section 5.0

Environmental Assessment

5.0 Environmental Assessment

5.1 Environmental Risk Assessment

The DGRs for the EA required 'a risk assessment of the potential environmental impacts of the Project, identifying the key issues for further assessment'. This risk assessment was undertaken as part of the Preliminary EA (Umwelt, 2009). The process used and the assessment outcomes are discussed in this section. The methodology used for the environmental risk assessment was in accordance with Xstrata Coal Risk Management Standard 1.02, Environmental Assessments, which is aligned to the general principles outlined in Australian Standard AS/NZS 4360:2004 Risk Management (Standards Australia, 2004). The risk assessment was completed using the Xstrata risk assessment process, and the risk matrix, consequence table and likelihood table used for the assessment are included in **Appendix 4**.

Consistent with the Xstrata quantitative risk assessment matrix, environmental risks were categorised as low, medium or high. The majority of activities were rated as low or medium level risks, with limited high risks. The activities identified as key risks in the preliminary environmental risk assessment for the Project (note: this is the initial risk rating prior to detailed assessment with no project specific controls in place) were:

- disturbance of Aboriginal places or objects;
- loss of threatened native flora and fauna;
- degradation of noise amenity;
- surface and groundwater management, including impacts on creeks;
- emission of greenhouse gases; and
- subsidence related impacts.

These issues are all subject to detailed assessment in this section of the EA. The assessment clearly defines the impacts of the project relevant to these risks and identifies any residual risk. Appropriate management and mitigation measures are also identified for the management of residual risk, where appropriate.

The Preliminary EA which included the preliminary risk assessment was provided to DoP along with the Project Application in order to assist with developing the DGRs for the Project. The Preliminary EA was also provided to other relevant government agencies with whom DoP consulted regarding the DGRs. As detailed in **Section 3.3**, the DGRs identified the key EA issues for the Project as:

- subsidence;
- biodiversity;
- surface and groundwater;
- air quality;
- noise;
- greenhouse gases;

- heritage – both Aboriginal and non-Aboriginal;
- traffic and transport;
- visual;
- waste;
- social and economic; and
- rehabilitation.

The following sections provide a detailed assessment of these key issues.

5.2 Subsidence

The DGRs for the Project have identified subsidence as a key issue, requiring detailed assessment, including requiring:

- accurate predictions of the potential subsidence effects of the proposed mine plan, and a robust sensitivity analysis of these predictions; and
- a detailed assessment of the potential impacts of these subsidence effects on both the natural and built environment.

A comprehensive subsidence assessment has been completed for the WWCOP by Ditton Geotechnical Services Pty Ltd (DGS). A summary of the key findings of the assessment is provided below, with the full assessment report included in **Appendix 5A**.

An independent peer review of the DGS subsidence assessment has been completed by Mine Subsidence Engineering Consultants Pty Ltd (MSEC) to assess the adequacy of the assessment against the DGRs and to further validate the subsidence predictions. The MSEC report is included as **Appendix 5B**, and the findings of the review have been considered in the finalisation of the DGS report included in this document.

Subsidence monitoring at WWC has been undertaken for over 20 years. This long history of monitoring has provided a sound basis on which the current subsidence predictions have been developed. The monitoring data from the adjacent Northern domain provides a valuable insight into potential subsidence impacts in the continued underground mining area, due to the close proximity and overall similarity in geological and surface feature characteristics of the areas. This long term subsidence monitoring and the current approved SMP, which outlines not only subsidence predictions but also contingency, consultation, remediation and mitigation strategies, provide WWC with a strong foundation on which to develop the subsidence predictions for the Project.

WWC as part of the approved SMP for the Western domain, has established long term relationships and existing subsidence management plans with the respective surface feature stakeholders within the continued underground mining area. As the Project progresses, these management plans will be revised in consultation with the existing stakeholders to reflect the surface features within the continued underground mining area.

Similarly, WWC as part of the existing SMP and associated stakeholder management plans, has developed and implemented effective subsidence remediation strategies. These existing remediation strategies will be revised in consultation with the respective stakeholders as the

project progresses to address potential subsidence impacts within the continued underground mining area.

5.2.1 Subsidence Processes

Longwall mining is a form of underground coal mining where coal is removed from a selected mining horizon within the coal seam. The longwall panels at WWC range between approximately 1 and 3 kilometres long and are approximately 180 metres wide.

Longwall panels are mined sequentially with adjacent panels separated by a barrier of coal, referred to as chain pillars.

The underground roadways along one side of the longwall are referred to as the maingate; the underground roadways on the adjacent side are called the tailgate. These underground roads are developed by continuous miner units. The end of the longwall block that includes the longwall equipment is referred to as the longwall face. The collapsing void behind the longwall is called the goaf.

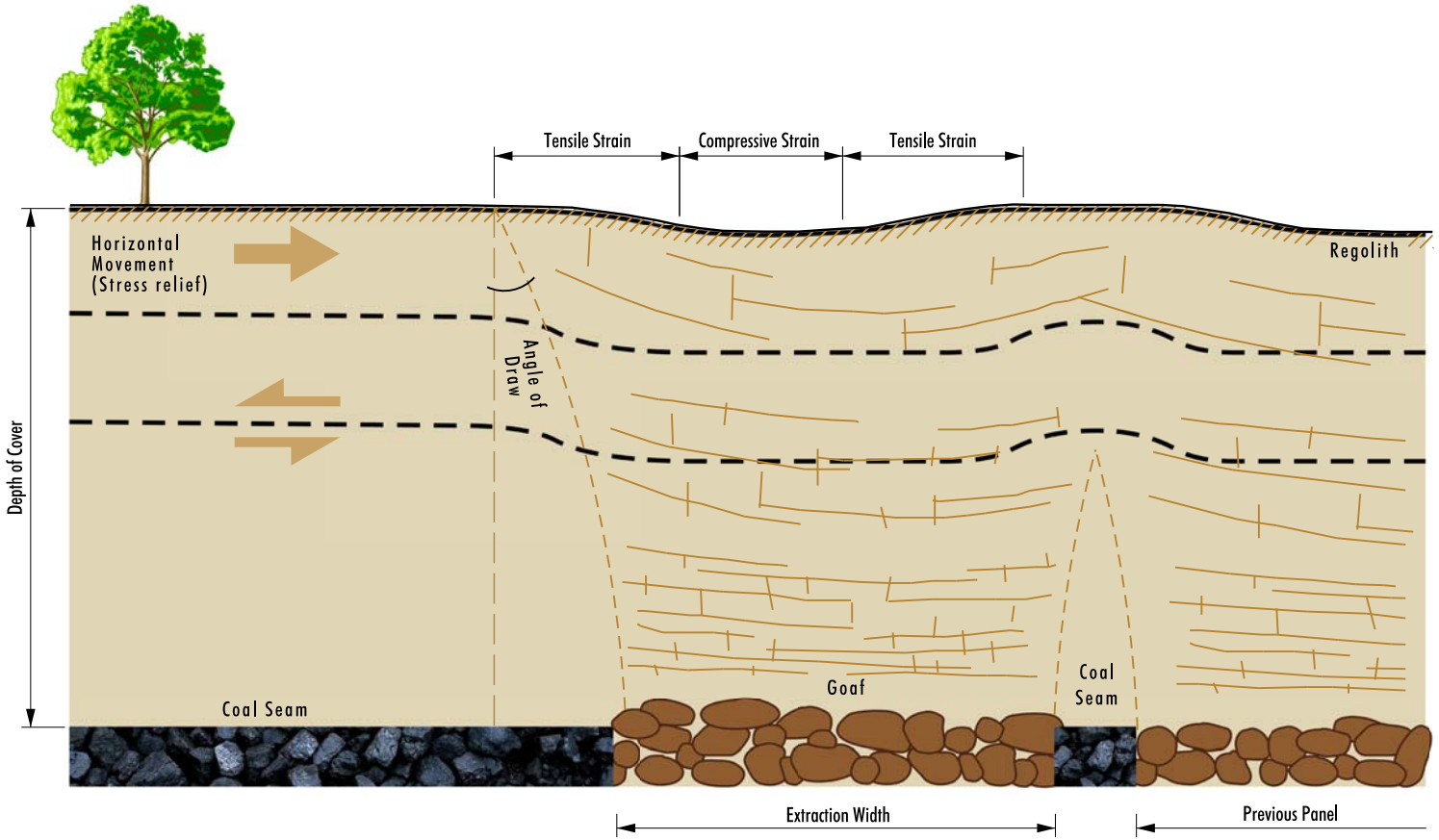
The longwall shearer is a machine that passes back and forth along the longwall face removing nominally 1 metre thick slices of coal during each pass. As the shearer removes the coal, the hydraulic roof supports advance forward into the newly created cavity. As mining progresses the area behind the face, i.e. the goaf, collapses causing the overlying rock to fracture and settle, this results in subsidence. This settlement progresses up through the overlying strata resulting in subsidence of the ground surface immediately above and surrounding the longwall panels. A diagrammatic representation of a typical subsidence profile is shown in **Figure 5.1**. It is important to note that direct connection between the surface and the underground workings has the highest potential to occur in areas of low depth of cover (i.e. <70 metres) to the seam. This connection, where it occurs is through a mosaic of fractures in the rock resulting from the subsidence.

The term ‘subsidence’ generally refers to the range of ground movements which result from mining operations. These movements are described by the following parameters:

- **subsidence** refers to the vertical and horizontal displacement of the ground;
- **tilt** is the change in the slope of the ground as a result of differential subsidence;
- **curvature** is the rate of change in tilt; and
- **strain** is the change in horizontal distance between two points on the ground. Tensile strains occur when the distance between two points increases and compressive strains occur when the distance between two points decreases.

The area of the Project predicted to be affected by subsidence due to mining is shown on **Figure 5.2**. The subsidence affectation zone for the Project has been defined by the following parameters:

- the conceptual mine plan;
- the area bounded by the 26.5 degree angle of draw (i.e. the angle of the line connecting the edge of the goaf and the limit of subsidence at the surface) (refer to **Figure 5.2**); and
- the predicted vertical limit of measurable subsidence, taken as the 20 millimetre subsidence contour.

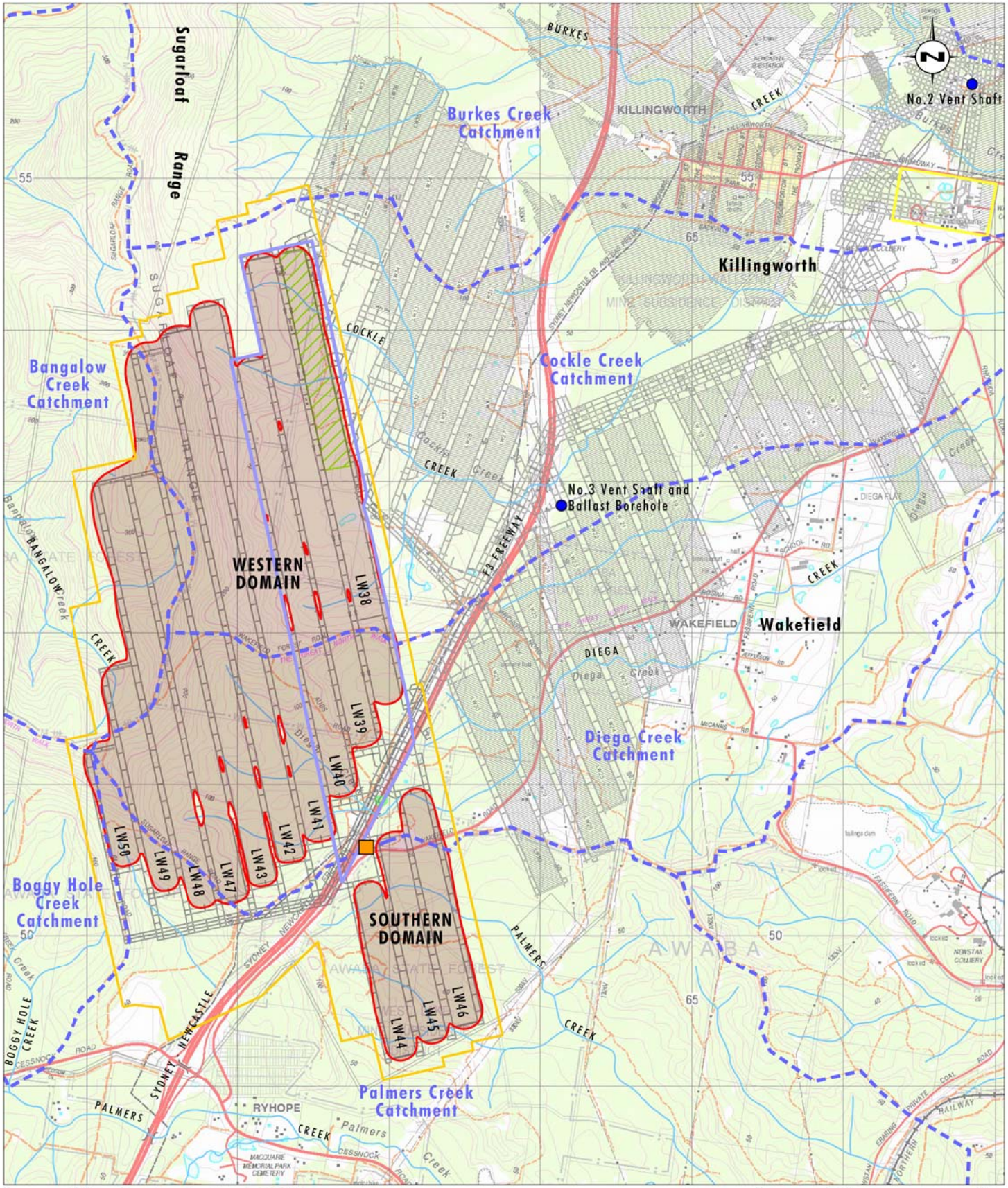


Cross-section of Subsidence Profile
(Not to Scale)

FIGURE 5.1

Typical Subsidence Profile

Note: Not to Scale
Source: SCT Operation PTY Limited, 2009
File Name (A4): R08_V1/2553_266.dgn



Source: OCAL, Department of Lands (2006)

0 0.5 1.0 2 km
1:35 000

Legend

- Existing West Wallsend Colliery Pit Top Facilities
- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Predicted Subsidence Affectation Zone
- Approved SMP Area
- Catchment Boundary
- Proposed Mining Services Facility
- Ventilation Shaft and Ballast Borehole
- Drainage Lines

FIGURE 5.2

Predicted Subsidence Affectation Zone within the Continued Underground Mining Area

File Name (A4): R08_V1/2553_267.dgn

The extent of subsidence depends on a number of factors including the width and height of the coal seam removed in a given longwall panel, the characteristics of the overlying rock strata and the depth of cover above mining operations. The vertical extent of subsidence is generally less than the thickness of coal removed due to the bulking effect of the collapsed strata.

