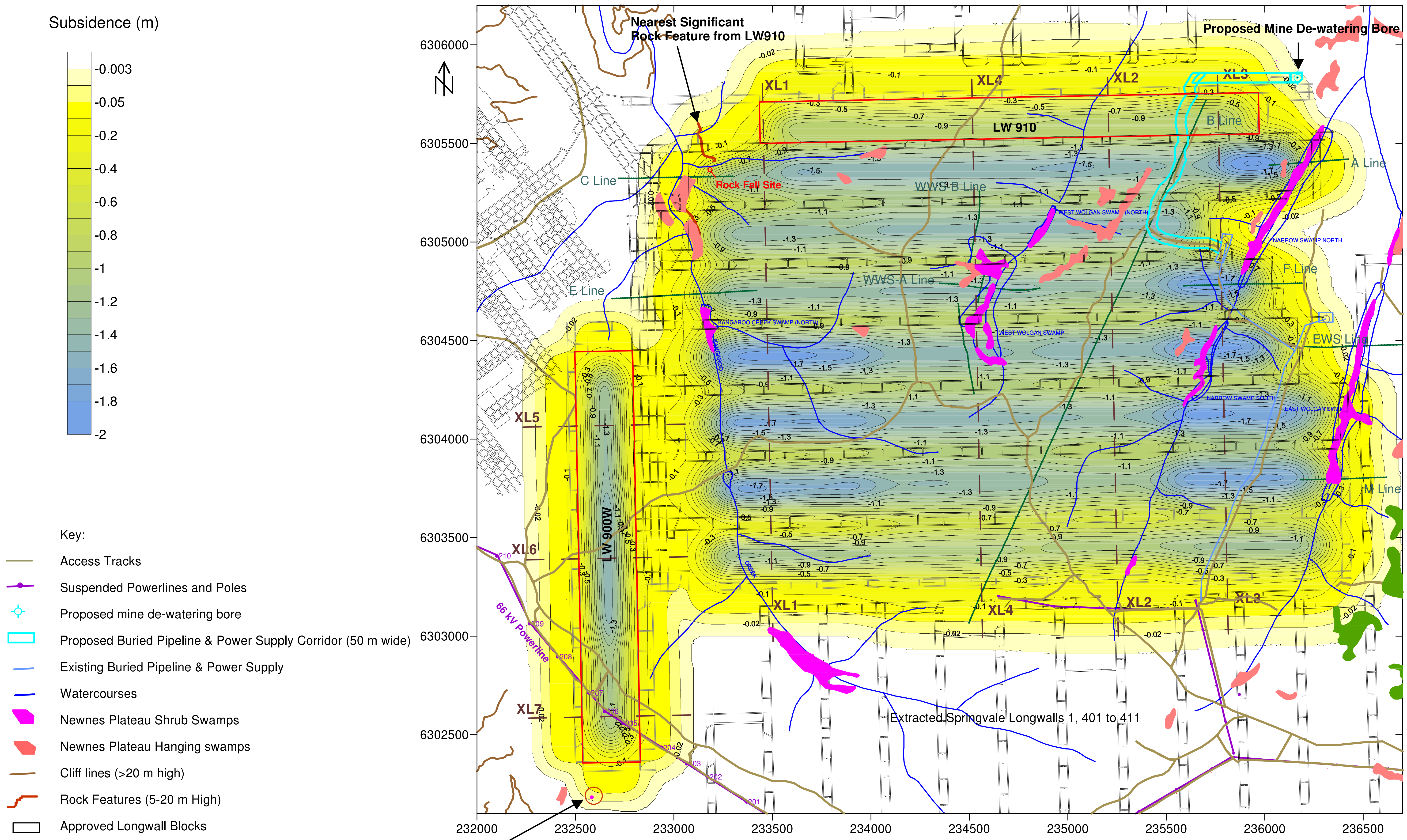
DgS	Engineer: S.Ditton	Client:	Centennial Angus Place Colliery ANP-001/1		
	Drawn: S.Ditton				
	Date: 01.02.10	Title:	SDPS Model Calibration Results v. ACARP, 2003 Subsidence Profile (U95%CL) along XL 6 above the Angus Place Longwall Panel 900W - see Figure 1 for Location		
	Ditton Geotechnical Services Pty Ltd	Scale:	NTS	Figure No:	16a



DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-001/1		
	Drawn:	S.Ditton				
	Date:	01.02.10	Title:	SDPS Model Calibration Results v. ACARP, 2003 Tilt Profile (U95%CL) along XL 6 above the Angus Place Longwall Panel 900W - see Figure 1 for Location		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	16b



DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-001/1			
	Drawn:	S.Ditton					
	Date:	01.02.10	Title:	SDPS Model Calibration Results v. ACARP, 2003 Horizontal Strain Profile (U95%CL) Along XL 6 above the Angus Place Longwall Panel 900W - see Figure 1 for Location			
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	16c	

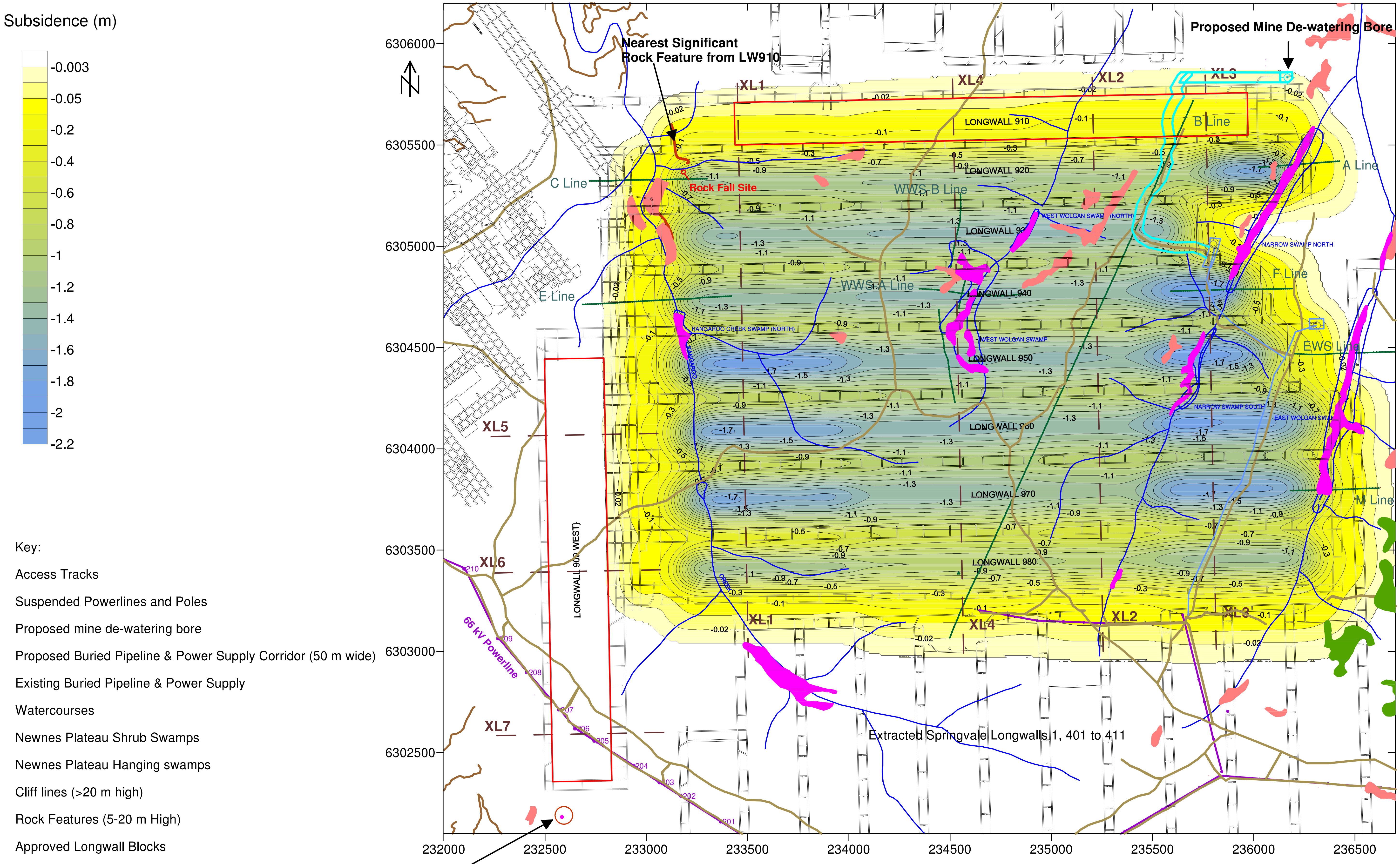


Nearest Significant Rock Feature from LW900W

Key:

- Access Tracks
- Suspended Powerlines and Poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging swamps
- Cliff lines (>20 m high)
- Rock Features (5-20 m High)
- Approved Longwall Blocks
- Proposed Longwalls
- A Line — Installed Subsidence Lines
- XL 1 — Subsidence Model Prediction Cross Lines

DgS Ditton Geotechnical Services Pty Ltd				
Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1	
Drawn:	S.Ditton			
Date:	14.08.10	Title:	Predicted Worst-case Cumulative Final Subsidence Contours for the Proposed Longwall Layout (900W - 910) Finishing 100m to east and the Approved Longwall Layout (920 - 980)	
		Scale:	1:18,000 (A3)	Figure No: 17a

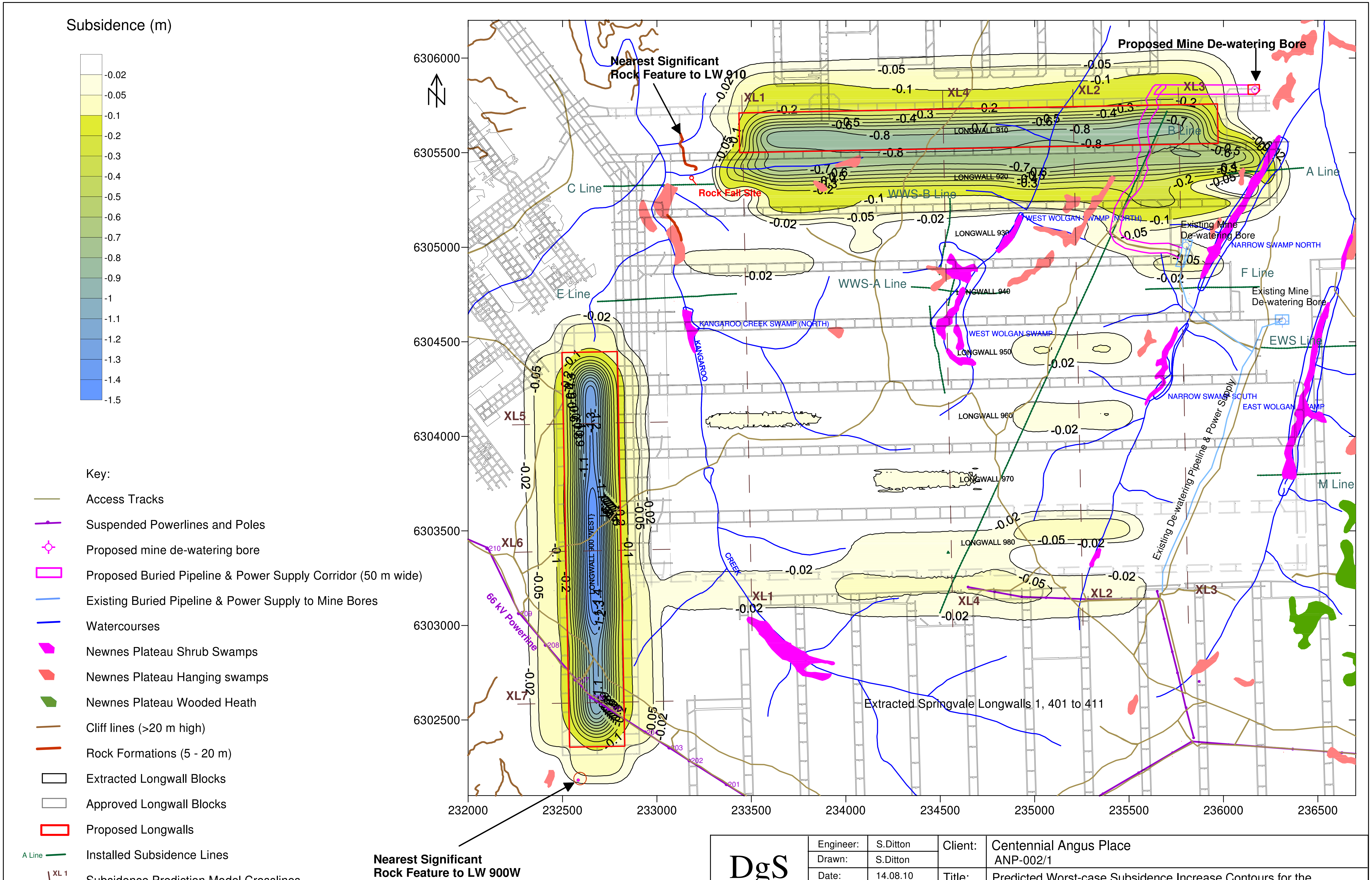


Key:

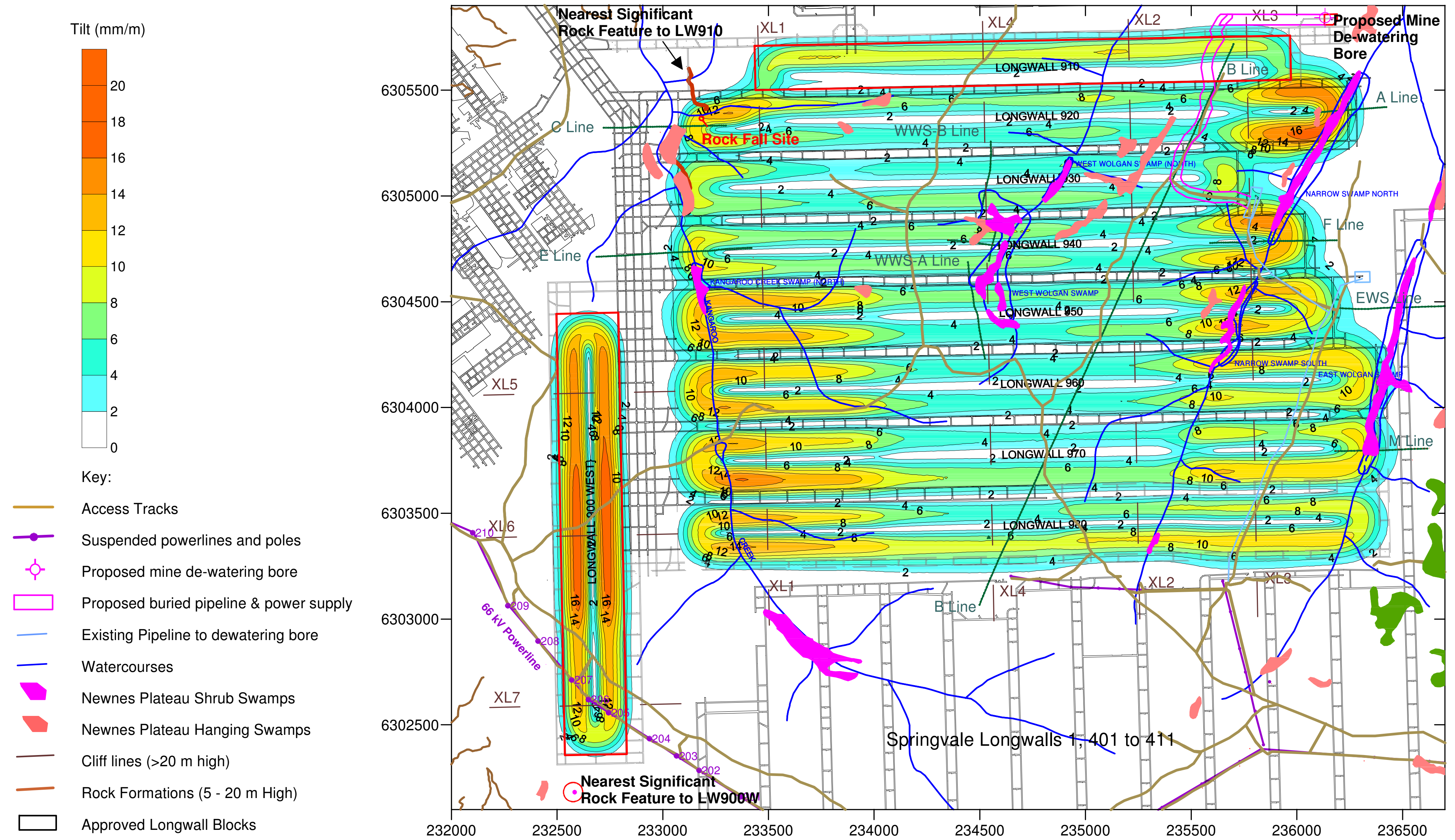
- Access Tracks
- Suspended Powerlines and Poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging swamps
- Cliff lines (>20 m high)
- Rock Features (5-20 m High)
- Approved Longwall Blocks
- Proposed Longwalls
- A Line — Installed Subsidence Lines
- XL 1 — Subsidence Model Prediction Cross Lines

Nearest Significant Rock Feature from LW900W

DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
Ditton Geotechnical Services Pty Ltd	Drawn:	S.Ditton		
	Date:	14.08.10	Title:	Predicted Worst-case Final Subsidence Contours for the the Approved Longwall Layout (920 - 980) Only
			Scale:	1:18,000 (A3) — Figure No: 17b



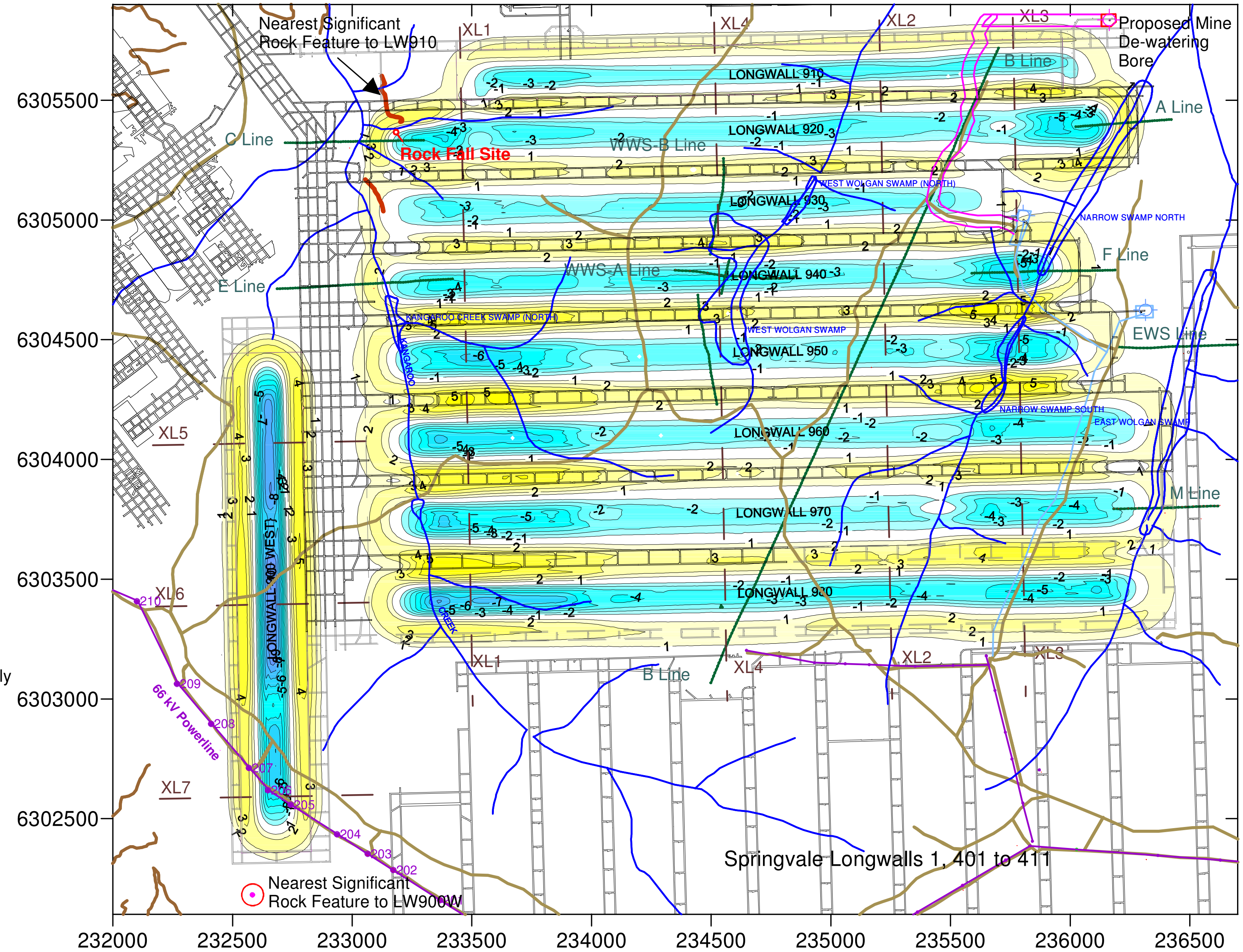
	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1	
DgS	Drawn:	S.Ditton			
	Date:	14.08.10	Title:	Predicted Worst-case Subsidence Increase Contours for the Proposed Longwalls 900W and 910 (with finish located 100 m east of current finish position)	
Ditton Geotechnical Services Pty Ltd			Scale:	1:18,000 (A3)	Figure No: 17c



DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1		
	Drawn:	S.Ditton				
	Date:	14.08.10	Title:	Predicted Worst-case Cumulative Final Principal Tilt Contours for the Proposed Longwall Layout (900W - 910) and the Approved Longwall Layout (920 - 980)		
	Ditton Geotechnical Services Pty Ltd		Scale:	1:25,000	Figure No:	18

Strain (mm/m)

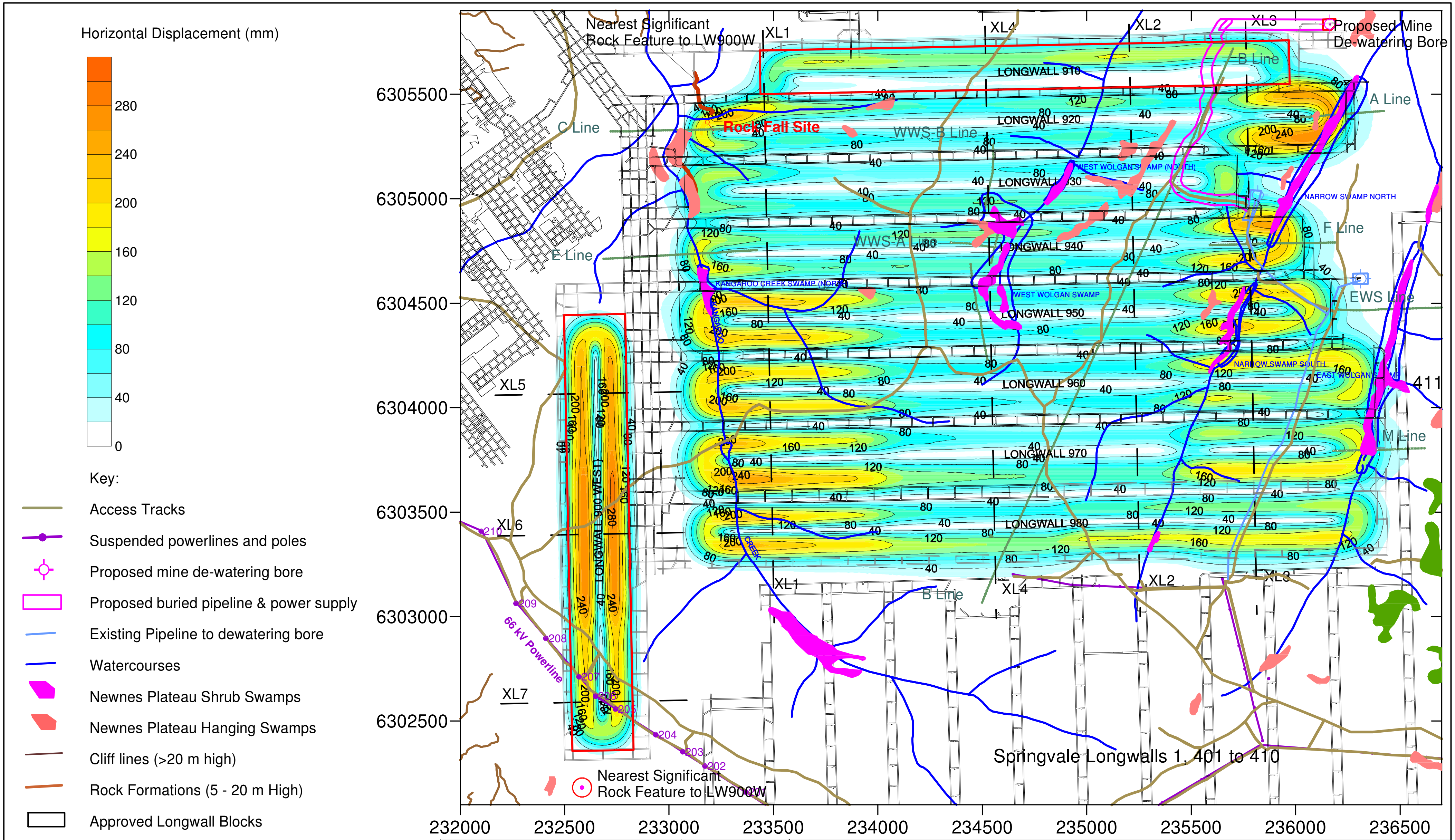
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12



Key:

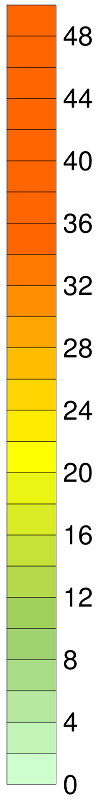
- Access Tracks
- Suspended powerlines and poles
- Proposed mine de-watering bore
- Proposed buried pipeline & power supply
- Existing Pipeline to dewatering bore
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging Swamps
- Cliff lines (>20 m high)
- Rock Formations (5 - 20 m High)
- Approved Longwall Blocks
- Proposed Longwalls
- A Line — Installed Subsidence Lines
- XL 1 — Subsidence Prediction Model Cross Lines

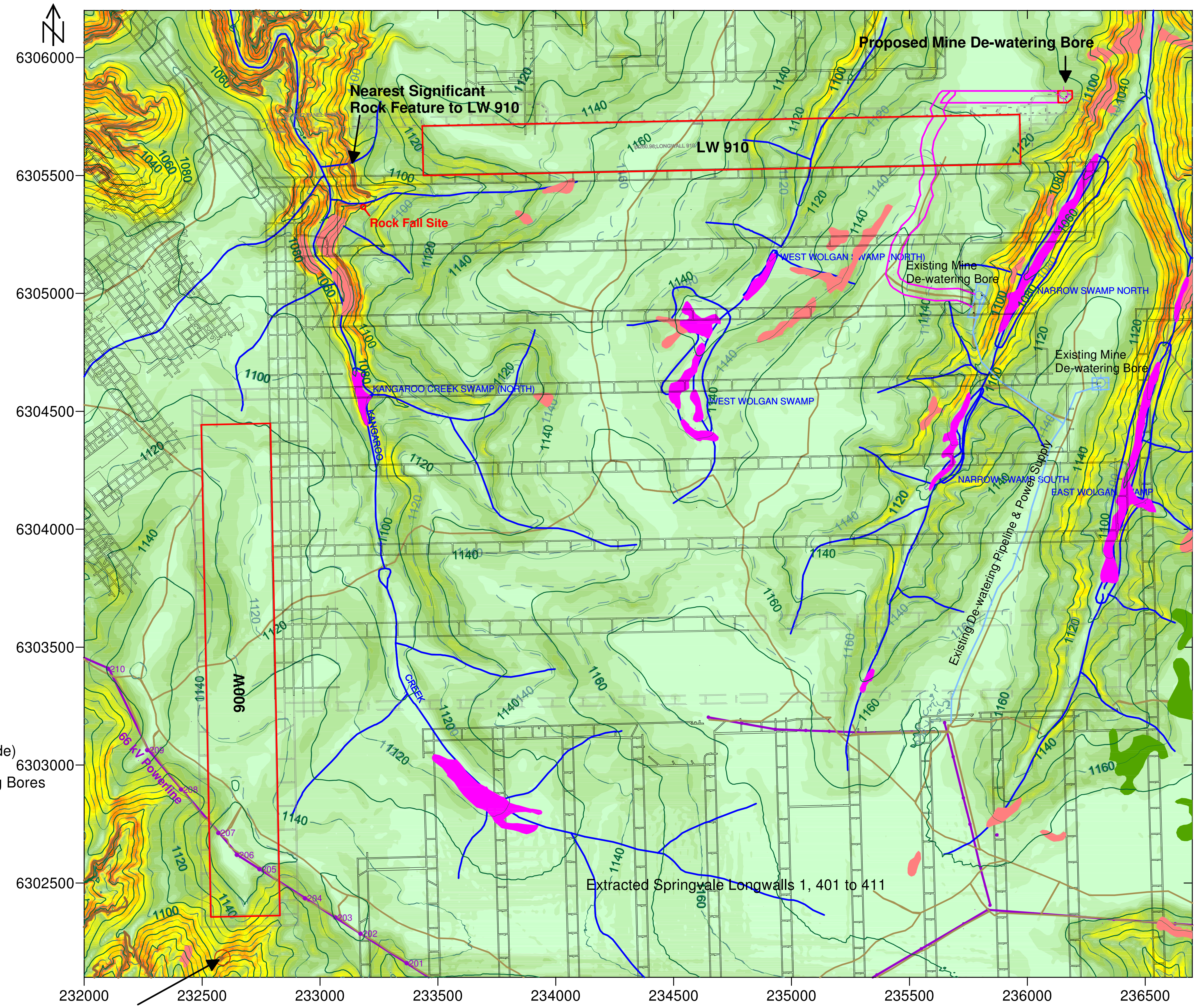
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton		
	Date:	01.03.10	Title:	Predicted Worst-case Cumulative Final Principal Horizontal Strain Contours for the Proposed Longwall Layout (900W - 910) and the Approved Longwall Layout (920 - 980)
	Ditton Geotechnical Services Pty Ltd		Scale:	1:25,000
			Figure No:	19



DgS Ditton Geotechnical Services Pty Ltd	Engineer: S.Ditton Drawn: S.Ditton Date: 14.08.10	Client:	Centennial Angus Place ANP-002/1
		Title:	Predicted Worst-case Cumulative Final Principal Horizontal Displacement Contours for the Proposed Longwall Layout (900W - 910) and the Approved Longwall Layout (920 - 980)
		Scale:	1:25,000 — Figure No: 20

Surface Gradient (o)



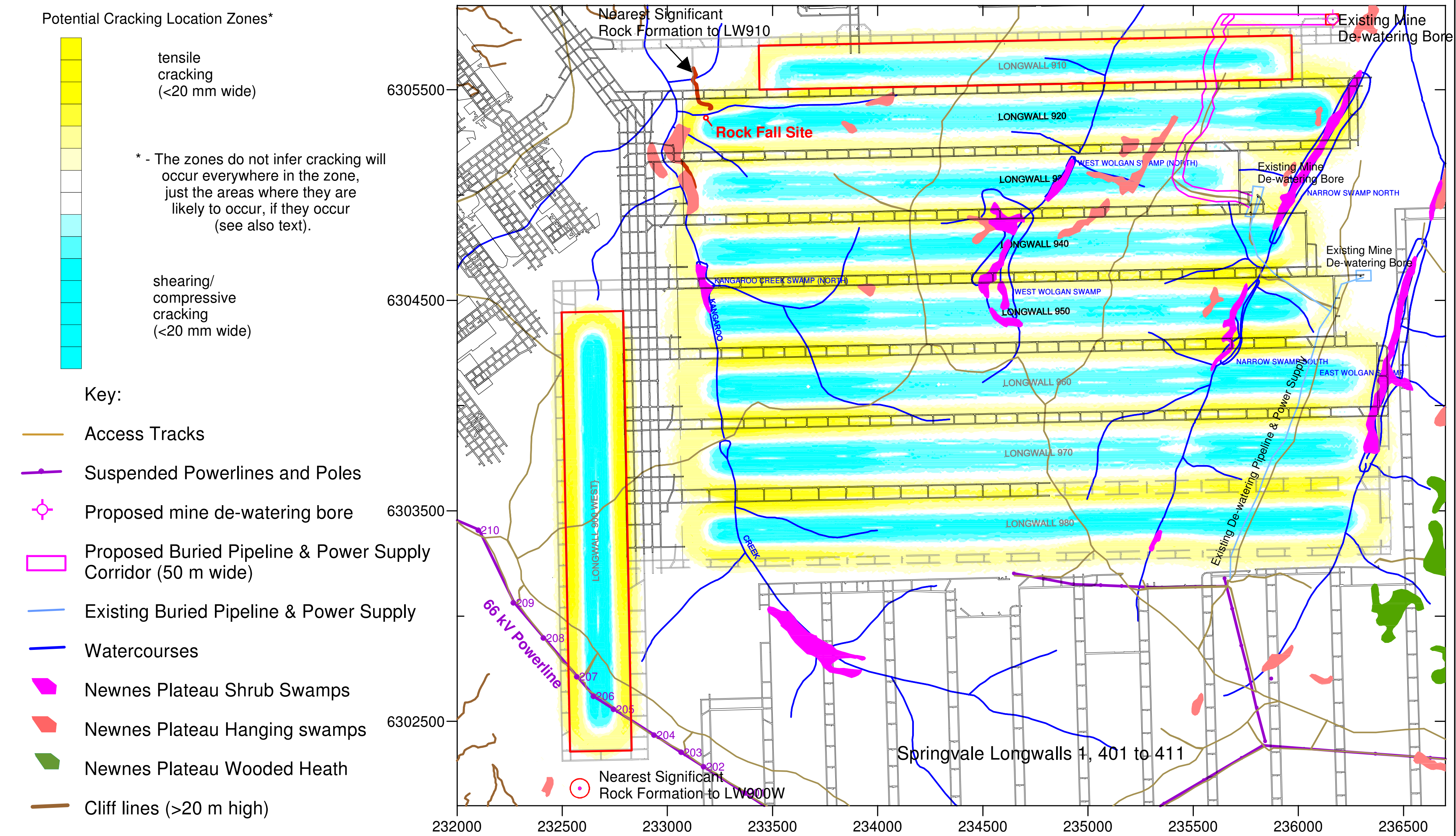


Nearest Significant Rock Feature to LW 900W

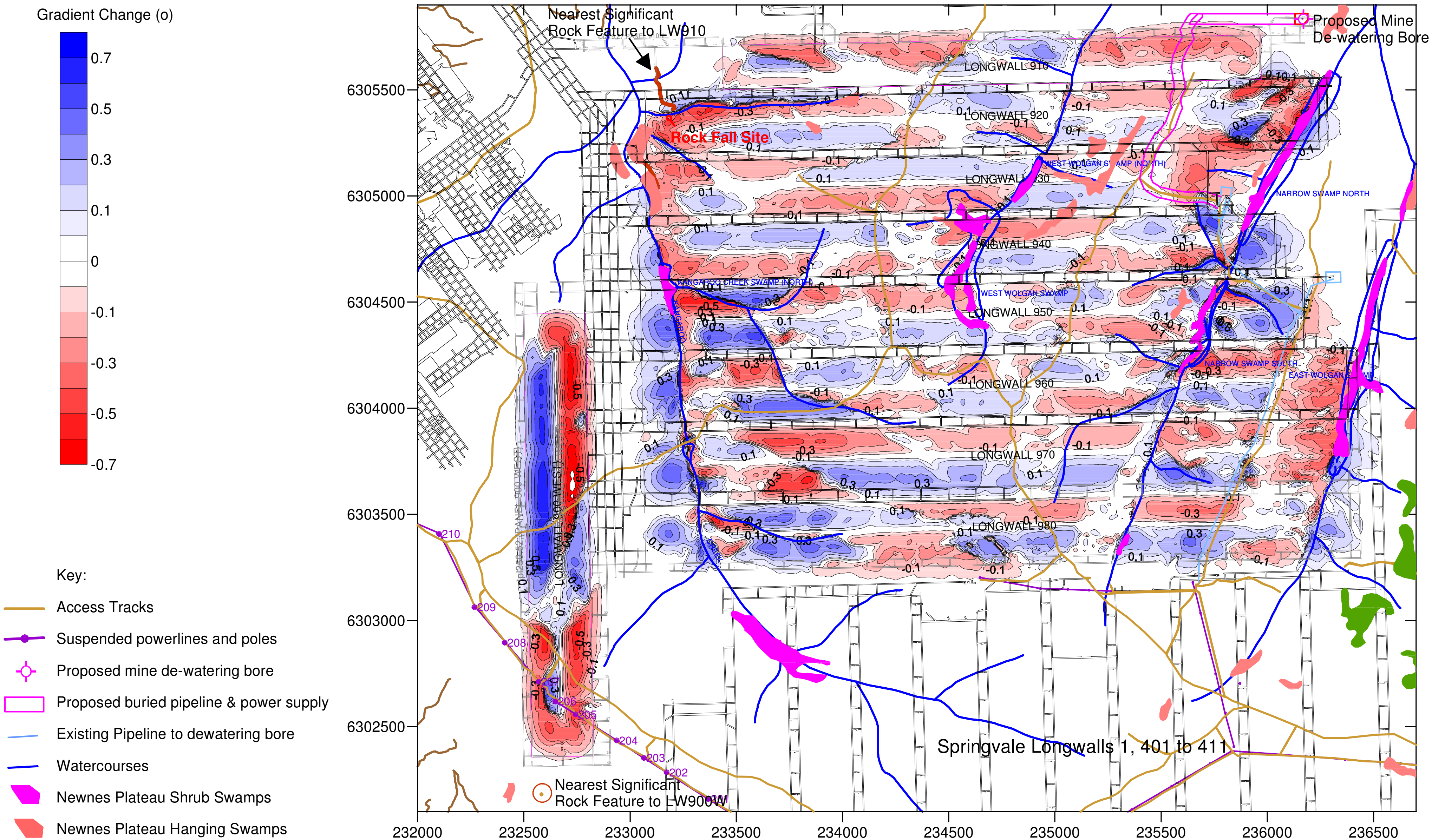
Key:

- Access Tracks
- Suspended powerlines and poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply to Mine De-watering Bores
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging swamps
- Newnes Plateau Wooded Heath
- Cliff lines (>20 m high)
- Rock Formations (5-20 m high)
- Approved Longwalls
- Proposed Longwalls
- Pre-Mining Level Contours
- Post-MIning Level Contours

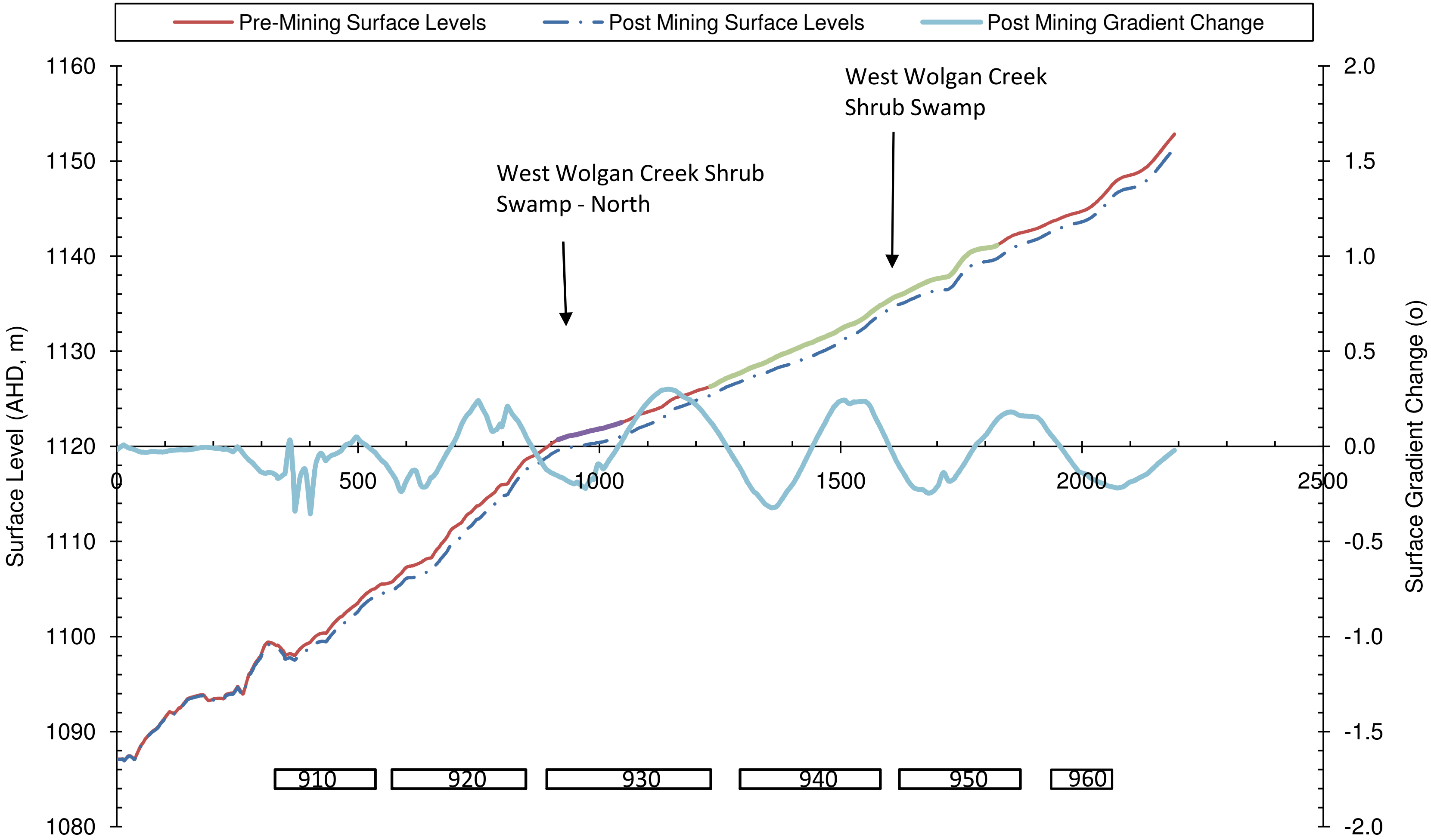
DgS Ditton Geotechnical Services Pty Ltd	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1	
	Drawn:	S.Ditton			
	Date:	14.08.10	Title:	Predicted Cumulative Post-Mining Surface Levels & Gradients due to the Proposed Longwall Layout (900W - 910) and the Approved Layout (920 - 980)	
			Scale:	1:18,000 (A3)	Figure No: 21



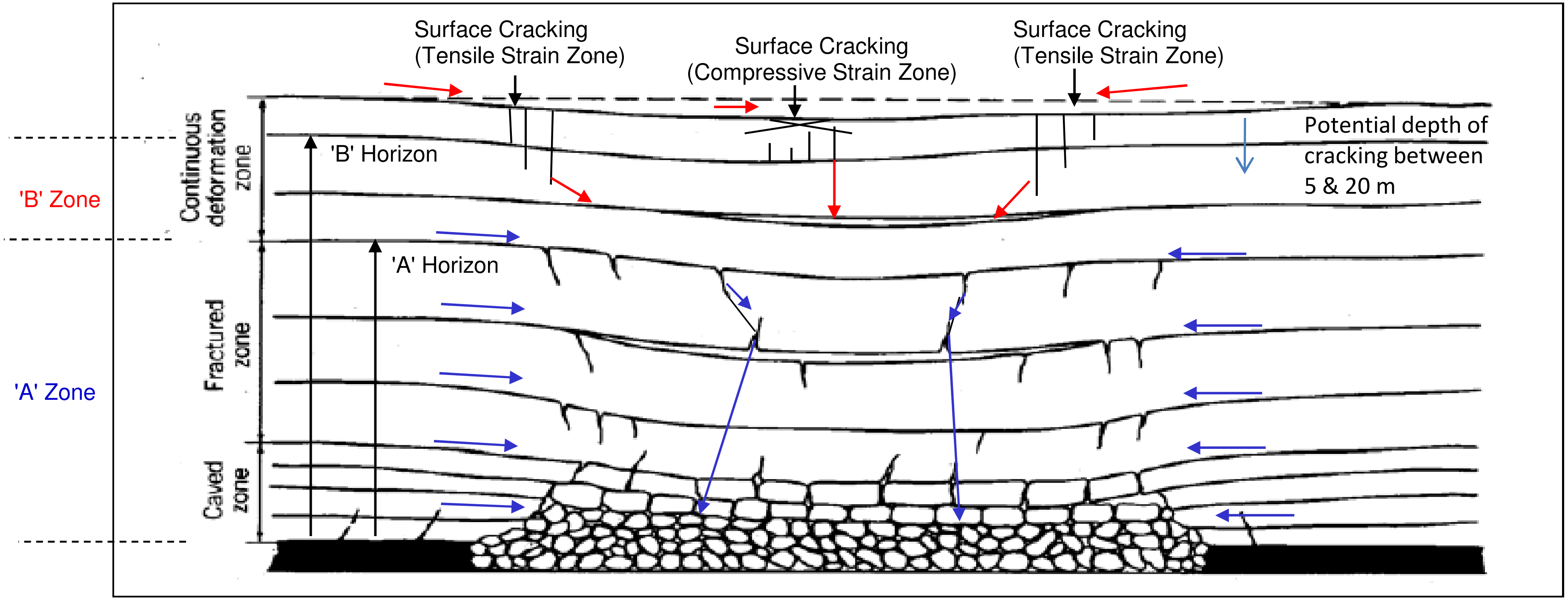
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton	Title:	Potential Location Zones for Tensile & Compressive Cracking above the Proposed Longwall Layout (900W - 910) and the Approved Longwall Layout (920 - 980)
	Date:	14.08.10		
Ditton Geotechnical Services Pty Ltd			Scale:	1:25,000
			Figure No:	22



DgS Ditton Geotechnical Services Pty Ltd	Engineer: S.Ditton	Client:	Centennial Angus Place ANP-002/1	
	Drawn: S.Ditton			
	Date: 27.02.10	Title:	Predicted Surface Gradient Change Contours due to the Proposed Longwall Layout (900W - 910) and the Approved Longwall Layout (920 to 980)	
		Scale:	1:25,000	Figure No: 23



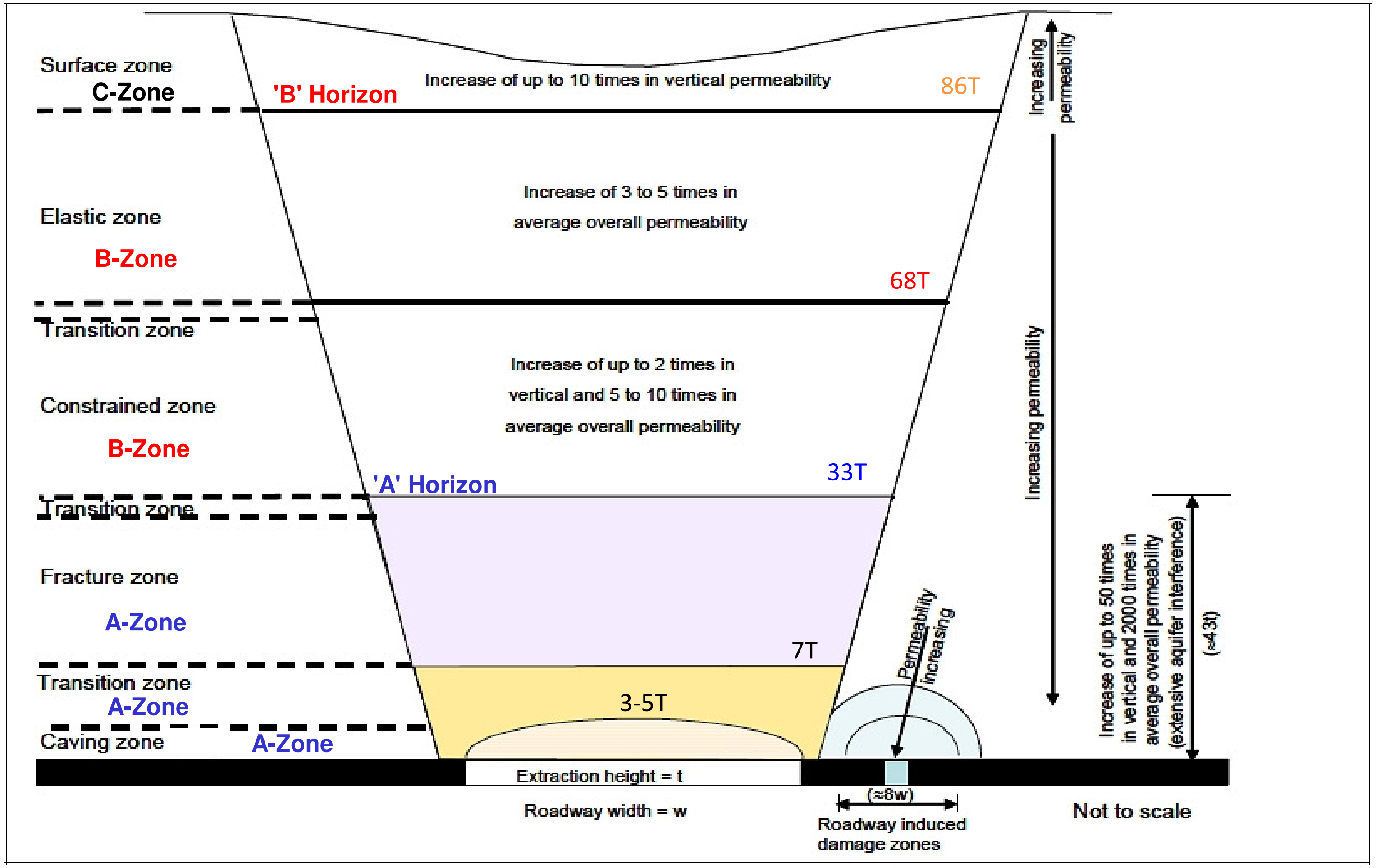
DgS	Engineer: S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1
	Drawn: S.Ditton		
	Date: 04.08.10	Title:	Predicted Pre and Post Mining Surface Levels along West Wolgan Creek due to CAPC LWs 910 to 980
	Ditton Geotechnical Services Pty Ltd	Scale:	NTS
		Figure No:	24



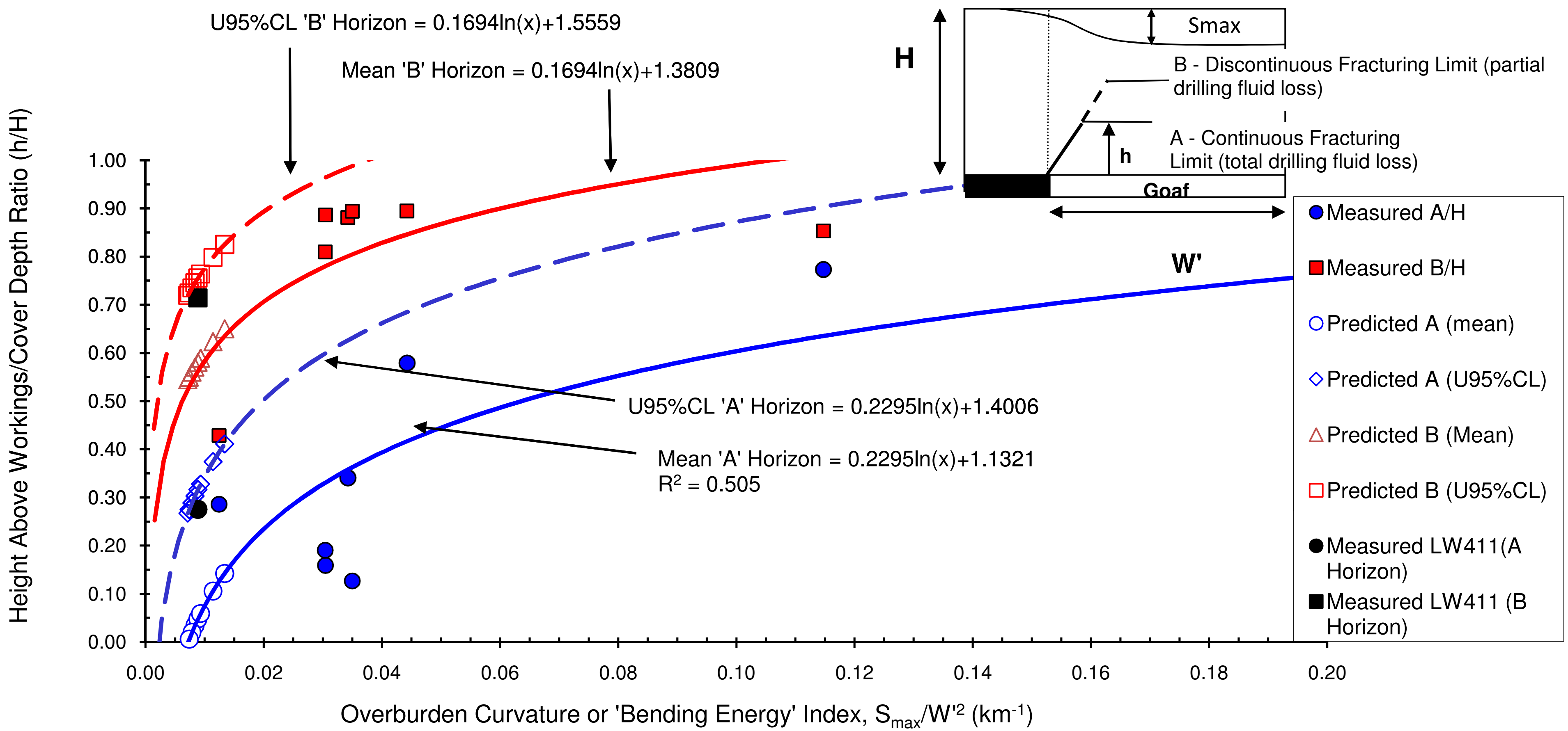
Zones in the Overburden According to Peng and Chiang (1984)

Key
'A' Horizon - Top of Zone of Continuous Crack Connection to Workings (**Whittaker and Reddish,1989**)
'B' Horizon - Top of Zone Of Discontinuous Crack Connection to Workings (**Whittaker and Reddish, 1989**)
Surface water flow path   Sub-surface water flow path

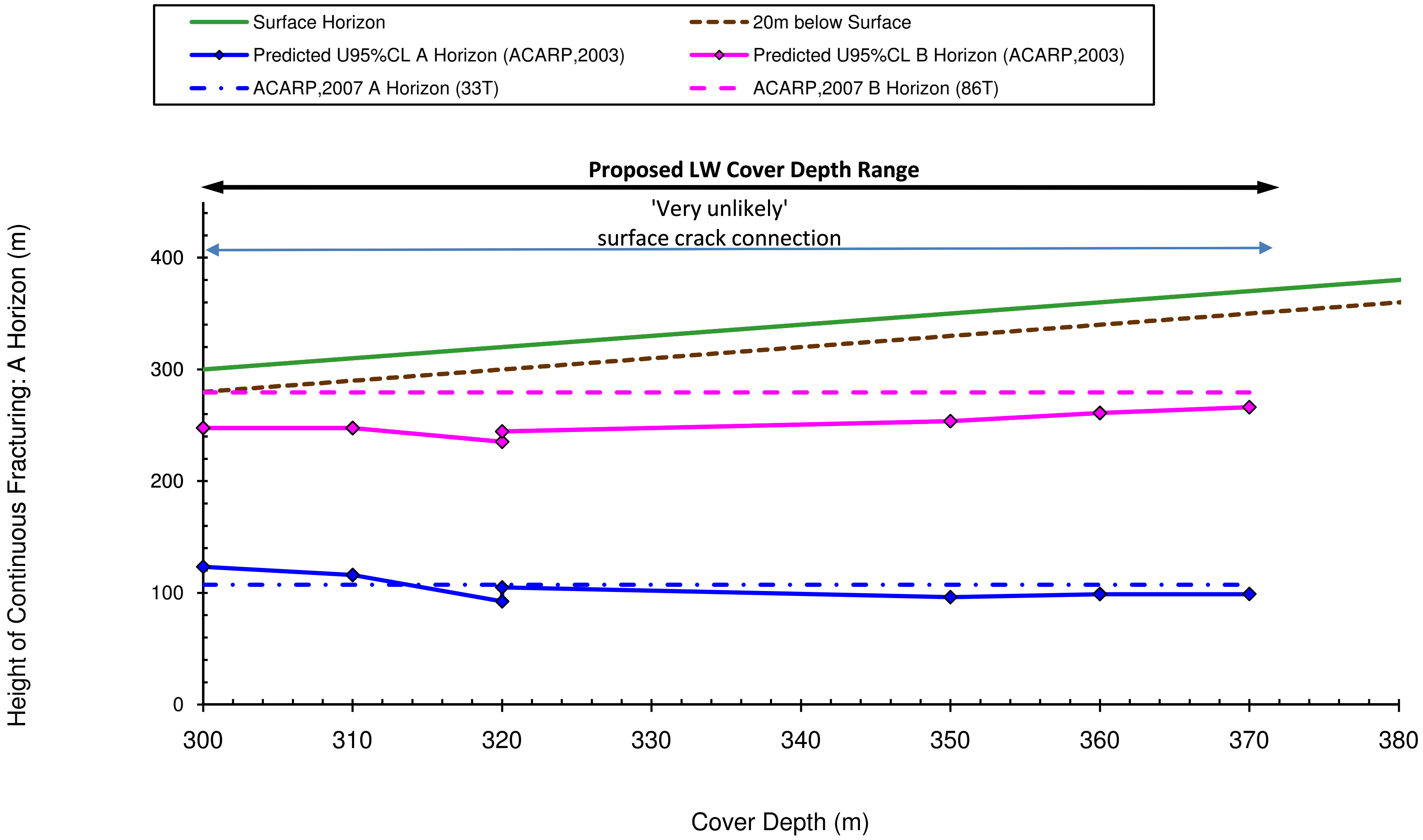
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton		
	Date:	12.03.10	Title:	Schematic Model of Overburden Fracture Zones Above Longwall Panels
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS
			Figure No:	25



DgS	Engineer: S.Ditton		Client:	Centennial Angus Place ANP-002/1
	Drawn: S.Ditton			
	Date: 12.03.10		Title:	Schematic Model of the Hydrogeological Response at the Springvale Coal Mine (extract from **ACARP,2007** based on piezometric data above LW 411)
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS — Figure No: 26



DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place
	Drawn:	S.Ditton		ANP-002/1
	Date:	10.03.10	Title:	Continuous and Discontinuous Sub-Surface Fracture Heights above the Proposed Longwalls LW310 and 300W based on ACARP, 2003 and ACARP,2007
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS — Figure No: 27



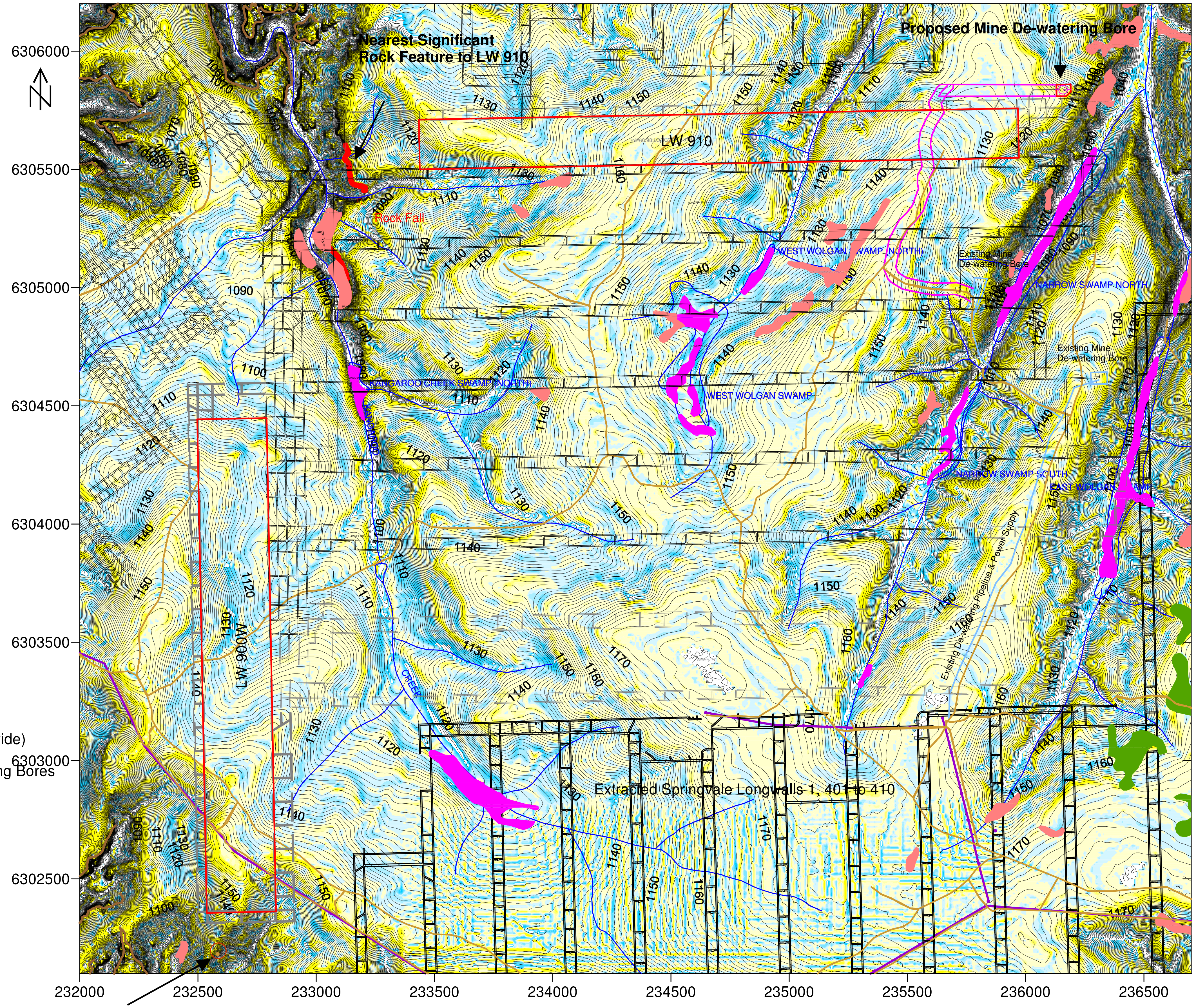
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place
	Drawn:	S.Ditton		ANP-002/1
	Date:	10.03.10	Title:	Predicted Sub-surface Fracture Height v. Cover Depth for the Proposed LWs 900W Extraction Panels (based on ACARP, 2003 Model)
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS Figure No: 28

Surface Curvature
(km-1)

3.5
2.5
1.5
0.5
-0.5
-1.5
-2.5
-3.5

Convex Surface

Concave Surface



**Nearest Significant
Rock Feature to LW 900W**

Key:

- Access Tracks
- Suspended powerlines and poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply to Mine De-watering Bores
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging swamps
- Newnes Plateau Wooded Heath
- Cliff lines (>20 m high)
- Rock Formations (5-20 m high)
- Approved Longwalls
- Proposed Longwalls
- 1140 Surface Level Contours (1m)
- Existing Potential Ponding Location (i.e. closed contour depression)

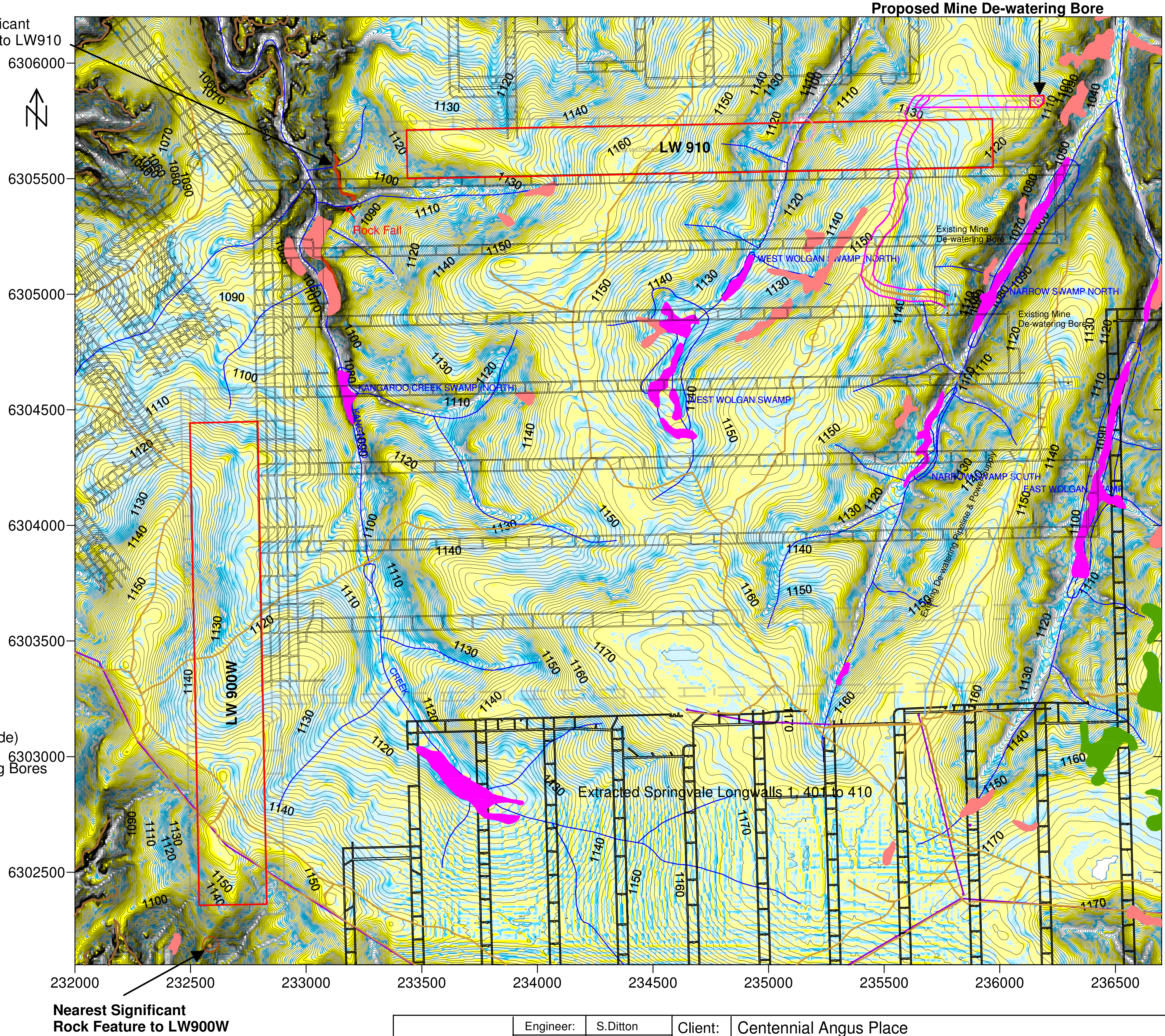
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton		
	Date:	22.03.10	Title:	Predicted Cumulative Pre-Mining Surface Ponding Potential due the Proposed Longwall Layout (900W - 910) and the Approved Longwall Layout (920 - 980)
Ditton Geotechnical Services Pty Ltd			Scale:	1:18,000 (A3)
			Figure No:	29a

Surface Curvature
(km-1)

3.5
2.5
1.5
0.5
-0.5
-1.5
-2.5
-3.5

Convex Surface

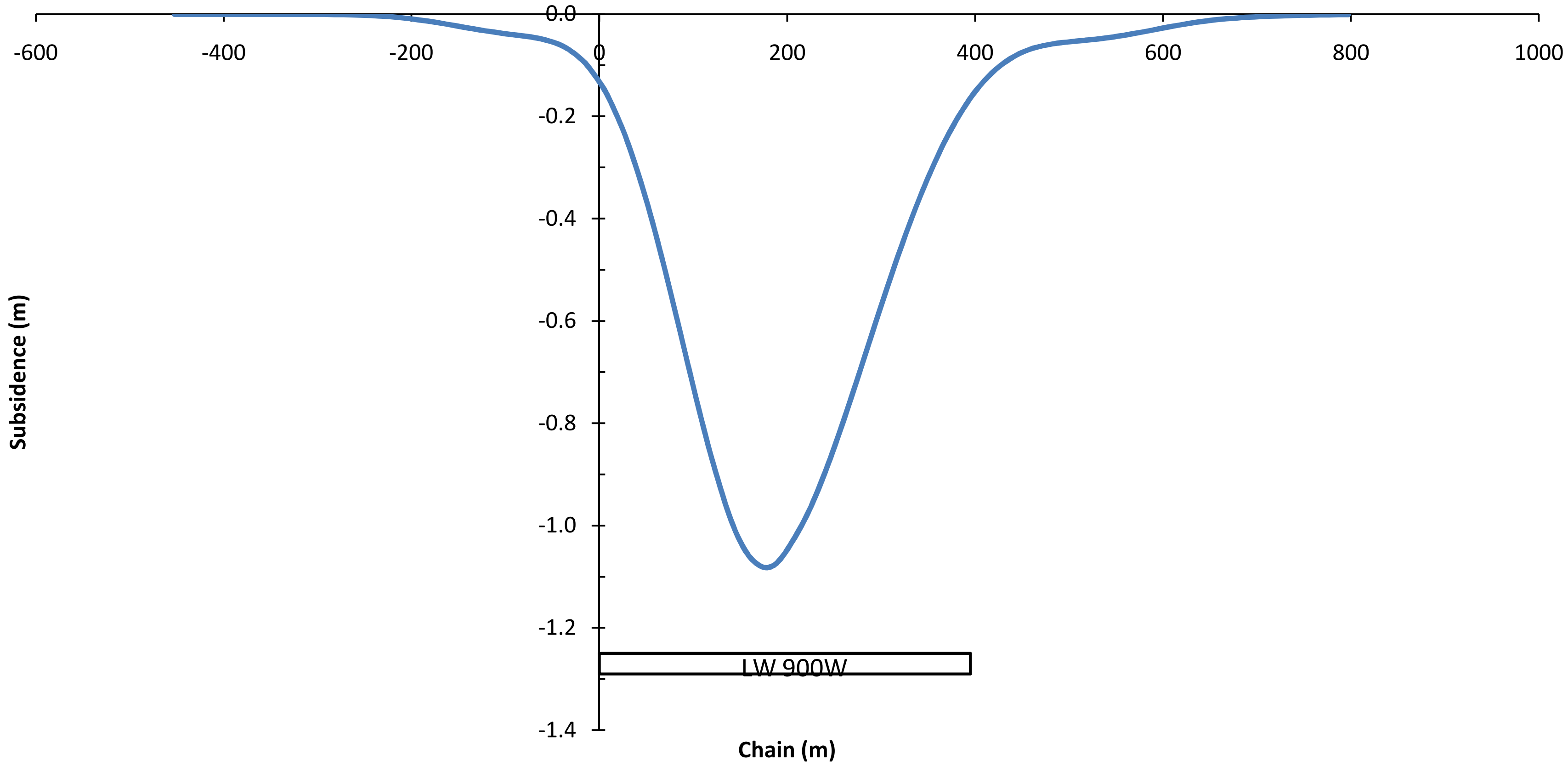
Concave Surface



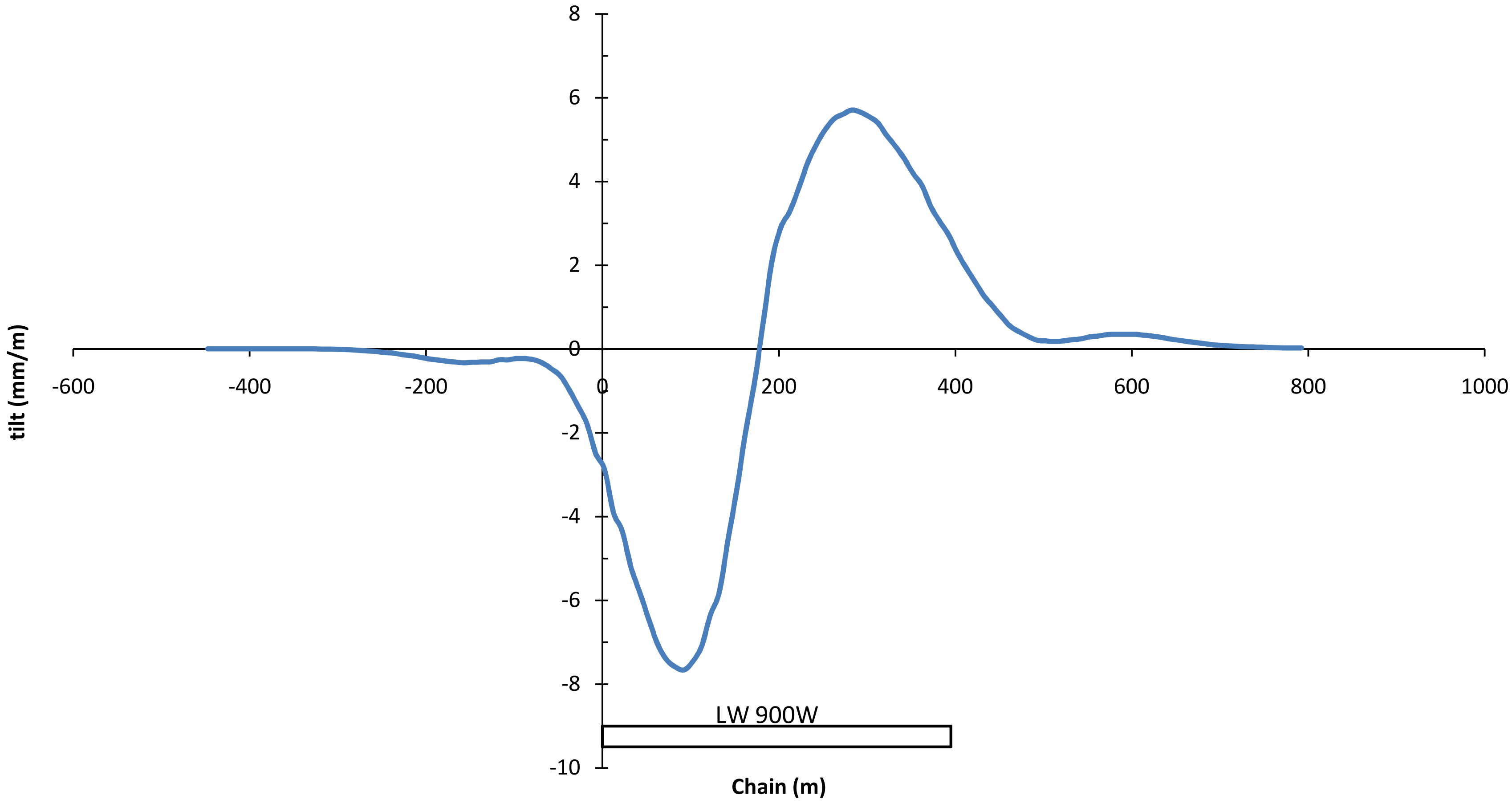
Key:

Access Tracks
Suspended powerlines and poles
Proposed mine de-watering bore
Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
Existing Buried Pipeline & Power Supply to Mine De-watering Bores
Watercourses
Newnes Plateau Shrub Swamps
Newnes Plateau Hanging swamps
Newnes Plateau Wooded Heath
Cliff lines (>20 m high)
Rock Formations (5-20 m high)
Approved Longwalls
Proposed Longwalls
1140 Surface Level Contours (1m)
Potential Ponding Location
(i.e. closed contour depression)

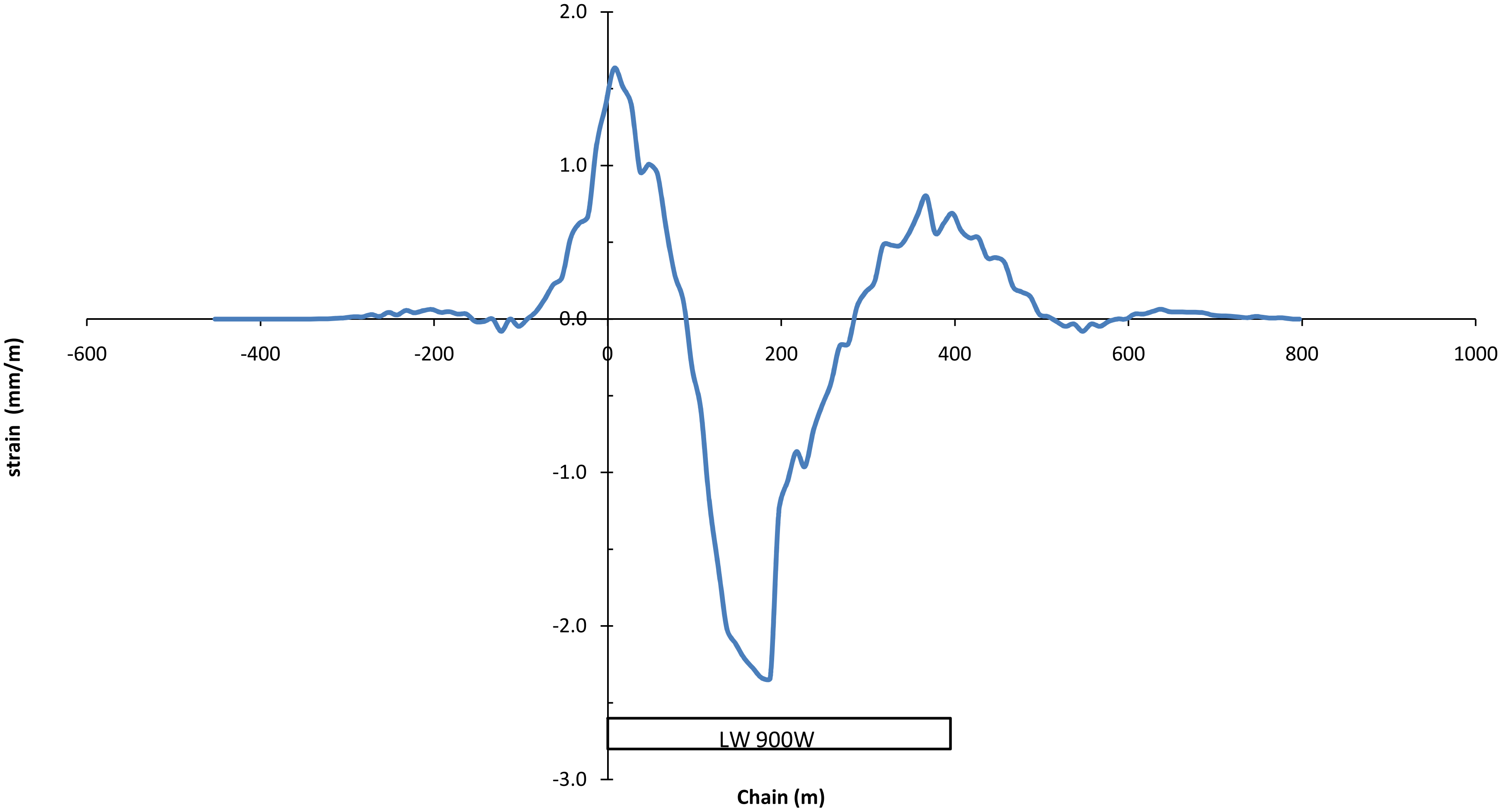
DgS Ditton Geotechnical Services Pty Ltd	Engineer: S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn: S.Ditton	Title:	Predicted Cumulative Post-Mining Surface Ponding Potential due the Proposed Longwall Layout (900W - 910) and the Approved Longwall Layout (920 - 980)
	Date: 14.08.10		
		Scale:	1:18,000 (A3) — Figure No: 29b



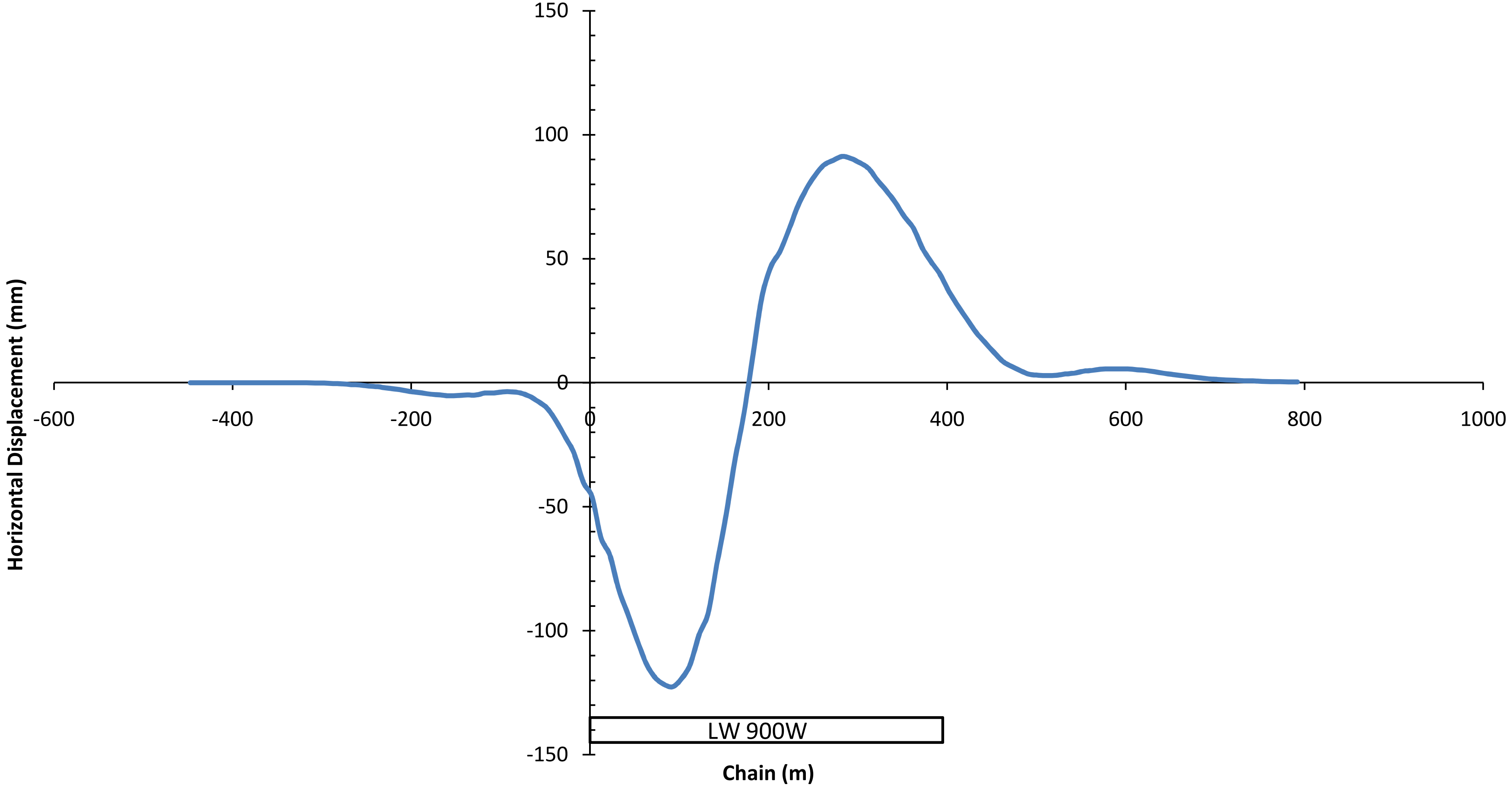
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1			
	Drawn:	S.Ditton					
	Date:	01.02.10	Title:	Predicted Worst-case Subsidence Profile along the Integral Energy Easement due to Longwall 900W			
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	30a	



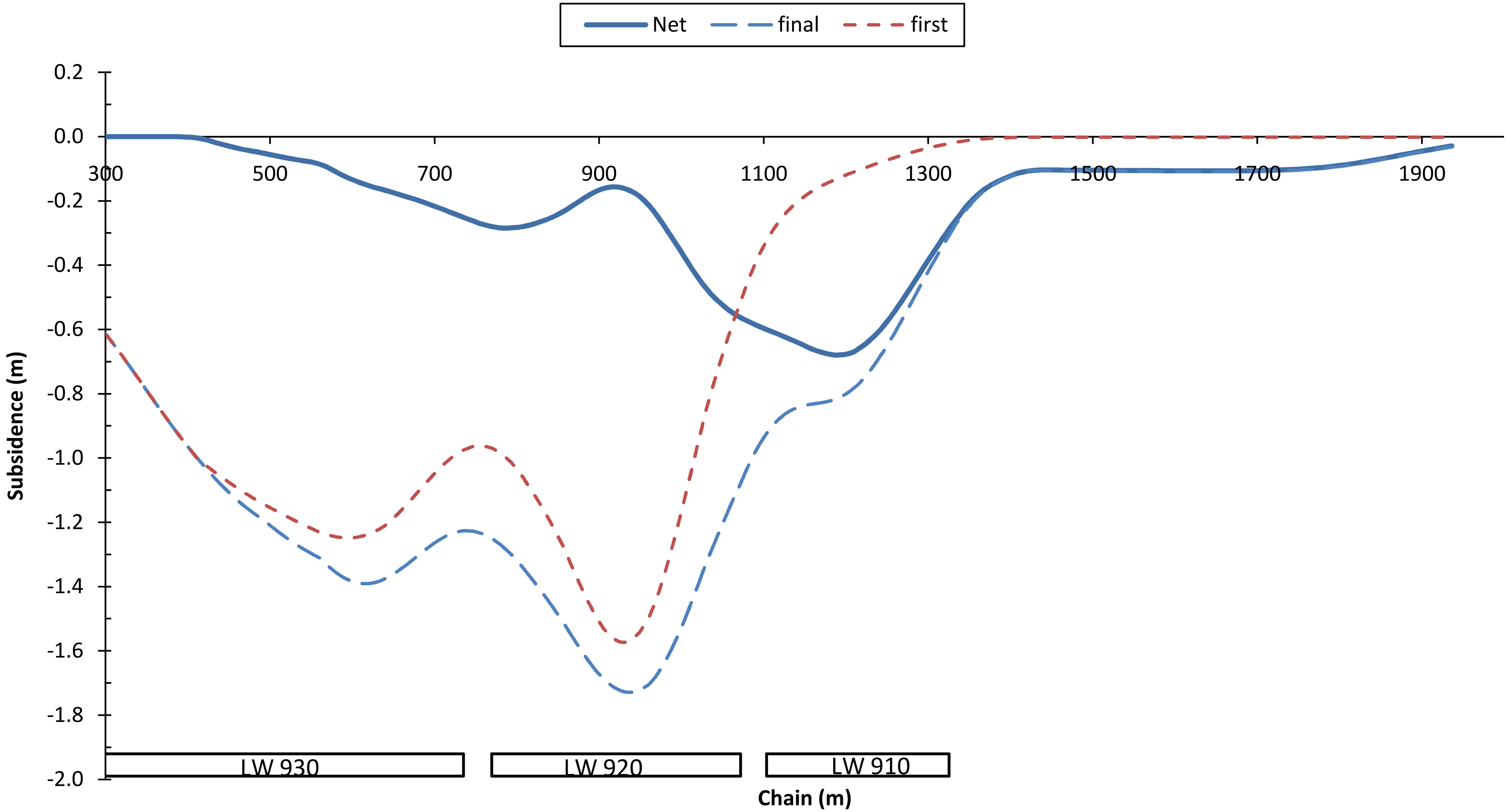
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery			
	Drawn:	S.Ditton		ANP-002/1			
	Date:	01.02.10	Title:	Predicted Worst-case Tilt Profile along the Integral Energy Easement due to Longwall 900W			
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	30b	



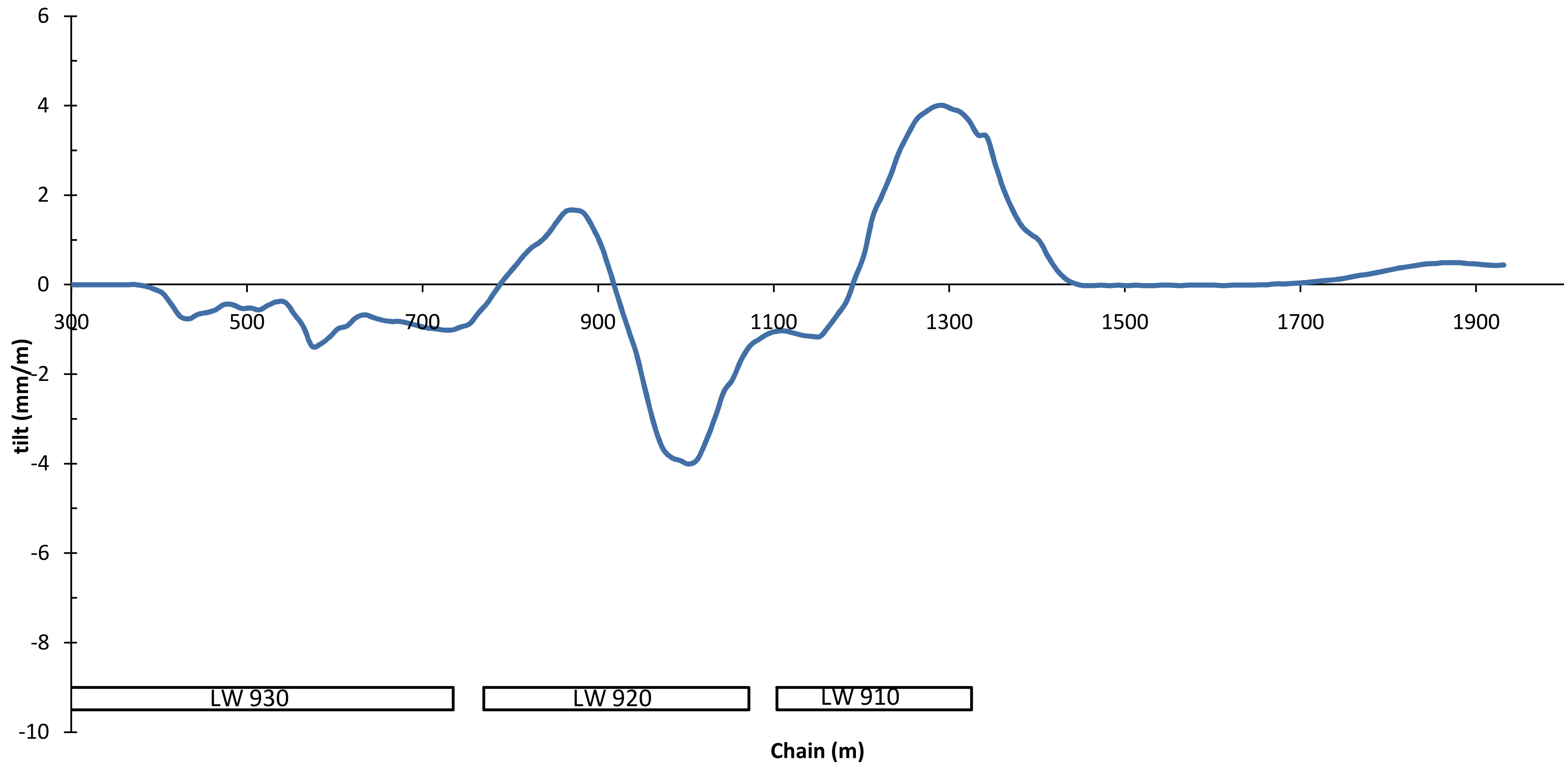
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1			
	Drawn:	S.Ditton					
	Date:	01.02.10	Title:	Predicted Worst-case Horizontal Strain Profile along the Integral Energy Easement due to Longwall 900W			
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS		Figure No:	30c



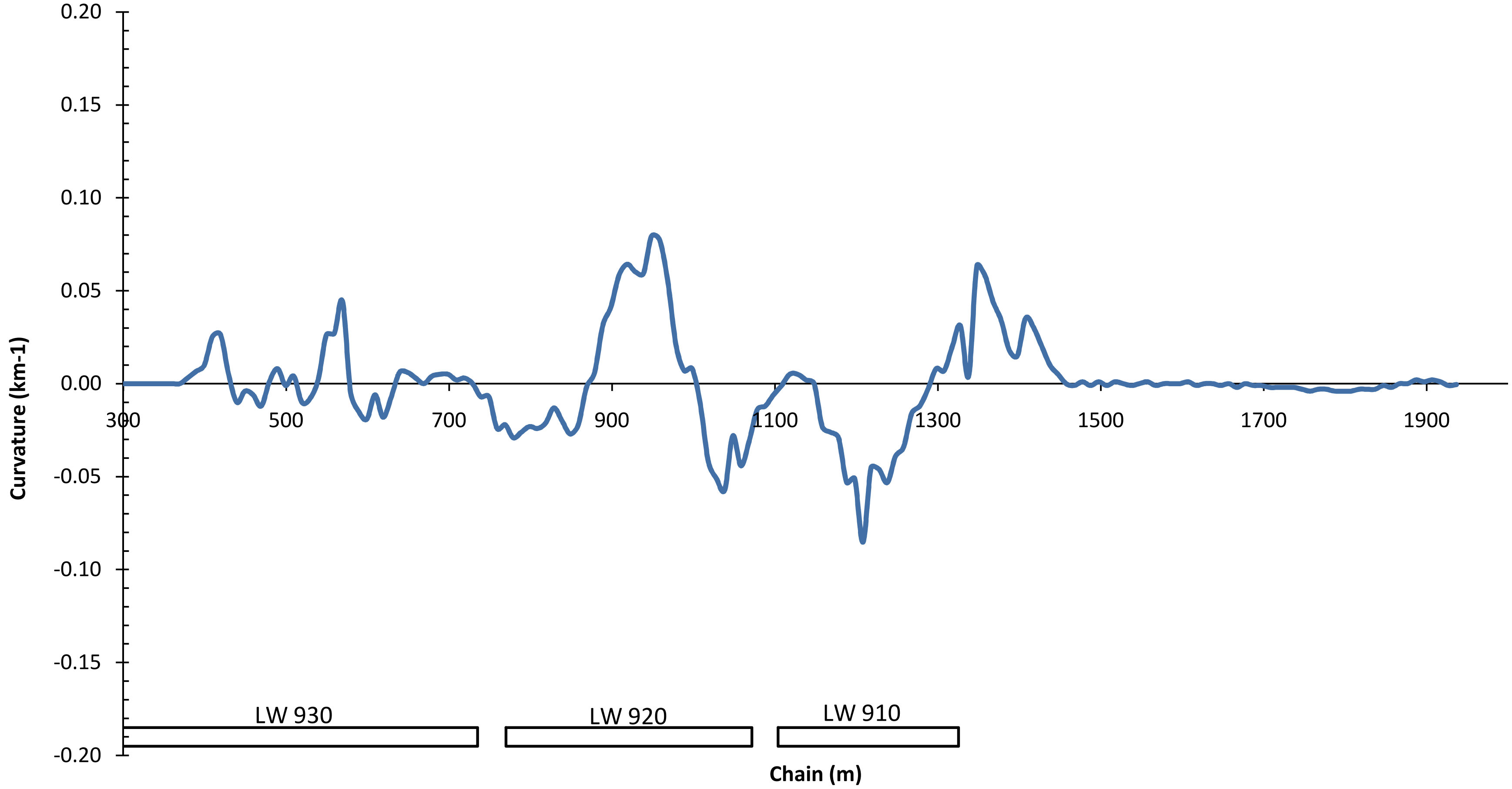
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1
	Drawn:	S.Ditton		
	Date:	01.02.10	Title:	Predicted Worst-case Horizontal Displacement Profile along the Integral Energy Easement due to Longwall 900W
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS
			Figure No:	30d



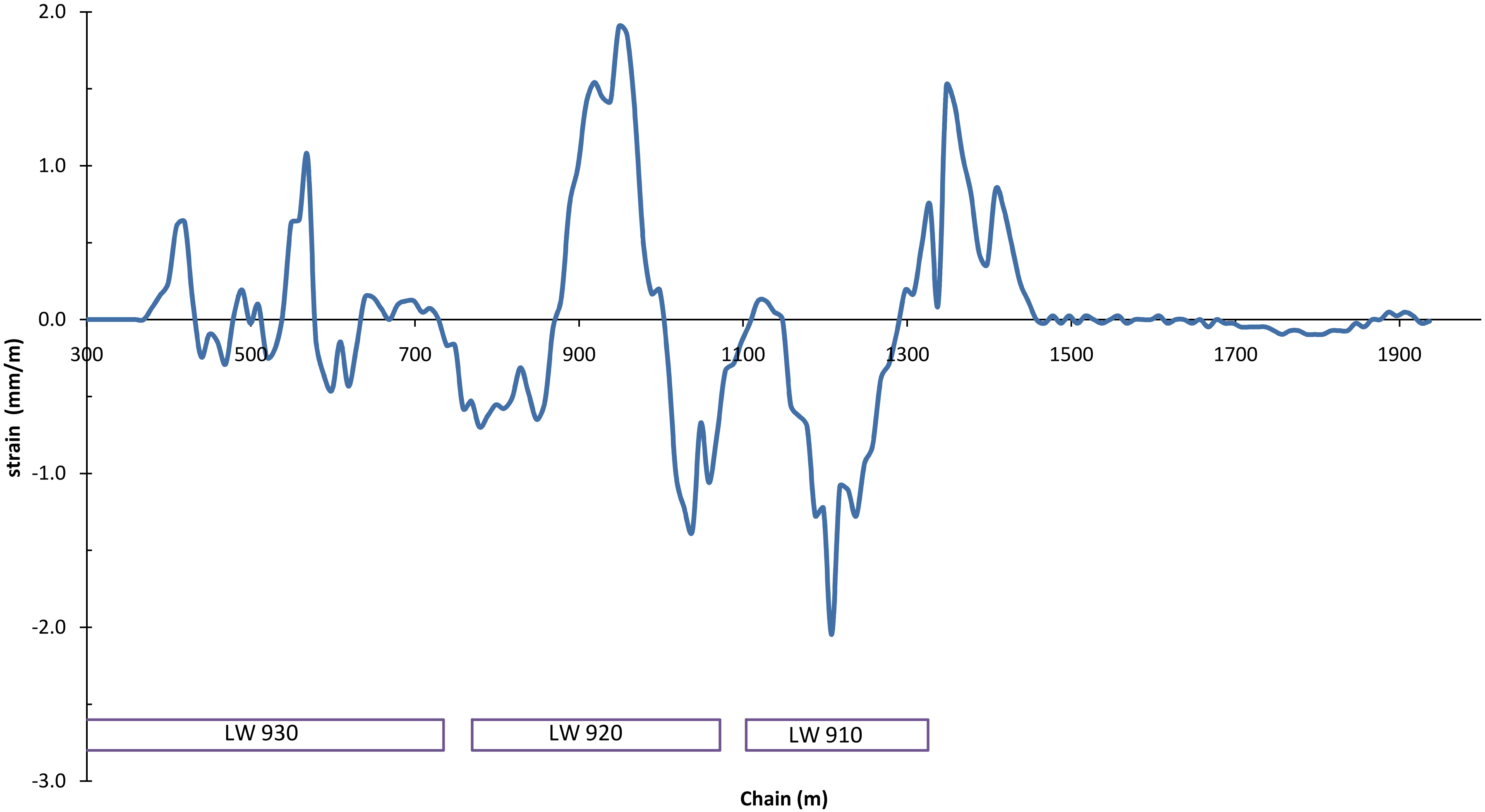
DgS	Engineer: S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1
	Drawn: S.Ditton		
	Date: 01.02.10	Title:	Predicted Worst-case Subsidence Profile along the Mine De-watering Easement due to Longwall 910
	Ditton Geotechnical Services Pty Ltd	Scale:	NTS — Figure No: 31a



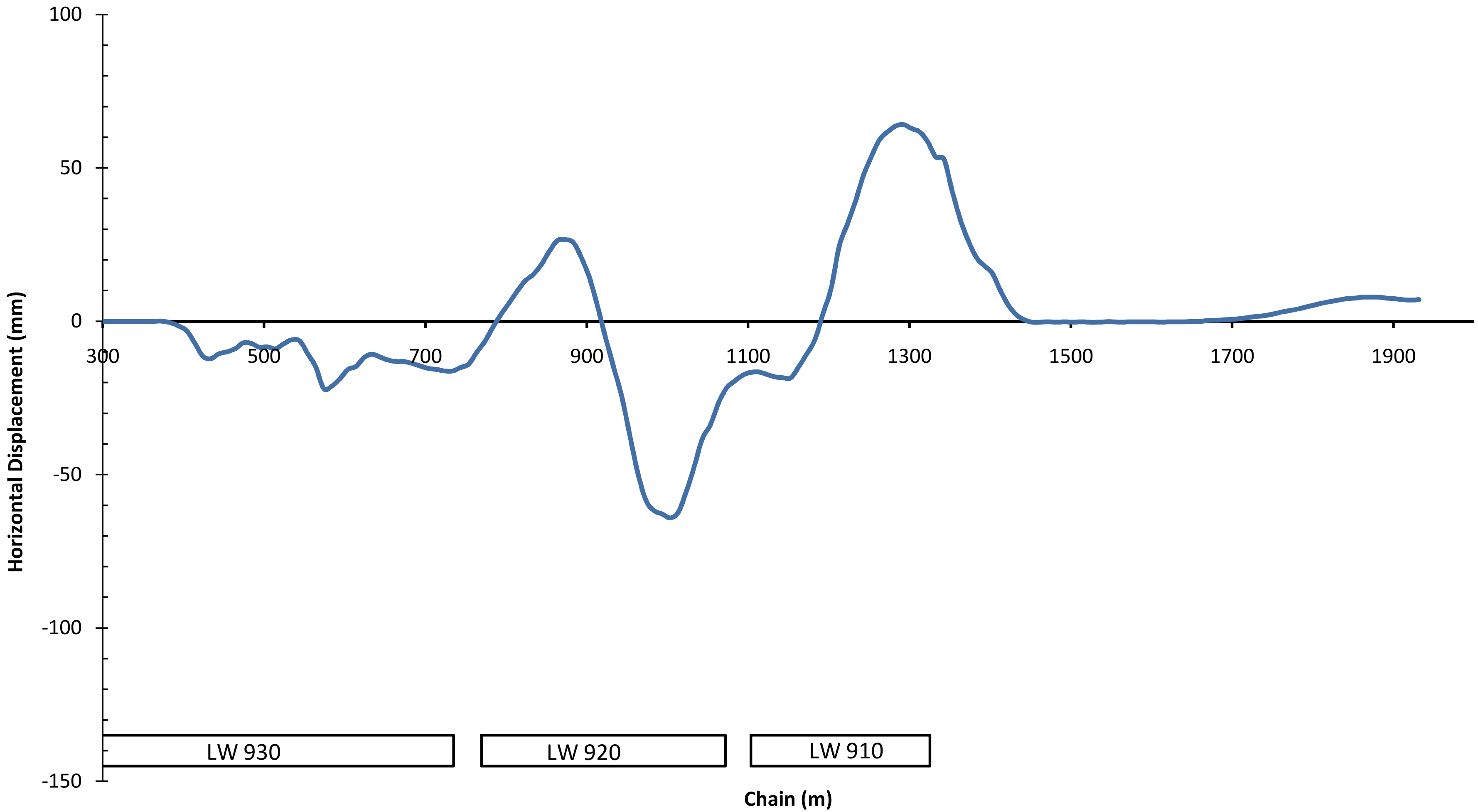
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1	
	Drawn:	S.Ditton			
	Date:	01.02.10	Title:	Predicted Worst-case Tilt Profile along the Mine De-watering Easement due to Longwall 910	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 31b



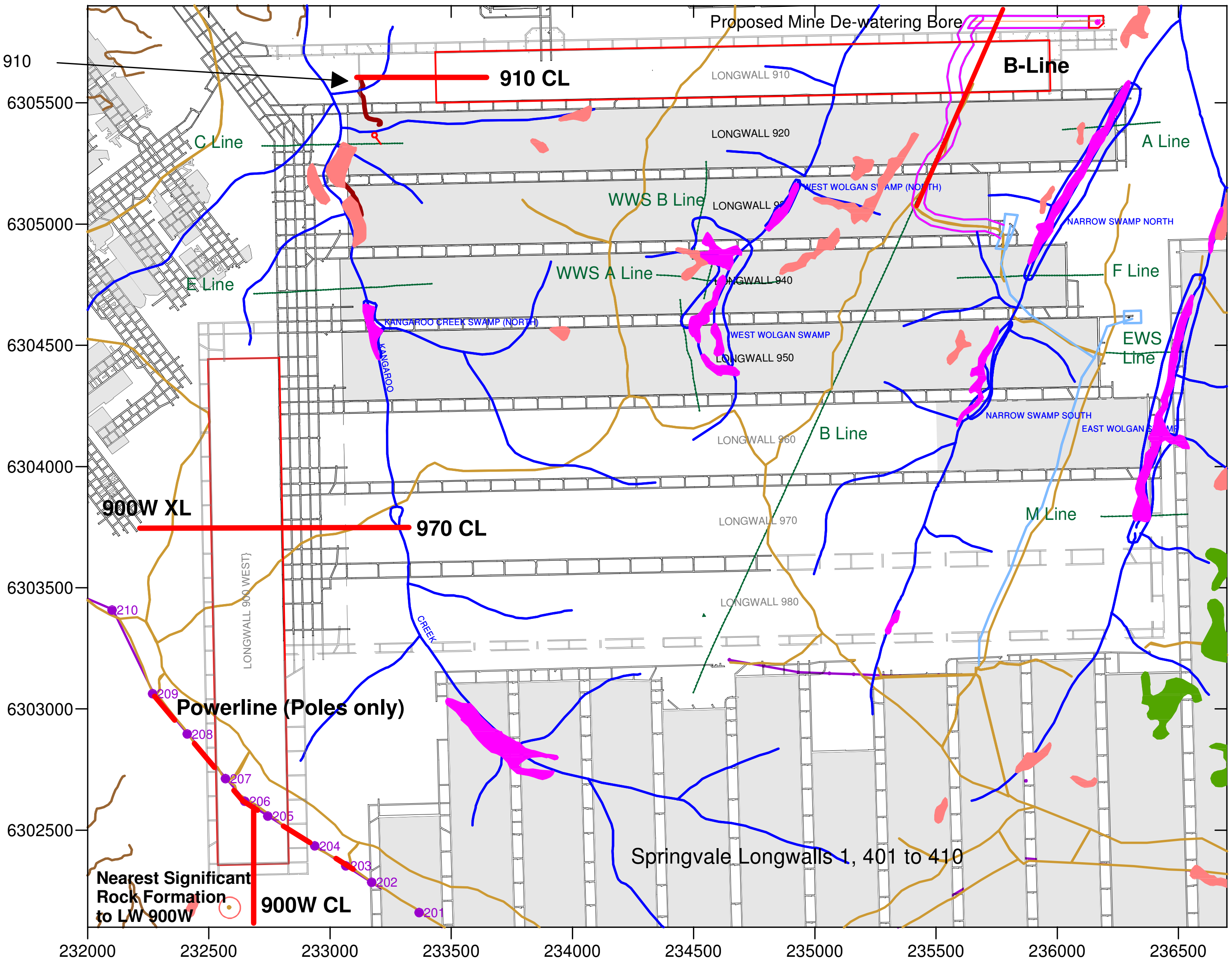
DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1		
	Drawn:	S.Ditton				
	Date:	01.02.10	Title:	Predicted Worst-case Curvature Profile along the Mine De-watering Easement due to Longwall 910		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	31c



DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1		
	Drawn:	S.Ditton				
	Date:	01.02.10	Title:	Predicted Worst-case Horizontal Strain Profile along the Mine De-watering Easement due to Longwall 910		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	31d



DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place Colliery ANP-002/1		
	Drawn:	S.Ditton				
	Date:	01.02.10	Title:	Predicted Worst-case Horizontal Displacement Profile along the Mine De-watering Easement due to Longwall 910		
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:	31e



Key:

- Access Tracks
- Suspended Powerlines and Poles
- Proposed mine de-watering bore
- Proposed Buried Pipeline & Power Supply Corridor (50 m wide)
- Existing Buried Pipeline & Power Supply to Mine Dewatering Bores
- Watercourses
- Newnes Plateau Shrub Swamps
- Newnes Plateau Hanging Swamps
- Newnes Plateau Wooded Heath
- Cliff lines (>20 m high)
- Rock Formations (5 - 20 m)
- Extracted Longwall Blocks
- Proposed Longwalls
- Installed Subsidence Lines
- Proposed Subsidence Lines

DgS	Engineer:	S.Ditton	Client:	Centennial Angus Place ANP-002/1
	Drawn:	S.Ditton		
	Date:	14.08.10	Title:	Proposed Surface Monitoring Lines above the Proposed Longwalls (900W - 910) and the Approved Longwalls (920-980)
	Ditton Geotechnical Services Pty Ltd		Scale:	1:25,000 — Figure No: 32

APPENDIX 6.1

Environmental Risk Assessment

Risk Assessment Document

Angus Place

Stage 1 Modification Environmental Assessment

Risk Assessment No.: RA0459

1. Background:

Angus Place intends to modify its current Project Approval (06_0021) to achieve the requirements outlined in the signed Project Description (referenced).

To complement the application, a detailed environmental assessment is required to address and evaluate potential new environmental risks associated with the modification.

It is Centennial Angus Place's intention for RPS HSO to assume the role of Principal Consultant. A number of sub-consultants are to be engaged to undertake specific assessments as per the indicative Director General Requirements.

2. Objective:

The following Hierarchy of Controls offers a framework for considering the effectiveness of controls. Note that the effectiveness of a control that is intended to reduce a risk decreases from top to bottom of the list. In other words, the closer the control type is to the top of the hierarchy, the more potentially effective the control.

·Eliminate the hazard or energy source (do not use the energy)
·Minimise or replace the hazard or energy source (reduce the amount of energy to a less damaging level or replace the energy with another hat has less potential negative consequences)
·Control the hazard or energy using engineered devices (ex. Lock outs, chemical containers, mechanical roof support, gas monitors, etc.)
·Control the hazard or energy by using physical barriers (ex. machine guarding, warning signs, etc.)
·Control the hazard or energy with procedures (ex. Isolation procedures, standard operating procedures, etc.)
·Control the hazard or energy with personal protective equipment (ex. hard hats, boots with toe caps, gloves, safety glasses, welding gear, etc.)
·Control the hazard or energy with warnings and awareness (ex. posters, labels, stickers, verbal warnings, etc.)

To assess the risks associated with each aspect of the modification
To determine the assessment parameters using a risk based approach
To evaluate the risks to determine the assessment levels required.

3. Potential Hazards:

Environmental impacts are identified as follows:

Archaeology
Flora and fauna
Subsidence modelling
Surface water
Groundwater
Air quality
Noise
Rehabilitation/disturbed land
Land capability
Greenhouse gas/energy
Socio-economic
Traffic and transport
Contaminated sites
Hydrogeological

4a. Risk Assessment Boundary Definition:

This risk assessment is limited to the specific aspects identified in the project description.

This risk assessment is limited to direct environmental impacts excluding business, legal, repuation etc. issues which are addressed in the Newnes Plateau and Surface Environmental Risk Assessment.

4b. Risk Assessment Boundary Definition

Mining of LW 900w

Mining of LW 910

Increase production capacity to 4 mtpa

Construction and operation of dewatering bore and associated infrastructure required at inbye end of 910

Stockpile modifications to improve coal handling water management

5. Risk Assessment Methods:

Yes/No	Method
	PROACTIVE TOOLS
Yes	Workplace Risk Assessment and Control (WRAC)
	Fault Tree Analysis (FTA)
	SIL Analysis to Australian Standard 61508 - Under Development
	Bow Tie Analysis (BTA)
	Failure Modes and Effects Analysis (FMEA)
	REACTIVE TOOLS:
	Root Cause Analysis (RCA) - Under Development

6. Previous Risk Assessment and other documents to be used and/or referenced:

Document Name	Title	Version	Referenced Document Date
S1 Project Description	S1 Project Description		
Project Approval 06_0021	Project Approval 06_0021		
Newnes Plateau Access Risk Assessment	Newnes Plateau Access Risk Assessment		
Newnes Plateau Environmental Risk Assessment	Newnes Plateau Environmental Risk Assessment		

7. Information Required for Risk Assessment:

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8. Venue and Time:

Date	Description	Location	Start Time	End Time	Comment
1.	Scoping	Enviro office	9:00 AM	3:30 PM	
2.	Assessment	Board room	9:00 AM		
3.	Review				

9. Risk Assessment Team Selection

Name	Title	Company	Yrs. of Exp.	Mobile Phone #	E-Mail Address	Role
Iain Hornshaw	Environmental Coordinator	Angus Place Colliery	2	0435 030 438	iain.hornshaw@centennialcoal.com.au	
Peter Corbett	Technical Services Manager	Angus Place Colliery	10	0428 253 203	peter.corbett@centennialcoal.com.au	
Steve McCall	Project Manager	RPS HSO			steve@rpshso.com.au	
Craig Anderson	Director Environment	RPS HSO			craig@rpshso.com.au	
Steve McCall	Project Planner	RPS HSO	5	0418 426 769	steve@rpshso.com.au	
Craig Anderson	Project Ecologist	RPS HSO	15	0418 681 581	craig@rpshso.com.au	
Fiona Bartier	Regional Environmental Officer- Projects	Centennial Coal	15			

Attendance:

Name	1. Attendance Code	2. Attendance Code	3. Attendance Code
Iain Hornshaw			
Peter Corbett			
Steve McCall			
Craig Anderson			
Steve McCall			
Craig Anderson			
Fiona Bartier			

Centennial Coal
Angus Place

10. Scoping Document Authorisation Details:

Approval Status: Not Approved Date:

Approver Name:

Comments:

WRAC Analysis Worksheet

L= Likelihood; MRC= Maximum Reasonable Consequence; RR= Risk Rank

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact to shallow groundwater ::: Caused by: Mine subsidence Resulting in: Impact to ecology due to water loss in upper aquifers.	1.1.a. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.1.b. No signficant change to depth of cover or overlying stratigraphy 1.1.c. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring.	**D** (Pb)	3 (E)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
	There is a risk to Angus Place from ::: Impact of surface aquifers on groundwater dependant ecosystems ::: Caused by: Mine subsidence Resulting in: Impact to groundwater dependant ecosystems.	1.2.a. There are no GDE's in proposed mining areas	**E** (Pb)	5 (E)	25 (L)	
	There is a risk to Angus Place from ::: Impact to deep groundwater aquifers ::: Caused by: Mine subsidence Resulting in: Impact to other groundwater users.	1.3.a. No local groundwater extraction within the proposed mining area	**C** (Pb)	4 (E)	18 (M)	2. Review CSIRO Hydrogeological Model
	There is a risk to Angus Place from ::: Impact to drainage lines ::: Caused by:	1.4.a. Only ephemeral drainage lines present in proposed mining areas 1.4.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections,	**C** (Pb)	4 (E)	18 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas

WRAC Analysis Worksheet

L= Likelihood; MRC= Maximum Reasonable Consequence; RR= Risk Rank

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Mine subsidence Resulting in: Impact to ecology due to loss of surface water flows.	seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.4.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m)				
	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to threatened/endangered species (DECC / DEWHA identification).	1.5.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.5.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.5.c. No signficant change to depth of cover or overlying stratigraphy 1.5.d. DECC Species Mapping	**C** (Pb)	4 (E)	18 (M)	3. Literature review of previous aecological studies within proposed mining areas and surrounding plateau areas 1. Extrapolate current monitoring and response protocols to proposed mining areas
	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Loss of ecological habitat.	1.6.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.6.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.6.c. No signficant change to depth of cover or overlying stratigraphy	**D** (Pb)	3 (E)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas

WRAC Analysis Worksheet

L= Likelihood; MRC= Maximum Reasonable Consequence; RR= Risk Rank

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	There is a risk to Angus Place from ::: Surface cracking ::: Caused by: Mine subsidence Resulting in: Public safety issue.	1.7.a. Public Safety Management Plan for existing mining area 1.7.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.7.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.7.d. No signficant change to depth of cover or overlying stratigraphy 1.7.e. Signage used to identify areas affected by mine subsidence on public roads	**D** (Pb)	5 (PI)	24 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas
	There is a risk to Angus Place from ::: Surface cracking ::: Caused by: Mine subsidence Resulting in: Damage to surface infrastructure.	1.8.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.8.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.8.c. No signficant change to depth of cover or overlying stratigraphy 1.8.d. Infrastructure designed with consideration of known subsidence parameters	**D** (Pb)	3 (BI)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in:	1.9.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil	**D** (Pb)	5 (R)	24 (L)	

WRAC Analysis Worksheet

L= Likelihood; MRC= Maximum Reasonable Consequence; RR= Risk Rank

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Impact to Forests NSW resources.	moisture monitoring. 1.9.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.9.c. No signficant change to depth of cover or overlying stratigraphy				
	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to sensitive surface topographical features e.g. cliff lines and pagodas.	1.10.a. Angle of draw reduced to avoid significant topographical features	**E** (Pb)	4 (E)	23 (L)	
	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to archaeological sites.	1.11.a. Angle of draw reduced to avoid significant topographical features 1.11.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.11.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.11.d. No signficant change to depth of cover or overlying stratigraphy	**D** (Pb)	4 (R)	21 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas 4. Literature review of previous arch studies in region
	There is a risk to Angus Place from ::: Subsidence levels exceed predictions ::: Caused by: Geological structures Resulting in: Greater than predicted surface impacts.	1.12.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.12.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.12.c. No signficant change to depth of	()	()		

WRAC Analysis Worksheet

L= Likelihood; MRC= Maximum Reasonable Consequence; RR= Risk Rank

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		cover or overlying stratigraphy				
	There is a risk to Angus Place from ::: Release of fugitive GHG emissions during mining and handling of LW 900w ::: Caused by: Release of GHG emissions Resulting in: Additional GHG emitted to atmosphere.	1.13.a. Ventilation monitoring as per Coal Mine OH&S regs 1.13.b. Small quantities of GHG produced in Western Coal Field	**A** (D)	5 (E)	15 (S)	5. Participation in GHG reduction programs 6. NGERS reporting
	There is a risk to Angus Place from ::: Additional grondwater water make ::: Caused by: Mining of LW panel Resulting in: Increased water make and increased requirement to discharge/transfer water.	1.14.a. Water Management Plan 1.14.b. Current mining areas are monitored using piezometers. 1.14.c. CSIRO models undertaken for Springvale 1.14.d. Historic dewatering volumetric data	**C** (Pb)	3 (BI)	13 (S)	7. Hydrogeological model to acertain predicted future water make 8. Construction and operation of proposed 910 dewatering bore in addition to existing 940 bore 9. Investigation of inseam pumping options
2. Increase production capacity to 4 mtpa	There is a risk to Angus Place from ::: Impact air quality ::: Caused by: Additional quantity of coal being handled Resulting in: Air quality criteria exceedances.	2.1.a. Air Quality Management Plan 2.1.b. Typically moist coal 2.1.c. Dust monitoring (depositional/TSP/PM10) 2.1.d. Tarped trucks 2.1.e. CHP area damped down to suppress dust	**C** (Pb)	4 (L)	18 (M)	10. Extrapolate current monitoring, management and response protocols to proposed mining area and pit top handling area.
	There is a risk to Angus Place from ::: Increase noise generated by operation ::: Caused by: Additional quantity of coal being handled Resulting in: Exceedance of current noise criteria.	2.2.a. Noise Management Plan - includes all monitoring criteria and commitments. 2.2.b. Contracted operation of haul road (includes environmental parameters i.e. truck movements) 2.2.c. Noise warning signs on haul road to inform operators	**D** (Pb)	4 (L)	21 (L)	10. Extrapolate current monitoring, management and response protocols to proposed mining area and pit top handling area.

WRAC Analysis Worksheet

L= Likelihood; MRC= Maximum Reasonable Consequence; RR= Risk Rank

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	There is a risk to Angus Place from ::: Release of GHG emissions from fuel used for transportation of increased coal production ::: Caused by: Release of GHG emissions Resulting in: Additional GHG emitted to atmosphere.		()	()		
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Impact to archaeological sites.	3.1.a. Extrapolation from previous predicted models 3.1.b. Site feasibility assessment and inspection (ground truth).	**C** (Pb)	4 (R)	18 (M)	11. Arch investigation as part of S1 EA
	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Impact to Forests NSW resources.	3.2.a. Existing occupation permits systems approved by Forests NSW	**A** (D)	5 (E)	15 (S)	12. NSW I&I security deposit as required under the AP mining lease 13. Forests NSW issued conditions regarding approved Occupation Permit 14. Rehabilitation standard/procedure
	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Loss of ecological habitat.	3.3.a. DECC Species Mapping 3.3.b. Pre activity site inspection and ground truthing 3.3.c. Previous ecological studies undertaken for Angus Place and surrounds 3.3.d. Aerial Photographic Interpretation	**A** (D)	4 (E)	10 (S)	1. Extrapolate current monitoring and response protocols to proposed mining areas 13. Forests NSW issued conditions regarding approved Occupation Permit 3. Literature review of previous aecological studies within proposed mining areas and surrounding plateau areas 14. Rehabilitation standard/procedure 15. Contractor Environmental Management Plan - detailing limits of area to be cleared by clear marking
	There is a risk to Angus Place from	3.4.a. DECC Species Mapping	**D** (Pb)	4 (E)	21 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas

WRAC Analysis Worksheet

L= Likelihood; MRC= Maximum Reasonable Consequence; RR= Risk Rank

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Significant impact to threatened/endangered species (DECC / DEWHA identification).	3.4.b. Pre activity site inspection and ground truthing 3.4.c. Previous ecological studies undertaken for Angus Place and surrounds 3.4.d. Aerial Photographic Interpretation 3.4.e. Set study area				16. Site specific ecological studies and impact minimisation recommendations
	There is a risk to Angus Place from ::: Use of additional electricity ::: Caused by: Operation of borehole pump Resulting in: Additional GHG emitted to atmosphere.	3.5.a. EEO/ESAP implementation process and innovations 3.5.b. Energy monitoring and GHG reporting as per NGERS requirements	**A** (D)	5 (F)	15 (S)	17. Investigate purchase of energy efficient equipment e.g. VVVF drives
4. Stockpile modifications to improve water management	There is a risk to Angus Place from ::: Discharge offsite of poor quality water ::: Caused by: sediment laden water Resulting in: non-compliance with current licence conditions and potential litigation.	4.1.a. Water Management Plan - detailing management and monitoring systems 4.1.b. Daily turbidity monitoring at LDP002	**B** (D)	4 (L)	14 (S)	18. Incorporate modifications into existing water management plan 19. Improve management of settling ponds to ensure regular "clean out".

Centennial Coal
Angus Place

WRAC Analysis Sorted by RR

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Loss of ecological habitat.	3.3.a. DECC Species Mapping 3.3.b. Pre activity site inspection and ground truthing 3.3.c. Previous ecological studies undertaken for Angus Place and surrounds 3.3.d. Aerial Photographic Interpretation	**A** (D)	4 (E)	10 (S)	1. Extrapolate current monitoring and response protocols to proposed mining areas 13. Forests NSW issued conditions regarding approved Occupation Permit 3. Literature review of previous aecological studies within proposed mining areas and surrounding plateau areas 14. Rehabilitation standard/procedure 15. Contractor Environmental Management Plan - detailing limits of area to be cleared by clear marking
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Additional grondwater water make ::: Caused by: Mining of LW panel Resulting in: Increased water make and increased requirement to discharge/transfer water.	1.14.a. Water Management Plan 1.14.b. Current mining areas are monitored using piezometers. 1.14.c. CSIRO models undertaken for Springvale 1.14.d. Historic dewatering volumetric data	**C** (Pb)	3 (BI)	13 (S)	7. Hydrogeological model to acertain predicted future water make 8. Construction and operation of proposed 910 dewatering bore in addition to existing 940 bore 9. Investigation of inseam pumping options
4. Stockpile modifications to improve water management	There is a risk to Angus Place from ::: Discharge offsite of poor quality water ::: Caused by: sediment laden water Resulting in: non-compliance with current licence conditions and potential litigation.	4.1.a. Water Management Plan - detailing management and monitoring systems 4.1.b. Daily turbidity monitoring at LDP002	**B** (D)	4 (L)	14 (S)	18. Incorporate modifications into existing water management plan 19. Improve management of settling ponds to ensure regular "clean out".
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Release of fugitive GHG emissions during mining and handling of LW 900w ::: Caused by: Release of GHG emissions Resulting in: Additional GHG emitted to atmosphere.	1.13.a. Ventilation monitoring as per Coal Mine OH&S regs 1.13.b. Small quantities of GHG produced in Western Coal Field	**A** (D)	5 (E)	15 (S)	5. Participation in GHG reduction programs 6. NGERS reporting

WRAC Analysis Sorted by RR

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Impact to Forests NSW resources.	3.2.a. Existing occupation permits systems approved by Forests NSW	**A** (D)	5 (E)	15 (S)	12. NSW I&I security deposit as required under the AP mining lease 13. Forests NSW issued conditions regarding approved Occupation Permit 14. Rehabilitation standard/procedure
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Use of additional electricity ::: Caused by: Operation of borehole pump Resulting in: Additional GHG emitted to atmosphere.	3.5.a. EEO/ESAP implementation process and innovations 3.5.b. Energy monitoring and GHG reporting as per NGERS requirements	**A** (D)	5 (F)	15 (S)	17. Investigate purchase of energy efficient equipment e.g. VVVF drives
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact to shallow groundwater ::: Caused by: Mine subsidence Resulting in: Impact to ecology due to water loss in upper aquifers.	1.1.a. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.1.b. No signficant change to depth of cover or overlying stratigraphy 1.1.c. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring.	**D** (Pb)	3 (E)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in:	1.6.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow	**D** (Pb)	3 (E)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas

WRAC Analysis Sorted by RR

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Loss of ecological habitat.	monitoring, meteorological monitoring, soil moisture monitoring. 1.6.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.6.c. No signficant change to depth of cover or overlying stratigraphy				
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface cracking ::: Caused by: Mine subsidence Resulting in: Damage to surface infrastructure.	1.8.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.8.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.8.c. No signficant change to depth of cover or overlying stratigraphy 1.8.d. Infrastructure designed with consideration of known subsidence parameters	**D** (Pb)	3 (BI)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact to deep groundwater aquifers ::: Caused by: Mine subsidence Resulting in: Impact to other groundwater users.	1.3.a. No local groundwater extraction within the proposed mining area	**C** (Pb)	4 (E)	18 (M)	2. Review CSIRO Hydrogeological Model
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact to drainage lines ::: Caused by: Mine subsidence Resulting in:	1.4.a. Only ephemeral drainage lines present in proposed mining areas 1.4.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring,	**C** (Pb)	4 (E)	18 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas

WRAC Analysis Sorted by RR

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Impact to ecology due to loss of surface water flows.	scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.4.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m)				
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to threatened/endangered species (DECC / DEWHA identification).	1.5.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.5.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.5.c. No signficant change to depth of cover or overlying stratigraphy 1.5.d. DECC Species Mapping	**C** (Pb)	4 (E)	18 (M)	3. Literature review of previous aecological studies within proposed mining areas and surrounding plateau areas 1. Extrapolate current monitoring and response protocols to proposed mining areas
2. Increase production capacity to 4 mtpa	There is a risk to Angus Place from ::: Impact air quality ::: Caused by: Additional quantity of coal being handled Resulting in: Air quality criteria exceedances.	2.1.a. Air Quality Management Plan 2.1.b. Typically moist coal 2.1.c. Dust monitoring (depositional/TSP/PM10) 2.1.d. Tarped trucks 2.1.e. CHP area damped down to suppress dust	**C** (Pb)	4 (L)	18 (M)	10. Extrapolate current monitoring, management and response protocols to proposed mining area and pit top handling area.
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by:	3.1.a. Extrapolation from previous predicted models 3.1.b. Site feasibility assessment and inspection (ground truth).	**C** (Pb)	4 (R)	18 (M)	11. Arch investigation as part of S1 EA

WRAC Analysis Sorted by RR

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Clearing and construction Resulting in: Impact to archaeological sites.					
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to archaeological sites.	1.11.a. Angle of draw reduced to avoid significant topographical features 1.11.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.11.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.11.d. No signficant change to depth of cover or overlying stratigraphy	**D** (Pb)	4 (R)	21 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas 4. Literature review of previous arch studies in region
2. Increase production capacity to 4 mtpa	There is a risk to Angus Place from ::: Increase noise generated by operation ::: Caused by: Additional quantity of coal being handled Resulting in: Exceedance of current noise criteria.	2.2.a. Noise Management Plan - includes all monitoring criteria and commitments. 2.2.b. Contracted operation of haul road (includes environmental parameters i.e. truck movements) 2.2.c. Noise warning signs on haul road to inform operators	**D** (Pb)	4 (L)	21 (L)	10. Extrapolate current monitoring, management and response protocols to proposed mining area and pit top handling area.
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Significant impact to threatened/endangered species (DECC / DEWHA identification).	3.4.a. DECC Species Mapping 3.4.b. Pre activity site inspection and ground truthing 3.4.c. Previous ecological studies undertaken for Angus Place and surrounds 3.4.d. Aerial Photographic Interpretation 3.4.e. Set study area	**D** (Pb)	4 (E)	21 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas 16. Site specific ecological studies and impact minimisation recommendations
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from	1.10.a. Angle of draw reduced to avoid significant	**E** (Pb)	4 (E)	23 (L)	

WRAC Analysis Sorted by RR

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to sensitive surface topographical features e.g. cliff lines and pagodas.	topographical features				
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface cracking ::: Caused by: Mine subsidence Resulting in: Public safety issue.	1.7.a. Public Safety Management Plan for existing mining area 1.7.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.7.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.7.d. No signficant change to depth of cover or overlying stratigraphy 1.7.e. Signage used to identify areas affected by mine subsidence on public roads	**D** (Pb)	5 (PI)	24 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to Forests NSW resources.	1.9.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring.	**D** (Pb)	5 (R)	24 (L)	

WRAC Analysis Sorted by RR

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		1.9.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.9.c. No signficant change to depth of cover or overlying stratigraphy				
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact of surface aquifers on groundwater dependant ecosystems ::: Caused by: Mine subsidence Resulting in: Impact to groundwater dependant ecosystems.	1.2.a. There are no GDE's in proposed mining areas	**E** (Pb)	5 (E)	25 (L)	
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Subsidence levels exceed predictions ::: Caused by: Geological structures Resulting in: Greater than predicted surface impacts.	1.12.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.12.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.12.c. No signficant change to depth of cover or overlying stratigraphy	()	()		
2. Increase production capacity to 4 mtpa	There is a risk to Angus Place from ::: Release of GHG emissions from fuel used for transportation of increased coal production ::: Caused by: Release of GHG emissions Resulting in: Additional GHG emitted to atmosphere.		()	()		

WRAC Analysis Sorted by Consequence

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Subsidence levels exceed predictions ::: Caused by: Geological structures Resulting in: Greater than predicted surface impacts.	1.12.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.12.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.12.c. No signficant change to depth of cover or overlying stratigraphy	()	()		
2. Increase production capacity to 4 mtpa	There is a risk to Angus Place from ::: Release of GHG emissions from fuel used for transportation of increased coal production ::: Caused by: Release of GHG emissions Resulting in: Additional GHG emitted to atmosphere.		()	()		
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface cracking ::: Caused by: Mine subsidence Resulting in: Damage to surface infrastructure.	1.8.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.8.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.8.c. No signficant change to depth of cover or overlying stratigraphy 1.8.d. Infrastructure designed with consideration of known subsidence parameters	**D** (Pb)	3 (BI)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Additional grondwater water make :::	1.14.a. Water Management Plan 1.14.b. Current mining areas are monitored using piezometers.	**C** (Pb)	3 (BI)	13 (S)	7. Hydrogeological model to acertain predicted future water make 8. Construction and operation of proposed 910 dewatering bore in addition to existing 940 bore

WRAC Analysis Sorted by Consequence

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Caused by: Mining of LW panel Resulting in: Increased water make and increased requirement to discharge/transfer water.	1.14.c. CSIRO models undertaken for Springvale 1.14.d. Historic dewatering volumetric data				9. Investigation of inseam pumping options
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact to shallow groundwater ::: Caused by: Mine subsidence Resulting in: Impact to ecology due to water loss in upper aquifers.	1.1.a. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.1.b. No signficant change to depth of cover or overlying stratigraphy 1.1.c. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring.	**D** (Pb)	3 (E)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Loss of ecological habitat.	1.6.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.6.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.6.c. No signficant change to depth of cover or overlying stratigraphy	**D** (Pb)	3 (E)	17 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from	1.3.a. No local groundwater extraction within the proposed mining	**C** (Pb)	4 (E)	18 (M)	2. Review CSIRO Hydrogeological Model

WRAC Analysis Sorted by Consequence

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	::: Impact to deep groundwater aquifers ::: Caused by: Mine subsidence Resulting in: Impact to other groundwater users.	area				
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact to drainage lines ::: Caused by: Mine subsidence Resulting in: Impact to ecology due to loss of surface water flows.	1.4.a. Only ephemeral drainage lines present in proposed mining areas 1.4.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.4.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m)	**C** (Pb)	4 (E)	18 (M)	1. Extrapolate current monitoring and response protocols to proposed mining areas
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to threatened/endangered species (DECC / DEWHA identification).	1.5.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.5.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.5.c. No signficant change to depth of cover or overlying stratigraphy 1.5.d. DECC Species Mapping	**C** (Pb)	4 (E)	18 (M)	3. Literature review of previous aecological studies within proposed mining areas and surrounding plateau areas 1. Extrapolate current monitoring and response protocols to proposed mining areas

WRAC Analysis Sorted by Consequence

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to sensitive surface topographical features e.g. cliff lines and pagodas.	1.10.a. Angle of draw reduced to avoid significant topographical features	**E** (Pb)	4 (E)	23 (L)	
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Loss of ecological habitat.	3.3.a. DECC Species Mapping 3.3.b. Pre activity site inspection and ground truthing 3.3.c. Previous ecological studies undertaken for Angus Place and surrounds 3.3.d. Aerial Photographic Interpretation	**A** (D)	4 (E)	10 (S)	1. Extrapolate current monitoring and response protocols to proposed mining areas 13. Forests NSW issued conditions regarding approved Occupation Permit 3. Literature review of previous aecological studies within proposed mining areas and surrounding plateau areas 14. Rehabilitation standard/procedure 15. Contractor Environmental Management Plan - detailing limits of area to be cleared by clear marking
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Significant impact to threatened/endangered species (DECC / DEWHA identification).	3.4.a. DECC Species Mapping 3.4.b. Pre activity site inspection and ground truthing 3.4.c. Previous ecological studies undertaken for Angus Place and surrounds 3.4.d. Aerial Photographic Interpretation 3.4.e. Set study area	**D** (Pb)	4 (E)	21 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas 16. Site specific ecological studies and impact minimisation recommendations
2. Increase production capacity to 4 mtpa	There is a risk to Angus Place from ::: Impact air quality ::: Caused by: Additional quantity of coal being handled Resulting in: Air quality criteria exceedances.	2.1.a. Air Quality Management Plan 2.1.b. Typically moist coal 2.1.c. Dust monitoring (depositional/TSP/PM10) 2.1.d. Tarped trucks 2.1.e. CHP area damped down to suppress dust	**C** (Pb)	4 (L)	18 (M)	10. Extrapolate current monitoring, management and response protocols to proposed mining area and pit top handling area.
2. Increase production capacity to	There is a risk to Angus Place from	2.2.a. Noise Management Plan -	**D**	4	21	10. Extrapolate current monitoring, management and response

WRAC Analysis Sorted by Consequence

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
4 mtpa	::: Increase noise generated by operation ::: Caused by: Additional quantity of coal being handled Resulting in: Exceedance of current noise criteria.	includes all monitoring criteria and commitments. 2.2.b. Contracted operation of haul road (includes environmental parameters i.e. truck movements) 2.2.c. Noise warning signs on haul road to inform operators	(Pb)	(L)	(L)	protocols to proposed mining area and pit top handling area.
4. Stockpile modifications to improve water management	There is a risk to Angus Place from ::: Discharge offsite of poor quality water ::: Caused by: sediment laden water Resulting in: non-compliance with current licence conditions and potential litigation.	4.1.a. Water Management Plan - detailing management and monitoring systems 4.1.b. Daily turbidity monitoring at LDP002	**B** (D)	4 (L)	14 (S)	18. Incorporate modifications into existing water management plan 19. Improve management of settling ponds to ensure regular "clean out".
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to archaeological sites.	1.11.a. Angle of draw reduced to avoid significant topographical features 1.11.b. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, scheduled subsidence monitoring 1.11.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.11.d. No signficant change to depth of cover or overlying stratigraphy	**D** (Pb)	4 (R)	21 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas 4. Literature review of previous arch studies in region
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Impact to archaeological sites.	3.1.a. Extrapolation from previous predicted models 3.1.b. Site feasibility assessment and inspection (ground truth).	**C** (Pb)	4 (R)	18 (M)	11. Arch investigation as part of S1 EA

Centennial Coal
Angus Place

WRAC Analysis Sorted by Consequence

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Impact of surface aquifers on groundwater dependant ecosystems ::: Caused by: Mine subsidence Resulting in: Impact to groundwater dependant ecosystems.	1.2.a. There are no GDE's in proposed mining areas	**E** (Pb)	5 (E)	25 (L)	
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Release of fugitive GHG emissions during mining and handling of LW 900w ::: Caused by: Release of GHG emissions Resulting in: Additional GHG emitted to atmosphere.	1.13.a. Ventilation monitoring as per Coal Mine OH&S regs 1.13.b. Small quantities of GHG produced in Western Coal Field	**A** (D)	5 (E)	15 (S)	5. Participation in GHG reduction programs 6. NGERS reporting
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Clearing and construction Resulting in: Impact to Forests NSW resources.	3.2.a. Existing occupation permits systems approved by Forests NSW	**A** (D)	5 (E)	15 (S)	12. NSW I&I security deposit as required under the AP mining lease 13. Forests NSW issued conditions regarding approved Occupation Permit 14. Rehabilitation standard/procedure
3. Construction and operation of dewatering bore and associated infrastructure required at inbye end of Longwall 910	There is a risk to Angus Place from ::: Use of additional electricity ::: Caused by: Operation of borehole pump Resulting in: Additional GHG emitted to atmosphere.	3.5.a. EEO/ESAP implementation process and innovations 3.5.b. Energy monitoring and GHG reporting as per NGERS requirements	**A** (D)	5 (F)	15 (S)	17. Investigate purchase of energy efficient equipment e.g. VVVF drives
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface cracking :::	1.7.a. Public Safety Management Plan for existing mining area 1.7.b. Current mining areas are monitored using:photographic	**D** (Pb)	5 (PI)	24 (L)	1. Extrapolate current monitoring and response protocols to proposed mining areas

WRAC Analysis Sorted by Consequence

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Caused by: Mine subsidence Resulting in: Public safety issue.	monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.7.c. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.7.d. No signficant change to depth of cover or overlying stratigraphy 1.7.e. Signage used to identify areas affected by mine subsidence on public roads				
1. Mining of Longwall 900W and Longwall 910	There is a risk to Angus Place from ::: Surface impacts ::: Caused by: Mine subsidence Resulting in: Impact to Forests NSW resources.	1.9.a. Current mining areas are monitored using:photographic monitoring, pre and post-mining inspections, seasonal flora / fauna monitoring, scheduled subsidence monitoring, piezometer monitoring, surface water flow monitoring, meteorological monitoring, soil moisture monitoring. 1.9.b. No change to mining layout from current practice (i.e maximum panel void width of 295m and length <3000m) 1.9.c. No signficant change to depth of cover or overlying stratigraphy	**D** (Pb)	5 (R)	24 (L)	

Centennial Coal
Angus Place

Recommended Controls

Recommended Controls Do NOT enter additional Recommended Controls on this sheet.	Place(s) Used	Allocated To (Only one SITE person for each Recommended Control)	Required By Date	Pulse User No.
1. Extrapolate current monitoring and response protocols to proposed mining areas	Events: 1.1, 1.4, 1.5, 1.6, 1.7, 1.8, 1.11, 3.3, 3.4			
2. Review CSIRO Hydrogeological Model	Events: 1.3			
3. Literature review of previous aecological studies within proposed mining areas and surrounding plateau areas	Events: 1.5, 3.3			
4. Literature review of previous arch studies in region	Events: 1.11			
5. Participation in GHG reduction programs	Events: 1.13			
6. NGERS reporting	Events: 1.13			
7. Hydrogeological model to acertain predicted future water make	Events: 1.14			
8. Construction and operation of proposed 910 dewatering bore in addition to existing 940 bore	Events: 1.14			
9. Investigation of inseam pumping options	Events: 1.14			
10. Extrapolate current monitoring, management and response protocols to proposed mining area and pit top handling area.	Events: 2.1, 2.2			
11. Arch investigation as part of S1 EA	Events: 3.1			
12. NSW I&I security deposit as required under the AP mining lease	Events: 3.2			
13. Forests NSW issued conditions regarding approved Occupation Permit	Events: 3.2, 3.3			
14. Rehabilitation standard/procedure	Events: 3.2, 3.3			
15. Contractor Environmental Management Plan - detailing limits of area to be cleared by clear marking	Events: 3.3			
16. Site specific ecological studies and impact minimisation recommendations	Events: 3.4			
17. Investigate purchase of energy efficient equipment e.g. VVVF drives	Events: 3.5			
18. Incorporate modifications into existing water management plan	Events: 4.1			
19. Improve management of settling ponds to ensure regular "clean out".	Events: 4.1			

CENTENNIAL RISK MATRIX

Consequence

Note: Consequence may result from a single event or may represent a cumulative impact over a period of 12 months. Use the worst case reasonable consequence if there is more than one.

Rating	Impact to Annual Business Plan (F)	Personal Injury (PI)	Business Interruption (BI)	Legal (L)	Reputation (R)	Environment (E)	Likelihood: A Certain	B Probable	C Possible	D Remote	E Improbable	Description (D)
							Common"	Has Happened within Centennial"	"Could Happen & has happened in non-CEY operations	Not Likely	"Practically impossible	Probability (Pb)
							Frequent incidents	Regular incidents	Infrequent incidents	Unlikely to occur. Very few recorded or known incidents	May occur in exceptional circumstances. Almost no recorded incidents.	Incident Frequency (IF)
							Operations – within 3 months	Operations – within 2 years	Operations – within 5 years	Operations – within 10 years	Operations – within 30 years	Operations (Op)
							Project – Every project	Project – Every 2 projects	Project – Every 5 projects	Project – Every 10 projects	Project – Every 30 projects	Project (Pr)
1. Catastrophic	>$50m	Multiple Fatalities	> 1month	Prolonged litigation, heavy fines, potential jail term	Prolonged International media attention	Long term impairment habitats/ ecosystem	1 (E)	2 (E)	5 (H)	7 (H)	11 (S)	
2. Major	$10m - $50m	Single Fatality	1 week to 1 month	Major breach/ major litigation	International media attention	Long term effects of ecosystem	3 (E)	4 (E)	8 (H)	12 (S)	16 (M)	
3. Moderate	$1m - $10m	Serious/ Disabling Injury	1 day to 1 week	Serious breach of regulation. prosecution/ fine	National media attention	Serious medium term environmental effects	6 (H)	9 (H)	13 (S)	17 (M)	20 (L)	
4. Minor	$100k - $1m	Lost Time Injury	12 hrs to 1 day	Non-compliance, breaches in regulation	Adverse local public attention	Minor effects to physical environment	10 (S)	14 (S)	18 (M)	21 (L)	23 (L)	
5. Insignificant	<$100k	First Aid Treatment Only	< 12 hrs	Low level compliance issue	Local complaints	Limited physical damage	15 (S)	19 (M)	22 (L)	24 (L)	25 (L)	

Risk Rating	Risk Category		Generic Management Actions
1 to 4	E	Extreme	Immediate intervention required from senior management to eliminate or reduce this risk
5 to 9	H	High	Imperative to eliminate or reduce risk to a lower level by the introduction of control measures. Management planning required at senior levels
10 to 15	S	Significant	Corrective action required, senior management attention needed to eliminate or reduce risk
16 to 19	M	Moderate	Corrective action to be determined, management responsibility must be specified
20 to 25	L	Low	Monitor and manage by corrective action where practicable

BOW TIE ANALYSIS Control Effectiveness Matrix			CONTROL – Impact / Status / Quality				
			A >= 80%	B 50 – 80%	C 50 / 50%	D 50 – 20%	E <= 20%
TYPE OF CONTROL	1.	Elimination of hazard					
	2.	Substitution					
	3.	Engineered without people					
	4.	Engineered with people					
	5.	Procedural					
	6.	Awareness					

APPENDIX 7.1

Director General's Requirements

NSW GOVERNMENT | Planning

Major Projects Assessment
Mining & Industry Projects
Phone: 02 9228 6587
Fax: 02 9228 6466
Email: paul.freeman@planning.nsw.gov.au

Our Ref: 9038493

Mr Jacques Le Roux
General Manager, Mining Engineering
Centennial Angus Place Pty Limited
PO Box 42
WALLERAWANG NSW 2790

Dear Mr Le Roux,

Angus Place Coal Project Modification (06_0021 MOD 1)
Director-General's Requirements

The Department has received your application to modify the Angus Place Coal Project.

The Director-General's requirements for the project are attached. These requirements have been prepared in consultation with relevant agencies, based on the information you have provided to date. I have also attached a copy of the agencies' comments for your information.

Please note that the Director-General may alter these requirements at any time.

If your proposal is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). This approval is in addition to any approvals required under NSW legislation. It is your responsibility to contact the Department of Environment, Water, Heritage and the Arts in Canberra (6274 1111 or http://www.environment.gov.au) to determine if the proposal requires an approval under the EPBC Act. If it is subsequently determined that an approval is required under the EPBC Act, please contact the Department of Planning immediately as supplementary Director-General's requirements may need to be issued.

I would appreciate it if you would contact the Department at least two weeks before you propose to submit your EA for the proposed modification. This will enable the Department to:

- confirm the applicable fee (see Division 1A, Part 15 of the Environmental Planning and Assessment Regulation 2000); and
- determine the number of copies (hard-copy and CD-ROM) of the Environmental Assessment (EA) that will be required for exhibition purposes.

Once it receives the EA, the Department will review it in consultation with the relevant agencies to determine if it adequately addresses the Director-General's requirements, and may require you to revise it prior to public exhibition.

The Department is required to make all the relevant information associated with the project publicly available on its website. Consequently, I would appreciate it if you would ensure that all the documents you subsequently submit to the Department are in a suitable format for the web, and arrange for an electronic version of the EA to be hosted on a suitable website.

If you have any enquiries about these requirements, please contact Paul Freeman.

Yours sincerely

DKitto 1/6/10

David Kitto
Director
Mining & Industry Projects
As delegate for the Director-General

Director-General's Requirements

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

Application Number	06_0021 MOD 1
Modification	Modifying the Angus Place Coal Project, including: • developing and extracting longwalls 900 west and 910; • increasing maximum production from 3.5 million tonnes per annum (Mtpa) to 4 Mtpa; • constructing a new dewatering bore at longwall 910; • constructing powerlines and services for the new dewatering bore; • extending the Springvale – Delta Water Transfer Scheme via an underground pipeline corridor to the new dewatering bore; • modifying the existing stockpile area; and • constructing access tracks.
Location	15 kilometres northwest of Lithgow
Proponent	Centennial Angus Place Pty Limited
Date of Issue	1 June 2010
General Requirements	The Environmental Assessment of the proposed modification must include: • an executive summary; • a detailed description of: – historical operations on the site; – existing and approved operations and infrastructure on site, including a copy of all statutory approvals that apply to these operations and infrastructure; and – the existing environmental management and monitoring regime on site; • a detailed description of the proposed modification, including: – need for the proposed modification; and – alternatives considered, including justification for the modified mine plan. • a risk assessment of the potential environmental impacts of the proposed modification, identifying the key issues for further assessment; • a detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment (see above), which includes: – a description of the existing environment, using sufficient baseline data; – an assessment of the potential impacts of the proposed modification, including any cumulative impacts, taking into consideration any relevant guidelines, policies, plans and statutory provisions (see below); and – a description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the proposed modification, including detailed contingency plans for managing any significant risks to the environment; • a statement of commitments, outlining all the proposed environmental management and monitoring measures; • a conclusion justifying the proposed modification on economic, social and environmental grounds, taking into consideration whether the project is consistent with the objects of the *Environmental Planning & Assessment Act 1979*; and

<table>
<tr><td></td><td>a signed statement from the author of the Environmental Assessment, certifying that the information contained within the document is neither false nor misleading.</td></tr>
<tr><td>Key Issues</td><td>
Subsidence – including:

accurate predictions of potential subsidence effects (both systematic and non-systematic) including cumulative effects and a sensitivity analysis;
identification of sensitive receptors potentially affected by subsidence (such as environmental features and infrastructure) and an assessment of significance of those receptors;
assessment of the potential impacts of subsidence effects on the natural and built environment, with particular reference to sensitive receptors;
identification of how mine design has been or would be used or adapted to manage and/or mitigate subsidence impacts;
identification of how subsidence impacts would be rehabilitated, including methodologies and response times; and
identification of further research required to address any uncertainties or information gaps.

Soil and Water – including:

detailed modelling of potential surface and groundwater impacts;
a revised site water balance;
a detailed assessment of potential impacts on:

the quality and quantity of surface water and groundwater resources; and
groundwater dependent ecosystems.

a detailed description of the proposed modification to the mine's water management system, water monitoring program and measures to mitigate surface and groundwater impacts.

Biodiversity – including:

a detailed assessment of potential impacts on any terrestrial and aquatic threatened species or populations, associated habitats and endangered ecological communities or groundwater dependent ecosystems; and
a detailed description of the measures that would be implemented to avoid or mitigate impacts on biodiversity.

Traffic & Transport – including impacts to Blackmans Flat and Lidsdale.
Noise & Vibration – including a cumulative assessment of traffic noise.
Air Quality.
Greenhouse Gases – including:

a quantitative assessment of the potential scope 1, 2 and 3 greenhouse gas emissions of the proposed modification;
a qualitative assessment of the potential impacts of these emissions on the environment; and
an assessment of all reasonable and feasible measures that could be implemented on site to minimise the greenhouse gas emissions of the project and ensure it is energy efficient.

Aboriginal Cultural Heritage.
Hazards - including bushfires.
</td></tr>
<tr><td>References</td><td>The environmental assessment of the key issues listed above must take into account relevant guidelines, policies, and plans. While not exhaustive, the following attachment contains a list of some of the guidelines, policies, and plans that may be relevant to the environmental assessment of this project.</td></tr>
<tr><td>Consultation</td><td>During the preparation of the Environmental Assessment, you should consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners.</td></tr>
</table>

	In particular you must consult with the: • Department of Environment, Climate Change and Water, including the NSW Office of Water; • Industry and Investment NSW; • Mine Subsidence Board; • Lithgow City Council; and • relevant Catchment Management Authorities. The consultation process and the issues raised must be described in the Environmental Assessment.
Deemed Refusal Period	90 days

Policies, Guidelines & Plans

Risk Assessment	
	AS/NZS 4360:2004 Risk Management (Standards Australia)
	HB 203: 203:2006 Environmental Risk Management – Principles & Process (Standards Australia)
Soil & Water	
Soil	Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC)
	Rural Land Capability Mapping (DLWC)
	Agricultural Land Classification (DPI)
Surface Water	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management (ARMCANZ/ANZECC)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC)
	Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC)
	State Water Management Outcomes Plan
	NSW Government Water Quality and River Flow Objectives (DECC)
	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC)
	Managing Urban Stormwater: Soils & Construction (Landcom)
	Managing Urban Stormwater: Treatment Techniques (DECC)
	Managing Urban Stormwater: Source Control (DECC)
	A Rehabilitation Manual for Australian Streams (LWRRDC and CRCCH)
	Technical Guidelines: Bunding & Spill Management (DECC)
	Environmental Guidelines: Use of Effluent by Irrigation (DECC)
Groundwater	National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC)
	NSW State Groundwater Policy Framework Document (DLWC, 1997)
	NSW State Groundwater Quality Protection Policy (DLWC, 1998)
	NSW State Groundwater Quantity Management Policy (DLWC, 1998)
	Guidelines for the Assessment & Management of Groundwater Contamination (DECC, 2007)
Biodiversity	
	Draft Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979* (DEC)
	NSW State Groundwater Dependent Ecosystem Policy (DLWC)
	Policy & Guidelines - Aquatic Habitat Management and Fish Conservation (NSW Fisheries)
	Policy & Guidelines - Fish Friendly Waterway Crossings (NSW Fisheries)
	State Environmental Planning Policy No. 44 – Koala Habitat Protection
Noise & Vibration	
	NSW Industrial Noise Policy (DECC)
	Environmental Noise Management – Assessing Vibration: a technical guide (DEC)
	Environmental Criteria for Road Traffic Noise (NSW EPA)
	Interim Construction Noise Guideline (DECC)
	DIN 4150 Part 3 - Structural Vibration: effects of vibration on structures (ISO, 1999)

Air Quality	
	Protection of the Environment Operations (Clean Air) Regulation 2002
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC)
	Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC)
Greenhouse Gases	
	National Greenhouse Accounts Factors (Australian Department of Climate Change (DCC))
	Guidelines for Energy Savings Action Plans (DEUS)
Aboriginal Heritage	
	Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (DECCW)
	Part 3A EP&A Act Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC & DoP)
Hazards	
	State Environmental Planning Policy No. 33 – Hazardous and Offensive Development
	Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines (DUAP)
	Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis

APPENDIX 7.2

Statutory Approvals: Haul Road and Subsidence Management Plan

1.

Council of the City of Greater Lithgow

180 Mort Street, Lithgow, N.S.W. Telephone: (063) 52 1077

Original Consent.

Coal Link Ap-MT.P.

Your Reference
Our Reference IR:DM 611/812/00
Contact Environmental 1866H

18th September, 1992.

C

Coal Link Pty. Limited,
"Astrolabe",
Rutherford Lane,
LITHGOW. N.S.W. 2790.

Dear Sir,

Please find enclosed a copy of development consent No. 105/92 issued in respect of the abovementioned development.

You are advised that the application has been approved subject to the attached conditions.

The development consent has specific pollution control requirements placed upon it, given the level of detail which was submitted with the Statement of Environmental Effects.

The Soil Management Plan, Erosion and Sediment Control Plan, Water Management Plan and Rehabilitation Plans are to be prepared and approved by Council prior to construction works being carried out. In order to expedite the construction program, you may complete these plans in stages. The plan for each stage must be finalised before construction of that stage commences.

Of course, the requirements of individual Government Departments must be complied with regarding their separate approvals.

I appreciate the level of co-operation your company has shown to Council in the assessment of the development proposal. Please contact Ian Rufus, Council's Senior Environmental Planner, if you wish to discuss any conditions of the development consent or have any questions in regard to Council's requirements.

Yours faithfully,

S.W. McPHERSON,
GENERAL MANAGER/TOWN CLERK.

PER:
ENVIRONMENTAL SERVICES,
MANAGER.

enc

A TRUE COPY

DIRECTOR/SECRETARY

Council of the City of Greater Lithgow

180 Mort Street, Lithgow, N.S.W., 2790. Telephone: (063) 52 1077

IR:DM 611/812/00
Your Reference: Environmental Services
Assessment No: 5275-20000000-3
Contact:

ENVIRONMENTAL PLANNING & ASSESSMENT ACT, 1979
NOTICE TO APPLICANT OF DETERMINATION OF A DEVELOPMENT APPLICATION

To Coal Link Pty. Limited of "Astrolabe", Rutherford Lane, Lithgow, being the applicant in respect of Development Application No. 105/92.

Pursuant to Section 92 of the Act, notice is hereby given of the determination by the consent authority of the Development Application No. 105/92 relating to the land described as follows: Various lands for the purpose of a private haul route.

The Development Application has been determined by GRANTING OF CONSENT SUBJECT TO THE CONDITIONS SPECIFIED IN THIS NOTICE.

The conditions of the consent are set out as follows: SEE ATTACHED SCHEDULE.

The reasons for the imposition of the conditions are set out overleaf.

Endorsement Date of Consent 14th September, 1992.

NOTES:

1. Subject to the provisions of Section 93 of the Act, consent shall become effective from the date of endorsement of the consent.
2. Subject to the provisions of Section 99 of the Act, any consent granted shall lapse if such development is not commenced within two (2) years from the date of endorsement.
3. Extensions of consent will be determined having regard to the nature of the application, the current policies and standards of Council and other matters under Section 90 of the Act.
4. Subject to the provisions of Section 97 of the Act, any applicant who is dissatisfied with the determination by the consent authority may appeal to the Land and Environment Court. The right of appeal may be exercised within twelve (12) months from the date of receipt of the consent notice.

DATED THIS FOURTEENTH DAY OF SEPTEMBER, 1992.

S.W. McPHERSON,
GENERAL MANAGER/TOWN CLERK.

PER: ____________

ENVIRONMENTAL SERVICES,
MANAGER.

IMPORTANT:

(1) It is to be clearly understood that the above consent is NOT an approval to carry out any structural work. A formal Building Application must be submitted to Council and be approved before any structural work is carried out to implement the above consent. Also the applicant is not relieved of any obligation to obtain any other approval required under any other Act.

attach

CERTIFIED AS
A TRUE COPY

....
DIRECTOR/SECRETARY

Address Correspondence to: Town Clerk, P.O. Box 19, Lithgow, 2790.
Fax No.: (063) 51 4259

SCHEDULE OF CONDITIONS:

General

1. *The applicant shall carry out the development of the Haul Road generally in accordance with the Development Application and the Statement of Environmental Effects, as modified by the following conditions.*

Statutory Requirements

2. *The Applicant is to meet the requirements of the relevant public authorities, including separate approvals where required. Copies of all approvals are to be provided to Council.*

Environment Protection Authority

3. *Prior to the commencement of construction all required approvals shall be obtained from the Environment Protection Authority and the development shall be conducted in accordance with the terms of those approvals and licences. The applicant is required to verify that bund walls will be appropriately located.*

Department of Water Resources

4. *The applicant is to obtain all approvals required by the Department of Water Resources.*

Department of Conservation and Land Management

5. *Alternative access is to be provided along Crown Roads when and if required to the satisfaction of the Regional Director.*
   Minimum batters are to be 1:2 or to the satisfaction of the Regional Director, where vegetation is to be established for stablisation with preferred batter slopes of 1:3. For cuttings, dependant upon rock material, batter slopes may be steeper where vegetative stablisation is not possible.

6. *The proponent, its construction company and sub-contractors will consult with and will provide maps and plans to, the Department of Conservation and Land Management in respect to the soil management plan, erosion and sediment control plan, water management plan and rehabilitation plan and will carry out all these works to the satisfaction of the Department of Conservation and Land Management.*

7. *The workshop and store site and any other temporary construction areas are to be rehabilitated and revegetated at the end of construction. Details are to be included in the rehabilitation plan.*

8. *The proponent, its construction company and sub-contractors will consult with the Department of Conservation and Land Management in respect to any application required to destroy or injure any tree (being tree, sapling, shrub or scrub) on land being identified as being protected land under the Soil Conservation Act, 1938.*

Department of Mineral Resources

9. *Detailed plans showing the location of the proposed haul road in relation to old mine workings are to be prepared and submitted to the District Inspector of Coal Mines.*

10. *Where the proposed haul road is to pass over or be constructed within 50 metres or less of old mine workings, the District Inspector of Coal Mines must be notified immediately prior to construction.*

11. *Prior to the proposed haul road passing over old underground mine workings, and if required by the District Inspector of Coal Mines, a detailed engineering study must be undertaken by the proponent, Coal Link Pty. Limited, to address the capability of the stratum overlying these old mine workings to support the construction and use of the proposed haul road.*

12. *The extraction and removal of any coal, as part of the construction phase for the proposed haul road, must be undertaken in compliance with the Mining Act, 1992, and the Coal Mines Regulation Act, 1982.*

Community Infrastructure Contribution

13. *The applicant shall pay the Council a contribution pursuant to Section 94 of the Environmental Planning and Assessment Act for community facilities for Council to utilise in the upgrading of facilities provided and to be provided in the City of Lithgow, as result of the development. The payment is due in three (3) equal installments with the first falling due on the anniversary of this consent in 1993. Each remaining payment will fall due on the successive anniversaries of the consent. The contribution shall be in accordance with Councils contributions plan for coal related development and shall be based on the number of employees engaged by the applicant or contracted to the operation of the road, including office and ancillary staff.*

.../4

CERTIFIED AS
A TRUE COPY

....

DIRECTOR/SECRETARY

Construction and Operation

14. *Construction disturbance is to be limited to the minimum area required for that purpose. Neutral water is to be used for dust suppression. Construction activities are to be restricted to the hours of construction activity may only be carried out on Sundays in areas which will not cause noise disturbance to any residence. Such activity shall only be carried out with the permission of the Environmental Protection Authority and Greater Lithgow City Council as listed in the Statement of Environmental Effects or as amended by the Environmental Protection Authority.*

Roads

15. *The applicant shall comply with Council's requirements, including the provision of satisfactory temporary access during construction where the Haul Road crosses the Wolgan Road.*

16. *The applicant is to comply with all requirements of the Roads and Traffic Authority regarding the construction of the bridge over the Mudgee Road including satisfactory temporary access along that road during construction.*

Landscaping

17. *The rehabilitation plan is to include details of establishment of trees and shrubs to assist in screening the development, including earth works and haulage vehicles, to screen the development from public view. In particular, the emphasis is to be placed on the more visible sections of the road and where the Haul Road crosses public roads. Planting is to include both fast growing and slower growing but longer lived tree species, with the species to be chosen from those endemic to the area. The plan is to including regeneration of bushland in the treed areas of the site to assist in the movement of small ground animals.*

18. *The rehabilitation plan is also to include revegetation upon decommissioning of the site. Consideration is to be given to retaining certain sections of the road within the State Forest for use by the Forestry Commission of New South Wales.*

Environmental Monitoring

19. *All trucks transporting coal are to be fitted with covers designed so as to ensure that coal is not deposited along the roadway. Design of the covers shall be approved by Council. The applicant shall ensure that monitoring of water quality in the Cox's River both up and down stream of the crossing is carried out and reporting to the reasonable requirements of the Department of Water Resources and Council. Council reserves the right to require air pollution monitoring to be carried out and included within the annual report. Further works to ameliorate air pollution may be required.*

.../5

Annual Report

20. *An Annual Report is required in respect of environmental quality monitoring, with each report being carried out with respect to the calendar year ending 31st December, and each report shall be submitted by 31st March, of the following year. The applicant shall agree to Council making the report publicly available. The annual report shall provide information on erosion and pollution control from the Haul Route. The need for the report shall be reviewed by Council in two years time, dependant upon satisfactory performance.*

Transportation

21. *All coal to be transported to Mt. Piper Power Station from the Angus Place Mine shall be transported along the Haul Route. No transportation of coal from Angus Place Mine to Mt. Piper is to take place along public roads.*

Maintenance

22. *The roadway and pollution control devices are to be maintained to the satisfaction of Council and the relevant authorities to ensure that pollution is minimised. This includes maintenance of the road surface to ensure that noise control measures are retained.*

23. *All vehicles carrying limestone road base to the site shall be restricted to main roads and the existing haul road, with no use of the Wolgan Road.*

24. *The owner of the private coal haul road shall cause the subject private haul road to be effectively maintained at all times. The road pavement, gutters and shoulders shall be effectively swept and vacuumed at least once per month, or as required. All stormwater drainage off the roadway shall pass through a settling basin prior to discharging into a drainage line or water way. The water quality of the discharge from the settling basin shall meet the requirements at all times of the Clean Waters Regulations.*

Having regard to the provisions of Section 90 of the Environmental Planning and Assessment Act, 1979.

Condition	Section 90(1)
3, 4, 14, 19, 21, 22, 23, 24.	Having regard to the existing and likely future amenity of the neighbourhood. (Section 90(1)(o))
4, 5, 6, 14, 19, 20, 21, 22, 23, 24.	Having regard to the impact of the development on the environment (whether or not the subject of an environmental impact statement) and where harm to the environment is likely to be caused, any means that may be employed to protect the environment or the mitigate that harm. (Section 90(1)(b))
5, 15, 16, 21.	Having regard to the amount of traffic likely to be generated by the development, particularly in relation to the capacity of the road system in the locality and the probable effect of that traffic on the road system. (Section 90(1)(j))
4, 5, 6, 14.	To ensure the development does not cause soil erosion. (Section 90(1)(ml))
4, 7, 8, 14, 17, 18.	To ensure adequate provision has been made for the landscaping of the land to which the development application relates and whether any trees or other vegetation should be preserved. (Section 90(1)(m))
2, 3, 4, 5, 7, 8, 9, 10, 11, 12.	Having regard to any representations made by a public authority in relation to the development application, or to the development of the area, and the rights and powers of that public authority. (Section 90(1)(h))
13.	Having regard to the social and economic effect of the development. (Section 90(1)(d))
13.	Having regard to the Council's contribution plan for the coal related development. (Section 90(1)(a))

CERTIFIED AS A TRUE COPY

....

DIRECTOR/SECRETARY

Coal>Link.
AP – MT. P.

12552:GPN/106 ILR:MAJ
Environmental Services

ENVIRONMENTAL PLANNING & ASSESSMENT ACT, 1979
NOTICE TO APPLICANT OF DETERMINATION OF A DEVELOPMENT APPLICATION - *AMENDED CONSENT*

To Coal>Link Pty Limited of "Astrolabe", Rutherford Lane, Lithgow, being the applicant in respect of Development Application No. 105/92.

Pursuant to Section 92 of the Act, notice is hereby given of the determination by the consent authority of the Development Application No. 105/92 relating to the land described as follows: Various lands for the purpose of a private haul route.

The Development Application has been determined by GRANTING OF CONSENT SUBJECT TO THE CONDITIONS SPECIFIED IN THIS NOTICE.

The conditions of consent are set out as follows: SEE ATTACHED SCHEDULE.

The reasons for the imposition of the conditions are set out as overleaf.

Endorsement Date of Consent 14 September 1992

NOTES:

1. Subject to the provisions of Section 93 of the Act, consent shall become effective from the date of endorsement of the consent.
2. Subject to the provisions of Section 99 of the Act, any consent granted shall lapse is such development is not commenced within five (5) years from the date of endorsement.
3. Subject to the provisions of Section 97 of the Act, any applicant who is dissatisfied with the determination by the consent authority may appeal to the Land and Environment Court. The right of appeal may be exercised within twelve (12) months from the date of receipt of the consent notice.

DATED SEVENTEENTH DECEMBER 2002

MR IAIN STEWART
GENERAL MANAGER

PER: ____________________
MR ANDREW MUIR
ENVIRONMENT & PLANNING MANAGER

IMPORTANT:

(1) It is to be clearly understood that the above consent is NOT an approval to carry out any structural work. A formal Building Application must be submitted to Council and be approved before any structural work is carried out to implement the above consent. Also the applicant is not relieved of any obligation to obtain other approval required under any other Act.

SCHEDULE OF CONDITIONS:

1. That the haulage of coal on the Mt. Piper Haul Road be approved for 24 hour operation, 7 days a week.
2. Truck movements shall be limited to five loaded truck movements per hour between the hours of 9.30 pm and 7.00 am. That is a total of five movements from the mine and five return trips.
3. The level of noise emanating from the transport of coal on the coal haul road shall not exceed a Laeq sound pressure level equivalent to the measured background, La90T measured over a 15 minute period, plus 5dB(A) when measured at any point within 10 metres of any residential receptor.
4. If complaints are received from any resident from Lot 2 DP825887 & Lot 243 DP751651 regarding the haulage of coal along it, the applicant shall furnish to Council a noise assessment determining the impact of noise to that residence. All assessments are to be undertaken in accordance with the EPA's Industrial Noise Policy (INP). If it is found that noise is in excess of the EPA's INP, the applicant shall go into negotiations to rectify the noise complaint through either modifying the haul roads operation or undertake necessary works to the complainants house to minimise noise. If a solution cannot be rectified between the parties within six (6) months of the complaint, Council will appoint a mediator at the applicants expense to help formulate a solution.
5. That the applicant shall, prior to commencement of 24 hour haulage, prepare and implement a Noise Management Plan to the satisfaction of Lithgow City Council. The Plan shall be provided to Council within 12 months of this approval; and include,

- Details of the methods to be used for the periodic monitoring of noise to evaluate, assess and report the Leq(15minute) noise emission levels due to the normal operations of the haul road. The level of noise emitted from the premises must be monitored for at least 72 hours every 12 months at locations agreed to in consultation with Lithgow City Council. The monitoring must determine Laeq15min levels and include an assessment of the impact of operational noise at the nearest affected residence.
- Details regarding operating configuration; determining survey intervals; weather conditions and seasonal variations; selecting variations, locations, periods and times of measurements.
- Specify the procedures for a noise monitoring program for the purpose of undertaking independent noise investigations.
- Outline the procedure to notify property owners and occupiers likely to be effected by noise from the operations;
- Establish a protocol for handling noise complaints that include recording, reporting and acting on complaints, particularly where complaints are received and it is demonstrated noise levels are in excess of the criteria contained in this consent;
- Outline proactive/predictive and reactive mitigation measures to be employed on the site to limit noise emissions;
- Identify longer-term strategies directed towards reducing noise levels that exceed the noise target levels for the amenity of the area.

- Survey and investigate noise reduction measures from plant and equipment annually, subject to noise results and/or complaints received, and report in the AEMR at the conclusion of the first 12 months of operations and set targets for noise reduction taking into consideration valid noise complaints in the previous year.

6. The applicant will undertake landscaping along the haul road as to reduce the potential of headlight glare into the Sharps residence located along Wolgan Road. The landscaping should include both established and juvenile plants and shrubs. All plantings should be undertaken and inspected by Council prior to the commencement of 24 hour haulage. Any damaged or deceased plants are to be replaced after a 12 month inspection.

7 The applicant shall carry out the development of the haul road generally in accordance with the Development Application and the Statement of Environmental Effects, as modified by the following conditions.

8 The applicant is to meet the requirements of the relevant public authorities, including separate approvals where required. Copies of all approvals are to be provided to Council.

9 Prior to the commencement of construction all required approvals shall be obtained from the Environment Protection Authority and the development shall be conducted in accordance with the terms of those approvals and licences. The applicant is required to verify that bund walls will be appropriately located.

10 The applicant is to obtain all approvals required by the Department of Water Resources.

11 Alternative access is to be provided along Crown Roads when and if required to the satisfaction of the Regional Director. Minimum batters are to be 1:2 or to the satisfaction of the Regional Director, where vegetation is to be established for stabilisation with preferred batter slopes of 1:3. For cuttings, dependant upon rock material, batter slopes may be steeper where vegetative stabilisation is not possible.

12 The proponent, its construction company and subcontractors will consult with and will provide maps and plans to the Department of Conservation and Land Management in respect to the Soil Management Plan, erosion and Sediment Control Plan, Water Management Plan and Rehabilitation Plan and will carry out all these works to the satisfaction of the Department of Conservation and Land Management.

13 The workshop and store site and any other temporary construction areas are to be rehabilitated and revegetated at the end of construction. Details are to be included in the Rehabilitation Plan.

14 The proponent, its construction company and subcontractors will consult with the Department of Conservation and Land Management in respect to any application required to destroy or injure any tree (being tree, sapling, shrub or scrub) on land being identified as being protected

land under the Soil Conservation Act, 1938.

15 Detailed plans showing the location of the proposed haul road in relation to old mine workings are to be prepared and submitted to the District Inspector of Coal Mines.

16 Where the proposed haul road is to pass over or be constructed within 50 metres or less of old mine workings, the District Inspector of Coal Mines must be notified immediately prior to construction.

17 Prior to the proposed haul road passing over old underground mine workings, and if required by the District Inspector of Coal Mines, a detailed engineering study must be undertaken by the proponent, Coal>Link Pty Limited, to address the capability of the stratum overlying these old mine workings to support the construction and use of the proposed haul road.

18 The extraction and removal of any coal, as part of the construction phase for the proposed haul road, must be undertaken in compliance with the Mining Act, 1992, and the Coal Mines Regulation Act, 1982.

19 The applicant shall pay the Council a contribution pursuant to Section 94 of the Environmental Planning and Assessment Act for community facilities for Council to utilise in the upgrading of facilities provided and to be provided in the City of Lithgow, as result of the development. The payment is due in three (3) equal instalments with the first falling due on the anniversary of this consent in 1993. Each remaining payment will fall due on the successive anniversaries of the consent. The contribution shall be in accordance with Council's Contributions Plan for Coal Related Development and shall be based on the number of employees engaged by the applicant or contracted to the operation of the road, including office and ancillary staff.

20 Construction disturbance is to be limited to the minimum area required for that purpose. Neutral water is to be used for dust suppression. Construction activities are to be restricted to the hours of construction activity may only be carried out on Sundays in areas which will not cause noise disturbance to any residence. Such activity shall only be carried out with the permission of the Environment Protection Authority and Lithgow City Council as listed in the Statement of Environmental Effects or as amended by the Environment Protection Authority.

21 The applicant shall comply with Council's requirements, including the provision of satisfactory temporary access during construction where the haul road crosses the Wolgan Road.

22 The applicant is to comply with all requirements of the Roads and Traffic Authority regarding the construction of the bridge over Castlereagh Highway including satisfactory temporary access along that road during construction.

23 The rehabilitation plan is to include details of establishment of trees and shrubs to assist in

screening the development, including earth works and haulage vehicles, to screen the development from public view. In particular, the emphasis is to be placed on the more visible sections of the road and where the haul road crosses public roads. Planting is to include both fast growing and slower growing but longer lived tree species, with the species to be chosen from those endemic to the area. The plan is to include regeneration of bushland in the treed areas of the site to assist in the movement of small ground animals.

24 The Rehabilitation Plan is also to include revegetation upon decommissioning of the site. Consideration is to be given to retaining certain sections of the road within the State Forest for use by the Forestry Commission of New South Wales.

25 All trucks transporting coal are to be fitted with covers designed so as to ensure that coal is not deposited along the roadway. Design of the covers shall be approved by Council. The applicant shall ensure that monitoring of water quality in the Cox's River both upstream and downstream of the crossing is carried out and reporting to the reasonable requirements of the Department of Water Resources and Council. Council reserves the right to require air pollution monitoring to be carried out and included within the annual report. Further works to ameliorate air pollution may be required.

26 An annual report is required in respect of environmental quality monitoring, with each report being carried out with respect to the calendar year ending 31 December and each report shall be submitted by 31 March of the following year. The applicant shall agree to Council making the report publicly available. The annual report shall provide information on erosion and pollution control from the haul route. The need for the report shall be reviewed by Council in two years time, dependant upon satisfactory performance.

27 All coal to be transported to Mt. Piper Power Station from the Angus Place Mine shall be transported along the haul route. No transportation of coal from Angus Place Mine to Mt. Piper is to take place along public roads.

28 The roadway and pollution control devices are to be maintained to the satisfaction of Council and the relevant authorities to ensure that pollution is minimised. This includes maintenance of the road surface to ensure that noise control measures are retained.

29 All vehicles carrying limestone roadbase to the site shall be restricted to main roads and the existing haul road, with no use of the Wolgan Road.

30 The owner of the private coal haul road shall cause the subject private haul road to be effectively maintained at all times. The road pavement, gutters and shoulders shall be effectively swept and vacuumed at least once per month, or as required. All stormwater drainage off the roadway shall pass through a settling basin prior to discharging into a drainage line or waterway. The water quality of the discharge from the settling basin shall meet the

requirements at all times of the Clean Waters Regulations..

Having regard to the provisions of Section 90 of the Environmental Planning and Assessment Act 1979.

Condition	Section 90(1)
10,11,21,26,28,29,30,31	Having regard to the existing and likely future amenity of the *neighbourhood*. (Section 90(1)(o))
1,7,11,12,13,21,26,27,28,29,30,31	Having regard to the impact of the development on the environment (whether or not the subject of an *environmental impact statement*) and where harm to the environment is likely to be caused, any means that may be employed to protect the environment or the mitigate that harm. (Section 90(1)(b))
2,3,4,5,6,12,22,23,28	Having regard to the amount of traffic likely to be generated by the development, particularly in relation to the capacity of the road system in the locality and the probable effect of that traffic on the road system. (Section 90(1)(j))
11,12,13,21	To ensure the development does not cause soil erosion. (Section 90(1)(ml))
11,14,15,21,24,25	To ensure adequate provision has been made for the landscaping of the land to which the development application relates and whether any trees or other vegetation should be preserved. (Section 90(1)(m))
9,10,11,12,14,15,16,17,18,19	Having regard to any representations made by a public authority in relation to the development *application*, or to the development of the area, and the rights and powers of that public authority. (Section 90(1)(h))
20	Having regard to the social and economic effect of the development. (Section 90(1)(d))

20 Having regard to the Council's contribution plan for the coal related development.
(Section 90(1)(a))

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

File N°: 04/1675

The Company Secretary
Centennial Angus Plan Pty Ltd
c/- Centennial Coal Company
PO Box 1000
TORONTO NSW 2283

Dear Sir/Madam

Re: Angus Place Colliery Longwalls 930- 980 Subsidence Management Plan

Please find attached the revised set of conditions that amends Conditions 9 and 14 of the approval for the Subsidence Management Plan application for Longwalls 930 - 980 dated October 2006 (including the "SMP Approved Plan" Drawing No. (AP6076)SMP2006VAR/Approved), and supporting supplementary information. These conditions now refer to the correct references. All other conditions remain the same as those approved by the Deputy Director-General dated 29 Dec 2006. Please note that these conditions supercede the conditions dated as above.

Should you be uncertain about any aspect of this approval, please contact Michael Lloyd, Subsidence Executive Officer, on (02) 4931 6603.

Yours faithfully

Elise Newberry
A/Director
Environmental Sustainability

19 Jan '07

APPENDIX A

Approval Conditions and Exclusions, Subsidence Management Plan for Longwalls 930 - 980.
ANGUS PLACE COLLIERY

Extent of Approval

1. Definitions

   In this document:

   "longwall mining" means the extraction of the longwall panels covered by the SMP.

   "SMP" means the Subsidence Management Plan for the workings shown on the SMP Approved Plan as set out in the *Angus Place* Colliery *Longwalls 930 – 980 Subsidence Management Plan Application Variation* dated October 2006 and supplementary supporting information provided to the Department.

   "SMP Approved Plan" means Plan No. (AP6076)SMP2006VAR/Approved titled 'Subsidence Management Plan 1st & 2nd Workings, signed by the Mine Manager on 20 November 2006 and approved by the Director General, NSW Department of Primary Industries.

2. The SMP is approved subject to the conditions set out in this document. The SMP, as modified by these conditions, must be implemented by the leaseholder. If there is any inconsistency between the approved SMP and the following conditions of this approval, the following conditions shall prevail to the extent of the inconsistency. The approved SMP also includes:

   a) 'Kangaroo Creek Management Plan' dated September 2006

   b) 'Newnes Plateau Shrub Swamp Management Plan' dated March 2006

   c) 'Subsidence Community Consultation Process' dated September 2006

   d) 'Environmental Monitoring Program' dated March 2006.

3. **Statutory Requirements** – This approval is granted pursuant to the requirements of the applicant's mining lease. The conditions of this approval are taken to be conditions of the mining lease and are enforceable as such.

   Any other necessary approvals, consents, licenses or permits by any Government Authorities under relevant legislation in relation to subsidence due to the extraction of the subject panels must be obtained and kept up-to-date before any surface or sub-surface features and/or areas, which are regulated under such legislation, are affected by any subsidence arising from the extraction of the subject panels.

   This approval does not constitute an approval under Section 138 *Coal Mines Regulation Act 1982.*

4. Longwall mining as set out in the SMP may be carried out until January 2014 or the expiry of Consolidated Coal Lease 704 or Mining Lease 1424, whichever occurs earlier. The Director-General may, at his or her discretion, extend this term upon request. The obligations set out in the SMP, as modified by this approval and any subsequent written notice of the Director-General, continue until the Director-General notifies the leaseholder that no further action is required.

5. The Director-General may vary the conditions of this approval by notice in writing at any time.

   The Director-General may, at his or her discretion, suspend or revoke this approval if:

   (a) the leaseholder fails to adhere to any condition of the approval; or

   (b) the head of any other government agency requests suspension or revocation on the basis of the leaseholder's non-compliance, or potential non-compliance, with legislation administered by that agency due to activities relating to this approval.

6. These approval conditions relate to the proposed extraction by longwall methods in the Lithgow Seam only.

7. **Notification** –The leaseholder shall give notice of this SMP approval to the Department of Planning, Department of Natural Resources, Department of Environment and Conservation, City of Greater Lithgow Council, Mine Subsidence Board, NSW State Forests, Hawkesbury Nepean Catchment Authority, Sydney Catchment Authority, NSW Heritage Office, Bathurst Local Aboriginal Land Council, the owners/operators of any infrastructure and landowners in the application area and any other relevant government agencies or stakeholders as listed in the *Guideline for Application for Subsidence Management Approvals*, that Director General's approval of the proposed Subsidence Management Plan has been granted. This notification and its distribution list shall be provided to the Director, Environmental Sustainability, within one month from the date of this approval.

Subsidence Management Conditions

8. The Leaseholder shall develop and implement a program to ensure on-going baseline data collection, investigation, assessment and regular reviews with the relevant stakeholders. A review schedule shall be developed in consultation with these stakeholders. The review schedule shall be submitted to the Director Environmental Sustainability within four months of this approval. The Leaseholder shall undertake further reviews if such reviews are requested by the Director Environmental Sustainability or the Principal Subsidence Engineer.

9. The required on-going baseline data collection, investigation, assessment and reviews shall aim to identify appropriate management measures to mitigate and/or remediate subsidence impacts. The Leaseholder shall ensure that management reviews are conducted in consultation with the relevant stakeholders, prior to subsidence of any important surface features or as otherwise determined in the said review schedule as per Condition 8.

10. The Leaseholder shall regularly seek advice and/or feedback from the relevant stakeholders, with regard to the adequacy, quality and effectiveness of the implemented management processes and the need for any appropriate management measures, early response actions or emergency procedures to ensure adequate management of any potential subsidence impacts due to longwall mining.

11. **Subsidence Monitoring** - The Leaseholder shall undertake a subsidence monitoring/reporting program for the subject panels. This program shall include but not be limited to any proposed inspection regimes, layout of monitoring points, parameters to be measured, monitoring methods and accuracy, timing and frequencies of surveys and inspections. It shall be agreed to by the Principal Subsidence Engineer prior to the commencement of longwall mining. The Leaseholder must implement any changes to the monitoring/reporting program, if required by the Principal Subsidence Engineer during the development of subsidence arising from longwall mining.

Subsidence Reporting

12. **End of Panel Report** - The Leaseholder shall prepare an end of panel report to encompass all environmental and subsidence monitoring, including a comparison of actual impacts with predicted subsidence impacts. This report shall be submitted to the Director, Environmental Sustainability, within three months of extraction being completed for each longwall panel.

13. The Leaseholder shall provide to the Mine Subsidence Board, the owners/operators of any infrastructure and the Director Environmental Sustainability and Principal Subsidence Engineer of the Department of Primary Industries, notification within 24 hours of occurrence or identification of the following during the development of subsidence caused by longwall mining. The same information shall also be made available to other relevant stakeholders if requested.

    a) Any observed subsidence impacts adverse to groundwater resources and/or the natural environment that may be affected by longwall mining;

    b) Any observed subsidence impacts adverse to the serviceability and/or safety of infrastructure and other built structures that may be affected by longwall mining;

    c) Any significant unpredicted and/or higher-than-predicted subsidence and/or abnormalities in subsidence development in any surface areas that may be affected by longwall mining;

d) Any adverse subsidence impacts reported by any relevant stakeholder, and

e) Any other relevant information requiring prompt notification.

Note: Pursuant to paragraph (e) of the subsidence management condition in the leaseholder's Coal Lease, the SMP is also subject to the requirements for subsidence monitoring and reporting set out in the document '*New Approval Process for Management of Coal Mining Subsidence – Policy* (2003)'. The monitoring and reporting requirements set out in that document apply, as modified by these conditions.

Implementation of Approved SMP

14. The Leaseholder shall prepare and regularly up-date a Subsidence Management Status Report until the completion of subsidence in the application area. This Status Report shall be provided to the Mine Subsidence Board, the Director of Environmental Sustainability and Principal Subsidence Engineer of the Department of Primary Industries. This Report shall also be made available to other relevant stakeholders if requested. It shall be submitted at a minimum four monthly interval from the date of this approval, or at any other interval as required in writing by the Director Environmental Sustainability or the Principal Subsidence Engineer, and shall include but not be limited to:

a) Face position of the longwall panel being extracted;

b) A summary of any management actions undertaken by the Leaseholder;

c) A summary of the results of consultation with the stakeholders as per Condition 10;

d) A summary of the observed and/or reported subsidence impacts, incidents, service difficulties, community complaints, and any other relevant information reported as per Condition 13;

e) A summary of subsidence development based on monitoring information from the subsidence monitoring programs, including a statement with regard to any identified trend in the development of ground deformations/subsidence movements in the application area, as compared with any defined triggers and/or the predicted subsidence to facilitate early detection of potential subsidence impacts;

f) A summary with regard to the adequacy, quality and effectiveness of the implemented management processes based on the monitoring and consultation information summarised above, and

g) A statement regarding any management actions to be undertaken or the need for early responses or emergency procedures to ensure adequate management of any potential subsidence impacts due to longwall mining.

Miscellaneous Conditions

15. **Infrastructure** –The Leaseholder shall develop a management plan to ensure the safety and serviceability of any infrastructure that may be affected by subsidence arising from longwall mining. The management plan shall be implemented to the satisfaction of the owners/operators of the said infrastructure.

16. **Public Safety** – The Leaseholder shall implement a public safety management plan to ensure public safety in any surface areas that may be affected by subsidence arising from longwall mining. This plan shall include, but not be limited to, regular monitoring of areas or infrastructure/structures posing safety risks, erection of warning signs, entry restrictions, backfilling of dangerous surface cracks and securing of unstable built structures or rockmass where required and appropriate, and the provision of timely notification of mining progress to the community and any other relevant stakeholders where management of public safety is required. The plan shall be developed and implemented to the satisfaction of the District Inspector of Coal Mines.

17. **Archaeological and Heritage Sites** - The Leaseholder shall ensure full compliance with any statutory requirements of the Department of Environment and Conservation and the Heritage Office, with regard to any archaeological and heritage sites that may be affected by subsidence arising from longwall mining or during the remediation of impacted areas.

APPENDIX 7.3

Surface Water Assessment

Centennial Angus Place Pty Ltd

Angus Place Colliery
Surface Water Assessment

October 2010

FUTURE POWER | Centennial Coal

Contents

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Appendices

Glossary

910 Dewatering bore	Proposed dewatering bore at the inbye end of proposed Longwall 910.
940 Dewatering bore	Existing dewatering bore within Longwall 940.
Aquifer	Underground water storage within either disturbed or undisturbed strata.
Aquitard / Aquiclude	Less permeable strata, not permeable enough to yield economic quantities of water.
Average Recurrence Interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, eg. floods with a discharge as big as, or larger than, the 100-year ARI flood event will occur on average once every 100 years. ARI is equal to the reciprocal of annual flood risk, e.g. an annual flood risk of 1/100 has an ARI of 100 years.
Bore	A constructed connection between the surface and a source of underground water that enables the underground water to be transferred to the surface either naturally or through artificial means
Clean catchment areas	Catchments in which there are no exposed surfaces containing coal or mined carbonaceous material.
Clean water	Waters on the premises that have not come into physical contact with coal, or mined carbonaceous material.
Coal Handling Plant	A facility where coal is screened and prepared for transport off-site.
Continuous miner	The electric powered cutting machine used to remove coal from the working face and load it into the shuttle car. It is also used to form mine roadways and extract coal pillars.
Confined aquifer	Aquifer confined between two aquitards.
Dewatering	Transfer of water from underground workings to the surface.
Dirty catchment areas	Catchments in which coal mined carbonaceous materials are present or areas where the topsoil has been disturbed.
Dirty water	Water on the premises that has come into physical contact with coal, mined carbonaceous materials or otherwise contains an elevated sediment load.
Electrical Conductivity	A measure of concentration of dissolved salts in water.
Fractures	Cracks within the strata either natural or resulting from underground works.
Groundwater	Water held in strata that is not overlying the strata of the coal seam, or within the coal seam.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks of the earth's crust.
Infiltration	Natural flow of surface water through ground surfaces as a result of rainfall events.

Inbye	Direction towards the mining face of the coal seam.
Interburden	The strata between coal seams.
Licensed Discharge Point	A location where Angus Place Colliery discharges water in accordance with conditions stipulated within the site Environment Protection License.
Lithgow seam	Deepest coal horizon of the Permian Age Illawarra Coal Measures, with an average depth of 380 metres at Angus Place.
Longwall	Longwall mining is a form of underground coal mining where a block of coal is mined using a longwall shearer. The longwall mining method is supported by roadway development, mined using a continuous miner unit.
Net extraction	Difference between water transferred from and to the underground water storage.
Oil Water Separator	Device designed to separate oil and suspended solids from water.
Overburden	The strata between the recoverable topsoil and the upper coal seam.
Partial Extraction	A continuous miner system of mining whereby some of the coal pillars in a panel, or parts thereof, are systematically extracted.
Permian Age	The youngest geological period of the Palaeozoic era, covering a span between approximately 290 and 250 million years.
pH	A measure of the acidity / alkalinity or water as a result of potential hydrogen ion concentration.
Project	Extension of underground coal mining and associated activities at Angus Place Colliery within the mining lease area.
Recharge	Inflow of water from surrounding strata into underground workings through infiltration. This can be as a result of rainfall events or from surrounding aquifers.
Run of Mine	Raw coal production (unprocessed).
Sediment-laden water	Water that has a high level of suspended solids.
Steady state condition	A condition in which the system has achieved equilibrium.
Subsidence	The vertical lowering, sinking or collapse of the ground surface.
Surface Water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Temporary storage	Volume of storage available within a dam between the permanent water level and the overflow level.
Total Suspended Solids	Particles that are suspended in a measured volume of water.
Turbidity	A measure of water cloudiness caused by the amount of suspended matter in the water.
Unconfined aquifer	An aquifer in which the water table forms the upper boundary.

Underground water	Water stored in underground aquifers. During the mining process a proportion of this water is released and managed by the underground settling and pumping system.

Abbreviations

AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARI	Average Recurrence Interval
BOM	Bureau of Meteorology
CHP	Coal Handling Plant
DECCW	Department of Environment, Climate Change and Water
DoP	Department of Planning
DI&I	Department of Industry and Investment (formerly Department of Primary Industries – Mineral Resources)
SDWTS	Springvale - Delta Water Transfer Scheme
EA	Environmental Assessment
EC	Electrical Conductivity
EP&A Act	Environmental Planning and Assessment Act 1979
EPL	Environment Protection Licence
kL	Kilolitres
kL/day	Kilolitres per day
LDP	Licensed Discharge Point
m	Metres
MB	Monitoring bore
ML	Megalitres
ML/day	Megalitres per day
Mt	Million tonnes
Mtpa	Million tonnes per annum
NoW	New South Wales Office of Water
NMQMS	National Water Quality Management Strategy
PA	Project Approval
PoEO Act	Protection of the Environment Operations Act 1997
ROM	Run of Mine
STP	Sewage Treatment Plant

SWMP	Surface Water Management Plan
T	Tonnes
TSS	Total Suspended Solids
WMAct	Water Management Act 2000

Executive Summary

The Angus Place Colliery operation is a joint venture owned in equal share between Centennial Cola Company Limited and SK Kores and is an underground mining operation for which the management of both surface and underground water is an important issue.

The objective of this surface water assessment was to examine the existing conditions with respect to both surface and groundwater and to determine the potential impact of the proposed operations on current and proposed water management systems.

The aspects of the water system that were investigated included:

- Clean water management.
- Dirty water management.
- Underground water management.
- Overall site water balance.
- Water quality.

The key components of the Project that would potentially impact water management were determined to be the development of two new longwalls, construction of a dewatering bore and the construction of surface water management controls.

Construction of the water management controls within the pit top and Run of Mine stockpile areas will enable greater management of dirty water however they will not have any significant impact on the volume of discharges through Licensed Discharge Point 002.

During the construction of both the pit top water management controls and the proposed 910 dewatering bore, the adoption of a range of standard sediment and erosion control measures would result in these works having minimal impact on the surface water within the Angus Place Colliery and therefore minimal impact on the downstream receiving waterways.

The development of the longwalls is likely to increase the volume of underground water entering the mine as a result of depressurisation however no detailed modelling is currently available to quantify the potential additional mine water make. The geologic profile previously developed for Angus Place indicates that the lower confined aquifers contribute to the goaf associated with the extraction of coal. The location of aquitards between the lower confined and upper unconfined aquifers result in negligible impact on the upper aquifer as a result of mining.

An assumption of an increase of 20l/s for each new longwall was therefore made for the purposes of the water balance. It was further assumed that the increase in mine water would directed to the existing 940 bore however for operational reasons, this could vary with a potential that the additional mine water make would be discharged through Licensed Discharge Point 001. On this basis, it was determined that the construction of the additional longwalls has the potential to contribute an additional 3.5 ML/day to the Springvale - Delta Water Transfer Scheme through the 940 dewatering bore.

Discharges through Licensed Discharge Point 002 and Licensed Discharge Point 003 were determined to be directly correlated to rainfall event based runoff. As the Project will not result in a variation to the catchment area contributing to each of these discharge points, the predicted annual discharges through these licensed discharge points will not be impacted by the Project.

The total average daily volume of mine water discharged from Angus Place Colliery was estimated from the water balance to be approximately 11 ML/day. As this is a daily average only, it is likely that operational variations will result in larger daily volumes in some instances. Therefore, it is recommended that the current volumetric licence condition nominated within Environmental Protection Licence 467 for Licensed Discharge Point 001 (30 ML/day) be maintained to provide operational flexibility. This flexibility would only be required in the event that no discharge through the Springvale - Delta Water Transfer Scheme (or the associated emergency discharge point Licensed Discharge Point 006) can occur.

A review of the quality of discharges from Angus Place Colliery indicated that the 80th percentiles of pH, total suspended solids and oil and grease for Licensed Discharge Points 001, 002, 003, 005 and 006 were within the concentration limits of Environmental Protection Licence 467 with the exception of total suspended solids through Licensed Discharge Point 003. Treatment measures that could be put in place to reduce the total suspended solid concentrations through Licensed Discharge Point 003 are currently being investigated by Centennial Angus Place.

A review of the ANZECC/ARMCANZ (2000) default trigger values, indicated that there were several additional parameters that exceeded the recommended concentration limits. These primarily included electrical conductivity, iron, lead and zinc. A review of the background ambient concentrations indicated that higher concentrations of iron and zinc were a characteristic of the natural catchment and therefore no treatment has been investigated.