Overburden depths for the Project are shown in **Table 5.1**.

Table 5.1 - Overburden Depths (metres) within the Continued Underground Mining Area

Typical Range	Minimum	Maximum
120-280	70	360

Figure 5.3 shows the range of depth of cover throughout the continued underground mining area. Modification to the mine plan has been undertaken to avoid areas of low depth of cover (i.e. <70 metres).

The predictions and impact assessment have been undertaken based on empirical modelling and comparison from previously recorded monitoring data in the context of the conceptual mine plan for the Project. As mining progresses, there will be ongoing refinement of the predictive model as a result of subsidence monitoring and comparison with predictions. The mine layout will also continue to be refined as the Project progresses resulting in changes to subsidence predictions. Any changes to the mine layout and subsidence predictions will be assessed as part of the SMP or other relevant process at that time.

5.2.2 Subsidence Prediction Methodology

Two empirically based prediction models (ACARP, 2003 and SPDS®) have been used by DGS to generate subsidence contours above the continued longwall mining area. Furthermore Surfer 8® software has then been used to generate subsidence predictions for tilt, horizontal displacement and strain contours above the panels from the SPDS® output files.

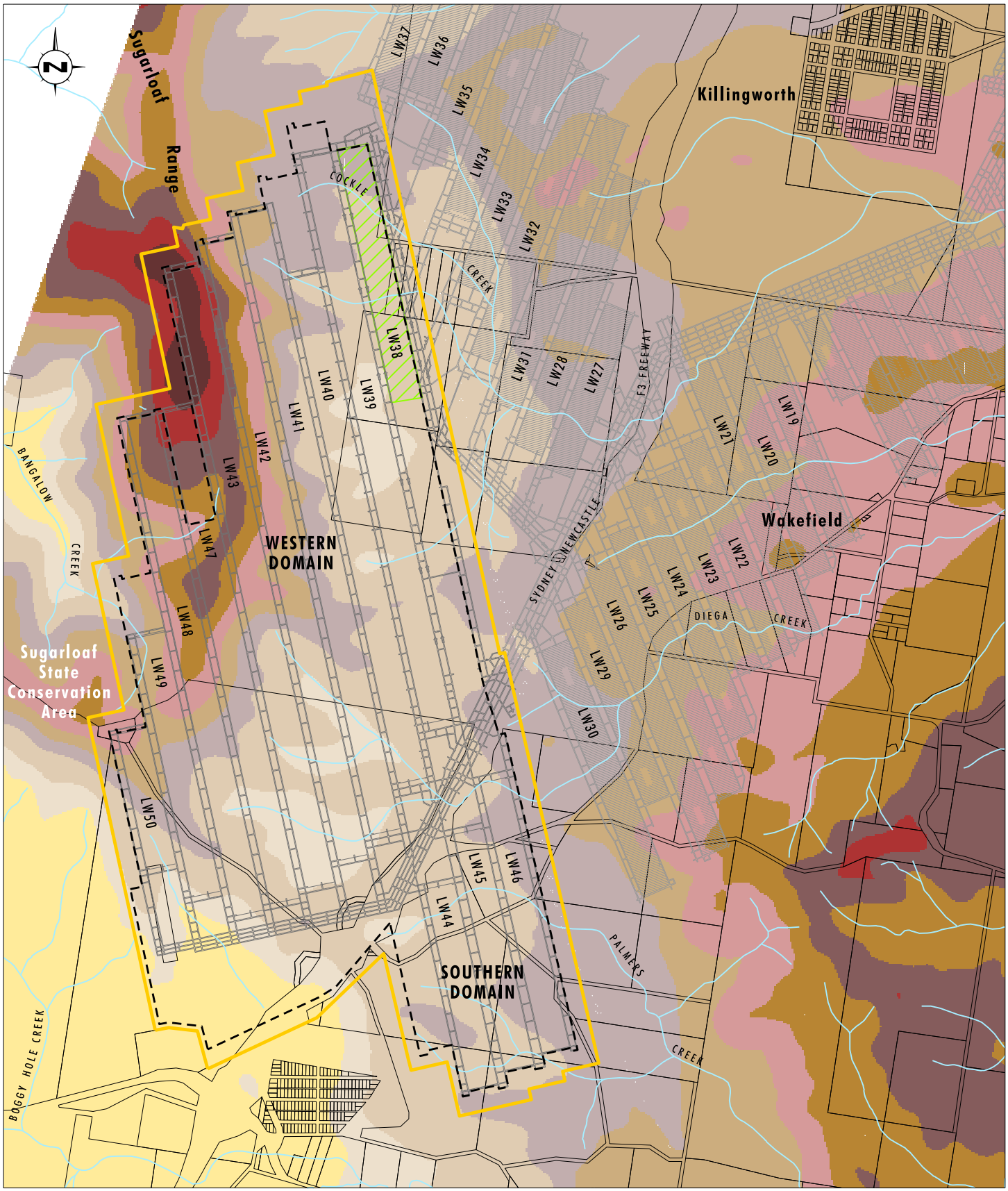
The assessment of impact on surface and subsurface features has also considered the predicted subsidence parameters and previous experience gained from detailed subsidence monitoring program undertaken in the previous 37 longwalls at WWC.

Specific details of the subsidence prediction models used in this assessment are included as part of **Appendix 5A**.

5.2.2.1 Subsidence Predictions

An overview of the subsidence predictions is discussed in the following section, and a detailed review of the predictions is included in the DGS report in **Appendix 5A**.

There are several massive sandstone channels and conglomerate units within the overburden which will have a subsidence reducing effect above a portion of the continued underground mining area and proposed panel geometries, due to their spanning and bulking properties. The Teralba Conglomerate Member is likely to reduce subsidence above the longwall panels beneath the ridges in the Western domain by approximately 50 per cent. This subsidence reducing affect has been observed and measured in the adjacent Northern domain longwalls.



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines

0 0.5 1.0 1.5km
1:30 000

Legend

- Existing West Wallsend Colliery Pit Top Facilities
- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Previously Approved Longwall Layout Boundary in Western and Southern Domains
- Drainage Line

Depth of Cover Range (m):

- 5 - 70
- 70 - 100
- 100- 145
- 145 - 180
- 180 - 215
- 215 - 250
- 250 - 285
- 285 - 320
- 320 - 355
- 355 - 390

FIGURE 5.3

Depth of Cover

File Name (A4): R08_V1/2553_297.dgn

The subsidence predictions for the Project have been developed based on the previous subsidence monitoring for WWC, in particular the Northern domain Longwalls 27, 28, 31-37, as shown in **Figure 5.2**.

The key subsidence impact parameter prediction results are presented below:

- maximum predicted panel subsidence after extracting multiple longwall blocks in the West Borehole Seam will range from 0.34 metre to 2.52 metre (9 per cent to 58 per cent of mining height);
- maximum predicted chain pillar subsidence after mining 3.3 to 4.8 metre high longwall panel faces will range from 0.12 metre to 1.0 metre above chain pillars;
- tilts are expected to vary widely over the panels due to the high cover depth range from 70 metre to 360 metre. Maximum panel tilts are estimated to range from 5 mm/m to 167 mm/m with concave and convex curvatures ranging from 0.24 to 6.6 km^{-1} (or radii of 4.2 kilometre to 0.15 kilometre);
- the maximum predicted tensile strains associated with the curvatures over the panels will range from 2 mm/m to 38 mm/m; and
- the maximum compressive strains associated with the continued longwalls will range from 2 mm/m to 38 mm/m.

Specific subsidence parameters including tilt and strain have been prepared for all surface features, both natural and man-made within the continued longwall mining area and are further detailed in **Section 5.2.3**.

5.2.3 Subsidence Impact Assessment

Subsidence impact assessment involves using subsidence predictions to forecast the level of impact on natural and man-made surface features within the subsidence affectation area. A comprehensive review of all natural features, archaeological sites and items of surface infrastructure potentially impacted by subsidence has been completed with detailed subsidence predictions and impact assessment provided for each aspect (refer to **Appendix 5A**).

Sections 5.1.3.1 to **5.2.3.19** provide a description of the subsidence impacts as expressed on the surface of the ground and the physical impact of such on the natural features, archaeological sites and surface infrastructure.

5.2.3.1 Surface Cracking

Potential Impacts

The development of surface cracking above a longwall panel is caused by the bending of the overburden strata as it sags down into the newly created void in the coal seam as the longwall is extracted. The sagging strata is supported by collapsed roof material (goaf) that slowly compresses to final maximum subsidence. The characteristics of the overburden, and vertical stress acting on the goaf, will influence the final maximum subsidence magnitude.

Based on the predicted range of maximum transverse tensile strains from 2 to 38 mm/m for cover depths of 360 metre to 70 metre, maximum surface cracking widths of between 10 millimetres and 380 millimetres may potentially occur within the limits of extraction for the continued underground mining area.

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 rock in the base of gullies or man-made cuttings on constructed roads.

Tensile cracks up to 20 or 30 metres behind the advancing longwall face may also potentially occur. The majority of these cracks are likely to range between 10 millimetres and 50 millimetres wide and will generally close in the central, compressive strain areas of the longwall panels after the subsidence trough has fully developed.

Surface cracking has the potential to impact upon a range of surface features, both natural and built. The main infrastructure items which are expected to be impacted by surface cracking are surface access tracks and fire trails. Surface cracking on these tracks and trails is expected to be minor, and as detailed above will generally close after the subsidence trough has fully developed. During mining, daily inspections of all surface access tracks and fire trails will be undertaken to identify potential surface cracking that may pose a public safety risk (refer to **Section 5.2.4**). The proposed subsidence remediation strategies to address potential surface cracking impacts are discussed further in **Section 5.2.4**.

The potential for direct hydraulic connection to the surface, due to sub-surface fracturing, is considered possible between 70 metres and 100 metres depth of cover. However direct connection to the surface is unlikely to occur where cover depths are greater than 100 metres. As shown on **Figure 5.3**, the low depth of cover areas (70-100 metres) are located in discrete areas in the mining area and are often associated with drainage lines. The potential impacts of direct hydraulic connection and related surface cracking has the potential to impact upon both surface water and ecological features. These areas have been subject to detailed investigation and the proposed management of these potential impacts are further discussed in **Sections 5.3.3** and **5.5.3** respectively.

5.2.3.2 Sub-Surface Cracking

The caving and subsidence development processes above a longwall panel typically results in sub-surface fracturing and shearing of sedimentary strata in the overburden (refer to **Figure 5.1**). The extent of fracturing and shearing is dependent on mining geometry and overburden geology.

Overburden can be divided into essentially four zones of surface and subsurface fracturing. The zones are generally defined (in descending order) as:

- Surface Zone;
- Continuous or Constrained Zone;
- Fractured Zone; and
- Caved Zone.

Two empirically-based models (Forster, 1995 and ACARP, 2003) have been used in this study to predict the heights of sub-surface fracturing within the continued underground mining area.

A detailed review of sub-surface fracturing heights is included in **Appendix 5A** DGS Report and generally indicates that sub-surface fracturing could develop to within 10 metres from the surface, and is the depth where interaction with surface cracking may start to occur.

5.2.3.3 Slope Stability

The continued underground mining area in the Western domain contains areas of steep slopes (15 to 30 degrees). The steep slopes are associated with the main Sugarloaf Range and the associated ridge spurs, predominantly across Longwalls 39 to 48, as shown in **Figure 5.4**.

Figure 5.4 shows that there are several low height cliffs (classified as >45 degrees) ranging from 2 metres to 15 metres in height. These cliffs are predominantly located on the north-easterly facing ridges of the main Sugarloaf Range. Evidence of fallen boulders and large trees was also observed in these steep areas.

The potential impacts on the cliff lines and steep slopes due to mine subsidence are outlined below:

- general slope instability (translational/rotational sliding) of cliff lines and steep slopes;
- local instability of cliff lines and steep slopes due to cracking, toppling failures and erosion; and
- rock fall movements from cliff lines and down slopes from cliffs and steep slopes.

The above impacts also occur due to natural weathering processes, however these effects may be accelerated by mine subsidence.

It is considered that the stability of cliff lines and steep slopes will be dependent on the following factors:

- existing slope magnitude and change in gradient due to tilt;
- orientation and depth of cracking due to tensile strain;
- presence of water in and on-going erosion of cracks;
- depth of soil cover;
- stabilising effect of vegetation; and
- the limited access for surface inspections and crack repair works (i.e. due to the relative inaccessibility of some areas, accessing cracked areas to remediate them would result in more impact than leaving them to repair through natural processes).