While the electrical conductivity of discharges from Angus Place Colliery were found to be higher than the recommended level for upland rivers, they remained in the lower end of the brackish scale. In order to determine if there has been an unacceptable adverse impact on the environment within Kangaroo Creek and Coxs River, Centennial Angus Place proposes to undertake toxicity and ecological assessments. Furthermore, investigations into transfer and/or treatment options for mine water will be progressed should such measures be identified as being required through the toxicity and ecological assessments.

As the Project includes extension of existing underground operations and no additional surface disturbances (other than the construction of clean water diversions), the impact on water quality as a result of the Project is considered to be negligible.

The development of the proposed longwalls also has the potential to impact existing watercourses. The alignment of longwall 910 is overlain by West Wolgan Creek (a second order stream) while longwall 900W is overlain by two first order tributaries of Kangaroo Creek.

Minor surface cracking and deformation (subsidence predictions between 0 and 100 m) is anticipated to occur within the Kangaroo Creek tributaries as a result of mining however the long term geomorphologic impacts, as a result of changes to longitudinal gradients and surface cracking, are expected to be negligible.

Surface deformation due to subsidence, surface cracking and ponding (as a result of the development of longwall 910) is anticipated within West Wolgan Creek. The existing gradient of West Wolgan Creek is considered to be relatively steep therefore the degree of grade change due to surface deformation is not anticipated to have a significant impact on existing erosion rates despite the Wollongambe soil landscape.

Additionally, the bed of West Wolgan Creek exhibits an alluvial valley fill composed of sand and silt, which will result in limited potential for surface cracking and re-routing of surface flows to sub-surface flows. The development of cracks within creeks or drainage lines may result in the sub-surface re-routing of surface flows particularly where the bed of channels are composed of bedrock. This impact is generally temporary in nature as bed load sediments deposit within cracks, sealing them over several storm events. It is further noted that the estimated volume of predicted ponding is limited to 0.05ML and the impact on flow transfers downstream is considered to be negligible.

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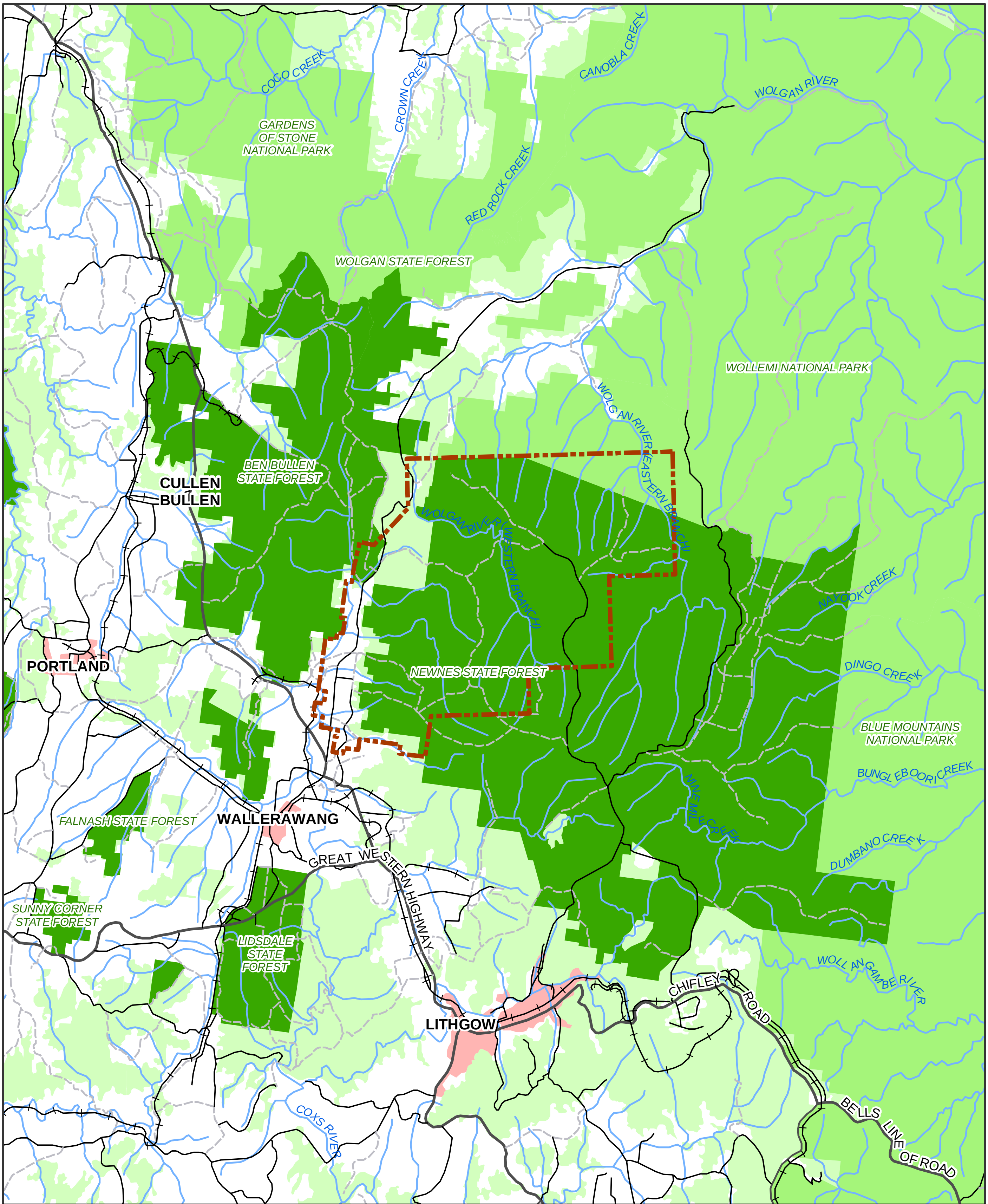
1. Introduction

Angus Place Colliery (Angus Place) exists as a joint venture company owned in equal share between Centennial Coal Company Limited and SK Kores. Angus Place was acquired from Powercoal Pty Ltd in August 2002. Angus Place is located five kilometres north of the village of Lidsdale, eight kilometres northeast of the township of Wallerawang and fifteen kilometres north of the city of Lithgow as shown on Figure 1.1.

Angus Place is bordered by Baal Bone Colliery and Invincible Colliery to the north, Centennial Springvale Coal to the south and the Wolgan Valley and Newnes Plateau to the north-east. The Angus Place pit top lies within the Coxs River Catchment, reporting to the Sydney Catchment area, with the mining lease area traversing both the Coxs and Wolgan River catchment areas, the latter of which reports to the Hawkesbury Nepean Catchment.

Angus Place commenced production in 1979, after being developed as an extension of the Newcom Mine at Kerosene Vale. Coal is extracted from the Lithgow Seam primarily by the operation of a longwall shearer and supporting continuous miner units developing access headings. Coal is currently extracted for domestic power generation at both Wallerawang and Mount Piper power stations.



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0 1.25 2.5 5 7.5

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

- Watercourse
- Railways
- Dual Carriageway
- Principal Road
- Secondary Road
- Minor Road
- Track
- State Forest
- Nature Conservation Reserve
- Forest or Shrub
- Angus Place Colliery Holding Bdy

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Locality Plan

Centennial Angus Place

DATE 16-08-2010

Figure 1.1

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig1_1_Locality_20100301.mxd

1.1 Modification Overview

The Modification aims to continue underground mining operations at Angus Place, which are supported by existing surface infrastructure, through the development and extraction of two additional longwall panels, extending the life of Angus Place to 2016.

Specifically, the Modification proposed to include the following:

- Development and extraction of longwalls 910 and 900 west (900W). 910 is directly north of the extracted 920 panel with 900W due west of the current mains headings. With regard to longwall 910, two options are proposed. This is because there may be a potential resource area situated to the north east of the proposed longwall area and, if this is the case, future access to this resource would be most efficient if it is accommodated within this proposed modification. A geological and geotechnical investigation, as well as a preliminary feasibility assessment, will be undertaken and the findings will inform the choice of option. The two options for Longwall 910 are
  - Option 1: In the event that the north eastern area is not considered viable, Longwall 910 will be approximately 200m wide and 2500m in length and allow the development of two mains headings.
  - Option 2: In the event that the north eastern area is considered viable, Longwall 910 will be approximately 2500m in length and 120m in width to allow the development of four mains headings to enable future access to the resource in the north east.
- Increase the production limit to four (4) million tonnes per annum. This seeks to make a provision for 12 consecutive months of production in the event Angus Place does not have a three month shut down due to a longwall changeover. The intensity of mining will not change. However, an increase of the annual production limit would allow a continuation in production in the event that a shutdown due to a longwall changeover (typically 6 weeks) is not required.
- Installation of a dewatering bore facility at the eastern end of Longwall 910. Infrastructure required to support the operation of this installation is as follows:
  - An access track to the site from Blackfellows Hands Road.
  - Powerline extension along the access tracks to supply electricity. This will likely be an extension of the existing 930 and 940 dewatering bore power line.
  - Extension of the Springvale – Delta Water Transfer Scheme, in terms of an underground corridor (to accommodate the underground pipeline) along the proposed dewatering bore access track. This will enable Angus Place to continue to transfer extracted groundwater to Delta Electricity's Wallerawang power station, reducing demand on water extracted by Delta from the Coxs River catchment.
- Assessment of the current Angus Place water management infrastructure. Recommendations developed from the findings of the pit top surface water assessment will be considered for implementation to improve the dirty water management system.
- Increase in personnel from the currently approved 215 to 225. In addition, up to 75 temporary contractors will be required to assist with underground development activities for up to 15 months.

Angus Place Colliery is seeking Project Modification Approval under Section 75W of Part 3A Major Projects of the *NSW Environmental Assessment and Planning Act 1979* (EP&A Act) for the proposed extension of the Angus Place Colliery (the Project).

1.2 Modification Project Area

The Modification project area includes the following, which are regionally illustrated on **Error! Reference source not found.**:

- Surface area above the two proposed longwalss 910 (Options 1 and 2) and 900W on Newnes Plateau, the dewatering borehole and supporting infrastructure (access track, powerline and pipeline).
- The Angus Place pit top.
- Private haul roads and Wolgan Road.

Proposed Additional Longwalls

Under Option 1, Longwall 910 is orientated in an east – west direction and is located parallel to the north of the existing 920 panel. Longwall 910 is located predominately within ML 1424 and partially within CCL 704. Longwall 910 is planned to be approximately 200m wide and 2500m long. It is anticipated that Option 1 will produce approximately 2,620,720 tinnes.

The layout of Longwall 910 Optino 2 remains in the same orientation as Option 1 however is reduced in width to approximately 120m. This allows the development of 4 mains headings to the north of Longwall 910 to enable access to potential resources situated to the north – east of the current extraction area. The length is planned to be approximately 2500m. It is anticipated that Option 2 will produce approximately 1,855,600 tonnes.

Longwall 900W is located directly west of the existing 950-980 panels and is orientated perpendicular to these panels in a north - south orientation. Development of longwall 900W will extend south beyond the 980 Panel. Longwall 900W is located predominantly in CCL 704, with a small portion within ML 1424 and it will extend partially into Centennial Springvale's ML 1326 (to gain separate lease area). Longwall 900W is planned to be 283.5m wide and 2079.7m in length. It is anticipated that Longwall 900W will produce 3,009,810.

Proposed Dewatering Bore

The proposed borehole and supporting infrastructure are to be situated on the Newnes Plateau at the eastern end of longwall 910. Minor land preparation will be required at this site to install and maintain the borehole. As the disturbance area exists within the Newnes State Forest, an Occupation Permit will be sought from the landowner.

Angus Place Pit Top

From an existing assessment, a specific issue has been detected to occur at the run of mine stockpile. Essentially, contaminated runoff from the stockpile, as a result of heavy rainfall, is channelled through the car park drainage system directly to two shallow sediment ponds prior to discharge via Licensed Discharge Point 002. An optimum solution has already been investigated and is planned for implementation to improve the system. This specific modification to the pit top dirty water management system aims to ensure that all contaminated stockpile runoff will be diverted to the coal handing plant sediment ponds, increasing residence time and enhancing settling ability.

Private Haul Roads

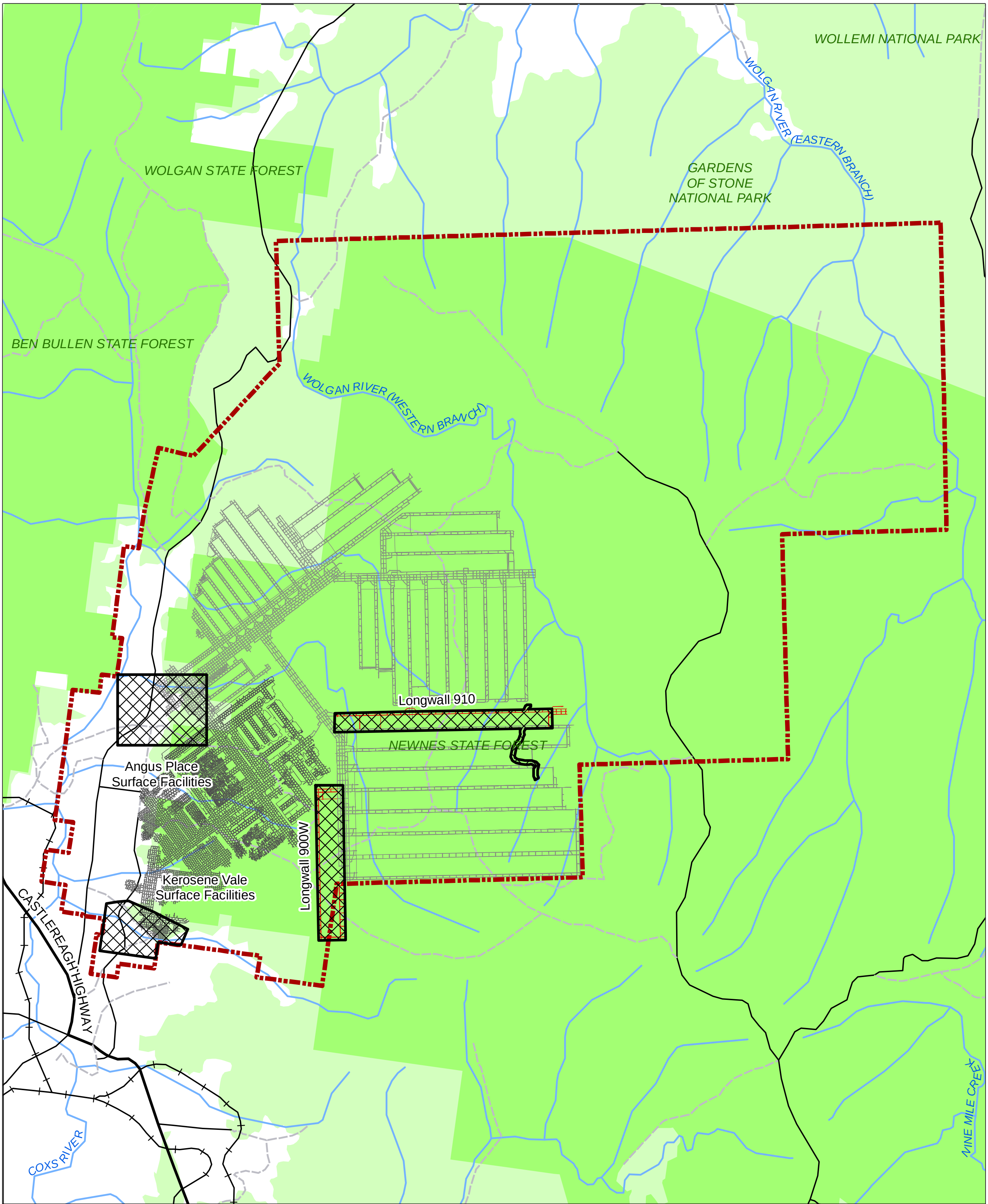
Angus Place holds Project Approval to transport 3.5 million tonnes per annum to Wallerawang Power Station, via the Wallerawang Haul Road and Mount Piper Power Station via the Mount Pipe Haul Road. The modification proposed to increase the allowable haulage limit of coal along these private haul roads to 4 million tonnes per annum. The increase in production limit to 4 million tonnes per annum may result in air quality and noise impacts to sensitive receptors.

Wolgan Road

The minor increase in personnel from 215 to 225 is considered to be a low risk; however, up to 75 temporary contractors will be required to assist with development activities over an approximate 15 month period. To that end, a light vehicle traffic assessment will be conducted along the Wolgan Road to determine what, if any, potential impacts may result from the proposed increase in personnel. In addition, a car parking assessment will also be undertaken.

Interaction with Old Workings

Longwall 910 maingate roadways will intersect the previously driven maingate roadways of Longwall 18. There is the possibility of localised water storage in Longwall 18 maingate roadways, which will be managed in accordance with the Angus Place Inrush Management System (as required under the *Coal Mine Health and Safety Regulations, 2006*). Due to the general seam dip to the north-east, known floor levels throughout the mine, and existing dewatering infrastructure in 300 Panel, it is not expected that additional long term dewatering infrastructure will be required to manage the interaction with these old workings.



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0 0.25 0.5 1 1.5 2 2.5
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

- Site Location
- Watercourse
- Railways
- Principal Road
- Secondary Road
- Minor Road
- Track
- Existing Workings
- Kerosene Vale "Newcom" Workings
- Proposed Workings
- State Forest
- Forest or Shrub
- Angus Place Colliery Holding Bdy
- Study Area

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Study Area

Centennial Angus Place

DATE 16-08-2010

Figure 1.2

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1.3 Objectives of this Report

The objectives of this surface water assessment are to:

- Assess the potential impacts of construction and operation of the Project on water management.
- Address the Director General Requirements of Section 75W of the EP&A Act in relation to water management.

The Director General's Requirements have identified a number of key issues relating to water. Table 1.1 outlines the nominated requirements and where they have been addressed within this report.

Table 1.1 Director General's Requirements

Director General's Requirements	Where addressed in this report
Detailed modelling of potential surface water impacts.	Section 5.
A revised site water balance.	Section 4.7, Section 5, Appendix A.
A detailed assessment of potential impacts on the quality and quantity of surface water resources.	Section 5.
A detailed description of the proposed modification to the mine's water management system, water monitoring program and measures to mitigate surface water impacts.	Section 5 and Section 6.

In addition to the Director General's Requirements, a review of individual agency letters was undertaken. A summary of the relevant aspects that have been addressed within this report are provided in Table 1.2.

Table 1.2 Agency Requests

Agency Letters	Where addressed in this report
Sydney Catchment Authority: - Water management. - Separation of clean and dirty water. - Water quality. - Impact on water management. - Impact on water quality	Section 4.2, 4.3, 4.8, 5.1 and 5.4.
Hawkesbury-Nepean Catchment Management Authority: - Water quality.	Section 4.8 and 5.4.

Agency Letters	Where addressed in this report
New South Wales Office of Water: ◗ Surface water management. ◗ Underground water management. ◗ Detailed site water balance. ◗ Water quality.	Section 4.2, 4.3, 4.8, 5.1 and 5.4.

1.4 Scope of Work

The scope of work for this investigation included:

- Confirmation of surface and groundwater management systems.
- Assessment of the surface water system within the pit top.
- Review of surface and groundwater water quality data.
- Establishment of a detailed site water balance.
- Application of the detailed site water balance to quantify the water budget for Angus Place Colliery for the Project.

2. Legislation

2.1 Legislation

The following section provides a brief overview of the legislation relevant to water investigations for the Project.

Environmental Planning and Assessment Act 1979, Section 75W

The Environmental Planning and Assessment Act 1979 (EP&A Act), administered by the NSW Department of Planning outlines the core legislation relating to planning and development activities in NSW and provides the statutory framework under which development proposals are assessed. Under this legislation, Part 3A provides for the control of major projects that require approval from the Minister for Planning. Part 3A has therefore been identified as the application pathway for the Angus Place Colliery modification.

Section 75W of the EP&A Act outlines the environmental assessment requirements applicable to the modification.

This report provides the results of a surface water impact assessment for the Project, which was undertaken to satisfy the requirement relevant to surface water for the Project.

Protection of the Environment Operations Act 1997

The objectives of the *Protection of Environment Operations Act 1997* (PoEO Act) are to protect, restore and enhance the quality of the environment. Some of the mechanisms that can be applied, under the PoEO Act, to achieve these objectives include reduction of pollution at source, monitoring and reporting of environmental quality.

Environmental Protection Licences (EPL's), issued under the PoEO Act, are a means by which the impact on the environment is regulated. For Angus Place Colliery, the relevant Environmental Protection Licence is EPL 467.

Water Act 1912, Part V

The *Water Act 1912* governs access, trading and allocation of licences associated with both surface and underground water for water sources where a water sharing plan has not been put in place. The elements to which the *Water Act 1912* applies include extraction of water from a river, extraction of water from underground sources, aquifer interference and capture of surface runoff in dams.

Part 5 of the *Water Act 1912* governs the management of groundwater sources within areas where a water sharing plan has not commenced. Within the Angus Place Colliery lease area, there are two existing licensed bores and the conditions associated with each include volumetric limits on the extraction of groundwater.

Water Management Act 2000

The *Water Management Act 2000* (WMAct) is intended to ensure that water resources are conserved and properly managed for sustainable use, benefiting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for the protection of catchment conditions.

2.2 Policy

The following section provides a brief overview of the policy documents relevant to water investigations for the Project.

National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000a)

The *National Water Quality Management Strategy* (NWQMS) provides a national framework to improving water quality in Australia's waterways. The main policy objective of the NWQMS is to achieve sustainable use of the nation's water resources; protecting and enhancing their quality, while maintaining economic and social development. The NWQMS process involves community and government development, and implementation of a management plan for each catchment, aquifer, estuary, coastal water or other water body. This includes use of high-status national guidelines with local implementation. National guidelines relevant to the Project are provided for water quality benchmarks and groundwater management.

National Water Quality Management Strategy Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000b)

As part of the NWQMS, there are a number of policies, procedures and guidelines that are nationally accepted for the undertaking of monitoring and reporting of water quality. This applies to fresh, groundwater and marine waters. For the Project these would be applied to surface and groundwater sampling.

Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECCW, 2004)

The Approved Methods for the Sampling and Analysis of Water Pollutants in NSW lists the sampling and analysis methods to be used when acquiring water samples when complying with an environmental protection legislation, licence or notice.

Managing Urban Stormwater: Soils and Construction (Vol. 1)

Managing Urban Stormwater: Soils and Construction (Vol 1) outlines the basic principles for the design and construction of sediment and erosion control measures. This document relates particularly to urban development sites however it is relevant to the Project, as it provides guidance on the configuration of erosion and sedimentation controls required during construction of the Project.

Managing Urban Stormwater: Soils and Construction (Vol. 2E)

Managing Urban Stormwater: Soils and Construction (Vol 2E) provides guidelines, principles and recommended minimum design standards for good management practice in erosion and sediment control during the construction and operation of mines and quarries. Volume 2E provides guidance in the application of the principles and practices of erosion and sediment control described in Volume 1 of Managing Urban Stormwater: Soils and Construction (Landcom 2004) to mines and quarries.

Managing Urban Stormwater: Source Control (EPA 1998)

The intent of this document is to provide guidance to local and state government agencies and developers, as well as community and business groups on a range of source control (water quality and quantity) techniques that can be adopted to minimise impacts of works on the surface water environment. It highlights the need for pollutant control using sustainable cost-effective structural and non-structural methods such as swales, basins and gross pollutant traps.

This document provides guidance to the Project for the selection of suitable source control measures where appropriate.

3. Methodology

To establish the potential impact of the Project the existing hydrologic, hydraulic and water quality conditions needed to be established. The existing condition assessment was based on a desktop study and field investigations.

3.1 Desktop Study

For the desktop component of the assessment of a number of tasks were undertaken including:

- Identification of waterways and drainage lines within the study area, based on the Department of Lands topographic information, in accordance with the *Water Management Act* 2000.
- Review of the existing Site Water Management Plan.
- Review of the Annual Environmental Management Report 2008.
- Review of existing Water Management maps including the documentation of clean and dirty water catchment delineation.
- Development of a detailed water balance model.
- Assessment of water quality data in relation to background and ANZECC trigger values and the *Drinking Water Catchments Regional Environmental Plan No.1*.

3.2 Field Investigations

A site inspection was conducted on 22 February 2010 to confirm the extent of clean and dirty water catchments and presence of surface water management measures implemented on site. An additional site inspection was undertaken on 24 and 25 May 2010 to confirm the details of the water management system for the development of the detailed water balance model.

4. Existing Environment

4.1 Coal Production Process

The coal production process at Angus Place Colliery comprises extraction, transfer to surface storage facilities, processing (crushing and screening) and transportation off site to Wallerawang and Mount Piper Power Stations. A schematic of the coal production process is provided in Figure 4.1 while Figure 4.2 indicates the location of the pit top facilities.

4.2 Water Management

Angus Place Colliery is located in the upper reaches of the Coxs River catchment, upstream of several of existing water storages as shown on Figure 4.3. These water storages include Lake Wallace, Lake Lyell and Warragamba Dam all of which are artificial dams.

Lake Wallace was constructed in 1978 to supply cooling water to the Wallerawang Power Station and is located approximately 4 kilometres downstream of the Angus Place Colliery lease boundary.

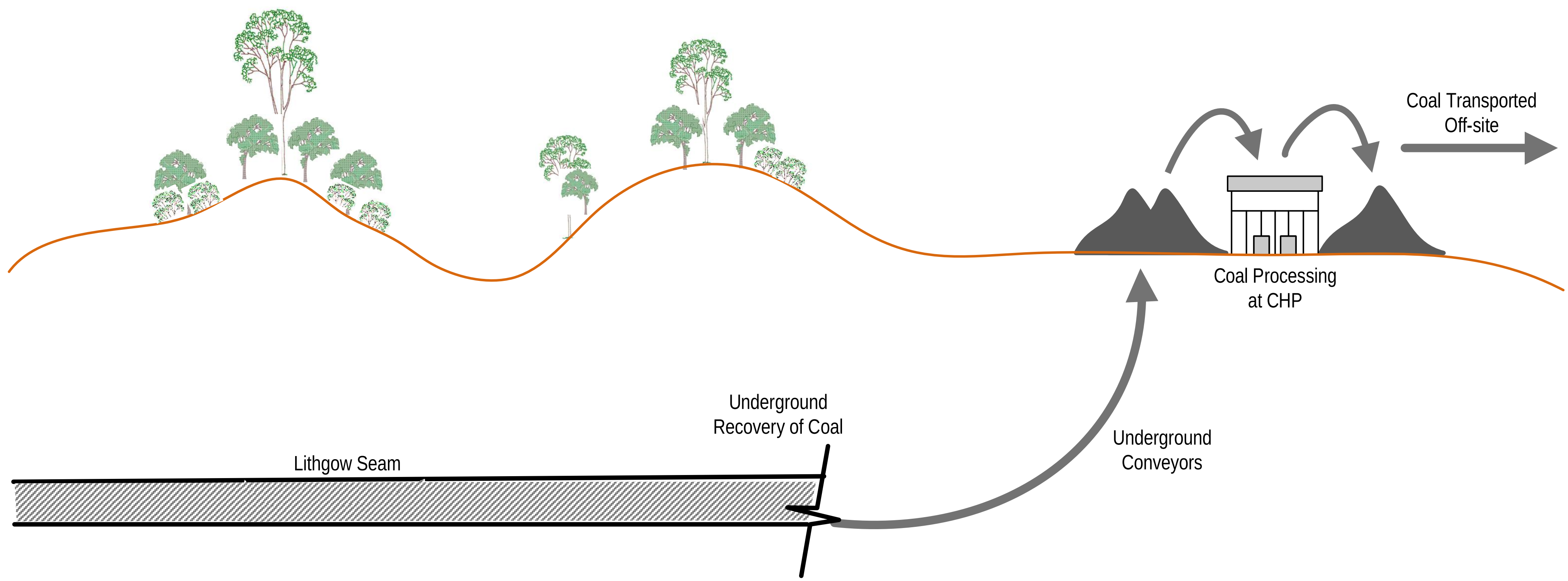
Lake Lyell is a further 12 kilometres downstream and was also constructed to supply cooling water to Wallerawang Power Station. Additionally, Lake Lyell also provides cooling water to Mt Piper Power Station and Thompson's Creek Dam (a secondary water storage for the provision of cooling water to Mt Piper Power Station).

Warragamba Dam (Sydney's major water supply) is located a further 95 kilometres downstream of Lake Lyell and receives inflows from a number of watercourses including Coxs River.

Angus Place Colliery's Environment Protection Licence (EPL) 476 includes both volumetric and concentration limits for the discharge of water off site.

The location of the licensed discharge points is indicated on Figure 4.4 and includes:

- LDP001 - Discharge of mine water make and runoff into Kangaroo Creek through wetlands.
- LDP002 - Discharge of surface water from the Angus Place Colliery pit top facilities into the Coxs River through settling ponds.
- LDP003 – Rainfall event based discharge of surface water from the old Kerosene Vale Colliery site into the Coxs River through a settling pond.
- LDP005 - Discharge of treated sewage effluent from Angus Place Colliery via a spray irrigation network to a designated utilisation area.
- LDP006 - Emergency discharge location for the 940 dewatering bore on the Newnes Plateau. This is situated in the Wolgan/Colo Catchment.



Coal Movement

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	MJP
CHECKED	IBJ
APPROVED	IBJ
SCALE	

Angus Place Colliery
Surface Water Assessment

Coal Process Schematic

Centennial
Angus Place

DATE 12-10-2010

Figure 4.1

GHD

LEGEND

- Pollution Control Structures
- Pollution Control Wetlands
- Buildings
- Infrastructure
- Creek
- Contour

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Surface Facilities

Centennial Angus Place

DATE 16-08-2010

Figure 4.2

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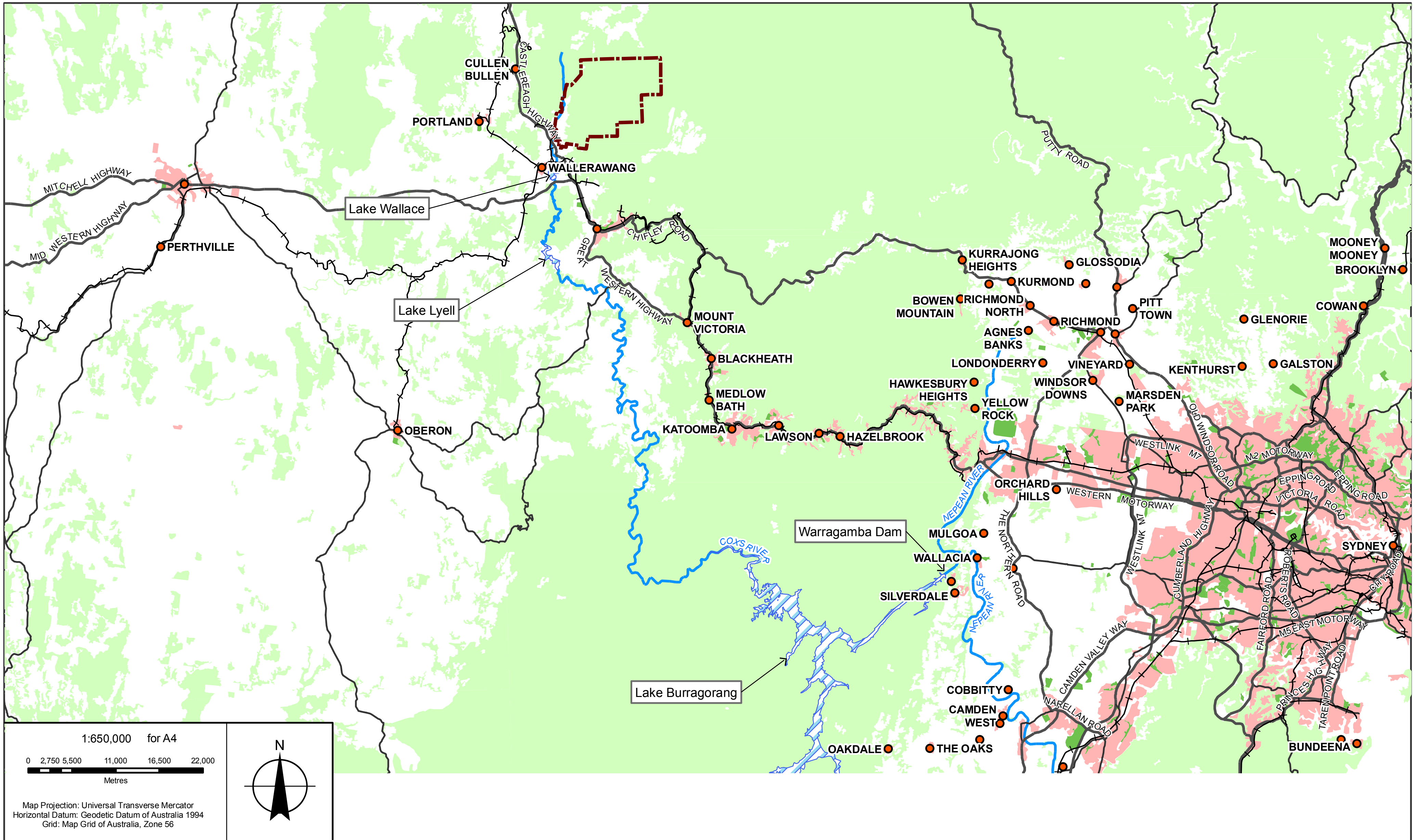


LEGEND

- Angus Place Colliery Holding
- Principal Road
- Secondary Road
- Reservoir
- Watercourse
- Built Up Area
- Recreation Area
- Forest Or Shrub

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

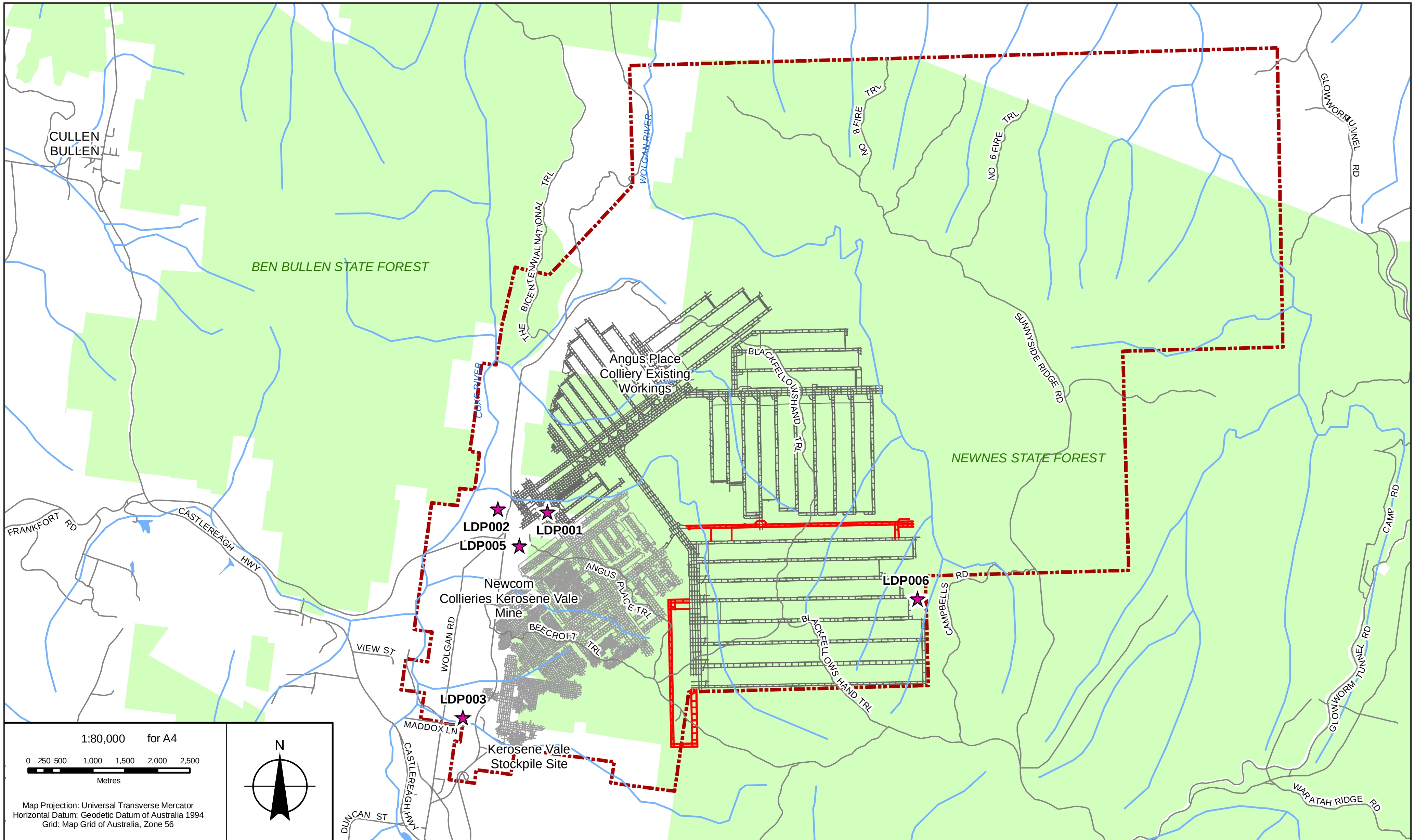
Angus Place within
Coxs River Catchment

Centennial
Angus Place

DATE 22-07-2010

Figure 4.3

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig4-3_Cox_River_Catchment_20100625.mxd



LEGEND

- Licensed Discharge Points
- State Forests
- Angus Place Colliery Holding
- Roads
- Existing Workings
- Kerosene Vale "Newcom" Workings
- Proposed Workings

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Licensed Discharge Point Locations

Centennial Angus Place

DATE 16-08-2010

Figure 4.4

GIS Filename: G\22\14985\GIS\MAPS\Deliverables\2214985_Fig4_4_DischargePts_20100624.mxd

The existing water management system at Angus Place Colliery was developed in accordance with EPL 467, the conditions of Project Approval PA 06_0021 and the "Statement of Commitments" which were committed to as part of the previous Lease Extension Project Approval Process.

The primary objectives for this system are discussed in detail in the *Site Water Management Plan Angus Place Colliery* (GSSE, 2007) and include:

- The separation of clean and dirty water.
- Maximising water recirculation.

Diversion of clean water runoff around the pit top, to avoid contamination, reduces the volume of water reporting to the dirty water management system. The Site Water Management Plan (SWMP) also discusses the inclusion of a range of other measures to achieve these objectives including sedimentation ponds, wetlands, oil water separators, regular monitoring of water quality and identification of potential risks to water quality.

Within the water management system there are five (5) categories of water including underground water, dirty water, clean water, waste and potable water that contribute to either the surface or underground water system. A schematic of the overall water management system is provided in Figure 4.5.

4.3 Surface Water

There are two surface water management areas associated with the surface facilities at Angus Place Colliery. These are the area encompassing the pit-top facilities at Angus Place and the Kerosene Vale site, south of the Angus Place pit top facilities shown on Figure 4.6.

Angus Place Pit Top

The Angus Place pit top is the location of the surface facilities that support the current extraction operations for Angus Place Colliery and are as previously indicated on Figure 4.2.

Clean Water Management

The clean water system consists of a series of diversion bunds and drains which intersect clean water runoff before it enters disturbed areas, thereby reducing the volume of dirty water runoff. The clean catchment areas are provided in Figure 4.7 while the diversion structure locations are provided in Figure 4.8.

Dirty Water Management

Dirty water runoff from the workshop, washdown bay and pit top are directed to the workshop grit trap and oil water separator before being directed to the two (2) settling ponds on the western side of Wolgan Road. These pollution control ponds discharge through LDP002.

Dirty water runoff from the coal handling plant (CHP) and upper stockpile area is directed through a series of four (4) pollution ponds before also being directed to the settlement ponds on the western side of Wolgan Road and subsequently discharging through LDP002.

Water within this dirty water system is treated through the addition of flocculants prior to discharge.

The dirty catchment areas are shown in Figure 4.7 and the dirty water diversion structure locations are provided in Figure 4.9.

Water Management Structures

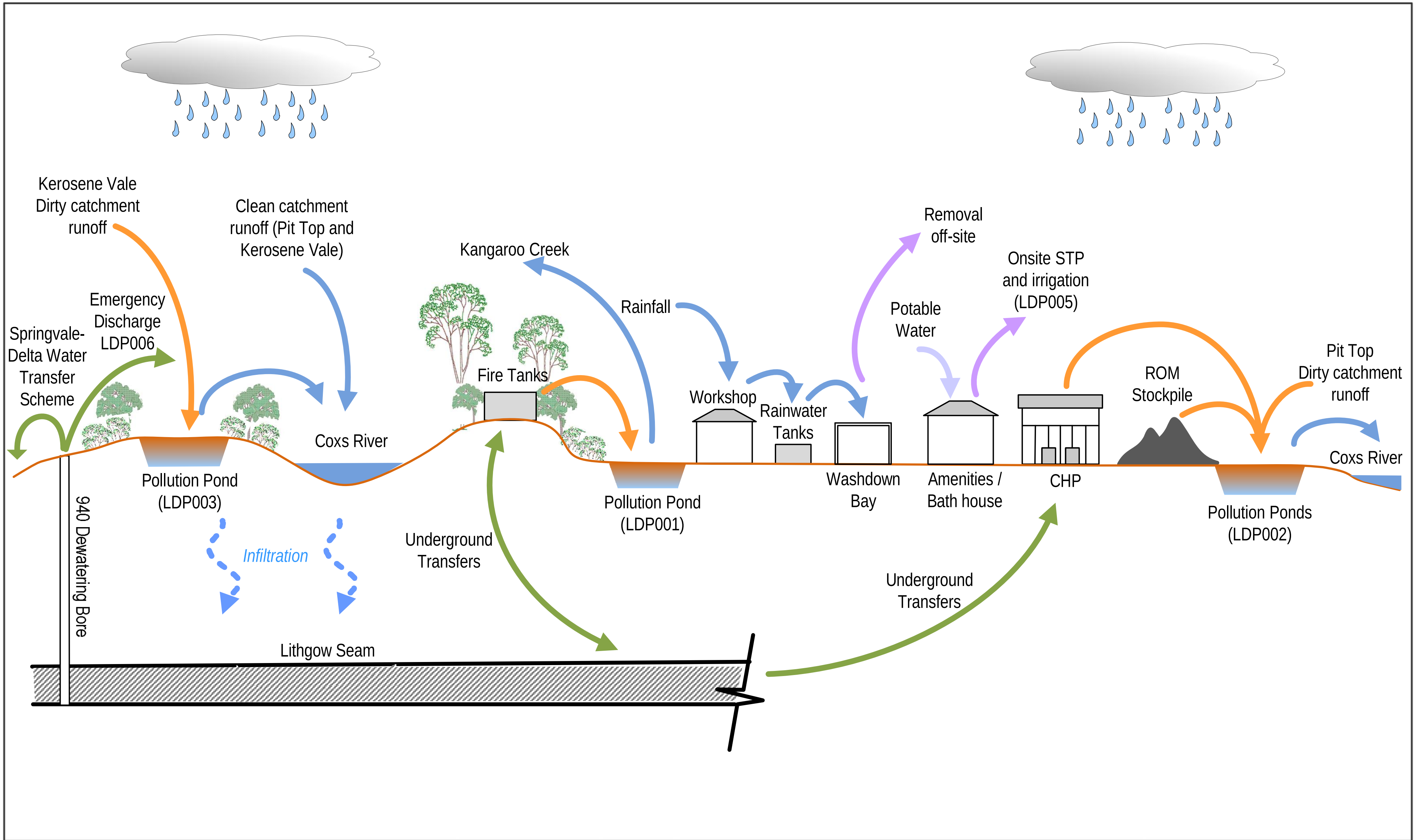
Details of the water management structures associated with the Angus Place Colliery pit top are provided in Table 4.1.

Table 4.1 Angus Place Pit Top Water Management Structures

Location	Capacity (ML)
Fire Fighting Tanks	0.2
Aerating Ponds and Wetlands (LDP001)	5.0
Oil / Water Separator	0.1
Primary Pollution Ponds	1.9
Secondary Pollution Pond	2.6
Filter Pond	1.2
Settling Ponds (West of Wolgan Road – LDP002)	7.5
Potable Water Tanks	0.3
Oxidation Ponds (LDP005)	7.0

The capability of a number of these water management structures, to cater for a maximum 1 in 100 year average recurrence interval (ARI) design storm event, was previously assessed by Connell Wagner Pty Ltd (2008). Through that investigation, it was determined that the existing spillways associated with each of the four (4) pollution ponds did not have the capability to cater for the 1 in 100 year peak flow rate from the contributing catchments.

Consequently, recommendations were made for upgrade works to each of the four (4) pollution ponds. These recommendations, along with upgrades to the ROM stockpile, are to be adopted as part of this Project. These upgrade works are discussed in Section 5.1 and the capacity of the overall existing surface water system is discussed in Section 4.7.



LOCATION	Angus Place
SEAM	Lithgow
DRAWN	MJP
CHECKED	IBJ
APPROVED	IBJ
SCALE	

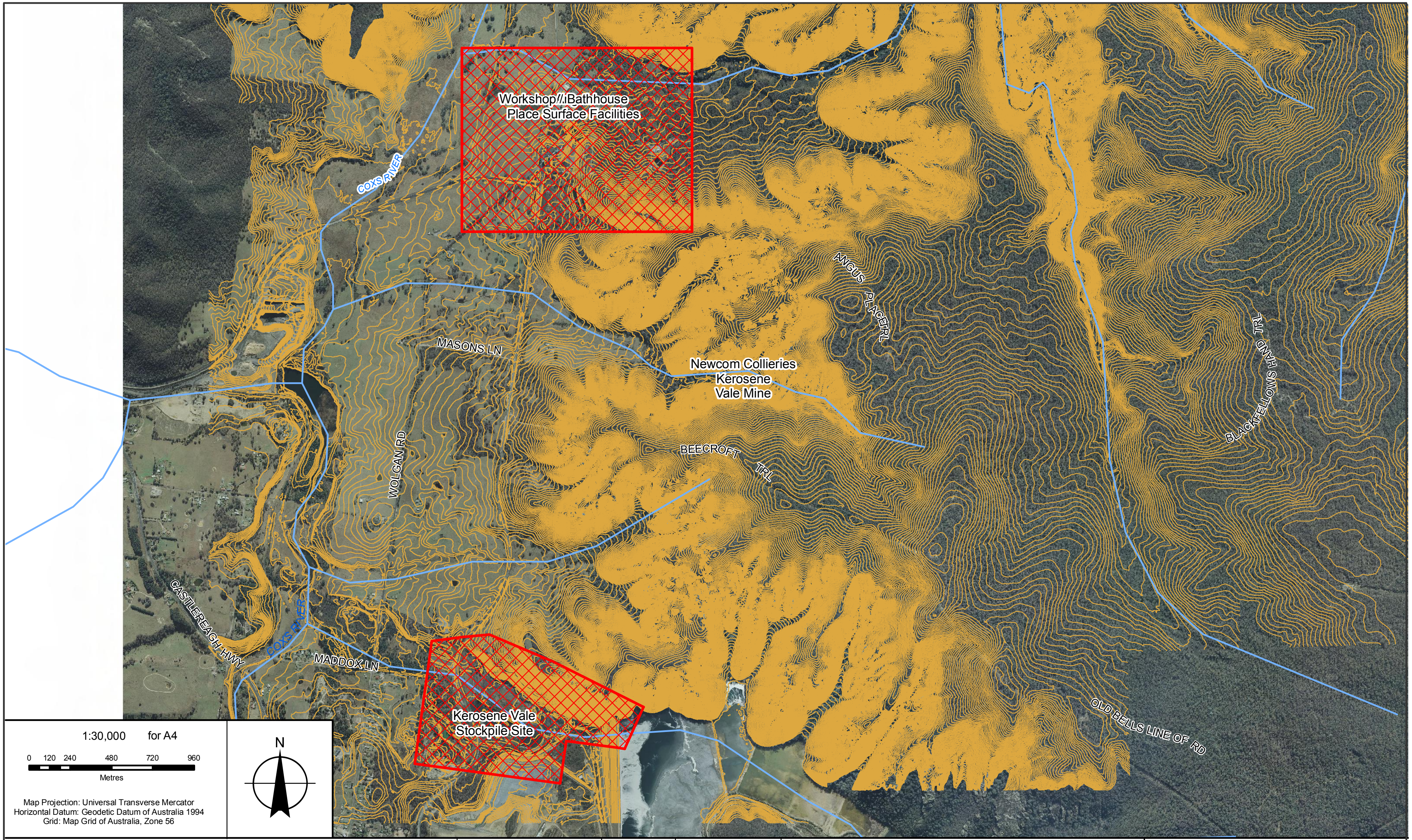
Angus Place Colliery
Surface Water Assessment

Water Management Schematic

Centennial Angus Place

DATE 30-09-2010

Figure 4.5



GHD

LEGEND

- Contours
- Creeks
- Management Areas

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

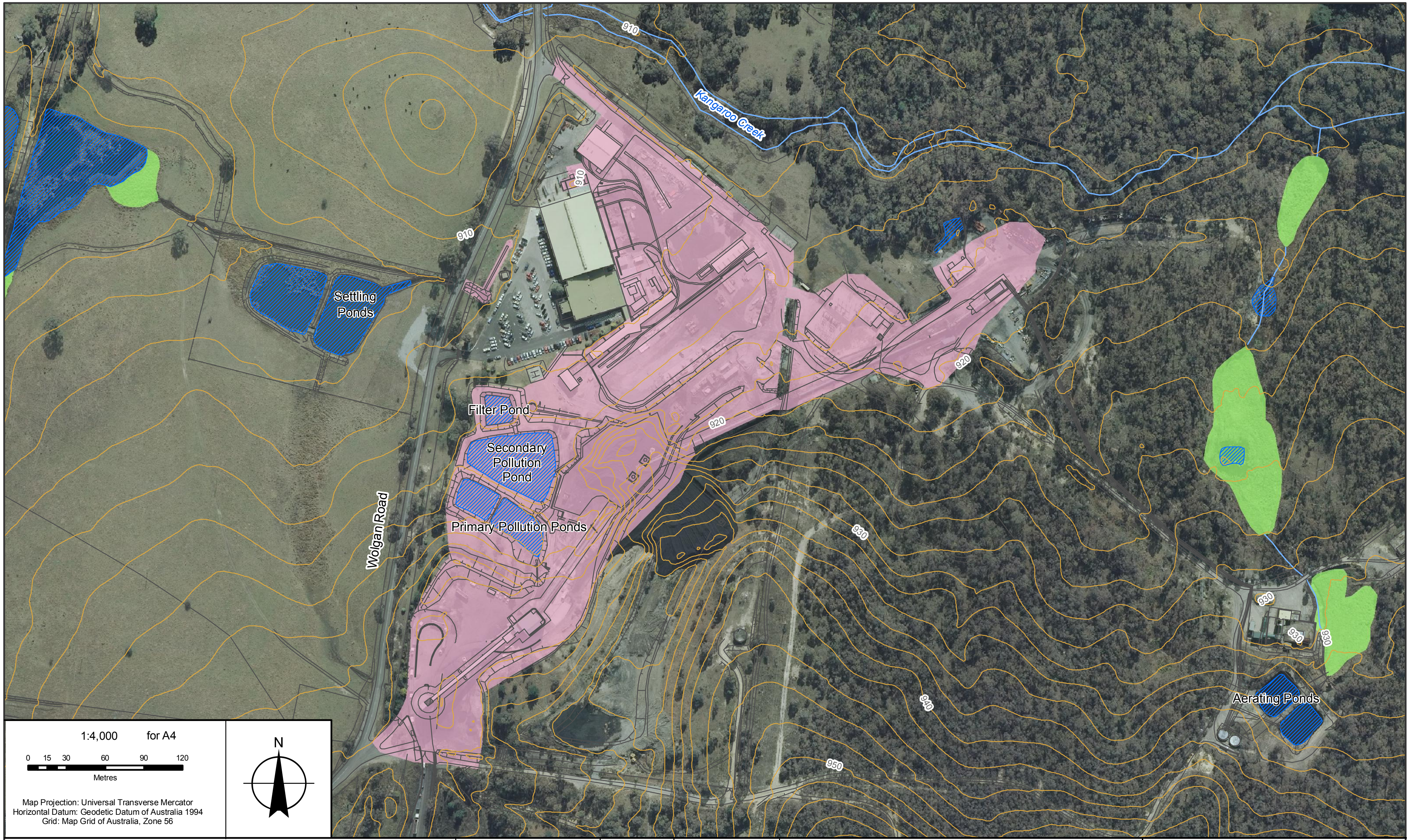
Location of Surface Water
Management Areas

Centennial
Angus Place

DATE 22-07-2010

Figure 4.6

GIS Filename: G\22\14985\GIS\MAPS\Deliverables\2214985_Fig4-6_SurfaceWater_ManagementAreas_20100624.mxd



GHD

LEGEND

- Infrastructure
- Creek
- 2m Contours
- Pollution Control Structures
- Wetlands
- Dirty Water Catchment
- Clean Water Catchment

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Angus Place
Clean and Dirty Water Catchment Areas

Centennial Angus Place

DATE 24-06-2010

Figure 4.7

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig4-7_Catchments_20100624.mxd

GHD

LEGEND

- Infrastructure
- Creek
- 2m Contours
- Pollution Control Structures
- Wetlands
- Existing Clean Water Diversions

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Angus Place
Existing Clean Water Diversions

Centennial Angus Place

DATE 16-08-2010

Figure 4.8

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig4_8_CleanWaterDiversions_20100624.mxd

GHD

LEGEND

- Infrastructure
- Creek
- 2m Contours
- Pollution Control Structures
- Wetlands
- Existing Dirty Water Diversions

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Angus Place
Existing Dirty Water Diversions

Centennial Angus Place

DATE 16-08-2010

Figure 4.9

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig4_9_DirtyWaterDiversions_20100624.mxd

Kerosene Vale

Kerosene Vale was a previous underground mine within the Angus Place Colliery mining lease area. Since the closure of those operations, Kerosene Vale has been used as a stockpile area with a capacity to cater for up to 500,000 tonnes of coal.

A small area of the Kerosene Vale site has been rehabilitated however a large portion of the site consists of compacted chitter, fines and a small area of stowage. As there are currently no plans for any additional coal extraction in the vicinity of the Kerosene Vale site, it is proposed to continue rehabilitation of this location thereby decreasing the area of dirty water catchment.

Clean Water Management

Clean water diversion bunds are located on the northern side of the main stockpile area and impede runoff entering the disturbed area. The clean catchment areas and diversion structure locations are provided in Figure 4.10.

Dirty Water Management

Dirty water runoff from the Kerosene Vale stockpile area and the partially rehabilitated pit top area, are directed through two settling ponds (with a total volume of 2.5 M) which discharge through LDP003. The dirty catchment areas and diversion structure locations are provided in Figure 4.11.

Water Management Structures

This system was included in of the detailed water balance however, the capacity of individual elements was not considered as the catchment areas contributing to each structure will not be altered as a result of the Project.

Watercourses

There are a number of named and un-named watercourses that either originate in or pass through the lease boundary area associated with Angus Place Colliery. Each of these watercourses contributes to Coxs River and the named watercourses include Kangaroo Creek and the Wolgan River. Figure 4.12 shows all of the watercourses within the Angus Place Colliery lease area and the catchments associated with Wolgan River and Coxs River.

Both Kangaroo Creek and Coxs River are directly impacted as a result of discharges from the pit top however mine workings are beneath several other watercourses including Wolgan River. Additionally, emergency discharges from LDP006 contribute a tributary of the Wolgan River.

GHD

LEGEND

- Clean Water Diversions
- Clean Water Catchment
- Settling Ponds
- Infrastucture
- Drain
- 10m Contours

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

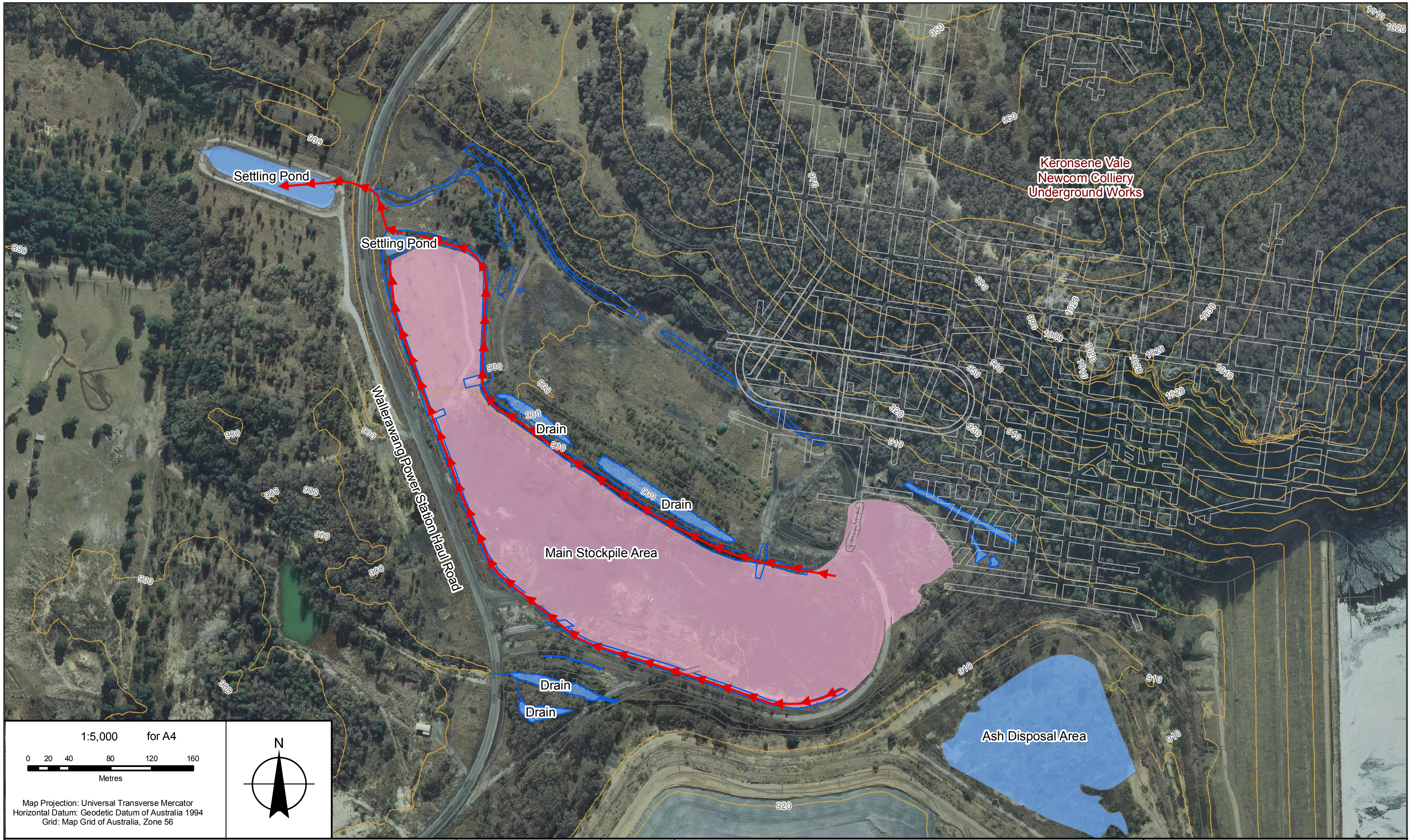
Kerosene Vale Clean Water
Catchment and Diversions

Centennial
Angus Place

DATE 24-06-2010

Figure 4.10

GIS Filename: G:\22\14985\GIS\Maps\Deliverables\2214985_Fig4-10_KeroVale_CleanWater_20100624.mxd



LEGEND

- Dirty Water Diversions
- Dirty Water Catchment
- Settling Ponds
- Infrastructure
- Drain
- 10m Contours

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

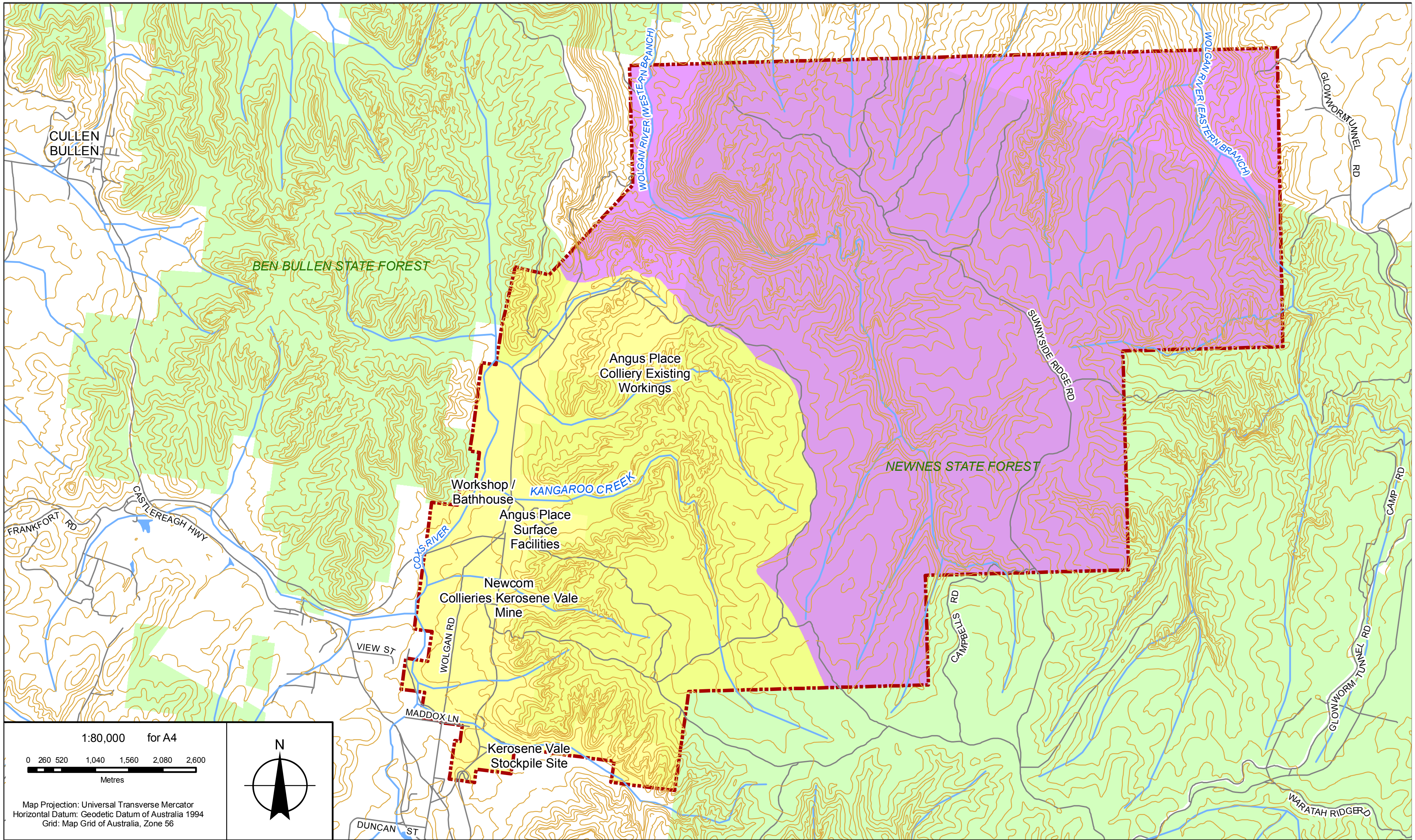
Kerosene Vale Dirty Water
Catchment and Diversions

Centennial
Angus Place

DATE 24-06-2010

Figure 4.11

GIS Filename: G:\22\14985\GIS\Maps\Deliverables\2214985_Fig4-11_KeroVale_DirtyWater_20100624.mxd



LEGEND

Angus Place Colliery Holding
Roads
Watercourse
Coxs River Catchment
Wolgan River Catchment
State Forests

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Watercourses within
Angus Place Colliery Lease Area

Centennial
Angus Place

DATE 22-07-2010

Figure 4.12

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig4_12_AngusPlace_Watercourses_20100624.mxd

Kangaroo Creek

The discharge of mine water into Kangaroo Creek, through LDP001, occurs at the base of the Newnes Plateau well downstream of the mining area. Upstream of the LDP001 inflow location, Kangaroo Creek does not have regular surface flow however after high rainfall events, historically some ponding has occurred.

Previous reports have indicated that the vegetation within Kangaroo Creek, upstream of the LDP001 discharge, shows that this section of the creek has been generally dry over an extended period of time. Downstream of the LDP001 discharge however, the vegetation has established in response to the consistent discharge of mine water resulting in a reasonably stable environment down to the Wolgan Road crossing location as shown in Plate 4.1.

Plate 4.1 Kangaroo Creek downstream of LDP001 discharge

Between Wolgan Road and the confluence with the Coxs River, the configuration of Kangaroo Creek is varied and includes some locations where significant erosion has occurred. The location of this erosion is in close proximity to the alignment of a historical rail line where it is likely that a culvert would have been located. This erosion is not recent and given the configuration of Kangaroo Creek elsewhere (and the volume of discharges through LDP001) is unlikely to be attributed to discharges from Angus Place Colliery.

The variation in watercourse profile through this section is indicated in Plate 4.2 and Plate 4.3, while Plate 4.4 shows the confluence between Kangaroo Creek and the Coxs River.

Plate 4.2 Kangaroo Creek Upstream of Coxs River Confluence

Plate 4.3 Kangaroo Creek in vicinity of historical rail line

Plate 4.4 Kangaroo Creek and Coxs River Confluence

Coxs River

The confluence of Kangaroo Creek and the Coxs River is in the headwaters of the Coxs River and consequently, there is little permanent flow within the Coxs River upstream of this location. Due to the profile of the river in this location, as shown in Plate 4.5, the flow downstream of the confluence is shallow and generally has a very low velocity.

LDP002 and LDP003 also discharge into the Coxs River however these discharges are as a direct result of rainfall events rather than a consistent volumetric discharge. These discharges will contribute to the Coxs River at times when there is also a contribution of natural catchment runoff from the surrounding farm land consequently they are considered likely to have minimal impact on the river.

As indicated in Section 4.2, there are several artificial water storages on Coxs River. An assessment of the lower Coxs River undertaken by CSIRO (2000) indicated that the construction of Lake Lyell in 1982 had only a minor impact on the flows downstream however an increase in water extraction from Lake Lyell from 1992 resulted in a modification to downstream flow regimes.

An assessment of the reduction in median flows (post 1992) by CSIRO (2000) indicated that there was a 95% reduction in flow downstream of Lake Lyell as a result of the increased water extraction for use as cooling water by the local power stations. Consequently, the discharge of flows from the upper Coxs River to the lower Coxs River (downstream of Lake Lyell) was significantly reduced.

The CSIRO investigation also found that while there was a significant reduction in flow immediately downstream of the lake, the impact on flow regimes declined with the distance downstream. Kelpie Point, approximately 80 km downstream of Lake Lyell, displayed only a 35% reduction in median flow.

Plate 4.5 Coxs River downstream of Kangaroo Creek Confluence

4.4 Underground Water

The underground mine water management system is amended from time to time to adapt to the current mining conditions. Within the current operations, water within the underground workings is collected and then transferred to underground storage areas to settle prior to being pumped to two (2) fire fighting tanks on the surface. From these tanks, the underground water is recirculated back underground (for fire fighting, cooling and dust suppression), pumped to the CHP or overflows to the ponds and wetlands associated with LDP001.

Hydrogeologic Assessments

A number of preliminary assessments of the hydrogeology within the Angus Place mining lease area have been undertaken. The assessment undertaken by Connell Wagner (2005) focused on the potential impact of mining on aquifers and the regional impact while the CSIRO (2005) report investigated the potential water make associated with longwalls 920 to 950.

Impact of Mining on Aquifers

The geologic profile developed for Angus Place Colliery for these reports indicated that there are five (5) aquifer zones within the lease area. The lower two (2) zones are associated with the Lithgow / Lidsdale coal seams while the upper three (3) zones are located in the overlying sandstone of the Permian Narrabeen Group as shown in Figure 4.13.

The lower four (4) aquifer zones were considered to be confined aquifers, being bound by aquitards / aquicludes, while the uppermost zone is considered to be unconfined. It is the unconfined upper aquifer zone that supports the surface vegetation in particular the shrub swamps of the Newnes Plateau. Conversely, the lower two aquifer zones will potentially drain into the goaf associated with the extraction of coal at Angus Place.

Due to the location of the aquitards / aquicludes between the lower four (4) aquifer zones and the upper unconfined zone, the impact of mining on stream flow and vegetation was determined (by Connell Wagner, 2005) to be negligible.

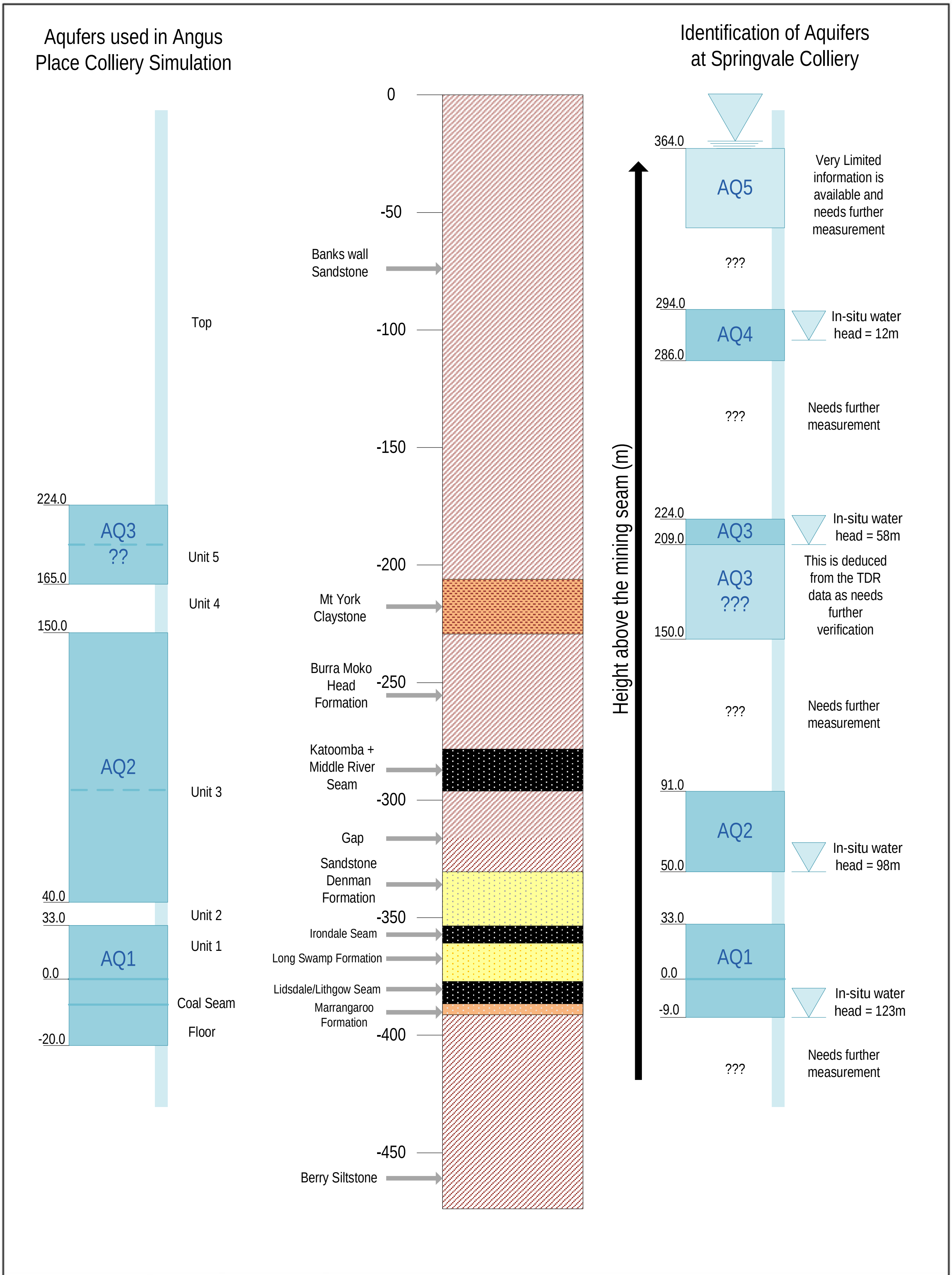
Water Make

The CSIRO (2005) report extrapolated from the existing Springvale Colliery hydrogeological model in order to predict the potential water make in longwalls 920 to 950 at Angus Place Colliery. The developed model was calibrated to reflect the known water make within the Springvale Colliery longwalls with site specific geologic information then incorporated for the Angus Place Colliery.

Due to the lack of site specific data within the Angus Place Colliery lease area, the estimation of water make was determined as a range. For the area between longwalls 920 and 950, the estimated water make varied from approximately 50 to 200 l/s. This indicated that each individual longwall contributed a water make of approximately 50 l/s.

During the development of the detailed water balance, a review of the available pumping information relating to the management of underground water was undertaken. Through this process, and consultation with Angus Place Colliery personnel, it was determined that the actual transfer rates of underground water was more in the order of 80 l/s for the current four longwalls. This indicated that, as an estimate, each longwall potentially contributed 20 l/s.

For the purposes of the development of the detailed mine water balance, consideration was given to this mine water make range. It is recommended that the mine water balance is reviewed once a detailed hydrogeologic model is developed for Angus Place Colliery.



LOCATION	Angus Place
SEAM	Lithgow
DRAWN	LJH
CHECKED	IBJ
APPROVED	IBJ
SCALE	

GHD

Angus Place Colliery
Surface Water Assessment

Geologic Profile

Centennial Angus Place

DATE 16-08-2010

Figure 4.13

Dirty Water Underground Transfers

There are numerous underground water transfers that occur at Angus Place Colliery. These include the transfer of underground water collected at the working face, to an underground storage area (old workings) and transfer to the Springvale - Delta Water Transfer Scheme.

Underground Storage

A portion of underground water is transferred to an underground storage area (known as the 300 district) prior to transfer to the surface (at an average rate of approximately 4.7 ML/day). The underground water is then either stored in the two (2) fire tanks for re-use for dust suppression underground (at an average rate of 0.6 ML/day), or discharged through LDP001.

Springvale - Delta Water Transfer Scheme

The remaining underground water is transferred, at a maximum rate of approximately 42.5 litres per second (3.7 ML/day), to the Springvale - Delta Water Transfer Scheme. This transfer occurs via the 940 dewatering bore located at the lowest point within the current workings and with a surface location on the Newnes Plateau (refer Figure 4.13). While this is the average transfer rate for the pumping infrastructure for the period from January 2006 to January 2010, adjustments to the pump could allow periodic increases and decreases to manage fluctuating water inflow rates, given the dynamic nature of longwall mining.

The Springvale - Delta Water Transfer Scheme was originally established between Centennial Springvale and Delta Electricity to improve the management of water at Springvale Colliery and to reduce the extraction of water by Delta Electricity from the Coxs River supplies. This scheme was then extended to include transfers from the dewatering bore at Angus Place Colliery and has a theoretical capacity of 30 ML/day however little information is available on the actual capacity of the pipeline.

To date the pipeline has transferred a maximum volume of 23.5 ML/day however works (currently being undertaken by Centennial Springvale) to the system may enable an increase in theoretical capacity up to 48 ML/day. This would enable the transfer scheme to provide around 50% of the total water demand of Delta Electricity.

During times of shut down or maintenance, Angus Place Colliery is licensed to discharge water under emergency circumstances into a tributary of the Wolgan River via LDP006. The location of this emergency discharge point is shown in Plate 4.6.

Plate 4.6 Emergency Discharge LDP006

4.5 Potable Water

For the financial years of 2004/2005 and 2005/2006, approximately 55 and 50ML respectively of potable water was purchased from Lithgow City Council. For the financial years of 2006/2007 and 2007/2008, this reduced to between 33 and 38ML respectively. The volume of potable water purchased in 2008/2009 decreased further to approximately 29ML. From this it can be seen that there has been a decrease in the demand for potable water in the bathhouse and administration buildings due to improved onsite water management and which now includes substituting water that is 'fit for purpose'.

4.6 Waste Water

Sewage and grey water from Angus Place Colliery bathhouse and administration buildings is treated at an onsite sewage treatment facility (licensed by DECCW) and disposed of at LDP005 via a spray irrigation network. Soil moisture at LDP005 is monitored to ensure that the irrigation applied does not result in surface water runoff. Approximately 20 ML per year passes through the onsite sewage treatment facility.

4.7 Water Balance

A detailed operational water balance was developed giving consideration to a broad range of data including rainfall, evaporation and water transfer rates and is provided in Appendix A.

The water balance was developed for the existing conditions and calibrated against pumping data to the Springvale - Delta Water Transfer Scheme and pumping from the 300 District (shown on Figure 4.13) to the fire tanks. The calibrated model was then amended to reflect the proposed conditions associated with the Project.

Results

The results of the water balance assessment for existing on-site conditions within the Project Application Area, as provided in Table 4.2, documented the inputs and outputs of the water management system as Angus Place Colliery.

Table 4.2 Existing Conditions Water Balance Results

	Average Year (2003)	Dry Year (2006)	Wet Year (1990)
Total Rainfall/Runoff Input (ML/year)	57	13	132
Potable Water Input (ML/year)	28	28	28
Outputs (Evaporation) (ML/year)	22	22	22
Discharge through LDP001 (ML/year)	1387	1381	1406
Discharge through LDP002 (ML/year)	55	37	89
Discharge through LDP003 (ML/year)	19	3	42
Discharge through 940 Bore (ML/year)	1341	1341	1341

Discharge via irrigation from Maturation Ponds	26	24	27

Results for the proposed conditions are discussed in Section 5.3 of this report while the calibration and detailed results are provided in the Water Balance Assessment report in Appendix A.

4.8 Water Quality

In reviewing the water quality associated with the Angus Place Colliery pit top, consideration was given to nine (9) monitoring locations. These locations included:

- LDP001 – Discharge of mine water make and runoff into Kangaroo Creek through wetlands.
- LDP002 – Discharge of surface water from the Angus Place Colliery pit top facilities into the Coxs River through settling ponds.
- LDP003 – Rainfall event based discharge of surface water from the old Kerosene Vale Colliery site into the Coxs River through a settling pond.
- LDP005 – Discharge of treated sewage effluent from Angus Place Colliery via a spray irrigation network to a designated utilisation area.
- LDP006 – Emergency discharge location for the 940 dewatering bore on the Newnes Plateau. This is situated in the Wolgan/Colo Catchment.
- Kangaroo Creek upstream – located upstream of LDP001 and is representative of the background condition of Kangaroo Creek.
- Kangaroo Creek downstream – located downstream of LDP001 and provides an indication of the impact of LDP001 discharges on Kangaroo Creek.
- Coxs River upstream – located upstream of LDP002 and downstream of the confluence of Coxs River and Kangaroo Creek.
- Coxs River downstream – located downstream of LDP001 and LDP002 and provides an indication of the impact of Angus Place Colliery discharges to the broader Coxs River Catchment.

Period of Data

The majority of Angus Place Colliery water quality monitoring points have data dating back to January 2001 (as indicated in Table 4.3). All water quality monitoring points are sampled monthly for pH, TSS, EC, oil and grease and temperature. The background sites have been sampled quarterly for manganese, iron, zinc, and sulphate since September 2004. The Angus Place Colliery licensed discharge points are generally sampled quarterly for metals and nutrients. LDP005 sampling differs due to its discharge to land rather than water and is sampled monthly for biological oxygen demand (BOD).

Table 4.3 Monitoring Location Data Period

Monitoring Location	From Date	To Date
LDP001	January 2001	April 2010
LDP002	January 2001	April 2010
LDP003	January 2001	April 2010
LDP005	September 2004	March 2010
LDP006[1]	February 2008	April 2010
Kangaroo Creek upstream	January 2001	April 2010
Kangaroo Creek downstream	January 2001	April 2010
Coxs River upstream	January 2001	April 2010
Coxs River downstream	January 2001	April 2010

[1] Data available for Borehole 940 that discharges to LDP006 in emergency situations

Water Quality Target Values

ANZECC/ARMCANZ (2000b) Guidelines provide default guideline values for six ecosystem types. These are:

- Upland rivers and streams.
- Lowland rivers.
- Freshwater lakes and reservoirs,
- Wetlands.
- Estuaries.
- Coastal and marine.

Upland streams are defined as those at greater than 150 meters altitude and as such, Kangaroo Creek and the upper Coxs River fall within this ecosystem type.

The ANZECC/ARMCANZ (2000b) Guidelines also recognise three categories of ecosystem condition, with a level of protection assigned to each. These are:

- High conservation/ecological value systems. Effectively unmodified or other highly-valued ecosystems, typically (but not always) occurring in national parks, conservation reserves or in remote and/or inaccessible locations.
- Slightly to moderately disturbed systems. Ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically, freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation. These systems could include

[1] Data available for Borehole 940 that discharges to LDP006 in emergency situations.

rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism.

- Highly disturbed systems. Measurably degraded ecosystems of lower ecological value. Examples of highly disturbed systems would be some shipping ports and sections of harbours serving coastal cities, urban streams receiving road and stormwater runoff, or rural streams receiving runoff from intensive horticulture.

Based on the above system definitions and the current and historic development in the area, the Kangaroo Creek catchment above LDP001 could be defined as a slightly to moderately disturbed system. The Upper Coxs River catchment downstream of LDP001 however could be defined as a highly disturbed system as it has experienced extensive current and historic disturbance due to coal mining, power generation and agriculture. This includes the 30 years of impacts of mining from Angus Place Colliery.

Aquatic Ecosystem Trigger Values

Discharge from mining activities potentially contains a range of compounds and elements that could have a detrimental impact on the receiving environment. Once the concentrations of each of these chemicals are known, it is necessary to assess their impact by comparing them to relevant trigger values for ecosystem protection. Trigger values may be derived from:

- ANZECC/ARMCANZ (2000b) default values.
- Licence limits.
- Site specific values.
- Local ecotoxicity testing.

The ANZECC/ARMCANZ (2000b) Guidelines define trigger values as:

"… the concentrations (or loads) of the key performance indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. They indicate a risk of impact if exceeded and should 'trigger' some action, either further ecosystem specific investigations or implementation of management/remedial actions." (ANZECC 2000, Volume 1, Appendix 1).

ANZECC/ARMCANZ (2000b) default trigger values for the most commonly monitored parameters at Angus Place Colliery are outlined in Table 4.4. They include stressor trigger values for NSW upland rivers and default freshwater trigger values for the protection of 95% aquatic species.

Table 4.4 ANZECC/ARCMCANZ (2000) Default Trigger Values

Parameter	Trigger Value	Comment
pH	6.5 – 9.0	NSW upland rivers (Table 8.2.8)
EC	350 µS/cm	NSW upland rivers (Table 8.2.9)
TSS	25 mg/L	25 mg/L and 25 NTU: NSW upland rivers (Table 8.2.11 and 8.2.12)
Turbidity	25 NTU	
Dissolved Oxygen	60 – 120 %	NSW upland rivers (Table 8.2.10)
Total Nitrogen (TN)	0.20 mgN/L	NSW upland rivers (Table 8.2.2)
Total Phosphorus (TP)	0.020 mgP/L	NSW upland rivers (Table 8.2.3)
Filterable Reactive Phosphorus (FRP)	0.015 mgP/L	NSW upland rivers (Table 8.2.5)
Nitrate	0.7 mg/L	ANZECC and ARMCANZ toxicity value for 95% species protection.
Ammonia	0.9 mg/L	
Aluminium	0.055 mg/L	ANZECC and ARMCANZ toxicity value for 95% species protection. Applies for pH > 6.5
Arsenic	0.013 mg/L	ANZECC and ARMCANZ toxicity value for 95% species protection. Guideline for As(V)
Boron	0.37 mg/L	ANZECC and ARMCANZ toxicity value for 95% species protection.
Cadmium	0.0002 mg/L	
Chromium (VI)	0.001 mg/L	
Copper	0.0014 mg/L	
Lead	0.0034 mg/L	
Manganese	1.9 mg/L	
Mercury	0.0006 mg/L	
Nickel	0.011 mg/L	
Selenium	0.011 mg/L	
Zinc	0.008 mg/L	

Derivation of Site Specific Trigger Values

Site specific trigger values can be derived on the basis of the ANZECC/ARMCANZ (2000b) Guidelines procedure. The recommended process is to calculate a series of different percentiles for different parameters as follows:

- For physicochemical parameters: 20th and/or 80th percentile
- For nutrients and non toxic compounds: 80th percentile.
- For heavy metals: 80th percentile.

The 50th percentile (or median) concentration represents ambient water quality concentrations at a particular site. To select the most appropriate trigger value for a site, the ambient water quality concentrations should be compared to:

- The ANZECC/ARMCANZ (2000b) default trigger values for freshwater ecosystems and toxicants in freshwaters.
- The derived site specific trigger value.
- The EPL limits.

In general, the highest value is selected as the trigger value (ANZECC/ARMCANZ, 2000b, procedure), though for metals if the ambient conditions are equal to or higher than the published trigger value or when no trigger value exists, then the 80th percentile of the data set should be adopted as the trigger value (ANZECC/ARMCANZ, 2000b, Section 8.3.5.5, Volume 2).

A good understanding of the ambient water quality and its seasonal variations is a critical component of an environmental assessment study. The background data collected should include each chemical that might be present in the discharge water and might enter the environment. This is of particular importance when natural background concentrations of these chemicals are high as may be the case in mining environments.

The ANZECC/ARMCANZ Guidelines (2000b) recommend that, for the purpose of deriving ambient values and site specific trigger values, a sufficient amount of data needs to be collected and that it should characterise seasonal variations:

"A minimum of two years of continuous monthly data at the reference site is required before a valid trigger value can be established. " (Volume 1, Section 7.4.4.1).

The background data currently available at the time of preparing this report ranges from five to nine years with monthly measurements for pH, TSS, EC, and oil and grease. The metal dataset is not as strong and the ANZECC/ARMCANZ (2000b) requirements for seasonal variation are not met. The most recent data utilised from the Angus Place water quality monitoring points as part of this analysis is April 2010.

For ecosystems that can be classified as highly disturbed, the 95% species protection trigger values may still apply. However it could be appropriate to apply a less stringent guideline trigger value such as 90% or 80% protection level. This depends largely on the state of the ecosystem, water management goals and the approval of DECCW.

Default trigger values were selected from the ANZECC/ARMCANZ (2000b) Guidelines and site derived trigger values were preferred to regionally derived trigger values. These default trigger values should not be applied as blanket values to all situations. It is critical to understand that these default trigger values have been derived for perennial freshwater systems, hence are not representative of ephemeral systems such as Kangaroo Creek, which is subject to strong first flush effects or ponding waters.

Table 4.5 ANZECC/ARMCANZ (2000b) Guidelines categorisation of Kangaroo Creek

Parameter	ANZECC Category
Physicochemical	Aquatic Ecosystem Protection, "Upland Rivers of NSW", (ANZECC/ARMCANZ, 2000b, Table 8.2.8 to 8.2.12).
Nutrients	Aquatic Ecosystem Protection, "Upland Rivers of NSW", (ANZECC/ARMCANZ, 2000b, Tables 8.2.2 to 8.2.7).
Metals and toxicants	"Freshwater" category (ANZECC/ARMCANZ, 2000b, Table 3.4.1), with 95% species protection for slightly-moderately disturbed ecosystems being considered as adequate.

Ecosystem Conditions: For heavy metals, it was considered that the ecosystem conditions which apply to the site are those of slightly-moderately disturbed systems; however the ANZECC/ARMCANZ (2000b) guidelines recommend that this should be confirmed through a consultative process (Section 8.3.5.2).

High and Low Reliability Trigger Values: High reliability trigger values were preferred in this analysis as low reliability values are obtained from an incomplete data set[2], however some low reliability values have been used where data is not sufficient to develop site specific trigger values. A list of default trigger values available for adoption in the absence of adequate monitoring data was presented in Table 4.4. The list is reflective of the parameters most commonly monitored at Angus Place Colliery.

Data Validation

All available data collected to date was considered in the determination of ambient conditions and the assessment of trigger values.

When the dataset was sufficient (in terms of number of data points) then percentiles were calculated for the derivation of site specific trigger values. For the purpose of providing some direction, where the dataset contains insufficient information, percentiles may be included with a note that they do not meet the minimum two year monthly sampling requirement.

Hardness Modified Trigger Values

The ANZECC/ARMCANZ (2000b) guidelines require the trigger values for several metals to be corrected for hardness to account for the hardness of the local water. The metals which fall in to this category are cadmium, chromium(iii), copper, lead, nickel and zinc. There is insufficient data available in the Angus Place Colliery dataset on the abovementioned suite of

[2] For toxicants two types of triggers exist, high reliability trigger values and low reliability trigger values. These are defined as follows: *"High Reliability Trigger Value Trigger values that have a higher degree of confidence because they are from an adequate set of chronic toxicity data.*

Low Reliability Trigger Value Trigger values that have a low degree of confidence because they are derived from an incomplete data set. They are derived using either assessment factors or from modelled data using statistical method. They should only be used as interim indicative working levels." (ANZECC & ARMCANZ, Volume 1, Appendix 1) metals and calcium carbonate. This does not allow for the determination of site specific trigger values for these parameters or to correct metals data for the hardness of the local waterway.

It is recommended that additional monitoring be undertaken on a monthly basis to determine a valid background hardness value for Kangaroo Creek against which to assess any discharge from Angus Place Colliery, as well as for a broader range of metals to determine any potential compliance issues.

EPL 467

The concentration limits specified in EPL 467 are provided in Table 4.6.

Table 4.6 EPL 467 Concentration Limits

Parameter	Discharge Limits
LDP001 & LDP002	
pH	6.5 – 9
TSS	30 mg/L
Oil and Grease	10 mg/L
LDP003	
pH	6.5 – 8.5
TSS	50 mg/L
Oil and Grease	10 mg/L

Surface Water Quality Data

The following sections are a summary of the statistical analysis undertaken on the available water quality data. The percentile values presented for nutrients and metals are only provided as an indication as the number of measurements is not sufficient to allow for a development of site specific trigger values.

For each site and parameter, the following information is summarised:

- Number of samples in the dataset.
- 20th and/or 80th percentile.
- Median (50th percentile).
- Minimum and maximum values.

Background Data

Kangaroo Creek Upstream

Kangaroo Creek is a tributary of the Coxs River. It is an ephemeral stream with a forested, slightly to moderately disturbed catchment. The Kangaroo Creek upstream water quality monitoring point is representative of the background condition of Kangaroo Creek. It is located upstream of all of the Angus Place licensed discharge points.

There is currently no water quality monitoring point on the Coxs River upstream of all of the Angus Place discharge points in the Angus Place dataset.

The ephemeral nature of Kangaroo Creek and quarterly monitoring has resulted in limited sampling opportunities for the site. As a result, there is insufficient data to derive site specific trigger values for most parameters.

Based on the information presented in Table 4.7, the following trends were observed at Kangaroo Creek upstream:

- The pH values indicate that the water is naturally slightly acidic. The majority of the values recorded are below the lower EPL limit and the ANZECC/ARMCANZ (2000b) default minimum trigger values for upland rivers over the nine years of monitoring. No values recorded are above the upper EPL limit or the default maximum trigger value.
- TSS is predominantly below both the ANZECC/ARMCANZ (2000b) default trigger value of 25 mg/L and EPL limit of 30 mg/L. According to the sampling notes, the majority of exceedances result from periods of very low flows and possible disturbances during sampling.
- EC is consistently below the ANZECC/ARMCANZ (2000b) default trigger value for upland rivers (350 µS/cm). The values detected above the ANZECC/ARMCANZ (2000b) trigger value correspond with sampling notes indicating very low flow conditions in Kangaroo Creek.
- The oil and grease measurements at all of the Angus Place monitoring points are well below the EPL limit of 10 mg/L. The majority (96%) of the samples taken were below the limit of reporting.
- The sulphate values are variable. An ANZECC/ARMCANZ (2000b) default trigger value for sulphate has not been determined for the protection of aquatic ecosystems. Guideline values for recreational purposes indicate a value of 400 mg/L as an appropriate concentration for the protection of environmental values.
- Data is available for manganese, iron and zinc. This is insufficient to determine a robust site specific trigger value as no metals have been monitored monthly over a period of 2 years, however an interim site specific trigger value is recommended for iron based on the limited dataset. The remaining metals and nutrients listed below have not been sampled at this monitoring location.

Table 4.7 Kangaroo Creek Upstream Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Physico-Chemical								
pH	pH	88	0	5.9	6.2	6.7	8.1	4.9
TSS	mg/L	86	11	2.0	4.0	12.1	41.0	0.4
EC	µS/cm	82	6	40	51	86	1010	20
Oil & Grease	mg/L	76	73	3.2	3.6	4.4	5.0	3.0
Turbidity	NTU	0	0	-	-	-	-	-
Dissolved Oxygen	%	0	0	-	-	-	-	-
Sulphate	mg/L	14	1	2.2	5.8	17.2	59.0	1.5
Dissolved Metals								
Manganese	mg/L	15	0	0.03	0.07	0.14	0.41	0.01
Iron	mg/L	15	1	0.48	0.72	1.31	7.15	0.40
Total Metals								
Aluminium	mg/L	0	0	-	-	-	-	-
Arsenic	mg/L	0	0	-	-	-	-	-
Boron	mg/L	0	0	-	-	-	-	-
Cadmium	mg/L	0	0	-	-	-	-	-
Chromium (VI)	mg/L	0	0	-	-	-	-	-
Copper	mg/L	0	0	-	-	-	-	-
Iron	mg/L	13	0	0.78	0.94	2.03	7.14	0.10
Lead	mg/L	0	0	-	-	-	-	-
Manganese	mg/L	0	0	-	-	-	-	-
Mercury	mg/L	0	0	-	-	-	-	-
Nickel	mg/L	0	0	-	-	-	-	-
Selenium	mg/L	0	0	-	-	-	-	-
Zinc	mg/L	15	10	0.019	0.030	0.037	0.038	0.014

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Total Hardness	mg/L	0	0	-	-	-	-	-
Nutrients								
Ammonia	mg/L	0	0	-	-	-	-	-
Nitrate	mg/L	0	0	-	-	-	-	-
Total Nitrogen	mgN/L	0	0	-	-	-	-	-
Total Phosphorous	mgP/L	0	0	-	-	-	-	-

Site water quality

LDP001

LDP001 primarily discharges water from underground mining operations to Kangaroo Creek. The licensed discharge point is situated to the east of the pit top, downstream of two settling ponds and a series of rock gabion structures along a wetland that allow for filtering of suspended solids prior to release into Kangaroo Creek.

A statistical summary of the data is presented in Table 4.8. Based on the information presented in this table, the following trends were observed at LDP001:

- The pH measurements indicate that the water is slightly alkaline, however within EPL limits and ANZECC/ARMCANZ (2000b) triggers for NSW upland rivers. The pH is very consistent and within a very narrow range with the 20^{th} and 80^{th} percentiles being 8.3 and 8.5 respectively.
- TSS is predominantly below both the ANZECC/ARMCANZ (2000b) default trigger value of 25 mg/L and EPL limit of 30 mg/L. According to the sampling notes, the majority of exceedances result from periods of very low flows and possible disturbances during sampling.
- EC is high relative to both background EC levels and the ANZECC/ARMCANZ (2000b)default trigger values. Over the nine years of measurements in the LDP001 dataset there appears to be a cyclical pattern of increasing and decreasing EC, however there has been no overall increase in EC over that period.
- Oil and grease is below the EPL limit of 10 mg/L for all but one sampling event. The majority (85%) of the samples taken over the last nine years were below the limit of reporting.
- Turbidity is within the ANZECC/ARMCANZ (2000b) default trigger value for NSW upland rivers (25 NTU).

- Sulphate measurements are variable. An ANZECC/ARMCANZ (2000b) default trigger value for sulphate has not been determined for the protection of aquatic ecosystems. Guideline values for recreational purposes indicate a value of 400 mg/L as an appropriate concentration for the protection of environmental values. All samples are below this value.
- The availability of metals data in the dataset is variable and the frequency of monitoring only quarterly. A significant number of samples are below the limit of reporting including filterable iron, arsenic, cadmium, hexavalent chromium (chromium(VI)), copper, lead, total manganese, mercury and selenium.
  - The 80th percentile for cadmium shows a value of 0.0007 mg/L, however this value is not hardness corrected and does not take in to consideration the 11 samples with results below the limit of reporting.
  - The 80th percentile for zinc shows a value of 0.103 mg/L above the selected trigger value of 0.008 mg/L. These values are not hardness corrected and the limited upstream dataset suggests that the background water quality may be high in zinc. Further sampling is needed to determine a site specific trigger value based on hardness corrected background data.
- All but one nitrogen and two phosphorous samples are above the ANZECC/ARMCANZ (2000b) default trigger value for the protection of aquatic ecosystems, however the lack of any background data means a site specific trigger value for total nitrogen and total phosphorous cannot be derived from the Angus Place dataset.

Table 4.8 LDP001 Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20th %	50th %	80th %	Max	Min
Physico Chemical								
pH	pH	115	0	8.3	8.4	8.5	8.9	7.7
TSS	mg/L	113	15	2	6	16	76	1
EC	µS/cm	108	0	913	980	1100	1360	725
Oil & Grease	mg/L	105	89	2.0	2.4	5.0	10.0	1.0
Turbidity	NTU	4	0	5.6	9.0	12.4	13.0	5.0
Dissolved Oxygen	%	0	0	-	-	-	-	-
Sulphate	mg/L	28	0	60.4	81.3	137.8	257.0	35.0
Dissolved Metals								
Manganese	mg/L	43	8	0.020	0.030	0.050	0.082	0.002
Iron	mg/L	43	26	0.05	0.06	0.10	0.43	0.03

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Total Metals								
Aluminium	mg/L	0	0	-	-	-	-	-
Arsenic	mg/L	15	7	0.0010	0.0020	0.0040	0.0040	0.0008
Boron	mg/L	13	1	0.05	0.06	0.07	0.08	0.05
Cadmium	mg/L	14	11	0.0001	0.0002	0.0007	0.0010	0.0001
Chromium (VI)	mg/L	11	11	-	-	-	-	-
Copper	mg/L	13	10	0.0010	0.0010	0.0011	0.0012	0.0010
Iron	mg/L	38	2	0.08	0.18	0.35	0.76	0.01
Lead	mg/L	14	9	0.0019	0.0020	0.0030	0.0030	0.0003
Manganese	mg/L	3	1	0.004	0.007	0.009	0.010	0.003
Mercury	mg/L	14	14	-	-	-	-	-
Nickel	mg/L	11	3	0.003	0.004	0.005	0.008	0.002
Selenium	mg/L	13	12	-	-	-	-	0.0003
Zinc	mg/L	24	1	0.034	0.060	0.103	0.129	0.004
Total Hardness	mg/L	7	0	144	157	195	204	106
Nutrients								
Ammonia	mg/L	14	6	0.040	0.095	0.260	0.353	0.020
Nitrate	mg/L	0	0	-	-	-	-	-
Total Nitrogen	mgN/L	12	1	0.6	0.8	1.1	7.0	0.1
Total Phosphorous	mgP/L	16	2	0.03	0.06	0.12	5.60	0.02

LDP002

LDP002 primarily includes runoff from the Angus Place Colliery surface and pit top area and discharges to the Coxs River.

A statistical summary of the data is presented in Table 4.9. Based on the information presented in this table, the following trends were observed at LDP002:

- The pH measurements indicate that the water is within EPL limits and ANZECC/ARMCANZ (2000b) triggers for NSW upland rivers. The pH is very consistent and within a very narrow range with the 20th and 80th percentiles being 7.5 and 8.0 respectively.
- TSS is predominantly below both the ANZECC/ARMCANZ (2000b) default trigger value of 25 mg/L and EPL limit of 30 mg/L. According to the sampling notes, the majority of exceedances are during very low flow events.
- EC is high relative to both background EC levels and the ANZECC/ARMCANZ (2000b) default trigger values. Over the nine years of measurements in the LDP002 dataset there appears to be a seasonal pattern of increasing and decreasing EC, however there has been no overall increase in EC over that period.
- Oil and grease is below the EPL limit of 10 mg/L for all but one sampling event. The majority (85 %) of the samples taken over the last nine years were below the limit of reporting.
- Turbidity is within the ANZECC/ARMCANZ (2000b) default trigger value for NSW upland rivers (25 NTU).
- Sulphate measurements are variable. An ANZECC/ARMCANZ (2000b) default trigger value for sulphate has not been determined for the protection of aquatic ecosystems. Guideline values for recreational purposes indicate a value of 400 mg/L as an appropriate concentration for the protection of environmental values. All samples are below this value.
- The availability of metals data in the dataset is variable and the frequency of monitoring only quarterly. A significant number of samples are below the limit of reporting including filterable iron, arsenic, cadmium, hexavalent chromium copper, lead, total manganese, mercury and selenium.
  - The 80th percentile for cadmium shows a value of 0.0007 mg/L, however this value is not hardness corrected and does not take in to consideration the 11 samples with results below the limit of reporting.
  - The 80th percentile for zinc shows a value of 0.103 mg/L above the selected trigger value of 0.008 mg/L. These values are not hardness corrected and the limited upstream dataset suggests that the background water quality may be high in zinc. Further sampling is needed to determine a site specific trigger value based on hardness corrected background data.
- All but one nitrogen and two phosphorous samples are above the ANZECC/ARMCANZ (2000b) default trigger value for the protection of aquatic ecosystems, however the lack of any background data means a site specific trigger value for total nitrogen and total phosphorous cannot be derived from the Angus Place dataset.

Table 4.9 LDP002 Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Physico Chemical								
pH	pH	107	0	7.5	7.8	8.0	8.7	6.7
TSS	mg/L	106	3	2.0	7.0	20.6	238.0	0.4
EC	µS/cm	105	0	396	495	600	1020	250
Oil & Grease	mg/L	96	84	1.0	1.4	2.8	23.0	1.0
Turbidity	NTU	4	0	34	68	183	320	19
Dissolved Oxygen	%	0	0	-	-	-	-	-
Sulphate	mg/L	18	1	18	38	67	145	8
Dissolved Metals								
Manganese	mg/L	17	1	0.040	0.088	0.291	0.860	0.009
Iron	mg/L	17	3	0.05	0.08	0.18	1.54	0.01
Total Metals								
Aluminium	mg/L	0	0	-	-	-	-	-
Arsenic	mg/L	15	6	0.0010	0.0010	0.0020	0.0021	0.0010
Boron	mg/L	13	9	0.036	0.055	0.076	0.084	0.030
Cadmium	mg/L	14	13	-	-	-	-	0.0005
Chromium (VI)	mg/L	11	11	-	-	-	-	-
Copper	mg/L	13	5	0.0010	0.0016	0.0020	0.0020	0.0010
Iron	mg/L	5	0	0.14	0.18	0.21	0.25	0.13
Lead	mg/L	14	9	0.0003	0.0010	0.0020	0.0020	0.0003
Manganese	mg/L	3	0	0.016	0.020	0.068	0.100	0.014
Mercury	mg/L	14	14	-	-	-	-	-
Nickel	mg/L	11	2	0.0036	0.0040	0.0044	0.0070	0.0030
Selenium	mg/L	13	12	-	-	-	-	0.0002
Zinc	mg/L	15	3	0.008	0.015	0.020	0.028	0.006
Total Hardness	mg/L	6	0	87	120	143	143	73

Parameter	Unit	No. of Samples	No. below Limit of reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Nutrients								
Ammonia	mg/L	14	7	0.03	0.06	0.10	0.16	0.02
Nitrate	mg/L	0	0	-	-	-	-	-
Total Nitrogen	mgN/L	12	2	0.4	0.6	1.4	3.3	0.3
Total Phosphorous	mgP/L	16	1	0.10	0.11	0.16	3.60	0.08

LDP003

LDP003 releases flows into the Coxs River and only discharges following periods of prolonged rainfall.

A statistical summary of the data is presented in Table 4.10. Based on the information presented in this table, the following trends were observed at LDP003:

- The pH measurements indicate that the water is within EPL limits and ANZECC/ARMCANZ (2000b)triggers for NSW upland rivers. The pH is very consistent and within a very narrow range with the 20^{th} and 80^{th} percentiles being 7.4 and 7.9 respectively.
- TSS is variable across the dataset, with the majority of samples above the ANZECC/ARMCANZ (2000b) default trigger value of 25 mg/L. The EPL limit of 50 mg/L is exceeded on nine occasions and sampling notes do not provide any explanation for these elevated values.
- EC is higher than background EC levels, however consistently within the ANZECC/ARMCANZ (2000b) default trigger value for NSW upland rivers (350 µS/cm). Over the nine years of measurements in the LDP003 dataset there appears to be a trend of decreasing EC, however gaps in the dataset do not allow rigorous interpretation of the trend.
- Oil and grease is below the EPL limit of 10 mg/L for all sampling events. The majority (86 %) of the samples taken over the last nine years were below the limit of reporting.
- The single turbidity measurement taken in 2010 (461 NTU) is above the ANZECC/ARMCANZ (2000b) default trigger value for NSW upland rivers (25 NTU).
- There are three sulphate measurements for LDP003. An ANZECC/ARMCANZ (2000b) default trigger value for sulphate has not been determined for the protection of aquatic ecosystems. Guideline values for recreational purposes indicate a value of 400 mg/L as an appropriate concentration for the protection of environmental values. All samples are well below this value.
- The availability of metals data in the dataset is minimal, with three quarterly samples taken in 2008. No samples were taken for total iron, total manganese, aluminium or hardness. A

significant number of samples are below the limit of reporting including filterable iron, boron, hexavalent chromium, mercury and selenium.

- The three results for both copper and zinc are above the selected trigger value. These values are not hardness corrected. There is no background data for copper and the limited upstream dataset suggests that the background water quality may be high in zinc. Further sampling is needed to determine a site specific trigger value based on hardness corrected background data.
- One lead result is above the selected trigger value of 0.0034 mg/L. This trigger value is not hardness corrected and there is no upstream data for lead to derive a site specific trigger value.
- Two of the three cadmium samples are on the selected trigger value of 0.0002 mg/L. The third is below the limit of reporting.

- All nitrogen and phosphorous samples are above the ANZECC/ARMCANZ (2000b) default trigger value for the protection of aquatic ecosystems, however the lack of any background data means a site specific trigger value for total nitrogen and total phosphorous cannot be derived from the Angus Place dataset.

Table 4.10 LDP003 Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Physico Chemical								
pH	pH	25	0	7.4	7.7	7.9	8.3	7
TSS	mg/L	25	0	17	40	92	320	2
EC	µS/cm	25	0	125	146	218	310	80
Oil & Grease	mg/L	22	19	1.0	1.0	5.2	8.0	1.0
Turbidity	NTU	1	0	-	-	-	-	461
Dissolved Oxygen	%	0	0	-	-	-	-	-
Sulphate	mg/L	3	1	26	28	29	30	25
Dissolved Metals								
Manganese	mg/L	3	0	0.005	0.007	0.008	0.009	0.004
Iron	mg/L	3	3	-	-	-	-	-
Total Metals								
Aluminium	mg/L	0	0	-	-	-	-	-
Arsenic	mg/L	3	1	0.001	0.001	0.001	0.001	0.001

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Boron	mg/L	3	3	-	-	-	-	-
Cadmium	mg/L	3	1	0.0002	0.0002	0.0002	0.0002	0.0002
Chromium (VI)	mg/L	3	3	-	-	-	-	-
Copper	mg/L	3	0	0.0036	0.0060	0.0060	0.0060	0.0020
Iron	mg/L	0	0	-	-	-	-	-
Lead	mg/L	3	1	0.002	0.004	0.006	0.007	0.001
Manganese	mg/L	0	0	-	-	-	-	-
Mercury	mg/L	3	3	-	-	-	-	-
Nickel	mg/L	3	0	0.003	0.004	0.005	0.005	0.002
Selenium	mg/L	3	3	-	-	-	-	-
Zinc	mg/L	3	0	0.014	0.021	0.023	0.024	0.009
Total Hardness	mg/L	0	0	-	-	-	-	-
Nutrients								
Ammonia	mg/L	3	2	-	-	-	-	0.02
Nitrate	mg/L	0	0	-	-	-	-	-
Total Nitrogen	mgN/L	3	0	0.76	1.00	1.12	1.20	0.60
Total Phosphorous	mgP/L	3	0	0.07	0.11	0.19	0.25	0.04

LDP005

LDP005 exists as a utilisation area situated above the sewerage aeration ponds off the Angus Place Colliery fire trail. EPL 467 does not require any water quality monitoring at LDP005 and the dataset provided is limited to quarterly monitoring since September 2004 for TSS, temperature and BOD.

- The 80^{th} percentile for TSS is 38 mg/L, however this monitoring location is for irrigation of treated effluent to land, therefore this monitoring point is not comparable to the selected trigger value for release to waters.
- The Department of Environment and Conservation environmental guideline for the use of effluent by irrigation (2004) states that secondarily treated effluent generally has a BOD less than 30 mg/L. All BOD samples at LDP005 are below this guideline value.

Table 4.11 LDP005 Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
pH	pH	0	0	-	-	-	-	-
TSS	mg/L	21	0	15	30	38	116	3
BOD	mg/L	18	0	7	11	14	23	3

LDP006

LDP006 is an emergency discharge point from the longwall 940 dewatering bore (bore 940) on Newnes Plateau. This licensed discharge point is only operated under emergency conditions with water discharged to the Wolgan River. The LDP006 dataset is limited due to emergency releases being irregular and infrequent. For the purpose of this report, the Borehole 940 dataset was analysed as it is representative of the quality of water discharged from LDP006 and has weekly data (for limited parameters) from February 2008.

A statistical summary of the data is presented in Table 4.12. Based on the information presented in this table, the following trends were observed at Bore 940:

- The pH measurements indicate that the water is within the ANZECC/ARMCANZ (2000b) trigger for NSW upland rivers. There is no EPL limit for this monitoring point. The pH is very consistent and within a very narrow range with the 20^{th} and 80^{th} percentiles being 7.1 and 7.5 respectively.
- TSS is consistently low with all samples below the ANZECC/ARMCANZ (2000b) default trigger value of 25 mg/L.
- EC is high relative to both background EC levels and the ANZECC/ARMCANZ (2000b) default trigger values. The two years of measurements do not show any discernable trends.
- Oil and grease is below the EPL limit of 10 mg/L for all but one sampling event. The majority (96 %) of the samples taken over the last two years were below the limit of reoprting. The single exceedance is not explained in the sampling notes, however could be due to a spill by plant operating in the underground workings.
- Filtered manganese and iron have been sampled once in January 2009. Manganese and iron are both below the selected trigger values of 1.9 mg/L and 1.31 mg/L respectively.

Table 4.12 Borehole 940 Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Physico Chemical								
pH	pH	101	0	7.1	7.3	7.5	8.2	6.9
TSS	mg/L	100	16	1	2	3	18	1
EC	µS/cm	101	0	773	920	1010	1310	668
Oil & Grease	mg/L	96	92	5	5	198	487	5
Dissolved Metals								
Manganese	mg/L	1	0	-	-	-	-	0.012
Iron	mg/L	1	0	-	-	-	-	0.14

Dowstream Data

Kangaroo Creek Downstream

The Kangaroo Creek downstream water quality monitoring point is able to show water quality changes as a result of the LDP001 discharges only.

Table 4.13 Kangaroo Creek Downstream Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20^{th} %	50^{th} %	80^{th} %	Max	Min
Physico Chemical								
pH	pH	109	0	8.1	8.3	8.5	9	6.3
TSS	mg/L	108	10	2	7	18	73	0.4
EC	µS/cm	103	0	664	910	1010	1200	98
Oil & Grease	mg/L	100	91	1.4	3.2	6.0	7.8	1.0
Turbidity	NTU	0	0	-	-	-	-	-
Dissolved Oxygen	%	12	12	-	-	-	-	-
Sulphate	mg/L	41	41	-	-	-	-	-

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20th %	50th %	80th %	Max	Min
Dissolved Metals								
Manganese	mg/L	21	3	0.019	0.040	0.048	0.103	0.014
Iron	mg/L	21	9	0.05	0.08	0.27	0.31	0.04
Total Metals								
Aluminium	mg/L	0	0	-	-	-	-	-
Arsenic	mg/L	0	0	-	-	-	-	-
Boron	mg/L	0	0	-	-	-	-	-
Cadmium	mg/L	0	0	-	-	-	-	-
Chromium (VI)	mg/L	0	0	-	-	-	-	-
Copper	mg/L	0	0	-	-	-	-	-
Iron	mg/L	19	2	0.20	0.40	0.57	1.00	0.01
Lead	mg/L	0	0	-	-	-	-	-
Manganese	mg/L	0	0	-	-	-	-	-
Mercury	mg/L	0	0	-	-	-	-	-
Nickel	mg/L	0	0	-	-	-	-	-
Selenium	mg/L	0	0	-	-	-	-	-
Zinc	mg/L	21	0	0.03	0.07	0.11	0.39	0.01
Total Hardness	mg/L	0	0	-	-	-	-	-
Nutrients								
Ammonia	mg/L	0	0	-	-	-	-	-
Nitrate	mg/L	0	0	-	-	-	-	-
Total Nitrogen	mgN/L	0	0	-	-	-	-	-
Total Phosphorous	mgP/L	0	0	-	-	-	-	-

Coxs River Upstream

The Coxs River upstream water quality monitoring point is just downstream of the confluence of Coxs River and Kangaroo Creek.

Table 4.14 Coxs River Upstream Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20th %	50th %	80th %	Max	Min
Physico Chemical								
pH	pH	98	0	6.9	8.2	8.5	9.1	4.6
TSS	mg/L	97	10	2.0	4.0	14.8	53.0	0.4
EC	µS/cm	95	0	429	850	992	1180	29
Oil & Grease	mg/L	83	74	1.84	3.00	5.34	9.30	1.50
Turbidity	NTU	0	0	-	-	-	-	-
Dissolved Oxygen	%	0	0	-	-	-	-	-
Sulphate	mg/L	17	0	45	66	125	242	2
Dissolved Metals								
Manganese	mg/L	19	2	0.022	0.035	0.074	1.150	0.013
Iron	mg/L	19	3	0.08	0.10	0.48	1.29	0.02
Total Metals								
Aluminium	mg/L	0	0	-	-	-	-	-
Arsenic	mg/L	0	0	-	-	-	-	-
Boron	mg/L	0	0	-	-	-	-	-
Cadmium	mg/L	0	0	-	-	-	-	-
Chromium (VI)	mg/L	0	0	-	-	-	-	-
Copper	mg/L	0	0	-	-	-	-	-
Iron	mg/L	17	2	0.21	0.4	0.72	2.17	0.06
Lead	mg/L	0	0	-	-	-	-	-
Manganese	mg/L	0	0	-	-	-	-	-
Mercury	mg/L	0	0	-	-	-	-	-

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20th %	50th %	80th %	Max	Min
Nickel	mg/L	0	0	-	-	-	-	-
Selenium	mg/L	0	0	-	-	-	-	-
Zinc	mg/L	19	2	0.018	0.035	0.057	0.090	0.005
Total Hardness	mg/L	0	0	-	-	-	-	-
Nutrients								
Ammonia	mg/L	0	0	-	-	-	-	-
Nitrate	mg/L	0	0	-	-	-	-	-
Total Nitrogen	mgN/L	0	0	-	-	-	-	-
Total Phosphorous	mgP/L	0	0	-	-	-	-	-

Coxs River Downstream

The Coxs River downstream water quality monitoring point is able to show water quality changes as a result of the LDP002 discharges when compared with Coxs River upstream results.

Table 4.15 Coxs River Downstream Statistical Summary

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20th %	50th %	80th %	Max	Min
Physico Chemical								
pH	pH	112	0	7.9	8.2	8.4	8.7	7.1
TSS	mg/L	111	6	2	6	12	134	1
EC	µS/cm	106	0	637	835	990	1260	99
Oil & Grease	mg/L	101	91	1.2	2.6	5.2	12.0	1.0
Turbidity	NTU	0	0	-	-	-	-	-
Dissolved Oxygen	%	0	0	-	-	-	-	-
Sulphate	mg/L	0	0	-	-	-	-	-

Parameter	Unit	No. of Samples	No. below Limit of Reporting	20th %	50th %	80th %	Max	Min
Dissolved Metals								
Manganese	mg/L	21	4	0.012	0.023	0.050	0.350	0.008
Iron	mg/L	21	1	0.14	0.22	0.34	0.58	0.03
Total Metals								
Aluminium	mg/L	0	0	-	-	-	-	-
Arsenic	mg/L	0	0	-	-	-	-	-
Boron	mg/L	0	0	-	-	-	-	-
Cadmium	mg/L	0	0	-	-	-	-	-
Chromium (VI)	mg/L	0	0	-	-	-	-	-
Copper	mg/L	0	0	-	-	-	-	-
Iron	mg/L	19	1	0.27	0.48	0.69	2.96	0.11
Lead	mg/L	0	0	-	-	-	-	-
Manganese	mg/L	0	0	-	-	-	-	-
Mercury	mg/L	0	0	-	-	-	-	-
Nickel	mg/L	0	0	-	-	-	-	-
Selenium	mg/L	0	0	-	-	-	-	-
Zinc	mg/L	21	8	0.007	0.010	0.023	0.040	0.007
Total Hardness	mg/L	0	0	-	-	-	-	-
Nutrients								
Ammonia	mg/L	0	0	-	-	-	-	-
Nitrate	mg/L	0	0	-	-	-	-	-
Total Nitrogen	mgN/L	0	0	-	-	-	-	-
Total Phosphorous	mgP/L	0	0	-	-	-	-	-

There are no water quality monitoring points in the Angus Place Colliery dataset downstream of either LDP003 or LDP006.

Discussion

To ensure appropriate analysis can be conducted on the Angus Place dataset in future, Centennial should analyse to a lower limit of reporting for Hexavalent chromium at least the same value as the default ANZECC/ARMCANZ (2000b) 95% species protection trigger of 0.002 mg/L. The majority of samples are currently below the LOR, however the recorded limit of reporting (0.01 mg/L) is an order of magnitude greater than the ANZECC/ARMCANZ (2000b) trigger.

The limit of reporting for the majority of copper, lead, zinc and total phosphorous samples remains above the default ANZECC/ARMCANZ (2000b) 95% species protection trigger. More recent samples have been analysed to a more sensitive limit of reporting, below the ANZECC/ARMCANZ (2000b) trigger. This sensitivity of analysis should continue to ensure that copper, lead, zinc and total phosphorous samples below limit of reporting can be used in further statistical analysis.

Only two of the five Angus Place licensed discharge points (LDP001 and LDP002) have a corresponding downstream monitoring point. The ANZECC/ARMCANZ (2000b) guideline states that site specific trigger values are not meant to be applied directly to contaminant levels in discharges from industry or mixing zones. They should be applied to the water outside the mixing zone of any point source. The existing downstream monitoring points are considered appropriate for this purpose, however the number of parameters monitored and the frequency of monitoring is insufficient to compare most parameters against selected trigger values. There are also no downstream monitoring points for LDP003 and LDP006. LDP005 is discharged to land. Centennial should consider installing a monitoring point downstream of LDP003 and expanding the monitoring program to conduct monthly monitoring for the full suite of parameters analysed in this study. LDP006 is at the top of a tributary to the Wolgan River and is unlikely to have a significant dilution effect from upstream flows during any emergency discharge. Due to the ephemeral nature of this creek and the infrequent release of water through the discharge point it is not considered necessary to measure upstream and downstream water quality.

Recommended Trigger Values

The site specific trigger values detailed in Table 4.16 have been derived based on the process described in the ANZECC/ARMCANZ (2000) Guideline. The justification of the process is presented in Table 4.17.

Table 4.16 Recommended Trigger Values

Parameter	Unit	Ambient Conditions[3]	Site Specific Derived Trigger Value[4]	ANZECC & ARMCANZ (2000)	EPL 467	Selected Site Specific Trigger Value
Physico Chemical						
pH	pH	6.2	6.7	6.5 - 9.0[5]	**6.5 – 9.0**	**6.5 – 9.0**
EC	µS/cm	51	86	**350**[5]	-	**350**
TSS	mg/L	4	12.1	25[5]	**30 – 50**	**30 – 50**
Oil and Grease	mg/L	3.6	4.4	-	**10**	**10**
Turbidity	NTU	-	-	**25**[5]	-	**25**
Dissolved Oxygen	%	-	-	**60 – 120**[5]	-	**60 – 120**
Sulphate	mg/L	5.78	17.2	**400**[6]	-	**400**
Dissolved Metals						
Manganese	mg/L	0.07	0.14	**1.9**[9]	-	**1.9**
Iron	mg/L	0.72	**1.31**[7]	0.3[8]	-	**1.31**
Total Metals						
Aluminium	mg/L	-	-	**0.055**[9]	-	**0.055**
Arsenic	mg/L	-	-	**0.013**[9]	-	**0.013**
Boron	mg/L	-	-	**0.37**[9]	-	**0.37**
Cadmium	mg/L	-	-	**0.0002**[9]	-	**0.0002**[10]
Chromium (VI)	mg/L	-	-	**0.001**[9]	-	**0.001**

[3] Median of the background data as per ANZECC and ARMCANZ Guideline recommendation.

[4] 80th percentile of the background data as per ANZECC and ARMCANZ Guideline recommendation.

[5] ANZECC and ARMCANZ value for NSW upland rivers.

[6] Recreational water quality guideline.

[7] The 80th percentile value is selected as an **interim** site specific trigger as the dataset does not meet the monitoring frequency required to determine a site specific trigger value.

[8] Not included in Table 3.4.1 of ANZECC 2000, however Section 8.3.7 of ANZECC 2000 states ‘the current Canadian guideline level is 300 µg/L, which could be used as an interim indicative working level’.

[9] ANZECC and ARMCANZ toxicity value for 95% species protection. These values apply for dissolved metals and are only to be used as an indication for total metals.

[10] These values have not been adjusted for hardness due to the lack of background hardness data

Parameter	Unit	Ambient Conditions[3]	Site Specific Derived Trigger Value[4]	ANZECC & ARMCANZ (2000)	EPL 467	Selected Site Specific Trigger Value
Copper	mg/L	-	-	**0.0014**[9]	-	**0.0014**[10]
Iron	mg/L	0.94	**2.03**[7]	0.3[8]	-	**2.03**
Lead	mg/L	-	-	**0.0034**[9]	-	**0.0034**[10]
Manganese	mg/L	-	-	**1.9**[9]	-	**1.9**
Mercury	mg/L	-	-	**0.0006**[9]	-	**0.0006**
Nickel	mg/L	-	-	**0.011**[9]	-	**0.011**[10]
Selenium	mg/L	-	-	**0.011**[9]	-	**0.011**
Zinc	mg/L	0.03	**0.037**[7]	0.008[9]	-	**0.037**[10]
Nutrients						
Ammonia	mg/L	-	-	**0.9**[9]	-	**0.9**
Nitrate	mg/L	-	-	**0.7**[9]	-	**0.7**
Total Nitrogen	mgN/L	-	-	**0.20**[5]	-	**0.20**
Total Phosphorus	mgP/L	-	-	**0.015-0.02**[5]	-	**0.015-0.02**

Table 4.17 Justification for the Selection of Site Specific Trigger Values

Parameter	Justification
Physico Chemical	
pH	Selected a site specific trigger value based on the median of the background conditions and upper limit of the EPL.
EC	The ANZECC trigger was selected as the background levels are below the trigger.
TSS	Site specific trigger value was selected from the EPL as it is currently a regulatory condition.
Oil and Grease	Site specific trigger value was selected from the EPL. There are no ANZECC guidelines for oil and grease. Most results are below the limit of reporting and all positive results consistently below the EPL limit.
Turbidity	There are no measurements of turbidity in the background data, therefore the ANZECC trigger was selected.
Dissolved Oxygen	There are no measurements of DO in the background data, therefore the ANZECC trigger was selected.
Sulphate	The ANZECC trigger was selected as the background levels are below the trigger.
Dissolved Metals	
Manganese	The ANZECC trigger was selected as the background levels are below the trigger. The background dataset does not meet the monitoring frequency required to determine a site specific trigger value.
Iron	The 80^{th} percentile was selected as an **interim** site specific trigger as background levels are above the ANZECC default trigger value. The background dataset does not, however, meet the monitoring frequency required to determine a site specific trigger value.
Total Meals	
Aluminium	There are no measurements of Al in the background data, therefore the ANZECC trigger was selected.
Arsenic	There are no measurements of As in the background data, therefore the ANZECC trigger was selected.
Boron	There are no measurements of Bo in the background data, therefore the ANZECC trigger was selected.
Cadmium	There are no measurements of Cd in the background data, therefore the ANZECC trigger was selected. These triggers have not been corrected for Hardness due to lack of data in the background dataset
Chromium	There are no measurements of CrVI in the background data, therefore the ANZECC trigger was selected.
Copper	There are no measurements of Cu in the background data, therefore the ANZECC trigger was selected. These triggers have not been corrected for

Parameter	Justification
	Hardness due to lack of data in the background dataset
Iron	The 80th percentile was selected as an **interim** site specific trigger as background levels are above the ANZECC default trigger value. The background dataset does not, however, meet the monitoring frequency required to determine a site specific trigger value.
Lead	There are no measurements of Pb in the background data, therefore the ANZECC trigger was selected. These triggers have not been corrected for Hardness due to lack of data in the background dataset.
Manganese	There are no measurements of Mn in the background data, therefore the ANZECC trigger was selected.
Mercury	There are no measurements of Hg in the background data, therefore the ANZECC trigger was selected.
Nickel	There are no measurements of Ni in the background data, therefore the ANZECC trigger was selected. These triggers have not been corrected for Hardness due to lack of data in the background dataset.
Selenium	There are no measurements of Se in the background data, therefore the ANZECC trigger was selected.
Zinc	The 80th percentile was selected as an **interim** site specific trigger as background levels are above the ANZECC default trigger value. The background dataset does not, however, meet the monitoring frequency required to determine a site specific trigger value. This interim trigger has not been corrected for hardness due to lack of data in the background dataset.
Nutrients	
Ammonia	There are no measurements of NH_3 in the background data, therefore the ANZECC trigger was selected.
Nitrate	There are no measurements of NO^{-3} in the background data, therefore the ANZECC trigger was selected.
Total Nitrogen	There are no measurements of TN in the background data, therefore the ANZECC trigger was selected.
Total Phosphorus	There are no measurements of TP in the background data, therefore the ANZECC trigger was selected.

5. Impact Assessment

An assessment of the potential impact on surface water, as a result of the Project, was undertaken. As outlined in Section 0 of this report, the works associated with the Project are limited to:

- Construction of Longwall 910 and 900W.
- Increase production from 3.5 Mtpa to 4 Mtpa.
- Construction of a dewatering bore at the inbye end of Longwall 910.
- Extension of Springvale - Delta Water Transfer Scheme to incorporate the new dewatering bore.
- Construction of powerlines and services required for the dewatering bore.
- Construction of access tracks.
- Modification to the existing ROM stockpile area to improve coal handling and water management.

5.1 Impacts to Surface Water

The location of the proposed works, as indicated on Figure 5.1 and Figure 5.2, is to the west and north of previously worked longwalls.

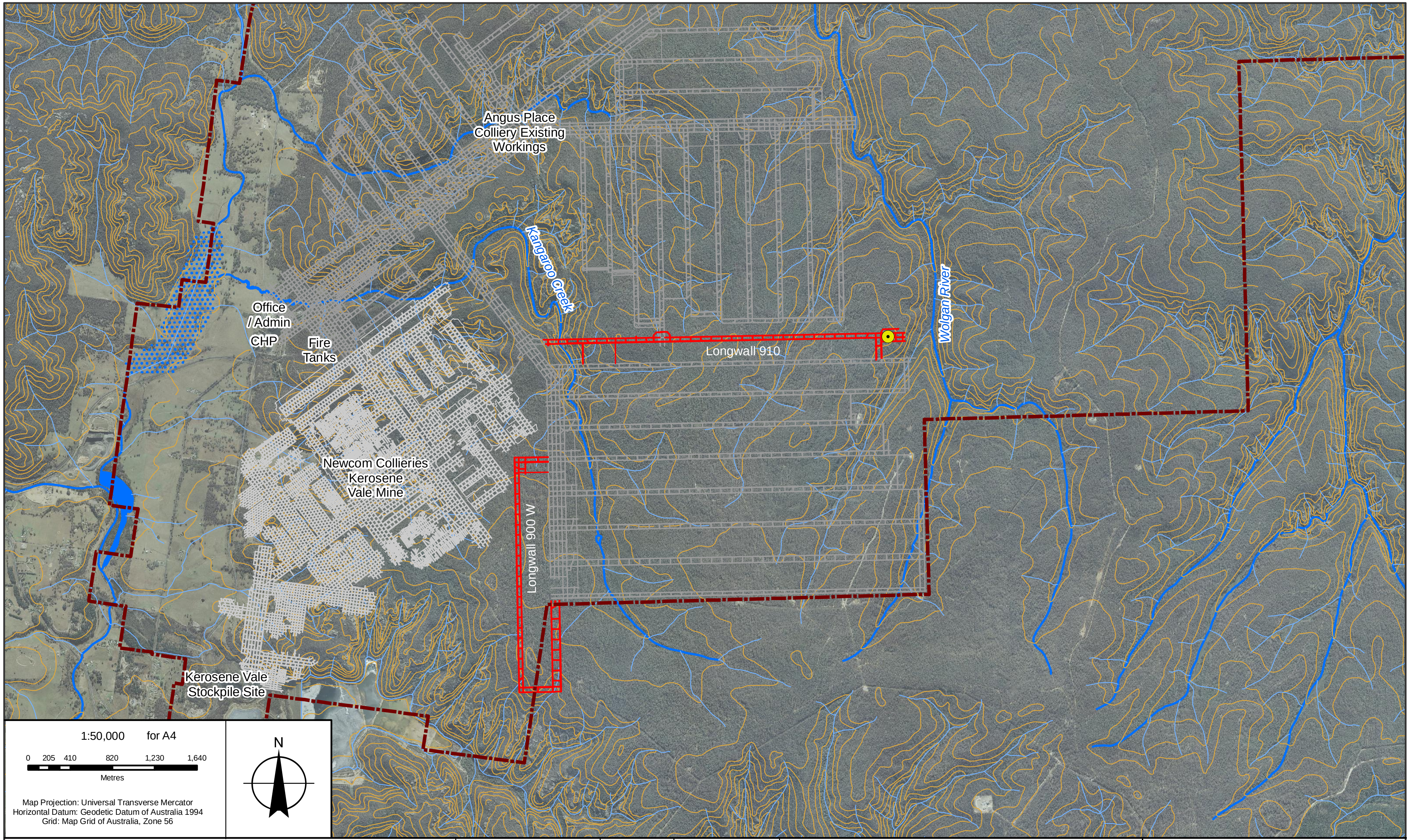
It is proposed that longwall 900W would run north-south and be located to the west of the existing workings (and marginally cross into the Centennial Springvale Colliery mining lease area) and that longwall 910 would run east-west between Kangaroo Creek and Wolgan River and be located north of longwall 920.

Watercourses

Coxs River

As discussed in Section 4.3, a previous assessment by the CSIRO (2000) on the impact of water extraction from the water storages along the Coxs River indicated that an increased extraction rate (for cooling water at the local power stations) resulted in a significant decrease in the median discharges from the upper to the lower Coxs River. Therefore flows within the upper Coxs River are more than likely than not, to stay within this system and be recycled as cooling water by the power stations.

As the Project will not result in any proposed amendments to the discharges from Angus Place Colliery, nor will there be any longwalls under this watercourse, there will be no increased impact on Coxs River.



GHD

LEGEND

- Creeks
- MajorCreeks
- Contours
- Proposed Dewatering Bore Location
- Angus Place Colliery Holding
- Existing Workings
- Kerosene Vale "Newcom" Workings
- Proposed Workings Option 1

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Location of Proposed Longwalls Option 1

Centennial Angus Place

DATE 16-08-2010

Figure 5.1

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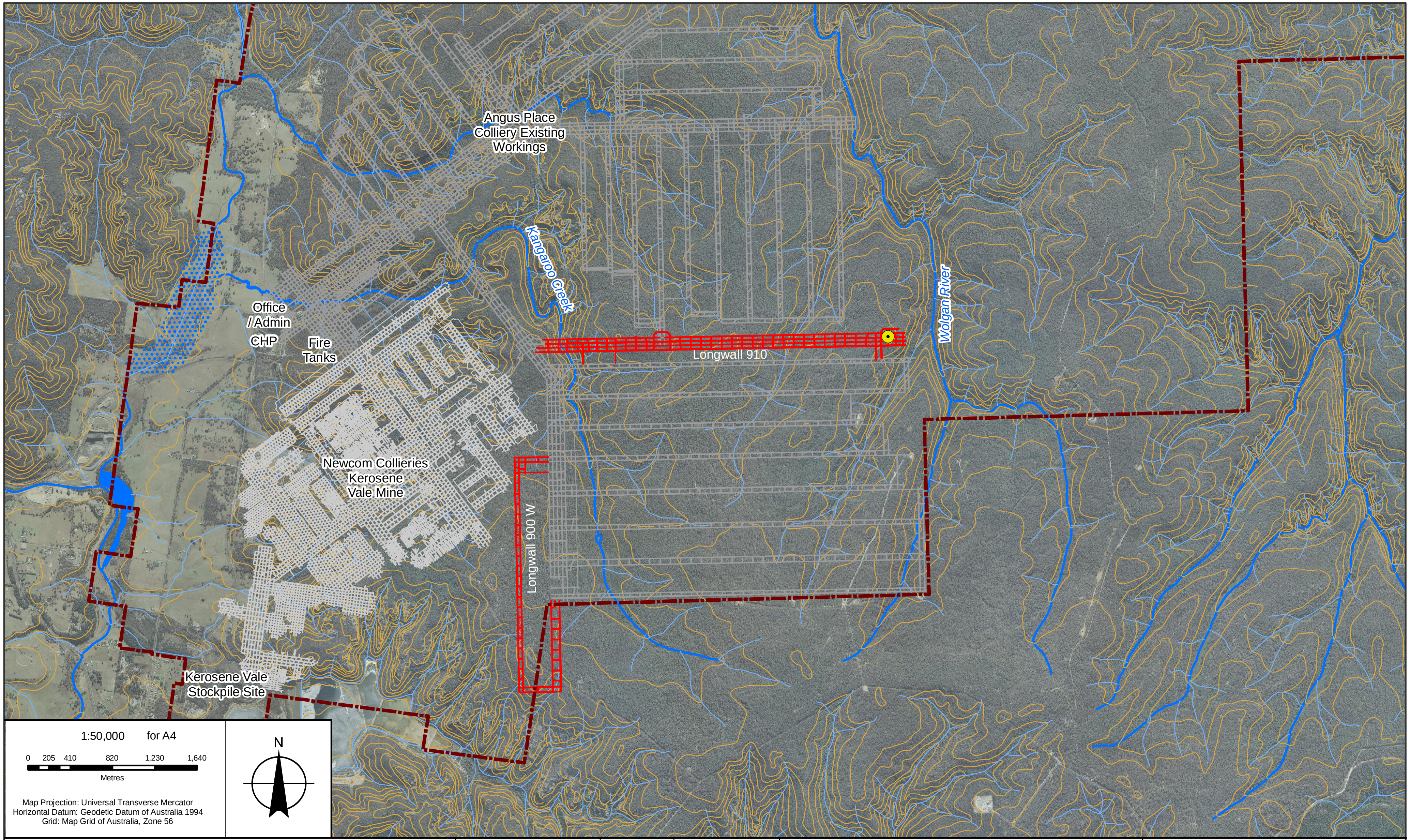

GHD

LEGEND
- Creeks
- MajorCreeks
- Contours
- Proposed Dewatering Bore Location
- Angus Place Colliery Holding
- Existing Workings
- Kerosene Vale "Newcom" Workings
- Proposed Workings Option 2

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Location of Proposed Longwalls Option 2

Centennial Angus Place

DATE 16-08-2010

Figure 5.2

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig5-2_ProposedWorksOpt2_20100816.mxd

Kangaroo Creek

There are two (2) first order tributaries of Kangaroo Creek that are potentially impacted by the predicted subsidence associated with longwall 900W. In the location of the watercourses, the predicted subsidence ranges from approximately 100 mm to 0 mm.

Land subsidence due to underground mining has the potential to impact on the geomorphology of surface waterways as a result of changes to longitudinal gradients of the waterways and/or through the localised cracking of a stream bed. These effects would largely be realised in the event that mining results in a warping (uneven displacement) of the landscape surface.

It is anticipated that there may be minor surface cracking within the Kangaroo Creek tributaries as a result of mining however the long term impact on the geomorphology of surface waterways is expected to be negligible.

Wolgan River

The Wolgan River tributary that traverses the proposed location of longwall 910 is a second order stream and the topography in this area provides a large flow area for surface flow as indicated in Plate 5.1.

Ditton Geotechnical Services Pty Ltd (DGS 2010) provided in their subsidence prediction report, an assessment of surface impacts based on worst-case subsidence predictions for the proposed longwall panels 910 and 900W at Angus Place Colliery. This indicates that the only significant drainage line in the impacted areas is the tributary of Wolgan River, referred to as West Wolgan Creek, that lies over longwall 910.

Based on pre and post mining terrain change analysis, DGS (2010) estimates that the section of West Wolgan Creek that overlies longwall 910 will be subject to grade changes of +0.1% to -0.6%. DGS (2010) has also predicted additional subsidence of between 0.15 and 0.25 m over longwalls 920 and 930 as a result of the extraction of coal associated with longwall 910. The existing grade of this section of creek is relatively steep (approximately 3%) and the degree of these grade change estimates will not have a significant impact on existing erosion rates.

A review of soil landscapes for the Project was undertaken by GSSE and is documented in their *Soils and Land Resource Assessment* report (GSSE 2010). This report indicates that the soil landscape associated with West Wolgan Creek is classified as Wollongambe, which is considered to have a severe erosion hazard following clearing and low fertility. As changes to the gradient of West Wolgan Creek are likely to occur as a result of subsidence and not clearing, no significant impact on erosion through this area is expected.

The GSSE (2010) report also indicated that the changes to surface gradients as predicted by DGS (2010) may result in minor terrain adjustment through erosion and sedimentation processes, surface cracking and ponding. These potential impacts are more likely to occur in locations of concentrated flow however the application of appropriate mitigation measures (as discussed in Section 6.1) would minimise these impacts.

The ponding predictions documented within DGS (2010) indicated that some minor ponding to a depth of 0.1 metres may occur towards the downstream extent of the section of West Wolgan Creek overlying longwall 910. The estimated volume of predicted ponding, based on this depth, is 0.05 ML and the impact on flow transfers downstream is considered to be negligible.

DGS (2010) also provided an analysis of tensile and compressive strains indicated that minor surface cracking may develop with crack widths generally in the range of 1 mm to 20 mm. The development of cracks within creeks or drainage lines may result in the sub-surface re-routing of surface flows particularly where the bed of channels are composed of bedrock. This impact is generally temporary in nature as bed load sediments deposit within cracks, sealing them over several storm events. The bed of West Wolgan Creek overlying longwall 910 exhibits an alluvial valley fill composed of sand and silt. As a result, the potential for surface cracking and re-routing of surface flows is considered low.

Consideration was also given to valley ‘closure’ and ‘uplift’ by DGS (2010). A review of the behaviour in locations of other longwalls at Angus Place indicated that uplift movements of between 30 and 50 mm have previously occurred. It is possible that similar movements could occur above longwall 910 and 900W however as the valleys are wider the uplift and closure movements are likely to be lower than previously observed. Consequently the impact on re-direction of surface flow to sub-surface flow is considered to be minimal due to limited cracking of the near surface rocks.

Plate 5.1 Wolgan River Tributary – Longwall 910

Modifications to ROM Stockpile Area

As indicated in Section 4.3, Connell Wagner Pty Ltd (2008) undertook an assessment of the existing pollution ponds within the Angus Place Colliery pit top. This assessment considered the ability of the ponds to cater for a maximum 1 in 100 year ARI design storm event.

The upgrade works that have subsequently been proposed by Centennial Angus Place include the demolition and replacement of the existing spillways as well as raising of sections of the existing embankments. In addition to the pollution pond upgrade works, it has been proposed to construct a dirty water diversion along the northern boundary of the ROM stockpile area.

This dirty water diversion will include a trapezoidal dish drain and a series of impermeable barriers to contain sediment laden water within the ROM stockpile area. This diversion drain would then direct the dirty water to the primary pollution ponds as indicated on Figure 5.3.

While there will be an increase in production from 3.5 to 4 Mtpa, the current footprint of the ROM stockpile will be maintained through operational efficiencies in coal handling and management. This will allow an increase in production without encroachment into the proposed diversion drains.

It is also proposed to re-align the existing clean water diversion to the west as indicated on Figure 5.4.

Kerosene Vale

Further improvements are proposed for the pollution pond (associated with LDP003) within the Kerosene Vale site. This includes additional testing of the water within the pollution pond to determine the most appropriate treatment measure (such as flocculation) to reduce the discharge of TSS. Consideration would also be given to increasing the area of rehabilitation within Kerosene Vale to reduce the dirty water catchment.

LEGEND

- Infrastructure
- Creek
- 2m Contours
- Pollution Control Structures
- Wetlands
- Proposed Clean Water Diversion

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Proposed Clean Water Diversions

Centennial Angus Place

DATE 16-08-2010

Figure 5.3

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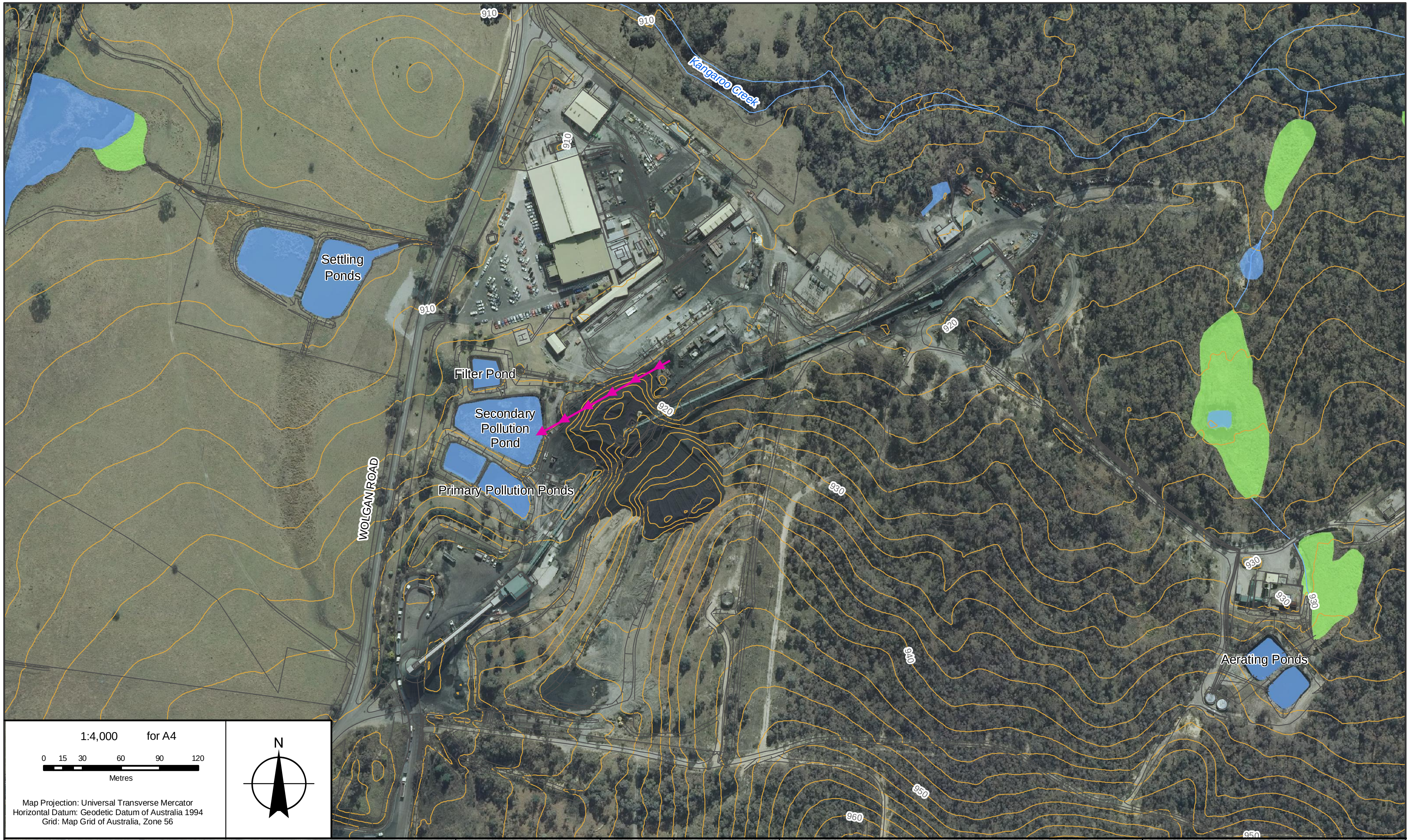


GHD

LEGEND

- Infrastructure
- Creek
- 2m Contours
- Pollution Control Structures
- Wetlands
- Proposed Dirty Water Diversion

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Proposed Dirty Water Diversions

Centennial Angus Place

DATE 16-08-2010

Figure 5.4

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\2214985_Fig5-4_ProposedDirtyDiversions_20100816.mxd

5.2 Impacts to Underground Water

The *Assessment of Hydrogeological Impacts* undertaken by Aurecon (2010) indicated that potential changes to the hydrogeological regimes could occur due to subsidence, surface strains, surface tilting as well as valley uplift and closure, all of which are predicted to occur to some degree by DGS (2010). The predicted incremental surface movements in the location of longwalls 910 and 900W are considered to be minor, therefore the portion of surface flow that would be directed to sub-surface flow as a result of surface movements is considered to be low.

Additionally, as discussed in Section 4.4, the geologic profile developed for Angus Place indicates that the location of aquitards between the lower aquifer zones and the upper unconfined zone results in negligible impact on the upper aquifer as a result of mining.

Connection to Existing Longwalls

The location of the proposed 910 longwall, as indicated on Figure 5.1, is in close proximity to the old workings referred to as the 300 district. This area was identified in Section 4.4 as underground water storage and Figure 5.5 shows that the stored water level is in the order of 806.

A review of the floor contours through the proposed 910 longwall (Option 1) location have indicated that there is a potential for seepage (in-rush) to occur between the old and the proposed workings. Centennial Angus Place has developed an in-rush management plan that would be adopted during the longwall development.

The potential for in-rush also resulted in the development of Option 2, which increases the distance between the proposed headings and the existing workings thereby reducing the risk of in-rush. An in-rush management plan would still be developed by Centennial Angus Place and adopted during the longwall development.

A review of the potential for in-rush to occur for the 900W longwall was also undertaken however the floor contours and underground water storage levels in the surrounding areas are such that, based on the available information, in-rush is unlikely to occur at this location.

Dewatering Bore and Associated Services

Due to the location of the proposed longwalls and the anticipated flow of underground water, the inbye end of longwall 910 is likely to form an underground water storage area. While location of the existing 940 dewatering bore may be able to remove water from the new workings, it is proposed to construct an additional dewatering bore at the inbye end of longwall 910 to allow greater flexibility in the management of underground water.

The proposed 910 dewatering bore would have a surface location west of the Wolgan River as indicated in Figure 5.1. The infrastructure for the proposed 910 bore would consist of a pipeline from the existing emergency discharge location (LDP006) to the location of the 910 bore. In normal operations, underground water would be transferred through the new pipeline and then continue along the existing pipeline from the LDP006 location through to the existing connection with the Springvale - Delta Water Transfer Scheme network.

It is anticipated that the management of underground water may require the combined use of both dewatering bores however, the total contribution of underground water to the Springvale - Delta Water Transfer Scheme is predicted to remain constant. This is discussed in more detail in Section 5.3.

5.3 Impacts to Water Balance

By comparing the data provided in Table 5.1 (proposed conditions) to the data within Table 4.2 (existing conditions), it can be seen that the development of longwalls 900W and 910 will result in an increase in discharges to the Springvale - Delta Water Transfer Scheme or through LDP001.

Table 5.1 Proposed Conditions Water Balance Results

	Average Year (2003)	Dry Year (2006)	Wet Year (1990)
Total Rainfall/Runoff Input (ML/year)	57	13	132
Potable Water Input (ML/year)	28	28	28
Outputs (Evaporation) (ML/year)	22	22	22
Discharge through LDP001 (ML/year)	1387	1381	1406
Discharge through LDP002 (ML/year)	55	37	89
Discharge through LDP003 (ML/year)	19	3	42
Discharge through 940/910 Bores (ML/year)	2604	2604	2604
Discharge via irrigation from Maturation Ponds	26	24	27

Based on the data provided in Table 5.1, consideration was given to the potential to reduce the volumetric limit associated with LDP001 within EPL 467 however due to operational and underground constraints, flows through LDP001 cannot be prevented. Further to this, in the event that discharge to the Springvale - Delta Water Transfer Scheme cannot occur and a discharge through the emergency discharge point LDP006 can also not occur, LDP001 may be the only discharge option.

For operational purposes, Centennial Angus Place therefore require the ability to discharge from both the 940 dewatering bore and LDP001.

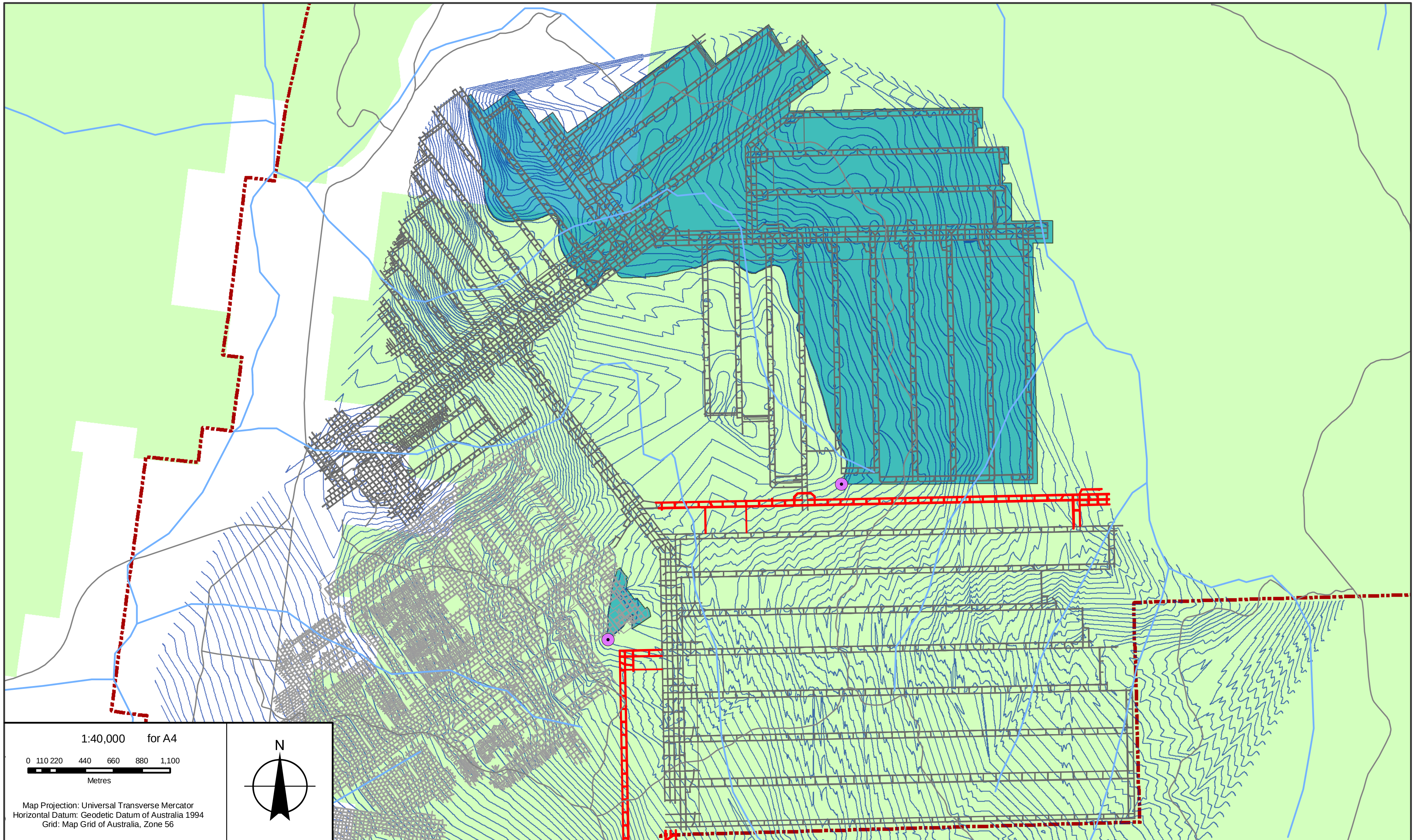
5.4 Water Quality

The 80th percentiles of pH, TSS and oil and grease for LDP001, LDP002, LDP003, LDP005 and LDP006 were within the concentration limits of EPL 467 with the exception of TSS discharges through LDP003 and oil and grease through LDP006. Treatment measures that could be put in place to reduce the TSS concentrations through LDP003 are currently being investigated by Centennial Angus Place. The high oil and grease concentration through LDP006 is however due to an isolated high concentration and therefore no additional treatments are currently being considered.

A review of the ANZECC/ARMCANZ (2000) default trigger values, indicated that there were several additional parameters that exceeded the recommended concentration limits. These primarily included electrical conductivity, iron, lead and zinc. A review of the background ambient concentrations indicated that higher concentrations of iron and zinc were a characteristic of the natural catchment and therefore no treatment has been investigated.

While the electrical conductivity of discharges from Angus Place Colliery were found to be higher than the recommended level for upland rivers, they remained in the lower end of the brackish scale. The environments within Kangaroo Creek and Coxs River are well established for these current conditions and consequently, it is proposed to undertake an ecological and toxicity assessment downstream of LDP001 to determine the biological effect of higher than background salinity levels. Additionally, investigations into transfer and/or treatment options for mine water will be progressed should the ecological assessment determine that there is a significant adverse impact on the ecology within Kangaroo Creek, downstream of LDP001.

As the Project includes extension of existing underground operations and no additional surface disturbances (other than the construction of clean water diversions), the impact on water quality as a result of the Project is considered to be negligible.



LEGEND

GHD

- State Forests
- Angus Place Colliery Holding
- Roads
- Watercourse
- Existing Workings
- Kerosene Vale "Newcom" Workings
- Proposed Workings
- Underground Water Storages
- Underground Water Level
- Floor Contours

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Surface Water Assessment

Extent of Underground Water Storages

Centennial Angus Place

DATE 16-08-2010

Figure 5.5

GIS Filename: G\22\14985\GIS\MAPS\Deliverables\2214985_Fig5-5_UG_WaterStorage_20100816.mxd

6. Mitigation Measures

The existing SWMP discusses in detail a range of mitigation measures currently incorporated within the water management system. These measures include water diversions for the separation of clean and dirty water, sedimentation ponds, wetlands, oil water separators and regular monitoring. The management of water at Angus Place Colliery will continue in accordance with the requirements of the SWMP.

6.1 Recommended Mitigation Measures

Longwall 900W and 910

As indicated in Section 5.1, there are no anticipated impacts on surface water as a result of this element of works associated with the Project however it is recommended that the existing monitoring program for watercourses be continued.

Additionally, as part of a broader subsidence management plan, DGS (2010) provides the following recommendations to monitor and manage subsidence and geomorphologic impacts in respect to drainage lines:

- Undertake pre and post mining inspections and survey to identify cracking and/or erosion along West Wolgan Creek, with the results communicated to the respective stakeholders.
- Where subsidence occurs along drainage lines, assessment the potential to undertake re-contouring to minimise interruption to surface flows.
- Any observed impact to be communicated to Forests NSW and any remediation will be undertaken in accordance with Forest NSW.
- Review and appraise changes to drainage paths in areas of potential ponding development.
- Assess and consult with the relevant government agencies to determine whether repairs to cracking or gully stabilisation works are required.

It is also recommended that quarterly monitoring along West Wolgan Creek be undertaken to identify locations of geomorphic variation. This will enable mitigation measures to be implemented, if required, and the impact of subsidence on the geomorphology of the watercourse minimised.

Dewatering Bore and Associated Services

The construction of the 910 dewatering bore and the associated infrastructure are the works most likely to have a potential impact on surface water. To offset the potential impacts of these works, a range of standard mitigation measures (in accordance with '*Managing Urban Stormwater: Soils and Construction*') will be put in place during the construction of the bore, power lines and other services required for the operation of the dewatering bore.

Modifications to ROM Stockpile Area

The modifications nominated for the ROM stockpile area are, in themselves, a permanent mitigation measure for this area that will result in improved water management and water quality discharges. During the construction of the permanent measures, a range of standard mitigation measures (in accordance with '*Managing Urban Stormwater: Soils and Construction*') would be put in place.

LDP001

As part of the pollution reduction program currently being negotiated with the Department of Environment, Climate Change and Water, Centennial Angus place proposed to undertake ecological and toxicity assessment in order to determination of the effect of elevated salinity on the health of Kangaroo Creek and upper Coxs River. Additionally, progressing the investigations into treatment and/or transfer options (as proposed by Centennial Angus Place) will further provide input into determination of appropriate actions should the ecological and toxicity assessments determine that there is an unacceptable adverse impact within Kangaroo Creek and upper Coxs River as a result of the discharges.

6.2 Water Quality Monitoring

Within the SWMP, the frequency of water quality monitoring and the parameters monitored are provided. This monitoring program should be expanded for the next two years to develop a dataset that will meet ANZECC (2000) requirements for developing site specific trigger values. The current and recommended monitoring program is outlined in Table 6.1. The current quarterly monitoring program should be increased to monthly at the licensed discharge points and upstream monitoring points and include a suite of filterable metals to give a more accurate representation of potential bio-availability.

In addition to the current monitoring locations, it is recommended that an additional monitoring point be added on the Coxs River upstream of the Kangaroo Creek confluence. This monitoring location will provide additional background data to allow more robust site specific trigger values to be developed for a range of parameters. Consideration should also be given to the installation of monitoring points downstream of LDP003 to allow any site specific trigger values to be applied to water quality from outside the mixing zone of all licensed discharge points.

In order to reduce the costs of the expanded monitoring program, an interim review of data could be undertaken after approximately six months to reduce the frequency of monitoring for any parameters of low risk (i.e. those parameters showing trends in concentration below the background or default trigger values). This review should be undertaken in consultation with key stakeholders.

Table 6.1 Monitoring Program – Current and Recommended

Location	Current Frequency	Current Parameters	Recommended Frequency	Recommended Parameters
LDP001	Monthly	pH, TSS, oil and grease, EC, temperature	**Monthly**	**pH, TSS, oil and grease, EC, temperature, total iron and total manganese, filterable metals, total nitrogen and total phosphorous, hardness.**
	Quarterly	pH, TSS, oil and grease, EC, temperature, filterable iron, total iron, filterable manganese, total zinc, sulphate, MBAS, phenolic, Also NPI required substances.	**Quarterly**	**sulphate, MBAS, phenolic, Also NPI required substances.**
LDP002	Monthly	pH, TSS, oil and grease, EC, temperature	**Monthly**	**pH, TSS, oil and grease, EC, temperature, total iron and total manganese, filterable metals, total nitrogen and total phosphorous, hardness.**
	Quarterly	pH, TSS, oil and grease, EC, temperature. Also NPS required substances.	**Quarterly**	**NPI required substances.**

Location	Current Frequency	Current Parameters	Recommended Frequency	Recommended Parameters
LDP003	During Discharge	pH, TSS, oil and grease, EC, temperature	**Monthly During Discharge**	**pH, TSS, oil and grease, EC, temperature, total iron and total manganese, filterable metals, total nitrogen and total phosphorous, hardness.**
LDP005 (STP)	Quarterly	TSS, temperature, BOD	**Quarterly**	**TSS, temperature, BOD**
Kangaroo Creek Upstream and Downstream	Weekly	pH, TSS, oil and grease, EC, temperature	**Weekly**	**pH, TSS, oil and grease, EC, temperature**
			Monthly	**total iron and total manganese, filterable metals, total nitrogen and total phosphorous, hardness.**
	Quarterly	pH, TSS, oil and grease, EC, temperature, filterable iron, total iron, filterable manganese and total zinc.		

Location	Current Frequency	Current Parameters	Recommended Frequency	Recommended Parameters
Coxs River Upstream and Downstream	Weekly	pH, TSS, oil and grease, EC, temperature	**Weekly**	**pH, TSS, oil and grease, EC, temperature**
			Monthly	**Total iron and total manganese, filterable metals, total nitrogen and total phosphorous, hardness.**
	Quarterly	pH, TSS, oil and grease, EC, temperature, filterable iron, total iron, filterable manganese and total zinc.		
Coxs River Downstream of LDP003			**Monthly**	**pH, TSS, oil and grease, EC, total iron, total manganese, filterable metals, total nitrogen, total phosphorous, hardness.**

7. References

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Appendix A

Water Balance

Centennial Angus Place Pty Ltd

Angus Place Colliery
Water Balance Assessment
October 2010

FUTURE POWER | Centennial Coal

Contents

Table Index

Figure Index

Graph Index

Appendices

Glossary

910 Dewatering bore	Proposed dewatering bore at the inbye end of proposed Longwall 910.
940 Dewatering bore	Existing dewatering bore within Longwall 940.
Aquifer	Underground water storage within either disturbed or undisturbed strata.
Aquitard / Aquiclude	Less permeable strata, not permeable enough to yield economic quantities of water.
Average Recurrence Interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, eg. floods with a discharge as big as, or larger than, the 100-year ARI flood event will occur on average once every 100 years. ARI is equal to the reciprocal of annual flood risk, e.g. an annual flood risk of 1/100 has an ARI of 100 years.
Bore	A constructed connection between the surface and a source of underground water that enables the underground water to be transferred to the surface either naturally or through artificial means
Clean catchment areas	Catchments in which there are no exposed surfaces containing coal or mined carbonaceous material.
Clean water	Waters on the premises that have not come into physical contact with coal, or mined carbonaceous material.
Coal Handling Plant	A facility where coal is screened and prepared for transport off-site.
Continuous miner	The electric powered cutting machine used to remove coal from the working face and load it into the shuttle car. It is also used to form mine roadways and extract coal pillars.
Confined aquifer	Aquifer confined between two aquitards.
Dewatering	Transfer of water from underground workings to the surface.
Dirty catchment areas	Catchments in which coal mined carbonaceous materials are present or areas where the topsoil has been disturbed.
Dirty water	Water on the premises that has come into physical contact with coal, mined carbonaceous materials or otherwise contains elevated sediment load.
Electrical Conductivity	A measure of concentration of dissolved salts in water.
Fractures	Cracks within the strata either natural or resulting from underground works.
Goaf	That part of a mine from which the mineral has been partially or wholly removed; the waste left in old workings.
Groundwater	Water held in strata that is not overlying the strata of the coal seam, or within the coal seam.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks of the earth’s crust.

Infiltration	Natural flow of surface water through ground surfaces as a result of rainfall events.
Inbye	Direction towards the mining face of the coal seam.
Interburden	The strata between coal seams.
Licensed Discharge Point	A location where Angus Place Colliery discharges water in accordance with conditions stipulated within the site Environment Protection License.
Lithgow seam	Deepest coal horizon of the Permian Age Illawarra Coal Measures, with an average depth of 380 metres.
Longwall	Longwall mining is a form of underground coal mining where a block of coal is mined using a longwall shearer. The longwall mining method is supported by roadway development, mined using a continuous miner unit.
Net extraction	Difference between water transferred from, and to, the underground water storage.
Oil Water Separator	Device designed to separate oil and suspended solids from water.
Overburden	The strata between the recoverable topsoil and the upper coal seam.
Partial Extraction	A continuous miner system of mining whereby some of the coal pillars in a panel, or parts thereof, are systematically extracted.
Permian Age	The youngest geological period of the Palaeozoic era, covering a span between approximately 290 and 250 million years.
Project	Extension of underground coal mining and associated activities at Angus Place Colliery within the mining lease area.
Recharge	Inflow of water from surrounding strata into underground workings through infiltration. This can be as a result of rainfall events or from surrounding aquifers.
Run of Mine	Raw coal production (unprocessed).
Steady state condition	A condition in which the system has achieved equilibrium.
Subsidence	The vertical lowering, sinking or collapse of the ground surface.
Surface Water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Temporary storage	Volume of storage available within a dam between the permanent water level and the overflow level.
Unconfined aquifer	An aquifer in which the water table forms the upper boundary.
Underground water	Water stored in underground aquifers. During the mining process a proportion of this water is released and managed by the underground settling and pumping system.

Abbreviations

AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
ARI	Average Recurrence Interval
BOM	Bureau of Meteorology
CHP	Coal Handling Plant
DECCW	Department of Environment, Climate Change and Water
DoP	Department of Planning
DI&I	Department of Industry and Investment (formerly Department of Primary Industries – Mineral Resources)
SDWTS	Springvale - Delta Water Transfer Scheme
EA	Environmental Assessment
EP&A Act	Environmental Planning and Assessment Act 1979
EPL	Environment Protection Licence
kL	Kilolitres
kL/day	Kilolitres per day
LDP	Licensed Discharge Point
m	Metres
MB	Monitoring bore
ML	Megalitres
ML/day	Megalitres per day
Mt	Million tonnes
Mtpa	Million tonnes per annum
NoW	New South Wales Office of Water
PA	Project Approval
ROM	Run of Mine
STP	Sewage Treatment Plant
SWMP	Surface Water Management Plan
T	Tonnes

Executive Summary

The Angus Place Colliery operation is a joint venture owned in equal share between Centennial Cola Company Limited and SK Kores and is an underground mining operation for which the management of both surface and underground water is an important issue. This water balance assessment was undertaken to confirm the existing water management systems and subsequently develop a water balance numerical model.

Inputs into this model were based on information provided by Angus Place Colliery and further estimations based on the available data. The water balance model was then amended to reflect the recorded information primarily relating to metered pumping data associated with transfers to the Springvale - Delta Water Transfer Scheme and pumping from the 300 District to the fire tanks.

The variability of data available for the development of the water balance model resulted in the adoption of a number of assumptions including the volume of mine water make and transfer rates between various elements of the water management system. To improve the estimates within the water balance model, it is recommended that additional metering be installed and a groundwater model developed. Once this information is then made available, the water balance could be revised to reflect this more comprehensive data.

For the existing conditions, it was determined that the average annual discharges from Angus Place Colliery through Licensed Discharge Point 001, Licensed Discharge Point 002, Licensed Discharge Point 003 and the 940 dewatering bore were 1405, 76, 28 and 1341 ML/year respectively. The model was then amended to reflect the proposed conditions associated with the Project.

For the proposed conditions, the model was modified to reflect the increase in mining extent. Within this model, it was assumed that the increase in underground water make will be directed to the 940 dewatering bore however for operational reasons, this may vary. The resulting predicted average annual discharges through Licensed Discharge Point 001, Licensed Discharge Point 002, Licensed Discharge Point 003 and the 940 dewatering bore were 1405, 76, 28, 2604 ML/year respectively. From this it can be seen that there will be an increase in discharges though the 940 dewatering bore as a result of the increase in mining extent.

Discharges through Licensed Discharge Point 002 and Licensed Discharge Point 003 were determined to be directly correlated to rainfall event based runoff. As the Project will not result in a variation in the total catchment area contributing to each of the licensed discharge points, the predicted annual discharges through these licensed discharge points will not be impacted by the Project.

As the water balance modelled assumed that any increase in underground water would be directed to the 940 dewatering bore, discharges through Licensed Discharge Point 001 would not be impacted by the Project. However, to provide operational flexibility, it is recommended that the volumetric limit applied to Licensed Discharge Point 001 within Environmental Protection Licence 467 be sufficient to cater for the discharge of all underground water.

The total average annual volume of underground water discharged from Angus Place Colliery has been estimated at 3995 ML/year (approximately 11 ML/day). As this is an annual average only, it is likely that operational variations will result in larger daily volumes in some instances. Therefore, it is recommended that the current volumetric licence condition nominated within Environmental Protection Licence 467 for Licensed Discharge Point 001 (30 ML/day) be maintained.

1. Introduction

Angus Place Colliery is a small underground coal mine owned and operated by Centennial Angus Place Pty Ltd, a wholly owned subsidiary of Centennial Coal Company Ltd (Centennial). The mine entry and surface facilities are located approximately 15 kilometres northwest of the city of Lithgow as shown on Figure 1.1.

1.1 Study Area

The study area for this water balance assessment encompasses the Angus Place Colliery holding boundary identified on Figure 1.1.

This water balance assessment has given consideration to the overall water management system associated with Angus Place Colliery and includes all water transfers associated with:

- Existing mining activities.
- Proposed mining activities.
- Surface operations.

1.2 Objectives of this Report

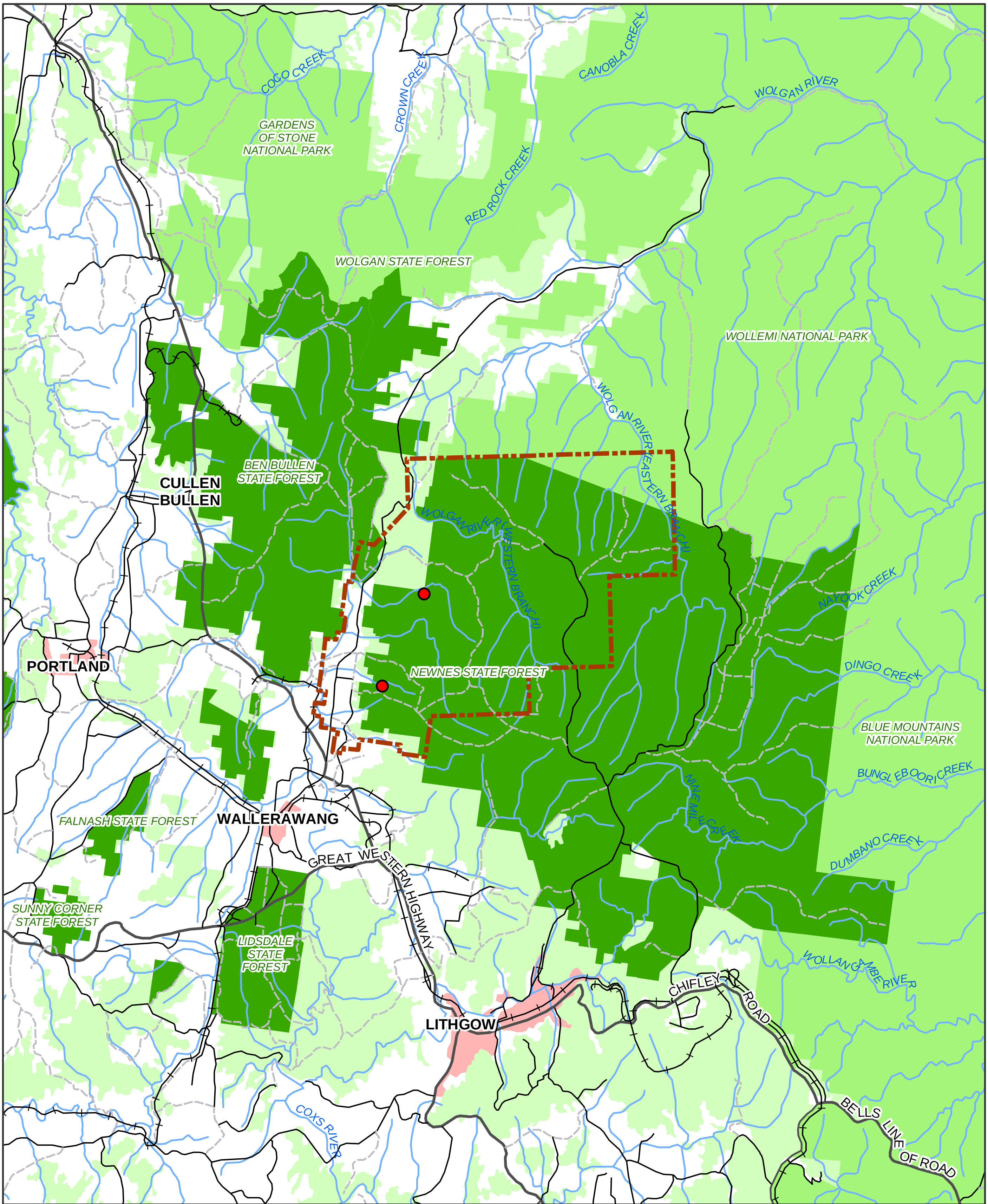
The objectives of this water balance are to:

- Quantify the water budget in relation to the surface water and groundwater management systems for existing operations.
- Revise the water budget in relation to the water management system for future operations.

Overview of Site Operations

The site features associated with operations at Angus Place Colliery are provided on Figure 1.2 and include:

- Underground mining.
- Coal processing at the Coal Handling Plant (CHP).
- Loading of coal for export from site by road.
- Mechanical maintenance activities – undertaken near the Administration area and at a workshop.
- Office and administrative activities.



1:200,000 for A4

0 1.25 2.5 5 7.5

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

Site Location	Principal Road	State Forest
Watercourse	Secondary Road	Nature Conservation Reserve
Railways	Minor Road	Forest or Shrub
Dual Carriageway	Track	Angus Place Colliery Holding Bdy

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Water Balance

Locality Plan

Centennial Angus Place

DATE 24-06-2010

Figure 1.1

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\Water Balance\2214985_WB_Fig1_1_Locality_20100628.mxd

LEGEND

- Pollution Control Structures
- Pollution Control Wetlands
- Buildings
- Infrastructure
- Creek
- Contour

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Water Balance

Surface Facilities

Centennial Angus Place

DATE 16-08-2010

Figure 1.2

GIS Filename: G\22\14985\GIS\MAPS\Deliverables\Water Balance\2214985_Fig1-2_SurfaceFacilities_20100628.mxd

Existing Mining Activities

Angus Place Colliery commenced longwall operations in 1979 after being developed as an extension of the Newcom Mine bord and pillar operations at Kerosene Vale. Current mining operations include extraction of coal at a rate of approximately 3,500,000 tonnes per annum utilising the longwall mining method. Historically, coal has been extracted from the combined Lithgow / Lidsdale seam of the Illawarra Coal Measures and the current operations have continued extraction within the Lithgow seam.

Future Mining Activities

Additional extraction areas have been proposed for the Angus Place Colliery and are addressed as part of the documentation currently being prepared as part of a Part 3A application under the *Environmental Planning and Assessment Act 1979.* In addition to additional extraction areas, it is proposed to increase the extraction rate to a maximum 4,000,000 tonnes per annum.

The mining operations will continue to be carried out using bord and pillar methods in the Lithgow coal seam, generally consistent with the manner in which Centennial Angus Place undertakes current mining operations at Angus Place Colliery. These operations will be supported by the existing pit top facilities.

Site Water Management

Angus Place Colliery's surface facilities area located within the Coxs River catchment, which contributes to Lake Wallace. Angus Place Colliery's Environmental Protection Licence (EPL) 476 therefore includes both volumetric and concentration limits for the discharge of water off site.

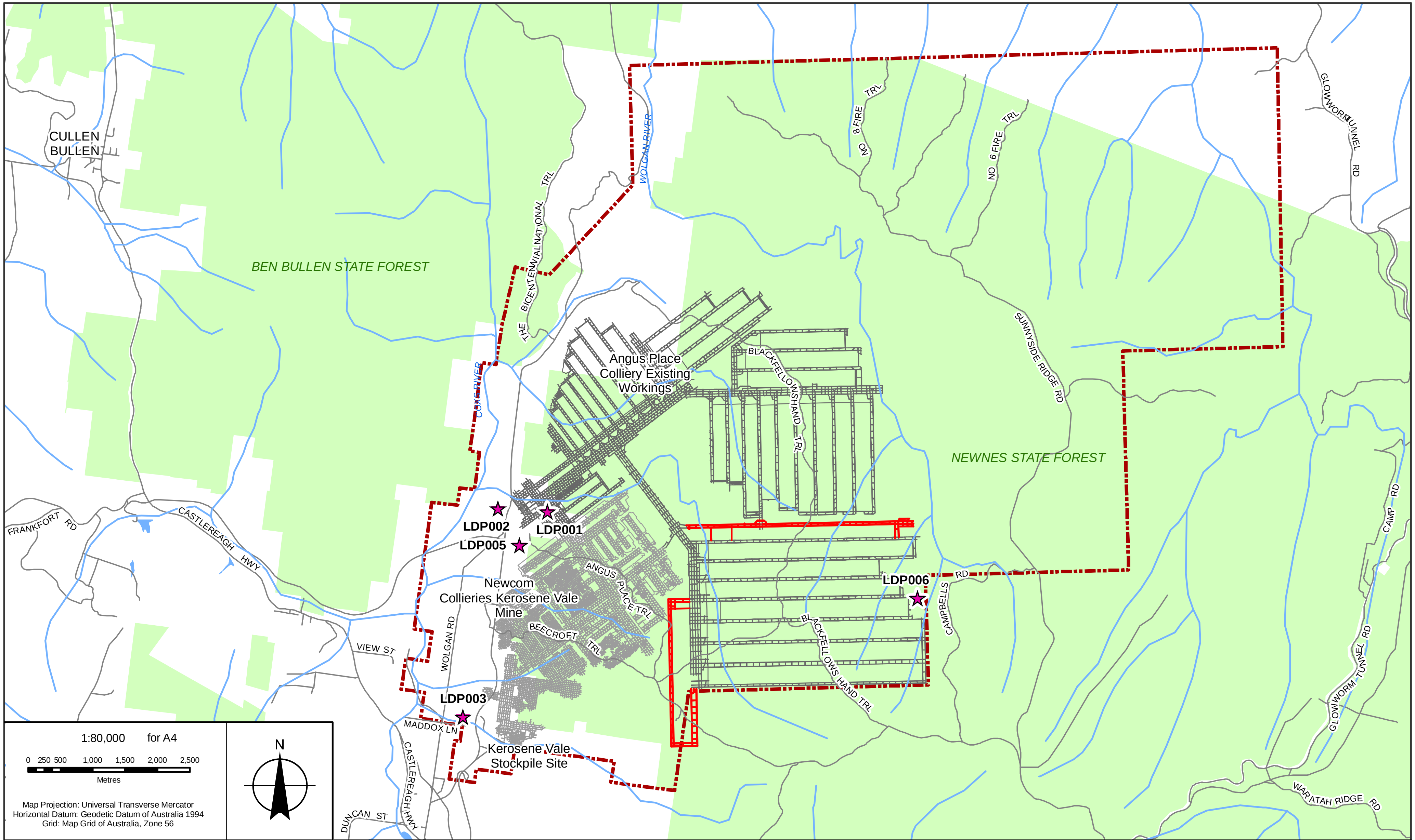
The location of Angus Place Colliery's discharge points are indicated on Figure 1.3 and include:

- LDP001 - Discharge of mine water make and runoff into Kangaroo Creek through wetlands.
- LDP002 - Discharge of surface water from the Angus Place Colliery pit top facilities into the Coxs River through settling ponds.
- LDP003 – Rainfall event based discharge of surface water from the old Kerosene Vale Colliery site into the Coxs River through a settling pond.
- LDP005 - Discharge of treated sewage effluent from Angus Place Colliery via a spray irrigation network to a designated utilisation area.
- LDP006 - Emergency discharge location for the 940 dewatering bore on the Newnes Plateau. This is situated in the Wolgan/Colo Catchment.

The primary objective of water management at Angus Place Colliery is the separation of clean and dirty water and the effective management of water through collection, treatment and discharge.

This is managed through a number of separate water systems including:

- Surface infrastructure.
- Underground infrastructure.
- Potable water supply.
- Wastewater collection and treatment.



LEGEND

- Licensed Discharge Points
- State Forests
- Angus Place Colliery Holding
- Roads
- Existing Workings
- Kerosene Vale "Newcom" Workings
- Proposed Workings

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	F.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Water Balance

Licensed Discharge Point Locations

Centennial Angus Place

DATE 16-08-2010 Figure 1.3

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Water Management Associated with Mining Operations

There are numerous water movements associated with the coal mining operations at the Angus Place Colliery. The main water movements include:

- Rain falling on vegetated areas within the lease area and generating clean water runoff. No clean water runoff is harvested at Angus Place Colliery however some clean water does contribute to the dirty water system.
- Runoff from disturbed areas is deemed to be dirty water runoff and is directed through the dirty water management system. Discharges from the dirty water system pass through licensed discharge points (LDPs).
- Potable water is provided to surface facilities by Lithgow City Council.
- Water that seeps into the underground workings is extracted and pumped to the underground water storages prior to being transferred to surface water storages.
- Removal of underground water with extracted coal.

Other Water Management

Potable water is provided to Angus Place Colliery by Lithgow City Council for use in the administration buildings, bathhouse and underground.

Waste water at Angus Place Colliery includes both grey water and sewage. Both the grey water and sewage from the bathhouse and other buildings contribute to the on-site sewage treatment facility prior to being disposed of via an on-site irrigation system.

Site Geology and Hydrogeology

The geology within the Angus Place Colliery lease area affects both the mining operations and management of water. Water management is affected as the stratigraphy will influence the potential for infiltration into the workings. The location of regional aquifers in relation to the workings also affects the management of water on-site.

The stratigraphy at Angus Place Colliery is reported within the Subsidence Prediction and Impact Assessment for the Proposed Longwall Panels 910 and 900 West at Angus Place Colliery, Lidsdale (2010) report as:

- Banks Wall Sandstone consisting of thickly bedded to massive conglomeratic sandstone with mine shale beds.
- Mount York Claystone.
- Burra-Moko Head Unit consisting of thickly bedded to massive conglomeratic sandstone with minor shale beds.
- Interbedded siltstone, sandstone and minor coal of the Newnes, Glen Davis and Denman Formations and including the Katoomba / Little Riverdale seams along with thinly bedded sandstone and siltstone of the Triassic Narrabeen Group’s Caley Formation.
- Lidsdale and Lithgow Seams consisting of interbedded coal, shale and mudstone.

Within the geologic profile, there are five (5) aquifer zones, the lower two (2) zones being associated with the Lithgow / Lidsdale coals seams while the upper three (3) zones are located in the overlying sandstone of the Permian Narrabeen Group.

The lower two (2) aquifer zones contribute to the goaf associated with the extraction of coal at Angus Place and result in the mine being considered moderately wet.

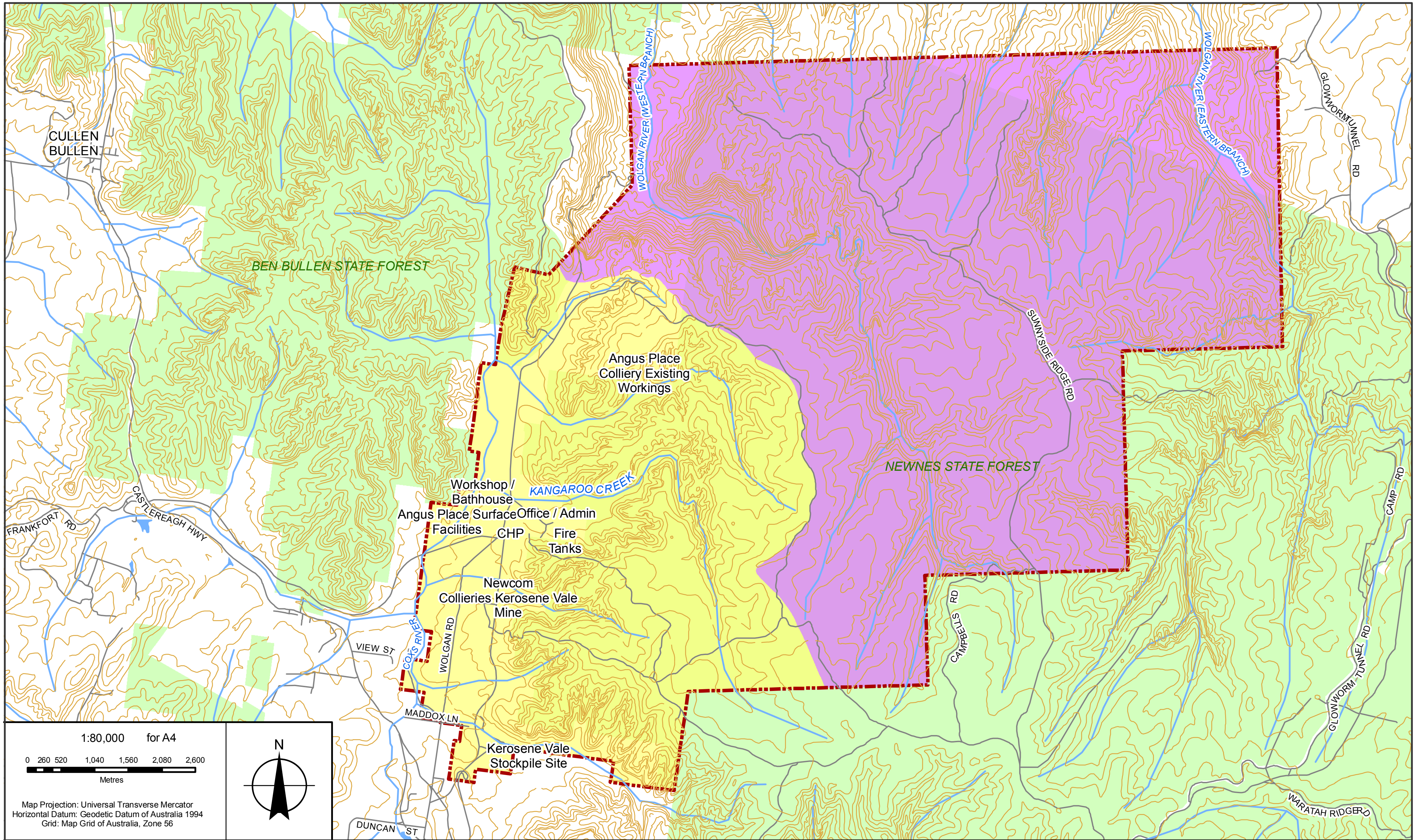
Site Hydrology

Surface water runoff within the Angus Place Colliery lease area is conveyed within a number of natural and constructed flow paths.

The natural flow paths (watercourses) that originate in or pass through the lease boundary area contribute to Coxs and Wolgan Rivers. The named watercourses are Kangaroo Creek and Wolgan River as shown in Figure 1.4.

Also shown on Figure 1.4 are the overall site catchment areas associated with Coxs River and Wolgan River. The location of the catchment divide is such that the pit top is primarily located within the Coxs River catchment while the mining areas are located below both the Coxs and Wolgan River catchment areas.

Angus Place Colliery does not extract water from any natural water course however it does discharge both mine water and rainfall runoff into Kangaroo Creek and Coxs River, through LDP001, LDP002 and LDP003. Occasionally, when the transfers to the Springvale - Delta Water Transfer Scheme are not possible, discharges are made through LDP006 which contribute the Wolgan River.



LEGEND

GHD

- Angus Place Colliery Holding
- Roads
- Watercourse
- Coxs River Catchment
- Wolgan River Catchment
- State Forests

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Water Balance

Watercourses within
Angus Place Colliery Lease Area

Centennial
Angus Place

DATE 22-07-2010

Figure 1.4

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\Water Balance\2214985_WB_Fig1-4_AngusPlace_Watercourses_20100628.mxd

2. Water Management

The water management system at Angus Place Colliery is comprised of surface, potable, waste and underground elements. Schematics of the surface, underground and potable and wastewater systems are provided in Section 2.1.

2.1 Existing Operations in Mining Lease Area

Surface Water System

Surface water consists of runoff that contributes to surface water storages. At Angus Place Colliery these include the Pit Top Dams (Primary, Secondary and Filter Ponds), the Settling Ponds, Kerosene Vale Dam and the LDP001 Dams and Wetlands.

Inputs

The inputs into the surface water system are shown on Figure 2.1 and consist of:

- Runoff from the contributing catchment areas (both clean and dirty) as a direct result of rainfall.
- Transfer of mine water.
- Harvesting of water from the workshop roof into rainwater tanks.

Outputs

The outputs from the surface water system are shown on Figure 2.1 and consist of:

- Evaporation.
- Discharge of clean catchment runoff into Kangaroo Creek.
- Discharge of clean catchment runoff into Coxs River.
- Discharges through LDP001 of mine water into Kangaroo Creek.
- Discharges through LDP002 from the Settling Ponds into Coxs River.
- Discharges through LDP003 from Kerosene Vale Settling Pond into Coxs River.
- Removal of water from the Grit Trap by a contractor.

Facilities

The facilities that manage surface water are provided in Table 2.1.

Table 2.1 Surface Water Management Structures

Location	Capacity (ML)
Primary Pollution Ponds	1.9
Secondary Pollution Pond	2.2
Filter Pond	1.2
Settling Ponds	7.5
Kerosene Vale Dam	2.5
LDP001 Dams and Wetlands	5.0
Fire Fighting Tanks	0.2

Underground Water System

Mining at Angus Place Colliery interacts with the Lithgow Seam. Although this seam would be considered a water bearing zone, there is moderate groundwater inflow into the workings therefore the mine is considered to be a relatively wet mine.

Inputs

The inputs into the underground water system are shown on Figure 2.2 and consist of:

- Natural recharge of the active underground workings.
- Natural recharge of the old underground workings.
- Dirty runoff into the 302 Portal

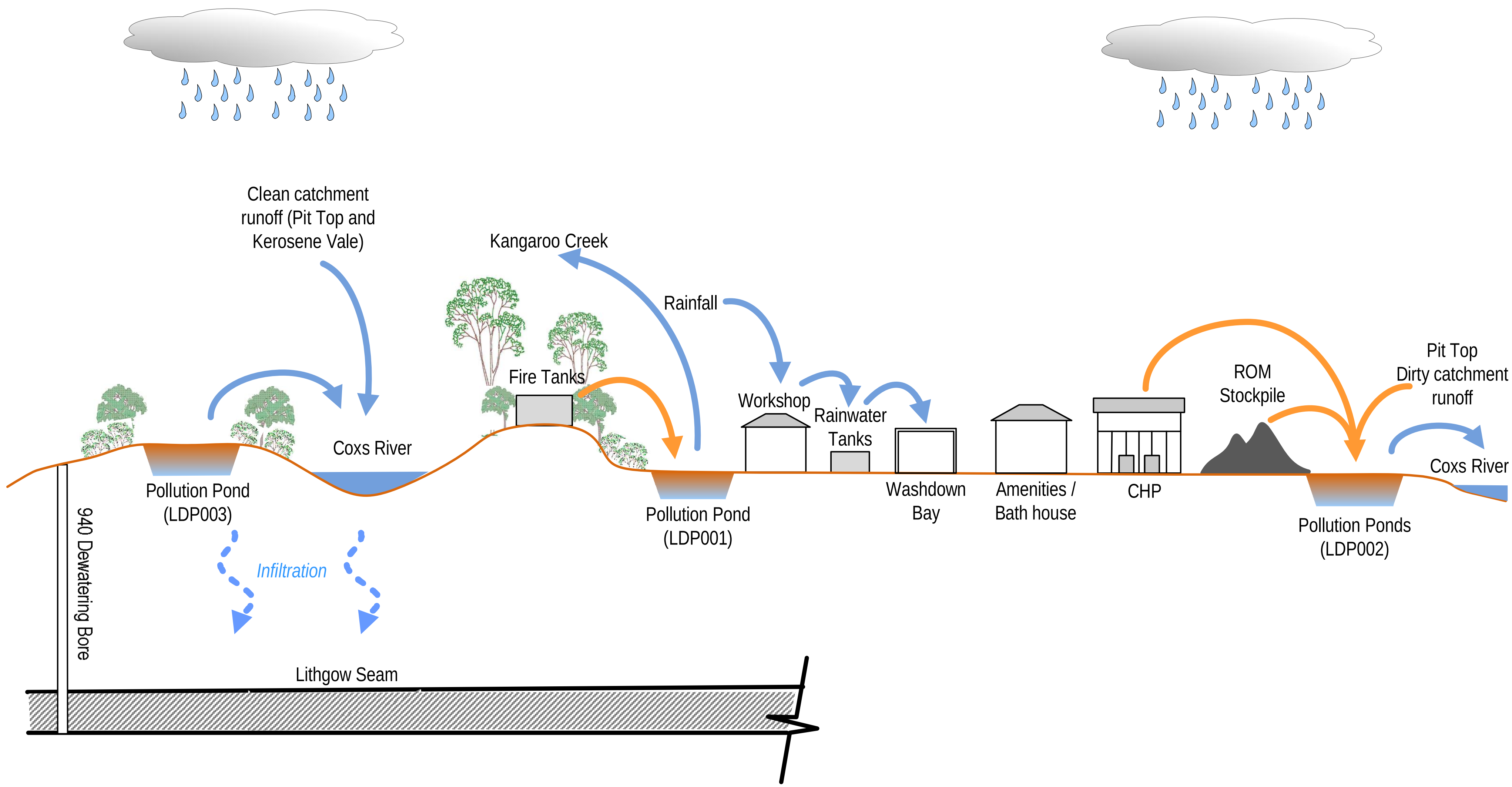
Outputs

The outputs from the underground water system are shown on Figure 2.2 and consist of:

- Discharges through the 940 bore into the Springvale - Delta Water Transfer Scheme
- Discharges through the 940 bore through LDP006 (when transfer to the Springvale - Delta Water Transfer Scheme is not possible)
- Transfer from the Fire Tanks to the CHP
- Transfer from the Fire Tanks to the Rainwater Tanks
- Overflows from the Fire Tanks to the LDP001 Dams and Wetlands

Facilities

The facilities to store water underground include the 300 District Underground Storage (approximately 2,495 ML capacity), the 20 Cut Through Dam and the 900 Underground District.



Dirty Water
Clean Water
Underground Water
Potable Water
Waste Water

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	MJP
CHECKED	IBJ
APPROVED	IBJ
SCALE	

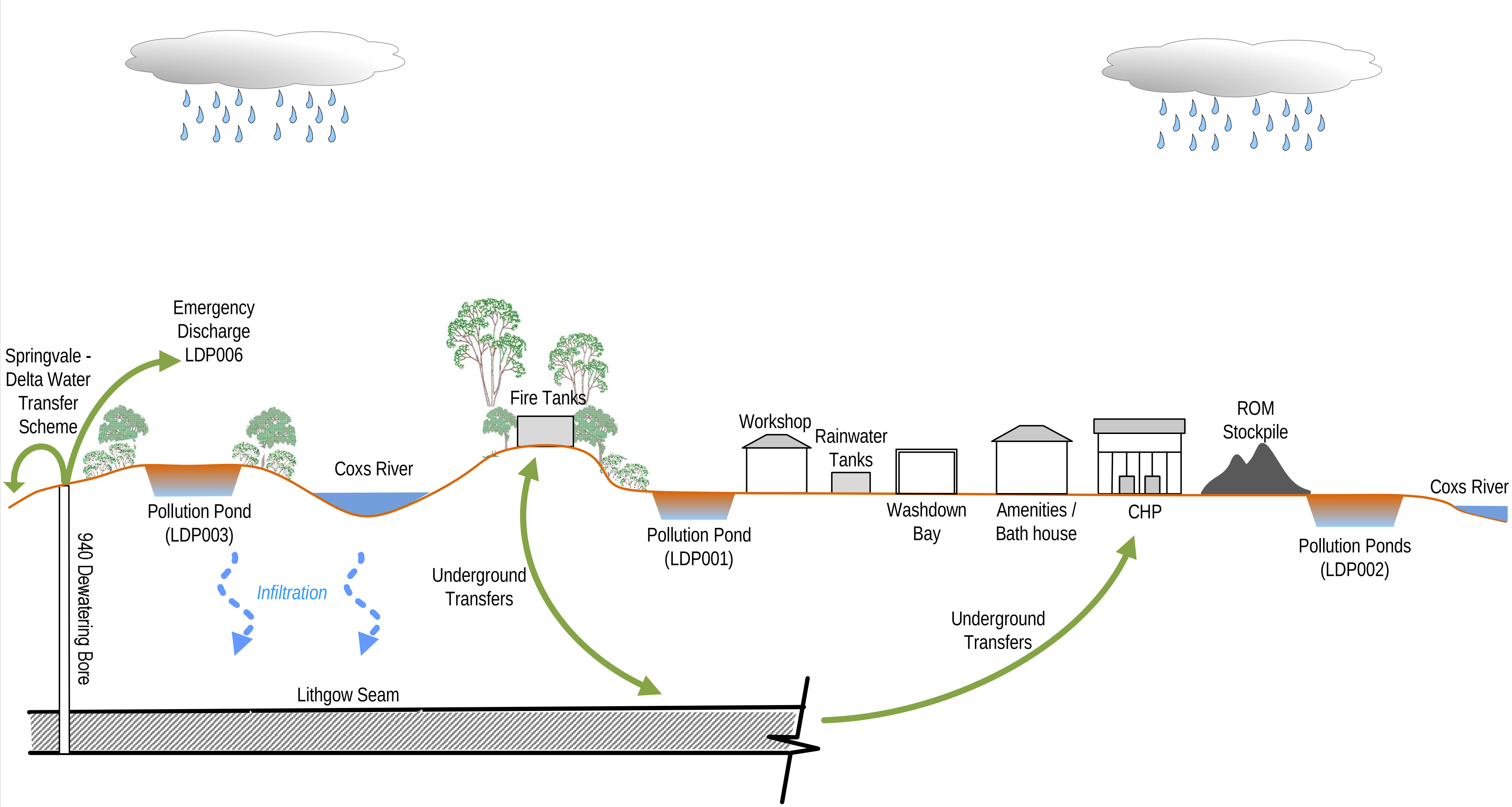
Angus Place Colliery
Water Balance

Surface Water Schematic

Centennial Angus Place

DATE 30-09-2010

Figure 2.1



- Dirty Water
- Clean Water
- Underground Water
- Potable Water
- Waste Water

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	MJP
CHECKED	IBJ
APPROVED	IBJ
SCALE	

Angus Place Colliery
Water Balance

Underground Water Schematic

Centennial
Angus Place

DATE 30-05-2010

Figure 2.2

Potable and Wastewater Systems

The potable and waste water systems are a component of the surface water system at Angus Place Colliery.

Inputs

The inputs into the potable and waste water systems are shown on Figure 2.3 and consist of:

- Potable water provided to the Administration and Bath House Buildings

Outputs

The outputs from the potable and waste water system are shown on Figure 2.3 and consist of:

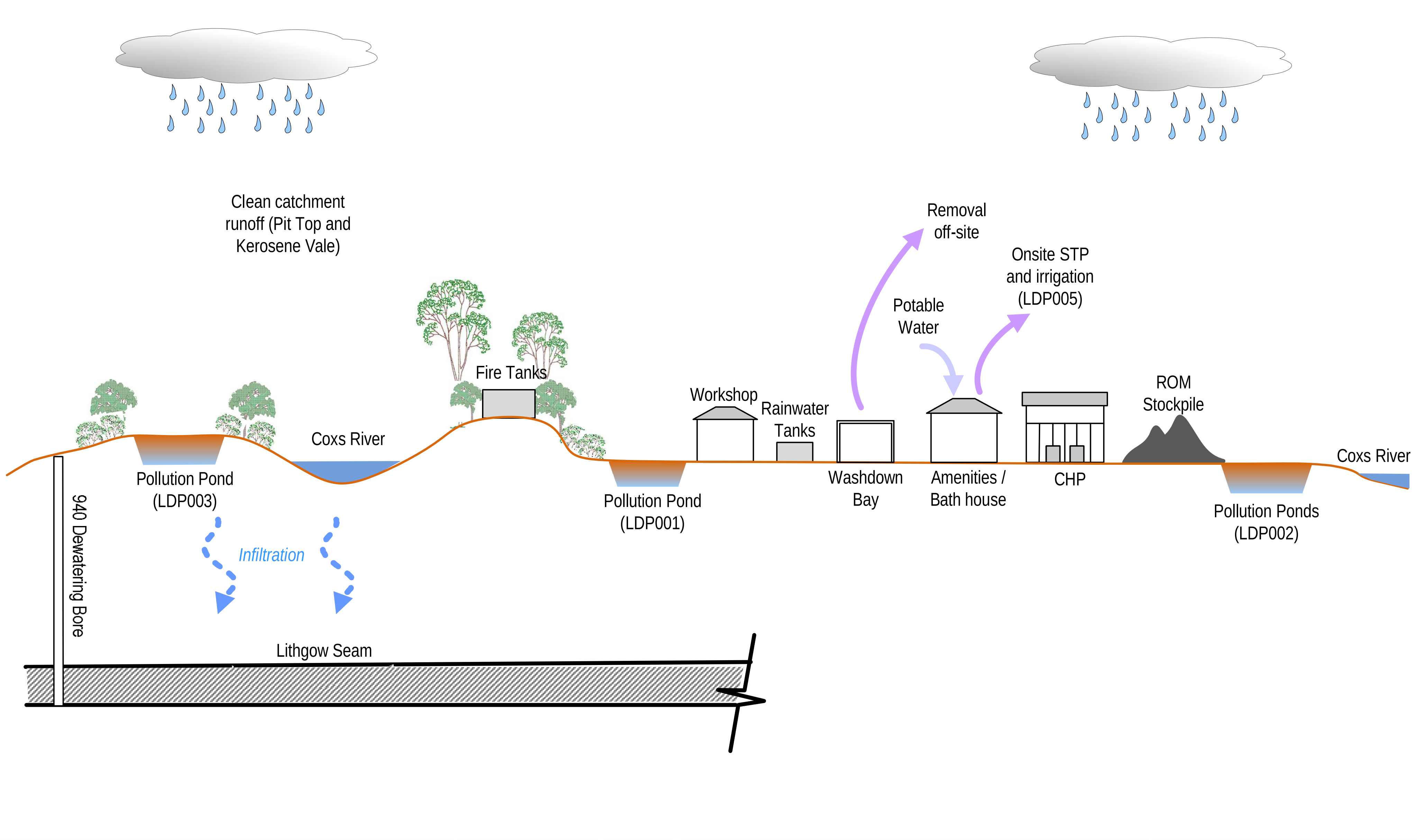
- Grey water and sewage from buildings directed to the Maturation Ponds and irrigated through LDP005

Facilities

The facilities that manage potable and waste water include the Maturation Ponds which have an aggregate capacity of 7ML.

Overall Water Management System

The interactions between each of the water management elements are indicated on Figure 2.4.



Dirty Water
Clean Water
Underground Water
Potable Water
Waste Water

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	MJP
CHECKED	IBJ
APPROVED	IBJ
SCALE	

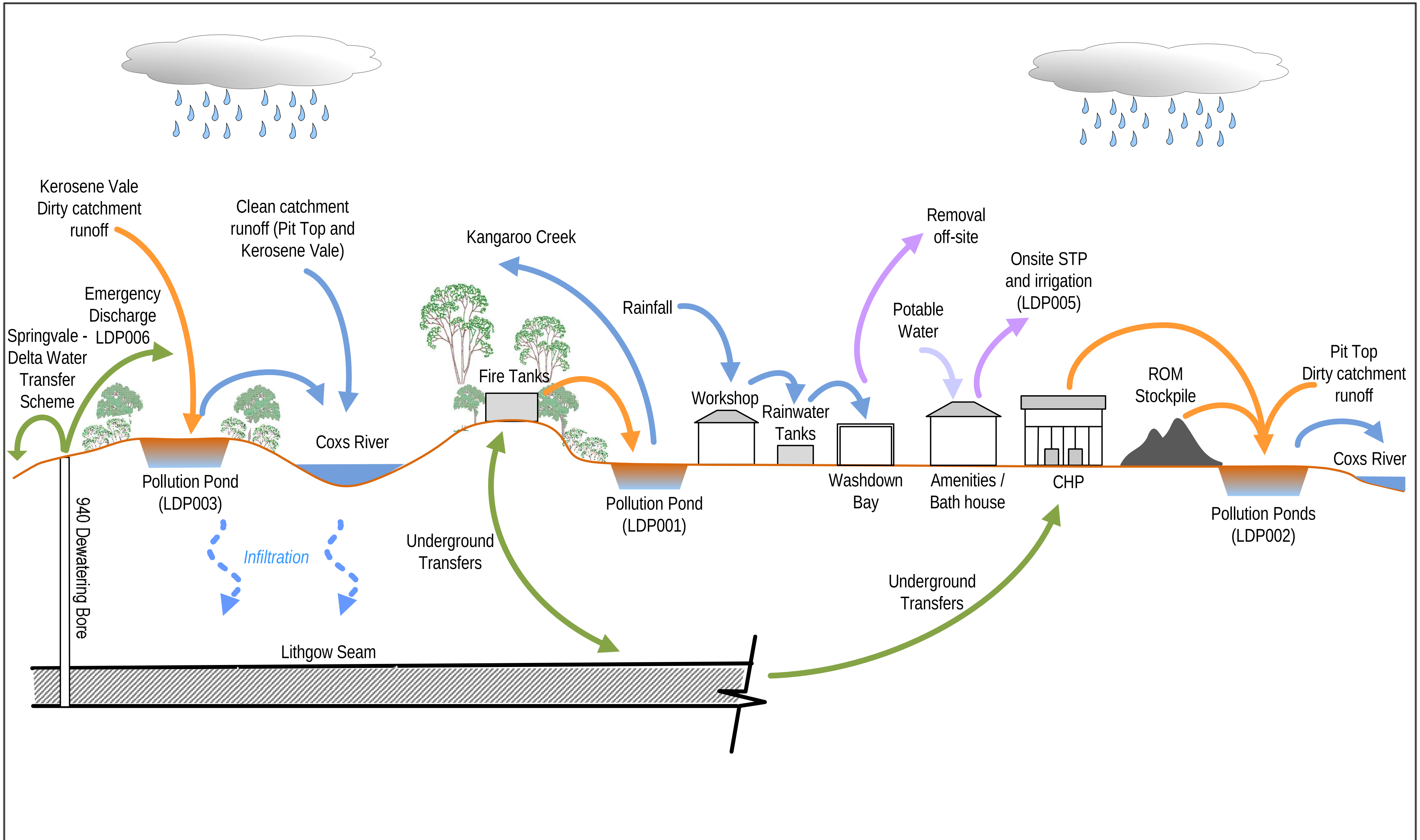
Angus Place Colliery
Water Balance

Potable and Waste Water Schematic

Centennial Angus Place

DATE 30-05-2010

Figure 2.3



GHD

- Dirty Water
- Clean Water
- Underground Water
- Potable Water
- Waste Water

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	MJP
CHECKED	IBJ
APPROVED	IBJ
SCALE	

Angus Place Colliery
Water Balance

Water Management Schematic

Centennial Angus Place

DATE 30-05-2010

Figure 2.4

2.2 Future Operations in Existing Mining Lease Area

The future operations proposed at Angus Place Colliery, as part of the current Part 3A Major Projects application under the *NSW Environmental Assessment and Planning Act 1979* (EP&A Act), are provided in Table 2.2.

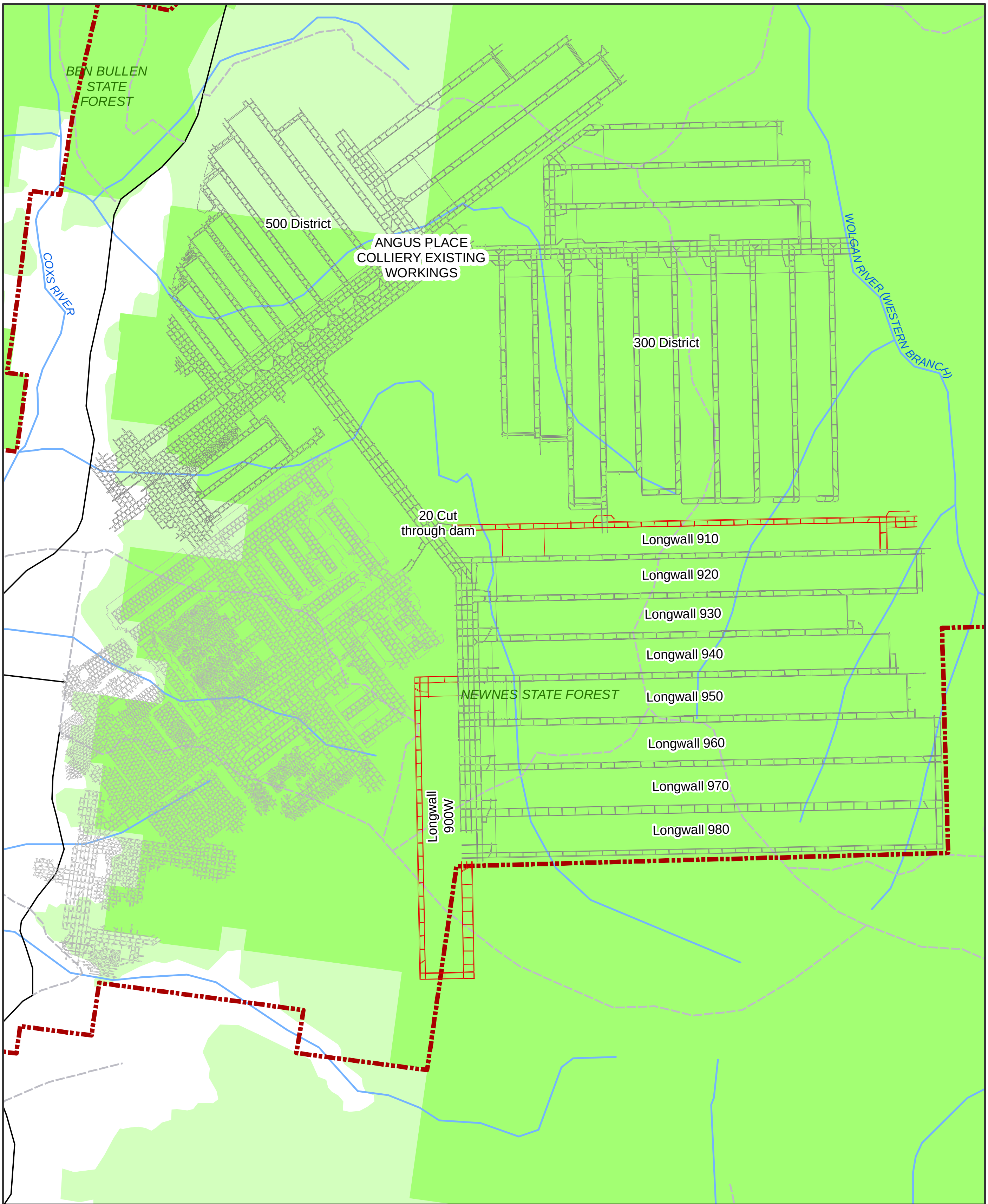
Table 2.2 Project Description

Development Component	Present Operations	Proposed Works
Description	• Extraction of up to 3.5MTpa of coal from Lithgow seam using continuous miners for development and longwall. • Longwalls 920 to 980 (refer Figure 2.5). • Delivery by overland conveyor and trucks to Wallerawang and Mt Piper Power Stations on private haul roads. • 7 days per week, 24 hours per day.	• Longwall 910 directly north of the current approval area. – Option1: 200m wide and 2500m long and the development of two mains headings. – Option 2: 120m wide and 2500m long and the development of four mains headings. • Longwall 900W due west of the current main headings.
Production Limit	• 3.5Mtpa.	• Increase production to 4Mtpa.

Development Component	Present Operations	Proposed Works
Surface Facilities	◗ Mine entries. ◗ Coal processing facilities including coal sizing, stockpiling, stacking and reclaim facilities. ◗ 2000 tonne final product bin and truck loading facilities. ◗ Workshop, stores, fuel and oil storage systems. ◗ Enclosed and bulk open material and equipment stores facilities ◗ Air compressors. ◗ High tension electrical switchyard. ◗ Surface water management ponds and pollution control equipment. ◗ Bath house. ◗ Sewerage treatment facility. ◗ Office, carpark and administration buildings. ◗ Ventilation facilities, bot upcast and downcast. ◗ Mine drift entries. ◗ Dewatering bores. ◗ Kerosene Vale decommissioned Newcom Colliery pit top and coal storage area. ◗ Wallerawang Haul Road. ◗ Mt Piper Haul Road.	◗ Additional dewatering bore at inbye end of Longwall 910. ◗ Extension of Springvale – Delta Water Transfer Scheme in terms of an underground pipeline corridor on Newnes Plateau. ◗ Powerlines and services required for dewatering bore. ◗ Required access tracks. ◗ Modification to stockpile area to improve coal handling and water management.
Hours of Operation	◗ 24 hours per day, 7 days per week.	◗ No change required.

From the details provided in Table 2.2, it can be seen that minimal changes to the existing operations are proposed for the future operations with the exception of the extension of underground workings (and increase in extraction intensity), the construction of clean water diversions and installation of an additional dewatering bore.

For the purposes of this site water balance, both the existing and proposed water management system have been assessed.



1:40,000 for A4

0 0.125 0.25 0.5 0.75 1 1.25
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

- Principal Road
- Secondary Road
- Minor Road
- Track
- Watercourse
- Railways
- Existing Workings
- Kerosene Vale "Newcom" Workings
- Proposed Workings
- State Forest
- Forest or Shrub
- Angus Place Colliery Holding Bdy

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	T.M
CHECKED	
APPROVED	
SCALE	refer to scalebar

Angus Place Colliery
Water Balance

900 District Longwall Layout

Centennial Angus Place

DATE 16-08-2010

Figure 2.5

GIS Filename: G:\22\14985\GIS\MAPS\Deliverables\Water Balance\2214985_WB_Fig2-5_LongwallLayout_20100722.mxd

3. Data

For both the hydrogeological and detailed water balance models, a range of data and site operational information was required.

3.1 Water Balance Model

Extent of Water Balance Model

The water balance for Angus Place Colliery has been developed to include the pit top infrastructure and mining operations.

Data Available from Angus Place Colliery

Data and site operational information has been made available by Angus Place Colliery for this assessment. From this provided information, input data for the water balance was derived. Table 3.1 and Table 3.2 indicate the sources of data and the modelling parameters used. Table 3.3 outlines the data derived from this information.

Table 3.1 Data Sources

Item	Comment
General Operational Data	Provided by Centennial
Areas of water storages	Provided by Centennial / Obtained from GIS
Catchment areas	Derived from topographic information
Maximum water transfer rates	Provided by Centennial
CHP water usage	Provided by Centennial
Storage Capacities	Provided by Centennial
Underground water usage	Provided by Centennial / Estimated from metered data
Site Potable Water Demand	Provided by Centennial
Building Usage Rates	Provided by Centennial
Washdown Bay Usage Rates	Provided by Centennial
Drainage Infrastructure Information	Provided by Centennial
Pumping Rules and Rates	Provided by Centennial
Underground Water Make	Estimated by Centennial and GHD

Table 3.2 Modelling Parameter Data

Parameter	Value
Mine Operations	Coal produced 7 days/week. Mining operations cease on 36 days per year.
Pervious (natural) Initial Loss	30 mm
Impervious areas Initial Loss	5 mm
Dirty Catchment to Primary Pollution Pond	17,145 m^2
Dirty Catchment to Secondary Pollution Pond	11,858 m^2
Dirty Catchment to Filter Pond	2,204 m^2
Dirty Catchment to 302 Portal	5,841 m^2
Dirty Catchment to Oil Water Separator	16,458 m^2
Dirty Catchment to Kerosene Vale Pond	7.69 ha
Impervious Catchment to Settling Ponds	21,648 m^2
Pervious (natural) Catchment to Settling Ponds	10 ha
Pervious (natural) Catchment to LDP001	14.8 ha
Losses from CHP	50%
Losses from Vehicle Washdown Bay	50%
Evapotranspiration Factor	0.8

Table 3.3 Supplied and Derived Data

Parameter	Annual Value	Daily Value
Annual total potable water demand (2009)	28 ML	76.7 kL
Total workday potable water demand (workday)	27.8 ML	84.4 kL
Total non-workday potable water demand (non-workday)	0.2 ML	6.8 kL
Admin Building usage (everyday)	2.5 ML	6.8 kL
Bath House usage (workday)	25.6 ML	77.6 kL
Coal Handling Plant (workday)	85.3 ML	256 kL
Underground Process Water (workday)	236.7 ML	648 kL
Washdown Bay	2.37 ML	6.5 kL
Emptying of grit trap by contractor	416 kL	1.1 kL
Mine water make from 500 District into 300 District	158 ML	432 kL

Parameter	Annual Value	Daily Value
Mine water make into 900 District	2,525 ML	6.9 ML
Mine water make from Kerosene Vale Old Workings into 20 Cut Through Dam	126 ML	345 kL
940 Extraction (existing)	1341 ML	3.7 ML

Operational Precedences for Water Transfer

In developing the detailed site water balance, a number of operational precedences were adopted. The rules adopted for the analysis of water transfers is provided in Table 3.4.

Table 3.4 Operational Precedence for Water Transfer

Feature	Comments
Water Supply	Water from Lithgow City Council Potable Supply. ◗ Total production day inflow is 99% of total annual potable water demand. ◗ Non-production day inflow is 1% of the total annual potable water demand.
Administration Building	Receives potable water from Lithgow City Council Potable Supply ◗ Demands everyday ◗ Discharges to the Car Park Pit
Bath House Building	Receives potable water from Lithgow City Council Potable Supply ◗ Demands only on workdays ◗ Discharges to the Car Park Pit
Car Park Pit	Inflow from Car Par and outflow to Maturation Pond
Maturation Ponds	Inflow from Car Park Pit ◗ Losses due to evaporation ◗ Overflows are applied to the irrigation area
Fire Tanks	Receives water pumped from Underground 300 District ◗ Transfers Process Water to the Underground Operations ◗ Transfers water to CHP ◗ Transfers water to Rainwater Tanks ◗ Excess flows are discharged to the LDP001 Dam and Wetlands
900 District	Receives 900 District Mine Water Make and Process Water for Underground Operations

Feature	Comments
	◗ 940 bore extracts everyday ◗ Remainder of inflows are directed to the 20 Cut Through Dam
Cut Through Dam	Receives water from the 900 District and Kerosene Vale Old Workings ◗ Inflows are directed to the 300 District Underground Storage
300 District	Receives water from: ◗ 20 Cut Through Dam ◗ 500 District Water Make ◗ Dirty Water Runoff into 302 Portal Inflows into the 300 District are directed to the Fire Tanks
LDP001	Receives overflows from the Fire Tanks and runoff from the natural upstream catchment
Rainwater Tanks	Receives rainwater from the Workshop roof. ◗ The rainwater tanks are topped up to 80% of full capacity from the Fire Tanks when the volume of water in the tanks reaches 20% or less. ◗ Supplies the Vehicle Washdown Bay
Vehicle Washdown Bay	Receives water from the Rainwater Tanks (everyday) and discharges runoff to the Grit Trap.
Grit Trap	Receives runoff from the Vehicle Washdown. ◗ Contractor removes a proportion ◗ The remainder is pumped to the Oil Water Separator
Oil Water Separator	Receives water from: ◗ Its own dirty water catchment ◗ Excess from the Grit Trap ◗ Overflows from the Rainwater Tanks Overflows from Oil Water Separator flow to the Settling Ponds
Primary Pollution Pond (Pit Top Ponds)	Receives runoff from the CHP and its own dirty water catchment. Overflows to Secondary Pollution Pond
Secondary Pollution Pond (Pit Top Ponds)	Receives overflows from the Primary Pollution Pond and its own dirty water catchment. Overflows to the Filter Pond
Filter Pond	Receives overflows from the Secondary Pollution Pond and its own

Feature	Comments
(Pit Top Ponds)	dirty water catchment. Overflows to the Settling Ponds.
Settling Ponds	Receives overflows from the Filter Pond and its own natural catchment. Overflows to the LDP002.
Kerosene Vale Pond	Receives runoff from Kerosene Vale Dirty Water Catchment and overflows into LDP003

Sourced Data

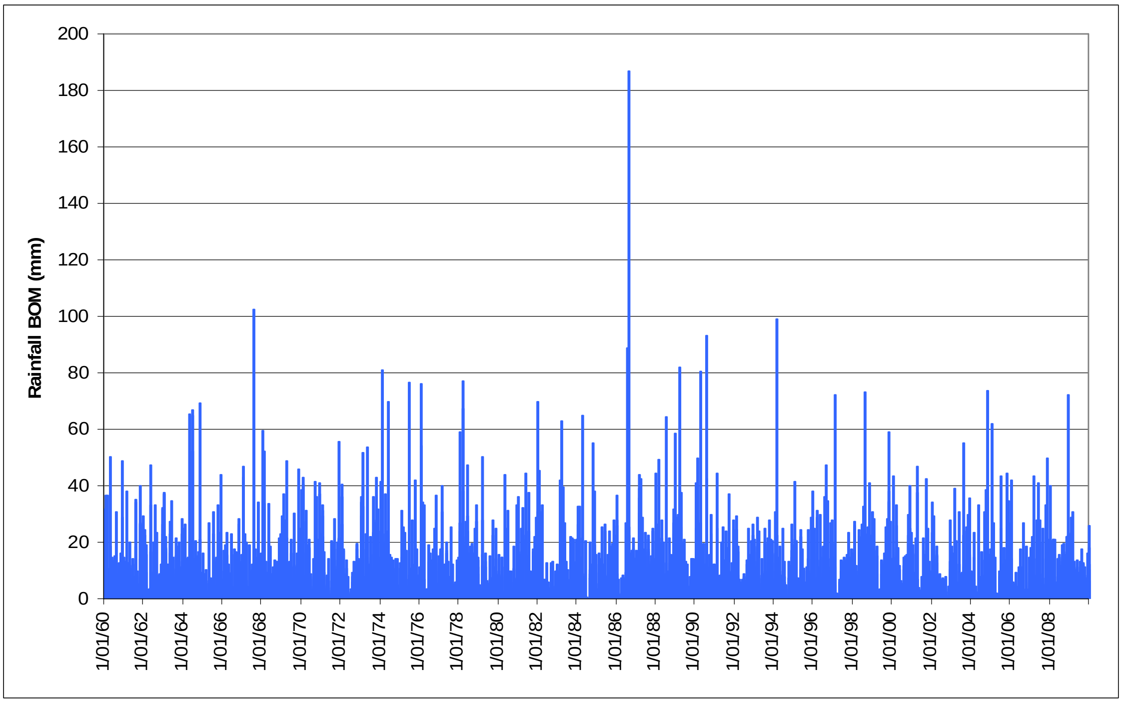
Topography

The topographic information used in establishing catchment areas included the provided site survey information and Department of Lands contours for the area.

Rainfall

While rainfall data was made available by Angus Place Colliery, this data only extended from approximately July 2009 to December 2009.

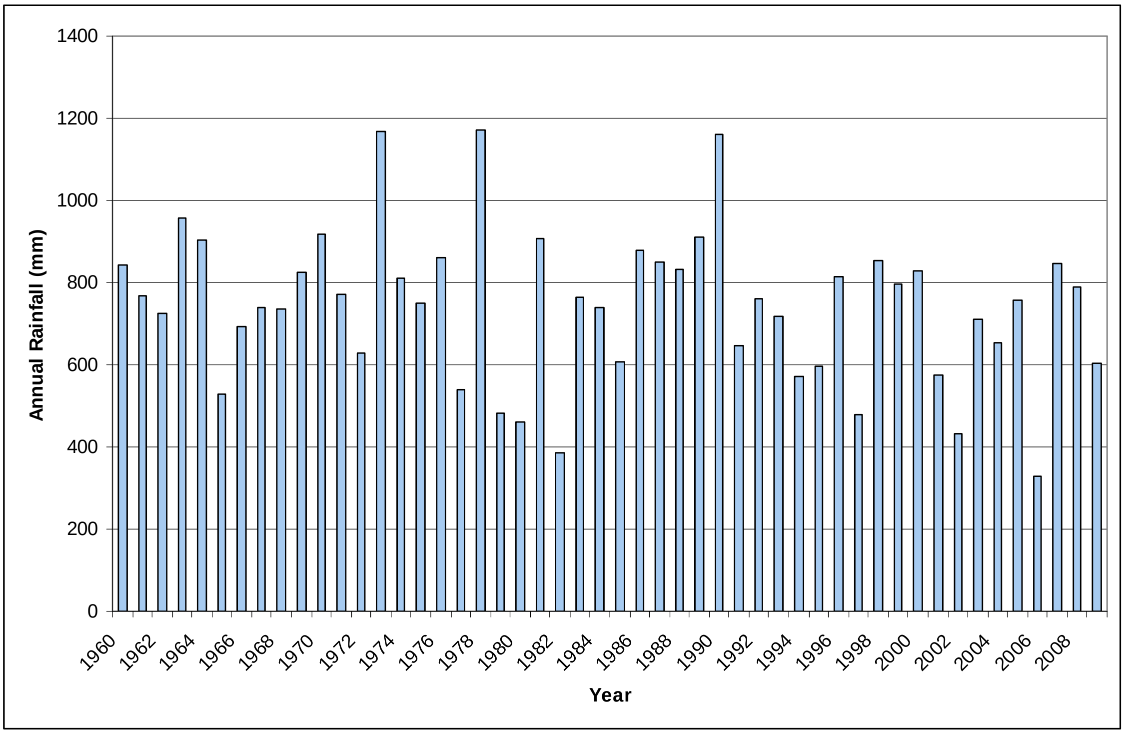
For the purposes of the water balance assessment, a more complete record period was required. Data from the Bureau of Meteorology (BOM) Lidsdale Station (Station number 63132), which is located approximately 5 kilometres to the south of Angus Place Colliery, was obtained and reviewed. The period of data used in this assessment extended from January 1960 through to December 2009 and is provided in Graph 3-1.



Graph 3-1 Lidsdale Rainfall Data

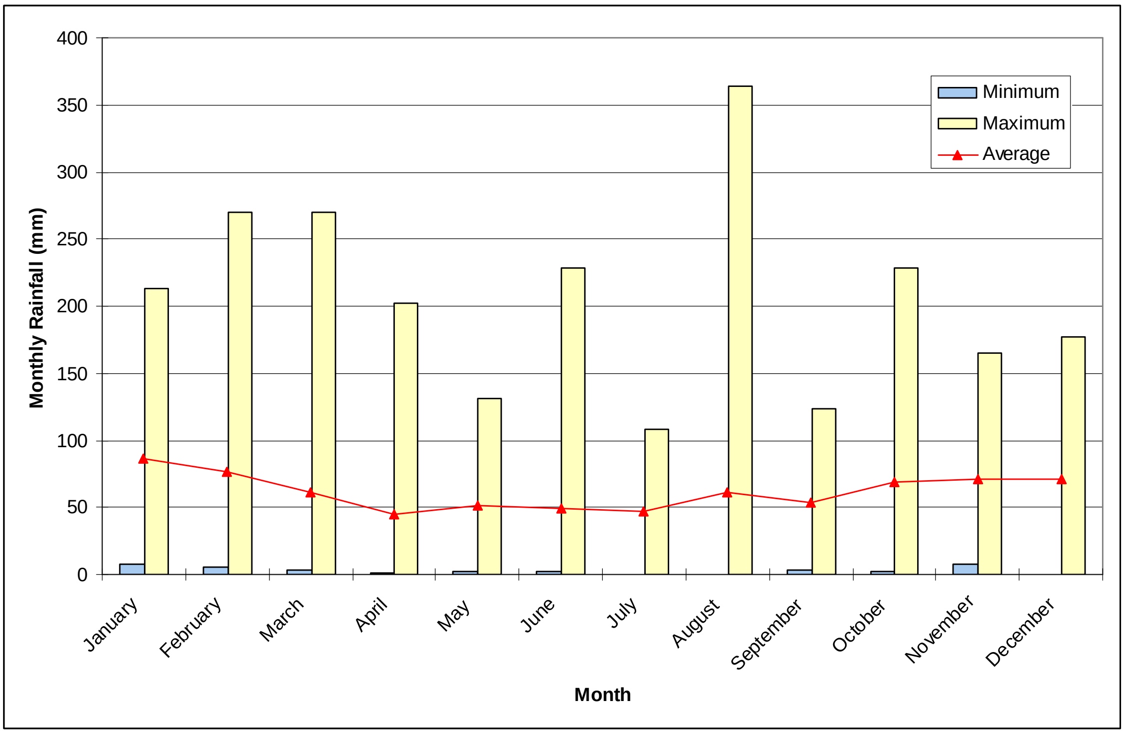
A summary of the annual rainfall at Lidsdale is given in Graph 3-2. The statistics for this rainfall data set were:

- Minimum annual rainfall – 329.8 mm in 2006.
- Average annual rainfall – 741.4 mm.
- Median annual rainfall – 758.6 mm.
- Maximum annual rainfall – 1171.0 mm in 1978.



Graph 3-2 Annual Rainfall at Lidsdale

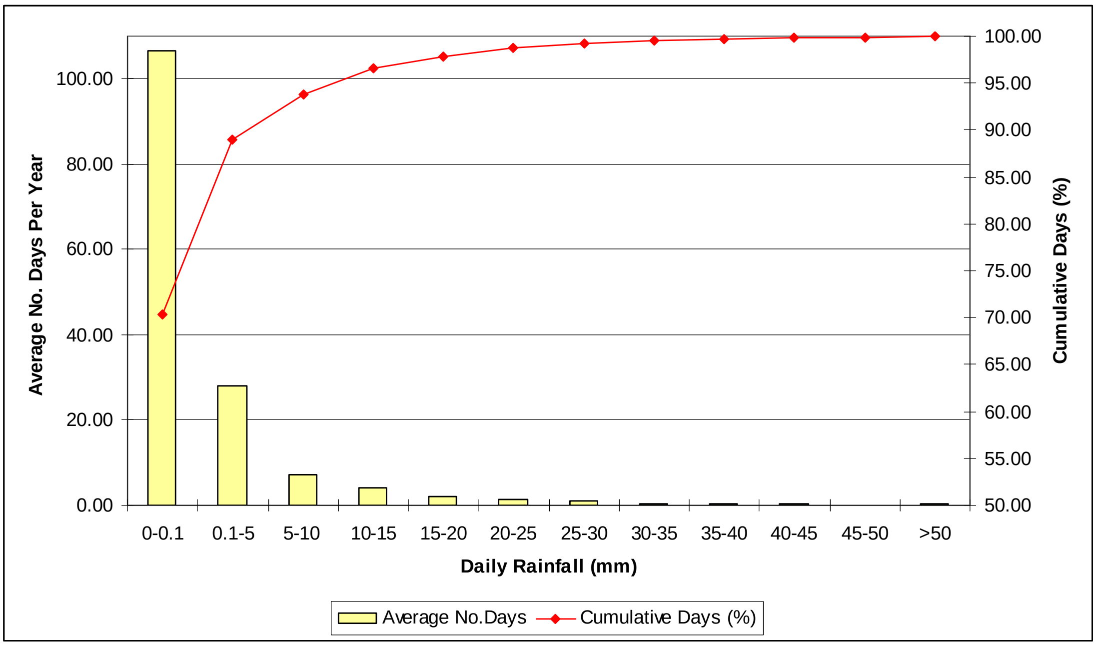
The monthly rainfall statistics were also determined for the period of record and selected statistics are provided in Graph 3-3. The average monthly rainfalls were observed to vary from a low of approximately 44 mm in April to a high of approximately 86 mm in January. Graph 3-3 shows a significant variation in the maximum recorded monthly rainfalls with the maximum monthly value being approximately 364 mm in August to a lowest maximum monthly value of approximately 108 mm in July.



Graph 3-3 Monthly Rainfall Statistics

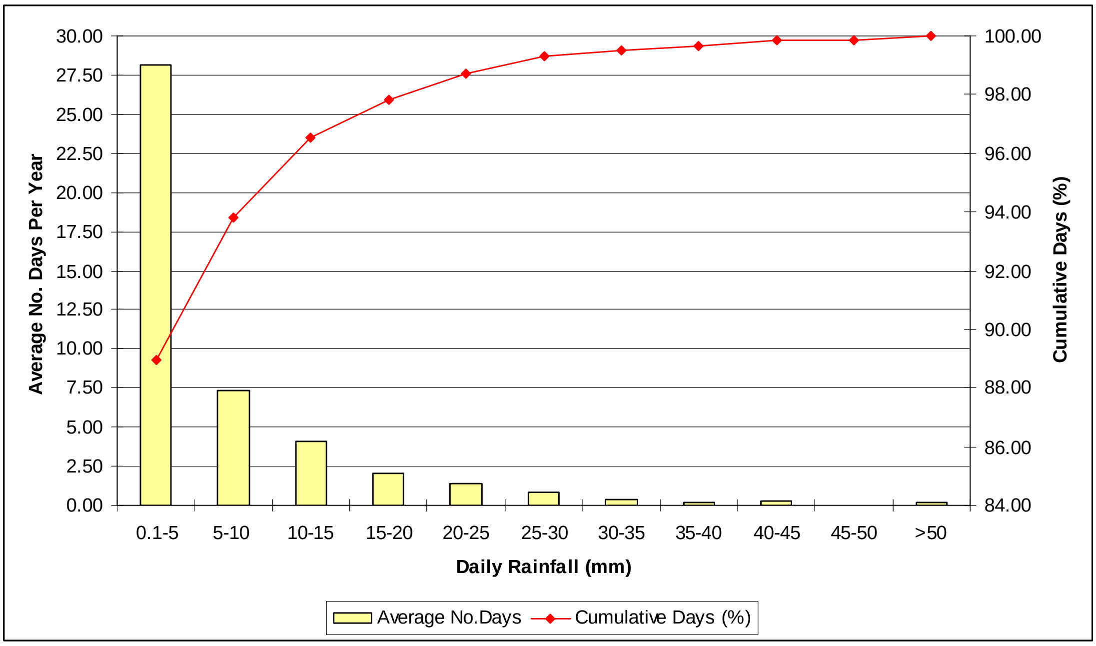
An analysis of the rainfall data was undertaken to enable an understanding of the likely rainfall patterns at the site. For various intervals of daily rainfall, the average number of days per year which fall within each interval are presented in Graph 3-4. The graph also presents the cumulative days per year as a percentage against the same rainfall intervals.

As presented in Graph 3-4, the average number of non rainfall days per year is approximately 107, which is greater than 70% of days in a year while the number of rain days receiving less than 5 mm of rainfall is approximately 19%.



Graph 3-4 Number of Rain Days of Various Magnitudes

The data presented within Graph 3-4 was amended to exclude days without recorded rainfall to enable a more detailed view of the data. As presented in Graph 3-5, the amount of rain falling on any one day decreases for rainfall greater than 5 mm. On average, approximately 11% of days in the year (or 40 days) receive greater than 5 mm of rain with approximately 1.3% of days in the year (or 5 days) receiving greater than 25 mm of rain.

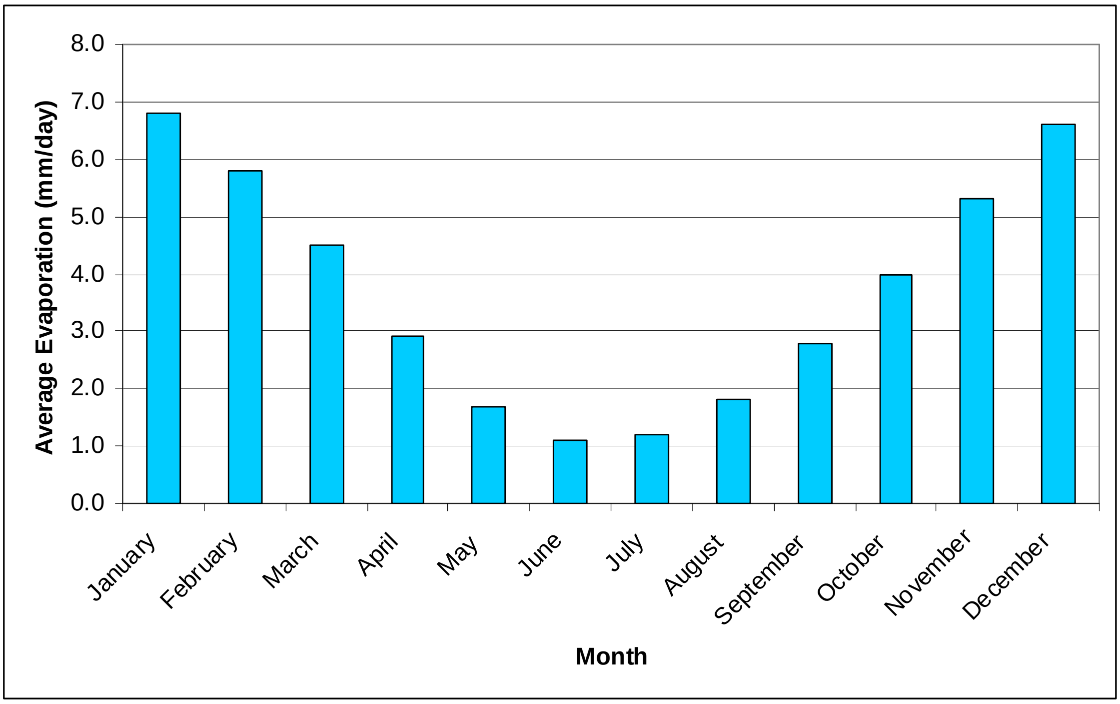


Graph 3-5 Daily Rainfall Magnitudes

Evaporation Data

As there was no evaporation data available at the Lidsdale BOM Station, a review of stations with a reasonable range of data was undertaken. The Bathurst Agricultural BOM Station, located approximately 60 km west of Angus Place, was determined to have the most comprehensive data range and was therefore adopted for this assessment.

The average daily evaporation adopted for the *Angus Place Colliery Site Water Management Plan* (based on the Bathurst BOM Station data) is presented in Graph 3-6.



Graph 3-6 Average Daily Evaporation Rates

These evaporation rates were then compared to the evaporation maps available from the BOM. In particular, the months of January and July were considered as shown in Figure 3.1.

Figure 3.1 Bureau of Meteorology January Evaporation Maps

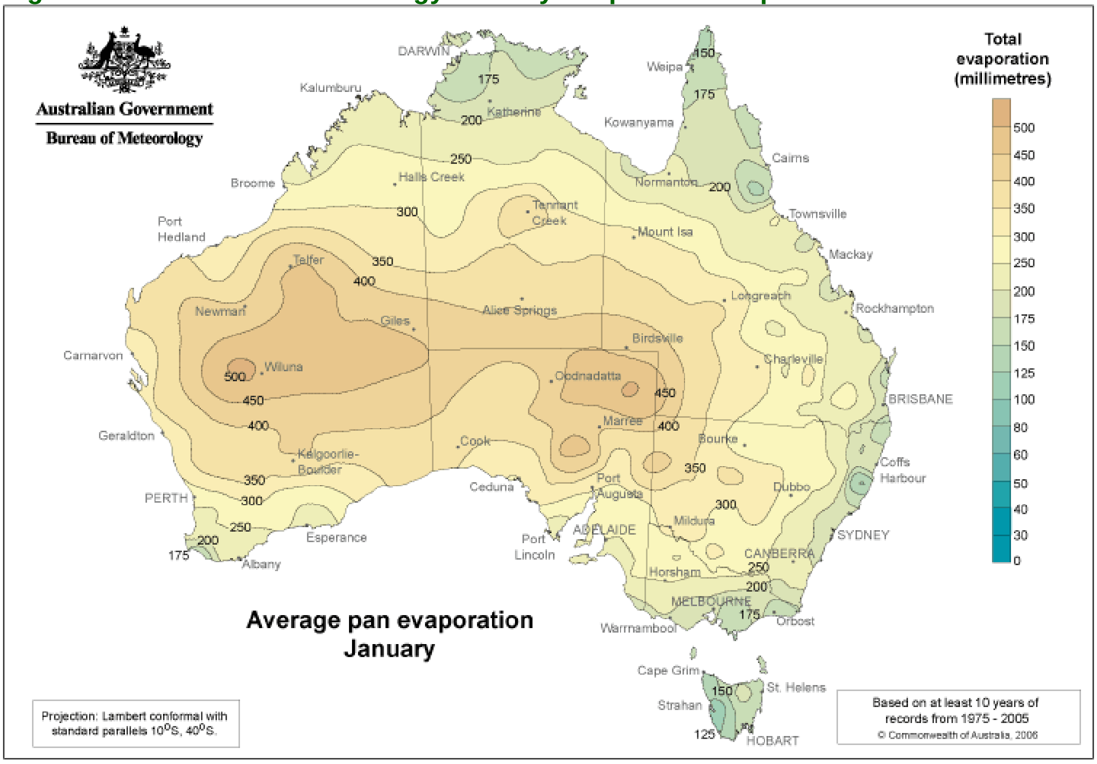
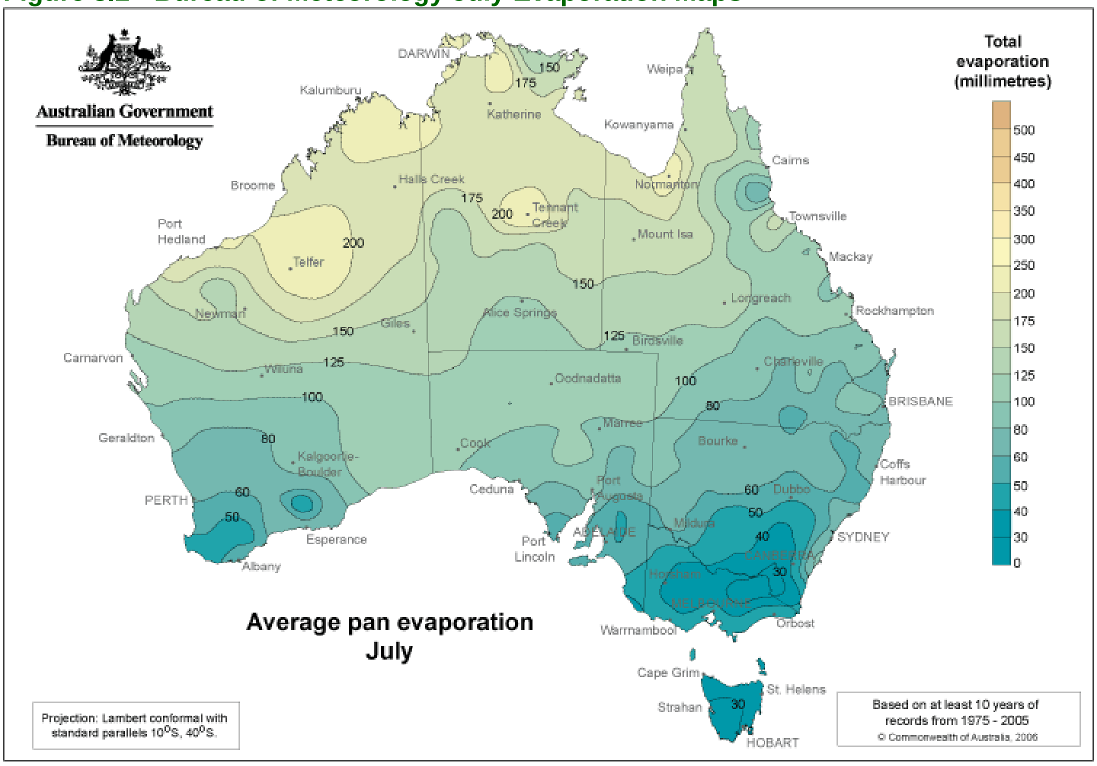


Figure 3.2 Bureau of Meteorology July Evaporation Maps



For both January and July, the monthly average evaporation was assessed and converted to daily evaporation as well as potential minimum and maximums as outlined in Table 3.5.

Table 3.5 Evaporation Data

Month	BOM Monthly Average (mm)	BOM Daily Average (mm)	BOM Daily Minimum (mm)	BOM Daily Maximum (mm)	Bathurst Daily Average (mm)
January (Figure 3.1)	150 – 175	5.2	4.8	5.6	6.8
July (Figure 3.2)	50 - 60	1.8	1.6	1.9	1.2

By comparing the average daily from the Bathurst meteorological station for January and July to the daily average as determined from the BOM figures, it can be seen that there is a reasonable correlation between the two sets of data. Therefore the Bathurst meteorological station data was adopted for the mine water balance. It should, however, be noted that the evaporation at Angus Place is expected to be less than that at Bathurst due to elevation and climatic variations.

The average annual evaporation rate was approximately 1351 mm, compared to the annual average rainfall of 741 mm. This gives an annual deficit (difference between annual rainfall and annual evaporation) of approximately 610 mm.

4. Modelling Representation

This section of the report discusses the development of the water balance model for the existing and proposed conditions at Angus Place Colliery.

4.1 Water Balance

The model used to represent the Angus Place Colliery water balance was GoldSim Version 10.00 (GoldSim Technology 2009). This software is a graphical object orientated system simulation software for completing either static or dynamic systems. It is like a “visual spreadsheet” that allows one to visually create and manipulate data and equations.

Simulation, in this context, is defined as a process of creating a model of an existing or proposed system (such as a mine water management system) in order to identify and understand the factors that control the system performance or predict (forecast) the future behaviour of the system.

A model representation of the existing mine water cycles was created using GoldSim and the results verified, as best as practical, for discharges through LDP001, LDP002, LDP003 and 940 bore based on the recorded discharges at these locations.

Once the model operation was verified as representing the existing site conditions, it was modified to include the future operations.

Water Cycle Modelling

The water balance modelling was completed using:

- Daily time steps for the analysis – daily rainfall data was the shortest period data available.
- Runoff from catchments was represented by an initial loss/runoff factor – this was used to convert daily rainfalls into surface runoff values when the daily rainfall has exceeded the initial loss of rainfall (infiltration which is subsequently transpired by vegetation).

Model Structure

The model was configured to represent the water cycles as a series of elements each containing preset rules and data, that were linked to represent the water transfer around the water cycles.

The overall structure of the model is shown in Appendix A for the existing water cycle and Appendix B for the proposed water cycle.

Model Data and Operational Rules

The data provided in Table 3.3 was incorporated into the model as transfer rates between the various model components. The rules identified in Table 3.4 were specified within the model to determine the priorities adopted within the model for water transfers.

GoldSim Representation

Existing Operations

The operation of the existing water cycle associated with coal production, as provided in Figure 4.1 and Figure 4.2, was modelled in GoldSim. To undertake the modelling the following simplifications were incorporated:

- Transfer rates were modelled using daily time steps. In reality, transfer rates are determined during the day on an "as needs basis" and may operate over periods smaller than a day.
- The rates of potable water to the Bath House and Administration Building were 84.4 kL and 6.8 kL per production day and non production day. This was based on the most recent year (2009) of metered data and estimated usage breakdown for each building.
- The rate of delivery of process water to the underground was 654 kL per day on workdays. This was based on the average pumping rate over a short period of time. In reality the demand for the underground workings varies daily based on underground activities.
- The rate of pumping of underground water to the 940 bore was 3,672 kL per day. This was based on the average pumping rate over a short period of time. In reality the pumping rate through the 940 bore varies with progression of mining and varies on a regular basis.
- Mine water make into various locations of the underground works were modelled as constant rates. In reality, the mine water make fluctuates with the progression of mining and varies on a regular basis.
- The demand of the CHP was assumed to be 259 kL per day.
- The demand of the Vehicle Washdown Bay was assumed to be 6.5 kL per day.
- Operating rules/precedences were established within the model in accordance with advice from Angus Place Colliery staff.

There was limited data available for the following segments of the model. The values for these portions of the model were therefore adjusted to replicate anecdotal site information.

- Mine water make.
- Pumping from the 900 District to the 20 Cut Through Dam
- Pumping from the 20 Cut Through Dam to the 300 District Underground Storage

The CSIRO (2005) report extrapolated from the existing Springvale Colliery hydrogeological model in order to predict the potential water make in longwalls 920 to 950 at Angus Place Colliery. The developed model was calibrated to reflect the known water make within the Springvale Colliery longwalls with site specific geologic information then incorporated for the Angus Place Colliery.

Due to the lack of site specific data within the Angus Place Colliery lease area, the estimation of water make was determined as a range. For the area between longwalls 920 and 950, the estimated water make varied from approximately 50 to 200 l/s. This indicated that each individual longwall contributed a water make of approximately 50 l/s.

During the development of the detailed water balance, a review of the available pumping information relating to the management of underground water was undertaken. Through this process, and consultation with Angus Place Colliery personnel, it was determined that the actual transfer rates of underground water was more in the order of 80 l/s for the current four longwalls. This indicated that, as an estimate, each longwall potentially contributed 20 l/s.

For the purposes of the development of the detailed mine water balance, consideration was given to this mine water make range.

Proposed Operations

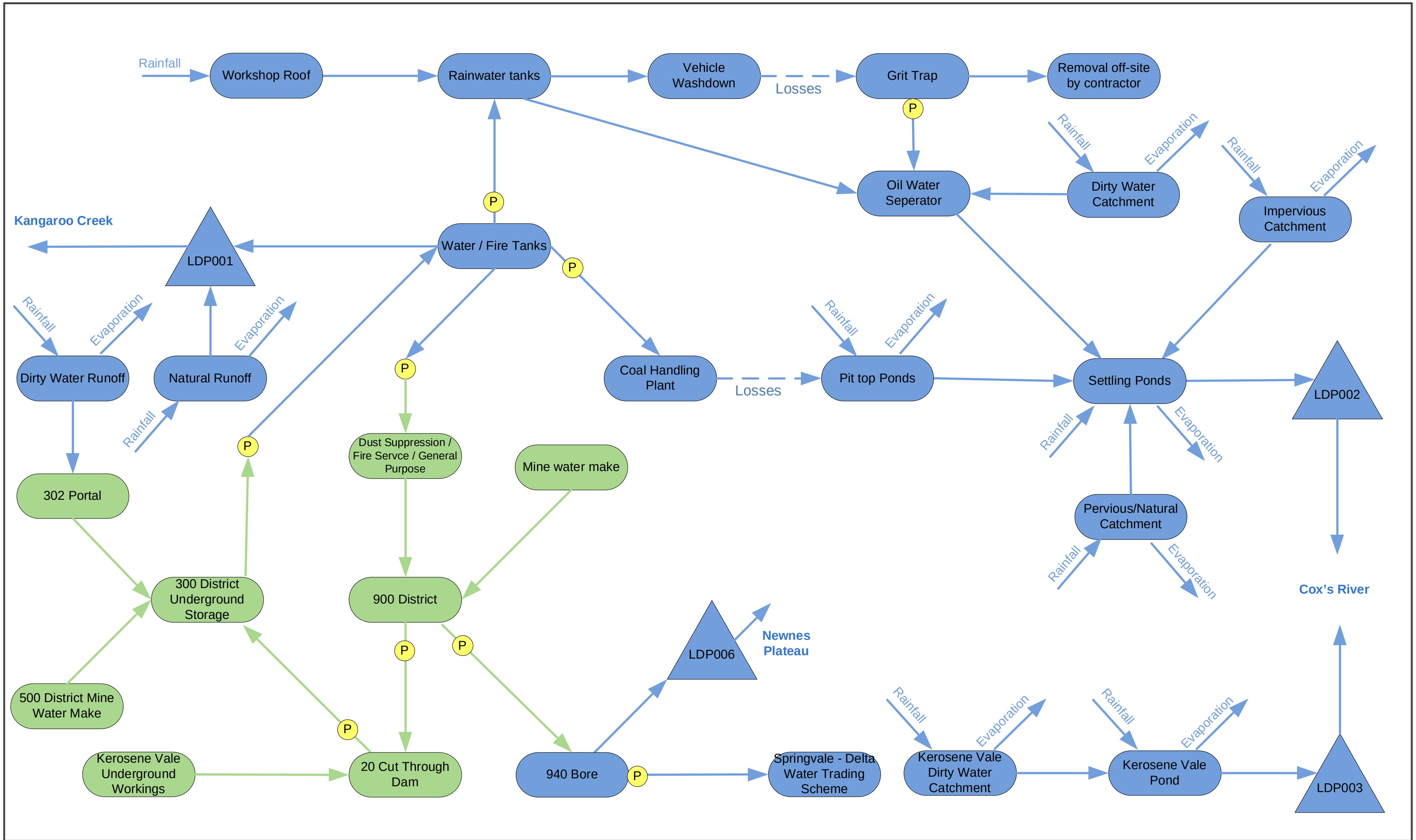
The existing conditions GoldSim model was modified to represent the proposed conditions of the water cycle on-site following the construction of the additional longwalls and the water management works associated with the ROM stockpile area.

Amendments to the model to represent these changes were limited to:

- Increase in mine water make into the 900 District from 80 l/s to 120 l/s to cater for two new longwalls.
- Increase in pumping through the 940/910 bores from 42.5 l/s to 82.5 l/s to cater for the increase in mine water make.

The additional mine water make into the 900 District workings would be pumped out through the existing 940 and proposed 910 bores. The existing 940 bore has a maximum capacity of approximately 98 l/s and the proposed 910 bore will provide an additional dewatering location if water make drains to a section of the new workings that cannot be serviced by the existing 940 bore.

The underground water transfer system currently operates such that process water is collected and transferred to the 900 district while mine water make is collected and transferred to the Springvale - Delta Water Transfer Scheme through the 940 dewatering bore. The configuration of this system will therefore enable the transfer of water make, in addition to process water, to the 900 district which will in turn discharge through LDP001. At times when the Springvale - Delta Water Transfer Scheme is experiencing operational difficulties and it is also not possible to discharge through LDP006 (the emergency discharge point), all process water and mine water would be transferred through to the 900 district.



Surface Water Transfers
Surface Water Losses
Underground Water Transfers
P Pump

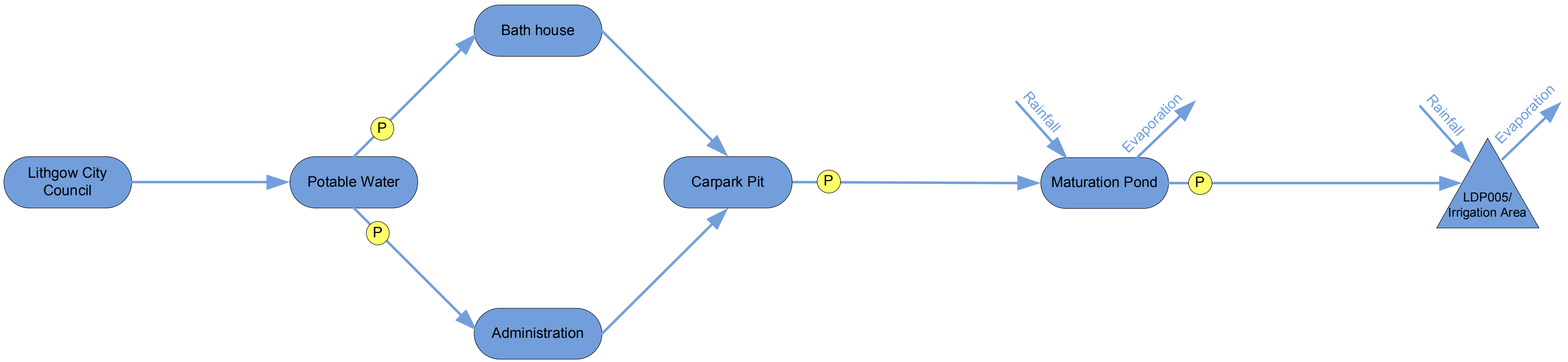
LOCATION	Angus Place
SEAM	Lithgow
DRAWN	SW
CHECKED	
APPROVED	
SCALE	

Angus Place Colliery
Water Balance
Surface and Underground
Water Balance Schematic

Centennial

DATE 26-6-10

Figure 4.1



Water Transfers

P Pump

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	SW
CHECKED	
APPROVED	
SCALE	

Angus Place Colliery
Water Balance
Potable Water Schematic

Centennial

DATE 26-6-10

Figure 4.2

5. Modelling Results

Calibration

Initially the model was established using the estimated flow rates, water usages and estimated infiltration rates. Adjustments were required to these initial values to more closely replicate the system performance for the period of observed data and the results of this modelling are provided in Appendix C.

LDP001

Daily records of discharges though LDP001 were available from Angus Place Colliery from January 2002 through to December 2009 however a recent review of this data by the Colliery indicated that there were some anomalies. Consequently, recalibration of the V-notch weir was undertaken in early 2010. A review of the data collected since the re-calibration indicated there were still some anomalies for discharges through LDP001.

Discharges through LDP001 are heavily dependant upon the transfer of underground water from the 300 district underground storage to the fire tanks. When compared to the available pumping data for 300 district, the LDP001 discharges were being under estimated. As the pumping data from the 300 district is considered more reliable than the discharge records for LDP001, these transfer rates were adopted.

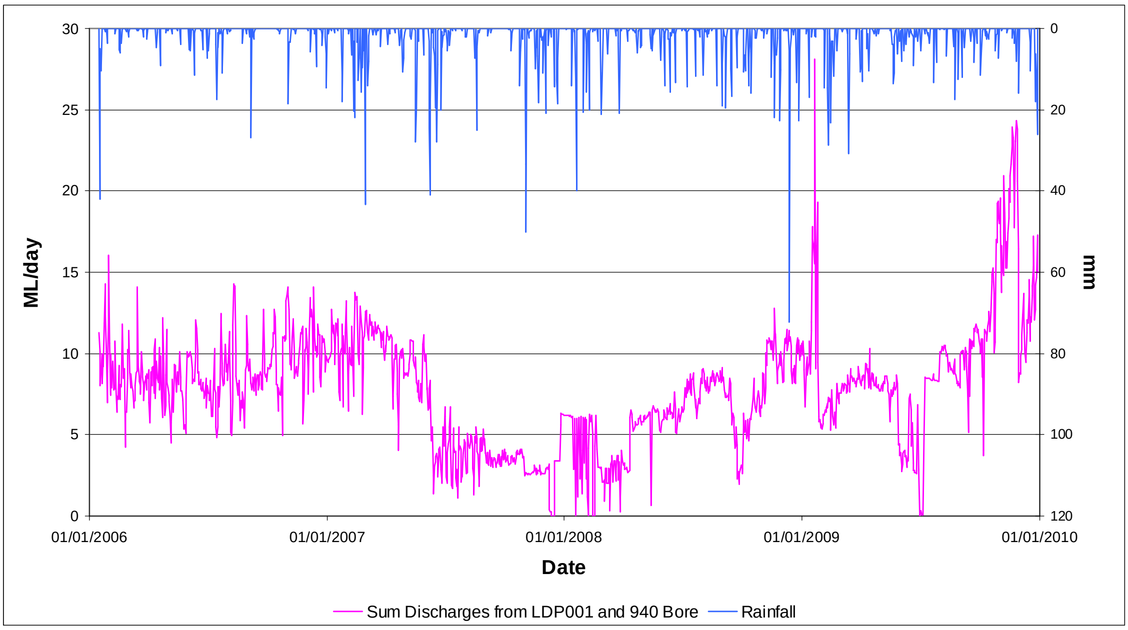
940 Bore

Metered pumping rates through the 940 bore to the Springvale - Delta Water Transfer Scheme were available from January 2006 to January 2010. As it was difficult to replicate the sporadic pumping rates of the 940 bore, modelled pumping rates were based on the average pumping rate over this period.

Underground Discharges

Consideration was given to a possible correlation between discharges through LDP001 and the 940 bore. Graph 5-1 shows the sum of these discharges as well as the rainfall over the same period. From this it can be seen that there is considerable variation in discharges of underground water. This is likely to be due to anomalies within the LDP001 data and the variation in operational requirements. It can also be seen from Graph 5-1 that there is no clear correlation between rainfall and the discharges.

Due to the nature of inputs into the water balance model, the operational variations will not be replicated for either the existing or proposed conditions. To enable an improved calibration, daily metered data would be required for each of the transfers within the water management system.



Graph 5-1 Recorded Mine Water Discharges

Results

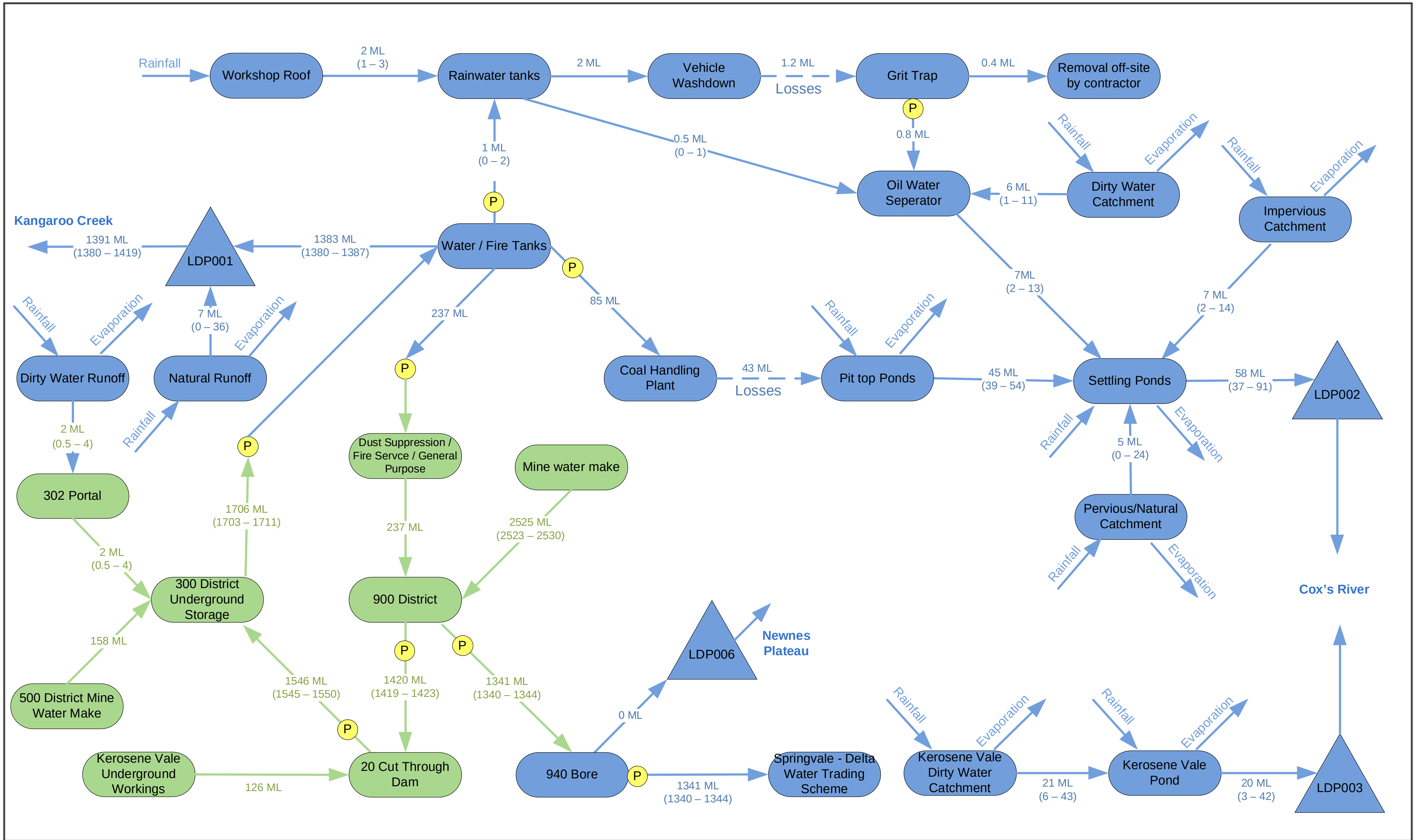
The existing conditions mean predicted values for each of the water transfers over the simulated period are provided on Figure 5.1 and Figure 5.2. Also provided are the respective minimum and maximum values in brackets to give an indication of the range of likely values. Where there is no value in brackets, there was not a range as the transfer rate was static across the simulation period.

A summary of the detailed water balance results is provided in Table 5.1.

Table 5.1 Existing Conditions Discharges

Discharge Point	Average Annual Discharges (ML/yr)	Average Daily Discharges (ML/day)
LDP001	1405	3.85
LDP002	76	0.21
LDP003	28	0.08
940 Bore	1341	3.67

Graph 5-2, Graph 5-3, Graph 5-4 and Graph 5-4 show the pattern of discharge from LDP001. LDP002, LDP003 and 940 bore respectively for the existing conditions. These graphs also indicate that discharges occur on a daily basis for LDP001 and 940 bore while discharges through LDP002 and LDP003 vary, primarily as a result of rainfall events.



GHD

Surface Water Transfers
Surface Water Losses
Underground Water Transfers
P Pump

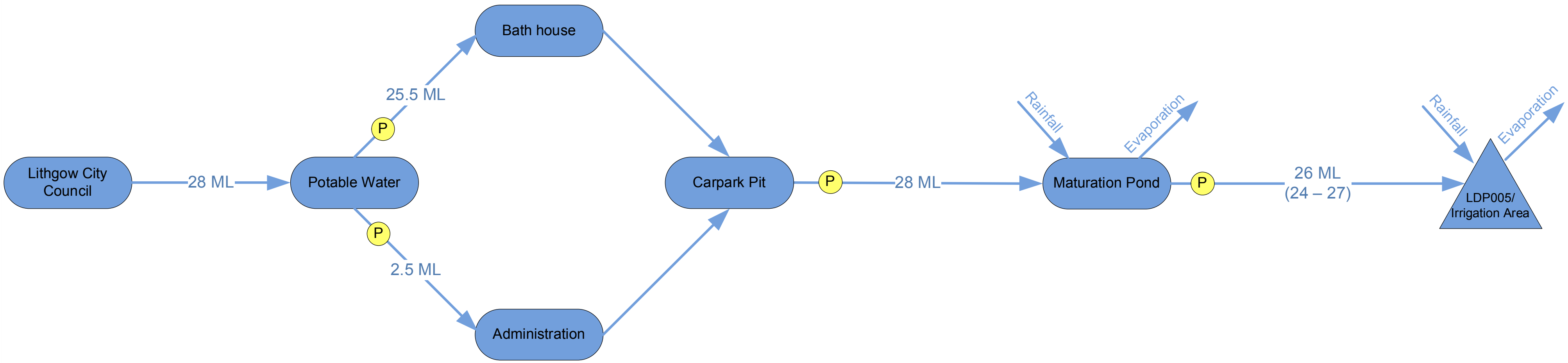
LOCATION	Angus Place
SEAM	Lithgow
DRAWN	SW
CHECKED	
APPROVED	
SCALE	

Angus Place Colliery
Water Balance
Surface and Underground Water
Existing Scenario Results

Centennial

DATE 07-07-10

Figure 5.1



Water Transfers
P Pump

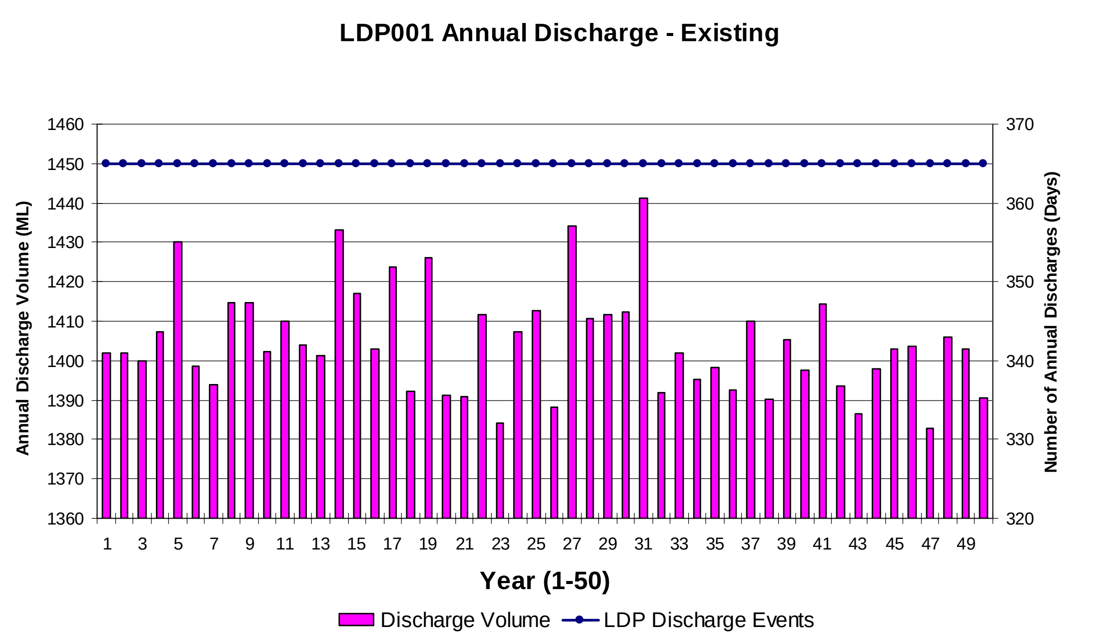
LOCATION	Angus Place
SEAM	Lithgow
DRAWN	SW
CHECKED	
APPROVED	
SCALE	

Angus Place Colliery
Water Balance
Potable Water
Existing Scenario Results

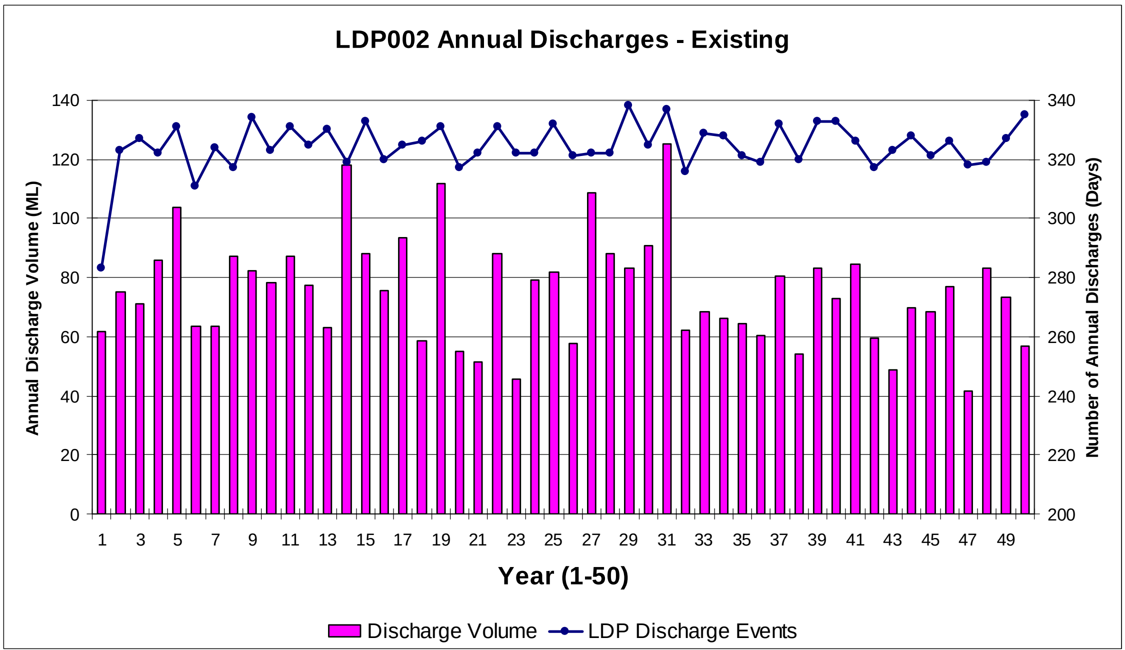
Centennial

DATE 26-6-10

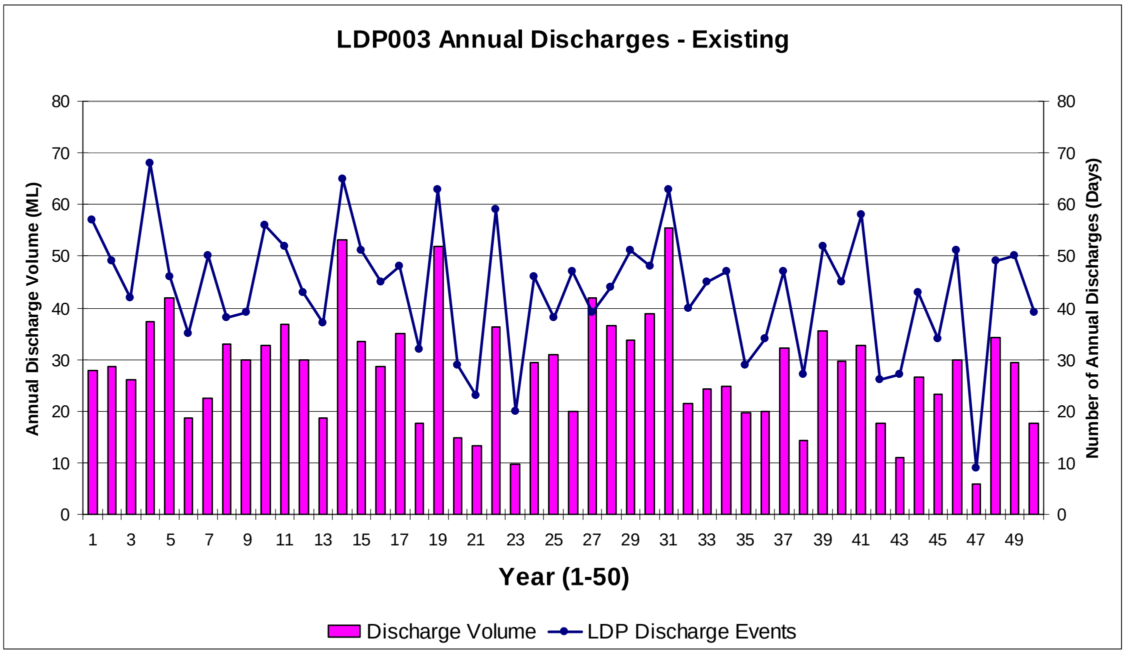
Figure 5.2



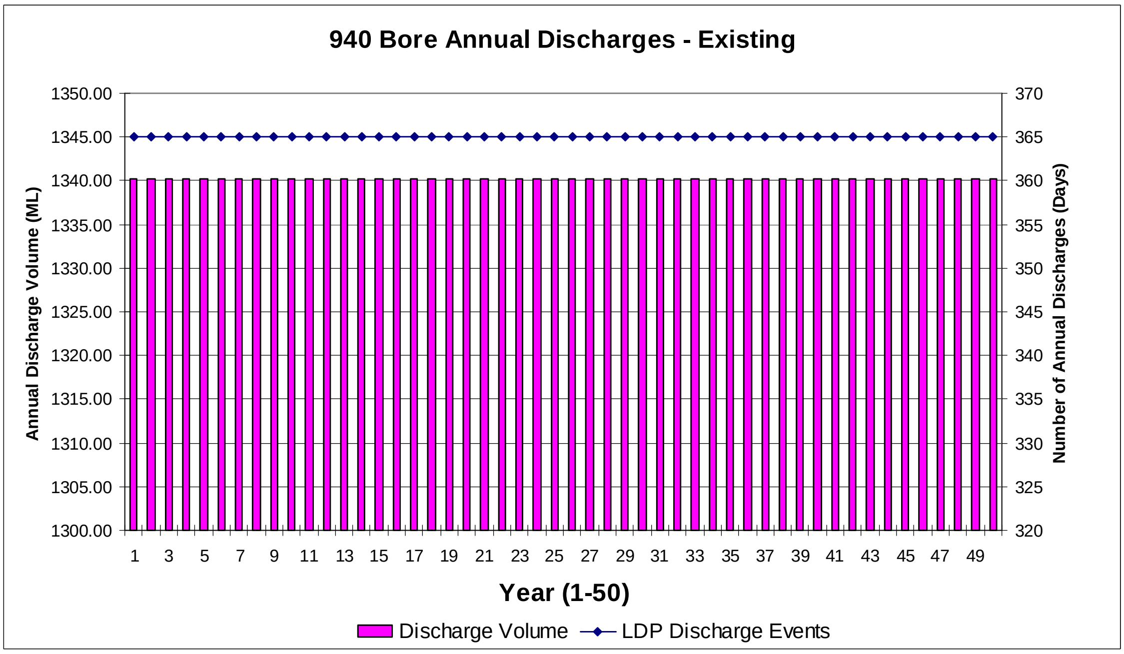
Graph 5-2 Predicted LDP001 discharge volumes



Graph 5-3 Predicted LDP002 discharge frequency and discharge volumes



Graph 5-4 Predicted LDP003 discharge frequency and discharge volumes



Graph 5-5 Predicted 940 Bore discharge frequency and discharge volumes

Operations Including the Proposed Extensions

As discussed in Section 4.1, water balance modelling was completed for both the existing and proposed operation conditions at Angus Place Colliery and the modifications made for the proposed operation conditions were also discussed in Section 4.1.

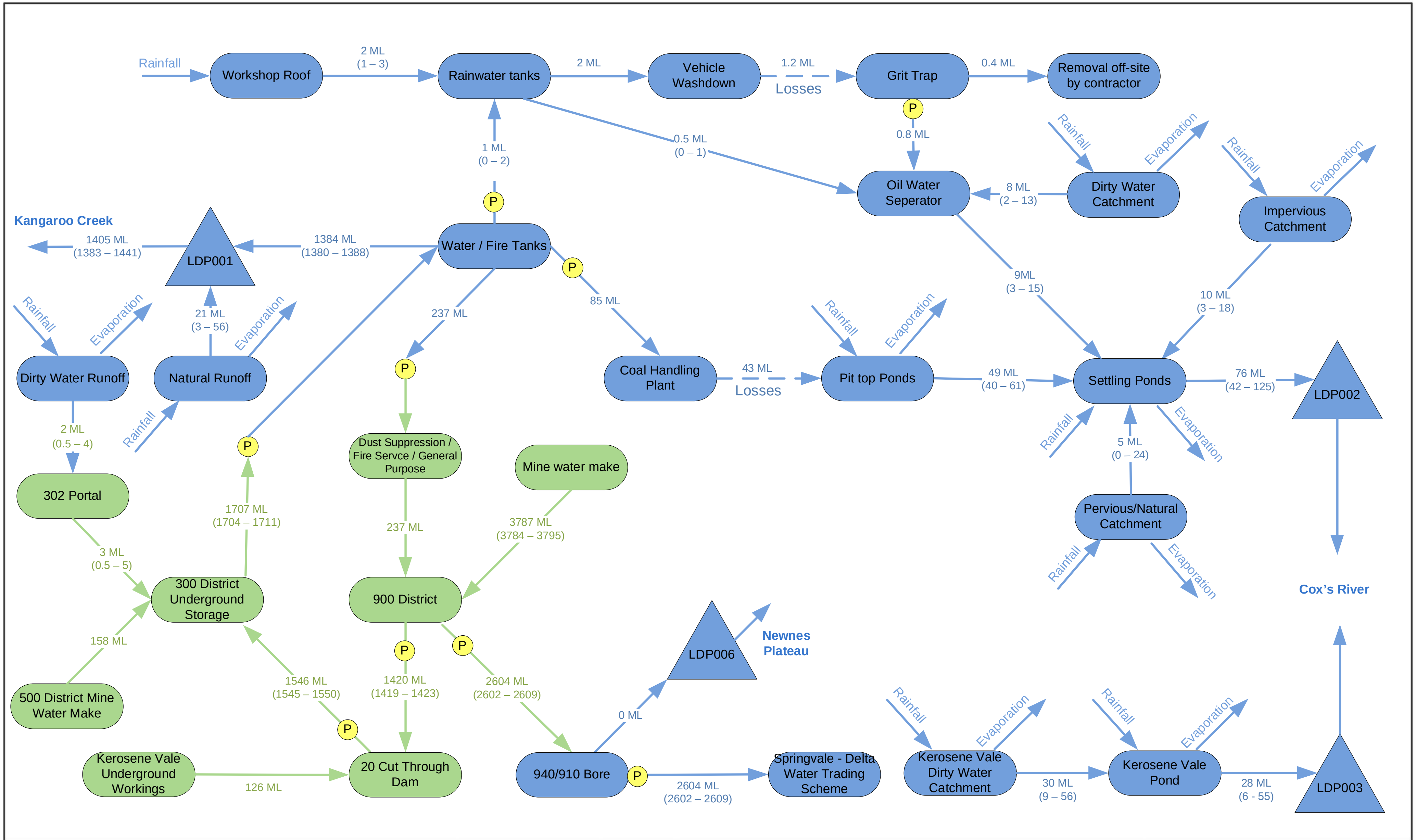
Predicted extraction and water transfer rates for the proposed operational conditions are shown on Figure 5.3 and the detailed results showing the maximum, minimum and mean transfer rates are provided in Appendix C. Additionally, a summary of the detailed water balance results is provided in Table 5.2.

Table 5.2 Predicted Annual discharges

Average over all years	
Through LDP001	1,405 ML/yr (no change)
Through LDP002	76 ML/yr (no change)
Through LDP003	28 ML/yr (no change)
Through 940/910 Bores	2,604 ML/yr

While ‘no change’ has been identified for LDP001, there is a potential for additional mine water make to be transferred through the underground pumping systems to discharge through LDP001. Therefore, discharges through LDP001 could potentially increase above this value.

By comparing the information provided in Table 5.1 and Table 5.2, it can be determined that there will be minimal impact on the discharges from Angus Place Colliery through LDP002 and LDP003 as a result of an extension to the life of the mine. Discharges through LDP001 are likely to increase, however, these increases are not considered substantial as most of the increased mine water make will be transferred to the 940 / 910 dewatering bores to the Springvale - Delta Water Transfer Scheme.



GHD

Surface Water Transfers
Surface Water Losses
Underground Water Transfers
P Pump

LOCATION	Angus Place
SEAM	Lithgow
DRAWN	SW
CHECKED	
APPROVED	
SCALE	

Angus Place Colliery
Water Balance
Surface and Underground Water
Proposed Scenario Results

Centennial

DATE 20-07-10

Figure 5.3

5.1 Qualifications on Predictions

Predicted water transfers are based upon a mix of data. Typical data sources for model construction and verification included:

- Relatively reliable data
  - Bureau of Meteorology rainfall data.
  - Monitored evaporation from Bathurst.
  - Surface catchment areas based on topographic maps.
  - Annual potable water demands.
  - Metered pumping data for water transfers
- Less reliable data
  - Monitored data
  - Site infiltration rates for impervious and natural vegetated catchments
  - Estimates of some storage capacities.

As a result of the items listed within the “less reliable data” category there is likely to be a risk that the provided estimates may be inaccurate. It is suggested that the individual predictions given above should be considered reliable to +/-50% until more site data is gathered. Additional data will allow refinement of the data sources and hence the model predictions to be confirmed as reliable.

It should also be noted that the adoption of historical rainfall and evaporation data within the detailed water balance model, does not take into account the potential impacts of climate change.

5.2 Recommendations

During the development of the water balance model, the variability of available data resulted in the adoption of a number of assumptions. To improve the estimates within the water balance model it is recommended that:

- Confirmation of flow rates through the various transfers over a 6 to 12 month period to be obtained through either monitoring or improved site knowledge.
- Review water balance calibration in relation to the updated transfer data.
- Recalibration of the V-notch weir downstream of LDP001.
- Recalibration of the V-notch weir downstream of LDP003.
- Water balance incorporates updated mine water make once the CSIRO hydrogeologic predictions are available.

6. Summary

Preparation of this water balance assessment required:

- Confirmation of the surface and groundwater management systems.
- Establishment of a GoldSim model to represent the water movement on-site.
- Application of the GoldSim model for the existing and proposed site-conditions.

Inputs into water balance model consisted of information provided by Angus Place Colliery and estimations based on available information. The estimations adopted included storage volumes and flow rates of some elements within the system as outlined in Table 3.2 and Table 3.3

The development of the model transfer rates were based on limited metered data from site and technical site knowledge. The outputs from the model were comparable to the recorded discharges and consistent with average transfer rates across the mine. The results of the model indicated that the average annual discharges from LDP001, LDP002, LDP003 were 1405 ML/yr, 76 ML/yr and 28 ML/yr respectively. The average annual discharge through the 940 dewatering bore to the Springvale - Delta Water Transfer Scheme was 1341 ML/yr.

For the proposed conditions, the calibrated model was adjusted to reflect the proposed water management system amendments discussed in Section 4.1. The resulting predicted annual discharges through LDP002 and LDP003 were determined to be unlikely to change as a result of the modifications. Discharges through LDP001 are likely to increase, however, these increases are not considered substantial as most of the increased mine water make will be transferred to the 940 / 910 dewatering bores to the Springvale - Delta Water Transfer Scheme. The combined discharge though the 940 and 910 bore may increase to 2604 ML/yr if all the predicted water make is discharge through these transfers.

From this it can be seen that there will be a possibility an increase in discharges from Angus Place Colliery through LDP001 and to the Springvale - Delta Water Transfer Scheme as a result of extension of the life of mine.

7. References

Bish 1999, *Hydrogeological Assessment for Coxs River Catchment.*

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Connell Wagner Pty Ltd 2005, *Summary Report on Impact of Mining on Aquifers and Shrub Swamps.*

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Ditton Geotechnical Services Pty Ltd 2010, *Subsidence Prediction and Impact Assessment for the Proposed Longwall Panels 910 and 900 West at Angus Place Colliery, Lidsdale*.

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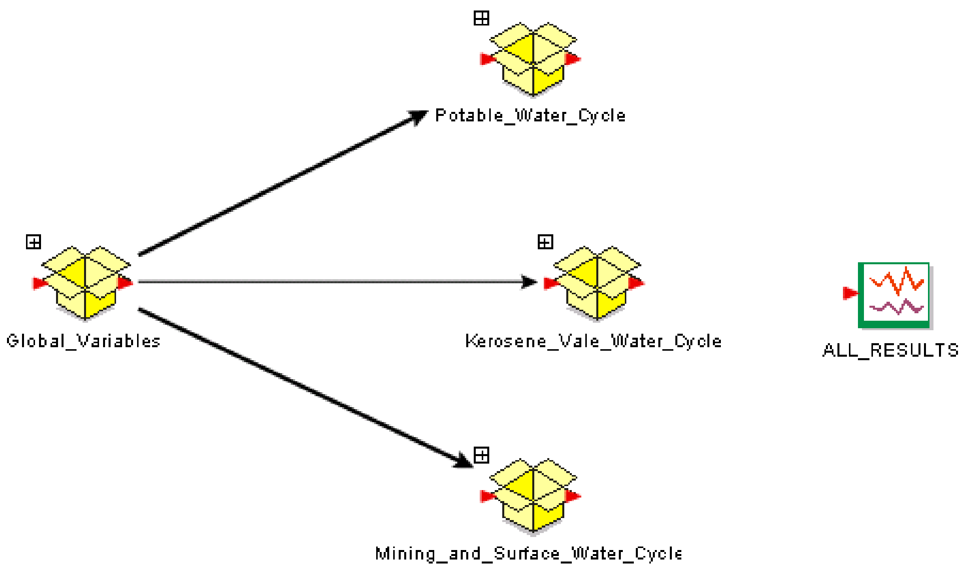
GSSE 2009, *Rehabilitation and Mine Closer Plan Kerosene Vale.*

Appendix A

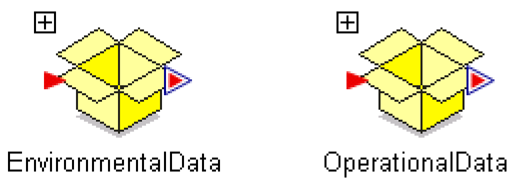
GoldSim – Operations

GOLDSIM MODEL LAYOUT

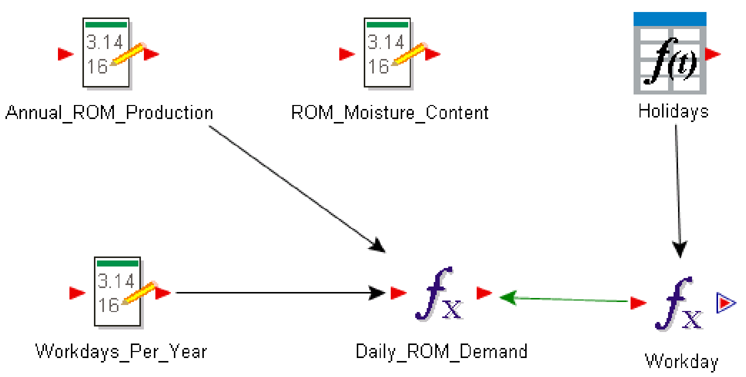
BROAD SCALE VIEW



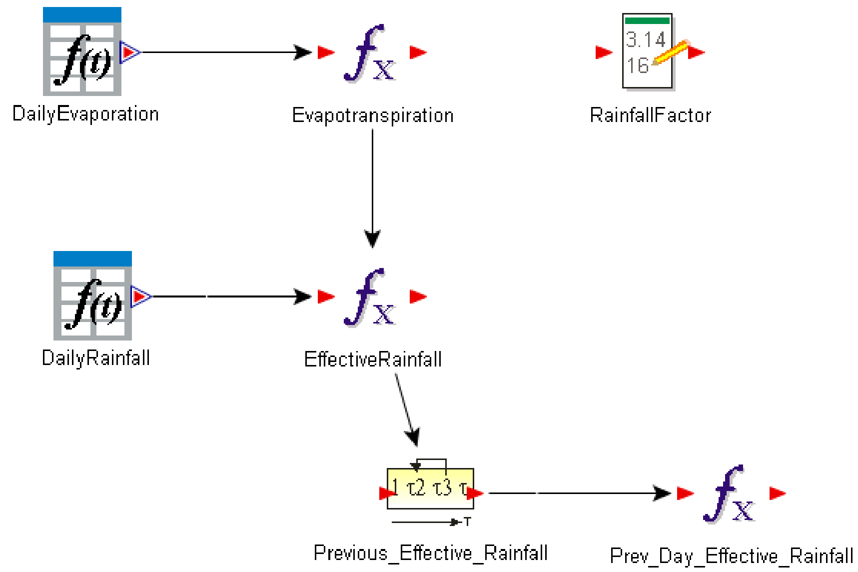
GLOBAL VARIABLES

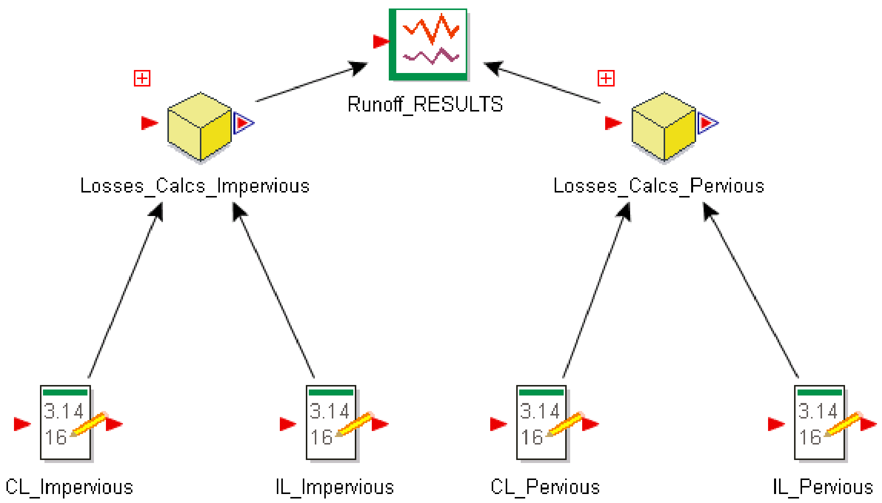


Operational Data

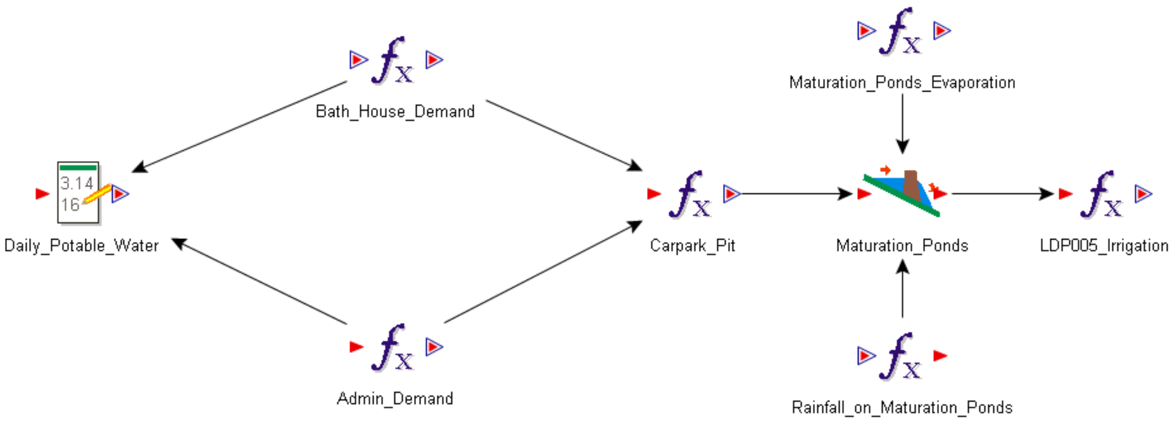


Environmental Data

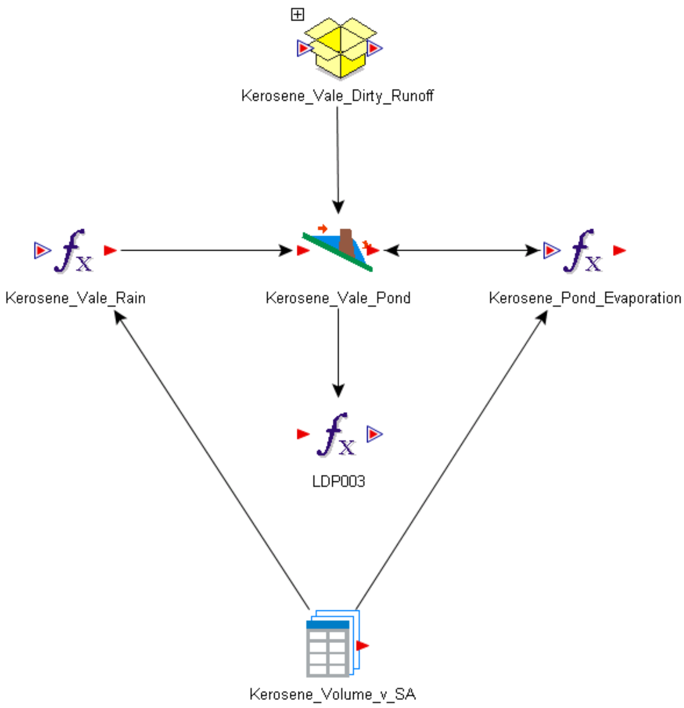




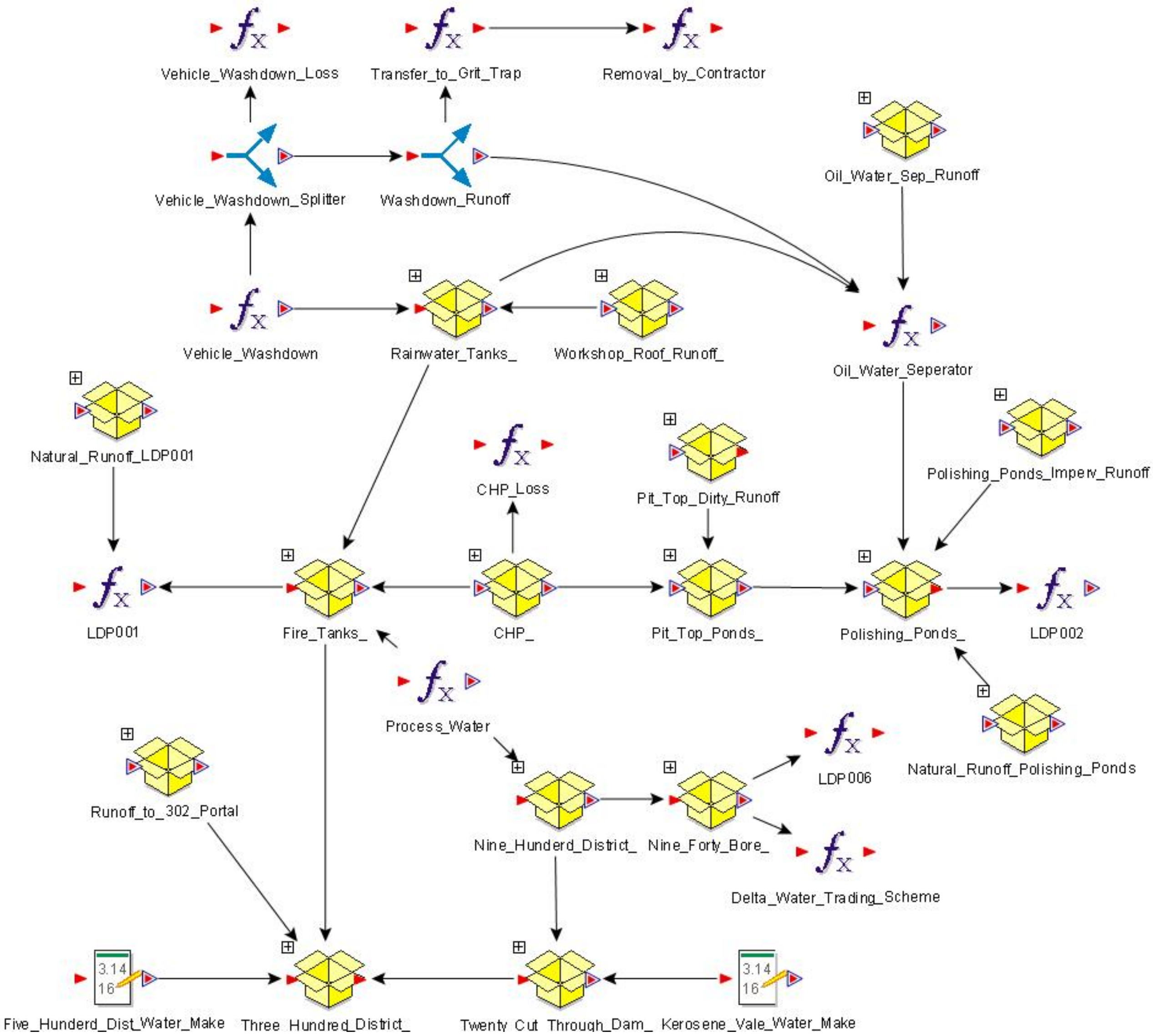
POTABLE WATER CYCLE



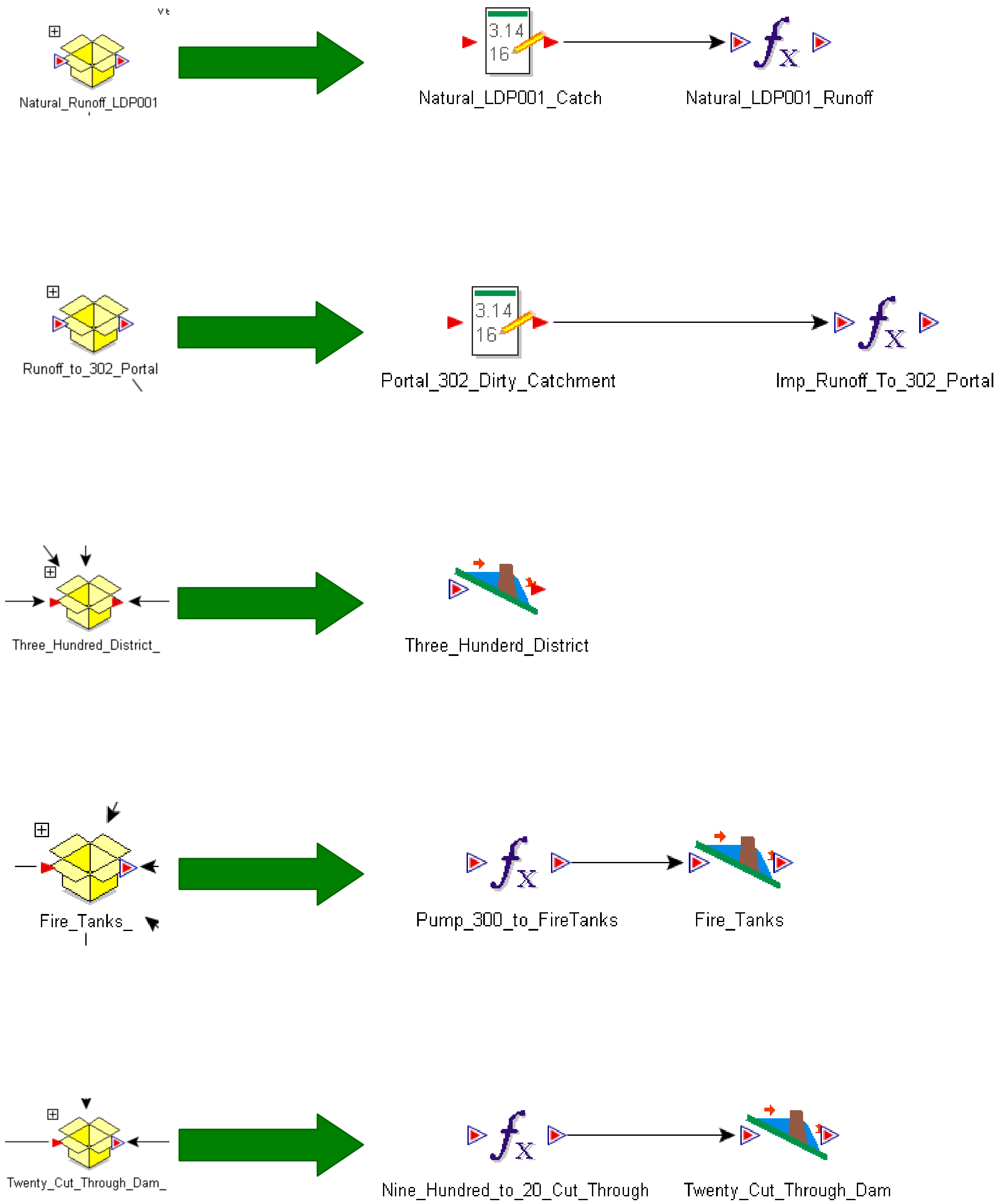
KEROSENE VALE WATER CYCLE

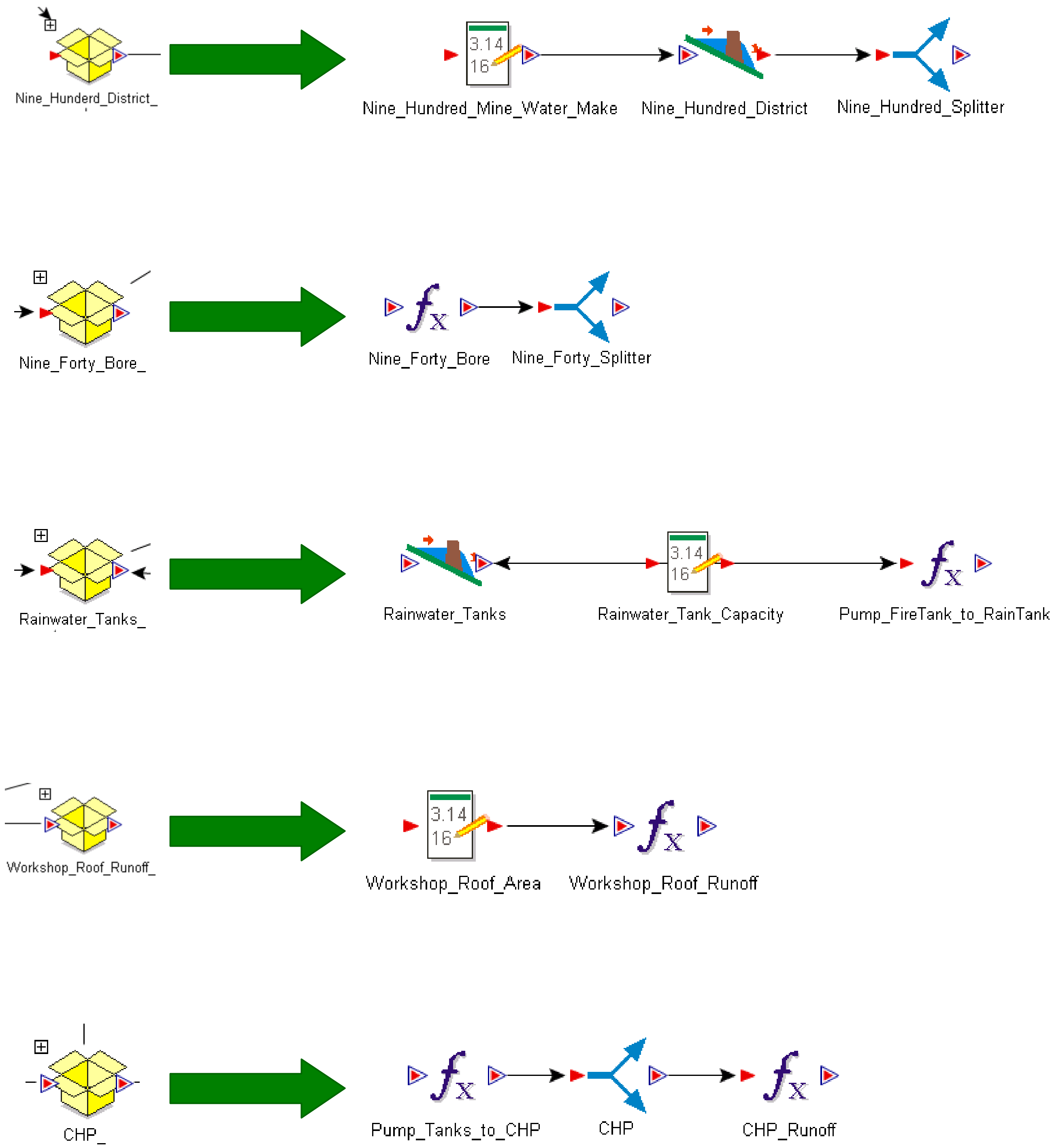


MINING AND SURFACE WATER CYCLE



MINING AND SURFACE WATER CYCLE – DETAILED VIEW

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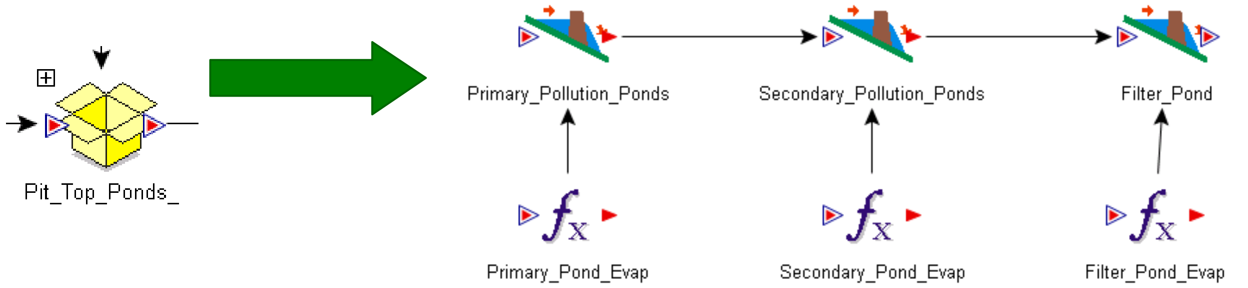
Nine_Hundred_Mine_Water_Make
Nine_Hundred_District
Nine_Hundred_Splitter
Nine_Forty_Bore_
Nine_Forty_Bore
Nine_Forty_Splitter
Rainwater_Tanks_
Rainwater_Tanks
Rainwater_Tank_Capacity
Pump_FireTank_to_RainTank
Workshop_Roof_Runoff_
Workshop_Roof_Area
Workshop_Roof_Runoff
CHP_
Pump_Tanks_to_CHP
CHP
CHP_Runoff



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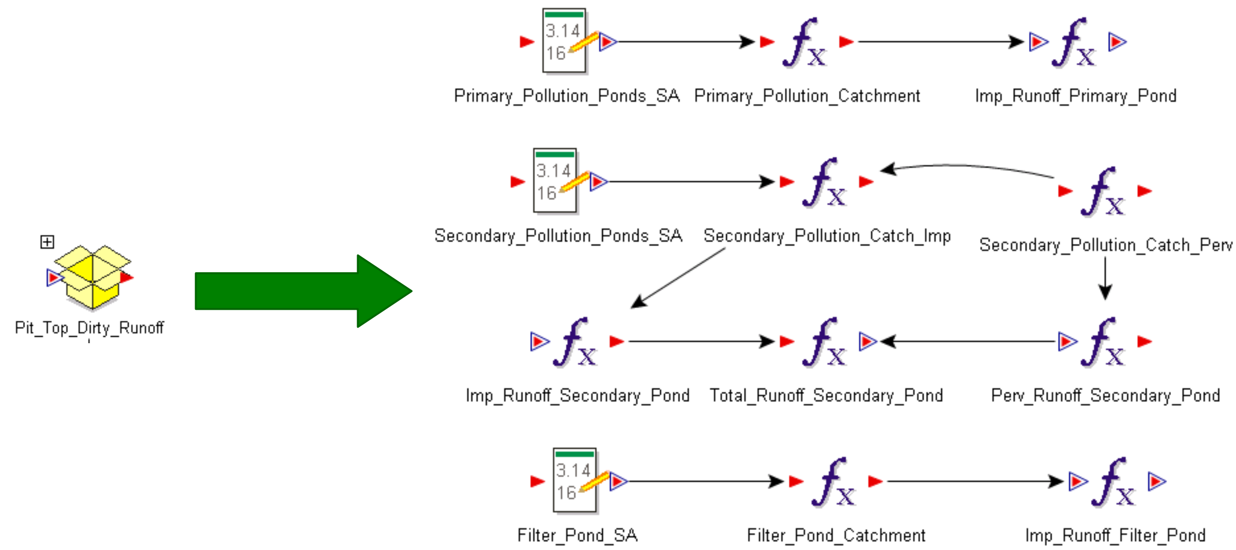
Secondary_Pollution_Ponds
Filter_Pond
Primary_Pond_Evap
Secondary_Pond_Evap
Filter_Pond_Evap



3.14
16
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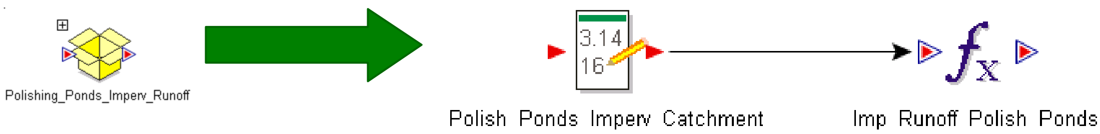
Primary_Pollution_Catchment
Imp_Runoff_Primary_Pond
Secondary_Pollution_Ponds_SA
Secondary_Pollution_Catch_Imp
Secondary_Pollution_Catch_Perv
Pit_Top_Dirty_Runoff
Imp_Runoff_Secondary_Pond
Total_Runoff_Secondary_Pond
Perv_Runoff_Secondary_Pond
Filter_Pond_SA
Filter_Pond_Catchment
Imp_Runoff_Filter_Pond

Oil_Water_Sep_Runoff
3.14
16
Oil_Water_Sep_Catchment
Imp_Runoff_Oil_Water_Catch



Polishing_Ponds_Imperv_Runoff
3.14
16
Polish Ponds Imperv Catchment
Imp Runoff Polish Ponds


Natural_Runoff_Polishing_Ponds
3.14
16
Natural_Polishing_Ponds_Catch
Natural_Polishing_Ponds_Runoff

Appendix B

GoldSim – Results

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EXISTING OPERATIONS

	Daily Potable Water Demand	Bath House Demand	Administration Demand	Car Park Pit Collection	Discharge through LDP005	Kerosene Vale Dirty Water Runoff	Discharge through LDP003	Fire Tanks to UG	900 District UG Water Make	940 Bore Discharge	LDP006 Discharge	900 District to 20 Cut Through Dam	Kerosene Vale Water Make to 20 Cut Through Dam	Transfer from 20 Cut Through Dam to 300 District	Water Make from 500 District into 300 District	Runoff into 302 Portal	Transfer from 300 District to Fire Tanks	Natural Runoff to LDP001
Units	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr
Current Operations																		
Mean	28.0	25.6	2.5	28.0	25.7	30.2	28.3	236.7	2524.7	1341.2	0.0	1420.1	126.2	1546.4	157.8	2.7	1706.8	20.7
Min	28.0	25.5	2.5	28.0	24.0	8.7	5.9	236.5	2522.9	1340.3	0.0	1419.1	126.1	1545.3	157.7	0.8	1703.7	2.5
Max	28.0	25.6	2.5	28.1	27.3	55.9	55.4	237.2	2529.8	1344.0	0.0	1423.0	126.5	1549.5	158.1	4.8	1711.3	55.7

	Overflow from Fire Tanks to LDP001	LDP001 Discharge	Transfer from Fire Tanks to CHP	Runoff from CHP	Runoff into Pit Top Ponds	Overflow from final Pit Top Pond to Settling Ponds	Transfer Fire Tank to Rainwater Tanks	Workshop Roof Runoff	Overflow from Rainwater Tanks to Oil Water Seperator	Vehicle Washdown Demand	Vehicle Washdown to Grit Trap	Grit Trap Removal by Contractor	Grit Trap to Oil Water Seperator	Runoff into Oil Water Seperator	Oil Water Seperator to Settling Ponds	Settling Ponds Impervious Area Catchment Runoff	Settling Ponds Pervious Area Catchment Runoff	LDP002 Discharge
Units	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr
Current Operations																		
Mean	1384.0	1404.7	85.3	42.7	12.9	49.3	0.8	1.9	0.3	2.4	1.2	0.4	0.8	7.5	8.6	9.9	14.0	75.5
Min	1380.5	1383.0	85.3	42.6	3.6	40.0	0.3	0.9	0.0	2.4	1.2	0.4	0.8	2.3	3.0	3.0	1.7	41.6
Max	1387.9	1441.3	85.5	42.8	24.5	61.0	1.5	3.1	1.0	2.4	1.2	0.4	0.8	13.4	15.2	17.6	37.7	125.3

PROPOSED OPERATIONS

	Daily Potable Water Demand	Bath House Demand	Administration Demand	Car Park Pit Collection	Discharge through LDP005	Kerosene Vale Dirty Water Runoff	Discharge through LDP003	Fire Tanks to UG	900 District UG Water Make	940/910 Bore Discharge	LDP006 Discharge	900 District to 20 Cut Through Dam	Kerosene Vale Water Make to 20 Cut Through Dam	Transfer from 20 Cut Through Dam to 300 District	Water Make from 500 District into 300 District	Runoff into 302 Portal	Transfer from 300 District to Fire Tanks	Natural Runoff to LDP001
Units	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr
Proposed Operations																		
Mean	28.0	25.6	2.5	28.0	25.7	30.2	28.3	236.7	3787.0	2603.6	0.0	1420.1	126.2	1546.4	157.8	2.7	1706.8	20.7
Min	28.0	25.5	2.5	28.0	24.0	8.7	5.9	236.5	3784.3	2601.7	0.0	1419.1	126.1	1545.3	157.7	0.8	1703.7	2.5
Max	28.0	25.6	2.5	28.1	27.3	55.9	55.4	237.2	3794.7	2608.8	0.0	1423.0	126.5	1549.5	158.1	4.8	1711.3	55.7

	Overflow from Fire Tanks to LDP001	LDP001 Discharge	Transfer from Fire Tanks to CHP	Runoff from CHP	Runoff into Pit Top Ponds	Overflow from final Pit Top Pond to Settling Ponds	Transfer Fire Tank to Rainwater Tanks	Workshop Roof Runoff	Overflow from Rainwater Tanks to Oil Water Seperator	Vehicle Washdown Demand	Vehicle Washdown to Grit Trap	Grit Trap Removal by Contractor	Grit Trap to Oil Water Seperator	Runoff into Oil Water Seperator	Oil Water Seperator to Settling Ponds	Settling Ponds Impervious Area Catchment Runoff	Settling Ponds Pervious Area Catchment Runoff	LDP002 Discharge
Units	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr	ML/yr
Proposed Operations																		
Mean	1384.0	1404.7	85.3	42.7	12.9	49.3	0.8	1.9	0.3	2.4	1.2	0.4	0.8	7.5	8.6	9.9	14.0	75.5
Min	1380.5	1383.0	85.3	42.6	3.6	40.0	0.3	0.9	0.0	2.4	1.2	0.4	0.8	2.3	3.0	3.0	1.7	41.6
Max	1387.9	1441.3	85.5	42.8	24.5	61.0	1.5	3.1	1.0	2.4	1.2	0.4	0.8	13.4	15.2	17.6	37.7	125.3

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APPENDIX 7.4

Assessment of Hydrogeological Impacts

Assessment of Hydrogeological Impacts Angus Place Project Modification Centennial Angus Place

Report ref:
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Revision 2

aurecon

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Contents

1. Introduction

Angus Place Colliery is seeking a Project Modification Approval under Section 75W of Part 3A of the EP&A Act. The purpose of the application is for the proposed modification of the current Angus Place Colliery mining operations Approval. Angus Place Colliery's proposal is to extend its operations through the extraction of two additional longwall panels, known as LW 910 and 900W, and the development of related surface infrastructure (listed in Section 2 below).

As part of the approval process, several environmental and scientific studies are required to examine the potential impact of the additional workings. In particular, the application needs to examine the impact of the proposed mining on the local groundwater regime. To assist with this examination, Angus Place Colliery engaged Aurecon to undertake an assessment of the likely impacts on the groundwater regime with reference to all of the available relevant groundwater-related data.

This report presents the results of that assessment, and attempts to respond to the Director General's Requirements (DGRs) for the project (06_0021 MOD 1). In particular, the DGRs identify several key issues, one of which is dealt with in this report. This issue is:

- *a detailed assessment of potential impacts on:*

  - *the quality and quantity of surface water and groundwater resources; and*
  - *groundwater dependent ecosystems*

This issue is dealt with in full in Section 4.2.

In addition to the DGRs, the NSW Office of Water (NoW), in response to the preliminary EA, requested that that the proposed mining achieve the following outcomes:

1. *no hydraulic connection between the mining operation and the surface water sources, or perched shallow groundwater sources*

2. *no impact on adjacent licensed water users, basic landholder rights, or minimum base flows in overlying rivers or groundwater-dependant ecosystems.*

Both of these aspects are dealt with in Section 4.2 below. The NoW submission identified groundwater resource protection as a key issue, and listed several issues that needed to be addressed in the EA. These issues are listed below along with the section of this report in which they are addressed.

1. *Identification of surrounding water users and any groundwater dependent ecosystems* (see Section 3.2)

2. *Detailed explanation of potential groundwater volume, piezometric level, water table heights and the direction of flow and quality, through mine life and projections into the post-mine period, applying to perched phreatic groundwater sources and their dependent ecosystems, any identified aquicludes/aquitards underlying the perched groundwater water source and all seams targeted for extraction* (see Section 3.2)

3. *Detailed explanation of groundwater drawdown or other impacts upon connected groundwaters associated with perched groundwater and any connective or other dependency of river flows or groundwater dependent ecosystems on groundwater heads within the Banks Wall Sandstone or other ground water sources, compared with cumulative predicted seepage flow migrating from fractured hard rock into the proposed underground mine workings* (see Section 4.2)

4. *Explanation of the site water balance for the proposed extension and total site operations, including any changes to water balance inputs from rainfall runoff and/or groundwater seepage to the open cut extension* (not applicable to this study)

5. *Detailed description of any proposed water supply system using groundwater as a source and assessment of current licensing arrangements against this* (not applicable to this study)

6. *Detailed analysis of the impacts of dewatering if required for the project, identifying the magnitude and duration of pumping, the areal extent of water level drawdown* (see Section 4.2 and 4.3)*, the likely quality of extracted groundwater, alternations to site water balance and the monitoring and reporting protocols to be adopted to meet licensing requirements* (mostly not applicable to this study)

7. *Measures to prevent contamination of either the Kangaroo Creek or Wolgan River water source(s), or any flow dependent perched groundwater dependent ecosystems resulting from changes in groundwater tables* (see Section 4.2)

8. *Identification of potential and likely groundwater-dependent ecosystems and any impact upon these ecosystems which may result from the proposal, this must include:*

   - *Terrestrial vegetation with seasonal or episodic reliance on groundwater, and*
   - *Aquatic and riparian ecosystems in, or adjacent to, streams or rivers dependent upon the input of groundwater to minimum base flows* (see Section 4.2)

None of the other Government agencies had any particular requirements relevant to this study.

2. The Proposed Project

Angus Place Colliery currently extracts on average 3MTpa, with approval to extract 3.5MTpa from the Lithgow Seam. Development activities within the 930 – 980 area are scheduled to be completed by December 2012 with Longwall operations within the current mining area (longwalls 930 – 980) planned to be completed by December 2014. Accordingly, further resources have been identified to be developed to ensure continued operations at Angus Place and continued supply of coal to established markets.

The proposed project includes the following works:

- The development and extraction of longwall 910
- The development and extraction of longwall 900 West (900W)
- one additional dewatering borehole located at the eastern end of longwall 910 and associated infrastructure (tracks, powerlines and pipelines) to enable connection to the Delta water transfer system
- Increase in production to a limit of 4.0 Mtpa

Longwall 910 is located directly north of the extracted 920 panel and is oriented in an east – west direction. Development would extend from the existing 303 district. There are two possible options for this longwall panel. Option 1 would be pursued if the potential coal resource to the north east is not found to be viable. In this case, the longwall will be about 200 m wide and 2500 m in length and will involve the development of two main headings. This option will produce 2,620,720 tonnes of coal. Option 2 would only be pursued if there is found to be a viable coal resource to the north east. With this option, the longwall panel would be narrower (120 m wide), which would allow four main headings to be developed for access to the north east area, but would reduce the production to 1,855,600 tonnes of coal.

Longwall 900W is located directly west of the existing 900 Panel main headings and is oriented in a north - south direction. Development would extend from the existing D900 Panel. The longwall will be 283.5 m wide and 2079.7 m in length and will produce 3,009,810 tonnes of coal. Longwall 900W is located partially within Springvale Mining Lease. Accordingly, a sub-lease (or equivalent) is being procured from Springvale to enable full extraction of the resource. At a production rate of 4.0 Mtpa, longwall 900W would have a life of less than 12 months.

Details of the proposed mining are summarised in Table 1 below.

Table 1 –Proposed Mining Geometry – Typical Layout

Feature	Longwall 900W	Longwall 910
Seam	Lithgow	Lithgow
Seam thickness	3.6 – 4.0 m	3.8 m
Typical Panel Width	200 m (120 m Option 2)	283.5 m
Typical Panel Length	2500 m	2079.7 m
Depth of Cover	300 – 320 m	320 – 360 m
Typical Chain Pillar Width	35 m	35 m

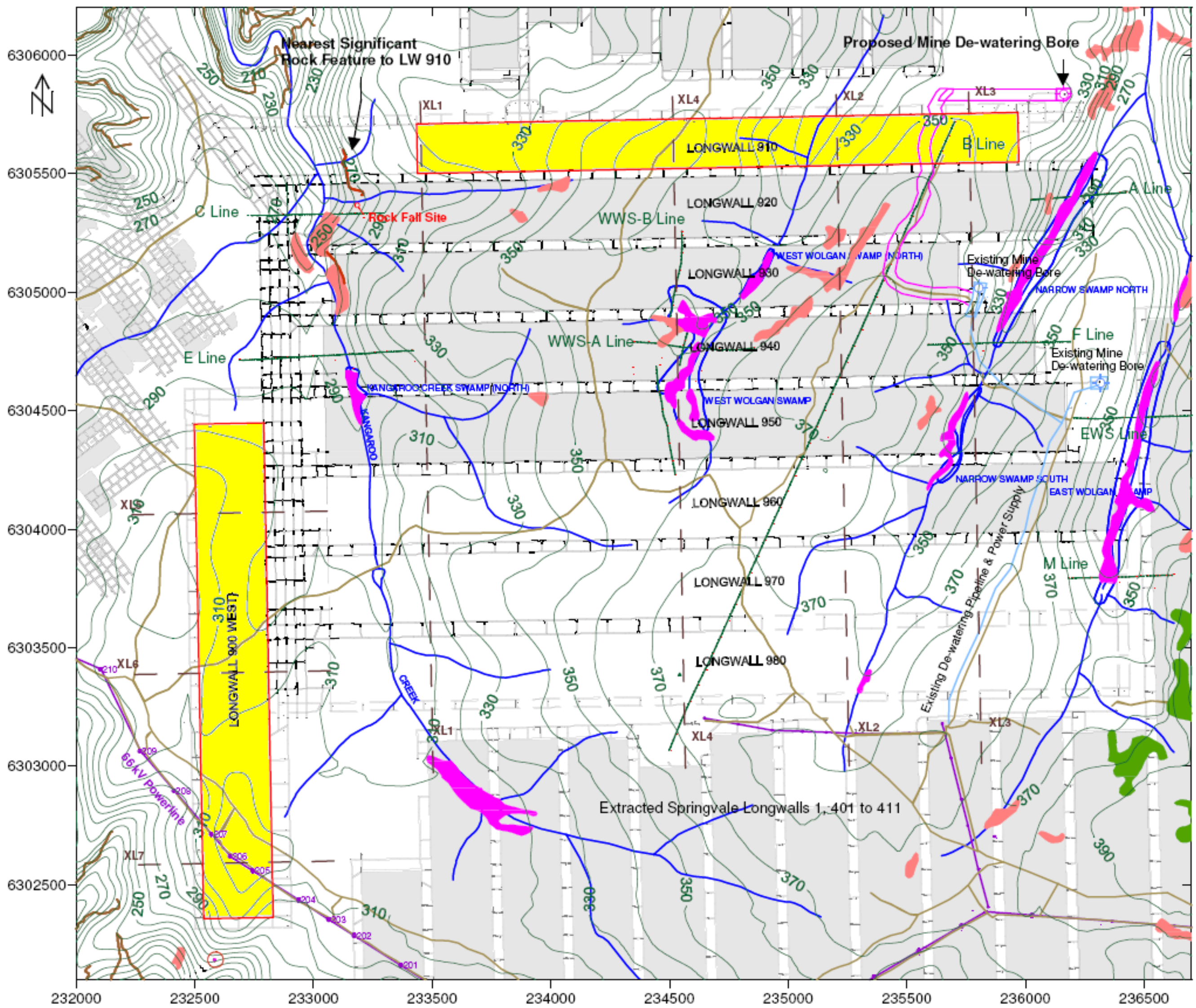

Figure 1 – Location of Proposed Longwall Panels (DGS, 2010)

3. Background Data

The study area for the current project encompasses the Newnes Plateau area over the Angus Place and Springvale lease areas. A detailed description follows.

3.1 Geology

The area overlying Angus Place Colliery forms part of the Newnes Plateau, northeast of Lithgow. The underlying strata comprise mostly sandstones of the Triassic Narrabeen Group, which are interbedded with shale and siltstone bands. The Narrabeen Group rocks are underlain by the Illawarra Coal Measures, which comprise interbedded sandstone, siltstone, shale and coal. The general dip of the bedding is to the northeast at about 2 degrees. The plateau area is cut by several deeply incised creek valleys, which drain to the north and west of the lease area. The Project area lies on the boundary between two catchments; the Wolgan-Colo River catchment to the north and the Coxs River catchment to the west.

In this area, the Narrabeen Group rocks near the surface belong to the Grose Sub-group, and include the Banks Wall Sandstone, the uppermost part of which is deeply weathered and generally very friable. The sandstone, which is up to 200 metres thick in this region, is underlain by the Mt York Claystone, a fine-grained stratum, with a thickness in this area ranging from 4 to 11 metres, that limits vertical infiltration of groundwater from the overlying strata. The underlying Burra-Moko Head Sandstone and Caley Formation make up the remainder of the lower part of the Narrabeen Group.

The Narrabeen Group rocks are underlain by the Illawarra Coal measures which comprise claystone, siltstone, sandstone and coal seams with a total thickness of about 120 metres in this area. The Lithgow Seam, which will be extracted in Longwalls 910 and 900W, is the lowermost seam in the coal measures and is located about 25 metres above the base of the coal measures. There are no major geological structures that cross the two proposed longwall panels (DGS, 2010).

The local stratigraphy is summarised in Table 2 below. The estimated height above the roof of the Lithgow Seam at Angus Place is also shown on this table.

Table 2 - Middle Permian to Tertiary Stratigraphy of the Western Coalfield

Period/ Age	Stratigraphy			Lithology	Height Above Lithgow Seam Roof
	Group	Subgroup	Formation		
Tertiary			Basalt	Basalt	
Triassic	Wiannamatta		Ashfield shale		
		Hawkesbury Sandstone			
	Narrabeen Group	Grose Subgroup	Burralow Formation		Surface 300-350 m
			Banks Wall Sandstone		200 m
			Mt York Claystone		195 m
			Burra –Moko Head Sandstone		
			Caley Formation		106 m
Permian	Illawarra Coal Measures	Wallerawang Subgroup	Farmers Creek Formation	Katoomba Seam, sandstone, claystone, siliceous claystone	
			Gap Sandstone	Sandstone	
		Charbon Subgroup	State Mine Creek Formation	Coal, mudstone, claystone	
			Watts Sandstone	sandstone	
			Denman Formation	Interbedded mudstone / sandstone, claystone, mudstone	
			Glen Davis Formation	Coal and claystone bands	
			Newnes Formation	Coal, sandstone	
			Irondale Seam	Coal	25 m
			Long Swamp Formation	Interbedded sandstone and siltstone	4 m
		Cullen Bullen Subgroup	Lidsdale Coal	Coal and claystone bands	
			Blackmans Flat Formation	Sandstone, conglomerate	0 m
			Lithgow Seam	**Coal and claystone bands**	**-3 m**
			Marrangaroo Formation	Sandstone, conglomerate	
		Nile Subgroup	Gundangaroo Formation	Coal, sandstone claystone	
			Coorongooba Creek Sandstone	Sandstone	
			Mount Marsden Claystone	Claystone	
	Shoalhaven Group		Berry Siltstone		-25 m
			Snapper Point Formation		

3.2 Hydrogeology

In general, the sedimentary strata in the Western Coalfield, comprise a non-uniform sequence of interbedded rocks of differing grainsize and strength properties. This invariably gives rise to layers of rock with a wide range of permeabilities, which form a sequence of aquifers and aquitards/aquicludes in the overburden. The term “aquifer” is generally applied to any stratum that has a high groundwater carrying capacity, relative to the surrounding rocks.

Previous investigations further to the east at Springvale and Clarence Collieries have identified near-surface aquifers in the Banks Wall Sandstone (part of the Blue Mountains sandstone aquifer) as a critical local natural water resource. One of these aquifers is the major source of potable water tapped by numerous bores in the Clarence village, but this appears to be limited to the plateau area north-east of Lithgow. There are no listed bores in the vicinity of the project area that utilise the local groundwater.

The aquifers in the Banks Wall Sandstone also provide base flows to some of the shrub swamps which occur to the east of Angus Place. These Newnes Plateau Shrub Swamps (NPSS) are listed under the Federal Environment Protection and Biodiversity Act (EPBC) (1999) and the State Threatened Species Conservation Act (TSC) (1995). The EPBC Act lists Temperate Highland Peat Swamps on Sandstone (of which Newnes Shrub Swamps are a subset) as a Nationally Threatened Ecological Community. The TSC Act lists Newnes Plateau Shrub Swamps as an Endangered Ecological Community (EEC). Another type of vegetation community that is listed under the Federal and State acts is the **hanging swamp**. This type of swamp is common on the Newnes Plateau and most are located on the flanks of valleys at high elevation. Hanging swamps are classified as NPSS communities and will be referred to as Newnes Plateau Shrub Swamps in this report. It is important to note that there are no NPSS located directly above either of the proposed longwall panels.

The monitoring of swamps on the Newnes Plateau since 2002 has indicated that there are a range of swamp types, which appear to differ essentially in the relative contributions of groundwater and rainfall/run-off to the swamp hydrology. Those swamps that have a relatively large groundwater contribution are more resistant to the natural variations that may occur in the local rainfall patterns. They are termed **permanently waterlogged swamps**, and generally have a constant flow of water from their downstream end. These swamps have a relatively stable, near-surface groundwater table that shows no major fluctuations, even after heavy rainfall or during prolonged dry periods. They are located mostly in broad valleys with catchments that are large enough to provide the infiltration required to feed the basal aquifer. Waterlogged swamps can also occur in valleys with very poor drainage or in depressions, so that rainfall/runoff ponds locally and provides a constant water source.

The swamps that have a relatively poor groundwater contribution are obviously more sensitive to the natural variations in rainfall patterns. These **periodically waterlogged swamps** normally do not have a constant flow from their downstream extremity, and show large variations in groundwater level, particularly after major rainfall events. They may also have small catchment areas, and some are located at high elevations with no significant flanking ridges or obvious drainage lines through the swamp. Hanging swamps are not peat-based and are generally supported by perched shallow aquifers that provide a **permanently or periodically waterlogged** environment, depending on the aquifer recharge area.

Available botanical mapping and hydrogeological monitoring strongly suggest that the hydrogeological regime over Angus Place is apparently different to the conditions that exist further to the east over Springvale and Clarence Collieries. While a number of NPSS have been identified in this area, the investigations show that there are no major permanently waterlogged swamps over the area that has been undermined in the Angus Place Colliery to date, apart from one small swamp located in Kangaroo Creek. This swamp is located just downstream of a spring, which provides a continuous supply of groundwater. There are also only two periodically waterlogged NPSS (West Wolgan and Narrow Swamps) and several hanging swamps over the approved and existing workings (LW 920 to 980). Vegetation mapping over the area has also shown that there are no NPSS over the two proposed longwall panels (LW910 and 900W), although the northern end of the Narrow Swamp and two small NPSS lie just within the the area around Longwall 910 that may experience some subsidence (DGS, 2010).

The lack of any major waterlogged swamps over Angus Place suggests that the aquifers in the near surface Banks Wall Sandstone formation may not be as well developed in this area. The seeps and springs that feed Kangaroo Creek provide the one exception to this. Even though there are no swamps located over longwalls 910 and 900W, there will probably be some minor aquifers in the upper sandstone sequence in this area.

Work by CSIRO at Springvale Colliery has identified a series of so-called aquifer zones in the overburden (CSIRO, 2010). although no detailed testing has been carried out in the region to confirm that these horizons are widespread water-bearing zones. In addition, the permeability of these zones is not high by normal aquifer standards, and no permeabilities have been measured in the project area. Although it is not certain whether these zones extend over the Angus Place workings, it is likely that there will be some similarities in the hydrogeological properties of the strata over Angus Place and Springvale. Two of the aquifer zones (AQ1 and AQ2) are located in the coal measure strata, while AQ3 is located in the Burra-Moko Head Sandstone. Three aquifer zone (AQ4-A, AQ4-B and AQ5) have been identified in the Banks Wall Sandstone. The graphic in Figure 2 gives details of the inferred hydrogeological section from the Springvale work, and for the purposes of this study, it is assumed that similar conditions exist over Angus Place Colliery.

While no permeability testing has been carried out in the Banks Wall Sandstone in the Project area to confirm the presence of aquifers, continuous, full-depth permeability testing was carried out on this formation in borehole AP1PR during a recent exploration program further to the east. This testing showed that the permeability of the Banks Wall Sandstone is mostly low (< 10^{-7} m/s), although three horizons showed a slightly higher permeability of between 10^{-6} and 10^{-7} m/s, and could be considered to be “relative” aquifers. Two of these horizons appear to correspond approximately with the CSIRO aquifer zone AQ4-A and one with AQ4-B. Although there is no certainty that these “aquifer” zones are present at the same horizons in the Project area, the spring on Kangaroo Creek that feeds the swamp is possibly the surface intersection of the AQ4-B aquifer horizon.

Limited investigations at Springvale have shown that the coal measure strata overlying the Lithgow Seam in this area also have low permeabilities (<10^{-8} m/s), however one or two layers may have a slightly higher permeability (up to 10^{-6} m/s), and could represent aquifers (Golder Associates, 2002). The few aquifers that do occur at depth in these strata are usually fractured rock aquifers (Bish, 1999). These include jointed coal seams and localised jointed or fractured zones, often adjacent to faults. In order to check if there were any fractured rock aquifers in the coal measure strata in the vicinity of Angus Place, limited permeability testing was carried out in the coal seams in bore AP1PR. The tests confirmed that the three major coal seams (Katoomba, Irondale and Lithgow) all have relatively low permeabilities of the order of 10^{-7} m/s.

Although there may not be any major aquifers in the local sedimentary rock sequence, most groundwater flow is generally in the horizontal direction along bedding planes, with some vertical flow occurring from the ground surface (infiltration), downward into the uppermost water bearing zone. A very limited volume of groundwater may also flow vertically from one water-bearing zone to another, depending on the magnitude of the permeability of the intervening strata, and the degree of vertical jointing and faulting in the system. At Angus Place, the Mount York Claystone, which underlies the Banks Wall Sandstone, forms a low permeability barrier to this vertical infiltration, so that most of the natural groundwater flow occurs above this horizon. Bish (1999) confirmed that the general flow direction in the strata in this region is sub-horizontally towards the north-east, away from the subcrop zone, where recharge to the aquifers can occur. This potential recharge zone is located to the west and northwest of the existing workings.

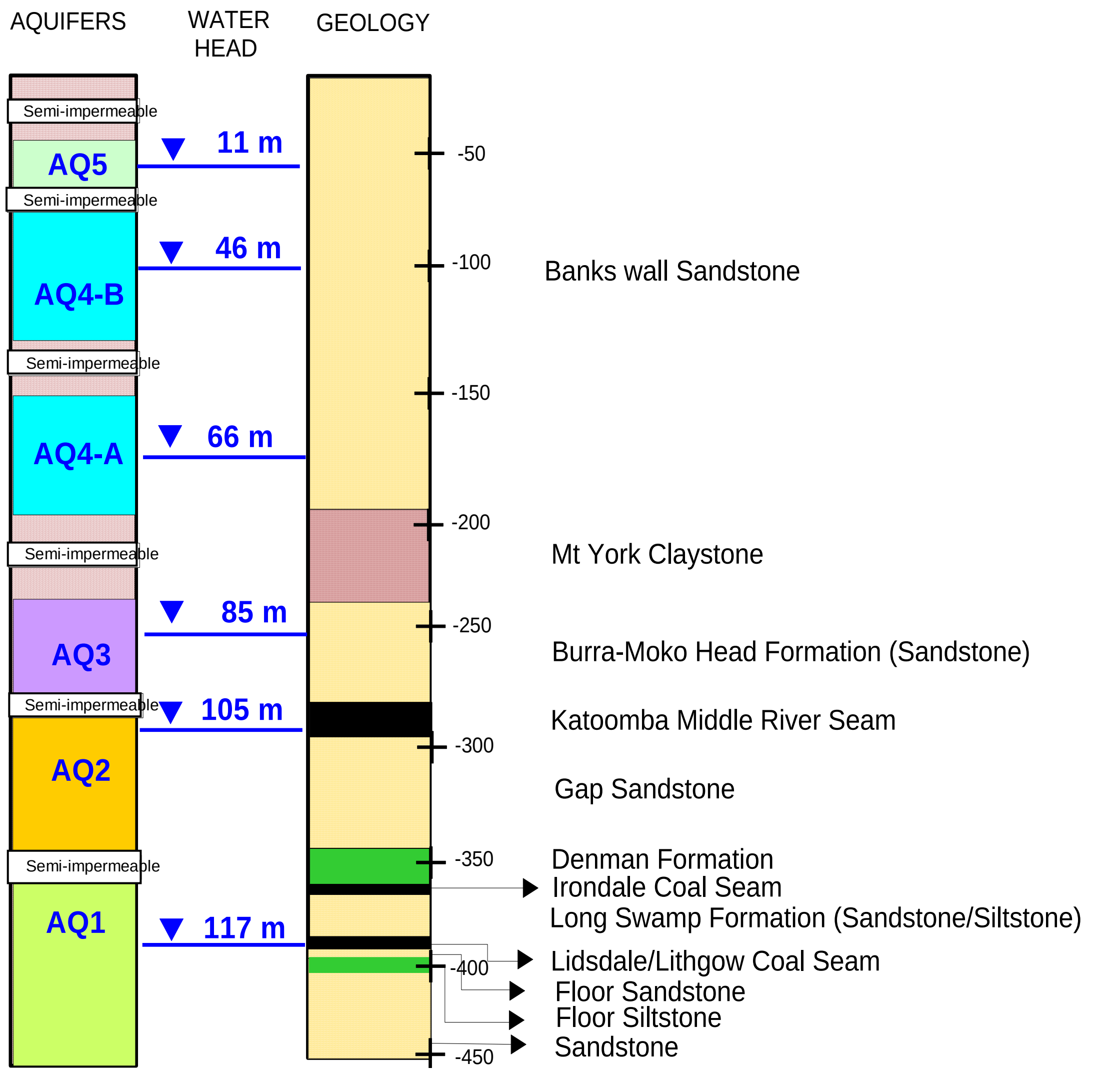

Figure 2 – Inferred hydrogeological section (CSIRO, 2010)

3.3 Physical Impacts of Longwall Mining

In order to determine the impact of the proposed mining on the hydrogeological regime in the Project area, there is a need to understand the mechanics of deformation of the overburden strata above a longwall mining operation. These deformations can be broadly classified into two categories: surface and sub-surface deformations. Both types of deformation are described below, and their potential impacts on hydrogeological system summarised.

3.3.1 Surface Deformations

Surface deformations resulting from coal extraction have been observed and measured on a routine basis at most underground coal mines for many years. In addition to the more obvious impacts on surface structures, these deformations have the potential to impact on shallow unconfined aquifers and surface waters. The deformations most commonly observed include subsidence, surface strains, surface tilts and valley bulging. The nature of these deformations, and the potential problems for local groundwater and surface water systems that can result from these phenomena, are described briefly below. Detailed predictions of the magnitude and distribution of these displacements are given in DGS, 2010.

Subsidence

Subsidence is the most commonly measured surface deformation, generally because its magnitude is an indicator of the overall potential impact from the extraction of the resource. The degree of subsidence is dependant on many factors including depth of cover, panel width, topography, geology and overburden properties. The formation of a subsidence trough over a longwall panel can lead to ponding of surface waters and disruption to stream flows if the subsidence is of sufficient magnitude. This is particularly likely at shallow depths of cover and for wide extraction areas, where the magnitude of the subsidence is greatest. It should be noted that normal vertical subsidence is unlikely to cause detrimental environmental consequences. Other surface impacts, such as excess tilts, strains and valley closure/uplift of sufficient magnitude (discussed below) are more likely to cause cracking, shearing and instability.

Surface Strains

Surface strains are dependant on the rate of change of the vertical subsidence, and result from differential horizontal displacement around a subsidence trough. Of the two main types of strain (compression and tensile), tensile strain is more likely to impact on surface and groundwater systems. For high subsidence values, the tensile strains may be large enough to cause cracks in the ground surface, which may divert surface water flows or drain the near-surface unconfined aquifer. It is important to note that both transient strains and residual strains result from longwall mining. In most cases, the residual strains are more important as they operate over a longer period of time and have a greater potential for long-term adverse impacts and consequences.

Surface Tilting

The degree of surface tilting experienced is also related to the magnitude of the surface subsidence, and can impact on the local hydrogeology. Where surface streams have very low gradients, mining-induced tilting may either disrupt the stream flow, cause ponding or increase the discharge, which may affect natural erosion patterns in the stream bed. Similarly, disruption to groundwater flow could be experienced in a near surface aquifer, where the tilt is sufficiently large and the hydraulic gradient in the aquifer is sufficiently low. As in the case of strains, both transient and residual tilts result from mining and, while both may impact on the hydrologic systems, it is the residual tilts that can have longer lasting impacts.

Valley Bulging (and Valley Closure)

Where a valley is undermined by a longwall panel, it is often observed that the valley floor subsides less than the surrounding ridge tops. This is known as the valley bulging effect. The difference in subsidence between the ridge top and the valley floor in such cases is called uplift. While the term uplift implies that the ground experiences an upward vertical movement, the normal vertical movement direction in the valley floor is still generally downwards, especially for large subsidence values. In high stress areas, the valley floor may actually rise rather than subside, and the rise in the ground surface is known as upsidence. The magnitude of the uplift is related to several factors including, most importantly, the depth and steepness of the valley and the magnitude and orientation of the in situ horizontal stresses in the rock mass. Where geological structures are present in the valley floor, the induced strains may concentrate on these features and increase the overall displacement.

Where the uplift is significant, it may give rise to cracking in the valley floor, which in turn may temporarily disrupt the stream flow. In such cases, some or all of the stream flow is diverted into shallow underground cracks, sometimes leaving the stream bed dry. Generally, the stream flow reappears downstream of the area affected by the mining, where there is no cracking. Cracking is more likely where resistant (brittle) rock is exposed in the stream bed. If soil or softer rock material is present, the excess strains caused by the valley bulging are more likely to be absorbed, and cracking is therefore less likely.

Valley closure is usually associated with valley bulging, particularly in deep, steep sided valleys. Valley closure refers to the measured horizontal displacement of the flanking ridges towards the centre of the valley.

3.3.2 Sub-Surface Deformations

In addition to the near-surface deformations described above, sub-surface deformations may also impact on deeper aquifer systems and, to a lesser extent, surface waters. An understanding of this phenomenon is therefore necessary to determine the potential for any adverse impact on the local hydrogeology from this source. A discussion of the sub-surface deformation process and its potential impacts follows.

When the void created by extraction of a coal seam becomes sufficiently large, the unsupported roof of the seam fractures and falls into the void. Collapse of the roof continues upwards until the void is filled by broken rock. This caved material supports the overlying strata, which sag downward. Fracturing occurs in the sagging strata immediately overlying the void, but decreases in intensity higher up in the overburden. This sagging is reflected on the ground surface as a subsidence trough. If the mine is at a shallow depth below an aquifer, the fractures induced in the sagging strata may interconnect and hence provide a seepage path between the aquifer and the mine.

Many previous studies both in Australia and overseas have examined the mechanics of strata deformation in order to understand the behaviour of the overburden strata above underground mines. Most studies have recognised several separate deformation zones in the overburden strata (Forster & Enever, 1992). Although there is some variation in the definition of these zones between the studies, a general description of each zone has been compiled and is given below. A graphic is presented in Figure 3 which shows the location of each of the zones.

<u>Caved Zone (including a lower caved zone and a transition zone)</u>
This zone comprises loose blocks of rock detached from the roof and occupying the cavity formed by mining. It can also contain large voids. Large increases in bulk permeability occur in this zone.

<u>Fractured Zone</u>
This zone comprises in-situ material lying immediately above the caved zone, which has sagged downwards and consequently suffered bending, significant fracturing, joint opening and bed separation. These beds rest on the underlying caved material causing it to compact. The fractured zone displays a significant increase in horizontal and vertical permeability, due to the interconnection of the fractures induced in the strata.

<u>Constrained or Elastic Zones</u>
The constrained zone comprises confined rock strata above the fractured zone that have sagged slightly, but, because they are constrained and the imposed strains are lower than in the fractured zone, the degree of fracturing and dislocation of the strata is limited. Some horizontal bed separation or slippage is generally present, as well as discontinuous vertical cracking (usually on the underside of thick strong beds). Increases in horizontal permeability occur but no significant increase in vertical permeability is likely.

<u>Surface Zone</u>
The surface zone comprises unconfined strata at the ground surface, in which mining induced tensile and compressive strains may result in the formation of cracks or ground heaving. Vertical permeability may increase slightly in this zone.

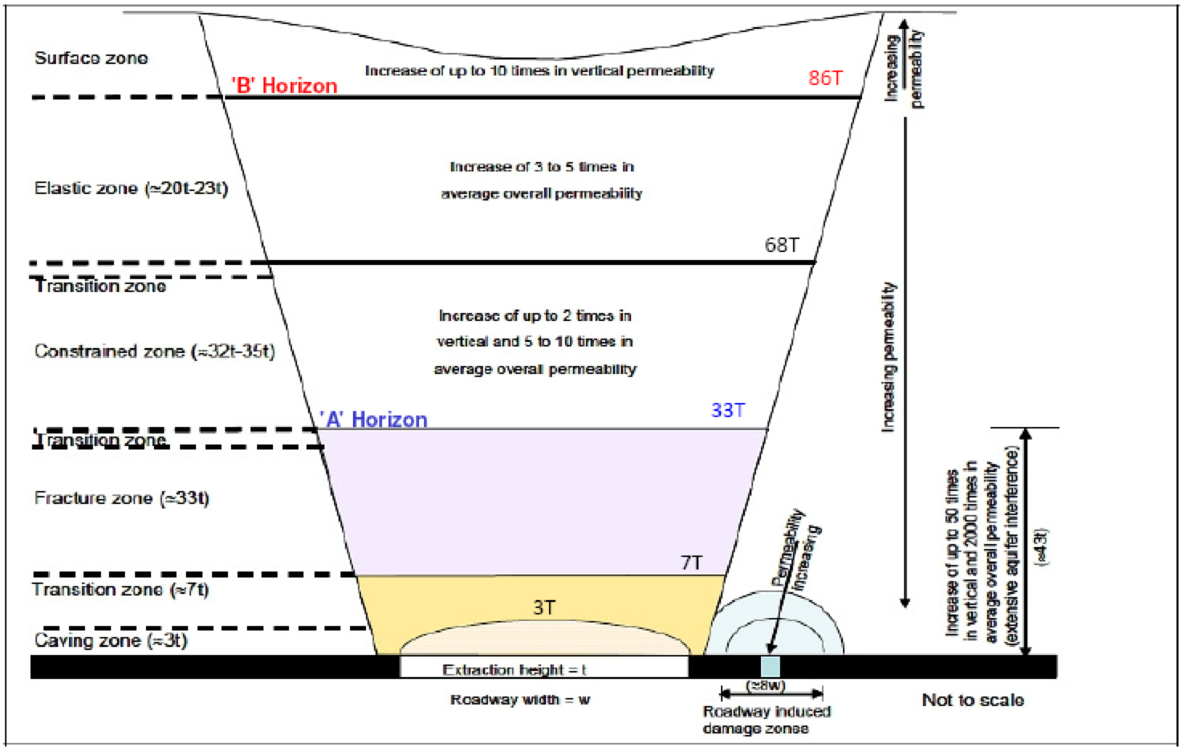

Figure 3 – Overburden Deformation Zones (DGS, 2010)

The thickness of each of the deformation zones listed above is influenced by many factors. The most significant of these is the size of the mine opening. As this opening widens, the degree of deformation in the overburden strata increases. Initially, caving occurs in the roof strata, followed by formation of the fractured zone above the caved material. At greater extraction widths, the extent of the fractured zone increases and deformations at the ground surface become apparent. The maximum degree of deformation occurs when the total extraction area reaches its critical width. Previous studies indicate that this critical width is about 1.4 times the depth of cover (Holla, 1991). For total extraction widths greater than the critical width (supercritical extraction), there is no increase in the vertical extent of the deformation zones. Studies have shown, that for any given coal seam extraction width and orientation, the extent of each of the strata deformation zones in the overburden is dependent on the seam extraction height, depth of cover and the physical properties of the overburden strata (Forster, 1995).

It is evident that the caved and fractured zones would normally experience an increase in vertical permeability and would therefore tend to drain groundwater from any aquifers which occur in these zones. However, the constrained zone, since it contains few interconnecting fractures, has the potential to prevent vertical hydraulic connection between the mine and any overlying aquifer, provided its initial permeability is low. Therefore, provided the initial permeability of the overburden strata is low, and there are no major aquifers within the caved or fractured zones above the mine, then there is limited potential for disruption to the groundwater regime or for groundwater inflows into the mine workings from the overburden.

In order to determine the impact of the proposed future mining on the aquifers, shrub swamps and groundwater dependant ecosystems, the height of the fractured zone above the proposed mine workings needs to be estimated. This is defined as the height of interconnected fracturing that could transmit water from the strata to the mine opening, or the height to the ‘A’ horizon shown on Figure 2. Estimating this height is normally based on previous experience, incorporating a qualitative evaluation of local geological and mining conditions. This is not a simple task; since the height of the fractured zone is dependant on many variables including seam thickness, rock type, rock strength and deformation properties, jointing, bedding and depth of cover.

Previous studies in the Newcastle Coal Measures (ECNSW, 1987, Forster & Enever, 1992) have suggested that the fractured zone extends to a height above the coal seam of between 20 and 33 times the coal extraction thickness above supercritical extraction areas. These findings have not been tested in the Western Coalfield, although it is expected that the height of fracturing may be slightly greater due to differences in the rock properties.

Several previous field studies have been carried out at various locations to investigate the extent of the overburden deformation zones above underground coal mines, and in particular to determine the height of the fractured zone. Using either piezometric or micro-seismic monitoring during mining, these studies have measured a height for the fractured zone of between 40 and 120 m, over a range in cover depths of 80 to 500 metres, and seam heights of 1.9 to 3.2 m (ECNSW, 1987, Forster & Enever, 1992, Seedsman & Kerr, 2001, Kelly et al, 1998).

Since the database of relevant field data in the Western Coalfield is not as extensive as for the Newcastle Coalfield, no rigorous assessment has been made of the likely fractured zone height above longwalls 900W and 910. However, previous extensometer and piezometer data at Springvale (Aurecon, 2009) give a good indication that it is likely to be restricted to the strata in the Illawarra Coal Measures, which extend approximately 100 metres above the Lithgow Seam.

The subsidence assessment report for the modification project (DGS, 2010) uses an empirical model to estimate this height (ACARP, 2003). The model takes into account the panel width, maximum subsidence, cover depth and geological conditions and predicts the mean ‘A’ horizon height and the upper 95% confidence limit height. For the two proposed longwall panels the model predicts an upper 95% confidence limit of the ‘A’ horizon of 92 to 123 m, which is in line with the 100 metres predicted from previous experience.

This assessment is of the same magnitude as the CSIRO model estimation for the fractured zone height in the hydrogeological model simulation (DGS, 2010). The CSIRO model identifies a fractured zone height above the seam of 75 to 101 metres (23T to 31T), which is slightly less conservative than the other estimates above. Nevertheless, due to the uncertainty in estimating the height of the fractured zone, a conservative fractured zone height of 150 metres will be assumed for the purposes of this evaluation, even though the chances of the fractured zone reaching this height are highly unlikely.

4. Predicted Impact on the Hydrogeological Regime

Before assessing the impact of the proposed mining on the hydrogeological regime, it is important to review the previous mining activity in the area and evaluate the impact of that mining prior to the commencement of the proposed extraction of longwalls 910 and 900W at Angus Place. To this end, the current hydrogeological conditions are summarised in Section 4.1 below, followed by an assessment of the incremental impact of the proposed extraction of the two longwall panels (Section 4.2). For Longwall 910, only Option 1 has been assessed as it has been assumed that the impact of the Option 2 configuration will be less than the impact of the Option 1 layout.

4.1 Current Hydrogeological Conditions

Underground mining in this region has been carried out for over a century, so that it is reasonable to assume that there has been at least some impact on the local hydrogeological regime. There have been no fewer than seven mines operating in the immediate vicinity of Angus Place during this period. These include Springvale Colliery, Clarence Colliery, Lithgow State Mine (abandoned), Fernbrook Colliery (abandoned), Renown Colliery (abandoned), Kerosene Vale Open Cut (abandoned) and Newcom Colliery (abandoned). All of these have had some impact on the hydrogeological regime.

Obviously, the extraction of the longwall panels in Angus Place Colliery has had the greatest influence on the local hydrogeological regime in the vicinity of the proposed longwalls 900W and 910. In Section 3.2.2, it was inferred (conservatively) that the fractured zone above the longwall panels could extend up to 150 metres above the extracted seam. If this is the case, then any aquifers in the coal measures would be drained and depressurised some distance from the mine opening. Previous experience with extensometer and piezometric monitoring at Springvale Colliery (Aurecon, 2009) shows that the fractured zone extends to at least 100 metres above the longwalls, resulting in the drainage of coal measure aquifers into the mine (see Figure 4).

Numerical modelling by the CSIRO (CSIRO, 2005) also indicates that significant changes occur in the horizontal and vertical permeability of the strata up to the base of the Mount York Claystone (caused by fracturing). Results of this modelling in 2005 predicted mine water inflows that are higher than the actual measured inflow, which suggests that the assumed permeability changes are conservative, and the fracturing may not extend as high as has been assumed. This modelling assumes that the two lowest aquifer zones in the coal measures (AQ1 and AQ2) drain into the mine opening, as well as AQ3 in the Burra-Moko Head Sandstone. Given the lower than predicted mine water inflows, it is therefore uncertain whether total drainage of AQ3 actually occurs.

Based on these data, it is reasonable to assume that the strata for a height of about 150 metres above the Lithgow Seam may have already been depressurised and partially drained of groundwater by previous longwall mining in the area. While the exact height of depressurisation is not certain, it is highly likely that it is limited to the strata below the Mount York Claystone, which is about 200 metres above the coal seam. Consequently, the hydrogeological regime in the Banks Wall Sandstone above the Mount York Claystone has been relatively unaffected by the mining to date.

This is confirmed by the available piezometric data from Springvale (Aurecon, 2009), which indicates that the impact of previous mining on the groundwater regime in the Banks Wall Sandstone Formation appears to be negligible. Figure 4 below shows a graph of the pore pressures in several piezometers in the overburden between longwalls 411 and 412 at Springvale, which indicates a significant response in most of the piezometers following the passage of longwall 411 in early 2006. The piezometer in the seam (piezo #1) as well as the two piezometers in the near-roof strata (piezos # 2 and #3) all failed shortly after undermining, indicating significant strata disturbance in the zone immediately above the coal seam, as would be expected. Of particular interest is the response in piezo #4, which is located about 107 metres above the mine opening. While there was a drop in pressure in this piezometer, the pressure head is always positive and recovers most of the pressure loss over the following months. This is a good indication that there are no major interconnected fractures linking this stratum with the mine opening, so that the height of interconnected fracturing above the mine must be less than 107 metres. The passage of longwall 412 past this site in February 2008 does not result in any additional drainage of the strata.

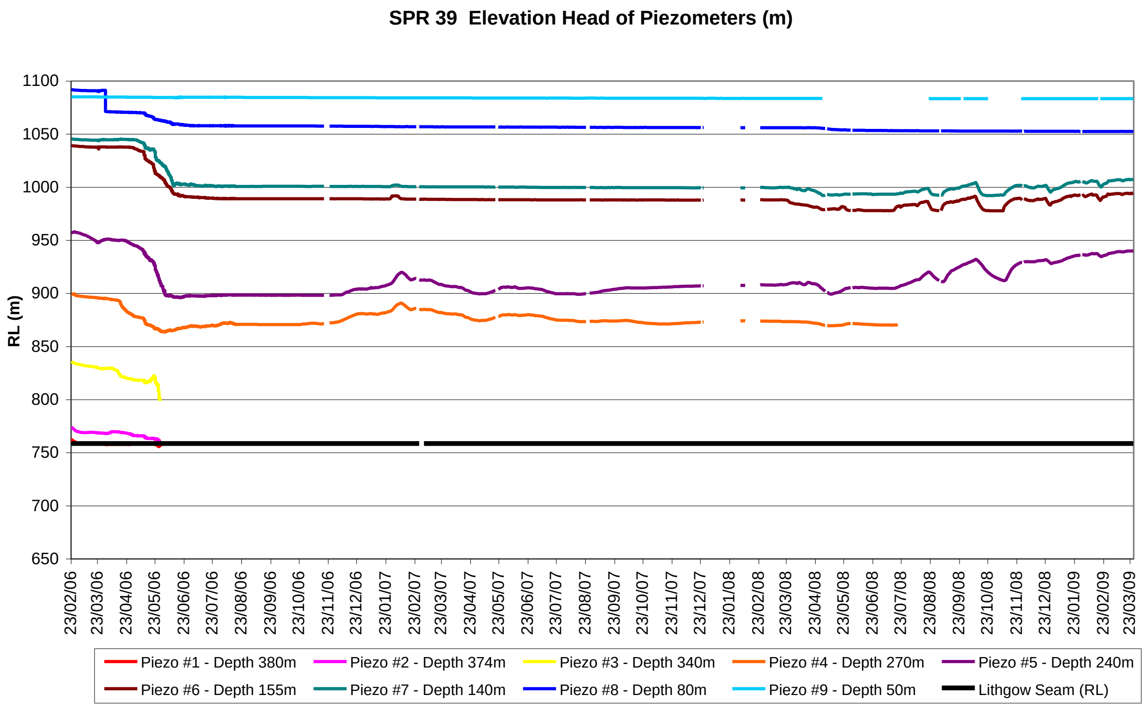

Figure 4 – Pore pressures in SPR 39 at Springvale Colliery adjacent to longwall 411

The lack of drainage indicated by the piezometers in the near surface Banks Wall Sandstone is partly due to the fact that the Mt York Claystone is above the overburden fractured zone and acts as an aquiclude, preventing any drainage downwards into the mine. At this height above the seam (200 m), the degree of deformation in the overburden is insufficient to induce any significant vertical fracturing in the aquiclude, which could lead to the drainage of any overlying aquifers. Consequently, any impact on aquifers in the Banks Wall Sandstone from the previous mining has been limited to minor temporary changes in groundwater levels caused by tilting subsidence, and some minor discontinuous fracturing. Since the tilts are less than about 1%, this impact is negligible.

Further evidence for the lack of impact on the near-surface aquifers is the persistence of the spring on Kangaroo Creek (possibly representative of AQ4-B), which appears to be unaffected by the extraction of several surrounding longwall panels, including LW 950 which has recently undermined it.

The only mining-related impact on the local hydrogeological regime at Angus Place is the apparent valley closure effect on Kangaroo Creek (from longwall 950), which has resulted in changes to the surface flow pattern in the watercourse, and partial drainage of a waterhole. It appears likely that the surface flow has been temporarily diverted to underground flow, which surfaces further downstream. Flow patterns at the downstream end of the creek appear to be normal.

4.2 Predicted Changes to the Current Hydrogeological Regime

As indicated above, the previous mining in the region has altered the natural hydrogeological regime to some degree. In particular, extraction of longwall panels at Angus Place has produced a fractured zone above the seam that has depressurised and drained the strata in the Illawarra Coal Measures. Since the strata are sub-horizontally bedded, there has also been some lateral drainage alongside the existing extracted areas.

Both of the proposed longwall panels (LW900W and 910) are located adjacent to and between areas that have been previously extracted (Figure 1). Because of this, it is assumed that the area where these longwalls are located has been largely depressurised in the coal measure strata from the adjacent mining activities. Numerical modelling by CSIRO (CSIRO, 2005) has predicted this depressurisation, so that the extraction of the two additional longwall panels will not result in any significant additional drainage.

Figure 5 below shows the predicted pore pressure (in Pascals) in the strata along a north-south section across the Angus Place and Springvale workings as predicted by the CSIRO model. It can be seen from this figure that the model predicts that the zone above longwall 910 (located between longwalls 16-24 and 920-950) has already been depressurised (indicated by zero pore pressure at seam level and negative pore pressures in the goaf), and only a very small strata volume will be affected by the extraction of this panel (indicated by the circled area). Any aquifers in the coal measure strata in this area will have been already drained by the previous longwall extraction surrounding LW 910. As a result, the Option 1 extraction will only have a marginal impact on the existing hydrogeological regime in the strata below the Mount York Claystone (Option 2 will have an even lower impact).

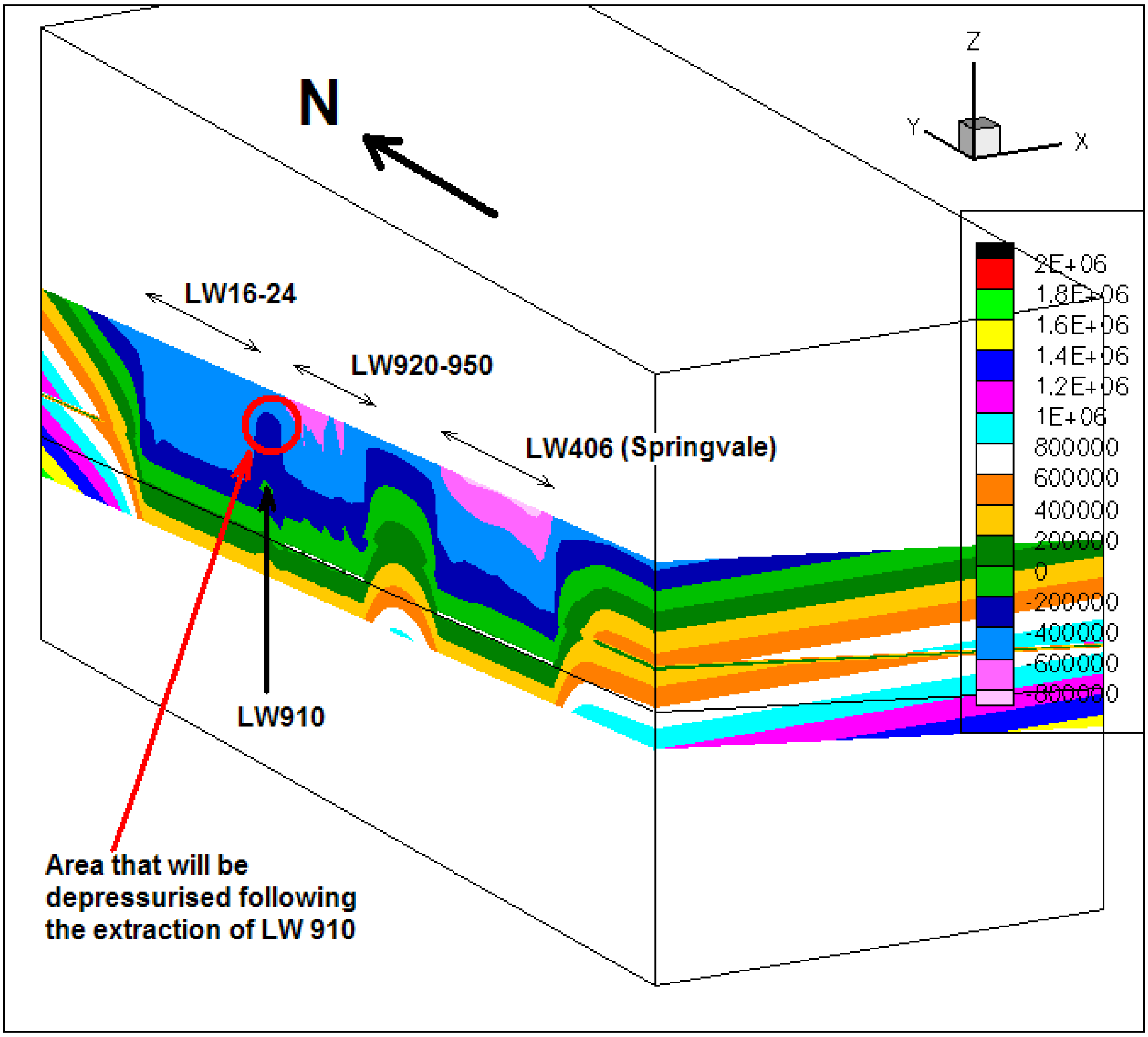

Figure 5 – Predicted pore water pressure in the overburden – current (after CSIRO, 2005)

Similarly, the extraction of longwall 900W will also have a minimal impact on the existing hydrogeological regime for the same reason. The small degree of additional depressurisation that will occur above LW 910 and 900W will not result in any significant additional drawdown in any aquifers in the coal measure strata surrounding the workings. Since the aquifers AQ1, AQ2 and possibly AQ3 have been drained or partially drained by fracturing above the existing longwalls, there is unlikely to be any additional impacts on these aquifers, apart from a minor expansion of the depressurised zone around the workings.

In addition, the extraction of the two proposed panels is highly unlikely to have any additional impact on the Narrabeen Group strata above the Coal Measures. This is because the extent of the fractured zone will **not** increase vertically as a result of this extraction, since the existing extracted area adjacent to the panels is already of supercritical width. There may be some minor temporary changes to groundwater levels in the aquifers in the Banks Wall Sandstone due to the subsidence effects, but there will be no general depressurisation or drainage of the aquifers, as these strata lie well above the fractured zone (‘A’ Horizon).

The indication from previous piezometric monitoring at Springvale (Aurecon, 2009) is that the Narrabeen Group strata above the Mount York Claystone (including AQ4-A, AQ4-B and AQ5) have not been impacted to any degree by the extraction of the existing longwall panels (see Figure 4). CSIRO note minor impacts on pore pressure levels in AQ4-A in two multi-level piezometer boreholes, but it is concluded that these pressure fluctuations are almost certainly due to strata relaxation above the goaf and do not indicate any connection between the aquifer and the mine (CSIRO, 2010). There has been no indication from the data of any impact on the upper aquifers that support the swamps.

Additional evidence for this lack of any near surface hydrogeological impact is the groundwater monitoring in Sunnyside Swamp over Springvale Colliery. The aquifer supporting this permanently waterlogged swamp (possibly AQ4B) has been undermined up-dip by three, 300 m wide longwall panels (LW 411, 412, 413). Any drainage from this aquifer due to the mining would almost certainly have led to groundwater level changes in the swamp, but no change in the groundwater levels have been observed over several years of monitoring (Figure 6).

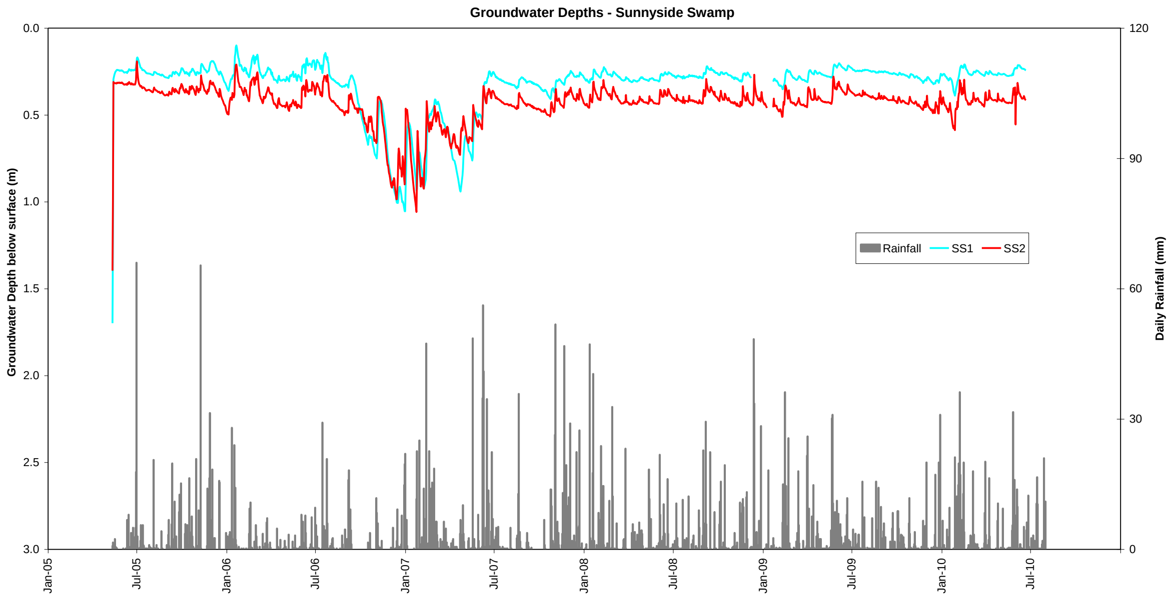

Figure 6 – Sunnyside Swamp groundwater levels in SS1 and SS2

The figure shows the groundwater level in the Sunnyside Swamp over most of the period from 2005 to the present. The data indicates that the groundwater level in the swamp responds to rainfall events and has been within 0.5 m of the surface over most of the monitoring period, except between mid 2006 and mid 2007 when there were severe drought conditions prevailing in the region. There is no evidence from these data that the aquifer feeding the swamp was undermined by three longwall panels during the period since monitoring started.

This has been further demonstrated recently when the aquifer feeding the spring on Kangaroo Creek was undermined by longwall 950. During the undermining, the flow from the spring showed no change, which provides good evidence that the upper aquifers are unlikely to be affected. Because of this, it is highly likely that the aquifer, which intersects the surface in Kangaroo Creek approximately 300 metres to the east of longwall 900W, will be unaffected.

It is also highly unlikely that the extraction of longwall 900W will have any additional impact on the surface water flows in Kangaroo Creek, since the longwall is far enough outside the zone of subsidence influence that direct subsidence impacts, including cracking, will not be in evidence. In addition, Kangaroo Creek has already been undermined by four longwall panels (LW 920 to 950) and will be directly undermined by another three longwall panels (960 to 980) prior to the extraction of longwall 900W, so that any additional adverse impact from the latter longwall will be negligible by comparison. To date, monitoring of flows at the downstream end of Kangaroo Creek has shown that the flows in the creek are still healthy and showing normal flow patterns, despite the degree of longwall extraction beneath the creek (Figure 7).

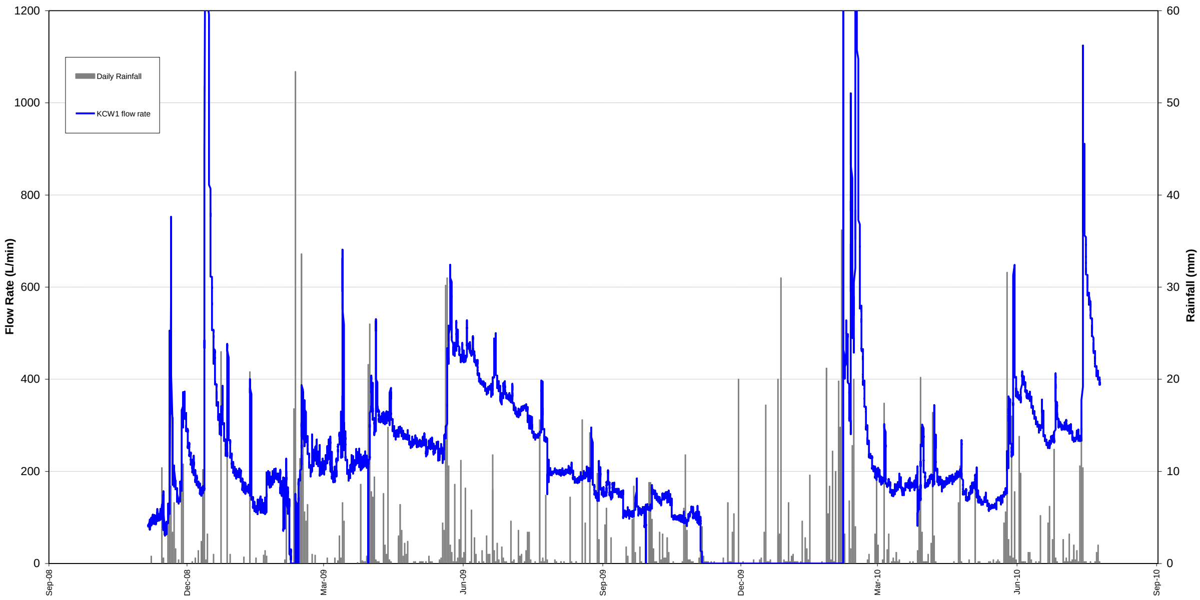

Figure 7 – Kangaroo Creek downstream flows

There are two tributaries of the Wolgan River that cross the area of influence of longwall 910 (West Wolgan and Narrow Swamp watercourses). There are no known aquifers that feed these watercourses, and observations/flow monitoring has confirmed that flow in these streams are ephemeral. Both watercourses will be undermined by at least six longwall panels before the extraction of longwall 910, and measurements to date have indicated that there appears to be no adverse impact on the flow patterns in the Narrow Swamp due to the longwalls that have already been extracted beneath it (920, 940 and 950) (Aurecon, 2009). Flow monitoring carried out in this swamp prior to the extraction of longwall 950, and during discharge events from LDP005, has shown that approximately 91% of the discharge from LDP005 reached a weir (NSW1) in the centre of the Narrow Swamp (Figure 8). The deficit in flow volume is apparently taken up in the peat deposits in the swamp (which is normally periodically waterlogged), since this part of the swamp had not been undermined at the time that the flow measurements were taken. The percentage of discharge from NSW1, which reached a weir at the northern end of the swamp (NSW2), was also 91%. Two longwall panels have undermined the Narrow Swamp in the section of the watercourse between NSW1 and NSW2, and so the flow monitoring indicates conclusively that the mining to date has not resulted in any significant changes to the total flow from the swamp. This is demonstrated in Figure 8, which shows the measured discharge at the LDP005 weir as well as the flows at the two weirs further downstream.

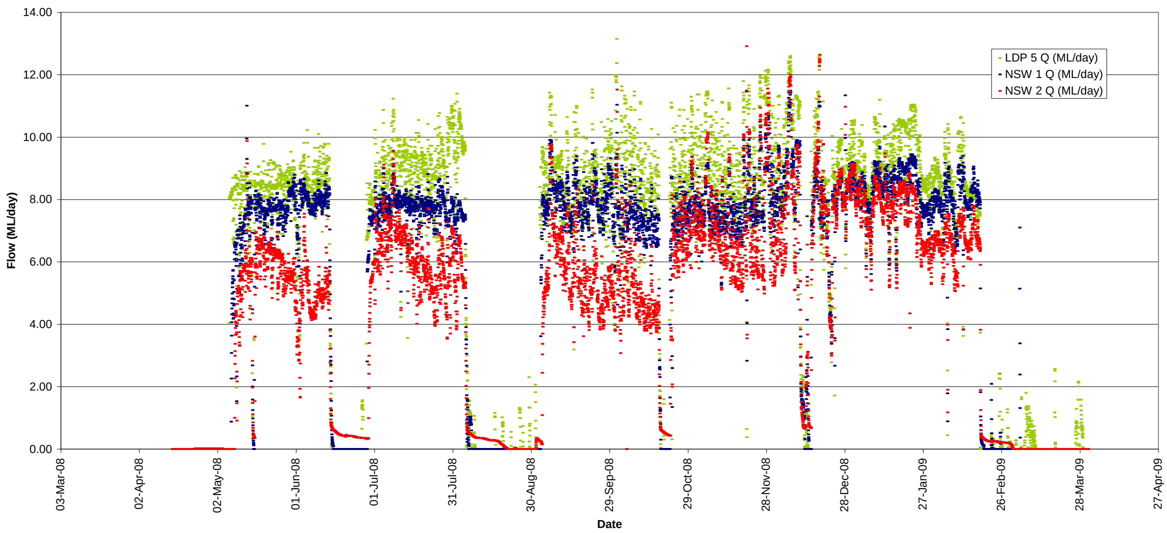

Figure 8 – Flow monitoring data from Narrow Swamp

Since there are no known near-surface aquifers that feed these the Narrow Swamp or West Wolgan watercourses, and longwall 910 is at a greater depth of cover than the other longwall panels, it is therefore highly unlikely that it will impact on groundwater flows to the watercourses or surface water flows in the watercourses. The results of the flow monitoring data in Narrow Swamp give good support to this contention.

The overall conclusion from this study is that there will be no impact on the quantity or quality of groundwater flows discharging to the Wolgan River or Kangaroo Creek from the extraction of longwalls 910 and 900W.

Although there are three swamps within the area that may be influenced by the extraction in Longwall 910, there will be no adverse subsidence-related impacts on the swamps, as the predicted incremental surface movements at the swamps are insufficient to cause any significant surface fracturing. There are two small NPSS on the southern side of longwall 910 that are in the potential influence zone of the longwall (Figure 9), but these swamps have already been undermined by longwall 920 so that any additional impacts should be minimal. Similarly, Narrow Swamp is just on the edge of the zone of influence where the ground movements will be negligible when compared to the subsidence from longwall 920. There is also one NPSS that is located to the east of longwall 920 (Figure 5), but this swamp is outside the area of any significant ground surface movement, cracking or induced surface strains, so that the potential for any impact is negligible.

The issue of valley closure has been covered elsewhere (DGS, 2010), and it has been concluded that while there may be some additional (but lower) upsidence in the creek valleys, “the movements, if they occur, are very unlikely to result in more damage than the minor cracking predicted for normal subsidence development of the near surface rocks”. As a result, the probability of any additional impact on the hydrogeological regime from valley closure effects is also very low. In addition, there are no major geological structures that cross the two proposed longwall panels (DGS, 2010), so that the potential for unexpected abnormal impacts from geological structures is considered to be negligible.

No precise predictions for groundwater make from the two longwall panels have been made during this study, as such predictions are beyond the scope of this report. Nevertheless, the additional groundwater inflows are likely to be minimal, since the area has been depressurised by the existing longwall panels, and the additional groundwater drainage from the overburden strata will be minimal.

In addition, since there are no registered water bores or other groundwater users in the vicinity of the project area, there will be no impact on third parties from the extraction of the proposed longwall panels.

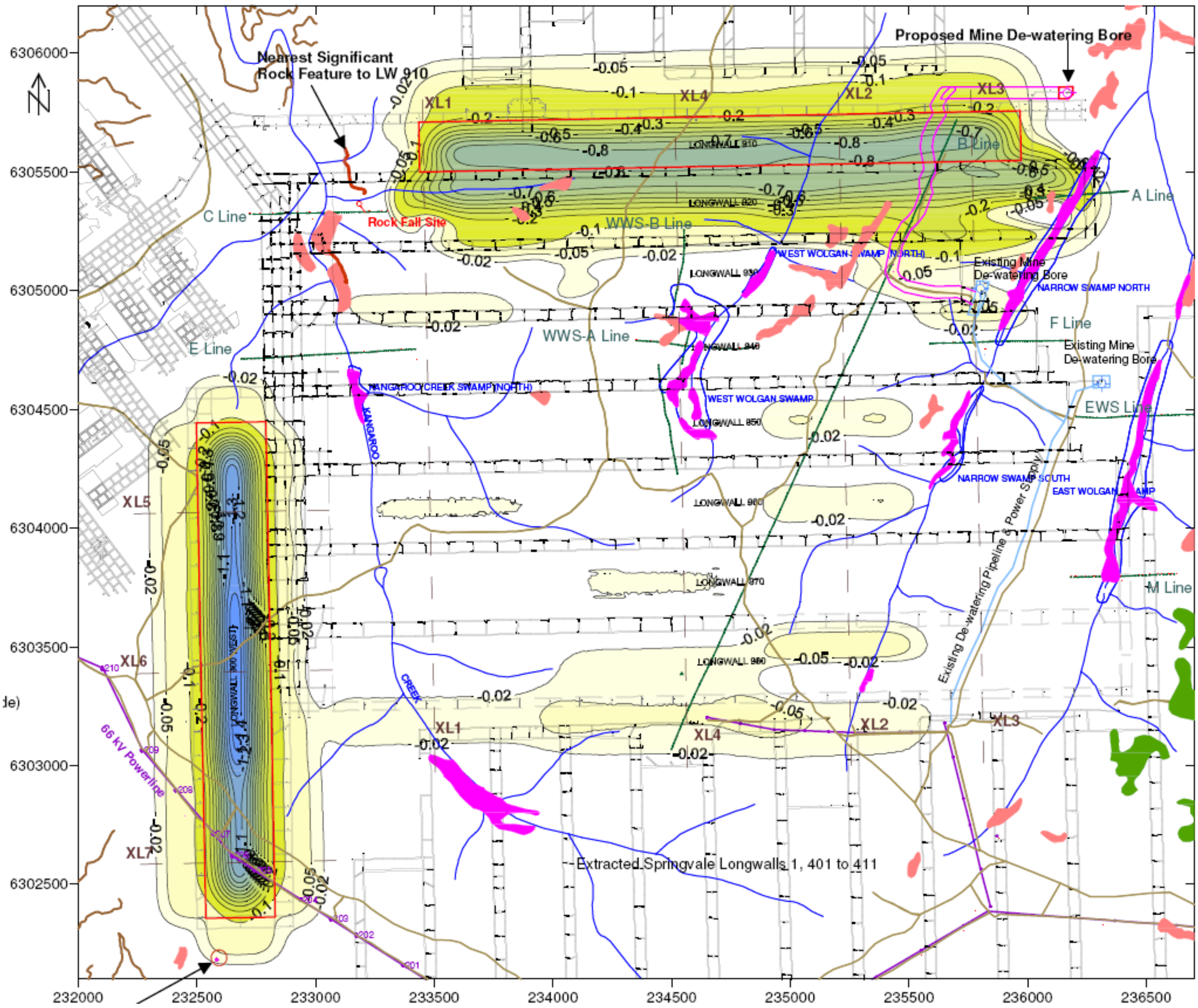

Figure 9 – Predicted worst case subsidence impacts from LW 910 and 900W (DGS, 2010)

4.3 Regional Impacts

Since the upper aquifers in the Banks Wall Sandstone are unlikely to suffer any significant long-lasting impacts due to the mining, the regional consequences on these aquifers are judged to be negligible. Nevertheless, it is possible that these aquifers may extend further to the east, and so this issue must be examined carefully, particularly since has been suggested in the past that there may be very slow drainage of the upper aquifers into the lower aquifers over a period of decades, with resulting impacts on the overlying shrub swamps. For this to occur there would need to be a reasonable hydraulic connection between the upper and lower aquifers. This is not demonstrated by any of the available piezometer data.

Pumping tests carried out at Clarence Colliery were designed to examine precisely this issue (ERM, 2003). The Katoomba Seam (aquifer AQ2) was pumped out and the near-surface aquifer zone monitored for any resultant drop in pressure. The testing showed that there was no measurable impact on the upper aquifers from the continuous pumping in the Katoomba Seam.

The most important aquifer zone in the region, the Clarence Aquifer, will also be unaffected by the proposed extraction at Angus Place. This is because the major source of recharge to this aquifer is via direct infiltration and percolation of rainwater in the vicinity of the Clarence village itself (Connell Wagner, 2006). There is no hydraulic connection between this aquifer at Clarence and the same aquifer horizon at Angus Place, due to the presence of the valley of Farmers Creek, which truncates the aquifer between the two sites. Ongoing monitoring of the Clarence aquifer to date has confirmed that there has been no impact from the extraction of previous longwall panels at Angus Place or Springvale, so that any impact from the two proposed panels is extremely unlikely.

In Section 4.1, it was determined that the lower coal measure aquifers would almost certainly be drained into the goaf. It therefore needs to be established that this will not have any wide-ranging impacts on the local hydrological regime. A search of the NSW Office of Water database of groundwater bores has shown that there are no domestic, industrial or agricultural users of the groundwater resources in these aquifers in the area surrounding the Angus Place Colliery, probably due to their depth, and the fact that most of the area is covered by the Newnes State Forest.

It has been shown in previous studies (CWPPI, 2005) that the drawdown in these aquifers can extend up to 1200 metres from the workings, and continuous pumping in the future may extend the drawdown somewhat. Nevertheless, even if the drawdown radius expands, the impact should be minimal, as the water in these lower aquifers represents a negligible contribution to stream flow and vegetation support in the region, since their depth and the presence of the Mount York Claystone effectively prevents any upwards groundwater flow to local creeks. In addition, this drawdown will still occur even if the two additional longwall panels are not extracted at all.

Once mining is completed, and pumping ceases, the drawdown radius will contract slowly, as the strata re-pressurise and the mine fills with water. Previous experience suggests that the pre-mining hydrogeological conditions will eventually re-establish over a period of several decades following mining. This has been demonstrated at the Lithgow State Mine south of Springvale, which ceased extracting coal in 1964. Since that time, the workings have completely filled with water, and the water head at seam level has been measured at 129 metres (CSIRO, 2003). This is very close to what the pre-mining level would have been. Other abandoned mines adjacent to Angus Place have also filled with water since mining activities ceased, including Newcom and Fernbrook Collieries.

The recharge area for the lower coal measure aquifers is located in the subcrop zone to the west and northwest of the mine where the coal seams outcrop or are near the ground surface (Bish, 1999). These areas have been largely mined out, in open cut and underground mines (eg Western Main, Ivanhoe), so that the permeability of the coal measure strata in these areas has been significantly increased over a wide area. It is also probable that rainfall infiltration has increased in this area. Due to this increased permeability, the recharge to the coal seams has been enhanced, so that the recovery of the aquifer systems should be accelerated. Based on this data, it is predicted that the regional hydrogeological regime at Angus Place should eventually be restored, even though it may take several decades to re-establish.

5. Conclusions and Recommendations

The current assessment has examined the potential for impacts on the hydrogeological regime from the future extraction of longwalls 910 (Option 1) and 900W at Angus Place Colliery. The main conclusions from the assessment are as follows:

- The area overlying Angus Place Colliery forms part of the Newnes Plateau, northeast of Lithgow. The underlying strata comprise mostly sandstones of the Triassic Narrabeen Group. The near the surface strata belong to the Grose Sub-group, and include the Banks Wall Sandstone, the uppermost part of which is deeply weathered and generally very friable. The sandstone, which is up to 200 metres thick in this region, is underlain by the Mt York Claystone, a thin, fine-grained stratum that limits vertical infiltration of groundwater from the overlying strata.

- Investigations have identified near-surface aquifers in the Banks Wall Sandstone as a critical local natural water resource. One of these aquifers, which is limited to the area east of Farmers Creek, is the major source of potable water tapped by numerous bores in the Clarence village, about 10 km east of Angus Place. In addition, the aquifers in the Banks Wall Sandstone can provide base flows to some of the large shrub swamps, which also occur to the east of Angus Place, but are largely absent from above the Angus Place lease area. The lack of any major waterlogged swamps over Angus Place suggests that the aquifers in the near surface Banks Wall Sandstone formation may not be as well developed in this area, and do not discharge over the project area.

- Underground mining in this region has been carried out for over a century, so that it is assumed that there has been at least some impact on the local hydrogeological regime, particularly in the coal measure strata. In particular, the extraction of the longwall panels in Angus Place Colliery has had the greatest influence on the local hydrogeological regime in the vicinity of the proposed longwall panels 900W and 910. Experience and ongoing monitoring indicate that the coal measure strata above the Lithgow Seam have already been depressurised and partially drained of groundwater by previous longwall mining in the area. There are no regional hydrological impacts from this drainage, since the water-bearing zones in the coal measures provide a negligible contribution to stream flow and vegetation support in the region, due to their depth and the lack of any upwards groundwater flow to local creeks.

- Although there has been drainage of coal measure strata in the area, the impact of previous mining on the groundwater regime in the overlying Banks Wall Sandstone Formation above the Mount York Claystone appears to be negligible. This is because the Mt York Claystone is above the overburden fractured zone and acts as an aquiclude, preventing any drainage downwards into the mine. Data from groundwater monitoring at Springvale has confirmed this conclusion.