It is considered that the potential for steep soil slope failure after mining would be 'High' for the predicted tilts, strains and cracks but may be reduced to 'Medium' potential overall, due to the high density of vegetation within the continued underground mining area. The consequence of a slope failure is likely to be localised and unlikely to impact on slope aesthetics or public safety. Management of these potential impacts is discussed further in **Section 5.2.4** and involves monitoring and remediation of areas of potential instability where appropriate.

5.2.3.4 Valley Closure and Uplift

Closure and uplift movements can potentially occur where longwalls are mined beneath valley crests and also along broader drainage gullies and man-made cuttings. Previous monitoring of closure and uplift, within the previous Northern domain underground mining area, has not been conclusive and has shown measured movements similar to those related to survey accuracy and natural ground movement (i.e. +/- 20mm)

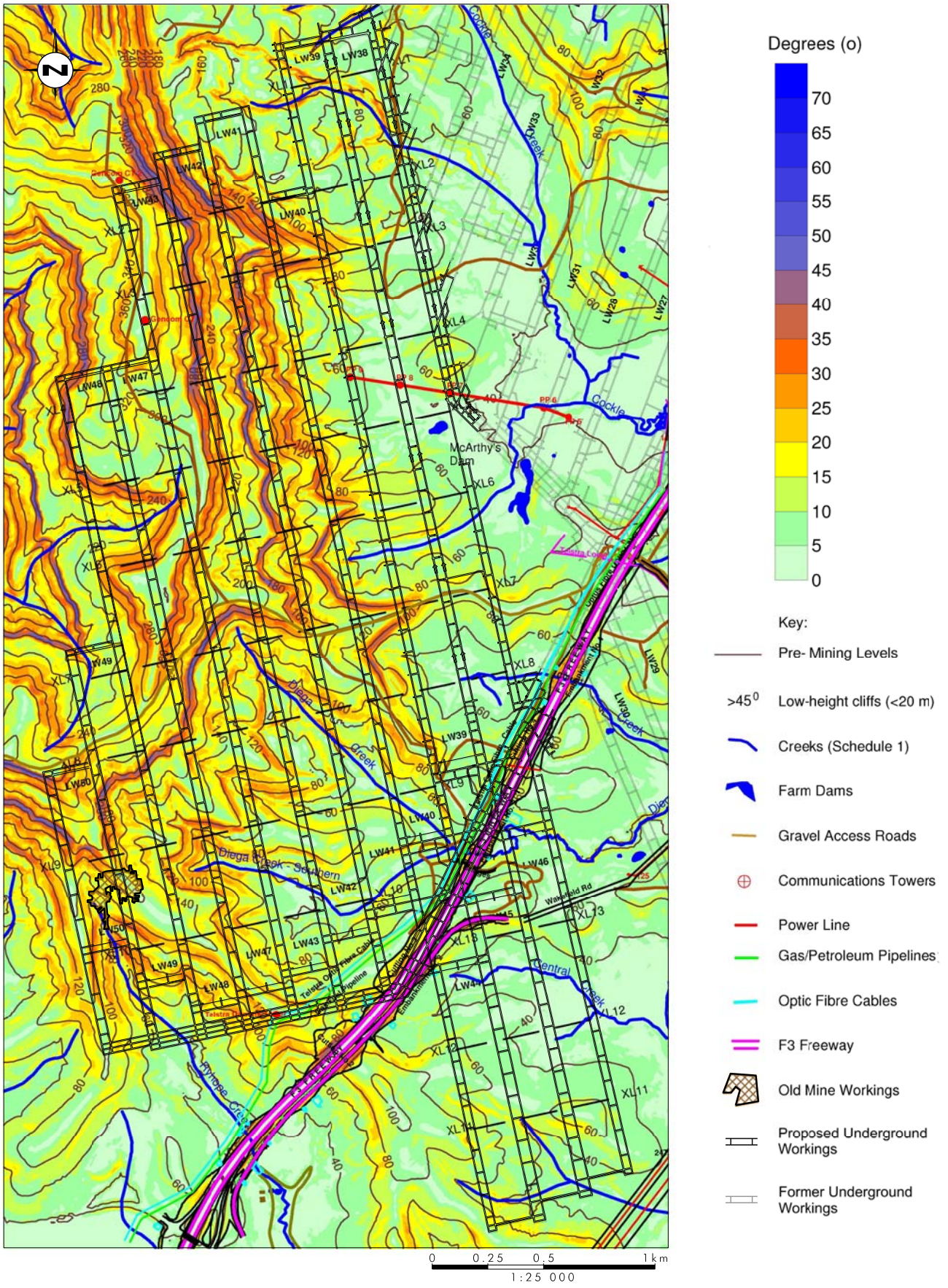


FIGURE 5.4

Pre-mining Surface Slopes
Continued Underground Mining Area

Source: Ditton Geotechnical Services Pty Ltd, 2009

File Name (A4): R08_V1/2553_268.dgn

Potential impacts for closure and uplift relate mainly to ephemeral creeks and the F3 Freeway, however if 'closure' and 'upsidence' does occur, it is unlikely to be greater than 230 millimetres and would therefore not be expected to cause more than minor cracking of the near surface rocks.

The development of upsidence cracking may also cause localised deviation of surface flows in rocky, ephemeral creek beds. Should this occur, surface flows would be expected to re-surface downstream of the impacted area. This cracking, due to the highly mobile nature of bedload sediments within the drainage lines would be expected to seal from the natural inflow and movement of sediment. It is noted that drainage lines above the continued underground mining area are limited to ephemeral first and second order drainage lines.

5.2.3.5 Ponding

Ponding refers to the potential for depressions to develop or for the increase in depth of existing depressions, at the surface above longwall panels. These depressions lead to ponding of surface water and can affect drainage patterns and subsequently flora, fauna and groundwater dependent ecosystems.

Ponding locations are generally expected to occur along the creeks and tributaries above the proposed longwall panels with gentle slopes and low-lying areas, as shown in **Figure 5.5**. No out-of-channel ponding is predicted within the continued underground mining area. The actual ponding depths will depend upon several other factors, such as rain duration, volume of bedload sediments, surface cracking and effective percolation and evapo-transpiration rates.

The predicted ponding depths within the continued underground mining area are detailed within **Appendix 5A**. Pre-mining surface contours provide an indication that some of the potential ponding locations are pre-existing depressions. From the assessments completed, ponding across the continued underground mining area increases from 7 hectares to 11 hectares in a total mining area of 1085 hectares.

The main potential impact from ponding is the potential impact upon flora and fauna within the ephemeral drainage lines. A specific assessment of the potential impacts from ponding is included in **Section 5.3**.

The proposed mitigation strategies to address the potential impacts of increased ponding are discussed in further detail in **Section 5.2.4** and are based on the existing monitoring strategies which are employed for the existing underground mining operations.

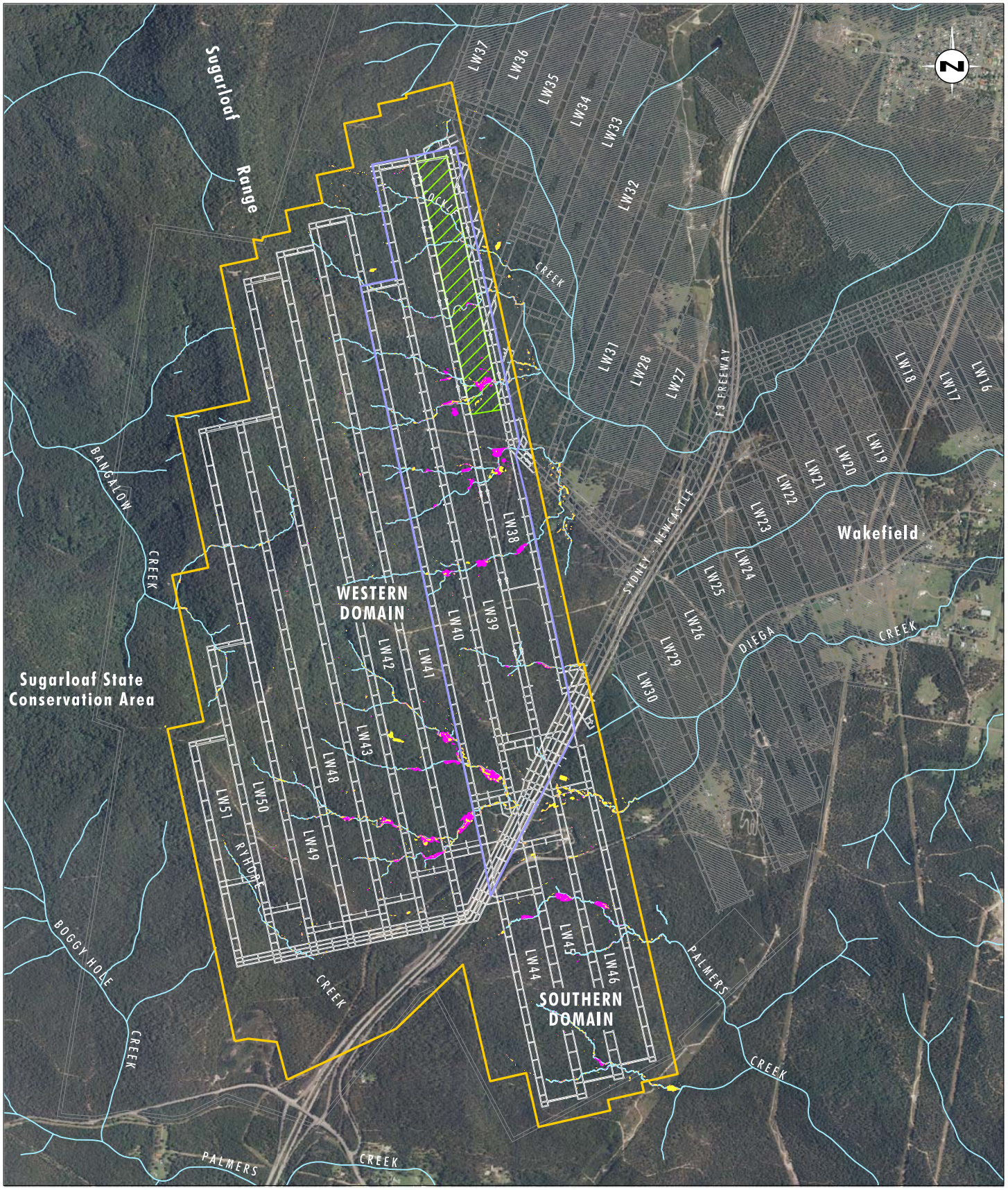
5.2.3.6 Aboriginal Archaeological Sites

Impact Potential Criteria

Subsidence predictions have been developed for the range of Aboriginal archaeological sites identified within the continued underground mining area, these predictions are provided in further detail in **Appendix 5A**. Each site has been ranked in accordance with its potential for both cracking and potential erosion damage, from very low to high potential for impact.

A brief overview of the potential impacts is discussed below. For a full review of the Aboriginal archaeological sites, their significance, the potential subsidence impacts and the potential management strategies, refer to **Section 5.9** of this EA.

Significant changes to the conceptual mine plan have been employed to protect and promote Aboriginal archaeology and cultural heritage values. These changes, which have involved



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - DEC AHIMS

0 0.5 1.0 1.5km
1:30 000

Legend

- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Approved SMP Area
- Drainage Line
- Pre-mining Ponding
- Post-mining Ponding

FIGURE 5.5

Potential Ponding within the Continued Underground Mining Area

the sterilisation of approximately 4.4 million tonnes of coal resource, have been based on extensive consultation with the registered Aboriginal stakeholders.

Potential Subsidence Impacts to Grinding Groove Sites

There are a total of eighteen axe grinding groove sites located within the continued longwall mining area, with fifteen located within the Awabakal Local Aboriginal Land Council (ALALC) boundary and three located in the Koompahtoo Local Aboriginal Land Council (KLALC) boundary, as shown in **Figure 5.6**.

Significant modifications have been made to the conceptual mine plan to protect three grinding grooves in the Southern domain. These changes have been undertaken based on the feedback on the cultural significance of these sites from the Aboriginal stakeholders. Following the modifications to the mine plan these particular grinding grooves are now ranked as very low to low, in respect of potential for cracking.

All other grinding grooves sites however are ranked Moderate to High for cracking potential.

The Erosion Potential for grinding grooves ranges from 'Very Low' to 'Moderate'.

The assessment and management of these impacts and potential offsets are discussed further in **Section 5.9**.

Potential Subsidence Impacts to Stone Arch, Stone Arrangements and Shelter Sites

A stone arch (site # 43), located above the starting position of Longwall 49, has been identified by the Aboriginal stakeholders as a feature of high Aboriginal cultural significance. The stone arch is a sandstone feature, approximately 4.8 metres high (above the creek bed) and has a span of 8.8 metres (refer to **Plate 5.1**).

The stone arrangement (site # 44) is located to the north of the starting positions of Longwalls 41 and 42. This stone arrangement was also identified as of high Aboriginal cultural significance and is closely associated to the nearby Wet Soak, above Longwall 40, according to feedback from the Aboriginal stakeholders.