- The proposed longwall panels (LW900W and 910) are located adjacent to and between areas that have been previously extracted, so that the extraction of the additional panels will only have a marginal additional impact on the existing hydrogeological regime in the strata below the Mount York Claystone. The available data suggest that the hydrogeological regime in the Narrabeen Group strata above the Mount York Claystone has not been impacted to any degree by the extraction of the existing longwall panels at Angus Place or Springvale. Consequently, the extraction of the two additional panels is unlikely to have any additional impact on these strata. As a result, it is concluded that there will be no impact on the aquifers in the Banks Wall Sandstone, and hence there will be no impact on the quality or quantity of the available groundwater resources in this rock unit. There will also be no impact on the quality or quantity of groundwater flow to either the Wolgan River or Kangaroo Creek.

- While there are no swamps above the two proposed longwall panels, there are three NPSS (including Narrow Swamp) within the predicted worst case area of subsidence influence of longwall 910. Nevertheless, all three of these swamps have previously been directly undermined by longwall 920, with no apparent adverse hydrogeological impacts. Since the level of incremental subsidence predicted for longwall 910 is significantly less than the subsidence already experienced at these swamps, the potential for additional impacts from longwall 910 is minimal.

- Because the two proposed longwall panels are within an area that has been subject to mining for several decades, any impacts on the hydrogeological regime will have already occurred. It is therefore highly unlikely that there will be any significant additional impacts on the local hydrogeological regime from the extraction of longwalls 910 and 900W, and no additional near-surface groundwater monitoring is recommended.

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APPENDIX 7.5

Soil and Land Resource Assessment

FINAL

Angus Place Colliery 75W Modification

Soils and Land Resource Assessment

Centennial Angus Place Pty Limited

October 2010

CCC07-003

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

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1.0 INTRODUCTION

1.1 Background

GSS Environmental (GSSE) was commissioned by RPS (RPS) on behalf of Centennial Angus Place Pty Limited (Angus Place), and its parent company Centennial Coal Company Ltd to undertake a desktop soil and land assessment for the proposed extension of the Angus Place Colliery.

Angus Place exists as a joint venture company owned in equal share between Centennial Coal Company Limited and SK Kores. Angus Place commenced production in 1979, after being developed as an extension of the Newcom Mine at Kerosene Vale. Coal is extracted from the Lithgow Seam primarily by the operation of a longwall shearer and supporting continuous miner units developing access headings. Coal is currently extracted for domestic power generation at both Wallerawang and Mount Piper power stations.

Angus Place Colliery received Project Approval for the extraction of Longwalls 930 to 980 in 2006 under the provisions of Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Angus Place is now seeking Project Modification Approval under Section 75W of Part 3A of the EP&A Act. A general plan showing Angus Place Colliery's location within the region is shown in **Figure 1**.

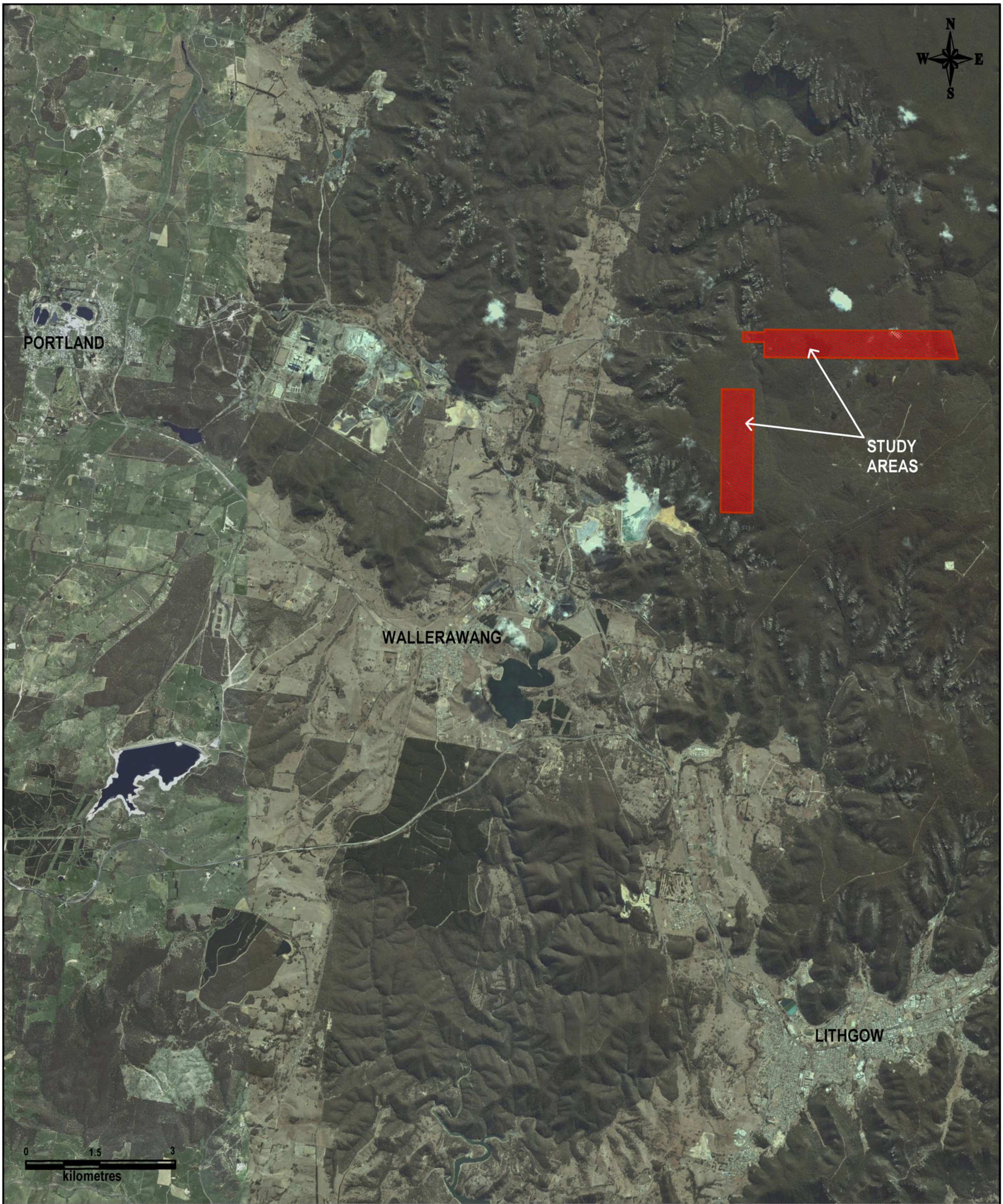
Currently, longwall mining methods are used at Angus Place for the extraction of each longwall block and are supported by mains development using continuous miner units. Development activities entail the extraction of coal to produce underground roadways and headings, enabling access to future longwall extraction areas. Development activities within the current approval area are scheduled to be completed by October 2012, with longwall operations within the current extraction area planned to be completed by June 2014.

1.2 Study Area

Angus Place Colliery is located 5 km north of the village of Lidsdale, 8 km northeast of the township of Wallerawang and 15 km northwest of the city of Lithgow as shown in the Locality Plan in **Figure 1**. The western coalfield of NSW is an active coal extraction area and nearby coal mines include Baal Bone Colliery (Xstrata), Invincible Colliery (CET Resources) and Springvale Colliery (Centennial). Angus Place Colliery Pit Top lies within the Cox's River Catchment, with the lease area traversing both the Cox's and Wolgan River Catchments, the latter of which reports to the Hawkesbury Nepean Catchment.

The entire surface area is contained within Newnes State Forest. The predominant land uses of the surrounding area include native hardwood harvesting and recreational activities such as bush walking, motorcycling and four wheel drive pursuits.

The Study Area includes those areas that extend outside the limit of extraction, which is referred to as the Angle of Draw (AoD). This assessment is based on a Study Area which captures the 26.5o AoD to ensure that all impacts are adequately addresses and managed.



LEGEND

Study Area

FIGURE 1

Location Plan

Project:	Angus Place Land Resource Assessment
Client:	Angus Place Colliery
File:	Fg1_CCC07-003_Location Plan_v1
Projection:	AMG (AGD66) Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	25/02/10	AR	KM	CR

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1.3 Project Description

Angus Place's proposal is to extend its operations through the extraction of two additional longwall panels and the development of related surface infrastructure.

Specifically the modification proposes to include the following:

- Development and extraction of longwalls 910 and 900 west (900W). 910 is directly north of the extracted 920 panel with 900W due west of the current mains headings. With regard to longwall 910, two options are proposed. This is due to the fact that there may be a potential resource area situated to the north east of the proposed longwall area and, if this is the case, future access to this resource would be most efficient if it is accommodated within this proposed modification. The two options for Longwall 910 are:

    - Option 1: In the event that the north eastern area is not considered viable, Longwall 910 will be approximately 200m wide and 2500m in length and allow the development of two mains headings.

    - Option 2: In the event that the north eastern area is considered viable, Longwall 910 will be approximately 2500m in length and 120m in width to allow the development of four mains headings to enable future access to the resource in the north east.
- Increase the production limit to four (4) million tonnes per annum. This seeks to make a provision for 12 consecutive months of production in the event Angus Place does not have a three month shut down due to a longwall changeover. The intensity of mining will not change. However, an increase of the annual production limit would allow a continuation in production in the event that a shutdown due to a longwall changeover (typically 8 weeks) is not required.
- Installation of a dewatering bore facility at the eastern end of Longwall 910. Infrastructure required to support the operation of this installation is as follows:

    - An access track to the study area from Blackfellows Hands Road.

    - Powerline extension along the access tracks to supply electricity. This will likely be an extension of the existing 930 and 940 dewatering bore power line.

    - Extension of the Springvale – Delta Water Transfer Scheme, in terms of an underground corridor (to accommodate the underground pipeline) along the proposed dewatering bore access track. This will enable Angus Place to continue to transfer extracted groundwater to Delta Electricity's Wallerawang power station, reducing demand on water extracted by Delta from the Cox's River catchment.
- Assessment of the current Angus Place water management infrastructure. Recommendations developed from the findings of the pit top surface water assessment will be considered for implementation to improve the dirty water management system
- Increase in personnel from the currently approved 215 to 225. In addition, up to 75 temporary contractors will be required to assist with underground development activities for up to 15 months.
- The project also involves modifications to the pit top area, private haul roads, and Wolgan Road. As these modifications will not impact on soils and land capability they were not included in the study area.

1.3.1 Proposed Additional Longwalls

Under Option 1, Longwall 910 is orientated in an east – west direction and is located parallel to the north of the existing 920 panel. Longwall 910 is located predominantly within ML 1424 and partially within CCL 704. Longwall 910 is planned to be approximately 200m wide and 2500m long. It is anticipated that Option 1 will produce approximately 2,620,720 tonnes.

Under Option 2, Longwall 910 remains in the same orientation, however is reduced in width to approximately 120m. This allows the development of 4 mains headings to the north of Longwall 910 to enable access to potential resources situated to the north-east of the current extraction area. The length is planned to be approximately 2500m. It is anticipated that Option 2 will produce approximately 1,855,600 tonnes.

Longwall 900W is located directly west of the existing 950-980 panels and is orientated perpendicular to these panels in a north - south orientation. Development of longwall 900W will extend south beyond the 980 Panel. Longwall 900W is located predominantly in CCL 704, with a small portion within ML 1424 and it will extend partially into Centennial Springvale's ML 1326 (to gain separate lease area). Longwall 900W is planned to be 283.5m wide and 2079.7m in length. It is anticipated that Longwall 900W will produce 3,009,810.

Both proposed longwalls have been reduced in length to minimise potential risks and impacts upon known sensitive surface landforms.

This assessment has been based on Option 1 as outlined above. However, as Option 2 considers a narrower longwall, resulting in a reduced predicted subsidence area, it will generate impacts within the range of impacts associated with Option 1. Therefore, it is considered that Option 1 has assessed the maximum impacts which are relevant to both options.

1.3.2 Proposed Dewatering

The proposed borehole and supporting infrastructure are to be situated on the Newnes Plateau at the eastern end of longwall 910. Minor land preparation will be required at this site to install and maintain the borehole.

1.4 Objectives

The major objectives of the assessment undertaken by GSSE include:

- assess areas to be disturbed by the Angus Place modification at a sufficient level of detail to satisfy the requirements of the Industry and Investment NSW (I&I NSW) and the NSW Department of Planning DoP);
- assess pre and post mining rural land capability and class assessment in accordance with Department of Environment, Climate Change and Water (DECCW) guidelines including figures of each;
- assess pre and post mining agricultural suitability in accordance with I&I NSW guidelines.

1.5 Director General's Requirements

This Soil and Land Capability Assessment has been prepared in accordance with the Director General's Requirements (DGR's) dated 1 June 2010 and correspondence from NSW Industry and Investment (I & I) dated 21 May 2010. It is noted that there are no specific DGR's relevant to this assessment.

2.0 EXISTING ENVIRONMENT

2.1 Geology

Angus Place Colliery is located in the southern portion of the Western Coalfield. The area overlying Angus Place Colliery forms part of the Newnes Plateau, northeast of Lithgow. The underlying strata comprise mostly sandstones of the Triassic Narrabeen Group, which are interbedded with shale and siltstone bands. The Narrabeen Group rocks are underlain by the Illawarra Coal Measures, which comprise interbedded sandstone, siltstone, shale and coal. The general dip of the bedding is to the northeast at about 2 degrees. The plateau area is cut by several deeply incised creek valleys, which drain to the north and west of the lease area. The Project area lies on the boundary between two catchments; the Wolgan-Colo River catchment to the north and the Coxs River catchment to the west.

In this area, the Narrabeen Group rocks near the surface belong to the Grose Sub-group, and include the Banks Wall Sandstone, the uppermost part of which is deeply weathered and generally very friable. The sandstone, which is up to 200 metres thick in this region, is underlain by the Mt York Claystone, a fine grained stratum, with a thickness in this area ranging from 4 to 11 metres, that limits vertical infiltration of groundwater from the overlying strata.

The Narrabeen Group rocks are underlain by the Illawarra Coal measures which comprise claystone, siltstone, sandstone and coal seams with a total thickness of about 120 metres in this area. The Lithgow Seam, which will be extracted in Longwalls 910 and 900W, is the lowermost seam in the coal measures and is located about 25 metres above the base of the coal measures (Aurecon, 2010).

2.2 Topography

The surface of the Newnes Plateau and the surrounding landscapes is gently to moderately inclined and covered mostly by particularly friable sandstones of the Narrabeen Group. The area is generally rugged with cliffs associated with the escarpment edges along the Plateau that are nearly vertical in relief, deep gullies and elevated ridge tops. The proposed mining area is situated underneath the level terrain on the top of the Newnes Plateau. Elevation within the project area varies between 900 m and 1,160 m above sea level.

2.3 Vegetation

Ground truthing of the study area identified ten (10) vegetation communities as follows (RPS 2010):

- MU 7 - Newnes Plateau Narrow-leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest;
- MU 8 - Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest;
- MU 14 - Tableland Mountain Gum – Snow Gum – Daviesia Montane Open Forest;
- MU 26 - Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest;
- MU 26a – (variant of MU 26) with Brittle Gum, Scribbly Gum and Mountain Gum;
- MU 43 – Pagoda Rock Sparse Shrubland;
- MU 44 - Sandstone Plateau Tea Tree – Dwarf Sheoak – *Banksia* Rocky Heath;
- MU 50 – Newnes Plateau Shrub Swamp;
- MU 51 – Newnes Plateau Hanging Swamp; and
- Cleared areas.

3.0 SURVEY METHODOLOGY

3.1 Introduction

A desktop review of existing soil information was undertaken in February 2010 by GSSE to:

1. Classify and determine the soil profile types of the study area;
2. Identify pre and post-mining rural land capability and agricultural suitability classifications; and
3. Identify any potentially unfavourable soil material which may pose high environmental risks if disturbed.

The survey was conducted in accordance with the methodology outlined in this section. The soils and land resource assessment results are presented in **Section 3** of this report.

3.2 Soil Mapping

An initial soil map was developed using the following resources and techniques:

1) Aerial photographs and topographic maps

Aerial photo and topographic map interpretation was used as a remote sensing technique allowing detailed analysis of the landscape, and mapping of features expected to be related to the distribution of soils within the study area.

2) Previous soil survey results

The following study was used as a source of information during this report.

- King (1993) Wallerawang 1:100,000 Soil Landscapes Sheet

  Describes soil landscapes within the study area at a scale of 1:100,000;

3) Desktop assessment of soils

Following the review of aerial photos, topographic maps and the previous soil survey that were available for the area, a desktop assessment of the soils information, land capability and agricultural suitability was undertaken.

3.3 Land Capability Assessment

The land capability assessment of the study area was conducted in accordance with DECCW's rural land capability classification system. The system consists of eight classes, which classify land on the basis of an increasing soil erosion hazard and decreasing versatility of use. It recognises the following three types of land uses:

- land suitable for cultivation;
- land suitable for grazing; and
- land not suitable for rural production.

These capability classifications identify limitations on the use of the land as a result of the interaction between the physical resources and a specific land use. The principal limitation recognised by these capability classifications is the stability of the soil mantle (Emery KA, 1986).

The method of land capability assessment takes into account a range of factors including climate, soils, geology, geomorphology, soil erosion, topography, and the effects of past land uses. The classification does not necessarily reflect the existing land use, rather it indicates the potential of the land for uses such as crop production, pasture improvement and grazing. Existing remote sensing data was also utilised where available (Department of Natural Resources, 2005).

The system allows for land to be allocated into eight possible classes (with land capability decreasing progressively from Class I to Class VIII). The classes are described in **Table 1** below.

A description of land capability classification for all land within the study area is discussed further in **Section 3.5**.

Table 1 – Rural Land Capability Classes

Land Class	Land Suitability	Land Definition
I	Regular Cultivation	No erosion control requirements
II	Regular Cultivation	Simple requirements such as crop rotation and minor strategic works
III	Regular Cultivation	Intensive soil conservation measures required such contour banks and waterways
IV	Grazing, occasional cultivation	Simple practices such as stock control and fertiliser application
V	Grazing, occasional cultivation	Intensive soil conservation measures required such contour ripping and banks
VI	Grazing only	Managed to ensure ground cover is maintained
VII	Unsuitable for rural production	Green timber maintained to control erosion
VIII	Unsuitable for rural production	Should not be cleared, logged or grazed
U	Urban areas	Unsuitable for rural production
M	Mining and quarrying areas	Unsuitable for rural production

Source: Emery KA (1986) Soil Conservation Service of NSW (now known as DECCW)

3.4 Agricultural Suitability Assessment

The agricultural suitability assessment of the study area was conducted in accordance with I&I NSW's agricultural suitability classification system. The system consists of five classes, providing a ranking of lands according to their productivity for a wide range of agricultural activities with the objective of determining the potential for vegetative growth within certain limits.

The classification is based upon the effects of climate, topography and soil characteristics, the cultural and physical requirements for various crops and pastures, and existing socio-economic factors including local infrastructure and geographic location. These factors combine to determine the productive potential of the land and its capacity to produce crops, pastures and livestock. The classes are described in **Table 2** below.

Table 2 – Agricultural Suitability Classification System

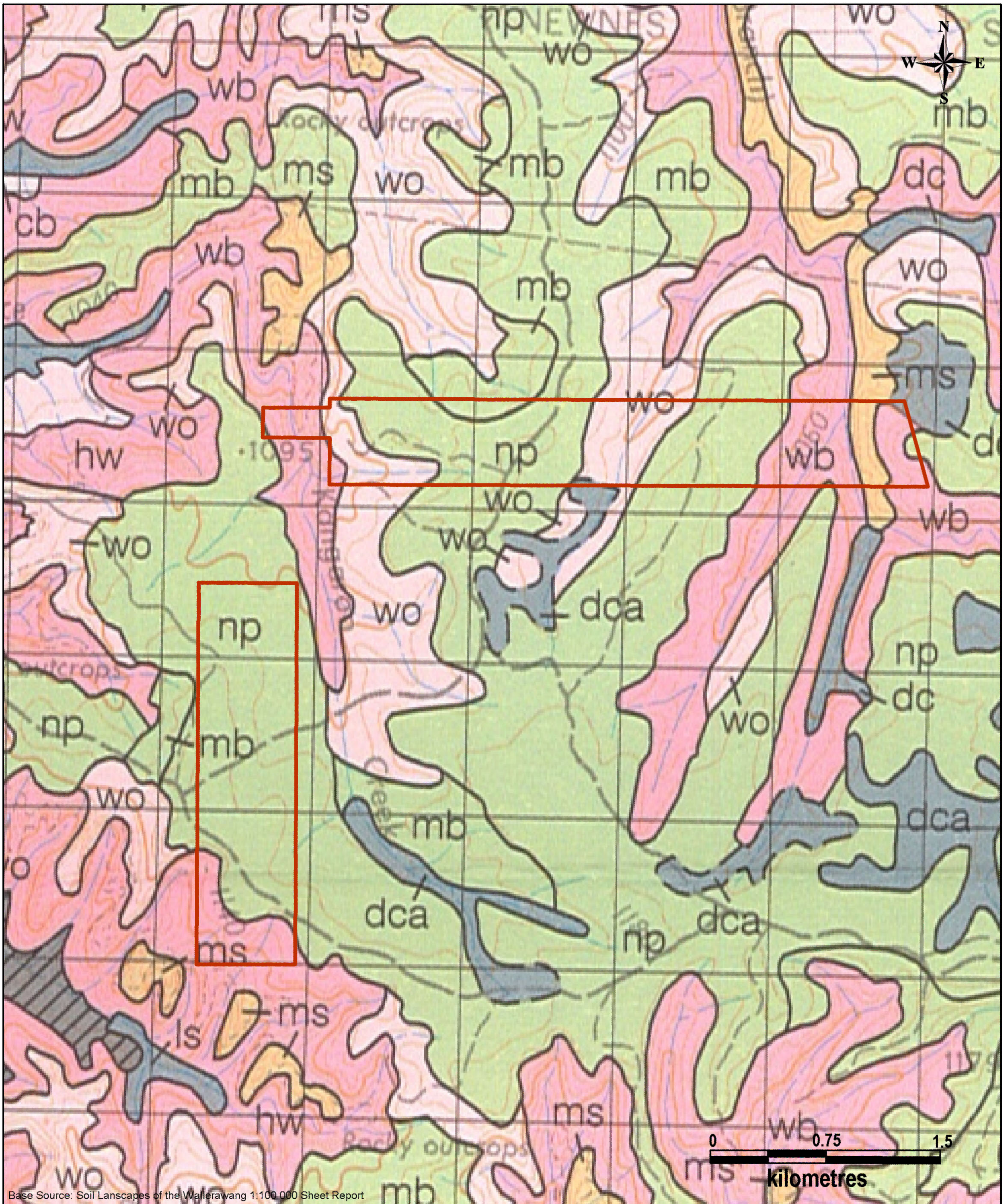
Class	Agricultural Suitability	Land Definition
1	Highly productive land suited to both row and field crops	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
2	Highly productive land suited to both row and field crops	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation. It has a moderate to high suitability for agriculture but edaphic (soil factors) or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.
3	Moderately productive lands suited to improved pasture and to cropping within a pasture rotation	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall level of production is moderate as a result of edaphic or environmental constraints. Erosion hazard or soil structural breakdown limit the frequency of ground disturbance, and conservation or drainage works may be required.
4	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing	Land suitable for grazing but not for cultivation. Agriculture is based on native or improved pastures established using minimum tillage. Production may be high seasonally but the overall level of production is low as a result of a number of major constraints, both environmental and edaphic.
5	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing	Land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors, which preclude improvement.

Source: NSW Agriculture & Fisheries (1990) (now known as I&I NSW).

4.0 RESULTS

4.1 Soil Landscape Units

Five (5) soil landscape units underpin the study area. These are the Newnes Plateau, Warragamba, Wollangambe, Mount Sinai and Deanes Creek soil units as delineated by the Soil Landscapes of the Wallerawang 1:100,000 Sheet (King 1993). **Table 3** on the following page describes the soil landscape units. The Newnes Plateau, Wollangambe and Warragamba units cover the majority of the study area and are described in detail in **section 4.1.1 – 4.1.3** below. Soil Landscape units are shown in **Figure 2.**



LEGEND

- Study Area
- ls Long Swamp
- dc Deanes Creek
  (variant - dca - valley-side tree swamps with 10 - 30% slopes)
- ms Mount Sinai
- mb Medlow Bath
- np Newnes Plateau
- cb Cullen Bullen
- hw Hassans Walls
- wb Warragamba
- wo Wollangambe

FIGURE 2

Soil Landscape Units

Project: Angus Place Land Resource Assessment

Client: Angus Place Colliery

File: Fg2_CCC07-003_Soil Units_v2

Projection: AMG (AGD66) Zone 56

Version:	Date:	Author:	Checked:	Approved:
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Table 3 – Landscape Units

Landscape Unit	Geology	Typical Landform	Typical Soils*	Limitations
Newnes Plateau (np)	Lithology of the parent material is predominately quartz sandstone and quartz lithic sandstone interbedded with thin red, grey and green claystone, shale and occasional conglomerate and ironstone lenses.	Level to undulating wide crests and ridges on plateau surfaces of Triassic Grose Sandstone. Local relief to 20m. Slopes <10%. Elevation generally >1000m. Infrequent rock outcrop. Partially cleared low open-forest and woodland and pine plantations.	Shallow (<50cm) Sands/Lithosols (Uc1.22, Ucl.24, Um1.2) on crests associated with rock outcrop; moderately deep (50-150cm) Earthy Sands (Uc5.21, Uc5.22, Um5.21) on gently inclined sideslopes and Leached Sands (Uc2.21) near drainage depressions; moderately deep (>50cm) Yellow Earths (Gn2.11) associated with shale/ironstone lenses; deep (>200cm) Earthy Sands (Uc.521, Uc5.22) on deeply weathered friable sandstones.	Acid, highly permeable, stony soils of low fertility, low-water holding capacity and localised shallow soils.
Warragamba (wb)	Narrabeen group – fine grained lithic sandstone occasionally interbedded with thin shale lenses.	The dominant landforms are moderate to very steep slopes. Local relief is 50-150m, slope gradients are >35%. Elevation is mostly <700m. Narrow sandstone and colluvial benches occur on the slopes which contain sandstone boulders. Small cliffs and scraps on some steeper slopes.	Shallow to deep (50-150cm) Lithosols (Uc6.1) on crests and ridges; Brown Earths (Gn3.2), Red Podzolic Soils (Dr3.41) on upper slopes, Yellow Podzolic Soils (Dy4.11, Dy4.41) on lower slopes.	Acid stony soils of low fertility.
Wollangambe (wb)	Narrabeen Group – quartz sandstone and quartz lithic sandstone interbedded with thin red, grey and green claystone, shale and occasional conglomerate and ironstone lenses.	Rounded convex crests and moderately to steeply inclined slopes. Local relief to 100m. Slopes usually <35%. Localised rock outcrop is common including broken scarps and small rock ledges and cliffs. Largely uncleared open-woodland and open-forest.	Shallow (<30cm) Siliceous Sands/Lithosols (Uc1.21,Uc1.24), Earthy Sands (Uc5.21, Uc5.22) and Yellow Earths (Gn2.21) on crests; moderately deep (<100cm) Earthy Sands (Uc5.21,Uc5.22), Yellow Earths (Gn2.21) and Red Earths (Gn2.11) on sideslopes; moderately deep (<120cm) Yellow Podzolic Soils (Dy5.11) and Gleyed Podzolic Soils (Dg3.1,Dg4.11) developed over shale lenses; shallow (<50cm) Siliceous Sands/Lithosols (Uc1.21,Uc1.24) on small rock ledges	High to severe water erosion hazard and low fertility.

Landscape Unit	Geology	Typical Landform	Typical Soils*	Limitations
			and broken scarps.	
Mount Sinai (ms)	Narrabeen group including the Banks Wall Sandstone, Mount York Claystone and Burra-Moko Head Sandstone. Lithology is predominately quartz sandstone and quatz-lithic sandstone occasionally interbedded with thin ironstone, conglomerate, red, grey and green claystone and shale lenses.	Narrow, rocky undulating crests and steep slopes with many rocky benches and pagoda rock formations on Narrabeen Group Sandstones. Local relief to 130m, slopes generally >30%. Abundant rock outcrop.	Very shallow (30cm) stony sands, Lithosols (Uc1.21,Uc1.24) on crests and sideslopes with rocky benches; shallow (<100cm) Earthy Sands (Uc5.22) and occasional Yellow Earths (Gn2.21) on insides of benches and in deeply weathered joint lines in the Narrabeen Group sandstones; shallow Earthy Sands (Uc5.22) in narrow incised valleys.	Extreme water erosion hazard and stony, shallow, acid, non-cohesive highly permeable soils of low fertility.
Deanes Creek (dca – variant)	Narrabeen Group Sandstones, in particular the Banks Wall Sandstone Member – friable sandstones, claystones and conglomerate.	Narrow gently inclined elongated swamps along drainage lines on Narrabeen Group Sandstones on the Newnes Plateau. Local relief to 30m, slopes 0-5% and elevation mostly >1000m.	Moderately deep (<130cm) waterlogged Humic Gleys (Dg3.51,Dg4.51) and Grey Earths (Gn2.81) near and along drainage lines with shallow to moderately deep (30-100cm) Peaty Sands (Uc1.24,Uc1.44,Uc5.11,Um1.33) and Earthy Sands (Uc5.22) on swamp margins.	Permanently high water tables and periodic to permanent water logging, acid soils of low fertility and high run-off.

Source: King (1993)

4.1.1 Newnes Plateau Soil Landscape

Loose – quartz-rich sand (topsoil)

Table 4 – Newnes Plateau – Loose quartz rich sand (topsoil)

Physical/Chemical Parameters	Limitations
Colour	Black (10YR 2/1), dull reddish brown (5YR 4/3) to dark greyish yellow (2.5YR 5/2), occasionally bleached
Texture	Sand to sandy loam
Structure	Single-grained
Fabric	Sandy
pH	Strongly acid (pH 4.5) to moderately acid (pH 5.5)
Coarse Fragments	Sandstone fragments, size and abundance variable, shape usually, angular
Roots	Few
Permeability	High
Other	Abundant organic matter
Existing Erosion	Minor sheet erosion and track erosion are present

Source: King (1993)

Reddish brown clayey sand (topsoil)

Table 5 – Newnes Plateau – Reddish brown clayey sand (topsoil)

Physical/Chemical Parameters	Limitations
Colour	Orange (7.5YR 6/6) to reddish brown (2.5YR 4/6) to bright reddish brown (5YR 5/8)
Texture	Clayey sand (occasionally light sandy clay loam) to sand with depth
Structure	Massive to single-grained
Fabric	Usually earthy and occasionally sandy
pH	Moderately acid (pH 5.5) to slightly acid (pH 6.5)
Coarse Fragments	Occasioanly scattered subrounded quartz gravels and ironstone
Roots	Few
Permeability	Moderate to high
Existing Erosion	Minor sheet erosion and track erosion are present

Source: King (1993)

4.1.2 Warragamba Soil Landscape

Single-grained loamy sand (topsoil)

Table 6 – Warragamba – Single grained loamy sand (topsoil)

Physical/Chemical Parameters	Limitations
Colour	Black (10YR 2/1), dull reddish brown (5YR 4/3) to dark greyish yellow (2.5YR 5/2), occasionally bleached
Texture	Sand to sandy loam
Structure	Single-grained
Fabric	Sandy
pH	Strongly acid (pH 4.5) to moderately acid (pH 5.5)
Coarse Fragments	Sandstone fragments, size and abundance variable, shape usually, angular
Roots	Few
Permeability	High
Other	Abundant organic matter
Existing Erosion	Minor sheet erosion and track erosion are present.

Source: King (1993)

Table 7 – Warragamba – Very dark reddish brown clayey sand (topsoil)

Physical/Chemical Parameters	Limitations
Colour	Dark reddish brown (5YR 2/3) to yellowish brown (10YR 5/6)
Texture	Clayey sand
Structure	Single grained, rarely weak/crumb polyhedral peds
Fabric	Sandy
pH	Strongly acid (pH 4.5) to slighty acid (pH 6.0)
Coarse Fragments	Sandstone fragments
Roots	Common
Permeability	High

Source: King (1993)

4.1.3 Wollangambe Soil Landscape

Table 8 – Wollangambe – Single grained loamy sand (topsoil)

Physical/Chemical Parameters	Limitations
Colour	Dark reddish brown (2.5YR 3/2) to greyish yellow brown (10YR 4/2) to dull yellowish brown (10YR 5/4) to brownish black (10YR 3/2)
Texture	Loamy sand, ranging from sand to sandy loam
Structure	Single grained
Fabric	Sandy
pH	Slightly acid (pH 6.0) to neutral (pH 7.0)
Coarse Fragments	Sandstone fragments
Roots	Few
Permeability	High

Source: King (1993)

Table 9 – Wollangambe – Red clayey sand (topsoil or subsoil)

Physical/Chemical Parameters	Limitations
Colour	Red (10YR 4/6) to bright brown (2.5YR 5/6)
Texture	Sand, clayey sand or sandy clay loam
Structure	Massive
Fabric	Earthy to sandy
pH	Slightly acid (pH 6.0)
Coarse Fragments	Occasioanly sandstone fragments
Roots	Few
Permeability	Moderate

Source: King (1993)

Table 10 – Wollangambe – Bright yellowish brown clayey sand (topsoil or subsoil)

Physical/Chemical Parameters	Limitations
Colour	Bright yellowish brown (7.5YR 6/8)
Texture	Clayey sand to sandy clay loam
Structure	Massive
Fabric	Usually earthy
pH	Slightly acid (pH 6.0 – 6.5)
Coarse Fragments	Rare sandstone fragments
Roots	Few
Permeability	Moderate

4.2 Land Capability

4.2.1 Pre-Mining

The rural land capability classification of the study area, in accordance with Department of Environment, Climate Change & Water (DECCW) mapping is shown in **Figure 3.** The Newnes State Forest has a modified land capability classification of 'State Forest' due to the land use zoning of State Forests, which overrides the general capability of the land for this assessment. However, for the purposes of this assessment, the rural land capability of the study area typically reflects Class VII land. Class VII land is land which, owing to its high soil erosion hazard and severe site limitations should remain under green timber. It generally has severe to very severe site limitations for other land uses, but may be suitable for wood production. Limitations include: slope, terrain, soil erosion, shallow soils and stoniness and poor drainage.

4.3 Agricultural Suitability

4.3.1 Pre-Mining

The agricultural suitability classification of the study area is shown in **Figure 4.** The study area consists of Class 4 & 5 agricultural suitability. Class 4 & 5 lands are marginal lands not suitable for cultivation and with a low to very low productivity for grazing. These lands are located within the Newnes State Forest.

4.4 Post Mining Land Capability and Agricultural Suitability

The proposed post mining land use for the study area is state forest. Impacts on land capability and agricultural suitability may be affected by surface subsidence. With appropriate management, the majority of the land within the study area will maintain the pre-mining land capability and agricultural suitability classification.

Provided that environmental controls as outlined in **Section 5** are in place and operating effectively during mining, there should be no adverse effects to the study area or surrounding land.

4.5 Potential Subsidence Impacts

4.5.1 Surface Cracking

The impact of longwall mining on soils and landform include uneven subsidence which may result in ponding of rainwater in depressions and surface cracking including tension cracks both parallel and perpendicular to the longwall panel. As longwall mining progresses through the coal seam, the roof strata will collapse into the void created behind the mining face. This collapse results in subsidence of the ground surface above the extraction area. Typically, subsidence does not occur immediately and develops over time as the mining progresses.

The predicted maximum final subsidence for the proposed panels ranges from 0.69 m to 1.47 m, depending on depth of cover. Based on the predicated range of maximum transverse tensile strains from 2 to 6 mm/m, for LWs 910 and 900W, surface cracking width of between 1 mm and 20 mm may occur within the limits of extraction (DGS, 2010).

Tensile fractures generally occur above longwalls between the panel ribs and the point of inflexion where convex curvatures and tensile strains develop. The cracks are likely to be <1mm wide below a depth of approximately 5m (Ditton Geotechnical Services, 2010). In addition, compressive shear fractures generally develop in the central area above a longwall panel and between the inflexion point locations. This zone is where concave curvatures and compressive strains occur (DGS, 2010).

The majority of soils in these areas above LW 900W and 910 include Newness Plateau, Warragamba and Wollangambe soil landscape units. A small portion of the Mount Sinai soil landscape unit lies in the eastern portion above LW910. The soils that form these soil landscapes are generally stable, however, the

LEGEND

- Study Area
- State Forest
- Land Capability Class VIII
- Land Capability Class VI
- Land Capability Class IV

FIGURE 3

Land Capability Classes

Project: Angus Place Land Resource Assessment

Client: Angus Place Colliery

File: Fg3_CCC07-003_Land Capability_v2

Projection: AMG (AGD66) Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	25/02/10	AR	KM	CR
2	13/08/10	AR	KM	KM

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LEGEND

Study Area

Agricultural Suitability Classes

Class 4

Class 5

FIGURE 4

Agricultural Suitability Classes

Project:	Angus Place Land Resource Assessment
Client:	Angus Place Colliery
File:	Fg4_CCC07-003_Ag Suitability_v2
Projection:	AMG (AGD66) Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	02/03/10	AR	KM	CR
2	13/08/10	AR	KM	KM

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Wollangambe soil landscape is considered an erosional landscape. The landscape is particularly susceptible to sheet erosion following clearing whilst severe rill and sheet erosion are commonplace along poorly designed access tracks. (King, 1993).

The change to surface gradients each panel is estimated to range by up to +/- 0.7^{o} (or +/- 1.2%). Minor terrain adjustment through erosion and sedimentation may occur where soils are exposed to stormwater runoff.

Other potential subsidence impacts may include the:

- topsoil loss or degradation, in areas of surface cracking;
- exposure of unstable (sodic or saline) subsoils, resulting in increased erosion potential;
- increased potential for surface erosion due to localised changes in topography and surface hydrology; and
- reduction in potential productivity of the land due to topsoil loss and modification of surface topography/hydrology.

These impacts may be magnified where subsidence occurs in areas of concentrated surface flow, such as gullies and drainage lines. These potential impacts can largely be managed through the implementation of appropriate controls, as described in **Section 5.1.**

4.5.2 Ponding

Ponding refers to the potential for closed-form depressions to develop at the surface above longwall panels. Ponding depths are depending on a range of factors such as rainfall duration, effective percolation and evapo-transpiration rates. Ponding locations are generally expected to occur along creeks and tributaries above the proposed longwall panels with gentle slopes and low lying areas (DGS, 2010).

Ponding depths of < 0.1 mm may develop along creeks and flatter areas beneath the proposed longwalls, based on post-mining surface level contour predictions. Any increases of existing ponded areas or development of new ponds are unlikely to cause significant impact to the existing environmental conditions (DGS, 2010).

4.5.3 Proposed Mine De-Watering Bore & Access Tracks

The access tracks above the proposed panels are unsealed roads managed by Forests NSW. These roads are accessible to the public. The roads are likely to be subsided by up to the maximum panel values presented earlier and may also be affected by vertical cracking or low angle compressive shearing. The typical crack widths are estimated to range between 1 mm and 20 mm across the road where it passes through the tensile and compressive strain zones above each longwall panel. Worst-case crack widths of up to 90 mm may occur if surface rock exists below the road and near the strain peaks. (DGS, 2010).

Post mining inspections of Forests NSW roads over the previously extracted longwalls have only found 'hairline' cracking (<1 mm wide) which quickly self heals following a rainfall event or grading activity.

A worst case assessment predicts that approximately 50 m to 100 m of the road above each longwall may be impacted by cracking. Any necessary repairs to tensile cracking or compressive shear failures through the road after mining of each panel is completed will be carried out in consultation with Forests NSW. It is recommended that appropriate warning signage be erected adjacent to the roads where they enter/exit an area that will be subsided. For detailed mitigation measures see **Section 5** below.

Disturbance activities that pose a risk of accelerating natural erosion processes include vegetation clearance, track construction, and bore construction. During the required vegetation clearance activities, the land surface may be disturbed. This mechanical disturbance of the topsoil and underlying subsoil may temporarily reduce the abilities of the soil to resist the dislodgement of particles from raindrop impact and surface water flow during rainfall events, and also more susceptible to wind erosion.

Given the small area surrounding the proposed dewatering borehole to be disturbed, that existing tracks will be used wherever possible, and with the mitigation measures implemented as described below in **Section 5** no significant impacts on soils or the resulting impacts of erosion and sedimentation are anticipated.

4.5.4 Potential Acid Generating Material

The potential for acid generation from the topsoil and subsoil (regolith) within the study area is low. Acid Sulphate Soils (ASS), which are the main cause of acid generation within the soil mantle, are commonly found less than 5 m above sea level, particularly in low-lying coastal areas such as mangroves, salt marshes, floodplains, swamps, wetlands, estuaries, and brackish or tidal lakes. There has been little history of acid generation from regolith material in the Central West Region (which is located approximately 160 km from the coast).

4.5.5 Cumulative Impacts

Cumulative impact assessment of the project area in conjunction with existing mining and associated and surrounding activities has been considered in this assessment.

This assessment of the soils and land capability impact shows a minimal potential temporary disturbance, with no long term impacts predicted. The environmental controls, monitoring and repair strategies proposed for the minor surface cracks which may occur will ensure no long term impacts are experienced.

5.0 DISTURBANCE MANAGEMENT

The greatest probable impact of underground mining on topsoil and land capability is surface impacts over longwalls 910 and 900W. If not appropriately managed, these surface disturbance impacts may also cause further degradation within the study area and adjoining lands, by way of subsoil exposure and increased erosion and sedimentation along drainage lines.

The following management and mitigation strategies are recommended for implementation during mining, in order to reduce the potential for degradation within the study areas and adjoining lands. These recommendations are based on the assessment of the existing site conditions and experience with the management of mining surface impacts at sites throughout New South Wales and Central Queensland.

5.1 Subsidence Mitigation

5.1.1 Surface Cracking

Most of the topsoil and subsoil material within the study area is relatively stable. If topsoil and surface vegetation cover are maintained, subsidence impacts should not cause a significant increase in erosion potential. If the subsoil is exposed, measures should be undertaken to divert surface run-off away from nearby drainage lines and surface cracks should be remediated in accordance with the recommendations presented below. Localised increases in surface gradients due to subsidence should be assessed through periodic surveys to ensure that erosion potential has not been increased and the potential for surface flow has not been interrupted.

In addition to mitigation measures outlined in the Angus Place Land Management Plan and measures outlined above, the following remedial techniques have proved effective at other sites and may be applicable for subsidence impact zones within the study area in order to maintain topsoil quality and agricultural land capability and suitability;

- Appropriate erosion and sedimentation control structures, such as catch drains and sedimentation dams, may be established prior to surface disturbance to prevent degradation of downstream water courses;
- Undertake pre-mining and post-mining inspections along the creek with results of inspections communicated to respective stakeholders; and
- Any observed impact caused by subsidence will be communicated to Forests NSW and any remediation required will be done so in accordance with them.

5.2 Erosion and Sediment Control

For an underground operation, such as that proposed for the study area, surface disturbance resulting from surface infrastructure construction and subsidence is expected to be minimal. However, where land disturbance does occur, controls outlined in the Angus Place Land Management Plan should be implemented along with consideration of the controls proposed below, which have been formulated according to results of industry wide research and experience.

For smaller areas of disturbance, such as the construction of access tracks and boreholes, localised sediment control measures such as sediment fencing should be established prior to ground disturbance. The effectiveness of these measures should be assessed regularly to ascertain the requirement for maintenance or replacement. For broader areas of disturbance, such as treatment of larger subsidence areas, erosion and sediment control should be integrated into landform and rehabilitation design.

5.2.1 Proposed Mine De-Watering Bore & Access Tracks

During the construction phases of the de-watering bore and access tracks the natural topsoil will be stripped and stockpiled for use in rehabilitation following completion of construction. Areas of subsoil may also be disturbed during construction. All erosion and sediment control works will generally be undertaken in accordance with the Blue Book (*Managing Urban Stormwater: Soils and Construction Vol. 1 & Mines and Quarries Vol.2E*) and with the Angus Place Land Management Plan & the Erosion and Sediment Control Plan (referenced within the Surface Water Management Plan). The erosion and sediment control measures will include, but not be limited to the following:

- Creation of a sump and sediment fencing on the down slope of the borehole;
- Reducing vehicular movements and the correct storage of soil stockpiles; and
- Cleared topsoil and subsoil will be selectively managed and reused in the rehabilitation of the borehole site and associated access tracks, which will be undertaken as soon as practical upon completion of the works.

Given the small area to be disturbed, that existing tracks will be used wherever possible, and with the mitigation measures implemented as described below no significant impacts on soils or the resulting impacts of erosion and sedimentation are anticipated.

6.0 CONCLUSION

This desktop soil and land resource assessment conducted by GSSE for the proposed project area associated with the proposal found the majority of soils in the areas above LW 900W and 910 include Newness Plateau, Warragamba and Wollangambe soil landscape units. The soils that form these soil landscapes are considered to be generally stable and impacts associated from mining are unlikely to cause significant impacts to existing environmental conditions.

The current land use for the project area is classified as state forest. With appropriate management the land within the study area will maintain the pre-mining land capability and agricultural suitability classification post-mining.

Ponding depths of < 0.1 m may develop along creeks and flatter areas beneath the proposed longwalls, based on post-mining surface level contour predictions. Any increases of existing ponded areas or development of new ponds are unlikely to cause significant impact to the existing environment.

Given the small area surrounding the proposed dewatering borehole to be disturbed, that existing tracks will be used wherever possible, and with the mitigation measures implemented described in **Section 5** no significant impacts on soils or the resulting impacts of erosion and sedimentation are anticipated.

7.0 REFERENCES

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APPENDIX 7.6

Rehabilitation Strategy

Angus Place Colliery 75W Modification

Rehabilitation Strategy

Centennial Angus Place Pty Limited

October 2010

CCC07-004

GSS ENVIRONMENTAL

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1.0 INTRODUCTION

1.1 Background

GSS Environmental (GSSE) was commissioned by RPS (RPS) on behalf of Centennial Angus Place Pty Limited (Angus Place Colliery), and its parent company Centennial Coal Company Ltd to prepare a *Rehabilitation Strategy* for the proposed extension of the Angus Place Colliery. A plan detailing the general locality of the Angus Place Colliery is shown as **Figure 1.**

Angus Place Colliery exists as a joint venture company owned in equal share between Centennial Coal Company Limited and SK Kores. Angus Place Colliery commenced production in 1979, after being developed as an extension of the Newcom Mine at Kerosene Vale. Coal is extracted from the Lithgow Seam primarily by the operation of a longwall shearer and supporting continuous miner units developing access headings. Coal is currently extracted for domestic power generation at both Wallerawang and Mount Piper power stations.

Angus Place Colliery received Project Approval for the extraction of Longwalls 930 to 980 in 2006 under the provisions of Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Angus Place Colliery is now seeking Project Modification Approval under Section 75W of Part 3A of the EP&A Act. A general plan showing Angus Place Colliery's location and the study areas are shown in **Figure 2**.

Currently, longwall mining methods are used at Angus Place Colliery for the extraction of each longwall block and are supported by mains development using continuous miner units. Development activities entail the extraction of coal to produce underground roadways and headings, enabling access to future longwall extraction areas. Development activities within the current approval area are scheduled to be completed by October 2012, with longwall operations within the current extraction area planned to be completed by June 2014.

1.2 Study Area

Angus Place Colliery is located 5 km north of the village of Lidsdale, 8 km northeast of the township of Wallerawang and 15 km northwest of the city of Lithgow. The Western Coalfields is an active coal extraction area and nearby coal mines include Baal Bone Colliery (Xstrata), Invincible Colliery (CET Resources) and Centennial Springvale. Angus Place Colliery Pit Top lies within the Cox's River Catchment, with the Mining Lease area traversing both the Cox's and Wolgan River Catchments.

The proposed longwall panels 910 and 900W are located beneath the Newnes State Forest, managed by Forests NSW. The Newnes State Forest is located 5km north-east of the Lithgow and 100km north-west of Sydney. The Newnes State Forest covers an area approximately 300km² and extends north from the escarpment of the Lett River Valley.

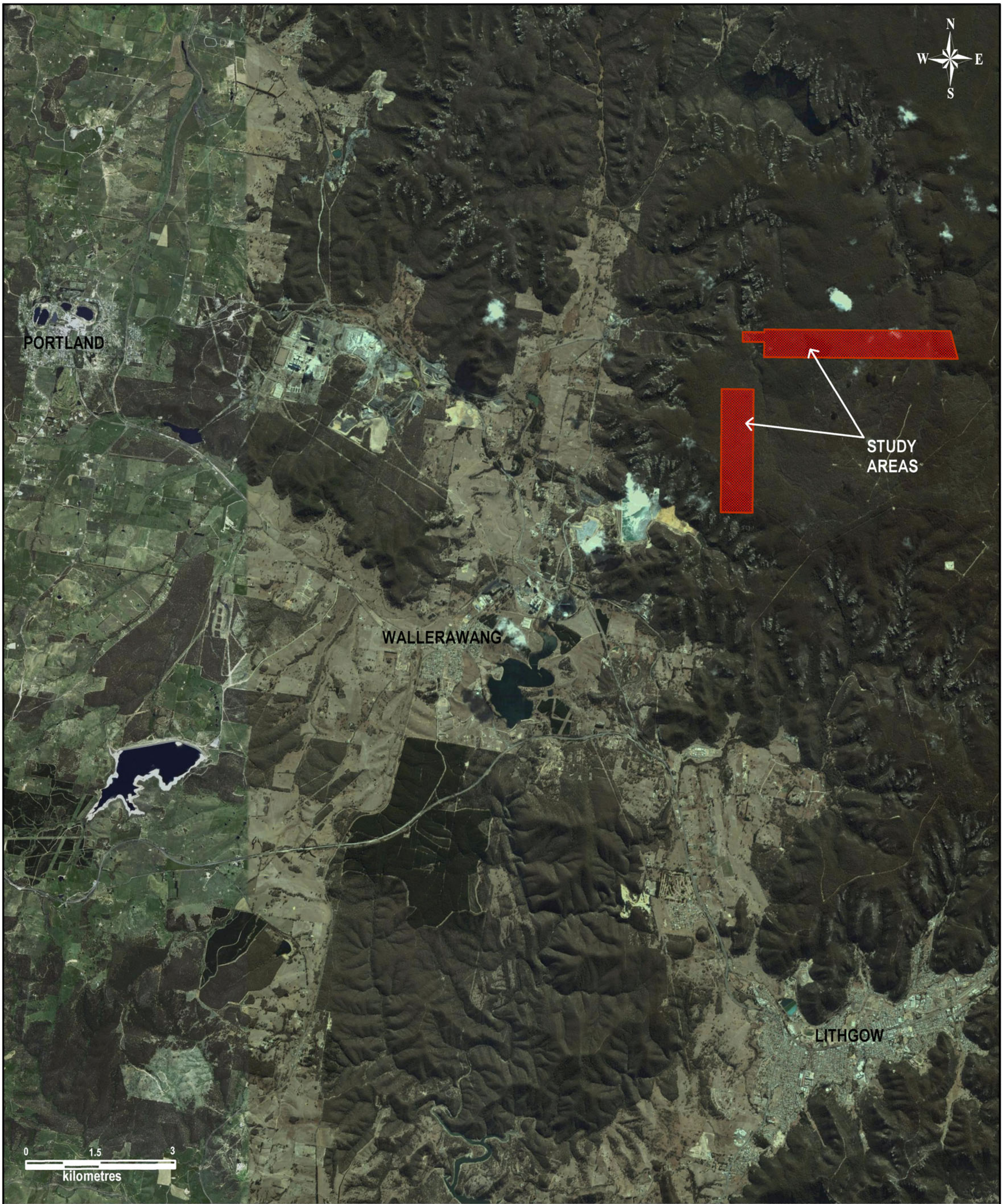
The Study Area includes those areas that extend outside the limit of extraction, which is referred to as the Angle of Draw (AoD). This assessment is based on a Study Area which captures the 26.5^{o} AoD to ensure that all impacts are adequately addresses and managed.

1.3 Project Description

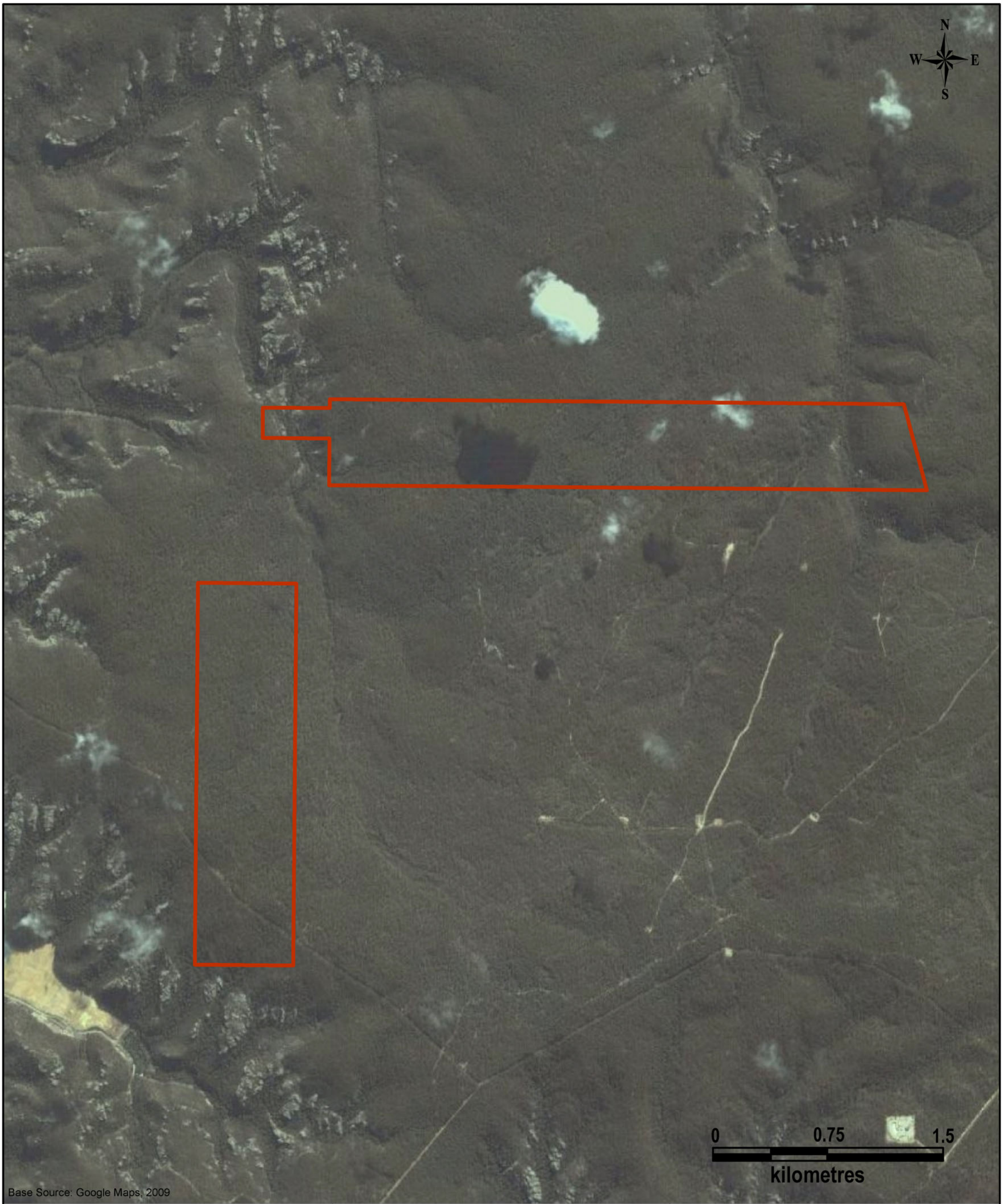
Angus Place Colliery proposes to extend its operations through the extraction of two (2) additional longwall panels and the development of related surface infrastructure.

Specifically the modification proposes to include the following:

- Development and extraction of longwalls 910 and 900 west (900W). 910 is directly north of the extracted 920 panel with 900W due west of the current mains headings. With regard to longwall 910, two options are proposed. This is due to the fact that there may be a potential resource area situated to the north east of the proposed longwall area and, if this is the case, future access to this



LEGEND Study Area					FIGURE 1 Location Plan	Project: Angus Place Rehabilitation Assessment Client: Angus Place Colliery
Version: 1	Date: 16/06/10	Author: AR	Checked: SS	Approved: SS	GSS ENVIRONMENTAL Environmental, Land and Project Management Consultants	File: Fg1_CCC07-004_Location Plan_v1 Projection: AMG (AGD66) Zone 56



LEGEND

Study Area

FIGURE 2

Study Areas

Project: Angus Place Rehabilitation Assessment

Client: Angus Place Colliery

File: Fg2_CCC07-004_Study Area_v2

Projection: AMG (AGD66) Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	16/06/10	AR	SS	SS
2	13/08/10	AR	KM	SS

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resource would be most efficient if it is accommodated within this proposed modification. The two (2) options for Longwall 910 are:

- Option 1: In the event that the north eastern area is not considered viable, Longwall 910 will be approximately 200m wide and 2500m in length and allow the development of two mains headings.

- Option 2: In the event that the north eastern area is considered viable, Longwall 910 will be approximately 2500m in length and 120m in width to allow the development of four mains headings to enable future access to the resource in the north east.

- Increase the production limit to 4 million tonnes per annum (Mtpa). This seeks to make a provision for 12 consecutive months of production in the event Angus Place Colliery does not have a three month shut down due to a longwall changeover. The intensity of mining will not change. However, an increase of the annual production limit would allow a continuation in production in the event that a shutdown due to a longwall changeover (typically 8 weeks) is not required.

- Installation of a dewatering bore facility at the eastern end of Longwall 910. Infrastructure required to support the operation of this installation is as follows:

  - An access track to the site from Blackfellows Hands Road.

  - Powerline extension along the access tracks to supply electricity. This will likely be an extension of the existing 930 and 940 dewatering bore power line.

  - Extension of the Springvale – Delta Water Transfer Scheme, in terms of an underground corridor (to accommodate the underground pipeline) along the proposed dewatering bore access track. This will enable Angus Place Colliery to continue to transfer extracted groundwater to Delta Electricity's Wallerawang power station, reducing demand on water extracted by Delta from the Cox's River catchment.

- Assessment of the current Angus Place Colliery water management infrastructure. Recommendations developed from the findings of the pit top surface water assessment will be considered for implementation to improve the dirty water management system

- Increase in personnel from the currently approved 215 to 225. In addition, up to 75 temporary contractors will be required to assist with underground development activities for up to 15 months.

1.3.1 Proposed Additional Longwalls

Under Option 1, Longwall 910 is orientated in an east – west direction and is located parallel to the north of the existing 920 panel. Longwall 910 is located predominantly within ML 1424 and partially within CCL 704. Longwall 910 is planned to be approximately 200m wide and 2500m long. It is anticipated that Option 1 will produce approximately 2,620,720 tonnes.

Under Option 2, Longwall 910 remains in the same orientation, however is reduced in width to approximately 120m. This allows the development of 4 mains headings to the north of Longwall 910 to enable access to potential resources situated to the north-east of the current extraction area. The length is planned to be approximately 2500m. It is anticipated that Option 2 will produce approximately 1,855,600 tonnes.

Longwall 900W is located directly west of the existing 950-980 panels and is orientated perpendicular to these panels in a north - south orientation. Development of longwall 900W will extend south beyond the 980 Panel. Longwall 900W is located predominantly in CCL 704, with a small portion within ML 1424 and it will extend partially into Centennial Springvale's ML 1326 (to gain separate lease area). Longwall 900W is planned to be 283.5m wide and 2079.7m in length. It is anticipated that Longwall 900W will produce 3,009,810.

This assessment has been based on Option 1 as outlined above. However, as Option 2 considers a narrower longwall, resulting in a reduced predicted subsidence area, it will generate impacts within the range of impacts associated with Option 1. Therefore, it is considered that Option 1 has assessed the maximum impacts which are relevant to both options.

1.3.2 Proposed Dewatering

The proposed borehole and supporting infrastructure are to be situated on the Newnes Plateau at the eastern end of longwall 910. Minor land preparation will be required at this site to install and maintain the borehole.

1.4 Director General's Requirements

This Rehabilitation Strategy has been prepared in accordance with the Director General's Requirements (DGR's) dated 1 June 2010 and correspondence from NSW Industry and Investment (I & I) dated 21 May 2010. **Table 1** below summarises the DGR's relevant to rehabilitation and indicates where specific issues have been addressed in this document.

Table 1 – Summary of Director General's Requirements

Specific Issue	Where Addressed in Document
Rehabilitation Proposed for Non-Subsidence Areas	**Section 3.0**
New Dewatering Bore at LW 910	**Section 3.0**
Associated Powerlines and Services	**Section 3.0**
Access Tracks	**Section 3.0**
Rehabilitation Objectives, Methodology and Completion Criteria	**Sections 3.0 & 5.0**

1.5 Objectives of the Rehabilitation Strategy

The purpose of the Rehabilitation Strategy is to establish objectives for the rehabilitation of the disturbed land that will result from the continuation of the Angus Place Colliery operations. Specifically, the Rehabilitation Strategy has been assigned the following key objectives:

- propose rehabilitation strategies for surface features that may be impacted by mining;
- propose short, medium and long term objectives for the rehabilitation of the site;
- propose an effective revegetation program;
- propose an effective monitoring programme to assess performance of the rehabilitated areas; and
- propose objectives and preliminary success criteria for mine closure.

This report has generally been prepared in accordance with the requirements of the following relevant strategic land use planning and resource management plans and policies relating to mine rehabilitation and mine closure. These include:

- I&I-MR Policy (edg 03) – Guidelines to the Mining, Rehabilitation & Environmental Management process;
- The Strategic Framework for Mine Closure (ANZMEC & MCA, 2000);
- Leading Practice Sustainable Development Program for the Mining Industry – Mine Closure (Federal Department of Industry, Tourism and Resources);
- Current Mine lease conditions; and
- The current Mining Operations Plan (MOP).

1.6 Structure of the Rehabilitation Strategy

The following sections summarise the key aspects addressed in the Rehabilitation Strategy for Angus Place Colliery.

1.6.1 Rehabilitation - Section 3

- defines how rehabilitation of the disturbed areas will be integrated with surrounding rehabilitation;
- provides short and long term objectives for the rehabilitation of the site;
- provides detail on the implementation of an effective revegetation program; and
- Specify and implement current best practice rehabilitation procedures.

1.6.2 Rehabilitation Monitoring - Section 4

- provides detail of an effective monitoring programme to assess performance of the rehabilitated areas; and
- describes individual aspects of the rehabilitation to be monitored.

1.6.3 Rehabilitation Success Criteria - Section 5

- provides details of preliminary success criteria for specific areas of the operation; and
- details the anticipated level of success.

2.0 CURRENT INFRASTRUCTURE, MINING AND REHABILITATION ACTIVITIES

2.1 Mine Infrastructure

Operations at Angus Place Colliery involve the following major components:

- Areas currently rehabilitated or under rehabilitation;
- Active underground mining areas;
- Coal processing facilities including coal sizing, stockpiling, stacking and reclaim facilities;
- Conveyors, gantries and transfer towers;
- Truck loading hopper;
- Ventilation facilities both upcast and downcast;
- Mine drift entries;
- Surface facilities, including office, car park and bathhouse;
- Fuel farm and oil storage areas;
- Air compressors;
- Workshop infrastructure;
- Sewage irrigation area;
- Various water management structures and dams; and
- Dewatering bores.

2.2 Existing and Proposed Mining

Angus Place Colliery holds coal supply contracts with Delta Electricity for supply of coal to the Mount Piper and Wallerawang Power Stations until 2014. Coal is currently delivered to these markets along private haul roads. With greater than 32 Million tonnes (Mt) of measured reserves, the mine has a nominal life of 12-15 years. The mine currently provides direct employment for 215 people plus additional indirect employment through the use of contractors, casuals and local businesses.

Coal extraction is currently undertaken in the area covered by Mine Lease 1424 and Consolidated Coal Lease (CCL) 704. The longwall method of mining is used to extract coal from the Lithgow seam. This process utilises continuous miner units to initially develop roadways and headings, with the longwall shearer extracting each developed longwall block. Coal is conveyed to the surface for sizing and fed to the product supply bin to be transported to either Wallerawang or Mt Piper Power Station via private haul roads. No coal washing occurs on site, consequently there is no production of washery tailings or reject material.

The Environmental Assessment (EA) seeks to modify the current approval, specifically in terms of the following key aspects:

- Develop and extract longwalls 900 west and 910;
- Increase the production limit to 4 Mtpa;
- Construct a dewatering bore at longwall 910;
- Construct powerlines and services for the new dewatering bore;

- Extend the Springvale – Delta Water Transfer Scheme via an underground pipeline corridor to the new dewater bore;
- Modify the existing stockpile area;
- Construct assess tracks; and
- Minor increase in personnel to 225

2.3 Existing Rehabilitation Activities

All necessary rehabilitation works have been carried out to ensure that the mine infrastructure and surface disturbance areas are stable and non-polluting. Exploration drilling undertaken within mining lease areas are appropriately rehabilitated once activities are complete.

As detailed in the current Mining Operation Plan (MOP) (current until July 2013), the only areas requiring rehabilitation during the MOP period include the following:

- 930 dewatering borehole;
- 930 passive ventilation hole;
- Land clearing associated with future dewatering boreholes and associated facilities;
- Ventilation holes; and
- Ballast/concrete drop holes.

3.0 REHABILITAITON MANAGEMENT

3.1 Rehabilitation Objectives

Angus Place Colliery is required, where necessary, to return any land disturbed due to exploration or mining activities, to a capacity which was present pre-mining. The current approved MOP for Angus Place Colliery sets out specific rehabilitation objectives. These objectives are listed as follows:

- Rehabilitation and the outcomes will be consistent with the Environmental Assessment which formed the basis for any approvals;
- Rehabilitation will be based on mine closure criteria and outcomes developed through stakeholder consultation;
- Compliance with the relevant regulatory requirements and that regulatory consensus is attained on the successful closure and rehabilitation of the site;
- Rehabilitation of native vegetation will be integrated with undisturbed native vegetation to provide consolidated areas and wildlife corridors where possible;
- The site will be rehabilitated to an agreed final land use compatible with the surrounding land fabric and land use requirements;
- The rehabilitation process will address limitations of land capability that may arise as a consequence of mining;
- The rehabilitation will be sustainable in terms of selected final land use;
- The rehabilitated site will be stable with permanent landforms with soils, hydrology and ecosystems having maintenance needs no greater than those of the surrounding land;
- Waste substances that have the potential to affect land use or result in pollution will be secured and safely contained;
- The rehabilitated site will not present a hazard to persons, stock or native fauna;
- The site will be clean and tidy and any remaining structures will be left in a condition that provides for the safety of the public; and
- Mine closure works are completed as quickly and cost effective as possible whilst providing that the above objectives are achieved.

3.2 Targeted Rehabilitation

In order to reduce the amount of disturbed land at any one time, rehabilitation will be targeted to areas that cease to be used for mining or mining-related activities as soon as practical. Results from current successful rehabilitation across the site, will be used to refine the proposed rehabilitation methods including aspects such as the selection of appropriate drainage measures / structures and plant species for re-establishment.

Notwithstanding this, in some areas it will only be possible to undertake temporary rehabilitation due to either difficult access to the site or that mining is still occurring. Therefore, rehabilitation will generally be limited to sowing associated with erosion and sediment control and stabilisation until mining has moved through a particular area.

3.3 Revegetation

3.3.1 Subsidence Areas

The Subsidence Prediction and Impact Assessment for the proposal, undertaken by Ditton (2010), has determined that due to the depth of cover, subsidence is generally predicted to be quite low across the Project Area. However, should subsidence impacts occur to surface features, rehabilitation will be undertaken in accordance with Trigger Action Response Plans (TARPs) and Subsidence Management Plan (SMP) as required by the current development consent conditions.

Whilst subsidence impacts are predicted to be low, there still may be the need to undertake rehabilitation should impacts occur. Rehabilitation methods for features may include such actions as repairing surface cracks in roads and general disturbed areas where the land surface has been cleared, or surface cracking in the natural environment.

Should cracking occur in roads or general disturbed areas, the surface will be graded and the cracks filled with sand, or other suitable material, prior to the surface being re-graded and compacted. If the area is no longer utilised, it should be deep ripped, topsoiled and appropriately revegetated (refer to **Section 3.3.3**)

Where access is an issue, the most natural way to rehabilitate surface cracking is to place locally occurring vegetative matter above or within the cracks, hastening the above natural processes that occur over a prolonged period.

Appropriate materials placed in or above the cracks will be determined by the size of the cracks and the intended depth to which these materials would be used in the rehabilitation. Logs, sticks, leaf litter and local soil could all be placed within and/or above the cracks.

This form of rehabilitation would result in a natural looking rehabilitated crack that would continue to accumulate additional natural leaf litter and debris over time.

Using this method of rehabilitation would avoid additional access requirements and significant disturbance to existing natural vegetation.

Infrastructure rehabilitation strategies for the following features will be specifically addressed through the SMP process. These include:

- Access tracks;
- Powerlines;
- Delta Electricity water supply pipeline; and
- Dewatering bore.

3.3.2 Infrastructure Items

Within the Project Area there are several infrastructure items that need to be constructed as part of the proposed mine extension works. The key items to be constructed are access tracks, powerlines, a bore for dewatering, and extension of the Delta Water Transfer Scheme. Should there be any impact from mining, rehabilitation works will be required to be undertaken.

Further, at mine closure these infrastructure areas will also be required to be fully rehabilitated. This will firstly involve removing any physical items from these areas prior to the re-establishment of vegetation.

The primary objective of the rehabilitation of infrastructure areas will be revegetation to stabilise all re-topsoiled batters, road verges, drains, banks, and cleared areas. All revegetation works will be scheduled to commence as soon as practicable and where access permits. Disturbance of native vegetation will be kept to a minimum and clearing will be constrained to the footprint area of the infrastructure items.

Prior to the re-establishment of vegetation cover, temporary control measures will be utilised for erosion and sediment control. These measures may include the use of sediment fences for non-channelised flow over disturbed areas, sand bags, rip rap, or any combination of those materials.

Consideration will be given to erosion and sediment control procedures for activities undertaken during the construction phase. These procedures may include restricted access during wet weather or to areas under rehabilitation, reporting of erosion and sediment hazards or incidents and regular checking and maintenance of structures.

All revegetation operations are best undertaken immediately after ripping so that the ripped surface has minimal time to crust prior to seed application. The most effective way of controlling erosion will be to establish and/or maintain a healthy vegetation cover. Vegetation will provide effective surface protection against raindrop impact, bind the underlying soil to resist detachment by surface flows, and improve and maintain the soil's infiltration capacity thereby decreasing the velocity and volume of runoff. Vegetation will also improve the aesthetic appearance of each area and the operational efficiency of structural sediment and erosion control measures employed.

3.3.3 Implementation of an Effective Revegetation Program

The Rehabilitation Strategy proposed for disturbed areas includes a separate species mix for reforested areas. Endemic species mixes should be utilised where possible. Fertiliser will be applied with mixes to increase the likelihood of initial revegetation success, however prior to application approval will be required from the land owner (Forests NSW).

The main revegetation steps will therefore include:

- Species selection;
- Sowing rates and species proportions;
- Seed pre-treatment;
- Equipment selection;
- Soil amelioration and fertiliser; and
- Timing.

Should natural revegetation require acceleration, the following rehabilitation methods and techniques will be implemented depending on the requirements. These include:

- Use of mulch for soil protection;
- Use of brush matting to import seed into cleared areas;
- Use of open weave jute mesh pegged in with steel pegs;
- Brush harvesting from nearby areas; and
- Ripping of compacted wheel tracks.

The seed mix proposed for rehabilitation within the Study Area (see **Tables 2 and 3**) has been used successfully at mine sites within the Lithgow region. The following species and sowing rates are proposed for use at Angus Place Colliery.

Table 2 - Understorey Species for Angus Place Rehabilitation

Species	Sowing Rate (kg/ha)
Acacia dealbata	0.5
Acacia buxifolia	0.3
Acacia rubida	0.3
Acacia decurrens	0.4
Acacia falciformis	0.3
Acacia brownii	0.3
Acacia myntifolia	0.4
Acacia terminalis	0.4
Allocacuarina distylla	0.2
Leptospermum polygalifolium	0.2
Leptospermum flavescens	0.1
Banksia spinulosa	0.1
Total	**3.5 kg/ha**

Table 3 - Overstorey Species for Angus Place Rehabilitation

Species	Sowing Rate (kg/ha)
Eucalyptus macrorhyncha	0.4
Eucalyptus rossii	0.4
Eucalyptus mannifera	0.4
Eucalyptus dalrympleana	0.4
Eucalyptus radiata	0.5
Eucalyptus bridgesiana	0.4
Eucalyptus pauciflora	0.4
Eucalyptus melliodora	0.4
Eucalyptus viminalis	0.6
Eucalyptus canonnii (if available)	0.1
Total	**4 kg/ha**

The prescribed sowing rate is 7.5 kg/ha of mixed seed, with seed pretreated where appropriate. Fertiliser (Granulock 15) will be mixed with seed at 100 kg/ha.

Where possible the seed will be sourced or collected from plants within the Blue Mountains area.

To improve the success of rehabilitation, fast growing pasture species will be sown to obtain initial ground coverage.

Where possible, direct seeding will be used on broadscale areas where there is sufficient access. However where suitable access is not available, brush matting may be utilised in conjunction with hand seeding. The direct seeding option is less labour intensive than direct planting of tube stock and long term establishment of native bushland type habitat is often more readily achieved using this method.

3.3.4 Rehabilitation Maintenance

Areas of completed rehabilitation will be regularly inspected and assessed against rehabilitation objectives following consultation with Forests NSW. Rehabilitation monitoring will include regular inspections for the following key aspects:

- evidence of any erosion or sedimentation;
- success of initial establishment of crop or grass cover and tree and shrub seeding / plantings
- natural regeneration of native species;
- weed infestation (primarily noxious weeds, although where rehabilitation areas are dominated by other weeds;
- integrity of graded banks, diversion drains, waterways and sediment control structures; and
- general stability of the rehabilitation areas.

Where rehabilitation success appears limited, maintenance works will be undertaken. This may include the following:

- re-seeding and, where necessary, re-topsoiling and/or the application of specialised treatments such as composted mulch or biosolids to areas with poor vegetation establishment;
- installation of tree guards around planted seedlings or construction of temporary fencing suitable for excluding native and feral fauna species should grazing by animals be excessive;
- replacement of drainage controls if they are found to be inadequate for their intended purpose, or compromised by vegetation or wildlife;
- de-silting or repair of sediment control structures; and
- where monitoring indicates the presence of excessive weeds or the potential for noxious weed infestation, necessary precautions to prevent the development of weeds within the rehabilitated areas will be undertaken.

Monitoring results, any required maintenance activities and any refinements of rehabilitation techniques will be reported in the sites Annual Environmental Management Report (AEMR).

3.3.5 Weed Management

The presence of weed species has the potential to have a major impact on revegetation and regeneration outcomes. Additionally, any presence of weed species within the surrounding land has the potential to significantly impact on the biodiversity value of the rehabilitated areas. Weed management will be a critical component of rehabilitation activities.

Weeds will be managed across the site through a series of control measures, including:

- hosing down equipment in an approved wash down area before entry to site;
- herbicide spraying (in consultation with Forests NSW) or scalping weeds from topsoil stockpiles prior to re-spreading topsoil;
- rehabilitation inspections to identify potential weed infestations; and
- identifying and spraying existing weed populations on-site together with ongoing weed spraying over the life of the mine.

The spread of declared noxious weeds will be prevented by using the measures above. The monitoring and control of weed populations using herbicides within the site will significantly reduce weed infestations.

Weed control, if required, will be undertaken in a manner that will minimise soil disturbance. Any use of herbicides will be carried out in accordance with Industry and Investment NSW (I&I NSW) and Department of Environment, Climate Change & Water (DECCW) requirements. Records will be maintained of weed infestations and control programs will be implemented according to best management practice for the weed species concerned.

3.3.6 Feral Animal Control

A feral animal control strategy will be implemented to contain the spread of weeds and detrimental impact on rehabilitation areas by feral animals. Goats, foxes, cats, rabbits, pigs and dogs will be controlled in accordance with Livestock Health and Pest Authority procedures.

4.0 REHABILITATION MONITORING

Regular monitoring of the rehabilitated areas will be required during the initial vegetation establishment period and beyond to demonstrate whether the objectives of the rehabilitation strategy are being achieved and whether a sustainable, stable landform has been provided. **Table 4** presents the recommended monitoring program, including the specific aspects and elements to be monitored and monitoring frequencies for those various aspects.

Monitoring will be conducted periodically by independent, suitably skilled and qualified persons at locations which will be representative of the range of conditions on the rehabilitating areas. Annual reviews will be conducted of monitoring data to assess trends and monitoring program effectiveness. The outcome of these reviews will be included in the Annual Environmental Management Report (AEMR).

The monitoring methodologies currently in use at Angus Place Colliery will be adopted and modified where necessary to enable an assessment of trends and the progress towards the achievement of the success criteria indicators identified in **Section 5.0**, with the monitoring undertaken regularly in order to establish the trend towards achievement of those criteria.

In addition to the rehabilitated areas, at least two reference sites will be monitored to allow a comparison of the development and success of the rehabilitation against a control. Reference sites indicate the condition of surrounding un-disturbed areas.

In developing the rehabilitation monitoring program, the following aspects will be taken into consideration.

- Replicated monitoring sites are needed in representative rehabilitation areas of different ages. One monitoring site per 20 to 40 ha is recommended for each major age class of the rehabilitation areas.
- Sites should be monitored quarterly after establishment for the first 12 months, and then every 12 months following.
- A standard monitoring plot design for areas rehabilitated with trees. The design includes:
  - 2 m x 2 m quadrates – these will provide some estimate of statistical variance, so that if required, statistical analyses can be undertaken to objectively compare different rehabilitation treatments and changes over time;
  - a 20 m x 10 m plot overlying the 2 m quadrats and located 5 m either side of the centerline, for ease of monitoring; and
  - a 50 m erosion monitoring transect on contour, running through the centre of the plot.

Figure 3 shows the monitoring plot design that is to be adopted for the monitoring of an area revegetated with trees.

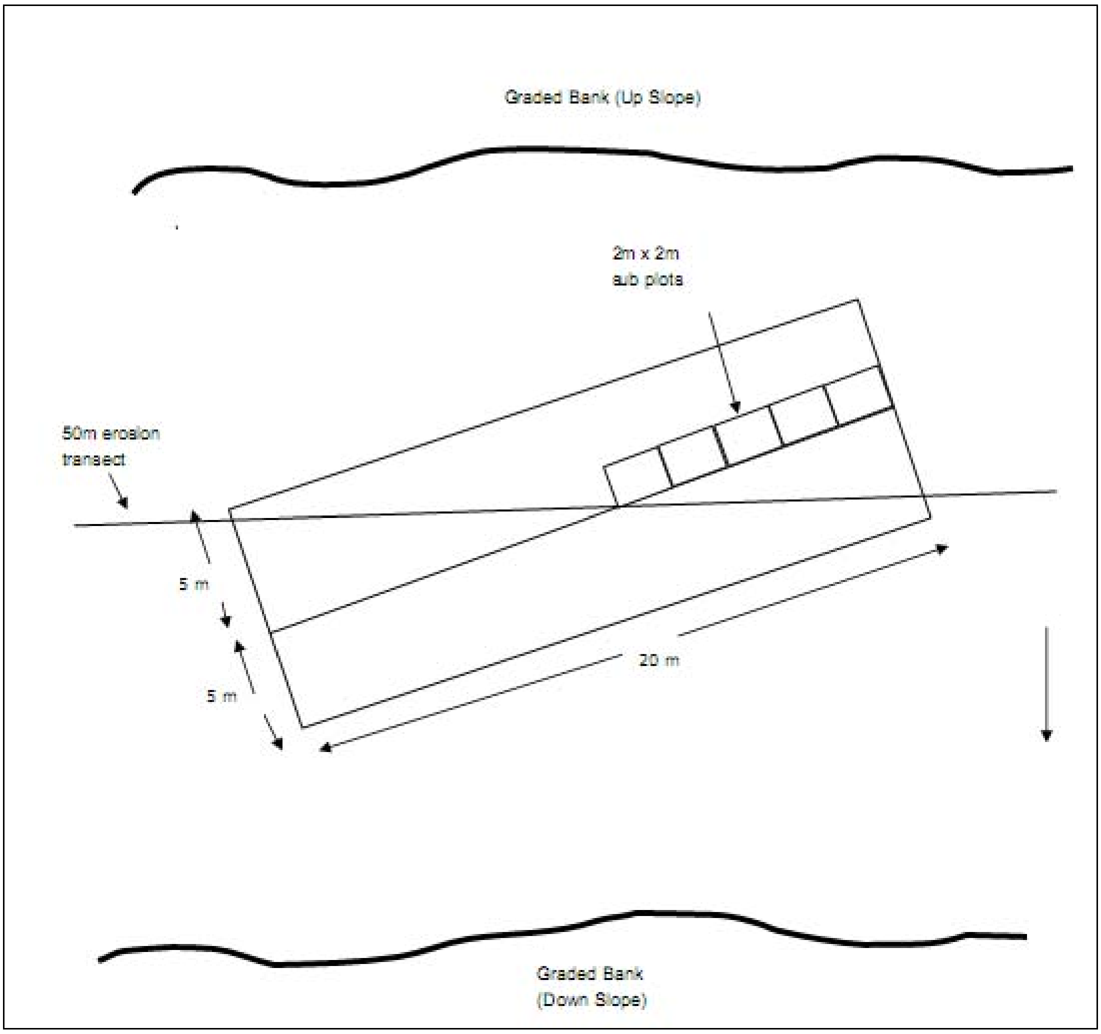

Figure 3 – Typical Monitoring Plot Design

For the areas rehabilitated with grass, it is proposed that transects be established across 'typical' sections of rehabilitation at the site and monitored for grass cover, pasture species diversity, weed occurrence, percentage of bare ground, extent and type of erosion, rock presence, topsoil presence/absence and other factors likely to influence rehabilitation development.

Rehabilitation methods will be improved as additional knowledge develops from monitoring data collected through these programs.

More specifically, monitoring of the elements in **Table 4** will be undertaken to determine the level of achievement of success criteria.

Table 4 – Proposed Rehabilitation Monitoring Program

Aspect of Rehabilitation	Elements to be Monitored	Monitoring Frequency
Ecosystem Establishment		
General Description	• Describe the vegetation in general terms, e.g. mixed eucalypt woodland with grass understorey and scattered shrubs, dense Acacia scrub, etc.	Quarterly for the first 12 months after establishment and then every 12 months
2m x 2m quadrats	• Count the number of plants of all species, excluding grass • Measure live vegetation cover for understorey and grasses (separately) using a line intercept method • Record details of ground cover (litter, logs, rocks etc.)	Quarterly for the first 12 months after establishment and then every 12 months
20m x 10m plots	• Count, by species, all trees >1.6m tall. • Tag and measure DBH of trees >1.6m tall, to a maximum of 10 for any one species. • Record canopy cover over the whole 20m centreline when trees are tall enough • Subjectively describe tree health, by species if relevant, noting signs of drought stress, nutrient deficiencies, disease and severe insect attack. Where health problems are noted, record the percentage of unhealthy trees. • Record any new plant species not present in the smaller plots, including any problem and declared noxious weeds • Take five surface soil samples (e.g. at approx. 5m intervals along the centreline) and bulk these for analyses of: pH, EC, chloride and sulfate; exchangeable Ca/Mg/K/Na; cation exchange capacity; particle size analysis and R1 dispersion index; 15 bar and field capacity moisture content; organic carbon; total and nitrate nitrogen; total and extractable phosphorus; Cu, Mn and Zn.	Quarterly for the first 12 months after establishment and then every 12 months
50m transect	• Along the 50m erosion monitoring transect, record the location, number and dimension of all gullies >30cm wide and/or 30cm deep. • Erosion pins should be established in plots located in newer rehabilitation to record sheet erosion if present	1 year after establishment and then every 2 years
Rehabilitation in general	• When traversing between monitoring plots, note the presence of species of interest not previously recorded (e.g. key functional or structural species, protected species, noxious weeds), as well as obvious problems including any extensive bare areas (e.g. those greater than 0.1ha). • Observations such as this can provide useful, broad scale information on rehabilitation success and problems.	Quarterly for the first 12 months after establishment and then every 12 months
Photographic record	• For each 20m x 10m plot, a photograph should be taken at each end of the plot, along the centreline looking in.	Quarterly for the first 12 months after establishment and then every 12 months
Habitat	• General observations relating to the availability and variety of food sources (e.g. flowering/fruiting trees, presence of invertebrates etc).	Quarterly for the first 12 months after establishment and then every 12 months

Aspect of Rehabilitation	Elements to be Monitored	Monitoring Frequency
	• Availability and variety of shelter (e.g. depth of leaf litter, presence of logs, hollows etc). • Presence/absence of free water in the rehabilitated areas	
Fauna	• General observations of vertebrate species (including species of conservation significance). • Detailed fauna surveys including presence and approximate abundance and distribution of vertebrate species (focussing on species of conservation significance).	After rehabilitation is 3 years old undertake monitoring biennially in both Autumn and Spring
Invertebrate	• Diversity and abundance of present species	Bi-Annually, during Autumn and Spring
Weeds and pests	• Species identity. • Approximate numbers/level of infestation. • Observations of impact on rehabilitation (if any).	Quarterly during the first two years and biennially after that. Inspections should be opportunistic after significant rainfall events.
Geotechnical Stability		
	• Assessment of the stability of batters and also looking at surface settlements (sink holes). In particular where these features could impact on the performance of any surface water management system. • Surface integrity of landform cover/capping (measurement of extent of integrity failure). • Presence / absence of landform slumping.	Annually
Surface and Groundwater		
	• Groundwater quality and depth. • Efficiency of landform surface water drainage systems (integrity of banks and drains) • Water quality including pH, EC and total suspended solids of water in water storages, and pits, sedimentation dams.	Quarterly or following rainfall events Monitoring of receiving waters

5.0 REHABILITATION SUCCESS CRITERIA

The following preliminary success criteria (or closure criteria as they are often referred to) for the rehabilitation areas are included in **Table 5**. The success criteria are performance objectives or standards against which rehabilitation success in achieving a sustainable system for the proposed post-mine land use is demonstrated. Satisfaction and maintenance of the success criteria (as indicated by monitoring results) will demonstrate that the rehabilitated landscape is ready to be relinquished from the mine's financial assurance and could be handed back to stakeholders in a productive and sustainable condition.

The success criteria comprise indicators for vegetation, fauna, soil, stability, land use and safety on a landform-type basis that reflects the nominated post-mine land use of a mosaic of native woodland, open grasslands with selective grazing opportunities.

For each element, standards that define rehabilitation success at mine closure are provided. Based on the generic indicators in **Table 5**, each criterion will be further developed to be specific, measurable, achievable, realistic and outcome based, and to reflect the principle of sustainable development. This will be based on results of further research and ongoing monitoring of the progressive rehabilitation areas. The success criteria will be reviewed every three to five years with stakeholder participation to ensure the nominated success criteria remain realistic and achievable.

Table 5 – Preliminary Rehabilitation Success Criteria

Rehabilitation Element	Indicator	Criteria
Landform stability	*Slope gradient*	No less than 75% of the area has slopes <10°. Where the slopes are steeper, additional water management structures will be utilised (as required). Where reject layers are present and exposed, the landform is capped with a minimum of 1.5m of inert material and be free-draining.
	Erosion control	Erosion control structures are installed at intervals commensurate with the slope of the landform. Average soil loss per annum is <40 tonnes/ha/yr (sheet erosion). Dimensions and frequency of occurrence of erosion rills and gullies are generally no greater than that in reference sites that exhibit similar landform characteristics.
	Surface Water Drainage	Use of contour banks and diversion drains to direct water into stable areas or sediment control basins. All landforms will be free draining except where specific structures (ie LDP003) have been constructed for the storage of water as required for sediment and erosion control or some post mining landuse.
Water quality	*EC, pH, TSS and oil and grease*	Ensure receiving waters affected by surface water runoff have contaminant limits of the Environmental Protection Licence (EPL)
Topsoil	*Salinity (electrical conductivity)*	Soil salinity content is <0.6 dS/m.
	pH	Soil pH is between 5.5 and 8.5.
	Sodium content	Soil Exchange Sodium Percentage (ESP) is <15%.
	Nutrient cycling	Nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or other microsymbionts. Adequate macro and micro-nutrients are present.
Vegetation	*Land use*	Area accomplishes and remains as a healthy native woodland.
	Surface cover	Minimum of 70% vegetative cover is present (or 50% if rocks, logs or other features of cover are present). No bare surfaces >20 m^2 in area or >10 m in length down slope.

Rehabilitation Element	Indicator	Criteria
	Species composition	Subject to proposed land use, comprise a mixture of native trees, shrubs and grasses representative of regionally occurring woodland.
	Resilience to disturbance	Established species survive and/or regenerate after disturbance. Weeds do not dominate native species after disturbance or after rain. Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Sustainability	Species are capable of setting viable seed, flowering or otherwise reproducing. Evidence of second generation of shrub and understorey species. Vegetation develops and maintains a litter layer evidenced by a consistent mass and depth of litter over subsequent seasons. More than 75% of shrubs and/or trees are healthy when ranked healthy, sick or dead.
Fauna	*Vertebrate species*	Representation of a range of species characteristics from each faunal assemblage group (e.g. reptiles, birds, mammals), present in the ecosystem type, based on pre-mine fauna lists and sighted within the three-year period preceding mine closure. The number of vertebrate species does not show a decrease over a number of successive seasons prior to mine closure.
	Invertebrate species	Presence of representatives of a broad range of functional indicator groups involved in different ecological processes.
	Habitat structure	Typical food, shelter and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present, including: a variety of food plants; evidence of active use of habitat provided during rehabilitation such as nest boxes, and logs and signs of natural generation of shelter sources including leaf litter.
Safety		Risk assessment to be undertaken in accordance with relevant guidelines and Australian Standards and risks reduced to levels agreed with the stakeholders.

6.0 FINAL LANDUSE

The proposed post mining land use for the study area is State forest. Impacts on land capability and agricultural suitability will result from surface subsidence. With appropriate management, the majority of the land within the study area will maintain the pre-mining land capability and agricultural suitability classification.

Provided that environmental controls (particularly subsidence management and erosion and sediment controls) are in place and operating effectively during mining, there should be no adverse effects to the study area or surrounding land.

7.0 REFERENCES

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APPENDIX 7.7

Flora and Fauna Assessment

RPS

Flora and Fauna Assessment

Proposed Longwalls 910 and 900W

Angus Place Colliery

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Draft V2	*2nd Client Review*	*RS*	*TL*	*16-8-10*	*-*	*T.Lambert*	*16-8-10*
Draft V3	*3rd Client Review*	*CA*	*TL*	*22-9-10*	*-*	*T Lambert*	*23-9-10*
Final	*Final for Issue*	*CA*	*TL*	*11-10-10*	*-*	*T Lambert*	*11-10-10*

Disclaimers

Executive Summary

INTRODUCTION

RPS Australia East (RPS) was engaged by Centennial Angus Place Pty Ltd to undertake a Flora and Fauna Assessment at Angus Place Colliery. This assessment supports a Section 75W Modification to the existing Part 3A Project Approval to extend mining activities. Aspects of the proposed modification that have the potential to impact on flora and fauna are:

- Development and extraction of longwalls 910 and 900 west (900W). 910 is directly north of the extracted 920 panel with 900W due west of the current mains headings.
- Increase production to the existing approved four (4) million tonnes per annum limit to cater for anticipated production improvements.
- Installation of a dewatering bore facility at the eastern end of longwall 910. Infrastructure required to support the operation of this installation is as follows:
  - An access track to the site from Black Fellows Hands Road.
  - Powerline extension along the access tracks to supply electricity. This will likely be an extension of the existing 930 and 940 dewatering bore powerline.
  - Extension of the Springvale – Delta Water Transfer Scheme, in terms of an underground corridor along the proposed dewatering bore access track. This will enable Angus Place to continue to transfer extracted groundwater to Delta Electricity's Wallerawang Power Station.

The project will also involve modifications to the pit top area and private haul roads. As these modifications will not impact on native vegetation communities or flora and fauna they were not included in the study areas.

This report addresses the requirements of the Director General (Ref: 9038493) as set out under Key Issues that relate to the assessment of potential impacts on biodiversity including terrestrial threatened species or populations, associated habitats and endangered ecological communities or groundwater dependent ecosystems. It also provides a description of the measures that would be implemented to avoid or mitigate impacts on biodiversity.

Fieldwork was undertaken to determine any potential significance to surface ecology within the zero subsidence line as generated by modelling, and also to cover all direct surface impact areas associated with the dewatering borehole, track, pipeline and powerline upgrades.

Notwithstanding that the fieldwork area did not extend to the boundary of the recently modelled subsidence area prediction (Figure 1.1) the field survey is considered adequate to assess the likely impacts on the fauna habitat and vegetation communities. This is based on a risk assessment approach that has used all relevant evidence. The evidence includes the prediction from the modelling by Ditton Geotechnical Services (2010) that the subsidence in the region outside of the field study area will be <30 mm. And that the prediction that cracking associated with the subsidence is expected to be minor, (<1 mm at 5 m depth) and self healing due to sedimentation.

The predicted maximum final subsidence for the proposed panels ranges from 0.69 to 1.47 m, depending on cover depth. The subsidence above the 34 m wide chain pillars between LWs 920 and 910 is estimated to range from 0.65 m to 1.04 m. Goaf edge subsidence is estimated to range from 0.07 to 0.21 m around LW 900W and from 0.15 to 0.37 m for LW 910 (DGS, 2010). This is not expected to cause significant impact to the health of the ecosystems in these areas.

Ponding depths of less than 0.1 m may develop along creeks and flatter areas beneath the proposed longwalls. Any increases of existing ponded areas or development of new ponds are likely to be in-channel and unlikely to cause significant impact to the existing environmental conditions (DGS, 2010).

This assessment aims to examine the likelihood of the proposal to have a significant effect on any threatened species, populations or ecological communities listed within the *Threatened Species Conservation Act 1995* (TSC Act 1995). The report recognises the relevant requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979) as amended by the *Environmental Planning and Assessment Amendment Act 1997*. Assessment is also made with regard to those threatened entities listed federally under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

VEGETATION

Ground truthing of the study site areas identified ten vegetation communities as follows:

1. MU 7 - Newnes Plateau Narrow-leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest;
2. MU 8 – Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest;
3. MU 26 – Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest;
4. MU 26a – (= Variant of MU26) with Brittle Gum, Scribbly Gum and Mountain Gum;
5. MU 43 – Pagoda Rock Sparse Shrubland;
6. MU 44 – Sandstone Plateau Tea Tree – Dwarf Sheoak – Banksia Rocky Heath;
7. MU 50 – Newnes Plateau Shrub Swamp (EEC);
8. MU 50 - Newnes Plateau Shrub Swamp with MU 8 Overstorey;
9. MU 51 – Newnes Plateau Hanging Swamp (EEC); and
10. Cleared areas.

One Endangered Ecological Community (EEC) was observed within the site. This EEC was *Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion* as listed in the TSC Act 1995. This EEC corresponds to vegetation communities MU50 - Newnes Plateau Shrub Swamp and MU 51 – Newnes Plateau Hanging Swamp as described and mapped within the Vegetation Mapping of the Western Blue Mountains (DEC 2006) and confirmed within this report. These communities also correspond to the federally listed (EPBC Act 1999) EEC known as Temperate Highland Peat Swamps on Sandstone.

Two threatened flora species listed within the TSC Act (1995) were observed on site during the flora surveys. These species were:

- *Derwentia blakelyi* (listed as Vulnerable under the NSW TSC Act 1995); and
- *Persoonia hindii* (listed as Endangered under the NSW TSC Act 1995).

Previous flora survey works conducted by Gingra Ecological Surveys (2008) over existing Angus Place coal extraction areas have recorded *Derwentia blakelyi* at Kangaroo Creek Swamp, West Wolgan Swamp and Narrow Swamp to the south of panel 910 and a single ROTAP species, namely, *Olearia quercifolia* (Oak-leaf Daisy Bush) at Kangaroo Creek Swamp.

No threatened flora species listed within the EPBC Act (1999) were observed within the subject site.

In consideration of Matters of National Environmental Significance under the EPBC Act with respect to the Temperate Highland Peat Swamps on Sandstone (a federally listed EEC) a referral is to be submitted to the Department of Sustainability, Environment, Water, Population and Communities.

HABITAT

Habitats within the site were found to be in a moderate to high condition. The majority of the site, particularly wooded areas on top of the plateau, has been subject to Forests NSW selective timber harvesting activities for a sustained period of time and recent fire history in some parts of the site was also evident. As a consequence large areas of forest canopy strata across the plateau exhibit a relatively young to moderately aged cohort of canopy trees with only a low to moderate density of mature hollow-bearing trees and a natural density of juvenile to immature canopy species in the understorey strata. Where shrub layers are present they represent a somewhat low diversity, likely due to a combination of disturbance and context in relation to elevation and soil composition. Ground-cover layers exhibit a relatively diverse assemblage of grasses, herbs and prostrate shrubs in areas not exhibiting recent disturbance. Generally those areas of vegetation occurring off the plateau, where forest harvesting activity has not been undertaken, remain intact with a natural complement of native flora species.

The site contains topographic and micro-habitat suited to some threatened flora species, notably *Persoonia hindii* and *Derwentia blakelyi*.

Some fallen timber, a sparse to medium groundcover and moderate levels of leaf litter provides shelter and foraging opportunities for a number of fauna guilds, with a low to moderate density of hollow-bearing trees providing shelter opportunities for arboreal mammals, bats and birds. There is a relatively low incidence of large hollows suited to the nesting purposes of cockatoos and forest owls. The site is a small part of a large contiguous area of native vegetation. Habitats within the site are therefore considered to exhibit a moderate capacity to support a diversity of faunal guilds.

FAUNA

A diversity of common fauna species across a number of faunal guilds were encountered within the site and its vicinity.

A range of mammals were recorded including a number of macropods, such as *Wallabia bicolor* (Swamp Wallaby) and *Macropus rufogriseus* (Red-necked Wallaby) and arboreal mammals such as *Petauroides volans* (Greater Glider). A single terrestrial mammal species, *Antechinus agilis* (Agile Antechinus), was recorded during trapping over the site. A diverse assemblage of Microchiropteran bats were recorded during nocturnal surveys, including three threatened species, namely *Chalinolobus dwyeri* (Large-eared Pied Bat – TSC Act: Vulnerable, EPBC Act: Vulnerable), *Falsistrellus tasmaniensis* (Eastern False Pipistrelle – TSC Act: Vulnerable) and *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat – TSC Act: Vulnerable). Due to their mobility and the presence of abundant suitable habitat within the site and the wider vicinity it is likely that a number of other threatened Microchiropteran bats may also use the area on at least an intermittent basis.

An immature *Cercartetus nana* (Eastern Pygmy Possum – NSW TSC Act: Vulnerable) was observed on Beecroft Track to the east of panel 900W within open forest habitat.

Dasyurus maculatus (Spotted-tailed Quoll) a species listed under the NSW TSC Act as Vulnerable and under the federal EPBC Act as Endangered was not observed during targeted surveys, but habitat in the west of panel 910 is of sufficient quality and isolation to support this species.

A moderate diversity of open forest birds including those characterising elevated habitats were observed across the site. A number of threatened bird species were recorded across the site including *Petroica multicolour* (Scarlet Robin - NSW TSC Act: Vulnerable), *Petroica phoenicea* (Flame Robin - NSW TSC Act: Vulnerable), *Daphoenositta chrysoptera* (Varied Sittella - NSW TSC Act: Vulnerable) and *Callocephalon fimbriatum* (Gang-Gang Cockatoo - NSW TSC Act: Vulnerable). There are no Allocasuarina tree species within the site suited to the foraging requirements of *Calyptorhynchus lathami* (Glossy Black-Cockatoo - NSW TSC Act: Vulnerable) and few hollows of sufficient size to provide breeding opportunities for this species.

Although no forest owl species were observed during targeted surveys it is likely that the site represents a portion of the local foraging range of both Masked and Powerful Owls, both listed within the NSW TSC Act as Vulnerable, due to the presence of terrestrial and arboreal mammals, which are the respective prey of these owl species. A limiting factor on the presence of forest owl species may be a generally low density of the large hollows that these species require for breeding, and in the case of the Masked Owl, hollows are also used for roosting purposes.

Targeted searches were also undertaken for *Eulamprus leuraensis* (Blue Mountains Water Skink - TSC Act: Endangered, EPBC Act: Endangered), but only a number of non-threatened common skink species were recorded, including two related species, *E. heatwolei* (Yellow-bellied Water Skink) and *E. quoyii* (Eastern Water Skink).

Surveys were also conducted for *Petalura gigantea* (Giant Dragonfly – NSW TSC Act: Endangered), but this species or suitable habitat were not observed during the fauna survey over the site.

Ongoing annual fauna monitoring over the Newnes Plateau has recorded a number of other threatened fauna species, including *Petaurus norfolcensis* (Squirrel Glider - NSW TSC Act: Vulnerable), *Climacteris picumnus* (Brown Treecreeper - NSW TSC Act: Vulnerable), *Chthonicola sagittata* (Speckled Warbler - NSW TSC Act: Vulnerable) and *Tyto tenebricosa* (Sooty Owl - NSW TSC Act: Vulnerable). Comprehensive surveys over the site did not encounter these species and habitats occurring within the site are considered to provide only marginal opportunities for the three bird species, due to the relative scarcity of local records, although habitat within the site was assessed as providing shelter and foraging opportunities for Squirrel Glider.

KEY THREATENING PROCESSES (KTPs)

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act 1995. There are 8 KTPs that have the potential to be applicable to the site as a consequence of the proposal, being:

- Alteration of habitat following subsidence due to longwall mining
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Anthropogenic climate change
- Clearing of Native Vegetation
- Infection of native plants by *Phytophthora cinnamomi*
- Invasion of native plant communities by exotic perennial grasses

- Loss of hollow-bearing trees
- Removal of dead wood and dead trees

Geologic assessment of underlying strata and projected slumping as a result of coal extraction activities has calculated a likely maximum subsidence of approximately 1.2m within 910 longwall panel and 1.5m within 900W longwall panel. Long-term annual monitoring thus far have not reported any significant adverse effects to the ecological values of the Newnes Plateau ecosystems and as such it is considered unlikely that the proposed Angus Place extension of current coal extraction consents will result in significant adverse impacts upon surface communities.

The remaining KTPs listed above are unlikely to be exacerbated by the proposed extraction works provided the recommendations included below are enacted.

PART 3A KEY THRESHOLDS ASSESSMENT

The proposal has been considered against the relevant key thresholds assessment criteria as set out within Draft Guidelines for Threatened Species Assessment for Part 3A Applications (DEC / DPI 2005). A Part 3A Key Thresholds Assessment provided in Section 8 of this document shows that the proposal satisfies the criteria by maintaining biodiversity values and will not:

- reduce the viability of a local population of any species, population or ecological community,
- accelerate the extinction of a local population of any species, population or ecological community, or
- adversely affect Critical Habitat of a local population of any species, population or ecological community.

CONCLUSIONS

The proposal is expected to modify a small area (approximately 4.2 ha) of native vegetation by clearing in order to extend and upgrade an existing access track, and to install a dewatering borehole at the eastern end of the proposed 910 longwall panel. The proposed longwalls have been designed based on minimum impact to significant surface features. After due consideration against the relevant key thresholds assessment criteria as set out within Draft Guidelines for Threatened Species Assessment for Part 3A Applications (DEC / DPI 2005), the proposal is expected to have minimal direct impacts on the site, with the access track and borehole requiring the removal or modification of only a relatively small linear area (4.2 ha) of a vegetation type that is common on the Newnes Plateau. The proposed longwall panels are expected to have an indirect impact on the ecology of the site via the expected subsidence and modified subsurface hydrology subsequent to the proposed coal extraction, projected subsidence predictions are considered unlikely to have a significant adverse impact upon ecological attributes within the site. This is due to the prediction that cracking associated with the subsidence is expected to be minor, (<1mm at 5m depth) and self healing due to sedimentation. As a consequence, the surface flora is not expected to suffer any significant disturbance or modification.

Two threatened flora species, five threatened bat species, four threatened bird species and one EEC have been recorded within the site during recent surveys, although habitat is considered suitable for a number of other threatened fauna, which may use the site on at least an intermittent basis.

As required by the Draft Guidelines for Threatened Species Assessment for Part 3A Applications (DEC / DPI 2005), an assessment of the Key Thresholds has determined that the proposed road upgrades, dewatering facility provisions and subsequent underground mining activities are likely to result in minimal impacts upon the available habitats on the site. The project is considered unlikely to cause a significant adverse effect upon threatened species recorded within the site or those which may potentially occur within the site on an intermittent basis.

RECOMMENDATIONS

The following mitigation measures have been recommended to minimise potential impacts of the proposal:

- Clearing should be minimised as the primary objective of the Project, particularly within those areas that contain hollow-bearing trees;
- Where the removal of hollow-bearing trees is not avoidable, inspection of hollow-bearing trees prior to and during clearing should be undertaken by a qualified ecologist to ensure removal and relocation of animals if required can occur in association with best practice protocols;
- It is recommended that precautions be implemented to avoid impacts upon waterways and associated vegetation to prevent the movement of sediments or contaminated waters / liquids into onsite and downslope drainage lines. Sedimentation and erosion controls are to be installed prior to commencement of works in accordance with *Managing Urban Stormwater: Soils and Construction* 4th Ed. 'The Blue Book';
- It is recommended that appropriate measures be employed to ensure that machinery working within the site does not bring materials (soils etc.) onto the sites that may infect onsite vegetation with *Phytophthora cinnamomi*. This will require vehicle inspections as part of the Clearing Permit;
- It is recommended that ongoing weed monitoring be instituted and potential weed infestations be appropriately managed to ensure surrounding communities (particularly swamps) are protected from invasive species;
- Many of above activities will occur as directed by the Rehabilitation Strategy for the project by GSS Environmental (2010), which will direct methods of restoration of disturbed areas and general environmental management of affected areas; and
- All of the above recommendations will need consultation and input from State Forests.

Terms & Abbreviations

Abbreviation	Meaning
API	Aerial Photograph Interpretation
DEC	Department of Environment and Conservation – now known as DECCW
DECCW	Department of Environment, Climate Change and Water
DEWHA	Department of Environment, Water, Heritage and the Arts – now known as SEWPAC
EEC	Endangered Ecological Communities
EP&A Act 1979	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act 1999	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic Information System
GDE	Groundwater Dependent Ecosystems
GPS	Global Positioning System
I&I NSW	NSW Industry and Investment
KTP	Key Threatening Process
LGA	Local Government Act
MNES	Matter of National Environmental Significance
PFC	Projected Foliage Cover
ROTAP	Rare or Threatened Australian Plants
RPS	RPS Newcastle
SEPP	State Environmental Planning Policy
SDWTS	Springvale - Delta Water Transfer Scheme
TSC Act 1995	*Threatened Species Conservation Act 1995*
SEWPAC	Department of Sustainability, Environment, Water, Population and Communities

Contents

Figures

Tables

Appendices

1 Introduction

RPS Australia East (RPS) was engaged by Centennial Angus Place Pty Ltd to undertake a Flora and Fauna Assessment at Angus Place Colliery. This assessment addresses a Section 75W Modification to the existing Part 3A Project Approval to extend mining activities. Aspects of the proposed modification that have the potential to impact on flora and fauna are two additional longwall panels (910 and 900W) proposed for development and extraction, the installation of a dewatering borehole at the eastern end of panel 910 and the upgrade and extension of an access track, powerline and Springvale – Delta Water Transfer Scheme to the dewatering borehole. The location and extent of the site under investigation is shown in **Figure 1-1.**

This report addresses the Director General's Requirements (Ref: 9038493) as set out under Key Issues that relate to the assessment of potential impacts on biodiversity including terrestrial threatened species or populations, associated habitats and endangered ecological communities or groundwater dependent ecosystems. It also provides a description of the measures that would be implemented to avoid or mitigate impacts on biodiversity as required.

This assessment aims to examine the likelihood of the proposal to have a significant effect on any threatened species, populations or ecological communities listed within the *Threatened Species Conservation Act 1995* (TSC Act 1995). The report recognises the relevant requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979) as amended by the *Environmental Planning and Assessment Amendment Act 1997*. Assessment is also made with regard to those threatened entities listed federally under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

1.1 Site Particulars

Locality - Angus Place Colliery is located near the village of Lidsdale in the NSW Western Coalfield. The Angus Place mine entrance is approximately 5km north of Wallerawang Power Station and approximately 5 km east of Mount Piper Power Station. The location and extent of the site is shown in Figure 1-1.

LGA - Lithgow

Area - Proposed Panel 900W – 159 ha - including predicted subsidence area;
Proposed Panel 910 – 258 ha - including predicted subsidence area;
Proposed upgrade and extension of access track and dewatering bore (partly within proposed Panel 910 and partly within existing approved panel 920) – 4.2 ha.

Boundaries - The proposed longwall panel 900W is oriented north-south and straddles a section of Beecroft Track, Kangaroo Creek Track and extends a further 2km to the north across a section of Angus Place Track.

The proposed longwall panel 910 is oriented east-west adjacent to the northern boundary of existing Angus Place coal workings and is centred approximately on Black Fellows Hands Road, extending for a distance of approximately 1.5km to the east and west.

The proposed track upgrade extends north-west from just upslope from the Narrow Swamp drainage line, and then traverses west and north along existing ridge-top tracks. The proposed track extension is from the existing ridge-top track to the proposed bore hole and is approximately 500 metres long.

The subject site is surrounded by native open forest / woodland currently managed by Forests NSW. The subject site is shown in Figure 1-1.

Current Land Use - The land is currently part of the Newnes State Forest managed by Forests NSW.

Topography - The site is located on the Newnes Plateau and consists of undulating land from 1060m to 1160m AHD. The land contains numerous first and second order watercourses and is accessible by established ridge-top tracks and numerous recent logging trails.

Soils - The soils of the area are variable depth sandy loams and skeletal sandy soils over Hawkesbury Sandstone. There are some sandstone outcroppings (pagodas) and escarpments associated with exposed spurs and the deeper drainage lines. Rocky outcrops on the plateau top are absent.

1.2 Description of the Proposal

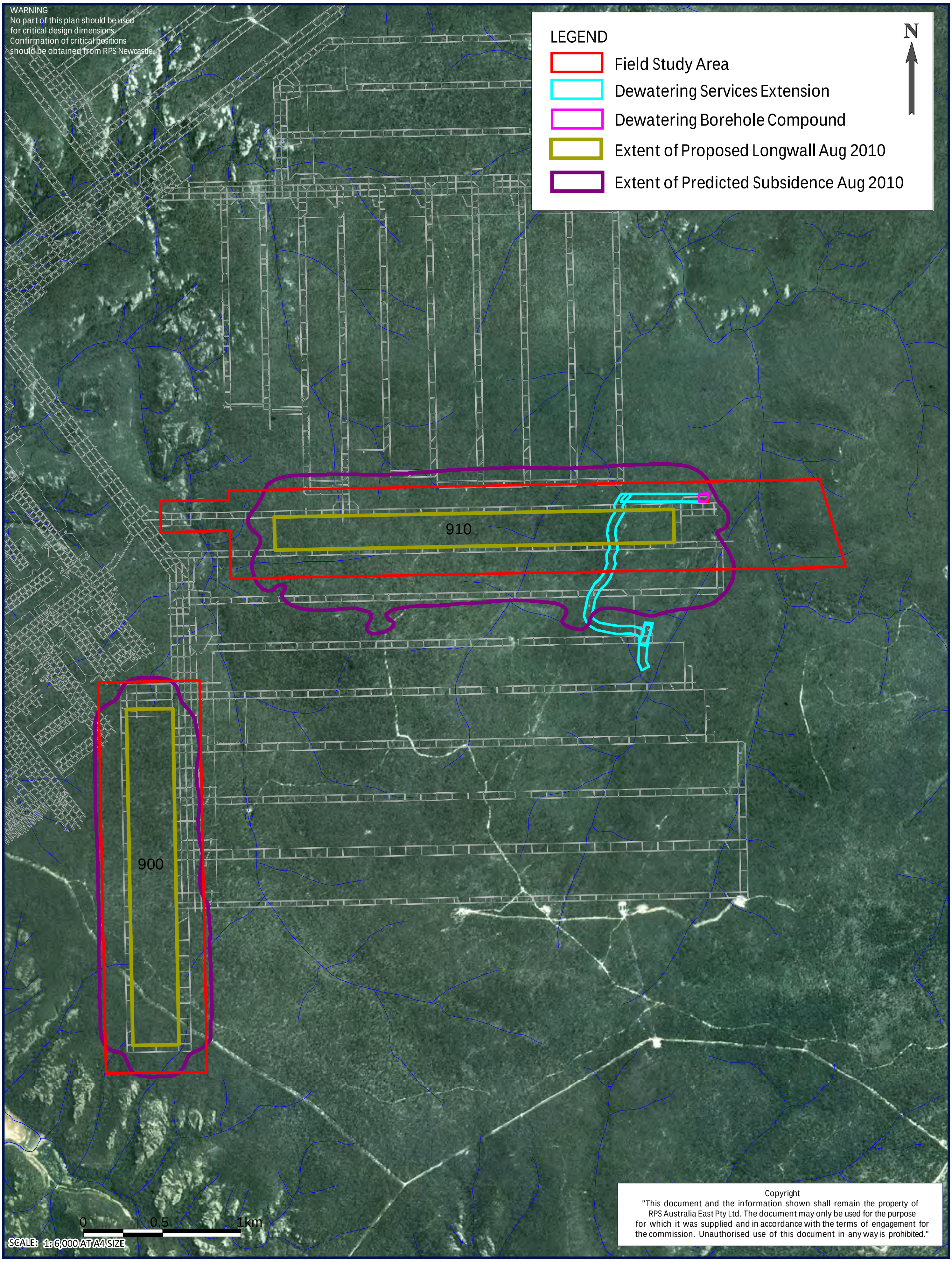
Angus Place Colliery exists as a joint venture company and is owned in equal share by the Centennial Coal Company Ltd and SK Kores. The Angus Place pit top is situated 5 kilometres north of the village of Lidsdale and is bordered by several other operations in addition to the Newnes Plateau. The current underground longwall workings are located to the east of the pit top site.

Specifically, the Modification proposed to include the following:

- Development and extraction of longwalls 910 and 900 west (900W). 910 is directly north of the extracted 920 panel with 900W due west of the current mains headings.
- Increase production limit to the existing approved four (4) million tonnes per annum in the event that an eight week shut down for longwall change over is not required.

- Installation of a dewatering bore facility at the eastern end of longwall 910. Infrastructure required to support the operation of this installation is as follows:
  - An access track to the site from Black Fellows Hands Road
  - Powerline extension along the access tracks to supply electricity. This will likely be an extension of the existing 930 and 940 dewatering bore powerline.
  - Extension of the Springvale – Delta Water Transfer Scheme, in terms of an underground corridor along the proposed dewatering bore access track. This will enable Angus Place to continue to transfer extracted groundwater to Delta Electricity's Wallerawang Power Station.
- Assessment of the current Pit Top water management controls. Specifically, it is proposed to modify the stockpile drainage system to ensure that all contaminated stockpile runoff will be diverted to the CHP sediment ponds, increasing residence time and enhancing settling ability. Suitable recommendations made will be considered for implementation.
- Increase in personnel from the currently approved 215 to 225. In addition, up to 75 temporary contractors will be required to assist with underground development activities for up to 15 months.

To modify the existing Project Approval 06_0021, Angus Place is seeking Ministerial approval under Section 75W of Part 3A Major Projects of the NSW Environmental Planning and Assessment Act 1979.



TITLE: FIGURE 1-1 STUDY AREA	LOCATION: ANGUS PLACE COLLIERY	DATUM: N/A PROJECTION: MGA ZONE 56 (GDA 94)	DATE: 11/10/2010 PURPOSE: ECO

LAYOUT REF: 26317 DRAFTING\MAPINFO\ARCH\FIG 1-1 STUDY AREA ECO
VERSION (PLAN BY): E (A.P-G.G-NW)

CLIENT: CENTENNIAL COAL
JOB REF: 26317

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RPS

1.3 Scope of the Study

The scope of this flora and fauna assessment report is to:

- identify vascular plant species found on the site;
- identify and map existing vegetation communities;
- assess the status of identified plant species and vegetation communities under relevant legislation;
- identify existing habitat types on the site and assess the habitat potential for threatened species, populations, or ecological communities known from the proximate area;
- identify threatened fauna potentially using the site; and
- assess the potential of the proposal to have a significant impact on any threatened species, populations or ecological communities identified during field surveys or as having potential habitat on the site.

Fieldwork was undertaken to cover all areas subject to substantial modelled subsidence of any potential significance to surface ecology, and also to cover all direct surface impact areas associated with the dewatering borehole and track upgrades etc. Notwithstanding that the fieldwork area did not extend to the boundary of the recently modelled subsidence area prediction, the field survey is considered adequate to assess the likely impacts on the fauna habitat and vegetation communities. This is based on a risk assessment approach that has used all relevant evidence. The evidence includes the prediction from the modelling by Ditton Geotechnical Services (2010) that the subsidence in the region outside of the field study area will be <30 mm. And that the prediction that cracking associated with the subsidence is expected to be minor, (<1 mm at 5 m depth) and self healing due to sedimentation. The risk of subsidence and therefore impact in these areas is considered to be low.

As the pit top and haul roads are part of an existing development they are not within the scope of this assessment.

The purpose of this report is to:

- ensure planning, management and development decisions are based on sound scientific information and advice by documenting the presence of any biodiversity components or potential significant impacts that may exist on the site;
- provide information to enable compliance with applicable assessment requirements contained within the TSC Act 1995, EP&A Act 1979, the EPBC Act 1999, and any other relevant state, regional and local environmental planning instruments; and
- enable the provision and analysis of ecological data that is comparable with data for other sites within the region to ensure continuity and consistency for survey and results.

1.4 Qualifications

This report was written by Toby Lambert B.Env.Sc., Allan Richardson B.Env.Sc. (Hons), Craig Anderson BAppSc(EAM) and Robert Sansom B.Sc. (Hons) of RPS. The academic qualifications and professional experience of all RPS consultants involved in the project are documented in Appendix 4.

1.5 Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S10300 (Valid 30 November 2010);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2011);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2011); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 26 May 2011).

1.6 Certification

As the principal author, I, Toby Lambert, make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the site;
- Commonwealth, state and local government policies and guidelines formed the basis of project surveying methodology, or where the survey work has been undertaken with specified departures from industry standard guidelines, details of which are discussed and justified in Section 2; and
- All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the *Animal Research Act 1995*, *National Parks and Wildlife Act 1974* and the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes*.

Principal Author and Certifier:

Toby Lambert
Senior Ecologist – Senior Project Manager
October 2010

2 Methodology

A variety of field survey techniques were employed over the course of fieldwork for this assessment to record a representative sample of flora species and fauna guilds across the site. Surveys were undertaken from the 18th to the 21st of January 2010, the 8th to the 12th and the 22nd to the 26th of February 2010. The surveys included site inspections, vegetation community surveys and various fauna survey methods including trapping, diurnal and spotlighting targeted surveys and habitat assessments. Targeted searches for threatened flora and fauna species were also undertaken.

RPS has undertaken numerous assessments of this nature within the local area and within wider NSW. Considerable local knowledge and experience supports an excellent understanding of the key ecological issues for this locality, and in particular the management strategies required to appropriately address and accommodate these issues in accordance with the requirements of determining authorities. Our extensive portfolio coupled with Commonwealth, State and Local Government policies, guidelines and stringent licensing form the basis for the adopted project methodology. The methodology was designed to meet the *Threatened Biodiversity Survey and Assessment Guidelines* (DEC, 2004).

2.1 Literature Review

A literature review was undertaken to assist in identifying distributions, suitable habitats and known records of threatened species so that field investigations could more efficiently focus survey effort. Information sources included:

- Aerial Photograph Interpretation (API) and literature reviews to determine the broad categorisation of vegetation within the site;
- Review of the Vegetation of the Western Blue Mountains – including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006);
- Review of fauna and flora records contained in the Department of Environment, Climate Change and Water (DECCW) Atlas of NSW Wildlife (accessed 24th January 2010) within a 10km radius of the site;
- Department of the Environment, Water, Heritage and the Arts (DEWHA) EPBC Act 1999 Protected Matters Search within a 10km radius of the site;
- DECCW Threatened Species, Populations and Ecological Communities website (*http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/*);
- Birdata (web version of Birds Australia's New Atlas of Australian Birds);
- Review of the Angus Place Colliery Proposed Mining and Coal Transport Environmental Assessment written by International Environmental Consultants Pty Ltd (2006);
- Review of the Angus Place Annual Environmental Monitoring Reports (AEMRs), Annual 2009 Flora Report for Angus Place, Springvale and Clarence mines, Lithgow,

NSW, University of Queensland (2010), and the assessment of Hydrological impacts by Aurecon (2010) and GHD (2010);

- A review of Geographic Information System (GIS) data including (but not limited to) aerial photography, topographic maps, State Environmental Planning Policy (SEPP) Mapping, Soil Landscapes and Acid Sulphate Soil Potential; and
- Collective knowledge gained from extensive work in the area.

2.2 Flora Survey

2.2.1 Vegetation Mapping

Flora surveys and vegetation mapping carried out on the site has been undertaken as follows:

- Review of the Vegetation of the Western Blue Mountains – including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006);
- Confirmation of the community type(s) present (dominant species) via undertaking flora surveys and identification;
- Consideration was given to the potential for the derived vegetation communities to constitute 'Endangered Ecological Communities' (EECs) as listed under the TSC Act 1995 and/or EPBC Act 1999; and
- Map the type and general extent of the communities present into definable map units where appropriate using a combination of Air Photo Interpretation (API) and ground truthing surveys.

A total of twelve flora quadrats (each 20m x 20m), several walking transects and several vehicular traverses were undertaken within the site (as shown in Figure 2.1). These surveys were undertaken by suitably qualified personnel on 18th, 19th, 20th and 21st January 2010. The vegetation surveys were undertaken to define and map vegetation communities and to search for threatened flora species. Additionally, further flora inspections, vegetation delineation and threatened flora searches were undertaken while conducting diurnal avifauna surveys and while otherwise traversing throughout the site on foot or within a vehicle.

2.2.2 Significant Flora Survey

A list of potentially occurring significant flora species from the locality (10km radius) was compiled, which included threatened species (Endangered or Vulnerable) and EEC's listed under the TSC Act 1995 and/or EPBC Act 1999. A total of 31 threatened flora species were identified as being recorded or as having potential habitat within the locality.

Two ecologists undertook targeted flora searches on the 18th, 19th, 20th and 21st of January 2010 and on the 22nd, 23rd, 24th, 25th and 26th of February 2010. In line with methodology such as the "Random Meander Technique" described by Cropper (1993) targeted searches throughout the proposed track upgrade, track extension area and the immediate surrounds of the proposed dewatering bore were undertaken.

In addition, searches for threatened flora species were also undertaken during traverses throughout the wider areas of the site, which were undertaken to delineate vegetation community boundaries within the proposed additional panel areas. The locations of all threatened flora species were recorded by the use of Trimble differential GPS units with sub-metre accuracy and are shown in Figure 3-2.

Targeted flora surveys were undertaken during the flowering period for *Genoplesium superbum* (September – March), when it can be detected. All other relevant species are non-cryptic or were surveyed within their recommended survey period.

2.2.3 Previous Flora Surveys

Previous flora survey and monitoring works conducted by Gingra Ecological Surveys over existing Angus Place coal extraction areas have recorded *Derwentia blakelyi* at Kangaroo Creek Swamp, West Wolgan Swamp and Narrow Swamp to the south of panel 910 and a single ROTAP species, namely, *Olearia quercifolia* (Oak-leaf Daisy Bush) at Kangaroo Creek Swamp.

Staff from the Centre for Mined Land Rehabilitation, University of Queensland (Vickers et al. 2010) undertook four seasonal surveys at the existing 14 Angus Place permanent monitoring sites. The presence of *Derwentia blakelyi and Olearia quercifolia* were also recorded during these surveys.

2.3 Habitat Survey

An assessment of the relative habitat value present on site was undertaken. This assessment focused primarily on the identification of specific habitat types and resources on the site favoured by known threatened species from the region. The assessment also considered the potential value of the site (and surrounds) for all major guilds of native flora and fauna.

Habitat assessment was based on the specific habitat requirements of each threatened fauna species in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.

2.4 Fauna Survey

The fauna survey methodology initially consisted of the production of an Expected Fauna Species List for the area (Appendix 1) and an assessment of the potential use of the site by threatened fauna species (as listed under the TSC Act 1995 and/or EPBC Act 1999) identified from the vicinity of the site. This was achieved by undertaking literature and database reviews followed by confirmation through field surveys, and any additional species observed were noted on the list.

Field surveys included: Terrestrial and Arboreal Trapping, Bat Trapping, Bat Echolocation Call Recording, Avifauna Surveys, Herpetofauna Surveys, Spotlighting, Secondary Indications and Incidental Observations.

The location and effort of each survey methodology was determined based on the fauna habitat located within the site via stratification of the site into habitat types.

2.4.1 Arboreal Trapping

Arboreal trapping was undertaken using 6 Elliott B size traps per trapping transect set for four nights (8th to 12th and 22nd to 26th of February 2009). Traps were mounted on brackets set at approximately 2m height on trees with a DBH greater than 30cm. Traps were baited with rolled oats, peanut butter and honey and the tree trunks were sprayed liberally with a honey and water mix each day in the late afternoon. Traps were checked early each morning. The location of each trap line is shown on Figure 2-1.

Arboreal traps targeted arboreal mammals such as the threatened *Petaurus norfolcensis* (Squirrel Glider), for which potential habitat was considered to occur within the study area. A total of seven trapping transects were undertaken within the site, resulting in 168 arboreal trap nights within the site.

2.4.2 Terrestrial Trapping

Terrestrial trapping was undertaken using 25 Elliott A, fourteen Elliott B and two cage traps set per trapping transect for eight nights (8th to 12th and 22nd to 26th of February 2009). Elliott A size traps were baited with rolled oats, peanut butter and honey. Dry dog food (Good-O's) was also used as bait within Elliott B traps in addition to rolled oats, peanut butter and honey. Cage traps were baited with chicken necks and dry dog food (Good-O's). Traps were checked early each morning, with any captures identified and released at point of capture. Traps were re-baited where necessary. The location of each trap line is shown on Figure 2-1.

Terrestrial traps (Elliott A) targeted small terrestrial mammals such as *Antechinus* and rats and cage traps targeted larger terrestrial mammals, such as bandicoots and quolls. A total of seven trapping transects were undertaken within the site, resulting in 700 Elliott A trap nights, 392 terrestrial Elliott B trap nights and 56 cage trap nights within the site.

2.4.3 Bat Trapping – Harp Traps

A total of two harp traps were placed along tracks within the open forest throughout the site for a total of eight consecutive nights (8th to 12th and 22nd to 26th of February 2009). Traps were checked early each morning, with any captures identified and released at point of capture. The location of the harp traps are shown on Figure 2-1.

A total of sixteen harp trap nights were undertaken within the site during surveys.

2.4.4 Bat Echolocation Call Recording

Bat echolocation calls were recorded using two Anabat II Detector and CF ZCAIM units set to remotely record for the entire night. Anabat surveys were undertaken on the 18th, 19th and 20th of January and the 22nd and 23rd of February 2010. Survey sites were changed each night with the emphasis for location placed on those areas deemed likely to provide potential hunting sites for bats. The location of each bat call survey site is shown on Figure 2-1.

Bat call analysis was undertaken by Anna McConville who is experienced in the analysis of bat echolocation calls.

2.4.5 Avifauna Survey

The presence of avifauna on the site was undertaken via targeted diurnal and nocturnal surveys, and by opportunistic observations during field surveys. Birds were identified by direct observation or by recognition of calls or through recognition of distinctive features such as nests, feathers, and owl regurgitation pellets etc. The potential for threatened avifauna to use the site was also assessed by identification of habitat attributes occurring within the site and their capacity to support threatened species that are known to occur in the wider locality.

Nocturnal surveys undertaken during spotlighting, attempted to identify roosting birds in a similar fashion to methods employed during diurnal surveys. Pre-recorded calls of owl species with the potential to occur within the site were broadcast in an effort to elicit vocal responses from the owls or to attract an owl to the playback site. The calls were broadcast through an amplification system (a hand held megaphone) designed to project the sound for at least 1km under still night conditions. As described by Kavanagh and Peake (1993) and Debus (1995), the call of each species was broadcast for at least five minutes, followed by five minutes of listening, and stationary spotlighting. Following the final broadcast and listening, the area was spotlighted on foot. Species broadcasted included *Ninox strenua* (Powerful Owl), *Ninox connivens* (Barking Owl), *Tyto tenebricosa* (Sooty Owl) and *Tyto novaehollandiae* (Masked Owl).

Opportunistic diurnal bird surveys were undertaken each day on the 18th, 19th, 20th and 21st of January 2010 and on the 8th, 9th, 10th, 11th, 12th, 22nd, 23rd, 24th, 25th and 26th of February 2010

A total of 3 nights of call playback were undertaken within the site (18, 19, 20 January 2010). The locations of the call playback sites are shown in Figure 2-1.

2.4.6 Herpetofauna Survey

Opportunistic and targeted herpetofauna searches were conducted during fauna surveys encompassing a diversity of habitats across the site. Known occurrences of threatened herpetofauna species from the region were taken into account during assessment of onsite habitat, to determine the potential for the site to support such species.

2.4.7 Spotlighting

Spotlighting was undertaken across the site via the use of 75-Watt hand-held spotlights and head torches during walking. A total of 8 person hours of spotlighting was undertaken over three nights (18th, 19th and 20th of January and the 23rd, of February 2010) within the site (Figure 2-1). The methodology discussed in Section 3.4.3 for call playback was also undertaken during spotlighting.

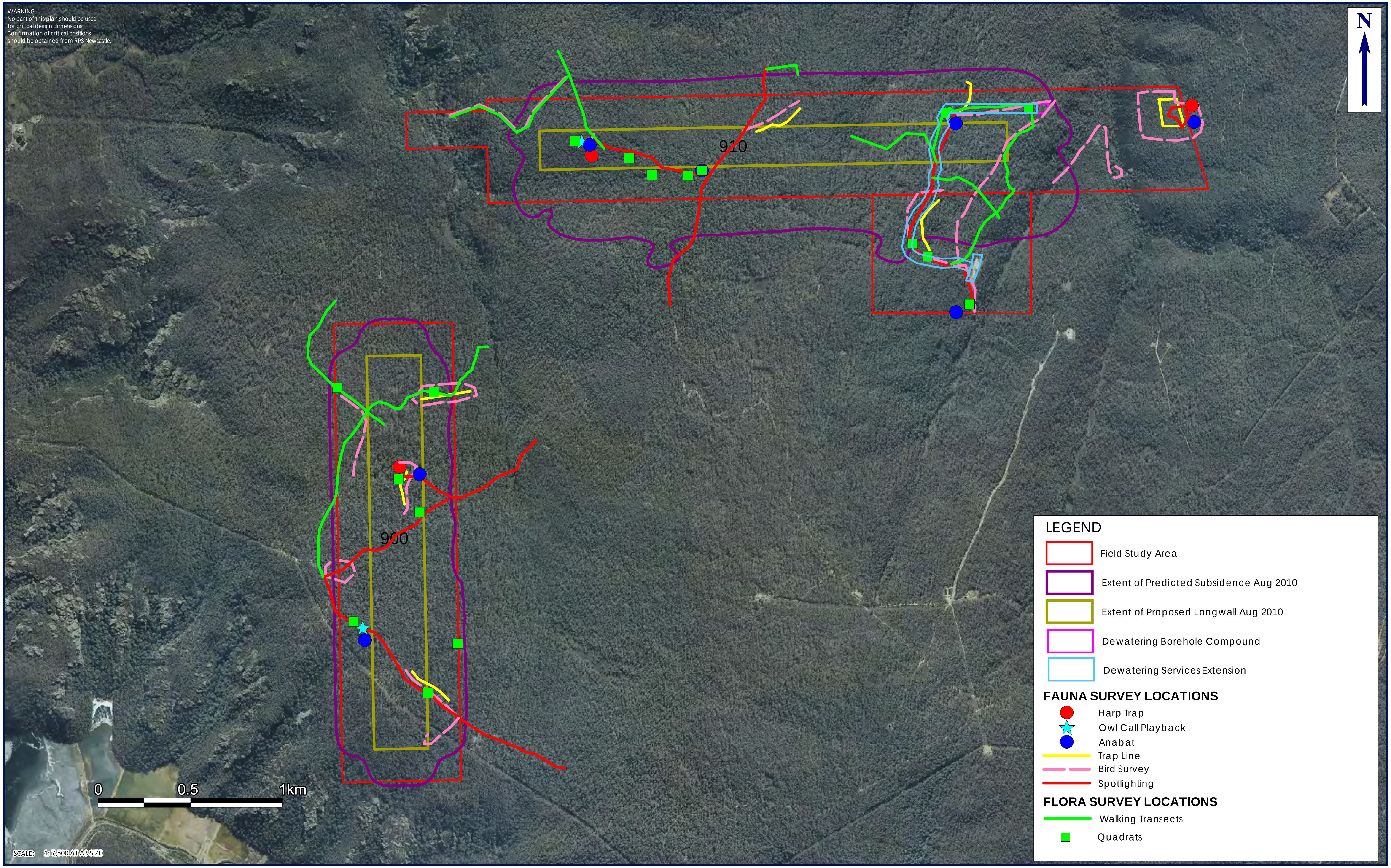
2.4.8 Secondary Indications and Incidental Observations

Opportunistic sightings of secondary indications (scratches, scats, diggings, tracks etc.) of resident fauna were noted. Such indicators included:

- Distinctive scats and scents left by mammals;
- Collection of predator scats for analysis;
- Nests made by various guilds of birds;
- Whitewash, regurgitation pellets and prey remains from Owls;
- Skeletal material of vertebrate fauna;
- The calls of fauna;
- Footprints left by mammals;
- chewed *Allocasuarina* cones indicative of feeding by *Calyptorhynchus lathami* (Glossy Black Cockatoo); and
- Chewed fruit remains indicative of past feeding by frugivorous birds such as Fruit-Doves.

2.4.9 Previous Fauna Surveys

On-going annual fauna monitoring over the Newnes Plateau has recorded a number of threatened fauna species, including *Petaurus norfolcensis* (Squirrel Glider), *Climacteris picumnus* (Brown Treecreeper), *Chthonicola sagittata* (Speckled Warbler) and *Tyto tenebricosa* (Sooty Owl). Comprehensive surveys over the site did not encounter these species, and habitats occurring within the site are considered to provide only marginal opportunities for the three bird species, due to the relative scarcity of local records, although habitat within the site was assessed as providing shelter and foraging opportunities for Squirrel Glider.



TITLE: FIGURE 2-1 FLORA AND FAUNA SURVEY LOCATIONS

LOCATION: ANGUS PLACE

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 12/08/2010
PURPOSE: ECOLOGY

CENTENNIAL\26317\DRAFTING\ECO FIGURES\
LAYOUT REF: 26317 FIG 2-1 FLORA & FAUNA SURVEY LOC D A3
VERSION (PLAN BY): D (A.P-T.L-N.W.)

CLIENT: CENTENNIAL COAL
JOB REF: 26317

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
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2.5 Survey Limitations

The limitations associated with this Flora and Fauna Assessment Report are presented herewith. The limitations have been taken into account specifically in relation to threatened species assessments, results and conclusions.

In instances where surveys were not able to reliably detect a particular species or guild, a precautionary approach has been adopted; as such 'assumed presence' of known and expected threatened species, populations and ecological communities has been made where relevant and scientifically justified to ensure a holistic assessment.

2.5.1 Flora Species / Communities

The seasonality of the surveys places limits on the number of flora species identified on the site as the surveys occurred in January and February when some species may have completed flowering and are therefore difficult to detect. Thus the flora species list cannot be considered to be comprehensive when only one survey period has been censused, due to seasonality of flowering.

Additionally, the cryptic nature of a number of flora species means that surveys may not have been able to detect species, despite potentially being present. There is a range of common albeit cryptic plant species that have a brief flowering period and hence small 'window' of effective 'detectability'. In addition, the seasonality of surveys also places limits on the number of flora species identified within the site at any given time. Therefore, some threatened species not detected cannot be discounted off-hand due to seasonality and other factors, and are therefore addressed in terms of their potential for occurrence within the site based on ecological factors.

The delineation of vegetation community boundaries is sometimes difficult due to the intergradations or ecotones of vegetation types. These ecotones can occur over a narrow width (2 to 10m) or very wide bands (30 to 150m width or greater) making the delineation of vegetation boundaries, in some cases, very subjective.

2.5.2 Fauna Species

The presence of fauna within a particular area is not static over time and may be seasonal in response to the availability of resources. The environmental conditions during which fauna surveys are undertaken greatly influence the species which are recorded. In terms of herpetofauna, conditions such as humidity, rainfall, temperature and barometric pressure can greatly affect the detectability of certain species. As such, where survey effort, targeting particular threatened fauna species, has not specifically met guidelines recommended by DECCW, habitat assessment and prediction of the occurrence of threatened fauna species has been applied.

Flowering and fruiting plant species, which attract some nomadic or migratory threatened species, often fruit or flower in cycles spanning a number of years. Furthermore, these resources might only be accessed in some areas during years when resources otherwise more accessible to threatened species fail. As a consequence threatened species may be absent from some areas even where potential habitat exists for extended periods.

Nevertheless, it is considered that the combined survey effort and dataset from all of the investigations undertaken to date within the locality provide a substantial picture of the fauna species and habitat values occurring within the site.

2.5.3 Data Availability and Accuracy

The collated threatened flora and fauna species records provided by the DECCW Atlas of NSW Wildlife (2010) for the region are known to vary in accuracy and reliability. Traditionally this is due to the reliability of information provided to DECCW for collation and/or the need to protect specific threatened species locations. During the review of threatened species records sourced from DECCW Atlas of NSW Wildlife (2010), consideration has been given to the date and accuracy of each threatened species record in addition to an assessment of habitat suitability within the site.

Similarly EPBC Protected Matters Searches provide a list of threatened species and communities that have been recorded within 10km, or which have suitable habitat within the wider area and are subject to the same inherent inaccuracy issues as State derived databases.

In order to address these limitations in respect to data accuracy, threatened species records have been used to provide a guide only to the types of species which occur within the locality of the site. As a consequence habitat assessment and the results of surveys conducted within the site have been used to assess the likelihood of occurrence of threatened species, populations and ecological communities to occur within the site.

3 Results

The prevailing weather conditions during the survey period are presented in Table 3-1 below.

Table 3-1: Prevailing Weather Conditions

	18th Jan 2010	19th Jan 2010	20th Jan 2010	21st Jan 2010	8th Feb 2010	9th Feb 2010	10th Feb 2010
Temperature	12-21°C	6-21°C	9 - 30°C	12-36°C	15-24°C	15-27°C	15-27°C
Rain (24 hrs to 9:00am)	5mm	0mm	0mm	0mm	10mm	1mm	0mm
Sun Rise	05:37	05:38	05:39	05:40	05:58	05:59	06:00
Sun Set	19:41	19:41	19:40	19:40	19:28	19:27	19:26
Moon Rise	18:31	09:26	11:16	01:46	00:56	01:46	02:40
Moon Set	21:39	22:05	22:58	16:44	15:53	16:44	17:29

	11th Feb 2010	12th Feb 2010	22th Feb 2010	23th Feb 2010	24th Feb 2010	25th Feb 2010	26th Feb 2010
Temperature	15-30°C	18-30°C	15 - 30°C	18-27°C	15-18°C	12-21°C	12-21°C
Rain (24 hrs to 9:00am)	1mm	1mm	0mm	0mm	1mm	0mm	0mm
Sun Rise	06:01	06:02	06:11	06:12	06:13	06:13	06:14
Sun Set	19:26	19:25	19:14	19:13	19:12	19:11	19:09
Moon Rise	03:36	04:33	14:11	15:12	16:10	17:02	17:48
Moon Set	18:09	18:44	N/A	00:08	01:07	02:12	03:24

Source: Bureau of Meterology website: http://www.bom.gov.au/products/IDN60801/IDN60801.94741.shtml information for Lithgow, and the Geoscience website: http://www.ga.gov.au/geodesy/astro/sunrise.jsp

3.1 Flora Survey

3.1.1 Vegetation Community Mapping

The Vegetation of the Western Blue Mountains – including the Capertee, Coxs, Jenolan and Gurnang Areas (DEC 2006) has mapped eleven vegetation communities within the site, namely:

1. MU 7 - Newnes Plateau Narrow-leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest;
2. MU 8 – Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest;
3. MU 14 – Tableland Mountain Gum – Snow Gum - Daviesia Montane Open Forest;

4. MU 26 – Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest;
5. MU 26a – (= Variant of MU26) with Brittle Gum, Scribbly Gum and Mountain Gum;
6. MU 28 – Sandstone Plateau and Ridge Scribbly Gum – Silvertop Ash Shrubby Woodland;
7. MU 29 – Sandstone Slopes Sydney Peppermint Shrubby Forest;
8. MU 43 – Pagoda Rock Sparse Shrubland;
9. MU 44 – Sandstone Plateaux Tea Tree – Dwarf Sheoak – Banksia Rocky Heath;
10. MU 50 – Newnes Plateau Shrub Swamp; and
11. MU 51 – Newnes Plateau Hanging Swamp.

However, ground truthing of the site identified ten vegetation communities as follows:

1. MU 7 - Newnes Plateau Narrow-leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest;
2. MU 8 – Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest;
3. MU 26 – Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest;
4. MU 26a – (= Variant of MU26) with Brittle Gum, Scribbly Gum and Mountain Gum;
5. MU 43 – Pagoda Rock Sparse Shrubland;
6. MU 44 – Sandstone Plateau Tea Tree – Dwarf Sheoak – Banksia Rocky Heath;
7. MU 50 – Newnes Plateau Shrub Swamp (EEC);
8. MU 50 - Newnes Plateau Shrub Swamp with MU 8 Overstorey
9. MU 51 – Newnes Plateau Hanging Swamp (EEC); and
10. Cleared areas.

The following section provides a brief outline of the dominant floral characteristics of each identified vegetation community. A full list of flora species is provided in Appendix 2.

1. MU 7 – Newnes Plateau Narrow-leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest

Description: This vegetation community occurred throughout large areas of the site and is located predominantly on the ridgetops and central parts of the plateau. This is a tall forest with a relatively open or sparse shrub layer and a variable dense to sparse ground layer.

Canopy Layer: 18 to 20m – 35% Percentage Foliage Cover (PFC). Dominant species include; *Eucalyptus radiata* (Narrow-leaved Peppermint), *Eucalyptus blaxlandii* (Blaxland's Stringybark), *Eucalyptus sieberi* (Silvertop Ash), *E. dalrympleana* (Mountain Gum), with *Eucalyptus oreades* (Blue Mountains Ash) also occurring in parts of this community.

Sub Canopy Layer: 10m to 15m – 20% PFC. Dominant species included; juvenile canopy species *Eucalyptus radiata* (Narrow-leaved Peppermint), *Eucalyptus blaxlandii* (Blaxland's Stringybark), *E. dalrympleana*

(Mountain Gum), with occasional *Eucalyptus oreades* (Blue Mountains Ash).

Shrub Layer: 0.5m to 2m – 5 to 20% Percentage Foliage Cover (PFC). Dominant shrub species included; *Daviesia latifolia, Monotoca scoparia* (Prickly Broom Heath), *Acacia terminalis* (Sunshine Wattle), *Lomatia silaifolia* (Crinkle Bush), *Polyscias sambucifolia* (Elderberry Panax), *Leucopogon lanceolatus* (Lance-leaf Beard-heath), *Boronia microphylla* (Small-leaved Boronia) and *Banksia cunninghamii*. Dominant small shrub species included; *Persoonia chamaepitys* (Mountain Geebung), *Phyllota squarrosa* (Dense Phyllota) and *Hibbertia obtusifolia* (Grey Guinea Flower).

Ground Layer: 0m to 1.2m – 35% Percentage Foliage Cover (PFC). Dominant species included; *Poa sieberiana* var. *cyanophylla*, *Lomandra glauca* (Pale Mat-rush), *Dianella revoluta* (Spreading Flax Lily), *Arrhenechthites mixta* (Purple Fireweed), *Gonocarpus tetragynus* (Poverty Raspwort), *Joyceae pallida* (Silvertop Wallaby Grass), *Lomandra multiflora* (Many-flowered Mat-rush) and *Viola hederacea* (Ivy-leaved Violet). The climber, *Billardiera scandens* (Hairy Appleberry) was also recorded within this community.

Classification: This vegetation community is considered to be commensurate with MU 7 – Newnes Plateau Narrow-leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest as described and mapped in 'The Vegetation of the Western Blue Mountains' (DEC 2006).

2. MU 8 – Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest

Description: This vegetation community occurred along the drainage line in the far western part of the proposed longwall panel 910 and along the western edges of drainage lines in the east of panel 910. 'The Vegetation of the Western Blue Mountains' (DEC 2006) mapped this community within the deeper ravine in the west. An inspection of the community (see Note above) showed that the vegetation mapping of this community by DEC (2006) was accurate. The following description was derived from a combination of the vegetation community description (DEC 2006) and visual observations from the escarpment.

This vegetation was very tall with the canopy layer being in excess of 20 metres. The dominant canopy species of the western section were *Eucalyptus fastigata* (Brown Barrel), and occasionally *E. oreades* (Blue Mountains Ash), where gullies entered from higher slope occurrences of MU 26. Mid-storey to lower-storey shrubs were often dominated by ferns such as *Pteridium esculentum* (Bracken Fern) and *Blechnum cartilagineum* (Gristle Fern) in the ground-cover layers. The eastern occurrences of this community occurred at the moister bases of east facing slopes between mid-slope MU 26 and drainage occurrences of MU 50. The occurrences of this community in the east showed influences of both these surrounding communities at times and canopy elements of this community shared the drainage line with MU 50 understorey occurrences for large areas.

Canopy Layer: To 27m – 30% Percentage Foliage Cover (PFC). Dominant species included; *Eucalyptus fastigata* (Brown Barrel), and to a lesser extent *E. oreades* (Blue Mountains Ash), in the west, *E. fastigata* (Brown Barrel), *E. oreades* (Blue Mountains Ash), *E. mannifera* subsp. *gullickii* (Brittle Gum) and E. *radiata* (Narrow-leaved Peppermint), in the east.

Sub Canopy Layer: 8m to 12m – 15% Percentage Foliage Cover (PFC). Dominant species included juvenile and suppressed *Eucalyptus fastigata* (Brown Barrel), *E. mannifera* subsp. *gullickii* (Brittle Gum) *E. radiata* (Mountain Gum), *E. radiata* (Narrow-leaved Peppermint) and *E. oreades* (Blue Mountains Ash).

Tall Shrub Layer: 5m to 8m – 20 to 20% Percentage Foliage Cover (PFC). Dominant tall shrub species included; *Acacia melanoxylon* (Blackwood), *Banksia cunninghamii* and, *Leptospermum polygalifolium* (Tantoon).

Shrub Layer: 1m to 2.5m – 15% Percentage Foliage Cover (PFC). Dominant shrub species included; *Lomatia myricoides* (River Lomatia), *Polyscias sambucifolia* (Elderberry Panax), *Leucopogon lanceolatus* (Lance Beard-heath), and *Monotoca scoparia*.

Ground Layer: 0m to 1.5m – 90% Percentage Foliage Cover (PFC). Dominant species included; *Pteridium esculentum* (Bracken Fern), *Blechnum cartilagineum* (Gristle Fern), *Gleichenia dicarpa* (Pouched Coral Fern), *Gahnia limicola* and *Dianella tasmanica* (Blue Flax Lily).

Classification: This vegetation community is considered to be commensurate with MU 8 – Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest as described and mapped in 'The Vegetation of the Western Blue Mountains' (DEC 2006).

3. MU 26 – Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest

Description: This vegetation community is generally open in structure with a sparse shrub layer to such an extent that it is not unusual to be able to see two hundred metres within it. This vegetation community occurred on the ridge-tops, and side-slopes within the site. The dominant canopy species were *E. blaxlandii* (Blaxland's Stringybark), *E. radiata* (Narrow-leaved Peppermint), *E. sieberi* (Silvertop Ash) and *E. oreades* (Blue Mountains Ash) sometimes sparsely / dominantly present. There is a variation of this vegetation community (MU 26a) which is described separately below. This vegetation community often has a wide ecotone with Map Unit 7 - Newnes Plateau Narrow-leaved Peppermint – Mountain Gum – Brown Stringybark Layered Forest. As a result it is difficult to determine the boundaries at the interface of these individual communities. In addition, the blurring of the community boundaries is enhanced by previous logging activities and subsequent regrowth.

Canopy Layer: 18 to 20m – 30 to 40% Percentage Foliage Cover (PFC). Dominant species included; *E. blaxlandii* (Blaxland's Stringybark), *E. radiata* (Narrow-leaved Peppermint), *E. sieberi* (Silvertop Ash), with *E. oreades* (Blue Mountains Ash) and to a lesser extent *E. dives* (Broad-leaved Peppermint), sometimes present.

Sub Canopy Layer: 8m to 15m – 30% Percentage Foliage Cover (PFC). Dominant species were mostly juvenile canopy species.

Shrub Layer: 1m to 4m – 2 to 5% Percentage Foliage Cover (PFC). Dominant shrub species included; *Monotoca scoparia* (Prickly Broom Heath), *Boronia microphylla* (Small-leaved Boronia), *Daviesia latifolia*, *Hakea dactyloides* (Broad-leaved Hakea), *Lomatia silaifolia* (Crinkle Bush), *Isopogon anemonifolius* (Flat-leaved Drumsticks), *Petrophile sessilis* (Conesticks), *Acacia terminalis* (Sunshine Wattle) and *Banksia cunninghamii*.

Ground Layer: 0m to 1.2m – variable 20 to 60% Percentage Foliage Cover (PFC). Dominant species included; *Joyceae pallida* (Silvertop Wallaby Grass), *Patersonia sericea* (Wild Iris), *Pimelea linifolia* (Slender Rice Flower), *Dianella revoluta* (Spreading Flax Lily), *Amperea xiphoclada* (Broom Spurge), *Dampiera stricta* (Blue Dampiera), *Austrostipa pubescens* (Tall Speargrass), *Gonocarpus tetragynus* (Poverty Raspwort) and *Lomandra glauca* (Pale Mat-rush). The climber, *Billardiera scandens* (Hairy Appleberry) was also recorded within this community.

Classification: This vegetation community is considered to be commensurate with MU 26 – Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest as described and mapped in 'The Vegetation of the Western Blue Mountains' (DEC 2006).

4. MU 26a – (= Variant of MU26) with Brittle Gum, Scribbly Gum and Mountain Gum

Description: This vegetation community occurs in slight depressions, hollows and some drainage lines. It is often interspersed within Map Units 7 and 26 described above. This community variant is easily identified by a combination of twisted white stemmed smooth-barked gums (*E. sclerophylla*, *E. mannifera* and *E. dalrympleana*) and sometimes *E. dives*, which may dominate in patches. It has a variable density shrub layer and a generally grassy ground layer characterised by graminoid species such as *Patersonia* sp., *Lomandra* sp. and *Dianella* sp. This community variant is also shorter in height, rarely exceeding 16 metres and is often more open than associated surrounding vegetation. Drier manifestations of this community around rocky outcrops are characterised by more stunted canopy elements.

A small variant of this community located along the existing access track to the existing Angus Place mine dewatering compound is characterised by some dense wet heath with a sedge and coral fern understorey. Eucalypts occur across this community in low densities. It does not warrant separate mapping but was noticeable in that it had more of a moist understorey with some similar species to the shrub swamp communities.

Canopy Layer: 10 to 16m – 20-30% Percentage Foliage Cover (PFC). Dominant species included; *E. sclerophylla* (Scribbly Gum), *E. mannifera* subsp. *gullickii*, *E. dives* (Broad-leaved Peppermint) and *E. dalrympleana* (Mountain Gum) with occasional *E oreades* (Blue Mountains Ash) or *E. sieberi* (Silvertop Ash).

Sub Canopy Layer: 6 to 8m – 15% Percentage Foliage Cover (PFC). Dominant species were juvenile eucalypt species with occasional occurrences of juvenile *E. pauciflora* (Snow Gum) in the understorey of eastern patches.

Shrub Layer: 2m to 4m – 5 to 25% Percentage Foliage Cover (PFC). Dominant shrub species included; *Monotoca scoparia* (Prickly Broom Heath), *Boronia microphylla* (Small-leaved Boronia), *Daviesia latifolia*, *Hakea dactyloides* (Broad-leaved Hakea), *Lomatia silaifolia* (Crinkle Bush), *Isopogon anemonifolius* (Flat-leaved Drumsticks), *Petrophile sessilis* (Conesticks), *Acacia terminalis* (Sunshine Wattle) and *Banksia cunninghamii.*

Ground Layer: 0m to 1.5m – variable 40 to 80% Percentage Foliage Cover (PFC). Dominant species included; *Joyceae pallida* (Silvertop Wallaby Grass), *Austrostipa pubescens* (Tall Speargrass), *Poa sieberiana* var. *cyanophylla*, *Lomandra longifolia* (Spiky-headed Mat-rush), *Patersonia sericea* (Wild Iris), *Mirbelia platylobioides, Phyllota squarrosa* (Dense Phyllota), *Pimelea linifolia* (Slender Rice Flower), *Dianella revoluta* (Spreading Flax Lily), *Amperea xiphoclada* (Broom Spurge), *Dampiera stricta* (Blue Dampiera), *Gonocarpus tetragynus* (Poverty Raspwort) and *Lomandra glauca* (Pale Mat-rush).

Classification: This vegetation community is considered to be commensurate with MU 26a (Gum Hollows Variant) – Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest as described and mapped in 'The Vegetation of the Western Blue Mountains' (DEC 2006).

5. MU 43 – Pagoda Rock Sparse Shrubland

Description: This vegetation community occurred within a small area near the western end of proposed longwall panel 910. This community encompasses large areas of bare rock with occasional benches, depressions, cracks or skeletal soils over rock which contains sparse vegetation suited to the harsh conditions within this habitat. Some sites include scattered *Callitris* pines or low stunted Eucalypts.

Canopy Layer: To 8m – less than 5% Percentage Foliage Cover (PFC). Dominant species included; *Eucalyptus sieberi* (Silvertop Ash), *E. blaxlandii* (Blaxland's Stringybark), *Allocasuarina distyla,* and occasional *Callitris rhomboidea* (Port Jackson Cypress).

Shrub Layer: 0.5 to 1.6m – 5 to 10% Percentage Foliage Cover (PFC). Dominant shrub species included; *Leptospermum arachnoides, Leptospermum trinervium* (Slender Tea-tree), *Monotoca scoparia* (Prickly Broom-heath) and *Petrophile pulchella* (Conesticks).

Ground Layer: 0m to 0.5m – 10 to 15% Percentage Foliage Cover (PFC). *Gonocarpus teucroides* (Raspwort), *Goodenia bellidifolia* (Daisy-leaved Goodenia), *Lomandra glauca* (Pale Mat-rush), *Platysace linariifolia* (Narrow-leafed Platysace) and *Stylidium graminifolium* (Grass Trigger Plant).

Classification: This vegetation community is considered to be commensurate with MU 43 – Pagoda Rock Sparse Shrubland as described and mapped in 'The Vegetation of the Western Blue Mountains' (DEC 2006).

6. MU 44 – Sandstone Plateaux Tea Tree – Dwarf Sheoak – Banksia Rocky Heath

Description: This community occurs on rock plates and rock terraces amongst rock pagodas and cliff edges usually in areas with wet skeletal soils on sandstone. This community is characterised by three consistently occurring species; *Allocasuarina nana* (Dwarf Sheoak), *Banksia ericifolia*, and *Leptospermum arachnoides*. The groundcover is rarely more than localised in nature, with sedges (particularly *Lepidosperma* sp.) being the dominant cover, and the small shrub *Platysace linearifolia* also common.

Canopy Layer: Generally Absent.

Shrub Layer: To 5m – 80 to 90% Percentage Foliage Cover (PFC). Dominant species included; *Allocasuarina nana* (Dwarf Sheoak), *Hakea dactyloides* (Broad-leaved Hakea), *Isopogon anemonifolius* (Flat-leaved Drumsticks), *Grevillea acanthifolia* subsp. *acanthifolia*, *Leucopogon lanceolatus* (Lance-leaved Beard Heath), *Lomatia silaifolia* (Crinkle Bush), *Monotoca scoparia* (Prickly Broom-heath), *Petrophile pulchella* (Conesticks), *Banksia ericifolia* (Heath-leaved Banksia) and *Leptospermum arachnoides* (Tea Tree).

Ground Layer: 0m to 1m – variable 30 to 85% Percentage Foliage Cover (PFC). *Gonocarpus teucrioides* (Raspwort), *Dampiera stricta* (Blue Dampiera), *Lepidosperma laterale* (Variable Sword Sedge), *Platysace linearifolia* (Narrow-leaved Platysace), *Goodenia bellidifolia* (Daisy-leaved Goodenia), *Lomandra glauca* (Pale Mat-rush), *Pteridium esculentum* (Bracken), *Platysace linariifolia* (Narrow-leafed Platysace) and *Stylidium lineare* (Narrow-leaved Trigger Plant).

Classification: This vegetation community is considered to be commensurate with MU 44 – Sandstone Plateaux Tea Tree – Dwarf Sheoak – Banksia Rocky Heath as described and mapped in 'The Vegetation of the Western Blue Mountains' (DEC 2006).

7. MU 50 – Newnes Plateau Shrub Swamp

Description: This vegetation community occurs along long gentle open drainage lines within the site. It forms a dense wet heath with an unevenly textured tussock / hummock grassy sedge understorey. Trees are typically absent, although sparsely scattered Eucalypts can occur in the margins where it interfaces with surrounding communities. Some areas of this community in the eastern end of panel 910 (downstream of Narrow Swamp) were considerably degraded and displayed a moderately high density of herbaceous weeds, particularly asteraceous species.

Canopy Layer: 5 to 8m – 0 to 10% Percentage Foliage Cover (PFC). Generally absent in the core of the community, only sparsely present within the margins. Typical species are dependant upon topographic context, but include; *E. mannifera* subsp. *gullickii* (Brittle Gum), *E. fastigata* (Brown Barrel) and *E. oreades* (Blue Mountains Ash) in deep drainage lines and *E. sclerophylla*, *E. dives* and *E. dalrympleana* in an upper-slope context.

Shrub Layer: 0.5m to 2m – 50 to 70% Percentage Foliage Cover (PFC). Dominant shrub species included; *Leptospermum continentale* (Tea-tree), *Leptospermum grandifolium* (Woolly Tea Tree), *Leptospermum polygalifolium* (Tantoon) with *Hakea dactyloides* (Broad-leaved Hakea) and *Boronia microphylla* (Small-leaved Boronia) occasionally at the edges.

Ground Layer: 0m to 0.5m – 10 to 60% Percentage Foliage Cover (PFC). Dominant species included; *Lepidosperma limicola, Baeckea linifolia* (Weeping Baeckea), *Pimelea linifolia* (Slender Rice Flower), *Empodisma minus*, *Epacris pulchella* (Wallum Heath), *Gahnia microstachya*, *Baloskion australe* and *Gleichenia dicarpa* (Pouched Coral Fern).

Classification: This community is a component of and corresponds to *Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion* as listed in the TSC Act 1995. This vegetation community also corresponds to the federally listed (EPBC Act 1999) EEC known as *Temperate Highland Peat Swamps on Sandstone*.

8. MU 50 – Newnes Plateau Shrub Swamp with MU 8 Overstorey

Description: This vegetation community occurs along the same long gentle drainage lines within the eastern drainage line of panel 910 as MU 50 usually occurs. It is characterised by the same dense wet heath with a sedge and coral fern understorey. Although trees are typically absent from MU 50, Eucalypts occur across this community in low densities. Due to the different canopy structure it has been mapped separately from open MU 50 occurrences and *Eucalyptus* sp. are those derived from MU 8 and MU 26 variations, which characterise neighbouring communities.

Canopy Layer: 20 to 25m – 0 to 25% Percentage Foliage Cover (PFC). Occasionally absent in the core of the community, and sparse to moderate density across the drainage basins. Typical species include; *E. mannifera* subsp. *gullickii* (Brittle Gum), *E. fastigata* (Brown Barrel) and *E. oreades* (Blue Mountains Ash.

Shrub Layer: 0.5m to 2m – 50 to 70% Percentage Foliage Cover (PFC). Dominant shrub species included; *Leptospermum continentale* (Tea-tree), *Leptospermum grandifolium* (Woolly Tea Tree), and *Leptospermum polygalifolium* (Tantoon) with *Hakea dactyloides* (Broad-leaved Hakea) and *Boronia microphylla* (Small-leaved Boronia) occasionally at the edges.

Ground Layer: 0m to 0.5m – 10 to 60% Percentage Foliage Cover (PFC). Dominant species included; *Lepidosperma limicola, Baeckea linifolia* (Weeping Baeckea), *Pimelea linifolia* (Slender Rice Flower), *Empodisma minus*, *Epacris pulchella* (Wallum Heath), *Gahnia microstachya*, *Baloskion australe* and *Gleichenia dicarpa* (Pouched Coral Fern).

9. MU 51 – Newnes Plateau Hanging Swamp

Description: This vegetation community occurs in gully heads and ridge-top sites where groundwater seepage travelling through permeable rock layers is directed laterally by impermeable layers. These form wet peaty soils in which a range of swamp heath flora species grow.

Upper Layer: 1 to 3m – 0 to 30% Percentage Foliage Cover (PFC). Generally absent in the core of the community, only sparsely present within the margins. Typical species include; *Grevillea acanthifolia* subsp, *acanthifolia, Baeckea linifolia* (Weeping Baeckea), *Epacris microphylla* (Coral Heath), *Hakea dactyloides* (Broad-leaved Hakea), and *Leptospermum continentale* (Tea-tree).

Ground Layer: 0m to 2m – 80 to 95% Percentage Foliage Cover (PFC). Dominant species include; *Gleichenia dicarpa* (Pouched Coral Fern), *Lepidosperma limicola, Drosera peltata* (Sundew), *Drosera spathulata* (Sundew), and *Gahnia sieberiana* (Red-fruited Saw-sedge).

Classification: This community is a component of and corresponds to *Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion* as listed in the TSC Act 1995. This vegetation community also corresponds to the federally listed (EPBC Act 1999) EEC known as *Temperate Highland Peat Swamps on Sandstone.*

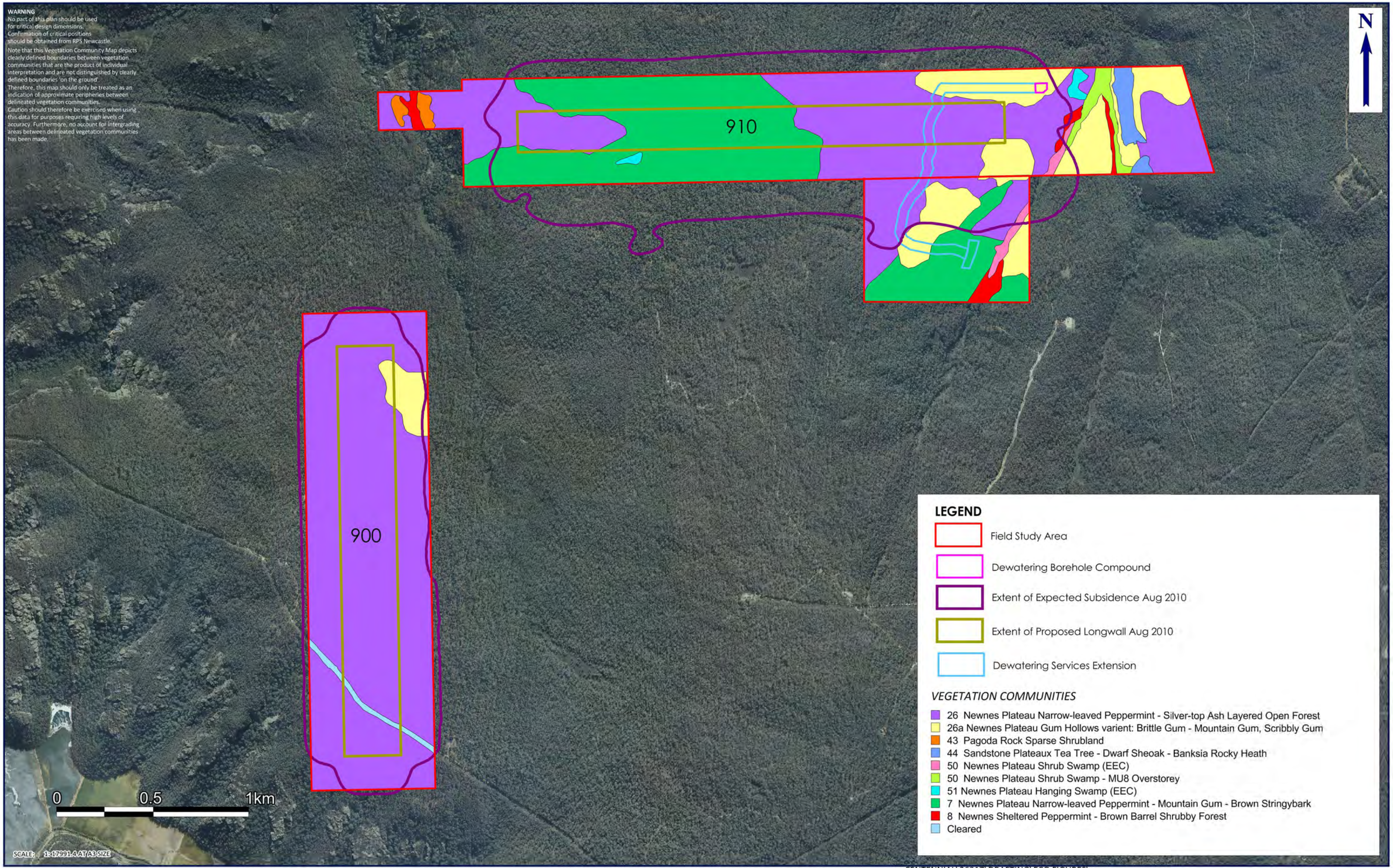
10. Cleared Areas

Description: This vegetation community occurs along power line easements, tracks and occasional areas cleared for Boreholes. The canopy layer has been removed along with all or most of the shrub layer. These areas contain mostly remnant native vegetation, however are sometimes more affected by weed invasion due to previous or repeated disturbance.

Canopy Layer: Generally absent, but occasionally regrowth 3 to 5m – 0 to 10% Percentage Foliage Cover (PFC). Typical species include whichever species are naturally occurring adjacent to the cleared area.

Shrub Layer: Generally sparse 0.5m to 2m – 5 to 30% Percentage Foliage Cover (PFC). Species include those species growing in native vegetation in proximity. In addition some exotic species such as Lantana may also be present.

Ground Layer: 0m to 1.5m – 10 to 90% Percentage Foliage Cover (PFC). Dominant species include species similar to those found in adjacent native vegetation communities.



TITLE: FIGURE 3-1 VEGETATION COMMUNITIES

LOCATION: ANGUS PLACE

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 7/10/2010
PURPOSE: ECOLOGY

LAYOUT REF: CENTENNIAL\26317\DRAFTING\ECO FIGURES\ 26317 FIG 4-1 VEGETATION COMMUNITIES F A3
VERSION (PLAN BY): D (A.P-T.L)

CLIENT: CENTENNIAL COAL
JOB REF: 26317

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3.1.2 Significant Flora

The results of database searches (DECCW Atlas of NSW Wildlife and EPBC Protected Matters Search) indicated that 31 threatened flora species have been previously recorded within 10km of the site (the locality) and/or have potential habitat within the site. The threatened flora species that have been recorded (in **bold**) or have the potential to occur within the locality of the site include:

▪ *Acacia bynoeana*	Bynoe's Wattle
▪ *Acacia flocktoniae*	Flockton Wattle
▪ *Asterolasia buxifolia*	
▪ *Boronia deanei*	Deane's Boronia
▪ *Callistemon linearifolius*	Netted Bottle Brush
▪ *Darwinia peduncularis*	
▪ ***Derwentia blakelyi***	
▪ *Eucalyptus cannonii*	Capertee Stringybark
▪ *Eucalyptus pulverulenta*	Silver-leafed Gum
▪ *Genoplesium superbum*	
▪ *Grevillea evansiana*	Evans Grevillea
▪ *Grevillea obtusiflora*	
▪ *Grevillea parviflora*	
▪ *Haloragodendron lucasii*	
▪ *Lastreopsis hispida*	Bristly Shield Fern
▪ *Leionema sympetalum*	Rylstone Bell
▪ *Melaleuca biconvexa*	Biconvex Paperbark
▪ *Olearia cordata*	
▪ *Persoonia acerosa*	Needle Geebung
▪ ***Persoonia hindii***	
▪ *Persoonia hirsuta*	Hairy Geebung
▪ *Persoonia marginata*	Clandulla Geebung
▪ *Phebalium bifidum*	
▪ *Philotheca ericifolia*	
▪ *Pomaderris brunnea*	Brown Pomaderris
▪ *Prostanthera cryptandroides* subsp. *cryptandroides*	Wollemi Mint Bush
▪ *Prostanthera stricta*	Mount Vincent Mint Bush
▪ *Pultenaea glabrata*	Smooth Bush-Pea

- *Pultenaea sp.* Glenowlan Point
- *Thesium australe* Austral Toadflax
- *Wollemia nobilis* Wollemi Pine

Two threatened flora species were observed within the proposed new panel areas during the flora surveys. These species were:

- *Derwentia blakelyi* (listed as Vulnerable under the NSW TSC Act 1995); and
- *Persoonia hindii* (listed as Endangered under the NSW TSC Act 1995).

One notable species, *Olearia quercifolia* (Oak Leaf Daisy Bush), which is listed as a *Rare or Threatened Australian Plant* (ROTAP) was recorded within degraded Newnes Plateau Shrub Swamp 250m to the east of Panel 910 at the edge of extent of predicted subsidence.

The locations of these threatened and notable flora species are shown in Figure 3-2.

Derwentia blakelyi

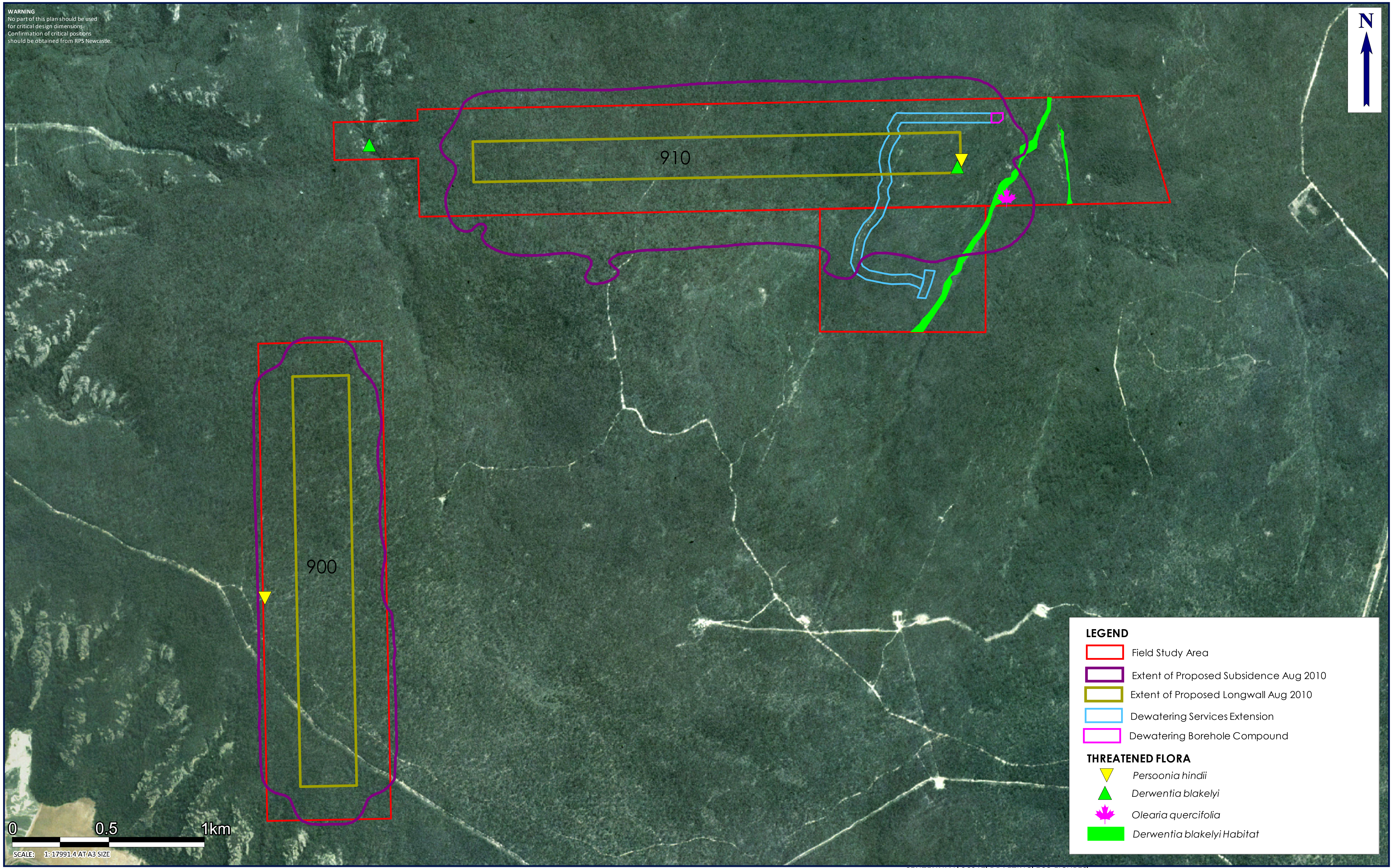
This is a small shrub which usually occurs in low densities, often in moister areas of Eucalypt forest. This species flowers in summer and is known from fewer than 20 locations. *D. blakelyi* is identifiable when not in flower by the distinctive ovate to lanceolate recurved leaves which are 'V' shaped in cross section with serrated edges. It grows in eucalypt forest often in moist areas and is known to occur in the Western Blue Mountains near Clarence, near Mt Horrible, Nullo Mountain and in the Coricudgy Range.

One individual was recorded within a deep drainage line in the west of Panel 910, seven specimens of this species were observed within a small area (located in excess of 200 metres to the south of the proposed dewatering bore within the proposed longwall Panel 910, and large numbers (estimated >5,000 individuals) were discovered in favourable habitat 250m from the eastern end of Panel 910 as shown in Figure 3-2.

Estimations of numbers were derived from a 20m x 20m quadrat containing 120 plants and extrapolating in relation to calculated area of habitat. *D. blakelyi* habitat was found to be between 10m and 50m wide (conservative average of 20m) and is at least 1km long. If the plant occurs at a density of 100 / 20mx20m plot then a potential 5,000 plants may occur within the study area. Considering that the total potential habitat within the study area exceeds double this area the calculations are considered to be conservative. The vast majority of this habitat and species occurrence is located outside the limit of subsidence. Those area located within the limits of subsidence are not likely to be impacted as subsidence in these areas is only predicted to be less than 0.05mm, i.e. virtually no discernable difference to the existing situation.

Persoonia hindii

An erect to spreading shrub 0.3 to 1m tall with slightly upwardly curving linear-oblong leaves usually concave on the upper surface. Numerous shoots arise from underground rhizomes with reddish young shoots often hairy. Mature leaves are glabrous. This species flowers from January to March with possible sporadic flowering in other months. Distribution is limited to the Newnes Plateau in the Upper Blue Mountains where it occurs in dry forest habitats. Forty-one specimens of this species were observed in a small area (20m x 5m) located in excess of 200 metres to the south of the proposed dewatering bore within the south-eastern corner of proposed longwall Panel 910, an additional 22 specimens were also observed near the western boundary of the proposed panel 900W as shown in Figure 3-2.



TITLE: FIGURE 3-2 THREATENED & NOTEABLE FLORA LOCATIONS

LOCATION: ANGUS PLACE

DATUM: N/A
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 12/08/2010
PURPOSE: ECOLOGY

LAYOUT REF: CENTENNIAL\26317\DRAFTING\ECO FIGURES\26317 FIG 4-3 THREAT FLORA D A3
VERSION (PLAN BY): D (A.P-T.L)

CLIENT: CENTENNIAL COAL
JOB REF: 26317

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3.2 Habitat Survey

Habitats within the site were assessed for their potential to support native fauna species including threatened fauna for which records occur within the wider locality. Broad habitat types recorded within the site included; open forest areas, riparian/damp areas characterised by swampy vegetation and exposed rocky areas.

3.2.1 Terrestrial Habitats

Most open forest communities within the site contain a grassy understorey component to ground-cover strata, which provide suitable habitat for a number of terrestrial mammals, including macropods and wombats. There is sufficient forest debris, due in part to timber harvesting activity, to provide foraging opportunities for small marsupial mammals and rats.

Understorey structure is generally characterised with sufficient structural diversity and debris to provide foraging opportunities for a range of common woodland bird species and reptiles.

Swamp heath vegetation also contains high densities of proteaceous plants, which provide foraging resources for nectivorous mammals and birds, and the dense cover, more secretive understorey bird species. The dampness of these habitats are suited to a range of common reptile and amphibians occurring in higher altitude areas.

3.2.2 Arboreal Habitats

Canopy tree species and understorey proteaceous shrubs provide abundant foraging resources such as foliage, seeds, pollen, nectar and invertebrates for a range of faunal guilds, including arboreal mammals, bats and birds.

The presence of arboreal and terrestrial mammal populations suggest that there are sufficient foraging opportunities to support forest owls, although a general paucity of large hollows places constraints upon breeding opportunities for these species and cockatoos.

Open woodlands and forests across the site, and the plateau in general, provide foraging opportunities for a range of microchiropteran bats that occur within the locality. Although the site's forests only exhibit a low to moderate density of hollow-bearing trees, there are sufficient to provide roosting and nesting habitat for a diversity of hollow-dwelling Microchiropteran bat species. There is also abundant roosting and den habitat for cave dwelling species, within rocky outcrops around the edges of the plateau and within the deeper gullies and associated escarpments throughout the area. Older mine subsidence areas located in the wider locality may also provide habitat for these species.

The cleared areas (mostly tracks, fire-trails and powerline easements) occurring within the site are considered to be insignificant in terms of providing habitat for native fauna species aside from providing foraging habitat along the ecotone between cleared and forested areas (such as for hunting by owls and Microchiropteran bat species).

3.2.3 Corridors and Habitat Linkages

The study area is located wholly within the Newnes State Forest. The subject sites and surrounds, for a distance of greater than 2km in any direction, contain native vegetation which is unbroken apart from occasional fire trails. Being a State Forest, the native vegetation is periodically selectively logged but there are no areas of clear-felling.

As a result of the almost complete vegetative cover within and external to the site, the habitat linkages throughout the site and surrounding area are excellent.

3.3 Fauna Survey

A relatively diverse range of fauna guilds are represented across the site, due to the moderately high quality of associated habitats. Those species observed within the site are discussed further below.

3.3.1 Terrestrial Mammals

Open forest communities containing grassy understorey components provide suitable habitat for a number of terrestrial mammals. Three species of macropod were observed within the site and the wider locality, namely *Macropus rufogriseus* (Red-necked Wallaby), *M. giganteus* (Eastern Grey Kangaroo) and *Wallabia bicolor* (Swamp Wallaby), and signs of *Vombatus ursinus* (Common Wombat) were encountered frequently during the survey period. During terrestrial mammal trapping surveys a single species, being *Antechinus agilis* (Agile Antechinus), was caught in low to moderate numbers where sufficient densities of understorey debris provide suitable shelter and foraging opportunities.

Dasyurus maculatus (Spotted-tailed Quoll) was not observed during targeted surveys, but habitat in the west of panel 910 is of sufficient quality and isolation to support this species. Although plateau forests, which characterise much of the study area, offer sufficient isolation from human habitation, the occurrence of ongoing timber harvesting and the resulting reduction in old growth attributes, such as oversized trees and associated forest debris, within forest habitats, may limit the potential for this species to occur over much of the site.

A full list of terrestrial mammals recorded within the site is provided in Appendix 1.

3.3.2 Arboreal Mammals

Canopy tree species and understorey proteaceous shrubs provide abundant foraging resources such as foliage, seeds pollen, nectar and invertebrates for possums, gliders and bats. Three arboreal mammal species, being *Petauroides volans* (Greater Glider), *Pseudocheirus peregrinus* (Common Ringtail Possum) and *Trichosurus vulpecula* (Common Brushtail Possum) were recorded during spotlighting. Although not observed during surveys, there is suitable habitat within the study area for smaller gliders such as *Petaurus breviceps* (Sugar Glider) and *P. norfolcensis* (Squirrel Glider).

Records for *Petaurus australis* (Yellow-bellied Glider) are sparse on the Newnes Plateau and this highly vocal species was not observed during spotlighting and call playback surveys.

An immature *Cercartetus nana* (Eastern Pygmy Possum) was observed on Beecroft Track to the east of panel 900W within open forest habitat similar to that occurring within the site. This species was not observed within the site, but its presence within similar habitat suggests that this species may utilise a wide range of habitats on the Newnes Plateau and as such its presence within the site cannot be discounted.

No other arboreal mammals were recorded during spotlighting surveys.

3.3.3 Bats

A total of seven species of microchiropteran bats were confidently identified from Anabat echolocation call recording or harp trapping surveys of the site, being:

- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Chalinolobus morio* (Chocolate Wattled Bat);
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle);
- *Rhinolophus megaphyllus* (Eastern Horseshoe Bat);
- *Saccolaimus falviventris* (Yellow-bellied Sheathtail Bat);
- *Vespadelus darlingtoni* (Large Forest Bat); and
- *Vespadelus regulus* (Southern Forest Bat).

Overall, a total of three threatened microchiropteran bat species were identified within the site, being *Chalinolobus dwyeri*, *Falsistrellus tasmaniensis* and *Saccolaimus flaviventris* (as shown in Figure 3-3).

A full list of bat species recorded within the site is provided in Appendix 1 with the results of the bat call analysis provided in Appendix 4.

3.3.4 Avifauna Survey

A moderate diversity of common open forest birds including those characterising elevated habitats were observed across the site. Avian species groups encountered, included, but were not limited to, Honeyeaters, Flycatchers, Fairy-wrens, Thornbills, Magpie / Butcherbirds / Currawongs, Parrots / Cockatoos, Quail-thrush, Whistlers, birds of prey and Frogmouths. High country birds such as Grey Currawongs and Red-browed Treecreepers were present as well as a number of threatened bird species including *Petroica multicolor* (Scarlet Robin), *Petroica phoenicea* (Flame Robin), *Daphoenositta chrysoptera* (Varied Sittella) and *Callocephalon fimbriatum* (Gang-Gang Cockatoo).

A number of other threatened bird species have been recorded within the Newnes Plateau, including *Climacteris picumnus* ssp. *victoriae* (Brown Treecreeper – South-eastern), *Chthonicola sagittata* (Speckled Warbler), *Melithreptus gularis* ssp. *gularis* (Black-chinned Honeyeater) and *Melanodryas cucullata* ssp. *cucullata* (Hooded Robin – South-eastern). The Speckled Warbler is considered to have only marginal habitat within the site, and the paucity of records from the plateau suggests this is the case. Although there are number of records from the Newnes Plateau for the Hooded Robin, Black-chinned Honeyeater and Brown Treecreeper these species were not observed during a wide variety of field surveys undertaken across the site including targeted avian census. It is likely that these species are localised in their preferences for habitat, and as they are each somewhat sedentary in habits, their absence from the site suggest that onsite habitat is not highly suitable.

There are no *Allocasuarina* tree species within the site that are suited to the foraging requirements of the Glossy Black-Cockatoo and few hollows of sufficient size to provide breeding opportunities for this species.

Although no forest owl species were observed during targeted surveys it is likely that the site represents a portion of the local foraging range of both Masked and Powerful Owls, due to the presence of terrestrial and arboreal mammals, which are the respective prey of these owl species. A limiting factor on the presence of forest owl species may be a generally low density of the large hollows that these species require for breeding, and in the case of the Masked Owl, hollows for roosting purposes.

Habitat within the site was considered to provide generally limited opportunities for *Tyto tenebricosa* (Sooty Owl), although a small area of tall gully forest habitat occurs at the western end of panel 910, which may represent habitat for locally occurring individuals.

A full list of bird species observed within the site is provided in Appendix 1.

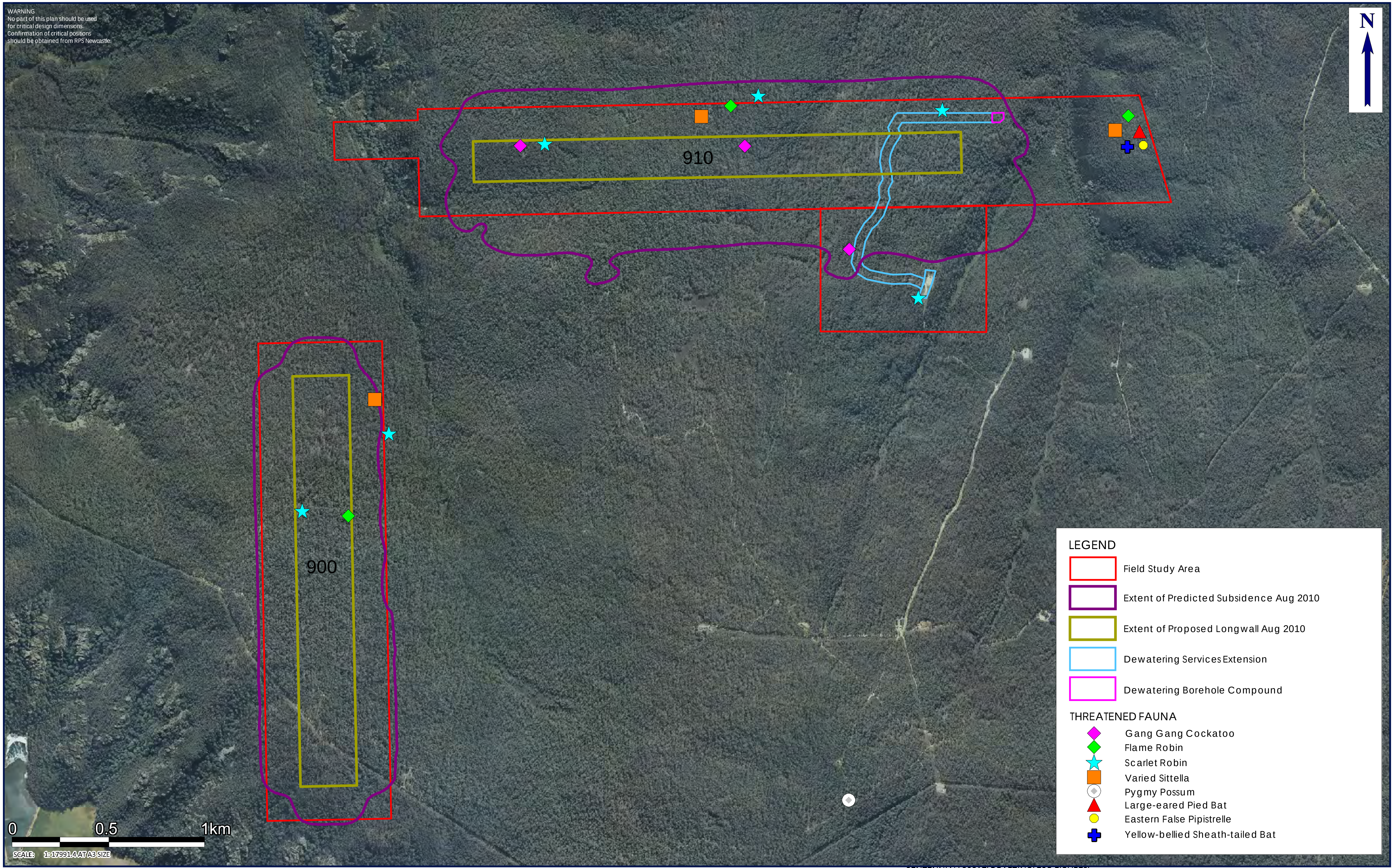
3.3.5 Herpetofauna

Targeted and opportunistic searches for *Eulamprus leuraensis* (Blue Mountains Water Skink) were also undertaken, but only a number of common skink species were recorded, including two species related to *E. leuraensis*, namely, *E. heatwolei* (Yellow-bellied Water Skink) and *E. quoyii* (Eastern Water Skink).

A full list of herpetofauna observed within the site is provided in Appendix 1.

3.4 Secondary and Incidental Observations

During fauna surveys macropod and wombat scats were evident, in addition some scratches on tree trunks were observed. The tree trunk scratches were most likely attributable to Greater Gliders and Ringtail Possums. No other secondary indications or incidental observations of note occurred.



TITLE: FIGURE 3-3 THREATENED FAUNA LOCATIONS	LOCATION: ANGUS PLACE	DATUM: N/A PROJECTION: MGA ZONE 56 (GDA 94)	DATE: 12/08/2010 PURPOSE: ECOLOGY	LAYOUT REF: CENTENNIAL\26317\DRAFTING\ECO FIGURES\ 26317 FIG 3-3 THREAT FAUNA D A3 VERSION (PLAN BY): D (A.P-T.L)

CLIENT: CENTENNIAL COAL
JOB REF: 26317

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4 Threatened Species and Communities Assessment

4.1 Identification of Subject Species and Communities

Threatened flora and fauna species (listed under the TSC Act 1995 and/or the EPBC Act 1999) that have been gazetted and recorded within a 10 km radius of the site have been considered within this assessment. Endangered Ecological Communities (EEC's) known from the broader area have also been addressed. Each species/community is considered for its potential to occur on the site and the likely level of impact as a result of the proposal. This assessment deals with each species/community separately and identifies the ecological parameters of significance associated with the proposal.

Those species/communities that have been identified as having either a moderate or greater chance of occurring within the site or that have been recorded on site during field investigations have been subject to further assessment and comment in Section 5-2 below.

This assessment deals with the following heads of consideration in tabulated form (refer to Table 5-1 overleaf):

'Species/Community' – Lists each threatened species/EEC known from the vicinity. The status of each threatened species under the TSC Act 1995 and the EPBC Act 1999 are also provided.

'Habitat Description' – Provides a brief account of the species / community and the preferred habitat attributes required for the existence / survival of each species / community.

'Chance of Occurrence on Site' – Assesses the likelihood of each species/community to occur on or within the immediate vicinity of the site in terms of the aforementioned habitat description and taking into account local habitat preferences, results of current field investigations, data gained from various sources (such as DECC Atlas of NSW Wildlife, herbariums, NSW Bird Atlas etc.) and previously gained knowledge via fieldwork undertaken within other ecological assessments in the locality.

'Likely Level of Impacts from Proposal' – Assesses the likely level/significance of impacts to each species/community that would result from the proposed development, taking into account direct and indirect short and long-term impacts.