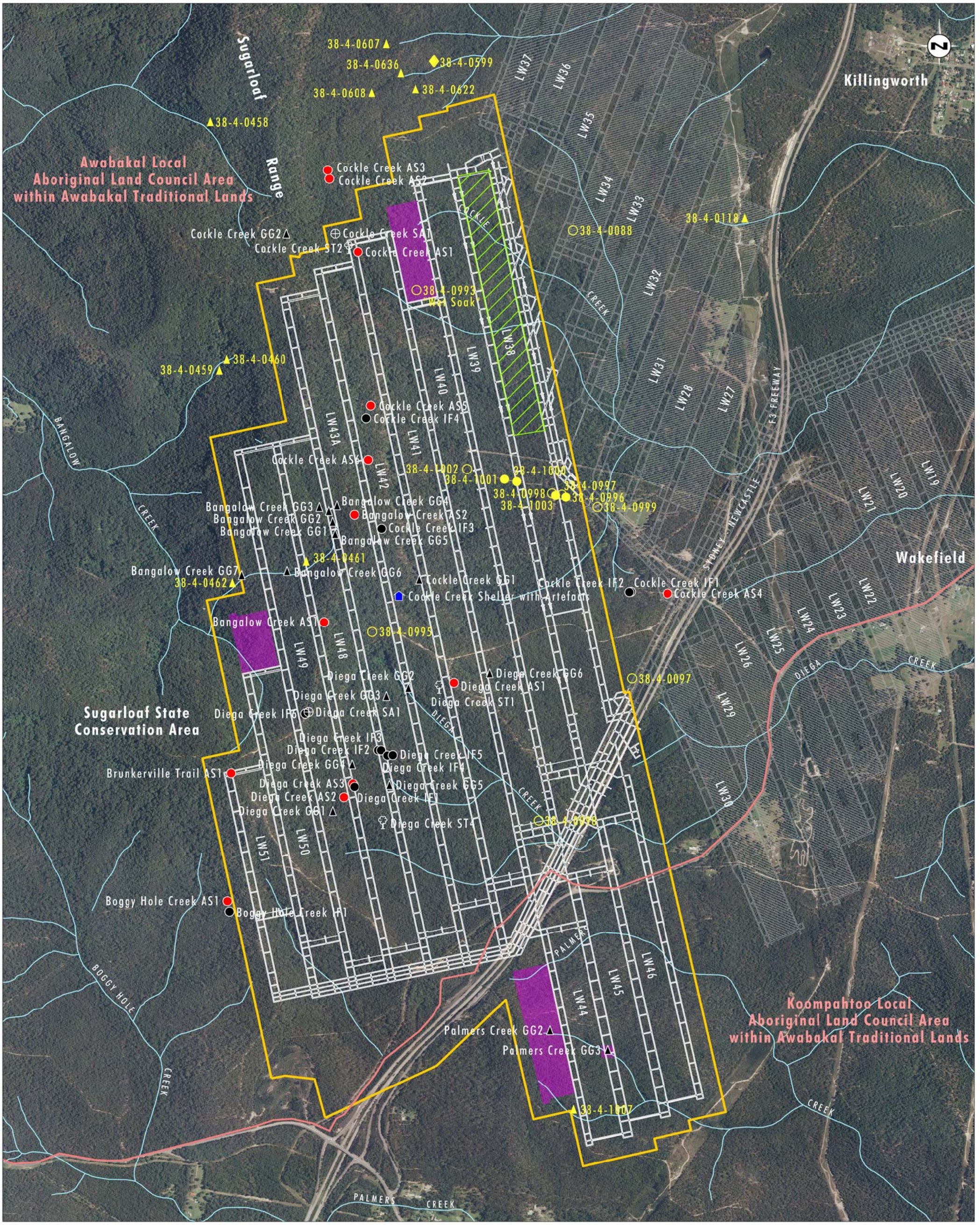
A number of rockshelters (site # 45 – 47) were located in cliff faces and under free standing scree boulders within the continued underground mining area (refer to **Plate 5.2**). The shelters were inspected during the field survey, however, only one shelter containing artefactual material was recorded as an Aboriginal archaeological site.

Significant changes have been made to the proposed mine plan to protect the sites referred to as natural features including the stone arch (site # 43) and the stone arrangement (site # 44), consequently the subsidence predictions list the cracking potential for these sites as Very Low, with no adverse impact expected.

The other sites including the rockshelter, second stone arrangement and stone cairns (site # 43 - 47) are within the subsidence affectation area and are assessed to have a 'Low' to 'Moderate' cracking potential.

The erosion potential for these sites ranges from 'Very Low' to 'Low'.

An assessment of the predicted impact to these sites and the proposed management strategies for these sites are further discussed in **Section 5.9**.



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines

0 0.25 0.5 1km
1:20 000

Legend

- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- LALC Boundary
- Drainage Line
- Revised Layout for Archaeology

- Artefact Scatter
- Isolated Find
- Axe Grinding Groove
- Shelter with Deposit
- Stone Arrangement
- Scarred Tree

Previously Recorded Artefacts

- Artefact Scatter
- Isolated Find
- Axe Grinding Groove
- Art
- Axe Grinding Groove with possible Art

FIGURE 5.6

Aboriginal Site Locations

PLATE 5.1
Site No.43 - Stone Arch

PLATE 5.2
Cockle Creek rock shelter wtih artefacts and PAD within the Continued Underground Mining Area

Potential Impacts to the Wet Soak Site

The 'Wet Soak' (site # 63) is a natural depression that is located north of the starting position of Longwall 40, as shown in **Figure 5.6**. The wet soak is located on the upper slopes of a ridge crest, and is approximately 40 metres long and 30 metres wide, with an embankment of approximately 1 metre on the eastern face. The site periodically holds water after rainfall and contains hydrophilic grass species. The site was originally identified during Aboriginal archaeological surveys for previous mining approvals for WWC. The site has been identified by the Aboriginal stakeholders as being of high Aboriginal cultural significance.

Based upon feedback received during the consultation process on the high cultural significance of the Wet Soak, significant modifications to the mine plan have been employed to protect the site.

Based on the subsidence predictions, it is assessed that the modifications to the proposed longwalls for the Wet Soak should provide adequate protection for the site (i.e. 'Very Low' cracking potential).

The Erosion Potential at the Wet Soak is also assessed as 'Very Low' (i.e. <0.3 per cent gradient increase).

Potential Impacts to Artefact Scatters, Isolated Finds and Scarred Trees

Numerous artefact scatters and isolated finds were identified during the Aboriginal archaeological survey (refer to **Figure 5.6**). Ten scarred trees were also identified as part of the survey. Details of the significance of these sites are provided in **Section 5.9**.

Based on the predictions it is concluded that the artefact scatters, isolated finds and scarred tree sites are unlikely to be adversely affected by surface cracking and increased erosion, due to the predicted tilts and strains. The main potential for impact to these sites is related to conducting subsidence remediation works.

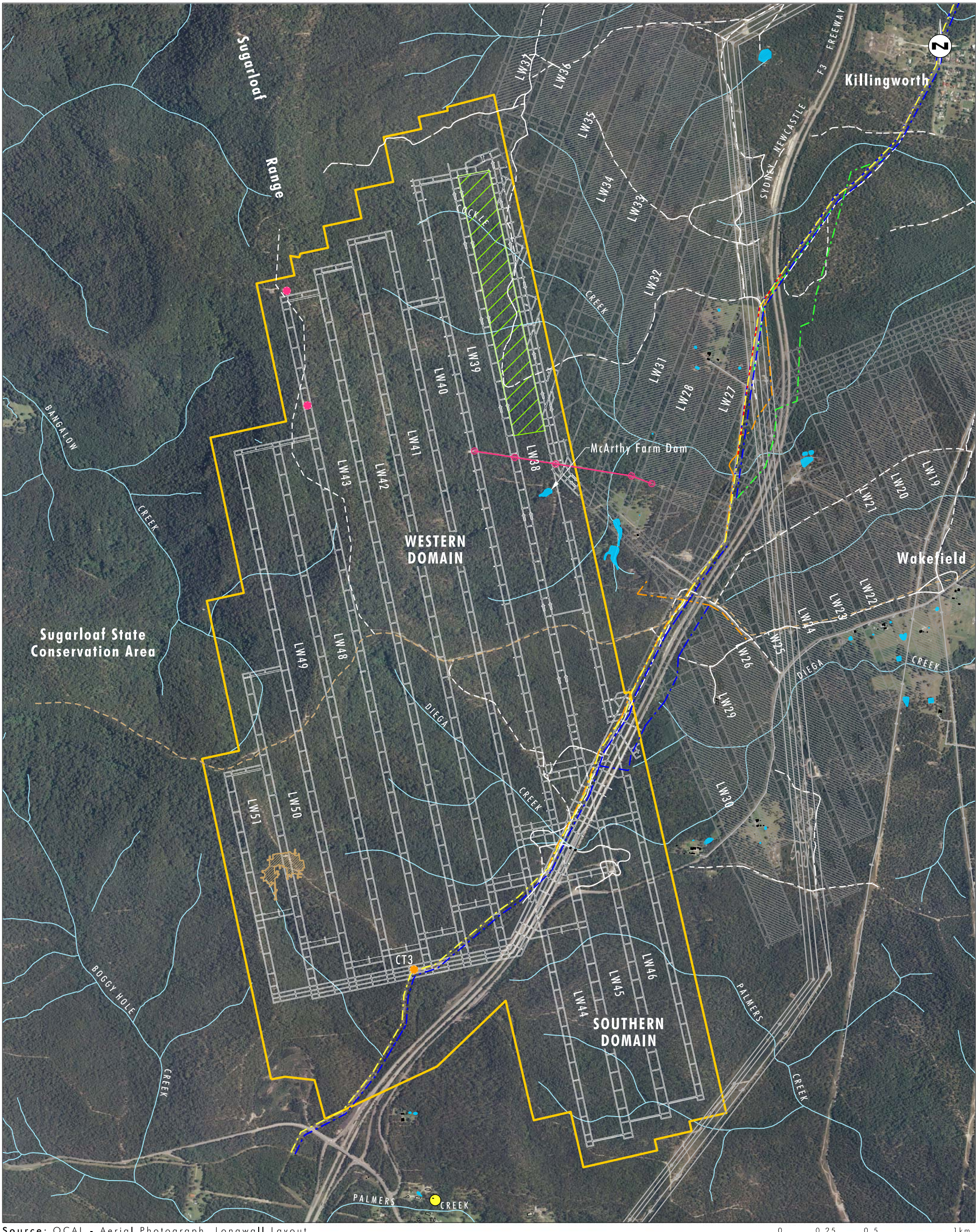
The management of these sites is further discussed in **Section 5.9**.

5.2.3.7 Gencom Communications Towers and the Proposed Power line

The two Gencom communications towers, referred to as CT1 and CT2, are located on the crest of the Sugarloaf range, ranging from 340 metres to 360 metres depth of cover respectively (refer to **Figure 5.7**). CT1 is a steel framed structure, 30 metres in height and approximately 2.5 metres wide at the slab base, as shown in **Plate 5.3**. CT2 is 60 metres in height and approximately 10 metres wide at the base, which is piered, as shown in **Plate 5.4**.

The subsidence predictions for CT1 are for 0.32 metres of subsidence, with tilts of 5 mm/m and strains of 2 mm/m, which may result in surface cracking up to 20 millimetres. CT2 is predicted to be subsided by 0.05 metres, with tilt of 2 mm/m and strains of 0.5 mm/m, which may result in surface cracks of up to 2 millimetres.

Associated to the Gencom communication towers is a proposed power line, as shown in **Figure 5.7**. Currently the powerline itself has not been constructed however some of the power poles have been installed. Through extensive consultation with Gencom, the power poles have been strategically located so as to place some of the poles on the chain pillars. This has reduced the potential subsidence impacts, with predictions for the poles ranging from 0.06 to 0.13 metres of subsidence, tilts of +/- 2 to 6 mm/m and strains of 1.5 to 5.5 mm/m.



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines

0 0.25 0.5 1km
1:20 000

Legend

- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Drainage Line
- Previous Bord and Pillar Workings
- Tracks
- Nextgen Cable
- Optus Cable
- Telstra Cable
- Telstra Optic Fibre
- Telstra Easement
- Power Lines
- Great North Walk
- Gencom Powerline
- High Pressure natural Gas Pipeline
- Bore Water
- Telstra Communication Tower
- Gencom Communication Tower

FIGURE 5.7

Existing Utility Locations and Surface Features within Continued Underground Mining Areas

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PLATE 5.3
Gencom Communications Tower (CT1)

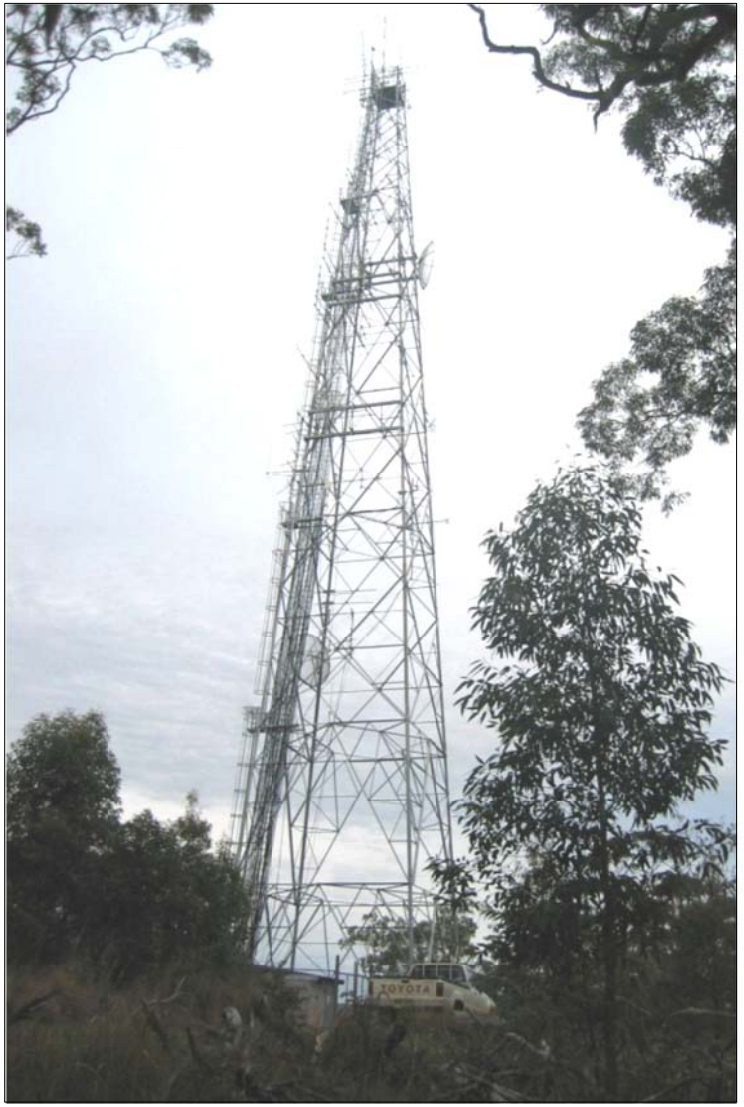


PLATE 5.4
Gencom Communications Tower (CT2)

Consultation with Gencom and WWC's experience with previously undermined TransGrid towers indicate that successful management of impacts of Gencom assets can be undertaken through a combination of techniques including mitigation, monitoring and remediation. The proposed management of the communication towers and associated powerline is discussed in detail in **Section 5.2.4**.

5.2.3.8 Great North Walk

The Great North Walk (GNW) is a 250 kilometre bush walking track, constructed in 1988, linking Sydney city with the Hunter Valley and Newcastle. The GNW, which is essentially an unsealed fire trail in the continued underground mining area, will be undermined by Longwalls 38 to 50 within the Western domain, as shown in **Figure 5.7**.

Based on the predictions for maximum tensile and compressive strain, the worst case surface crack width is estimated to range between 30 millimetres and 140 millimetres across the GNW.

Approximately 30 to 50 metres of the GNW above each of the longwalls may require remediation to tensile cracking in the order of 30 millimetres to 140 millimetres at any one time. Potential also exists for instability of steep slopes and any isolated boulders that exist along the reach of the GNW. The existing management plan focuses on public safety and has been developed in consultation with the Land and Property Management Authority (LPMA) for the GNW addresses these potential impacts, including inspections and subsidence remediation works. Further discussion of the proposed management of these potential impacts is discussed further in **Section 5.2.4**.

5.2.3.9 Wakefield Road

Wakefield Road is a sealed road, owned and maintained by LMCC that is located above the Southern domain Longwalls 45 and 46. The cover depths in this location range from 120 metres to 150 metres.

Wakefield Road has been undermined previously by several WWC longwalls. On these previous occasions the subsidence impacts were managed effectively in conjunction with LMCC and the MSB. Traffic controls will be implemented during subsidence of the road and until remediation works have been completed to appropriately manage road safety.

The road is expected to be exposed to subsidence in the order of 1.76 metres, with strains ranging from -3 mm/m to -11 mm/m and tilts of 24 mm/m to 34 mm/m and surface cracking of between 60 millimetres and 90 millimetres.

Part of Wakefield Road within the continued underground mining area includes an embankment to the south of Longwall 45. This embankment is outside of the 20 millimetres subsidence contour and therefore not expected to be adversely impacted by subsidence. As with previously undermined sections of Wakefield Road, it is proposed to develop a management plan with the relevant stakeholders which provides for a safe, serviceable and repairable public asset. This process has been implemented successfully for previous underground mining beneath Wakefield Road. The proposed management of subsidence impacts on Wakefield Road is further discussed in **Section 5.2.4**.

5.2.3.10 Abandoned Bord and Pillar Workings

An area of old abandoned bord and pillar mine workings, dating back to the 1880s, exists in the area above Longwalls 49 and 50 in the Western domain. The details and information available for these workings indicate they have been carried out in the Great Northern seam,

with approximately 130 metres depth of interburden to the proposed WWC workings. Evidence of the mine workings identified during site inspections were several pieces of rail infrastructure observed at the seam outcrop.

Subsidence predictions for the longwall panels above the abandoned workings are for maximum subsidence of 0.35 metres to 1.56 metres, with tilts of 23 millimetres to 28 millimetres and strains of -9 mm/m to -7 mm/m. Despite a lack of sensitive surface features in the vicinity of the old workings, there is potential for reactivation of these old workings and therefore the potential for increased subsidence impacts which has also been assessed and is detailed in **Appendix 5A**.

The proposed management of the abandoned workings is further discussed in **Section 5.2.4**.

5.2.3.11 Property Fences

Several post and wire fences exist within the continued underground mining area, mainly related to the private properties in the area. These fences would typically be exposed to curvatures and strains in excess of 0.2 km^{-1} and 2 mm/m respectively.

Impacts to these fences may include tilting of posts, distortion of gates and breakage of wires. The proposed management of the subsidence impacts on fences is further discussed in **Section 5.2.4**.

5.2.3.12 Ephemeral Creeks, Tributaries and Alluvium

The main drainage systems within the continued underground mining area are those of the upper reaches Cockle, Diega, Ryhope, Central and Palmers Creeks, all draining to Lake Macquarie. On the western side of the Sugarloaf range, a small section of Bangalow Creek, which drains to Wallis Creek, will also be undermined.

Each of these drainage systems is described in detail in **Section 5.5**.

The drainage systems within the continued underground mining area are ephemeral in nature, flowing only during rainfall events. The drainage systems are typified by existing bed and bank erosion, primarily related to the high velocity of flows from the nearby Sugarloaf Range, the dispersive nature of the bed and bank materials, and the limited existence of stabilising bed controls within the drainage lines.

The potential subsidence impacts on the drainage systems are discussed below:

- the main potential for impact in the drainage systems is related to surface cracking. The dimensions of potential surface cracking vary across the drainage systems. Cracks that do occur within the drainage lines may potentially result in the re-routing of surface flows during rainfall events. Such re-routing is not predicted to result in loss of water from the creek. Any re-routed water is expected to surface further downstream. As per previous experience at WWC in the Northern domain underground mining area, the high level of bed load within the drainage lines is expected to result in self healing of the surface cracks;

- the potential for increased erosion rates may also occur as a result of subsidence impacts, mainly due to the differences in bed level gradients associated with the chain pillars. The rates of erosion would be expected to reach a new equilibrium after several storm events have occurred; and

- some in-channel surface water ponding may occur in sections of the creek channels as a result of subsidence impacts in the continued underground mining. The creek profiles

indicate, however, that it is unlikely that any out-of-channel ponding will occur, due to the presence of relatively steep gradients. As the slope of the land surrounding the channels is relatively steep, it is envisaged that if any out-of channel ponding does occur, flow will be directed back to the creek system by the existing landform causing no significant impact.

Significant modifications to the mine plan have been undertaken to reduce the potential impacts to the Palmers Creek drainage system and associated alluvium, with no longwall mining proposed to be undertaken below 70 metres depth of cover. Modifications have also been made to the mine plan to reduce the potential for surface water impacts in low depth of cover areas in the proximity of Ryhope Creek (refer to **Figure 2.5**).

The proposed management of subsidence impacts on the drainage systems will be developed based on the existing management strategies which have been successfully employed by WWC for managing similar impacts in previously mined areas. The proposed management strategies for the creek systems within the continued underground mining areas are discussed in **Section 5.2.4**.

5.2.3.13 Caltex/Jemena Petroleum and Natural Gas Pipelines

The Jemena high pressure natural gas pipeline and Caltex liquid petroleum pipeline are located adjacent and parallel to the western side of the F3 Freeway within the services easement in the Western domain, as shown in **Figure 5.7**.

The services easement is one of the most significant and sensitive surface features within the continued underground mining area. The overall mine layout for WWC has been designed to minimise subsidence impact on the services easement and the F3 Freeway. The main development headings and long term stable pillars of coal at WWC have been strategically located under these features so as to reduce the potential for adverse subsidence impacts.

The services easement has been previously undermined by WWC with no adverse subsidence impacts. The proposed longwalls in the Western domain are located between 80 metres and 100 metres to the west of the easement and have been positioned outside the angle of draw limits. The depth of cover for the services easement ranges from 50 metres to 140 metres, however, longwall extraction will not occur under the service easement as part of this Project. The potential for subsidence impact is therefore predicted to be negligible.

Due to the sensitivity of the easement a specific subsidence monitoring program will be undertaken to assess potential subsidence impacts, as outlined in **Section 5.2.4**.

5.2.3.14 Telstra/Nextgen/Optus Optic Fibre Cables

Three fibre optic cables (FOCs) owned and operated by Telstra, Optus and Nextgen are located within the services easement 10 metres to 20 metres east of the high pressure gas pipelines. The FOCs are currently buried in shallow depth trenches. Similarly to the gas and oil pipelines, the FOCs are known to be extremely sensitive to movements, as movement has the potential to impact upon the strength of signal along the cable.

The FOCs are located outside of the angle of draw from the proposed longwall mining. The potential for subsidence impact is therefore predicted to be negligible.

Due to the sensitivity of the FOCs, a subsidence monitoring program is outlined in **Section 5.2.4**.

5.2.3.15 F3 Freeway

The F3 Freeway, as shown in **Figure 5.7**, along with the associated services easement, has formed the most significant built surface feature within the continued underground mining area for WWC. Previous mining activities in Longwall 28 have resulted in cracking in areas of the F3 Freeway. As a result of this incident, changes to the mine plan were made to reduce the potential for adverse subsidence impacts on the F3 Freeway. The continued underground mining area has been designed so as to minimise the potential for subsidence impact, with the main development headings positioned beneath the Freeway. The pillars of coal between the main development headings have been designed to be long-term stable and are therefore not predicted to result in subsidence. A significant barrier of coal has also been retained between the F3 Freeway and the proposed longwalls in the Western and Southern domains.

The proposed longwalls are strategically located so that the F3 Freeway is positioned outside the angle of draw and is therefore outside the predicted subsidence affectation area.

The potential for far field movements has been considered and is expected to be 'negligible'. Due to the sensitivity of the F3 Freeway a proposed specific subsidence monitoring program is discussed in **Section 5.2.4**.

5.2.3.16 Telstra Communications Tower

A Telstra mobile network services tower (CT 3) is located on the crest of a hill and approximately 146 metres south of the finishing point of Longwall 47, as shown in **Figure 5.7**. The cover depth at the tower is 135 metres and the angle of draw to the tower is 50^{o}. Whilst is assessed that the tower is likely to be outside the measureable limits of vertical subsidence it may be susceptible to far field movements.

Based on previous monitoring of far field movements in the area, the potential impact to the tower is expected to be negligible.

5.2.3.17 TransGrid Transmission Towers

A number of 330 kV TransGrid Towers exist to the south of the continued underground mining area, approximately 250 metres to 460 metres away. These towers are well outside the angle of draw and have had cruciform footings already fitted and are unlikely to be impacted by the proposed longwalls.

5.2.3.18 State Survey Marks

Several state survey control marks have the potential to be affected by mine subsidence from the proposed longwall mining. LPMA will be notified following the undermining of survey marks within the continued underground mining area.

5.2.4 Subsidence Management Strategies and Proposed Subsidence Monitoring Program

5.2.4.1 Proposed Subsidence Management Strategies

Table 5.2 provides an outline of the proposed subsidence management strategies relating to the natural and built features within the continued underground mining area.

In the majority of cases the proposed subsidence management strategies are based on the existing subsidence management strategies that are currently employed by WWC in

consultation with the respective stakeholders. These management strategies have been progressively refined over the approximately 20 years of longwall mining at WWC.

Table 5.2 - Summary of Proposed Subsidence Management Measures

Surface Feature	Proposed Subsidence Management
Surface Cracking	• Surface crack remediation works will primarily be carried out in accessible areas where required, mainly where surface cracking occurs across access roads and tracks, or potentially in ephemeral watercourses. Surface cracks will be identified during subsidence monitoring inspections and appropriate remediation strategies developed for each situation; • All surface crack remediation will be undertaken in consultation with the relevant stakeholders and may involve either the ripping/tilling of small to moderate sized cracks or pouring crushed rock, gravel, concrete or grout into larger sized cracks. The specific remediation strategies are further detailed in the existing WWC Surface Crack Remediation procedure; • Management strategies to address subsidence crack impacts in creeks and watercourses include undertaking pre-mining and post-mining inspections. This includes daily inspections of surface access tracks / fire trails when mining is being undertaken. The results of these inspections are then communicated to the respective stakeholders. Should a significant impact be identified during these inspections, an appropriate remediation strategy is developed. Specific monitoring requirements are outlined in **Section 5.2.4.2**.
Sub-surface cracking	The practical options available for controlling sub-surface fracturing are limited to the following (in order of increasing impact to proposed mining layouts): • address large surface cracks as soon as possible if they occur along the creeks, assess the potential for grouting; and • decrease the longwall mining height to reduce the potential for continuous sub-surface fracture heights.
Creeks and Watercourses	WWC will continue the existing strategies which are used to address subsidence crack impacts in creeks and watercourses, including: • undertaking pre-mining and post-mining inspections to assess potential subsidence impacts; • communicating inspection results to the respective stakeholders; • any impacts identified during inspections will result in the development of a remediation strategy, in consultation with the relevant stakeholders; • remediation strategies may include remediating large surface cracks, as soon as possible, if they occur along the creeks and assessing the potential for grouting.
Slope Stability	To reduce the potential for adverse impacts from slope and cliff line instability and increased erosion due to cracking, the proposed subsidence management strategy will include; • surface slope and cliff line monitoring (combined with general subsidence monitoring along cross lines and centre lines); • removal of potentially unstable boulders from cliff lines in close proximity to public access tracks; • placement of signs along public access ways warning of rock fall dangers and mine subsidence impacts; • infilling of surface cracking, where possible, to prevent ingress of run-off into the slopes and cliffs; and • on-going review and appraisal of any significant changes to surface slopes such as cracking along ridges, increased erosion down slopes, foot slope seepages and drainage path adjustments observed after each longwall is extracted.