Table 4-1: Assessment of Likelihood of Occurrence of Threatened Species and Communities and Assessment of Potential Impacts

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Plants			
Derwentia blakelyi (V)	Occurring in small numbers, often in moister areas of Eucalypt forest, this species flowers in summer and is known from fewer than 20 locations. It is known to occur in the Western Blue Mountains near Clarence, near Mt Horrible, Nullo Mountain and in the Coricudgy Range.	**High** This species was recorded within a 10 km radius of the site which does contain suitable damp riparian and hillside habitat. This species was observed at three locations within the site: in the west of the Panel 910 (1 individual) within MU 8 Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest; seven specimens of this species were observed in close proximity to each other within MU 26 Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest at the top of an east facing slope in the east of Panel 910 and in large numbers (estimated at potentially > 5000 individuals) at the bottom of east facing slopes 250m to the east of Panel 910.	**Low** Due to the location of this species in excess of 200 metres from the nearest above ground works, it is unlikely to be affected by the proposal provided the recommendations in Section 9 regarding water management are adhered to. Subsidence impacts are considered unlikely to be significant as its existing habitat will remain in-situ.
Persoonia hindii (E)	An erect to spreading shrub with linear-oblong leaves usually concave on the upper surface. Numerous shoots arise from underground rhizomes with reddish young shoots often hairy. Mature leaves are glabrous. Distribution is limited to the Newnes plateau in the Upper Blue Mountains where it occurs in dry forest habitats.	**High** Forty-one specimens of this species were observed in excess of 200 metres to the south of the proposed bore in panel 910. A further 22 specimens were observed 150m from the western boundary of the proposed Panel 900W.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of mine subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole. It is unlikely to be affected by the proposal provided the recommendations in Section 9 regarding water management are adhered to. Subsidence impacts are considered unlikely to be significant as its existing habitat will remain in-situ.
Genoplesium superbum (E)	A terrestrial orchid restricted to the southern tablelands of NSW where it has been recorded from 2 locations near Nerriga, approximately 20 km apart. The species occurs predominantly in wet heathland on shallow soils above a sandstone cap but has also been found in open woodland interspersed with heath. Flowers – Sep to Mar.	**Moderate** This species has been recorded within the locality of the site. It is considered that some areas of habitat within the vicinity of the site are likely to be suitable for this species. This species was not observed within the subject site during flora surveys undertaken during its flowering period.	**Low** This species is unlikely to be significantly affected by the proposal due to the generally low levels of impact on native vegetation expected from the proposal.
Leionema sympetalum Rylstone Bell (V, V*)	Restricted to exposed rocky sandstone formations known as pagodas. The species occurs in dry sclerophyll forest and probably also occurs in open or closed heathland communities. Flowers Autumn to Spring.	**Moderate** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Some areas of habitat within the vicinity of the site are suitable for this species. This species was not observed within the site.	**Low** This species is unlikely to be significantly affected as proposed above ground works are located outside any areas of suitable habitat such as rocky sandstone (Pagoda) and heathland areas. In addition there will be generally low levels of impact on native vegetation expected from the proposal due to the small size and linear nature of vegetation disturbance.
Boronia deanei subsp. *deanei* *Boronia deanei* subsp. *acutifolia* *(V, V*)*	Occurs in wet heath appearing to prefer the margins of open forest where it adjoins swamps and streams. It is known to occur in the Blue Mountains in the upper Kangaroo River near Carrington falls, the Endrick River near Nerriga and on the Nalbaugh Plateau.	**Low – Moderate** Although this species has been recorded within a 10 km radius of the site and the site has some areas of suitable damp riparian habitat, it was not observed within the site despite targeted surveys for threatened flora in potential habitat.	**Low** This species is unlikely to be significantly affected by the proposal due to the generally low levels of impact on native vegetation expected from the proposal, and the absence of records for the species from the site.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Persoonia acerosa (V, V*)	An erect shrub between 1 and 2m with characteristic needle-like leaves that are deeply channelled above. It has been recorded in dry-sclerophyll forest, low scrubby-woodland and heath growing on low-fertility soils. This species prefers open habitat with lower competition and increased light, hence its presence in roadside habitats. It occurs on the Central Coast and in the Blue Mountains largely in the Katoomba, Wentworth Falls and Springwood areas, but once occurred as far north as Mount Tomah where it is now considered to be absent.	**Low – Moderate** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Some areas of habitat within the vicinity of the site are suitable for this species. This species was not observed within the site.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to the small size and linear nature of vegetation disturbance.
Acacia bynoeana Bynoe's Wattle (E, V*)	Small, prostrate shrub found in low heath and open woodland, generally on loamy clays and sand. Occurs from the Lower Hunter south to Southern Highlands. Is known to prefer open sometimes slightly disturbed sites such as trail margins and recently burnt patches. Other species that are usually associated in the overstorey include such species as *Corymbia gummifera* (Red Bloodwood), *Eucalyptus racemosa* (Scribbly Gum), E. *Parramattensis* subsp. *decadens* (Drooping Red Gum), *Banksia serrata* (Saw Banksia), *Angophora bakeri* (Narrow-leaved Apple).	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Habitat within the site is generally unsuitable for this species. This species was not observed within the site during flora surveys.	**Low** This species is unlikely to be significantly affected by the proposal due to the lack of local records, the lack of preferred habitat within the site and the generally low levels of impact on native vegetation expected from the proposal.
Acacia flocktoniae Flockton Wattle (V, V*)	The Flockton Wattle is found only in the Southern Blue Mountains (at Mt Victoria, Megalong Valley and Yerranderie). Grows in dry sclerophyll forest on sandstone.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. This species was not observed on-site during flora surveys. The site is outside the known distribution of this species, however habitat within the vicinity of the site is potentially suitable for this species.	**Low** The site is outside the currently known distribution of this species (the southern Blue Mountains) and is unlikely to be affected by the proposal due to the generally low levels of impact on native vegetation expected from the proposal.
Asterolasia buxifolia (E)	Probably grows in sclerophyll forest; known only from a collection in 1834 from the Bells Road area of the Blue Mtns	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA in 1834 which is the only known record. This species was not observed within the site during flora surveys.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Callistemon linearifolius Netted Bottlebrush (V)	A shrub to 3 to 4m high. Grows in dry sclerophyll forest on the coast and adjacent ranges, chiefly from Georges R. to the Hawkesbury R. Flowers – Spring to Summer.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. This species was not observed within the subject site.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Darwinia peduncularis (V)	A divaricate shrub to 1.5 m high which grows in dry sclerophyll forest on sandstone hillsides and ridges; Hornsby to Hawkesbury R. and west to Glen Davis. Flowers - winter to early spring.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. The subject site is outside the known distribution of this species and it was not observed within the subject site during flora surveys.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Eucalyptus cannonii Capertee Stringybark (V,V*)	The altitude range of *Eucalyptus cannonii* is from about 460 m to 1040 m. Within the range, the species appears to tolerate most situations except the valley floors. Recorded from Tablelands Grassy Woodland Complex communities and Talus Slope Woodland, and in Winburndale Nature Reserve within woodland dominated by Red Stringybark (*Eucalyptus macrorhyncha*) and Long-leaved Box (*Eucalyptus goniocalyx*). Produces white flowers from January to April. The seed is spread by wind or gravity, generally in close proximity (within 30 m) to the parent plant; no dormancy mechanism. Associated species are similarly diverse: *Eucalyptus viminalis, Eucalyptus mannifera, Eucalyptus polyanthemos, Eucalyptus rossii, Eucalyptus blakelyi, Eucalyptus oblonga, Eucalyptus sparsifolia, Eucalyptus bridgesiana, Eucalyptus dalrympleana, Eucalyptus melliodora, Eucalyptus dives* and *Angophora floribunda*.	**Low** This species has been recorded within a 10 km radius of the site, and although habitat within the vicinity of the site (Grassy Woodland) is structurally suitable for this species *E. cannonii* is not known to occur within the vegetation types occurring on the Newnes Plateau where the site occurs. This species was not observed within the site during flora surveys.	**Low** Due to the lack of individuals and lack of preferred vegetation communities observed on the site, this species is unlikely to be affected by the proposal.
Eucalyptus pulverulenta Silver-leafed Gum (V,V*)	Grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum (*Eucalyptus mannifera*), Red Stringybark (*E. macrorhyncha*), Broad-leafed Peppermint (*E. dives*), Silvertop Ash (*E. sieberi*) and Apple Box (*E. bridgesiana*). Often occurs on granite substrates.	**Low** Although this species has been recorded within a 10 km radius of the site, habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Grevillea evansiana Evans Grevillea (V, V)	Grows in dry sclerophyll forest or woodland, occasionally in swampy heath, in sandy soils, usually over Hawkesbury sandstone. Flowers August to December, with peak flowering in September. Occurs east of Rylstone.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. This species was not observed on-site during flora surveys. Some areas of habitat within the site are suitable for this species.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Grevillea obtusiflora subsp. *fecunda* (E,E*)	Subspecies *obtusiflora* occurs as scattered groups in the understorey of low open eucalypt forest at an altitude of 730 metres above sea level. Subspecies *fecunda* occurs in clusters within low, open scrub beneath open, dry sclerophyll forest, on orange, sandy loam soils with sandstone boulders, at an altitude of 570 metres. Species growing in association with subspecies *obtusiflora* include *Eucalyptus crebra, E. dealbata, E. tenella, Callistemon linearis, Acacia buxifolia, Acacia elongata, Leucopogon sp., Caustis flexuosa, Dianella sp.* and *Patersonia sp.* Species growing in association with subspecies *fecunda* include *Eucalyptus tenella, E. fibrosa, E. macrorhyncha, E. punctata, Callitris endlicheri, Acacia buxifolia, Leptospermum continentale, Monotoca elliptica, Persoonia linearis, Indigofera sp.* and *Pomax umbellata*.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. This species is not known to occur within the vegetation types observed in the vicinity of the proposal, therefore the habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals in the locality and lack of preferred habitat observed on the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Grevillea parviflora Small-flower Grevillea (V,V*)	Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks. Plants are capable of suckering from a rootstock and most populations demonstrate a degree of vegetative spread, particularly after disturbance such as fire. Flowering has been recorded between July to December as well as April-May. Flowers are insect-pollinated and seed dispersal is limited. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Grows in sandy or light clay soils usually over thin shales.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Haloragodendron lucasii (E)	Confined to a very narrow distribution on the north shore of Sydney. Is known to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland. Is associated with high moisture and high soil-phosphorus soils.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Lastreopsis hispida Bristly Shield Fern (E)	A fern with 15-60cm (occasionally up to 90cm) fronds scattered on creeping rhizomes. The main rachis of fronds is covered with dark red-brown bristly scales with tuberculate bases. Ranging south to Victoria it occurs in NSW within wet forests of the Blue Mountains where it grows on rotting logs.	**Low** Although this species has been recorded within 10km of the site, habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Melaleuca biconvexa Biconvex Paperbark (V, V*)	A small shrub to large tree – depending on age and habitat. Grows in areas of impeded drainage. Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, but the main concentration of records is in the Gosford/Wyong area.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Only one record of this species is known in Lithgow LGA, located in the Wolgan Valley. The proposal is outside the known distribution of this species. Habitat within the vicinity of the site is unsuitable for this species This species was not observed within the site.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Olearia cordata (V, V*)	A shrub to 2m high. Grows in dry sclerophyll forest and open shrubland, on sandstone; chiefly from Wisemans Ferry to Wollombi. Flowers – Nov to Apr.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. The site is outside the known distribution of this species.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Persoonia hirsuta Hairy Geebung (E, E*)	A spreading shrub with variable leaves characterised by hairy branchlets leaves and flowers. Occurring as isolated individuals or very small groups the Hairy Geebung is found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone. Occurring in more coastal contexts from Royal NP north to Gosford, the southern tablelands and the Blue Mountains in the Springwood Lithgow and Putty areas.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. There is suitable habitat for this species within the vicinity of the site. This species was not observed within the site.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Persoonia marginata Clandulla Geebung (V, V*)	Grows in dry sclerophyll forest and woodland communities on sandstone. Recorded flowering period varies and includes December and Winter. Known from the Capertee district and at Ben Bullen.	**Low** This species has been recorded within a 10 km radius of the site. Habitat within the vicinity of the site is suitable for this species. This species was not observed within the site.	**Low** Due to the lack of individuals observed on the site this species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of mine subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Phebalium bifidum (E)	Occurs in Ironbark shrubby woodland or heath on structured loam soil.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Philotheca ericifolia (V, V*)	Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies. It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include *Melaleuca uncinata, Eucalyptus crebra, E. rossii, E. punctata, Corymbia trachyphloia, Acacia triptera, A. burrowii, Beyeria viscosa, Philotheca australis, Leucopogon muticus* and *Calytrix tetragona*.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Suitable soil and topographical habitat is present within the site, however, the associated species or vegetation types do not occur within the site, therefore, habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Pomaderris brunnea Rufous Pomaderris (V, V*)	Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines. Also grows in open forest. Associated species include *Eucalyptus amplifolia* (Cabbage Gum), *Angophora floribunda* (Rough-barked Apple), *Acacia parramattensis* (Parramatta Green Wattle), *Bursaria spinosa* (Blackthorn), *Kunzea ambigua* (Tick Bush). In northern NSW it has been recorded as flowering in September and October. (DEC 2005)	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Prostanthera cryptandroides subsp. cryptandroides Wollemi Mint Bush (V, V*)	At Glen Davis, occurs in open forest dominated by *Eucalyptus fibrosa*. Other eucalypt species may be present as sub-dominants. In the Denman-Gungal and Widden-Baerami Valley areas, occurs on rocky ridgelines on Narrabeen Group Sandstones in association with a range of communities. Associated communities include: Narrabeen Rocky Heath, Narrabeen Acacia Woodland, Narrabeen Exposed Woodland; Open Heath of *Calytrix tetragona, Leptospermum parviflorum, Isopogon dawsonii;* and Open Scrubland of *Eucalyptus dwyeri, Baeckea densifolia, Dillwynia floribunda, Aotus ericoides* and *Hemigenia cunefolia.*	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Prostanthera stricta Mount Vincent Mint Bush (V)	An erect shrub to 2m high. Grows in sclerophyll forest, in sandy alluvium near watercourses; in the Widden Valley district. Flowers – Winter to Spring.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. There is suitable habitat within the site, however the site is outside the known distribution of this species.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Pultenaea sp. Genowlan Point (E, CE*)	Closely related to *Pultenaea glabra*, but smaller in size, exhibiting red keel petals and inflorences growing into a leafy shoot in contrast to dormant. Likely to be fire sensitive, with recruitment occurring from a persistent soil stored seed bank following fire. Occurs on well drained stony soil near cliff edges. Known from a single population at Genowlan Point in the Capertee Valley within the Rylstone Local Government Area. The population is restricted to a very small area of only 250 square metres on Crown Land.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. The site is outside the known distribution of this species. Habitat within the vicinity of the site is unsuitable for this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Pultenaea glabra Smooth Push-Pea (V, V*)	An erect smooth shrub to 2m with hairless stems and leaves. It grows on the margins of swamps and drainage lines in wet heath and dry forest in the higher Blue Mountains and Glen Davis areas. The majority of records occur within the Blue Mountains LGA at Katoomba-Hazelbrook and Mount Victoria areas, with suspected occurrences to the north in the Mount Wilson and Mount Irvine areas.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. Habitat within the vicinity of the site is suitable for this species. This species was not observed within the site during flora surveys.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Thesium australe Austral Toadflax (V*)	Erect perennial herb to 40 cm high, pale green to yellow-green, glabrous; stems 1-several, little-branched, wiry, striate. Grows in grassland or woodland, often in damp sites.	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. This species was not observed within the site. There are some areas of suitable habitat within the site.	**Low** This species is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence and the small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole.
Wollemia nobilis Wollemi Pine (E*)	Trees to 40 m high; trunk to 1 m diam.; bark densely covered with dark brown nodules or tubercles. Wild population known only from a single gorge in a remote part of the Wollemi N.P	**Low** This species has not been recorded within a 10 km radius of the site, however it has been recorded within Lithgow LGA. The proposal is outside the known natural distribution of this species. There is no suitable habitat for this species within the site.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Herpetofauna			
Eulamprus leuraensis Blue Mountains Water Skink (E, E*)	A very dark coloured *Eulamprus* water skink occurring in the Blue Mountains in isolated and naturally fragmented sedge and shrub swamps. Occurs from the Newnes plateau to just south of Hazelbrook (DECCW 2009).	**Moderate** Although this species has been recorded within the wider locality of the site, this species was not observed during targeted filed surveys. Shrubby Swamp habitats on the eastern side of proposed panel 910 provides potential habitat for this species and due to its somewhat cryptic nature its presences in this habitat cannot be entirely discounted.	**Low** Habitat for this species within the site is unlikely to be significantly affected by the proposal and as such this species is unlikely to be impacted upon by the proposed works.
Mixophyes balbus Southern Barred Frog (E, V*)	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Breeds in streams during summer after heavy rain, outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Eggs are laid on rock shelves or shallow riffles in small, flowing streams.	**Moderate** Stream-side habitat in the vicinity of the site has some suitable shelter, and flowing water favoured for breeding by this species is present. Although this species was not recorded within the proposed works area it is possible in the light of other local records that this species may occur within the wider vicinity of the site.	**Low** Due to the low impact and relatively unchanged nature of the site post-construction, this species is unlikely to be affected by the proposal.
Heleioporus australiacus Giant Burrowing Frog (V, V)	The current distribution of *H. australiacus* is south-eastern NSW to Vic. Locally it occurs north to Jervis Bay (Daly 1996), and is mostly restricted to sandy creek banks, often in association with crayfish burrows in this area (Robinson, M. 1996). The northern population has a marked preference for sandstone ridge-top habitat and broader upland valleys. In these locations the frog is associated with small headwater creek lines and along slow flowing to intermittent creek-lines. *H. australiacus* is grey to dark chocolate brown or black above with a white belly, a few yellow spots along the flanks. During the summer, males call like an owl hoot, from burrows within creek banks. Females lay eggs in a foamy nest in the burrow, and the developing tadpoles are washed from the burrows into the creeks during heavy rain.	**Low – Moderate** Woodland habitat within the study area may provide suitable substrates for the burrowing habits of this species, however the stream characteristics (running water) are not suited to the breeding requirements of this species.	**Low** Due to the lack of preferred breeding habitat observed on the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Litoria booroolongensis Booroolong Frog (E, E*)	Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. Shelter under rocks or amongst vegetation near the ground on the stream edge. Sometimes bask in the sun on exposed rocks near flowing water during summer. Breeding occurs in spring and early summer and tadpoles metamorphose in late summer to early autumn. Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools.	**Low – Moderate** Although stream-side habitat in the east of the study has some suitable shelter, stream-side rocky or cobble bank habitats favoured by this species are not present. This species was not recorded within the proposed works area.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Hoplocephalus bungaroides Broad-headed Snake (E, V*)	Largely confined to Triassic sandstones, including the Hawkesbury, Narellan and Shoalhaven formations, within the coast and ranges. Nocturnal, sheltering by day in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. In summer it is known to become semi-arboreal in its search for prey including geckos and skinks, and will shelter in hollows in large trees within 200 m of rocky escarpments. The Broad-headed Snake is regarded as potentially dangerous, although it has not been attributed to any human fatalities. Destruction of habitat, particularly the removal of sandstone slabs has lead to a decline in numbers.	**Low** The preferred exfoliating sandstone habitat of this species does not occur with the proposed works area and no records occur within the vicinity of the proposed works area.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Litoria littlejohni Little John's Tree Frog (V, V*)	Occurs on the plateaus and eastern plains of the Great Dividing Range from scattered locations between the Watagan Mountains NSW south to Buchan in Victoria. It is pale brown dark speckles. Occurs along permanent rocky creeks with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. Despite its very large distribution there are very few records of the *Litoria littlejohni*. It is known to call through most of the year with a peak in Summer. Clusters of up to 60 eggs are attached to submerged twigs, stems or branches, often near the banks of still pools or clear, slowly flowing streams. Metamorphosis occurs mostly in the months of December and January.	**Low** This species was not recorded within the site during fieldwork. Although this species is known to occur in open woodland habitat there are no records for this species from the Newnes Plateau.	**Low** Due to the lack of local records, it is considered unlikely that this species will be affected by the proposal.
Pseudophryne australis Red-crowned Toadlet (V)	Generally restricted to Hawkesbury Sandstone where it may be found beside temporary creeks, gutters and soaks and under rocks and logs. Breeds in deep leaf litter inundated with heavy rain (Robinson, M, 1996). This species isn't commonly found near permanent flowing streams but prefers permanently moist soaks and areas of dense vegetation or litter along or near headwater stream beds. Typically found in open woodland and heath communities.	**Low** The preferred micro-habitats suited to this species do not occur within the site and no records occur near to the proposed works area.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Varanus rosenbergi Rosenberg's Goanna (V)	Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Individuals require large areas of habitat.	**Low** Despite its mobile habits, the dry habitats favoured by this species do not occur within the site. As such it is unlikely that this species occurs within the proposal area.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Insects			
Paralucia spinifera Bathurst Copper Butterfly (E, V*)	A small sized butterfly with a wingspan of 20-30mm, occurring on the Central Tablelands of NSW in an area approximately bounded by Oberon, Hartley and Bathurst. This species is known at 35 locations, all within the Greater Lithgow, Bathurst Regional and Oberon local government areas. It favours sites with a southwest to north-west aspect, usually where direct sunlight reaches the habitat, and with extremes of cold such as regular winter snowfalls or heavy frosts.	**Low** This species was not observed within the study area and known populations of this species are from a small area to the south and east of Bathurst. The preferred larval feed plant of this butterfly, *Bursaria spinosa* (Native Blackthorn), does not occur in the vicinity of the site.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Petalura gigantea Giant Dragonfly (E)	*Petalura gigantea* can be found along the east coast of NSW, from the Victorian border to northern NSW. There are only a handful of known locations in NSW. They occur in permanent swamps and bogs with some water and open vegetation.	**Low** This species was not observed within the site, and the site does not contain the swampy habitat favoured by this species.	**Low** Due to the lack of individuals and preferred habitat observed on the site, this species is unlikely to be affected by the proposal.
Avifauna			
Callocephalon fimbriatum Gang-Gang Cockatoo (V)	Found in the summer months in tall mountain forests and woodlands, and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open Eucalypt forests and woodlands, and often found in urban areas in some districts.	**High** This species was recorded within the site during flora and fauna surveys. Although foraging habitat occurs widely within the site and the wider locality, the site provides limited breeding opportunities due to the relatively low density of large breeding hollows suited to this species for breeding purposes.	**Low** A significant amount of habitat suited to this species will not be affected by the proposal.
Daphoenositta chrysoptera Varied Sittella (V)	A canopy species occurring across a wide variety of wooded habitats including wet and dry forests / woodlands and in some areas, tall heathlands. Forages for a range of invertebrate prey and differs from treecreeper species in foraging in both up and down orientations on trunks and branches. Occurs widely across mainland Australia in suitable habitat.	**High** The study area is characterised by suitable habitat for this species. This species was recorded on a number of occasions within the study area during targeted field surveys.	**Low** Although this species occurs within the site, the proposal is unlikely to affect a significant area of potential habitat.
Petroica boodang Scarlet Robin (V)	A woodland and open forest species, which forages in the mid to lower storeys on a variety of invertebrate prey. Generally an altitudinal migrant the Scarlet Robin spends the warmer months in the ranges and winters in lowland dry open forests and woodland. Occurs patchily in eastern Australia across wooded habitats.	**High** The site supports suitable habitat for this species and it was widely recorded within the site during targeted field surveys.	**Low** Although this species occurs widely within the site, the proposal is unlikely to affect a significant area of potential habitat. A significant amount of habitat suited to this species will not be affected by the proposal.
Petroica phoenicea Flame Robin (V)	A woodland and open forest species, which prefers the wooded edges of open areas and forages in the lower storey on a variety of invertebrate prey. Generally an altitudinal migrant the Flame Robin, like a number of other robin species spends the warmer months in the ranges and winters in more lowland open country and woodlands. Usually encountered in high altitudinal areas including above snowline habitat in some regions.	**High** The site supports suitable habitat for this species, and it was sparsely yet widely recorded within the site and the wider locality during targeted field surveys.	**Low** Although this species occurs widely within the site the proposal is unlikely to affect a significant area of potential habitat. A significant amount of habitat suited to this species will not be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Ninox strenua Powerful Owl (V)	Occurs in coastal and adjacent ranges of eastern Australia in sclerophyll forests and woodlands where suitable prey species occur (being predominantly arboreal mammals such gliders and flying foxes, but also preys on birds). Requires large and specific hollow characteristics for nesting. Pairs appear to mate for life and occupy exclusive territories in the order of 1000 ha in size.	**Moderate – High** It is likely that the site occurs within the foraging range and perhaps the breeding territory of locally occurring Powerful Owl individuals. However, a general paucity of large hollows places limitation on breeding opportunities within the site's vicinity.	**Low** Although this species is likely to occur within the site the proposal is unlikely to affect a significant area of potential habitat.
Tyto novaehollandiae Masked Owl (V)	Found in a range of habitats, more commonly found in dry eucalypt forests and woodlands. A forest owl which often hunts on forest edges and also roadsides. Requires large Eucalypt hollows for nesting and these hollows are also preferred for roosting sites. Breeding has also been recorded in caves.	**Moderate – High** It is likely that the site occurs within the foraging range and perhaps the breeding territory of locally occurring Powerful Owl individuals. However, a general paucity of large hollows places limitation on breeding and roosting opportunities within the site's vicinity.	**Low** Although this species is likely to occur within the site the proposal is unlikely to affect a significant area of potential habitat.
Glossopsitta pusilla Little Lorikeet (V)	*Glossopsitta pusilla* extends from Cairns to Adelaide coastally and to inland locations. Commonly found in dry, open eucalypt forests and woodlands. Can be found in roadside vegetation to woodland remnants. *G. pusilla* feeds on abundant flowering Eucalypts, but will also take nectar from, *Melaleuca* sp and *Mistletoe* sp. *Eucalyptus albens* (White Box) and *E. melliodora* (Yellow Box) are favoured food sources on the western slopes in NSW. On the eastern slopes and coastal areas favoured food sources are *Corymbia maculata* (Spotted Gum), *E. fibrosa* (Broad-leaved Ironbark), *E. robusta* (Swamp Mahogany) and *E. pilularis* (Blackbutt). Nesting takes place in hollow bearing trees.	**Moderate** A widely ranging species in wooded areas across eastern Australia due to its nectivorous habits. this species is likely to use surrounding forests and woodlands for foraging purposes on at least a seasonal basis.	**Low** A significant amount of habitat suited to this species will not be affected by the proposal.
Tyto tenebricosa Sooty Owl (V)	Occurs in wet Eucalypt forest and rainforest with tall emergent trees, often in easterly facing gullies. Within these areas this species hunts for a range of mainly mammalian prey at all levels of the forest strata. Roosts in tree hollow or dense canopy vegetation. Also nests in large Eucalypt tree hollows. Has been observed on ground to catch its prey (HSO ecologist pers. obs.).	**Moderate** Although wooded habitats in the vicinity of the site are largely dry, the study area contains tall forests in the west of panel 910, which offer potential foraging and breeding opportunities for locally occurring Sooty Owl individuals.	**Low** Although potential habitat for this species potentially occurs within the study area the proposal is unlikely to affect potential habitat to any discernible degree.
Climacteris picumnus Brown Treecreeper (V)	Frequents drier forests and woodlands, particularly open woodland lacking a dense understorey. Also found in grasslands in proximity to wooded areas where there are sufficient logs, stumps and dead trees nearby. Feeds on invertebrate larvae and small insects, particularly ants. Utilises hollows for roosting/nesting. Appears not to persist in remnants less than 200ha. A number of records exist on the Newnes Plateau to the northwest of the sites (Atlas of NSW Wildlife Data 2009).	**Moderate** An open woodland bird, this species has sparse occurrences in Newnes Plateau forests. This species was not recorded within the site during targeted field surveys.	**Low** Although this species is likely to occur within the site, the proposal is unlikely to affect a significant area of potential habitat.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Lophoictinia isura Square-tailed Kite (V)	Found in a range of habitats, locally within sclerophyll forests and woodlands where appropriate / preferred prey species occur (being predominantly terrestrial mammals). Requires large Eucalypt hollows for nesting and prefers to roost in these hollows as well.	**Low – Moderate** This species was not observed within the site during fauna surveys. In NSW the Square-tailed Kite breeds in the north and moves widely in the south outside of the breeding season, where it forages over structurally rich vegetation communities where an abundance of its favoured passerine bird species prey occurs. There is only a single record for this species well to the west of the Newnes Plateau (Atlas of NSW Wildlife data 2009) in the locality. However, due to its mobility and wide use of wooded habitats the occurrence of this species within the site on at least an intermittent basis cannot be discounted.	**Low** A significant amount of habitat suited to this species will not be affected by the proposal.
Ninox connivens Barking Owl (V)	Occurs mainly in dry sclerophyll woodland. Nests in large Eucalypt hollows, and roosts in hollows or thick vegetation. Can be found roosting in dense *Acacia* sp. and *Casuarina* sp. or the dense clumps of Eucalypt trees. More commonly found west of the divide and on the slopes. Favours tree lined watercourses, with hollow bearing tress. Hunts a range of prey species including birds and both terrestrial and arboreal mammals.	**Low - Moderate** Generally a more western species, individuals are occasionally recorded in more easterly habitat, particularly those areas characterised by large expanses of wooded habitat. As such this species may sparsely occur in Newnes Plateau forests on an intermittent basis.	**Low** Due to the unlikelihood of occurrence it is unlikely that this species will be adversely affected by the proposal.
Chthonicola sagittata Speckled Warbler (V)	Occupies Eucalypt and Cypress woodlands in drier areas and on the western/eastern slopes of the Great Dividing Range. More commonly found on the western slopes, mainly due to habitat. Requires a grassy understorey, a sparse shrub layer and an open canopy. Most foraging takes place on ground around tussocks, around bushes and trees. Appears unable to persist in districts where no forested fragments larger than 100ha remain.	**Low – Moderate** A dry open woodland bird favouring habitats with dense understorey areas, this species is only likely to sparsely occur in western areas of the Newnes Plateau. This species was not observed within the site during targeted avian surveys.	**Low** Although there is limited opportunity for species to occur within the site, the proposal is unlikely to affect a significant area of potential habitat.
Melithreptus gularis gularis Black-chinned Honeyeater (V)	In NSW this species occurs in eastern Australia, along the inland slopes of the Great Dividing Range, extending to the coast between Sydney and Newcastle, NSW, Occupies dry Eucalypt woodland within an annual rainfall range between 400-700 mm, particularly within associations containing Ironbark and Box species (Garnett et al, 2000). It is estimated that the Black-chinned Honeyeater spends 60% of its time searching foliage for such food as insects, nectar and lerp.	**Low – Moderate** A woodland / open forest bird, this species may sparsely occur in Newnes Plateau forests in areas where habitat structural diversity is high. However, this species was not observed within the site during targeted avian surveys and habitat within the site is not considered to offer sufficient structural diversity to suit this species.	**Low** Although there is limited opportunity for species to occur within the site, the proposal is unlikely to affect a significant area of potential habitat.
Oxyura australis Blue-billed Duck (V)	A frequenter of deep freshwater swamps with thick vegetation. This species is wholly aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, buy prefers to dive. Most birds will leave their breeding swamps in favour of larger more open swamps and lakes for over-wintering. Most birds will nest in *Typha* sp. (Cumbungi) over deep water during spring/summer, they will also nest in trampled *Muehlenbeckia* sp. (Lignum) and *Eleocharis obicis* (Spike-rush). In NSW mostly occurring within 300km of the Murray-Darling basin, but may occur in more coastal areas during dry inland conditions.	**Low** Suitable wetland habitat for this species does not occur in the vicinity of the site.	**Low** Due to the lack of preferred habitat observed on the site, this species is unlikely to be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Heiraaetus morphonoides Little Eagle (V)	The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Lays two or three eggs during spring, and young fledge in early summer. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion (DECCW 2010).	**Low** This species was not recorded within the site during fieldwork. Although this species is known to occur in open eucalypt forest, woodland or open woodland there are no records for this species from the Newnes Plateau.	**Low** A significant amount of habitat suited to this species will not be affected by the proposal.
Calyptorhynchus lathami Glossy Black-Cockatoo (V)	Occurs in forests and woodlands where it forages predominantly on *Allocasuarina* cones, particularly those of *A. littoralis*, *A. torulosa* and at time *A. distyla*. Requires large Eucalypt tree hollows for nesting. Local records occur on the Newnes Plateau (Atlas of NSW Wildlife Data 2009).	**Low** This species was not observed within the proposed works area during fauna surveys. This species requires forest habitats containing *Allocasuarina* species (*A. littoralis*, *A. torulosa* and/or *A. distyla*) for foraging purposes and Eucalypts of sufficient size to develop hollows large enough for breeding sites. No favoured *Allocasuarina* sp. were observed within the site and there are limited hollow-bearing trees to represent breeding opportunities for this species. Therefore the proposed works area is unlikely to represent suitable habitat for this species.	**Low** Habitat suited to this species will not be affected by the proposal.
Lathamus discolor Swift Parrot (E, E*)	On the mainland this species frequents Eucalypt forests and woodlands with large trees having high nectar production during winter. Mainland winter foraging sites often vary from year to year. Swift Parrots are dependent on habitats that provide winter foraging resources such as nectar and lerps (sugary exudates from leaf insects). Within these habitats, Swift Parrots prefer foraging in mature trees that provide a higher quality and quantity of nectar than regrowth trees.	**Low** A widely ranging species in wooded areas across south-eastern mainland Australia in winter. Due to its nectivorous habits this species may use forests and woodlands in the wider locality for foraging purposes on a seasonal basis. However, *Eucalyptus* sp. occurring within the study area do not flower in winter and as such there are no favoured foraging habitat opportunities for this species in the vicinity of the site.	**Low** Unlikely to be affected, as habitat suited to this species will not be affected by the proposal.
Rostratula australis Australian Painted Snipe (E, V*)	A small freshwater and estuarine wader, which prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber	**Low** This species was not recorded within the site during fieldwork. This species is unlikely to occur within the site due to the lack of appropriate habitat.	**Low** Due to the lack of habitat resources, hence preferred habitat on site, it is considered unlikely this species will be affected by the proposal.
Neophema pulchella Turquoise Parrot (V)	In NSW this species occurs in eucalypts woodlands and open forests, with a ground cover of grasses and low understorey of shrubs (NPWS, 2002). The species has also been recorded in a variety of other habitats, including savannah and riparian woodlands and farmland (Morris 1980; Quinn and Reid 1996). It forages primarily on the seeds of shrubs, grasses and herbs, both native and introduced. Breeding pairs nest in small hollow branches of Eucalypts. There is a record for this species just to the west of the township of Capertee.	**Low** An open woodland bird, this species may sparsely occur in Newnes Plateau forests particularly during extended dry periods in more westerly areas. However it is unlikely that this species occurs within the locality on more than rare occasions.	**Low** Due to the unlikelihood of occurrence, it is unlikely that this species will be adversely affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Pomatostomus temporalis Grey-crowned Babbler (V)	Occupies open forests and woodlands, *Acacia* shrubland and adjoining farmland. Also Box-Gum Woodlands on the divide slopes and Box-Cypress Pine and open Box Woodlands on the plains. They feed on terrestrial invertebrates and insects on lower trunks and branches. Generally they prefer wooded areas with an intact ground cover, although in such areas as the Hunter Valley they occur in sparsely vegetated areas such as properties and golf courses. Appears unable to persist in cleared and highly fragmented habitats. Nest comprise of a dome shape stick nest which is often only a couple of metres from the ground in shrubs or Eucalypt saplings.	**Low** A dry open woodland bird favouring habitats with open understorey areas, this species may sparsely occur in western areas of the Newnes Plateau. However there are no habitat opportunities for this species within the site and this species was not observed during avian surveys.	**Low** There is limited opportunity for species to occur within the site, and as such the proposal is unlikely to affect a significant area of potential habitat.
Grantiella picta Painted Honeyeater (V)	*Grantiella picta* inhabits dry forests and woodlands especially those infested with mistletoe species. It can be found along water courses with *Allocasuarina* and *Melaleuca* sp. and *Acacia* woodlands. It has also been recorded in treed farmland and gardens. Box-Ironbark forests containing mistletoe such as *Amyema miquelii* are habitat on the foothills of the divide. *G. picta* also has a strong association with *Acacia sp.* with mistletoe. Such species include *A. pendula* (Weeping Myall) and *A. slicina* (Willow Wattle) and also the mistletoe *Amyema. quandong*. These *acacia* sp. are also used for breeding. Predominately a western species and on the slopes. Is infrequently recorded east of the divide during summer.	**Low** Generally a more western species, individuals are occasionally recorded in more easterly habitat, particularly in areas characterised by large mistletoe infestations when westerly habitats are experiencing extended dry periods. As such this species is only likely to sparsely occur in Newnes Plateau forests on a rare basis.	**Low** Although there is limited opportunity for species to occur within the site, the proposal is unlikely to affect a significant area of potential habitat.
Anthochaera phrygia Regent Honeyeater (E, E*) (TSC Act Prelim CE)	Occurs in temperate woodlands and open forest, including forest edges. Seasonal movements appear to be dictated by the flowering of various species of *Eucalyptus* sp. that are characteristic of the dry forests and woodlands of South-Eastern Australia. The Regent Honeyeater prefers to forage on large-flowered *Eucalypts*. They also forage on mistletoe and *Banksia* flowers, and arthropods. Nesting occurs mainly between November and January, but breeding has been recorded in all months between July and February.	**Low** Well known as occurring in the Capertee area, individuals are recorded in more easterly habitat, particularly in areas characterised by winter flowering *Eucalyptus* ssp. when westerly habitats are experiencing extended dry periods. As such this species may occur in Newnes Plateau forests on an intermittent basis.	**Low** Although there is limited opportunity for species to occur within the site the proposal is unlikely to affect a significant area of potential habitat.
Melanodryas cucullata Hooded Robin (V)	Primarily known from Eucalypt forest, woodland and scrub, although has been known to use cleared paddocks with regrowth or stumps in close proximity to wooded areas. Favours areas with sparse shrub cover and fallen timber. Appears unable to persist in remnants less than 100-200ha. Generally absent from Lower Hunter but has previously been recorded as far east as Quorrobolong (HSO pers. obs.).	**Low** Generally a more western species, occurring in open woodlands with diverse understorey attributes, habitat within the site is not considered suitable for this species, despite the occurrence of records further to the east in the wider locality.	**Low** There is limited opportunity for species to occur within the site, and as such the proposal is unlikely to affect a significant area of potential habitat.
Stagonopleura guttata Diamond Firetail (V)	Occupies open woodlands / forests and associated habitats with grassy understorey. Generally found west of the Divide or in drier semi-coastal areas such as the upper Hunter Valley. Appears unable to persist in remnants less than 200ha. A small number of records exist from the Lower Hunter Region (HBOC, Atlas of NSW Wildlife data 2009).	**Low** Generally a more western species, occurring in open woodlands with grassy understorey strata, habitat within the site is not considered suitable for this species. Nearby occurrences are known from lower altitude areas.	**Low** Habitat suited to this species will not be affected by the proposal.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Mammals			
Hollow-dwelling Microchiropteran Bats	These threatened Microchiropteran bat species are highly mobile species with a range of habitat preferences that overlap and utilise a range of different habitat niches. They shelter, roost and breed in tree hollows.	**Moderate – High** There are widespread foraging and roosting opportunities for hollow-dwelling Microchiropteran bats within woodland and open forest habitats associated with the study area and the wider locality. As a consequence it is likely that these mobile species may occur within the site on at least an intermittent basis.	**Low** Although it is likely that most of the locally occurring Microchiropteran bats may occur within the site on at least an intermittent basis, the relatively small amount of potential habitat that will be removed as a consequence of the proposal is not considered to be of significance to these species, due to the abundance of similar habitat elsewhere within the locality.
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat (V)	Range of habitats from rainforest to arid shrubland, roosts in tree-hollows, sometimes roosts in mammal burrows when no hollows available. Seasonal movements are unknown, may migrate to southern Australia in summer. Feeds by foraging for insects over the canopy, but flies low in arid shrubland.	**High** This species was positively recorded within the site during fieldwork.	
Falsistrellus tasmaniensis Eastern False Pipistrelle (V)	This species is found in a variety of forest types such as open forests, woodlands and wetter sclerophyll forests (usually with trees >20m). This species roosts in tree hollows. Hunts beetles, moths, weevils and other flying insects below or just above the canopy.	**High** This species was recorded within the study area during fieldwork and both foraging and sheltering habitat occur within the study area.	
Mormopterus norfolkensis Eastern Freetail-bat (V)	This species forages predominantly in dry forests and woodlands east of the divide. Individuals have been recorded in riparian zones in rainforest and wet sclerophyll forest. Forages above the canopy or forest edges. It roosts in tree hollows, under bark and within man-made structures.	**Moderate** This species was not recorded within the site during fieldwork, although potential foraging and roosting habitat are widespread within the locality and due to its mobility it may occur within the site on at least an intermittent basis.	
Scoteanax rueppellii Greater Broad-nosed Bat (V)	Forages in moister gullies and wet sclerophyll forests as well as in lightly wooded areas and open spaces/ ecotones, most commonly found in tall wet forest. Open woodland and habitat and dry open forest suits the direct flight of this species as it searches for beetles and other larvae. This species roosts in tree hollows, although has been recorded in buildings.	**Moderate** This species was not recorded within the site during fieldwork, although potential foraging and roosting habitat are widespread within the locality and due to its mobility it may occur within the site on at least an intermittent basis.	

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Miniopterus schreibersii subsp. *oceanensis* Eastern Bentwing Bat (V)	Prefers to forage in well-vegetated areas, such as within wet and dry sclerophyll forests and rainforests and also dense coastal Banksia scrub. Requires caves or similar structures for roosting habitat. Occasionally roost in tree hollows. Largely confined to more coastal areas. Often found roosting with *Miniopterus schreibersii* (Eastern Bentwing-bat).	**Moderate** This species was not detected during targeted field surveys on site at the time of the survey. Habitat exists within the site and records for this species occur in the locality. Therefore this species has the potential to occur within the site on at least an intermittent basis.	**Low** Although it is likely that most of the locally occurring Microchiropteran bats may occur within the site on at least an intermittent basis, the relatively small amount of potential habitat that will be removed as a consequence of the proposal is not considered to be of significance to these species, due to the abundance of similar habitat elsewhere within the locality.
Miniopterus australis Little Bentwing Bat (V)	This species forages in tall open forests and the edges of rainforest. It roosts in mine shafts and similar structures. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of *Hirundo ariel* (Fairy Martin), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years.	**Moderate** This species was not detected during targeted field surveys on site at the time of the survey. Habitat exists within the site and records for this species occur in the locality. Therefore this species has the potential to occur within the site on at least an intermittent basis.	
Chalinolobus dwyeri Large-eared Pied Bat (V,V*)	Found in well-timbered areas containing gullies. The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy.	**High** Due to the recorded occurrence of this species within the site and the availability of habitat within the site:	
Myotis macropus Southern Myotis (V)	Usually found near bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. Although usually recorded foraging over wet areas, it also utilises a variety of wooded habitats adjacent to such areas including rainforest, wet and dry sclerophyll forest, woodland, and swamp forest. Roosts in small colonies of between 15 and several hundred individuals in caves, mines and disused railway tunnels.	**Low – Moderate** This species was not recorded within the site during fieldwork. This species is unlikely to occur within the site due to the lack of appropriate habitat.	
Cercartetus nanus Eastern Pygmy Possum (V)	Occurs from rainforest through sclerophyll forest to tree heath. Favoured food being banksias, myrtaceous shrubs and trees and insects. Nesting sites are generally in drier habitats (Strahan, 1995a) Records exist from the Watagan Mountains (Atlas of NSW Wildlife data).	**Moderate** This species was not observed within the site, although it was observed to the east of proposed panel 900w in similar habitat as occurs widely over the site and the general locality.	**Low** Although this species has some opportunity to occur within the site, the proposal is unlikely to affect a significant area of potential habitat.
Dasyurus maculatus Spotted-tailed Quoll (V, E*)	Found in a variety of forested habitats from sclerophyll forests, rainforests and coastal woodlands. This species creates a den in fallen hollow logs or among rocky outcrops. Generally does not occur in otherwise suitable habitats that are in close proximity to urban development. A number of records occur across the Newnes Plateau (Atlas of NSW Wildlife data). It is an opportunistic hunter of a variety of prey.	**Low – Moderate** Habitat of sufficient quality and extent for this species does occur within the western end of panel 910. Overall the study area has limited opportunities due to the general paucity of old growth vegetation components and ongoing disturbance. However, due to the isolation of the plateau in general interspersed with higher quality pockets of habitat, the presence of this species more widely over the site cannot be entirely discounted on an intermittent basis.	**Low** Although this species has some opportunity to occur widely within the the study area the proposal is unlikely to affect a significant area of potential habitat.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Petaurus norfolcensis Squirrel Glider (V)	Occurs in eucalypt forests and woodlands where it feeds on sap exudates and blossoms. In these areas tree hollows are utilised for nesting sites. Also requires winter foraging resources when the availability of normal food resources may be limited, such as winter-flowering shrub and small tree species.	**Low – Moderate** Although suitable habitat for this species occurs within the site, it or its close relative the Sugar Glider were not observed during nocturnal spotlighting surveys or arboreal trapping.	**Low** Although this species has opportunity to occur widely within the site, the proposal is unlikely to affect a significant area of potential habitat.
Petaurus australis Yellow-bellied Glider (V)	Usually associated with tall, mature wet Eucalypt forest usually with high rainfall and nutrient rich soils. Also known from tall dry open forest and mature woodland. In the north of NSW they favour mixed coastal forests to dry escarpment forests and in the south they prefer moist coastal gullies to creek flats and tall montane forests. The diverse diet of this species is primarily made up of Eucalypt nectar, sap, honey dew, manna and invertebrates found under decorticating bark and pollen. Tree hollows for nest sites are essential, as are suitable food trees in close proximity.	**Low** There are few records for this species in the wider locality. Chance of occurrence is low, but cannot be entirely discounted.	**Low** Although this species has some opportunity to occur within the site the proposal is unlikely to affect a significant area of potential habitat.
Potorous tridactylus Long-nosed Potoroo (V, V*)	Prefers cool rainforest, wet sclerophyll forest and heathland. Essentially, requires dense understorey with occasional open areas. These open areas most likely consist of sedges, ferns, heath or grass-trees. Sleeps by day in a nest on the ground, and digs for succulent roots, tubers, fungi and subterranean insects. Some diggings seemingly attributable to this species may belong to *Isoodon macrourus* (Northern Brown Bandicoot). Generally east of the divide, hides by day in dense vegetation, sometimes feeds during winter during daylight hours during overcast or low light conditions.	**Low** This species was not recorded within the site during fieldwork. This species is unlikely to occur within the site due to the lack of appropriate dense understorey habitat and other records within the locality.	**Low** Habitat suited to this species will not be affected by the proposal.
Pteropus poliocephalus Grey-headed Flying-fox (V, V*)	Forages over a large area for nectar / fruits etc. Occurs across subtropical and temperate forest, sclerophyll forest and woodlands, heaths, swamps, urban gardens and cultivated crops. Frequently observed to forage in flowering Eucalypts. Seasonally roosts in communal base camps situated within wet sclerophyll forests or rainforest. These camps are usually located within 20km's of their food source. Frequently observed to forage in flowering Eucalypts.	**Low** This species was not recorded within the site during fieldwork. This species is unlikely to occur within the site due to the paucity of other records within the locality.	**Low** Habitat suited to this species will not be affected by the proposal.
Petrogale penicillata Brush-tailed Rock-wallaby (E,V*)	Occurs in forests and woodlands along the Great Divide and on the western slopes in escarpment country with suitable caves and rocky overhangs for shelter. Records exist from the Watagan Mountains where it is associated with the above habitats (DEC 2005; RPS pers. obs.).	**Low** There is some potential habitat for this species within the western section of proposed panel 910. However, this species was not observed during fauna surveys within the site.	**Low** Habitat suited to this species will not be significantly affected by the proposal.
Phascolarctos cinereus Koala (V)	Occurs in forests and woodlands where it requires suitable feed trees (particular *Eucalyptus* spp.) and habitat linkages. Will occasionally cross open areas, although it becomes more vulnerable to predator attack and road mortality during these excursions. Records from the Upper Hunter are largely confined to substantial woodland and forest habitat within reserves.	**Low** There are no preferred feed trees species of the Koala within the study area, although Scribbly Gums (*Eucalyptus sclerophylla*) within the site are closely related to a preferred feed tree species, being *Eucalyptus signata*. There are a paucity of records for this species within the locality of the site and no individuals were observed during fauna surveys.	**Low** There is limited opportunity for species to occur within the site, and as such the proposal is unlikely to affect a significant area of potential habitat.

Species / Community	Habitat Description	Chance of Occurrence On Site	Likely Level of Impact
Endangered Ecological Communities			
Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion (E) Temperate Highland Peat Swamps on Sandstone (E*)	This community occurs in the headwaters of water courses draining the Newnes Plateau. It occurs where low slope gradients and vegetation impede water flow in headwater valleys and is dominated by sedges and shrubs that favour poorly drained sites. The community occurs at higher elevations than Blue Mountains sedge swamps and in the Bell and Clarence area the transition between these communities occurs at approximately 850-950 metres. Newnes Plateau shrub swamp has a greater dominance of shrubs when compared to Blue Mountains Sedge Swamps.	**High** An inventory of plant species, soils and topography for the site shows that this EEC occurs within the subject site. It is considered that Map Unit 50 – Newnes Plateau Shrub Swamp and MU 51 Newnes Plateau Hanging Swamp correspond to this EEC.	**Low** This EEC is unlikely to be significantly affected as there will be generally low levels of impact on native vegetation expected from the proposal due to low levels of subsidence. The small size and linear nature of vegetation disturbance required for the track upgrade, extension and bore hole is unlikely to significantly impact upon this community. The community does also occur down slope from the dewatering borehole and this should not impact upon the community provided recommendations provided in Section 7 are adhered to.
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions (E) Temperate Highland Peat Swamps on Sandstone (E*)	This community is associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. It occurs on undulating tablelands and plateaus, above 400-500 m elevation, generally in catchments with basic volcanic or fine-grained sedimentary substrates or, occasionally, granite. It comprises a dense, open or sparse layer of shrubs with soft-leaved sedges, grasses and forbs. It is the only type of wetland that may contain more than trace amounts of *Sphagnum* spp., the hummock peat-forming mosses. This community is known to occur within the Lithgow LGA.	**Low** An inventory of plant species for the site indicates that the primary peat species required for this EEC is absent from the locally occurring swamps and poorly drained areas. It is therefore considered that the swampy vegetation in the vicinity of the proposed works does not constitute this EEC but is commensurate with another EEC (Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion) listed above.	**Low** Due to the absence of this EEC within the proposed works area it is unlikely that this endangered community will be affected by this proposal.
White Box – Yellow Box – Blakeley's Red Gum Grassy Woodland and derived native Grassland (CE*)	This community is dominated by *Eucalyptus albens, E. melliodora* and *E. blakelyi* and has an open grassy understorey with sparsely scattered shrubs. It can also take the form of grassland wherever the trees have been removed.	**Low** An inventory of plant species for the site exhibits some species that are found associated with this community (eg. *E. mannifera*) however, the key indicative species are not present within the site. It is considered that this EEC does not occur on-site.	**Low** Due to the absence of this EEC within the site it is unlikely that this endangered community will be affected by this proposal.

Notes: (V) = Vulnerable Species listed under the *Threatened Species Conservation Act 1995*.
(E) = Endangered Species listed under the *Threatened Species Conservation Act 1995*.
(CE) = Critically Endangered Species listed under the *Threatened Species Conservation Act 1995*.
(V*) = Vulnerable Species listed under the *Commonwealth EPBC Act 1999*.
(E*) = Endangered Species listed under the *Commonwealth EPBC Act 1999*.
(CE*) = Critically Endangered Species listed under the *Commonwealth EPBC Act 1999*.

5 Key Threatening Processes

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act 1995. There are eight KTPs that have the potential to affect the site as a consequence of the proposal, being:

- Alteration of habitat following subsidence due to longwall mining
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
- Anthropogenic climate change
- Clearing of Native Vegetation
- Infection of native plants by *Phytophthora cinnamomi*
- Invasion of native plant communities by exotic perennial grasses
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees

"Alteration of habitat following subsidence due to longwall mining"

Geological assessment of underlying strata and projected caving as a result of coal extraction activities has calculated a likely subsidence ranging from 0.69 to 1.47 metres depending on cover depth. Long-term annual monitoring undertaken by Angus Place thus far has not reported any significant adverse effects to the ecological value of the Newnes Plateau ecosystems attributable to mine induced subsidence. Based on this previous monitoring on the Newnes Plateau and the design of 910 and 900W with regard to the avoidance of significant surface features such as NPSS it is considered unlikely that the proposed Angus Place extension of current coal extraction consents will result in significant adverse impacts upon surface communities.

Vegetation mapping over the area has shown that there are no significant swamp areas over the two proposed longwall panels (LW910 and 900W). There are small areas of NPSS located within the subsidence areas related to LW910. Ditton Geotechnical Services (2010) report that although there are three swamps within the area that may be influenced by the extraction in Longwall 910, there will be no adverse subsidence-related impacts on the swamps, as the predicted incremental surface movements at the swamps are insufficient to cause any significant surface fracturing. There are two small hanging swamps on the southern side of longwall 910 that are in the potential influence zone of the longwall, but these swamps have already been undermined by LW 920 so that any additional impacts should be minimal. Similarly, Narrow Swamp is just on the edge of the zone of influence where the ground movements will be negligible when compared to the subsidence from longwall 920. There is also one hanging swamp that is located to the east of longwall 920, but this swamp is outside the area of any significant ground surface movement, cracking or induced surface strains, so that the potential for any impact is negligible. Thus hydrological changes due to subsidence are not expected to alter the habitats and condition of the overlying vegetation communities or other components of biodiversity including terrestrial threatened species or populations, associated habitats and endangered ecological communities or Groundwater Dependent Ecosystems.

In addition, in relation to surface water impacts, GHD (2010) concludes that as the project includes extension of existing underground operations and no additional surface disturbances (other than the construction of clean water diversions), the impact on water quality as a result of the project is considered to be negligible.

"Alteration of the natural flow regimes of rivers, streams, floodplains and wetlands"
The proposal is not likely to significantly contribute to the Key Threatening Process "Alteration of the natural flow regimes of rivers, streams, floodplains & wetlands" as the proposed works will not directly affect any rivers, creeks or streams. Subsidence may however impact upon the drainage lines above the longwall panels. Previous monitoring of other similar situations has indicated that the natural flow regimes of these creeklines are unlikely to be affected to a significant degree.

"Anthropogenic Caused Climate Change"
The proposal is likely to contribute to the Key Threatening Process "Anthropogenic Caused Climate Change" as a result of clearing a small amount of native vegetation. The extent to which the proposal could contribute to this process is considered unlikely to be significant.

"Clearing of Native Vegetation"
The proposed development will require the removal of a small area of native vegetation and as such will incrementally contribute to the Key Threatening Process "Clearing of Native Vegetation". The extent to which the proposal could contribute to this process is considered unlikely to be significant.

"Infection of native plants by *Phytophthora cinnamomi*"
The proposed development has the potential to result in the importation of this fungus. Cleaning protocols for vehicles should be implemented for the low-level above-ground activities. It is considered that the project is unlikely to significantly contribute to this process.

"Invasion of native plant communities by exotic perennial grasses"
The proposed development is considered unlikely to significantly contribute to this process due to the comparatively low level of surface disturbance that is proposed.

"Loss of hollow-bearing trees"
The proposed development may require the removal of hollow-bearing trees and as such will contribute to the Key Threatening Process "Removal of Hollow-bearing Trees". Overall the proposal is considered unlikely to significantly contribute to this process due to the low level of above-ground disturbance and to the majority of the habitats (including hollow-bearing trees) being retained post-mining.

Prior to the development of surface infrastructure all hollow bearing trees will be tagged and subsequently avoided where possible during clearing.

“Removal of dead wood and dead trees”

The proposed development will require the removal of ground debris in above-ground areas of disturbance. These form a minor component of the overall works and the vast majority of this habitat will be retained in-situ. It is not expected that the proposal will significantly contribute to this process.

6 Other Legislative Considerations

6.1 Considerations under the *State Environmental Planning Policy 44 – Koala Habitat Protection*

6.1.1 First Consideration – is the Land subject to SEPP-44?

The subject site is located within Greater Lithgow LGA which is listed within Schedule 1 of State Environmental Planning Policy 44 (SEPP 44) – 'Koala Habitat Protection'. Therefore SEPP-44 applies to the land.

6.1.2 Second Consideration – is the Land 'Potential Koala Habitat'?

Schedule 2 of the State Environmental Planning Policy 44 (SEPP 44) – 'Koala Habitat Protection' lists 10 tree species that are considered indicators of 'Potential Koala Habitat'. The presence of any of the species listed on a site proposed for development triggers the requirement for an assessment for 'Potential Koala Habitat'. SEPP 44 defines potential Koala Habitat as:

"areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component".

No Schedule 2 feed tree species were recorded within the site, therefore the site does not constitute Potential Koala Habitat and no further provisions of this policy apply.

6.2 Considerations under the *Environment Protection and Biodiversity Conservation Act 1999*

Considerations have been made under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999). An EPBC Act Protected Matters Search was undertaken within the SEWPAC on-line database (accessed 2010) to generate a list of those matters of National Environmental Significance (NES) from within 10km of the site, which may have the potential to occur within the site. This data, combined with other local knowledge and records, was utilised to assess whether the type of activity proposed on the site will have, or is likely to have a significant impact upon a matter of NES, or on the environment of Commonwealth land.

A referral of the proposed action in accordance with the EPBC Act 1999 will be submitted to SEWPAC.

Commonwealth land

The site is not land owned by the Commonwealth, and hence this portion of the Act is not applicable.

World Heritage Properties

The site is not a World Heritage Property, however The Gardens of Stone National Park which forms part of the Greater Blue Mountains Area of NSW (a World Heritage Property) is located approximately 6 km to the north of the subject site. It is expected that the proposal will not have a significant impact upon The Greater Blue Mountains Area of NSW.

National Heritage Places

The site is not a National Heritage Place, however The Greater Blue Mountains Area of NSW (a National Heritage Place) is located approximately 6 km to the north of the subject site. It is expected that the proposal will not have a significant impact upon The Greater Blue Mountains Area of NSW.

Wetlands protected by international treaty (the Ramsar convention)

There are no wetlands protected by international treaty (the Ramsar convention) arising from the EPBC Act Protected Matters Report generated for an area within 10km of the site.

Nationally listed threatened species and ecological communities

A total of 23 threatened species or ecological communities listed under the EPBC Act 1999 have been recorded or have suitable habitat within a 10 km radius of the site (see Table 4-1 for likelihood of occurrence of threatened species listed under EPBC Act 1999). The potential for the proposal to significantly impact on individuals or local populations have been assessed in Section 5.0 above and in Appendix 3.

This assessment concluded that the proposal occurs in the vicinity of one threatened ecological community known as Temperate Highland Peat Swamps on Sandstone, but that no impacts are likely to adversely affect this community provided that the recommendations in Section 9 are adhered to.

Also, the nationally threatened species *Chalinolobus dwyeri* (Large-eared Pied Bat) was recorded on site during fieldwork. The relatively small amount of habitat that will be removed as a consequence of the proposal is not considered to be of significance in this case, due to the abundance of similar habitat elsewhere within the locality.

Another species was assessed as having a moderate or greater chance of occurrence within the site, being *Eulamprus leuraensis* (Blue Mountains Water Skink). However, due to the type, location and extent of proposed works, it is unlikely to be significantly impacted upon by the proposal.

Nationally listed migratory species

A total of 11 migratory species listed under the EPBC Act 1999 have been recorded or have suitable habitat within a 10 km radius of the site. The proposal is unlikely to substantially modify, destroy or isolate an area of important habitat, result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat or seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

All nuclear actions
No type of nuclear activity is proposed for the site.

The environment of Commonwealth marine areas
No Commonwealth marine areas exist within or adjacent to the site.

Summary Statement:
Based on the above, it is considered the current proposal will not impact on matters of NES (The threatened ecological community *Temperate Highland Peat Swamps on Sandstone* (THPSS) listed under EPBC Act). Due to the low level of direct impact upon the THPSS and the recorded presence of *Chalinolobus dwyeri,* it may however be advisable to submit a referral to SEWPAC as a precautionary measure. A referral will be submitted to SEWPAC for this project.

7 Expected Impacts

7.1 Flora

Derwentia blakelyi

This species was recorded in the west of the Panel 910 (1 individual) within MU 8 Newnes Sheltered Peppermint – Brown Barrel Shrubby Forest, seven specimens of this species were observed in close proximity to each other within MU 26 Newnes Plateau Narrow-leaved Peppermint – Silvertop Ash Layered Open Forest at the top of an east facing slope in the east of Panel 910 and in large numbers (estimated at potentially > 5000 individuals) at the bottom of east facing slopes 250m to the east of Panel 910. Given that the distance from any of the proposed works is greater than 200 metres of forested land, it is considered that these specimens are unlikely to be impacted by the proposal. This species is known to occur at 27 locations within 10km of the site (DECCW Wildlife Atlas Database, 2010) and there are large areas of known and potential habitat for this species within the region.

Due to the retention of these specimens and the large spatial separation from the proposed works areas, combined with the low probability that subsidence would impact upon the viability of this species on the site, it is considered that the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Persoonia hindii

Forty-one specimens of this species were observed in a small area (20m x 5m) located in excess of 200 metres to the south of the proposed dewatering bore within the proposed longwall Panel 910, an additional 22 specimens were also observed 150m from the western boundary of the proposed panel 900W as shown in Figure 3-2. The two areas occupied by this species are in excess of 200 metres distant from any proposed surface works. None of the specimens of *Persoonia hindii* are expected to be removed or otherwise impacted by the proposal.

Due to the retention of these flora specimens and the large spatial separation from the proposed surface works areas, it is considered that the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The expected subsidence from the proposed underground longwall mining within the site is expected to have low levels of direct impact on the surface vegetation, fauna and the habitats currently present. In particular, the proposal will not result in any significant impact on Threatened Species, Populations or Ecological Communities which are listed within the TSC Act 1995 or the EPBC Act 1999.

The proposed upgrade to the existing track, extension of the track to the proposed dewatering bore and the installation of the bore is expected to have minimal impact on the existing vegetation, flora and their habitats currently present due to the narrow-linear nature of the proposed surface works. This narrow-linear area of works is not expected to disrupt or isolate any vegetated areas or disrupt any corridors allowing flora or fauna species or propagules to freely travel within the area.

A small area of vegetation will require removal in order to upgrade and extend the access track required, and to create a compound and install the proposed dewatering bore at the eastern extent of the proposed longwall panel 910. Assuming that the dewatering bore will require clearing of a compound of approximately 2796 m^2 (as with other bores observed in the locality) the total clearing for the proposal will be approximately as follows.

Proposed Surface Works	Approximate Area (m^2)
Compound for the dewatering bore (approximately 60 x 50 m)	2,796
Upgrading the existing track (north - approximately 1232 x 20 m) (south – approximately 177 x 20 m)	28,180
Area for extending a new track from the existing track to the bore compound (approximately 445 x 25 m)	11,125
Total	42,101

Newnes Plateau Shrub Swamp

One Endangered Ecological Community (EEC) was observed within the site. This EEC is Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion (NPSS). This EEC corresponds to Map Unit 50 – Newnes Plateau Shrub Swamp and Map Unit 51 – Newnes Plateau Hanging Swamp as described earlier in this report and shown in Figure 3-1. This EEC is also included in the Temperate Highland Peat Swamps on Sandstone vegetation community which is listed as an EEC within the EPBC Act 1999.

There are some areas containing this EEC within and adjacent to the site. Vegetation mapping over the area has shown that there are no significant swamp areas over the two proposed longwall panels (LW910 and 900W). There are small areas of NPSS located within the subsidence areas related to LW910. Aurecon (2010) report that of the swamps located within the area that may be influenced by the extraction in Longwall 910, there will be no adverse subsidence-related impacts on the swamps, as the predicted incremental surface movements at the swamps are insufficient to cause any significant surface fracturing. There is one small hanging swamp on the southern side of longwall 910 that is in the potential influence zone of the longwall, but this swamp has already been undermined by LW 920 so that any additional impacts should be minimal. Similarly, Narrow Swamp is just on the edge of the zone of influence where the ground movements will be negligible when compared to the subsidence from longwall 920. Hydrological changes due to subsidence are not expected to alter the habitats and condition of the overlying vegetation communities or other components of biodiversity including terrestrial threatened species or populations, associated habitats and endangered ecological communities or Groundwater Dependent Ecosystems.

In addition, in relation to surface water impacts, GHD (2010) concludes that as the project includes extension of existing underground operations and no additional surface disturbances (other than the construction of clean water diversions), the impact on water quality as a result of the project is considered to be negligible.

LDP006 is an emergency discharge point from the 940 dewatering bore on Newnes Plateau. This licensed discharge point is only operated under emergency conditions. Emergency conditions are considered to exist when the bore water cannot be fed into the Springvale Delta Water Transfer Scheme. This is a pipeline system on Newnes Plateau that transfers mine water from three bores (2 belonging to Springvale and 1 Angus Place) to the Wallerawang Power Station. The emergency discharge point was developed as a contingency and is licensed accordingly. Water is discharged to the Wolgan River from LDP006 via Narrow Swamp North. All discharge events occur in accordance with the Angus Place Environment Protection License with a report sent to the NSW Department of Environment, Climate Change and Water as stipulated in Condition E1.5 of the Angus Place EPL. This discharge point will continue to operate in accordance with the license. While GHD (2010) indicated some parameters for the discharge water were elevated, discharge from this point only occurs on an emergency basis. This is not considered likely to impact significantly upon any of the downstream shrub swamp vegetation.

Map Unit 50 – Newnes Plateau Shrub Swamp occupies a total of approximately 394 hectares within the area mapped for the ‘Vegetation of the Western Blue Mountains’ (DEC, 2006). It is considered that the negligible impacts upon this community will not have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

7.2 Fauna

The surveys have demonstrated that while the site contains suitable habitat for a number of fauna, the actual impact of the proposal is considered to be of a low level. The vast majority of habitats will be retained in their existing state. While some subsidence is predicted to occur, this is not expected to result in any substantial alteration of fauna and its habitat.

The threatened fauna recorded on the site consisted of threatened bird and bat species. Due to the low level of direct impacts expected as outlined above, these species are not likely to be significantly affected by the proposal.

7.3 Groundwater Dependent Ecosystems (GDEs)

The NSW Groundwater Dependent Ecosystem (GDE) Policy (DLWC 2002) is part of a coordinated strategy at Commonwealth, State and local levels and is specifically designed to protect ecosystems which rely on groundwater for their survival, so that wherever possible the ecological processes and biodiversity of these dependent ecosystems are maintained or restored. The policy provides guidance on how to protect and manage these valuable natural systems in a practical sense. The range of tools include a rapid assessment process which provides information on the type and susceptibility of the GDE being assessed. This assessment also provides information on the strengths, weaknesses and opportunities for preserving and managing GDE.

Map Unit 50 - Newnes Plateau Shrub Swamp (NPSS) and Map Unit 51 - Newnes Plateau Hanging Swamp (NPHS) vegetation communities are classified as GDEs as they are dependent on the groundwater sourced from the locally occurring bedding planes with permeable and impermeable layers.

A rapid assessment of the GDEs known in the local area in accordance with the NSW Groundwater Dependent Ecosystem Policy is as follows:

Geographical Area

The NPSS and NPHS vegetation communities occur within the Newnes Plateau and associated drainage lines to the north-east of Lithgow in NSW.

Types of GDEs Present

The GDEs within the locality of the site were assessed in detail within Appendix H (Connell Wagner 2005) of the Subsidence Management Plan (SMP) produced by Centennial Angus Place Pty Ltd (2005). The following is an extract from Appendix H - Report on Impact of Mining on Aquifers and Shrub Swamps (Connell Wagner 2005):

"Generally, shrub swamps have developed in the application area at altitudes in excess of 1100 metres, in valleys underlain by Narrabeen Group strata. The swamps develop in areas which are subject to a constant supply of water - both groundwater and surface runoff.

The groundwater source is initiated when rainfall infiltrates the sandy soils and the sandstone on the adjacent ridges. At relatively shallow depths in the sandstone is a thin layer of claystone, or tightly cemented sandstone which is impervious to vertical groundwater percolation and forms an aquitard. The groundwater, when it meets this impermeable barrier, travels laterally until it reaches the edge of the impervious layer, which has been exposed by geological erosion in an adjacent valley. In conjunction with rainfall runoff, this produces a condition of constant moisture, which has allowed a range of plant species to gradually colonise these sites over long periods of time, forming a rare plant community.

The constant saturation of the valley floor creates anaerobic (oxygen starved) conditions in the soil, which inhibit the microbial breakdown and decomposition of dead plant material. This organic matter accumulates in a partly decomposed state as peat. Peat has an extraordinary ability to absorb water, and so the swamp soil acts as a sponge, retaining much rainwater for later slow release. The peat is generally mixed with sand derived from the weathering of the soft sandstone on the ridges, which is washed into the valley by rainfall run-off.

Since the shrub swamps are supplied by two water sources (rainfall runoff and groundwater), and they store large quantities of water, they are resistant to some extent to natural variations in flow from either of the water sources (eg drought conditions will reduce runoff). In general, rainfall runoff provides the greatest water volume to the swamps. Normally, between 20% and 30% of the total rainfall in the area runs off the ground surface and into the swamps. When this occurs, any voids in the dry peat at the surface soak up the water, and any excess runoff flows down the creek channel and into the Wolgan River.

In contrast, less than 5% of rainfall infiltrates the ground surface and enters the groundwater system. Most of this water then enters the swamp by seepage at the margins, although a small proportion leaks through the aquitard and into the underlying strata. Unlike rainfall, the seepage is continuous, and is proportional to the hydraulic head in the aquifer beneath the flanking ridges. During droughts, the seepage from the aquifer keeps the swamp supplied with groundwater, albeit at a reduced rate, so that under normal climatic conditions, the plants are continuously supplied with water.

Three main shrub swamps have been identified within the area covered by the application. These are:

East Wolgan Swamp – forms part of a first order watercourse and is partially located over the northern end of longwall 411 in Springvale and partly over longwalls 960 to 980 in Angus Place. The swamp is located in a valley with a flat base about 30 metres wide. Stream flows, which currently include discharge from the Springvale Colliery, feed north to a tributary of the Wolgan River.

Narrow Swamp – located on a first order watercourse in the Wolgan catchment and is situated above longwalls 930 to 950. The swamp is about 25 metres wide and occupies the base of a broad valley.

West Wolgan Swamp – this swamp is the smallest of the swamps and is located above longwalls 930 to 950. It occupies a broad depression near the ridge top at the upper end of a watercourse, upstream of the Narrow Swamp. This watercourse feeds eventually into the Wolgan River.

At Angus Place, the available data indicate that the two main shrub swamps (East Wolgan and Narrow Swamps) are fed by the uppermost aquifer, AQ5, which is located about 30 to 50 metres below the ridges adjacent to these swamps (and at greater depth beneath the ridge top further to the south). Both swamps occupy watercourses that flow in a general *northerly direction into a tributary of the Wolgan River. The remaining swamp (West Wolgan) appears to be fed by a perched aquifer above aquifer AQ5."*

The NPSS and NPHS vegetation communities are classified as 'Wetlands' according to the criteria in Section 2.3 of the NSW Groundwater Dependent Ecosystem Policy (DLWC 2002).

The type of groundwater system is classified as a Sedimentary Rock Aquifer according to Section 2.4 of the NSW Groundwater Dependent Ecosystem Policy (DLWC 2002).

Vulnerability of the GDEs

The NPSS and NPHS GDEs are highly dependent on the continuous flow of groundwater into the swamps. The swamps themselves are situated on deep beds of peat which absorbs and holds large quantities of water which is slowly released over time to the lower catchment. These GDEs are reliant on the groundwater infiltration to a greater extent than overland flow resulting from rainfall events. The recharging and holding of large amounts of water by the surrounding geology as well as the peat within the swamps and the subsequent very slow release of the water by the geology and swamp ensure that a constant flow of water is permeating the area.

Mining at depths of up 300 to 350 metres below the surface is expected to result in a maximum subsidence of 0.69 to 1.47 metres (Ditton Geotechnical Services Ltd 2010).

This is likely to result in minor surface cracking and shearing which may range in width from 1mm to 20mm where deep soil profiles exist (DgS 2010). There may also be increases or decreases of surface gradients of up to 0.3 degrees (0.5%) along ephemeral watercourses or gullies that exist above the proposed longwall panels. There is also the potential for a minor increase in erosion and sedimentation along creek beds after several storm events or until a new equilibrium is reached.

Gully stormwater or groundwater seepage flows may be temporarily re-routed to below-surface pathways and re-surface downstream of cracked areas where shallow surface rock present. The temporary loss of surface water flows is unlikely to occur where deep alluvial soil profiles exist (such as within swamp areas). Creek bed sediment is likely to infill any surface cracking during storm events.

Ponding depths of less than 0.1m may develop along creeks and flatter areas beneath the longwalls. Any increases of existing ponded areas or development of new ponds are likely to be in-channel and unlikely to cause significant impact to the existing environmental conditions.

Assess the value of the GDEs

The NPSS and NPHS vegetation communities are very valuable from several viewpoints:

- These vegetation types are rare, occupying a total of 394ha and 272ha for NPSS and NPHS respectively (DEC 2006).
- These vegetation communities provide the only known habitat for the Blue Mountains

Water Skink (*Eulamprus leuraensis*) which is listed as an Endangered species under the NSW TSC Act and as an Endangered species under the Commonwealth EPBC Act.

- These vegetation communities provide a high value habitat or resource for a number of flora and fauna species and provides a refuge during times of drought due to the water holding capacity of the underlying peat.
- The NPSS and NPHS vegetation communities act as repositories for nutrients by absorbing them and converting them into vegetation or otherwise locking or trapping these nutrients within the natural processes within the swamps.
- The swamp communities act as large filters by removing nutrients and minerals from the water.
- The swamp communities have a high aesthetic value.

List management tools for protecting and managing GDEs

Management tools for GDEs within the Newnes Plateau area are generally those of retention, buffering and monitoring within the Newnes State Forest. These strategies are utilised by the NSW Department of Primary Industries (Forestry) as well as several underground mining companies within the area. NPSS and NPHS have a high priority with respect to conservation and every effort to avoid significant impacts of any type are taken by these industries. Threats to these communities include: Longwall mining for coals leading to changes to the hydrology of catchments and the associated swamps and severe and rapid erosion, roadworks, quarrying and periodic timber harvesting from adjacent plantations all leading to incremental clearing, fragmentation, erosion and sedimentation, invasion of exotic species, including species of Pinus, and changes to fire regimes.

An assessment by Ditton Geotechnical Services Pty Ltd (2010) has determined that the local geology and the proposed longwall panels will result in subsidence of between 0.69 and 1.47 metres which is likely to produce minor cracking and ponding on the surface of less than 0.1m which is not likely to result in any permanent re-routing of the water flow or result in any long-term erosion effects. The expected cracks are most likely to self-heal due to natural infilling.

I&I NSW have standard operating procedures for selective logging which include buffers located around any steep slopes and also creeklines. These buffers are not logged and are left in their natural state to control erosion and avoid any impacts such as sedimentation of creeklines. In addition the practice of selective logging ensures that areas of vegetation are not clear-felled which contributes to many negative impacts on creeklines and associated swamps.

The mine has a comprehensive water table monitoring program in place as well as regular monitoring of flora and fauna within its lease area. This enables collection of a large amount of data which is collated, analysed and presented within an annual monitoring report.

Prioritise Management Actions

Management actions such as retention and buffering around the swamp vegetation communities within the Newnes State Forest will retain these communities in an as near natural state as possible. Regular monitoring provides comprehensive data for use in determining if any changes are taking place. These management actions are at present the least invasive or damaging and are also the most cost effective. If any change is detected within the environment of the swamp vegetation communities then active remedial action is an option, however it is expected that this will be costly and will require very strict procedures and monitoring to achieve. Presently the status of the NPSS and NPHS communities has been maintained within expected annual and longer term climactic changes (such as the recent drought).

Implement Management Actions

All management actions that are conceivably possible are presently being enacted. This comprises of retention, monitoring, research and planning for minor impacts as a result of subsidence due to longwall mining.

The planned mining actions for proposed longwalls 910 and 900 West have been designed to avoid any longwall mining under any occurrences of NPSS. This strategy has been implemented to minimise any impacts on these communities.

Pro-active management such as water allocations, water rights and the like do not apply to these GDEs as there is no water extraction proposed for the swamps or the associated groundwater flows.

Review of management actions

It is essential to review management plans to assess their effectiveness. Changes may need to be reflected in management action to bring about greater resource protection. Review of the plan should be undertaken at regular intervals of 2 years or at the most every 5 years. This review should consider the extent to which the plan was implemented and whether it has succeeded in achieving its goals.

8 Part 3A Key Thresholds Assessment

As required by the Draft Guidelines for Threatened Species Assessment for Part 3A Applications (DEC / DPI 2005), the following assessment of Key Thresholds is provided for the proposal.

1. Whether or not the Proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

The proposal is unlikely to reduce viability of any species, population or ecological community, given the low level of impact and the extensive expanse of similar habitat in the broader locality.

Impacts from subsidence are predicted to be minor, based on the previous experiences in this area coupled with the type of overlying strata and ecological communities.

The removal of 4.2 ha of surface vegetation to accommodate essential surface facilities will result in a slight regional reduction in vegetation cover. However, given the expanse of the affected vegetation / habitat types in the broader locality, this is considered unlikely to lead to a realised reduction in biodiversity.

2. Whether or not the Proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

The proposal is unlikely to reduce viability of any species, population or ecological community, given the low level of impact and the extensive expanse of similar habitat in the broader locality.

3. Whether or not the Proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.

The removal of the relatively small area of habitat for the proposal is considered unlikely to accelerate the extinction or place at risk of extinction any species, population or ecological community, given the extensive expanse of similar habitat in the broader locality.

The broader potential impacts of subsidence have also been considered and are not likely to significantly affect any flora or fauna species, their habitats or ecological communities.

4. Whether or not the Proposal will adversely affect critical habitat.

There is no declared “Critical Habitat” within the locality, and as such the proposal will not adversely affect any such habitat.

9 Conclusion and Recommendations

9.1 Conclusion

The proposal will directly modify a small area (approximately 4.2 ha) of native vegetation in order to extend and upgrade an existing access track, and to install a dewatering borehole at the eastern end of the proposed 910 longwall panel. The proposal will have minimal direct impacts on the subject site, with the access track and borehole requiring the removal or modification of only a relatively small linear area of vegetation. The proposed longwall panels will have an indirect impact on the ecology of the subject site via the expected subsidence and modified subsurface hydrology subsequent to the proposed coal extraction, although projected subsidence predictions are considered unlikely to have a significant adverse impact upon ecological attributes within the study area.

Two threatened flora species, three threatened bat species, four threatened bird species and one EEC have been recorded within the site during recent surveys, although habitat is considered suitable for a number of other threatened fauna, which may use the site on at least an intermittent basis.

The proposed road upgrades, dewatering facility provisions and subsequent underground mining activities are likely to result in minimal impacts upon the available habitats on the site. The project is considered unlikely to cause a significant adverse effect upon threatened species recorded within the study area or those which may potentially occur within the site on an intermittent basis.

9.2 Recommendations

The following mitigation measures have been recommended to minimise potential impacts of the proposal:

- The minimal amount of clearing should take place as a general objective of the project, particularly within those areas that contain hollow-bearing trees;
- Where the removal of hollow-bearing trees is not avoidable, inspection of hollow-bearing trees prior to and clearing should be undertaken by a qualified ecologist to ensure removal and relocation of animals can occur and the following protocol should be adopted:
  - A qualified ecologist shall supervise the removal of the hollow-bearing trees to ensure the protection of native fauna;
  - Trees shall be soft-felled to minimise impacts upon any fauna inside; and
  - Felled habitat trees shall be left for two days to allow fauna inside to escape unless the absence of fauna can be confirmed at an earlier time.

A staged approach to clearing of any hollow-bearing trees will be undertaken to enable arboreal fauna (particularly gliders and possums) to safely leave the work area. This method provides a disturbance stimulus and time for fauna to leave the area. It also is likely to reduce the need for human intervention in the rescue and/or translocation of arboreal fauna. This method is recommended as preferable over the situation where the habitat tree is felled in the midst of a previously cleared swathe and escaping fauna must cross a treeless and open expanse (exposed to high risks of predation) to reach secure habitat.

Once felled the trees will be examined for the presence of fauna by a qualified ecologist, who will examine potential shelter sites (hollows, nests, termitaria, epiphytes, decorticating bark, crevices).

When an animal is detected in a tree, clearing activities are directed elsewhere to allow fauna time to leave, or the animal will be carefully removed from the tree. After fauna are observed to leave or are removed safely from the tree, the habitat tree will be disturbed again and placed carefully in the direction of remaining trees (care will be taken to ensure trees are not pushed into the 'Exclusion Zone').

Any fauna disturbed during clearing procedures will first be permitted to escape into adjacent habitat. Where this does not occur or where fauna appear to be shocked or injured, fauna will be carefully captured and held in appropriate circumstances and a local wildlife rescue organisation will be contacted if required.

Appropriate temporary housing for fauna is species-dependent. An appropriate large safe container will be used for capture of koalas, which are then transferred into a thick sack. Gliders, possums, snakes and frogs will be similarly held individually in a calico bag until release in adjacent habitat. Nesting birds and eggs will be placed in a covered cardboard box equipped with soft cloth. Rescued fauna will be protected from exposure to heat and removed from the area undergoing clearing activities to minimise exposure to noise. Any fauna which cannot be released immediately or by the evening of the day clearing occurred will be passed onto a wildlife rescue organisation/carer.

- It is recommended that measures be implemented to avoid impacts upon waterways and associated vegetation resulting from soil disturbance, namely adequate erosion and sedimentation controls.
- It is recommended that appropriate measures be employed to ensure that machinery working within the site does not bring materials (soils etc.) onto the sites that may infect onsite vegetation with *Phytophthora cinnamomi*; and
- It is recommended that ongoing weed monitoring be instituted and potential weed infestations be appropriately managed to ensure surrounding communities (particularly hanging swamps) are protected from invasive species.

Many of above activities will occur as directed by the Rehabilitation Strategy for the project by GSS Environmental (2010), which will direct methods of restoration of disturbed areas and general environmental management of affected areas.

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Appendix I

Known and Expected Fauna Species List

APPENDIX A: EXPECTED FAUNA LIST

Below is a list of fauna species that could be *reasonably* expected to be found within the site at some occurrence. Such an approach has been taken given the unlikelihood to record *all* potentially occurring species within an area during formal fauna surveys (due to seasonality, climatic limitations, crypticism etc).

Family sequencing and taxonomy follow for each fauna class:

Birds – Christidis and Boles (1994).

Herpetofauna - Cogger (1996).

Mammals - Strahan (ed.) (1995) and Churchill (1998).

✓ - Species observed or indicated by scats, tracks etc. on site during this investigation.

* - Indicates an introduced species

Known and Expected Bird List

Appendix Key: **1** = Results of ecological investigations conducted within the study area
✓ = Species Detected
* = introduced species
(C) = listed as CAMBA species
(J) = listed as JAMBA species
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
(EM) = Species listed under the Commonwealth EPBC Act as Migratory
(EMa) = Species listed under the Commonwealth EPBC Act as Marine
Species indicated in **BOLD** font are those threatened species known from within Lithgow LGA (Atlas of NSW Wildlife data)

Data Source: ✓ = Species recorded during this survey

Family Name	*Scientific Name*	Common Name	Recorded
Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	
	Acanthiza lineata	Striated Thornbill	✓
	Acanthiza nana	Yellow Thornbill	
	Acanthiza pusilla	Brown Thornbill	✓
	Acanthiza reguloides	Buff-rumped Thornbill	✓
	Aphelocephala leucopsis	Southern Whiteface	
	Calamanthus pyrrhopygius	Chestnut-rumped Heathwren	
	Gerygone fusca	Western Gerygone	
	Gerygone mouki	Brown Gerygone	
	Gerygone olivacea	White-throated Gerygone	
	Origma solitaria	Rockwarbler	
	Pycnoptilus floccosus	Pilotbird	
	Pyrrholaemus saggitatus	**Speckled Warbler (V)**	
	Sericornis citreogularis	Yellow-throated Scrubwren	
	Sericornis frontalis	White-browed Scrubwren	✓
	Sericornis magnirostris	Large-billed Scrubwren	
	Smicrornis brevirostris	Weebill	

Family Name	*Scientific Name*	Common Name	Recorded
Accipitridae	*Accipiter cirrocephalus*	Collared Sparrowhawk	
	Accipiter fasciatus	Brown Goshawk	✓
	Accipiter novaehollandiae	Grey Goshawk	
	Aquila audax	Wedge-tailed Eagle	
	Elanus axillaris	Black-shouldered Kite	
	Haliaeetus leucogaster	White-bellied Sea-Eagle	
	Haliastur sphenurus	Whistling Kite	
	Lophoictinia isura	**Square-tailed Kite (V)**	
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	✓
Alaudidae	*Alauda arvensis**	Eurasian Skylark	
	Mirafra javanica	Horsfield's Bushlark	
Alcedinidae	*Alcedo azurea*	Azure Kingfisher	
	Dacelo novaeguineae	Laughing Kookaburra	✓
	Todiramphus sanctus	Sacred Kingfisher	✓
Anatidae	*Anas gracilis*	Grey Teal	
	Anas rhynchotis	Australasian Shoveler	
	Anas superciliosa	Pacific Black Duck	✓
	Aythya australis	Hardhead	
	Biziura lobata	Musk Duck	
	Chenonetta jubata	Australian Wood Duck	
	Cygnus atratus	Black Swan	
	Malacorhynchus membranaceus	Pink-eared Duck	
	Oxyura australis	**Blue-billed Duck (V)**	
Apodidae	*Hirundapus caudacutus*	White-throated Needletail (EM)	✓
Ardeidae	*Ardea pacifica*	White-necked Heron	
	Egretta novaehollandiae	White-faced Heron	
	Nycticorax caledonicus	Nankeen Night Heron	

Family Name	*Scientific Name*	Common Name	Recorded
Artamidae	*Artamus cinereus*	Black-faced Woodswallow	
	Artamus cyanopterus	Dusky Woodswallow	
	Artamus leucorynchus	White-breasted Woodswallow	
	Artamus superciliosus	White-browed Woodswallow	
	Cracticus nigrogularis	Pied Butcherbird	✓
	Cracticus torquatus	Grey Butcherbird	✓
	Gymnorhina tibicen	Australian Magpie	✓
	Strepera graculina	Pied Currawong	✓
	Strepera versicolor	Grey Currawong	✓
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	
	Cacatua sanguinea	Little Corella	
	Callocephalon fimbriatum	**Gang-Gang Cockatoo (V)**	✓
	Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	✓
	Calyptorhynchus lathami	**Glossy Black-Cockatoo (V)**	
	Eolophus roseicapillus	Galah	
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	✓
	Coracina papuensis	White-bellied Cuckoo-shrike	
	Coracina tenuirostris	Cicadabird	
	Lalage tricolor	White-winged Triller	
Caprimulgidae	*Eurostopodus mystacalis*	White-throated Nightjar	
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel	
	Vanellus miles	Masked Lapwing	
Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola	
Climacteridae	*Climacteris erythrops*	Red-browed Treecreeper	✓
	Climacteris picumnus victoriae	**Brown Treecreeper (eastern subspecies) (V)**	

Family Name	*Scientific Name*	Common Name	Recorded
	Cormobates leucophaea	White-throated Treecreeper	✓
Columbidae	*Geopelia cuneata*	Diamond Dove	
	Geopelia humeralis	Bar-shouldered Dove	
	Geopelia placida	Peaceful Dove	
	Leucosarcia melanoleuca	Wonga Pigeon	
	Macropygia amboinensis	Brown Cuckoo-Dove	
	Ocyphaps lophotes	Crested Pigeon	
	Phaps chalcoptera	Common Bronzewing	
	Phaps elegans	Brush Bronzewing	
Coraciidae	*Eurystomus orientalis*	Dollarbird	
Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough	✓
Corvidae	*Corvus coronoides*	Australian Raven	✓
	Corvus mellori	Little Raven	
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	✓
	Cacomantis variolosus	Brush Cuckoo	
	Chalcites basalis	Horsfield's Bronze-Cuckoo	
	Chalcites lucidus	Shining Bronze-Cuckoo	
	Chalcites osculans	Black-eared Cuckoo	
	Cuculus pallidus	Pallid Cuckoo	
	Cuculus saturatus	Oriental Cuckoo	
	Eudynamys orientalis	Pacific Koel	
	Scythrops novaehollandiae	Channel-billed Cuckoo	
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	✓
Dicruridae	*Grallina cyanoleuca*	Magpie-lark	
	Monarcha melanopsis	Black-faced Monarch	
	Monarcha trivirgatus	Spectacled Monarch	
	Myiagra cyanoleuca	Satin Flycatcher	✓
	Myiagra inquieta	Restless Flycatcher	

Family Name	*Scientific Name*	Common Name	Recorded
	Myiagra rubecula	Leaden Flycatcher	✓
	Rhipidura albiscapa	Grey Fantail	✓
	Rhipidura leucophrys	Willie Wagtail	
	Rhipidura rufifrons	Rufous Fantail	✓
Estrildidae	*Lonchura castaneothorax*	Chestnut-breasted Mannikin	
	Neochmia modesta	Plum-headed Finch	
	Neochmia temporalis	Red-browed Finch	✓
	Stagonopleura bella	Beautiful Firetail	
	Stagonopleura guttata	**Diamond Firetail (V)**	
	Taeniopygia bichenovii	Double-barred Finch	
	Taeniopygia guttata	Zebra Finch	
Eupetidae	*Cinclosoma punctatum*	Spotted Quail-thrush	✓
	Psophodes olivaceus	Eastern Whipbird	✓
Falconidae	*Falco berigora*	Brown Falcon	
	Falco cenchroides	Nankeen Kestrel	
	Falco longipennis	Australian Hobby	
	Falco peregrinus	Peregrine Falcon	
	Falco subniger	Black Falcon	
Fringillidae	*Carduelis carduelis**	European Goldfinch	
Hirundinidae	*Cheramoeca leucosterna*	White-backed Swallow	
	Hirundo neoxena	Welcome Swallow	✓
	Petrochelidon ariel	Fairy Martin	
	Petrochelidon nigricans	Tree Martin	
Laridae	*Larus novaehollandiae*	Silver Gull	
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	✓
	Malurus lamberti	Variegated Fairy-wren	✓
	Stipiturus malachurus	Southern Emu-wren	

Family Name	*Scientific Name*	Common Name	Recorded
Megapodiidae	*Alectura lathami*	Australian Brush-turkey	
Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	
	Acanthorhynchus tenuirostris	Eastern Spinebill	✓
	Anthochaera carunculata	Red Wattlebird	✓
	Anthochaera chrysoptera	Little Wattlebird	
	Entomyzon cyanotis	Blue-faced Honeyeater	
	Epthianura albifrons	White-fronted Chat	
	Gliciphila melanops	Tawny-crowned Honeyeater	
	Grantiella picta	**Painted Honeyeater (V)**	
	Lichenostomus chrysops	Yellow-faced Honeyeater	✓
	Lichenostomus fuscus	Fuscous Honeyeater	
	Lichenostomus leucotis	White-eared Honeyeater	✓
	Lichenostomus melanops	Yellow-tufted Honeyeater	
	Lichenostomus penicillatus	White-plumed Honeyeater	
	Manorina melanocephala	Noisy Miner	✓
	Manorina melanophrys	Bell Miner	
	Meliphaga lewinii	Lewin's Honeyeater	
	Melithreptus brevirostris	Brown-headed Honeyeater	✓
	Melithreptus gularis gularis	**Black-chinned Honeyeater (eastern subspecies) (V)**	
	Melithreptus lunatus	White-naped Honeyeater	✓
	Myzomela sanguinolenta	Scarlet Honeyeater	✓
	Philemon citreogularis	Little Friarbird	
	Philemon corniculatus	Noisy Friarbird	✓
	Phylidonyris niger	White-cheeked Honeyeater	
	Phylidonyris novaehollandiae	New Holland Honeyeater	✓
	Phylidonyris pyrrhoptera	Crescent Honeyeater	

Family Name	*Scientific Name*	Common Name	Recorded
	Plectorhyncha lanceolata	Striped Honeyeater	
	Xanthomyza phrygia	**Regent Honeyeater (E, E*)**	
Menuridae	*Menura novaehollandiae*	Superb Lyrebird	✓
Meropidae	*Merops ornatus*	Rainbow Bee-eater	
Motacillidae	*Anthus australis*	Australian Pipit	
Muscicapidae	*Turdus merula**	Eurasian Blackbird	
	Zoothera lunulata	Bassian Thrush	✓
Neosittidae	***Daphoenositta chrysoptera***	**Varied Sittella (V)**	✓
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	✓
	Falcunculus frontatus	Eastern Shrike-tit	✓
	Pachycephala pectoralis	Golden Whistler	✓
	Pachycephala rufiventris	Rufous Whistler	✓
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	✓
	Pardalotus striatus	Striated Pardalote	✓
Passeridae	*Passer domesticus**	House Sparrow	
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	✓
	Melanodryas cucullata	Hooded Robin	
	Melanodryas cucullata cucullata	**Hooded Robin (south-eastern form) (V)**	
	Microeca fascinans	Jacky Winter	
	Petroica boodang	**Scarlet Robin (V)**	✓
	Petroica goodenovii	Red-capped Robin	
	Petroica phoenicea	**Flame Robin (V)**	✓
	Petroica rosea	Rose Robin	
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant	
	Phalacrocorax melanoleucos	Little Pied Cormorant	

Family Name	*Scientific Name*	Common Name	Recorded
	Phalacrocorax sulcirostris	Little Black Cormorant	
	Phalacrocorax varius	Pied Cormorant	
Phasianidae	*Coturnix pectoralis*	Stubble Quail	
	Coturnix ypsilophora	Brown Quail	
Podargidae	*Podargus strigoides*	Tawny Frogmouth	✓
Podicipedidae	*Podiceps cristatus*	Great Crested Grebe	
	Poliocephalus poliocephalus	Hoary-headed Grebe	
	Tachybaptus novaehollandiae	Australasian Grebe	
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler	
	Pomatostomus temporalis temporalis	**Grey-crowned Babbler (eastern subspecies) (V)**	
Psittacidae	*Alisterus scapularis*	Australian King-Parrot	✓
	Glossopsitta concinna	Musk Lorikeet	
	Glossopsitta pusilla	**Little Lorikeet (V)**	
	Lathamus discolor	**Swift Parrot (E,E*)**	
	Melopsittacus undulatus	Budgerigar	
	Neophema pulchella	**Turquoise Parrot (V)**	
	Platycercus adscitus eximius	Eastern Rosella	✓
	Platycercus elegans	Crimson Rosella	✓
	Psephotus haematonotus	Red-rumped Parrot	
	Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	
	Trichoglossus haematodus	Rainbow Lorikeet	
Ptilonorhynchidae	*Ptilonorhynchus violaceus*	Satin Bowerbird	✓
Pycnonotidae	*Pycnonotus jocosus**	Red-whiskered Bulbul	
Rallidae	*Fulica atra*	Eurasian Coot	
	Gallinula tenebrosa	Dusky Moorhen	
	Gallirallus philippensis	Buff-banded Rail	
	Porphyrio porphyrio	Purple Swamphen	

Family Name	*Scientific Name*	Common Name	Recorded
	Pozana fluminea	Australian Spotted Crake	
	Pozana pusilla	Baillon’s Crake	
	Pozana tabuensis	Spotless Crake	
	Rallus pectoralis	Lewin’s Rail	
Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper (EM)	
	Gallinago hardwickii	Latham's Snipe (EM)	
Strigidae	*Ninox boobook*	Southern Boobook	
	Ninox connivens	**Barking Owl (V)**	
	Ninox strenua	**Powerful Owl (V)**	
Sturnidae	*Acridotheres tristis**	Common Myna	
	*Sturnus vulgaris**	Common Starling	
Sylviidae	*Acrocephalus australis*	Australian Reed-Warbler	
	Cincloramphus cruralis	Brown Songlark	
	Cincloramphus mathewsi	Rufous Songlark	
	Megalurus gramineus	Little Grassbird	
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill	
	Platalea regia	Royal Spoonbill	
	Threskiornis molucca	Australian White Ibis	
	Threskiornis spinicollis	Straw-necked Ibis	
Turnicidae	*Turnix varia*	Painted Button-quail	
Tytonidae	*Tyto alba*	Barn Owl	
	Tyto novaehollandiae	**Masked Owl (V)**	
	Tyto tenebricosa	**Sooty Owl (V)**	
Zosteropidae	*Zosterops lateralis*	Silvereye	✓

Known and Expected Mammal List

Appendix Key: **1** = Results of ecological investigations conducted within the study area
✓ = Species Detected
* = introduced species
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
Species indicated in **BOLD** font are those threatened species known from within Lithgow LGA (Atlas of NSW Wildlife)

Data Source: ✓ = Species recorded during this survey

Family Name	*Scientific Name*	Common Name	Recorded
Acrobatidae	*Acrobates pygmaeus*	Feathertail Glider	
Bovidae	*Bos taurus**	European Cattle	
	*Capra hircus**	Goat	
Burramyidae	***Cercartetus nanus***	**Eastern Pygmy-possum (V)**	✓
Canidae	*Canis lupus familiaris**	Dog	
	*Canis lupus**	Dingo, domestic dog	
	*Vulpes vulpes**	Fox	
Cervidae	*Cervus sp.**	Deer	
Dasyuridae	*Antechinus agilis*	Agile Antechinus	✓
	Antechinus flavipes	Yellow-footed Antechinus	
	Antechinus stuartii	Brown Antechinus	
	Antechinus swainsonii	Dusky Antechinus	
	Antechinus/Sminthopsis sp.	unidentified 'Marsupial Mouse'	
	Dasyurus maculatus	**Spotted-tailed Quoll (V, V*)**	
Emballonuridae	***Saccolaimus flaviventris***	**Yellow-bellied Sheathtail-bat (V)**	✓
Equidae	*Equus caballus**	Horse	

Family Name	*Scientific Name*	Common Name	Recorded
Felidae	*Felis catus**	Cat	
Leporidae	*Lepus capensis**	Brown Hare	
	*Oryctolagus cuniculus**	Rabbit	
Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo	✓
	Macropus robustus	Common Wallaroo	
	Macropus rufogriseus	Red-necked Wallaby	✓
	Petrogale penicillata	**Brush-tailed Rock-wallaby (E, V*)**	
	Wallabia bicolor	Swamp Wallaby	✓
Molossidae	*Mormopterus "Species 2"*	Undescribed Freetail Bat	
	Mormopterus norfolkensis	**Eastern Freetail-bat (V)**	
	Mormopterus planiceps	Little Mastiff-bat	
	Mormopterus sp.	Mastiff-bat	
	Austronomus australis	White-striped Freetail-bat	
Muridae	*Hydromys chrysogaster*	Water-rat	
	*Mus musculus**	House Mouse	
	Rattus fuscipes	Bush Rat	
	Rattus lutreolus	Swamp Rat	
	*Rattus rattus**	Black Rat	
Ornithorhynchidae	*Ornithorhynchus anatinus*	Platypus	
Peramelidae	*Isoodon/Perameles sp.*	unidentified Bandicoot	
Petauridae	***Petaurus australis***	**Yellow-bellied Glider (V)**	
	Petaurus breviceps	Sugar Glider	
	Petaurus norfolcensis	**Squirrel Glider (V)**	
Phalangeridae	*Trichosurus caninus*	Short-eared Possum	
	Trichosurus sp.	Brushtail Possum	
	Trichosurus vulpecula	Common Brushtail Possum	

Family Name	*Scientific Name*	Common Name	Recorded
Phascolarctidae	***Phascolarctos cinereus***	**Koala (V)**	
Potoroidae	*Bettongia gaimardi*	Tasmanian Bettong	
Pseudocheiridae	*Petauroides volans*	Greater Glider	
	Pseudocheirus peregrinus	Common Ringtail Possum	
Rhinolophidae	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat	✓
Suidae	*Sus scrofa**	Pig	
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	
Vespertilionidae	***Chalinolobus dwyeri***	**Large-eared Pied Bat (V, V*)**	✓
	Chalinolobus gouldii	Gould's Wattled Bat	
	Chalinolobus morio	Chocolate Wattled Bat	✓
	Falsistrellus tasmaniensis	**Eastern False Pipistrelle (V)**	✓
	Miniopterus australis	**Little Bentwing-bat (V)**	
	Miniopterus schreibersii oceanensis	**Eastern Bentwing-bat (V)**	
	Myotis adversus	**Large-footed Myotis (V)**	
	Nyctophilus geoffroyi	Lesser Long-eared Bat	
	Nyctophilus gouldi	Gould's Long-eared Bat	
	Nyctophilus sp.	Long-eared bat	
	Scoteanax rueppellii	**Greater Broad-nosed Bat (V)**	
	Scotorepens balstoni	Inland Broad-nosed Bat	
	Scotorepens orion	Eastern Broad-nosed Bat	
	Vespadelus darlingtoni	Large Forest Bat	✓
	Vespadelus pumilus	Eastern Forest Bat	
	Vespadelus regulus	Southern Forest Bat	✓
	Vespadelus vulturnus	Little Forest Bat	
Vombatidae	*Vombatus ursinus*	Common Wombat	

Known and Expected Reptile List

Appendix Key: **1** = Results of ecological investigations conducted within the study area
✓ = Species Detected
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(EE) = Species listed under the Commonwealth EPBC Act as Endangered
(EMa) = Species listed under the Commonwealth EPBC Act as Marine
Species indicated in **BOLD** font are those threatened species known from within Lithgow LGA (Atlas of NSW Wildlife)

Data Source: ✓ = Species recorded during this survey

Family Name	*Scientific Name*	Common Name	Recorded
Agamidae	*Amphibolurus muricatus*	Jacky Lizard	✓
	Amphibolurus nobbi	Nobbi	
	Physignathus lesueurii	Eastern Water Dragon	
	Pogona barbata	Bearded Dragon	
	Rankinia diemensis	Mountain Dragon	✓
Chelidae	*Chelodina longicollis*	Eastern Snake-necked Turtle	
Elapidae	*Austrelaps ramsayi*	Highland Copperhead	
	Austrelaps superbus	Lowland Copperhead	
	Cryptophis nigrescens	Eastern Small-eyed Snake	✓
	Drysdalia rhodogaster	Mustard-bellied Snake	
	Furina diadema	Red-naped Snake	
	Hoplocephalus bungaroides	**Broad-headed Snake (E, V*)**	
	Notechis scutatus	Tiger Snake	
	Parasuta dwyeri	Dwyer's Snake	
	Parasuta spectabilis	Mallee Black-headed Snake	
	Pseudechis guttatus	Spotted Black Snake	
	Pseudechis porphyriacus	Red-bellied Black Snake	
	Pseudonaja textilis	Eastern Brown Snake	
	Vermicella annulata	Bandy-bandy	
Gekkonidae	*Diplodactylus vittatus*	Wood Gecko	

Family Name	*Scientific Name*	Common Name	Recorded
	Oedura lesueurii	Lesueur's Velvet Gecko	
	Phyllurus platurus	Broad-tailed Gecko	
	Underwoodisaurus milii	Thick-tailed Gecko	
Pygopodidae	*Pygopus lepidopodus*	Common Scaly-foot	
Scincidae	*Acritoscincus duperreyi*	Eastern Three-lined Skink	
	Acritoscincus platynota	Red-throated Skink	
	Carlia tetradactyla	Southern Rainbow-skink	
	Cryptoblepharus virgatus	Cream-striped Shinning-skink	
	Ctenotus robustus	Robust Ctenotus	
	Ctenotus taeniolatus	Copper-tailed Skink	✓
	Egernia cunninghami	Cunningham's Skink	
	Egernia saxatilis	Black Rock Skink	✓
	Egernia saxatilis intermedia		
	Egernia striolata	Tree Skink	
	Egernia whitii	White's Skink	✓
	Eulamprus heatwolei	Yellow-bellied Water-skink	✓
	Eulamprus leuraensis	**Blue Mountains Water skink (E, E*)**	
	Eulamprus quoyii	Eastern Water-skink	✓
	Eulamprus tenuis	Barred-sided Skink	
	Eulamprus tympanum	Southern Water-skink	
	Hemiergis decresiensis	Three-toed Earless Skink	
	Lampropholis delicata	Dark-flecked Garden Sunskink	✓
	Lampropholis guichenoti	Pale-flecked Garden Sunskink	
	Lampropholis sp.	unidentified grass skink	
	Lerista bougainvillii	South-eastern Slider	
	Lygisaurus foliorum	Tree-base Litter-skink	
	Morethia boulengeri	South-eastern Morethia Skink	

Family Name	***Scientific Name***	Common Name	Recorded
	Pseudemoia entrecasteauxii	Tussock Cool-skink	
	Pseudemoia pagenstecheri	Tussock Skink	
	Saiphos equalis	Three-toed Skink	
	Saproscincus mustelinus	Weasel Skink	
	Tiliqua nigrolutea	Blotched Blue-tongue	
	Tiliqua scincoides	Eastern Blue-tongue	
Typhlopidae	*Ramphotyphlops nigrescens*	Blackish Blind Snake	
Varanidae	***Varanus rosenbergi***	**Rosenberg's Goanna (V)**	
	Varanus sp.	Unidentified Goanna	
	Varanus varius	Lace Monitor	

Known and Expected Frog List

Appendix Key: **1** = Results of ecological investigations conducted within the study area
✓ = Species Detected
* = introduced species
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
Species indicated in **BOLD** font are those threatened species known from Within Lithgow LGA (Atlas of NSW Wildlife)

Data Source: ✓ = Species recorded during this survey

Family Name	*Scientific Name*	Common Name	Recorded
Hylidae	***Litoria booroolongensis***	**Booroolong Frog (E, E*)**	
	Litoria caerulea	Green Tree Frog	
	Litoria citropa	Blue Mountains Tree Frog	
	Litoria dentata	Bleating Tree Frog	
	Litoria ewingii	Brown Tree Frog	
	Litoria fallax	Eastern Dwarf Tree Frog	
	Litoria latopalmata	Broad-palmed Frog	
	Litoria lesueuri	Lesueur's Frog	
	Litoria peronii	Peron's Tree Frog	
	Litoria phyllochroa	Leaf-green Tree Frog	
	Litoria sp.	Unidentified Tree Frog	
	Litoria verreauxii	Verreaux's Frog	
	Litoria wilcoxii		
Myobatrachidae	*Crinia parinsignifera*	Eastern Sign-bearing Froglet	
	Crinia signifera	Common Eastern Froglet	
	Heleioporus australiacus	**Giant Burrowing Frog (V, V*)**	
	Limnodynastes dumerilii	Eastern Banjo Frog	
	Limnodynastes fletcheri	Long-thumbed Frog	
	Limnodynastes ornatus	Ornate Burrowing Frog	

Family Name	***Scientific Name***	**Common Name**	**Recorded**
	Limnodynastes peronii	Brown-striped Frog	
	Limnodynastes tasmaniensis	Spotted Grass Frog	
	Mixophyes balbus	**Stuttering Frog (E, V*)**	
	Neobatrachus sudelli	Sudell's Frog	
	Pseudophryne australis	**Red-crowned Toadlet (V)**	
	Pseudophryne bibronii	Bibron's Toadlet	
	Pseudophryne sp.		
	Uperoleia laevigata	Smooth Toadlet	

Appendix 2

Flora Species List

Family	Scientific Name	Common Name
TREES		
Casuarinaceae	*Allocasuarina nana*	Dwarf She-oak
Cupressaceae	*Callitris rhomboidea*	Port Jackson Cypress
Myrtaceae	*Eucalyptus blaxlandii*	Blaxland's Stringybark
Myrtaceae	*Eucalyptus dalrympleana*	Mountain Gum
Myrtaceae	*Eucalyptus dives*	Broad-leaved Peppermint
Myrtaceae	*Eucalyptus fastigata*	Brown Barrel
Myrtaceae	*Eucalyptus oreades*	Blue Mountains Ash
Myrtaceae	*Eucalyptus pauciflora*	Snow Gum
Myrtaceae	*Eucalyptus radiata*	Narrow-leaved Peppermint
Myrtaceae	*Eucalyptus sclerophylla*	Scribbly Gum
Myrtaceae	*Eucalyptus sieberi*	Silvertop Ash
SHRUBS		
Apiaceae	*Platysace linearifolia*	Narrow-leafed Platysace
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax
Asteraceae	*Cassinia arcuata*	Sifton Bush
Asteraceae	*Cassinia cunninghamii*	Cunningham's Everlasting
Asteraceae	*Olearia erubescens*	Silky Daisy Bush
Casuarinaceae	*Allocasuarina distyla*	-
Epacridaceae	*Brachyloma daphnoides*	Daphne Heath
Epacridaceae	*Epacris microphylla*	Coral Heath
Epacridaceae	*Epacris pulchella*	Wallum Heath
Epacridaceae	*Leucopogon lanceolatus*	Lance-leaf Beard-heath
Epacridaceae	*Monotoca elliptica*	Tree Broom-heath
Epacridaceae	*Monotoca scoparia*	Prickly Broom-heath
Euphorbiaceae	*Amperea xiphoclada var. xiphoclada*	Broom Spurge
Fabaceae/faboide	*Daviesia latifolia*	-
Fabaceae/faboide	*Daviesia squarrosa*	-
Fabaceae/faboide	*Gompholobium huegelii*	Pale Wedge Pea
Fabaceae/faboide	*Mirbelia platylobioides*	-
Fabaceae/faboide	*Phyllota squarrosa*	Dense Phyllota
Fabaceae/faboide	*Acacia buxifolia*	Box-leaf Wattle
Fabaceae/faboide	*Acacia rubida*	Red-stemmed Wattle
Fabaceae/faboide	*Acacia terminalis*	Sunshine Wattle
Myrtaceae	*Baeckea linifolia*	Weeping Baeckea
Myrtaceae	*Leptospermum arachnoides*	-
Myrtaceae	*Leptospermum continentale*	Tea-tree
Myrtaceae	*Leptospermum grandifolium*	Woolly Tea-tree
Myrtaceae	*Leptospermum obovatum*	-
Myrtaceae	*Leptospermum polygalifolium* subsp. *polyga*	Tantoon
Myrtaceae	*Leptospermum trinervium*	Slender Tea-tree
Proteaceae	*Banksia cunninghamii subsp. cunninghamii*	-
Proteaceae	*Banksia ericifolia* var. *ericifolia*	Heath-leaved Banksia
Proteaceae	*Grevillea acanthifolia subsp. acanthifolia*	-
Proteaceae	*Grevillea laurifolia*	Laurel-leaf Grevillea
Proteaceae	*Hakea dactyloides*	Broad-leaved Hakea
Proteaceae	*Hakea sericea*	Needlebush
Proteaceae	*Isopogon anemonifolius*	Flat-leaved Drumsticks
Proteaceae	*Lomatia myricoides*	River Lomatia
Proteaceae	*Lomatia silaifolia*	Crinkle Bush
Proteaceae	*Persoonia chamaepitys*	Mountain Geebung

Proteaceae	***Persoonia hindii***	**-**
Proteaceae	*Persoonia myrtilloides subsp. myrtilloides*	-
Proteaceae	*Persoonia oblongata*	-
Proteaceae	*Persoonia recedens*	-
Proteaceae	*Petrophile pulchella*	Conesticks
Proteaceae	*Petrophile sessilis*	Conesticks
Rhamnaceae	*Pomaderris andromedifolia*	-
Rutaceae	*Boronia microphylla*	Small-leaved Boronia
Santalaceae	*Leptomeria acida*	Native Currant
Santalaceae	*Omphacomeria acerba*	-
Scrophulariaceae	***Derwentia blakelyi***	**-**

GROUNDCOVERS

Asteraceae	*Arrhenechthites mixta*	Purple Fireweed
Asteraceae	*Helichrysum rutidolepis*	Pale Everlasting
Asteraceae	*Hypochaeris glabra**	Smooth Catsear
Asteraceae	*Hypochaeris radicata**	Flatweed
Asteraceae	*Lagenophora stipitata*	-
Asteraceae	*Senecio linearifolius*	Fireweed
Clusiaceae	*Hypericum gramineum*	Small St Johns Wort
Cyperaceae	*Gahnia aspera*	Saw Sedge
Cyperaceae	*Gahnia microstachya*	-
Cyperaceae	*Gahnia sieberiana*	Red-fruited Saw-sedge
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge
Cyperaceae	*Lepidosperma limicola*	-
Dennstaedtiaceae	*Pteridium esculentum*	Bracken
Dilleniaceae	*Hibbertia (monogyna ?)*	-
Dilleniaceae	*Hibbertia obtusifolia*	Grey Guinea Flower
Droseraceae	*Drosera peltata*	Sundew
Droseraceae	*Drosera spathulata*	Common Sundew
Euphorbiaceae	*Poranthera microphylla*	-
Gentianaceae	*Centaurium erythraea**	Common Centaury
Gleicheniaceae	*Gleichenia dicarpa*	Pouched Coral Fern
Goodeniaceae	*Dampiera stricta*	Blue Dampiera
Goodeniaceae	*Goodenia bellidifolia*	Daisy-leaved Goodenia
Goodeniaceae	*Goodenia hederacea* subsp. *hederacea*	Ivy-leaved Goodenia
Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort
Haloragaceae	*Gonocarpus teucroides*	Raspwort
Iridaceae	*Patersonia glabrata*	Leafy Purple-flag
Iridaceae	*Patersonia sericea*	Wild Iris
Lomandraceae	*Lomandra filiformis* subsp. *coriacea*	Wattle Mat-rush
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*	Wattle Mat-rush
Lomandraceae	*Lomandra glauca*	Pale Mat-rush
Lomandraceae	*Lomandra longifolia*	Spiky-headed Mat-rush
Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush
Orchidaceae	*Dipodium punctatum*	Hyacinth Orchid
Oxalidaceae	*Oxalis perrenans*	Yellow-flowered Wood Sorrel
Phormiaceae	*Dianella caerulea* var. *producta*	Blue Fla1 Lily
Phormiaceae	*Dianella revoluta* var. *revoluta*	Spreading Fla1 Lily
Poaceae	*Austrodanthonia racemosa var. racemosa*	Wallaby Grass
Poaceae	*Austrostipa pubescens*	Tall Speargrass
Poaceae	*Joycea pallida*	Silvertop Wallaby Grass
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Rice Grass

Poaceae	*Poa seiberiana* var. *cyanophylla*	-
Restionaceae	*Baloskion australe*	-
Restionaceae	*Empodisma minus*	-
Stylidiaceae	*Stylidium graminifolium*	Grass Trigger Plant
Stylidiaceae	*Stylidium lineare*	Narrow-leaved Trigger Plant
Thymelaeaceae	*Pimelea linifolia* subsp. *linifolia*	Slender Rice Flower
Tremandraceae	*Tetratheca rupicola*	Black-eyed Susan
Violaceae	*Hybanthus monopetalus*	Slender Violet
Violaceae	*Hybanthus vernonii* subsp. *vernonii*	-
Violaceae	*Viola betonicifolia*	Native Violet
Violaceae	*Viola hederacea*	Ivy-leaved Violet
Xanthorrhoaceae	*Xanthorrhoea resinosa*	-

CLIMBERS

Pittosporaceae	*Billardiera scandens*	Hairy Appleberry

Appendix 3

Anabat Analysis

Introduction

This Appendix presents the methods and results of the echolocation bat call identification undertaken for data collected during surveys at Angus Place, Newnes Plateau in the Sydney Basin Bioregion as discussed within this report.

Methods

The identification of bat echolocation calls recorded during surveys was undertaken using AnalookW (Version 3.5g) software. The identification of calls was undertaken with reference to *Bat Calls of NSW: region based guide to the echolocation calls of microchiropteran bats* (Pennay et al. 2004) and through the comparison of recorded reference calls from the Sydney Basin.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- **Definite** - Pass identified to species level and could not be confused with another species
- **Probable** - Pass identified to species level and there is a low chance of confusion with another species
- **Possible** - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- **Species group** - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality
- **Unknown** - Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.

Call sequences that were less than three pulses in length were not analysed and were assigned to 'Unknown' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

Results

A total of 613 call sequences were recorded at three sites over two nights, of which 443 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, 85 call sequences (19%) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 1). Species recorded confidently within the site include:

- *Chalinolobus dwyeri* (Large-eared Pied bat)
- *Chalinolobus morio* (Chocolate Wattled bat)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Rhinolophus megaphyllus* (Eastern Horseshoe bat)
- *Saccolaimus flaviventris* (Yellow-bellied Sheath-tailed bat)
- *Vespadelus darlingtoni* (Large Forest bat)
- *Vespadelus regulus*

Additional bat species that are known to exist within the locality of the site, but could not be confidently identified to species (those classified as possible or as a species group), include:

- *Chalinolobus gouldii* (Gould's Wattled bat)
- *Miniopterus australis* *(*Little bent-wing bat)
- *Miniopterus schreibersii oceanensis* (Eastern bent-wing bat)
- *Mormopterus norfolkensis* (East-coast Freetail bat)
- *Mormopterus Species 2* (Eastern Freetail bat)
- *Nyctophilus geoffroyi* (Lesser long-eared bat)
- *Nyctophilus gouldi* (Gould's long-eared bat)
- *Scotorepens orion* (Eastern broad-nosed bat)
- *Scoteanax rueppellii* (Greater broad-nosed bat)
- *Vespadelus vulturnus* (Little Forest bat)

Note that *Nyctophilus* species (Long-eared Bats) cannot currently be distinguished by bat call analysis as their call parameters overlap almost completely.

Table 1 below summarises the results of the bat call analysis

Table 1: Results of bat call analysis (number of passes per site per night)

IDENTIFICATION	Creek 24/02/2010	Ridge 1 22/02/2010	Ridge 2 23/26/1009
DEFINITE			
Chalinolobus dwyeri	-	1	-
Chalinolobus morio	-	1	-
Falsistrellus tasmaniensis	-	-	1
Rhinolophus megaphyllus	2	-	-

IDENTIFICATION	Creek 24/02/2010	Ridge 1 22/02/2010	Ridge 2 23/26/1009
Saccolaimus flaviventris	1	-	-
Vespadelus darlingtoni	9	31	3
Vespadelus regulus	-	1	-
PROBABLE			
Falsistrellus tasmaniensis	1	1	-
Nyctophilus Species	-	3	-
Rhinolophus megaphyllus	1	-	-
Vespadelus darlingtoni	7	19	3
Vespadelus regulus	2	1	-
POSSIBLE			
Chalinolobus dwyeri	-	2	-
Chalinolobus morio	-	3	2
Miniopterus schreibersii oceanensis	1	-	3
Vespadelus darlingtoni	14	3	-
SPECIES GROUPS			
Chalinolobus gouldii / Mormopterus Species 2	-	3	-
Chalinolobus morio / Vespadelus vulturnus	1	-	-
Chalinolobus morio / Vespadelus vulturnus / Miniopterus australis	-	3	-
Falsistrellus tasmaniensis / Scotorepens orion / Scoteanax rueppellii	-	1	-
Miniopterus schreibersii oceanensis / Vespadelus darlingtoni / Vespadelus regulus	15	91	183
Miniopterus schreibersii oceanensis / Vespadelus regulus	7	4	6
Mormopterus norfolkensis / Mormopterus Species 2	-	1	-
Vespadelus darlingtoni / Vespadelus regulus	2	10	-
UNKNOWN			

IDENTIFICATION	Creek 24/02/2010	Ridge 1 22/02/2010	Ridge 2 23/26/1009
Short calls	54	64	48
‘Noise’ files	1	1	2
TOTAL	**118**	**244**	**251**

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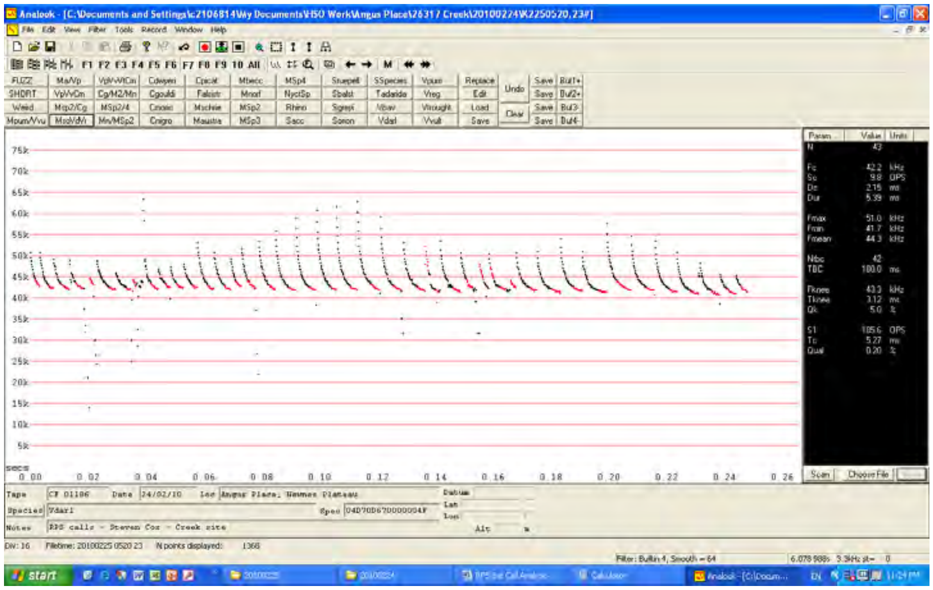
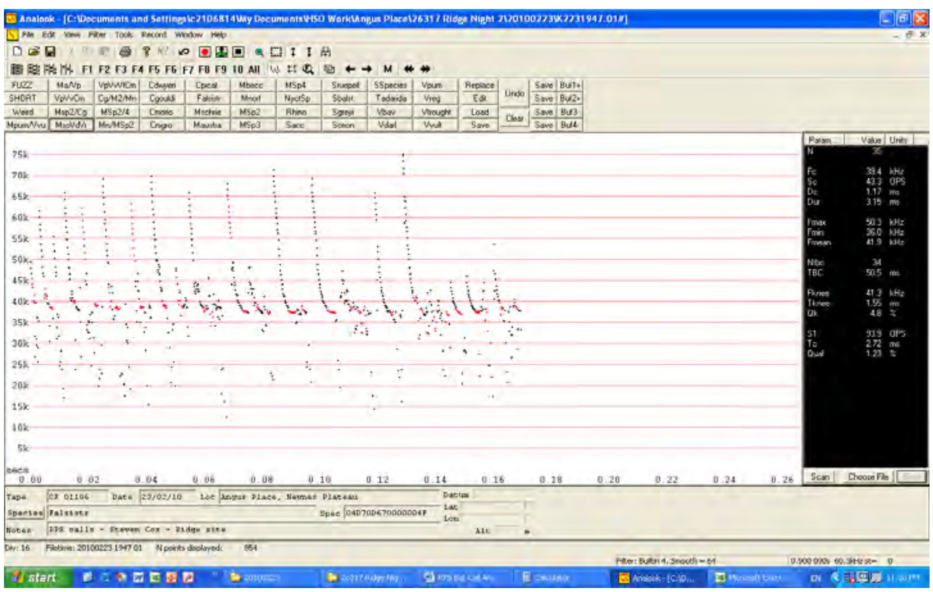
Sample Calls

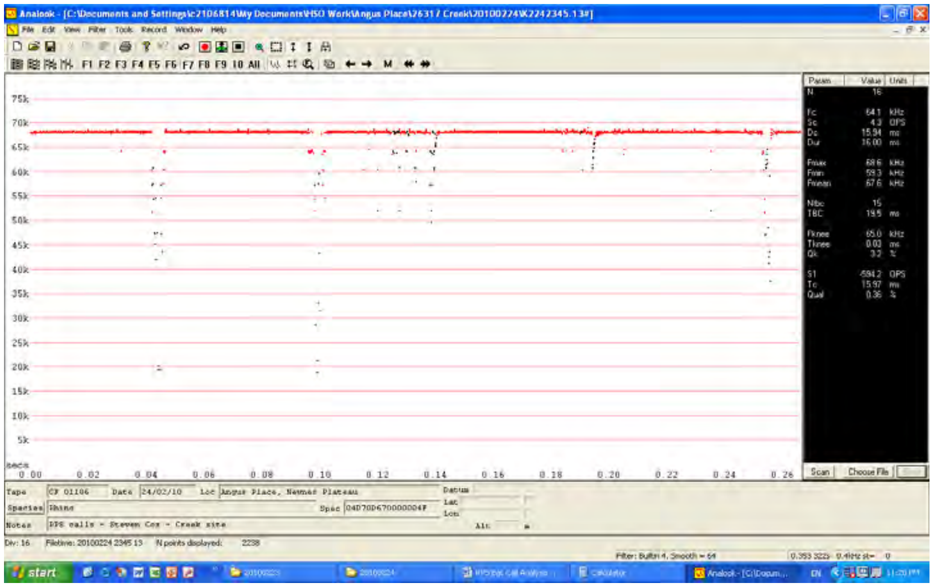
A sample of the calls actually identified from the site for each species is given below.



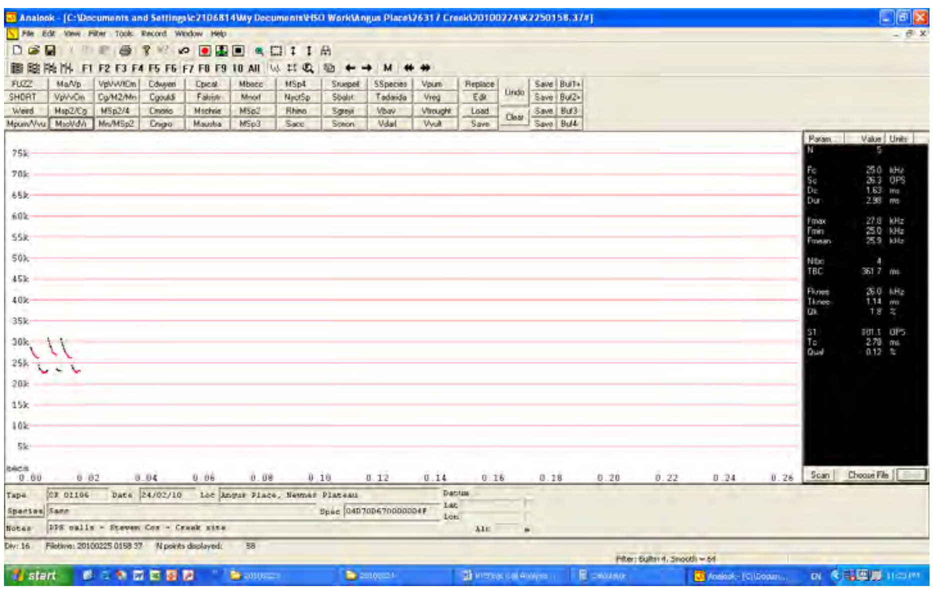
Vespadelus darlingtoni – Definite call



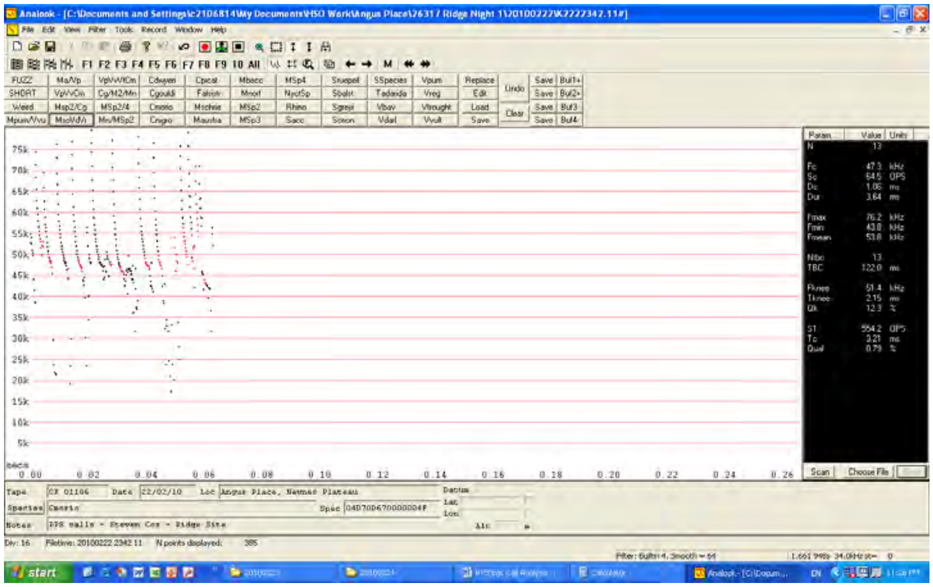
Falsistrellus tasmaniensis – Definite call



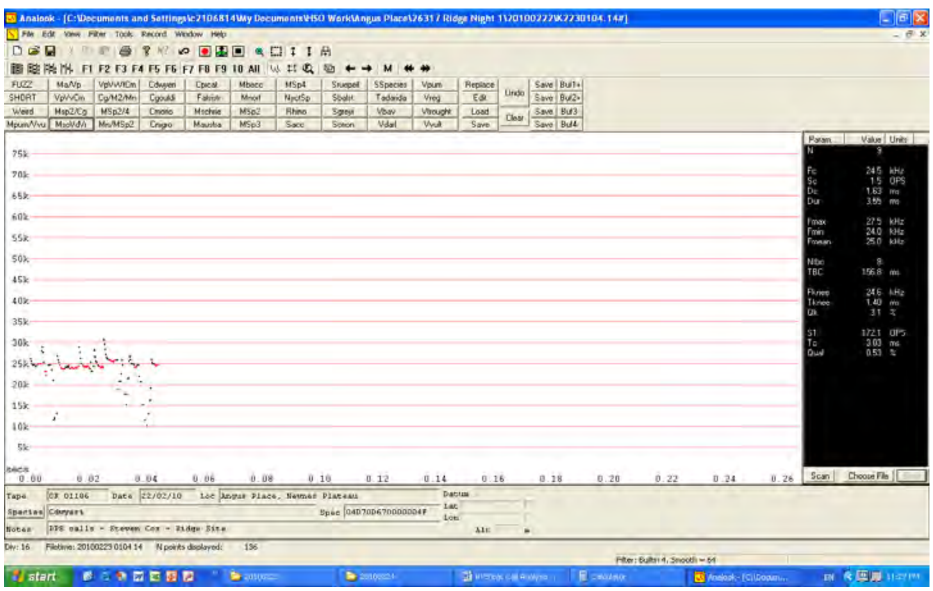
Rhinolophus megaphyllus – Definite call



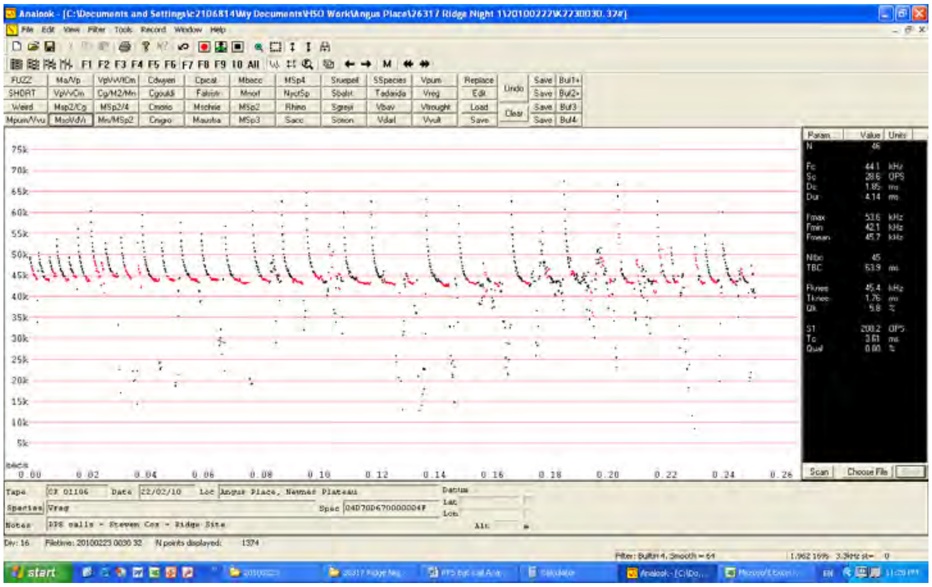
Saccolaimus flaviventris – Definite call



Chalinolobus morio – Definite Call



Chalinolobus dwyeri – Definite call



Vespadelus regulus – Definite Call

Appendix 4

Qualifications

RPS

Curriculum Vitae

TOBY LAMBERT

Senior Ecologist / Senior Project Manager

Newcastle, NSW

Bachelor of Environmental Science, University of Newcastle, 1993 - 1996

Accredited BioBanking Assessor, Tafe NSW – Ryde, 2009

NSW Driver's Licence (Class C)

OH&S Induction Training (Green Card)

NPWS Scientific Investigation Licence and NSW Animal Ethics Research Authority

AREAS OF EXPERTISE:

Toby has over fourteen years experience in undertaking and managing a diverse array of ecological and environmental surveys and assessments. As a Senior Ecologist – Senior Project Manager, he supervises all facets of flora and fauna assessment and related reports: planning, supervision of field and reporting staff, project scheduling, budget management, liaising with clients and Government departments and providing advice of all kinds. He has also been called upon to prepare expert evidence for matters at the NSW Land and Environment Court. Toby has produced ecological and environmental documentation for private and public projects ranging in complexity. These include a number of wind farms throughout Australia and New Zealand, coal mines and a range of infrastructure projects within the Hunter region. Toby has also managed ecological master planning for residential projects in Sydney, the Central Coast and the Hunter. Toby's fields of expertise are Environmental Impact Assessment and mediation, flora, fauna and habitat survey method, design and identification, detailed understanding of legislation and threatened species issues, terrestrial fauna surveys and project management. He has experience in conducting comprehensive fauna surveys and preparing related documentation in a broad array of environments throughout New South Wales, with most projects located in the greater Sydney area, Blue Mountains, Central Coast, Hunter and Forster / Great Lakes regions. Toby has also undertaken ecological projects in Western Australia, Queensland, the ACT and New Zealand.

SELECTED PROJECT EXPERIENCE:

Ecology

- **Hunter Economic Zone Industrial Estate -** Project Manager for the environmental component of the development of the Hunter Economic Zone industrial estate at Kurri Kurri, to be the largest industrial estate in NSW.
- **Centennial Coal -** Environmental Project Manager for consultancy works to Centennial Coal covering a broad range of disciplines, but primarily focussed on ecological impact assessments, monitoring and management at six coal mines in the western Blue Mountains and Lake Macquarie NSW.
- **Peabody Energy Australia -** Senior Project Manager for project specific and ongoing monitoring requirements for Wambo Coal Mine at Warkworth in the Upper Hunter Valley. Toby liases directly with the Environmental Manager of the mine in relation to requirements to fulfil consent conditions for the ongoing development and operation of the project.
- **Allco Wind Energy -** This involved undertaking fauna surveys for a 100 turbine wind farm on the North Island of New Zealand and coordinating other ecological specialists to prepare an ecological impact assessment for submission to Taranaki Council. Aspects included regular liason with the Department of Conservation regarding issues of significance, survey methodology, and mitigation and management measures to protect significant ecological features. Local bird groups were also involved and Toby was involved in the public consultation sessions.

- **Stockland Wallarah Peninsula -** This Lake Macquarie, NSW project required a multi-disciplinary approach to an innovative residential proposal on environmentally sensitive land. Project management of, and participation in, a large and diverse planning team were major features of this work. Toby was a pivotal member of the project management team that provided the detailed ecological input and advice that was required from the early stages of the planning process to the point of submission to determining authorities. The proposal required sophisticated and creative impact assessment and reporting. Toby made a major contribution to the production of a series of comprehensive ecological reports that ensured the ecological integrity of the site was maintained in the post-development landscape.

PREVIOUS EXPERIENCE:

Senior Project Manager - Cumberland Ecology, Epping **2005**
Duties included flora and fauna surveying and survey design; overseeing and contribution to the preparation of complex ecological and environmental reports for both small and large projects; flora and fauna surveying and survey design; liaison with both the private sector and federal, state and local government departments.

Principal Consultant / Co-Founder - Keystone Ecological, Kariong **2004 - 2005**
Preparation and development of Keystone Ecological Flora and Fauna Impact Assessment report format; development of client database, including organisation of promotional material, logo design and customer relations; administration including preparation of quotes and invoices and organising accounts and BAS statements; Flora and fauna surveying and survey design; along with Anabat II Data Analysis.

Project Manager - Ecology - Conacher Travers Environmental, Somersby **1998 - 2004**
Supervision of flora and fauna survey design; report quality control; production of technical reports such as Review of Environmental Factors, Flora & Fauna Assessments, Statement of Environmental Effects, Species Impact Statements and Plans of Management, Land and Environment Court Evidence preparation, EPBC Act Referrals and Preliminary Information preparation; Flora & fauna surveying; liaison with Department of Environment and Conservation, Department of Environment and Heritage, Department of Infrastructure, Planning and Natural Resources, Department of Agriculture, Local Governments and private clients; Anabat II Data Analysis; Water Testing; Data Recording and Statistical Analysis.

Volunteer for Green and Golden Bell Frog Survey - Australian Museum, North Avoca **1999 - 2001**
Survey and searches for the endangered species Green & Golden Bell Frog; assisting in weighing, measuring and micro-chipping frogs for on-going research purposes.

Environmental Scientist - Australian Defence Industries (ADI), St Marys **1998**
Bore Water Sampling; statistical analysis of test results; and report production.

Environmental Scientist - Anne Clements & Associates, North Sydney **1997**
Field Assistant to Botanist and data recording.

Research Assistant - University of Newcastle **1996**
Initiation of design of final year project for Biology Dept; research into fire regimes on species composition & regeneration in open woodland; use of advanced scientific equipment including infra red gas analyser in the field, and replication of experiments using computer database; theoretical knowledge on soils, nutrient cycles & vegetation types.

MEMBERSHIPS & ACHIEVEMENTS:

- Ecological Consultants Association of NSW (ECA) – Council Member
- Newcastle Green Drinks for Environmental Professionals organising committee

RPS

Curriculum Vitae

CRAIG ANDERSON

Senior Ecologist – Senior Project Manager

Newcastle, NSW

Bachelor Applied Science (Environmental Assessment & Management), University of Newcastle, 1994

Graduate Diploma in Archaeological Heritage, UNE, Current

RFS/PIA NSW Consulting Planners Bushfire Training

AREAS OF EXPERTISE:

Craig has over 15 years experience in a wide range of environmental consulting. He has undertaken and managed commissions for a diverse range of projects within land development, energy, mining, infrastructure and conservation, including State Significant developments.

Craig has an extensive background in ecological field surveys, encompassing all aspects of flora and fauna identification, targeted surveying and mapping. He was involved in the initial formulation of an Association of Consulting Ecologists for NSW in 1998 and has acted as an expert witness in several Land and Environment Court matters relating to ecology and bushfire assessment. He is an experienced negotiator of ecological / development outcomes, and has a detailed understanding of legislation related to ecological matters.

Craig has been actively involved in representations to the Department of Environment on behalf of the NSW Urban Taskforce in regards to proposed changes to the NSW Threatened Species Conservation Act, and for the Urban Development Institute of Australia (UDIA) on matters relating to issues such as the proposed listing of endangered ecological communities, regional environmental biodiversity strategies, and the Native Vegetation Act and the operations of the Catchment Management Authority (CMA).

SELECTED PROJECT EXPERIENCE:

Ecology

- **Buttaba Hills (336 Lots) –** Species Impact Statement
- **Hunter Economic Zone (800+ ha industrial estate) –** Species Impact Statement
- **Pelaw Main By-Pass to Hunter Economic Zone –** Species Impact Statement
- **Residential development / Eco-Resort / Fauna Sanctuary at Paxton -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **SEPP 5 Aged Care facilities, Kariong, Hawks Nest, Wallsend, Glenhaven -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Caravan Park extensions, Fern Bay -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Road & Rail Infrastructure for the Hunter Economic Zone -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Alignments for Hunter Gas Pipeline Infrastructure -** Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation
- **Landscape Concept Plan, rural subdivision at Oakhampton Heights -** Vegetation Management Plan
- **Creek Rehabilitation Plan, Warners Bay -** Vegetation Management Plan
- **Vegetation Management Plan for a retained creek line with Sugar Valley Golf Course, West Wallsend -** Vegetation Management Plan
- **Individual Koala Plan of Management under SEPP 44 at Hawks Nest –** Management Plan

- **Ecological Constraints Management Plan, Hawks Nest North -** Management Plan
- **Management Plan for the Green & Golden Bell Frog at Culburra -** Management Plan
- **Fuel Management Plan over lots within a rural-residential estate at Glen Oak -** Management Plan
- **Ecological Constraints Master Plan for Hunter Economic Zone -** Management Plan
- **Environmental Plan of Management for Residential / Tourism Sanctuary Project at Paxton -** Management Plan
- **Green and Golden Bell Frog Survey and Management Plan, Gillieston Heights -** Targeted Species Study
- Targeted Species Studies as part of the Ecological Constraints Master Plan for the Hunter Economic Zone

PREVIOUS EXPERIENCE:

Senior Ecologist, Wildthing Environmental Consulting **1995 – 2000**
Oversaw operations in NSW and Qld, and project managed and undertook numerous ecological and bushfire assessments for a diverse array of clients / projects.

Environmental Officer, Pulver Cooper & Blackley / Kel Nagle Cooper & Associates **1994 - 1995**
Undertook a range of environmental, planning and survey investigations; fieldwork; reporting for a range of land development; and golf course development projects.

MEMBERSHIPS & ACHIEVEMENTS:

- Frog and Tadpole Study Group (FATS)
- Hunter Birds Observers Club (HBOC). Committee Member 2009. Records Appraisal Committee, 2008 – present
- Bird Observers Club of Australia (BOCA)
- Donaldson Conservation Trust. Board member (independent environmental expert). 2009 – present.

RPS

Curriculum Vitae

STEVEN COX

Senior Ecologist – Project Manager

Newcastle, NSW

Bachelor of Applied Science (Environmental Science) (Honours)

NSW Driver's Licence (Class C)

OH&S Induction Training (Green Card)

NPWS Scientific Investigation Licence

Senior First Aid

AREAS OF EXPERTISE:

Steven has 12 years experience in the environmental industry with key experience in ecological project management, survey design, field survey, report writing, report review and client relations. In his position as Senior Ecologist, Steven is responsible for the management of ecological projects at all levels, ranging from proposal preparation to report delivery and client liaison. His areas of expertise are design & management of ecological impact assessment projects; flora, fauna and habitat survey methodology design and management; detailed understanding of threatened species legislation and issues; terrestrial fauna and fauna habitat surveys; ecological project management and report writing; along with tree felling supervision and ecological report review.

Steven has project managed and / or participated in numerous mining, energy, local government and private projects, including impact assessments for new coal and gold mines, extensions to existing mines, power substations, power lines, pipelines, access roads and private infrastructure. Steven has designed and / or undertaken the ecological component of structure plans for local government; prepared an affidavit for court proceedings (in an alleged illegal clearing case); and undertaken ecological report reviews for a local council. He has participated in Koala and Platypus field survey and impact assessment; together with nest box installation and monitoring.

SELECTED PROJECT EXPERIENCE:

Ecology

- **Rocglen Coal Mine Extension Project** – Gunnedah NSW (2010).
- **Ecosystem Function Analysis** – Wambo Coal, Singleton NSW (2010).
- **Annual Flora and Fauna Monitoring** – Karuah, NSW (2010).
- **Narrabri Coal Mine Stage 2 Extension Project** – Narrabri, NSW (2009).
- **Muswellbrook Transmission Line Upgrade** – Muswellbrook, NSW (2009).
- **Anvil Hill Flora and Fauna Impact Assessment** – Muswellbrook NSW (2006).
- **Preparation of Expert Witness Affidavit (illegal clearing)** – Forster NSW (2006)
- **Project Management** – Management of numerous land development and mining ecological projects across NSW (2005-2010).

Curriculum Vitae

- CONTINUED -

PREVIOUS EXPERIENCE:

Senior Ecologist – Ecotone Ecological Consultants **2008 - 2009**
Duties included flora and fauna surveying and survey design; overseeing and contribution to the preparation of complex ecological and environmental reports for both small and large projects; liaison with both the private sector and federal, state and local government department.

PhD Candidate – Koala Ecology, University of Sydney **2007 – 2008**
Steven investigated selected aspects of the ecology of the koala in the Bathurst area of NSW. The project involved the capture and subsequent radio-tracking of up to 50 koalas across a fragmented agricultural landscape. At this stage of the project (2007-2008) activities were limited to data entry, data analysis and report/chapter writing.

Senior Ecologist – Umwelt Australia Pty Ltd **2005 – 2006**
Duties included: preparation of fee proposals; desktop studies and literature searches; flora and fauna surveying and survey design; contribution to the preparation of complex ecological and environmental reports for both small and large projects.

Casual Lecturer / Demonstrator - University of Newcastle **2002 – 2005**
Duties included the delivery of first and second year biology and ecology lectures; demonstration of first and second year biology and ecology laboratory sessions; field trip organisation and management; lecture and laboratory session design; report and exam marking.

Casual Ecologist – Cenwest Environmental Consultants Pty Ltd **1997-2005**
Duties principally comprised all aspects of preparation and completion of fauna surveys across mine sites and development sites within NSW, and the writing of fauna impact assessment reports.

PhD Candidate – Koala Ecology, Charles Sturt University **1997 – 2008**
Steven investigated selected aspects of the ecology of the koala in the Bathurst area of NSW. The project involved the capture and subsequent radio-tracking of up to 50 koalas across a fragmented agricultural landscape. Duties included: project design, site selection, landholder liaison, licensing, koala capture, koala tracking, habitat assessment, data entry, data analysis and report/chapter writing

Platypus Researcher **1996 – 2001**
Steven ran the field component of a long-term platypus research project from 1996 to 2001. Duties included: landholder liaison, volunteer liaison, field preparation, platypus capture and handling, data entry, database creation and management, scientific paper production.

MEMBERSHIPS & ACHIEVEMENTS:

- NSW Animal Ethics Research Authority
- Landscape Function Analysis (LFA)
- Hunter Bird Observer Club (HBOC)
- Birds Australia (BA)
- Ecological Society of Australia (ESA)
- Royal Zoological Society of Australia (RZS)
- Australian Mammal Society (AMS)
- Australian Society of Herpetologists (ASH)

Curriculum Vitae

Name: Allan Richardson

Office: RPS Harper Somers O'Sullivan

Position in Company: Senior Ecologist

Qualifications / Awards
B.Env.Sc. (Environmental Management)
B.Env.Sc. (Hons) (Biology) – Migratory Wading Bird Study
2002 Hunter Environmental Institute Scholarship
Waterways Authority Boating Licence
OH&S Induction Training (Green Card)
NSW Driver's Licence (Class C)
NPWS Scientific Licence
NSW Animal Ethics Research Authority
St John Ambulance Senior First Aid Certificate

Memberships:
Hunter Bird Observers Club
Victorian Wader Study Group

Areas of Expertise:

- Ornithological Surveys and Research
- Targeted and general Terrestrial flora and fauna surveys
- Threatened Flora & Fauna Assessment, Reporting and Legislation
- GPS Survey and GIS Mapping Projects
- High Level Nature Photography
- Tertiary and General Ecological Tutoring, Demonstrating and Presenting

Recent Experience Includes:

Allan Richardson has broad range of Ecological Assessment reporting experience underpinned by over 27 years of ecological field experience. Over four and a half years of project experience has primarily included a range of flora and fauna assessment disciplines as required by a wide range of corporate and domestic client requirements. Allan has a strong grounding in threatened species ecology in both coastal and western NSW regional areas, with specialist migratory wader studies expertise in Central NSW and Roebuck Bay in North Western Australia.

Allan's wide ranging interest across different ecological disciplines, has been a central part of important threatened species projects, including, the Critically Endangered North Rothbury Persoonia, Hunter Estuary Green and Golden Bell Frog populations, Migratory Wader habitat usage surveys, seasonal Swift Parrot movements and specialised Avifauna Wind Farm Surveys on the east and west coast. Allan's broad ecological experience also represents an important part of RPS HSO's threatened flora and vegetation community mapping, targeted fauna survey works and threatened species habitat assessments over both small and large spatial areas for a range of client needs. His depth of experience and a strong knowledge of Australian fauna and regional vegetation contribute strongly to RPS HSO's ability to meet the consultation and regulatory needs of the development community.

Curriculum Vitae

Name: Robert Sansom

Office: RPS Harper Somers O'Sullivan

Position in Company: Botanist /Ecologist

Qualifications / Memberships:

Bachelor of Science
Bachelor of Science (Honours)
NSW Driver's Licence (Class C)
OH&S Induction Training (Green Card)
Planning for Bushfire Prone Areas (Short Course)
Erosion and Sediment Control – Fundamentals of Erosion and Sediment Control
NPWS Scientific Investigation Licence
NSW Animal Ethics Research Authority

Areas of Expertise:

- Environmental and ecological impact assessment, monitoring and reporting
- Terrestrial flora and habitat survey design, execution, analysis and reporting
- Spatial mapping of vegetation and threatened flora species using differentially corrected GPS accurate to less than 1 metre
- Understanding of threatened species legislation, issues and requirements
- Bushland and vegetation management planning and monitoring
- Threatened Flora Management Plans and Monitoring
- Bushfire Threat Assessments
- Production of a wide variety of reports and assessments
- Targeted threatened flora surveys
- Flora identification and habitat assessment
- Delineation and GPS mapping of vegetation community boundaries
- Ecological Community quality assessments and reports
- Experience in PATN Statistical package

Recent Experience Includes:

Robert has over eleven years experience in undertaking a diverse array of ecological and environmental surveys and assessments. Rob has also produced or sourced background information on ecological and environmental matters for use by expert witnesses in support of clients in the NSW Land and Environment Court.

Rob's fields of special competence are Threatened Flora species searches; Threatened Flora, Vegetation and Bushland Management Plans; delineation and GPS plotting of Vegetation Community boundaries; and species / community / wetland monitoring surveys and reporting.

APPENDIX 7.8

Cultural Heritage Impact Assessment

RPS

Cultural Heritage Impact Assessment

Angus Place Colliery

75W Modification

Prepared by:

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Report No: 26317
Version/Date: Final, October 2010

Prepared for:

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Wolgan Road

LIDSDALE NSW 2790

Document Status

Version	*Purpose of Document*	*Orig*	*Review*	*Review Date*	*Format Review*	*Approval*	*Issue Date*
Draft A	*Draft for Client Review*	*PS*	*DR*	*4/3/2010*	*17/6/2010*	*D. Rigby*	*5/3/2010*
Draft 2	*Draft for client review*	*DR*	*GG*	*18/6/2010*	*JH 21-6-10*	*G Goode*	
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Final	*Final Draft for client review*	*DR*	*DR*	*1.9.2010*		*D .Rigby*	*1.9.2010*
Final	*Final*	*DR*	*GG*	*12.10.2010*	*JH 12-10-10*	*D. Rigby*	*12.10.2010*

Disclaimers

Executive Summary

RPS has been commissioned by Centennial Angus Place Pty Limited to assess the potential impact to Aboriginal and European Cultural Heritage in the portion of land as defined by the subsidence model allocated for Longwalls 910 and 900W at Angus Place Colliery. Centennial Angus Place Pty Limited is preparing an Environmental Assessment (EA) to support an application for Project Modification Approval under Section 75W of Part 3A Major Projects of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). Angus Place Colliery is located five kilometres north of the village of Lidsdale, eight kilometres northeast of the township of Wallerawang and fifteen kilometres northwest of the city of Lithgow. Angus Place Colliery is bordered by Baal Bone Colliery (Xstrata) and Invincible Colliery (CET Resources) to the north; Centennial Springvale Coal to the south; and the Wolgan Valley and Newnes Plateau to the north-east. The Angus Place pit top lies within the Cox's River Catchment, reporting to the Sydney Catchment area; with the mining lease area traversing both the Cox's and Wolgan River catchment areas, the latter of which reports to the Hawkesbury Nepean Catchment. With respect to this study, the proposed development will incorporate the commissioning of an additional dewatering borehole and supporting infrastructure as well as the development and extraction of Longwalls 910 and 900W.

This assessment comprises a detailed background review incorporating environmental context, reviews of previous archaeological reports for the area, a history of Lithgow LGA, and Aboriginal Heritage Information Management System (AHIMS) database search results. A detailed field survey was also conducted.

This assessment has been conducted in accordance with the *National Parks and Wildlife Act 1974* (NPW Act) and meets the requirements of the *NPWS Standards and Guidelines Kit 1997*. The Community Consultation process was conducted under the *Interim Community Consultation Requirements for Applicants 2005* (ICCR). Participating Aboriginal Community Stakeholders, Bathurst Local Aboriginal Land Council (BLALC), Warrabinga Native Title Claimants Aboriginal Corporation (WNTCAC) and Mingaan Aboriginal Corporation (MAC), were registered through these *Interim Community Consultation Requirements for Applicants 2005* (ICCR). Although new consultation guidelines *Aboriginal Cultural Heritage Consultation Requirements for Proponents (2010)* were released in April 2010; DECCW has advised that consultation commenced for projects prior to the 12th April 2010 can continue under the ICCR process. The proponent is not required to recommence consultation under the new 2010 guidelines. Representatives of each of these groups were present during the survey. This report reflects their comments and views (Refer Appendix 6).

Although the project is divided into three areas; Longwalls, Angus Place Pit Top and Private Haul Road, the Archaeological considerations were only relevant to the proposed Longwalls. As such, the field investigation, which focused on landform units, was divided into the dewatering borehole compound, services extension and Longwalls 910 and 900W design angle of draw areas. The angle of draw is that angle between the vertical and the line joining the edge of the mining void with the limit of vertical subsidence, usually taken as 20mm (DPI-MR, Dec 2003). The archaeological pedestrian survey was conducted over four days in partnership with members of the Aboriginal

Community Stakeholders.

Effective survey coverage of the Study Area identified only one Aboriginal Cultural Heritage Site, for which a site card has been submitted to the NSW Department of Environment, Climate Change and Water (DECCW) for registration on the AHIMS database (Refer Appendix 7). The site is located in the western section of proposed Longwall 910 (Refer Figure 7-3).

One Aboriginal Cultural Heritage Site was identified within the study area. A Rock Shelter with PAD is located within the western section of the proposed Longwall 910 (RPS Angus Place RS PAD1 – Refer Figure 7-3 and Appendix 7). No items of European cultural heritage were found within the study area.

No subsidence is predicted in the area of the Rock Shelter with PAD. Also, other sites previously registered on the AHIMS database are located outside of the study area. Therefore, the proposed modifications are unlikely to impact upon the Aboriginal cultural heritage sites.

DGS (2010) estimate that crack widths between 1mm and 20mm could occur through the tensile and compressive strain zones above each longwall panel which could affect some access tracks and unsealed gravel roads, with a worst case scenario of up to 90mm if surface rock lies near the strain peaks below the road. As such, it is considered that, for subsidence events of less than 50mm there would be no risk of impact to artefact scatters or open camp sites, and no risk to low risk of impacts to any potential rock shelters or grinding grooves; and for subsidence events of more than 50mm but less than 100mm there is no risk for artefact scatters or open camp sites and low risk for potential rock shelters or grinding grooves.

The Mitigation Measures included in this report (Section 10) provide advice on the requirements necessary if there is likely to be any disturbance or impact to the Aboriginal cultural heritage site (RPS Angus Place RS PAD1). Mitigation Measures that address the concerns of the Study Area are detailed below:

Mitigation Measure 1 - Aboriginal Community Consultation

Liaison established with the Aboriginal Community as per the DECCW Interim Community Consultation Requirements for Applicants (2005) during this project should be maintained during the proposed works should any matters relating to Aboriginal heritage occur.

Mitigation Measure 2 - Aboriginal Archaeological Management

One Aboriginal cultural heritage site was located and recorded during the survey. The site was recorded as a Rock Shelter with PAD (RPS Angus Place RS PAD1).

There was no subsidence predicted in the area of RS PAD1 (DGS April 2010) – Refer Appendix 8. However, it is recommended that during the general course of the project the site could be monitored for the effects of cracking or movement, and ongoing management of the site could include monitoring. Monitoring of the Rock Shelter with Pad would include pre and post mining inspections to assess and quantify any impact.

During the course of project work:

Mitigation Measure 3

Ensure that disturbance associated with the proposed mining operations is limited to the boundaries of the Study Area identified in this report. If works are planned outside of the Study Area, new and subsequent European and Aboriginal archaeological investigations will need to be initiated.

Mitigation Measure 4

If it is suspected Aboriginal Cultural Heritage Material has been encountered, work should cease immediately in that locale. If Aboriginal site/s are identified in the study area, then all works in the area should cease, the area cordoned off and contact made with DECCW Enviroline 131 555, a suitably qualified archaeologist and the relevant Aboriginal stakeholders, so that it can be adequately assessed and managed.

Mitigation Measure 5

In the event that skeletal remains are uncovered, work is to stop in the vicinity immediately and the relevant command area of the NSW Police contacted. If skeletal remains are deemed to be of Aboriginal origin, then all works in the area should cease, the area cordoned off and contact made with DECCW Enviroline 131 555, a suitably qualified archaeologist and the relevant Aboriginal stakeholders, so that it can be adequately assessed and managed.

European Heritage

Mitigation Measure 6

If, during the course of clearing works, significant European cultural heritage material is uncovered, work should cease in that area immediately. The NSW Heritage Branch should be notified and works only recommence when an appropriate and approved management strategy instigated.

Contents

Figures

Tables

Plates

Appendices

1 Introduction

RPS Australia East Pty Ltd has been commissioned by Centennial Angus Place Pty Limited to assess the potential impact to Aboriginal and European Cultural Heritage in the portion of land allocated for longwalls 910 and 900W at Angus Place Colliery.

Angus Place Colliery exists as a joint venture company owned in equal share between Centennial Coal Company Limited and SK Kores. Angus Place Colliery was acquired from Powercoal Pty. Ltd. in August 2002. Angus Place Colliery is located five kilometres north of the village of Lidsdale, eight kilometres northeast of the township of Wallerawang and fifteen kilometres northwest of the city of Lithgow. Angus Place is bordered by Baal Bone Colliery (Xstrata) and Invincible Colliery (CET Resources) to the north; Centennial Springvale Coal to the south; and the Wolgan Valley and Newnes Plateau to the north-east. The Angus Place pit top lies within the Cox's River Catchment, reporting to the Sydney Catchment area; with the mining lease area traversing both the Cox's and Wolgan River catchment areas, the latter of which reports to the Hawkesbury Nepean Catchment.

Centennial Angus Place Pty Limited is preparing an Environmental Assessment (EA) in support of an application for Project Modification Approval under Section 75W of Part 3A Major Projects of the Environmental Planning and Assessment Act 1979 (EP&A Act). With respect to this study, the proposed development for the Study Area on Newnes Plateau will incorporate the commissioning of an additional dewatering borehole and supporting infrastructure as well as the development and extraction of longwalls 910 and 900W.

1.1 Modification Project Area

The Modification aims to continue underground mining operations at Angus Place Colliery, which are supported by existing surface infrastructure, through the development and extraction of two additional longwall panels, extending the life of Angus Place through until 2016.

Specifically, the Modification proposes to include the following:

- Development and extraction of longwalls 910 and 900 west (900W). 910 is directly north of the extracted 920 panel with 900W due west of the current mains headings. With regard to longwall 910, two options are proposed. This is because there may be a potential resource area situated to the north east of the proposed longwall area and, if this is the case, future access to this resource would be most efficient if it is accommodated within this proposed modification. A geological and geotechnical investigation, as well as a preliminary feasibility assessment, will be undertaken and the findings will inform the choice of option. The two options for Longwall 910 are:

    1. Option 1: In the event that the north eastern area is not considered viable, Longwall 910 will be approximately 200m wide and 2500m in length (Figure 3) and allow the development of two mains headings.

2. Option 2: In the event that the north eastern area is considered viable, Longwall 910 will be approximately 2500m in length and 120m in width to allow the development of four mains headings to enable future access to the resource in the north east.

- Increase to the production limit of four (4) million tonnes per annum. This seeks to make a provision for 12 consecutive months of production in the event Angus Place Colliery does not have a three month shut down due to a longwall changeover. The intensity of mining will not change. However, an increase of the annual production limit would allow a continuation in production in the event that a shutdown due to a longwall changeover (typically 8 weeks) is not required.

- Installation of a dewatering bore facility at the eastern end of Longwall.

The Project Area which is the subject of this modification can be described in three sections as follows;

1. Surface area above the two proposed longwalls 910 (Options 1 and 2) and 900W on Newnes Plateau, the dewatering borehole and supporting infrastructure (access track, powerline and pipeline);
2. the Angus Place Colliery pit top; and
3. Private haul roads and Wolgan Road.

1.2 The Study Area

The archaeological Study Area which is the subject of this report is relevant only to the surface area above the proposed longwalls (i.e. item 1 above). The overarching reason for this position is that there are no modifications scheduled for the existing Angus Place Colliery pit top, nor will the exiting stockpile footprint change (item 2 above). In relation to the haul road, the same logic can be applied in that there are no physical changes scheduled for the existing private haul road (item 3 above).

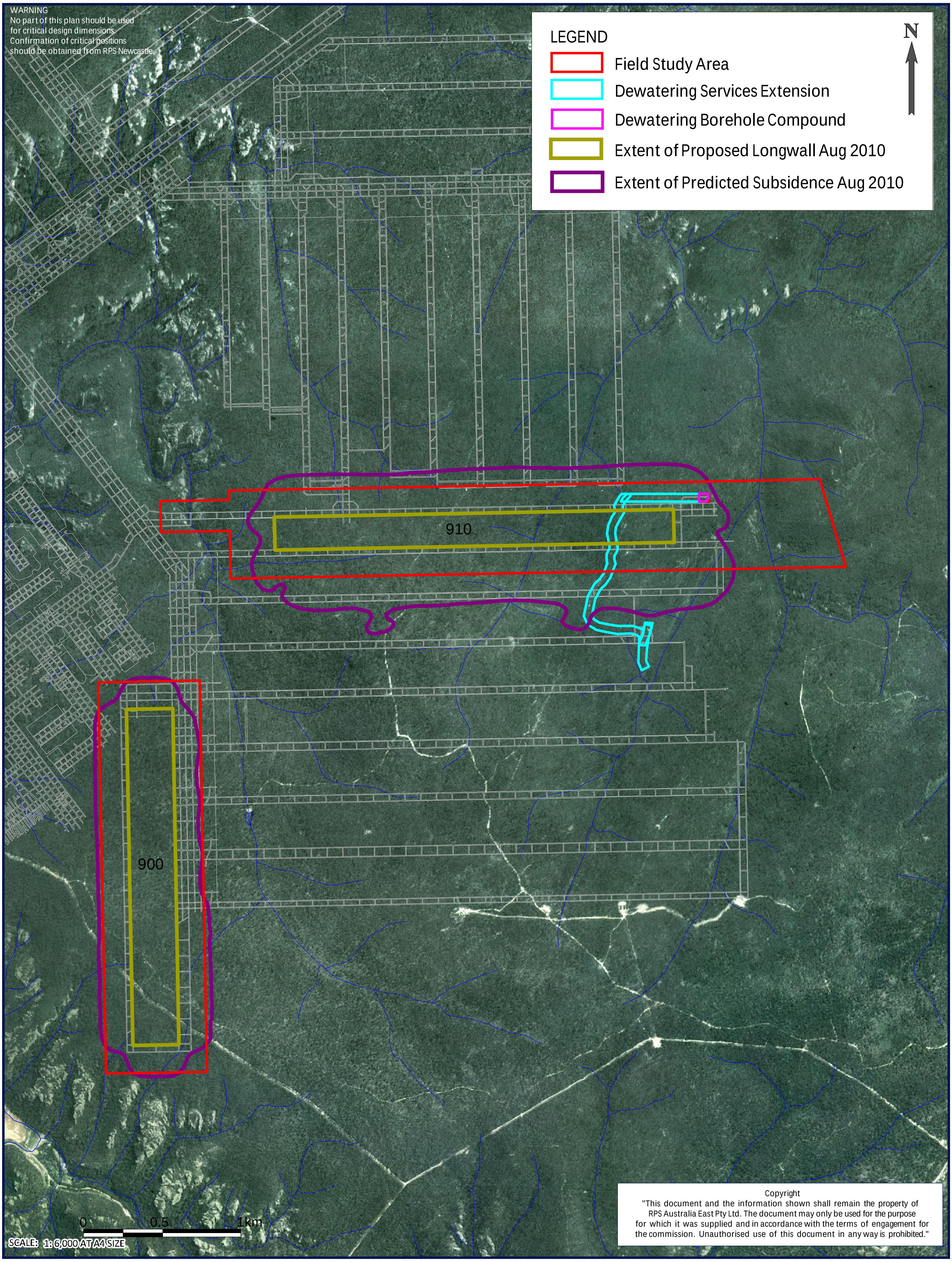
The cultural heritage assessment focuses on the effects associated with the proposed longwalls, dewatering bore and its associated infrastructure (access tracks, powerline and pipeline). There are not anticipated to be any significant cultural heritage effects associated with the modifications at the pit top or to the haul roads in relation to an increase in the limit to the amount of coal produced. Therefore, the Study Area for the purposes of this assessment has been informed by the modelled subsidence areas defined by Ditton Geotechnical Services and the areas of the dewatering bore and its associated infrastructure. Angus Place is bordered by Baal Bone Colliery (Xstrata) and Invincible Colliery (CET Resources) to the north; Centennial Springvale Coal to the south; the Ben Bullen State Forest to the south east and the Wolgan Valley and Newnes Plateau to the north-east.

The location of the Study Area can be found in Figure 1-1.

1.3 Background

Underground mining has occurred in the Lithgow LGA mining lease area since at least the 1860's, with longwall mining replacing bord and pillar mining techniques in the late 1970's. The land comprising the proposed longwall mine extension area is currently used for forestry, recreational activities such as bushwalking and occasionally camping (Planning 2006).

Angus Place Colliery commenced production in 1979, after being developed as an extension of the Newcom Mine at Kerosene Vale. Coal is extracted from the Lithgow Seam primarily by the operation of a longwall shearer and supporting continuous miner units developing access headings. Coal is currently extracted for domestic power generation at both Wallerawang and Mount Piper power stations. Approximately 215 personnel are employed by Angus Place Colliery, operating across three shifts enabling 24 hours, 7 days a week production.



TITLE: FIGURE 1-1 STUDY AREA

LOCATION: ANGUS PLACE COLLIERY

DATUM: N/A

PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 11/10/2010

PURPOSE: ARCHAEOLOGY

LAYOUT REF: 26317 DRAFTING\MAPINFO\ARCH\FIG 1-1 STUDY AREA

VERSION (PLAN BY): B (A.P-G.G-NW)

CLIENT: CENTENNIAL COAL

JOB REF: 26317

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

RPS

1.4 Legislative Context

It is incumbent on any land manager to adhere to legislative requirements that protect both Aboriginal cultural heritage and European cultural heritage in NSW. At the national level those items that are accorded National Significance status are under the control of the Commonwealth Government. These items are recorded and protected under the National Heritage List and the Commonwealth Heritage List. The extensive Register of the National Estate lists those items considered of value for future generations.

The State Heritage database is maintained by the NSW Heritage Branch and lists all items that have been identified as of heritage value on Regional Environment Plans (REP) and Local Environment Plans (LEP) throughout NSW. The State Heritage Register lists those places which are of State Significance.

A brief overview of relevant NSW legislation is listed below with a more detailed explanation of legislation governing Aboriginal and Historical heritage provided in Appendix 1.

1.4.1 The National Parks and Wildlife Act (1974)

The primary state legislation relating to cultural heritage is the National Parks and Wildlife Act (NPW 1974, as amended). The legislation is overseen by the Department of Environment, Climate Change and Water (DECCW), and specifically the Director-General of the DECCW.

There are three main sections of the NPW Act (1974) that the proponent should consider during works in the associated leases. These include (but are not limited to) the following:

It is an offence under Part 6 of the NPW Act (1974) for any person/company to:

- destroy, deface, damage, cause or allow the destruction/defacement to an Aboriginal object or Aboriginal place (Section 90);
- disturb, move, excavate for the purposes of finding Aboriginal objects, or take possession of Aboriginal objects (Section 86) unless a valid Permit under Section 87 of the Act has been issued by the Director General of the DECCW; and
- be aware of the location of an Aboriginal object and fail to report it to the DECCW (Director-General) within a reasonable timeframe (Section 91).

Although Aboriginal heritage sites and objects are primarily protected by the National Parks & Wildlife Act 1974 (NPW Act), Amended 2001, if an Aboriginal site, object or place is of great significance, it may be protected by a heritage order issued by the Minister subject to advice by the Heritage Council.

Other legislation of relevance to Aboriginal cultural heritage in NSW includes the NSW Local Government Act (1993). Local planning instruments also contain provisions relating to indigenous heritage and development conditions of consent.

In 2005, the DECCW released the *Interim Community Consultation Requirements for Applicants 2005* (ICCR's) which guide Aboriginal community notification and consultation procedures for sites that require applications under Section 87 and Section 90 of the National Parks and Wildlife Act (1974). The consultation requirements are outlined in detail in Appendix 1.

On the 12th April 2010 the DECCW released the new *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (ACH Consultation Requirements) 2010. These replace the *Interim Community Consultation Requirements* (ICCR's) and are effective immediately. DECCW has advised that consultation commenced for projects prior to the 12th of April 2010 can continue under the ICCR process.

1.4.2 The Heritage Act (1977)

The primary NSW legislation in relation to historic matters is covered by the NSW Heritage Act 1977 and matters relating to that legislation should be directed to the NSW Heritage Branch. The protective provisions contained in this Act safeguards items of significance.

An excavation permit is often required if it is known or suspected that an item of significance will be exposed or discovered and the work must be undertaken by a qualified archaeologist with an excavation permit issued by the Heritage Council of NSW.

1.4.3 Environmental Planning & Assessment Act 1979 (EP&A Act)

This Act regulates a system of environmental planning and assessment for New South Wales. Land use planning requires that environmental impacts are considered, including the impact on cultural heritage and specifically Aboriginal heritage.

Part 3A of the EP&A Act relates to major projects, and if applicable, obviates the need to conform to other specific legislation. In particular, S75U of the EP&A Act explicitly removes the need to apply for S87 or S90 permits under the NPW Act. This means that although Aboriginal cultural heritage is considered during the planning process, a permit is not required to disturb or destroy an Aboriginal object or place. However, although the requirements to obtain a Section 90 Permit for a site or Section 87 Permit for conservation/research are not required, the Director-General of Planning must nonetheless consult with other government agencies, including DECCW and National Parks & Wildlife, prior to any decision being made.

Appendix 1 details the various relevant legislative Acts.

1.5 Scope of Assessment

This Cultural Heritage Impact Assessment (CHIA) incorporates a desk top review and pedestrian survey of the Study Area. The pedestrian survey was conducted within the zero subsidence boundary determined using angle of draw calculations. Subsidence modelling undertaken subsequently determined a zero subsidence contour line covering a slightly larger area. The land between these two areas is predicted to subside by minor amounts (in the order of 20mm) and has been the subject of both desk top investigations and limited field survey. It was found that the majority of the area, particularly along the southern boundary line had been covered during exiting and entering the zero subsidence boundary using angle of draw calculations. In addition whilst accessing the Dewatering Borehole Compound much of the area to the north was in fact investigated. It was found in all instances that the landscape was similar in exposure and landform characteristics, in which no artefactual material had been previously identified. The archaeological predictive model developed for the area provided information about the potential for archaeological sites to occur. It involves reviewing existing literature and consulting site databases to determine basic patterns of site distribution and correlating this distribution with the associated environment. Correlations between the two specific areas such as the predominance for scattered sandstone and quartz rocks to occur that were noted throughout the field survey and are part of the Narrabeen Sandstone Group conglomerate formation indicates a lack of raw stone material suitable for stone tool manufacture. The AHIMS results although demonstrating regular use of the natural landscape around the Newnes State Forest at a regional level, did not indicate site locations inside the zero subsidence contour line.

The assessment considers the potential for Aboriginal and European archaeological sites to occur, the location of any registered sites in the Study Area, and the implications for the project with regard to any existing or potential archaeological material located in the Study Area.

This Aboriginal archaeological assessment includes:

- Liaison and partnership with the Aboriginal community;
- A review of all relevant documentation and statutory requirements with regard to Aboriginal heritage and non-Indigenous heritage;
- Review of data from the DECCW Aboriginal Heritage Information Management System (AHIMS) to identify known Aboriginal sites;
- A review of environmental information and previous archaeological work to develop a predictive model for Aboriginal archaeological site patterning within the Study Area;
- An assessment of archaeological sensitivity within the Study Area;
- An archaeological survey; and
- Mitigation Measures for the management for Aboriginal and non-Indigenous sites.

This archaeological report for Aboriginal and European heritage impact assessment has been written in accordance with the National Parks and Wildlife Act of 1974 (NPW Act) and meets all of the requirements of the NPWS Standards and Guidelines Kit (1997). A review of the documentary evidence includes a search of the DECCW Aboriginal Heritage Information Management System (AHIMS) database (Appendix 2).

In relation to European heritage the report was written with guidelines detailed in the NSW

Heritage Manual (1994) issued by the NSW Heritage Branch.

1.6 Subsidence Predictions

Centennial Angus Place Colliery Pty Limited proposes to use longwall mining in the proposed Study Area. The panels have been designed to provide long term stability. This underground mining technique removes a part of the coal face which may cause destabilisation of the geological strata above the coalface. Subsidence impacts caused by this type of mining usually occur immediately after the mining process often forming a depression or trough-shaped profile with surface cracking and possible deformation of sandstone rock features. The vertical subsidence and degree of impact is dependent on several factors. These include the extent and depth of longwall mining and the nature of the overlying geological strata.

Ditton Geotechnical Services Pty Ltd (DGS 2010) has modelled the subsidence predictions for Angus Place Colliery Proposed Longwalls 910 and 900W. They carried out an assessment on the cliff lines incorporating Proposed Longwalls 900W and 910 and Approved Longwalls 920 – 980. The report states that the extracted void width for Longwall 910 will be 208m and for Longwall 900W will be 293m in the 3.25m thick Lithgow Seam. According to DGS 2010, depth of cover ranges from 300m to 370m, which results in sub-critical to critical panel width/cover depth ratios for Longwall 910 of 0.56 to 0.65 and for Longwall 900W of 0.92 to 0.98.

The cumulative predicted final worst-case subsidence contours for the Study Area is shown on Figure 17a of the Ditton Geotechnical Services Pty Ltd 2010 report (DGS 2010). This model shows that there is minimal predicted subsidence impact in both Longwalls 910 and 900W, and that the maximum vertical subsidence would not exceed 1.6m and that will only occur in a small area. The majority of the Study Area, and particularly that area where significant rock features occur, is likely to have a vertical subsidence between zero and 2mm and therefore will be likely to experience a nil to minimal subsidence impact. Thus the overall impact of subsidence in the Study Area will be minimal.

Centennial Angus Place Pty Limited has adopted a strategy to minimise and avoid all risks and impacts throughout the design of the modification. In this regard, the length of each longwall has been checked and revised to ensure that zero subsidence predictions are clear of any known significant features. The result of this approach is that the residual risk for impact to archaeological material is negligible.

1.7 Aboriginal Community Consultation

Consultation regarding this project commenced with the Aboriginal Community Stakeholders under the ICCR (2005). Although new consultation guidelines Aboriginal Cultural Heritage Consultation Requirements for Proponents (2010) were released in April 2010; DECCW has advised that consultation commenced for projects prior to the 12th of April 2010 can continue under the ICCR (2005) process. In these circumstances the proponent is not required to recommence consultation under the new 2010 guidelines.

In the release of the ACH Consultation Requirements specific transitional arrangements have been stipulated in a supporting document, *Questions and Answers 2: Transitional Arrangements*. Section 1 (Q1) of this document indicates that if Aboriginal consultation was commenced prior to the 12th of April 2010 (including advertising and notification of stakeholders) then consultation is to be continued under the previous ICCR guidelines. Aboriginal consultation was commenced as stipulated in Section 1 of the transitional guidelines and therefore consultation for this assessment has been undertaken in accordance with the ICCRs.

An advertisement was placed in the Lithgow Mercury (9th January 2010) and the Western Advocate (9th January 2010) (Appendix 3). Letters in accordance with the *Interim Community Consultation Requirements for Applicants* (2005) were mailed out (5th January 2010).

Aboriginal stakeholder groups registered in the Lithgow LGA were advised of the survey. Bathurst Local Aboriginal Land Council (BLALC), Warrabinga Native Title Claimants Aboriginal Corporation (WNTCAC) and Mingaan Aboriginal Corporation (MAC) participated in the survey which took place over four days from Tuesday 9th February to Friday 12th February 2010.

In addition to the above requirements Centennial Angus Place Pty Limited is subject to an Indigenous Land Use Agreement (ILUA) entitled the Centennial Coal Projects Ancillary Deed (CCPAD 2003). This document requires Centennial Angus Place Pty Limited to consult with the Gundungurra Native Title Claim Group (GNTCL). To this end a Cultural Heritage Management Plan (Refer Schedule 7 of the CCPAD 2003) was developed for implementation by Centennial Angus Place Pty Limited in order to avoid or minimise (where appropriate) the potential impact on Aboriginal sites. The requirements for specific situations which require Aboriginal cultural heritage survey undertaken in conjunction with the GNTCL are defined in clause 2 of the CHMP.

As such, Centennial Angus Place Pty Limited, will comply with the notification protocols set out in Section 2 of Schedule 7 of the CHMP. This requires that prior to carrying out any surface ground breaking work that is likely to impact upon Aboriginal sites in the project area, notice be given in writing 10 business days with a six day right of reply for GNTCL. It should be noted that the proposed works do not impact on any Aboriginal sites or places.

A copy of this report was sent to all respondents for their comment.

The Consultation Log can be found in Appendix 3 and responses from the Aboriginal Community Stakeholder groups can be found in Appendix 6.

1.8 Limitations

The desktop review was limited to all available documents directly concerning the Study Area which included AHIMS site searches and archaeological reports that relate to the regional archaeology. The pedestrian survey covered all landform types existing in the Study Area with existing dirt access tracks providing good access and ground surface visibility. Away from these areas visibility could be considered low with dense grasses, leaf and bark litter, shrubs and scattered woodland vegetation. The steep terrain especially surrounding water courses were handled with care as much of the ground cover was fairly dense with vegetation and leaf litter. Snakes and wombat burrows were also an added concern, particularly in areas containing thick, long grass where the ground surface was not visible.

1.9 Authorship

This RPS Australia East Pty Ltd (RPS) report was written by Archaeologists Gillian Goode and Philippa Sokol, and reviewed by Archaeology Manager Darrell Rigby, all of RPS.

1.10 Acknowledgements

RPS would like to acknowledge the following people who assisted in the Cultural Heritage Impact Assessment.

Name	Company
Warwick Peckham	Sites Officer, Bathurst Local Aboriginal Land Council
Kevin Williams Wendy Lewis	Sites Officers, Warrabinga Native Title Claimants Aboriginal Corporation
Richard Peters	Sites Officer, Mingaan Aboriginal Corporation
Iain Hornshaw	Environmental Officer, Angus Place Colliery

1.11 Abbreviations

Abbreviation	Definition
ACS	Aboriginal Community Stakeholders
AHIMS	Aboriginal Heritage Information Management System
BLALC	Bathurst Local Aboriginal Land Council
CHIA	Cultural Heritage Impact Assessment
DECCW	Department of Environment, Climate Change and Water
MAC	Mingaan Aboriginal Corporation
NPWS	NSW National Parkes and Wildlife Service
RPS	RPS Australia East Pty Ltd
WNTCAC	Warrabinga Native Title Claimants Aboriginal Corporation

2 Environmental Context

The environmental context of an area is researched by archaeologists in order to obtain data relevant to the regional area and the specific Study Area. Environmental factors assessed include local geology and soils, topography, hydrology, climatic conditions, and the availability of flora and fauna resources. This information is then utilised to predict what the past local environment was like. Interactions between people and their environment are important in predicting the formation of the archaeological record and its preservation.

2.1 Geology and Soils

The Study Area is comprised of several soil landscapes. Longwall 900W is comprised of the Newnes Plateau and Hassans Walls soil landscapes. Longwall 910 is also comprised of the Newnes Plateau together with Wollangambe and Warragamba soil landscapes. A small portion of the Mt Sinai soil landscape is located adjacent to a Wolgan River tributary on the western side of Longwall 910 (King 1992).

The Blue Mountains area comprises typically of deep incised gorges with sandstone bed-rock, steep sided cliffs and pagodas, narrow incised valleys with spring fed creek lines and inter-bedded sandstone conglomerate rocks. Soil landscapes are comprised of conglomerate sandstones containing pebble sized quartz clasts together with green claystone (King 1992). The inter-bedded sandstone sheets are jointed and contain shale and ironstone lenses. Sandstone rock outcrops in the Newnes Plateau would have been useful in providing temporary or permanent shelters for the majority of the year. Quarrying of raw materials for stone tool manufacture would most likely have occurred in nearby areas where suitable raw material was available (King 1992).

The local geology for Longwalls 900W and 910 are outlined in the tables below. The rock types in the study area are potentially unsuitable, as raw material resources for stone tool manufacture although it is possible that stone tools could be manufactured from the quartz pebbles eroding out of the conglomerate, although the majority of the quartz in the area is too fractured (King 1992).

Table 2-1: Newnes Plateau Soil Landscape

	Np1	Np2	Np3	Np4
Colour	Black to dark grey yellow	Orange to bright reddish brown	Dark reddish brown to dull yellow	Light grey
Texture	Sand to loamy sand	Clayey sand to sand with depth	Sandy clay loam to light sandy clay loam	Clayey sand to sand
Structure	Single-grained	Massive to single-grained	Massive to occasional weak and poorly defined peds	Massive
Course Fragments	Sandstone fragments of variable size, shape and abundance. Quartz pebbles occasionally present	Occasional scattered sub-rounded quartz and ironstone gravels	Occasional sandstone and ironstone fragments	Platy ironstone fragments and complex bands
Exposed Condition	Loose, incoherent and porous when dry, occasionally water repellent	Soft to firm and coherent when dry	Firm and coherent when dry	Firm to hard with a sugary-like appearance in exposed batters
pH level	Strongly acid (Ph 4.5) to moderately acid (pH 5.5)	Moderately acid (Ph 5.5) to slightly acid (Ph 6.5)	Moderately acid (Ph 5.0) to slightly acid (Ph 6.5)	Strongly acidic (pH 4.5) to moderately acid (pH 5.5)
Permeability	High	Moderate to high	Moderate to high	Slow
Erosion	Moderate to high	High	Moderate	Moderate
Fertility	Very low to low	Low to moderate	Moderate	n/a

(source; King, 1992:29)

Table 2-2: Hassans Walls Soil Landscape

	Hw1	Hw2	Hw3	Hw4
Colour	Black or dark brown	Grey yellow brown, yellow brown to brown	Bright yellow brown, dull yellow orange to brown	Light grey and occasional red and yellow mottles
Texture	Loamy sand to sandy loam	Sand to loamy sand	Andy clay, silty clay to medium clay	Medium clay
Structure	Single-grained	Single-grained	Weak to moderate pedal with angular blocky peds	Moderately pedal and angular blocky
Course Fragments	Abundant sandstone gravels to boulders	Abundant sandstone fragments and quartz pebbles, ranging in size from gravel to boulders	Common to none	Few, some platy shale fragments at depth
Exposed Condition	Soft, loose and incoherent when dry, occasionally water repellent, spongy where organic matter is high	Soft, loose and incoherent in the dry state	Not generally exposed	Not generally exposed
pH level	Moderately acid (Ph 5.0) to neutral (pH 7.0)	Moderately acid (Ph 5.0) to slightly acid (Ph 6.0)	Moderately acid (Ph 5.5) to slightly acid (Ph 6.5)	Strongly acid (pH 4.0) to moderately acid (pH 5.0)
Permeability	Moderate to high	High	Moderate	Slow to moderate
Erosion	Low to high	Low to high	Low to high	High
Fertility	Very low	Very low	Very low	Low

(source; King, 1992:52)

Table 2-3: Mt Sinai Soil Landscapes

	Ms1	Ms2	Ms3	Ms4
Colour	Light grey to dull yellow orange	Brownish black	Brown to yellow orange and yellow brown	Bright yellow brown to yellow orange
Texture	Coarse sand	Loamy sand	Loamy sand to sandy loam	Clayey sand to sandy clay loam
Structure	Single-grained	Single-grained	Single-grained	Massive
Course Fragments	Abundant rounded to sub-rounded quartz gravels	Sub-rounded quartz gravels, angular sandstone and ironstone fragments, size and abundance variable	Common sub-rounded quartz gravels and angular sandstone fragments	Sandstone fragments and quartz gravels
Exposed Condition	Loose and incoherent when dry and wet	Loose, water repellent and incoherent when dry, slightly coherent when dry	Loose and incoherent when dry	Loose when dry
pH level	Moderately acid (pH 5.5) to slightly acid (pH 6.5)	Moderately acid (pH 5.0) to slightly acid (pH 6.0)	Moderately acid (pH 5.0) to slightly acid (pH 6.0)	Strongly acid (pH 4.5) to moderately acid (pH 5.5)
Permeability	High	High	High	Moderate
Erosion	High	High	High	High
Fertility	Very low	Very low	Very low	Very low

(source; King, 1992:43)

Table 2-4: Wollangambe Soil Landscape

	Wo1	Wo2	Wo3	Wo4
Colour	Dark reddish brown, dull yellow brown to brownish black	Red to bright brown	Bright yellowish brown	Light grey, dull yellow orange to bright yellowish brown
Texture	Loamy sand, ranging from sand to sandy loam	Sand, clayey sand or sandy clay loam	Clayey sand to sandy clay loam	Sandy clay to clay to silty clay loam
Structure	Single-grained	Massive	Massive	Moderately pedal when dry, with angular and sub-angular blocky peds; massive when wet
Course Fragments	Sandstone fragments often present	Occasional sandstone fragments	Rare sandstone fragments	Few
Exposed Condition	Loose, incoherent, occasionally water repellent when dry	Loose to firm, coherent when dry	Loose to firm, moderately coherent when dry	Hard, with well-developed void pattern when dry, soft and plastic when wet
pH level	Slightly acid (pH 6.0) to neutral (pH 7.0)	Slightly acid (pH 6.0)	Slightly acid (Ph 6.0 – 6.5)	Moderately acid (pH 5.0) to slightly acid (pH 6.5)
Permeability	High	Moderate	Moderate	Slow to moderate
Erosion	Low to moderate-high	Low to high	Low to high	High to very high
Fertility	Very low	Very low	Very low	Low

(source; King, 1992:89)

Table 2-5: Warragamba Soil Landscape

	Wb1	Wb2	Wb3
Colour	Brownish black to yellowish brown	Dark reddish brown to yellowish brown	Variable including dull brown, yellow brown orange and reddish brown; occasional faint red and yellow mottles
Texture	Loamy sand	Clayey sand	Clay loam to medium clay, often increasing with depth
Structure	Single-grained	Single-grained with rare weak crumb	Moderately pedal with angular blocky peds
Course Fragments	Sandstone rock fragments (2-10%)	Sandstone fragments common; charcoal occasionally present	Sandstone rock fragments
Exposed Condition	Loose, incoherent, occasionally water repellent when dry	Loose when dry	Firm when dry, plastic when wet
pH level	Moderately acid (Ph 5.0) to slightly acid (pH 6.0)	Strongly acid (Ph 4.5) to slightly acid (ph 6.0)	Strongly acid (Ph 4.5) to slightly acid (ph 6.0)
Permeability	High	High	Moderate
Erosion	Moderate to high	Moderate to high	Moderate to high
Fertility	Very low	Very low	Low

(source; King, 1992:63)

2.2 Topography and Hydrology

Topography of the Newnes Plateau landscape generally incorporates broad, level and gently inclined plateau surfaces. Slope gradients range up to 10%, with <20m of local relief and elevation typically >1000m. Swampy drainage depressions are common and on ridgelines localised sandstone outcrops are rare (King 1992:29).

Topography of the Hassans Walls landscape comprises precipitous sandstone cliffs ranging from 100m – 200m and is often formed above steep to very steep colluvial side slopes. The gradients of the slopes are generally >40% and become gentler on lower slopes and narrow drainage flats. Local relief is >100m and elevation varies between 280 m to >1000 m. Drainage patterns are parallel (King 1992:52).

Topography of the Wollangambe landscape comprises rounded crests that are generally narrow and convex (<50m) and moderately to steeply inclined side slopes. Local rock outcrops occur as small benches, cliffs and low broken scarps. Local relief of the landscape in generally <100m, slopes are generally <35% with elevations of >600m (King 1992:89).

Topography of the Warragamba landscape comprises moderate to very steep slopes with sloping narrow ridges of 10m – 20m wide. Local relief is 50m – 150m with slope gradients of >35% and elevation of mostly <700m. Narrow sandstone and colluvial benches occur on slopes containing sandstone boulders. Small cliffs and scarps can be seen on some steep slopes. Drainage lines in the area are often narrow and filled with boulders (King 1992:63).

The hydrology of the Study Area is defined by several creek lines and rivers. Longwall 900W is intercepted in the north east by a tributary of Kangaroo Creek and Longwall 910 is intercepted by the Wolgan River from the north. These resource zones are large enough to provide reliable water for most of the year.

The topography and hydrology suggest that the local environment would have been favourable to past Aboriginal occupation and in most cases utilised for transitory activity through the landscape. Parts of the landscape that incorporate narrow ridgelines and steep cliffs made access difficult. The availability of fresh water in the Study Area locality would have contributed to a diverse local habitat providing a variety of food and other exploitable resources.

2.3 Climate

Approximately 18,000 years ago climatic conditions began to change affecting the movement and behaviour of past human populations in their environments. During this time, notably at the start of the Holocene (11,477 years ago), the melting of the ice sheets in the Northern Hemisphere and Antarctica caused the sea levels to rise, with a corresponding increase in rainfall and temperature. The change in climatic conditions reached its peak about 6,000 years ago (Short, 2000:19-21). Up until 1,500 years ago, temperatures decreased slightly and then stabilised about 1,000 years ago, which is similar to the temperature currently experienced. Consequently, the climate in the locality of the Study Area for the past 1,000 years would be much the same as present day providing a year round habitable environment.

The climatic conditions will impact upon the soils, vegetation and the potential occupation of an area. They may also affect the durability of associated cultural materials. The area has a warm temperate to very hot and dry climate which periodically encounters high and low pressure systems. In the summer months the area may experience moderate winds with hot and humid weather. In the winter months the winds will produce cool to very cold weather with wet conditions caused by frosts developing in low lying areas (Meteorology 2010). Average temperatures throughout the year can range between -0.3 degrees Celsius in July and 24.6 degrees Celsius in January. Summer season is the wettest and produce a maximum average rainfall of 108.5mm in January and an average minimum of 52.2mm in July (Australian Bureau Meteorology 2010). These regional temperatures would be suitable for occupation for the majority of the year, with appropriate shelter required during the winter months, especially throughout the coolest months and periodic wet periods.

2.4 Flora and Fauna

The occurrence of vegetation communities within the Study Area is dictated by the topography, which is characterised by slightly undulating plateau country bisected by deep drainage gullies. The undulating plateau country supports a range of woodland and open forest vegetation communities with grassy or shrubby understorey strata (King 1992; Australian Bureau of Meteorology 2010). Where deep drainage lines cut through the plateau wetter vegetation communities are sometimes associated with mid-slope soaks, draining strata or riparian areas where shrub swamp communities are supported by increases in water availability. Elsewhere, where dry rocky outcrops limit soil depth stunted heath communities occur. Dominant trees occurring across the plateau communities include *Eucalyptus dalrympleana* (Mountain Gum), *E. radiata* (Narrow-leaved Peppermint), *E. blaxlandii* (Brown Stringybark), *E. oreades* (Blue Mountains Ash), *E. sieberi* (Silvertop Ash), *E. sclerophylla* (Scribbly Gum) and *E. dives* (Broad-leaved Peppermint) (King 1992). Dominant understorey plants are, the shrubs, *Daviesia latifolia* and *Monotoca scoparia* and the tussock grasses *Joycea pallida* and *Poa sieberiana* (King 1992). Shrub swamp habitats lack a tree cover stratum, but are dominated by myrtaceous shrubs such as *Leptospermum* sp. and *Baeckea* sp. with *Gleichenia dicarpa* (Pouched Coral Fern) and a range of sedges often dominating the ground-cover layer (King 1992).

Fauna species encountered within the study area include a number of macropods, such as *Wallabia bicolor* (Swamp Wallaby) and *Macropus rufogriseus* (Red-necked Wallaby), arboreal mammals, *Petauroides volans* (Greater Glider) (King 1992) and a moderate diversity of open forest birds including those characterising elevated habitats, being Grey Currawongs, Red-browed Treecreepers, Scarlet Robins and Flame Robins.

The moderate diversity of flora and fauna species may have provided seasonal food resources for small Aboriginal groups or communities moving throughout the region.

2.5 Condition of the Study Area

The Study Area is situated on a landscape which incorporates varying levels of gentle slopes to steep and in some places sheer cliffs. The steeply sloped areas were generally associated with creek lines and were situated in the eastern and western portions of Longwall 910 and in the south eastern portion of Longwall 900W. Both of these areas are wholly contained in the Newnes State Forest. Access into the Study Areas is via existing forestry tracks. Blackfellows Hands Road is the main access route and was intercepted by minor vehicle and bike tracks that were used to gain access into different portions of the Study Area.

Disturbance from tree logging extended across the Study Area and comprised both medium and large trees. The majority of the felling was contained to ridgelines and gently sloped areas where it can be easily accessible by logging machinery. Across the two Longwall Study Areas are dirt access tracks from the loggers and associated machines. A scattering of remnant felled trees remain and the disused tracks have started to revegetate. In addition the previous works associated with the dewatering station and pipeline and power line works have added to the disturbance of this area.

Natural disturbances to the study area were evidenced by wombat burrows, rock slides, and storm damage from lightening strike, bush fires and flash flooding.

2.6 Discussion

At a regional and a local level the environmental climate at Angus Place would have been suitable to have sustained pre contact Aboriginal occupation in the area. The warmer months were most likely spent in the Plateau area, while cooler months were spent in low lying valleys away from high altitude areas.

A range of resources including fresh water, fauna, flora and shelter would have been available in the area. Access to raw materials for stone tool manufacture were most likely sourced from other localities, as the majority of the local area comprises of friable sandstone rocks, large outcrops and pagodas. Veined quartz and other pebble sized rocks are also eroding out of the conglomerate rocks in the area. Much of this raw material is very coarse grained and is generally not suitable for stone tool manufacture.

The Newnes State Forest covers much of the Study Area. A majority of the area is undisturbed except for borehole impact zones, logging areas and associated machine tracks, electricity easements, the proposed dewatering station, pipeline area, and access tracks. The borehole areas noted on the field survey are all disused and have been covered with bark shavings from logged trees which will prevent additional impacts and possible erosion to the exposed soils and help support the regrowth of the local vegetation. Any areas of undisturbed context are expected to retain their integrity and in situ cultural material may still occur if suitable soil conditions exist.

3 Aboriginal Prehistory

3.1 Ethnography

The ethnographic information used to interpret the archaeological record is often biased and may be deeply prejudiced particularly in relation to lifestyle, social practices, community interactions, religion and other facets of Aboriginal life (L'Oste Brown 1998). It is important to recognise this possible bias when using early European accounts that describe the lifestyles of Aboriginal people, particularly the interpretation of their daily life and beliefs. Nonetheless, some of these ethnographic records can provide important information and insight on local Aboriginal customs and cultural materials evidenced during the early years of European settlement.

3.2 The Traditional Owners

The Study Area is located in the Sydney Basin Bioregion on the Blue Mountains of NSW. A number of distinct Aboriginal groups occupied the Sydney Basin when the First Fleet arrived in 1788; the largest of these groups were the people of the Dharug language group, the alternate spellings to this name were Dharuk and Dharook. The Dharug language was comprised of two dialects, one was used between Sydney Harbour and Botany Bay, and the other was spoken to the west of the Hawkesbury, Blue Mountains and Nepean districts (the later known as Muru-Murak or 'Mountain pathway') (Murray & White 1988).

The Dharuk were recognised as specialist toolmakers, their tools were highly respected by other tribes who would often trade with them. Their weaponry was crafted in the form of spears, clubs and ground stone axes. At ceremonial events the Dharuk painted their faces, arms and thighs, and necklaces of kangaroos and reeds were worn (Mid Mountains Historical Society 2007).

3.3 Implements for Gathering Food and Weapons

As an addition to using plants for food, the Dharug would also have used them as a means of raw materials for utilitarian items, decorative items and medicines with some species providing more than one resource. Grass stalks could be used for weaving or basketry. Large trees provided bark and fibres which were used for tools, containers and possibly the construction of watercraft, whilst resinous saps from Grass Trees for example were an adhesive used in the hafting process. Bark fibres were twisted into twine which could then be woven into traps, containers or baskets and a variety of wooden tools were used as well.

3.4 Foods and Useful Plants

The Dharug used many native plants and animals. The Sydney surrounds offered a variety of food especially fish and shellfish gathered from the sea, these resources changed seasonally and were more reliable in summer than in winter. Inland communities relied on foods such as possum, vegetable roots, seeds and berries as well as mullet, eel and kangaroo (Murray & White 1988).

Men and women in Aboriginal communities had distinct roles in the hunting and gathering of food resources. Men were responsible for hunting possums, fish, birds and kangaroo, and at times collaborated with other bands to hunt and eat the larger animals. Fire was used at times to reduce the vegetation in order to catch game. Women often harvested plant foods especially yam's by means of digging sticks as these were generally the communities' staple diet (DECC 2008).

3.5 Campsites and Shelters

Gunyahs or bark huts were usually made from the broad leafed paperbark, box or stringybark trees and were erected mostly by women. They were generally located close to a reliable fresh water source or opportunistically situated on trade routes. Rock shelters are common in the Blue Mountains region, and would have been occupied as shelter or in association with open camp site areas. Campsites were not only the place for sleeping, eating, tool making and social activity, but were also the centre for hunter-gathering in the local area (Mid Mountains Historical Society 2007). Resources gathered within an area may have been reserved to be traded with members from neighbouring tribes for items not readily available to them.