Table 5.2 - Summary of Proposed Subsidence Management Measures (cont)

Surface Feature	Proposed Subsidence Management
Valley Closure – "uplift"	• Install and monitor survey lines along ephemeral drainage gullies and along gully crests during and after longwall undermining. • Review predictions of upsidence and valley crest movements after each longwall. • Assess 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.
Ponding	• A suitable monitoring and trigger response plan, based on consultation with the DECCW and other relevant authorities, will be developed to assess potential ponding impacts on existing vegetation (refer to **Section 5.3**); • The on-going review and appraisal of changes to surface drainage paths and surface vegetation in areas of ponding development (if they occur), after each longwall is extracted.
Aboriginal Cultural Heritage sites	• The development of a suitable monitoring and response plan based on consultation with the relevant Aboriginal stakeholders and DECCW, to ensure potential impacts to sites are managed appropriately. • Development of appropriate monitoring and remediation strategies in accordance with the recommendations outlined in **Section 5.9** and **Appendix 13**.
Gencom Communication Towers and proposed power-line	• The development of a suitable monitoring and response plan based on consultation with Gencom, to ensure the impacts on the towers and powerlines do not result in unsafe conditions or loss of serviceability during and after mining.
Great North Walk	• The development of a suitable monitoring and response plan for the GNW, based on consultation with DECCW and Land and Management Authority, to ensure the management of impacts on the walk does not result in unsafe conditions during and after the effects of mining. • Management of subsidence impacts to the GNW are proposed to be based on inspections and prompt remediation, • Erection of signage along the affected area which cautions users of the GNW of the hazards associated with mine subsidence. A contact phone number would be provided in the event that subsidence impacts are encountered. • Emergency response plans will be developed to close the road temporarily at short notice if required.
Wakefield Road	• The development of a suitable monitoring and response plan, based on the previous subsidence management plan developed in consultation with LMCC, to ensure the management of impacts on the road does not result in unsafe conditions during and after the effects of mining. • To effectively manage public safety concerns, 24-hour surveillance of the road (and embankment) by a roadwork crew, while the road is being undermined, as cracking may develop rapidly. • The stability of the embankment will also be monitored along the crests and toes, with cracks repaired as soon as possible to prevent excessive moisture ingress into the embankment.

Table 5.2 - Summary of Proposed Subsidence Management Measures (cont)

Surface Feature	Proposed Subsidence Management
F3 Freeway, Services Easement	• The development of a suitable specific monitoring and response plans with the respective stakeholders; • Conduct periodic subsidence monitoring of the F3 Freeway and the services easement, including the following: • pre-mining surveys and condition assessments of the F3 Freeway pavement edges, drainage structures, cuttings and Archery Road; • visual inspections of the Northbound and Southbound pavement of the F3 Freeway and Archery Road during mining periods; • post mining surveys and condition assessments of the F3 Freeway pavement edges, drainage structures, cuttings and Archery Road; and • Conduct a review of monitoring data after the completion of each longwall panel; and • Conduct a pre and post mining risk assessment on the Freeway fill embankments.
Abandoned Bord and Pillar Workings	• The development of a suitable monitoring and response plan, based on consultation with DECCW and regulatory authorities, to address the potential for additional subsidence impacts. • Any subsidence cracks, steps or pot holes will be infilled or repaired in accordance with the WWC Surface Crack Remediation procedure (refer to Appendix 5c) and consultation with the MSB.
Fences and Livestock Management	• The development of a suitable monitoring and response plan, based on consultation with owners and regulatory authorities.

5.2.4.2 Proposed Subsidence Survey Monitoring Program

To monitor and assess the potential subsidence impacts on the identified surface, natural and built features, a detailed Subsidence Survey Monitoring Program has been developed for the Project and is included as **Appendix 5A**. The monitoring program will involve the following:

- the installation of subsidence survey points to monitor potential subsidence impacts on the identified surface features;
- conducting visual inspections within the continued underground mining area to assess potential subsidence impacts and to identify any potential remediation that may be required;
- installation of monitoring for potential sub-surface impacts on groundwater; and
- post mining interrogation of aerial photography.

The results of the monitoring program will be communicated to the respective stakeholders in accordance with the previously discussed SMPs and used to refine the ongoing management of subsidence as the Project progresses.

5.2.4.3 Subsidence Management Plan

WWC currently has an approved SMP for the mining of Longwalls 38 to 40. It is proposed to continue mining within the area approved under the SMP in accordance with current development consents whilst this project is being determined. A comprehensive SMP (or Extraction Plan) will be developed for the Project to provide detailed guidance for subsidence management, as required by project approval conditions. This plan will be developed based on the existing SMP and will refine subsidence management strategies including mitigation, monitoring and remediation.

The SMP will also include revised stakeholder SMPs that have been established with each of the identified stakeholders within the continued underground mining area. These plans specify subsidence predictions and specific management measures for natural and man-made surface features.

5.3 Ecology

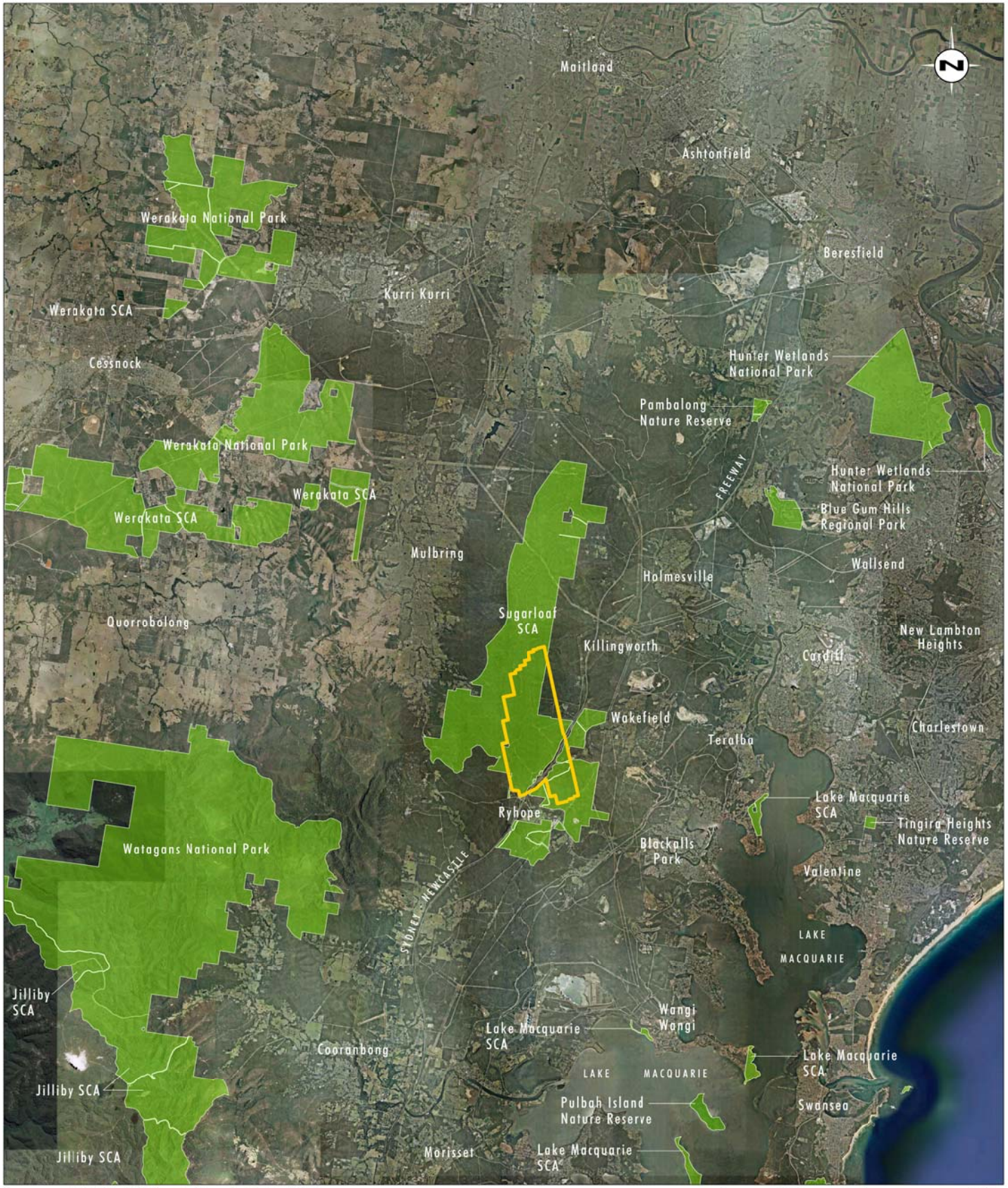
A comprehensive ecological survey and assessment was undertaken for the Project by Umwelt, in accordance with relevant DECCW survey and assessment guidelines. The DGRs for the Project identified biodiversity as a key issue for investigation. In accordance with the DGRs, this assessment included:

- baseline flora and fauna surveys, describing vegetation communities, habitat types and species assemblages present;
- assessment of the potential direct and indirect impacts on threatened species, their habitats, populations and ecological communities and a description of any measures taken to avoid and/or mitigate potential impacts;
- assessment of potential impacts on the SSCA; and
- details of any measures to avoid or mitigate potential biodiversity impacts and, in instances where impacts cannot be avoided, appropriate details on offset habitat packages or strategies.

The complete ecological assessment is included in **Appendix 6**, with a summary of the key findings outlined below.

The continued underground mining area lies beneath an expansive tract of native vegetation associated with the Sugarloaf Range linking the Watagan Mountains to Mount Sugarloaf. Most of the sugarloaf range was gazetted as SSCA in 2007, covering an area of 3937 hectares. Approximately 91 per cent of the continued underground mining area occurs within the SSCA. The remaining 9 per cent consists of private and crown land. However, the area of SCA proposed to be undermined represents only 25 per cent of the total area of the SSCA. On a regional scale, this large remnant ultimately links with larger remnant vegetation areas to the south including Olney State Forest and Watagans National Park (refer to **Figure 5.8**).

The ecological values of the continued underground mining area were recognised early in the project. WWC has undertaken detailed concept and pre-feasibility studies into the proposed mining operation and as part of this process possible alternative mine and infrastructure plans were considered. The potential for ecological impacts and the potential for minimising impacts were considered in these project planning processes.



Source: DECCW 2009 and Google Earth 2009

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1:200 000

Legend

- Continued Underground Mining Area
- Regional Conservation Area

FIGURE 5.8

Regional Conservation Areas

As discussed in **Section 1.2**, WWC has a long history of longwall mining, including extraction of numerous longwall panels from beneath remnant vegetation areas on the Sugarloaf Range including the SSCA (formerly managed by Forests NSW). Ecological monitoring undertaken in the Northern domain between 2005 and 2008 has provided valuable local information about the impact of longwall mining on native vegetation with these results considered in the preparation of the ecological impact assessment. This monitoring has shown that subsidence impacts in the Northern domain were within predicted levels and that the impact of longwall mining on vegetation communities and fauna habitats was negligible.

5.3.1 Survey Methodology

Prior to commencement of field surveys a review of all relevant and available literature was undertaken in order to gain a greater understanding of the ecological values of the continued underground mining area and the locality.

A search of the DECCW Atlas of NSW Wildlife database and the DEWHA Protected Matters database was undertaken to identify threatened species, endangered populations and Threatened Ecological Communities (TECs) whose range falls within the continued underground mining area, and/or have been previously recorded within a 10 kilometre radius. The data obtained from these two database searches was used to compile a list of threatened species, populations and TECs with potential to occur within the continued underground mining area.

Table 5.3 provides a summary of the total ecological sampling effort across the 30 flora survey sites, four fauna survey sites and additional fauna survey sites as described in the Survey Methodology Section of the Ecological Assessment provided in **Appendix 6**.

Table 5.3 – Summary of the Total Survey Effort in the Project Area

Vegetation Survey	**Survey Method**
Vegetation Quadrats	30 vegetation quadrats
Vegetation Transects	9.5 kilometres of threatened flora transects
Fauna Survey	
Diurnal Birds	8 x 2 hectare surveys for one person hour each 17 x 20 minutes additional surveys 13.6 person hours total survey effort
Nocturnal Birds, Mammals and Reptiles	11 nocturnal call playback sessions 10 x 2 hectare surveys totalling 20 person hour walking spotlighting 15 kilometres additional driving spotlighting 2 kilometres additional walking spotlighting
Small Mammal Trapping	368 trap nights using Elliot ‘A’ traps 360 trap nights using Elliot ‘B’ traps 1400 nights of hair funnels
Large Mammal trapping	60 trap nights using wire cage traps
Arboreal Mammal Trapping	160 trap nights using Elliot ‘B’ traps 560 nights of hair funnels
Micro-bat Surveys	12 Anabat echolocation surveys totalling 24 nights 7 harp trap surveys totalling 14 nights

Table 5.3 – Summary of the Total Survey Effort in the Project Area (cont)

Vegetation Survey	Survey Method
Diurnal Herpetological Surveys	8 x 2 hectare search areas lasting one person hour 17 x 20 minute additional surveys 13.6 person hours total survey effort
Fauna Habitat Assessment	25 habitat assessments
SEPP 44 Koala Habitat Assessment	30 SEPP 44 koala habitat assessments
Aquatic Assessment	10 creekline transects

5.3.2 Survey Results

5.3.2.1 Flora Species

A total of 264 species were recorded within the continued underground mining area from 82 families. Fabaceae (Faboideae) (pea plants) was the most speciose plant family (24 species recorded), followed by Myrtaceae (myrtaceous plants) with 23 species recorded and Poaceae (grasses) with 22 species recorded. Of the 264 species recorded, 250 (95 per cent) were native and 14 (5 per cent) were introduced. A full list of the flora species recorded during the survey effort is presented in the Ecological Assessment (refer to **Appendix 6**).