3.6 Clothing

Summer weather would generally have required little in the way of protective clothing, the milder days of Autumn and Spring required more in the way of protective clothing against frequent cool winds. Winter however saw the intense use of animal skins for both clothing and as blankets. The Dharug people exploited all the resources available seasonally throughout their rangeland including using the by-products of their hunting activities, such as the skins from Possum, Kangaroo and probably Koala for items such as cloaks (Murray & White1988).

3.7 Aboriginal History after European Contact

Initial contact between the European settlers and the Dharuk people occurred in 1791 when Phillip's party arrived at the banks of the Hawkesbury and greetings were exchanged with the natives, peacefully sharing their campfire on the river bank at Pitt Town. Tench and Dawes made plans to explore the Blue Mountains and were ferried across the river by Aborigines in bark canoes (Mid Mountains Historical Society 2007).

In 1794, 22 settlers obtained land along the shorelines of the Hawkesbury-Nepean. Within a year there were 546 people occupying the banks of the river which accounted for the main source of the colony's food supply. This area was also an important source of food for the Dharuk people (Mid Mountains Historical Society 2007).

Initially, when white explorers entered the Blue Mountains they did not record any large groups of 'Aborigines' being in residence. Aboriginal presence was noted by Blaxland in 1814 in the valleys where he heard people calling (Gollan 1987). However, an earlier expedition by Barrallier in 1802, who met and observed Aborigines in the Wollondilly Valley, was escorted out of the Blue Mountains by an Aboriginal guide who had knowledge of the tracks leading to the coast. This first contact record and contemporary opinion suggests that the identity of the mountain people adjacent to the Cumberland Plain were the Dharug (Gollan 1987).

Three Frenchmen; Quoy, Gaudichaud and Pellion travelled across the Blue Mountains to Bathurst where they encountered Aborigines in the Springwood area. Pellion made drawings of the natives, including Karadra a sick old man lying on kangaroo skins near a fire and receiving attentions from a younger man. It was recorded that a local native man was peacefully disposed towards the explorers (Mid Mountains Historical Society 2007).

Windradyne (c.1800-1829), was an Aboriginal resistance leader, he was also known as "Saturday". Windradyne was a northern Wiradjuri man of the upper Macquarie River region in central-western New South Wales (Australians ND).

On arrival of the first settlers, Windradyne attempted to peacefully communicate with the European counterparts. Windradyne had Wiradjuri people befriend the new settlers and assist them with areas to camp. However, when the Europeans began to clear the land it became obvious to the Aborigines that their arrival to Australia was not on a temporary basis. The settlers started destroying the environment and places that were sacred to the natives. Windradyne was determined to not let these people destroy local families and their society. After the conflict many of the Wiradjuri surrendered to the British, but Windradyne was able to elude capture, and later in 1824 Windradyne and 130 Wiradjuri warriors walked for 17 days from Bathurst across the Blue Mountains and into the settlement of Paramatta to attend the annual native feast. On arrival to the feast Windradyne had the word peace stuck in his hat (Australians ND). He was accepted by the British as a result of this encounter.

4 European History

The initial discovery of Botany Bay in 1770 was followed by the arrival of the First Fleet in January 1788. Later the fleet moved further north to Port Jackson where the colony of Sydney Cove was founded (NSW National Parks and Wildlife Service 1991). In the first few years of British contact the new colonists quickly began to explore their new surroundings extending to the north, south and west out of Sydney Town.

Under the advice of local Aborigines, in 1813 explorers Blaxland, Wentworth and Lawson made an efficient job of traversing the southern watershed landscape of the Grose catchment. They descended the western sandstone escarpment at Mount York, than travelled onto Mount Blaxland besides the upper Cox's River where they crossed the Blue Mountains barrier. Within two years William Cox constructed the first road along the explorers route that extended over the Great Divide reaching the fertile plains of the Lithgow valley and Bathurst (Drive 2010).

The Lithgow valley was first settled in 1824 and was named by Surveyor General John Oxley, after William Lithgow, Governor Brisbane's private secretary. It was not until 1869 that the town began to prosper following the construction of the western railway line (Lithgow Tourism 1996 - 1999).

The Zig Zag Railway was engineered and completed in 1869 this allowed for the movement of trains into the valley. The combination of great coal reserves and rail service provided Lithgow with the ideal location for industries dependent on these resources (Lithgow Tourism 1996 - 1999).

Coal mining in Lithgow began with the first cut in Bowenfels and was used to run the steam engine at the local flour mill from the 1850s. The Lithgow coal reserves were important for the development of the Great Western Railway. Coal for trading purposes was first mined at Lithgow in 1868.

Coal mining began in the Wallerawang district around 1873 with a number of mines being operated on the Lithgow seam and in the area of Lidsdale and Wallerawang. The major working mines at the time in the Wallerawang district were The Irondale Colliery, Cullen Bullen Colliery, The Ivanhoe Colliery, The Commonwealth Colliery, The Great Western Mine and The Invincible Colliery.

Between 1900 and 1910 several smaller mines were opened between Piper's Flat and Blackman's Flat, which incorporated The Angus Colliery (Lithgow Tourism 1996 - 1999).

4.1 European Cultural Heritage

4.1.1 Registered Historic Items

The State Heritage database is maintained by the NSW Heritage Branch and lists all items that have been identified as of heritage value on Regional Environment Plans and Local Environment Plans throughout NSW.

The State Heritage Register lists those places which are of State Significance which have been listed by the NSW Heritage Branch under the NSW Heritage Act. In contrast the NSW State Heritage Inventory contains items considered by Local Councils and State Government Agencies to be of heritage value.

4.1.1.1 Items Listed under the Register of National Estate

No items in the Angus Place locality were given national significance through listing under the Register of National Estate.

Register of National Estate

4.1.1.2 Items Listed under the NSW Heritage Register

A search was conducted of the NSW Heritage Register. Heritage items have been documented in the regional area and are detailed below in Table 4-1. There are no sites in close proximity to, or in the Study Area.

NSW Heritage Register

Table 4-1: Items listed under the NSW Heritage Register

Item Name	Address	Suburb	LGA	Listed Under Heritage Act
Ben Bullen Railway Station group	Wallerawang-Gwabegar railway	Ben Bullen	Lithgow	Yes
Bowenfels National School Site	70 Mudgee Street	Old Bowenfels	Lithgow	Yes
Bowenfels Rail Viaducts	Main Western railway 159.156 km	Bowenfels	Lithgow	Yes
Bowenfels Railway Station and Stationmaster's House	Main Western railway	Bowenfels	Lithgow	Yes
Collits' Inn	Hartley Vale Road	Hartley Vale	Lithgow	Yes
Cooerwull Railway footbridge	Top Points Zig Zag Railway	Lithgow	Lithgow	Yes
Eskbank Railway Station group	Main Western railway	Lithgow	Lithgow	Yes
Fernhill	Great Western Highway	Bowenfels	Lithgow	Yes
Great Zig Zag Railway and Reserves	Brewery Lane	Lithgow	Lithgow	Yes
Great Zig Zag Railway deviation	Main Western Railway	Lithgow	Lithgow	Yes

Item Name	Address	Suburb	LGA	Listed Under Heritage Act
tunnels and dam				
Hartley Historic Site	Great Western Highway	Hartley	Lithgow	Yes
Lithgow Blast Furnace	Inch Street	Lithgow	Lithgow	Yes
Lithgow Valley Colliery & Pottery Site	Bent Street	Lithgow	Lithgow	Yes
Marrangaroo railway viaduct	Main Western railway	Marrangaroo	Lithgow	Yes
McKanes Falls Bridge	Jenolan Caves Road	Lithgow	Lithgow	Yes
Rydal rail underbridges	Main Western railway	Rydal	Lithgow	Yes
Rydal Railway Station group	Main Western railway	Rydal	Lithgow	Yes
St John the Evangelist Church	Main Street	Wallerawang	Lithgow	Yes
Tarana Railway Station and yard group	Main Western railway	Tarana	Lithgow	Yes
Wallerawang rail bridges over Cox's River	Main Western Railway	Wallerawang	Lithgow	Yes
Wallerawang Railway Station and yard group	Main Western railway	Wallerawang	Lithgow	Yes
Wambool old-rail truss overbridges	Main Western Railway	Wambool	Lithgow	Yes

4.1.1.3 Lithgow City Council Local Environmental Plan (LEP)

Lithgow City Council LEP (Schedule 1) lists those items considered of significance at the local, state and national level. The Lithgow LEP documents Heritage listed items in the regional area which are detailed below in Table 4-2. There are no sites in close proximity to, or in the Study Area.

Table 4-2: Items listed under the Greater Lithgow LEP

Item Name	Address	Suburb	LGA	Source
Airdrie	Kirkley Street	South Bowenfels	Lithgow	LGOV
Ambermere	Great Western Highway	Little Hartley	Lithgow	LGOV
Andrew Brown's Private Cemetery	Cooerwull Road (off)	Lithgow	Lithgow	LGOV
Anglican Church	Cartwright Street	Rydal	Lithgow	LGOV
ANZ Bank	30 Main Street (cnr)	Lithgow	Lithgow	LGOV
Bank	156 Main Street	Lithgow	Lithgow	LGOV
Barton Park Cemetery		Wallerawang	Lithgow	SGOV
Ben Avon	Great Western Highway	South Bowenfels	Lithgow	LGOV
Ben Bullen Railway Station Group		Ben Bullen	Lithgow	SGOV

Item Name	Address	Suburb	LGA	Source
Blackman and Merrick family cemetery	Gap Road	Hartley Vale	Lithgow	LGOV
Blast Furnace Site	Inch Street	Lithgow	Lithgow	LGOV
Bowenfels Presbyterian cemetery	Great Western Highway	South Bowenfels	Lithgow	LGOV
Bowenfels Railway Station And Residence Group		Bowenfels	Lithgow	SGOV
Bowenfels Railway Station Group	Main Western Line	Bowenfels	Lithgow	LGOV
Bowenfels Underbridges		Bowenfels	Lithgow	SGOV
Braemar House	50 Tweed Road	Bowenfels	Lithgow	LGOV
Brogan's Creek Crossing Loop		Brogan's Creek	Lithgow	SGOV
Caddies Restaurant	1 Cooerwull Road	Bowenfels	Lithgow	LGOV
Capertee Railway Station Group		Capertee	Lithgow	SGOV
Cemetery	Mead Street	Meadow Flat	Lithgow	LGOV
Collits Inn	Hartley Vale Road	Hartley Vale	Lithgow	LGOV
Collitt's / Mt.York burial ground	Hartley Vale Road	Hartley Vale	Lithgow	LGOV
Cooerwull (Lithgow) Footbridge	On Top Of Up Side Cutting On Display	Cooerwull	Lithgow	SGOV
Cooerwull Footbridge		Lithgow	Lithgow	SGOV
Cooerwull House	Great Western Highway	Bowenfels	Lithgow	LGOV
Cooerwull Presbyterian Church	Great Western Hwy	Lithgow	Lithgow	LGOV
Cooerwull, Lithgow Footbridge	Over Main West, West Of Lithgow Station	Lithgow	Lithgow	SGOV
Cottage (duplex)	16 and 18 Lithgow Street	Lithgow	Lithgow	LGOV
Cox's River Convict Stockade		Lake Lyell, Lithgow	Lithgow	SGOV
Cullen Bullen		Cullen Bullen	Lithgow	SGOV
Eliza Rodd Grave	Jenolan Caves Road (off)	Hartley	Lithgow	LGOV
Emoh	Great Western Highway	South Bowenfels	Lithgow	LGOV
Eskbank House	Bennett Street	Lithgow	Lithgow	LGOV
Eskbank Station Group		Eskbank	Lithgow	SGOV
Fernhill	Great Western Highway	South Bowenfels	Lithgow	LGOV

Item Name	Address	Suburb	LGA	Source
Forty Bends	Great Western Highway	South Bowenfels	Lithgow	LGOV
Forty Bends Cemetery	Old Forty Bends Road	South Bowenfels	Lithgow	LGOV
Forty Bends Cottage	Old Forty Bends Road	South Bowenfels	Lithgow	LGOV
General Cemetery	Capertee Road	Dark Corner	Lithgow	LGOV
General Store (former)	Bathurst Street (0.5km N of town)	Rydal	Lithgow	LGOV
Glen Alice Cemetery	Glen Alice Road	Glen Alice	Lithgow	LGOV
Glen Alice Church	Glen Alice Road	Glen Alice	Lithgow	LGOV
Great Zig Zag	Lithgow Valley Reserve	Lithgow	Lithgow	LGOV
Gymnasium	Railway Parade	Lithgow	Lithgow	LGOV
Harp of Erin	Great Western Highway	Little Hartley	Lithgow	LGOV
Hartley Court House	Old Bathurst Road	Hartley	Lithgow	LGOV
Hermitage Colliery Managers Cottage	8 Coalbrook Street	Lithgow	Lithgow	LGOV
Hoskins Memorial Presbyterian Church	Bridge Street	Lithgow	Lithgow	LGOV
Hospital Cottage	Lithgow Road	Wallerawang	Lithgow	SGOV
Hospital Farm Barn	Lithgow Road	Wallerawang	Lithgow	SGOV
House	22-24 Lithgow Street	Lithgow	Lithgow	LGOV
House	20 Lithgow Street	Lithgow	Lithgow	LGOV
House group	1-13 and 2-12 Brisbane Street	Lithgow	Lithgow	LGOV
James Street Underbridge, Lithgow	Stone Arches 0.5Km Past Station	Lithgow	Lithgow	SGOV
La Salle Academy South Bowenfels	Rabaul Street (off)	Lithgow	Lithgow	LGOV
Lidsdale House Gardens	Mudgee Road	Lidsdale	Lithgow	LGOV
Lithgow (Hayley Street) Footbridge	West End Of Station	Lithgow	Lithgow	SGOV
Lithgow (Syd End) Footbridge	At Station Off EsbankStreet O/B	Lithgow	Lithgow	SGOV
Lithgow Court House	Bridge Street	Lithgow	Lithgow	LGOV
Lithgow Fire Station	58 Cook Street	Lithgow	Lithgow	SGOV
Lithgow general cemetery	Great Western Highway	Lithgow	Lithgow	LGOV
Lithgow No. 2 Dam	Farmers Creek	Lithgow	Lithgow	LGOV
Lithgow Primary School	Mort Street	Lithgow	Lithgow	LGOV

Item Name	Address	Suburb	LGA	Source
Residence				
Lithgow Railway Station Group		Lithgow	Lithgow	SGOV
Lithgow Valley Colliery and Pottery Office Building	69 Bent Street	Lithgow	Lithgow	LGOV
Lithgow Zig Zag Group		Lithgow	Lithgow	SGOV
Lockyers Pass	Hartley Vale Road	Hartley Vale	Lithgow	LGOV
Lowther Park	Jenolan Caves Road	Lowther	Lithgow	LGOV
Lowther Park and Cemetery	Jenolan Caves Road	Lowther	Lithgow	LGOV
Marrangaroo Prayer Chapel	Great Western Highway	Marrangaroo	Lithgow	LGOV
Mary Slaven's Grave		Wallerawang	Lithgow	SGOV
Meades Farm	Great Western Highway	Little Hartley	Lithgow	LGOV
Methven	1 Evans Place	Bowenfels	Lithgow	LGOV
Moyne	Coxs River Road	Kanimbla	Lithgow	LGOV
Moyne Farm and Cemetery	Coxs River Road (off)	Little Hartley	Lithgow	LGOV
National School Group (former)	Great Western Highway	South Bowenfels	Lithgow	LGOV
Newnes		Wolgan Valley	Lithgow	LGOV
Office	31 Main Street	Lithgow	Lithgow	LGOV
Oil Shale Works and Refinery		Glen Davis	Lithgow	LGOV
Old Roman Catholic Cemetery	Great Western Highway	Hartley	Lithgow	LGOV
Portland Cement Group	Williwa Street	Portland	Lithgow	LGOV
Presbyterian Church and Sessions Hall	Great Western Highway	South Bowenfels	Lithgow	LGOV
Railway Cottage	Portland Road	Pipers Flat	Lithgow	LGOV
Railway Items Newnes Junction - Sodwalls	Main Street	Wallerawang	Lithgow	LGOV
Railway Items Newnes Junction - Sodwalls	Main West Line	Sodwalls	Lithgow	LGOV
Railway Items Newnes Junction - Sodwalls	Main West Line	Newnes Junction	Lithgow	LGOV
Railway Items Newnes Junction - Sodwalls	Main West Line	Rydal	Lithgow	LGOV
Railway Items Newnes Junction - Sodwalls	Main West Line	Marrangaroo	Lithgow	LGOV
Railway Items Newnes	Main West Line	Clarence	Lithgow	LGOV

Item Name	Address	Suburb	LGA	Source
Junction - Sodwalls				
Repco Store	Railway Parade	Lithgow	Lithgow	LGOV
Rosedale	Great Western Highway	Little Hartley	Lithgow	LGOV
Royal Hotel	Great Western Highway	South Bowenfels	Lithgow	LGOV
Royal Hotel (former)	Old Bathurst Road	Hartley Historic Site	Lithgow	LGOV
Rydal General Cemetery		Rydal	Lithgow	LGOV
Rydal Railway Station	Bathurst Street	Rydal	Lithgow	LGOV
Rydal Station Group		Rydal	Lithgow	SGOV
Rydal Underbridges		Rydal	Lithgow	SGOV
School and Residence	Main Street	Wallerawang	Lithgow	LGOV
School Residence	Rydal Road	Tarana	Lithgow	LGOV
Shale Mining and Works Remains	Hartley Vale Road	Hartley Vale	Lithgow	LGOV
Six Foot Track		Megalong Valley	Lithgow	LGOV
Sodwalls Inn	Sodwalls Road	Sodwalls	Lithgow	LGOV
Somerset House	Great Western Highway	South Bowenfels	Lithgow	LGOV
St Bernard's Roman Catholic Church Group	Old Bathurst Road	Hartley Historic Site	Lithgow	LGOV
St John the Evangelist Church	Main Street	Wallerawang	Lithgow	LGOV
St John the Evangelist's Anglican Church	Great Western Highway	Hartley	Lithgow	LGOV
St Thomas Anglican Church	Wicketty War Road	Hampton	Lithgow	LGOV
Staff Cottages for Small Arms Factory	1,2,3 Commonwealth Avenue	Lithgow	Lithgow	LGOV
State Mine Site	State Mine Gully	Lithgow	Lithgow	LGOV
Sunny Corner General Cemetery	Dark Corner Road	Sunny Corner	Lithgow	LGOV
Sunny Corner Smelter Ruins	Sunny Corner PO 1km North/East	Sunny Corner	Lithgow	LGOV
Sweet Briars	Great Western Highway	South Bowenfels	Lithgow	LGOV
Tarana Station And Yard Group		Tarana	Lithgow	SGOV
Terrace	8,10,12,14 Lithgow Street	Lithgow	Lithgow	LGOV
Thompson's Creek Sites and Graves	Thompson's Creek	Portland	Lithgow	SGOV

Item Name	Address	Suburb	LGA	Source
Timber slab cottage	Mid Hartley Road	Hartley Vale	Lithgow	LGOV
Umera	Great Western Highway	South Bowenfels	Lithgow	LGOV
Union Theatre / Outbuilding	65 Bridge Street	Lithgow	Lithgow	LGOV
Victoria Pass	Great Western Highway	Mount Victoria	Lithgow	LGOV
Walker-Barton private cemetery		Wallerawang	Lithgow	LGOV
Wallerawang (Sydney) Footbridge		Wallerawang	Lithgow	SGOV
Wallerawang A and B Power Stations chimney stack	Main Steet	Wallerawang	Lithgow	SGOV
Wallerawang Footbridge (1960)		Wallerawang	Lithgow	SGOV
Wallerawang Schoolhouse		Wallerawang	Lithgow	SGOV
Wallerawang Station And Yard Group		Wallerawang	Lithgow	SGOV
Wallerawang Station Footbridge		Wallerawang	Lithgow	SGOV
Wallerawang Underbridges		Wallerawang	Lithgow	SGOV
Wambool Underbridge And Overbridge		Wambool	Lithgow	SGOV
West Fund; King's Chinese Restaurant	Railway Parade	Lithgow	Lithgow	LGOV
Willowvale	Portland Road	Wallerawang	Lithgow	LGOV
Wolgan Valley Railway	Main West Line	Newnes Junction	Lithgow	LGOV
Wolgan Valley Station	Wolgan Road	Wallerawang	Lithgow	LGOV
Zig Zag Brewery (former)	Brewery Lane	Lithgow	Lithgow	LGOV

5 Aboriginal Archaeological Context

This chapter presents a review of documentary and physical evidence pertaining to Aboriginal archaeology of the region and in particular the Study Area. Such information is considered as it provides context and accuracy to predictions made about the potential for archaeological remains to occur in the Study Area.

5.1 Aboriginal Heritage Information Management System

A search was undertaken of the DECCW Aboriginal Heritage Information Management System (AHIMS) for an area encompassed by coordinates Easting 230025 to 240025 and Northing 6293770 to 6313770 (MGA Zone 56). The AHIMS search was conducted over a 10 kilometre radius of the Longwall 900W and 910 Study Areas.

The AHIMS results detailed in Table 5-1 support the suitability of the regional area for the occurrence of different types of rock shelters. Shelters predominate including shelters with deposit (n=36) and shelters with art (n=14). Also recorded in the regional area were a range of artefact sites including artefact scatters and isolated finds (n=18), axe grinding grooves (n=3) and scarred trees (n=2). These results indicate that the regional area has predisposition to rock shelter sites with potential for rock engravings, art, grinding grooves and deposit. Several sites reflecting occupation patterns were recorded including habitation structure (n=1), potential archaeological deposit (n=1) and stone arrangement (n=1). One European stone arrangement site (n=1) was recorded reflecting the use of the region by European settlers.

The AHIMS data exhibits a high frequency of rock shelters, containing deposit and art. These sites generally occur in specific geological and topographical areas comprising of sandstone exposures, shelving, deep incised gorges, pagodas and overhangs. The rock shelters with either deposit or art are restricted to the steeply sloping ground as characterised by the cliff lines bordering the Kangaroo Creek and Wolgan River tributaries.

The results of the AHIMS search shows that midden shelter sites are unlikely to occur due to the lack of fresh water shell fish in the area. Axe grinding grooves are often found on large, open and relatively flat areas of sandstone outcrop in close proximity to water. Exposed sandstone along the Kangaroo Creek and Wolgan River and other tributary drainage lines and nearby swamps, and water holes on the ridges are potential areas for grinding groove sites in this area.

Artefacts occur in open plateau regions and on level, well drained areas in close proximity to water courses. Scarred trees used for making canoes are likely to be in close proximity to water, whereas trees that were used for making shields may have been some distance from water on a variety of landforms (DEC, 2005).

Figure 5-1 provides the location of the AHIMS sites.

Table 5-1: AHIMS Site Type and Frequency

Site Type	Frequency in Search Area
Shelter with Deposit	36
Shelter with Art	14
Artefact Scatter	10
Artefact(s) Unspecified	5
Isolated Find	3
Shelter with Art, Shelter with Deposit	3
Axe Grinding Groove	2
Scarred Tree	2
Aboriginal Ceremony and Dreaming	1
Axe Grinding Groove, Shelter with Deposit	1
Habitation Structure	1
European Stone Arrangement	1
Potential Archaeological Deposit	1
Stone Arrangement (2)	1
Total	**81**

A complete list of results from the AHIMS search can be found in Appendix 2.
A glossary of Aboriginal site types can be found in Appendix 4.

5.2 Regional Archaeological Context

The majority of the archaeological surveys and excavations in the Blue Mountains region have been in conjunction with environmental assessments for the coal mines, installation of power lines, telecommunications, and state forest works. Based on the information available, a number of trends in site location and patterning are evident.

A regional based study undertaken by Gollan (Gollan 1987) conducted archaeological investigations in the Newnes Plateau region in order to provide a comprehensive assessment of the archaeological resources of the plateau and regional and local significance. This report was undertaken for the NPWS.

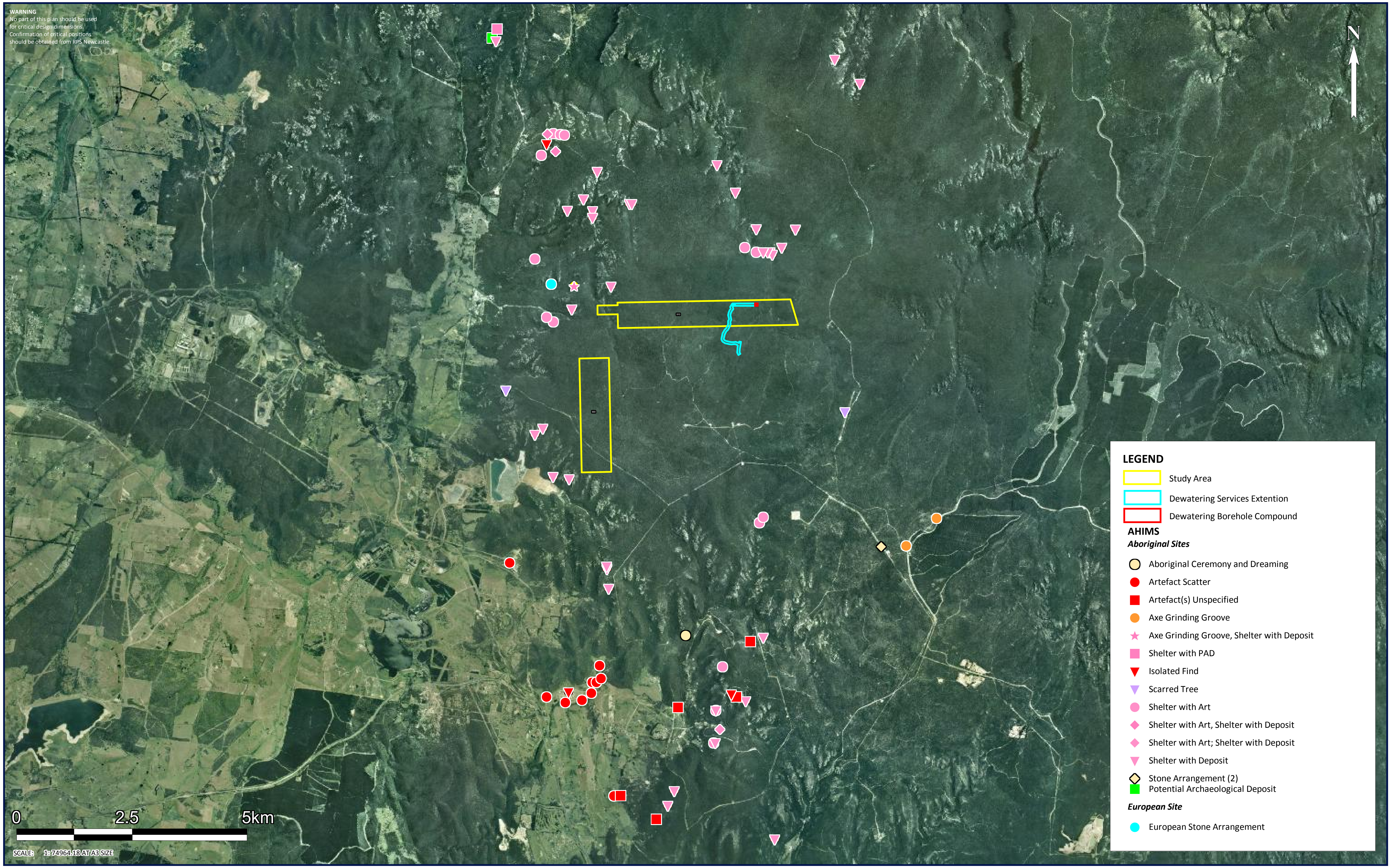
Gollan (Gollan 1987:114-120) concluded, at a regional level, that the plateau area, being of relatively flat lying and gently sloping land, provided suitable resources for Aboriginal occupation. Gollan (Gollan 1987:118) suggested that artefact scatters (and isolated finds) are likely to be found on the fringes of swamps because lithic material and food resources were available in these areas. This is evidenced by the predominance of sites in association with these areas. Gollan also found that there was evidence of the grinding of stone artefacts on the Plateau with several grinding groove sites and ground edged artefacts recorded. Shelters with art were also predominant in areas of the plateau where suitable rock types such as pagodas and inter-bedded sandstone and claystone rock outcrops were found.

Gollan (Gollan 1987:130) considered the plateau to be of high scientific and social significance based on the diversity of Aboriginal cultural heritage sites in the area. At a regional level Gollan was of the opinion that the plateau area was important with respect to both inter-site as well as intra-site diversity (Gollan 1987:131). Gollan (Gollan 1987:114) described the forested upland areas as having the potential to have provided substantial archaeological resources for an upland hunter/ gatherer economy.

A predictive archaeological model undertaken in the Clarence Outbye Area (HSO 2008) showed that 80 % of shelter sites were located along minor drainage lines and 20% along major drainage lines; 80% of Artefact scatters were identified near smaller tributaries and only 16% along major drainage lines. Scarred trees were found on moderate slopes close to the 1000m elevation and axe grinding grooves wre located just below ridges at high elevations.

A comparison between the AHIMS search for the Study Area (which lies to the west of Clarence area) shows the same patterning for shelter sites, artefact sites were in lower lying areas along minor tributaries, grinding grooves were located in rocky outcrop at higher elevations and found scarred trees were also located at high elevation. Only a few rock shelters were along the main drainage line, whereas the majority were along tributaries of the Wolgan River and Lambs Creek.

At a regional level, the Blue Mountains area was therefore able to provide shelter and a resource-rich habitat as evidenced by the distribution of sites in the gently sloping and relatively flat swamp margins, low lying crest areas, flat lying ridge tops, and rocky outcrops lining the various water courses.



TITLE: FIGURE 5-1 AHIMS SEARCH RESULTS

LOCATION: ANGUS PLACE COLLIERY

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 3/3/2010
PURPOSE: ARCHAEOLOGY

LAYOUT REF: CENTENNIAL/26317/DRAFTING/ARCHAEOLOGY/FIG 5-1 AHIMS
VERSION (PLAN BY): A (A.P-G.G)

CLIENT: CENTENNIAL COAL
JOB REF: 26317

241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

5.3 Local Archaeological Context

A number of archaeological surveys have been undertaken and reports have been produced in the Angus Place regional area. The most relevant investigations to the Study Area are summarised below and the information will assist with predictive modelling to help identify potential archaeological sites and provide for planning and management recommendations to be made with confidence.

Gaul, post 1980. Prehistoric Archaeology 391-1, Assignment 2: Black-Fellows Hands Shelter and Environs. University of New England.
It was recorded pre 1979 (Johnson, 1979) but was not registered with DECCW until Gaul undertook research in the 1980's and has since been recorded with DECCW AHIMS #45-1-0007 (Gaul, post 1980). The assignment was aimed at recording the art component of a group of three rock shelters at the western escarpment of the Blue Mountains, west of Sydney. Three shelters were surveyed using a 20m tape, string level and a camera.

Site A – Blackfellows Hand Shelter was located 1km north east from the start of Blackfellows Hand Track. It comprised a large open shelter with the main section being 60m long. The shelter contained occupational deposit slopes that continued for about 40m and also included a small number of chert flakes near the entrance of the shelter. The art panel contained a combination of motifs including arms, feet, weapons and kangaroo appendages. The colours of the motifs comprised of white, yellow and red.

Site B – Shelter was located approximately 700 m down Black Fellows Hands Track. The area contained a 40m long shelter with a low overhanging roof. The floor contained a deposit suspected to be 50cm – 1m in depth. Red hand stencils were found on walls and ceiling. Those on the ceiling were the best preserved art motifs.

Site C – Shelter was situated approximately 300 m further down the track. The shelter was 30 m long and strewn with large rocks from roof-fall. There was little space for deposit with the majority of it having eroded down the slope. The numbers of stencils were difficult to measure and contained mainly fingertips. The stencils were coloured white and yellow but many of them were faded (Gaul post 1980).

Gorecki, 1983. Archaeological Survey Kariwara Colliery Lease, Lithgow NSW.
A field survey was undertaken from January 24th to January 29th 1983 commissioned by Longworth and McKenzie Pty Limited. The survey was conducted on the Newnes Plateau approximately nine kilometres north of Lithgow in the Newnes State Forest. The survey aimed to locate and establish archaeological significance of Aboriginal relics and provide recommendations regarding protective measures for Aboriginal relics. Gorecki's previous assessment was situated immediately east of the current Study Area.

The survey area was divided into four environmental zones based upon geology, topography, vegetation cover and ground cover visibility. The archaeological potential of these zones were assessed. The four zones incorporated the following:

- Zone 1. Lagoon paddock
- Zone 2. Valley floors. These included Sawyers Swamp Creek, Kangaroo Creek and Wolgan River.
- Zone 3. Escarpments
- Zone 4. Plateau

The results of the survey found five archaeological sites and 19 potential occupation sites. Common sites found were a combination of shelters with art and deposit, with the deposited raw material consisting of quartz, chert, indurated mudstone, quartzite and fine grained igneous inclusions. Potential occupation sites have been referred to as shelters which may have been used in the past, but have no deposit at all or have the potential for relics in their deposit (Gorecki 1983).

Stockton, 1983. A Survey for Prehistoric Sites on the proposed Clarence Transfer for the Lithgow Water Supply, NSW.
This study was conducted to support the water requirements of the City of Greater Lithgow due to the rapid increase in coal mining and power generation in the area. Groundwater would be used from Clarence Colliery to supplement natural surface flows into council's Farmer's Creek Dam. The project requirements were a rising dam, settling ponds and a lined channel. The project was located 7km north east of Lithgow Post Office and incorporated the gently sloping ridge of the undulating surface of the Newnes Plateau.

The field survey was conducted in three stages.
Stage 1 – Area comprising 120m x 120m for the proposed settling dams.
Stage 2 – Route of the pipeline which had already been constructed.
Stage 3 – Lined channel and associated access road.
The creek channel section uncovered one isolated find comprised of grey chert and small artefact scatter comprised of two grey quartzite pieces.

Stockton recommended that additional archaeological surveys should always be carried out prior to any clearing or construction work in relation to the proposed project (Stockton 1983).

Rich, 1988. Proposed Prison at Marrangaroo Creek near Lithgow, NSW.
The archaeological assessment for the proposed construction works were located 6km north of Lithgow. The proposed development included prison construction, access roads, additional buildings, car parks and a lake. This study was located approximately 5km south of the current Study Area.

Two known Aboriginal sites were previously recorded in the survey area (#45-1-89 and #45-1-90) in 1983. Transects were made between the creek in the south and the railway line in the north. Sandstone ledges north of the railway line were inspected for shelters.

The survey uncovered eight open sites, and ground truthing of the two sites as mentioned above. The isolated finds and artefacts identified in the open sites were generally small to medium size and were manufactured from quartz, quartzite and mudstone. Existing registered sites in the area were relocated and audited: Marrangaroo Creek Site #45-1-89 was located along a track and eroded bank of a small gully. Five artefacts were identified comprising of flake pieces of chert, milky and yellow quartz. Marrangaroo Creek Site #45-1-90 located on a levee bank between Marrangaroo Creek and a flood overflow channel. The artefact scatter site contained approximately 11 artefacts comprising flakes of indurated mudstone, quartz and milky quartz. A previously recorded (1983) quartzite multifaceted core could not be relocated on the survey.

The natural presence of quartz and quartzite for stone tool manufacture in the survey area indicates that the pebbles may have been readily available in the area (Rich 1983).

Rich and Gorman, 1992. Proposed Springvale Colliery and Conveyor, Wallerawang: Archaeological Survey for Aboriginal Sites.
An archaeological assessment was conducted for the proposed Springvale Colliery and related facilities located near Wallerawang in the Blue Mountains. The survey was divided into four locations; Springvale Pit Top Area 500m x 350m, Proposed Springvale Longwall Mine Area 7.5km x 5km, Proposed Conveyor Route measuring less than 10m wide and approximately 10km long and the Proposed Washery covering an area of 1km x 500m, including the reject emplacements and dams.

The field survey uncovered 11 artefacts scatter sites, an isolated find, two possible site locations, and three shelters with PAD (Potential Archaeological Deposit) were found.

The artefacts scatters were generally located on well exposed areas containing several artefacts with dominant raw material comprising of quartz, quartzite and mudstone. Shelters were predominantly composed of sandstone pagodas which are typical for the regional landscape and commonly located along tributary lines. Two of the shelters contained evidence of rock art.

Archaeological test excavations were recommended to be carried out at the two potential site locations to determine the presence of sites and if proposed works will impact on them (Rich 1992).

Rich, 1993. Springvale Coal Project, Wallerawang, NSW: Archaeological Inspection of Aboriginal Sites Affected by Construction Works.
This report was undertaken by Rich subsequent to the 1992 archaeological assessment undertaken by Rich and Gorman (1992). An assessment was made of existing recorded sites that had been, or were likely to be, affected by development works.

Several recommendations were made additional to those outlined in the 1992 report. These included the updating of existing recorded site cards where necessary (Rich 1993).

Central West Archaeological and Heritage Services Pty Ltd, 2000. An Aboriginal Archaeological Study of the Marangaroo Department of Defence Site, Lithgow, NSW
Central West Archaeological and Heritage Services Pty Ltd was commissioned by Dames and Moore Pty Ltd, on behalf of the Department of Defence, to carry out an Aboriginal

archaeological study of the Marrangaroo Department of Defence Site. Site entrance located approximately 2.2km east of the Great Western Highway and 10km north of Lithgow. The study area was approximately 1,700ha. The survey was both by vehicle and on foot.

The survey yielded 17 Aboriginal sites which consisted of 10 rock shelter sites, 2 rock shelter sites with art and one with deposits. 4 artefact scatter sites and 1 isolated artefact were also found. In addition 12 Potential Archaeological Deposits were recorded in the survey area.

It was recommended that protective buffer zones be established for the rock shelter sites and that if the proposed works were likely to impact on a site then a S87 and/or S90 Permit should be obtained (Central West Archaeological and Heritage Services Pty Ltd 2000).

OzArk Environmental & Heritage Managament P/L, 2006. Flora/ Fauna and Heritage Assessment: Two Proposed Dewatering Borehole Sites for Underground Mining Activities within the Newnes State Forest, Lithgow, NSW.

The report was commissioned by Centennial Angus Place Pty Ltd (CAP) and details the results of a heritage assessment of approximately 1 ha of land in the Newnes State Forest, Lithgow, immediately south east of the current Study Area. The survey was conducted by pedestrian transects.

The survey recorded no Aboriginal sites in the locations of the two proposed dewatering boreholes and associated easement and access tracks. There were no constrains to the proposed development and no further archaeological investigation was considered necessary (Ozark Environmental & Heritage Management Pty Ltd 2007).

OzArk Environmental and Heritage Management P/L (2007) Indigenous Heritage Assessment for Subsidence Management Plan over Three Proposed Longwalls (29 – 31), Baal Bone Colliery.

OzArk Environmental and Heritage Management P/L was commissioned by Xstrata Coal Pty Ltd for the preparation of a Subsidence Management Plan (SMP) over proposed longwalls 29 – 31 located beneath the Ben Bullen State Forest, Cullen Bullen, NSW. This Study Area was located 7km north west of the current study area. OzArk's study comprised an extensive plateau of erosion resistant Triassic sandstone dissected by steep – sided valleys. The area contains remnant surface layer of weathered sandstone and shales of the Narrabeen Group overlaying a complex stratigraphical sequence including the Lidsdale and Lithgow Seams, which are both sub – groups of the Illawarra coal Measures.

A pedestrian field survey of a 250 ha area was conducted and yielded one isolated find and one rock shelter with no surface evidence of Aboriginal occupation. Recommendations for sites recorded were formulated. The report stated that if subsidence predictions indicate that the location of the shelter is likely to suffer extensive disturbance, and plans of the underlying longwalls cannot be altered, then a programme of limited sub surface test excavation in the rock shelter and its immediate environment would be recommended to determine the presence or absence of Aboriginal occupation evidence (Ozark Environmental & Heritage Management Pty Ltd 2007).

5.4 Literature Review Discussion

The archaeological reports detailed in section 5.3 Local Archaeological Context and results of the AHIMS search found that the most commonly occurring site type associated with the Angus Place region is Shelters with either Archaeological Deposit or Art, or Shelters containing both. Artefact scatters were the second most commonly occurring site type. This supports the ethnographic evidence (Section 3) that the Aboriginal population readily exploited and relied on the natural landscape as a consistent and plentiful resource.

The Newnes Plateau and Blue Mountains region has probably been exploited for extensive periods by Aboriginal people and further investigation into the area may uncover patterns of Aboriginal land use and occupation.

6 Predictive Model for the Study Area

6.1 Predictive Modelling

A predictive model is created to form an educated estimate of the potential for an archaeological site to occur. It involves reviewing existing literature and consulting site databases to determine basic patterns of site distribution and correlating this distribution with the associated environment. The use of land systems and environmental factors in predictive modelling is based upon the assumption that these factors provided constraints that influenced land use patterns by past populations, resulting in different spatial distributions and types of sites detectable in the archaeological record. Predictive models can be used as a basis for the planning and management of Aboriginal and European heritage, and for formulating survey strategies to include areas of maximum archaeological potential.

The summary of environmental data (Section 2), ethnographic accounts (Section 3) and previous archaeological work (Section 4 and Section 5) were used to create a predictive model for sites in the Study Area.

6.2 Predictive Model for Aboriginal Archaeology in the Study Area

6.2.1 Site Types and Location

The climate information indicates that the area was suitable for habitation by the Aborigines for a majority of the year; colder months were most likely spent off the plateau where altitude and cooler conditions are more extreme; and in the lower valley areas which provided shelter and reduced exposure to cool winds. The AHIMS database records that shelter sites containing deposits, art and PAD regularly occur in the Newnes Plateau area and have been found in the vicinity of the Longwalls 900W and 910.

6.2.2 Site Aspect

The variety of landforms comprising the Study Area include crests and spurs, with moderately inclined upper, middle and lower sloped areas with various aspects. Rocky ridges in the Longwall 910 area generally aligned in a north to south direction, with minor ridges running laterally in an east to west direction. As such, slopes along the major creek lines tend to face west and east.

6.2.3 Slope

The terrain of the Study Area comprises flat topped, gently sloping crests, high ridges, steep sided upper and mid sloped areas and benched lower slope areas. Some areas are lined by vertical cliff faces and pagodas which overhang the permanent spring fed creek lines. In some areas these incised sections open out into alluvial channels with gentler sloping lower banks. The flat topped ridges or Plateau areas would be the most accessible routes to traverse the landscape accessed via gentle slopes leading to valley floors. There is minimal shelter except in the lower slopes amongst scattered rock outcrops and pagodas close to permanent water. Archaeological investigations in the vicinity of the Study Area have identified a preference for sites to be located near steep cliffs and sandstone outcropping in close proximity to local creek lines. A number of shelters containing an archaeological deposit and art have been found associated with tributaries of both Kangaroo Creek and the Wolgan River.

Open landscapes would provide little shelter from environmental conditions such as strong winds, heavy rains, and cool winter nights. Open and closed woodlands would provide for temporary shelter in warmer weather.

6.2.4 Distance from Water

The Longwalls are located in close proximity to available water sources. Both Longwalls are intercepted by substantial creeklines. Tributaries of the Wolgan River, Kangaroo Creek and Coxs River enter both Longwalls 900W and 910. Longwall 910 has the most available access to permanent water sources, as Kangaroo Creek and Wolgan River intercept the Longwalls to the east and west. Fresh water may have been available on a seasonal basis from the associated drainage lines and tributaries.

6.2.5 Food

The Newnes State Forest would have been an area of much Aboriginal cultural activity in the past and would provide for ample supplies of fresh water and local resources. Tributaries from the Cox's River, Wolgan River and Kangaroo Creek penetrate through the Newnes Plateau. Flora and fauna resources in both terrestrial and freshwater areas would be available in the region and for a majority of the year, including along the creek lines during times of increased rainfall.

6.2.6 Summary

The area presents as a range of resources typical to the regional environment that would have been used and exploited by past Aboriginal populations. The AHIMS results demonstrate regular use of the natural landscape around the Newnes State Forest as evidenced by the number of Aboriginal shelter sites. The broader plateau landscape would have provided for good transitory access routes between resource zones. Local fresh water and terrestrial environments, especially the abundance of shelter, would have made the Study Area potentially desirable for campsites and as a locality for gathering a variety of flora and fauna species.

6.3 Predictive Model for European Heritage in the Study Area

The results of database searches (Register of National Estate, NSW Heritage Office) and the Lithgow City Council LEP (Section 4.1) and additional historical research provide a concept of the types of sites and activities that could have been carried out in the Study Area.

The Lithgow area presented a rich industrial environment which provoked the initial settlement of the region. The early occupants were mostly railway workers, who helped to construct the train line from Sydney to Bathurst, and miners in the local collieries. The discovery of the Lithgow coal seam was a prosperous addition to the regional economy, with many of the early settlers arriving to take advantage of the mining boom. Both of these industry sectors combined contributed to the Lithgow LGA as it is today.

It is the cultural remains from the early years of coal mining that are most likely to occur in the Study Area which may include discarded machinery, tool implements and structures and potentially built structures from the early years of settlement.

In determining the value of sites from a heritage perspective, The Heritage Branch Assessment Criteria was used (Refer Appendix 5).

7 Field Survey

The archaeological pedestrian survey of the Angus Place Colliery Study Area was conducted on Tuesday 9th, Wednesday 10th, Thursday 11th and Friday 12th February 2010. The majority of the survey days were conducted in warm temperate and humid conditions; on one of the days a heavy thunderstorm hit which caused the survey to finish early afternoon. Survey team members included Warwick Peckham (BLALC), Richard Peters (MAC), Kevin Williams and Wendy Lewis (WNTCAC), together with Senior Archaeologist Gillian Goode and Archaeologist Philippa Sokol from RPS. At the time of the survey the Study Area had proposed plans underway for the construction of Longwalls 910 and 900W and the purpose of the survey was to ascertain areas for potential impact and to develop mitigation measures accordingly.

A Rock Shelter with PAD was identified in the west of Longwall 910 and is situated inside the Study Area – Refer Appendix 7 (RPS Angus Place RS PAD1).

Scattered sandstone and quartz rocks were noted throughout the survey and are part of the Narrabeen Sandstone Group conglomerate formation. This raw material is difficult to knap and unsuitable for stone tool manufacture.

In relation to European cultural heritage items in the Study Area; the field survey investigations found no items of European cultural heritage.

7.1 Methodology

The survey was conducted on foot and effective coverage of all landform units was undertaken. The Study Area comprises two separate portions; one is located in the north and the other in the west being Longwalls 910 and 900W (Figure 7-1). An additional area was surveyed covering the proposed Dewatering Borehole Compound and associated Services Extension area to the west of the Wolgan River (Figure 7-2). The methodology for field survey was to investigate the Study Areas according to landform unit, as it is landforms that can determine the level of Aboriginal archaeological potential. Systematic coverage of these portions of the Study Area was undertaken.

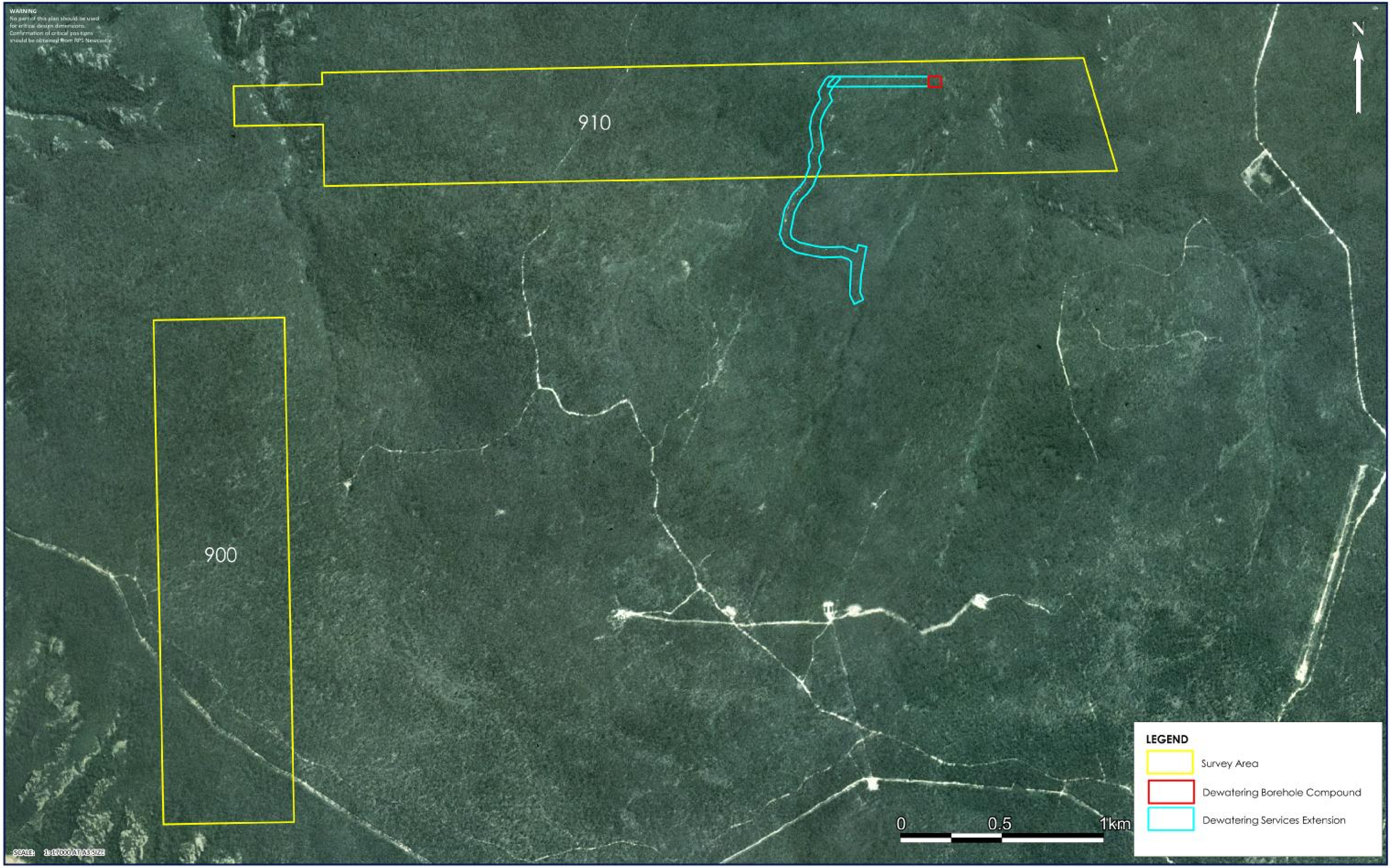
Longwall 910 was divided into four survey units and Longwall 900W into two survey units (Figure 7-3), with each area being traversed in evenly spaced transects.

A map specifying the survey units and any identified archaeological sites from the field assessment are detailed in Figure 7-3.

7.2 Landforms

The Study Area was assessed by its landforms and as such these landforms were used for comparative purposes of Aboriginal occupation patterns and predictive modelling. Landforms investigated on the survey included crests, spurs, gentle and steep mid slopes, ephemeral drainage lines and moderately sloping sides, together with and extended into steep sided valleys in order to follow permanent creek lines (Figure 7-1).

Additional survey of an area for the proposed development of a Dewatering Borehole Compound in Longwall 910 area and associated infrastructure connecting to an existing Dewatering Borehole Compound to the south of Longwall 910 was also undertaken (Figure 7-2).



TITLE: FIGURE 7-1 SURVEY AREAS
LOCATION: ANGUS PLACE COLLIERY
DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)
DATE: 3/3/2010
PURPOSE: ARCHAEOLOGY
LAYOUT REF: 26317 FIGURE 7-1 SURVEY AREA A A3
VERSION (PLAN BY): A (A.P-G.G)

CLIENT: CENTENNIAL COAL
JOB REF: 26317

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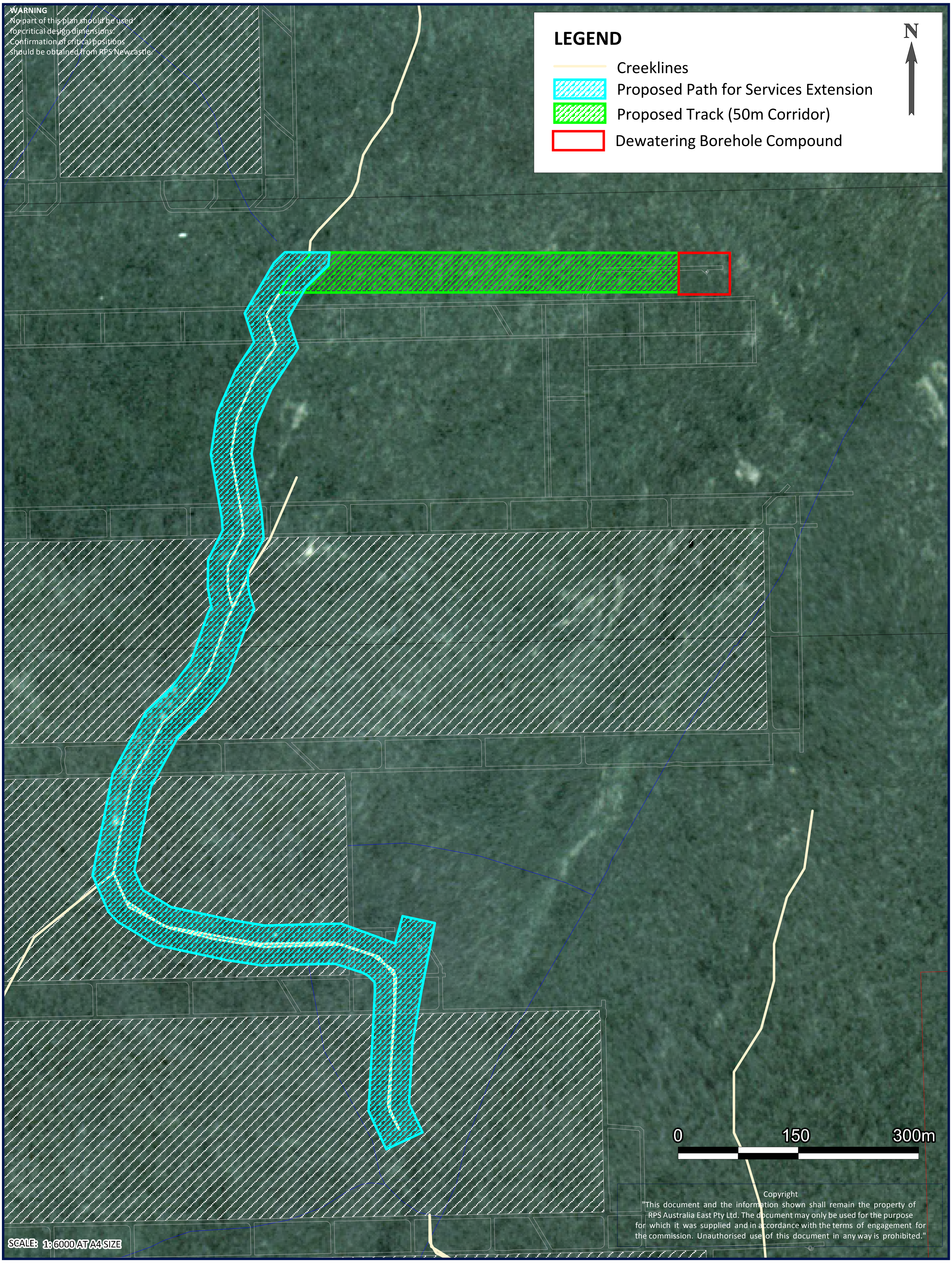

TITLE: FIGURE 7-2 COMPOUND & SERVICES EXTENTION

LOCATION: ANGUS PLACE COLLIERY

DATUM: DATUM

PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 12/10/2010

PURPOSE: ARCHAEOLOGY

LAYOUT REF: 26317 DRAFTING\MAPINFO\ARCH\FIG 7-2 SERVICES A A4

VERSION (PLAN BY): A (A.P-G.G)

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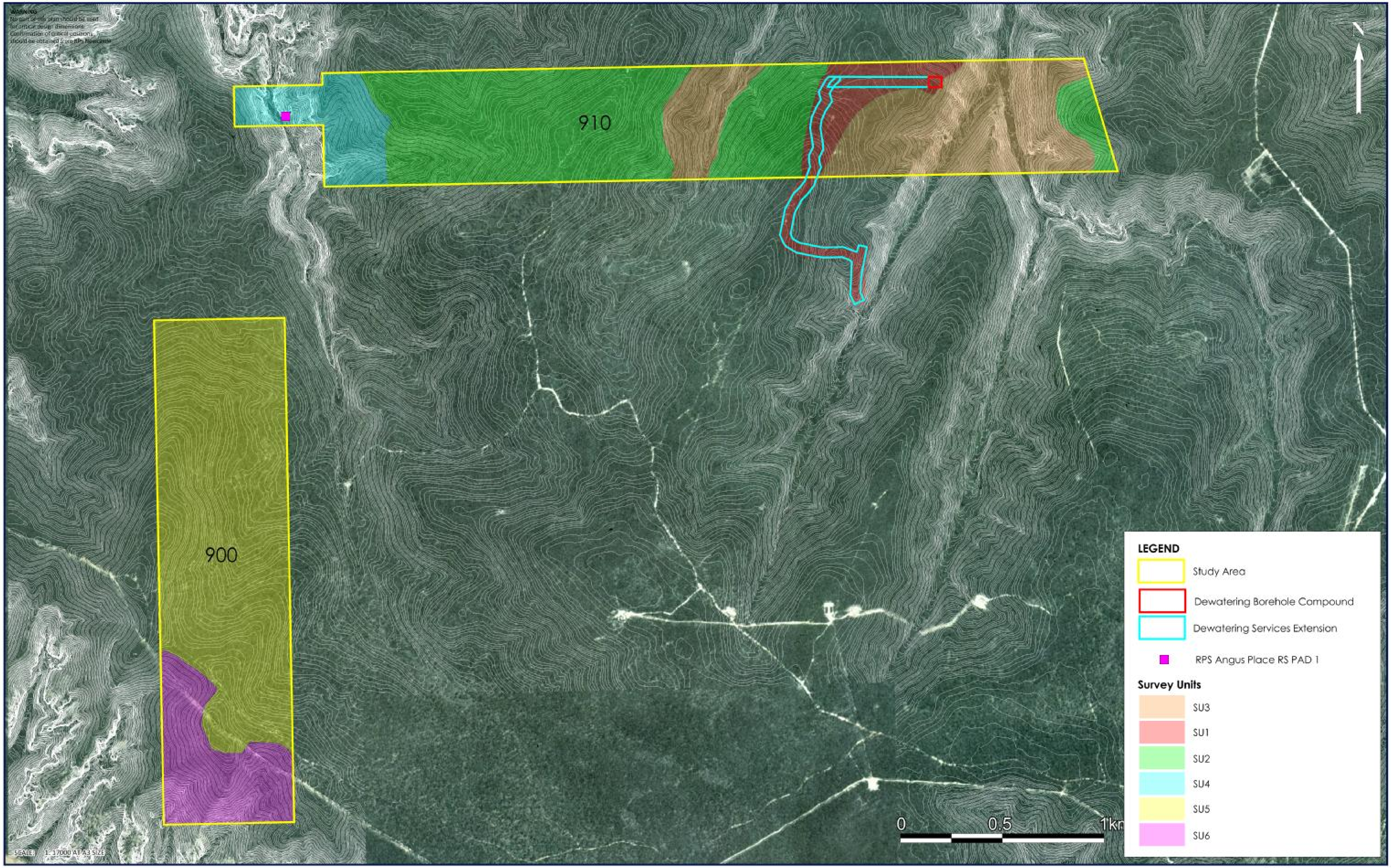

TITLE: FIGURE 7-3 SURVEY UNITS & ABORIGINAL ARCHAEOLOGICAL SITE

LOCATION: ANGUS PLACE COLLIERY

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 3/3/2010
PURPOSE: ARCHAEOLOGY

LAYOUT REF: 26317 FIGURE 7-1 SURVEY UNITS A A3
VERSION (PLAN BY): A (A.P-G.G)

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7.3 Survey Units

7.3.1 Longwall 910 Survey Results

7.3.1.1 Survey Unit 1 – Longwall 910 Dewatering Borehole

No items of Aboriginal or European cultural significance were identified in Survey Unit 1.

Survey unit 1 (SU1) incorporated the proposed Dewatering Borehole Compound and associated infrastructure including the installation of a pipeline to connect to the existing services (Figure 7-1 and 7-2). The compound and associated access tracks and infrastructure are located to the west of the Wolgan River and cross the central eastern section of the proposed Longwall 910 area.

The proposal for the development of the dewatering station and the extension of pipeline to the existing services was to follow the existing 4WD access track to the existing 930 Dewatering Borehole Compound located to the south of Longwall 910 (Plate 1). The track area was surveyed with a 25m corridor to either side for the installation of the pipeline and associated infrastructure. The existing 930 Dewatering Borehole Compound and associated services are used to remove excess water from the underground workings.

The Dewatering Borehole Compound and pump out areas were highly disturbed and felled trees had been used as erosion control measures in upper slope areas (Plate 2). The water is piped down a steep slope below the existing dewatering pump station (Plate 3). The area along the track was extremely disturbed by excavation of windrows, access track clearing, and from the effects of water discharge down slope (Plate 4).

The Proposed Dewatering Borehole Compound in the northern part of Longwall 910 area is located on gently sloping ground directly above a steeply inclined slope on the western bank of the Wolgan River. The proposed compound area measures 50m x 50m but a further 50m buffer around this area was also investigated. An area 50m wide was surveyed along an existing motocross bike trail leading from the end of the existing 4WD track (in the northern part of Longwall 910) to the proposed Dewatering Borehole Compound.

The 4WD track area was disturbed by ground clearance works associated with previous borehole clearance works, installation of subsidence monitoring pegs, tree felling, installation of windrows and use by 4WD and motocross vehicles. The area designated for the proposed Dewatering Borehole Compound was accessed along an existing motocross track. The proposed compound area has been disturbed by sheet wash and there was evidence of some rubbish dumping in this area.

Visibility was fair to good along the existing tracks although vegetation was increasingly dense at a distance of 5m either side of the track. There was no evidence of any Aboriginal cultural heritage material in the area encompassing the proposed Dewatering Borehole Compound and Services Extension areas.

7.3.1.2 Survey Unit 2 - Longwall 910 Crest, Upper and Middle Sloped Areas

No items of Aboriginal or European cultural significance were identified in Survey Unit 2.

Landforms in Survey unit 2 (SU2) were assessed according to low, moderate and high potential. Access into this area was via a well used 4WD trail called Black Fellows Hand Road, which is one of the main access routes across the plateau. SU2 contained several smaller tracks that branched off from the main trail (Plate 5). SU2 was investigated according to landform unit which included crests and ridgelines, upper slope, mid slope and lower slopes.

Access and visibility into SU2 was good and the pedestrian survey was conducted without much difficulty. Ground surface visibility was low caused by dense leaf litter, ribbon bark, native grasses and felled trees (Plate 6). There were several areas of exposed soils and erosion scalds. These areas were inspected for items of cultural significance. Much of the material found in these exposed areas included coarse grained sandstones and conglomerate pebbles and cobbles, and quartz pieces that had eroded from conglomerate rocks in the area.

Crest areas were generally considered as having high potential for Aboriginal cultural heritage items. These areas were surveyed for artefact scatters and possible isolated finds which may have resulted from Aboriginal people traversing the high land and discarding items no longer useful to them. Other potential site types in crest areas include sandstone outcrops suitable for grinding, hearths (stone arrangements), and scarred trees (any large trees that had not been subject to logging). Due to the high elevation of SU2, large sandstone outcrops suitable for shelters were not predicted likely. No Aboriginal cultural heritage sites were identified.

Upper to mid slope areas were surveyed for potential artefact scatters, isolated finds and scarred trees. Scattered large trees were seen but none contained scars or engravings. Artefact sites and isolated finds were a potential in suitably sloped areas such as spurs and associated with ground surface erosion on slopes (Plate 7). No Aboriginal cultural heritage sites were identified.

Mid sloped areas were investigated for scarred trees, although the occurrence of scarred trees in previously logged areas is unlikely. Artefact scatters were also taken into consideration on lower mid sloped areas that were generally a 3°C gentle slope (Plate 8). No Aboriginal cultural heritage sites were identified.

7.3.1.3 Survey Unit 3 – Longwall 910 Wolgan River Confluence and Associated Creek Terraces and Steeply Sloping Valley Sides

No items of Aboriginal or European cultural significance were identified in Survey Unit 3.

Survey unit 3 (SU3) incorporated the eastern portion of land in the Longwall 910 area that consisted of steeply descending slopes leading to the incised valleys and ephemeral gullies associated with the Wolgan River and its tributaries (Plate 9).

Lower slopes were considered areas of high potential and these were investigated for artefacts scatters and isolated finds, scarred trees, rock shelters and pagodas (especially in areas adjacent to creek lines), grinding grooves on sandstone beds adjacent to rock shelters, and rock shelters with the potential to contain art, deposits and PAD (Plate 10).

Creek lines were found to be ephemeral with small water-filled pond areas, or permanent with water welling up through the sandstone via springs. The Wolgan River and several unnamed tributaries converge in this part of the study area. Banks on either side of the confluence were surveyed. A steeply sloped sandstone spur lay between the two major creek lines. This area of inter-bedded sandstone rocks (Plate 11) was surveyed by following the contours until the confluence point was reached. At the tip of the spur a marker peg was noted to signify the northern Longwall 910 boundary and a second peg marked the southern boundary. The flat lying sandstone rocks at the confluence were investigated for the potential of grinding grooves, but none were identified (Plate 12).

The western branch of the Wolgan River showed evidence of repeated flooding events with the deposition of alluvial gravels. The lower slopes were gently sloping with outcropping sandstone rocks and a few pagodas directly above the river terraces. Disturbances included the effects of flooding, erosion along the creek banks and down the screed slopes, and wombat burrows. Vegetation on both sides of the creek lines above the creek bed comprised thick scrub and the slopes were densely covered. There were several areas of exposed soils with sandstone and quartz pebbles eroded out of the overlying conglomerate rocks.

The eastern branch of the Wolgan River was lined with steeply sloping sandstone rocks and several pagodas. Several of the pagodas located just above the creek line in this area had been eroded forming small overhangs (Plate 13) but none of them were considered of adequate depth or height to provide for shelter (Plate 14).

<u>Upper to mid slope areas</u> were steeply sloping and there was the potential for sandstone outcrops or pagodas to contain over hangs suitable for human habitation. Outcrops on the ascending ridges were inspected but there were no rock shelters present in these rock formations. There were large expanses of sheet sandstone visible on the mid slope area on the eastern side of the Wolgan River but there were no rock shelters found in this part of the Study Area (Plate 15). At the top of this slope there were large expanses of flat lying sandstone, but no grinding grooves were evident (Plate 16).

There was no evidence of any Aboriginal cultural heritage objects or sites in this area.

7.3.1.4 Survey Unit 4 – Longwall 910 Kangaroo Creek

<u>No items of Aboriginal or European cultural significance were identified in Survey Unit 4.</u>

Survey unit 4 (SU4) incorporated the eastern portion of land in the Longwall 910 area. The area is bisected by Kangaroo Creek which lies in an incised valley with steeply descending upper slopes (Plate 17) and mid slope areas (Plate 18). Kangaroo Creek is a spring fed creek with fresh water welling up through the alluvial gravels that lie in the creek bed. The valley bottom is comprised of sandstone bed rock. The western bank of Kangaroo Creek is lined by towering sandstone cliffs and the eastern bank by pagodas and broken cliff lines comprised of inter-bedded sandstone conglomerate rocks. The pagodas have been undercut by fluvial action resulting in several overhangs and rock falls with boulders scattered down the screed slopes.

The majority of this part of the Study Area had overhangs which were suitable for small wildlife to shelter under, but only one was considered large enough to have the provided shelter for Aboriginal people (Plate 19). The shelter was approximately 20m long, 12m wide and 15m high (Plate 20). This shelter had a sandy floor (Plate 21) which was approximately 400mm deep (RPS Angus Place RS PAD1). The site co-ordinates for the Rock Shelter with PAD are GDA 232966E 6305664N Lithgow Map Sheet (Refer Figure 7-3). The shelter was 2m from a temporary creek line and water hole and located approximately 10m above Kangaroo Creek (Plate 22). The area is undisturbed and the valley floor has many large trees and dense vegetation along its length (Plate 23 and Plate 24).

There was no evidence of any Aboriginal cultural heritage objects or sites in this area.

7.3.1.5 Survey Unit 5 – Longwall 900W Crest, Upper and Middle Sloped Areas

No items of Aboriginal or European cultural significance were identified in Survey Unit 1.

Landforms in survey unit 5 (SU5) were assessed according to low, moderate and high potential. Access into this area was via an unnamed trail that intersected in the west with the Angus Place trail along the crest. SU5 contained a few smaller tracks that branched off from the main trail. SU5 was investigated according to landform unit which included crests and ridgelines, upper mid slope, mid slope and lower slopes.

Access and visibility into SU5 was good and the pedestrian survey could be conducted without much difficulty. Ground surface visibility was very low to nil and was caused by heavy leaf and ribbon bark, native grasses and felled trees. There were very few areas of exposed soils and when these areas were located they were inspected for items of cultural significance (Plate 25). Much of the material found in these exposed areas included coarse grained sandstones and conglomerates, and quartz pieces that had eroded from conglomerate rocks in the area (Plate 26).

Crest areas were generally considered as high potential for Aboriginal cultural heritage items. These areas were surveyed for artefact scatters and possible isolated finds which may have resulted from Aboriginal people traversing the high land and discarding items no longer useful to them. Other potential in these areas that were investigated by the survey team included sandstone outcrops suitable for grinding, hearths (stone arrangements), and scarred trees (where large trees had not been subject to logging). Due to the high elevation of SU5, large sandstone outcrops suitable for shelters were not predicted.

Upper to mid slope areas were surveyed for potential artefacts scatters, isolated finds and scarred trees. Scattered large trees were seen but none containing scars or engravings. Artefacts sites and isolated finds were considered likely if the area was gently sloping and would probably be associated with ground surface erosion on slopes.

Mid slope areas were investigated for any scarred trees that remained after logging. Artefact scatters were also considered likely on lower mid slope areas that were gently sloping.

Lower slopes are also considered areas of high potential and these were investigated for artefact scatters and isolated finds, scarred trees, rock shelters and pagodas (especially in areas adjacent to creek lines), grinding grooves on sandstone beds adjacent to rock shelters, and rock shelters with the potential to contain art, deposits and PAD.

7.3.1.6 Survey Unit 6 – Steep Sided Slopes and Ephemeral Drainage Lines

No items of Aboriginal or European cultural significance were identified in Survey Unit 6.

These landform units were identified in the south west portion of Longwall 900W. The survey team began their investigations from the intersection at the Angus Place trail and continued south east along the crest areas and associated gentle mid and upper slopes. Adjacent and to the south of the crest areas lay an electricity easement. Soils in this area were well exposed and the vegetation was minimal enough to enable portions of ground surface to be observed (Plates 25). Many conglomerate pebbles comprised of quartz and claystone were noted in the area (Plate 26), but no items of Aboriginal cultural heritage were identified.

The survey team followed the contours which encircled the upper and mid slopes and travelled down the ephemeral drainage lines. Evidence of logging was seen in the area along with used vehicle tracks. Some of the large felled trees and leaf litter limited ground surface visibility. These drainage lines were all dry, but contained evidence of water flow during periods of high rainfall.

7.4 Effective Coverage

The amount of ground surface observed varies depending on factors such as soil disturbance, vegetation cover, steepness and accessibility of the terrain. Ground surface visibility was considered low. Visibility was restricted by leaf litter and vegetation. Erosion scalds and sheet wash occurred in some parts of the Study Area with lateritic cover of sandstone, claystone and quartz pebbles and cobbles.

7.5 Survey Results – Aboriginal Archaeology

On conclusion of the field survey all six members of the survey team, RPS Archaeologists Gillian Goode and Philippa Sokol, and the Aboriginal Community Stakeholders agreed that the area had been subject to major disturbance by logging and minor disturbance associated with the maintenance of the dirt access tracks. Other areas of scattered disturbance included previous borehole investigation areas, electricity easements and 4WD and motocross dirt access tracks. In summary the following can be said for the Angus Place Colliery archaeological survey:

- No Aboriginal archaeological sites or PADs were found on crest ridges;
- No Aboriginal archaeological sites or PADs were identified on the upper or mid slope areas which were generally 18° - 30° slopes;
- Ephemeral creek and drainage lines descended relatively steeply to narrow, deeply incised gorges with permanent spring fed water running through the linear jointed sandstone bedrock;
- Triassic sandstone pagodas and cliffs lined some of the sections of permanent creek lines;
- In some areas pagodas and inter-bedded sandstone outcrops were undercut by erosion forming small overhangs; and
- Only one Rock Shelter with PAD was identified and the site card is attached in Appendix 7 (RPS Angus Place RS PAD1).

The vegetation of the Study Area was predominantly dense and ground surface visibility was generally considered low. Exposed areas were inspected for items of archaeological significance but no items were identified. Sandstone outcrops and overhangs were assessed for Aboriginal archaeological potential.

The minimal amount of stone artefact sites recorded in the locality may be reflections on the lack of available raw material in the area for stone tool manufacturing. Of note, the common rock type for the area is coarse grained conglomerate sandstone and friable quartz, which is generally unsuitable to be used as a stone tool raw material.

7.6 Survey Results – European Historic

<u>No items of European archaeological significance were identified during the field investigation.</u>

The Lithgow region has had a strong settlement history and was initially settled as a result of its booming coal mine industry. During the course of the field survey the Study Area was inspected for potential items of European history that may relate to its past settlement patterns.

No evidence resembling the early Lithgow settlement history and mining industry or other items of European cultural historical significance was observed during the field investigation.

8 Aboriginal Archaeology Significance Assessment

The term 'archaeological significance' (also referred to as scientific significance) is a value allocated to Aboriginal or European heritage sites by archaeologists to help determine appropriate management strategies and mitigation measures for their ongoing care and management.

8.1 Archaeological Significance

The Study Area incorporating Longwalls 900W, 910 and Dewatering Borehole Compound and Services Extension had been disturbed by dirt tracks for public access by 4WD and motor cross bikes, logging, power line easements, dewatering pump stations and borehole investigation sites. There were a number of felled trees from current State Forest works.

No Aboriginal archaeological sites or PADs were found on crest ridges, upper or mid slope areas which were generally steeply sloped, or along ephemeral creek and drainage lines. There were a number of sandstone outcrops and pagodas scattered along Kangaroo Creek and the Wolgan Rivers. Several of the pagodas had over hangs which were inspected for evidence of habitation, rock art, grinding grooves on associated flat sandstone outcrops and also for their archaeological deposit potential.

Only one Rock Shelter with PAD was identified in the western portion of Longwall 910 which is located inside the Study Area. This site was located on the west facing, lower sloped area above a permanent spring fed creek line of the Kangaroo Creek tributary. All other accessible pagodas and rock formations were inspected and no other Aboriginal archaeological sites or PADs were identified.

The rock shelter was relatively large with a high overhang located adjacent to a water hole, as well as being in close proximity to Kangaroo Creek. The floor of the rock shelter contained a sandy deposit of approximately 40cm in depth. No artefacts or cultural material was identified on the surface of the sandy floor and there was no evidence of rock art on the sandstone faces. However, there is the potential for subsurface deposit to be present. The mid and upper slopes above the rock shelter were very steep, but access from Kangaroo Creek was possible. In the absence of any other suitable shelters in the immediate vicinity, the significance of this rock shelter with PAD is assessed as being of moderate archaeological significance.

In summary:

1. the dewatering station and pipeline area can be considered to have nil to low significance;
2. Crest ridges, upper and mid slopes, and ephemeral creek and drainage lines have nil to low significance;
3. Lower slopes and banks of Kangaroo Creek and the Wolgan River and their tributaries have nil to low significance except for the area containing the one Rock

Shelter with PAD on Kangaroo Creek (RPS Angus Place RS PAD1). The site co-ordinates for the Rock Shelter with PAD are GDA 232966E 6305664N Lithgow Map Sheet.

8.2 Site Specific Significance Assessment

The archaeological significance given to a site or area in the absence of identified sites is based on several criteria detailed below. This criterion is then used to ascertain the archaeological significance of the Rock Shelter with PAD site.

- Rarity in a local and regional context
- Representativeness in a local and regional context
- Integrity in a local and regional context
- Connectedness in a local and regional context
- Complexity in a local and regional context
- Ability to contribute to the archaeological understanding of the cultural sequence in a local and regional context

Rarity: *This criterion examines the site type against those occurring in the local and regional context. If the site type being assessed is considered to be rare at either regional or local levels, this raises its importance in the archaeological record. In Australia, the most common site type is an artefact scatter. For the local area, the most common site types are shelters with deposit, art and PAD.*

Only one Rock Shelter with PAD (RPS Angus Place RS PAD1) was identified in the western portion of the Longwall 910 area. This site was located on the west facing, lower sloped area above a permanent spring fed creek line of Kangaroo Creek. The Rock Shelter with PAD (RPS Angus Place RS PAD1) would be considered to be of low importance for rarity.

Representativeness: *This criterion relates to determining if the site can be characterised as representative of the sites (types, integrity etc) present in the local and regional context. The purpose of this is to conduct further investigations on a sample of sites within a given area, in order to add to the archaeological understanding of the area, but to leave a representative sample in situ for future generations.*

Shelters with deposit, art and PAD are representative of the most common site found across the local and regional area. In this instance, the Rock Shelter with PAD (RPS Angus Place RS PAD1) has the potential to be classified as moderate for representativeness as it appears to contain a relatively undisturbed floor.

Integrity: *This criterion refers to how undisturbed and intact a site is. A site with contextual integrity can provide information relating to chronology, social systems, tool technology, site formation processes, habitation, frequency of use as well as other forms* *of analysis. If a site has been the subject of moderate to large degrees of disturbance, it has a low probability of retaining integrity, and thus the information able to be obtained from the site is reduced.*

It would appear that the area surrounding RPS Angus Place RS PAD1 has been subject to disturbances by water flow after heavy rain when the creek would have been fast flowing. Use by animals would contribute to disturbances within the confines of the shelter. The area in front of the open end of the shelter contained a thick cover of vegetation which may offer some protection from climatic conditions and activities from fauna. The area is considered to have low to moderate integrity.

Connectedness: *The connectedness criterion relates to the relationship between a site and others in the local and regional environment. If a site is determined to have connectedness with other sites, the depth of knowledge that can be obtained from the connected sites increases and can be used to develop an understanding of more traditional practices that cannot be identified by looking at one site in isolation. The connectedness could relate to age, the landform in which they are contained, the contents of the sites etc. This criterion is often ascertained without subsurface investigations.*

The connectedness of this Rock Shelter with PAD site (RPS Angus Place RS PAD1) has been assessed in relation to other shelters found in the vicinity of the spring fed creek line of the Kangaroo Creek tributary with available fresh water. The area is considered to have moderate significance for connectedness.

Complexity: *The complexity criterion relates to the contents of the site. This may relate to a high number of artefacts per square metre or features which can add to the layer of information that can be obtained from a site (e.g. hearths, knapping floors, ochres etc).*

The complexity of the Rock Shelter with PAD site at this point can only be assessed in terms of size and evidence of potential deposit as it shows limited evidence of complexity apparent at the surface. It is considered that given the location of the site, complexity be assigned as low – moderate.

Contribute to Knowledge: *The ability of a site to contribute to knowledge is largely dependent on the site having moderate to high significance assessments for the other criteria. The ability to contribute to knowledge requires 'new' knowledge to be drawn from the site and add to the local and/or regional context.*

The Rock Shelter with PAD site (RPS Angus Place RS PAD1) contains a significant sized overhang stretching for approximately 15 metres. The position of the shelter adjacent to a spring fed creek containing a relatively intact floor suggests that the shelter has the potential to contain archaeological deposit. The site is therefore considered to have moderate potential to contribute to the archaeological record.

8.3 Cultural Significance

This can only be determined by Aboriginal community. This section is to be completed once community feedback has been received with the responses to be located in Appendix 8.

8.4 European Historical Significance Assessment

The rich mining history and local settlement patterns in the region of the Study Area have been listed in Lithgow archival recordings along with other historical items listed on the NSW Heritage Register and Council Local Environmental Plan (LEP) (Section 4). Items of historical significance are assessed following the NSW Heritage Criteria Assessment Criterion. A copy of this can be found at Appendix 5.

<u>No items of European cultural significance were identified in the Study Area.</u>

9 Impact Assessment

No European cultural heritage sites were located during the survey of the Study Area. The only Aboriginal cultural heritage site identified was a Rock Shelter with PAD (RPS Angus Place RS PAD1 – refer Appendix 7). No other area was considered likely to have the potential to contain archaeological deposit.

9.1 Proposed Development

The proposed development for the Study Area will incorporate extensions of Longwalls 910 and 900W for future mining exploration works. It should be noted that the primary aim of the risk minimisation strategy developed for this project is to avoid all impacts.

9.1.1 Aboriginal Cultural Heritage Impact Assessment

It is considered that there is no potential for the proposed development to impact upon the Rock Shelter with PAD (Appendix 7) identified in Longwall 910. Information provided by Centennial Angus Place Pty Limited regarding the angle of draw for the proposed Longwall development indicates that the Rock Shelter with PAD (RPS Angus Place RS PAD1) lies outside of the area likely to be affected by subsidence. For even greater assurance that there will be no impact to the Rock Shelter with PAD (RPS Angus Place RS PAD1), Centennial Angus Place Pty Limited has adopted a move to a zero subsidence contour that encircles the project which in effect has moved the impact area further away from the site.

A study conducted by DGS (2010) showed the overall predicted cumulative worst-case subsidence impact would be minimal in the overall Study Area. RPS placed an overlay of the Study Area onto the subsidence contours in Figure 17a of the DGS 2010 report. This showed that there was no subsidence predicted in the western part of Longwall 910 and there is no subsidence predicted in the area of the Rock Shelter with PAD (RPS Angus Place RS PAD1-Refer Figure 7-3). Also other sites previously registered on the AHIMS database are located well outside of the immediate Study Area and will therefore not be liable to impacts by subsidence from the proposed development works.

There were no other Aboriginal Cultural Heritage sites identified in the Study Area. The proposed development works are considered unlikely to impact upon any Aboriginal cultural heritage sites under the current subsidence and angle of draw calculations provided by Centennial Angus Place. DGS (2010) predicts nil subsidence in the area where RPS Angus Place RS PAD1 site occurs and for the majority of the Study Area a vertical subsidence between zero and 2mm is predicted.

9.1.2 European Cultural Heritage Impact Assessment

No items of European historical significance or potential for archaeological deposit were identified in the Study Area during the field investigation.

10 Mitigation Measures

The mitigation measures that stem from this archaeological assessment are based on the legislation designed to address the potential impact from the Angus Place Colliery development works upon sites of cultural significance. It should be noted that the primary aim of the risk minimisation strategy developed for this project is to avoid all impacts, which means that the residual risk for impact to archaeological material is negligible.

10.1 Aboriginal Cultural Heritage

Mitigation Measure 1 - Aboriginal Community Consultation
Liaison established with the Aboriginal Community as per the *DECCW Interim Community Consultation Requirements for Applicants (2005)* during this project should be maintained during the proposed works should any matters relating to Aboriginal heritage occur.

Mitigation Measure 2 - Aboriginal Archaeological Management
One Aboriginal cultural heritage site was located and recorded during the survey. The site was recorded as a Rock Shelter with PAD (RPS Angus Place RS PAD1).

There was no subsidence predicted in the area of RS PAD1 (DGS April 2010). However, it is recommended that during the general course of the project the site could be monitored for the effects of cracking or movement and ongoing management of the site could include monitoring. Monitoring of the Rock Shelter with Pad would include pre and post mining inspections to assess and quantify any impact.

During the course of project work:

Mitigation Measure 3
Ensure that disturbance associated with the proposed mining operations is limited to the boundaries of the Study Area identified in this report. If works are planned outside of the Study Area, new and subsequent European and Aboriginal archaeological investigations will need to be initiated.

Mitigation Measure 4
If it is suspected Aboriginal Cultural Heritage Material has been encountered, work should cease immediately in that locale. If Aboriginal site/s are identified in the study area, then all works in the area should cease, the area cordoned off and contact made with DECCW Enviroline 131 555, a suitably qualified archaeologist and the relevant Aboriginal stakeholders, so that it can be adequately assessed and managed.

Mitigation Measure 5
In the event that skeletal remains are uncovered, work is to stop in the vicinity immediately and the relevant command area of the NSW Police contacted. If skeletal remains are deemed to be of Aboriginal origin, then all works in the area should cease, the area cordoned off and contact made with DECCW Enviroline 131 555, a suitably qualified

archaeologist and the relevant Aboriginal stakeholders, so that it can be adequately assessed and managed.

10.2 European History

No European cultural heritage sites were located during the survey of the Study Area. During the course of any construction work the following Mitigation Measure should be considered.

Mitigation Measure 6

If, during the course of clearing works, significant European cultural heritage material is uncovered, work should cease in that area immediately. The NSW Heritage Branch should be notified and works only recommence when an appropriate and approved management strategy instigated.

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12 Plates

Plate 1: View of dewatering station.

Plate 2: View of felled trees for erosion control measures at dewatering station.

Plate 3: View from Wolgan River tributary looking up degraded dewatering station track.

Plate 4: View of degraded dewatering station track.


Plate 5: View of track across plateau from Black Fellows Hands Road.


Plate 6: Vegetation and leaf litter hindering ground surface visibility.


Plate 7: View of upper and mid sloped areas in the Study Area.


Plate 8: View of mid sloped areas in the Study Area.


Plate 9: View of lower sloped areas in the Study Area.

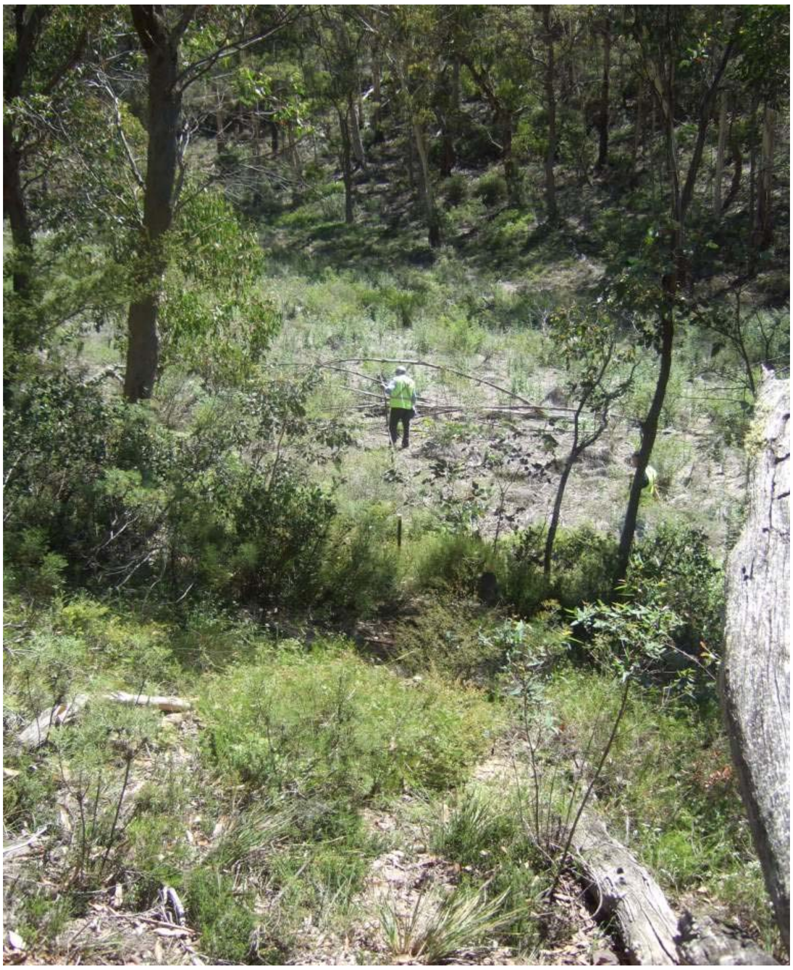


Plate 10: View down slope into the Wolgan River tributary of Longwall 910.

Plate 11: View of sandstone bedrock along the spur.

Plate 12: Sandstone bedrock along spur with no evidence of grinding grooves.

Plate 13: Pagoda overhang on eastern bank of Wolgan River tributary to south of confluence.

Plate 14: Pagoda.

Plate 15: View of mid slope area on eastern bank of Wolgan River tributary showing drainage lines and sheet sandstone.

Plate 16: Exposed flat sandstone sheet rock. No grinding grooves.

Plate 17: Descent to deep gorge; upper slopes.

Plate 18: Descent to deep gorge; mid slopes.

Plate 19: Rock Shelter with PAD on lower slope above Kangaroo Creek – photo facing south west.

Plate 20: View to north east showing height of Rock Shelter with PAD.

Plate 21: view to south west showing floor of Rock Shelter with PAD.

Plate 22: Temporary water source adjacent to Rock Shelter with PAD - view to north.

Plate 23: Permanent creek line with towering cliffs.

Plate 24: Large trees along length of permanent creek line.

Plate 25: Sheet wash erosion showing pebbles.

Plate 26: Fractured quartz pebbles and conglomerate sandstone cobbles.

Appendix 1

Legislative Requirements

SUMMARY OF STATUTORY CONTROLS

The following overview of the legal framework is provided solely for information purposes for the client, it should not be interpreted as legal advice. RPS Australia East Pty Ltd will not be liable for any actions taken by any person, body or group as a result of this general overview, and recommend that specific legal advice be obtained from a qualified legal practitioner prior to any action being taken as a result of the summary below.

COMMONWEALTH

Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (ATSIHP Act), Amendment 2006

The purpose of this Act is to preserve and protect all heritage places of particular significance to Aboriginal and Torres Strait Islander people. This Act applies to all sites and objects across Australia and in Australian waters (s4).

It would appear that the intention of this Act is to provide national baseline protection for Aboriginal places and objects where State legislation is absent. It is not to exclude or limit State laws (s7(1)). Should State legislation cover a matter already covered in the Commonwealth legislation, and a person contravenes that matter, that person may be prosecuted under either Act, but not both (s7(3)).

The Act provides for the preservation and protection of all Aboriginal objects and places from injury and/or desecration. A place is construed to be injured or desecrated if it is not treated consistently with the manner of Aboriginal tradition or is or likely to be adversely affected (s3).

THE AUSTRALIAN HERITAGE COMMISSION ACT 1975

The Australian Heritage Commission Act 1975 established the Australian Heritage Commission which assesses places to be included in the National Estate and maintains a register of those places. Places maintained in the register are those which are significant in terms of their association with particular community or social groups and they may be included for social, cultural or spiritual reasons. The Act does not include specific protective clauses.

The Australian Heritage Council Act 2003 together with The Environment Protection and Biodiversity Conservation Act 1999 (Amended) includes a National Heritage List of places of National heritage significance, maintains a Commonwealth Heritage List of heritage places owned or managed by the Commonwealth and ongoing management of the Register of the National Estate.

STATE

It is incumbent on any land manager to adhere to legislative requirements that protect Aboriginal culture heritage in NSW. The relevant legislation includes but is not limited to:

National Parks & Wildlife Act 1974 (NPW Act), Amended 2001.

The DECCW issued their *Interim Community Consultation Requirements* in January 2005 to replace all previous consultation guidelines that related to Part 6 of the NPW Act 1974. The requirement of the guidelines is for the proponent, or consultant for the proponent, to contact the Local Aboriginal Land Council(s), Registrar of Aboriginal Owners, Native Title Services, local councils and the DECCW, to request contact information for any/all potential Aboriginal people/groups with an ancestral interest in the cultural heritage of the project area.

The updated consultation guidelines *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (2010) were released in April 2010; DECCW has advised that consultation commenced for projects prior to the 12th of April 2010 can continue under the ICCR process.

The NPW Act provides statutory protection for all Aboriginal relics (not being a handicraft made for sale), with penalties levied for breaches of the Act. Part 6 of this Act is the relevant part concerned Aboriginal objects and places, with the Section 86 and Section 90 being the most pertinent:

Section 91: Under Section 91 of the Act it stipulates that a person who is aware of unregistered Aboriginal sites must report these to the DECCW, regardless of the land status (Freehold, leasehold, Crown land).

Section 90: "A person who, without first obtaining the consent of the Director-General, knowingly destroys, defaces or damages, or knowingly causes or permits the destruction or defacement of or damage to, an Aboriginal object or Aboriginal place is guilty of an offence against this Act." Under s.5 of the Act "object" means any deposit, object or material evidence (not being a handicraft made for sale) relating to Aboriginal habitation of the area. This applies to habitation both prior to and concurrent with the occupation of that area by persons of non Aboriginal extraction, and includes Aboriginal remains.

Section 87: Preliminary Research Permits issued under Section 87 of the Act, allow the permit holder to conduct investigations of areas considered to be potential sites for the purpose of research, and also for conservation work associated with known sites.

Impact Permits issued under Section 90 of the Act are for salvaging sites prior to ground disturbance works associated with construction. Any disturbance, damage or destruction of Aboriginal sites, known or unknown, is considered to contravene the NPW Act (1974) and the DECCW will pursue the person/company responsible.

Penalties under these two sections are currently 50 penalty units, or 6 months in gaol, or both for an individual and 200 penalty units for a corporation. The DECCW record all S.87 and S.90 permits issued in order to manage Aboriginal sites and ensure representative samples of sites are left in situ for future generations. In order to achieve this, the DECCW need to be made aware of all Aboriginal sites located in NSW.

Section 86: This section of the Act states that "A person, other than the Director-General or a person authorised by the Director-General in that behalf, who:

- disturbs or excavates any land, or causes any land to be disturbed or excavated, for the purpose of discovering an Aboriginal object,

- disturbs or moves on any land an Aboriginal object that is the property of the Crown, other than an Aboriginal object that is in the custody or under the control of the Australian Museum Trust,
- takes possession of an Aboriginal object that is in a national park, historic site, state conservation area, regional park, nature reserve, karst conservation reserve or Aboriginal area,
- removes an Aboriginal object from a national park, historic site, state conservation area, regional park, nature reserve, karst conservation reserve or Aboriginal area, or
- erects or maintains, in a national park, historic site, state conservation area, regional park, nature reserve, karst conservation reserve or Aboriginal area, a building or structure for the safe custody, storage or exhibition of any Aboriginal object,

except in accordance with the terms and conditions of an unrevoked permit issued to the person under section 87, being terms and conditions having force and effect at the time the act or thing to which the permit relates is done, is guilty of an offence against this Act."

Section 84: Aboriginal places of traditional significance (that may or may not contain archaeological material) are given protection under Section 84 of the NPW Act. To be an Aboriginal place for the purposes of this Act, this is a place that, in the opinion of the Minister, is or was of special significance with respect to Aboriginal culture.

ENVIRONMENTAL PLANNING & ASSESSMENT ACT 1979 (EP&A ACT)

This Act regulates a system of environmental planning and assessment for New South Wales. Land use planning requires that environmental impacts are considered, including the impact on cultural heritage and specifically Aboriginal heritage. Within the EP&A Acts, Parts III, IV, and V relate to Aboriginal heritage.

Part III regulates the preparation of planning policies and plans. Part IV governs the manner in which consent authorities determine development applications and outlines those that require an environmental impact statement. Part V regulates government agencies that act as determining authorities for activities conducted by that agency or by authority from the agency. The National Parks & Wildlife Service is a Part V authority under the EP&A Act.

In brief, the NPW Act provides protection for Aboriginal objects or places, while the EP&A Act ensures that Aboriginal cultural heritage is properly assessed in land use planning and development.

Part 3A of the EPA relates to major projects, and if applicable, obviates the need to conform to other specific legislation. In particular, s75U of the EPA Act explicitly removes the need to apply for s87 or s90 permits under the NPW Act. This means that although Aboriginal cultural heritage is considered during the planning process, a permit is not required to disturb or destroy an Aboriginal object or place. However, the Director-General of Planning must nonetheless consult with other government agencies, including DECCW and National Parks & Wildlife, prior to any decision being made.

THE HERITAGE ACT 1977

This Act protects the natural and cultural history of NSW with emphasis on non-Aboriginal cultural heritage through protection provisions and the establishment of a Heritage Council. Although Aboriginal heritage sites and objects are primarily protected by the National Parks & Wildlife Act 1974 (NPW Act), Amended 2001, if an Aboriginal site, object or place is of great significance, it may be protected by a heritage order issued by the Minister subject to advice by the Heritage Council.

Other legislation of relevance to Aboriginal cultural heritage in NSW includes the NSW Local Government Act (1993). Local planning instruments also contain provisions relating to Aboriginal heritage and development conditions of consent.

Appendix 2

AHIMS Registered Sites

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0002	Bungleboori;Old Bells Line Track;	AGD	56	239300	6300400	Open Site	GDG : -	Axe Grinding Groove	**Jelinek**		NRS/17798/1/299
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0005	Old Bells Line Track;	AGD	56	239960	6301000	Open Site	GDG : -	Axe Grinding Groove	**Jelinek**	1474	NRS/17798/1/299
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0007	Blackfellows Hand Rock;Wolgan Gap;	AGD	56	231700	6308990	Enclosed Shelter	ART : -, AFT : -	Shelter with Art, Shelter with Deposit	**Jelinek**	809	NRS/17798/1/299
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0008	Lindsdale;Kerosene Vale;	AGD	56	231640	6301900	Enclosed Shelter	AFT : -	Shelter with Deposit	**Wright**		NRS/17798/1/299
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0024	Angus Place;Angus Place Cave;	AGD	56	231250	6306650	Enclosed Shelter	ART : -	Shelter with Art	**Unknown Author**		NRS/17798/1/300
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0040	Angus Place;	AGD	56	231650	6305280	Enclosed Shelter	ART : -	Shelter with Art	**Jelinek**		NRS/17798/1/300
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0041	Angus Place;	AGD	56	231500	6305380	Enclosed Shelter	ART : -	Shelter with Art	**ASRSYS**		NRS/17798/1/300
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0044	Beecroft;	AGD	56	230620	6303780	Open Site	TRE : -	Scarred Tree	**Brayshaw**		NRS/17798/1/300
		Status	Valid								
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0046	Wolgan Gap;Blue Mountains;	AGD	56	231800	6309360	Enclosed Shelter	ART : -	Shelter with Art	Jelinek		NRS/17798/1/300
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0078	Rock Art;Angus Place Colliery;26;Kangaroo Creek;	AGD	56	232100	6306050	Enclosed Shelter	AFT : -, GDG : -	Axe Grinding Groove, Shelter with Deposit	Donlon, McIntyre, Gorecki	339, 2016, 2220	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0079	European Stone Arrangement	AGD	56	231600	6306100	Open Site	STA : -	Not an Aboriginal Site	Gorecki		NRS/17798/1/301
		Status Not a Site									
		Primary Contact							Permit(s)		
45-1-0084	Location 15, Site 3;Newnes State Forest;	AGD	56	236900	6307300	Enclosed Shelter	AFT : -	Shelter with Deposit	Gorecki	339, 2016, 2220	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0087	Marangaroo Ridge 2;	AGD	56	232810	6299890	Enclosed Shelter	AFT : -	Shelter with Deposit	Brayshaw		NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0088	Marangaroo Ridge 3;	AGD	56	232850	6299460	Enclosed Shelter	AFT : -	Shelter with Deposit	Mary Dallas Consulting Archaeologists		NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0089	Marangaroo Ridge 4;	AGD	56	232490	6297420	Open Site	AFT : -	Open Camp Site	Brayshaw	1414	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0090	Marangaroo Ridge 5;	AGD	56	232580	6297420	Open Site	AFT : -	Open Camp Site	ASRSYS	1414	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0091	Marangaroo Ridge 1;	AGD	56	232800	6299950	Enclosed Shelter	AFT : -	Shelter with Deposit	**ASRSYS**	679	NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0107	Maroo - YLS/4	AGD	56	232960	6294940	Open Site	AFT : -	Open Camp Site	**Bonhomme Craib & Associates**		NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0112	MC 1;	AGD	56	231500	6297100	Open Site	AFT : -	Open Camp Site	**Brayshaw, Rich**	1414	NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0113	MC 2;	AGD	56	232470	6297180	Open Site	AFT : -	Open Camp Site	**Brayshaw, Rich**	1414	NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0114	MC 3;	AGD	56	232650	6297780	Open Site	AFT : -	Open Camp Site	**Rich**	1414	NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0115	MC 4;	AGD	56	232680	6297500	Open Site	AFT : -	Open Camp Site	**Brayshaw, Rich**	1414	NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0116	MC 5;	AGD	56	232270	6297030	Open Site	AFT : -	Open Camp Site	**Brayshaw, Rich**	1414	NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0117	MC 6;	AGD	56	231910	6296980	Open Site	AFT : -	Open Camp Site	**Brayshaw, Rich**		NRS/17798/1/301
		Status	Valid								
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0125	Baalbone Pagoda 1;	AGD	56	230400	6311400	Enclosed Shelter	AFT : -	Shelter with Deposit	**Godwin**		NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0133	7 Newnes State Forest	AGD	56	235600	6308100	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0135	9 Newnes State Forest	AGD	56	232300	6307950	Enclosed Shelter	AFT : -	Shelter with Deposit	**Higgins, Ingram**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0136	10 Newnes State Forest	AGD	56	232500	6307700	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0137	11 Newnes State Forest	AGD	56	236600	6306900	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0138	12 Newnes State Forest	AGD	56	235800	6306900	Enclosed Shelter	ART : -	Shelter with Art	**Donlon, McIntyre, Powell**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0139	13 Newnes State Forest	AGD	56	236050	6306800	Enclosed Shelter	ART : -	Shelter with Art	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0140	14 Lambs Creek	AGD	56	233300	6307850	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, George, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0141	15 Lambs Creek	AGD	56	233350	6307850	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, George**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0142	16 Lambs Creek	AGD	56	232600	6308550	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, George**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0143	17 Newnes State Forest	AGD	56	232500	6307550	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0144	18 Newnes State Forest	AGD	56	236350	6306800	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, George**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0145	19; Newnes State Forest	AGD	56	236400	6306750	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, George**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0146	20; Newnes State Forest	AGD	56	236050	6307300	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, George, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0147	21 Newnes State Forest	AGD	56	231420	6302950	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre, Sim**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0148	22; Newnes State Forest	AGD	56	231250	6302820	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre, Sim**	339, 2016	NRS/17798/1/672
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0149	**23 NewnesState Forest**	AGD	56	236300	6306800	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0150	**24 Newnes State Forest**	AGD	56	236200	6306800	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0151	**27 Newnes State Forest**	AGD	56	232050	6305550	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0152	**28;Kangaroo Creek;**	AGD	56	232900	6306050	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0153	**29;Newnes State Forest;**	AGD	56	238300	6310480	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/301
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0156	**32 Newnes State Forest**	AGD	56	237750	6311000	Enclosed Shelter	AFT : -	Shelter with Deposit	**McIntyre, Donovan**	339, 2016	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0157	**33 PAD 7;Newnes State Forest;**	AGD	56	235200	6308700	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0158	**34 PAD 9;Newnes State Forest\Lambs Creek;**	AGD	56	232300	6307950	Enclosed Shelter	AFT : -	Shelter with Deposit	**McIntyre, Donovan**	339, 2016	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0159	35 PAD 14;Newnes State Forest;	AGD	56	231990	6301850	Enclosed Shelter	AFT : -	Shelter with Deposit	**McIntyre, Powell**	339, 2016	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0160	36 (PAD 8);	AGD	56	231950	6307700	Enclosed Shelter	AFT : -	Shelter with Deposit	**Donlon, McIntyre**	339, 2016, 2220	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0199	MC 1;NEWNES SF;	AGD	56	236200	6298400	Enclosed Shelter	AFT : -	Shelter with Deposit	**Gollan**		NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0200	SMC 1;NEWNES SF;	AGD	56	236450	6294000	Enclosed Shelter	AFT : -	Shelter with Deposit	**Gollan**		NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0204	S11;Newnes Plateau;	AGD	56	236120	6300900	Enclosed Shelter	ART : -	Shelter with Art	**Baker, Rich**	2300	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0205	S10;Newnes Plateau;	AGD	56	236200	6301020	Enclosed Shelter	ART : -	Shelter with Art	**Baker, Rich**	2300	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0212	GS1;Springvale Colliery;	AGD	56	230700	6300020	Open Site	AFT : -	Open Camp Site	**Rich, Gorman**	2300, 2608	NRS/17798/1/302
		Status Valid									
		Primary Contact							Permit(s)		
45-1-0250	MC7 (IF2);Marrangaroo Creek (IF2);	AGD	56	231980	6297200	Open Site	AFT : -	Isolated Find	**Rich**		NRS/17798/1/303
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-0253	BH-IF-1;	AGD	56	231500	6309150	Open Site	AFT : -	Isolated Find	**Hunt**		NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0254	WG-RS-2;	AGD	56	231650	6309380	Enclosed Shelter	ART : -	Shelter with Art	**Hunt**		NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-0255	WG-RS-1A	AGD	56	231890	6309350	Enclosed Shelter	ART : -	Shelter with Art	**Hunt**		NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-2555	WG-RS-3	AGD	56	231520	6309370	Enclosed Shelter	ART : -, AFT : -	Shelter with Art, Shelter with Deposit	**Hunt**		NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-2556	BH-RS-2	AGD	56	231390	6308910	Enclosed Shelter	ART : -	Shelter with Art	**Hunt**		NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-2557	M-OS-1	AGD	56	234520	6298440	Open Site	ACD : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636, 98115	NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-2558	M-S-6	AGD	56	235260	6296390	Enclosed Shelter	ART : -, AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		
45-1-2559	M-S-5	AGD	56	235620	6297100	Open Site	ART : -	None	**Central West Archaeological and Heritage Services Pty Ltd**		NRS/17798/1/303
		Status	Valid								
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-2560	M-S-4	AGD	56	235170	6296810	Enclosed Shelter	ART : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/303
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2561	M-S-3	AGD	56	235170	6296810	Enclosed Shelter	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	1157	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2562	M-S-11	AGD	56	235320	6297760	Enclosed Shelter	ART : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2563	M-S-1	AGD	56	234130	6294730	Enclosed Shelter	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2564	M-OS-4	AGD	56	233880	6294430	Open Site	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2565	M-OS-3	AGD	56	233110	6294950	Open Site	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2566	M-OS-2	AGD	56	234350	6296870	Open Site	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2567	M-S-9	AGD	56	235130	6296100	Enclosed Shelter	ART : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-2568	M-S-8	AGD	56	235160	6296100	Enclosed Shelter	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2569	M-S-12	AGD	56	235920	6298310	Open Site	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2570	M-S-10	AGD	56	235820	6297010	Enclosed Shelter	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2571	M-S-2	AGD	56	234270	6295050	Enclosed Shelter	AFT : -	None	**Central West Archaeological and Heritage Services Pty Ltd**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2578	Springvale 1	AGD	56	238760	6300377	Open Site	STA : 2	None	**McAdam**		NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2592	M-IF-1, Lithgow	AGD	56	235510	6297160	Open Site	AFT : 1	None	**Kelton**	97636	NRS/17798/1/304
		Status Valid									
		Primary Contact							Permit(s)		
45-1-2600	SV3-ST1	AGD	56	237975	6303313	Open Site	TRE : 1	None	**Benton, Cameron**		
		Status Valid									
		Primary Contact		Bathurst LALC					Permit(s)		
45-1-2665	BBC-RS1	GDA	56	230426	6311660	Enclosed Shelter	PAD : -	None	**OzArk Cultural Heritage Management**	100391	
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Angus Place

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 230025, Easting to = 240025, Northing From = 6293770, Northing to = 6313770, Requestor like 3023%, Service ID = 28859, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
45-1-2667	BBC - RS 1	AGD	56	230426	6311660	Enclosed Shelter	HAB : 1	None	**Benton**	100578	
		Status	Valid								
		Primary Contact							Permit(s)		

Appendix 3

Aboriginal Consultation Log

Date	Description	Contact Method	Outcome
5/01/2010	Stage 1 Letters sent to DECCW, Lithgow City Council and Registrar of Aboriginal Owners.	Mail	Awaiting response
5/01/2010	Stage 1 Letters sent to Bathurst Local Aboriginal Land Council (BLALC)	Mail	Awaiting response
09/01/10	Stage 1 ICCR Adverts in local papers. Weekend Advocate and Lithgow Mercury.	Email	Registration of interest regarding adverts in Weekend Advocate and Lithgow Advocate close Friday 22nd January.
12/01/2010	Lithgow City Council replied to the Stage 1 Letters	Mail	
14/01/2010	DECCW replied to Stage 1 Letters	Mail	
25/01/10	Stage 2 ICCR letters with attached map and field survey methodology. Letters sent to BLALC, Warrabinga Native Title Claimants Aboriginal Corporation (WNTCAC) and Mingaan Aboriginal Corporation (MAC),	Mail	Awaiting response
28/01/10	Sent letter to Robyn Williams outlining the project methodology and map of study area.	Mail	
01/02/10	MAC contacted RPS HSO to register interest and availability for upcoming field work. Informed they would send through valid certificates.	Phone	Fax in pm outlining in writing registration of interest, certificate of company registration and valid Workers Compensation Certificate. RPS HSO informed them a email will be sent outline field survey details and meeting place map.
02/02/10	PS spoke to Toni – Lee of BLALC to enquire if they have received Stage 2 letters and methodology and Toni –lee indicated they have not yet received it.	Phone	PS re – sent stage 2 letter plus methodology via email on 03/02/10.
03/02/10	WNTCAC register interest in works and contact details of nominated site officer.	Phone	RPS HSO informed them an email will be sent outline field survey details and meeting place map.
03/02/10	BLALC registered interest and availability in works.	Phone	RPS HSO informed them an email will be sent outline field survey details and meeting place map.
05/02/10	Information sent to BLALC, WNTCAC and MAC field survey details and meeting place map.	Email	MAC email bounced back. Fax of email sent through am 08/02/10.
05/02/10	Office of the Registrar responded to stage 1 letters	Mail	
08/02/10	MAC sent their certificate of registration and insurances.	Fax	
15/02/10	WNTCAC sent tax invoice	Mail	
15/02/10	BLALC sent letter regarding survey indicating that they have no objectives with the proposal	Mail	Comments to be included in final report.
16/02/10	Copy of field survey map outlining survey units covered during survey sent to BLALC and WNTCAC.	Email	Awaiting comments for report
16/02/10	Copy of field survey map outlining survey units covered during survey	Mail.	Awaiting comments for report

	sent to MAC.		
17/02/10	Sent job invoicing details to BLALC, WNTCAC and MAC.	Email.	
17/02/10	MAC sent letter regarding results of survey indicating that they have no objections to the proposal	Mail	Comments to be put in final report
18/02/10	MAC sent invoice	Mail	
18/02/10	BLALC sent invoice	Mail	

Appendix 4

Glossary of Site Types

GLOSSARY OF SITE TYPES

The following is a brief description of most Aboriginal site types.

Artefact Scatters

Artefact scatters are defined by the presence of two or more stone artefacts in close association (i.e. within fifty metres of each other). An artefact scatter may consist solely of surface material exposed by erosion, or may contain sub-surface deposit of varying depth. Associated features may include hearths or stone-lined fireplaces, and heat treatment pits.

Artefact scatters may represent:

- Camp sites: involving short or long-term habitation, manufacture and maintenance of stone or wooden tools, raw material management, tool storage and food preparation and consumption;
- Hunting or gathering activities;
- Activities spatially separated from camp sites (e.g. tool manufacture or maintenance); or
- Transient movement through the landscape.

The detection of artefact scatters depends upon conditions of surface visibility, including vegetation cover, ground disturbance and recent sediment deposition. Unfavourable conditions obscure artefact scatters and prevent their detection during surface surveys.

Bora Grounds

Bora grounds are a ceremonial site associated with initiations. They are usually comprise two circular depressions in the earth, and may be edged with stone. Bora grounds generally occur on soft sediments in river valleys, although they may also be located on high, rocky ground in association with stone arrangements.

Burials

Human remains were often placed in hollow trees, caves or sand deposits and may have been marked by carved or scarred trees. Burials have been identified eroding out of sand deposits or creek banks, or when disturbed by development. The probability of detecting burials during archaeological fieldwork is extremely low.

Culturally Modified Trees

Culturally modified trees include scarred and carved trees. Scarred trees are caused by the removal of bark for use in manufacturing canoes, containers, shields or shelters. Notches were also carved in trees to permit easier climbing. Scarred trees are only likely to be present on mature trees remaining from original vegetation. Carved trees, the easiest to identify, are caused by the removal of bark to create a working surface on which engravings are incised. Carved trees were used as markers for ceremonial and symbolic purposes, including burials. Although, carved trees were relatively common in NSW in the early 20th century, vegetation removal has rendered this site type extremely rare. Modified trees, where bark was removed for often domestic use are less easily identified. Criteria for identifying modified trees include: the age of the tree; type of tree (the bark of many trees is not suitable, also introduced species would be unlikely subjects); axe marks (with the need to determine the type of axe - stone or steel – though Aborigines after settlement did use steel); shape of the scar (natural or humanly scarred); height of the scar above the ground (reasonable working height with consideration given to subsequent growth).

Fish Traps

Fish traps comprised arrangements of stone, branches and/or wickerwork placed in watercourses, estuaries and along coasts to trap or permit the easier capture of sea-life.

Grinding Grooves

Grinding grooves are elongated narrow depressions in soft rocks (particularly sedimentary), generally associated with watercourses, that are created by the shaping and sharpening of ground-edge implements. To produce a sharp edge the axe blank (or re-worked axe) was honed on a natural stone surface near a source of water. The water was required for lubricating the grinding process. Axe grinding grooves can be identified by features such as a narrow short groove, with greatest depth near the groove centre. The grooves also display a patina developed through friction between stone surfaces. Generally a series of grooves are found as a result of the repetitive process.

Isolated Finds

Isolated finds occur where only one artefact is visible in a survey area. These finds are not found in apparent association with other evidence for prehistoric activity or occupation. Isolated finds occur anywhere and may represent loss, deliberate discard or abandonment of an artefact, or may be the remains of a dispersed artefact scatter. Numerous isolated finds have been recorded within the study area. An isolated find may flag the occurrence of other less visible artefacts in the vicinity or may indicate disturbance or relocation after the original discard.

Middens

Shell middens comprise deposits of shell remaining from consumption and are common in coastal regions and along watercourses. Middens vary in size, preservation and content, although they often contain artefacts made from stone, bone or shell, charcoal, and the remains of terrestrial or aquatic fauna that formed an additional component of Aboriginal diet. Middens can provide significant information on land-use patterns, diet, chronology of occupation and environmental conditions.

Mythological / Traditional Sites

Mythological and traditional sites of significance to Aboriginal people may occur in any location, although they are often associated with natural landscape features. They include sites associated with dreaming stories, massacre sites, traditional camp sites and contact sites. Consultation with the local Aboriginal community is essential for identifying these sites.

Rock Shelters with Art and / or Occupation Deposit

Rock shelters occur where geological formations suitable for habitation or use are present, such as rock overhangs, shelters or caves. Rock shelter sites generally contain artefacts, food remains and/or rock art and may include sites with areas of potential archaeological deposit, where evidence of rock-art or human occupation is expected but not visible. The geological composition of the study area greatly increases the likelihood for rock shelters to occur.

Stone Arrangements

Stone arrangements include lines, circles, mounds, or other patterns of stone arranged by Aboriginal people. These may be associated with bora grounds, ceremonial sites, mythological or sacred sites. Stone arrangements are more likely to occur on hill tops and elevated terrace crests that contain stone outcrops or surface stone, where impact from recent land use practices has been minimal.

Stone Quarries

A stone quarry is a place at which stone resource exploitation has occurred. Quarry sites are only located where the exposed stone material is suitable for use either for ceremonial purposes (e.g. ochre) or for artefact manufacture.

Appendix 5

NSW Heritage Branch Significance Criteria

Heritage Council of New South Wales

Heritage Act 1977

CRITERIA FOR LISTING ON THE STATE HERITAGE REGISTER

The State Heritage Register is established under Part 3A of the Heritage Act (as amended in 1998) for listing of items of environmental heritage[1] which are of state heritage significance[2].

To be assessed for listing on the State Heritage Register an item will, in the opinion of the Heritage Council of NSW, meet one or more of the following criteria[3]:

a) an item is important in the course, or pattern, of NSW's cultural or natural history;

b) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history;

c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW;

d) an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons;

e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history;

f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history;

g) an item is important in demonstrating the principal characteristics of a class of NSW's
 - cultural or natural places; or
 - cultural or natural environments.

An item is not to be excluded from the Register on the ground that items with similar characteristics have already been listed on the Register.

---

[1] ***environmental heritage*** means those places, buildings, works, relics, moveable objects, and precincts, of state or local heritage significance (section 4, *Heritage Act, 1977*).

[2] ***state heritage significance***, in relation to a place, building, work, relic, moveable object or precinct, means significance to the State in relation to the historical, scientific cultural, social, archaeological, architectural, natural or aesthetic value of the item (section 4A(1), *Heritage Act, 1977*).

[3] Guidelines for the application of these criteria may be published by the NSW Heritage Office.

Appendix 6

Aboriginal Community Comments

MINGAAN ABORIGINAL CORPORATION

ABN: 83905372168
38 Tweed Road
LITHGOW NSW 2790
Telephone / Fax: 02 6352 2473
Email: helenriley44@yahoo.com.au

ANGUS PLACE COLLIERY - NEWNES PLATEAU

A survey was conducted for Angus Place Colliery from Tuesday 9th to Friday 12th February 2010.

Mingaan was present from Wednesday 10th to Friday 12th February 2010. The survey area is located within the Newnes State Forest. The survey was for the purposed De Watering Pipe Line and Underground Long Wall sections No: 900 and 910 areas.

Pipe Line Survey

As this area has been extensively disturbed due to previous clearing of the area no evidence of Aboriginal activity was recorded.

Longwall section 900 and section 910 survey areas

Due to the extremely steep gullies and high cliffs in some areas made it difficult to examine thoroughly. On the plateau visibility was nil in both sections surveyed.

Located in the valley of section 910 is a shelter with possible archaeological discovery potential and has been recorded on the map provided by the archaeologist.

No other evidence of Aboriginal activity or artefacts was recorded or discovered during this survey only the one possible shelter.

Mingaan Aboriginal Corporation recommends that no large trees are to be disturbed during any work within the survey areas.

As there will be minimum impact to the areas surveyed, Mingaan Aboriginal Corporation has no objections to Angus Place Colliery commencing the proposed projects within the surveyed areas.

Present at this survey were:

Gillian Goode	Senior Archaeologist	RPS Harper Somers O'Sullivan
Phillipa Sokol	Archaeologist	RPS Harper Somers O'Sullivan
Warwick Peckham	Coordinator	Bathurst Local Aboriginal Land Council
Kevin Williams	Representative	Warrabinga
Richard Peters	Representative	Mingaan Aboriginal Corporation

Richard J. Peters

RICHARD J PETERS
17th February 2010

Bathurst Local Aboriginal Land Council

149 Russell Street Bathurst NSW 2795
PO Box 1500 Bathurst NSW 2795
Ph: 02 6332 6835
Fax: 02 6332 3623

<u>Cultural Heritage Impact Assessment at Angus Place Colliery</u>

<u>Proposed Long Walls – 900w and 910 at Angus Place</u>

A survey was carried out over 4 days on the 9th, 10th, 11th and 12th February 2010 for Angus place Colliery for the proposed long walls as per the study areas.

The four day survey was undertaken on foot the majority of the survey was carried out over rugged steep and very difficult terrain with thick dense under growth making visibility zero.

No aboriginal artefacts being located, there was one rock shelter located with potential archaeological deposits by Gillian Goode from RPS Harper Somers and O'Sullivan and Kevin Williams from Warrabinga Native Title Claimants apart from this site there being no other Aboriginal artefacts, open camp sites, grinding grooves, sacred trees or ceremonial grounds located.

The Bathurst Local Aboriginal Land Council have no objectives to this proposal proceeding.

Present at Survey:

Phillipa Sokol – Archaeologist RPSHSO
Gillian Goode – Archaeologist RPSHSO
Kevin Williams – Warrabinga Native Title Claimants
Richard Peters – Mingaan Aboriginal Corporation
Warwick Peckham – Bathurst Local Aboriginal Land Council

Yours Sincerely,

Warwick Peckham

Warwick Peckham
CEO
15th February 2010

Appendix 7

Site Cards

AHIMS Aboriginal Heritage Information Management System

Department of Environment & Climate Change NSW

Aboriginal Site Recording Form

AHIMS Registrar
PO Box 1967, Hurstville NSW 2220

Office Use Only

Site Number

Date received / / Date entered into system / / Date catalogued / /

Entered by (I.D.)

Information Access

☐ Gender/male ☐ Gender/female ☐ Location restriction ☐ General restriction ☐ No access

Office Use Only

For Further Information Contact:

☐ **Nominated Trustee**

Title | Surname | First Name | Initials

Organisation

Address

Phone number | Fax

Client on system ☐

☐ **Knowledge Holder**

Title | Surname | First Name | Initials

Organisation

Address

Phone number | Fax

Client on system ☐

Aboriginal Heritage Unit or Cultural Heritage Division Contacts

Geographic Location

Site Name: RPS ANGUS PLACE RS PAD 1

Easting: 232966

Northing: 6305664

AGD/GDA: GDA

Mapsheet: LITHGOW

Zone: 56

Location Method: Non-Differential GPS

Other Registration:

Primary Recorder

Title	Surname	First Name	Initials
MS	GOODE	GILLIAN	

Organisation: RPS AUSTRALIA EAST PTY LTD

Address: PO BOX 428 HAMILTON NSW 2303

Phone number: 02 49616500 Fax: 02 49616794

Date recorded: 11/02/2010

Client on system ☐

NPWS Aboriginal Site Recording Form - Site Information

OPEN/CLOSE SITE Closed Site

Site Context

Landform

- [x] Mountainous
- [ ] Plain
- [ ] Rolling hills
- [ ] Steep hills
- [ ] Undulating plain

Landform Unit

- [ ] Beach
- [ ] Coastal rock platform
- [ ] Dune
- [ ] Intertidal flat
- [ ] Lagoon
- [ ] Tidal Creek
- [ ] Tidal Flat
- [x] Cliff
- [ ] Crest
- [ ] Flat
- [x] Lower slope
- [ ] Mid slope
- [ ] Upper slope
- [ ] Plain
- [ ] Ridge
- [ ] Tor
- [ ] Valley flat
- [ ] Levy
- [x] Stream bank
- [ ] Stream channel
- [ ] Swamp
- [ ] Terrace
- [ ] Terrace flat

Slope

25 degrees

Vegetation

- [x] Closed forest
- [ ] Grasslands
- [ ] Isolated clumps of trees
- [ ] Open forest
- [ ] Open woodland
- [ ] Scrub
- [ ] Woodland
- [ ] Cleared
- [ ] Revegetated
- [ ] N/A

Land use

- [ ] Conservation
- [ ] Established urban
- [ ] Farming-intensive
- [ ] Farming-low intensity
- [ ] Forestry
- [ ] Industrial
- [ ] Mining
- [ ] Pastoral/grazing
- [x] Recreation
- [ ] Semi-rural
- [ ] Service corridor
- [ ] Transport corridor
- [ ] Urban expansion
- [ ] Residential

Water

Distance to permanent water source	10	metres
Distance to temporary water source	2	metres
Name of nearest permanent water source	Kangaroo Creek	
Name of nearest temporary water	Unnamed tributary	

Directions for Relocation

South down Black Fellows Hands Road until it reaches Kangaroo Creek, then walk in a northern direction up the creek line until the junction of Kangaroo Creek and drainage line meets. Ten metres above this the shelter is on the northern side of the drainage line, east of Kangaroo Creek.

Current Land Tenure

- [x] Public
- [ ] Private

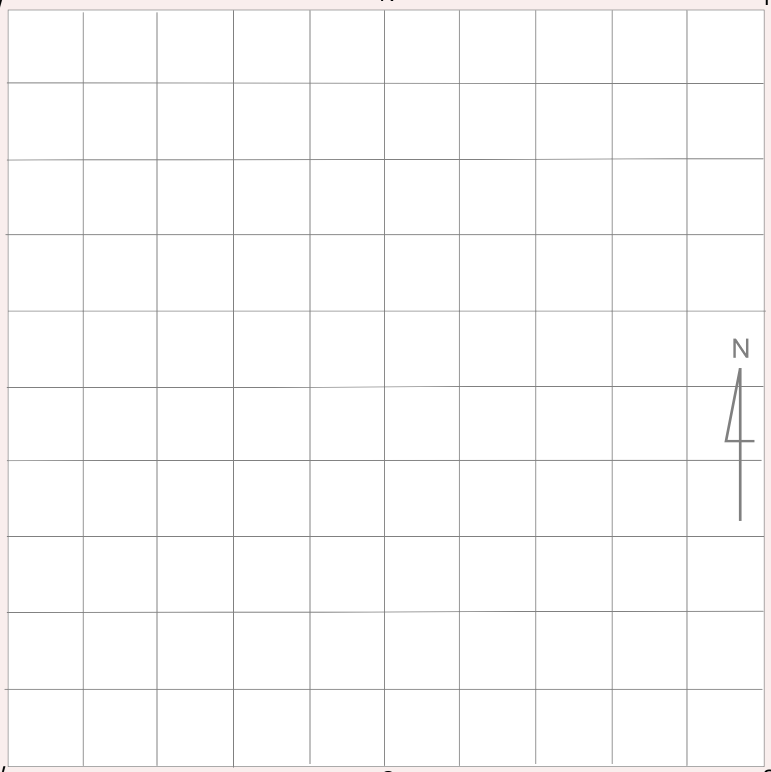
National Park / other Government Dept.

Primary report **I.D.** (I.D. Office Use only)

Site Location Map

NW N NE

W E



SW S SE

NPWS Aboriginal Site Recording Form - Site Information

General Site Information

Closed Site

Shelter/Cave Formation
- [ ] Boulder
- [ ] Wind erosion
- [x] Water erosion
- [ ] Rock collapse

Rock Surface Condition
- [ ] Boulder
- [ ] Sandstone platform
- [ ] Silica gloss
- [ ] Tessellated
- [x] Weathered
- [ ] Other platform

Condition of Ceiling
- [ ] Boulder
- [ ] Sandstone platform
- [ ] Silica gloss
- [ ] Tessellated
- [x] Weathered
- [ ] Other platform

Shelter Aspect
- [ ] North
- [ ] North East
- [ ] East
- [ ] South East
- [ ] South
- [x] South West
- [ ] West
- [ ] North West

Open Site

Site Orientation
- [ ] N-S
- [ ] NE-SW
- [x] E-W
- [ ] SE-NW
- [ ] N/A

Features

- [ ] 1. Aboriginal Ceremony & Dreaming
- [ ] 2. Aboriginal Resource & Gathering
- [ ] 3. Art
- [ ] 4. Artefact
- [ ] 5. Burial
- [ ] 6. Ceremonial Ring
- [ ] 7. Conflict
- [ ] 8. Earth Mound
- [ ] 9. Fish Trap
- [ ] 10. Grinding Groove
- [ ] 11. Habitation Structure
- [ ] 12. Hearth
- [ ] 13. Non Human Bone & Organic Material
- [ ] 14. Ochre quarry
- [x] 15. Potential Archaeological Deposit
- [ ] 16. Stone Quarry
- [ ] 17. Shell
- [ ] 18. Stone Arrangement
- [ ] 19. Modified Tree
- [ ] 20. Water Hole

Site Plan

Indicate scale, boundaries of site, features

NW N NE

W E

SW S SE

Site Dimensions

Closed Site Dimensions (m)

20m	Internal length
12m	Internal width
15m	Shelter height
240sqm	Shelter floor area

Open Site Dimensions (m)

	Total length of visible site
	Average width of visible site
	Estimated area of visible site
	Length of assessed site area

Aboriginal Community Interpretation and Management Recommendations

Preliminary Site Assessment

Site Cultural & Scientific Analysis and Preliminary Management Recommendations

If the site is likely to be impacted upon by any development works, than application will need to be sought under Section 87 and Section 90 of the NPW Act 1974.

This section should only be filled in by the Endorsees

Endorsed by: ☐ Knowledge Holder ☐ Nominated Trustee ☐ Native Title Holder ☐ Community Consensus

Title

Surname

First Name

Initials

Organisation

Address

Phone number

Fax

Attachments (No.)

☐ A4 location map
☐ B/W photographs
☐ Colour photographs
☐ Slides
☐ Aerial photographs
☐ Site plans, drawings
☐ Recording tables
☐ Other
☐ Feature inserts-No. ☐

Comments

NPWS FEATURE RECORDING FORM - ARTEFACT

Site I.D.:

Site Name: RPS ANGUS PLACE RS PAD 1

First recorded date: 11/02/2010

Importance: Cannot be presently determined

No. of instances: 1

Recorded by: G. GOODE

	Yes No
Stone artefacts only	No
Artefacts collected	No
Permit issued	No

Percentage of Non-stone Artefacts to Percentage of Stone Artefacts

0-9% 10-19% 20-29% 30-39% 40-49% 50-59% 60-69% 70-79% 80-89% 90-100%

0-9%

Feature Context & Condition

Scatter No.:

Easting: 2 3 2 9 6 6

Northing: 6 3 0 5 6 6 4

Density

(Artefact count per square metre)

Dimensions

20 Length (m) 12 Width (m) 15 Depth (m)

	Yes No
In situ	No
Stratified	No

Feature Condition

- [x] Very good
- [ ] Good
- [ ] Poor

General Condition

- [x] Weathered
- [ ] Vehicle damage
- [ ] Surface water wash
- [ ] Fire damage
- [ ] Erosion
- [ ] Stock damage
- [ ] Exposed archaeological material

Recommended Action

- [ ] Boardwalk
- [ ] Fencing
- [ ] Closure to public
- [x] Continued inspection
- [ ] Fire hazard reduction
- [ ] Expert assessment
- [ ] Meeting with land manager
- [ ] Revegetation
- [ ] Signage
- [ ] Soil erosion control
- [ ] Track closure/re-routing
- [ ] Additional recording

Feature Plan (Indicate scale, location of instances)

NW N NE

W E

SW S SE

Feature Environment

(Complete when *feature* environment differs to *site* environment, use attributes from cover card, p. 2)

Land form	Mountainous
Land form unit	Creek bank
Slope	Lower
Vegetation	Closed Forest
Land use	Recreational

Water

Distance to permanent water source: 10 metres

Distance to temporary water source: 2 metres

Name of nearest permanent water source: Kangaroo Creek

Name of nearest temporary water: Unnamed Tributary

Photo 1: View to north showing pagodas with rock shelter.

Photo 2: View to west showing floor of rock shelter with sandy PAD.

Photo 3: View to north showing height of rock shelter.

Photo 4: temporary water source adjacent to rock shelter view to north.

RPS

APPENDIX 7.9

Social Impact Assessment

RPS

Social Impact Assessment

Angus Place Colliery Proposed Modifications

Prepared by:

RPS

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Prepared for:

Centennial Angus Place Pty Limited

Report No: PR104424

Version/Date: Final October 2010

Document Status

Version	Purpose of Document	Orig	Review	Review Date	Format Review	Approval	Issue Date
Draft	Team Review	DM	KH	16/08/10		KH	23/08/10
Final	Final for EA	KH	AD	11/10/10	KM	KH	12/10/10

We have prepared this report for the sole purposes of Centennial Angus Place Pty Limited ("**Client**") for the specific purpose of the provision of an environmental assessment for an application for project Approval under Section 75W of Part 3A of the Environmental Planning and Assessment Act 1979 ("**Purpose**"). This report is strictly limited to the Purpose and the facts and matters stated in it and does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.

In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up-to-date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

This report is presented without the assumption of a duty of care to any other person (other than the Client) ("**Third Party**"). The report may not contain sufficient information for the purposes of a Third Party or for other uses. Without the prior written consent of RPS Australia East Pty Ltd:

a) this report may not be relied on by a Third Party; and

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In this note, a reference to loss and damage includes past and prospective economic loss, loss of profits, damage to property, injury to any person (including death) costs and expenses incurred in taking measures to prevent, mitigate or rectify any harm, loss of opportunity, legal costs, compensation, interest and any other direct, indirect, consequential or financial or other loss.

Contents

1 Introduction

Centennial Angus Place Pty Ltd operates the Angus Place Colliery, located approximately 15 kilometres northwest from the city of Lithgow in the western coalfield of NSW.

In 2006 Centennial Angus Place Pty Limited applied, under Part 3A of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act), for continued mining operations. Project Approval (PA 06_0021) was granted by the NSW Department of Planning (DoP) in September 2006. The supporting document for PA 06_0021 is the Angus Place Colliery Proposed Mining and Coal Transport Environmental Assessment. The approval granted Angus Place Colliery the ability to extend mining operations, specifically the development and extraction of additional longwall panels 920 to 980 and installation of key mining infrastructure comprising a services borehole, upcast ventilation facility and downcast ventilation facility.

On behalf of Centennial Angus Place Pty Limited [1], RPS Australia East Pty. Ltd. (RPS) have prepared this SIA as part of an Environmental Assessment (EA) to support an application for Project Modification Approval under Section 75W of Part 3A of the EP&A Act. The purpose of the application is for the proposed modification of the current Angus Place Colliery Project Approval (PA 06_0021). Centennial Angus Place Pty Limited proposes to extend its operations through the development and extraction of two additional longwall panels, as well as development of the required supporting surface infrastructure.

Angus Place Colliery currently extracts approximately 3 million tonnes per annum (Mtpa) and has current approval to extract up to 3.5Mtpa. Under the current approval, Angus Place Colliery is scheduled to complete development by October 2012, with longwall mining operations due for completion by June 2014. Approval for continued mining, as per the proposed modifications, is therefore sought to enable continued operations at Angus Place Colliery and sustain the supply of coal to established markets up to 2016.

This SIA is concerned with predicting and assessing the likely consequences of a proposed action on people by:

- examining the existing social environment:
- predicting the effects of a project on the social environment;
- evaluating the effects of a project on people; and
- proposing actions to mitigate these effects.

This SIA examines the existing social environment by presenting the demographic profile of the existing local area and region surrounding the colliery, through a review of existing social and community infrastructure and existing social issues. The social impacts of the proposal and proposed mitigation measures are then presented.

[1] Centennial Angus Place Pty Limited manages and operates the Angus Place Colliery. Centennial Angus Place Pty Limited is the manager of Angus Place Colliery, for and on behalf of the owners of Angus Place Colliery, namely Centennial Springvale Pty Limited and Springvale SK Kores Pty Limited, pursuant to the Springvale Joint Venture Agreement.

1.1 Site Description and Current Operations

The Colliery is situated approximately 150 kilometres west of Sydney and near the community of Lidsdale. The principal components of Angus Place Colliery are an underground longwall mine, associated development panels and supporting surface infrastructure. Coal in the Lithgow seam is mined through longwall mining methods. Coal is conveyed to the surface for sizing and then transported to either Wallerawang or Mt Piper Power Station on private haul roads.

Angus Place Colliery has approval, Project Approval 06_0021, to extract 3.5 million tonnes per annum from the Lithgow Seam.

The mine currently operates 7 days a week, 24 hours per day and employs 215 fulltime equivalent (FTE) staff.

The original consent included the following conditions to address social impacts of the operations:

- Establishment of a Community Consultation Committee
- Establishment of a Community Enhancement Fund
- Preparation of an Annual Environmental Management Report
- Establishment of a complaints management system including a telephone complaints line
- Preparation of a Mine Closure Strategy

Apart from the Mine Closure Strategy, each of these has been implemented.

1.2 Proposed Modifications

The proposed modifications to the existing approved mine operations at Angus Place comprise:

- Two (2) additional longwalls (910 & 900W)
- Increase in production limit from 3.5 million tonnes per annum to 4 million tonnes per annum
- Dewatering bore and associated infrastructure comprising:
  - Access track
  - Powerline
  - Pipeline to enable the extension of Springvale Delta Water transfer scheme
- Increase in staff from 215 FTE to 225 FTE
- Up to 75 temporary contractors over a 15 month period to undertake the proposed development activities

The proposed modifications would enable the continued operations at Angus Place Colliery to 2016.

Operating parameters such as hours of operation and traffic access remain unchanged.

2 Methodology

The Director General's Requirements include:

"A conclusion justifying the proposed modifications on economic, social and environmental grounds, taking into account whether the project is consistent with the objects of the Environmental Planning and Assessment Act 1979;"

Social issues are addressed in this report including changes to the community and population, facilities and services and housing and accommodation.

This SIA is based on a desktop analysis using the following data sources:

- Literature review on social impacts of mining
- Compilation and analysis of Place of Usual Residence Census data from the Australian Bureau of Statistics (ABS)
- Review of other published social data such as Bureau of Crime Statistics Recorded Crime Incidents from 2004-2008
- Review of existing project approval (Project Approval 06_0021)
- Review of Project Approval Compliance Report (Hansen Bailey 2007)
- Review of Lithgow City Council Social Plan
- Review of relevant strategic and statutory planning documents

3 Strategic context

The existing Angus Place Colliery is located in the local government area of Lithgow in the central western part of NSW. At present the area is not subject to any State-level regional planning strategies.

Lithgow City Council has adopted a *Strategic Plan* which outlines a vision and strategic direction for the LGA in relation to economic, social and environmental issues. The *Strategic Plan* is not site specific but provides general directions on issues the Council have identified as being important to the local community.

In the *Strategic Plan* mining is identified as a regionally significant resource which should be protected from conflicting land uses.

Council is also currently preparing an *Economic Development Strategy*, which was exhibited in March 2010. The draft *Economic Development Strategy* supports the continuation of mining in the local government area, while seeking to diversify the local economic base.

Other relevant Lithgow City Council strategic documents are:

- *Crime Prevention Plan*
- *Social Plan 2006-2011*
- *Cultural Plan 2008-2013*

4 Social Considerations

This section provides baseline data on the affected community based on information from ABS statistics, social planning undertaken by Lithgow Council, the existing planning approval, the existing Angus Place Colliery community consultation group, NSW Health and Bureau of Crime Statistics information and a literature review.

The Director General's Requirements for the 75W modification, issued on 1 June 2010 requires that the proposed modification "be justified on economic, social and environmental grounds, taking into consideration whether the project is consistent with the objects of the Environmental Planning and Assessment Act 1979".

The relevant objects of the EPA Act are:

- the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment
- the provision and co-ordination of community services and facilities
- ecologically sustainable development
- the provision and maintenance of affordable housing
- to provide increased opportunity for public involvement and participation in environmental planning and assessment

"Community" is not defined in the EPA Act and its applicability will vary according to the context and the likely impacts of the proposal. In this SIA the impacts of the proposal have been assessed using two localities, a primary locality and a secondary locality, which include the relevant affected communities. This approach assumes there is a small area, the primary locality, which will most likely experience the direct impacts of the proposal such as new and/or changing population, construction impacts (noise, dust, traffic changes) and changes to the physical environment that may influence crime and community safety. It also assumes the proposal will impact on a wider community, the secondary locality, which is the main supplier of housing, community services and social infrastructure. There may also be some construction impacts, for example, truck movements, on this wider community.

In this SIA, the primary locality is the area within which the proposed development is located. It is the area bounded on the north by Cullen Bullen, on the west by Portland, on the south by Chifley Road, on the east by Old Coach Road, the Glowworm Tunnel Road and the Wollemi National Park. The local area includes the townships of Wallerawang, Marrangaroo, Portland, Cullen Bullen and Blackmans Flat. The primary locality will be referred to in the SIA as the "local area" and is shown on Figure 4-1.

The secondary locality comprises the local government areas of Lithgow and Bathurst. The secondary locality will be referred to in the SIA as the "region" and is shown on Figure 4-2.

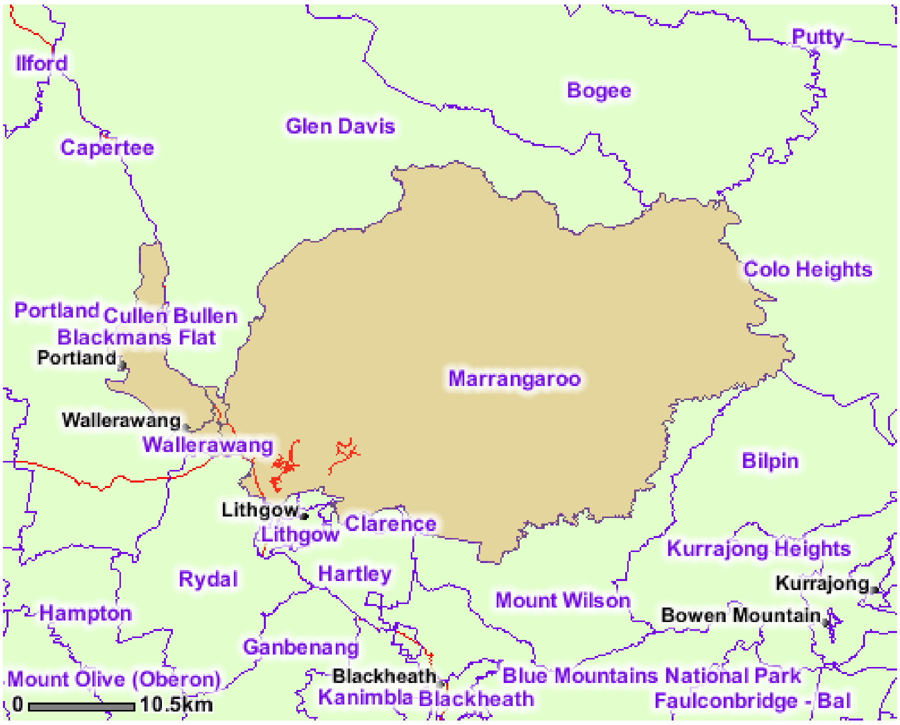


Figure 4-1 Local area for the purposes of this study (shaded brown) (Source: Australian Bureau of Statistics)

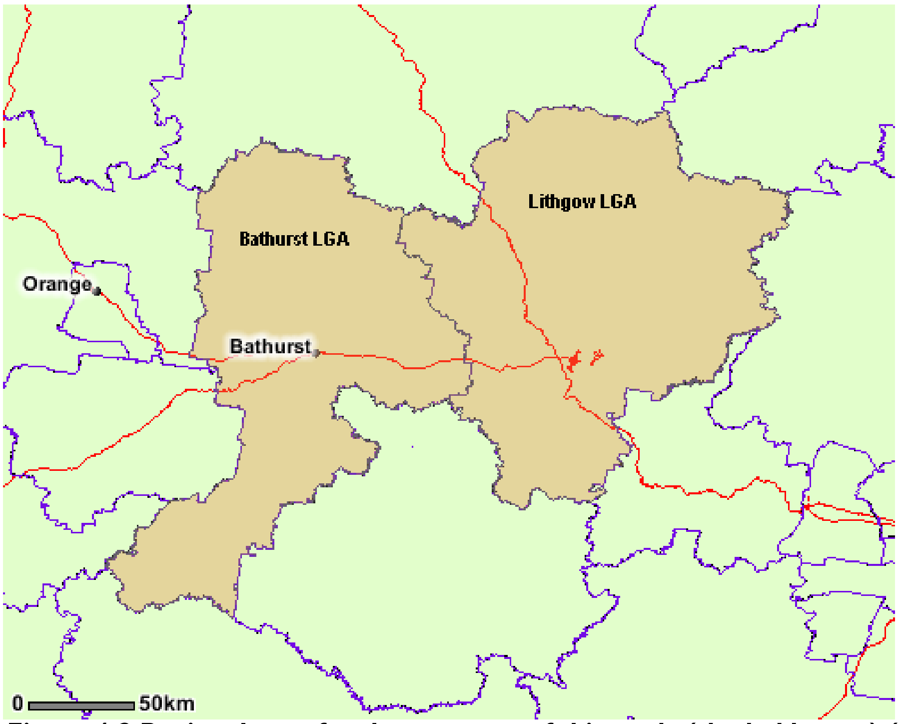


Figure 4-2 Regional area for the purposes of this study (shaded brown) (Source: Australian Bureau of Statistics)

4.1 Demographic Profile

The socio-demographic profile below presents and compares baseline demographic data for three areas: the local area, the region and, for comparison, NSW as a whole.

Data for the local area has been compiled based on three Statistical State Suburbs: Wallerawang, Marrangaroo and Blackmans Flat. The region is the local government areas of Lithgow City Council and Bathurst Regional Council.

4.1.1 Population

In 2006 the population of the local area was 2,950 persons and 930 dwellings. This is an average household size of 2.7 persons.

In the local areas 1,906 persons and 690 dwellings are within the township of Wallerawang and 869 persons and 169 households in the suburb of Marrangaroo.

The region has a population of 55,600 people, 19,756 in Lithgow and 35,844 in Bathurst Regional Council area. The local area is 5% of the total population of the region.

The region has a smaller average household size, 2.5 persons per household and NSW as a whole has an average household size of 2.6 persons per household.

4.1.2 Age distribution

The median age in the local area is 37 years old is the same as in the region and NSW as a whole, although Lithgow LGA has a median age of 40 years old.

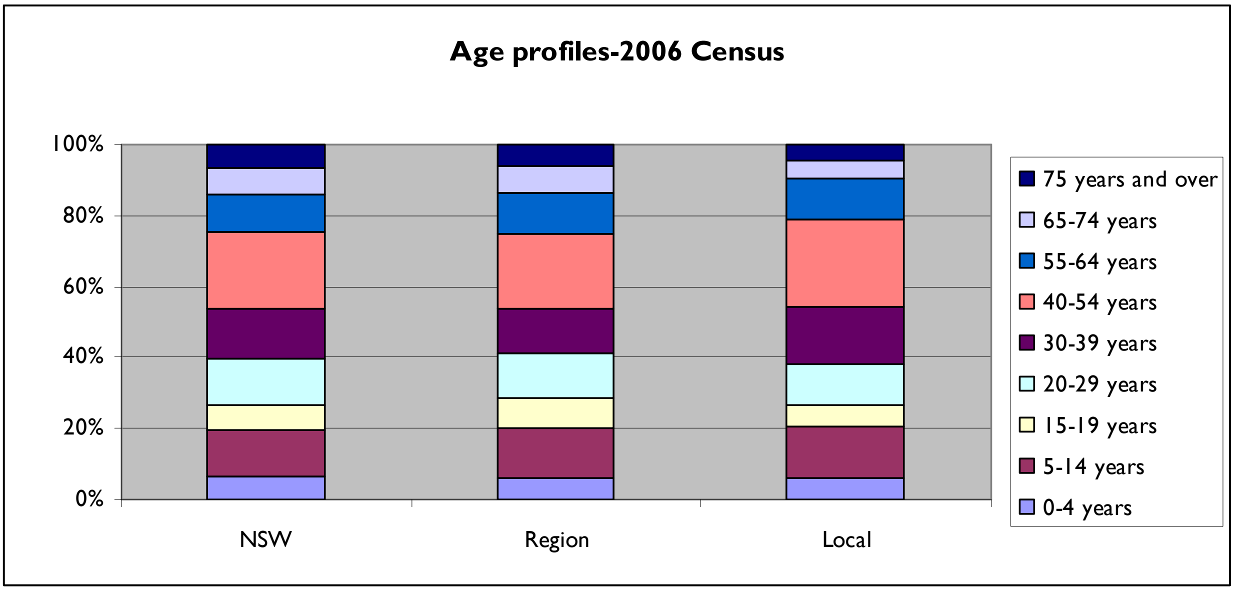


Figure 4-3 Age Profiles-2006
Source: ABS Census of Population and Housing

Overall, the population of the local area is younger than the population of the region. As a proportion of the total population, people 65 years old and over make up only 9% of the total local area population, while making up 13% of the population of the region, and around 14% of the NSW population.

4.1.3 Place of birth

A high proportion of people (87%) in both the local area and the region were born in Australia. This does not reflect the diversity of NSW as a whole, where 69% of persons were born in Australia.

4.1.4 Household type

87% of people in the local area live in a "family household", as compared with a lone person household or group household made up of unrelated individuals. This is higher than the region (83%) and the whole of NSW (85%).

The local area has comparatively fewer lone person households, around 8%, compared with around 11% in the region and 9.5% in NSW as a whole.

In the local area "Couples with Children" (Figure 4-4) is the predominant family type, making up 65% of families. This is a higher proportion than in both the region and in NSW, where "Couples with Children" are 58% and 61%, respectively.

The proportion of one parent families in the local area is lower than in the region. 12% of families in the local area are one parent families compared with 15% of families in the region. The key difference between the local area and the region is the proportion of couple families without children. In the region, couples without children make up 26% of all families; in the local area they make up only 22%. In NSW couples without children make up 24% of families.

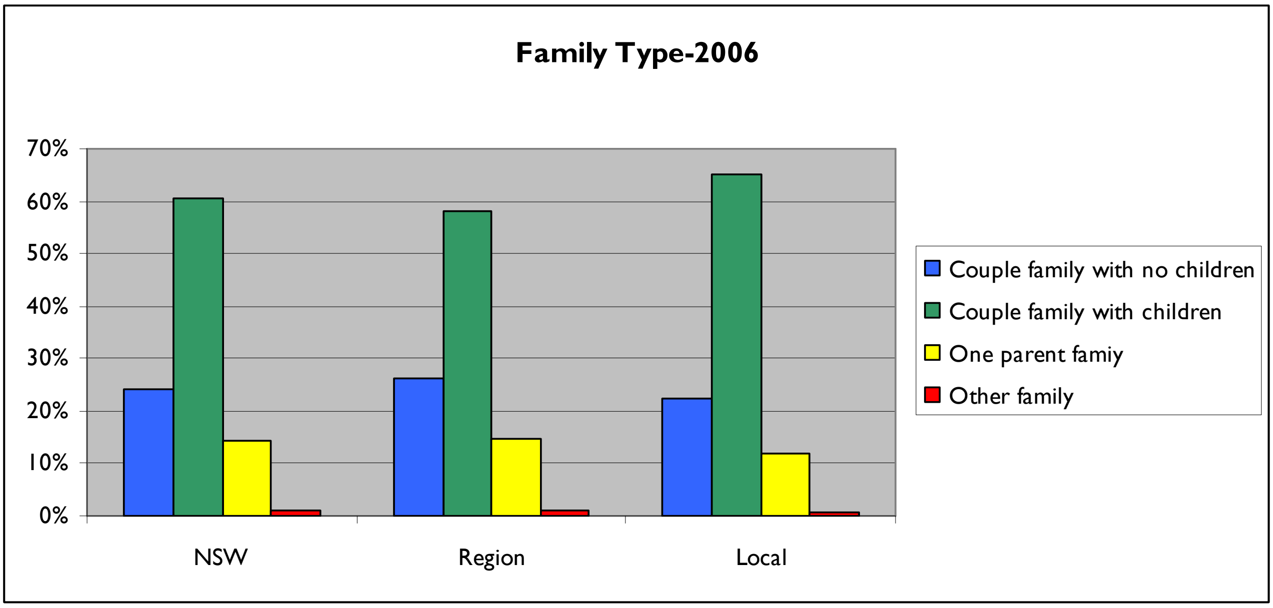


Figure 4-4 Family type-2006
Source: ABS Census of Population and Housing

4.1.5 Dwelling characteristic and tenure

The majority of dwellings in the local area are separate houses. Some 96% of dwellings in the local area are separate houses which is higher than the region (87%) but considerably higher than NSW as a whole (71%). Semi detached dwellings and flats make up around 2% of all dwellings in the local area, compared with around 12% in the region and 28% in NSW.

Compared to the region and NSW, the local area has a higher proportion of dwellings being purchased compared to dwellings owned outright. In the local area, 38% of dwellings are owned and 36% are being purchased. The proportion of owner-occupied dwellings in the region is 37% and in NSW as a whole is 35%. The proportion being purchased in the region and in NSW as a whole is 32%.

The proportion of dwellings being rented in significantly lower in the local area. 23% of occupied private dwellings are being rented in the local area, compared with 27% in the region and 30% in NSW. Most of those renting in the local area are renting from a public housing authority, with equal numbers renting from real estate agents as rent from individuals (such as a family member or friend).

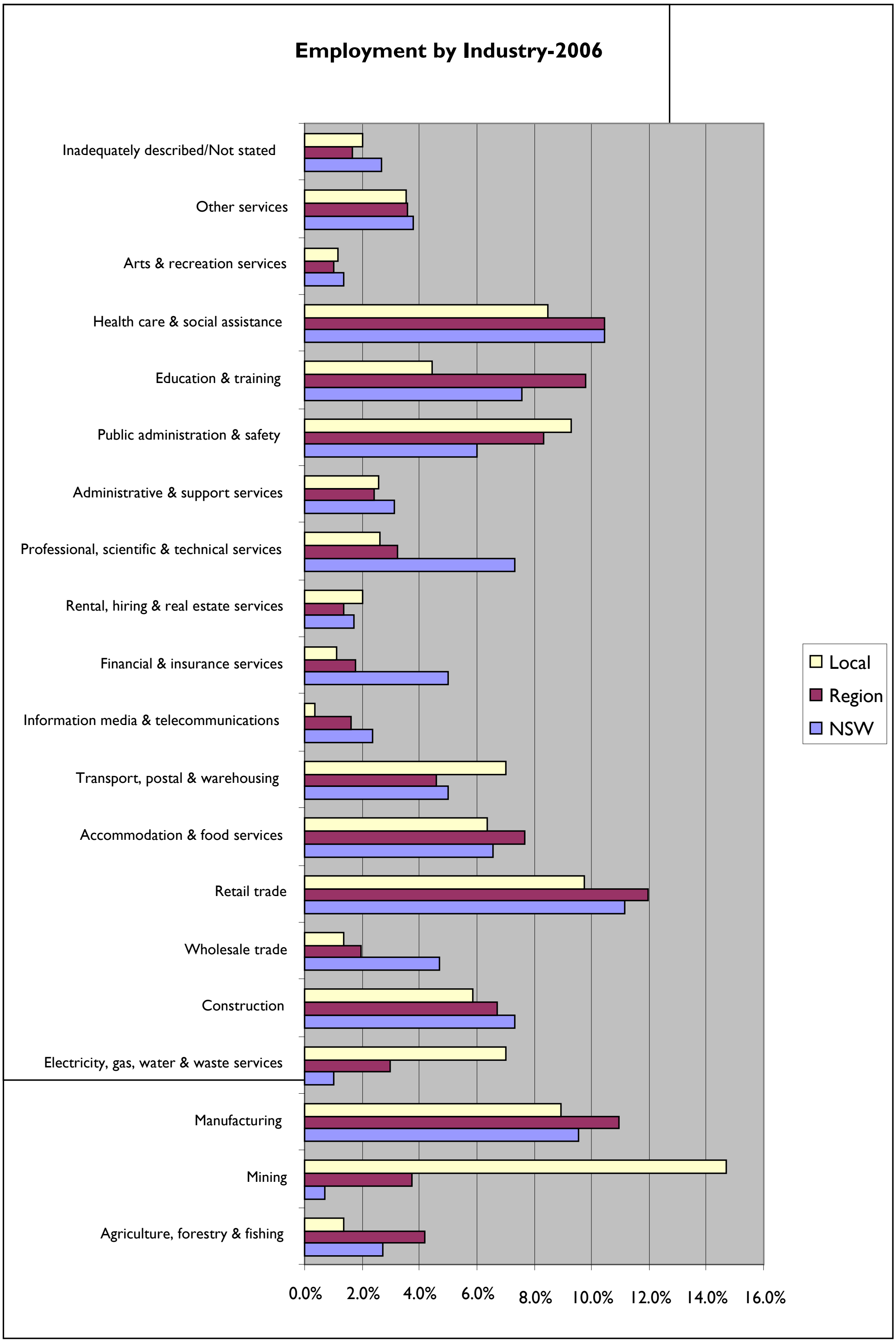
4.1.6 Occupation and industry of employment

Figure 4-5 shows employment by industry in 2006 for the local area, region and NSW. Some 15% of employed persons in the local area work in mining. This is higher than in the region (4%), higher than the rest of Lithgow LGA (10%) and significantly higher than NSW as a whole (1%).

The next largest industries of employment in the local area are retail trade, public administration, manufacturing and health care & social assistance.

Larger proportions of persons in the local area are also employed in electricity, gas & water services and arts & recreation services compared to the region.

Figure 4-5 Employment by Industry-2006
Source: ABS Census of Population and Housing



The residential location of existing Angus Place Colliery staff is provided in Table 4-1. The majority of the existing staff resides in the region, specifically in Lithgow (43.5%) but over 35% live in the townships of the local area.

Table 4-1 Residential location of existing staff

Source: *Angus Place Colliery Section 75W Modification Project Traffic Impact Assessment* by Stapleton Transportation & Planning Pty Ltd

Suburb	No. of employees	% of employees
Bathurst	5	2.2%
Ben Bullen	1	0.4%
Blackheath	5	2.2%
Bowenfelds	1	0.4%
Capertee	1	0.4%
Cullen Bullen	2	0.9%
Hartley	1	0.4%
Hazel Grove	1	0.4%
Katoomba	2	0.9%
Kelso	8	3.6%
Lidsdale	12	5.4%
Lithgow	97	43.5%
Little Hartley	2	0.9%
Marrangaroo	8	3.6%
Marrangaroo Fields	6	2.7%
Mt Lambie	1	0.4%
Mt Victoria	2	0.9%
Peel	1	0.4%
Pipers Flat	7	3.1%
Portland	20	9.0%
Sodwalls	1	0.4%
South Bowenfels	7	3.1%
Wallerawang	30	13.5%
Wentworth Falls	1	0.4%
Yetholme	1	0.4%
TOTAL	**223**	**100.0%**

4.2 Health

The local area and Lithgow LGA are located in the NSW Health Sydney West Area Health Service (SWAHS). SWAHS covers the area from Auburn in western Sydney to Lithgow.

Health data for small areas, such as the local area, is difficult to obtain but NSW Health has prepared a social and health profile for Lithgow LGA. This provides health status information about the area's residents (SWAHS 2009). The following information is based on the NSW Health Lithgow study.

In the period 2002-2007, in Lithgow LGA there was a higher prevalence of current asthma, obesity, "overweight and obesity" than for SWAHS and NSW as a whole. The only significant difference though was the prevalence of "overweight and obesity" between the LGA and NSW. Lithgow had a higher proportion of current smokers than NSW and lower proportion of smoke free households. Between 2001 and 2005 there was a statistically significantly higher rate of new cancers in the Lithgow LGA and an overall death rate from cancer per 100,000 that was higher than in SWAHS and NSW. Deaths due to lung cancer were the most frequent cancer death. Life expectancy in Lithgow LGA was slightly lower than in SWAHS and NSW.

Compared to NSW, residents of Lithgow LGA have higher hospitalisation rates for all health areas except for injuries.

4.3 Crime

Table 4-2 presents 2008 crime statistics for the Lithgow LGA. In general Lithgow LGA has rates for offences (per 100,000 persons) that are higher than that for NSW. Of the 75 offences listed in Table 4-2, Lithgow LGA has above NSW average rates for 44 of the offences. Lithgow LGA has particularly high rates in driving offences such as speeding, domestic and non-domestic violence, break and enter-dwelling, steal from motor vehicle and steal from dwelling. Drug related offences tend to be lower than the average, except for cultivating cannabis and trafficking and dealing in cannabis and amphetamines. The NSW Bureau of Crime Statistics local crime report for Lithgow LGA in 2007 includes "crime hotspot" maps which show that comparatively few of these crimes occur in the local area and that most are concentrated in Lithgow City.

Table 4-2 Recorded crime statistics 2008
Source: NSW Bureau of Crime Statistics

Type of offence	Lithgow LGA		NSW	
	Total	Rate per 100,000 population	Total	Rate per 100,000 population
Homicide				
Murder	0	0.0	75	1.1
Attempted murder	0	0.0	51	0.7
Murder accessory, conspiracy	1	4.8	7	0.1
Manslaughter	1	4.8	6	0.1
Driving causing death	3	14.5	144	2.1
Assault				
Domestic violence related	112	541.2	25862	375.4
Non-domestic violence related	180	869.8	43340	629.1
Assault Police	5	24.2	2855	41.4
Sexual offences				
Sexual assault	15	72.5	4190	60.8
Indecent assault, act of indecency	14	67.7	3404	49.4
Other sexual offences	6	29.0	1819	26.4
Abduction and kidnapping	2	9.7	407	5.9
Robbery				
Robbery without a weapon	6	29.0	4590	66.6
Robbery with a firearm	0	0.0	380	5.5
Robbery with a weapon not a firearm	1	4.8	1897	27.5
Blackmail and extortion	0	0.0	86	1.2
Harassment, threatening behaviour and private nuisance	90	434.9	24838	360.5
Other offences against the person	4	19.3	1479	21.5
Theft				

Type of offence	Lithgow LGA		NSW	
	Total	Rate per 100,000 population	Total	Rate per 100,000 population
Break and enter - dwelling	169	816.7	44782	650.0
Break and enter - non-dwelling	96	463.9	22889	332.3
Receiving or handling stolen goods	23	111.1	5826	84.6
Motor vehicle theft	100	483.2	24523	356.0
Steal from motor vehicle	136	657.2	57816	839.2
Steal from retail store	45	217.5	19843	288.0
Steal from dwelling	134	647.5	21747	315.7
Steal from person	19	91.8	10467	151.9
Stock theft	5	24.2	569	8.3
Fraud	48	232.0	38466	558.4
Other theft	165	797.3	37745	547.9
Arson	36	174.0	7262	105.4
Malicious damage to property	577	2788.2	109438	1588.6
Drug offences				
Possession and/or use of cocaine	0	0.0	482	7.0
Possession and/or use of narcotics	0	0.0	818	11.9
Possession and/or use of cannabis	41	198.1	14735	213.9
Possession and/or use of amphetamines	3	14.5	2679	38.9
Possession and/or use of ecstacy	2	9.7	1779	25.8
Possession and/or use of other drugs	3	14.5	1684	24.4
Dealing, trafficking in cocaine	0	0.0	140	2.0
Dealing, trafficking in narcotics	0	0.0	277	4.0
Dealing, trafficking in cannabis	3	14.5	535	7.8
Dealing, trafficking in amphetamines	8	38.7	817	11.9
Dealing, trafficking in ecstacy	1	4.8	435	6.3
Dealing, trafficking in other drugs	0	0.0	106	1.5
Cultivating cannabis	4	19.3	1188	17.2
Manufacture drug	0	0.0	50	0.7
Importing drugs	0	0.0	26	0.4
Other drug offences	7	33.8	3143	45.6
Prohibited and regulated weapons offences	41	198.1	8642	125.4
Disorderly conduct				
Trespass	36	174.0	9231	134.0
Offensive conduct	46	222.3	8724	126.6
Offensive language	41	198.1	6676	96.9
Criminal intent	5	24.2	1503	21.8
Betting and gaming offences	2	9.7	309	4.5
Liquor offences	38	183.6	17912	260.0
Pornography offences	0	0.0	125	1.8
Prostitution offences	1	4.8	208	3.0
Against justice procedures				
Escape custody	1	4.8	215	3.1
Breach Apprehended Violence Order	58	280.3	11581	168.1
Breach bail conditions	46	222.3	23586	342.4
Fail to appear	0	0.0	877	12.7
Resist or hinder officer	26	125.6	7787	113.0
Other offences against justice procedures	3	14.5	683	9.9

Type of offence	Lithgow LGA		NSW	
	Total	Rate per 100,000 population	Total	Rate per 100,000 population
Driving offences				
Driving under the influence of alcohol or drugs	7	33.8	1110	16.1
Dangerous or negligent driving	133	642.7	25129	364.8
Driving while licence cancelled or suspended	55	265.8	17438	253.1
Driving without a licence	168	811.8	27550	399.9
Driving licence offences, nec	331	1599.5	66641	967.3
Registration offences	372	1797.6	68023	987.4
Roadworthiness offences	3	14.5	907	13.2
Exceeding the prescribed content of alcohol limit	109	526.7	27706	402.2
Exceeding legal speed limit	1651	7978.2	218994	3178.9
Parking offences	5	24.2	2732	39.7
Other regulatory driving offences	739	3571.1	198197	2877.0
Transport regulatory offences	21	101.5	39482	573.1
Other offences	71	343.1	15569	226.0

4.4 Social and community infrastructure

A review of existing social and community infrastructure was undertaken based on the Lithgow City Council Social Plan and Lithgow Information and Neighbourhood Centre Community Guide.

The review showed that the local area has a few community facilities, mostly in Wallerawang and Portland, and that community services are mostly located at the regional level.

Lithgow City is the main hub for community services. The regional level services are listed in Table 4-3.

Given the small population of Wallerawang and the local area, it therefore relies on Lithgow City for most of its community and recreation services. Based on the community consultation undertaken by Lithgow City Council it was found that there was a need for additional community and recreation services in Wallerawang and that access to services in Lithgow and Portland was a key issue. Transport and accessibility has a particular impact on groups such as children, young people and older people.

Partly to address the lack of services and access issues, mobile community services have been developed. For example, Galloping Gumnut Mobile Children's Services Van Inc. is a service that provides mobile preschool program to the Lithgow City Council area. This service was extended on a trial basis to Wallerawang in 2008.

Table 4-3 Regional Level Social & Community Infrastructure

Social and community infrastructure
▪ Uniting Care
▪ Lithgow Community Tenancy Scheme
▪ Lithgow Library Learning Centre
▪ Family Support Service, Lithgow
▪ Centrelink office
▪ Lions Club of Lithgow

Social and community infrastructure
▪ Quota International of Lithgow Inc.
▪ Adolescent and Family Counsellor Service
▪ Red Cross, Lithgow Branch
▪ Rotary Club of Lithgow Inc
▪ View Club
▪ Bowenfels Cottage
▪ Lithgow Community Technology Centre
▪ Lithgow Community Projects
▪ Beehive Re-creative Centre
▪ Valley Social Club
▪ Family Support Service
▪ Evans Community Options Project
▪ Josephite Foundation No Interest Loan Scheme
▪ Department of Housing office
▪ Police Citizens Youth Club (PCYC)

4.4.1 Education

Child care and early learning

The following child care and early learning facilities are located in the local area:

- Uniting Care Family Day Care (in carers' home in Wallerawang)
- Little Possums Wallerawang Playgroup (Wallerawang)
- Pied Piper Pre School (Wallerawang)
- Portland/Wallerawang Parents as Teachers Program
- Blinky Bill Portland Child Care Centre
- Gumnut House Child Care Centre
- Jack and Jill Pre-school

Primary and Secondary

Public primary schools are located in the local area and the region:

Table 4-4 Public primary schools in local area
Source: NSW DET, School Locator, http://www.schools.nsw.edu.au/schoolfind/locator/

School	Enrolment	Locality
Cullen Bullen Public School	29	Local
Lithgow Public School	439	Region
Portland Central School	159	Local
Wallerawang Public School	221	Local

Apart from Portland Central School, which provides primary and secondary education, public secondary education is located at the regional level: Lithgow High School and Bathurst High School.

Tertiary

Tertiary education is located at the regional level.

There are two technical colleges (TAFE) within the region: Lithgow College and Bathurst College.

Lithgow College focuses on the electrical and engineering trades and provides certificate level courses in access and general education, aged care, business, computing, outdoor recreation and hospitality. Bathurst College is a major centre for access and general education and trade programs as well as courses in business, hospitality, information technology and management. The college specialises in bricklaying, children's services, communication and media, design, digital media, fitness, human resources management, refrigeration and air conditioning and welfare courses.

A campus of the Charles Sturt University is located within the region at Bathurst.

4.4.2 Health

There is a public hospital within the local area, the Portland District Health, and two in the region, Lithgow Integrated Health and Bathurst Base Hospital.

Portland District Health has 69 approved acute beds, 30 nursing home beds and a 58 place Supported Residential Service. It also offers community health services. Lithgow Integrated Health consists of a 46 bed public hospital, 14 bed private hospital, 13 bed nursing home, 31 hostel type units and community health centre. Bathurst Base Hospital which has 101 beds and provides the following services: surgical , medical , pathology , emergency medicine , obstetrics , radiology , gynaecology , oncology , Intensive Care , coronary care , paediatrics , physiotherapy and acute care.

There are community health facilities at Wallerawang, Portland and Lithgow and an occupational health and rehabilitation service at Wallerawang.

4.4.3 Community services

At the local level, a "Meals on Wheels" service operates from Wallerawang.

The main provider of community services is at the regional level; this is the Lithgow Information and Neighbourhood Centre (LINC). LINC is a provider of Home Aged and Community Care (HACC) services including: aged day care, community lunches, overnight respite care, and interest-free loans. Apart from HACC-funded services, LINC has a Community Development Worker, a counselling service for adolescents and families, supported accommodation services, playgroups and meeting space.

4.5 Identified community issues

Existing community engagement gives some indication of the local community issues at the level of the local area and regional level.

Amongst the consultation undertaken are those by Lithgow Council for its *Social Plan* and *Economic Development Strategy*. The existing Angus Place Colliery Community Consultative Committee also provides an indication of community attitudes to the colliery. The colliery has also been in media reports which provide an indication of community perceptions of the mine's activities.

The Lithgow City Council *Social Plan 2006-2011* was prepared based on focus groups with residents from the social plan target groups and service providers. This process generated a number of core community issues. In summary these are:

- Enhance community relationships and governance (community engagement, information dissemination and community group funding arrangements)
- Improve health outcomes
- Provide cultural and recreational opportunities
- Provide lifelong learning opportunities
- Improve community safety including road and footpath safety
- Improve access to public transport
- Provide access to affordable housing and crisis accommodation

The draft *Economic Development Strategy* recognised the following weaknesses with energy sector in Lithgow:

- Heavy reliance upon fluctuating markets
- Market has a tendency of fluctuating
- Heavy reliance upon workers with niche skills
- Specialised industry implies smaller potential workforce
- Negative perceptions of mining sector e.g. coal mining considered a 'dirty' industry
- Multiplier effects rely heavily on the state of the energy sector

The *Strategy* also recognised that the sector had a number of local strengths:

- Availability of local workforce
- Energy' has historical roots in Lithgow
- Industry is well regarded and supported by the community
- Large local employer
- Businesses provide community support through sponsorship
- Economic multiplier effects
- Proportion of energy workforce is well paid
- Supported by State and Federal government
- Generous local sponsors

A *Project Approval Compliance Audit Report* on Project Approval 06_0021 was undertaken in December 2007 by Hansen Bailey for Centennial Angus Place. The Audit Report noted the following:

- The few community complaints related to noise from transport on private haul roads
- Community Enhancement Contributions to Wolgan Road improvements were made in 2007
- Community Enhancement Fund was established and applications for 2007-2008 received
- Community Consultative Committee was established in 2007
- Complaints register established and maintained
- Telephone complaints line established and community notified
- Mine Closure Strategy is required and would need to be submitted in 2011

The Centennial Angus Place Community Consultative Committee (CAPCCC) was established in 2007 in accordance with Project Approval 06_0021. The minutes of the meetings between February 2007 and December 2009 were reviewed. The main issue with the operation of the mine raised by the CAPCCC was noise.

News media has also reported health concerns amongst some people in the community in relation to coal mining and the Wallerawang power plant (Benns 2010).

A literature review on the social impacts of mining identified the following social impacts listed in Table 4-5.

Table 4-5 Social impacts identified in literature review
Source: Petkova, et.al, 2009; Rolfe & Timmer (n.d); CSRM, 2008

Social impacts	Impact type (positive/negative)
Demographic change	Diversification (positive) High population turnover (negative) Atypical population structures (negative) Supply of service not in line with population changes (negative)
Demand for and cost of access to accommodation	Increase property values (positive) Higher rents (negative)
Business and employment opportunities and constraints	Local spending (positive) Increased employment (positive) Difficulties attracting staff for non-mining business (negative)
Atypical work schedules	Reduced numbers in local clubs and sport teams (negative) Long commuting (negative)
Environment and amenity	Improvements in infrastructure (positive) Improved service levels in towns (positive) Building and renovation of housing (positive) Operational impacts (noise, dust, traffic) (negative)
Increase financial support for towns	Positive
Education of communities	Positive

4.6 Summary

In summary the existing social environment is characterised by:

- high proportion of the local population employed in mining
- relatively lack of diversity in housing stock, at the local and regional level, with the stock overwhelmingly separate houses
- lower levels of households in the local area renting and a higher proportion purchasing
- high proportion of people in the local area in "family households"
- majority of current employees of Angus Place live in the regional centre (Lithgow) with about 35% living in the townships in the local area
- social infrastructure predominantly located at the regional level
- significant health differences between region (Lithgow LGA) and NSW: levels of "overweight and obesity", number of smokers, rates of new cancers and hospitalisations
- high rates of reported crime in the region (Lithgow LGA), which is not reflected at the local level

5 Assessment of Social Impacts

This section reviews the likely social impacts of the proposal. Economic impacts and impacts on Aboriginal Heritage are also social impacts, but are not dealt with in this report as they have been comprehensively reviewed in separate reports for the Environmental Assessment.

5.1 Existing community and population change

The proposal would result in the continuation of the mine to 2016 and therefore the retention of 215 jobs plus an additional 10 jobs and would therefore have a beneficial effect.

The proposal would result in a negligible population increase as the increase in the number of permanent employees is small. Based on an additional 10 staff, with the existing average household size (2.7 persons), the population increase as a result of this project could be around 30 people. Based on previous patterns of residential location by Angus Place Colliery staff, the majority of these people (around 13 persons) would locate in Lithgow, and around 11 persons would locate in the townships that make up the local area. The remainder would locate throughout the region. However, it could be the case that some of the ten additional staff would be from the local area and therefore the effects on the local community would be less than if all ten relocated to the area.

There would also be up to 75 temporary contractors. Due to the short term nature of the work it is not anticipated that the contractors would need to permanently relocate although short term accommodation may be sought (see section 5.3 below).

Lithgow City Council has identified a desirable growth rate of 1-2% per annum. This will mean a total population in Lithgow Local Government Area in 2025 of 25,500 – 31,000 people. The small population increase resulting from this proposal is therefore well within the expectations of Lithgow City Council and consistent with local government policy.

In terms of integrating the new population with the existing population, the local area and the region already has a higher share of mining workers and the population and social characteristics of the new workers is expected to be similar to the existing population. There should not be any major issues with the new population integrating into existing communities.

5.2 Community facilities and services

It is expected that given the negligible population increase, local community services can accommodate the change. The centralisation of services at the regional level (particularly in Lithgow) will also match the likely location pattern of the majority of the new population.

Centennial Coal contributes to local community facilities and service through the Community Engagement Funds administered by the existing Community Consultative Committee. The services funded include:

- Kidney Kar Rally
- Lithgow High School
- Lithgow District Soccer Inc
- Blackheath Kooraburra Kindergarten Inc
- Angus Mens Touch Football Team
- Lithgow Storm JRL Coaching Camp
- La Salle Hornets Cricket Club Inc

- Centennial Coal Western Charity Golf Day
- Portland Central School
- Lithgow City Bowling Club - Mens Sub-body
- Lithgow Swimming Club
- Angus Place Touch Team (a/shift)
- Lidsdale Lions Cricket Club
- Lithgow Swimming Club Triathlon
- Wallerawang Junior Cricket
- St Patrick's School Lithgow
- Lithgow Thistle Soccer Club
- Wallerawang Junior Rugby League Club

Centennial Coal are in the process of consulting with Lithgow City Council about a Voluntary Planning Agreement for a potential fund for local community projects and local road maintenance. This would be in addition to the sum already available under the existing Project Approval.

5.3 Housing and accommodation

A feature of the local area was the homogeneity of the housing stock. This lack of diversity in housing type is not untypical of non-metropolitan areas but may place pressure on short term workers and new workers, and pressure on rents.

One implication of this lack of diversity in housing in the local area is that workers might choose to locate to the larger regional centres (for example, Bathurst) that have a range of housing options. This increases commuting times until appropriate local accommodation is found.

Figure 5-1 and **Figure 5-2** show median rent at December for 2 bedroom flats (**Figure 5-1**) and 2 bedroom houses (**Figure 5-2**) in NSW, Bathurst and Lithgow. Rent changes appear to be consistent with movements in the market overall and do not suggest a "bubble" created by the operations of the mine.

Figure 5-1 Median Rent 2006-2009
Source: NSW Housing *Rent and Sales Reports*

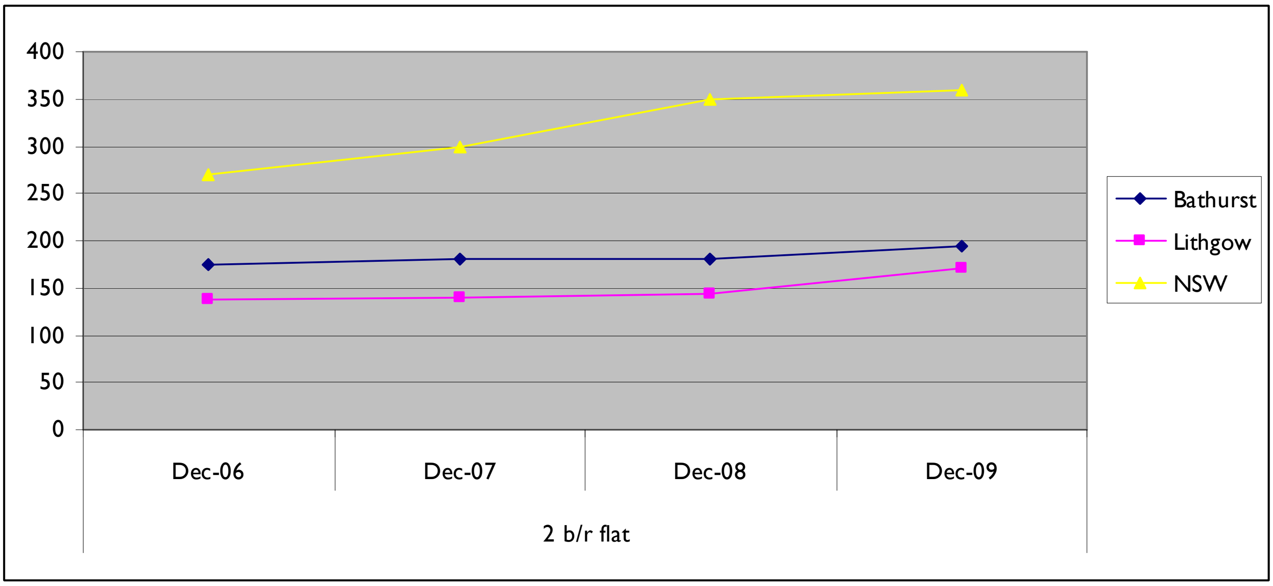
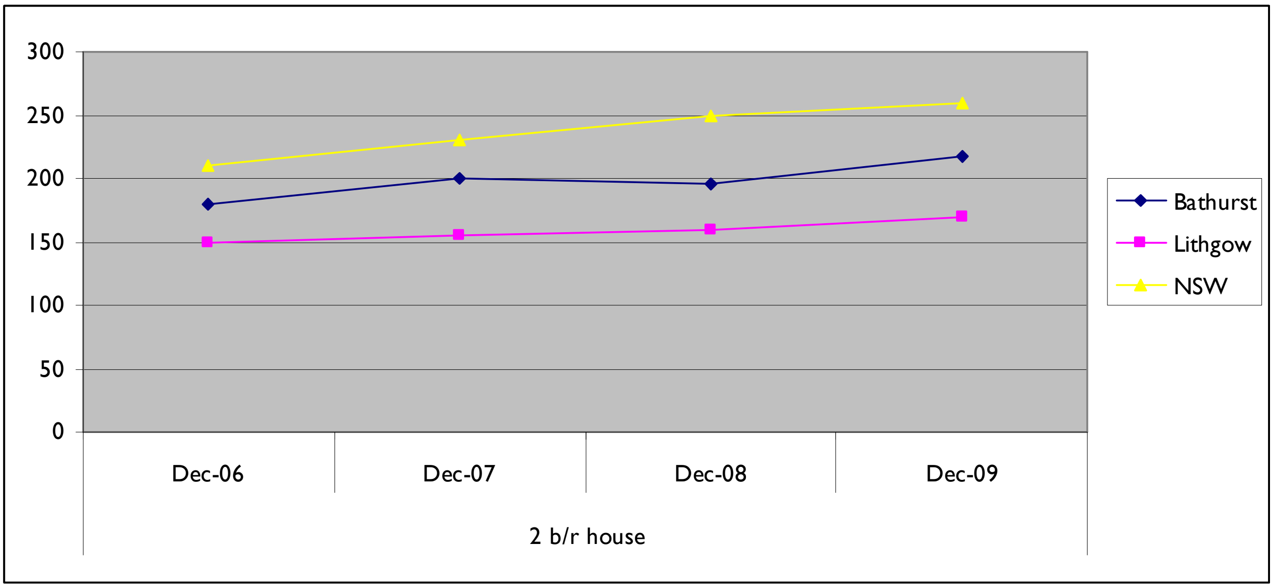


Figure 5-2 Median Rent 2006-2009
Source: NSW Housing Rent and Sales Reports



In terms of short term accommodation for contract workers, there were 593 rooms in Bathurst Region Council area as at December 2009 and 1,579 bed spaces (ABS Tourist Accommodation, Small Area Data, New South Wales, Dec 2009).

Occupancy rates in the December Quarter were 43.3%. There is less short term accommodation in the Lithgow LGA. The level of short term accommodation at the regional level appears to be adequate for the comparatively small number of contract workers required during the construction phase, although it may be considerable distance from the Colliery.

5.4 Operational impacts

Although there have been few reported complaints regarding the operation of the mine, the main operational impacts relate to noise, particularly from vehicles using the haul roads. The Noise Impact Assessment (Heggies, 2010a) identifies limits to truck movements in order to comply with project noise levels. A mix of 50 tonne and 80 tonne trucks would be used to transport the coal along the private haul roads and these vehicles are found to have similar noise levels. Therefore, truck noise is anticipated to be similar to present levels.

The Air Quality Assessment (Heggies, 2010b) reports on the effects of dust and particulates as residential receptors. Dust and particulates are predicted to be below the air quality criteria for the project.

The Traffic Impact Assessment (STAP, 2010) finds that the increase in traffic generation due to additional staff would not significantly alter existing levels on local public roads.

Effects on local people due to noise, dust and traffic are therefore likely to be negligible.

There are existing health concerns with the operation of coal mines in the Lithgow area. Environmental monitoring is in place at the existing Colliery and Centennial Coal should contribute to an informed understanding of local health issues by more widely promoting the results of environmental monitoring.

5.5 Crime

Lithgow LGA has particularly high rates in traffic incidents such as speeding. Based on the Traffic Assessment prepared for this Environmental Assessment, all current employees drive to work.

5.6 "Do nothing" option

The "do nothing" option is for the proposed modifications not to proceed. However, it is anticipated that discussions and/or further applications would take place that would seek to extend operations and that operations might be scaled down during this process.

Considering the high proportion of local people employed in mining in the local area (15%), the continued operations of the colliery is a positive impact that would minimise disruption to the local community that would occur if the proposal otherwise did not proceed (the "do nothing" option).

Considering the high proportion of local people employed directly by regional mines, as well as indirectly by local mine contractor and supplier firms, it is considered that continued operations at Angus Place would result in less disruption to the local community as a whole. The scaling down of operations would likely result in job losses in the local community. Strong connections to established local communities are evidenced by the large proportion of home-ownership and home-purchasing and large number of family households, particularly households with children. When people remain in employment within their current communities they tend to maintain their social networks. This stability could be disrupted if the mine extension did not proceed.

Other positive impacts include the contribution of Centennial Coal to the local community through the Community Enhancement Fund, the improvements to local infrastructure funded through the original approval, and the education of communities through the provision of mine tours.

5.7 'Good practice' trends

In 2007 the Centre for Social Responsibility in Mining at the University of Queensland reviewed current mining practices in assessing and managing the social impacts of mining. The study recognises the following as emerging 'good practice' trends:

- Adoption of more structured approach to community support activities and increased willingness to invest in community development initiatives
- Utilise partnerships in delivering community development outcomes
- Sophisticated approaches to community engagement
- Increased use of social science research to understand and manage social impacts
- Willingness to collaborate on addressing regional level issues and impacts

The current proposal has been assessed against these good practice trends in Table 5-1.

Table 5-1 Operational Level Social Impact Management Good Practice Trends
Source: CSRM, *Assessing and Managing the Socio-Economic Impacts of Projects*

'Good practice' trend	Comment
Adoption of more structured approach to community support activities and increased willingness to invest in community development initiatives	The existing Community Enhancement Fund is a structured approach to supporting community activities. It involves guidelines for funding and a panel made up of local representatives to assess applications. Also, Centennial Coal are in the process of consulting with Lithgow City Council on a Voluntary planning Agreement for further funds for local community projects.
Utilise partnerships in delivering community development outcomes	The existing Community Enhancement Fund represents a partnership between the local community and Centennial Coal to deliver relevant community development outcomes.
Sophisticated approaches to community engagement	The Community Consultation Committee represents two-way communication between Centennial Coal and the local community. Other communication methods used include: ▪ Notification letter to local residents ▪ Personal Visits of the mine available on request ▪ Website ▪ Community complaints line
Increased use of social science research to understand and manage social impacts	SIA and Economic Assessment prepared for proposed modifications.
Willingness to collaborate on addressing regional level issues and impacts	Lithgow City Council is represented on the Community Consultative Committee and Community Engagement Fund steering group

6 Mitigation and Management

6.1 Mitigation

The following are mitigation and management methods that could be employed such that any potential negative benefits are minimised:

- Maintain existing operational procedures designed to minimise impacts of noise, dust, etc to the local community
- Maintain existing community consultation to recognise and address any operational or social impacts
- Maintain existing complaints handling procedures

6.2 Monitoring

Table 6-1 outlines some measures that may be used to monitor the social impacts of the proposal:

Table 6-1 Proposed social impact monitoring measures

Impact	Measure	Potential mechanism
Operational impacts	Number of complaints Consultative Committee Feedback	Existing Complaint Register Consultative Committee
Housing and accommodation	Commuting distance of staff/contractors	Staff survey
Health	Level of community awareness of environmental reporting	Newsletters and website with feedback mechanism Consultative Committee

7 Conclusion

Overall, it is anticipated that the proposed modifications at Angus Place Colliery would not have significant negative social impacts and would have the positive benefit of maintaining 215 jobs and creating an additional 10 jobs and 75 temporary contractor jobs and therefore maintaining a local community. The proposal is the continuation of an existing operation which is located in an established mining area where coal mining has been undertaken since 1949.

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APPENDIX 7.10

Economic Assessment

Angus Place Modification Economic Assessment

Final Report

Prepared for

Centennial Angus Place Pty Ltd

By

Gillespie Economics
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October 2010

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EXECUTIVE SUMMARY

Angus Place Colliery (Angus Place) is located approximately 18 km north west of Lithgow in the Western Coalfield of NSW. Mining under the current Project Approval (06_0021) is planned to be completed in 2014. Angus Place is proposing to extend its operations by a Modification that principally includes the development and extraction of two additional longwall panels.

The main decision criterion for assessing the economic desirability of a project to society is its net benefit. Net benefit is the sum of the discounted benefits to society less the sum of the discounted costs. A positive net benefit indicates that it would be desirable from an economic perspective for society to allocate resources to a proposal, because the community as a whole would be better off.

In a simple framework, the benefits to society of mining relate to the net production and employment benefits, while the economic costs to society relate to any environmental impacts.

The Modification is estimated to have net production benefits of $73M or $93M, depending on which option is adopted for mining of longwall 910. However, because the potential incremental employment benefits and environmental impacts of the Modification have not been valued, this net production benefit represents a minimum threshold value.

This minimum threshold value is the minimum opportunity cost to society of not proceeding with the Modification. Interpreted another way, any residual environmental impacts of the Modification, after mitigation by Centennial Angus Place Pty Ltd, would need to be valued at greater than $73M or $93M to make the Modification questionable from an economic efficiency perspective.

The main environmental impacts of the Modification relate to greenhouse gas generation and the clearing of 4.2ha of native vegetation. Using a carbon value of $30/t CO_2-e, the incremental greenhouse gas emissions of the Modification are valued at $2M present value. Using non-market values for vegetation conservation from Gillespie (2009), vegetation clearing impacts would be valued at $4.1M. These environmental impacts of the Modification are therefore valued at significantly less than the estimated net production benefits.

The net production benefits of the Modification are distributed between a range of stakeholders including Centennial Angus Place Pty Ltd and its shareholders in the form of net profits, the NSW government in the form of royalties, the Commonwealth Government in the form of company tax and the local region from the establishment of a Voluntary Planning Agreement to fund local community projects. The State Government also receives additional income by way of payroll tax while the Commonwealth Government would receive additional revenues in the form of income tax.

Residual environmental impacts, such as clearing of native vegetation and greenhouse gas generation, would be borne by the general community, although if a carbon tax or an emissions trading scheme is implemented by the Australian government, then greenhouse gas costs would be internalised into the operating costs of Centennial Angus Pty Ltd.

The Modification would extend the period over which the mine would provide a stimulus to the Lithgow and Bathurst economy. The annual regional economic impacts associated with the additional years of operation of Angus Place are estimated at:

- $204M in annual direct and indirect regional output or business turnover;

- $106M in annual direct and indirect regional value added;
- $47M in annual direct and indirect household income; and
- 440 direct and indirect jobs.

The Modification would also provide stimulus to the regional economy from May 2011 from additional expenditures on contractor mining services to assist with development activities. These impacts are estimated at:

- $26M in annual direct and indirect regional output or business turnover;
- $17M in annual direct and indirect regional value added;
- $8M in annual direct and indirect household income; and
- 76 direct and indirect jobs.

Cessation of mining at the end of the Modification may lead to a reduction in regional economic activity. The significance of these Project cessation impacts would depend on:

- The degree to which any displaced workers and their families remain within the region, even if they remain unemployed. This is because continued expenditure by these people in the regional economy (even at reduced levels) contributes to final demand.
- The economic structure and trends in the regional economy at the time. For example, if cessation of the mine takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing, diversified economy.
- Whether other mining developments or other opportunities in the region arise that allow employment of displaced workers.

Given these uncertainties it is not possible to foresee the likely circumstances within which cessation of Angus Place would occur. It is therefore important for regional authorities and leaders to take every opportunity provided by the regional economic stimulus of Angus Place to strengthen and broaden the region's economic base.

1 INTRODUCTION

Centennial Angus Place Pty Ltd (a wholly owned subsidiary of Centennial Coal Company Limited) owns and operates Angus Place Colliery (Angus Place) which is located approximately 18 km north west of Lithgow in the Western Coalfield of NSW.

Angus Place received Project Approval for the extraction of Longwalls 930 to 980 in September 2006 and currently extracts on average 3 million tonnes per annum (Mtpa), with approval to extract 3.5Mtpa. Mining within the current approval area is planned to be completed in 2014.

Angus Place is proposing to extend its operations through a Modification that includes the development and extraction of two additional longwall panels and an increase in full time staff to 225.

An Environmental Assessment of the Modification is required in accordance with provisions of Section 75W of the NSW *Environmental Planning and Assessment Act, 1979*. The Director-General's Requirements identify the need for *"a conclusion justifying the proposed modification on economic,...........grounds...."* This economic assessment has been prepared to address this requirement and support the broader Modification Environmental Assessment.

2 BACKGROUND

From a socio-economic perspective there are two important aspects of the proposed Modification:

- the economic efficiency of the Modification (i.e. consideration of economic costs and benefits); and
- the regional economic impacts of the Modification (i.e. the economic stimulus that the project would provide to the regional economy).

The draft *Guideline for Economic Effects and Evaluation in EIA* (James and Gillespie, 2002) identified economic efficiency as the key consideration of economic analysis. Benefit cost analysis (BCA) is the method used to consider the economic efficiency of proposals. The draft guideline identified BCA as essential to undertaking a proper economic evaluation of proposed developments that are likely to have significant environmental impacts (James and Gillespie, 2002).

The draft guideline considered that regional economic impact assessment may provide additional information as an adjunct to the economic efficiency analysis. Economic stimulus to the local economy can be estimated using input-output modelling of the regional economy (regional economic impact assessment).

This assessment report provides:

- an evaluation of the economic efficiency of the Modification (Section 3);
- identification the distribution of impacts between stakeholder groups (Section 4);
- a regional economic impact assessment of the Modification (Section 5);
- consideration of the impacts of mine cessation (Section 6); and

- a conclusion summarising the above (Section 7).

3 ECONOMIC EFFICIENCY

The main decision criterion for assessing the economic desirability of a project to society is its net benefit. Net benefit is the sum of the discounted benefits to society less the sum of the discounted costs. A positive net benefit indicates that it would be desirable from an economic perspective for society to allocate resources to a proposal, because the community as a whole would be better off.

In a simple framework, the benefits to society of mining relate to the net production and employment benefits, while the economic costs to society relate to any environmental impacts.

Net production benefits of the Modification are a function of expected incremental coal production, sale price and costs of production over time associated “with” the Modification compared to “without” the Modification. These values can be estimated from market data. Employment benefits and environmental costs are non-market values that can be estimated using non-market valuation methods.

3.1 Identification of the “With” and “Without” Modification Scenario

“Without” the Modification mining under the existing consent is assumed to occur until 2014 at a rate of 3.3Mpta with employment of 215 full time staff. The Wallerawang and Mount Piper power stations would then need to source coal from more remote locations or purchase coal that would otherwise be exported, potentially impacting on the cost of electricity production.

“With” the Modification, mining of two additional longwalls (longwall 910 and longwall 900W) would occur (extending the mine life) with employment of 225 full time staff during the extended mine life. The Modification would also provide 45 additional contractor jobs from May 2011 for a period of 15 months to assist with development activities. This would bring total contractor employment at this time up to approximately 75.

The mining of the two additional longwalls would yield 4.9 Mt or 5.6 Mt of coal depending on which option is adopted for the mining of longwall 910. “With” the Modification, Wallerawang and Mount Piper power stations could continue to obtain thermal coal from a nearby source.

3.2 Decommissioning Costs, and Capital and Land Costs

The Modification extends the life of Angus Place and hence the approximately $2.6M of decommissioning costs that would have been incurred in 2014 following cessation of the mine are deferred. This is an economic benefit of the Modification.

However, the $25M of residual capital value and $2.5M of residual land value that would have been realised in 2014 would be deferred, representing an additional cost of the Modification.

3.3 Capital Costs

The additional mine life would not require any additional mining equipment to be purchased and hence there would be no incremental capital costs. However, there would be additional costs associated with temporary contractors to assist with development activities over an approximate 15 month period. These costs are estimated at $32M per annum.

3.2 Operating Costs

Incremental operating costs are associated with continuation of mining, with total operating costs dependent on which option is adopted for the mining of longwall 910. While royalties are a cost to Centennial Angus Place Pty Ltd they are part of the overall producer surplus benefit of the mining activity that is redistributed by government. Royalties are therefore not included in the calculation of the resource costs of the Modification. Nevertheless, it should be noted that the Modification would generate total royalties of $11.9M or $13.8M, depending on which option is adopted for the mining of longwall 910.