5.3.2.2 Vegetation Communities

Seventeen vegetation communities have been delineated within the continued underground mining area. Forest communities include:

- Freemans Peppermint – Apple – Bloodwood Forest;
- Regenerating Freemans Peppermint – Apple – Bloodwood Forest;
- Sugarloaf Uplands Bloodwood - Apple Forest;
- Hunter Valley Moist Spotted Gum – Ironbark Forest;
- Sugarloaf Uplands Dry Spotted Gum - Ironbark Forest;
- Coastal Foothills Spotted Gum Ironbark Forest;
- Coastal Ranges Dry Blackbutt Forest;
- Alluvial Tall Moist Forest;
- Riparian Paperbark – Peppermint Forest;
- Swamp Mahogany Paperbark Forest;
- Coastal Ranges Mesic Peppermint Forest; and
- Coastal Wet Gully Forest.

Additional communities recorded in the continued underground mining area include:

- Coastal Warm Temperate Rainforest;
- Mesic Paperbark Thicket;

- Freshwater Wetland;
- Aquatic Vegetation; and
- Disturbed Areas.

The distribution of vegetation communities within the continued underground mining area is shown on **Figure 5.9**.

5.3.2.3 Threatened Flora Species and Endangered Populations

Two threatened flora species were recorded in the continued underground mining area: black-eyed Susan (*Tetratheca juncea*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*). Both of these species are listed as vulnerable under the *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth EPBC Act. The locations of records of these species are shown in **Figure 5.10**.

No threatened flora populations were recorded within the continued underground mining area, and none are expected to occur.

5.3.2.4 Endangered Ecological Communities

Two endangered ecological communities (EEC) listed under the TSC Act were recorded in the continued underground mining area. River-flat Eucalypt Forest on Coastal Floodplains EEC was recorded (mapped as Alluvial Tall Moist Forest), covering an area of approximately 12 hectares. Swamp Sclerophyll Forest on Coastal Floodplains EEC (mapped as Swamp-Mahogany Paperbark Forest) was found to cover an area of approximately 3 hectares. No additional TECs were recorded in the proposed underground mining area or Mining Services Facility or are considered likely to occur. The location of these communities within the continued underground mining area is shown on **Figure 5.9**.

5.3.2.5 Fauna Species

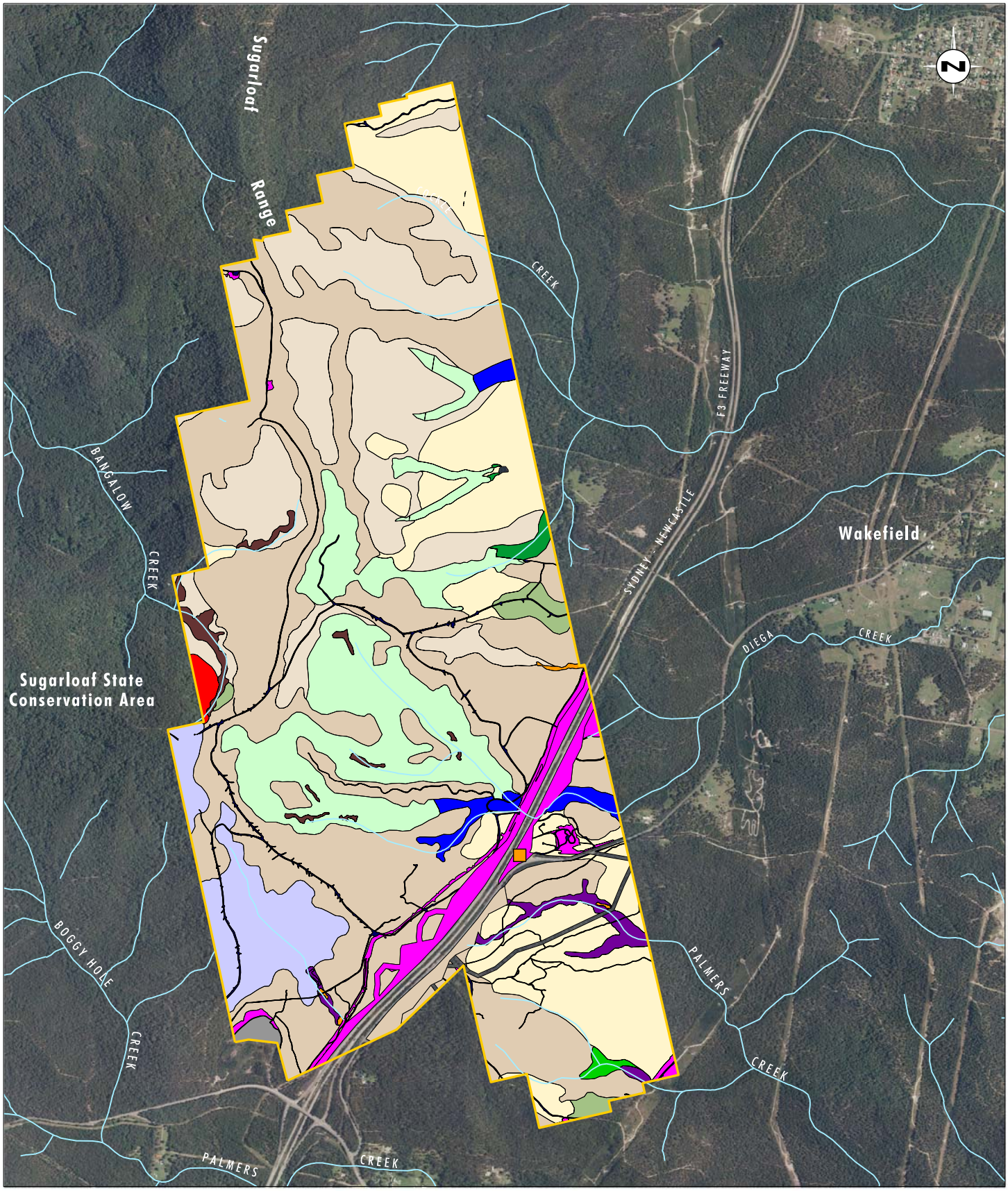
A total of 112 vertebrate fauna species were recorded within the continued underground mining area, comprising 33 mammal species, 68 bird species, 5 reptile species and 6 amphibian species. Eighteen of the bird species identified in the continued underground mining area are listed as migratory species under the schedules of the EPBC Act.

A full list of the fauna species recorded is provided in the Ecological Assessment (refer to **Appendix 6**).

5.3.2.6 Threatened Fauna Species and Endangered Populations

A total of 17 threatened fauna species have been recorded within the continued underground mining area. Recorded threatened species include 12 species of mammal (including 7 species of micro-bat and 1 species of mega-bat) and 5 bird species. No threatened reptile or amphibian species were identified during surveys. The threatened fauna species listed under the TSC Act that were identified within the continued underground mining area include:

- yellow-bellied glider (*Petaurus australis*);
- spotted-tailed quoll (*Dasyurus maculatus*);
- koala (*Phascolarctos cinereus*);
- common planigale (*Planigale maculata*);



Source: OCAL - Aerial Photograph
LPI - Drainage Lines
Bell & Driscoll 2009 - Vegetation Communities

0 0.5 1.0 1.5km
1:30 000

Legend

- Continued Underground Mining Area
- Drainage Line
- Alluvial Tall Moist Forest
- Cleared Land
- Disturbed - Regrowth
- Swamp Mahogany-Paperbark Forest
- Coastal Wet Gully Forest
- Mesic Paperbark Thicket
- Coastal Foothills Spotted Gum-Ironbark Forest
- Coastal Ranges Dry Blackbutt Forest
- Coastal Ranges Mesic Peppermint Forest
- Coastal Warm Temperate Rainforest
- Freemans Peppermint-Apple-Bloodwood Forest
- Hunter Valley Moist Spotted Gum-Ironbark Forest
- Regenerating Freemans Peppermint-Apple-Bloodwood Forest
- Riparian Paperbark-Peppermint Forest
- Sugarloaf Uplands Smooth-barked Apple Forest
- Sugarloaf Uplands Dry Spotted Gum-Ironbark Forest
- Dam
- Proposed Mining Services Facility

FIGURE 5.9

Vegetation Communities

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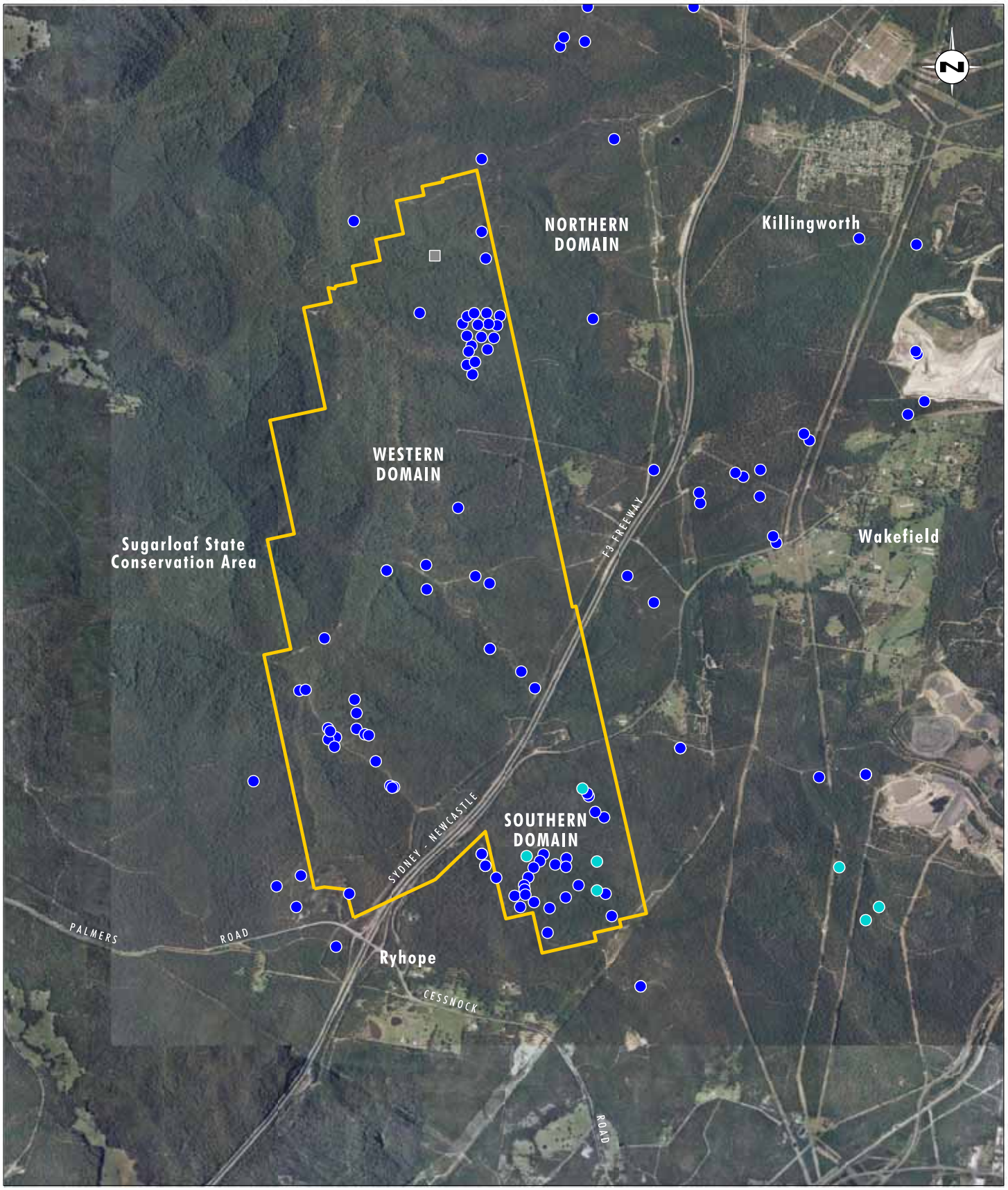


Source: OCAL

0 0.5 1.0 2km

1:40 000

Legend

- Continued Underground Mining Area
- *Tetratheca juncea*
- *Grevillea parviflora* subsp *parviflora*
- Yellow-bellied Glider
- Stephens Banded Snake
- Spotted-tailed Quoll
- Speckled Warbler
- Sooty Owl
- Powerful Owl
- Masked Owl
- Little Bentwing-bat
- Large-eared Pied Bat
- Koala
- Grey-headed Flying-fox
- Greater Broad-nosed Bat
- Glossy Black-Cockatoo
- Eastern Freetail-bat
- Eastern False Pipistrelle
- Eastern Bentwing-bat
- Brown Treecreeper
- Large-footed Myotis
- Varied sittella
- Common Planigale
- Scarlet Robin

FIGURE 5.10

Threatened Species Locations

File Name (A4): R08_V1/2553_265.dgn

- grey-headed flying-fox (*Pteropus poliocephalus*);
- little bentwing-bat (*Miniopterus australis*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- eastern freetail bat (*Mormopterus norfolkensis*);
- eastern false pipistrelle (*Falsistrellus tasmaniensis*);
- large-footed myotis (*Myotis adversus*);
- greater broad-nosed bat (*Scoteanax ruepellii*);
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*);
- sooty owl (Tyto *tenebricosa*);
- powerful owl (*Ninox strenua*);
- scarlet robin (*Petroica boodang*);
- varied sittella (*Daphoenositta chrysoptera*); and
- glossy black-cockatoo (*Calyptorhynchus lathami*).

Three of the TSC Act listed mammal species recorded during surveys are also listed under the EPBC Act; the grey-headed flying-fox (*Pteropus poliocephalus*), the large-eared pied bat (*Chalinolobus dwyeri*) and the spotted-tailed quoll (*Dasyurus maculatus*).

No endangered fauna populations were recorded within the continued underground mining area, and none are expected to occur.

5.3.2.7 Groundwater Dependent Ecosystems

Three vegetation communities in the continued underground mining area are considered likely to be dependent on groundwater resources:

- Alluvial Tall Moist Forest EEC (covering 12 hectares);
- Swamp Mahogany Paperbark Forest EEC (covering 3 hectares); and
- Riparian Paperbark Peppermint Forest (covering 10 hectares).

A freshwater wetland was also identified in the continued underground mining area. This wetland was extensively investigated as part of the Aboriginal Archaeology Assessment (refer to **Appendix 12**). This wetland is considered to be fed by surface water and is not considered to be groundwater-dependent ecosystem (GDE) (Umwelt 2008b).

5.3.3 Impacts on Ecological Values

A total of 1085 hectares of native vegetation occur in the continued underground mining area, providing habitat for 19 threatened species and 15 hectares of EEC.

No direct clearing of vegetation above the proposed subsidence areas is required for the project. Subsidence is not expected to impact the structure and floristic composition of vegetation communities, although some subsidence cracking is likely to occur in areas of vegetation. This prediction is supported by ecological monitoring undertaken for past

longwall mining at WWC. Some minor vegetation disturbance will occur as a result of subsidence management works (e.g. subsidence remediation works and survey lines), however, subsidence remediation works would not generally be required in areas of intact vegetation with works typically limited to public access areas (e.g. vehicle tracks). Surface water ponding resulting from subsidence is expected to be confined to channels (refer to **Section 5.5**) thus is not predicted to substantially affect the floristic or structural characteristics of adjacent riparian vegetation communities.

There a several small areas of low depth of cover (70 metres to 100 metres) within the continued underground mining area, as shown in **Figure 5.3**. These areas may be subject to direct hydraulic connection with the underground mine workings. Due to both the potential surface water impacts and potential mine safety issues, these cracks may require immediate remediation. The presence of these cracks will be monitored as part of the subsidence monitoring program. In the event that such cracks are observed, options for re-sealing of the cracks will be assessed and implemented. Where possible access to undertake the remediation works will be undertaken using existing access tracks, however due to the remote nature of these areas and the extensive vegetation cover, the construction of new access tracks may be required to provide for the remediation activities. The exact location of the potential subsidence cracks cannot be accurately determined at this stage and therefore a detailed management process is outlined in **Section 5.3.4**.

A total of 0.5 hectares of disturbed land adjacent to the F3 Freeway and Wakefield Road will be disturbed for the construction of proposed Mining Services Facility. This area has been extensively cleared, has low ecological value and is dominantly occupied by weeds with some Eucalypt regrowth.

5.3.3.1 Impact on Vegetation Communities

The vegetation within the continued underground mining area is considered to be of high ecological significance and 91 per cent of the area falls within the SSCA.

As discussed above, surface water ponding is predicted to be confined to existing channels and no out-of-channel flows are expected as a result of subsidence. An assessment of the impact of ponding on vegetation communities has concluded that approximately 1.8 hectares of Alluvial Tall Moist Forest EEC occurs within the surface water ponding impact zone and approximately 0.45 hectare of Swamp Mahogany Paperbark Forest. These communities are not expected to be significantly impacted as the communities are adapted to ‘wet’ conditions and the ponding is expected to be of short duration.

While subsidence cracking is predicted within native vegetation communities, subsidence remediation works are not typically undertaken in areas of native vegetation. This is consistent with current practice at WWC. Based on subsidence predictions and experience from previous mining at WWC, tree fall is not predicted and subsidence remediation works within intact vegetation are not expected to be required. This predicted impact is not expected to result in a significant loss of floristic diversity or community composition of the continued underground mining area, SSCA or the region.

The construction of the Mining Services Facility will not result in the removal of native vegetation communities and will not significantly impact ecological values.

The Project is not likely to result in the removal of native vegetation communities.

5.3.3.2 Impact on Fauna Species

The Project is not expected to result in the loss of fauna species diversity or abundance from within the Project area due to the very small area of clearing predicted to be required for surface infrastructure, including the ancillary surface infrastructure, and the limited surface remediation works expected to be required to repair subsidence impacts. This expectation is supported by the results of ecological monitoring conducted by Umwelt in WWC between 2005 and 2008 (Umwelt 2005; 2006; 2007; 2009).

5.3.3.3 Impact on Groundwater-dependent Ecosystems

GDEs are ecosystems which have their species composition and their natural ecological processes determined by groundwater (DLWC 2002). According to the Groundwater Dependent Ecosystem Policy (DLWC 2002), ecosystems which depend on groundwater are:

- wetlands and red gum forests;
- other terrestrial vegetation;
- ecosystems in streams fed by groundwater;
- limestone cave systems;
- springs; and
- hanging valleys and swamps.

Of these ecosystems, those potentially relevant to the project area include other terrestrial vegetation and wetlands. There have been no recordings of significant GDEs such as hanging swamps and limestone cave systems within the continued underground operations area.

Three vegetation communities in the continued underground mining area are considered likely to be dependent on groundwater resources: Alluvial Tall Moist Forest EEC (covering 12 hectares); Swamp Mahogany Paperbark Forest EEC (covering 3 hectares); and Riparian Paperbark Peppermint Forest (covering 10 hectares). A freshwater wetland was also identified in the continued underground mining area. This wetland was extensively investigated as part of the Aboriginal Archaeology Assessment (refer to **Appendix 12**). This wetland is considered to be fed by surface water and is not considered to be a GDE (Umwelt 2008b).

The Project is not expected to result in a significant adverse impact on groundwater resources and similarly alluvial aquifers are not expected to be significantly adversely impacted (refer to **Section 5.4**). The only potential impact on GDEs is from ponding, which is expected to be minimal, increasing from 7 hectares to 11 hectares in a total mining area of 1085 hectares. These results indicate that it is unlikely that the Project will result in a significant negative impact on identified GDEs such as Alluvial Tall Moist Forest EEC, Swamp Mahogany Paperbark Forest EEC and Riparian Paperbark Peppermint Forest.

5.3.3.4 Impact on Cliffline Habitats

Of the threatened micro-bat species recorded from the continued underground mining area (or with the potential to occur), the following are known to utilise caves (or similar structures) for roosting/breeding:

- little bentwing-bat (*Miniopterus australis*);
- large-eared pied bat (*Chalinolobus dwyeri*);
- large-footed myotis (*Myotis adversus*);
- eastern cave bat (*Vespadelus troughtoni*); and
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*).

No evidence of breeding or roosting caves for any micro-bat species has been recorded from surveys completed within the continued underground mining area. Such caves are typically very rare in the landscape, and there is no certainty that they occur in the continued underground mining area. The extensive clifflines of the surrounding area are likely to provide comparable potential for roosting/breeding caves as those within the continued underground mining area. However, the possibility of the presence of such caves cannot be excluded from consideration.

Also, it is important to note that the continued underground mining area is not expected to comprise an important population of the large-eared pied bat (*Chalinolobus dwyeri*). A conservative approach has been taken in the assessment to account for uncertainty in relation to impacts on cliffline habitat and the detailed assessment in **Appendix 6** has confirmed that this project will not have a significant impact on this species.

5.3.3.5 Impact of the Project on the SSCA

The Project is not expected to have a significant impact on the ecological values of the SSCA. The Project will not result in the substantial loss of vegetation communities or the floristic composition of vegetation communities; fauna species or habitat; or threatened species, populations and TECs or their habitat. No significant impacts on ecological values have been observed in the previous longwall mining areas of WWC, which are similar in ecological composition to the continued underground mining area.

5.3.3.6 Impact on Threatened Species, Endangered Populations and EECs

Species listed under the Threatened Species Conservation Act 1995

Nineteen threatened species listed under the TSC Act were recorded in the continued underground mining area. Assessments of significance were undertaken to assess the likely impacts on the threatened species, endangered populations and EECs that were recorded in the continued underground mining area, as well as for those species with likely habitat within the area. The assessment of significance is included as Appendix D in the Ecological Assessment and concludes that the Project will not have a significant impact on any identified threatened species or EECs.

Threatened and Migratory Species Listed Under the Environment Protection and Biodiversity Conservation Act 1999

Four EPBC Act listed vulnerable species were recorded in the continued underground mining area during surveys: black-eyed Susan (*Tetratheca juncea*), small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*), grey-headed flying-fox (*Pteropus poliocephalus*) and the large-eared pied bat (*Chalinolobus dwyeri*). The spotted-tailed quoll (*Dasyurus maculatus*) is listed as endangered under the EPBC Act and has been previously recorded on one occasion (in 2006) in the central portion of the continued underground mining area (DECCW 2009).

The EPBC Act lists criteria which are used to determine whether an action is likely to have a significant impact on an endangered or vulnerable species. These criteria are addressed in

the Assessment of Significance provided in Appendix E of the Ecological Assessment. The Assessment of Significance for the threatened species concludes that the Project will not have a significant impact on endangered or vulnerable species known to occur in the continued underground mining area.

The migratory species recorded within the continued underground mining area are not considered to be part of an important population, as defined by the EPBC Act. Records of these species are distributed broadly across NSW, with no obvious concentrations of records in the local area to suggest the presence of an ecologically significant proportion of the population of these species. The continued underground mining area is not at the limit of the known distribution for any of the species, nor is there evidence to suggest these species are declining in the local area. It is unlikely that the continued underground mining area forms an area of important habitat. Therefore it is considered that the Project will not have a significant impact on any migratory species listed under the EPBC Act.

5.3.3.7 Threatened species assessed under *Fisheries Management Act 1994*

Neither the upper catchment of Lake Macquarie, nor the lower catchment of the Hunter River, are known to support any threatened species, populations or ecological communities listed under the *Fisheries Management Act 1994* (FM Act). No species, populations or ecological communities listed under the FM Act were recorded in the continued underground mining area; therefore threatened aquatic species listed under the FM Act will not be impacted by the Project.

5.3.3.8 State Environmental Planning Policy (SEPP) 44 (Koala Habitat Protection)

Under Part 1 (5) of the SEPP 44 (Land to which this Policy Applies), it is stated that the Policy does not apply to land dedicated or reserved under the NP&W Act, which includes the SSCA.

Approximately 93 hectares of the continued underground mining area occurs beneath private property which is subject to the provisions of SEPP 44. An assessment of potential koala habitat undertaken on this land determined that potential koala core habitat is limited to approximately 3 hectares of Swamp Mahogany Paperbark Forest which contains swamp mahogany (*Eucalyptus robusta*) as a dominant species.

The Project will not result in the clearing of Swamp Mahogany Paperbark Forest and therefore swamp mahogany (*Eucalyptus robusta*) will not be directly cleared as a result of the Project.

The predicted surface water impacts are not expected to result in the disturbance of potential koala habitat. Minor alterations to the ponding regime are not expected to result in the alteration of the structural or floristic composition of Swamp Mahogany Paperbark Forest and koala feed trees listed under SEPP 44 are not expected to be lost as a result of the Project.

As outlined in **Section 4.3.4**, a koala plan of management is required.

The Project is not expected to significantly impact on the koala or its habitat and the species is expected to persist in the project area in the long term.

5.3.4 Impact Mitigation Strategy

One of the key goals of the impact mitigation strategy is to maintain or improve ecological features and functions within the continued underground mining area, in order to mitigate the impacts associated with mining in the continued underground mining area.

As part of the Project, the existing West Wallsend Biodiversity and Land Management Plan will be updated to include the commitments in the Ecological Assessment impact mitigation strategy (refer to **Appendix 6**) and to guide the ongoing management of ecological values identified in the continued underground mining area.

The exact locations for the construction of various minor surface infrastructure facilities such as ventilation infrastructure and associated services cannot be known at this stage of the Project and it may be necessary to disturb some areas of native vegetation for the construction of these surface facilities. Where this is unavoidable, areas containing significant ecological features such as known threatened species habitat, or hollow-bearing trees will be avoided. Where it will be necessary to disturb areas of native vegetation for these types of infrastructure, the following due diligence processes will be implemented:

- due-diligence inspections will be completed by a suitably qualified ecologist to identify any significant ecological features at identified potential infrastructure sites and any required management and mitigation measures;

- disturbance to native vegetation communities will be limited to the minimum area required;

- areas of known ecological significance (refer to **Figures 5.9** and **5.10**) will be avoided where possible (that is, areas containing known records of threatened species, Endangered Populations and TECs. Hollow-bearing trees should be retained, where possible);

- appropriate disturbance setbacks to known or identified significant ecological features will be established where possible; and

- pre-clearance surveys of any sites containing hollow-bearing trees or significant habitat features.

Due diligence inspections will ensure that only the minimum area required for surface infrastructure developments will be cleared and that flora and fauna species, including threatened species will not be significantly impacted.

As discussed in **Section 5.3.3**, there are several areas within the continued underground mining area that may be susceptible to direct hydraulic connection. A detailed subsidence monitoring program will be undertaken in these areas to identify potential connective cracking issues. In the event that such cracking is observed a due diligence process as outlined above, will be followed to minimise the potential for impacts upon sensitive ecological features. Where possible existing tracks will be utilised