3.3 Revenues

There are two main economic benefits of the Modification. The first relates to the direct value of the coal recovered from Angus Place. An indication of this value is the market value of the coal as indicated by the contract price with Wallerawang and Mount Piper power stations.

The second economic benefit relates to the fact that without the Modification, export coal from other Centennial Mines would be required to supply Wallerawang and Mount Piper power stations. The Modification enables other coal to be diverted to its highest value use – export, rather than lower value domestic thermal use. The value of this additional benefit is equal to the premium obtained by exporting coal instead of supplying it to Wallerawang and Mount Piper power stations adjusted for additional washing and delivery costs (to Port) compared to delivery to Wallerawang and Mount Piper power stations.[1]

There is obviously considerable uncertainty around future coal prices and hence assumed coal values have been subjected to sensitivity testing (see Section 2.6).

3.5 Threshold Value Analysis

At the NSW Treasury recommended central discount rate of 7%, the Modification is estimated to have net production benefits of $73M or $93M, depending on which option is adopted for mining of longwall 910[2]. However, because the potential incremental employment benefits and environmental impacts of the Modification have not been valued, the net production benefit of $73M to $93M represents a minimum threshold value. It is a minimum threshold value because the Modification would also provided employment benefits to community in the form of the mine providing 225 direct full time jobs for a number of years and up to 75 contractors to assist with development activities over a 15 month period. Studies have shown that the community may have non-use economic values for these employment effects (Gillespie 2008, Gillespie 2009). However, conservatively, no values for these benefits have been included in the analysis.

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[1] An alternative but equivalent approach to the consideration of the economic value of the coal is to recognise that while Angus Place supplies coal to Wallerawang and Mount Piper power stations at a negotiated financial price, the appropriate estimate of the economic value for thermal coal from Angus Place is the world price for this coal (Sinden and Thampapillai 1995). The current FOB world price for thermal coal is around $100/t. However, this relates to washed coal delivered to Port. The operating costs referred to earlier do not include allocations for washing and delivery to port as this is not required by Wallerawang and Mount Piper power stations. Consequently the economic value of the coal at the power stations is the world price for thermal coal adjusted for washing and delivery costs (to Port).

[2] The former figure relates to Option 2 for longwall 910 while the latter figure relates to Option 1 for longwall 910.

This minimum threshold value is the minimum opportunity cost to society of not proceeding with the Modification. Interpreted another way, any environmental impacts of the Modification, after mitigation by Centennial Angus Place Pty Ltd, would need to be valued at greater than $51M to $59M to make the Modification questionable from an economic efficiency perspective.

The main environmental impacts of the Modification relate to greenhouse gas generation and the clearing of 4.2ha of native vegetation. Using a carbon value of $30/t CO_2-e, the incremental greenhouse gas emissions of the Modification are valued at $2M present value. Using non-market values for vegetation conservation from Gillespie (2009), vegetation clearing impacts would be valued at $4.1M. These environmental impacts of the Modification are therefore valued at significantly less than the estimated net production benefits.

4 DISTRIBUTION OF IMPACTS

While Centennial Angus Place Pty Ltd would initially bear the production costs and receive the production benefits (revenue) of the Modification, the net production benefits would be distributed between a number of stakeholders including Centennial Angus Place Pty Ltd and its shareholders in the form of net profits, the NSW government in the form of royalties, the Commonwealth Government in the form of company tax and the local region from the establishment of a Voluntary Planning Agreement to fund local community projects. The Voluntary Planning Agreement is currently being negotiated.

The State Government also receives additional income by way of payroll tax while the Commonwealth Government would receive additional revenues in the form of income tax.

Residual environmental impacts, such as clearing of native vegetation and greenhouse gas generation, would be borne by the general community, although if a carbon tax or an emissions trading scheme is implemented by the Australian government, then greenhouse gas costs would be internalised into the operating costs of Centennial Angus Pty Ltd.

5 REGIONAL ECONOMIC IMPACTS

Regional economic impact assessment is concerned with the effect of an impacting agent on an economy in terms of a number of specific indicators, such as gross regional output, value-added, income and employment.

These indicators are defined as follows:

- ***Gross regional output*** - is the gross value of business turnover;
- ***Value-added*** – is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output;
- ***Income*** – is the wages paid to employees including imputed wages for self employed and business owners; and
- ***Employment*** – is the number of people employed (including full-time and part-time).

There are two impacting agents for the Modification:

- the additional expenditure in the regional economy as a result of an extension in the life of the mine; and
- the incremental expenditure on a mining contractor to assist with development activities.

The economy on which the impact is estimated in this report is the Lithgow and Bathurst local government areas.

For this assessment, Gillespie Economics developed an input-output table of the Lithgow and Bathurst regional economy using the Generation of Regional Input-output Tables procedure developed by the University of Queensland (Bayne and West 1998).

To estimate the impacts of extended years of operation of the mine, revenue, expenditure and employment profile of the mine for the 2008/09 financial year was obtained and scaled to reflect the increased level of production predicted for the Modification. A new input-output sector representing the mine was then developed and inserted into regional input-output model, with the computer program IO7 (Input-Output Analysis Version 7.1) used to estimate the direct and indirect output, value-added, income and employment impacts of the Modification in the years of extended operation.

To estimate the annual regional economic impact of additional mining contractor expenditure, the computer program IO7 was used to model additional final demand expenditure in the mining services sector.

Table 1
Estimated Regional Economic Impacts of the Extended Mine Life

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($M)	138,695	40,793	24,072	64,865	203,560
Type 11A Ratio	*1.00*	*0.29*	*0.17*	*0.47*	*1.47*
VALUE ADDED ($M)	79,382	15,402	11,585	26,987	106,369
Type 11A Ratio	*1.00*	*0.19*	*0.15*	*0.34*	*1.34*
INCOME ($M)	27,527	10,296	8,640	18,936	46,463
Type 11A Ratio	*1.00*	*0.37*	*0.31*	*0.69*	*1.69*
EMPLOYMENT (No.)	225	102	113	215	440
Type 11A Ratio	*1.00*	*0.45*	*0.50*	*0.95*	*1.95*

The annual regional economic impact associated with the additional years of production as a result of the Modification is estimated at in the order of:

- $204M in annual direct and indirect regional output or business turnover;
- $106M in annual direct and indirect regional value added;
- $47M in annual direct and indirect household income; and
- 440 direct and indirect jobs.

Table 2
Estimated Regional Economic Impacts of the Mining Contractor Expenditure

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($M)	19,149	3,143	4,180	7,323	26,472
Type 11A Ratio	*1.00*	*0.16*	*0.22*	*0.38*	*1.38*
VALUE ADDED ($M)	13,773	1,395	2,012	3,406	17,179
Type 11A Ratio	*1.00*	*0.10*	*0.15*	*0.25*	*1.25*
INCOME ($M)	5,375	1,194	1,500	2,694	8,069
Type 11A Ratio	*1.00*	*0.22*	*0.28*	*0.50*	*1.50*
EMPLOYMENT (No.)	45	11	20	31	76
Type 11A Ratio	*1.00*	*0.25*	*0.44*	*0.68*	*1.68*

The annual regional economic impact associated with the additional mining contractor expenditure as a result of the Modification is estimated at in the order of:

- $26M in annual direct and indirect regional output or business turnover;
- $17M in annual direct and indirect regional value added;
- $8M in annual direct and indirect household income; and
- 76 direct and indirect jobs.

6 MINE CESSATION

Cessation of mining after the Modification may lead to a reduction in economic activity in the region. The significance of these Project cessation impacts would depend on:

- The degree to which any displaced workers and their families remain within the region, even if they remain unemployed. This is because continued expenditure by these people in the regional economy (even at reduced levels) contributes to final demand.
- The economic structure and trends in the regional economy at the time. For example, if cessation of the mine takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing, diversified economy.
- Whether other mining developments or other opportunities in the region arise that allow employment of displaced workers.

Given these uncertainties it is not possible to foresee the likely circumstances within which cessation of Angus Place would occur. It is therefore important for regional authorities and leaders to take every opportunity provided by the regional economic stimulus of Angus Place to strengthen and broaden the region's economic base.

7 CONCLUSION

The Modification is estimated to have net production benefits of \$73M or \$93M, depending on which option is adopted for mining of longwall 910. However, because the potential incremental employment benefits and environmental impacts of the Modification have not been valued, this net production benefit represents a minimum threshold value that the value of any environmental impacts of the Modification, after mitigation by Centennial Angus Place Pty Ltd, would need to exceed to make the Modification questionable from an economic efficiency perspective.

The main environmental impacts of the Modification relate to greenhouse gas generation and the clearing of 4.2ha of native vegetation. Using a carbon value of \$30/t CO_2-e, the incremental greenhouse gas emissions of the Modification are valued at \$2M present value. Using non-market values for vegetation conservation from Gillespie (2009), vegetation clearing impacts would be valued at \$4.1M. These environmental impacts of the Modification are therefore valued at significantly less than the estimated net production benefits.

The net production benefits of the Modification are distributed between a range of stakeholders including Centennial Angus Place Pty Ltd and its shareholders in the form of net profits, the NSW government in the form of royalties, the Commonwealth Government in the form of company tax and the local region from the establishment of a Voluntary Planning Agreement to fund local community projects. The State Government also receives additional income by way of payroll tax while the Commonwealth Government would receive additional revenues in the form of income tax.

Residual environmental impacts, such as clearing of native vegetation and greenhouse gas generation, would be borne by the general community, although if a carbon tax or an emissions trading scheme is implemented by the Australian government, then greenhouse gas costs would be internalised into the operating costs of Centennial Angus Pty Ltd.

The Modification would extend the period over which the mine would provide a stimulus to the Lithgow and Bathurst economy. The annual regional economic impacts associated with the additional years of operation of Angus Place are estimated at:

- \$204M in annual direct and indirect regional output or business turnover;
- \$106M in annual direct and indirect regional value added;
- \$47M in annual direct and indirect household income; and
- 440 direct and indirect jobs.

The Modification would also provide stimulus to the regional economy from May 2011 from additional expenditures on contractor mining services to assist with development activities. These impacts are estimated at:

- \$26M in annual direct and indirect regional output or business turnover;
- \$17M in annual direct and indirect regional value added;
- \$8M in annual direct and indirect household income; and
- 76 direct and indirect jobs.

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APPENDIX 7.11

Air Quality Impact Assessment

REPORT 30-2506-R1

Revision 1

Angus Place Colliery
Section 75W Modification
Air Quality Impact Assessment

PREPARED FOR

Angus Place Colliery
c/- RPSHSO
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13 OCTOBER 2010

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Angus Place Colliery

Section 75W Modification

Air Quality Impact Assessment

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EXECUTIVE SUMMARY

Heggies Pty Ltd (Heggies) has been commissioned by Angus Place Colliery to undertake an Air Quality Assessment (AQA) for a proposed extension to the Angus Place Colliery (i.e. the Angus Place Coal Project [the Project]) in the Western Coalfields of New South Wales (NSW).

The proposed modifications to Angus Place would involve:

- The development and extraction of longwall 910 which is located directly north of the existing 920 panel and is oriented in an east-west direction.
- The development and extraction of longwall 900W which is located directly west of the existing 900 panel main headings and is oriented in a north-south direction.
- One additional dewatering borehole located at the eastern end of longwall 910.
- Increase in production limit from 3.5 MTpa to 4.0 MTpa. This seeks to make a provision for 12 consecutive months of production in the event Angus Place does not have a three month shut down due to a longwall changeover. The intensity of mining will not change.

Ambient background particulate matter monitoring data was obtained from the NSW Department of Environment, Climate Change and Water (DECCW), who maintains an air quality monitoring site in Bathurst, approximately 50km northwest of the Project Site.

Based on the available data**,** site-specific ambient air quality levels adopted for assessment purposes are as follows.

- Dust: An annual average ambient dust deposition level of the order of 1.0 g/m^2/month;
- PM_{10}: A daily varying 24-hour average concentration based on local ambient monitoring data.

The following project-specific air quality goals have been established for assessment of the Project Site.

- A 24-hour maximum PM_{10} concentration of 50 $\mu g/m^3$;
- An Annual average PM_{10} concentration of 30 $\mu g/m^3$;
- A total monthly average dust deposition rate (background plus increment) of 4 g/m^2/month.

Atmospheric dispersion modelling predictions of fugitive emissions from the Project Site were undertaken using the CALPUFF dispersion model. Primary sources of emissions during operational activities are considered to be the operation of bulldozers and excavator on coal, conveying run-of-mine coal and wind generated emissions from stockpiles.

All modelling predictions indicate that the concentrations of particulate matter and dust deposition attributable to the Project would be within the current NSW DECCW air quality goals at all surrounding residences.

A Scope 1, 2 and 3 GHG assessment has been conducted and presented within this report.

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1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been commissioned by Angus Place Colliery to undertake an Air Quality Assessment (AQA) for a proposed extension to the Angus Place Colliery (i.e. the Angus Place Coal Project [the Project]) in the Western Coalfields of New South Wales (NSW).

This AQA has been prepared in accordance with the NSW Department of Environment and Climate Change and Water's (DECCW) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (Department of Environment and Conservation, 2005) (hereafter the Approved Methods). The Approved Methods outline the requirements for conducting an AQA, as follows:

- Description of local topographic features and sensitive receptor locations.
- Establishment of air quality assessment criteria;
- Analysis of climate and dispersion meteorology for the region;
- Description of existing air quality environment;
- Compilation of a comprehensive emissions inventory for proposed operations; and,
- Completion of atmospheric dispersion modelling and analysis of results.

The scope of the AQIA was also designed to address the DECCW's and Director-General's requirements for the project with regard to air quality. A synopsis of these requirements is given in **Table 1**.

Table 1 Requirements Pertaining to Air Quality Issues

Requirements	Relevant Section
A description of the existing air quality including the following parameters: • Dust deposition; • Total suspended particulates; and • PM_{10} particulate matter.	**Section 8**
Identification and location of all fixed and mobile sources of air emissions from the development including: • Location of all emission sources; • Identification of all pollutants of concern; and • Estimation of emissions quantity.	Appendix A (Emissions Inventory)
Details of the project essential for predicting and assessing impacts on air quality.	**Section 5.3**
A description of the topography and surrounding land uses.	**Section 5**
Details of exact locations of dwellings.	**Section 5**
Estimation of resulting ground level concentrations of all pollutants.	**Section 10**
Detailed description of the methodology used to assess air quality impacts including: • Justification and discussion of choice of dispersion model and model parameters; and • Dispersion model input/output files.	**Section 9** and **Appendix B**
Air quality impact predictions including plans showing projected incremental levels of; • 24-hour average PM_{10} concentrations; • Annual average dust deposition rates; and • Annual average total suspended particulate concentrations.	**Section 10**
Assessment of cumulative air quality impacts and a description of the methodology used.	**Section 9**
Assessment of the potential impacts on air quality other than by dust, e.g. nitrogen oxide emissions from diesel equipment and/or odour emissions arising from mine ventilation.	**Section 9.1.2**
Description of the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality goals.	**Section 10**
Description of contribution (if any) that the development will make to regional pollution particularly in sensitive locations.	**Section 10**
Description of control measures to be implemented to minimise pollutants including dust generation during any construction activities and coal handling and stockpiles.	**Section 2**
Specifications of pollution control equipment and management protocols for both point and fugitive emissions.	**Section 2**
Details of an air quality monitoring program to determine effectiveness of mitigation and to verify predictions, including provision for investigations in response to complaints.	**Section 2**

This report also includes a quantitative Greenhouse Gas Assessment which examines the potential Scope 1, 2 and 3 greenhouse gas emissions of the Project, potential impacts of these emissions on the environment and an assessment of all reasonable and measures that could be implemented to minimise the emissions of greenhouse gas emissions.

Additional policies, guidelines and plans referenced within this assessment are the *Protection of the Environment Operations (Clean Air) Regulation, 2002*, the "*Approved Methods for the Sampling and Analysis of Air Pollutants in NSW*" (Department of Environment and Conservation, 2007), and the "*National Greenhouse Accounts Factors*" (hereafter the NGA Factors) (Department of Climate Change, 2009).

1.1 Report Structure

This AQA is structured as follows:

Section 1	Introduction and report structure
Section 2	A description of the existing Angus Place Colliery including: ▪ Overview of current Angus Place operations; ▪ Particulate sources and emissions; and ▪ Existing mitigation measures.
Section 3	A description of the Project
Section 4	Description of the study area including: ▪ Local topography; ▪ Receptor details; ▪ Local sources; and ▪ Regional sources.
Section 5	Ambient air quality criteria including: ▪ Goals applicable to particulate matter less than 10 microns (PM_{10}); ▪ Goal applicable to total suspended particulates (TSP); ▪ Nuisance Impacts of fugitive emissions; and ▪ Project air quality goals.
Section 6	A description of the prevailing dispersion meteorology including: ▪ Meteorological modelling; and ▪ Meteorological conditions.
Section 7	A description of the baseline air quality in the region
Section 8	Emissions parameters and calculations
Section 9	Dispersion modelling results
Section 10	Greenhouse gas assessment
Section 11	Conclusions

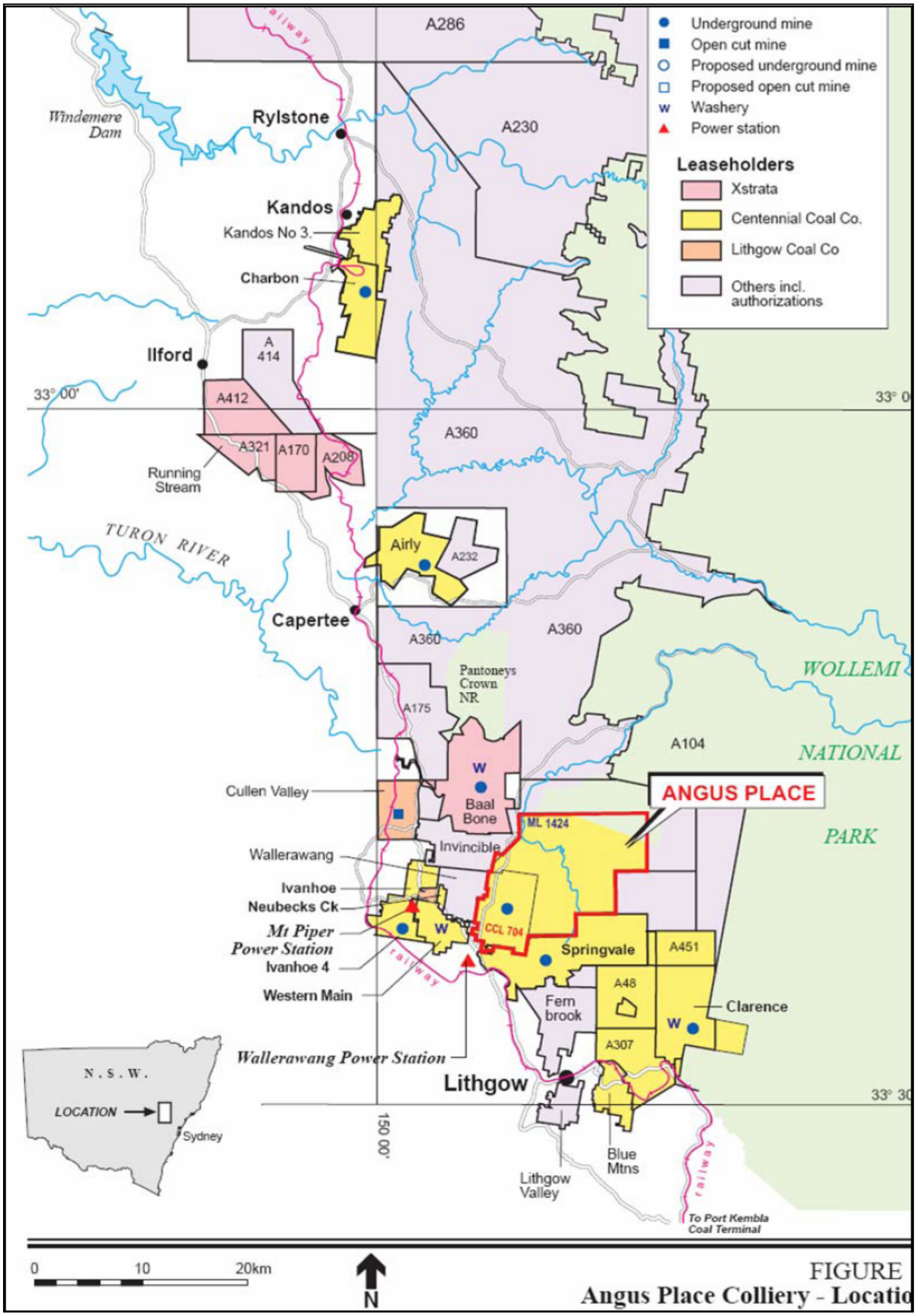
2 EXISTING ANGUS PLACE COLLIERY

2.1 Summary of Existing Mining Operations

Angus Place Colliery is an underground mining operation located 5 km north of the village of Lidsdale, 8 km northeast of the township of Wallerawang and approximately 15 km northwest of the city of Lithgow in the Lithgow local government area, as shown in Error! Reference source not found.. It is bordered by Springvale Colliery to the south, Ivanhoe Colliery to the northwest and the Wolgan Valley and Newnes Plateau to the north and east respectively.

Coal extraction is currently undertaken within Mining Lease (ML) 1424 and Consolidated Coal Lease (CCL) 704. Coal is mined by continuous miner units, for development headings and a longwall, for secondary extractions.

Figure 1 Project Site Location



Coal is then conveyed to the surface from a stackout/reclaim stockpile which is equipped with underground feeders enabling coal to be loaded onto the reclaim conveyor. Coal is then conveyed to the coal sizer where it is crushed and sized, then delivered to the truck loading hoppers by a conveyor. Loaded trucks then transport the coal to Mount Piper or Wallerawang power stations via private haul roads. Angus Place holds coal supply contracts with Delta Electricity for supply of coal to Mount Piper and Wallerawang power stations.

No coal washing occurs on site, therefore there is no production of washery tailings or reject material. Angus Place currently produces approximately 3 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal and operates 7 days a week, 24 hours per day. Angus Place has a current annual production limit of 3.5 Mtpa.

2.2 Emissions to Air Associated with Angus Place

This subsection provides a review of the likely emission to air sources associated with the existing Angus Place Colliery.

Atmospheric pollutants generated by activities occurring at the Project Site primarily comprise fugitive emissions of particulates (as PM_{10}[1], TSP[2]), those generated through the combustion of fuel in vehicles (nitrogen oxides [NO_x], sulfur dioxide [SO_2], volatile organic compounds [VOCs], carbon monoxide [CO], PM_{10}) and fugitive emissions from the coal seam.

Fugitive particulate emissions are considered to be the main pollutant sources from the Angus Place Colliery. Therefore, the focus of this assessment will be fugitive emissions of dust and particulates.

Major sources of particulate (PM_{10}, and dust) from current mining activities at Angus Place are expected to occur as a result of the activities presented in **Table 2**.

Table 2 Probable Particulate Generating Activities occurring at Angus Place

Activity	Particulate Emission Source
Stockpile Management	Excavator and dozer managing stockpiles
Stockpiles / Open Areas	Wind erosion of stockpiles and open areas
Conveying	Conveying coal from stockpile to crusher and trucks, underground to stockpile
Truck loading	Loading trucks from coal chute

Source: Centennial Coal, 2006

Given the Project is essentially an extension of the existing mining activities at Angus Place, the particulate emission sources presented in **Table 2** are generally not predicted to significantly change as part of the Project. Quantification of the potential Project air quality emissions is provided in **Section 8.1**.

2.3 Existing Air Quality Mitigation and Management Measures

The dust mitigation and management measures that are currently being implemented at Angus Place include:

- Permanent road sealing (asphalt seals);
- Water sprays on conveyors;
- Enclosures on main conveyors;

[1] PM_{10} is used to describe particulate matter with an aerodynamic diameter of 10 microns (µm) or less.
[2] TSP (Total Suspended Particulate) describes particulate matter which is less than 50 microns in diameter.

- Belt cleaners at main conveyors;
- Enclosed coal chute at stacking conveyor discharge point;
- Watering of ROM coal handling areas; and,
- Road sweeping.

Section 8.1 presents a summary of air quality monitoring undertaken at Angus Place. Site specific monitoring data presented in Section 8.4 indicates that dust deposition rates in the vicinity of the Angus Place operations are low, which suggests that the above dust mitigation and management practices are currently being implemented in accordance with best practice.

2.4 Air Quality Complaints

It is Heggies understanding that there have been no complaints in regard to air quality from the Project Site.

3 ANGUS PLACE COLLIERY EXTENSION PROJECT

Angus Place Colliery received Project Approval for the extraction of Longwalls 920 to 980 in 2006 under the provisions of Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Angus Place Colliery is now seeking Project Modification Approval under Section 75W of Part 3A of the EP&A Act. The purpose of the application is for the proposed modification of the current Angus Place Colliery Project Approval. The proposal aims to extend its operations through the extraction of two additional longwall panels and the development of related surface infrastructure.

Specifically, the Modification proposes to include the following:

- Development and extraction of longwalls 910 and 900 west (900W). 910 is directly north of the extracted 920 panel with 900W due west of the current mains headings. With regard to longwall 910, two (2) options are proposed. This is because there may be a potential resource area situated to the north east of the proposed longwall area and, if this is the case, future access to this resource would be most efficient if it is accommodated within this proposed modification. A geological and geotechnical investigation, as well as a preliminary feasibility assessment, will be undertaken and the findings will inform the choice of option. The two (2) options for longwall 910 are:
  - Option 1: In the event that the north eastern area is not considered viable, Longwall 910 will be approximately 200m wide and 2500m in length and will allow the development of two (2) main headings.
  - Option 2: In the event that the north eastern area is considered viable, Longwall 910 will be approximately 2500m in length and 120m wide to allow the development of four (4) mains headings to enable future access to the resource in the north east.
- Increase the production to four (4) mtpa. This seeks to make a provision for 12 consecutive months of production in the event that Angus Place does not have a three (3) month shut down due to a longwall changeover. The intensity of mining will not change. However, an increase of the annual production limit would allow a continuation in production in the event that a shutdown due to longwall changeover (typically three (3) months) is not required.
- Installation of an additional dewatering borehole located at the eastern end of longwall 910. Infrastructure required to support the operation of this installation is as follows:
  - An access track to the site from Blackfellows Hands Road.
  - Powerline extension along the access tracks to supply electricity. This will likely be an extension of the existing 930 and 940 dewatering bore powerline.

- Extension of the Springvale-Delta Water Transfer Scheme, in terms of an underground corridor (to accommodate the underground pipeline) along the proposed dewatering bore access track. This will enable Angus Place to continue to transfer extracted groundwater to Delta Electricity's Wallerawang power station, reducing the demand on water by Delta from the Cox's River catchment.

- Assessment of the current Angus Place water management infrastructure. Recommendations developed from the findings of the pit top surface water assessment will be considered for implementation to improve the dirty water management system.
- Increase in personnel from the currently approved 215 to 225. In addition, up to 75 temporary contractors will be required to assist with underground development activities for up to 15 months.

4 EXISTING MINE APPROVAL CONDITIONS

Project Approval 06_0021 (PA) was granted on 13 September 2006 for the Angus Place Colliery Extension Project under Part 3A of the *Environmental Planning and Assessment Act 1979* by the then Minister for Planning.

Angus Place is also licensed under the *Protection of the Environment Operations Act 1997*, Environmental Protection Licence (EPL) No. 467.

4.1 Project Approval (06_0021)

The Angus Place PA states the following with regard to air quality:

Conditions 14 and 16 of Schedule 3 state that:

- *The proponent shall ensure that the dust emissions generated by the project do not cause additional exceedances of the air quality criteria listed in **Table 3** and **Table 4** at any residences on, or more than 25 percent of privately-owned land.*
- *The proponent shall prepare (and following approval implement) an Air Quality Monitoring Program for the project, to the satisfaction of the Director-General. The program must include and air monitoring protocol for evaluating compliance with the air quality criteria in this approval. The program shall be prepared in consultation with DEC, and be submitted to the Director-General within 6 months of the date of this approval.*

In accordance with Condition 16, an Air Quality Monitoring Program was prepared for Angus Place in March 2007.

Table 3 DECCW Goals for PM_{10} - 24-hour and Annual

Averaging Period	Maximum Concentration
24-hour	50 µg/m^3
Annual	30 µg/m^3

Table 4 DECCW Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 $g/m^2/month$	4 $g/m^2/month$

4.2 Environmental Protection Licence (EPL No: 467)

The Angus Place Environmental Protection Licence (EPL) states the following with regard to air quality:

Section 4, Condition 3.1 of the EPL specifies that;

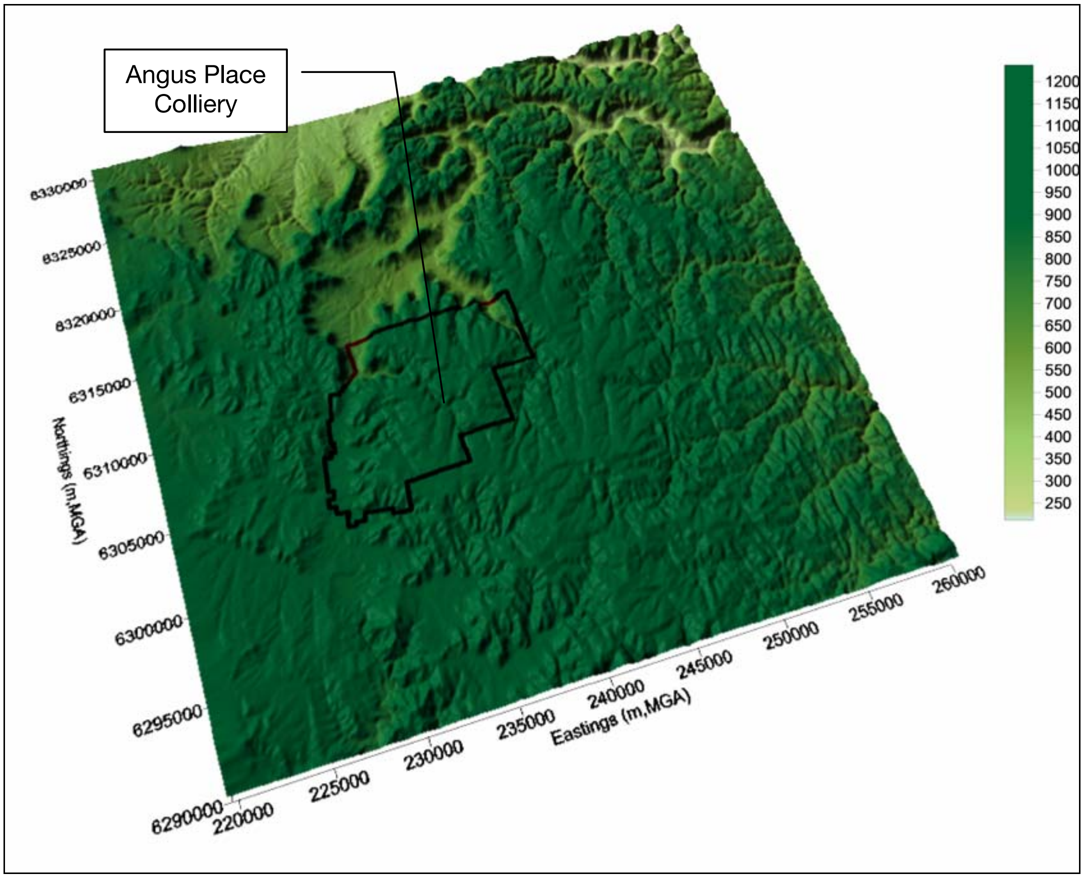
> *"The premises must be maintained in a condition which minimises or prevents the emission of dust from the premises".*

5 STUDY AREA

5.1 Local Topography

Angus Place is located within a region of significant topographical variation as shown in Error! Reference source not found.. The boundary of the site lies along the western edge of the Great Dividing Range and is situated at an altitude of between approximately 900 m to 1100 m AHD. It is bordered by the Wolgan Valley to the north and the Newnes Plateau to the east. The Pit top lies within the Cox's River surface catchment.

Figure 2 Three Dimensional Representation of Regional Scale Topography Surrounding Angus Place Mine



Note: Vertical exaggeration of two applied

5.2 Sensitive Receptors

The nearest potentially affected residential receptors to the Angus Place Colliery are the Sharpe (R1) and Mason (R2) residences which are illustrated in **Figure 3**. These two (2) locations are identified in the Project Approval as key monitoring locations.

Receptors R1 (Sharpe) and R2 (Mason) will also be used to assess and evaluate air quality with the addition of a third receptor (R3), as illustrated in **Figure 3**.

The purpose of R3 was to assess and evaluate air quality impacts on the northern side of the Project Site boundary, and is not representative of an existing sensitive receptor location.

Figure 3 Sensitive Receptor Locations

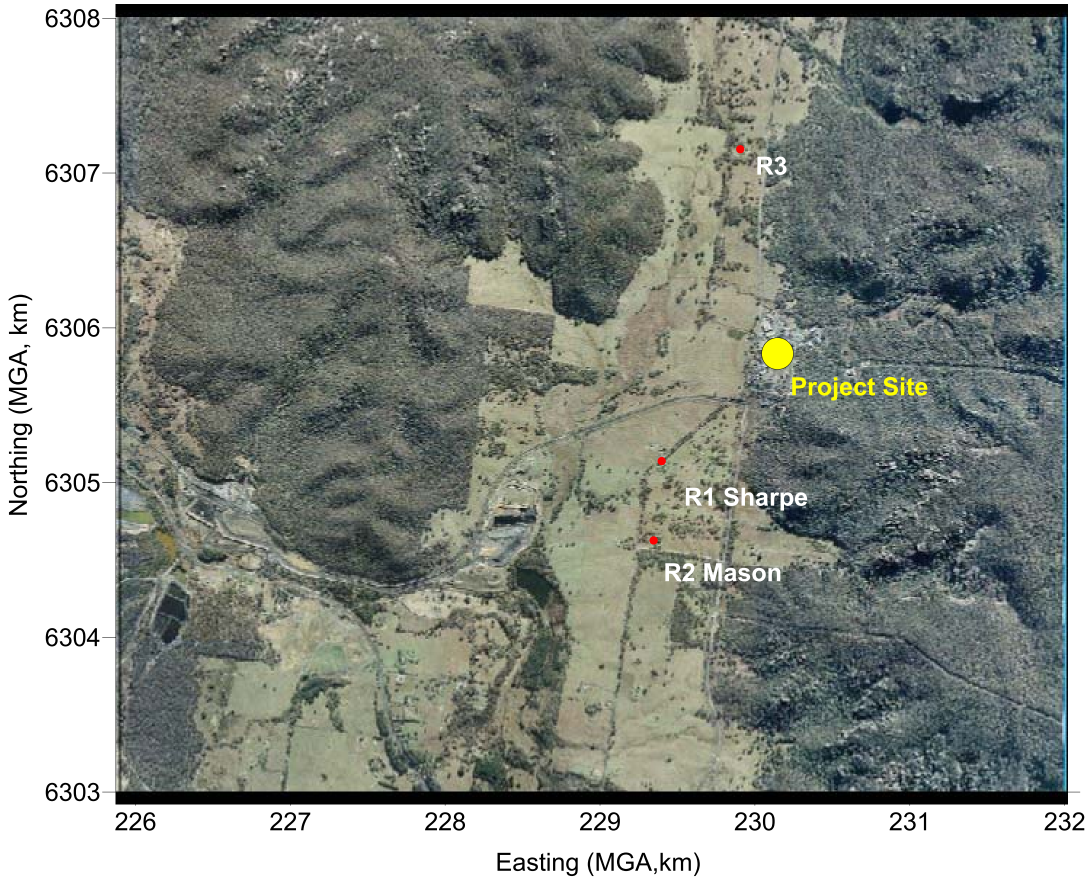


Table 5 Nearest Sensitive Receivers

Descriptor	Location (m, MGA56)		Approximate Distance (km) / Direction from Project Site boundary
	Easting	Northing	
R1	229398	6305139	0.7 / SW
R2	229346	6304626	1.1 / SW
R3	229905	6307154	1.0 / N

5.3 Potential Cumulative Air Quality Emission Sources

5.3.1 Local sources

Sources of atmospheric pollution surrounding the Project Site are mainly from mining activities from the mines in the vicinity of the Project Site. The Project Site is bordered by Springvale Colliery approximately 5.3 km to the south and Ivanhoe Colliery approximately 6.3 km to the northwest. Other coal mines that operate within close proximity to the Project Site include Pine Dale Coal Mine and Lambert's Gully approximately 3 km and 4 km northwest respectively from the Project Site boundary.

Given the above, it is considered that the surrounding coal mining operations have the potential to cause cumulative impacts upon receptors surrounding the Project Site due to the distance between the Project Site and these sources.

5.3.2 Regional Sources

Concentrations of particulates can be regionally elevated under certain conditions, such as bushfires or dust storms. Although these events are relatively unusual, they do occur and can result in elevated concentrations of particulates over several days in some instances. These events can be identified through the use of a regional network of air quality monitors.

6 AIR QUALITY CRITERIA

6.1 Goals Applicable to Particulate Matter Less than 10 Microns (PM_{10})

PM_{10} is considered to be an important pollutant in terms of potential impact due to its ability to penetrate into the respiratory system.

The DECCW PM_{10} assessment goals as expressed in the Approved Methods are:

- A 24-hour maximum concentration of 50 micrograms per cubic metre (µg/m^3); and
- An annual average concentration of 30 µg/m^3.

The 24-hour PM_{10} reporting standard of 50 µg/m^3 is numerically identical to the "*Ambient Air Quality National Environment Protection Measure"* (NEPM) (National Environmental Protection Council, 1998) reporting standard except that the NEPM reporting standard allows for five exceedances per year. This goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best practice dust control measures.

6.2 Goal Applicable to Total Suspended Particulates (TSP)

The annual goal for TSP is given as 90 µg/m^3, as recommended by the National Health and Medical Research Council (NHMRC) at their 92nd session in October 1981. This goal has also been adopted in the Approved Methods.

6.3 Nuisance Impacts of Fugitive Emissions

The preceding sections are concerned in large part with the health impacts of particulate matter. Nuisance (amenity) impacts also need to be considered, mainly in relation to deposition of dust. In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4 grams per square metre per month (g/m^2/month).

To avoid dust nuisance the DECCW has developed assessment criteria for dust deposition (also called "dust fallout"). **Table 6** presents the allowable increase in dust deposition relative to the ambient levels.

Table 6 DECCW Criteria for Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m^2/month	4 g/m^2/month

Source: DECCW (2005)

6.4 Project Air Quality Goals

The air quality goals adopted for the assessment of the Project are those specified in the Approved Methods or the NEPM.

In summary, the specific goals being applied to this study are as follows:

- PM_{10}: A 24-hour maximum concentration of 50 µg/m^3 (Project-only[3]); and
  An annual average concentration of 30 µg/m^3 (Project and other sources).
- TSP: An annual average of 90 µg/m^3 (Project and other sources).
- Deposited Dust: An incremental (Project only) annual average dust deposition rate of 2 g/m^2/month; and,
  A total annual average dust deposition rate of 4 g/m^2/month (Project and other sources).

7 PREVAILING AND DISPERSION METEOROLOGY

7.1 Meteorological Data Availability

To adequately characterise the dispersion meteorology of Angus Place, data were reviewed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. The climate and meteorology of and surrounding the Project Site was characterised based on:

- Hourly meteorological data from the Angus Place weather station; and,
- A site specific dataset generated through meteorological modelling conducted by Heggies for the purposes of air quality dispersion modelling.

7.2 Meteorological Conditions

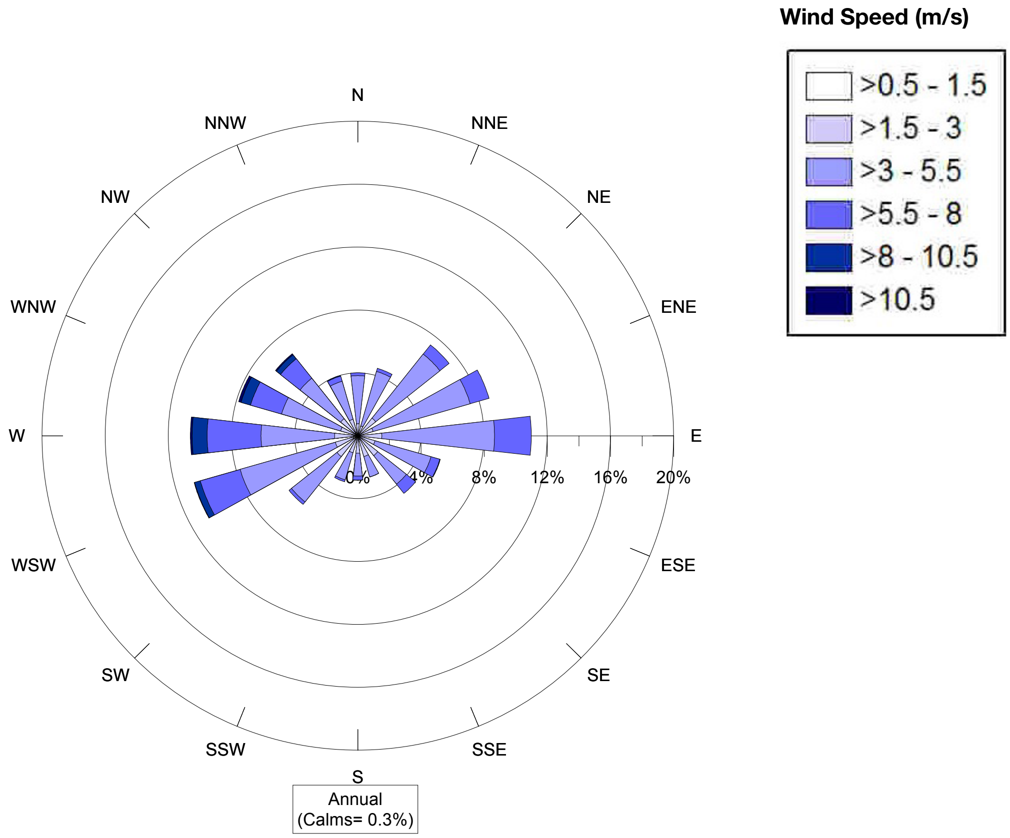
7.2.1 Wind Regime

A summary of the 2006 annual wind speed and direction measured at the Project Site is presented as a wind rose in **Figure 4**. This wind rose displays occurrences of winds from all quadrants. Data availability for 2006 was generally good.

Figure 4 indicates that winds experienced at the Project Site are predominately light to fresh (between 1.5 metres per second [m/s] and 10.5 m/s) and primarily from the west southwest and eastern quadrant. Calm wind conditions (wind speed less than 0.5 m/s) were observed to occur 0.3% of the time throughout 2006.

3 Based on recent approvals granted for mining projects, this goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best practice dust control measures. Refer to **Section 2.3** for a discussion of best practice dust control measures employed at the Project Site.

Figure 4 Annual Wind Rose for Angus Place - 2006



The seasonal variation in predicted wind speed and direction at the Project Site was also reviewed. Analysis of the seasonal wind variation indicated that:

- In spring, light to fresh winds are experienced predominantly from the west to northwest (approximately 40% of the time of seasonal wind direction).
- In summer, light to fresh winds (between 1.5 m/s and 5.5 m/s) are experienced predominantly from the east northeast to east.
- In autumn, light to fresh winds are experienced predominantly from the west southwest to west.
- In winter, fresh winds are experienced predominantly from the west southwest to west northwest.

7.2.2 Relative Humidity

The relative humidity in the region surrounding the Project Site can be described as moderate. The mean 9 am relative humidity at Lithgow was 60% to 82%, while the 3.00 pm relative humidity varies between 50% and 67% throughout the year, recorded between 1912 and 2006. This is in general agreement with data collected at the Project Site.

7.3 Meteorological Modelling

In order to calculate all required meteorological parameters required by the dispersion modelling process, meteorological modelling using The Air Pollution Model (TAPM) meteorological model (Version 3) has been implemented.

TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations, with no local data inputs required.

TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

Additionally, the TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. The wind speed and direction observations are used to realign the predicted solution towards the observation values. This function of accounting for actual meteorological observations within the region of interest is referred to as "data assimilation".

Thus, direct measurements for 2006 of hourly average wind speed and wind direction at the Project Site onsite weather station was input into the TAPM simulations to provide realignment to local conditions.

Table 7 details the parameters used in the TAPM meteorological modelling for this assessment

Table 7 Meteorological parameters used for this study

TAPM (v 3.0)	
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 300 m)
Number of grid points	25 x 25 x 30
Year of analysis	2006
Centre of analysis	230183 m E, 6305737 m S
Data assimilation	Meteorological data assimilation using wind data from Angus Place onsite weather station into lower 4 levels of model

7.3.1 Atmospheric Stability and Mixing Depth

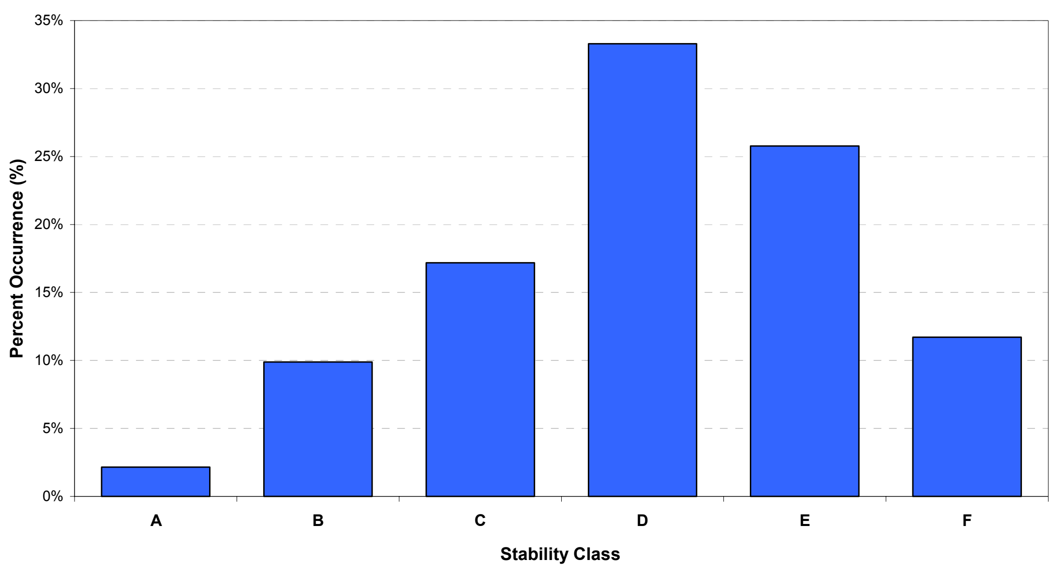
Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, "A" to "F", to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models (see **Table 8)**.

Table 8 Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category	Example Description
A	Very unstable	Low wind, clear skies, hot daytime conditions
B	Unstable	Clear skies, daytime conditions
C	Moderately unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

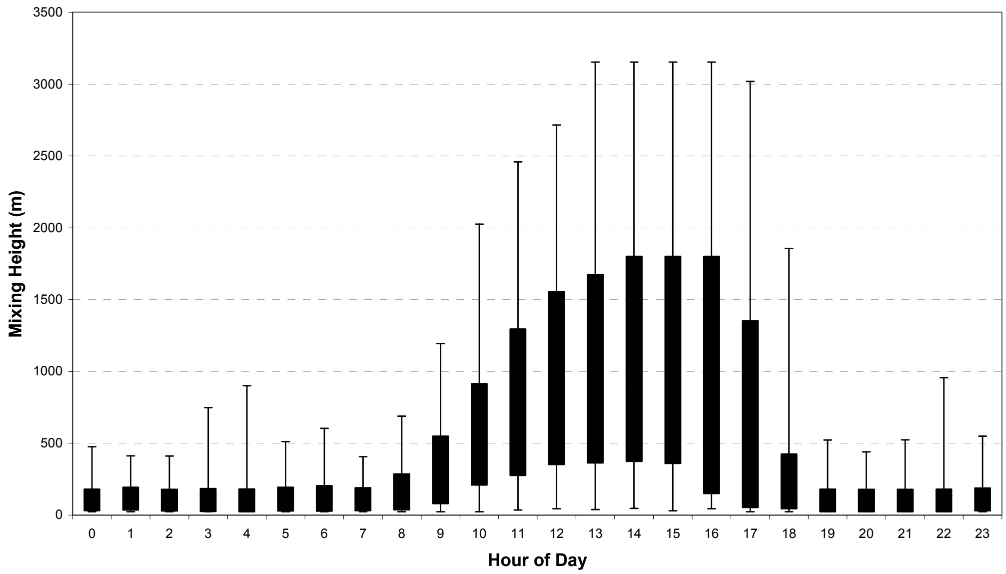
The frequency of each stability class at the Project Site is presented in **Figure 5**. The figure indicates a high frequency of occurrence of conditions typical to Stability Class "D". Stability Class D is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing.

Figure 5 Calculated Annual Stability Class Distributions for Angus Place-2006



Diurnal variations in maximum and average mixing depths predicted by TAPM at Angus Place during 2006 are illustrated in **Figure 6**. It can be seen that an increase in the mixing depth occurs during the morning, due to the onset of vertical mixing following sunrise. The figure indicates that the maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

Figure 6 TAPM-Predicted Diurnal Variation in Mixing Depth for Angus Place, 2006



8 BASELINE AIR QUALITY

The quantification of cumulative air pollution concentrations and the assessment of compliance with ambient air quality limits necessitate the characterisation of baseline air quality. Given that particulate matter would represent the primary Project-related emissions to air and that air quality limits are given for $PM_{10,}$ TSP and dust deposition, it is pertinent that existing suspended fine particulate concentrations and dust deposition rates be quantified.

8.1 Angus Place Air Quality Monitoring Network

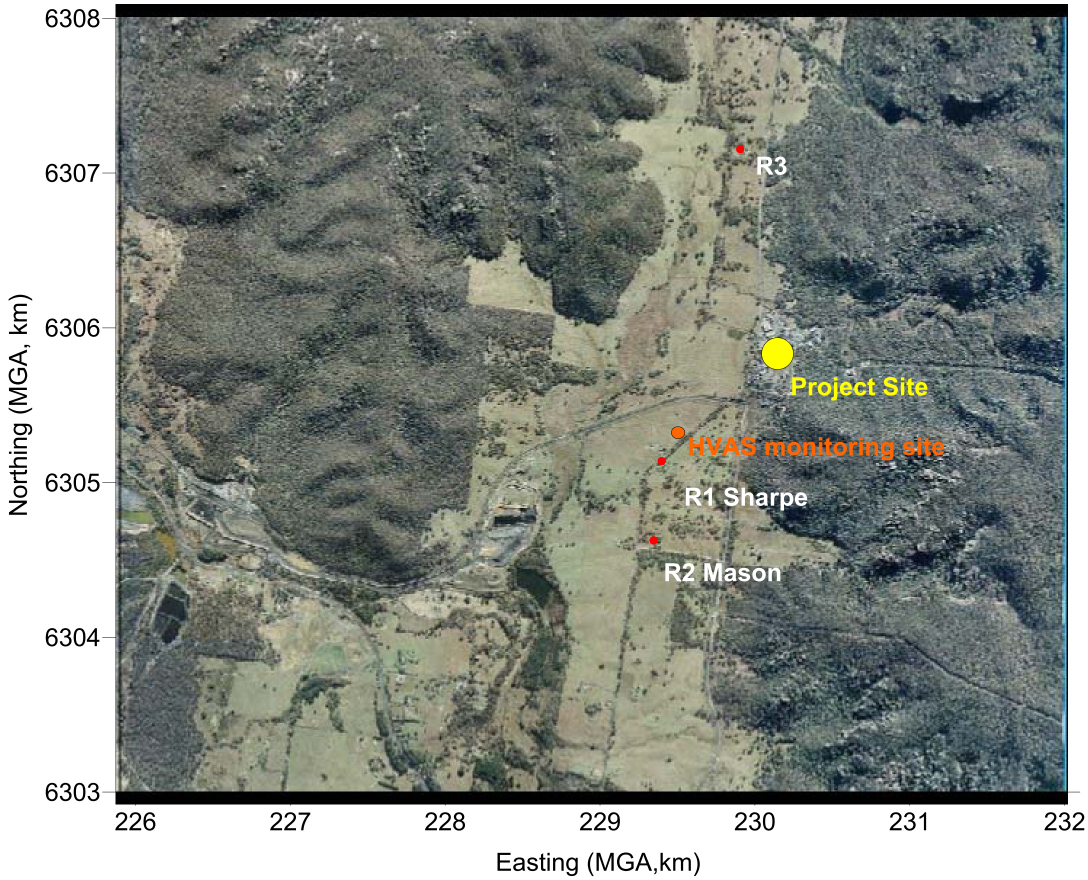
As part of the operational conditions of consent for the Project Site, Angus Place are required to maintain a routine air quality monitoring network to ensure compliance with the relevant air quality assessment criteria. Pollutants that are monitored by the Angus Place air quality monitoring network are PM_{10}, TSP and dust deposition. **Figure 9** illustrates the location of the Angus Place air quality monitoring network.

8.2 Particulate Matter

PM_{10} and TSP monitoring equipment have been established at one (1) location to the southwest of the pit top, in the vicinity of the nearest neighbour (Residence R1). The location is illustrated in **Figure 7**. The monitoring equipment operates on a one-in-six day cycle to record ambient concentrations of PM_{10} and TSP.

The monitoring equipment was installed in May 2009. Due to the recent establishment of this monitoring equipment, there is insufficient data available for use in the assessment of existing background PM_{10} concentrations in accordance with the DECCW Approved Methods. However, the DECCW maintains a network of air quality monitoring stations across metropolitan and regional NSW.

Figure 7 HVAS Monitoring Locality



The closest DECCW air quality monitoring station to the Project Site is the Bathurst air quality monitoring site, located at the Bathurst Sewage Treatment Plant, off Morrisset Street, approximately 50 km to the northwest of the Project Site. The following air quality parameters are recorded at the monitoring station:

- Ozone (O_3);
- Particulate matter (as PM_{10} using a tapered element oscillating microbalance [TEOM]); and
- Wind speed, wind direction and sigma theta (a measure of wind direction variability).

To provide an indication of the suitability of the Bathurst DECCW monitoring station for use as background at Angus Place, **Table 9** provides a statistical comparison with the Project Site for the period 10 May 2009 to 28 June 2010.

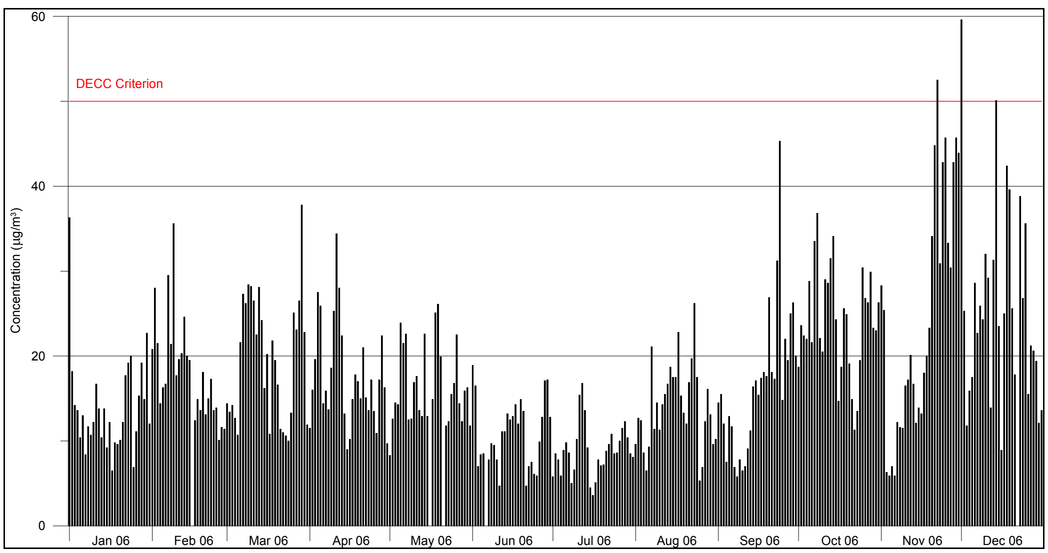
Table 9 DECCW Bathurst 2009/2010 dataset in comparison with Angus Place dataset

PM$_{10}$ Concentrations (µg/m^3)	Angus Place (µg/m^3)	DECCW Bathurst (µg/m^3)
Average 10/5/2009 to 28/6/2010	6.1	12.5
Minimum Concentration 10/5/2009 to 28/6/2010	<1	1.2
Maximum Concentration 10/5/2009 to 28/6/2010	27	37

As detailed in **Table 9**, the DECCW regional air quality monitoring station has a higher 24-hour average PM$_{10}$ concentration for all statistical parameters. Therefore the use of Bathurst PM$_{10}$ data to represent Angus Place is considered to represent a conservative assumption.

Because there is no local PM$_{10}$ data available during the selected modelling year (2006), verified PM$_{10}$ data from the Bathurst monitoring station for 2006 showing 24-hour average concentrations has been obtained from the NSW DECCW, and is presented in **Figure 8**.

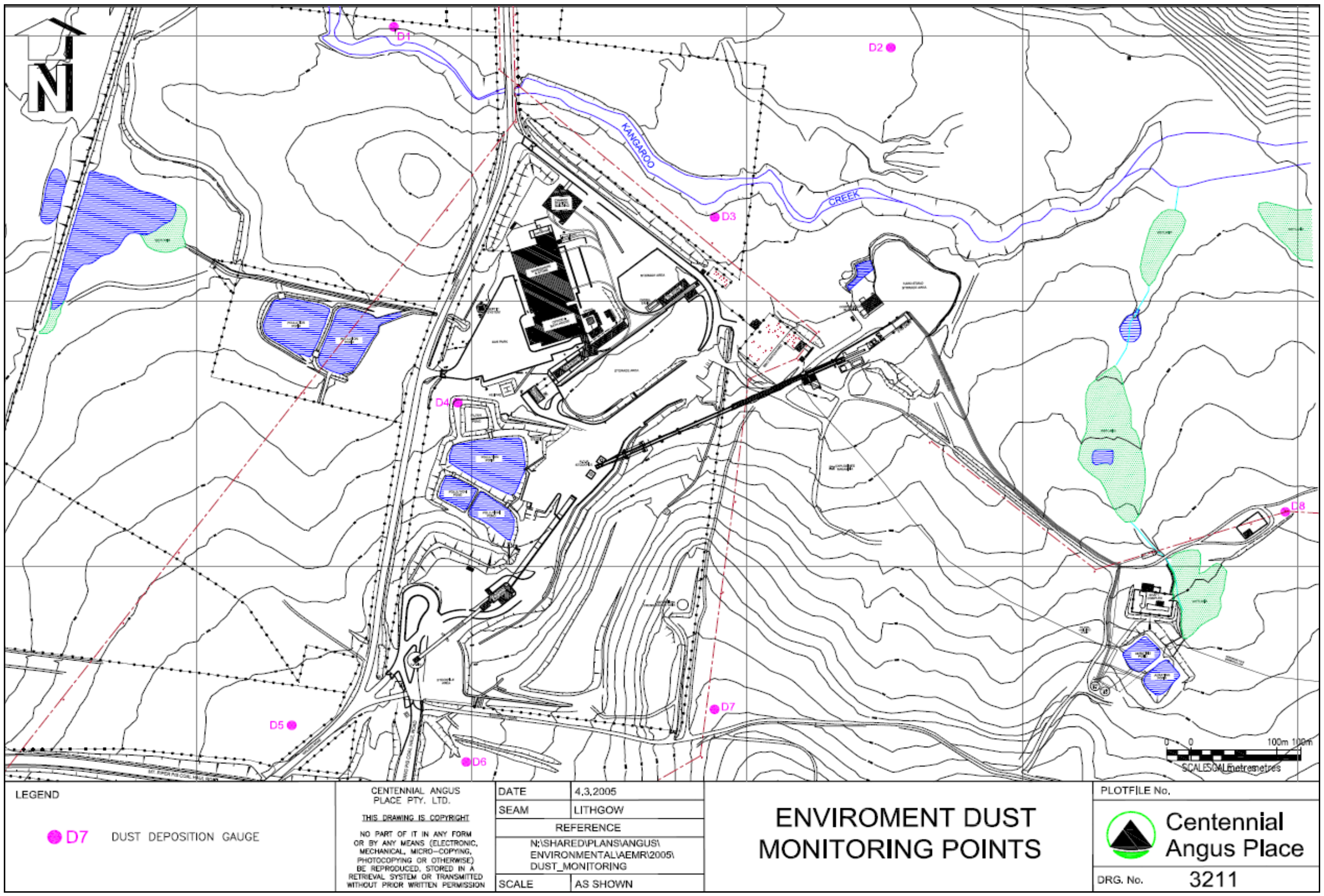
Figure 8 24 Hour Average PM$_{10}$ Concentration (µg/m^3) Bathurst 2006



Source: DECCW

Data for 2006 has been selected as this is contemporaneous with the meteorological dataset used in this assessment, as per the requirements for Level 2 modelling assessments listed in Section 5.1 of the NSW DECC Approved Methods. For modelling purposes, the daily 24-hour average PM$_{10}$ concentrations recorded at the Bathurst monitoring station have been used as the background PM$_{10}$ concentration at the Project Site. The method for application and suitability of the selection of this Bathurst dataset is discussed below.

Figure 9 Environmental Monitoring Locations



The Bathurst dataset will be applied in the modelling by pairing in time each individual 24-hour average predicted increment (modelled concentration only) with the corresponding concentration from the background dataset for each day of the modelled year. From this pairing, the maximum total 24-hour average PM_{10} concentration (background + predicted increment) will be used as the first assessment of compliance with the NSW DECC PM_{10} assessment criterion.

Figure 8 indicates that the highest 24-hour average PM_{10} concentration recorded at the DECCW's Bathurst monitoring site was 59.6 µg/m³ recorded on 1 December 2006. This is above the DECCW goal of 50 µg/m³. In addition to this exceedance, there were two further exceedances during this period, 52.5 µg/m³ on 22 November 2006 and 50.1 µg/m³ on 14 December 2006.

Review of the NEPM *New South Wales Annual Compliance Report 2006* (DECC, 2007) has indicated that extensive bushfire events occurred in the southern NSW / northern Victoria region between 21 November and 31 December 2006, a fact reflected in the elevated PM_{10} concentrations shown in **Figure 8**. Indeed, the three exceedances of the DECC goal recorded at Bathurst in 2006 were attributed to bushfires in the Blue Mountains, Hunter and Victorian Alps regions. However, in accordance with the Approved Methods, these values have been included in the assessment as it is appropriate to demonstrate that no *additional* exceedances of the impact assessment criteria will occur as a result of the proposed expanded operations at the Project Site.

The highest PM_{10} concentration not in exceedance of the 24-hour criterion at Bathurst was 45.7 µg/m³, recorded on 25 November 2006. It is noted that this concentration is also amongst the identified bushfire period and may be considered as elevated for the region. The annual average PM_{10} concentration for 2006, recorded at the DECCW's Bathurst monitoring site was 17.5 µg/m³. It is noted that for periods of missing data (5 days), the annual average PM_{10} concentration was used in lieu of daily readings.

8.3 Total Suspended Particulates

TSP concentrations (24-hour average, 1-in-6 day cycle) are also measured by High Volume Air Sampler (HVAS) at one (1) location in the vicinity of the Angus Place Colliery. The location of the HVAS is illustrated in **Figure 7**.

The TSP monitoring results for 2009/2010 (including site specific TSP/PM_{10} ratios) are presented in **Table 10**

Table 10 2009/2010 TSP Angus Place Monitoring Results (including TSP/PM_{10} ratio)

	Angus Place
Annual Average TSP	16.5
Annual Average PM_{10}	6.1
TSP/PM_{10} Ratio	2.7 : 1

Due to the one-in-six day cycle, there is insufficient data available for use in the assessment of existing background TSP concentrations in accordance with the DECCW Approved Methods.

It is considered appropriate that the above TSP/PM_{10} ratio be applied to the annual PM_{10} data measured at Bathurst to enable the calculation of an annual background TSP concentration.

Based on the TSP/PM_{10} ratio for Angus Place provided in **Table 10**, and the annual average PM_{10} concentration for PM_{10} at Bathurst (17.5 µg/m³), the proposed background TSP concentration for the project site is assumed to be 47.3 µg/m³

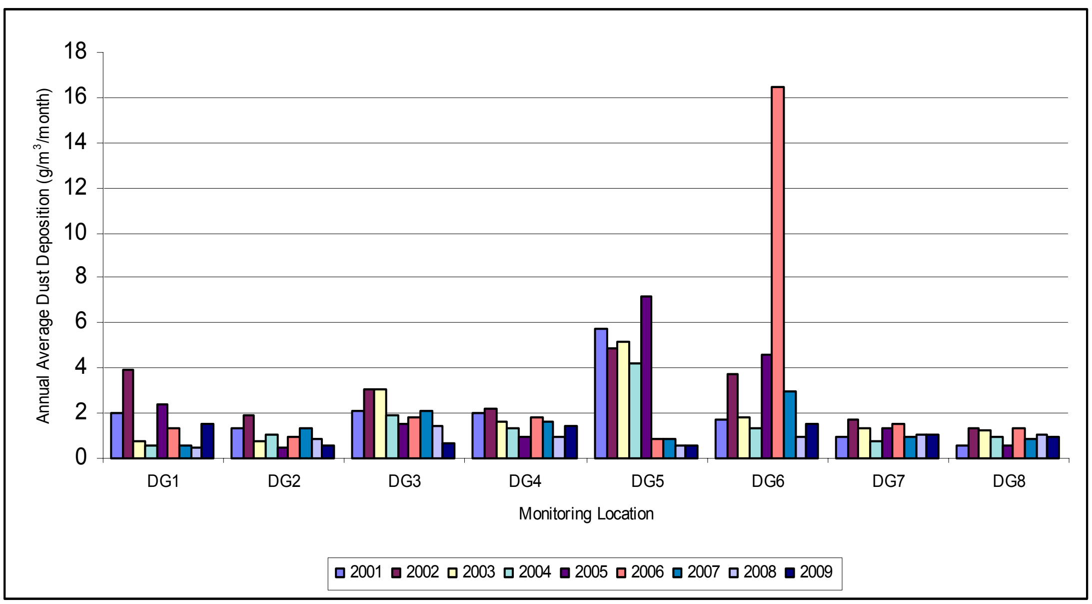
8.4 Dust Deposition

Dust deposition levels have been monitored surrounding the Project Site since 2001 at the locations indicated in **Figure 9**. Available dust deposition data for the period January 2001 to October 2009 are presented in **Table 11** and **Figure 10** .

Table 11 Historic Dust Depositional Monitoring Results-January 2001-October 2009

Date	Dust Gauge ID – Annual Average Dust Deposition (g/m²/month)							
	DG1	**DG2**	**DG3**	**DG4**	**DG5**	**DG6**	**DG7**	**DG8**
2001	2.0	1.3	2.1	2.0	5.7	1.7	1.0	0.6
2002	3.9	1.9	3.1	2.2	4.9	3.7	1.7	1.3
2003	0.8	0.8	3.1	1.6	5.2	1.8	1.3	1.2
2004	0.6	1.1	1.9	1.3	4.2	1.3	0.8	1.0
2005	2.4	0.5	1.5	1.0	7.2	4.6	1.3	0.6
2006	1.3	1.0	1.8	1.8	0.9	16.5	1.5	1.3
2007	0.6	1.3	2.1	1.6	0.9	3.0	1.0	0.9
2008	0.5	0.9	1.4	1.0	0.6	1.0	1.1	1.1
2009	1.5	0.6	0.7	1.4	0.6	1.5	1.1	1.0
Average	**1.5**	**1.0**	**2.0**	**1.5**	**3.4**	**3.9**	**1.2**	**1.0**

Figure 10 Annual Average Dust Deposition Levels- Angus Place Network, 2001-2009



A review of the dust deposition level presented within **Table 11** indicated that the highest annual average for any site was 3.9 g/m^2/month occurring at DG6 located 110 m south-southeast of the Truck loading bin. The highest monthly average at any site was 16.5 g/m^2/month, occurring at DG during 2006. Dust deposition exceeded 4 g/m^2/month at DG5 from 2001- 2005; however the exceedances in 2005 were primarily attributable to sample contamination from bird dung, insects or plant material.

It is important to the distance of the DG2 monitoring location from Angus Place operations, it is likely that this location best provides a measure of ambient dust deposition levels without the influence of local mining operations.

8.5 Background Air Quality for Assessment Purposes

For the purposes of this assessment background air quality concentrations/levels as presented **Table 12** have been adopted. The maximum monitored values from site data have been adopted. Daily varying background 24-hour PM_{10} concentrations from the DECCW Bathurst monitoring site have been adopted. In the absence of any site-specific TSP monitoring data, the annual average TSP concentration was assumed to be 44 µg/m^3 for the purposes of this assessment.

Table 12 Background Air Quality used for Assessment Purposes

Air Quality Parameter	Concentration / Level
PM_{10}	Daily varying (24- hour)
	17.5 µg/m^3 (annual average)
TSP	47.3 µg/m^3 (annual average)
Dust Deposition	1.0 g/m^2/month (annual average)

9 AIR QUALITY MODELLING METHODOLOGY

Activities associated with the existing Colliery that have the potential to generate particulates have been identified in **Section 2.2** of this report. As the Project is proposed to be a continuation of existing Angus Place operations, potential sources of dust are considered to be generally the same , however the locations of mining activities and the intensity of mining would be altered as a result of the Project (this has included the changes to the stockpiling of coal at pit top).

As described in **Section 3**, the installation of an additional dewatering borehole and associated infrastructure is proposed to be undertaken at the eastern end of longwall 910. This activity has not been considered within the quantitative assessment, because it is considered to be short term and the modelling undertaken for the operation of the mine is considered to adequately represent a worst case scenario for particulates.

The dust generating activities identified in **Section 2.2** have been quantified for the one (1) scenario of the Project.

9.1 Emissions Inventory

The quantities of dust emissions from the Project have been estimated using various factors developed by the Department of the Environment, Water, Heritage and the Arts' (DEWHA) National Pollutant Inventory (NPI) Emission Estimation Technique Manuals (EETM). **Table 13** below presents the emissions inventory for the scenario.

Table 13 Emissions Inventory Summary

Activity	Total Particulate Emission Factor	PM_{10} Emission Factor	Emission Factor Units
Bulldozer on stockpile management	12.168	3.704	kg/hr
Excavator on coal	0.012	0.006	kg/t
Conveying (2 sources)	0.0050	0.002	kg/t
Loading stockpiles	0.004	0.002	kg/t
Truck loading	0.0004	0.0002	kg/hole
Main stockpile wind erosion	0.05	0.03	kg/ha/hr
Stockpile adjacent truck loading chute	0.05	0.03	kg/ha/hr

9.1.1 Model Assumptions

The following sections detail the assumptions made in creating the emissions inventory for the operational scenario. **Appendix A** details the emissions inventory compiled for this assessment.

- Underground coal mining and product distribution (excluding mobile plant) operations occur 24 hours a day, seven days a week.
- It is assumed that maximum annual coal production is 4.0 million tonnes.
- It is assumed that coal to the ROM stockpile is loaded directly from underground conveying. ROM Coal is then transported to the CHP via underground reclaiming. Product Coal is loaded on to haulage trucks for distribution to the end user (power stations) of Kerosene Vale stockpile.
- It is assumed that one dozer is in operation at the ROM stockpile and one dozer is in operation at the Product Stockpile.
- It is assumed that the dozer is in operation 24 hours per day at the ROM stockpile.
- The emission factors for the excavator and dozer were derived from Table 1 of the EETMM. The equations corresponding to Excavators (on coal) and Bulldozers (on coal) were used.
- The emission factors for the product conveying were derived from Table 2 of the EETMM. The equations corresponding to Handling, Transferring and Conveying were used.
- During the modelling process, an emission reduction factor of 50% for enclosure was applied to the conveyor during transfer of coal to the ROM stockpile and the stacking conveyor discharge point.
- An emission reduction factor of 50% of water sprays was applied to the conveyor during stockpile management, truck unloading, front end loader loading trucks, transfer and conveying and screening to capture the wetness of the sand, (the processing of the sand is a wet process). Reduction factors were obtained from Table 3 of the EETMM.
- The emission factor for truck loading was derived from Table 1 of the EETMM. The emission factor corresponding to train loading were used.
- The following moisture content (mc) and silt content (sc) will be assumed for the modelling.
  - Coal: mc – 10%, sc – 6% (based on information provided by the Proponent).

9.1.2 Underground Ventilation Emissions

There are a number of ventilation fans situated around the Project Site, designed to stimulate the movement of fresh air to underground mining areas and remove emissions associated with the mining activities (diesel combustion, coal seam gas extractive operations). Heggies have conducted a number of dispersion modelling assessments for ventilation shafts associated with underground coal mining operations.

Based on the level of annual underground extraction at the Project Site (4.0 Mtpa) and the knowledge of potential emissions associated with significantly larger underground coal mines, it is considered that minimal impacts will be associated with the ventilation fans at the Project Site.

A review of a previous air quality assessment-*'Air Quality Assessment, Modelling of Odour and PM_{10} emissions from the Angus Place Ventilation Shaft- Holmes Air Sciences, July 2006'* conducted for Angus Place focused on the modelling of odour and PM_{10} emissions from the Ventilation shafts at the Colliery. Four different scenarios were modelled to show the differences between angle shafts.

- Scenario 1- elbow shaft parallel to the ground (0°);
- Scenario 2- shaft angled at 15° to the ground;
- Scenario 3 - shaft angled at 45° to the ground;
- Scenario 4- shaft emitting perpendicular to the ground (90°).

Results provided in Holmes (2006) indicated that conservative odour goal of 4 odour units (OU) was not exceeded at any of the sensitive receptors, except for scenario 1, where the nearest receptor experienced levels slightly above 4 OU. However, the predicted concentrations of PM_{10} data were compliant for all scenarios.

It is noted that the minor exceedance within Scenario 1 reflects highly conservative assumptions (as noted within the Holmes 2006 report). There have been no odour complaints at this receiver. It is therefore assumed that these assumptions are overly conservative and in reality the assumptions made within the odour modelling are more applicable.

With this conclusion in mind, and in the absence of site specific emissions data, potential particulate and odorous emissions from the ventilation shafts at the Project Site have been disregarded in this modelling assessment.

9.1.3 Annual Wind Erosion Emission Rates

Annual Wind Erosion at the Project Site was estimated using the following equation, as per Section A1.1.15 of the EETMM:

$$EF = 1.9 \times \left(\frac{s}{1.5}\right) \times 365 \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \text{ kg/ha/year}$$

where s = silt content, p = number of days when rainfall is greater than 0.25 mm, f = percentage of time that wind speed at the mean height of the stockpile is greater than 5.4 m/s. PM_{10} is 50% of TSP, as derived by this equation.

The suspension of particulate matter typically commences when wind speed approaches 5 m/s (SKM, 2005). To reflect this within the modelling process, the annual wind erosion amount has been divided proportionally amongst the hours throughout the year that are greater than 5 m/s.

Calpuff provides the following default wind speed bands (in metres per second) by which the emission rate for a source can be varied: 0 - 1.54 m/s, 1.54 - 3.09 m/s, 3.09 - 5.14 m/s, 5.14 - 8.23 m/s, 8.23 - 10.8 m/s and 10.8+ m/s.

To derive a wind erosion proportion for each wind speed band, the United States Environmental Protection Agency's (US EPA) erosion potential equation within Chapter 13, Section 13.2.5 Industrial Wind Erosion (US EPA, 2006), was used to estimate the erosion potential for each band. Within this equation, a Particle Threshold Friction Velocity of 0.5 m/s (considered highly conservative as fine coal dust is quoted as 0.54 m/s) was assumed. Hourly friction velocity was derived from hourly wind speed and the US EPA's conversion equation (US EPA, 2006).

9.2 Atmospheric Dispersion Modelling

The particulate dispersion modelling carried out for the Project utilises the DECCW and US EPA approved CALPUFF Dispersion Model software. CALPUFF is a transport and dispersion model that advects (or puffs) material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the meteorological fields generated by CALMET, although it can utilise a single station meteorological file generated by (for example TAPM) as is the case in this assessment (refer **Section 5.3**). The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST module is then used to process these files, producing tabulations that summarise results of the simulation.

The choice of the CALPUFF (Version 6.1) modelling system for the current assessment is based on the high percentage of calm conditions experienced at the site (approximately 14% in 2007). The advantages of using CALPUFF (rather than using a steady state Gaussian dispersion model such as Ausplume) is its ability to handle calm wind speeds (<0.5 m/s).

More advanced dispersion models (such as CALPUFF) are approved for use by the DECCW in situations where these models may be more appropriate than use of the Ausplume model. Such situations include those noted above (i.e. high frequency of calm wind conditions).

10 AIR QUALITY MODELLING RESULTS

Results of the dispersion model predictions for the Project Site are presented in the following sections. The input and outputs for the Calpuff model are presented in **Appendix D**.

10.1 CALPUFF Modelling Results

Dispersion modelling predictions of dust deposition and PM_{10} concentrations for the receptors nominated in **Section 5.2** attributable to the Project operations are presented in **Section 10.1.1** to **Section 10.1.3.**

10.1.1 Dust Deposition

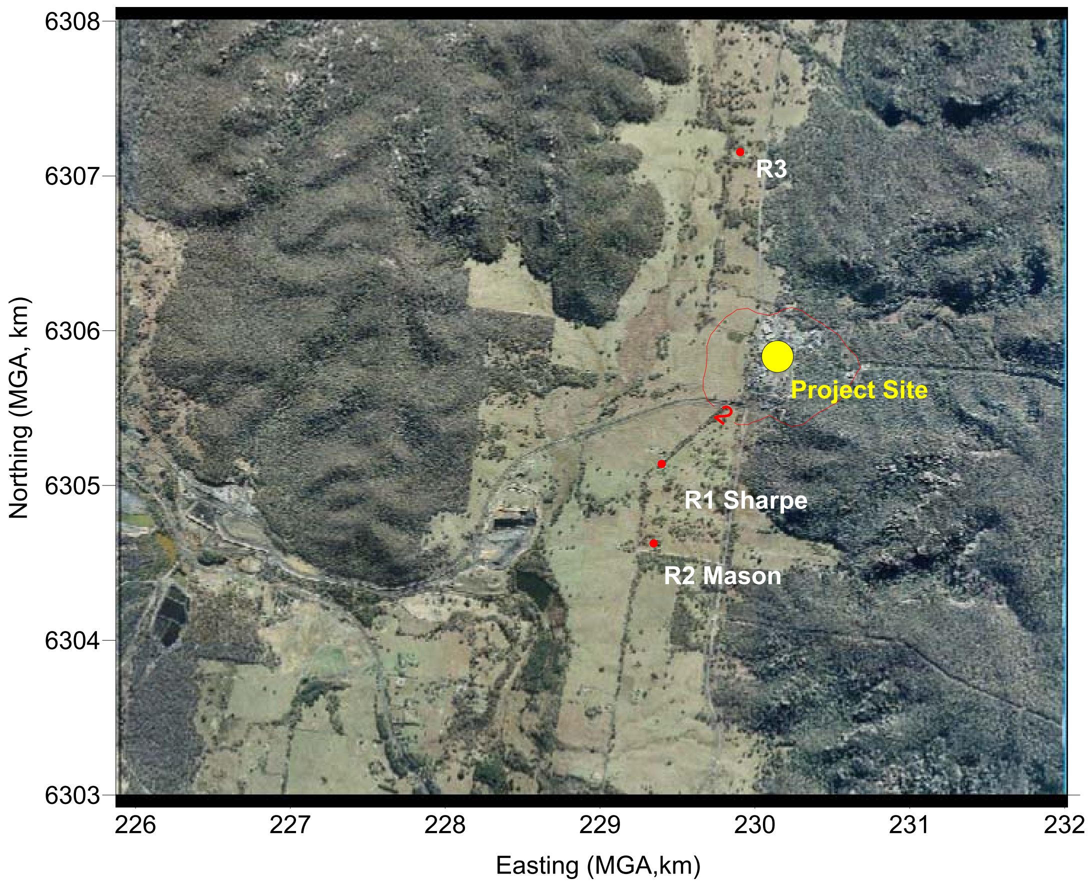
Table 14 shows the results of the dispersion modelling for dust deposition from the Project at each of the identified receptors using the emission rates calculated in **Appendix A**. For the purposes of this assessment receptors are defined as dwellings.

A contour plot of the incremental increase in dust deposition is presented in **Figure 11**. The contour plots are indicative of the levels of dust deposition that could potentially be reached under the meteorological conditions modelled.

Table 14 Background and incremental dust deposition at Sensitive Receivers

Residence ID	Dust Deposition Annual Average (g/m²/month)			
	background	increment	Background + increment	Assessment criterion
R1	1.0	0.4	1.4	3
R2	1.0	0.2	1.2	3
R3	1.0	0.3	1.3	3

Figure 11 Incremental Dust Deposition Contour Plot (g/m²/mth)



The results indicate that annual average dust deposition levels at all receptors surrounding the Project are predicted to below the Project criterion of 3 g/m²/month (cumulative dust deposition) when using a conservative background deposition level of 1.0 g/m²/month.

10.1.2 PM_{10}

Table 15 shows the results of the dispersion modelling for annual average PM_{10} from the Project at each of the identified receptors (see **Appendix A** for the emission rates input into the model).

Table 15 Annual Average PM_{10} Concentrations at Sensitive Receivers

Residence ID	PM_{10} - Annual Average (µg/m^3)			
	background	increment	Background + increment	Assessment criterion
R1	17.5	0.4	17.9	30
R2	17.5	0.2	17.7	30
R3	17.5	0.5	18.0	30

An annual average background concentration of 17.5 µg/m^3 has been applied to obtain an indication of the potential cumulative impacts associated with the Project and to allow comparison with the annual average PM_{10} criterion of 30 µg/m^3.

The results indicate that annual average PM_{10} levels at all receptors surrounding the Project are predicted to below the Project criterion of 30 µg/m^3.

Table 16 to **Table 18** present the results of the CALPUFF predictions for 24-hour PM_{10} at the residences nominated in **Section 4.4** (see **Appendix A** for the emission rates input into the model). The tables show the five highest maximum 24-hour average PM_{10} concentrations as well as the five highest predicted increment concentrations predicted at Receptors R1 to R3. It has been assumed that background levels of PM_{10} vary on a daily basis. This has been simulated by using daily monitoring data provided by the NSW DECCW, coupled with contemporaneous meteorological observations.

A contour plot of the worst case incremental 24-hour average PM_{10} at a sensitive receiver is presented in **Figure 12**. The contour plots are indicative of the levels of dust deposition that could potentially be reached under the meteorological conditions modelled.

Table 16 24-Hour Average PM_{10} Concentrations – R1

Date	PM_{10} 24-hour average (µg/m³)			Date	PM_{10} 24-hour average (µg/m³)		
	Background	Predicted increment	Total		Background	Highest predicted increment	Total
25/11/2006	45.7	<0.1	45.7	28/4/2006	22.4	8.4	30.8
29/11/2006	45.7	<0.1	45.7	18/6/2006	12.0	7.1	19.1
24/9/2006	45.3	<0.1	45.3	20/6/2006	13.5	6.6	20.1
21/11/2006	44.8	<0.1	44.8	18/5/2006	25.1	6.5	31.6
30/11/2006	43.9	2.5	46.4	16/5/2006	17.5	5.6	23.1

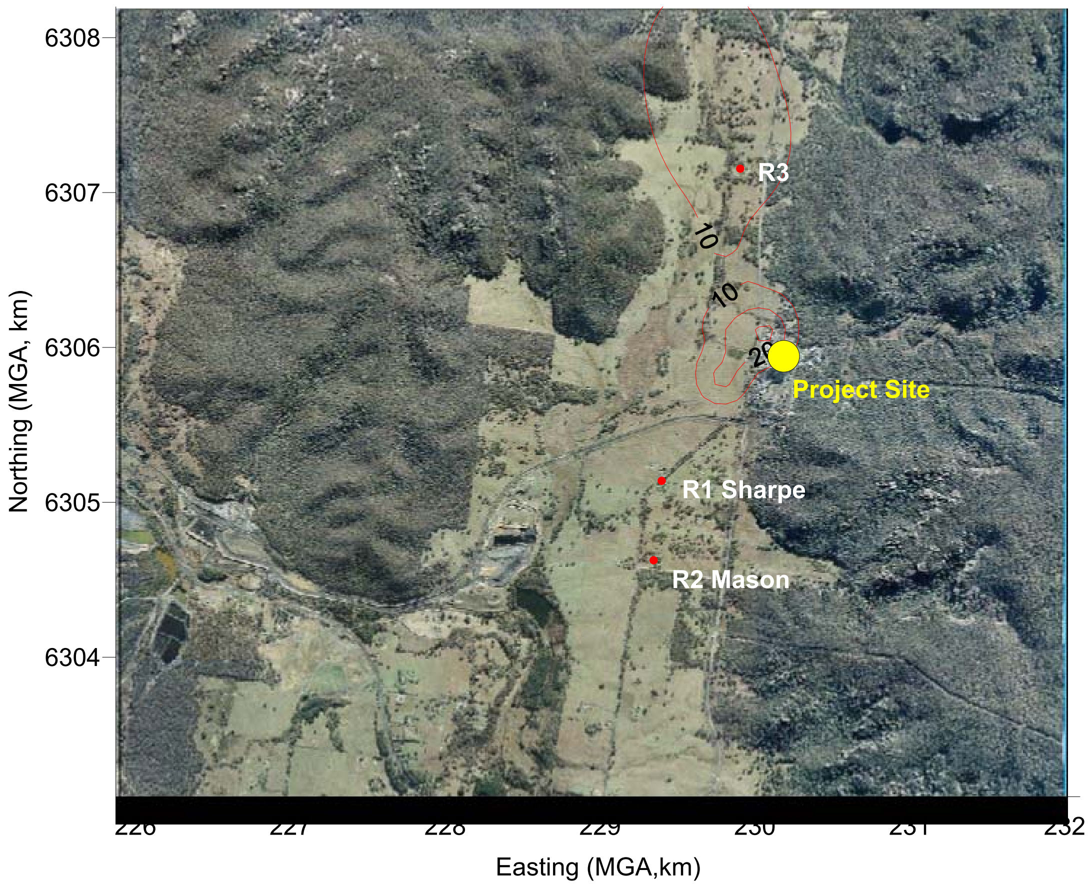
Table 17 24-Hour Average PM_{10} Concentrations – R2

Date	PM_{10} 24-hour average (µg/m³)			Date	PM_{10} 24-hour average (µg/m³)		
	Background	Predicted increment	Total		Background	Highest predicted increment	Total
25/11/2006	45.7	0.6	46.3	29/12/2006	19.4	3.3	22.7
29/11/2006	45.7	<0.1	45.7	15/2/2006	18.5	3.1	21.6
24/9/2006	45.3	<0.1	45.3	22/7/2006	9.6	3.0	12.6
21/11/2006	44.8	<0.1	44.8	19/6/2006	14.9	2.7	17.6
30/11/2006	43.9	0.7	44.6	4/10/2006	22.0	2.7	24.7

Table 18 24-Hour Average PM_{10} Concentrations – R3

Date	PM_{10} 24-hour average (µg/m³)			Date	PM_{10} 24-hour average (µg/m³)		
	Background	Predicted increment	Total		Background	Highest predicted increment	Total
25/11/2006	45.7	0.5	46.2	27/4/2006	17.2	17.9	35.1
29/11/2006	45.7	0.1	45.8	21/8/2006	16.9	13.7	30.6
24/9/2006	45.3	<0.1	45.3	15/9/2006	17.1	12.5	29.6
21/11/2006	44.8	<0.1	44.8	8/6/2006	9.7	9.3	19.0
30/11/2006	43.9	<0.1	43.9	26/6/2006	9.9	8.1	18.0

Figure 12 Worst Case Incremental 24-hr average PM_{10} Contour Plot ($\mu g/m^3$)



It is noted that **Figure 12** illustrates the worst case 24-hour average contour plot at a receiver. This correlates with an incremental increase of 17.9 $\mu g/m^3$ at receiver R3 (see **Table 18**).

Table 16 to **Table 18** differentiate between the five highest predicted maximum 24-hour average PM_{10} concentrations (background plus predicted increment) and the five highest predicted PM_{10} increment concentrations associated with the Project Site experienced by receptors surrounding the site. to **Table 18** that total 24-hour average PM_{10} (background plus predicted increment) are less than 50 µg/m^3 at all the nearest sensitive receptors.

10.1.3 TSP

Table 19 shows the results of the dispersion modelling for annual average TSP from the Project at each of the identified receptors (see **Appendix A** for the emission rates input into the model).

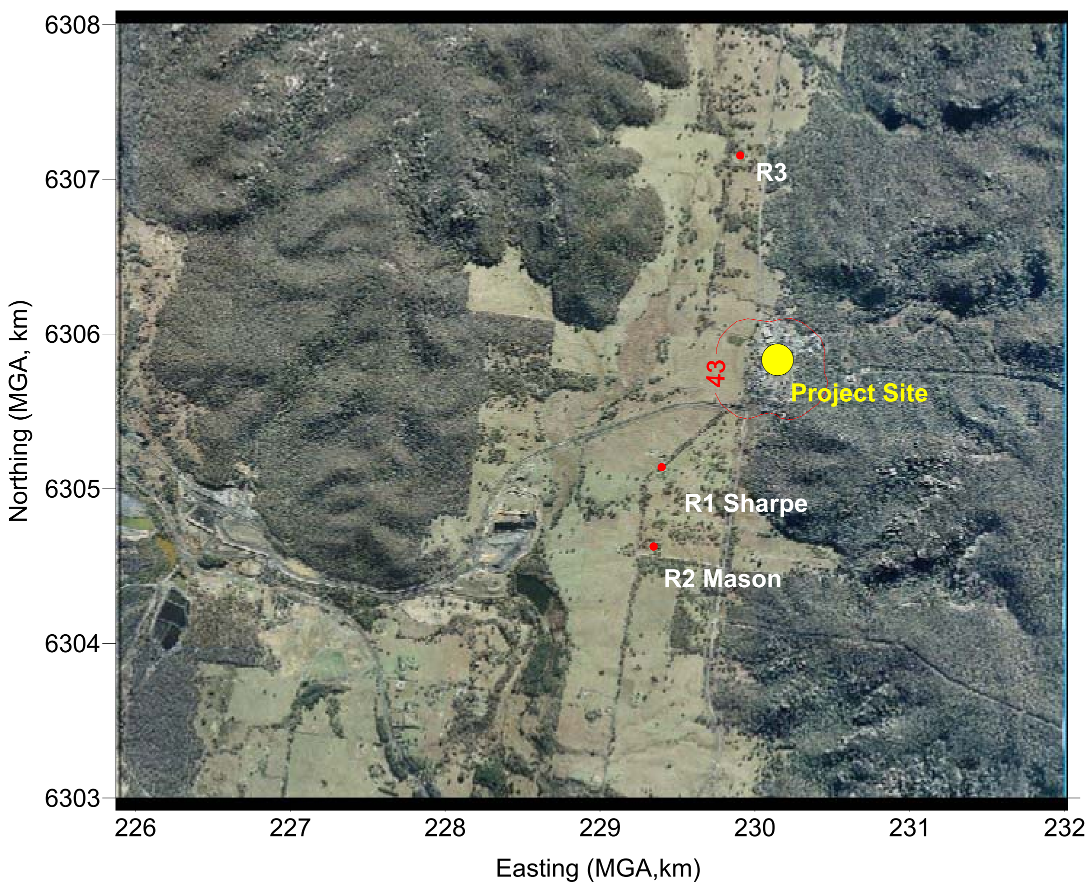
A contour plot of the worst case incremental annual average TSP is presented in **Figure 12**. The contour plots are indicative of the levels of TSP that could potentially be reached under the meteorological conditions modelled.

Table 19 Annual Average TSP Concentrations at Sensitive Receivers

Residence ID	TSP - Annual Average (µg/m³)			
	background	increment	Background + increment	Assessment criterion
R1	47.3	1.2	48.5	90
R2	47.3	0.6	47.9	90
R3	47.3	1.4	48.7	90

An annual average background concentration of 47.3 µg/m³ has been applied to obtain an indication of the potential cumulative impacts associated with the Project and to allow comparison with the annual average TSP criterion of 90 µg/m³.

Figure 13 Incremental Annual average TSP Contour Plot (µg/m³)



It is noted that the annual average TSP contour presented in **Figure 13** is set at 43 µg/m³. When considering the nominated TSP background of 47.3 µg/m³, the contour represents the area beyond which the project criterion is not is not exceeded.

The results indicate that annual average TSP concentrations at all receptors surrounding the Project are predicted to below the Project criterion of 90 µg/m³.

10.2 Air Quality Mitigation, Management and Monitoring Measures

As discussed in **Section 2.3**, Angus Place currently employs air quality mitigation and management measures at the Colliery which is considered to be generally best practice.

Specific air quality mitigation measures that were included in the dispersion modelling include:

- Permanent road sealing (asphalt seals);
- Dust suppressions;
- Enclosures on main conveyors;
- Belt cleaners at main conveyors;
- Enclosed coal chute at stacking conveyor discharge point;
- Watering of ROM coal handling areas; and
- Road sweeping.

11 GREENHOUSE GAS ASSESSMENT

A quantitative greenhouse gas assessment has been undertaken to estimate potential greenhouse gas (GHG) emissions associated with the Project.

Activity data for the following have been obtained from the Proponent:

- Total Run of Mine (ROM) Coal Production (tonnes[t]);
- Total Electricity Consumption (kilowatt-hours [kWh]);
- Total Diesel Consumption (litres[L]);
- Solid Waste to Landfill (t);
- Fugitive Emissions of Coal Seam Methane (CH_4) and CO_2 via ventilation shafts (m^3 and percentage content of CO_2 and CH_4 in ventilation return air);
- Emissions from use of sulphur hexafluoride (SF_6);
- Emissions from the use of Liquid Petroleum Gas (LPG);
- Emissions from the use of oils and greases (consumed without combustion); and,
- Weekly Total Employee Vehicle Movements.

Data have been sourced primarily from the Proponent provided spreadsheet 'ANG Greenhouse Report 2008-2009' with data on employee transport provided separately.

Data was made available for the period July 2008 to June 2009, being the most recent complete financial year of data which has been independently audited and verified to meet the requirements of the National Greenhouse and Energy Reporting System (NGERS) legislation. The product extracted during this reporting period was 2.2 million tonnes per annum (Mtpa). Data presented in this report for Scope 1 and 2 emissions is directly extracted from the Angus Place NGERS report for the July 2008 to June 2009 period and utilises NGERS emission factors, or other acceptable NGERS emission calculation methodologies. Scope 3 emissions have been calculated using proponent provided data, or activity data reported under NGERS in the case of diesel and electricity consumption.

To assess the GHG impact of the proposed Angus Place operations (to 4.0 Mtpa extraction rate), activity data has been scaled to reflect the proposed modified ROM extraction operations of 4.0 Mtpa as outlined in **Table 21**. Data has also been obtained from the Angus Place Energy Savings Action Plan (ESAP) to identify baseload and non baseload energy consumption.

11.1 Energy Saving Action Plan

The Energy Savings Action Plan (ESAP) for the Angus Place Colliery was provided by the Proponent (2010). The ESAP contains information on the energy consumption at the Project Site and also provides a breakdown of the main areas of energy consumption and how these are related to coal production. The ESAP covers the period 1 July 2007 to 30 June 2008 and relates to an annual coal production rate of 3.2 Mt.

The ESAP indicates that equipment which provides relatively constant demand regardless of coal production are items such as mine ventilation fans, surface facilities and air compressor pumping used in mine dewatering. These items operate 24 hours, 365 days per year and account for **46.6 %** of total energy used at the mine. This energy is considered to be a ***baseline energy usage*** and is not affected by changes in the production rate or schedule.

The remaining **53.4%** of energy usage is associated with activities which are directly related to production and will therefore change with production volumes.

The energy consumed at the Project Site is primarily diesel and electricity. The use of diesel is generally split between underground fleet (70%) and surface fleet (30%). A large proportion of the underground diesel consumption is used in the day to day transport of men, materials and equipment, which is not strongly linked to production. For the purposes of this assessment, the surface component of the diesel usage (30%) is assumed to be directly linked to production rates, with the remaining 70% used underground assumed to be a base load diesel usage.

According to the ESAP, electricity consumption during the year 1 July 2007 to 30 June 2008 was approximately 35.3 GWh. The main areas of electricity consumption are presented in **Table 20** which indicates that approximately 17 GWh (48%) of electricity usage is baseline usage with the remaining 18.3 GWh (52%) being directly related to production.

Table 20 Electricity Consumption at Angus Place Colliery (2007/2008 from ESAP Report)

Area	Consumption (GWh, [%])	Baseline or Production Related
Ventilation	11.72 (33%)	Baseline
Compressed Air	4.1 (12%)	Baseline
Surface Infrastructure	1.18 (3%)	Baseline
Coal Production Equipment	7.99 (23%)	Production
Underground Conveyors	6.9 (20%)	Production
Tertiary Crushing and Loading Plant	1.2 (3%)	Production
Other - unspecified	2.21 (6%)	Production

To assess the GHG impact of the proposed modification to the Angus Place operations (to 4.0 Mtpa extraction rate), activity data has been scaled as outlined in **Table 21**. Baseline diesel and electricity consumption has been taken into account, with the scaling factors applied only to the proportion of the energy usage which is directly related to production.

Table 21 Summary of Project Related Activity Data Relevant to GHG Emissions (Current and Proposed Operations)

Activity	Quantity (Current Project Operations – July 2008 to June 2009 [2.2 Mtpa])	Quantity (Modified Project Operations [4.0 Mtpa])	Scaling Factor Applied
Annual ROM production (Mt)	2.2 Mtpa	880,000	1.82 (4.0 Mt/2.2 Mt)
Annual Electricity Consumption (kWh)	36,626,143	56,683,896	1.82 applied to non-baseload use
Annual Diesel Consumption (litres)	517,059	643,973	1.82 applied to non-baseload use
Annual Fugitive Emissions from Mine Ventilation Shaft (Million m^3)	84,968	84,968	Assumed no change in volume or composition (CO_2 – 0.19%, CH_4 – 0.01%)
Solid Waste to Landfill (t)	385	385	Assumed no change in waste generation
Sulphur hexafluoride (SF_6) (kg)	7.413	7.413	Assumed no change
Liquid Petroleum Gas (LPG) (kg)	200	200	Assumed no change
Petroleum Based Oil/ greases used (L)	124,000	124,000	Assumed no change
Employee Vehicle Movements	11,648	11,648	Assumed no change in employee numbers

11.2 Direct and Indirect Emissions (Emissions Scope)

National Greenhouse and Energy Reporting Regulations 2008 defines scope 1 and scope 2 emissions as;

Division 2.5 Meaning of *emissions*, production and consumption: section 10

2.23 Meaning of *emissions*, *production* and *consumption*

(2) ***Emissions*** of greenhouse gas, in relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of one of the following:

(a) an activity, or series of activities (including ancillary activities) that constitute the facility (***scope 1 emissions***);

(b) 1 or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility (***scope 2 emissions***).

Meaning of production

(3) ***Production*** of energy, in relation to a facility, means 1 of the following:

(a) the extraction or capture of energy from natural sources for final consumption by or from the operation of the facility or for use other than in the operation of the facility;

(b) the manufacture of energy by the conversion of energy from 1 form to another form for final consumption by or from the operation of the facility or for use other than in the operation of the facility.

Note 1: Emissions from the use of petroleum based oils/ greases not reported in 2008/2009 however may be required in future

Meaning of consumption

(4) ***Consumption*** of energy, in relation to a facility, means the use or disposal of energy from the operation of the facility including own-use and losses in extraction, production and transmission.

The NGERS legislation does not include scope 3 emissions.

The National Greenhouse Accounts workbook (NGA) the methodology used for estimating scope 3 emissions in this assessment is defined as follows:

- *Various emission factors can be used to calculate scope 3 emissions. For ease of use, this workbook reports specific 'scope 3' emission factors for organisations that:*
  - *(a) burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or*
  - *(b) consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the T&D network.*

It is noted that Angus Place Colliery has a restricted capacity to reduce their GHG emissions under Scope 3. Reductions in the emissions of GHG resulting from the extraction and transport of fossil fuels for use in electricity production or onsite diesel combustion are beyond the control of Angus Place Colliery but are reported here for completeness, as required by the Department of Planning.

11.3 Greenhouse Gas Calculation Methodology

Quantification of potential Project emissions has been undertaken in relation to both carbon dioxide (CO_2) and other non-CO_2 greenhouse gas emissions.

For comparative purposes, non-CO_2 greenhouse gases are awarded a "CO_2-equivalence" (CO_2-e) based on their contribution to the enhancement of the greenhouse effect. The CO_2-e of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-CO_2 greenhouse gases are contained within the Intergovernmental Panel on Climate Change (IPCC), (1996) document "*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*".

The GWPs of relevance to this assessment are:

- methane (CH_4): GWP of 21 (21 times more effective as a greenhouse gas than CO_2);
- nitrous oxide (N_2O): GWP of 310 (310 times more effective as a greenhouse gas than CO_2); and,
- Sulphur hexafluoride (SF_6): GWP of 23,900 (23,900 times more effective as a greenhouse gas than CO_2).

The short-lived gases such as carbon monoxide (CO), nitrogen dioxide (NO_2), and non-methane volatile organic compounds (NMVOCs) vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

The greenhouse gas emissions associated with the modified Project have been assessed in terms of direct (Scope 1) emission potential, indirect (Scope 2) emission potential and significant upstream/downstream (Scope 3) emission potential.

A summary of the potential Project GHG emission sources is provided in **Table 22**.

Table 22 Summary of Potential Project Greenhouse Gas Emissions

Project Component	Direct Emissions	Indirect Emissions	
	Scope 1	**Scope 2**	**Scope 3**
Fugitive Emissions	Emissions from the release of coal seam methane and carbon dioxide as a result of extraction activities.	N/A	N/A
Diesel	Emissions from the combustion of diesel at the Project in both mobile and fixed plant and equipment (Includes ROM coal transport by coal haulage contractor)	N/A	Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Project Site.
Liquid petroleum gas	Emissions from the combustion of LPG at the Project in mobile equipment	N/A	N/A
Consumption of sulphur hexafluoride	Consumption of SF_6 for gas insulated switchgear and circuit breaker applications	N/A	N/A
Use of Oils and Greases	Consumption (non combustion) of oils and greases	N/A	N/A
Electricity	NA	Emissions associated with the consumption of generated and purchased electricity at the Project Site.	Estimated emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed at the Project Site and the electricity lost in delivery in the transmission and distribution network.
Coal Combustion	N/A	N/A	Emissions from the combustion of coal from the Project.

N/A = Not applicable

Fugitive emissions - Coal Seam Methane and Carbon Dioxide

The process of coal formation creates significant amounts of CH_4. Some of this CH_4 remains trapped in the coal until the pressure on the coal is reduced, which occurs during the coal mining process. The stored CH_4 is then released to the atmosphere.

Fugitive emissions from extraction of coal as defined by NGERS were estimated for the 08-09 financial year using Method 4, subdivision 3.2.2.2 of the NGERS Measurement Determination 2008.

It is assumed that based on the mine being non gassy and additionally that in association with the planned production there will be no increase in ventilation required and therefore no increase in fugitive emissions will result from the project modifications

Diesel Usage

The primary fuel source for the vehicles operating at the Project Site is diesel. Diesel consumption for all mobile and fixed equipment is calculated as 517,059 (L) used in the underground operation in the assessment year (July 2008 to June 2009). Based on the adopted scaling factor of 1.82, applied only to non-baseload diesel consumption) the estimated diesel consumption resulting from modified Project operations for all mobile and fixed equipment is assumed to be 643,973 L per annum.

Scope 1 emissions from use of diesel fuel as defined by NGERS were estimated for the 08-09 financial year using Method 1, Division 2.4.2 section 2.41 of the NGERS Measurement Determination 2008.

Liquid Petroleum Gas

LPG used on site is related to periodic use for staff amenities

LPG consumption is estimated as 200 kg per annum, which is not expected to change due to the modified Plant operations.

Scope 1 emissions from use of LPG as defined by NGERS were estimated for the 08-09 financial year using Method 1, Division 2.4.2 section 2.41 of the NGERS Measurement Determination 2008.

Emissions of Sulphur Hexafluoride

Sulphur hexafluoride (SF_6) is used in gas insulated switchgear and circuit breaker applications on site.

The stock of SF_6 for the financial year 08-09 is estimated as 7.413 kg per annum, which is not expected to change due to the modified Project operations.

Scope 1 emissions from use of SF_6 as defined by NGERS were estimated for the 08-09 financial year using Method 1, Division 2.48A of the NGERS Measurement Determination.

It has been assumed that the leakage rate from switchgear is 0.5% per annum as per Table 25 of the NGA Factors Workbook (2009).

11.3.1 Scope 2: Indirect Emissions through the Consumption of Purchased Electricity

Scope 2 GHG emissions as defined by NGERS were estimated for the 08-09 financial year using Method 1, Chapter 7, section 7.2 of the NGERS Measurement Determination 2008

State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

Electricity consumption at the Project Site has been calculated as (approximately) 36.6 Megawatt-hours (MWh) in the current year of mining (July 2008 to June 2009). Based on the adopted scaling factor of 1.82 (applied to non-baseload electricity consumption only) the estimated electricity consumption resulting from modified Project operations is assumed to be (approximately) 52.6 MWh per annum.

The emission factor for Scope 2 (0.89 tonnes of CO_2-equivalents per kilowatt hour [t CO_2-e/kWh]) represents the consumption of purchased electricity in NSW.

11.3.2 Scope 3: Other Indirect Emissions

As discussed previously, Scope 3 emissions of GHG attributable to the Project are reported for completeness. Angus Place Colliery has a restricted capacity to reduce their GHG emissions under Scope 3. Reductions in the emissions of GHG resulting from the extraction and transport of fossil fuels for use in electricity production or onsite diesel combustion are beyond the control of Angus Place Colliery. Also beyond the control of Angus Place Colliery are the operations of coal consumers.

Combustion of Product Coal

Indirect emissions of GHG from the combustion of product coal are expected "downstream" due to the combustion of coal produced by the Project. Up to 4.0 Mtpa of ROM coal may be produced by Angus Place during a year which does not experience a longwall changeover, with the majority destined for the domestic energy generation sector, specifically Mt Piper and Wallerawang Power Stations.

This calculation assumes that 100% of ROM coal produced by the Project is combusted to produce electricity at Mt Piper and Wallerawang Power Stations.

The GHG emissions from combustion of product coal by other (non-Angus Place Colliery) entities have been based on a coal energy content of 27 GJ/t for thermal (black coal) (Table 1 of the NGA Factors).

It is noted that no Scope 3 emission factor exists for black coal used for electricity generation purposes within the most recent (June 2009) version of the NGA Factors. In this instance, the Scope 3 emission factor for "Black coal for electricity NSW" published in Table 1 of the January 2008 version of the NGA Factors has been used within this assessment.

Extraction, Production and Transport of Fuel Burned for the Generation of Electricity and Electricity Consumed in the Transmission and Distribution System

The NGA Factors provides Scope 3 emission factors for the consumption of purchased electricity by each state. State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

The NSW Scope 3 emission factor (0.18 kg CO_2-e/kWh) covers both the emissions from the extraction, production and transport of fuels used in the production of the purchased electricity (i.e. fugitive emissions and stationary and mobile fuel combustion emissions) and also the emissions associated with the electricity lost in transmission and distribution on route to the customer. In this report, Scope 2 and 3 emissions for the consumption of purchased electricity have been reported separately so that the share of the transport and distribution loss can be correctly attributed under Scope 3 emissions - Generation of Electricity Consumed in a transmission and distribution system.

Extraction, Production and Transport of Diesel Consumed at the Project

Scope 3 GHG emissions attributable to diesel used at the Project relate to its extraction, production and transport.

The annual emissions of CO_2 and other GHG from this source have been estimated using Table 38 of the NGA Factors, an emission rate of 5.3 kg CO_2-e/GJ and an assumed energy content of Diesel of 38.6 GJ/kL.

Employees Commuting To and From Work

Fuel usage and consequent GHG emissions attributable to company employees commuting to and from work can be reported under Scope 3 GHG emissions. Data has been provided by the Proponent on the assumed number of vehicle trips undertaken by mine employees per week. It has been assumed that the number of trips per week will be 224 vehicle movements per week or 11,648 movements per year (one way).

43% of staff originate from Lithgow. This is by far the most dominate location where staff originate from. It has therefore been assumed that all employee vehicle trips originate in Lithgow, approximately 19.5 km to the southeast of the Project Site. Assuming that all employee-owned vehicles have a fuel efficiency of 10 L/100 km and operate on diesel as a *worst case assumption*, the total annual diesel consumption by employee owned vehicles would be 1,423L per annum.

The annual emissions of CO_2 and other GHG from this source have been estimated using Table 38 of the NGA Factors, an emission rate of 5.3 kg CO_2-e/GJ and an assumed energy content of Diesel of 38.6 GJ/kL.

Waste Generation

Solid waste generated at the Project Site and disposed of in landfill between July 2008 and June 2009 totalled 315 tonnes. It has been assumed that generation of waste is independent of ROM production and, assuming that full time employee numbers will increase by only 10 during the proposed modification, waste generation is assumed to remain at 315 tonnes per annum.

Waste sent to landfill results in emissions of CH_4 as waste is degraded. Table 42 of the NGA Factors provides GHG emission factors based on broad waste streams (municipal solid waste, commercial and industrial waste and construction and demolition waste). To provide a worst case assessment of GHG emissions from waste sent to landfill, the emission rate for commercial and industrial waste (1.1 t CO_2-e / tonne waste) has been used within this assessment.

Extraction, Production and Transport of Diesel Consumed at the Modified Project

Scope 3 greenhouse gas emissions attributable to diesel used at the modified Project relate to its extraction, production and transport.

The annual emissions of CO_2 and other greenhouse gases from this source have been estimated using Table 38 of the NGA Factors (DCC, 2009).

Sources not Included

The following Scope 3 GHG emission sources were not included within the assessment:

- Employee business travel; and
- Outsourced activities.

11.4 Greenhouse Gas Calculation Results

Calculated Scope 1, Scope 2 and Scope 3 emissions of greenhouse gas resulting from the emissions sources outlined above for the existing (July 2008 to June 2009, 2.2 Mtpa ROM extraction rate) and modified Project (4.0 Mtpa ROM extraction rate) are presented in **Table 23.**

11.4.1 Scope 1 Emissions Estimations

Direct (Scope 1) GHG emissions (CO_2-e) resulting from modified Project operations are estimated to be 26,323 t per annum, an increase of approximately 343 tonnes per annum.

11.4.2 Scope 2 Emissions Estimations

Indirect (Scope 2) GHG emissions (CO_2-e) resulting from modified Project operations are estimated to be 46,888 tonnes per annum, an increase of approximately 14,291 tonnes per annum on current operations.

11.4.3 Scope 3 Emissions Estimations

Indirect (Scope 3) GHG emissions (CO_2-e) resulting from modified Project operations are estimated to be 1,023,210 tonnes per annum, an increase of approximately 440,640 tonnes per annum on current operations. The increased emissions are due to increases in diesel and electricity consumption and combustion of coal by third parties. No significant increases result from employee vehicle use or waste generation as these activities remain are similar between the current and modified scenarios.

Table 23 Summary of GHG Emissions Attributable to the Project (Current and Modified)

Emissions Scope	Emissions Source	Activity Data		Activity Rate	Emission Factor (CO_2-e)			Total Emissions (t CO_2-e/annum)	
		Current	Modification		Emission Factor	Units	Source	Current	Modification
Scope 1	Fugitive Emissions [1]	2,228,214	4,000,000	tpa ROM	-	-	NGERS method 4	24,450	24,450
	Diesel Combustion	517	644	kL/annum	69.9[2]	kg CO_2-e /GJ	NGERS method 1 / Table 4 NGA Factors	1,395	1,738
	LPG consumption	0.39	0.39	kL/annum	60.8	kg CO_2-e/GJ	NGERS method 1 / Table 4 NGA Factors	0.6	0.6
	Use of sulphur hexafluoride	7.413	7.413	kg/annum	23.9	t CO2 /kg	NGERS method 1 / App 1 NGA Factors [3]	0.9	0.9
	Use of oils / grease	124	124	kL/annum	1.08	t CO2 /kL	NGERS method 1	134	134
Sub-Total Scope 1								**25,980.5**	**26,323.5**
Scope 2	Electricity Consumption	36.6	52.6	MWh/annum	0.89	kg CO_2-e /kWh	NGERS method 1 / Table 5 NGA Factors	32,597	46,888
Sub-Total Scope 2								**32,597**	**46,888**
Scope 3	Diesel Combustion	517	644	kL/annum	5.3[2]	kg CO_2-e /GJ	Appendix 4 Table 39 NGA Factors	106	132
	Electricity Consumption	36.6	52.6	MWh/annum	0.18	kg CO_2-e /kWh	Appendix 4 Table 39 NGA Factors	6,593	9,843
	Waste Generation	385	385	t/annum	1.1	t CO_2-e / t waste	Appendix 4 Table 42 NGA Factors	423	423
	Employee	1,424	1,424	L/annum	5.3	kg CO_2-e /GJ	Appendix 4	0.3	0.3

Emissions Scope	Emissions Source	Activity Data		Activity Rate	Emission Factor (CO_2-e)			Total Emissions (t CO_2-e/annum)	
		Current	Modification		Emission Factor	Units	Source	Current	Modification
	Transport						Table 38 NGA Factors		
	Coal Combustion	2,200,000	4,000,000	tpa ROM	8.7[4]	kg CO_2-e /GJ	Table 1 NGA Factors (January 2008)	516,870	939,600
Sub-Total Scope 3								**523,992**	**949,998**
TOTAL								**582,570**	**1,023,210**

Note 1: Fugitive emissions are related to the ventilation data viz, Flow, Pressure, Temperature and gas % and it is considered that these parameters and therefore the fugitive emissions will not change materially with the proposed additional production. Emissions are as reported for Angus Place during the 08/09 year under NGERS using NGERS Method 4

Note 2: For transport energy purposes

Note 3: includes leakage factor of 0.5% as per Table 25 of NGA Workbook

Note 4: Black Coal used in electricity generation assumed to have an energy content of 27 GJ/t as per Table 1 of the NGA Factors

11.5 Comparison with National and State GHG Emissions

The estimated annual emissions associated with the modified Project are presented in **Table 24**.

Table 24 Scope 1, 2 and 3 GHG Emissions Estimated to Result from Modified Project Operation (t CO_2-e / annum)

Emission Scope	Estimated Emissions (t CO_2-e/annum)
1	26,324
2	46,888
3	949,998
TOTAL	**1,023,210**

Emissions of GHG in NSW were reported to be 163 Mt in 2007, 27% of the Australian total GHG emissions of 597 Mt. Comparison of the emissions attributable to the modified Project with NSW and Australia emission totals is presented in **Table 25**

Table 25 Comparison of Modified Project GHG Emissions with State and National Totals 2007

Emission Scope	Estimated Emissions (tCO_2-e/annum)	Percentage of NSW 2007 GHG Emission Total	Percentage of Australian 2007 GHG Emission Total
1	26,324	0.0016	0.0044
TOTAL (1,2 and 3)	1,023,210	0.63	0.17

11.6 Greenhouse Gas Mitigation Measures

Angus Place Colliery is currently implementing a number of measures to minimise to the greatest extent practicable GHG emissions from the Colliery. Relevant measures are described below:

- Maximising energy efficiency as a key consideration in the development of the mine plan. For example, significant savings of greenhouse gas emissions (through increased energy efficiency) are achieved by mine planning decisions which minimise transportation distances for ROM coal and therefore fuel use.
- The Project Site has developed and implemented an Energy and Greenhouse Management System and monitors and reports energy usage at the Colliery. KPI's including energy demand and GHG emissions per tonne of ROM coal produced are tracked.

Additional measures that Angus Place Colliery are striving to achieve include:

- Utilise ventilation modelling to identify opportunities to reduce ventilation flow thus energy used by main fan as the production areas become closer to the mine pit bottom and ventilation circuit resistance is lowered;
- Identify and implement cost effective measures to improve energy efficiency;
- Regular maintenance of plant and equipment to minimise fuel consumption; and
- Consideration of energy efficiency in plant and equipment selection/phase.

12 CONCLUSIONS

Modelling of potential mining fugitive dust and PM_{10} emissions was undertaken using the CALPUFF Dispersion Model software approved by the DECCW.

One (1) scenario was modelled to represent potential Project emissions:

The findings of the modelling exercise indicate that the Project would generally comply with the relevant criteria. In summary:

- Dust deposition levels are predicted to be below the Project air quality criteria at all surrounding dwellings.
- Cumulative annual average PM_{10} and TSP concentrations are predicted to be below the Project air quality goal at all surrounding dwellings.
- Incremental maximum 24-hour PM_{10} concentrations attributable to the Project are predicted to be well below the Project air quality goals at the majority of surrounding dwellings.

The modelling methodology contains a number of assumptions which mean that conservative 'worst case' scenarios were modelled. Therefore, all particulate predictions should be viewed as conservative, with levels expected to be lower than those modelled during standard operations.

The assessment also considers emissions of CH_4 and CO_2 from the proposed Project and includes estimates of direct and indirect GHG emissions.

The total lifetime direct (Scope 1) emissions from the Project are estimated to be approximately 26,324 CO_2-e in any one year.

Indirect (Scope 2 and 3) emissions would be released in the process of mining coal, and through the transport and end use of the coal. The total lifetime indirect emissions (Scope 2 and 3) from mining coal and end use of the coal are estimated to be 996,886 t CO_2-e, per annum.

13 REFERENCES

The following material has been referenced within this report:

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14 GLOSSARY AND TERMS

AHD	Australian Height Datum
AEMR	Annual Environmental Management Report
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
CH_4	Methane
CHPP	Coal Handling and Preparation Plant
CO2	carbon dioxide
CO_2-e	Carbon dioxide equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSM	Coal seam methane
DECCW	NSW Department of the Environment, Climate Change and Water
GHG	Greenhouse gas
g/m^2/month	Grams per square metre per month
HVAS	High volume air sampler
µg	Microgram (g x 10^{-6})
µm	Micrometre or micron (metre x 10^{-6})
m^3	Cubic metre
MGA	Map Grid of Australia
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NMHC	Non methane hydrocarbon
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
ROM	Run of mine
TAPM	“The Air Pollution Model”
tpa	Tonnes per annum
TSP	Total suspended particulate
USEPA	United States Environmental Protection Agency

Appendix A

Emissions Inventory

Angus Place Expansion Project	**Source ID**	**Moisture content (%)**	**Silt Content (%)**	**TSP Emission Factor**	**PM_{10} Emission Factor**	**Emission Factor Units**	**Notes/Controls**	**Emission Reduction from controls**	**Throughput (tonnes per hour)**	**Number of Hectares of stockpile**	**Average number of kilometres per hour**	**Working days available**	**Working hours per day**	**TSP Emission Rate (mg/s)**	**PM_{10} Emission Rate (mg/s)**	**TSP Emission Flux ($mg/s/m^2$)**	**PM_{10} Emission Flux ($mg/s/m^2$)**	**Easting**	**Northing**	**width**	**length**	**operational area**	**Equivalent circle diameter**	**height**	**radius**	**Sigma Y**
Particulate Generating Activities																										
Dozer- Stockpile management	FELsto	10	6	12.168	3.704	kg/h			N/A	N/A	N/A	365	24	3380.10	1028.79	N/A	N/A	230148	6305796	3	7	8400	103	3	N/A	3.5
Excavator- Stockpile management	Excasto	10	N/A	0.012	0.006	kg/t			457	N/A	N/A	365	24	1484.65	713.77	N/A	N/A	230121	6305856	3	7	8400	103	3	N/A	3.5
Conveying (two sources)	Conve	10	N/A	0.0050	0.002	kg/t	conveying	70%	457	N/A	N/A	365	24	190.26	76.10	N/A	N/A	varies	varies	2.5	0.4	1	1	8	N/A	0.2
Loading stockpiles (via conveyor)	LoaSto	N/A	N/A	0.004	0.002	kg/t	Water sprays	50%	457	N/A	N/A	365	24	253.68	107.81	N/A	N/A	230111	6305844	2	2	4	2	8	N/A	1
Truck loading (from loading chute)	TruLoa	N/A	N/A	0.0004	0.0002	kg/t			457	N/A	N/A	365	24	50.74	21.56	N/A	N/A	229944	6305658	1	1	1	1	3	N/A	0.5
Stockpiles and Exposed areas																										
Main Stockpile Wind Erosion	Mstoc	N/A	6	0.05	0.03	kg/ha/hr			N/A	0.77	N/A	N/A	N/A	N/A	N/A	1.07E-03	6.42E-04	230134	6305836	112	75	8400	103	15	N/A	37.5
Stockpile and Exposed area	StoExp	N/A	6	0.05	0.03	kg/ha/hr			N/A	0.12	N/A	N/A	N/A	N/A	N/A	1.67E-04	1.00E-04	229965	6305649	30	30	900	34	4	N/A	15

Calpuff Input and Output File

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 INPUT GROUP: 1 -- General run control parameters
 --------------

     Option to run all periods found
     in the met. file     (METRUN)   Default: 0       ! METRUN = 1 !

          METRUN = 0 - Run period explicitly defined below
          METRUN = 1 - Run all periods in met. file

      Starting date:   Year (IBYR) -- No default       ! IBYR = 2007 !
      (used only if   Month (IBMO) -- No default       ! IBMO = 0 !
       METRUN = 0)      Day (IBDY) -- No default       ! IBDY = 0 !
                       Hour (IBHR) -- No default       ! IBHR = -1 !

      Base time zone        (XBTZ) -- No default       ! XBTZ = -10 !
         PST = 8., MST = 7.
         CST = 6., EST = 5.

      Length of run (hours) (IRLG) -- No default       ! IRLG = 1 !
```

```
Number of chemical species (NSPEC)
                                Default: 5       ! NSPEC = 2 !

Number of chemical species
to be emitted  (NSE)            Default: 3       ! NSE = 2 !

Flag to stop run after
SETUP phase (ITEST)             Default: 2       ! ITEST = 2 !
(Used to allow checking
of the model inputs, files, etc.)
      ITEST = 1 - STOPS program after SETUP phase
      ITEST = 2 - Continues with execution of program
                  after SETUP

Restart Configuration:

   Control flag (MRESTART)      Default: 0       ! MRESTART = 0 !

      0 = Do not read or write a restart file
      1 = Read a restart file at the beginning of
          the run
      2 = Write a restart file during run
      3 = Read a restart file at beginning of run
          and write a restart file during run

   Number of periods in Restart
   output cycle (NRESPD)        Default: 0       ! NRESPD = 0 !

      0 = File written only at last period
     >0 = File updated every NRESPD periods

Meteorological Data Format (METFM)
                                Default: 1       ! METFM = 3 !

      METFM = 1 - CALMET binary file (CALMET.MET)
      METFM = 2 - ISC ASCII file (ISCMET.MET)
      METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
      METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                  surface parameters file (SURFACE.DAT)
      METFM = 5 - AERMET tower file (PROFILE.DAT) and
                  surface parameters file (SURFACE.DAT)

Meteorological Profile Data Format (MPRFFM)
       (used only for METFM = 1, 2, 3)
                                Default: 1       ! MPRFFM = 1 !

      MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
      MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
Averaging Time (minutes) (AVET)
                                Default: 60.0    ! AVET = 60 !
PG Averaging Time (minutes) (PGTIME)
                                Default: 60.0    ! PGTIME = 60 !
```

```
!END!

-------------------------------------------------
NOTICE: Starting year in control file sets the
        expected century for the simulation.  All
        YY years are converted to YYYY years in
        the range:  1957 2056
-------------------------------------------------



-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                   Default: 1     ! MGAUSS = 1 !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                              Default: 3     ! MCTADJ = 3 !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                          Default: 0     ! MCTSG = 0 !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated 0 (MSLUG)                   Default: 0     ! MSLUG = 0 !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled ?
     (MTRANS)                              Default: 1     ! MTRANS = 1 !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)            Default: 1     ! MTIP = 1 !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to simulate building
     downwash? (MBDW)                      Default: 1     ! MBDW = 1 !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                   Default: 0     ! MSHEAR = 0 !
        0 = no  (i.e., vertical wind shear not modeled)
```

```
   1 = yes (i.e., vertical wind shear modeled)

Puff splitting allowed? (MSPLIT)      Default: 0     ! MSPLIT = 0 !
   0 = no (i.e., puffs not split)
   1 = yes (i.e., puffs are split)

Chemical mechanism flag (MCHEM)       Default: 0     ! MCHEM = 0 !
   0 = chemical transformation not
       modeled
   1 = transformation rates computed
       internally (MESOPUFF II scheme)
   2 = user-specified transformation
       rates used
   3 = transformation rates computed
       internally (RIVAD/ARM3 scheme)
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM = 0 !
   0 = aqueous phase transformation
       not modeled
   1 = transformation rates adjusted
       for aqueous phase reactions

Wet removal modeled ? (MWET)          Default: 1     ! MWET = 0 !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY = 1 !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)

Method used to compute dispersion
coefficients (MDISP)                  Default: 3     ! MDISP = 3 !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW = 3 !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
```

```
        (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 = 3 !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY = 0 !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 <Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV = 0 !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 <Direct user input (s)   -- e.g., 300


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB = 1 !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH = 0 !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL = 1 !
elevated inversion?
(MPARTL)
```

```
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV = 0 !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF = 0 !
(MPDF)
   0 = no
   1 = yes

Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0 !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0 !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                      Default: 0     ! MFOG = 0 !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                        Default: 1     ! MREG = 0 !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                  METFM    1 or 2
                  AVET     60. (min)
```

```
PGTIME   60. (min)
MGAUSS   1
MCTADJ   3
MTRANS   1
MTIP     1
MCHEM    1 or 3 (if modeling SOx, NOx)
MWET     1
MDRY     1
MDISP    2 or 3
MPDF     0 if MDISP=3
         1 if MDISP=2
MROUGH   0
MPARTL   1
SYTDEP   550. (m)
MHFTSZ   0
```

```
!END!

--------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          TSP !            !END!
! CSPEC =         PM10 !            !END!


                                                               Dry
OUTPUT GROUP
     SPECIES          MODELED          EMITTED       DEPOSITED
NUMBER
      NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,
(0=NONE,
    (Limit: 12                                        1=COMPUTED-GAS
1=1st CGRUP,
     Characters                                       2=COMPUTED-PARTICLE
2=2nd CGRUP,
     in length)                                       3=USER-SPECIFIED)     3=
etc.)

!          TSP  =          1,               1,           2,                  0
!
!         PM10  =          1,               1,           2,                  0
!


!END!

-------------
```

```
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.



--------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST = 0 !
     (FNORTH)                   Default=0.0     ! FNORTH = 0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN = 56 !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = S !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 0N !
     (RLON0)                    No Default      ! RLON0 = 0E !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
```

```
              RLAT0 is REPLACED by 0.0N (Equator)
       LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
              RLAT0 identifies latitude of tangent-point of mapping plane

   Matching parallel(s) of latitude (decimal degrees) for projection
   (Used only if PMAP= LCC or PS)
   (XLAT1)                    No Default      ! XLAT1 = 30N !
   (XLAT2)                    No Default      ! XLAT2 = 60N !

       LCC :  Projection cone slices through Earth's surface at XLAT1 and
XLAT2
       PS  :  Projection plane slices through Earth at XLAT1
              (XLAT2 is not used)

   ----------
   Note:  Latitudes and longitudes should be positive, and include a
          letter N,S,E, or W indicating north or south latitude, and
          east or west longitude.  For example,
          35.9  N Latitude  =  35.9N
          118.7 E Longitude = 118.7E


   Datum-region
   ------------

   The Datum-Region for the coordinates is identified by a character
   string.  Many mapping products currently available use the model of the
   Earth known as the World Geodetic System 1984 (WGS-84 ).  Other local
   models may be in use, and their selection in CALMET will make its output
   consistent with local mapping products.  The list of Datum-Regions with
   official transformation parameters provided by the National Imagery and
   Mapping Agency (NIMA).

   NIMA Datum - Regions(Examples)
   --------------------------------------------------------------------------
----
   WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
   NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
   NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
   NWS-84    NWS 6370KM Radius, Sphere
   ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

   Datum-region for output coordinates
   (DATUM)                    Default: WGS-84     ! DATUM = WGS-84 !


 METEOROLOGICAL Grid:

   Rectangular grid defined for projection PMAP,
   with X the Easting and Y the Northing coordinate

          No. X grid cells (NX)      No default     ! NX = 40 !
          No. Y grid cells (NY)      No default     ! NY = 40 !
       No. vertical layers (NZ)      No default     ! NZ = 1 !

         Grid spacing (DGRIDKM)      No default     ! DGRIDKM = 0.2 !
                                     Units: km
```

```
               Cell face heights
                   (ZFACE(nz+1))      No defaults
                                      Units: m
   ! ZFACE =  0.0, 3000.0 !

           Reference Coordinates
          of SOUTHWEST corner of
               grid cell(1, 1):

           X coordinate (XORIGKM)     No default     ! XORIGKM = 225.7 !
           Y coordinate (YORIGKM)     No default     ! YORIGKM = 6302 !
                                     Units: km
```

COMPUTATIONAL Grid:

The computational grid is identical to or a subset of the MET. grid. The lower left (LL) corner of the computational grid is at grid point (IBCOMP, JBCOMP) of the MET. grid. The upper right (UR) corner of the computational grid is at grid point (IECOMP, JECOMP) of the MET. grid. The grid spacing of the computational grid is the same as the MET. grid.

```
   X index of LL corner (IBCOMP)      No default     ! IBCOMP = 1 !
             (1 <= IBCOMP <= NX)

   Y index of LL corner (JBCOMP)      No default     ! JBCOMP = 1 !
             (1 <= JBCOMP <= NY)


   X index of UR corner (IECOMP)      No default     ! IECOMP = 40 !
             (1 <= IECOMP <= NX)

   Y index of UR corner (JECOMP)      No default     ! JECOMP = 40 !
             (1 <= JECOMP <= NY)
```

SAMPLING Grid (GRIDDED RECEPTORS):

The lower left (LL) corner of the sampling grid is at grid point (IBSAMP, JBSAMP) of the MET. grid. The upper right (UR) corner of the sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid. The sampling grid must be identical to or a subset of the computational grid. It may be a nested grid inside the computational grid. The grid spacing of the sampling grid is DGRIDKM/MESHDN.

```
   Logical flag indicating if gridded
   receptors are used (LSAMP)         Default: T     ! LSAMP = F !
   (T=yes, F=no)

   X index of LL corner (IBSAMP)      No default     ! IBSAMP = 1 !
    (IBCOMP <= IBSAMP <= IECOMP)

   Y index of LL corner (JBSAMP)      No default     ! JBSAMP = 1 !
    (JBCOMP <= JBSAMP <= JECOMP)
```

```
        X index of UR corner (IESAMP)      No default     ! IESAMP = 2 !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP = 2 !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN = 1 !
        (MESHDN is an integer >= 1)

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                             *                           *
     FILE                       DEFAULT VALUE             VALUE THIS RUN
     ----                       -------------             --------------

   Concentrations (ICON)              1                   ! ICON = 1 !
   Dry Fluxes (IDRY)                  1                   ! IDRY = 1 !
   Wet Fluxes (IWET)                  1                   ! IWET = 0 !
   Relative Humidity (IVIS)           1                   ! IVIS = 1 !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                           Default: T         * LCOMPRS = *

   *
    0 = Do not create file, 1 = create file


    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

       Mass flux across specified boundaries
       for selected species reported hourly?
       (IMFLX)                         Default: 0         ! IMFLX = 0 !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported hourly?
       (IMBAL)                         Default: 0         ! IMBAL = 0 !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)


    LINE PRINTER OUTPUT OPTIONS:
```

```
        Print concentrations (ICPRT)    Default: 0         ! ICPRT = 0 !
        Print dry fluxes (IDPRT)        Default: 0         ! IDPRT = 0 !
        Print wet fluxes (IWPRT)        Default: 0         ! IWPRT = 0 !
        (0 = Do not print, 1 = Print)

        Concentration print interval
        (ICFRQ) in hours                Default: 1         ! ICFRQ = 8760 !
        Dry flux print interval
        (IDFRQ) in hours                Default: 1         ! IDFRQ = 8760 !
        Wet flux print interval
        (IWFRQ) in hours                Default: 1         ! IWFRQ = 8760 !

        Units for Line Printer Output
        (IPRTU)                         Default: 1         ! IPRTU = 3 !
                        for            for
                   Concentration    Deposition
            1 =       g/m**3         g/m**2/s
            2 =      mg/m**3        mg/m**2/s
            3 =      ug/m**3        ug/m**2/s
            4 =      ng/m**3        ng/m**2/s
            5 =     Odour Units

        Messages tracking progress of run
        written to the screen ?
        (IMESG)                         Default: 2         ! IMESG = 2 !
          0 = no
          1 = yes (advection step, puff ID)
          2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


      SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                  ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------
WET FLUXES ------   -- MASS FLUX --
    SPECIES
    /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   SAVED ON DISK?
    -------       ------------------------   ------------------------   --------
----------------   ---------------
 !          TSP =     1,           1,           1,           1,           0,
0,           0   !
 !         PM10 =     1,           1,           1,           1,           0,
0,           0   !

      OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

        Logical for debug output
        (LDEBUG)                                 Default: F     ! LDEBUG = F !

        First puff to track
        (IPFDEB)                                 Default: 1     ! IPFDEB = 1 !

        Number of puffs to track
        (NPFDEB)                                 Default: 1     ! NPFDEB = 1 !

        Met. period to start output
        (NN1)                                    Default: 1     ! NN1 = 1 !
```

```
       Met. period to end output
       (NN2)                                   Default: 10    ! NN2 = 10 !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL = 0 !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC = 0 !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL = 2 !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0
!
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0
!
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0.0
!
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0.0
!
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                      1 **
     HILL information
```

```
 HILL           XC         YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2
SCALE 1    SCALE 2    AMAX1     AMAX2
  NO.          (km)       (km)       (deg.)    (m)      (m)       (m)        (m)
(m)          (m)        (m)        (m)
 ----          ----       ----       ------  -----  ------    ------    ------   -
------    -------    -----     -----
```

```
 ---------------
 Subgroup (6c)
 ---------------

     COMPLEX TERRAIN RECEPTOR INFORMATION

                          XRCT         YRCT        ZRCT          XHH
                          (km)         (km)         (m)
                         ------       -----      ------         ----
```

```
 -------------------
 1
      Description of Complex Terrain Variables:
           XC, YC  = Coordinates of center of hill
           THETAH  = Orientation of major axis of hill (clockwise from
                     North)
           ZGRID   = Height of the  0  of the grid above mean sea
                     level
           RELIEF  = Height of the crest of the hill above the grid elevation
           EXPO 1  = Hill-shape exponent for the major axis
           EXPO 2  = Hill-shape exponent for the major axis
           SCALE 1 = Horizontal length scale along the major axis
           SCALE 2 = Horizontal length scale along the minor axis
           AMAX    = Maximum allowed axis length for the major axis
           BMAX    = Maximum allowed axis length for the major axis

           XRCT, YRCT = Coordinates of the complex terrain receptors
           ZRCT    = Height of the ground (MSL) at the complex terrain
                     Receptor
           XHH     = Hill number associated with each complex terrain receptor
                     (NOTE: MUST BE ENTERED AS A REAL NUMBER)

    **
      NOTE: DATA for each hill and CTSG receptor are treated as a separate
            input subgroup and therefore must end with an input group
terminator.

 -------------------------------------------------------------------------------
```

```
 INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
 --------------

       SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
        NAME        (cm**2/s)                                           (s/cm)
(dimensionless)
```

```
      -------     -----------      ----------      ----------    --------------
------     -----------------------
 * DRYGAS = *

 !END!


 -------------------------------------------------------------------------------


 INPUT GROUP: 8 -- Size parameters for dry deposition of particles
 --------------

      For SINGLE SPECIES, the mean and standard deviation are used to
      compute a deposition velocity for NINT (see group 9) size-ranges,
      and these are then averaged to obtain a mean deposition velocity.

      For GROUPED SPECIES, the size distribution should be explicitly
      specified (by the 'species' in the group), and the standard deviation
      for each should be entered as 0.  The model will then use the
      deposition velocity for the stated mean diameter.

       SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
        NAME             DIAMETER                   DEVIATION
                         (microns)                  (microns)
       -------      -------------------        ------------------
 !         PM10 =         0.48,                      2   !
 !          TSP =           30,                      2   !

 !END!


 -------------------------------------------------------------------------------


 INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
 --------------

      Reference cuticle resistance (s/cm)
      (RCUTR)                          Default: 30    ! RCUTR = 30 !
      Reference ground resistance  (s/cm)
      (RGR)                            Default: 10    ! RGR = 10 !
      Reference pollutant reactivity
      (REACTR)                         Default: 8     ! REACTR = 8 !

      Number of particle-size intervals used to
      evaluate effective particle deposition velocity
      (NINT)                           Default: 9     ! NINT = 9 !

      Vegetation state in unirrigated areas
      (IVEG)                           Default: 1     ! IVEG = 1 !
         IVEG=1 for active and unstressed vegetation
         IVEG=2 for active and stressed vegetation
         IVEG=3 for inactive vegetation

 !END!
```

```
--------------------------------------------------------------------------------

INPUT GROUP: 10 -- Wet Deposition Parameters
---------------

                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------
* WETDEPOS = *
!END!

--------------------------------------------------------------------------------

INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 0            ! MOZ = 0 !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                    Default: 12*80.
     ! BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                   Default: 12*10.
     ! BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                   Default: 0.2          ! RNITE1 = 0.2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                   Default: 2.0          ! RNITE2 = 2 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                   Default: 2.0          ! RNITE3 = 2 !

     H2O2 data input option (MH2O2)    Default: 0            ! MH2O2 = 0 !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
```

```
      (Used only if MAQCHEM = 1 and
       MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
      (BCKH2O2) in ppb                  Default: 12*1.
      ! BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !


  --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
      (used only if MCHEM = 4)

      The SOA module uses monthly values of:
           Fine particulate concentration in ug/m^3 (BCKPMF)
           Organic fraction of fine particulate     (OFRAC)
           VOC / NOX ratio (after reaction)         (VCNX)
      to characterize the air mass when computing
      the formation of SOA from VOC emissions.
      Typical values for several distinct air mass types are:

         Month    1    2    3    4    5    6    7    8    9   10   11   12
                 Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

      Clean Continental
         BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
         OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
         VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

      Clean Marine (surface)
         BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
         OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
         VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

      Urban - low biogenic (controls present)
         BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
         OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
         VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

      Urban - high biogenic (controls present)
         BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
         OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
         VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

      Regional Plume
         BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
         OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
         VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

      Urban - no controls present
         BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
         OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
         VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

      Default: Clean Continental
      ! BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00 !
      ! OFRAC = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.15 !
```

```
      ! VCNX = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00 !


 !END!


 -------------------------------------------------------------------------------


 INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
 ---------------

      Horizontal size of puff (m) beyond which
      time-dependent dispersion equations (Heffter)
      are used to determine sigma-y and
      sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP = 550
!

      Switch for using Heffter equation for sigma z
      as above (0 = Not use Heffter; 1 = use Heffter
      (MHFTSZ)                                   Default: 0      ! MHFTSZ = 0 !

      Stability class used to determine plume
      growth rates for puffs above the boundary
      layer (JSUP)                               Default: 5      ! JSUP = 5 !

      Vertical dispersion constant for stable
      conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = 0.01
!

      Vertical dispersion constant for neutral/
      unstable conditions (k2 in Eqn. 2.7-4)
      (CONK2)                                    Default: 0.1    ! CONK2 = 0.1 !

      Factor for determining Transition-point from
      Schulman-Scire to Huber-Snyder Building Downwash
      scheme (SS used for Hs <Hb + TBD * HL)
      (TBD)                                      Default: 0.5    ! TBD = 0.5 !
         TBD <0   ==> always use Huber-Snyder
         TBD = 1.5 ==> always use Schulman-Scire
         TBD = 0.5 ==> ISC Transition-point

      Range of land use categories for which
      urban dispersion is assumed
      (IURB1, IURB2)                             Default: 10     ! IURB1 = 21 !
                                                          19     ! IURB2 = 22 !

      Site characterization parameters for single-point Met data files ---------
      (needed for METFM = 2,3,4,5)

         Land use category for modeling domain
         (ILANDUIN)                              Default: 20     ! ILANDUIN = 20
!

         Roughness length (m) for modeling domain
         (Z0IN)                                  Default: 0.25   ! Z0IN = 0.25 !
```

```
         Leaf area index for modeling domain
         (XLAIIN)                               Default: 3.0    ! XLAIIN = 3 !

         Elevation above sea level (m)
         (ELEVIN)                               Default: 0.0    ! ELEVIN = 0 !

         Latitude (degrees) for met location
         (XLATIN)                               Default: -999.  ! XLATIN = -
33.387075 !

         Longitude (degrees) for met location
         (XLONIN)                               Default: -999.  ! XLONIN =
150.093259 !

      Specialized information for interpreting single-point Met data files -----

         Anemometer height (m) (Used only if METFM = 2,3)
         (ANEMHT)                               Default: 10.    ! ANEMHT = 10 !

         Form of lateral turbulance data in PROFILE.DAT file
         (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
         (ISIGMAV)                              Default: 1      ! ISIGMAV = 1 !
             0 = read sigma-theta
             1 = read sigma-v

         Choice of mixing heights (Used only if METFM = 4)
         (IMIXCTDM)                             Default: 0      ! IMIXCTDM = 0
!
             0 = read PREDICTED mixing heights
             1 = read OBSERVED mixing heights

      Maximum length of a slug (met. grid units)
      (XMXLEN)                                  Default: 1.0    ! XMXLEN = 1 !

      Maximum travel distance of a puff/slug (in
      grid units) during one sampling step
      (XSAMLEN)                                 Default: 1.0    ! XSAMLEN = 1 !

      Maximum Number of slugs/puffs release from
      one source during one time step
      (MXNEW)                                   Default: 99     ! MXNEW = 99 !

      Maximum Number of sampling steps for
      one puff/slug during one time step
      (MXSAM)                                   Default: 99     ! MXSAM = 99 !

      Number of iterations used when computing
      the transport wind for a sampling step
      that includes gradual rise (for CALMET
      and PROFILE winds)
      (NCOUNT)                                  Default: 2      ! NCOUNT = 2 !

      Minimum sigma y for a new puff/slug (m)
      (SYMIN)                                   Default: 1.0    ! SYMIN = 1 !

      Minimum sigma z for a new puff/slug (m)
```

```
      (SZMIN)                                    Default: 1.0    ! SZMIN = 1 !

      Default minimum turbulence velocities sigma-v and sigma-w
      for each stability class over land and over water (m/s)
      (SVMIN(12) and SWMIN(12))
                       ----------  LAND  ----------       ---------  WATER  ----
------
         Stab Class :  A    B    C    D    E    F         A    B    C    D    E
F
                      ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---
---
      Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37,
.37, .37
      Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06,
.03, .016

            ! SVMIN = 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37,
0.37, 0.37 !
            ! SWMIN = 0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06,
0.03, 0.016 !

      Divergence criterion for dw/dz across puff
      used to initiate adjustment for horizontal
      convergence (1/s)
      Partial adjustment starts at CDIV(1), and
      full adjustment is reached at CDIV(2)
      (CDIV(2))                                  Default: 0.0,0.0  ! CDIV = 0, 0
!

      Minimum wind speed (m/s) allowed for
      non-calm conditions. Also used as minimum
      speed returned when using power-law
      extrapolation toward surface
      (WSCALM)                                   Default: 0.5    ! WSCALM = 0.5
!

      Maximum mixing height (m)
      (XMAXZI)                                   Default: 3000.  ! XMAXZI = 3000
!

      Minimum mixing height (m)
      (XMINZI)                                   Default: 50.    ! XMINZI = 50 !

      Default wind speed classes --
      5 upper bounds (m/s) are entered;
      the 6th class has no upper limit
      (WSCAT(5))                      Default   :
                                      ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                               Wind Speed Class :  1     2     3     4     5
                                                  ---   ---   ---   ---   ---
                                        ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.8 !

      Default wind speed profile power-law
      exponents for stabilities 1-6
      (PLX0(6))                       Default   : ISC RURAL values
```

```
                                 ISC RURAL : .07, .07, .10, .15, .35, .55
                                 ISC URBAN : .15, .15, .20, .25, .30, .30

                           Stability Class :  A     B     C     D     E
F
                                             ---   ---   ---   ---   ---
---
                                    ! PLX0 = 0.07, 0.07, 0.1, 0.15, 0.35,
0.55 !

      Default potential temperature gradient
      for stable classes E, F (degK/m)
      (PTG0(2))                      Default: 0.020, 0.035
                                    ! PTG0 = 0.02, 0.035 !

      Default plume path coefficients for
      each stability class (used when option
      for partial plume height terrain adjustment
      is selected -- MCTADJ=3)
      (PPC(6))                 Stability Class :  A     B     C     D     E
F
                              Default  PPC : .50,  .50,  .50,  .50,  .35,
.35
                                             ---   ---   ---   ---   ---
---
                                     ! PPC = 0.5, 0.5, 0.5, 0.5, 0.35, 0.35
!

      Slug-to-puff transition criterion factor
      equal to sigma-y/length of slug
      (SL2PF)                              Default: 10.        ! SL2PF = 10 !

      Puff-splitting control variables ------------------------

        VERTICAL SPLIT
        --------------

        Number of puffs that result every time a puff
        is split - nsplit=2 means that 1 puff splits
        into 2
        (NSPLIT)                           Default:   3        ! NSPLIT = 3 !

        Time(s) of a day when split puffs are eligible to
        be split once again; this is typically set once
        per day, around sunset before nocturnal shear develops.
        24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
        0=do not re-split    1=eligible for re-split
        (IRESPLIT(24))                     Default:  Hour 17 = 1
        ! IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

        Split is allowed only if last hour's mixing
        height (m) exceeds a minimum value
        (ZISPLIT)                          Default: 100.       ! ZISPLIT = 100
!

        Split is allowed only if ratio of last hour's
        mixing ht to the maximum mixing ht experienced
```

```
        by the puff is less than a maximum value (this
        postpones a split until a nocturnal layer develops)
        (ROLDMAX)                          Default: 0.25       ! ROLDMAX = 0.25
!


        HORIZONTAL SPLIT
        ----------------

        Number of puffs that result every time a puff
        is split - nsplith=5 means that 1 puff splits
        into 5
        (NSPLITH)                          Default:   5        ! NSPLITH = 5 !

        Minimum sigma-y (Grid Cells Units) of puff
        before it may be split
        (SYSPLITH)                         Default:  1.0       ! SYSPLITH = 1 !

        Minimum puff elongation rate (SYSPLITH/hr) due to
        wind shear, before it may be split
        (SHSPLITH)                         Default:  2.        ! SHSPLITH = 2 !

        Minimum concentration (g/m^3) of each
        species in puff before it may be split
        Enter array of NSPEC values; if a single value is
        entered, it will be used for ALL species
        (CNSPLITH)                         Default:  1.0E-07   ! CNSPLITH = 1E-
7 !

      Integration control variables ------------------------

        Fractional convergence criterion for numerical SLUG
        sampling integration
        (EPSSLUG)                          Default:   1.0e-04  ! EPSSLUG =
0.0001 !

        Fractional convergence criterion for numerical AREA
        source integration
        (EPSAREA)                          Default:   1.0e-06  ! EPSAREA = 1E-6
!

        Trajectory step-length (m) used for numerical rise
        integration
        (DSRISE)                           Default:   1.0      ! DSRISE = 1 !

      Boundary Condition (BC) Puff control variables ------------------------

        Minimum height (m) to which BC puffs are mixed as they are emitted
        (MBCON=2 ONLY).  Actual height is reset to the current mixing height
        at the release point if greater than this minimum.
        (HTMINBC)                          Default:   500.     * HTMINBC = *

        Search radius (km) about a receptor for sampling nearest BC puff.
        BC puffs are typically emitted with a spacing of one grid cell
        length, so the search radius should be greater than DGRIDKM.
        (RSAMPBC)                          Default:   4.       * RSAMPBC = *
```

```
       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                             Default:   1        * MDEPBC = *
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!


-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  ! NPT1 = 0 !

     Units used for point source
     emissions below                (IPTU)  Default: 1  ! IPTU = 1 !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  ! NSPT1 = 0 !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  ! NPT2 = 0 !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                         a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                              b
c
   Source      X UTM     Y UTM     Stack    Base     Stack    Exit  Exit    Bldg.
Emission
```

```
    No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash
Rates
               (km)      (km)       (m)      (m)       (m)  (m/s) (deg. K)
   ------   ---------- ---------- ------  ------   -------- ----- -------- -----
--------

 --------
```

a
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

```
SRCNAM  is a 12-character name for a source
        (No default)
X       is an array holding the source data listed by the column headings
        (No default)
SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
        (Default: 0.,0.)
FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
        the effect of rain-caps or other physical configurations that
        reduce momentum rise associated with the actual exit velocity.
        (Default: 1.0  -- full momentum used)
ZPLTFM  is the platform height (m) for sources influenced by an isolated
        structure that has a significant open area between the surface
        and the bulk of the structure, such as an offshore oil platform.
        The Base Elevation is that of the surface (ground or ocean),
        and the Stack Height is the release height above the Base (not
        above the platform).  Building heights entered in Subgroup 13c
        must be those of the buildings on the platform, measured from
        the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
        downwash method) for sources with building downwash.
        (Default: 0.0)
```

b
0. = No building downwash modeled, 1. = downwash modeled
NOTE: must be entered as a REAL number (i.e., with decimal point)

c
An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IPTU (e.g. 1 for g/s).

```
---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                   a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------


--------
```

[a] Building height, width, length, and X/Y offset from the source are treated as a separate input subgroup for each source and therefore must end with an input group terminator. The X/Y offset is the position, relative to the stack, of the center of the upwind face of the projected building, with the x-axis pointing along the flow direction.

Subgroup (13d)

POINT SOURCE: VARIABLE EMISSIONS DATA[a]

Use this subgroup to describe temporal variations in the emission rates given in 13b. Factors entered multiply the rates in 13b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

```
IVARY determines the type of variation, and is source-specific:
(IVARY)                                Default: 0
      0 =       Constant
      1 =       Diurnal cycle (24 scaling factors: hours 1-24)
      2 =       Monthly cycle (12 scaling factors: months 1-12)
      3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                               where first group is DEC-JAN-FEB)
      4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                               first group is Stability Class A,
                               and the speed classes have upper
                               bounds (m/s) defined in Group 12
      5 =       Temperature   (12 scaling factors, where temperature
                               classes have upper bounds (C) of:
                               0, 5, 10, 15, 20, 25, 30, 35, 40,
                               45, 50, 50+)
```

----
[a] Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters

Subgroup (14a)

Number of polygon area sources with

```
     parameters specified below (NAR1)       No default  ! NAR1 = 2 !

     Units used for area source
     emissions below           (IARU)       Default: 1  ! IARU = 1 !
           1 =       g/m**2/s
           2 =      kg/m**2/hr
           3 =      lb/m**2/hr
           4 =    tons/m**2/yr
           5 =    Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =    Odour Unit * m/min
           7 =    metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  ! NSAR1 = 4 !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  ! NAR2 = 0 !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
                                     a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                         b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------

   1 ! SRCNAM = SRC_7 !
   1 ! X =        15.0,   1047.9,         7.5, 1.00E00, 1.00E00 !
!END!
   2 ! SRCNAM = SRC_8 !
   2 ! X =         4.0,   1036.9,           2, 1.00E00, 1.00E00 !
!END!

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------
```

```
           COORDINATES (UTM-km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                                 a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------

   1 ! SRCNAM = SRC_7 !
   1 ! XVERT = 230.060,230.132,230.189,230.131 !
   1 ! YVERT = 6305.844,6305.758,6305.795,6305.893 !
!END!
   2 ! SRCNAM = SRC_8 !
   2 ! XVERT = 229.954,229.987,229.988,229.961 !
   2 ! YVERT = 6305.634,6305.633,6305.683,6305.685 !
!END!

--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                               a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)


   1 ! SRCNAM = SRC_7 !
   1 ! IVARY = 4 !    (6 speed classes for each stability)
   1 ! TSP = 0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014,
```

```
         0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014      !
!END!
   1 ! SRCNAM = SRC_7 !
   1 ! IVARY = 4 !    (6 speed classes for each stability)
   1 ! PM10 = 0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5      !
!END!
   2 ! SRCNAM = SRC_8 !
   2 ! IVARY = 4 !    (6 speed classes for each stability)
   2 ! TSP = 0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014,
         0,0,0,1.5E-6,6.1E-5,0.00014      !
!END!
   2 ! SRCNAM = SRC_8 !
   2 ! IVARY = 4 !    (6 speed classes for each stability)
   2 ! PM10 = 0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5,
         0,0,0,7.6E-7,3.1E-5,7E-5      !
!END!

--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


--------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                             No default  ! NLN2 = 0 !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)        No default   ! NLINES = 0 !

     Units used for line source
     emissions below                (ILNU)          Default: 1   ! ILNU = 1 !
```

```
          1 =        g/s
          2 =       kg/hr
          3 =       lb/hr
          4 =     tons/yr
          5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
          6 =     Odour Unit * m**3/min
          7 =     metric tons/yr

    Number of source-species
    combinations with variable
    emissions scaling factors
    provided below in (15c)        (NSLN1) Default: 0  ! NSLN1 = 0 !

    Maximum number of segments used to model
    each line (MXNSEG)                            Default: 7   ! MXNSEG = 7 !

    The following variables are required only if NLINES > 0.  They are
    used in the buoyant line source plume rise calculations.

       Number of distances at which               Default: 6   ! NLRISE = 6 !
       transitional rise is computed

       Average building length (XL)               No default   * XL = *
                                                  (in meters)

       Average building height (HBL)              No default   * HBL = *
                                                  (in meters)

       Average building width (WBL)               No default   * WBL = *
                                                  (in meters)

       Average line source width (WML)            No default   * WML = *
                                                  (in meters)

       Average separation between buildings (DXL) No default   * DXL = *
                                                  (in meters)

       Average buoyancy parameter (FPRIMEL)       No default   * FPRIMEL = *
                                                  (in m**4/s**3)

 !END!

 ---------------
 Subgroup (15b)
 ---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

a
 Source     Beg. X      Beg. Y      End. X    End. Y     Release    Base
Emission
  No.     Coordinate  Coordinate  Coordinate Coordinate  Height    Elevation
Rates
             (km)        (km)        (km)       (km)       (m)       (m)
 ------   ----------  ----------  ---------  ----------  -------   ---------
---------
```

----

a
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

b
An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by ILNTU (e.g. 1 for g/s).

Subgroup (15c)

BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA [a]

Use this subgroup to describe temporal variations in the emission rates given in 15b. Factors entered multiply the rates in 15b. Skip sources here that have constant emissions.

IVARY determines the type of variation, and is source-specific:

```
(IVARY)                                Default: 0
      0 =       Constant
      1 =       Diurnal cycle (24 scaling factors: hours 1-24)
      2 =       Monthly cycle (12 scaling factors: months 1-12)
      3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                               where first group is DEC-JAN-FEB)
      4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                               first group is Stability Class A,
                               and the speed classes have upper
                               bounds (m/s) defined in Group 12
      5 =       Temperature   (12 scaling factors, where temperature
                               classes have upper bounds (C) of:
                               0, 5, 10, 15, 20, 25, 30, 35, 40,
                               45, 50, 50+)
```

----
a
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters

Subgroup (16a)

```
      Number of volume sources with
      parameters provided in 16b,c (NVL1)     No default  ! NVL1 = 6 !

      Units used for volume source
      emissions below in 16b       (IVLU)     Default: 1  ! IVLU = 1 !
            1 =        g/s
            2 =       kg/hr
            3 =       lb/hr
            4 =     tons/yr
            5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
            6 =     Odour Unit * m**3/min
            7 =     metric tons/yr

      Number of source-species
      combinations with variable
      emissions scaling factors
      provided below in (16c)      (NSVL1)    Default: 0  ! NSVL1 = 0 !

      Number of volume sources with
      variable location and emission
      parameters                   (NVL2)     No default  ! NVL2 = 0 !

      (If NVL2 > 0, ALL parameter data for
       these sources are read from the VOLEMARB.DAT file(s) )

 !END!

 ---------------
 Subgroup (16b)
 ---------------
                                                    a
            VOLUME SOURCE: CONSTANT DATA
            ------------------------------

b
          X UTM      Y UTM      Effect.    Base     Initial    Initial
Emission
        Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z
Rates
           (km)       (km)         (m)       (m)        (m)       (m)
        ----------  ----------   ------    ------    --------   --------   -----
---

    1 ! SRCNAM = SRC_1 !
    1 ! X =  230.056, 6305.821,     3.0,   1047.8,        3.5,       1.5,
3.38E00, 1.03E00 !
 !END!
    2 ! SRCNAM = SRC_2 !
    2 ! X =  230.121, 6305.856,     3.0,   1047.6,        3.5,       1.5,
1.48E00, 7.10E-01 !
 !END!
    3 ! SRCNAM = SRC_3 !
    3 ! X =  230.226, 6305.895,     8.0,   1047.2,        0.2,         4, 1.90E-
01, 8.00E-02 !
 !END!
    4 ! SRCNAM = SRC_4 !
```

```
   4 ! X =  230.055, 6305.762,     8.0,   1048.3,        0.2,         4, 1.90E-
01, 8.00E-02 !
 !END!
   5 ! SRCNAM = SRC_5 !
   5 ! X =  230.111, 6305.844,     8.0,   1047.7,        1.0,         4, 2.50E-
01, 1.10E-01 !
 !END!
   6 ! SRCNAM = SRC_6 !
   6 ! X =  229.944, 6305.658,     3.0,   1036.4,        0.5,       1.5, 5.00E-
02, 2.00E-02 !
 !END!

 --------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

 ---------------
 Subgroup (16c)
 ---------------
                                              a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



 --------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.
```

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information

---

Subgroup (17a)

Number of non-gridded receptors (NREC) No default ! NREC = 144 !

!END!

Subgroup (17b)

NON-GRIDDED (DISCRETE) RECEPTOR DATA [a]

Receptor No.		X UTM Coordinate (km)	Y UTM Coordinate (km)	Ground Elevation (m)	Height [b] Above Ground (m)	
1	! X =	228.283,	6304.588,	930.5,	0.0 !	!END!
2	! X =	228.283,	6304.888,	931.4,	0.0 !	!END!
3	! X =	228.283,	6305.188,	933.0,	0.0 !	!END!
4	! X =	228.283,	6305.488,	935.6,	0.0 !	!END!
5	! X =	228.283,	6305.788,	939.5,	0.0 !	!END!
6	! X =	228.283,	6306.088,	986.6,	0.0 !	!END!
7	! X =	228.283,	6306.388,	991.2,	0.0 !	!END!
8	! X =	228.283,	6306.688,	994.3,	0.0 !	!END!
9	! X =	228.583,	6304.888,	932.0,	0.0 !	!END!
10	! X =	228.583,	6305.188,	933.6,	0.0 !	!END!
11	! X =	228.583,	6305.488,	936.1,	0.0 !	!END!
12	! X =	228.583,	6305.788,	939.8,	0.0 !	!END!
13	! X =	228.583,	6306.088,	986.4,	0.0 !	!END!
14	! X =	228.583,	6306.388,	990.7,	0.0 !	!END!
15	! X =	228.583,	6306.688,	993.7,	0.0 !	!END!
16	! X =	228.883,	6304.888,	937.0,	0.0 !	!END!
17	! X =	228.883,	6305.188,	934.4,	0.0 !	!END!
18	! X =	228.883,	6305.488,	936.8,	0.0 !	!END!
19	! X =	228.883,	6305.788,	940.2,	0.0 !	!END!
20	! X =	228.883,	6306.088,	986.2,	0.0 !	!END!
21	! X =	228.883,	6306.388,	990.2,	0.0 !	!END!
22	! X =	228.883,	6306.688,	993.0,	0.0 !	!END!
23	! X =	229.183,	6304.888,	941.5,	0.0 !	!END!
24	! X =	229.183,	6305.188,	942.7,	0.0 !	!END!
25	! X =	229.183,	6305.488,	937.4,	0.0 !	!END!
26	! X =	229.183,	6305.788,	940.6,	0.0 !	!END!
27	! X =	229.183,	6306.088,	986.1,	0.0 !	!END!
28	! X =	229.183,	6306.388,	989.6,	0.0 !	!END!
29	! X =	229.183,	6306.688,	999.4,	0.0 !	!END!

```
30 ! X =        229.483,     6304.888,        948.3,             0.0 !    !END!
31 ! X =        229.483,     6305.188,        949.0,             0.0 !    !END!
32 ! X =        229.483,     6305.488,        949.7,             0.0 !    !END!
33 ! X =        229.483,     6305.788,        940.9,             0.0 !    !END!
34 ! X =        229.483,     6306.088,        985.9,             0.0 !    !END!
35 ! X =        229.483,     6306.388,        999.8,             0.0 !    !END!
36 ! X =        229.483,     6306.688,        999.7,             0.0 !    !END!
37 ! X =        229.783,     6304.888,       1033.7,             0.0 !    !END!
38 ! X =        229.783,     6305.188,       1033.4,             0.0 !    !END!
39 ! X =        229.783,     6305.488,       1033.1,             0.0 !    !END!
40 ! X =        229.783,     6305.788,       1032.8,             0.0 !    !END!
41 ! X =        229.783,     6306.088,       1004.1,             0.0 !    !END!
42 ! X =        229.783,     6306.388,       1004.1,             0.0 !    !END!
43 ! X =        229.783,     6306.688,       1004.1,             0.0 !    !END!
44 ! X =        230.083,     6304.888,       1041.6,             0.0 !    !END!
45 ! X =        230.083,     6305.188,       1040.6,             0.0 !    !END!
46 ! X =        230.083,     6305.488,       1039.6,             0.0 !    !END!
47 ! X =        230.083,     6305.788,       1048.1,             0.0 !    !END!
48 ! X =        230.083,     6306.088,       1014.7,             0.0 !    !END!
49 ! X =        230.083,     6306.388,       1004.4,             0.0 !    !END!
50 ! X =        230.083,     6306.688,       1004.5,             0.0 !    !END!
51 ! X =        230.383,     6304.888,       1047.1,             0.0 !    !END!
52 ! X =        230.383,     6305.188,       1045.8,             0.0 !    !END!
53 ! X =        230.383,     6305.488,       1050.8,             0.0 !    !END!
54 ! X =        230.383,     6305.788,       1048.4,             0.0 !    !END!
55 ! X =        230.383,     6306.088,       1014.6,             0.0 !    !END!
56 ! X =        230.383,     6306.388,       1011.8,             0.0 !    !END!
57 ! X =        230.383,     6306.688,       1004.7,             0.0 !    !END!
58 ! X =        230.683,     6304.888,       1050.7,             0.0 !    !END!
59 ! X =        230.683,     6305.188,       1053.1,             0.0 !    !END!
60 ! X =        230.683,     6305.488,       1051.3,             0.0 !    !END!
61 ! X =        230.683,     6305.788,       1048.7,             0.0 !    !END!
62 ! X =        230.683,     6306.088,       1014.4,             0.0 !    !END!
63 ! X =        230.683,     6306.388,       1011.4,             0.0 !    !END!
64 ! X =        230.683,     6306.688,       1009.2,             0.0 !    !END!
65 ! X =        230.983,     6304.888,       1054.8,             0.0 !    !END!
66 ! X =        230.983,     6305.188,       1053.6,             0.0 !    !END!
67 ! X =        230.983,     6305.488,       1051.8,             0.0 !    !END!
68 ! X =        230.983,     6305.788,       1048.9,             0.0 !    !END!
69 ! X =        230.983,     6306.088,       1014.3,             0.0 !    !END!
70 ! X =        230.983,     6306.388,       1011.0,             0.0 !    !END!
71 ! X =        230.983,     6306.688,       1008.7,             0.0 !    !END!
72 ! X =        231.283,     6304.888,       1055.2,             0.0 !    !END!
73 ! X =        231.283,     6305.188,       1054.0,             0.0 !    !END!
74 ! X =        231.283,     6305.488,       1052.1,             0.0 !    !END!
75 ! X =        231.283,     6305.788,       1049.1,             0.0 !    !END!
76 ! X =        231.283,     6306.088,       1014.2,             0.0 !    !END!
77 ! X =        231.283,     6306.388,       1010.7,             0.0 !    !END!
78 ! X =        231.283,     6306.688,       1008.4,             0.0 !    !END!
79 ! X =        231.583,     6304.888,       1055.4,             0.0 !    !END!
80 ! X =        231.583,     6305.188,       1054.2,             0.0 !    !END!
81 ! X =        231.583,     6305.488,       1052.3,             0.0 !    !END!
82 ! X =        231.583,     6305.788,       1049.2,             0.0 !    !END!
83 ! X =        231.583,     6306.088,       1014.2,             0.0 !    !END!
84 ! X =        231.583,     6306.388,       1010.5,             0.0 !    !END!
85 ! X =        231.583,     6306.688,       1008.2,             0.0 !    !END!
86 ! X =        226.707,     6302.013,        934.7,             0.0 !    !END!
```

```
 87 ! X =     226.707,   6303.013,     930.8,          0.0 !   !END!
 88 ! X =     226.707,   6304.013,     930.5,          0.0 !   !END!
 89 ! X =     226.707,   6305.013,     932.8,          0.0 !   !END!
 90 ! X =     226.707,   6306.013,     985.1,          0.0 !   !END!
 91 ! X =     226.707,   6307.013,     995.5,          0.0 !   !END!
 92 ! X =     226.707,   6308.013,     997.7,          0.0 !   !END!
 93 ! X =     226.707,   6309.013,     998.8,          0.0 !   !END!
 94 ! X =     227.707,   6302.013,     935.5,          0.0 !   !END!
 95 ! X =     227.707,   6303.013,     931.3,          0.0 !   !END!
 96 ! X =     227.707,   6304.013,     929.5,          0.0 !   !END!
 97 ! X =     227.707,   6305.013,     931.4,          0.0 !   !END!
 98 ! X =     227.707,   6306.013,     985.1,          0.0 !   !END!
 99 ! X =     227.707,   6307.013,     996.9,          0.0 !   !END!
100 ! X =     227.707,   6308.013,     998.7,          0.0 !   !END!
101 ! X =     227.707,   6309.013,     998.8,          0.0 !   !END!
102 ! X =     228.707,   6302.013,     940.6,          0.0 !   !END!
103 ! X =     228.707,   6303.013,     935.5,          0.0 !   !END!
104 ! X =     228.707,   6304.013,     933.0,          0.0 !   !END!
105 ! X =     228.707,   6305.013,     932.9,          0.0 !   !END!
106 ! X =     228.707,   6306.013,     985.1,          0.0 !   !END!
107 ! X =     228.707,   6307.013,     999.0,          0.0 !   !END!
108 ! X =     228.707,   6308.013,     998.9,          0.0 !   !END!
109 ! X =     228.707,   6309.013,     999.0,          0.0 !   !END!
110 ! X =     229.707,   6302.013,    1031.2,          0.0 !   !END!
111 ! X =     229.707,   6303.013,    1031.2,          0.0 !   !END!
112 ! X =     229.707,   6304.013,    1031.3,          0.0 !   !END!
113 ! X =     229.707,   6305.013,    1031.2,          0.0 !   !END!
114 ! X =     229.707,   6306.013,    1004.0,          0.0 !   !END!
115 ! X =     229.707,   6307.013,    1004.0,          0.0 !   !END!
116 ! X =     229.707,   6308.013,    1004.0,          0.0 !   !END!
117 ! X =     229.707,   6309.013,    1004.0,          0.0 !   !END!
118 ! X =     230.707,   6302.013,    1045.4,          0.0 !   !END!
119 ! X =     230.707,   6303.013,    1050.5,          0.0 !   !END!
120 ! X =     230.707,   6304.013,    1053.0,          0.0 !   !END!
121 ! X =     230.707,   6305.013,    1053.9,          0.0 !   !END!
122 ! X =     230.707,   6306.013,    1015.4,          0.0 !   !END!
123 ! X =     230.707,   6307.013,    1005.0,          0.0 !   !END!
124 ! X =     230.707,   6308.013,    1005.1,          0.0 !   !END!
125 ! X =     230.707,   6309.013,    1005.0,          0.0 !   !END!
126 ! X =     231.707,   6302.013,    1050.4,          0.0 !   !END!
127 ! X =     231.707,   6303.013,    1054.6,          0.0 !   !END!
128 ! X =     231.707,   6304.013,    1056.4,          0.0 !   !END!
129 ! X =     231.707,   6305.013,    1055.0,          0.0 !   !END!
130 ! X =     231.707,   6306.013,    1015.3,          0.0 !   !END!
131 ! X =     231.707,   6307.013,    1006.6,          0.0 !   !END!
132 ! X =     231.707,   6308.013,    1005.3,          0.0 !   !END!
133 ! X =     231.707,   6309.013,    1005.2,          0.0 !   !END!
134 ! X =     232.707,   6302.013,    1051.2,          0.0 !   !END!
135 ! X =     232.707,   6303.013,    1055.4,          0.0 !   !END!
136 ! X =     232.707,   6304.013,    1055.6,          0.0 !   !END!
137 ! X =     232.707,   6305.013,    1053.9,          0.0 !   !END!
138 ! X =     232.707,   6306.013,    1015.4,          0.0 !   !END!
139 ! X =     232.707,   6307.013,    1007.7,          0.0 !   !END!
140 ! X =     232.707,   6308.013,    1006.0,          0.0 !   !END!
141 ! X =     232.707,   6309.013,    1005.2,          0.0 !   !END!
142 ! X =     229.398,   6305.139,     946.9,          0.0 !   !END!
143 ! X =     229.346,   6304.626,     944.2,          0.0 !   !END!
```

```
 144 ! X =       229.905,     6307.154,      1004.3,           0.0 !   !END!

   ****  CONFIRMATION OF CONTROL DATA  ****


--------------  INPUT GROUP 1  ---------------

metrun  =  1
ibyr    =  0
ibmo    =  0
ibdy    =  0
ibhr    =  0
ibsec   =  0
ibdathr =  0
ieyr    =  0
iemo    =  0
iedy    =  0
iehr    =  0
iesec   =  0
iedathr =  0
nsecdt  =  3600
irlg    =  0
iavg    =  1
xbtz    =  -10.0000000
nspec   =  2
nse     =  2
itest   =  2
metfm   =  3
mprffm  =  1
mrestart=  0
nrespd  =  0
avet    =  60.0000000
pgtime  =  60.0000000

--------------  INPUT GROUP 2  ---------------

mgauss =  1
mctadj =  3
mctsg  =  0
mslug  =  0
mtrans =  1
mchem  =  0
maqchem  =  0
mwet   =  0
mdry   =  1
mtilt  =  0
mdisp  =  3
mdisp2 =  3
mturbvw =  3
mtauly =  0.00000000E+00
mtauadv=  0
mcturb =  1
mrough =  0
mtip   =  1
mbdw   =  1
mshear =  0
mrise  =  1
```

```
msplit =  0
mpartl =  1
mpartlba=  1
mtinv  =  0
mpdf   =  0
msgtibl=  0
mbcon  =  0
msource=  0
mfog   =  0
mreg   =  0

--------------  INPUT GROUP 3  ---------------

SPECIES: TSP           j: 1  isplst(-,j) =   1  1  2  GROUP: TSP
SPECIES: PM10          j: 2  isplst(-,j) =   1  1  2  GROUP: PM10

--------------  INPUT GROUP 4  ---------------

pmap    = UTM
datum   = WGS-84
daten   = 02-21-2003
utmhem  = S
iutmzn  =  56
nx      =  40
ny      =  40
nz      =  1
zface  =  0.00000000E+00 3000.00000
dgridkm =  0.200000003
xorigkm =  225.699997
yorigkm =  6302.00000
iutmzn  =  56
ibcomp  =  1
jbcomp  =  1
iecomp  =  40
jecomp  =  40
lsamp   =  F
ibsamp  =  1
jbsamp  =  1
iesamp  =  2
jesamp  =  2
meshdn  =  1

--------------  INPUT GROUP 5  ---------------

icon    =  1
idry    =  1
iwet    =  0
it2d    =  0
irho    =  0
ivis    =  1
lcomprs =  T
icprt   =  0
idprt   =  0
iwprt   =  0
icfrq   =  8760
idfrq   =  8760
iwfrq   =  8760
```

```
 (note:  i_frq values converted to timesteps)
 iprtu   =  3
 imesg   =  2
 imflx   =  0
 imbal   =  0
 inrise  =  0
 iqaplot =  1
 ldebug  =  F
 ipfdeb  =  1
 npfdeb  =  1
 nn1     =  1
 nn2     =  10

 GROUP: TSP            j:   1  ioutop(-,j) =  1 1 1 1 0 0 0
 GROUP: PM10           j:   2  ioutop(-,j) =  1 1 1 1 0 0 0

 --------------  INPUT GROUP 6  ---------------

         ------  Subgroup (6a)  ------

 nhill  =  0
 nctrec =  0
 mhill  =  2
 xhill2m=  1.00000000
 zhill2m=  1.00000000
 xctdmkm=  0.00000000E+00
 yctdmkm=  0.00000000E+00

         ------  Subgroup (6b)  ------


         ------  Subgroup (6c)  ------


 --------------  INPUT GROUP 7  ---------------

 SPECIES: TSP            j:   1  dryg(-,j) =    -999.00   -999.00   -999.00   -
999.00   -999.00
 SPECIES: PM10           j:   2  dryg(-,j) =    -999.00   -999.00   -999.00   -
999.00   -999.00

 --------------  INPUT GROUP 8  ---------------

 SPECIES: TSP            j:   1  dryp(-,j) =      30.00      2.00
 SPECIES: PM10           j:   2  dryp(-,j) =       0.48      2.00

 --------------  INPUT GROUP 9  ---------------

 rcutr   =  30.0000000
 rgr     =  10.0000000
 reactr  =  8.00000000
 pconst  =  2.30000001E-08
 bmin    =  1.00000001E-07
 bmax    =  2.49999994E-06
 qswmax  =  600.000000
 dconst1 =  2.00000000
 dconst2 =  0.666666687
```

```
dconst3 =  4.79999988E-04
dconst4 =  0.666666687
nint    =  9
iveg    =  1

--------------  INPUT GROUP 10  ---------------

SPECIES: TSP           j:   1  wa(-,j) =  0.000E+00   0.000E+00
SPECIES: PM10          j:   2  wa(-,j) =  0.000E+00   0.000E+00

--------------  INPUT GROUP 11  ---------------

moz       =  0
bcko3m    =  80.0000000 80.0000000 80.0000000 80.0000000
          =  80.0000000 80.0000000 80.0000000 80.0000000
          =  80.0000000 80.0000000 80.0000000 80.0000000
bcknh3m   =  10.0000000 10.0000000 10.0000000 10.0000000
          =  10.0000000 10.0000000 10.0000000 10.0000000
          =  10.0000000 10.0000000 10.0000000 10.0000000
rnite1    =  0.200000003
rnite2    =  2.00000000
rnite3    =  2.00000000
mh2o2     =  0
bckh2o2m =  1.00000000 1.00000000 1.00000000 1.00000000
          =  1.00000000 1.00000000 1.00000000 1.00000000
          =  1.00000000 1.00000000 1.00000000 1.00000000
bckpmf    =  1.00000000 1.00000000 1.00000000 1.00000000
          =  1.00000000 1.00000000 1.00000000 1.00000000
          =  1.00000000 1.00000000 1.00000000 1.00000000
ofrac     =  0.150000006 0.150000006 0.200000003 0.200000003
          =  0.200000003 0.200000003 0.200000003 0.200000003
          =  0.200000003 0.200000003 0.200000003 0.150000006
vcnx      =  50.0000000 50.0000000 50.0000000 50.0000000
          =  50.0000000 50.0000000 50.0000000 50.0000000
          =  50.0000000 50.0000000 50.0000000 50.0000000

--------------  INPUT GROUP 12  ---------------

sytdep    =  550.000000
mhftsz    =  0
jsup      =  5
conk1     =  9.99999978E-03
conk2     =  0.100000001
iurb1     =  21
iurb2     =  22

anemht    =  10.0000000
isigmav   =  1
imixctdm =  0
ilanduin =  20
z0in      =  0.250000000
xlaiin    =  3.00000000
elevin    =  0.00000000E+00
xlatin    =  -33.3870735
xlonin    =  150.093262

xmxlen    =  1.00000000
```

```
mxnew    =  99
xsamlen  =  1.00000000
mxsam    =  99
ncount   =  2
sl2pf    =  10.0000000
wscalm   =  0.499994993
cdiv     =  0.00000000E+00 0.00000000E+00

wscat    =  1.53999996   top for class 1
wscat    =  3.08999991   top for class 2
wscat    =  5.13999987   top for class 3
wscat    =  8.22999954   top for class 4
wscat    =  10.8000002   top for class 5

Over LAND
svmin    =  0.500000000  for stability 1
svmin    =  0.500000000  for stability 2
svmin    =  0.500000000  for stability 3
svmin    =  0.500000000  for stability 4
svmin    =  0.500000000  for stability 5
svmin    =  0.500000000  for stability 6
swmin    =  0.200000003  for stability 1
swmin    =  0.119999997  for stability 2
swmin    =  7.99999982E-02  for stability 3
swmin    =  5.99999987E-02  for stability 4
swmin    =  2.99999993E-02  for stability 5
swmin    =  1.60000008E-02  for stability 6

Over WATER
svmin    =  0.370000005  for stability 1
svmin    =  0.370000005  for stability 2
svmin    =  0.370000005  for stability 3
svmin    =  0.370000005  for stability 4
svmin    =  0.370000005  for stability 5
svmin    =  0.370000005  for stability 6
swmin    =  0.200000003  for stability 1
swmin    =  0.119999997  for stability 2
swmin    =  7.99999982E-02  for stability 3
swmin    =  5.99999987E-02  for stability 4
swmin    =  2.99999993E-02  for stability 5
swmin    =  1.60000008E-02  for stability 6

symin    =  1.00000000
szmin    =  1.00000000
szcap_m  =  5000000.00
xminzi   =  50.0000000
xmaxzi   =  3000.00000

plx0     =  7.00000003E-02    for stability 1
plx0     =  7.00000003E-02    for stability 2
plx0     =  0.100000001    for stability 3
plx0     =  0.150000006    for stability 4
plx0     =  0.349999994    for stability 5
plx0     =  0.550000012    for stability 6

ptg0     =  1.99999996E-02    for stability 5
ptg0     =  3.50000001E-02    for stability 6
```

```
ppc      =  0.500000000    for stability 1
ppc      =  0.500000000    for stability 2
ppc      =  0.500000000    for stability 3
ppc      =  0.500000000    for stability 4
ppc      =  0.349999994    for stability 5
ppc      =  0.349999994    for stability 6
tbd      =  0.500000000
tibldist =  1.00000000 10.0000000 9.00000000
nlutibl  =  4
nsplit   =  3
iresplit =  0 0 0 0
         =  0 0 0 0
         =  0 0 0 0
         =  0 0 0 0
         =  0 1 0 0
         =  0 0 0 0
zisplit  =  100.000000
roldmax  =  0.250000000
nsplith  =  5
sysplith =  200.000000
shsplith =  0.111111112
cnsplith =  1.00000001E-07 1.00000001E-07
epsslug  =  9.99999975E-05
epsarea  =  9.99999997E-07
dsrise   =  1.00000000
trajincl =  20.0000000
mdepbc   =  1
htminbc  =  500.000000
rsampbc  =  10.0000000

--------------  INPUT GROUP 13  ---------------

npt1     =  0
iptu     =  1   units =     g/s
      converted to g/s by factor:  1.00000000
nspt1    =  0
npt2     =  0


--------------  INPUT GROUP 14  ---------------

nar1     =  2
iaru     =  1   units =     g/s/m^2
   converted to g/s/m^2 by factor:  1.00000000
nsar1    =  4
nar2     =  0

cnamar1  = SRC_7           SRC_8
htar1    =  15.0000000 4.00000000
elar1    =  1047.90002 1036.90002
sz0ar1   =  7.50000000 2.00000000

area source: SRC_7             number:  1
qar1     =  8698.89453 8698.89453
area1    =  8698.89453
[x,y]ar1grd  =  21.8000031 19.2211914
```

```
[x,y]ar1grd  =  22.1600342 18.7890625
[x,y]ar1grd  =  22.4449921 18.9746094
[x,y]ar1grd  =  22.1549988 19.4653320
emission factors for species: TSP
IVARY =  4
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
emission factors for species: PM10
IVARY =  4
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000

area source: SRC_8             number:  2
qar1     =  1529.63013 1529.63013
area1    =  1529.63013
[x,y]ar1grd  =  21.2699890 18.1689453
[x,y]ar1grd  =  21.4350128 18.1640625
[x,y]ar1grd  =  21.4400482 18.4155273
[x,y]ar1grd  =  21.3050079 18.4252930
emission factors for species: TSP
IVARY =  4
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
emission factors for species: PM10
IVARY =  4
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000

--------------  INPUT GROUP 15  ---------------

nln2     =  0
nlines   =  0
ilnu     =  1   units =     g/s
      converted to g/s by factor:  1.00000000
nsln1    =  0
xl       =  0.00000000E+00
hbl      =  0.00000000E+00
wbl      =  0.00000000E+00
wml      =  0.00000000E+00
dxl      =  0.00000000E+00
fprimel  =  0.00000000E+00
```

```
 mxnseg     =  7
 nlrise   =  6


 --------------  INPUT GROUP 16  ---------------

 nvl1     =  6
 ivlu     =  1   units =     g/s
      converted to g/s by factor:  1.00000000
 nsvl1    =  0
 nvl2     =  0

 cnamvl1  = SRC_1           SRC_2
 xvl1grd  =  21.7800140 22.1050262 22.6300049 21.7749786 22.0549774 21.2200165
 yvl1grd  =  19.1040039 19.2797852 19.4750977 18.8110352 19.2211914 18.2910156
 htvl1    =  3.00000000 3.00000000 8.00000000 8.00000000 8.00000000 3.00000000
 elvl1    =  1047.80005 1047.59998 1047.19995 1048.30005 1047.69995 1036.40002
 sy0vl1   =  3.50000000 3.50000000 0.200000003 0.200000003 1.00000000
0.500000000
 sz0vl1   =  1.50000000 1.50000000 4.00000000 4.00000000 4.00000000 1.50000000

 volume source: SRC_1             number:  1
 qvl1     =  3.38000011 1.02999997

 volume source: SRC_2             number:  2
 qvl1     =  1.48000002 0.709999979

 volume source: SRC_3             number:  3
 qvl1     =  0.189999998 7.99999982E-02

 volume source: SRC_4             number:  4
 qvl1     =  0.189999998 7.99999982E-02

 volume source: SRC_5             number:  5
 qvl1     =  0.250000000 0.109999999

 volume source: SRC_6             number:  6
 qvl1     =  5.00000007E-02 1.99999996E-02

 --------------  INPUT GROUP 17  ---------------

 nrec     =  144
 xng      =  12.9150391 12.9150391 12.9150391 12.9150391 12.9150391 12.9150391
12.9150391 12.9150391 14.4149780 14.4149780 14.4149780 14.4149780 14.4149780
14.4149780 14.4149780 15.9149933 15.9149933 15.9149933 15.9149933 15.9149933
15.9149933 15.9149933 17.4150085 17.4150085 17.4150085 17.4150085 17.4150085
17.4150085 17.4150085 18.9150238 18.9150238 18.9150238 18.9150238 18.9150238
18.9150238 18.9150238 20.4150391 20.4150391 20.4150391 20.4150391 20.4150391
20.4150391 20.4150391 21.9149780 21.9149780 21.9149780 21.9149780 21.9149780
21.9149780 21.9149780 23.4149933 23.4149933 23.4149933 23.4149933 23.4149933
23.4149933 23.4149933 24.9150085 24.9150085 24.9150085 24.9150085 24.9150085
24.9150085 24.9150085 26.4150238 26.4150238 26.4150238 26.4150238 26.4150238
26.4150238 26.4150238 27.9150391 27.9150391 27.9150391 27.9150391 27.9150391
27.9150391 27.9150391 29.4149780 29.4149780 29.4149780 29.4149780 29.4149780
29.4149780 29.4149780 5.03501892 5.03501892 5.03501892 5.03501892 5.03501892
5.03501892 5.03501892 5.03501892 10.0350189 10.0350189 10.0350189 10.0350189
10.0350189 10.0350189 10.0350189 10.0350189 15.0350189 15.0350189 15.0350189
```

```
15.0350189 15.0350189 15.0350189 15.0350189 15.0350189 20.0350189 20.0350189
20.0350189 20.0350189 20.0350189 20.0350189 20.0350189 20.0350189 25.0350189
25.0350189 25.0350189 25.0350189 25.0350189 25.0350189 25.0350189 25.0350189
30.0350189 30.0350189 30.0350189 30.0350189 30.0350189 30.0350189 30.0350189
30.0350189 35.0350189 35.0350189 35.0350189 35.0350189 35.0350189 35.0350189
35.0350189 35.0350189 18.4899902 18.2299805 21.0250092
 yng      =  12.9394531 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 14.4409180 15.9399414 17.4389648 18.9404297 20.4394531
21.9409180 23.4399414 6.59179688E-02 5.06591797 10.0659180 15.0659180 20.0659180
25.0659180 30.0659180 35.0659180 6.59179688E-02 5.06591797 10.0659180 15.0659180
20.0659180 25.0659180 30.0659180 35.0659180 6.59179688E-02 5.06591797 10.0659180
15.0659180 20.0659180 25.0659180 30.0659180 35.0659180 6.59179688E-02 5.06591797
10.0659180 15.0659180 20.0659180 25.0659180 30.0659180 35.0659180 6.59179688E-02
5.06591797 10.0659180 15.0659180 20.0659180 25.0659180 30.0659180 35.0659180
6.59179688E-02 5.06591797 10.0659180 15.0659180 20.0659180 25.0659180 30.0659180
35.0659180 6.59179688E-02 5.06591797 10.0659180 15.0659180 20.0659180 25.0659180
30.0659180 35.0659180 15.6958008 13.1298828 25.7690430
 zng      =  0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
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0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
```

```
 elevng   =  930.500000 931.400024 933.000000 935.599976 939.500000 986.599976
991.200012 994.299988 932.000000 933.599976 936.099976 939.799988 986.400024
990.700012 993.700012 937.000000 934.400024 936.799988 940.200012 986.200012
990.200012 993.000000 941.500000 942.700012 937.400024 940.599976 986.099976
989.599976 999.400024 948.299988 949.000000 949.700012 940.900024 985.900024
999.799988 999.700012 1033.69995 1033.40002 1033.09998 1032.80005 1004.09998
1004.09998 1004.09998 1041.59998 1040.59998 1039.59998 1048.09998 1014.70001
1004.40002 1004.50000 1047.09998 1045.80005 1050.80005 1048.40002 1014.59998
1011.79999 1004.70001 1050.69995 1053.09998 1051.30005 1048.69995 1014.40002
1011.40002 1009.20001 1054.80005 1053.59998 1051.80005 1048.90002 1014.29999
1011.00000 1008.70001 1055.19995 1054.00000 1052.09998 1049.09998 1014.20001
1010.70001 1008.40002 1055.40002 1054.19995 1052.30005 1049.19995 1014.20001
1010.50000 1008.20001 934.700012 930.799988 930.500000 932.799988 985.099976
995.500000 997.700012 998.799988 935.500000 931.299988 929.500000 931.400024
985.099976 996.900024 998.700012 998.799988 940.599976 935.500000 933.000000
932.900024 985.099976 999.000000 998.900024 999.000000 1031.19995 1031.19995
1031.30005 1031.19995 1004.00000 1004.00000 1004.00000 1004.00000 1045.40002
1050.50000 1053.00000 1053.90002 1015.40002 1005.00000 1005.09998 1005.00000
1050.40002 1054.59998 1056.40002 1055.00000 1015.29999 1006.59998 1005.29999
1005.20001 1051.19995 1055.40002 1055.59998 1053.90002 1015.40002 1007.70001
1006.00000 1005.20001 946.900024 944.200012 1004.29999


 --------------------------------------------------------------------------------
---------------------------------------------------
          INPUT FILES

 Default Name     Unit No.     File Name and Path
 ------------     --------     ------------------
  CALPUFF.INP         1        C:\CALPUFF\30-2506\CALPUFF.INP
   PLMMET.DAT         7        ANGUSP~1.DAT


 --------------------------------------------------------------------------------
---------------------------------------------------
          OUTPUT FILES

 Default Name     Unit No.     File Name and Path
 ------------     --------     ------------------
  CALPUFF.LST         2        CALPUFF.LST
     CONC.DAT         8        CONC.DAT
     DFLX.DAT         9        DFLX.DAT
     VISB.DAT        11        VISB.DAT



 Constant Meteorological Fields
 Created from PLMMET.DAT
  AUSPLUME METFILE

 -- Data begin at:
  IBYR    =  2006
  IBMO    =  1
  IBDY    =  1
  IBJUL   =  1
  IBHR    =  0
  IBSEC   =  0
```

```
-- Data end at:  ?
 IEYR    =  2011
 IEMO    =  1
 IEDY    =  2
 IEJUL   =  2
 IEHR    =  0
 IESEC   =  0

 IRTYPE  =  1
 LCALGRD =  F
 NXM     =  40
 NYM     =  40
 NZM     =  1
 XGRIDM  =  200.000000
 XORIGM  =  225700.000
 YORIGM  =  6302000.00
 PMAPM   = UTM
 DATUMM  = WGS-84
 DATENM  = 02-21-2003
 IUTMZNM =  56
 UTMHEMM = S
 XLAT1M  =  30.0000000
 XLAT2M  =  60.0000000
 RLAT0M  =  0.00000000E+00
 RLON0M  =  0.00000000E+00
 FEASTM  =  0.00000000E+00
 FNORTHM =  0.00000000E+00
 IWFCOD  =  1
 NSSTA   =  1
 NUSTA   =  1
 NPSTA   =  1
 NOWSTA  =  0
 NLU     =  10
 IWAT1   =  500
 IWAT2   =  599
 ANEMHT  =  10.0000000
ZFACEM  =     0.000,  3000.000,

WARNING  subr. METQA -- Unknown Time Zone
  Met file does not indicate time zone of data
  CALPUFF assumes met data are Time Zone  -10.0000000


WARNING  subr. METQA -- Unknown DATUM
  Met file does not indicate DATUM of data
  CALPUFF assumes met DATUM is WGS-84

XSSTA    =  225700.000
YSSTA    =  6302000.00
XLATSS   =  -33.3870735
YLONSS   =  150.093262
XUSTA    =  225700.000
YUSTA    =  6302000.00
XPSTA    =  225700.000
YPSTA    =  6302000.00

Surface roughness lengths (m)                                 z0
```

```
 Multiply all values by 10 **  -4

  40 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  39 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  38 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  37 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  36 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  35 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  34 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  33 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  32 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  31 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  30 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  29 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  28 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  27 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
```

```
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  26 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  25 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  24 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  23 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  22 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  21 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  20 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  19 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  18 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  17 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  16 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  15 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  14 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  13 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  12 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  11 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  10 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   9 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   8 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   7 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   6 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   5 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   4 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   3 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   2 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   1 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
     ------------------------------------------------------------------------------
--------------------------------------------
          1     2     3     4     5     6     7     8     9    10    11    12
13    14    15    16    17    18    19    20

 Surface roughness lengths (m)                                z0
```

```
 Multiply all values by 10 **  -4

  40 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  39 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  38 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  37 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  36 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  35 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  34 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  33 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  32 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  31 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  30 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  29 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  28 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  27 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
```

```
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  26 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  25 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  24 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  23 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  22 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  21 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  20 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  19 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  18 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  17 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  16 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  15 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  14 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +    +    +    +    +    +    +    +    +    +    +    +
+    +    +    +    +    +    +    +
  13 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  12 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  11 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  10 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   9 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   8 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   7 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   6 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   5 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   4 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   3 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   2 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   1 I 2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500  2500
2500  2500  2500  2500  2500  2500  2500  2500
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
     ---------------------------------------------------------------------------
--------------------------------------------
         21    22    23    24    25    26    27    28    29    30    31    32
33    34    35    36    37    38    39    40

 Land use categories                                          ILANDU
```

Multiply all values by 10 ** -2

```
  40 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  39 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  38 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  37 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  36 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  35 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  34 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  33 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  32 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  31 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  30 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  29 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  28 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  27 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  26 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  25 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  24 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  23 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  22 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  21 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  20 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  19 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  18 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  17 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  16 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  15 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  14 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  13 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  12 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  11 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  10 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   9 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   8 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   7 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   6 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   5 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   4 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   3 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   2 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   1 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
     ---------------------------------------------------------------------------
--------------------------------------------
          1     2     3     4     5     6     7     8     9    10    11    12
13    14    15    16    17    18    19    20

 Land use categories                                          ILANDU
```

```
 Multiply all values by 10 **  -2

  40 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  39 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  38 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  37 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  36 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  35 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  34 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  33 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  32 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  31 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  30 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  29 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  28 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  27 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  26 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  25 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  24 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  23 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  22 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  21 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  20 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  19 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  18 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  17 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  16 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  15 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  14 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  13 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  12 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  11 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  10 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   9 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   8 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   7 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   6 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   5 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   4 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   3 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   2 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   1 I 2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000  2000
2000  2000  2000  2000  2000  2000  2000  2000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
     ---------------------------------------------------------------------------
--------------------------------------------
         21    22    23    24    25    26    27    28    29    30    31    32
33    34    35    36    37    38    39    40

 Terrain heights (m)                                           TERR
```

GRID NOT PRINTED -- all values zero

Leaf area index XLAI

Multiply all values by 10 ** -3

```
  40 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  39 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  38 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  37 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  36 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  35 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  34 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  33 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  32 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  31 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  30 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  29 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  28 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  27 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  26 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  25 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  24 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  23 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  22 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  21 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  20 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  19 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  18 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  17 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  16 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  15 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  14 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
```

```
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  13 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  12 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  11 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  10 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   9 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   8 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   7 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   6 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   5 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   4 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   3 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   2 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   1 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
     ------------------------------------------------------------------------
------------------------------------------
```

```
          1     2     3     4     5     6     7     8     9    10    11    12
13    14    15    16    17    18    19    20

 Leaf area index                                                      XLAI

 Multiply all values by 10 **  -3

  40 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  39 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  38 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  37 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  36 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  35 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  34 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  33 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  32 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  31 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  30 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  29 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  28 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
```

```
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  27 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  26 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  25 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  24 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  23 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  22 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  21 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  20 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  19 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  18 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  17 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  16 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  15 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  14 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
```

```
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  13 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  12 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  11 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  10 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   9 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   8 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   7 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   6 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   5 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   4 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   3 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   2 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
   1 I 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
3000  3000  3000  3000  3000  3000  3000  3000
     I     +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
     ---------------------------------------------------------------------------
--------------------------------------------
```

```
         21    22    23    24    25    26    27    28    29    30    31    32
33    34    35    36    37    38    39    40

 Nearest surface station no. to each grid point               NEARS

 Multiply all values by 10 **  -3

  40 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  39 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  38 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  37 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  36 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  35 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  34 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  33 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  32 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  31 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
+     +     +     +     +     +     +     +
  30 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
     I    +     +     +     +     +     +     +     +     +     +     +     +
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  29 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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     I    +     +     +     +     +     +     +     +     +     +     +     +
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  28 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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     I     +     +     +     +     +     +     +     +     +     +     +     +
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  27 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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     I     +     +     +     +     +     +     +     +     +     +     +     +
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  26 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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     I     +     +     +     +     +     +     +     +     +     +     +     +
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  25 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  24 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  23 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  22 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  21 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  20 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  19 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  18 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  17 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  16 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  15 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  14 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  12 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  10 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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   5 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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   3 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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         1     2     3     4     5     6     7     8     9    10    11    12
13    14    15    16    17    18    19    20

 Nearest surface station no. to each grid point               NEARS

 Multiply all values by 10 **  -3

  40 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
1000  1000  1000  1000  1000  1000  1000  1000
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  39 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  38 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  37 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  36 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  35 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  34 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  33 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  32 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  31 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  28 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  26 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  19 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  18 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  17 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  16 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  12 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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  11 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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   9 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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   8 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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     I    +     +     +     +     +     +     +     +     +     +     +     +
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   7 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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   6 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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     I    +     +     +     +     +     +     +     +     +     +     +     +
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   5 I 1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000  1000
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         21     22     23     24     25     26     27     28     29     30     31     32
33     34     35     36     37     38     39     40


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           REVISED CONTROL DATA
         Running All Met Periods

 -------------  INPUT GROUP 1  ---------------

 metrun  =  1
 ibyr    =  2006
 ibmo    =  1
 ibdy    =  1
 ibhr    =  0
 ibsec   =  0
 nsecdt  =  3600
 irlg    =  43848
 ibdathr =  200600100
 iedathr =  201100200
 iesec   =  0

 (End-times in other data files are NOT checked)

 ---------------------------------------------
 RDPLM: End-Of-File found in PLMMET file

 EOF reached in MET or CHEM data file
 Last period processed IRLG = 8760



  LAST PERIOD PROCESSED ENDS AT:
       Year: 2007  Month:  1   Day:  1   Julian day:   1   Hour:  0   Second:
0


  End of run -- Clock time: 08:19:14
                      Date: 06-11-2010

        Elapsed Clock Time:     2099.0 (seconds)

                  CPU Time:     2099.0 (seconds)
```

RPS

APPENDIX 7.12

Traffic Impact Assessment

Angus Place Colliery
Section 75W Modification Project

Traffic Impact Assessment FINAL REPORT

October 2010

prepared for

Angus Place Colliery

prepared by

Stapleton Transportation & Planning Pty Ltd

STAPLETON TRANSPORTATION AND PLANNING Pty Ltd

Level 9, 99 Bathurst Street, Sydney, NSW 2000

Phone +61 2 9264 STAP Email stap@ozemail.com.au

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Executive Summary

Stapleton Transportation & Planning Pty Ltd (STAP) has completed a detailed independent assessment of the potential access, traffic and parking characteristics associated with the proposed Section 75W Modification Project at the Angus Place Colliery. **STAP has determined that the Project would have no significant impact on the local traffic and transport network**.

- The Project will result in minor increases in Site generation. These increases – and the broader Site peak periods – occur outside of what are already very low generating commuter peak periods and as such **there would be no significant impact on the classification or operation of local roads and intersections**.

- Based on future traffic forecasts which include average annual increases in sub-regional traffic generation, **the local traffic network will continue to operate at a very high level of service through the anticipated life of the Project**.

- **Access to the Site will continue to operate safely and efficiently** based on the geometry of the approved access intersections with Wolgan Road; the minor additional trip demands; and the very low passing flows.

- **All parking for Site staff will continue to be provided on-site in previously approved parking areas**.

- **All coal will continue to be transported to the adjacent Mount Piper and Wallerawang Power Stations by private haul roads**; no coal will be transported by public roads.

- A mix of 50 tonne and 80 tonne vehicles will be employed to carry coal along the haul roads; **the number of vehicle movements along the haul roads, limited in accordance with the findings of the Noise Impact Assessment by Heggies, would not compromise existing haul road operating approvals.**

Introduction

i. Background

In 2006, Centennial Angus Place Pty Ltd (Centennial) applied under Part 3A of the NSW *Environmental Planning and Assessment Act 1979*, for continued mining operations at the Angus Place Colliery (APC), located 7km north of the town of Wallerawang. Project Approval 06_0021 was granted by the NSW Department of Planning (DoP) in September 2006.

The principle components of Project Approval 06_0021 provide for underground longwall mining; supporting surface infrastructure (Angus Place Pit Top); an additional coal stockpile area at Kerosene Vale; and dedicated haulage roads to Delta Electricity's Wallerawang and Mount Piper power stations.

Development activities within the current approval area are scheduled to be completed by October 2012, with longwall operations within the current extraction area planned to be completed by June 2014. Accordingly, further resources are required to be developed to allow development activities to continue ahead of longwall progression.

Angus Place proposes a Section 75W Modification to continue underground mining operations (the Project) at the APC, which are supported by existing surface infrastructure, through the development and extraction of two additional longwall panels. The Project would extend the life of the APC to 2016, and includes: -

- Development and extraction of longwalls 910 and 900 west (900W).
- An increase of the production limit to four (4) million tonnes per annum (mtpa).
- Installation of a dewatering bore facility at the eastern end of longwall 910 and infrastructure required to support the operation of this installation.
- Assessment of the current APC Pit Top water management controls.
- An increase in personnel from the currently approved 215 to 225; in addition, up to 75 temporary contractors will be required to assist with underground development activities for up to 15 months.

Full details of the Project are provided in the broader Environmental Assessment (EA) prepared by RPS which this Traffic Impact Assessment (TIA) accompanies.

ii. Assessment Criteria & Methodology

Stapleton Transportation & Planning Pty Ltd (STAP) has been commissioned to prepare this independent TIA for the Project. This has included: -

- **Reference to the specific traffic and transport assessment requirements provided by the Director-General, 1st June 2010**. In this regard, the Director General's Requirements (DGRs) require an assessment of *Traffic & Transport – Including impacts to Blackmans Flat and Lidsdale*. While the potential impacts in Lidsdale are central to this TIA, from the outset STAP notes that in regard to the general public traffic network the Project would have no significant impact on Blackmans Flat, simply as a function of distance from the Site and the very minor additional generation of the Project itself (refer **Section 3** below).

  STAP acknowledges that the reference to Blackmans Flat may refer to the haul road providing access from the APC to the Mount Piper Power Station. The operation of the haul road is covered by a separate approval and is not examined in significant detail this TIA; notwithstanding, STAP has examined general truck movements along the haul roads with reference to the current noise limits (as defined in the Heggies Noise Impact Assessment (see **Section 1.3.1** below).

- **A detailed review and assessment of all general potential impacts**. STAP has undertaken a rigorous assessment of the existing operation of the local road network, and the manner in which that network would operate further to an approval of the Project which has included: -

  - Observations of the local road network and sourcing of traffic data

  - A detailed review of current Site activities and potential changes to those activities arising from the Project.

  - A review of the key traffic and transport guidelines and assessment criteria, including: -
    - RTA Guide to Traffic Generating Developments (RTA Guide)
    - AustRoads Guide to Traffic Engineering Practice Part 5: Intersections at Grade (AustRoads GTEP Part 5)
    - AustRoads Rural Road Design Guide (AustRoads RRDG)

  - Detailed trip generation and distribution analysis

  - Intersection and carriageway performance assessment.

As stated above, the operation of the private haul roads from the APC to the Mount Piper and Wallerawang coal power stations, and the power stations themselves, are subject to separate approvals and do not therefore require detailed review as part of this TIA.

1 The Angus Place Colliery

1.1 Location

The APC is located off Wolgan Road approximately 3.5km north of the village of Lidsdale. The APC is an underground colliery, and is shown in its sub-regional context in **Figure 1.1.1**, while a more detailed plan of the APC Pit Top – to/from which APC vehicles are generated to the public road network – is shown in **Figure 1.1.2**.

1.2 General Operations

Full details of existing (and proposed) operations at the APC are provided in other sections of the EA which this TIA accompanies; key issues relating to access, traffic and parking are examined below.

1.2.1 Annual Capacity

The APC has a current extraction limit of 3.5mtpa, which was increased from 2.3mtpa as part Project Approval 06_0021. All coal produced by the APC is transported to the nearby Delta Electricity power stations at Mount Piper and Wallerawang via private haul roads (see also **Section 1.3** below).

1.2.2 Operation Hours & Staff

The APC operates 24 hours a day, 7 days a week, and employs 215 full-time equivalent staff primarily across 3 shifts per 24 hour period. Shift times and staff are outlined below in **Table 1.2.2.**

Table 1.2.2 Existing APC Shifts & Staff

Angus Place Colliery Staff & Shifts	Staff	Vehicle Equivalent
Weekday		
Day 6:00am - 2:00pm	72	72
Afternoon 2:00pm - 10:00pm	53	53
Night 10:00pm - 6:00am	40	40
Weekend		
Day 6:00am - 2:00pm	28	28
Afternoon 2:00pm - 10:00pm	28	28
Night 10:00pm - 6:00am	5	5
Office		
Day 6:30am - 5:00pm	32	32
Max On-Site Staff/Vehicles	104	104

Figure 1.1.1 The Angus Place Colliery

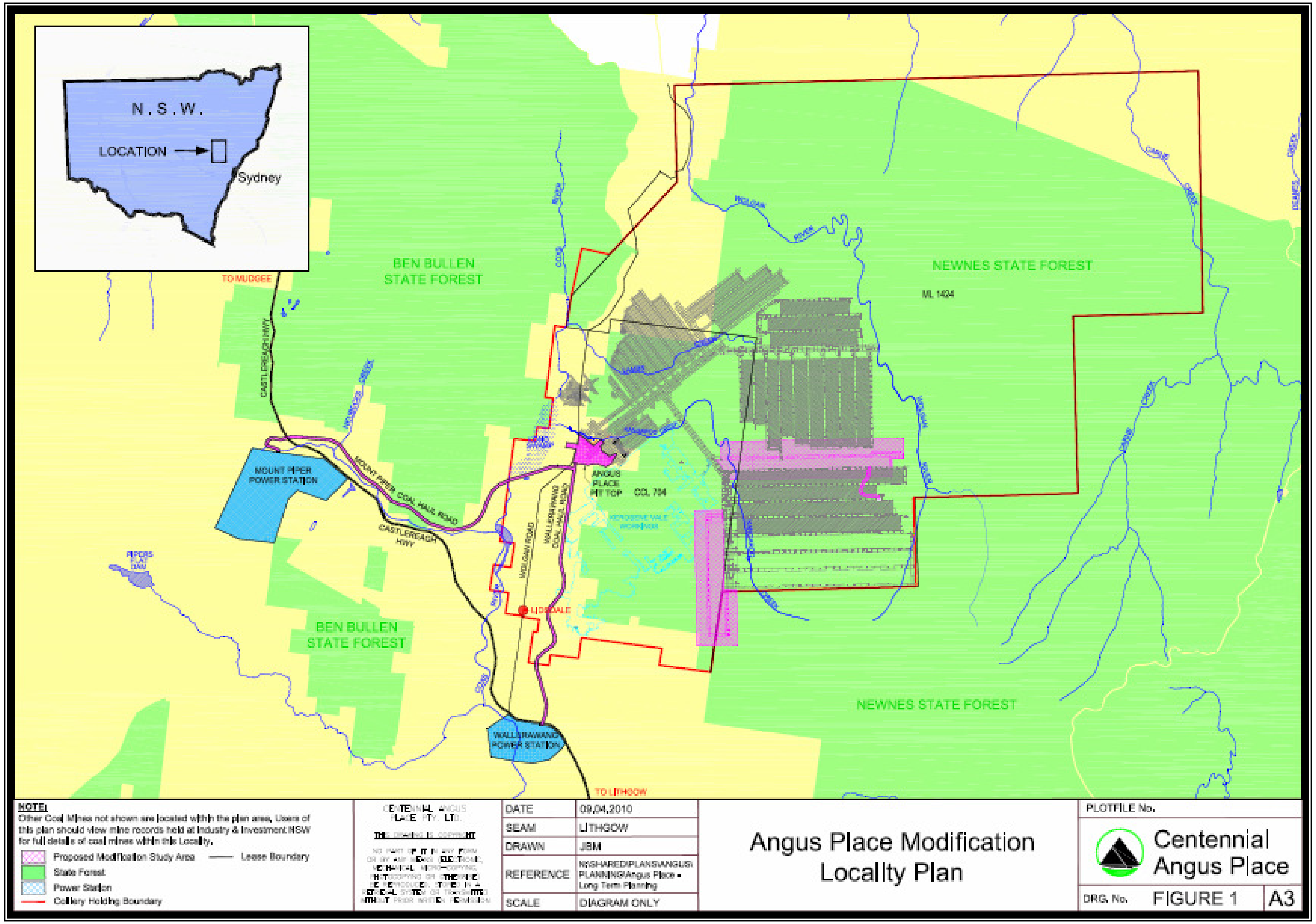
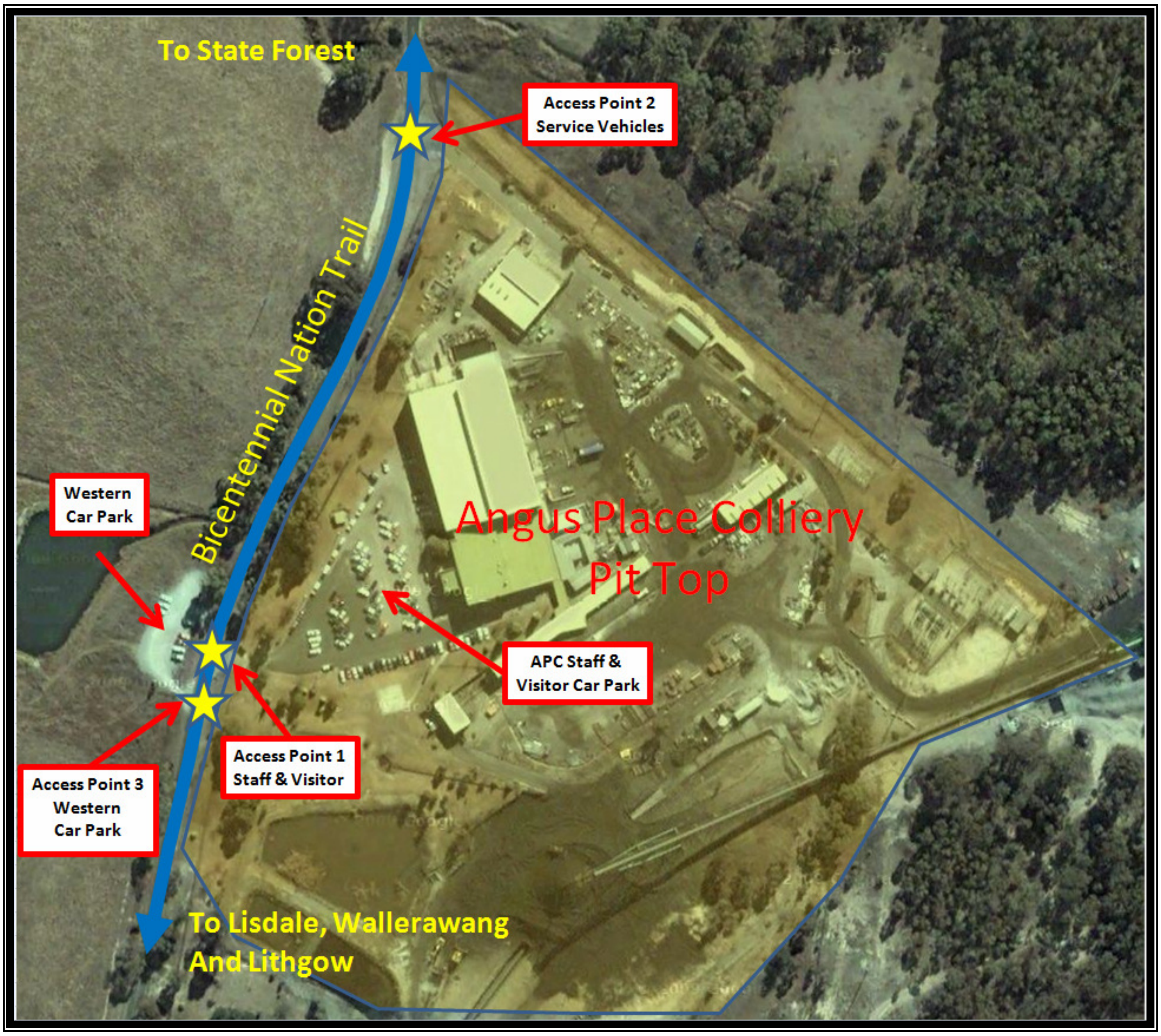


Figure 1.1.2 The Angus Place Colliery Pit Top



1.3 APC Vehicle Access

1.3.1 Coal Movement

One of the greatest advantages of the APC (by design) is that there is no coal carrying heavy vehicle generation to the local road network; rather, coal is exclusively transported via private haul roads to the nearby power stations.

As stated in the **Introduction**, the operations of the Mount Piper and Wallerawang power stations, as well as the private haul roads, are covered by operational approvals which appropriately consider the generation from the APC, and therefore do not require further detailed assessment as part of this TIA. Nonetheless, it is important to briefly examine these movements in light of the Project.

At present, the haulage task is accomplished using vehicles with a 50 tonne capacity; at operational capacity (currently limited to 3.5mtpa) this results in a peak of approximately 200 - 220 loaded trucks (400 - 440 total trips) per day between the APC and the two power stations. The majority (approximately 68%) of coal is currently hauled to the Wallerawang power station, and the remainder (32%) to Mount Piper.

A mix of 50 tonne and 80 tonne trucks will be used for the proposed modified operations. A Noise Impact Assessment prepared by Heggies Pty Ltd for the Project has identified limits to truck movements along the haul roads so that Project noise levels at residential receptors are not exceeded; with reference to the Executive Summary of the Noise Impact Assessment, the limits to the haul roads are: -

- *4 mtpa from Angus Place to Wallerawang on the Wallerawang haul road:*
    - *Daytime (7.00am to 6.00pm) – 10 loads per hour.*
    - *Evening (6.00pm to 10.00pm) – 8 loads per hour.*
    - *Night-time (10.00pm to 7.00am) – No truck movements permitted.*

- *4mtpa from Angus Place to Mount Piper on the Mount Piper haul road:*
    - *Daytime (7.00am to 6.00pm) – 8 loads per hour.*
    - *Evening (6.00pm to 9.30pm) – 8 loads per hour.*
    - *Night-time (9.30pm to 7.00am) – 5 loads per hour.*

Noise modelling indicates that the proposed increase to 4 mtpa can be accommodated with the use of the new 80 tonne haul trucks without exceedences of the Project Specific Noise Levels or existing consent conditions.

Further to the summary of the Noise Impact Assessment, STAP is of the opinion that the use of a mix of 50 tonne and 80 tonne trucks can accommodate the increased production limit provided for by the Project without exceeding the existing haul road consent conditions. In summary: -

- The haulage approvals effectively provide for the movement of 142 truck loads per day (over 18 hours) along the Wallerawang haul road, and for 163 truck loads per day (over 24 hours) along the Mount Piper haul road.

- Based on the existing year round approval for the use of the haulage routes, an average daily haulage demand of approximately 11,000 tonnes would require 137 trucks of 80 tonne capacity, or 219 trucks of 50 tonne capacity.

- As such, the use of 80 tonne trucks would effectively allow for the haulage of the total 4mtpa limit to a single power station. In reality, the existing (and predicted future continuation of) proportional distribution of coal to the two power stations will allow both haul routes to operate below the consent limits with a mix of both 80 tonne and 50 tonne trucks.

In summary, STAP has determined that the haul roads can continue to operate within the existing consent conditions noise/truck load per hour limits even further to a sustained production increase to a 4mpta limit (in the event that changeover periods are not required) as per the Project.

1.3.2 General Vehicle Access

General vehicle access for the APC is provided via the APC Pit Top.

Two primary access points are provided to the APC Pit Top. Access Point 1 (AP1) provides a two-way driveway linking to staff and visitor parking, and generally provides for small vehicle (staff cars) access. Access Point 2 (AP2) to the north of AP1 provides a wide two-way access driveway linking to service vehicle areas behind the primary on-site administration offices. Both AP1 and AP2 operate at a high level of service as a result of: -

- Intersection geometry, including a ~7.0m carriageway with wide general verges; extended turning path areas adjacent to the intersections; and wide access driveways.

- Very low traffic flows – and particularly very minor passing flows in Wolgan Road.

- An almost exclusive trip distribution to and from the south.

Two additional minor access points are provided to the broader APC Pit Top from Wolgan Road. Access Point 3 (AP3) is located almost opposite AP1, and provides access to an approved (Project Approval 06_0021) additional parking area on the western side of Wolgan Road. AP3 provides a gravel two-way driveway leading to an informal parking area; it is proposed that this car park – along with the primary car park off AP1 - will be used to accommodate the peak parking demands that will occur at times during the Project (see **Section 3**).

A final access point is located approximately 500m to the south of the APC Pit Top (adjacent to the Coal Bin), and is used primarily by haul contractors and on rare occasions for emergency and service vehicles. This access point has a nominal traffic generation that would not be affected by the Project.

1.4 APC Traffic Generation

1.4.1 Staff Vehicle Trips

With regard to the local road network, the most significant generation of the APC is that of staff arriving for and departing after shifts, along with minor office and visitor staff demands. Further to our discussions with APC officers, it has been determined that almost the entire staff complement drives to the APC via private vehicle, and that there is only a minor level of car sharing. This is not surprising considering: -

- The nature (and hours) of the work;
- The location of the Site;
- The available capacity within the local road network;
- The abject lack of other travel options (i.e. walk, cycle of public transport); and
- The [appropriate in our opinion] provision of on-site parking.

Importantly, given the nature of the shift structure at the APC broad peak periods are generated around the shift start and end times, i.e. not all staff arrive immediately before a shift and depart immediately after a shift. The arrival pattern is more constrained (i.e. staff generally arrive within 30 minutes of the shift staff) but the departure pattern is set over a longer period. This is reflected in the traffic surveys at AP1, more details of which are provided in **Section 2** below.

1.4.2 Staff Origins & Destinations

The APC has provided STAP with general information in regard to the residential locations of staff, so as to provide information for the distribution of existing and future trips. The origin/destination data is shown in **Table 1.4.2.**

Table 1.4.2 Staff Origins/Destinations

Suburb	Postcode	No. of employe	%
BATHURST	2795	5	2%
BEN BULLEN	2790	1	0%
BLACKHEATH	2785	5	2%
BOWENFELS	2790	1	0%
CAPERTEE	2846	1	0%
CULLEN BULLEN	2790	2	1%
HARTLEY	2790	1	0%
HAZELGROVE	2787	1	0%
KATOOMBA	2780	2	1%
KELSO	2795	8	4%
LIDSDALE	2790	12	5%
LITHGOW	2790	97	43%
LITTLE HARTLEY	2790	2	1%
MARRANGAROO	2790	8	4%
MARRANGAROO FIELDS	2790	6	3%
MT LAMBIE	2790	1	0%
MT VICTORIA	2786	2	1%
PEEL	2795	1	0%
PIPERS FLAT	2897	7	3%
PORTLAND	2847	20	9%
SODWALLS	2790	1	0%
SOUTH BOWENFELS	2790	7	3%
WALLERAWANG	2845	30	13%
WENTWORTH FALLS	2782	1	0%
YETHOLME	2795	1	0%

1.4.3 Heavy Vehicle Trips

As discussed, all coal generated by the APC is transported by private haul roads to the nearby power stations. This provides significant cost and efficiency benefits to the entire mining operation and also to the local network, particularly in local centres such as Lidsdale, Wallerawang and Blackmans Flat where such movements could have an impact on local amenity if facilitated by the public road network.

The APC Pit Top generates only a minor additional heavy vehicle demand, specifically being deliveries of equipment and light materials; maintenance vehicles; and occasionally machinery and the like. The majority of these movements are to AP2, with a small number to AP1 where access to the infrastructure around the main offices is required. More detail of the APC heavy vehicle generation is provided in **Section 2**.

As a temporary arrangement due to the induction of a new haulage contract, unloaded coal trucks (minus trailers) occasionally access the regional road network, specifically travelling to and from Lithgow for diesel fuel. These movements are generated directly to the Castlereagh Hwy via the Wallerawang Power Station access point to the Castlereagh Hwy, i.e. the APC vehicles utilise the haulage road to the power station and then the Castlereagh Hwy. This reduces to a minimum the heavy vehicle generation to Wolgan Road.

1.5 Parking

All staff and heavy vehicle parking is provided on-site; the APC generates no off-site parking demand.

The primary parking area is located immediately off AP1, providing primarily for staff and visitors. Access from the parking area is then available to both the APC Pit Top offices and administration areas, and to the mine access points. A total of approximately 135 formal parking spaces are available within the main car park off AP1, including designated disabled and visitor spaces appropriately located in close proximity to the administration office entrance.

As described in **Section 1.3.2**, an additional approved parking area is located on the western side of Wolgan Road off AP3. This car park currently provides informal parking (approximately 25 parking spaces); it is proposed that this informal car park will be formalised as part of the Project so as to appropriately meet future peak demand (see **Section 3** below).

The current peak 'standard' on-site demand for approximately 105 – 110 parking spaces – being the peak staff demand and peak visitor demand – is therefore appropriately provided for by the on-site parking capacity off AP1. Based on our observations and discussions with APC staff, during peak shift changeover – and specifically at the end of the day shift and the start of the afternoon shift – there are few available spaces for a period of time, but in general the AP1 car park provides for this existing peak demand.

2 The Local Transport Environment

2.1 Key Local & Regional Roads

The road network which provides for the APC, and more broadly for the local sub-region (linking to key arterial and sub-arterial routes) is shown in **Figure 2.1**. Key intersections – detailed further below in **Section 2.2** - are also shown.

Figure 2.1 Sub-Regional Road Network

2.1.1 Castlereagh Highway

The Castlereagh Hwy (State Highway 18, State Route 86) is a regional highway connecting the Great Western Hwy at Marrangaroo to Mudgee and Gulgong and then further through north-west NSW. In the sub-region around the APC, the Castlereagh Hwy generally provides two traffic lanes and well designed at-grade and grade separated intersections appropriate to the through and turning traffic demands in this part of the regional network.

The Castlereagh Hwy has a posted speed limit of 80km/h through the 'busier' section of the network that includes the intersections with Wolgan Road, [Wallerawang] Main Road and Mudgee Road, but otherwise is generally 100km/h.

2.1.2 Great Western Hwy

The Great Western Hwy (State Highway 5, National Route 32) is a regional highway which intersects with the Castlereagh Highway at Marrangaroo. The Great Western Hwy links to the east to Lithgow, Katoomba and then through to the broader Sydney metropolitan area (M4); and west to Bathurst.

2.1.3 Wolgan Road/Bicentennial National Trail

Wolgan Road north from the Castlereagh Hwy operates as a local collector road, providing for the local township of Lidsdale and the APC. North of the APC, it has a very local role providing minor residential/farm access as well as access to the Wolgan Valley, with minimal traffic demands.

Between the Castlereagh Hwy and the APC, Wolgan Road has two traffic lanes over a [generally] 7m carriageway with wide verges. Local intersections provide excellent geometry, sight distance and controls appropriate to the low flow of traffic in the area (see also **Section 2.2** below). Wolgan Road has a posted 50km/h speed through Lidsdale, which then increases to 80km/h through to the APC and north.

Wolgan Road through Lidsdale would have a nominal capacity of up to 3,000vpd (essentially a rural collector road) through the village centre, based on the width of carriageway, intersection treatments and general traffic demands. Outside of Lidsdale it would have a nominal capacity of approximately 1,000vpd - 1,500vp based on the carriageway and verge widths, and vehicle speeds.

2.1.4 Mudgee Road

Mudgee Road is a minor link distributor road between Wolgan Road and the Castlereagh Hwy, allowing for local trips (generated to the north of Mudgee Road) to travel to and from the west (to a secondary intersection with the Castlereagh Hwy) thus avoiding the main intersection to the south of Wolgan Road & the Castlereagh. Mudgee Road has a posted 50km/h speed limit.

2.1.5 Main Street

Main Street is a local collector route running south from the Castlereagh Hwy to Wallerawang. It provides two wide traffic lanes, and becomes more urban in nature on the immediate approach to Wallerawang. Main Street has a posted speed limit of 50km/h.

2.2 Key Local Intersections

2.2.1 APC Pit Top Access Points & Wolgan Road

As described in **Section 1**, the APC Pit Top provides 2 primary access driveways with Wolgan Road; AP1 provides for general staff and visitor trips, while AP2 provides for service vehicle trips. Both intersections operate as simple priority T intersections (priority to Wolgan Road) and provide sight distance in excess of that required with reference to the RTA RDG.

With reference to the RTA RDG and AustRoads Part 5 (Section 4, Figure 4.3a and Figure 4.3b) – and further to our on-site observations - these intersections operate at a high level of service simply due to the abject lack of passing traffic in Wolgan Road; indeed, using the AustRoads Part 5 tables, delays on average are less than 1 second, i.e. there are virtually no occasions where a vehicle turning to or from either AP1 or AP2 is delayed by a passing vehicle.

At present there are no on-site works requiring additional contractor demands, and as such the western car park is not generally in use. Regardless, it is our opinion (again with reference to the appropriate intersection capacity guidelines) that even if this car park were to be utilised at capacity the resulting trip generation to Wolgan Road combined with that from AP1 and AP2 would not result in any significant traffic delays or general safety impacts.

2.2.2 Wolgan Road & Mudge Road & Skelly Road

This priority (to Wolgan Road) 4-way intersection provides turning lanes to and from Wolgan Road. A more detailed assessment of the operation of this intersection is provided in **Section 2.3** and **Section 2.4**.

2.2.3 Wolgan Road & Castlereagh Hwy & Main Street

This priority (to Castlereagh Hwy) off-set 4-way intersection provides turning slip lanes and to and from the Castlereagh Hwy. A more detailed assessment of the operation of this intersection is provided in **Section 2.3** and **Section 2.4**.

2.3 Existing Traffic Flows

In order to better define local traffic flows, STAP commissioned traffic surveys in the local area, including classifier counter surveys and intersection surveys.

Classifier counters (or tube counters) were installed at the two APC access driveways (AP1 and AP2) and also in Wolgan Road north of Mudgee Road from the 22nd May to 28th May 2010 inclusive. A summary of the classifier counter data is provided in **Tables 2.3.1 – 2.3.3**.

The tube counters were supplemented by intersection surveys which were conducted at the intersection of Wolgan Road & Castlereagh High & Main Street; and the intersection of Wolgan Road & Mudgee Road & Skelly Road. These intersections provide for virtually 100% of the traffic generated by the APC and also provide de facto data for the intersection of Castlereagh Hwy & Mudge Road. The survey results are provided below in **Figure 2.3.1** and **Figure 2.3.2** below.

2.4 Existing Road & Intersection Operation

2.4.1 General Road Conditions

Overall, based on our observations and review of the traffic data, it is clear that the local network operates at a very good level of service.

The Castlereagh Hwy generates flows that represent only a small percentage of its capacity, and the excellent intersection and sight distances provided along the route ensure high levels of service by any measure.

This is true also for Wolgan Road. Even considering additional environment capacity conditions in Wolgan Road – which appropriately provide speed reductions through Lidsdale - the sight distances, road geometry and good intersection design ensures that it operates at only a fraction of its capacity. Through Lidsdale, the peak daily flow of just over 1,000vpd represents approximately one third of capacity, while north of Lidsdale the flow is approximately 400 – 500vpd, based in most part on the generation of the APC itself. Minor additional flows may be generated during holiday periods (visitors to the local forest areas) but even under these conditions the flow would be well below capacity.

Table 2.3.1 Access Point 1 Two-Way Classified Data

Time	Mon 24-May-10			Tue 25-May-10			Wed 26-May-10			Thu 27-May-10			Fri 28-May-10			Weekday Average			Sat 22-May-10			Sun 23-May-10		
	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-13
100	1	0	0	17	4	0	3	3	1	8	0	0	6	1	0	7	2	0	2	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	1	0	0	1	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
600	15	1	0	7	1	0	7	1	0	14	0	0	14	0	0	11	1	0	2	1	0	4	1	0
700	66	9	5	64	11	5	71	8	2	52	4	5	47	8	5	60	8	4	18	3	0	20	1	0
800	20	0	1	8	2	0	20	0	0	11	0	0	26	0	0	17	0	0	4	0	0	1	0	0
900	10	0	0	24	4	0	27	1	0	24	0	0	12	0	1	19	1	0	3	1	1	0	0	0
1000	8	0	0	9	1	0	8	0	0	7	1	1	10	0	0	8	0	0	0	0	0	0	0	0
1100	7	1	0	14	0	0	11	1	0	10	2	0	7	0	0	10	1	0	0	0	0	0	0	0
1200	8	0	0	15	0	0	10	0	0	12	0	0	3	0	0	10	0	0	0	0	0	0	0	0
1300	9	1	0	8	2	0	13	0	0	4	0	0	14	0	0	10	1	0	0	0	0	0	0	0
1400	14	1	0	20	2	0	25	1	0	11	1	0	26	3	0	19	2	0	4	2	0	0	0	0
1500	54	5	0	66	3	1	43	6	0	57	2	1	46	1	1	53	3	1	0	0	0	0	0	0
1600	41	1	0	38	3	0	38	1	0	43	0	0	36	0	0	39	1	0	0	0	0	0	0	0
1700	35	0	0	28	0	0	37	0	0	35	0	0	6	0	0	28	0	0	0	0	0	0	0	0
1800	3	2	0	4	0	0	2	0	0	1	0	0	6	1	0	3	1	0	2	0	0	6	2	0
1900	2	2	0	1	0	0	1	0	0	0	0	0	14	0	0	4	0	0	26	1	0	15	0	0
2000	1	0	0	1	1	0	1	0	0	1	0	0	7	0	0	2	0	0	5	0	0	13	0	0
2100	0	0	0	1	0	0	1	0	0	0	0	0	4	1	0	1	0	0	0	0	0	0	0	0
2200	4	0	0	5	0	0	4	0	0	4	1	0	21	4	0	8	1	0	0	0	0	2	1	0
2300	26	4	0	40	1	3	38	3	1	37	2	2	0	0	0	28	2	1	0	0	0	18	2	1
2400	13	0	0	12	0	0	8	2	0	8	1	0	1	0	0	8	1	0	0	0	0	2	0	0
Totals	337	27	6	382	35	9	370	27	4	340	14	9	309	20	7	348	25	7	67	8	1	81	7	1

Table 2.3.2 Access Point 2 Two-Way Classified Data

Time	Mon 24-May-10			Tue 25-May-10			Wed 26-May-10			Thu 27-May-10			Fri 28-May-10			Weekday Average			Sat 22-May-10			Sun 23-May-10		
	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-13
100	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
500	0	0	0	1	2	1	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0
700	0	0	0	0	0	0	1	1	0	1	2	0	1	1	0	1	1	0	0	0	0	0	0	0
800	0	0	0	2	0	0	0	1	0	0	3	0	0	3	0	0	1	0	0	0	0	0	0	0
900	0	0	0	1	3	0	0	4	1	0	0	0	0	4	0	0	2	0	0	1	0	0	0	0
1000	1	3	0	3	6	0	0	1	0	1	4	0	1	3	0	1	3	0	0	1	0	0	0	0
1100	1	2	0	2	1	0	1	3	0	0	4	0	6	9	0	2	4	0	0	1	0	0	0	0
1200	0	1	0	1	3	0	0	0	0	1	0	1	0	4	0	0	2	0	0	1	0	0	0	0
1300	1	0	0	0	2	3	1	1	0	0	1	1	4	3	2	1	1	1	2	0	1	0	0	0
1400	2	1	0	2	3	0	1	1	0	0	2	0	0	1	0	1	2	0	0	1	0	0	0	0
1500	0	1	0	0	0	0	2	2	0	0	1	0	4	0	0	1	1	0	0	0	0	0	0	0
1600	0	1	0	1	0	0	1	2	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0
1700	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1800	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
2100	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2200	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2300	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	5	10	0	13	20	4	8	20	2	7	19	4	19	29	4	10	20	3	2	5	1	0	0	0

Table 2.3.3 Wolgan Road North of Mudgee Road Two-Way Classified Data

Time	Mon 24-May-10			Tue 25-May-10			Wed 26-May-10			Thu 27-May-10			Fri 28-May-10			Weekday Average			Sat 22-May-10			Sun 23-May-10		
	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-13	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-12	Class 1-2	Class 3-5	Class 6-13
100	3	0	0	32	0	0	20	1	0	24	0	0	18	0	0	19	0	0	1	0	0	0	0	0
200	0	0	0	2	0	0	1	0	0	4	0	0	1	0	0	2	0	0	4	0	0	0	0	0
300	3	0	0	1	0	0	1	0	0	2	0	0	3	0	0	2	0	0	5	0	0	0	0	0
400	0	0	0	1	0	0	3	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
500	3	0	0	2	0	2	4	0	0	4	1	0	3	1	1	3	0	1	0	0	0	0	0	0
600	26	4	1	20	1	0	25	3	1	20	2	2	26	1	1	23	2	1	13	0	0	0	0	0
700	127	5	0	116	3	0	123	4	2	106	4	0	109	0	0	116	3	0	32	0	0	0	0	0
800	58	12	1	61	8	0	61	9	0	56	10	0	67	5	0	61	9	0	24	0	0	0	0	0
900	67	14	3	88	14	2	80	11	2	59	7	0	54	10	0	70	11	1	31	1	0	0	0	0
1000	51	8	4	59	7	1	43	5	0	54	11	0	39	4	0	49	7	1	30	2	0	0	0	0
1100	28	4	1	56	11	0	38	6	1	35	8	0	41	10	0	40	8	0	37	4	0	0	0	0
1200	47	7	0	45	9	0	46	5	1	48	2	2	38	8	0	45	6	1	60	3	0	0	0	0
1300	50	8	0	40	5	4	46	5	0	35	1	2	55	13	2	45	6	2	40	6	0	0	0	0
1400	63	3	0	60	10	0	74	6	0	38	7	0	64	4	0	60	6	0	61	3	0	0	0	0
1500	96	5	1	101	14	2	83	7	1	90	5	0	89	4	0	92	7	1	58	1	0	0	0	0
1600	99	13	1	94	8	0	93	7	2	81	6	0	120	6	0	97	8	1	56	1	0	0	0	0
1700	90	10	1	95	6	2	91	8	2	84	6	0	72	8	0	86	8	1	47	2	1	0	0	0
1800	60	1	0	59	0	0	50	0	0	42	2	3	74	0	0	57	1	1	56	0	0	0	0	0
1900	32	0	0	25	0	0	41	0	0	29	0	0	49	0	0	35	0	0	36	1	0	0	0	0
2000	32	2	0	27	1	1	27	1	0	29	0	1	36	1	0	30	1	0	39	0	0	0	0	0
2100	10	2	0	17	0	0	11	0	0	14	1	0	22	1	0	15	1	0	10	1	0	0	0	0
2200	21	0	0	23	0	0	14	0	0	19	0	0	34	1	0	22	0	0	13	0	0	0	0	0
2300	32	1	0	47	0	0	56	1	0	52	0	0	7	0	0	39	0	0	26	0	0	0	0	0
2400	21	2	0	16	2	0	15	1	0	14	2	0	7	0	0	15	1	0	2	0	0	0	0	0
Totals	1019	101	13	1087	99	14	1046	80	12	940	75	10	1028	77	4	1024	86	11	681	25	1	0	0	0

Figure 2.3.1 AM Peak Hour 8:00am – 9:00am

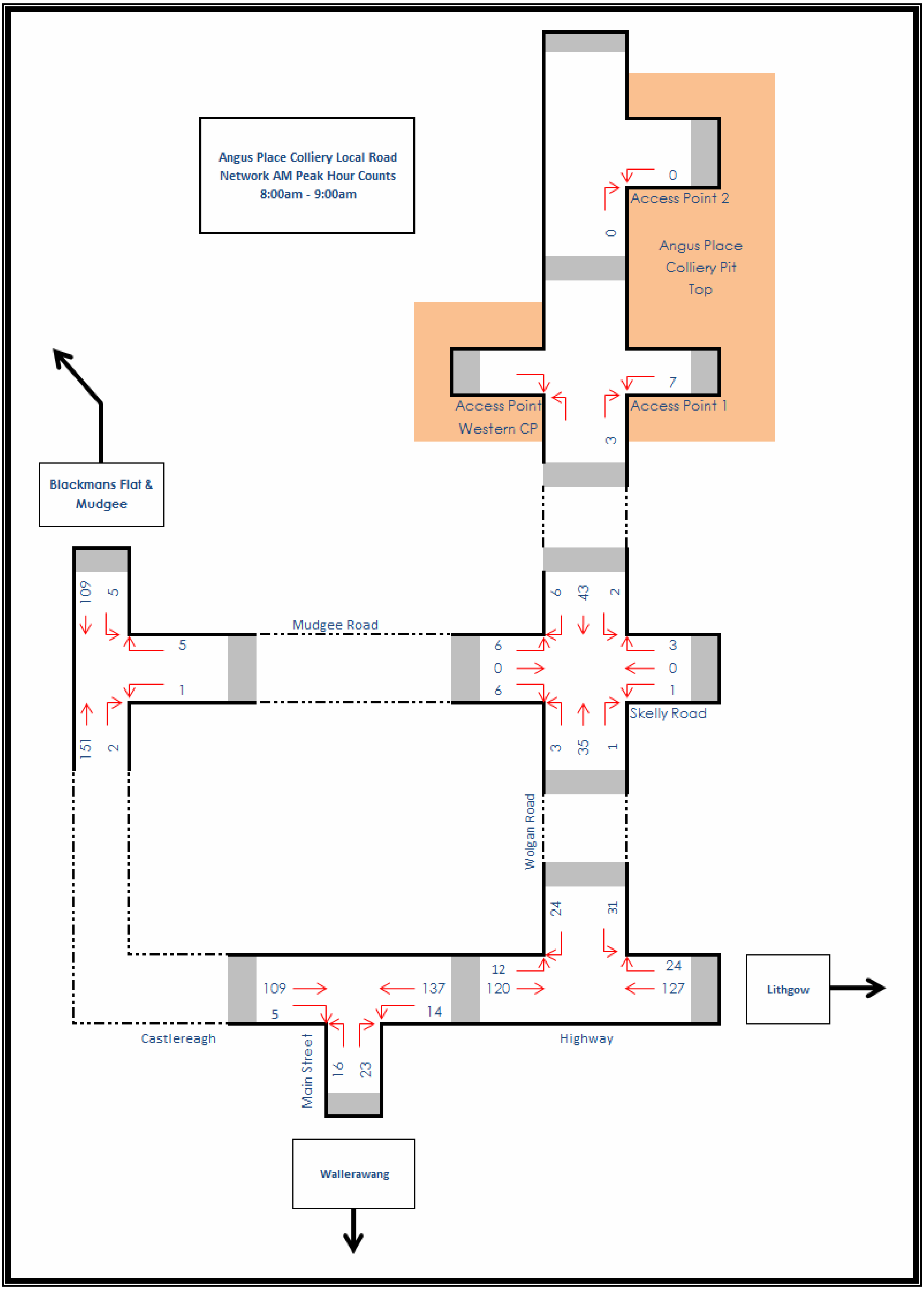
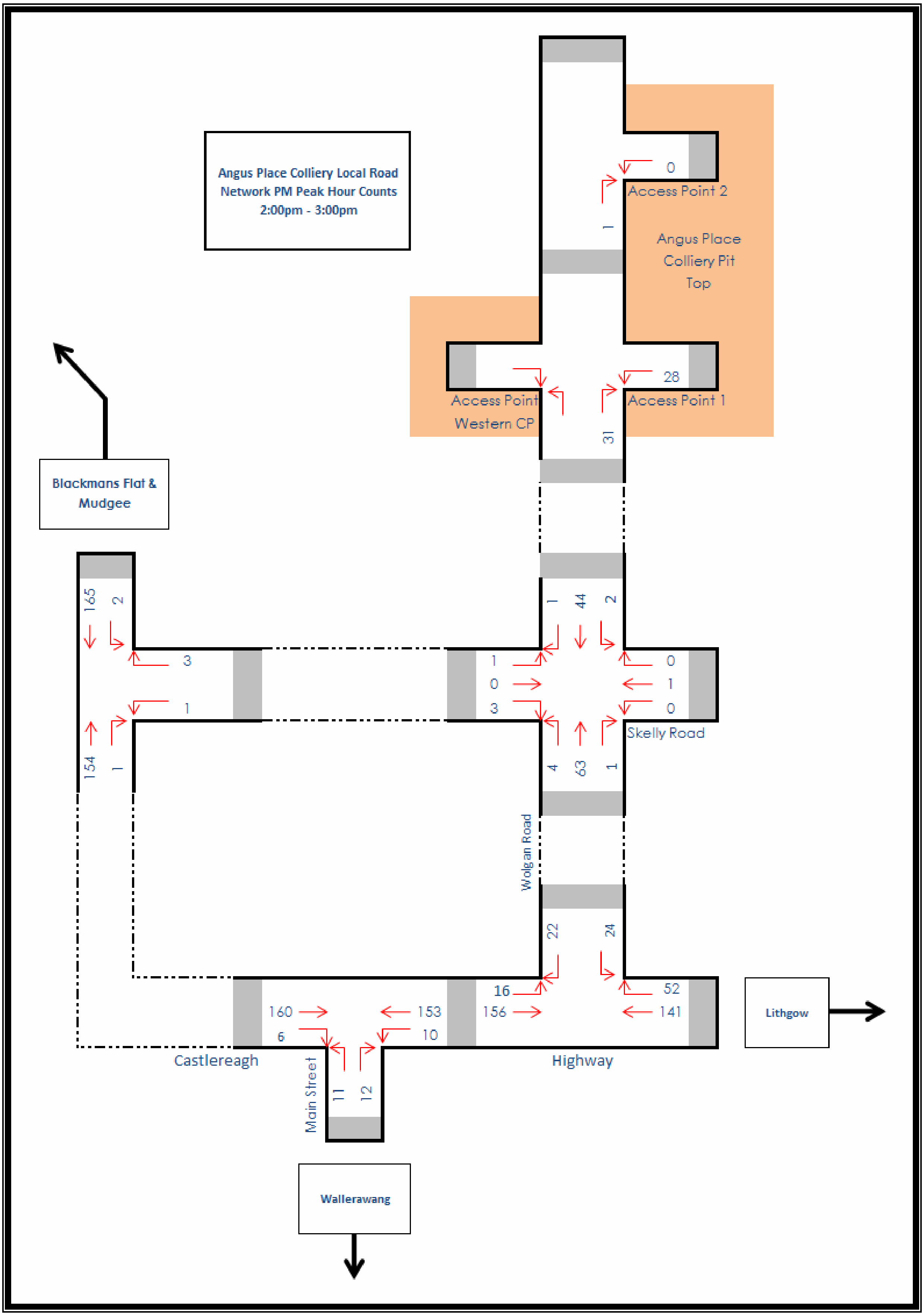


Figure 2.3.2 PM Peak Hour 2:00pm – 3:00pm



2.4.2 Intersection Operation Assessment

In order to define the current levels of service at the key local intersections, STAP has completed intersection analysis using the SIDRA model. SIDRA is an RTA approved intersection performance model that determines key performance measures for 'isolated' intersections, be they priority, roundabout or signal controlled. The analysis includes: -

- Surveyed peak hour traffic flows and speed profiles;
- Existing intersection geometry and control: and
- Existing lane availability and utilisation based on the time period and/or local conditions.

SIDRA reports the following key performance measures: -

- **Level of Service**

  Level of Service (LoS) is a basic performance indicator assigned to an intersection based on average delay. At priority controlled intersections LoS is based on the worst approach delay. The RTA LoS criteria, which have been used in the assessment, are provided below: -

Level of Service (RTA Method)	Control delay per vehicle in seconds (d) (including geometric delay)		
	Signals and Roundabouts	Rating	Stop and Give Way / Yield Signs
A	d < 14.5	Good	d < 14.5
B	14.5 < d < 28.5	Good with acceptable delay	14.5 < d < 28.5
C	28.5 < d < 42.5	Satisfactory	28.5 < d < 42.5
D	42.5 < d < 56.5	Near capacity	42.5 < d < 56.5
E	56.5 < d < 70.5	At capacity	56.5 < d < 70.5
F	70.5 < d	Over capacity	70.5 < d

- **Delay**

  Delay represents the difference between interrupted and uninterrupted travel times through an intersection, and is measured in seconds per vehicle in this assessment. Delays include queued vehicles accelerating and decelerating from/to the intersection stop, as well as general delays to all vehicles travelling through the intersection. With reference to the LoS criteria above, the average intersection delay for signals and roundabouts represents an average of delays to all vehicles on all approaches, while for priority intersections the average delay for the worst approach is used.

- **Degree of Saturation**

  Degree of Saturation (DoS) is defined as the ratio of demand (arrival) flow to capacity. DoS above 1.0 represent over-saturated conditions (demand flows exceed capacity) and degrees of saturation below 1.0 represent under-saturated conditions (demand flows are below capacity). The capacity of the movement with the highest DoS is reported.

The intersection of Castlereagh Highway & Wolgan Road & Main Street essentially operates as a four approach priority intersection, with the minor approach legs from Wolgan Road and Main Street off-set (i.e. like two adjacent T intersections). Additionally, the left hand turn movement from Wolgan Road to Castlereagh Hwy is provided with an additional approach lane away from the intersection, again assisting in the operation of the broader intersection. STAP has modelled this intersection as a 'standard' four approach intersection; this provides for a worst case assessment of its operation.

Table 2.4.2 below provides the results of the SIDRA intersection analysis.

Table 2.4.2 Existing Intersection Performance

Angus Place Colliery Existing Intersection Performance	Level of Service Intersection		Average Delay Intersection (s)		Degree of Saturation	
	AM	PM	AM	PM	AM	PM
Castlereagh Hwy & Wolgan Rd & Main St	A	A	< 5	< 5	0.070	0.070
Wolgan Rd & Mudgee Rd & Skelly St	A	A	< 5	< 5	0.031	0.034

The SIDRA analysis results provided above confirm our observations on-site, and specifically show that the local intersections operate at a very high level of service, with minimal average delays and significant spare capacity. More broadly, it is the opinion of STAP that the local intersections are all designed appropriately with regard to sight distances, turning and general approach lanes, and that the speeds assigned to each intersection appropriately meet the traffic and turning demands.

Finally, the access intersections at the APC Pit Top also operate at a high level of service based on the minimal passing flow in Wolgan Road, such that on average there is no delay to vehicles entering and departing the Site.

2.5 Existing Network Summary

In summary, the local and regional traffic infrastructure provides a high level of service based on broad geometry and available turning lanes; good sight distances; and – perhaps most importantly – very low traffic flows away from the primary arterial and sub-arterial roads. The design of local roads and intersection also specifically caters for the movement of both light and heavy vehicles through the local sub-region, and provides excellent access routes to the regional network.

The generation of the APC itself is also relatively low, particularly during the commuter peak periods, and Wolgan Road provides wide traffic lanes and verges that appropriately meet the existing traffic demands with reference to AustRoads RRDG (Section 11). Further away from the Site – in Wallerawang, Blackmans Flat, and in other local centres - the traffic generated by the APC would is minimal.

3 The Section 75W Modification Project

3.1 Project Characteristics

Centennial proposes a Section 75W Modification to continue underground mining operations at the Angus Place Colliery, which are supported by existing surface infrastructure, through the development and extraction of two additional longwall panels. The Project would extend the life of the APC to 2016. Full details of the Project are provided in other sections of the EA which this TIA accompanies.

This TIA specifically examines aspects of the Project which have a bearing on the existing and future operation of the local transport environment. With no proposed changes to access locations; no changes to the (proportional) generation of light or heavy vehicles by the APC; and most importantly no significant changes to the movement of coal via the private haulage routes (as detailed in **Section 1.3.1**), the only transportation characteristics that could be potentially impacted by the Project are: -

- The operation of the key local roads and intersections as a result of staff increases (10 full-time and up to 75 contract staff) and therefore vehicle generation increases associated with the Project.

- The operation of the key local roads and intersections over the Project horizon based on average annual increases in the local network.

- The provision of appropriate on-site parking to accommodate the additional staff and contractor staff demands.

These issues are examined in detail below.

From the outset, it is important to state that the Project will not increase general heavy vehicle trips (general deliveries) to the Site via Wolgan Road, i.e. the existing small number of weekly service vehicle trips will remain unchanged by the Project.

3.2 Traffic Generation

3.2.1 Additional Trip Potential

The Project will require the employment of an additional 10 full-time staff for the life of the Project, and up to an additional 75 contract staff assist with the development of underground activities for a period of up to 15 months. **Up to 85 additional staff could therefore be employed at any one time during the Project**.

Further to our discussions with the APC, it has been determined that these additional staff and contractors would be proportionally distributed across the existing shift structure. For the majority of the Project life this would mean only a handful of additional staff (i.e. a proportion of the 10 additional full-time staff) during any one shift, while during the peak stages with contractor demand there would be more staff per shift.

Taking these factors into account, the estimated maximum numbers of employees per shift – and by association maximum vehicle generation potential - is shown in **Table 3.2.1**.

Table 3.2.1 Project Shit Staff & Vehicle Peak

Angus Place Colliery Future Staff & Shifts	Staff	Vehicle Equivalent	Vehicle Increase
Weekday			
Day 6:00am - 2:00pm	109	109	37
Afternoon 2:00pm - 10:00pm	80	80	27
Night 10:00pm - 6:00am	61	61	21
Weekend			
Day 6:00am - 6:00pm	42	42	14
Night 6:00pm - 6:00am	42	42	14
Office			
Day 6:30am - 5:00pm	32	32	0
Max On-Site Staff/Vehicles	141	141	37

To provide for a worst case assessment, STAP has added these maximum (i.e. full time and contractor staff) trip generation increases to the existing network peak periods. In the AM commuter peak hour, we have therefore added the additional trips generated at the end of the Night Shift (departure trips) and the start of the Day Shift (arrival trips); STAP notes the APC normally generates few if any trips during the AM commuter peak period, but rather much earlier (i.e. 6:00am – 7:00am) when the shifts conclude/commence, as shown in the traffic data in **Section 2**.

In the PM peak, the hour 2:00pm – 3:00pm represents a peak for the APC and an equivalent PM commuter peak. We have therefore added the additional trips generated at the end of the Day Shift (departure trips) and the start of the Afternoon Shift (arrival trips) to this peak hour.

3.2.2 Trip Distribution

STAP has distributed the additional trips to the key local intersections with reference to the staff origin/destination breakdown provided in **Table 1.4.1** and to the existing surveyed distribution. We have also allocated contractor peak demand to the western car park off AP3.

3.2.3 Average Annual Traffic Increase

In order to assess the operation of the local network over the expected life of the Project STAP has prepared a simple future assessment that examines the operation of the local roads and intersections further to average annual increases in the local network.

To this end, STAP has increased flows along the Castlereagh Hwy by 1% per year over 6 years (compound). With reference to the available RTA Traffic Volume Data for the Western Region, data for the Castlereagh Hwy (RTA Count Stations 99.818; 99.889; 99.253 and 99.254) actually suggests that flows along the Castlereagh Hwy are at best stable, i.e. an increase of 1% per year would represent a maximum increase potential.

The flows along Wolgan Road and Main Street have not been increased by the same percentage as there is no evidence of additional traffic generation potential (other than that detailed in **Section 3.3.1** above), and specifically no likelihood of general average increases.

3.3 Total Future Flows

The future (effectively 2016) traffic flows for the morning and evening peak periods, based on the Project and average annual increases to the existing flows, are shown in **Figure 3.3.1** (AM Peak) and **Figure 3.3.2** (PM Peak) below.

3.4 Future Intersection Performance

STAP has re-examined the performance of the key intersections using the SIDRA model. The assessment has been completed to assess network performance for a future year 2016; this in our opinion provides the most appropriate forecast horizon for the Project. The results of the future SIDRA assessment are provided in **Table 3.4.1**.

Table 3.4.1 Future Intersection Performance

Angus Place Colliery Future Intersection Performance	Level of Service Intersection		Average Delay Intersection (s)		Degree of Saturation	
	AM	PM	AM	PM	AM	PM
Castlereagh Hwy & Wolgan Rd & Main St	A	A	< 5	< 5	0.096	0.102
Wolgan Rd & Mudgee Rd & Skelly St	A	A	< 5	< 5	0.043	0.055

Figure 3.3.1 Future AM Peak Hour 8:00am – 9:00am

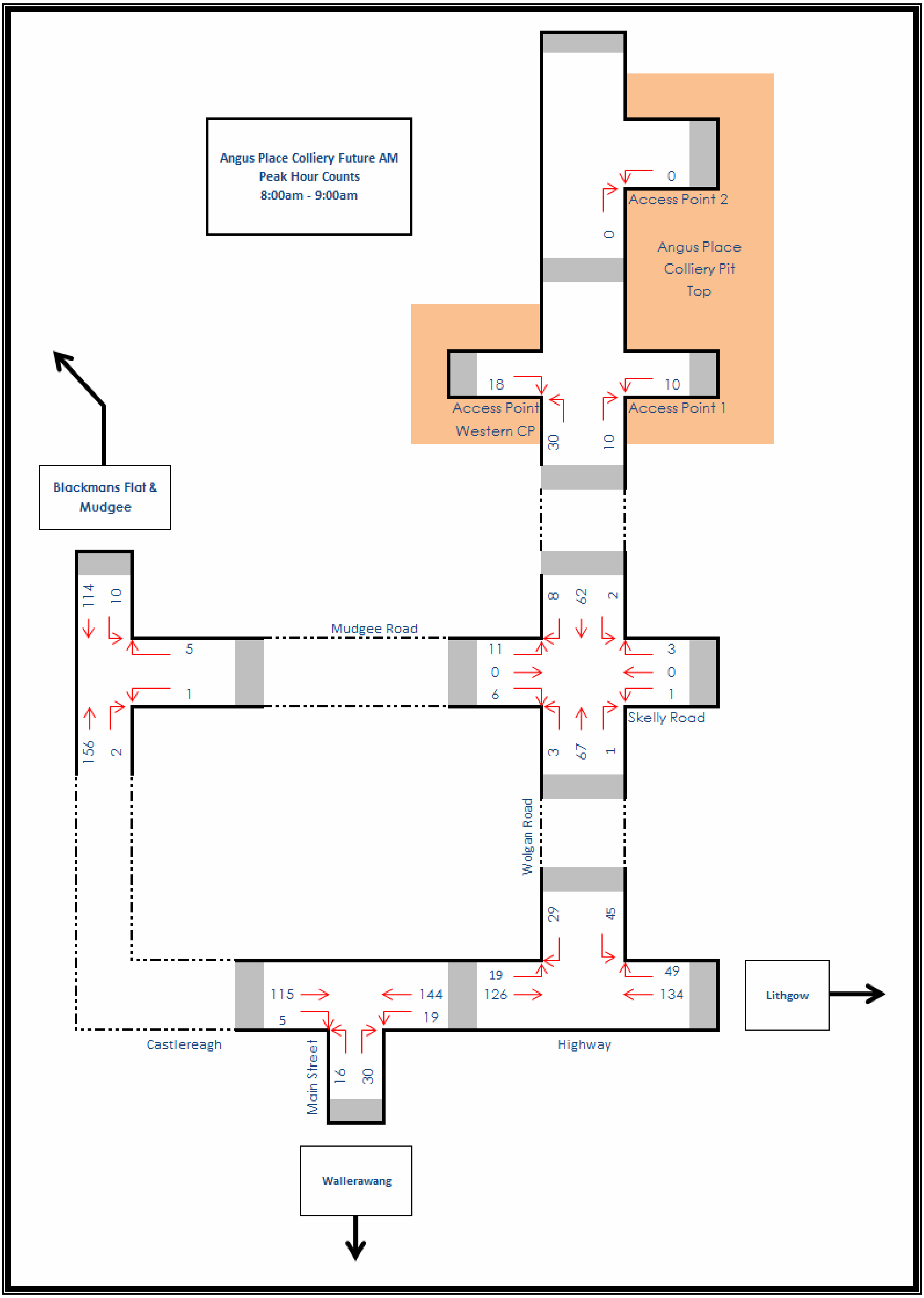
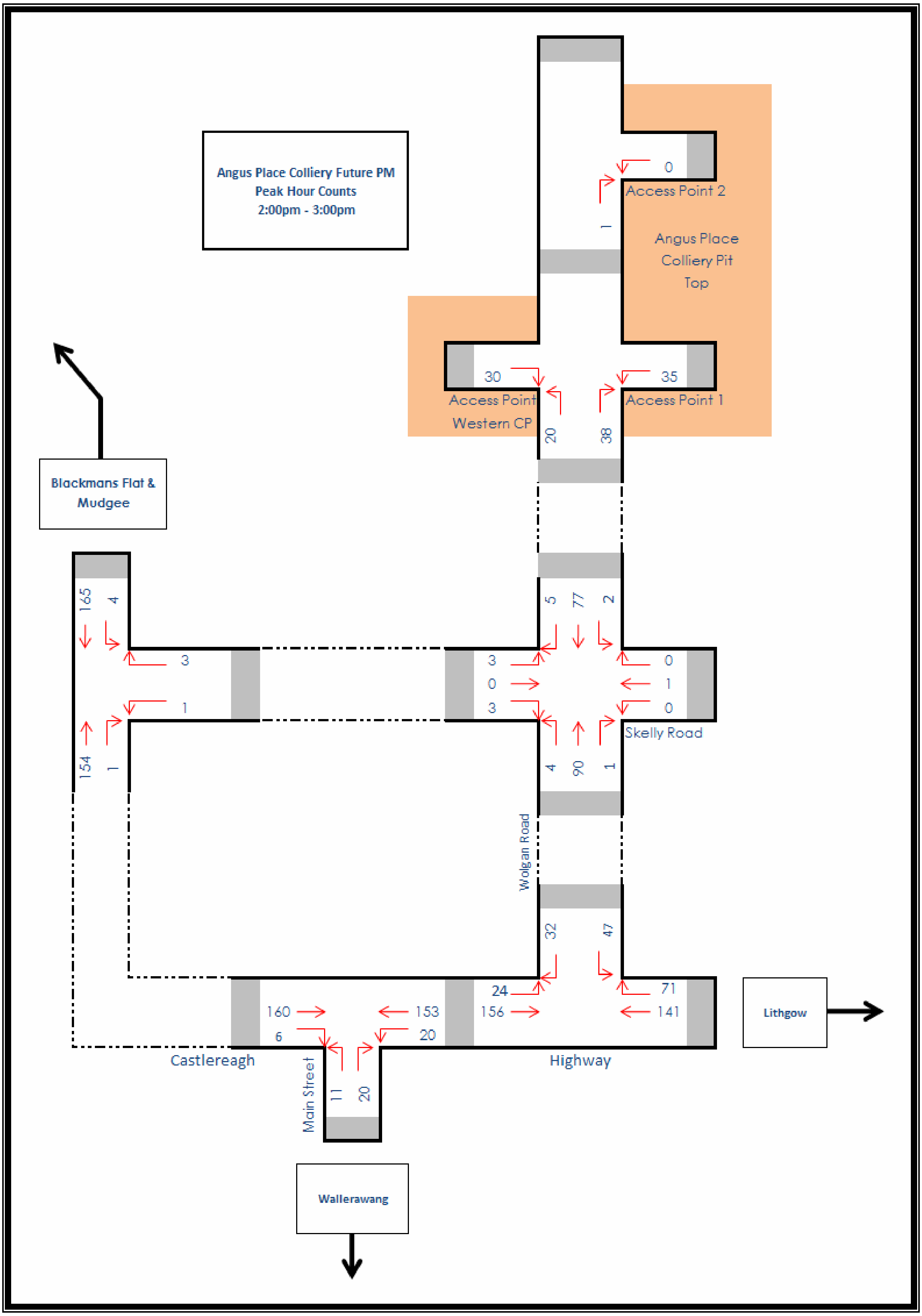


Figure 3.3.2 Future PM Peak Hour 2:00pm – 3:00pm



3.5 Future Traffic Impact Assessment

The SIDRA and general traffic assessment shows that the Project would have no impact on the operation of local roads or intersections. Specifically: -

- The SIDRA analysis shows that there is no significant change to the operation of the local intersection over the Project life, and indeed no change at all to average delays and levels of service even when tested under worst case conditions.

- The additional staff trip generation would not alter the classification characteristics of any of the roads servicing the APC, with both the Castlereagh Hwy and Wolgan Road remaining well below their actual and – in the case of Wolgan Road particularly – environmental capacities.

- The higher usage of the approved western car park via AP3 would not alter the high level of service provided by the APC Pit Top access points.

In summary therefore – and with specific reference to the Director General's Requirements – STAP has determined that the Project would have not significantly adverse impacts on the local traffic network, either within the key local centre of Lidsdale, or further afield in local centres such as Wallerawang or Blackmans Flat.

3.6 Site Parking

The Project will require the provision of additional parking spaces to appropriately accommodate all staff parking demands on-site, and specifically to accommodate the peak periods with contractor parking demand.

As shown in **Table 3.2.1** above, the Project will generate an additional demand for up to 37 parking spaces (during the Day Shift) and therefore a maximum demand for up to 141 parking spaces (being the existing shift and office demand plus the additional Project demand).

As for past peak periods of activity at the APC where there has been a contractor demand, it is proposed that this additional parking be provided in the approved western car park via AP3.

As discussed in **Section 1.5**, this informal parking area currently provides for approximately 25 parking spaces. **It is proposed that this parking area will be formalised to provide a minimum of 40 parking spaces**; this would provide not only for the peak contractor demand, but also provide additional flexibility during shift changeover periods. The provision of 40 spaces is provided for in the previous approval (Project Approval 06_0021).

STAP recommends that the APC investigate the formalisation of the western car park. This would entail the provision of car park marking (delineating spaces and access aisles) and potentially the provision of a suitable surface material. All spaces and aisles should be provided in accordance with AS2890.1:2004.

Finally, and further to our on-site observations and acknowledging the minimal flows in Wolgan Road adjacent to the APC Pit Top, it is the opinion of STAP that the provision of formal pedestrian facilities to provide access to the western car park is not required, i.e. there is no need for a pedestrian crossing; certainly the general warrants for the provision of a crossing would not be met. In this regard we would note further that the current approval for the car park does not require any such facilities.

4 Conclusions & Recommendations

Stapleton Transportation & Planning Pty Ltd (STAP) has completed a detailed independent assessment of the potential access, traffic and parking characteristics associated with the proposed Section 75W Modification Project at the Angus Place Colliery. **STAP has determined that the Project would have no significant impact on the local traffic and transport network**.

- The Project will result in minor increases in Site generation. These increases – and the broader Site peak periods – occur outside of what are already very low generating commuter peak periods and as such **there would be no significant impact on the classification or operation of local roads and intersections**.

- Based on future traffic forecasts which include average annual increases in sub-regional traffic generation, **the local traffic network will continue to operate at a very high level of service through the anticipated life of the Project**.

- **Access to the Site will continue to operate safely and efficiently** based on the geometry of the approved access intersections with Wolgan Road; the minor additional trip demands; and the very low passing flows.

- **All parking for Site staff will continue to be provided on-site in previously approved parking areas**.

- **All coal will continue to be transported to the adjacent Mount Piper and Wallerawang Power Stations by private haul roads**; no coal will be transported by public roads.

- A mix of 50 tonne and 80 tonne vehicles will be employed to carry coal along the haul roads; **the number of vehicle movements along the haul roads, limited in accordance with the findings of the Noise Impact Assessment by Heggies, would not compromise existing haul road operating approvals.**

Following our assessment of the key issues associated with the Project STAP has concluded that the Project is supportable from an access, traffic and parking perspective.

APPENDIX 7.13

Noise Impact Assessment

REPORT 30-2506-R2

Revision 2

Angus Place Colliery - Expansion Project
Section 75W - Project Approval Modification
Noise Impact Assessment

PREPARED FOR

Centennial Coal
c/- RPS HSO
PO Box 428
Hamilton NSW 2303

12 OCTOBER 2010

HEGGIES PTY LTD
ABN 29 001 584 612

Angus Place Colliery - Expansion Project

Section 75W - Project Approval Modification

Noise Impact Assessment

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EXECUTIVE SUMMARY

[illegible] *NSW Environmental Planning and Assessment Act 1979* [illegible]

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EXECUTIVE SUMMARY

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TABLE OF CONTENTS

TABLE OF CONTENTS

1 INTRODUCTION

[illegible] *NSW Environmental Planning and Assessment Act 1979* [illegible]

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- [illegible].
- [illegible].
- [illegible].
- [illegible].
- [illegible] *Description and Measurement of Environmental Noise* [illegible].
- [illegible] *NSW Industrial Noise Policy* [illegible]
- *Angus Place Colliery 75W Modification Project TIA June 2010* [illegible].
- [illegible] *Dynamic Measurement of Tyre/Road Noise* [illegible].

[illegible] **Table 1.**

Table 1 Director-General's Requirements Pertaining to Noise and Vibration Issues

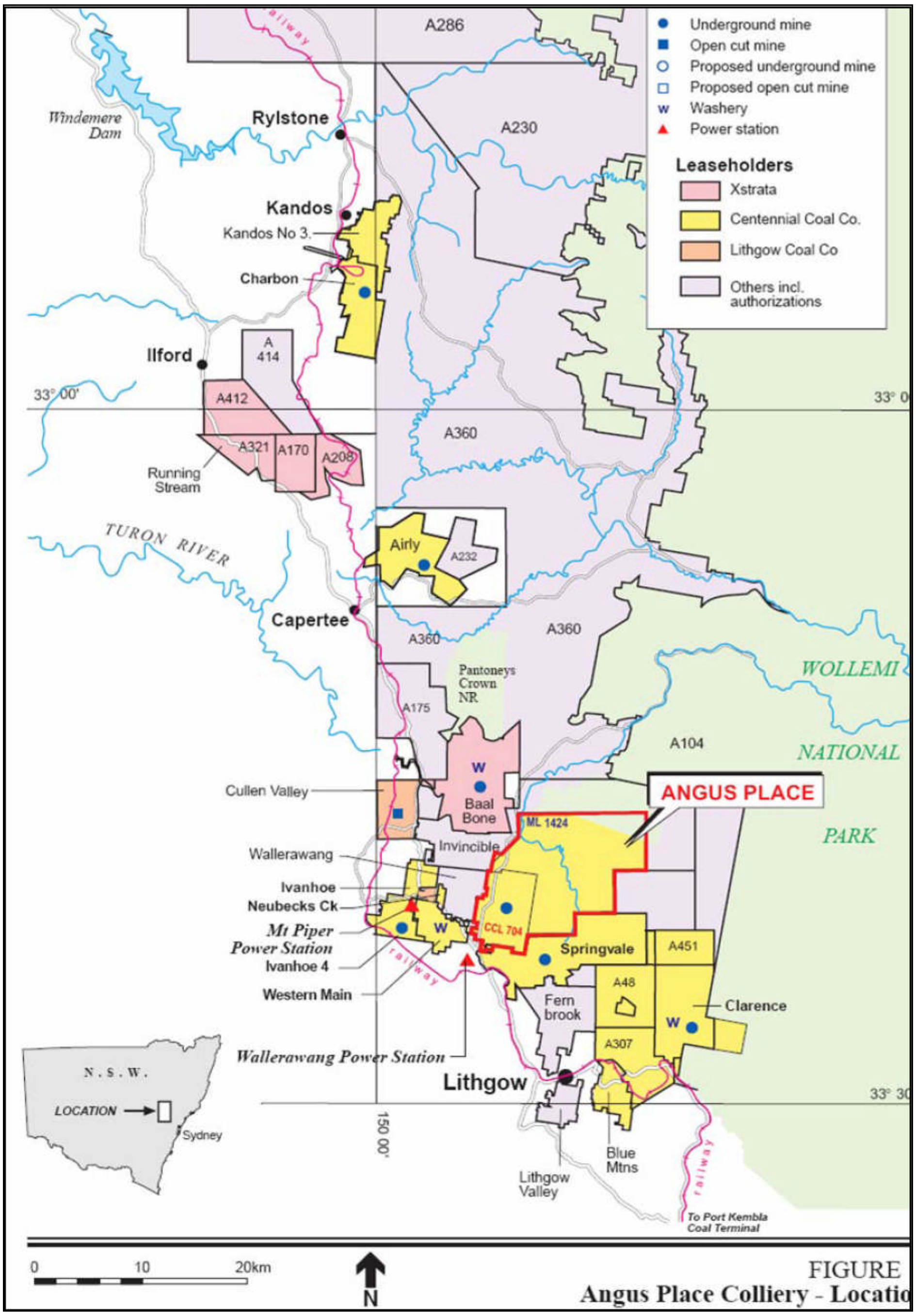
Government Agency	Paraphrased Requirement	Relevant Sections
[illegible]	[illegible].	[illegible]
	[illegible].	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]

2 PROJECT OVERVIEW

2.1 Site Location

[illegible] **Figure 1**. [illegible]

Figure 1 Regional Location



[illegible]

2.2 Summary of Existing Mining Operations

[illegible]

2.3 Project Description

[illegible] *Environmental Planning and Assessment Act 1979* [illegible]

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- [illegible]
- [illegible]
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- [illegible]
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2.4 Modification Project Area

[illegible]

- [illegible]
- [illegible]
- [illegible]

2.5 Acoustically Significant Sources

2.5.1 Construction

[illegible]

2.5.2 Mining Operations

[illegible]

[illegible]

[illegible] **Table 2**.

Table 2 Angus Place Colliery Haul Truck Sound Power Levels

Item	Octave Band Centre Frequency – SWL (dB)								Overall SWL (dBA)
	31.5	63	125	250	500	1k	2k	4k	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] Table 2 [illegible]

Tyre-Road Noise and Haul Road Details

[illegible]

[illegible] Table 3 [illegible]

Table 3 Equivalent sound pressure levels on various road surface types compared to a dense asphalt grading course

Road Surface	Equivalent Sound Pressure Level
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible] Table 3 [illegible]

[illegible]

- [illegible]
- [illegible]

[illegible] Table 4 [illegible]

Table 4 Haul Road Surface Type

Haul road	Road Surface Type (as per Table 3[illegible]	Equivalent Sound Pressure Level
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

2.6 Nearest Potentially Affected Receivers

[illegible] **Figure 2** [illegible] **Table 5**. [illegible]

[illegible]

Figure 2 Nearest Sensitive Receivers

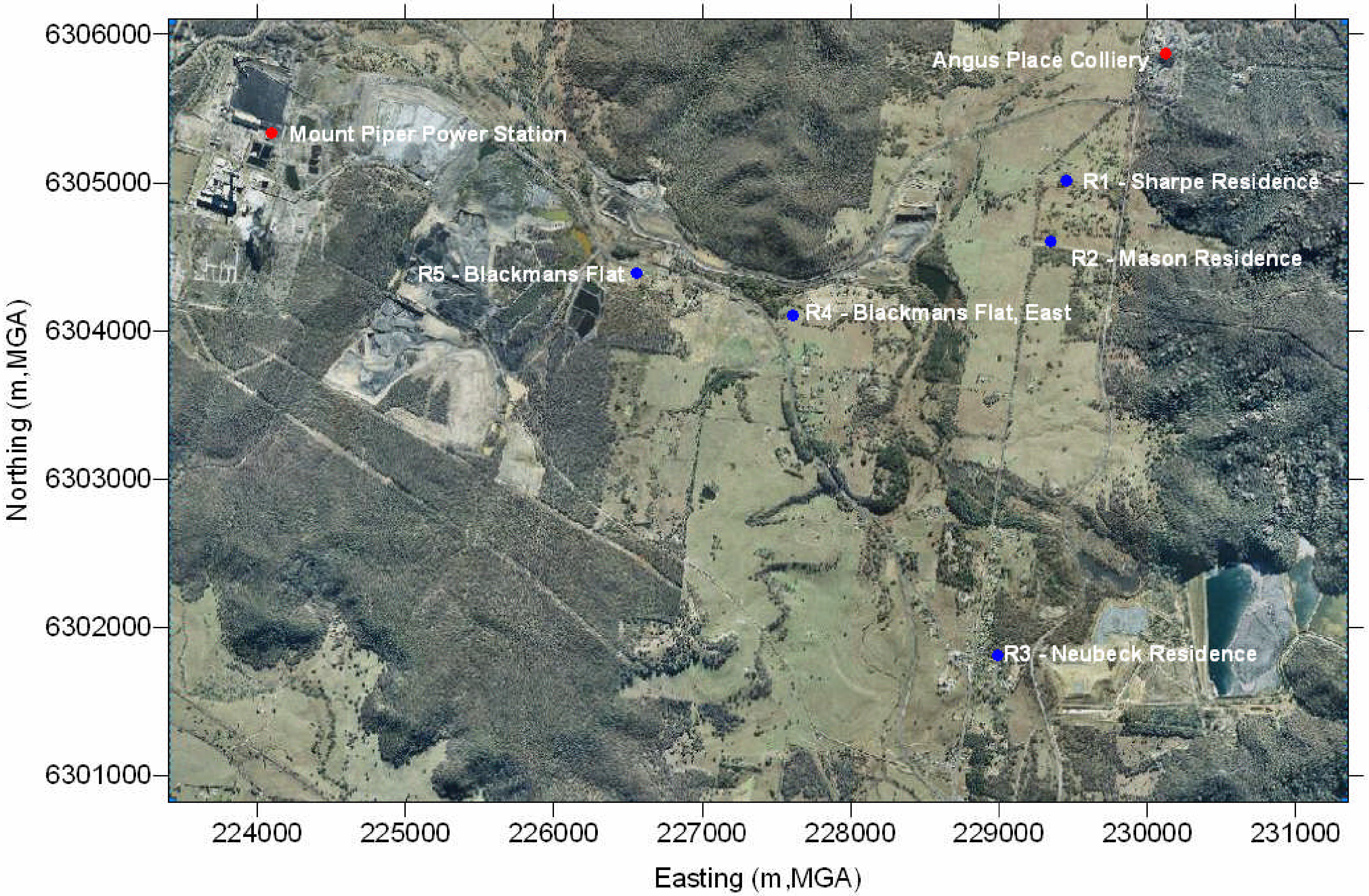

Table 5 Distance of Receivers to Angus Place Colliery and Haul Roads

Receiver	Distance (metres) from Angus Place Bin	Nearest Distance (metres) from Haul Road[1]	Elevation (m)
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

3 NOISE IMPACT ASSESSMENT PROCEDURES

3.1 General Objectives - Industrial Noise Policy

[illegible]

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[illegible]

[illegible]

[illegible] **Table 6**.

Table 6 Amenity Criteria
Recommended LAeq Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq(Period) Noise Level (dBA)	
			Acceptable	Recommended Maximum
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		
[illegible]			[illegible]	[illegible]
[illegible]			[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible] **Table 6** [illegible] **Table 7**.

Table 7 Modification to Acceptable Noise Level (ANL)* to Account for Existing Levels of Industrial Noise

Total Existing LAeq noise level from Industrial Noise Sources	Maximum LAeq Noise Level for Noise from New Sources Alone, dBA
≥ [illegible]	[illegible] *likely to decrease* [illegible] [illegible] *unlikely to decrease* [illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible] eq [illegible] **Table 6**

3.2 Road Traffic Noise

[illegible] *Environmental Criteria for Road Traffic Noise* [illegible] **Table 8** [illegible].

Table 8 Road Traffic Noise Criteria – NSW Environmental Criteria for Road Traffic Noise

Type of Development	Descriptor	Traffic Noise Criteria
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]

[illegible]

4 EXISTING MINE APPROVAL CONDITIONS

[illegible] *Environmental Planning and Assessment Act 1979* [illegible].

[illegible] *Protection of the Environment Operations Act 1997* [illegible].

[illegible] *Environmental Planning and Assessment Act 1979* [illegible].

4.1 Project Approval (06_0021)

[illegible]

NOISE

Impact Assessment Criteria

17. From no later than 28 February 2007, the Proponent shall ensure that the noise generated by the project, including the Proponent's operation of the haul road to the Wallerawang power station, does not exceed the noise impact assessment criteria presented in Table 6 at any residence on privately owned land.

Table 6** **Noise Impact Assessment Criteria dB(A) LAeq(15minute)

Land	*Day*	*Evening*	*Night*
Sharpe	*42 dBA*	*38 dBA*	*36 dBA*
Mason (West) and other Wolgan Road rural properties	*41 dBA*	*37 dBA*	*35 dBA*
Lidsdale village residents	*44 dBA*	*40 dBA*	*35 dBA*

Notes: a) For more information on the references to land in this condition, see 'Property Details' figure of the EA.
b) The noise criteria do not apply where the Proponent and the affected landowner have reached a negotiated agreement in regard to noise, and a copy of the agreement has been forwarded to the Director-General and DEC.
c) Noise from the project is to be measured at the most affected point or within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the LAeq(15 minute) noise limits in the above table. Where it can be demonstrated that direct measurement of noise from the project is impractical, the DEC may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.
d) The noise emission limits identified in the above table apply under meteorological conditions of:
- Wind speeds of up to 3 m/s at 10 metres above ground level; or
- Temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.

Land Acquisition Criteria

18. If, after 31 August 2007, the noise generated by the project, including the operation of the haul road to the Wallerawang power station, exceeds the criteria in Table 7, the Proponent shall, upon receiving a written request for acquisition from the landowner (excluding the landowners listed in Table 1), acquire the land in accordance with the procedures in conditions 7-9 of schedule 4.

Table 7 *Land Acquisition Criteria dB(A) LAeq(15minute)*

Land	*Day*	*Evening*	*Night*
Sharpe, Mason (West) and other Wolgan Road rural properties	*44 dBA*	*40 dBA*	*40 dBA*
Lidsdale village residents	*47 dBA*	*43 dBA*	*43 dBA*

Note: The notes under Table 6 also apply under Table 7.

Operating Hours – Wallerawang Power Station Haul Road

19. The Proponent shall not use the Wallerawang power station haul road at night.

Note: Night is defined as the period from 10pm to 7am on Monday to Saturday, and 10pm to 8am on Sundays and public holidays.

Noise Monitoring Program

22. The Proponent shall prepare (and following approval implement) a Noise Monitoring Program for the project, to the satisfaction of the Director-General. This program must include a combination of attended and unattended noise monitoring, and a noise monitoring protocol for evaluating compliance with the noise impact assessment criteria in this approval. The program shall be prepared in consultation with DEC, and be submitted to the Director-General within 6 months of the date of this approval.

[illegible] *Angus Place Noise Monitoring Peer Review* [illegible] *Angus Place Colliery Noise Monitoring Program* [illegible]).

4.2 Environmental Protection Licence (EPL No: 467)

[illegible].

L6.1 *Noise from the premises must not exceed:*

a) 42 dBA Leq(15minute) during the day (7am to 6pm); and

b) 38 dBA dBA Leq(15minute) during the evening (6pm to 10pm); and

c) at all other times 36 dBA Leq(15minute) except as expressly provided by this licence at the Sharpe residence;

d) 41 dBA Leq(15minute) during the day (7am to 6pm); and

e) 37 dBA dBA Leq(15minute) during the evening (6pm to 10pm); and

f) at all other times 35 dBA Leq(15minute) except as expressly provided by this licence at the Mason (west) residence and other Wolgan Road properties; and;

g) 44 dBA Leq(15minute) during the day (7am to 6pm); and

h) 40 dBA dBA Leq(15minute) during the evening (6pm to 10pm); and

i) at all other times 36 dBA Leq(15minute) except as expressly provided by this licence at Lidsdale Village residences;

Where LAeq means the equivalent continuous noise level - the level of noise equivalent to the energy-average of noise levels occurring over a measurement period.

Note: The above noise limits were established under project approval 06_0021 by the Department of Planning.

L6.2 *Noise from the premises is to be measured at the most affected point or within the residential boundary, or at the most affected point within 30 m of a dwelling (rural situations) where the dwelling is more than 30 m from the boundary, to determine compliance with condition L6.1.*

The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.

Where it can be demonstrated that direct measurement of noise from the premises is impractical, the EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy).

L6.3 *The noise emission limits identified in this licence apply under meteorological conditions of:*

a) wind speeds of up to 3 m/s at 10 metres above ground level; or *b) temperature inversion conditions of up to 3oC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level.*

[illegible]

4.3 Development Consent No. 105/92

[illegible]

Schedule of Conditions

1. *That the haulage of coal on the Mt. Piper Haul Road be approved for 24 hour operation, 7 days a week.*

2. *Truck movements shall be limited to five loaded truck movements per hour between the hours of 9.30 pm and 7.00 am. That is a total of five movements from the mine and five return trips.*

3. *The level of noise emanating from the transport of coal on the haul road shall not exceed a LAeq sound pressure level equivalent to the measured background, LA90T measured over a 15 minute period, plus 5 dBA when measured at any point within 10m of any residential receiver.*

4. *If complaints are received from any resident from LOT 2 DP825887 & Lot 243 DP751651 regarding the haulage of coal along it, the applicant shall furnish to Council a noise assessment determining the impact of noise to that residence. All assessments are to be undertaken in accordance with the EPA's Industrial Noise Policy (INP). If it is found that noise is in excess of the EPA's INP, the applicant shall go into negotiations to rectify the noise complaint through either modifying the haul roads operation or undertake necessary works to the complainants house to minimize noise. If a solution cannot be rectified between the parties within six (6) months of the complaint, Council will appoint a mediator at the applicant's expense to help formulate a solution.*

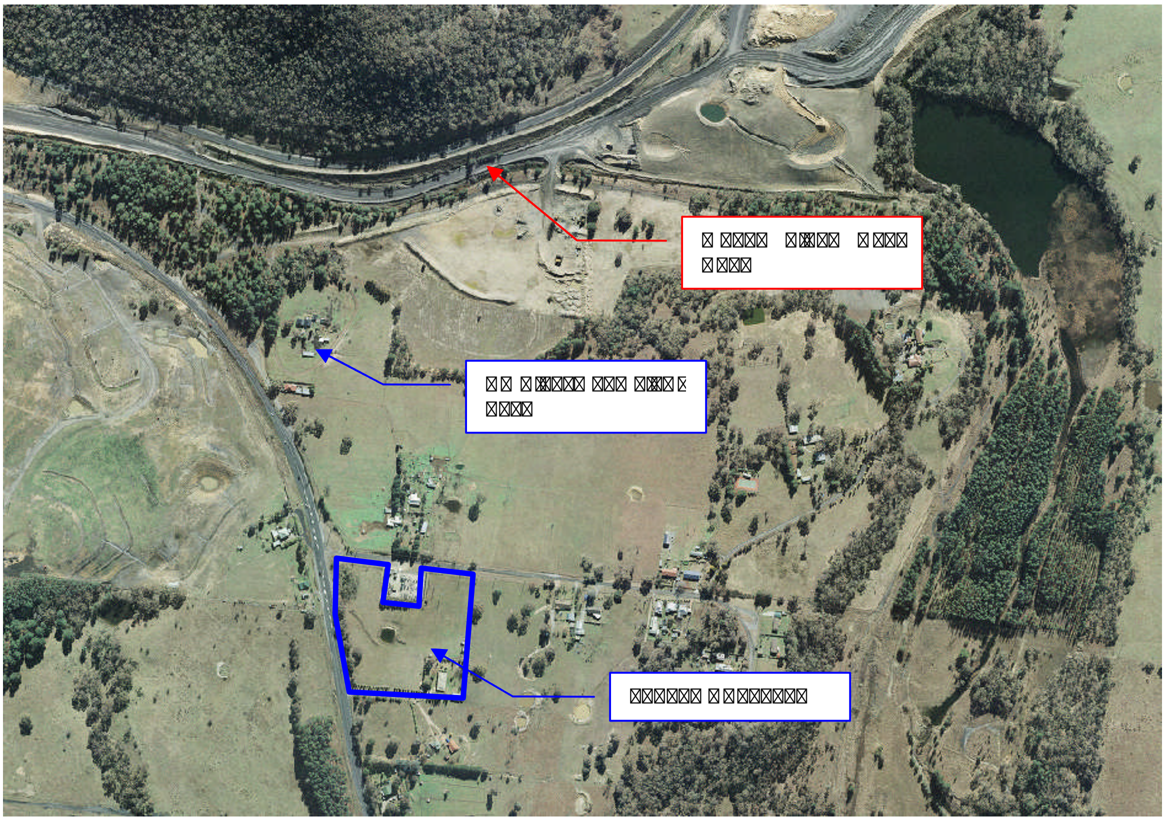
5. *The applicant shall, prior to commencement of 24 hour haulage, prepare and implement a Noise Management Plan to the satisfaction of the Lithgow City Council. The Plan shall be provided to Council within 12 months of this approval and include:*

- *Details of the methods to be used for the periodic monitoring of noise to evaluate, assess and report the LAeq(15minute) noise emission levels due to the normal operations of the haul road. The level of noise emitted from the premises must be monitored for at least 72 hours every 12 months at locations agreed to in consultation with Lithgow City Council. The monitoring must determine LAeq15min levels and include an assessment of the impact of operational noise at the nearest affected residence.*
- *Details regarding operating configuration; determining survey intervals; weather conditions and seasonal variations; selecting variations, locations and times of measurements.*
- *Specify the procedures for a noise monitoring program for the purpose of undertaking independent noise investigations.*
- *Outline the procedure to notify property owners and occupiers likely to be affected by noise from the operations.*
- *Establish a protocol for handling noise complaints that include recording, reporting and acting on complaints, particularly where complaints are received and it is demonstrated noise levels are in excess of the conditions contained in this consent.*
- *Outline proactive/predictive and reactive mitigation measures to be employed on the site to limit noise emissions.*

- *Identify longer-term strategies directed towards reducing the noise levels that exceed the noise target levels for the amenity of the area.*
- *Survey and investigate noise reduction measures from plant and equipment annually, subject to noise results and/or complaints received, and report in the AEMR at the conclusion of the first 12 months of operations and set targets for noise reductions taking into consideration valid noise complaints in the previous year.*

[illegible] **Figure 2**. [illegible] **Figure 3** [illegible]

Figure 3 Mount Piper Haul Road Receivers



5 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

[illegible] Section 4 [illegible]

5.1 General Methodology

[illegible]

[illegible]

[illegible]

5.2 Operator-Attended Noise Monitoring

[illegible]

[illegible] Table 9. [illegible]

Table 9 Operator Attended Noise Survey Results

Location	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Levels LAmax (dBA)
		LAmax	LA1	LA10	LA90	LAeq	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

5.3 Unattended Continuous Noise Monitoring

[illegible] **Table 10**.

[illegible]

Table 10 Ambient Noise Monitoring Locations

Location	Address Location Description	Logger Serial No.
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

[illegible] **Table 11**. [illegible] **Appendix A**.

Table 11 Summary of Existing Ambient Noise Levels

Location	Period	Background LA90 Noise Level Rating Background Level	Measured LAeq(Period)	Estimated Existing Industrial Contribution LAeq
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

Table 12 Previous Noise Monitoring Data from Blackmans Flat

Location	Period	Background LA90 Noise Level / Rating Background Level	Measured $L_{Aeq(Period)}$	Estimated Existing Industrial Contribution L_{Aeq}
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

5.4 Existing Meteorological Environment

[illegible] *Transportation Noise Impact Assessment* [illegible] **Table 13.** [illegible]

Table 13 Prevailing Wind Conditions in accordance with NSW INP

Season	Winds ± 45° ≤3 m/s with Frequency of Occurrence ≥30%		
	Daytime	Evening	Night
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Table 13 [illegible]

6 PROJECT SPECIFIC NOISE CRITERIA

6.1 Operational Noise Design Criteria

[illegible] **Section 4.1**.

[illegible] **Section 3.1** [illegible]

[illegible]. [illegible].

[illegible] *an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry"* [illegible].

[illegible] **Table 14**. [illegible] **Table 12**. [illegible].

Table 14 Project Specific Noise Criteria – Mount Piper Haul Road

Locations	Period	Measured Background Noise Level (LA90)	Intrusiveness Criteria LAeq(15minute)	Amenity Criteria LAeq(Period)	Project Specific Noise Criteria
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

7 EXISTING ANGUS PLACE COLLIERY NOISE EMISSIONS

7.1 Background and Overview

[illegible].

[illegible] *Angus Place Noise Monitoring Peer Review* [illegible] *Angus Place Colliery Noise Monitoring Program* [illegible]*)*.

7.2 Noise Monitoring Results

[illegible] *30-1942 QR01 2008 May Qtr 20080627* [illegible] *30-1942 QR07 2009 December Qtr 20100216* [illegible]

[illegible].

[illegible] **Table 15**[illegible]**Table 16** [illegible] **Table 17.**

Table 15 Daytime Quarterly Noise Monitoring Results

Location	Angus Place Colliery Contributed Noise Level LAeq (15 minute) dBA[1]							
	Noise Assessment Criteria	Dec 2009	Sept 2009	July 2009	Apr 2009	Jan 2009	Sept 2008	May 2008
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	**43**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 16 Evening Quarterly Noise Monitoring Results

Location	Angus Place Colliery Contributed Noise Level LAeq (15 minute) dBA[1]							
	Noise Assessment Criteria	Dec 2009	Sept 2009	July 2009	Apr 2009	Jan 2009	Sept 2008	May 2008
[illegible]	[illegible]	[illegible]	[illegible]	**39**	**40**	**41**	**40**	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	**39**	[illegible]	**41**	[illegible]	**39**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 17 Night-time Quarterly Noise Monitoring Results

Location	Angus Place Colliery Contributed Noise Level LAeq (15 minute) dBA[1]							
	Noise Assessment Criteria	Dec 2009	Sept 2009	July 2009	Apr 2009	Jan 2009	Sept 2008	May 2008
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37	38	38
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

8 PROJECT NOISE IMPACT ASSESSMENT

8.1 Overview

[illegible] **Table 15**[illegible]**Table 16** [illegible] **Table 17**.

[illegible]

[illegible]

[illegible]

- [illegible]
  - [illegible]
  - [illegible]
- [illegible]
  - [illegible]
  - [illegible]

Note: Truck movements are referred to in this report as loads per hour (or loads). This equates to loaded truck movements and associated return journeys. Therefore 10 loads per hour would be 10 movements from the mine and 10 return trips (i.e. 20 truck movements per hour).

8.2 Methodology and Assumptions

[illegible]

[illegible] **Section 2.5.2** [illegible]

[illegible] **Table 2**. [illegible]

[illegible]

8.3 Noise Model Validation and Calibration

[illegible]

8.4 Meteorological Parameters

Table 18 [illegible] **Table 18**.

Table 18 Meteorological Parameters for Noise Predictions

Period	Temperature	Humidity	Wind Speed	Wind Direction
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

8.5 Noise Model Results

8.5.1 Wallerawang Haul Road

[illegible] **Section 8.1** [illegible]

[illegible] **Table 19**. [illegible]

Table 19 Predicted Noise Levels and Truck Movements - Wallerawang Haul Road

Location	Period	Criteria (LAeq15min) dBA	Loads per Hour	Predicted Haul Road Contribution (LAeq15min) dBA	Average Colliery Contribution[1] (LAeq15min) dBA	Total Angus Place Colliery Contribution[2] (LAeq15min) dBA
[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]

[1] [illegible]

[2] [illegible]

Table 19 [illegible]

[illegible]

[illegible]

8.5.2 Mount Piper Haul Road

[illegible] **Section 8.1** [illegible]

[illegible] **Table 20**. [illegible]

Table 20 Predicted Noise Levels and Truck Movements – Mount Piper Haul Road

Location	Period	Project Specific Noise Criteria ($L_{Aeq15min}$) dBA	Loads per Hour	Predicted Haul Road Contribution ($L_{Aeq15min}$) dBA
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table 20 [illegible]

[illegible]

8.6 Road Traffic Noise

8.6.1 Road Traffic Parameters

[illegible]

[illegible] *Angus Place Colliery 75W Modification Project TIA June 2010* [illegible]

[illegible] *Angus Place Colliery 75W Modification Project TIA June 2010* [illegible].

8.7 Vibration Assessment

[illegible].

8.8 Cumulative Assessment

[illegible] **Section 3.1** [illegible]

[illegible] *amenity* [illegible].

[illegible].

[illegible].

[illegible]

- [illegible].
- [illegible].
- [illegible].

[illegible]

[illegible]

[illegible]

9 NOISE MITIGATION AND CONTINUOUS IMPROVEMENT

9.1 Continuous Improvement

[illegible]

> ***Continuous Improvement***
>
> *21. The Proponent shall:*
>
> *(a) implement all reasonable and feasible best practice noise mitigation measures;*
>
> *(b) investigate ways to reduce the noise generated by the project, including noise generated from use of the Wallerawang power station haul road; and*
>
> *(c) report on these investigations and the implementation and effectiveness of these measures in the AEMR, to the satisfaction of the Director-General.*

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

9.2 Haul Road Inspections

[illegible] **Section 2.5** [illegible]

[illegible] **Appendix B** [illegible] *Angus Place Haul Road Inspection Protocol July 2008*[illegible]

[illegible] **Appendix C**.

[illegible] **Table 3** [illegible].

10 CONCLUSION

[illegible]

[illegible]

[illegible]

[illegible]

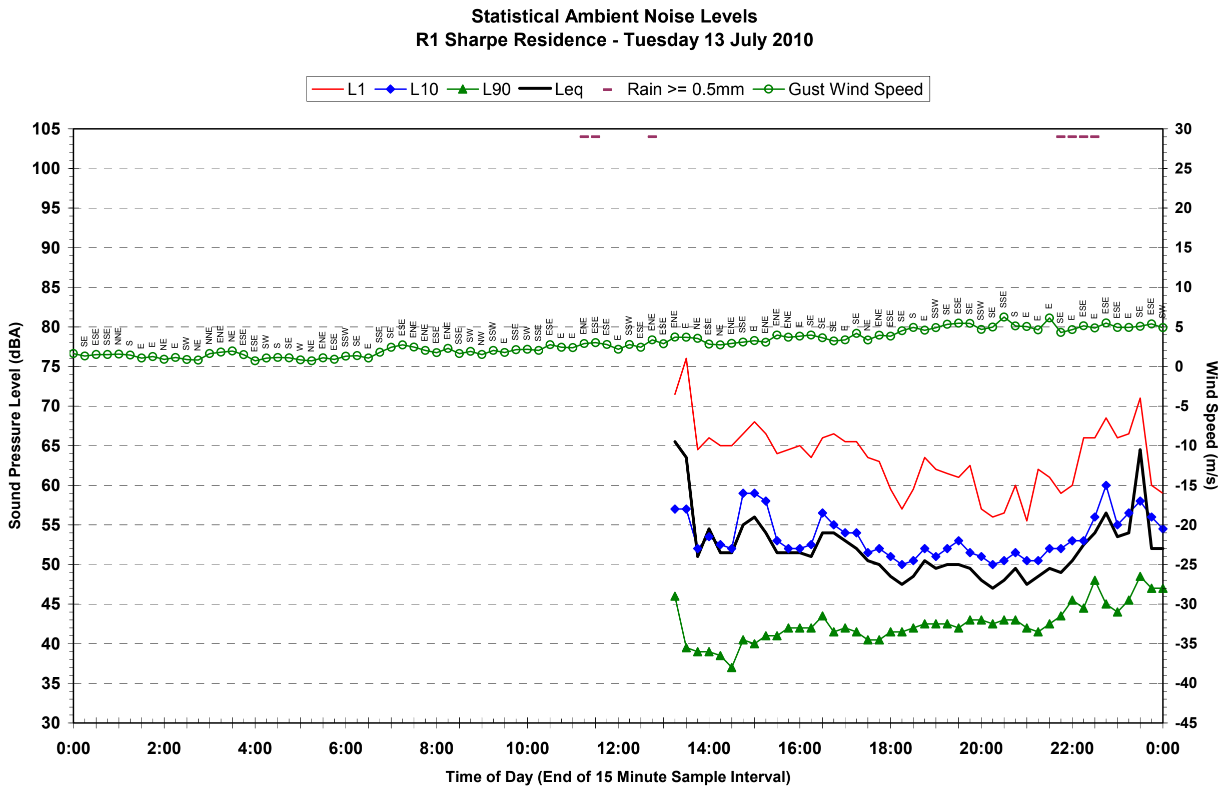
[illegible]

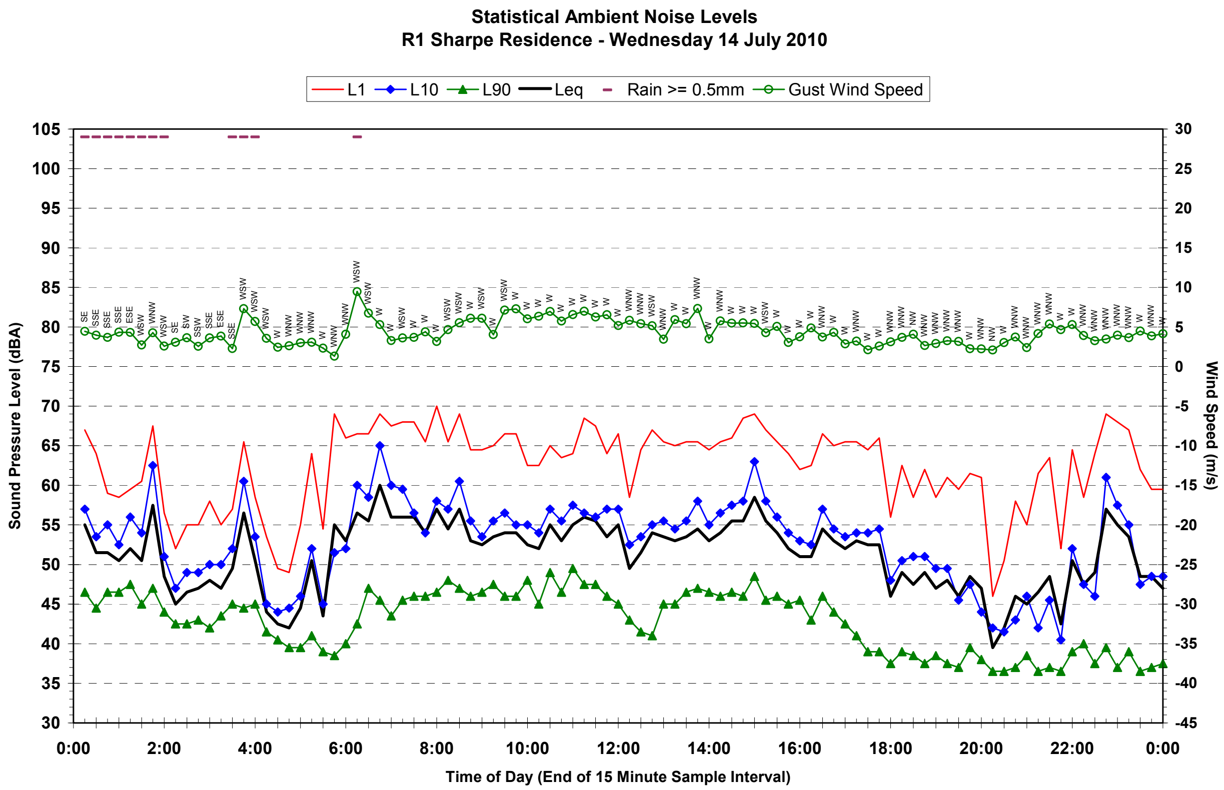
[illegible]

[illegible]

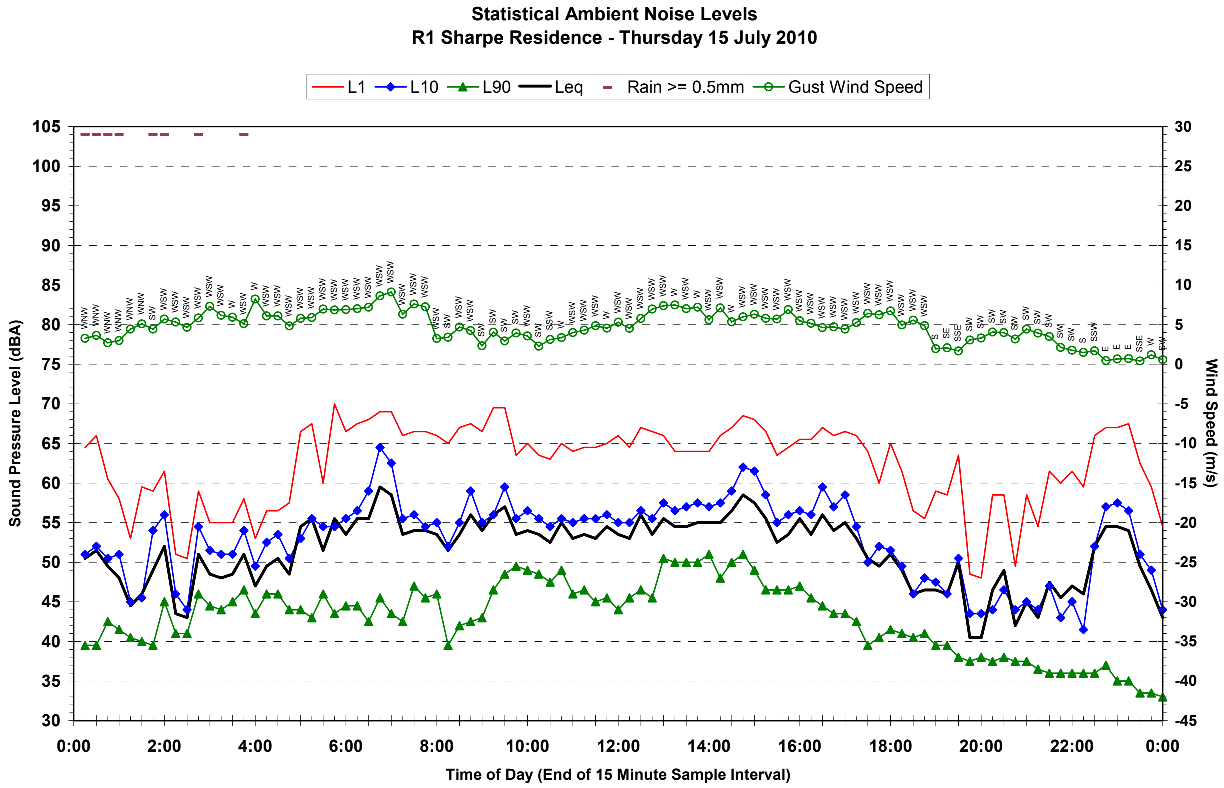
- [illegible]
    - [illegible]
    - [illegible]
    - [illegible]
- [illegible]
    - [illegible]
    - [illegible]

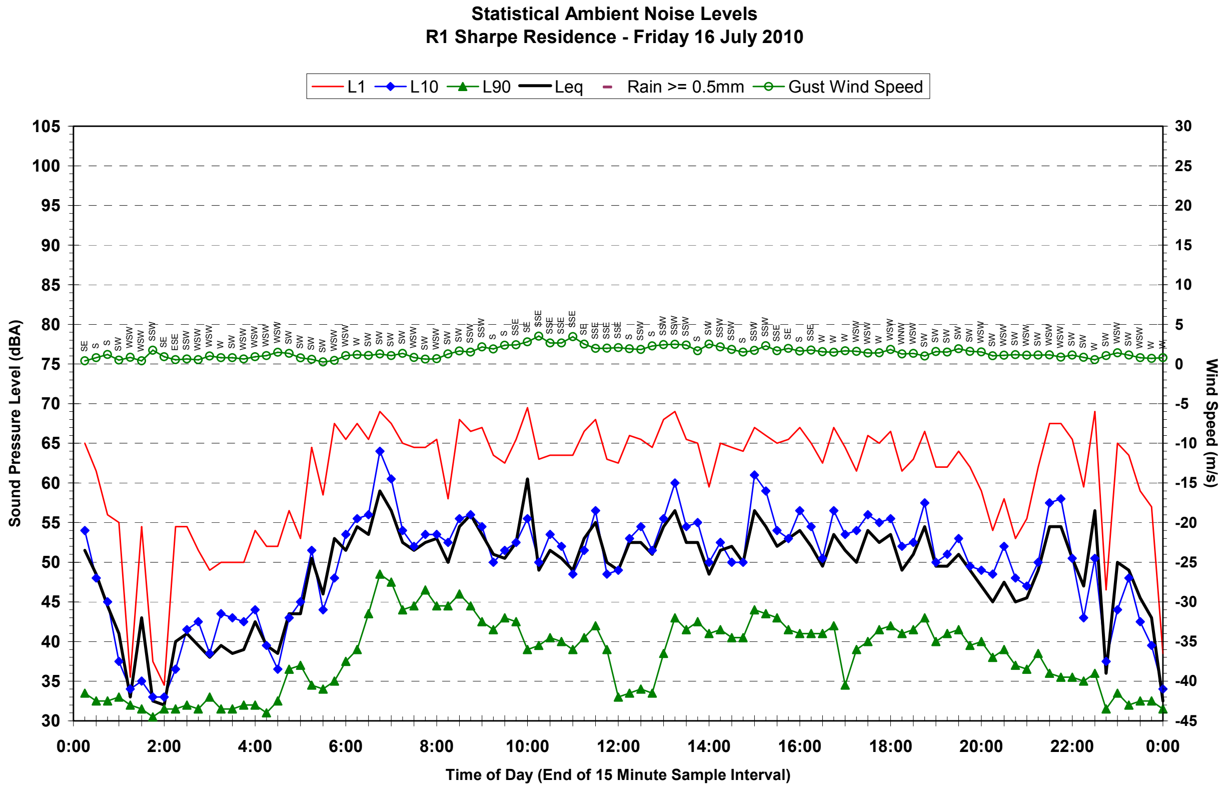
Statistical Ambient Noise Levels



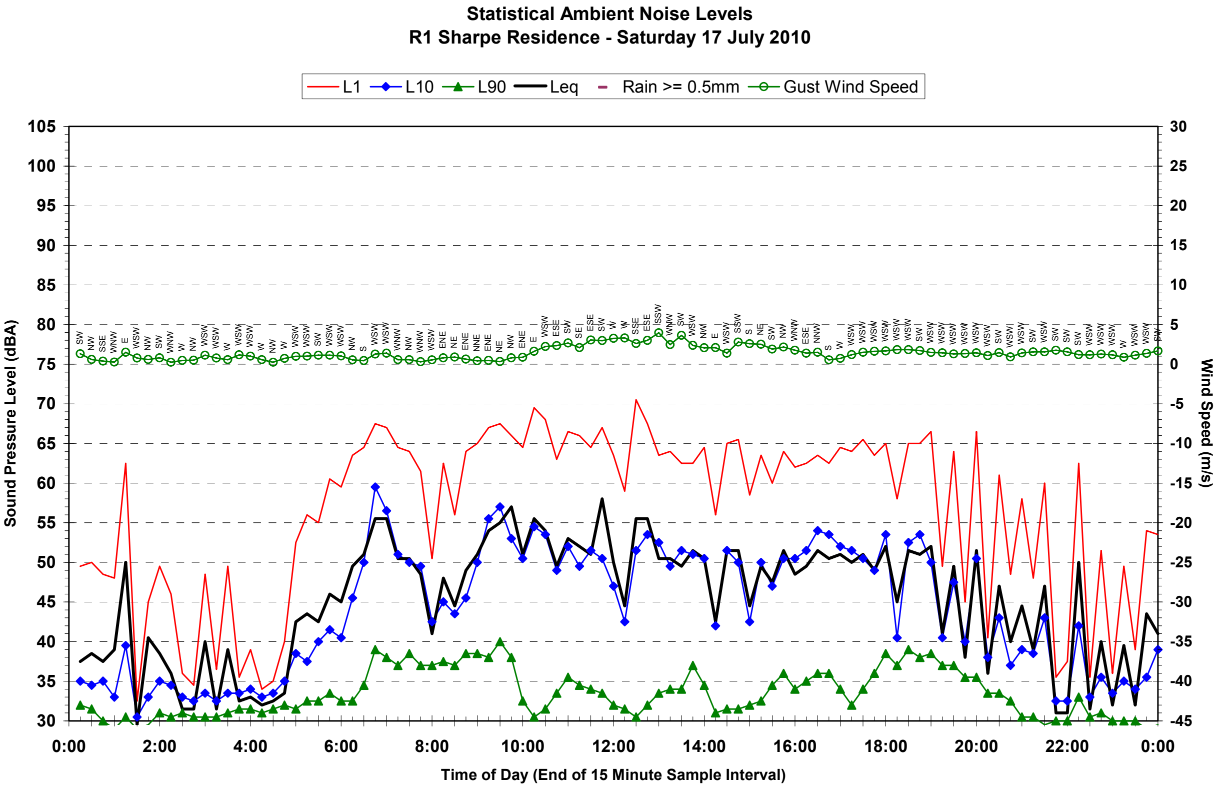


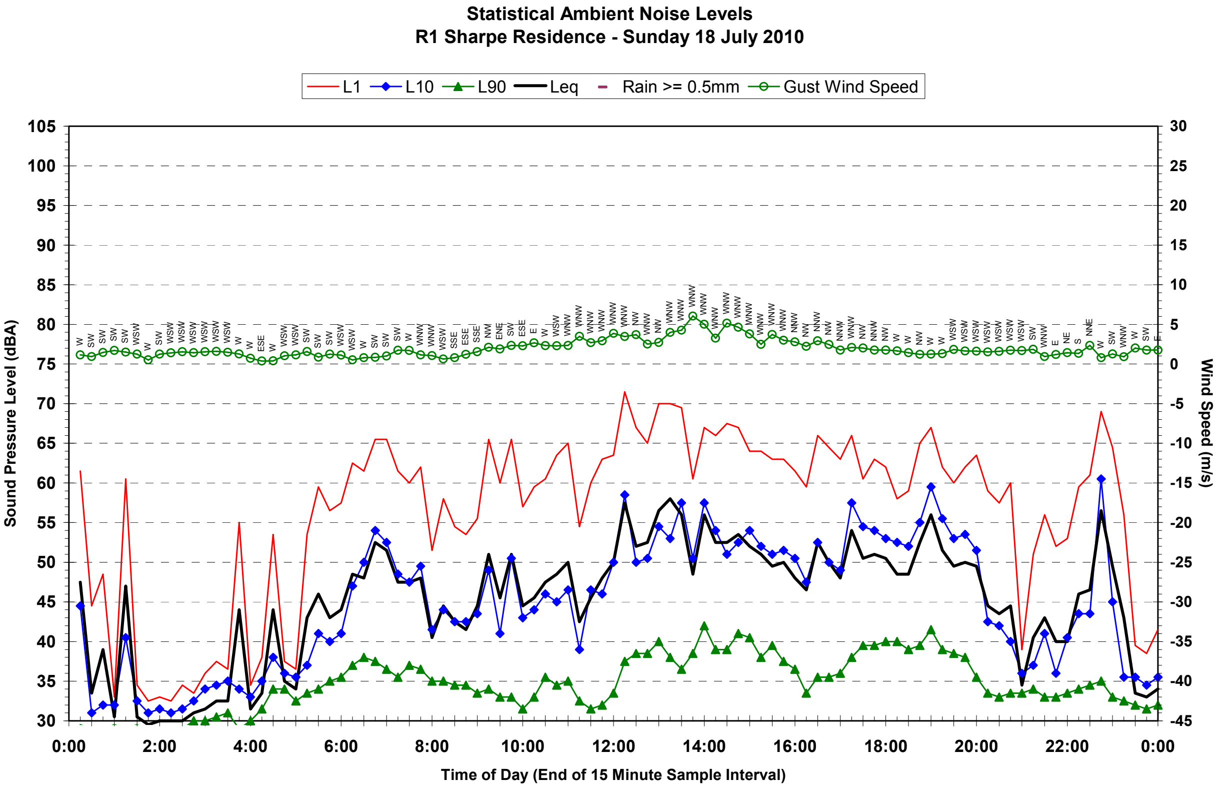
Statistical Ambient Noise Levels



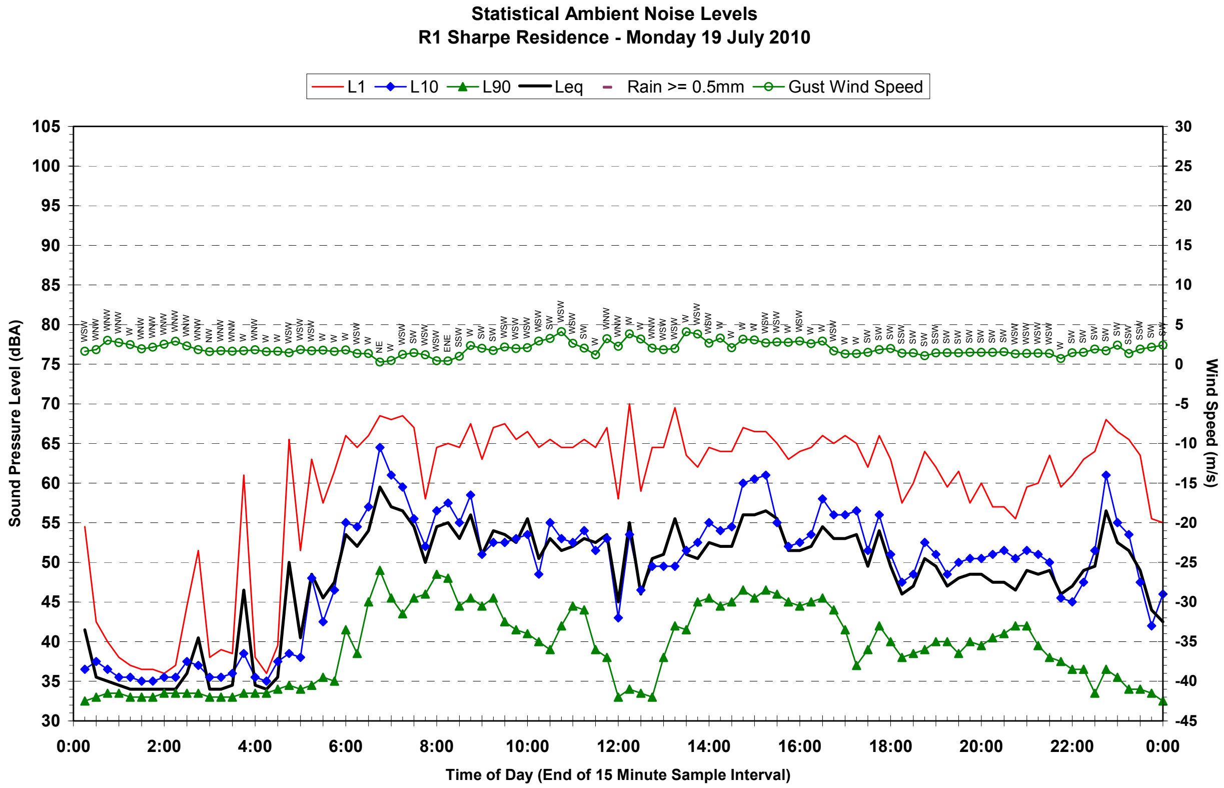


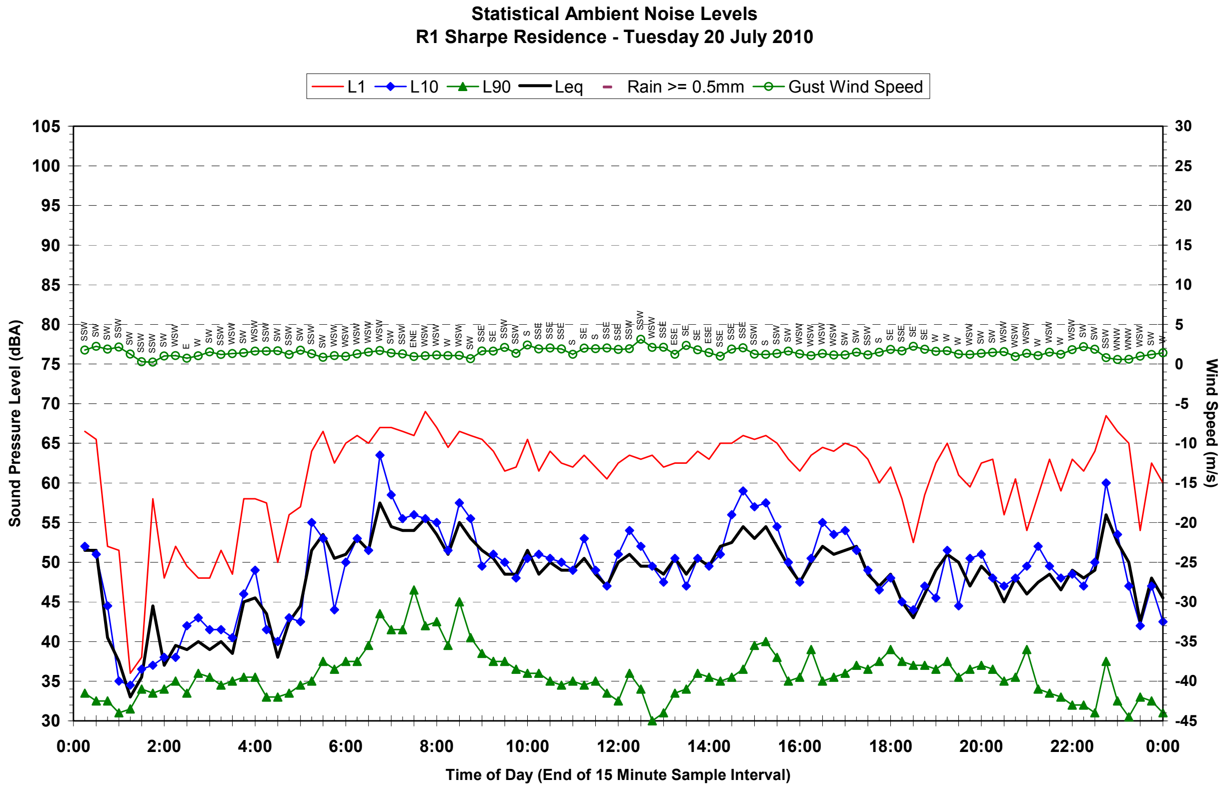
Statistical Ambient Noise Levels

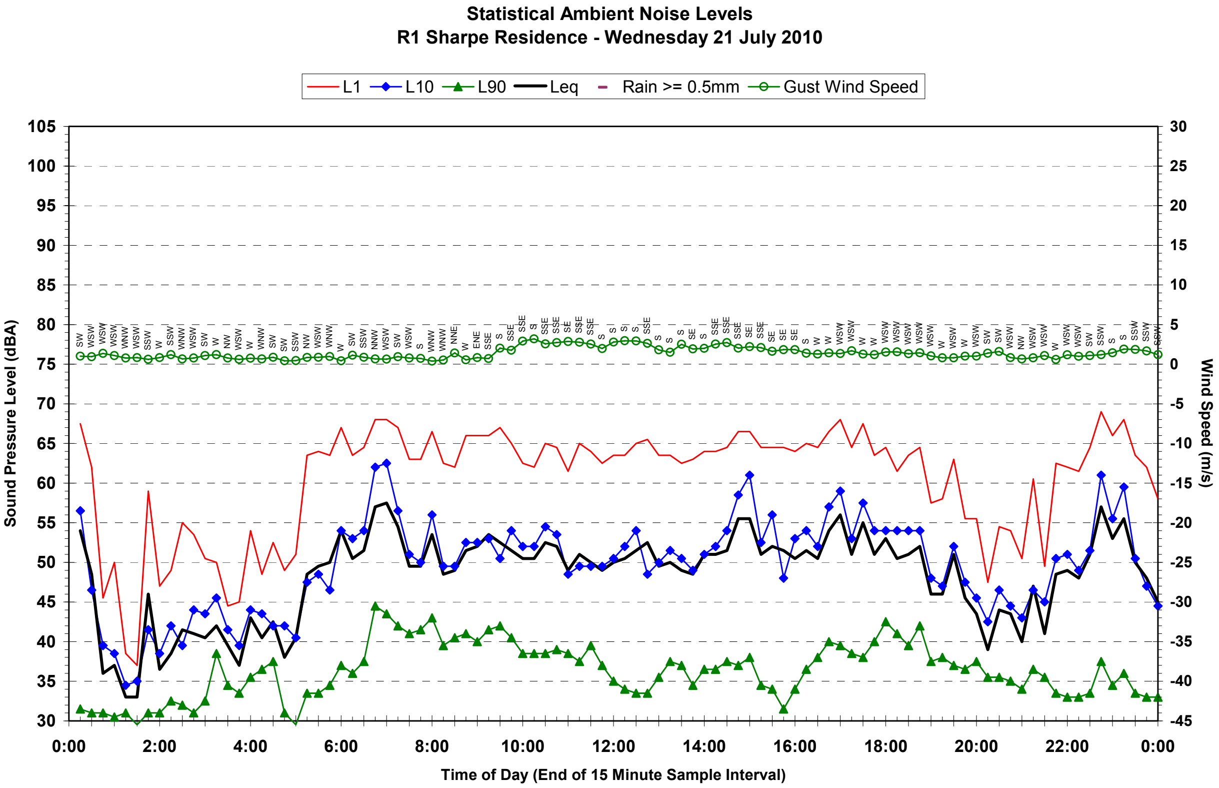


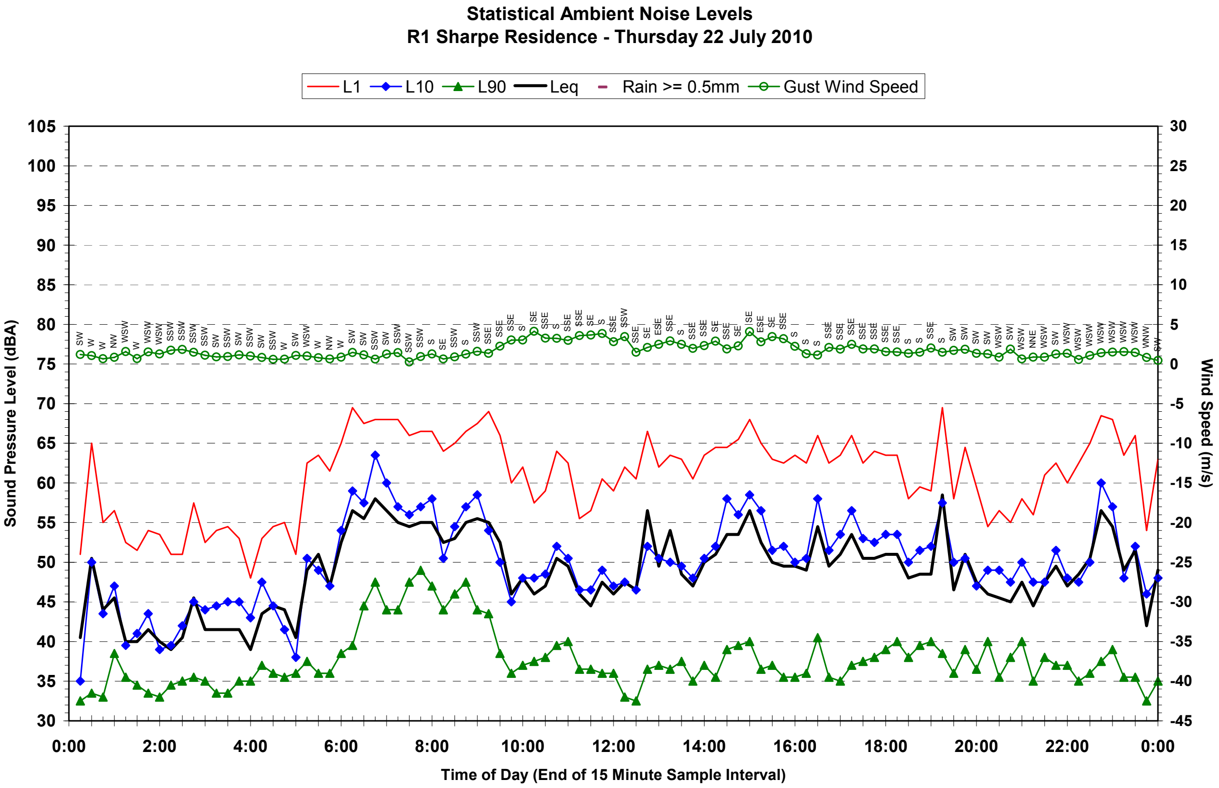


Statistical Ambient Noise Levels

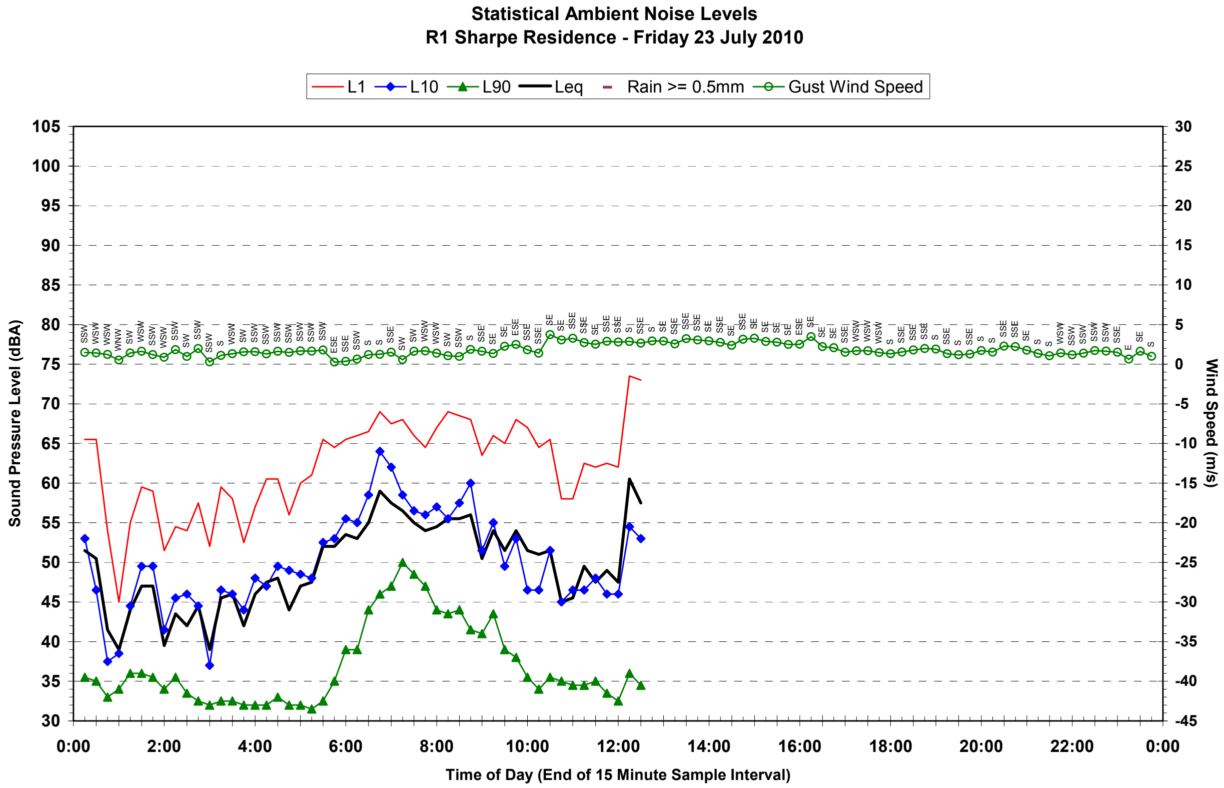





Statistical Ambient Noise Levels
R1 Sharpe Residence - Wednesday 21 July 2010
L1
L10
L90
Leq
Rain >= 0.5mm
Gust Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
R1 Sharpe Residence - Thursday 22 July 2010
L1
L10
L90
Leq
Rain >= 0.5mm
Gust Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels



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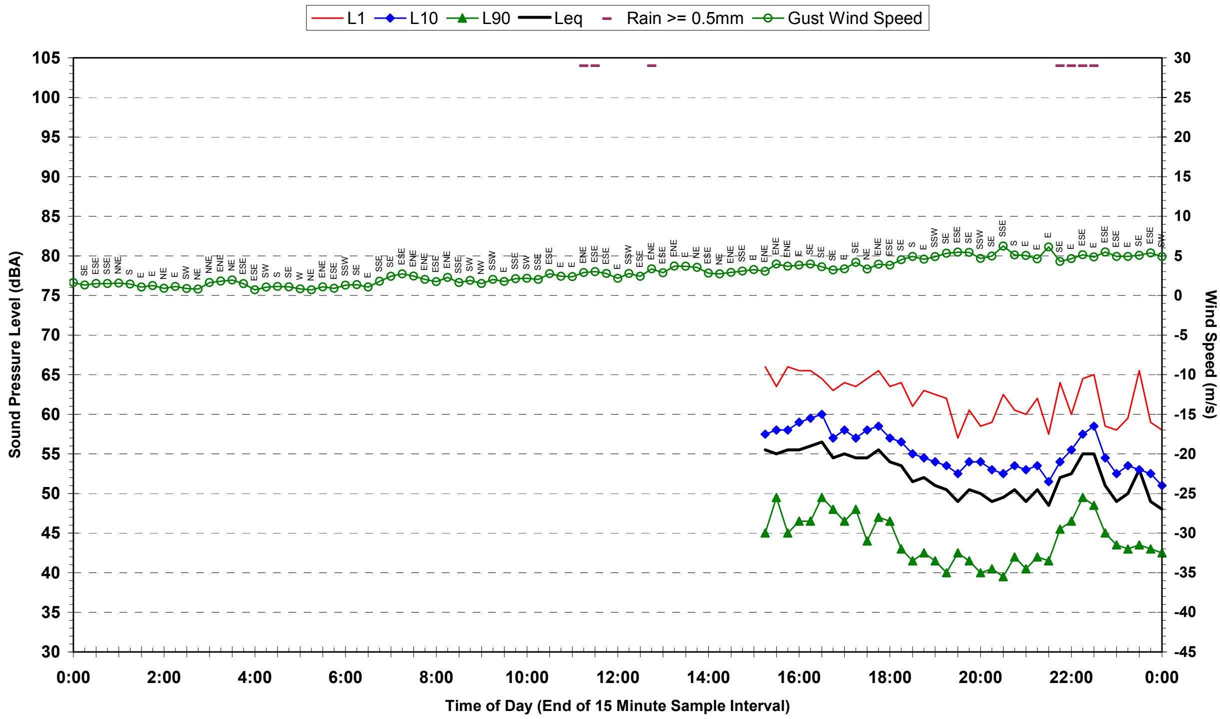

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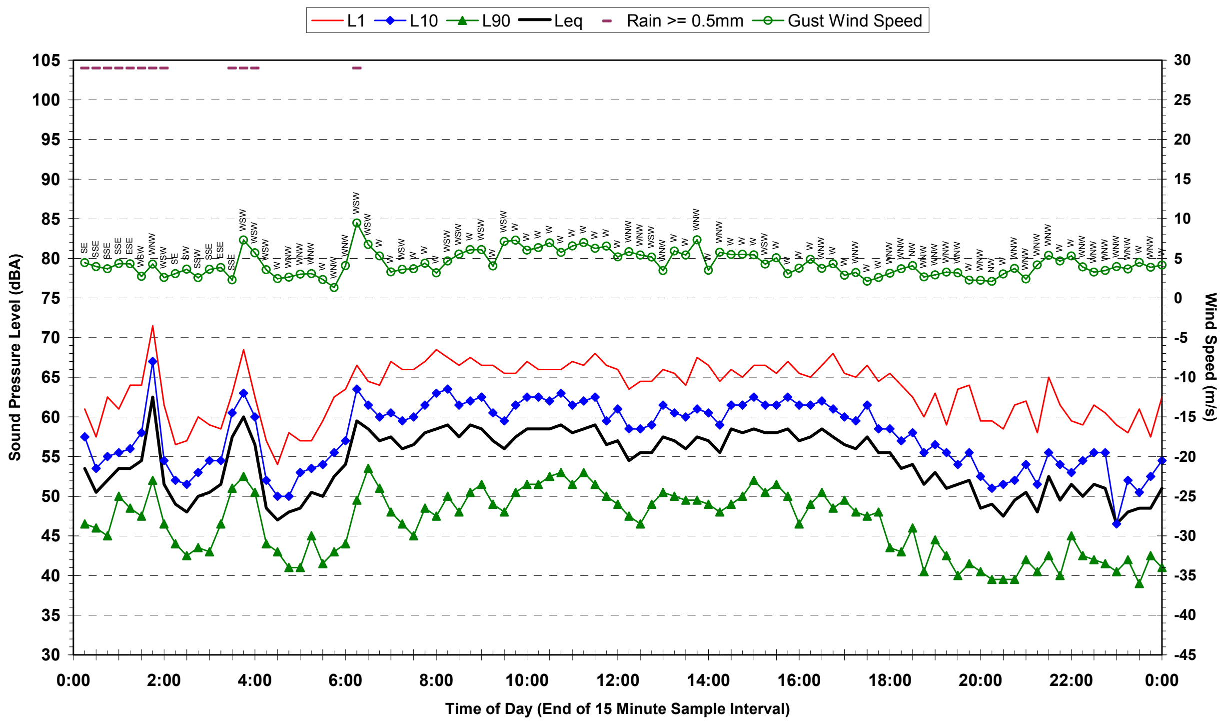
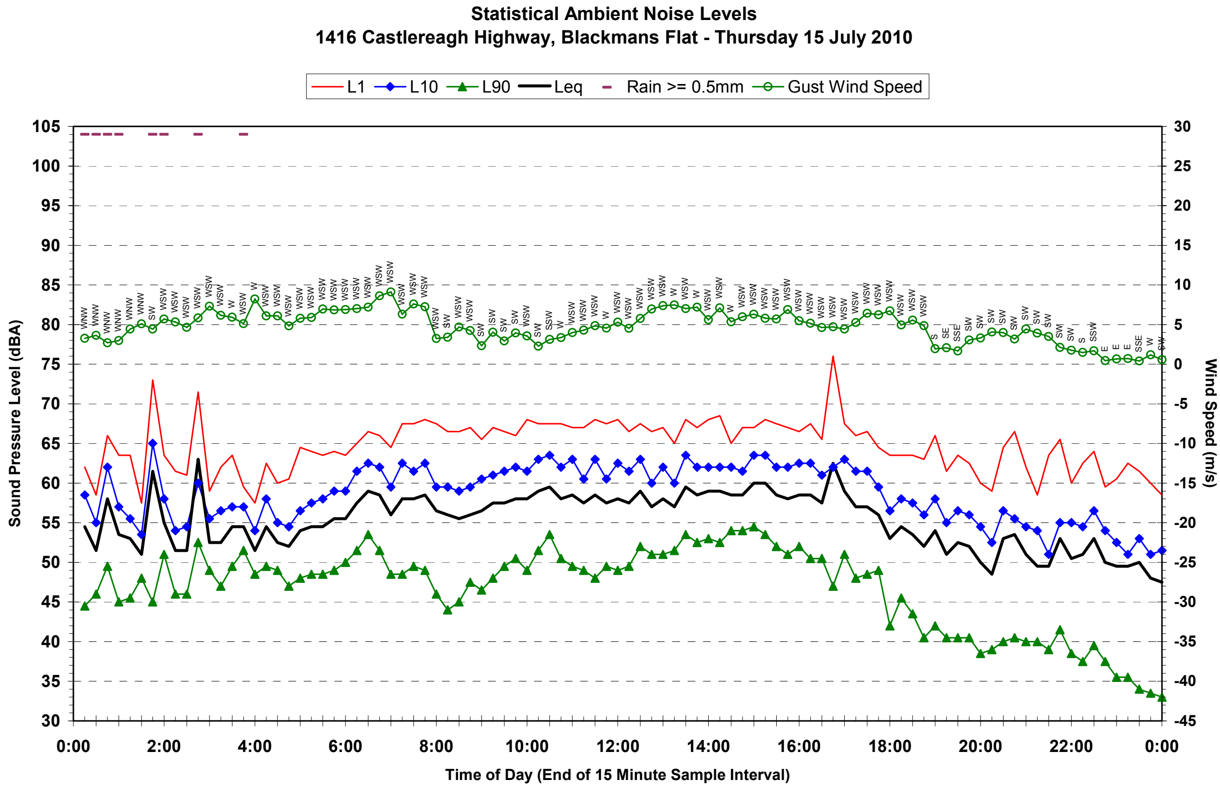
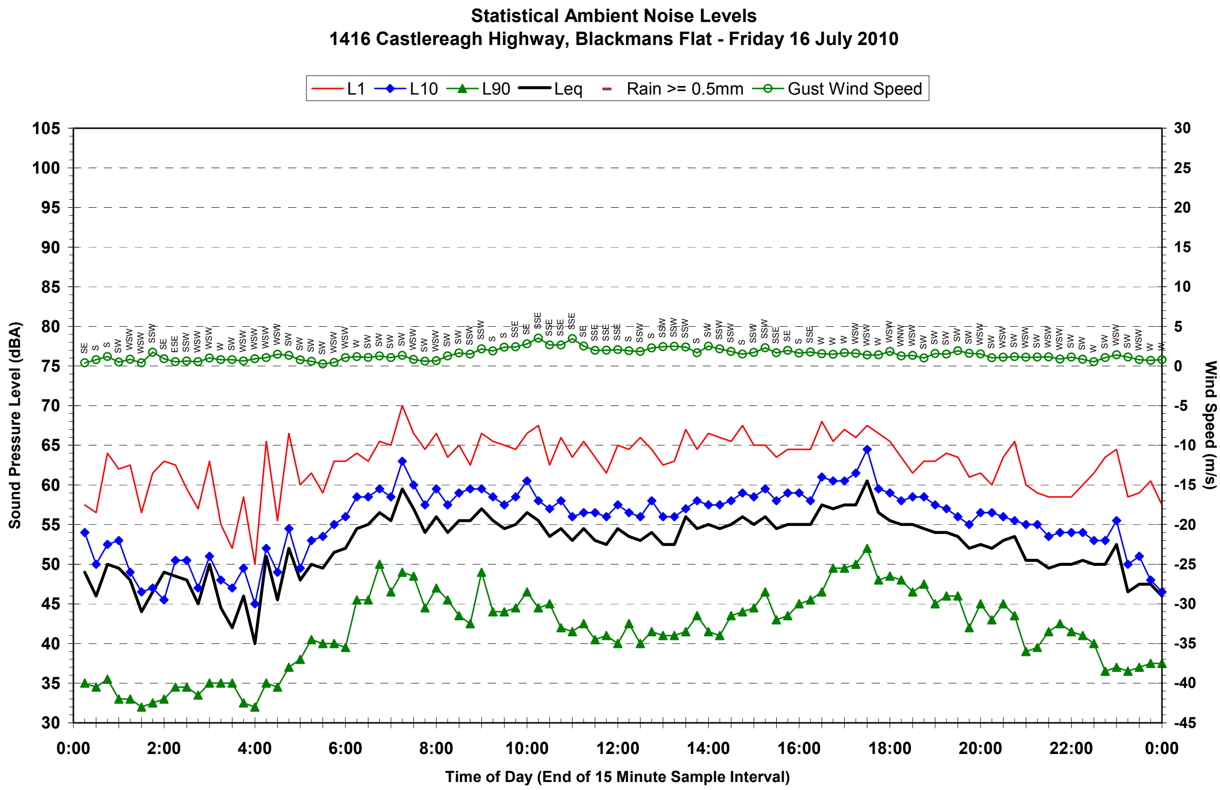


Statistical Ambient Noise Levels





Statistical Ambient Noise Levels

Statistical Ambient Noise Levels
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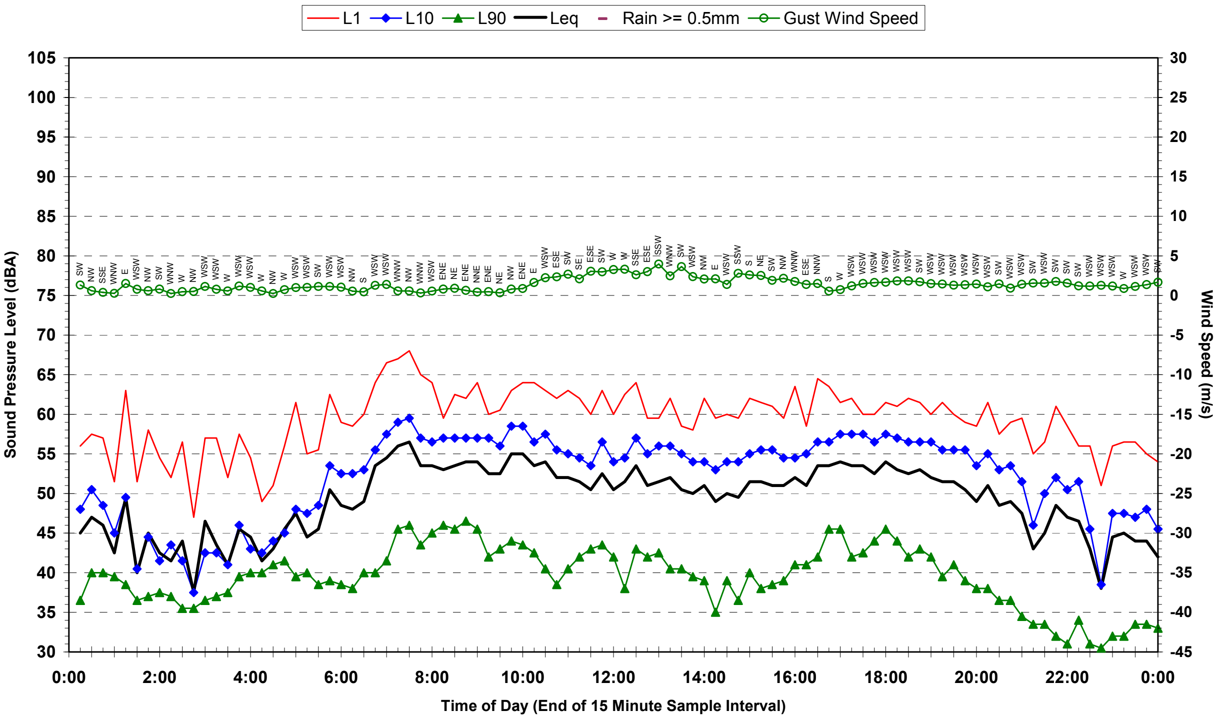

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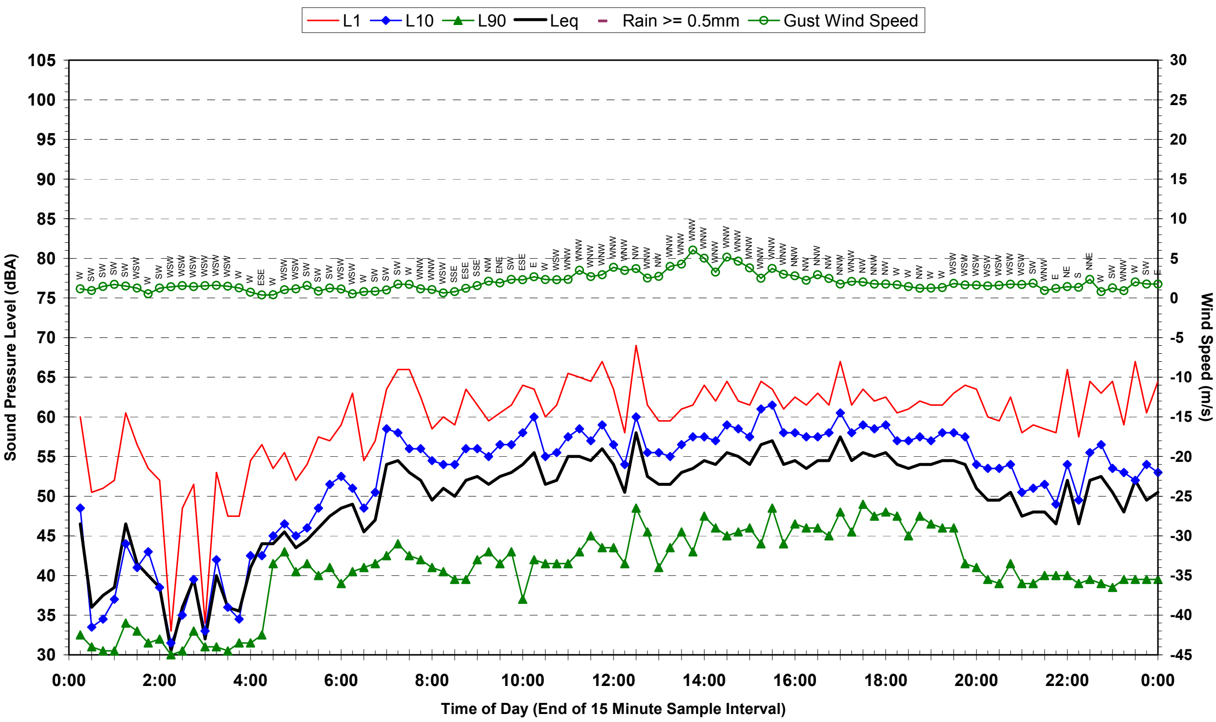
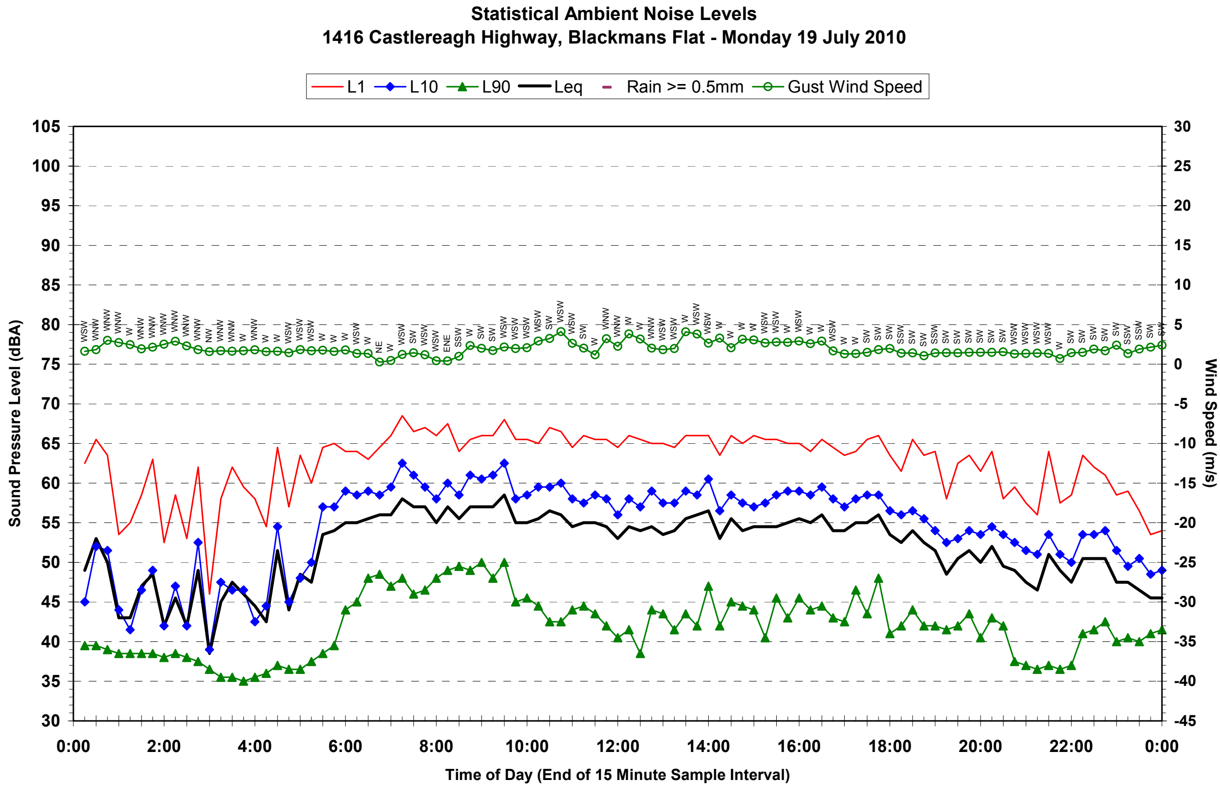
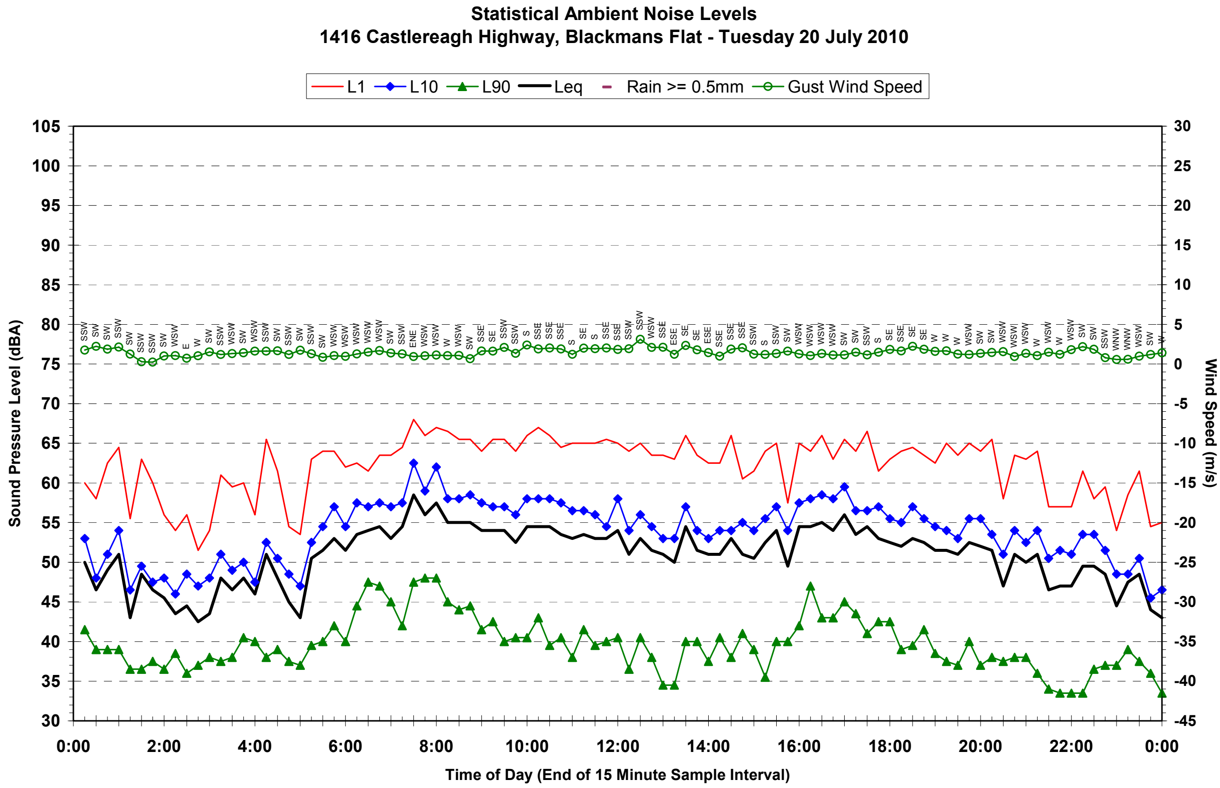
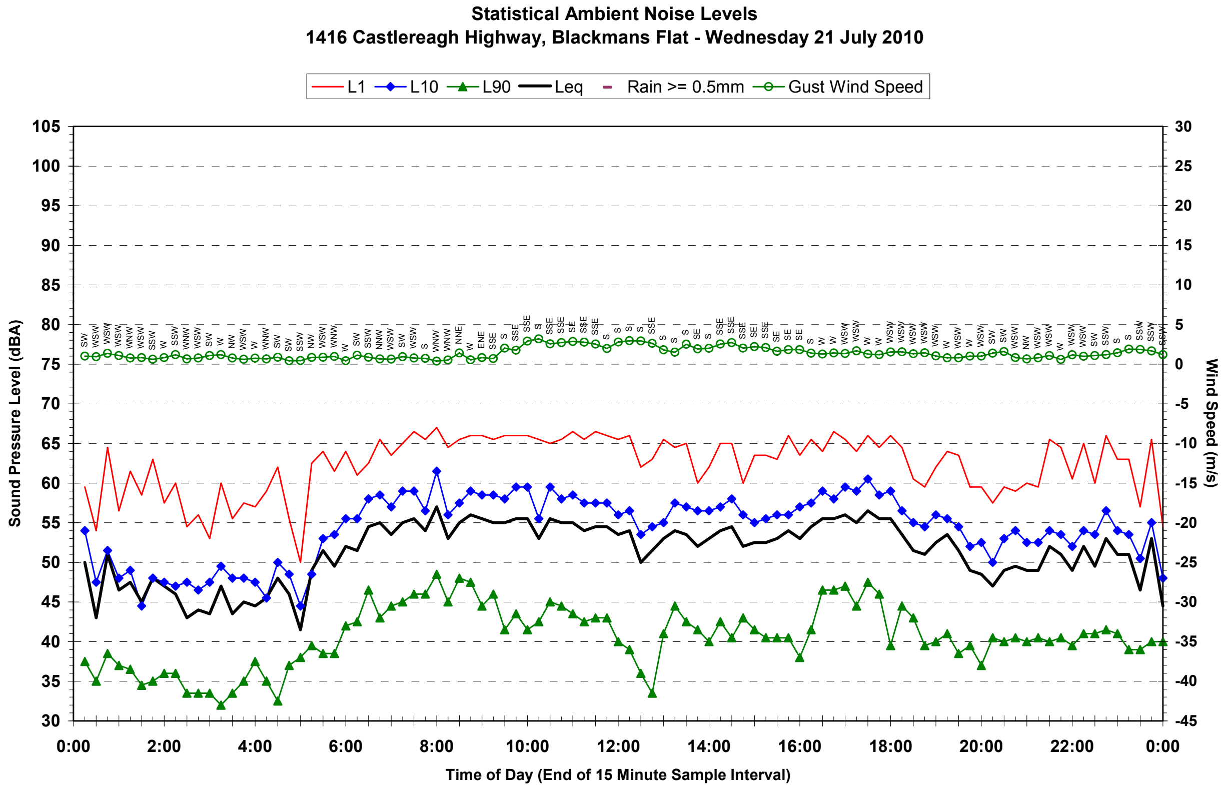


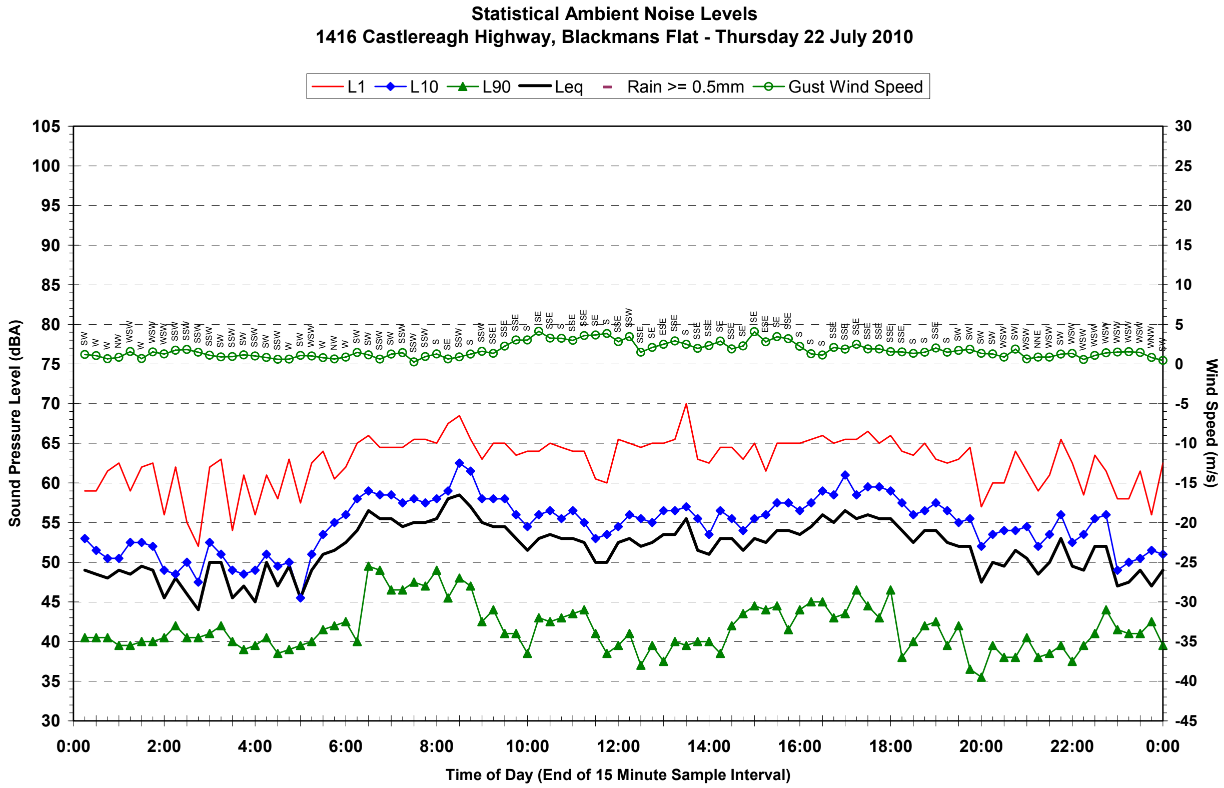
Statistical Ambient Noise Levels



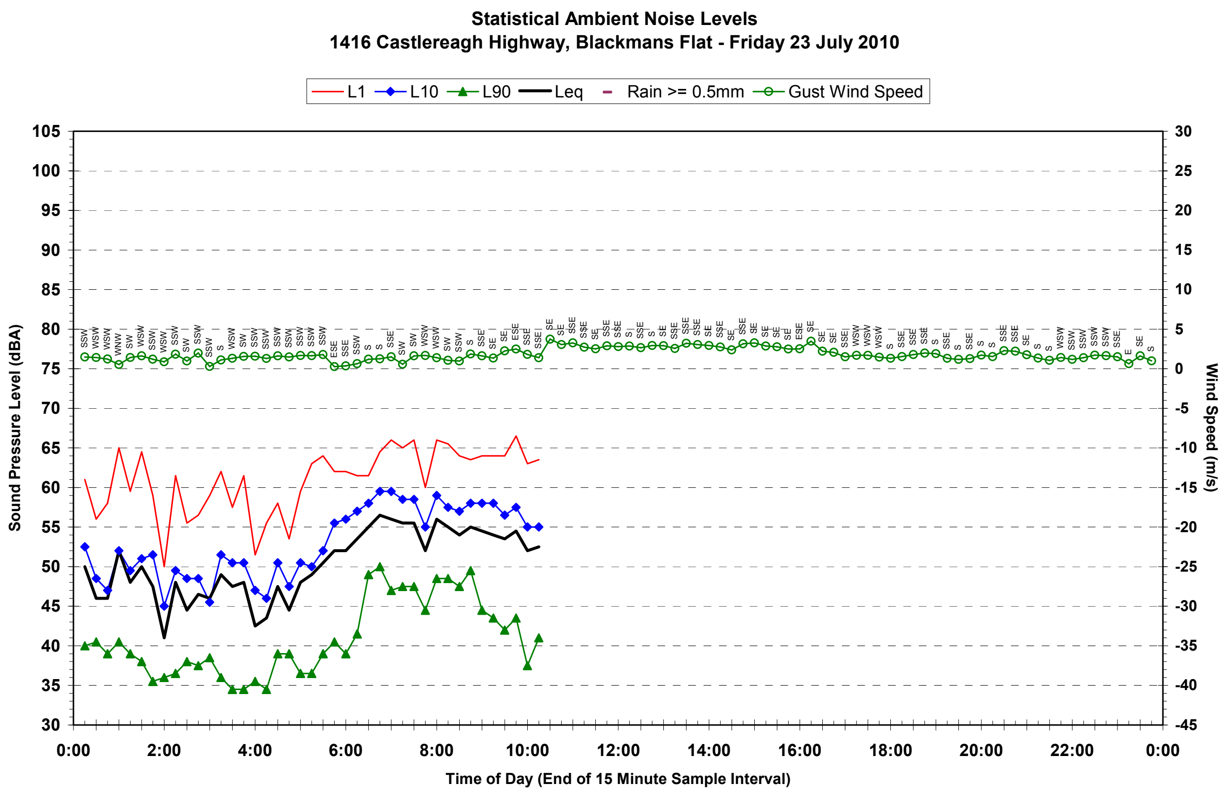




Statistical Ambient Noise Levels
1416 Castlereagh Highway, Blackmans Flat - Wednesday 21 July 2010
L1
L10
L90
Leq
Rain >= 0.5mm
Gust Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
1416 Castlereagh Highway, Blackmans Flat - Thursday 22 July 2010
L1
L10
L90
Leq
Rain >= 0.5mm
Gust Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)



Statistical Ambient Noise Levels
1416 Castlereagh Highway, Blackmans Flat - Friday 23 July 2010
L1
L10
L90
Leq
Rain >= 0.5mm
Gust Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sample Interval)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00

Angu Place Haul Road Protocol

HEGGIES

REPORT 30-1942R4

Revision 0

Angus Place - Haul Road Inspection Protocol July 2008

PREPARED FOR

Centennial Angus Place Pty Ltd
Wolgan Rd
Lidsdale NSW 2790

6 AUGUST 2008

HEGGIES PTY LTD
ABN 29 001 584 612

Incorporating New Environment Graeme E. Harding & Associates Eric Taylor Acoustics

Angus Place - Haul Road Inspection Protocol

July 2008

PREPARED BY:

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
30-1942R4	Revision 0	6 August 2008	Ben Carlyle	Rod Linnett	Rod Linnett

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background and Objectives

Previous investigations undertaken by Heggies personnel have identified that the Wallerawang Haul Road linking Angus place and power station is a significant contributor to the plants overall noise emissions. Many factors influence the noise emissions associated with the haul road, such as, the number and timing of truck movements, the type of trucks, the proximity of receptors, road surface type and the roads structural condition etc.

Most of these factors, with varying degrees, can not be altered without having some affect on productivity and/or monetary constraints. However, maintaining the road surface in the best practical condition is factor which can minimise unnecessary noise emissions, has little impact on productivity, and if undertaken effectively can have little impact on monetary constraints.

The purpose of this assessment is to formulate a methodology or protocol so that haul road deformations (ie potholes, corrugation etc) can be identified and prioritised so that specific deformations with the highest potential to contribute towards noise emissions can be identified for maintenance and repair.

Upon implementation of this protocol it is envisaged that resources (monetary and personnel), typically utilised for maintaining haul road integrity, will have the added benefit of reducing unnecessary noise emissions in an efficient and effective manner.

1.2 Description of Haul Road and Receivers

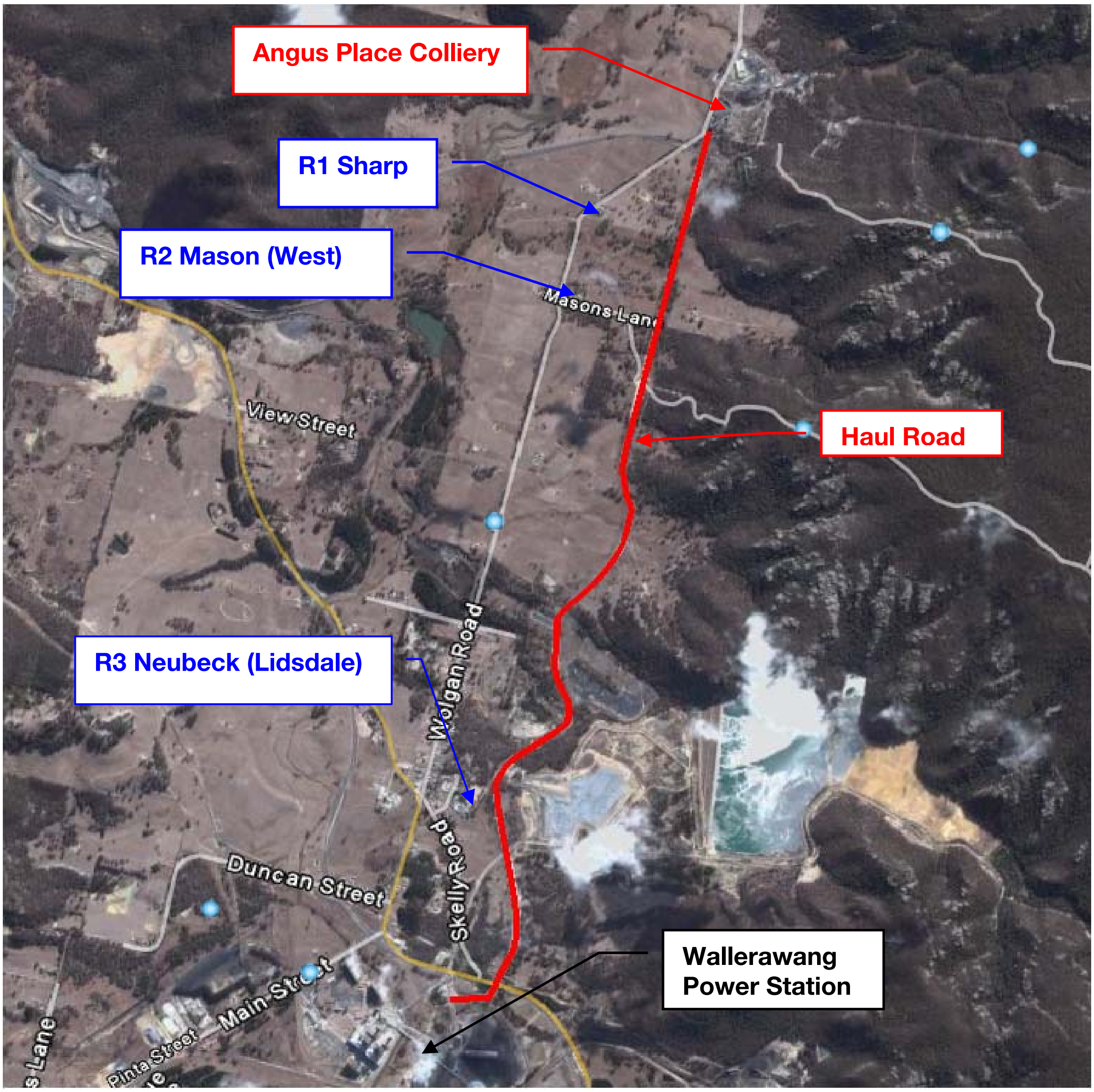
Angus Place currently uses the haul road to deliver coal via road registrable semi-trailers, trucks and dog to the Wallerawang Power Station located approximately 5.5km to the south. The first 2 km of the two (2) lane haul road from Angus Place is straight, upon which time the remaining length of the haul road meanders until reaching the Wallerawang Power Station (see **Figure 1**). The haul road has several small fluctuations in elevation where the grade of the road alters.

Three residential locations, namely Sharp, Mason and Neubeck (Lidsdale) are situated in close proximity to the haul road (see **Figure 1**). **Table 1** indicates the distance each of these receivers is located from Angus Place Bin and the Haul Road.

Table 1 Distance of Receivers to Angus Place and Haul Road

Receiver	Distance (metres) from Angus Place Bin	Nearest Distance (metres) from Haul Road	Height (m)
Sharp	760	460	905
Mason	1 200	440	905
Neubeck	3 500	180	900

Figure 1 Haul Road and Nearest Sensitive Receivers



1.3 Road Type and Deformation Background Information

Traffic noise is not only caused by the vehicles' engines and exhausts but also by the road surface together with the vehicles tyres driving over it. With increasing vehicle speed, the tyre-road interaction noise increases more strongly than engine and exhaust noise. As a guideline tyre-road interaction noise is the dominant traffic noise source for speeds above 40-50 km/h for cars and 60 km/h for trucks (Adams, G *et al* 2006).

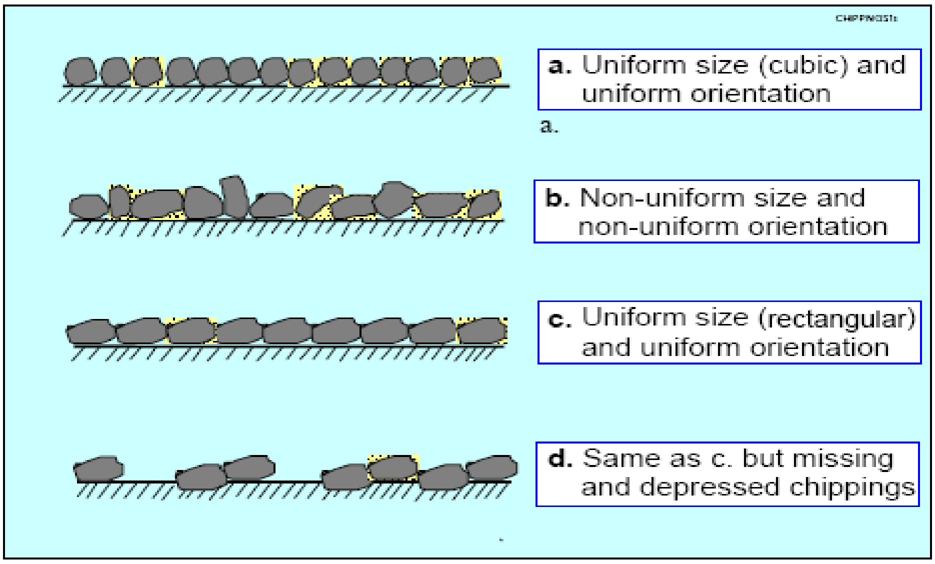
As seen in **Table 2**, different road surfaces or pavement types yield differences in noise generation.

Table 2 Equivalent noise pressure levels on various types of road surface compared to a dense asphalt wearing course

Road Surface	Noise Pressure Levels
Small element pavement	+2 to +5 dBA
Broomed concrete pavement	+2 dBA
Dense asphalt wearing course	0 dBA
Porous asphalt wearing course (ZOAB)	-3 dBA

Table 2 shows that road surface type can influence noise emissions by as much as 8 dBA. The values within **Table 2** have been derived on the basis that the road surfaces are in optimum condition upon which they were designed. However if a road surface has undergone some structural deformation it may in fact yield higher noise production than an equivalent surface type which is in optimum condition. This is seen in **Figure 2** which shows that a deformed surface (ie d) has a lower 'acoustic performance' than an equivalent surface in optimum condition (ie c).

Figure 2 Example of various shapes of chippings and their orientation. From best to worst in this example they rank a, c, b and d.



Truck engine and exhaust noise dominates tyre-road interaction noise up to speeds of approximately 60km/h. However, when a heavily deformed road is being utilised this speed is reduced somewhat.

In terms of the Wallerawang haul road, since haul trucks approach speeds of 60-80km/h identification and repair of significant deformations would be beneficial in terms of reducing noise emissions.

2 METHODOLOGY

The methodology for the identification and qualification of road deformations is based on a Risk Assessment Matrix. This Risk Assessment Matrix has several integral components which are; haul road zoning, deformation type and location of deformation. The following sections define and discuss these integral components.

2.1 Haul Road Zoning

In terms of potential noise impacts and the restriction of such, certain sections of the haul road are deemed more critical than others and deserve a higher priority. This ‘criticalness’ is a reflection of:

- The distance from the haul road and the nearest sensitive receiver, and
- The presence of intervening topography, natural shielding and/or barriers.

Based on the preceding factors, sections of the Haul Road have been assigned a High Priority (red), Moderate Priority (yellow) or Low Priority (green) as shown in **Figure 3**. A **Road Zoning Multiplication Factor (RZMF)** has been assigned for each Priority Group and is outlined in **Table 3**.

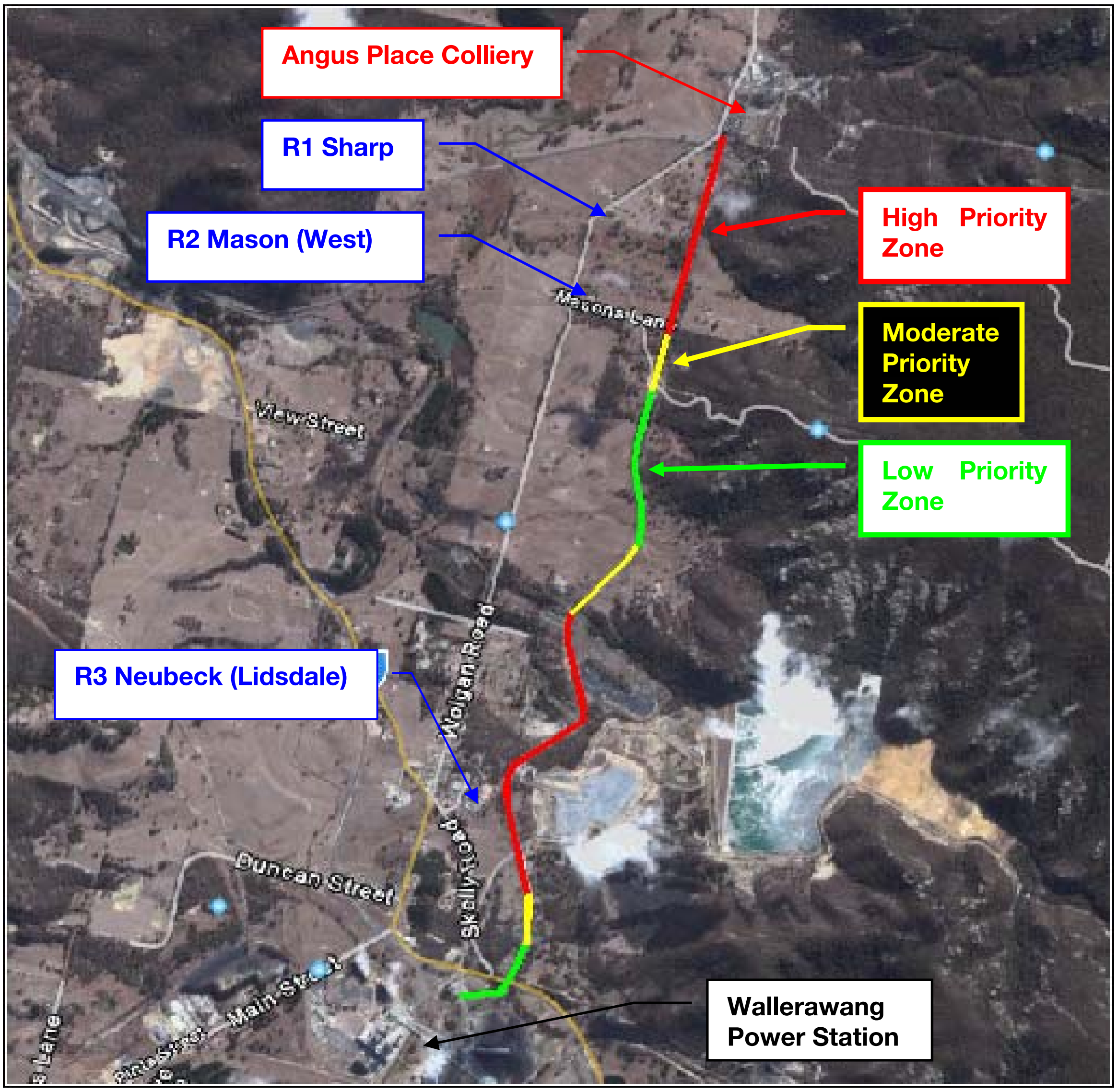
Table 3 Road Zoning Multiplication Factor of Haul Road Priority Groups

Priority Group	Road Zoning Multiplication Factor (RZMF)
High Priority (Red)	3
Moderate Priority (Yellow)	2
Low Priority (Green)	1

Note: Since the RZMFs are relative between Priority Groups the actual RZMF value assigned is not vital.

It is recommended that, 250 metre intervals are marked on the haul road from Angus Place to Wallerawang. It is proposed that these intervals be sign-posted to display chainage and zone (colour coded). Some ‘ground truthing’ (ie site inspection/verification) will be required to verify the spatial extent of zones within **Figure 3**.

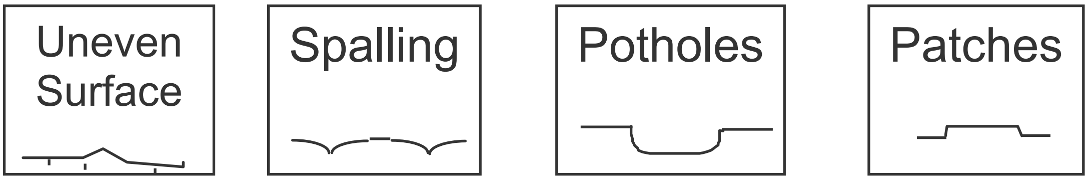
Figure 3 Haul Road Priority Sections



2.2 Type of Deformation

Numerous types of deformations have the potential to increase noise production by increasing surface roughness. Some road deformation types and graphics of their associated cross sectional profiles are displayed in **Figure 4**. Definitions of some road deformations are displayed in **Appendix B**.

Figure 4 Road Surface Deformation Types and Cross Sectional Profile



The severity to which these deformations increase noise production is dependant on many variables, such as:

- The orientation of the deformation in relation to approaching trucks (tyres).
- The length, width and depth of the deformation.

Based on the preceding, namely the size of the deformation, a **Deformation Severity Rating (DSR)** has been assigned for specific deformation types and is shown in **Table 4**.

Table 4 Deformation Severity Rating of Deformation Types

Deformation Type	Size	Consequence Severity Rating (CSR)
Pothole	>300mm in width or length and/or >50mm deep	5
	150mm to 300mm in width or length and/or 20mm to 50mm deep	4
	<150mm in width or length and/or <20mm deep	3
Spalling and Corrugations	>20mm in depth and/ or >1 metre in length	4
	<20mm in depth or <1 metre in length	3
Patches and Uneven Surfaces	>25mm elevated height	2
	<25mm elevated height	1

Note: Since the DSRs are relative between Deformation Types the actual DSR value assigned is not vital.

2.3 Location of Deformation

The location of the deformation on the haul road strongly influences the probability that it will be run over by a truck. A deformation aligned with the tyre track has a much higher probability of been run over than a deformation aligned with the centre of the road or the centre of the lane.

Based on the preceding a **Probability Rating (PR)** has been assigned for the location of a deformation and is shown in **Table 5**.

Table 5 Probability Rating of Deformation Location

Location of Deformation	Probability Rating (PR)
Aligned with Tyre Track	100
Aligned with Centre of Road or Centre of Road Lane	50

3 RISK ASSESSMENT MATRIX

Based on that contained within **Section 2** a Risk Assessment Matrix has been formulated and is shown in **Table 6**.

Table 6 Risk Assessment Matrix

USE THE RISK ASSESSMENT MATRIX BELOW TO DETERMINE THE RISK CATEGORY																
RZMF[1]		x1					x2					x3				
DSR[2]		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PR[4]	**CSR[3]**	**1**	**2**	**3**	**4**	**5**	**2**	**4**	**6**	**8**	**10**	**3**	**6**	**9**	**12**	**15**
Almost Certain	**100**	Low 100	Low 200	Low 300	Low 400	Mod 500	Low 200	Low 400	Mod 600	Mod 800	High 1000	Low 300	Mod 600	High 900	High 1200	High 1500
Possible	**50**	Low 50	Low 100	Low 150	Low 200	Low 250	Low 100	Low 200	Low 300	Low 400	Mod 500	Low 150	Low 300	Mod 450	Mod 600	Mod 750

[1] Road Zoning Multiplication Factor (RZMF)
[2] Deformation Severity Rating (DSR)
[3] Consequence Severity Rating (CSR) = RZMF x DSR
[4] Likelihood of defomation being 'runover' - Almost Certain = deformation located on tyre track; Possible = deformation located on centre of road or lane

Assess the haul road zone, the most credible deformation and then the likelihood of the deformation being 'runover'
The intersection of the consequence severity and the likelihoood will be the assessed risk

Low - LOW PRIORITY Monitor for Further Degradation	Mod - MODERATE PRIORITY Flag for Future Haul Road Maintenance Services	High - HIGH PRIORITY Nominate for Next Haul Road Maintenance Service

4 APPLICATION OF RISK ASSESSMENT MATRIX

4.1 Inspection Procedure

In order to implement the Risk Assessment Matrix effectively the following is recommended:

- The haul road is to be inspected on a regular (monthly) basis,
- With reference to **Section 2** the 'Haul Road Inspection Sheet' (within **Appendix A**) is to be filled out in sequential order left to right.
- The results of the inspection are prioritised to create work orders for the repair of road deformations.

5 CONCLUSION

I trust the preceding meets your current requirements. If you have any questions or would like any further information please do not hesitate to contact me on (02) 4908 4500 or email ben.carlyle@heggies.com.

Regards

Ben Carlyle
Project Consultant/Heggies Pty Ltd

6 REFERENCES

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http://www.concretecentre.com/main.asp?page=660

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APPENDIX A

HAUL ROAD INPSECTION SHEET

Haul Road Inspection Sheet

HAUL ROAD INSPECTION SHEET					
LANE: SOUTH/NORTH BOUND					
Chainage	RZMF (Refer Figure 3 & Table 3)	Deformation Type (Refer Figure 4)	DSR (Refer Table 4)	PR (Refer Table 5)	Risk Category Result (RZMF x DSR x PR = Risk Category Result)

LOW PRIORITY (0-400) Monitor for Further Degradation	MODERATE PRIORITY (500-800) Flag for Future Haul Road Maintenance Services	HIGH PRIORITY (900-1500) Nominate for Next Haul Road Maintenance Service

Table 3 Road Zoning Multiplication Factor of Haul Road Priority Groups

Priority Group	Road Zoning Multiplication Factor (RZMF)
High Priority	3
Moderate Priority	2
Low Priority	1

Figure 4 Road Surface Deformation Types and Cross Sectional Profile

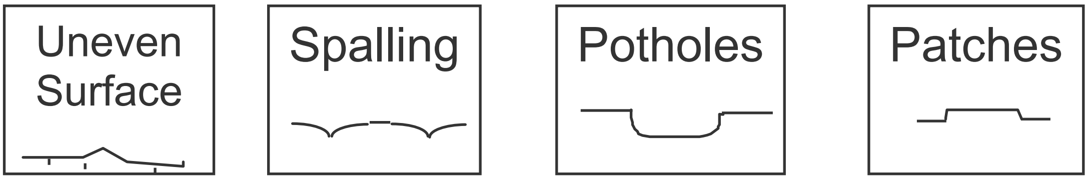

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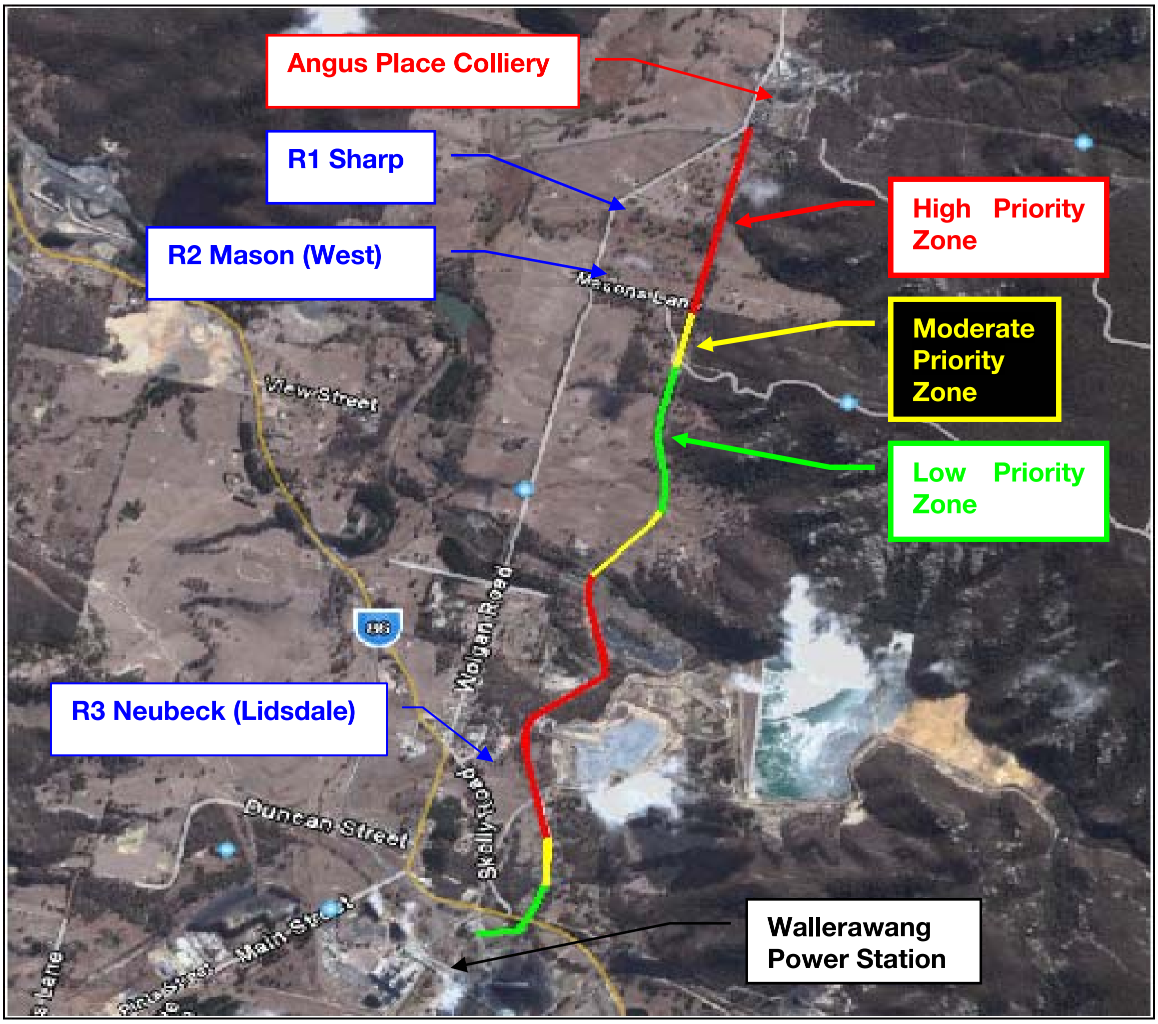
Table 5 Probability Rating of Deformation Location

Location of Deformation	Probability Rating (PR)
Aligned with Tyre Track	100
Aligned with Centre of Road or Centre of Road Lane	50

Figure 3 Haul Road Priority Sections



APPENDIX B

ROAD DEFORMATION DEFINITIONS

ROAD DEFORMATION DEFINITIONS

Pothole

A **Pothole** is defined as a hole or pit in a road surface

Potholes develop when two factors are present at the same time – water and traffic. Without water and traffic present at the same time, potholing simply will not develop.

There are two major methods by which these factors (water and traffic) lead to pothole development

1. Fatigue failure produces the classic bowl shaped crater and is caused by excessive flexing of the pavement, most commonly on thin pavements when excess water is in the base. Water from rainstorms or poor drainage weakens the soil beneath the the pavement. Then the pavement flexes excessively up and down with traffic until it starts to crack and brake in several places.

   Thinner pavements (under 10cm) are more prone to potholing because the pavement disintegrates into very small, 2 to 5cm pieces that traffic can easily disloge.

   Thicker pavements (greater than 10cm) may also crack by the fatigue mechanism, but generally the internal forces that cause slab deformation diminish and prevent breakdown into smaller pieces that can easily pop out.
2. Raveling failure is significantly different, but, again, occurs only when traffic is present and water actually washes away the adhesive asphalt films that hold the stone aggregate together. Once the ashphalt adhesive is washed away, the stone particles ravel away. This condition occurs when the water has a chance to permeate a pavement that lacks sufficent density to prevent water penetration.

In order to prevent potholes, the key is proper drainage off the surface and away from the edges, for both paved and unsurfaced roads. For paved surfaces, the surface must be kept sealed, and, if possible, sloped to drain water from the surface to prevent water from getting into the base or supporting layers.

Corrugations

Corrugations is the name in Australia, Africa and Asia of the process which results in roads (particularly gravel roads or dirt roads) developing a series of regular bumps with short spacing in the road surface. In North America the equivalent term is washboarding.

Corrugation is an instability that occurs when vehicles move above a critical speed, that depends on the properties of the vehicles and the road surface. If all the vehicles move below their critical speed the road will remain flat, but if they move faster, ripples will slowly grow and move in the direction of the vehicles. It has been argued that the vehicle's suspension is important, but this can not explain why corrugated road forms when vehicles' suspensions vary so much. Many have argued that suspension is irrelevant and recent experiments confirm that corrugated road forms without suspension.

The most effective way to permenately eliminate washboarding is through installation of cellular confinment systems, which impede the lateral soil movement that causes washboarding.

Spalling

Spalling can be described as the breaking of layers or pieces of concrete from the surface of a structural element when it is exposed to the high and rapidly rising temperatures experiences in fires. There are three main types of spalling:

Surface Spalling affects aggregate on the concrete's surface, whereby concrete fragments typically up to 20mm in diameter become detached.

Corner break-off or sloughing off. This tends to occur in the later stages of a fire and affects more vulnerable concrete on wall corners where it is heated on two planes.

Explosive spalling early rapid heat-rise forcibly separates pieces of concrete at high pressure, with an 'explosive' effect. The most dangerous form of spalling.

Patches and Unevenness

Patches and unevenness of the road surface arise when an area of pavement has been replaced with a new material to repair the existing pavement.

Example Haul Road Inspection Sheet

Centennial Angus Place

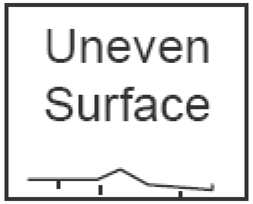
Angus Place Colliery Monthly Environmental Haul Road Inspection Report

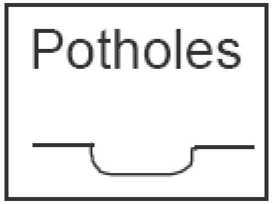
INSPECTION BY: **Bradley Condon** **DATE: 4/12/09** **TIME: 2.00pm**

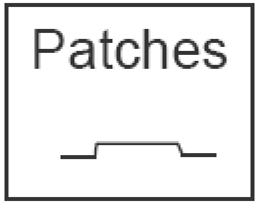
Item for Inspection	Condition			Corrective Action / Comments	Responsibility
	1	2	3	1 – Poor (immediate action) 2 – Good (actions required) 3 – Very good (no actions required	
Low priority zones		X		Some damage mainly consisting of potholes and patches	
Medium priority zones	X			Extensive damage consisting of potholes and patches	
High priority zones	X			Extensive damage consisting of potholes and patches	
Coal spillage	X			High particularly in high priority areas, near power plant	
LDP3					
Surface General	X			Work generally required	
Other/General Comments					

Completed inspections are to be filed by the Environmental Department and corrective action managed through the site Work Order system.

Note: Remember to look for the following when inspecting the haul road. These types of deformations would be likely to increase noise levels when vehicles pass over them.







Date Effective: Review as Required: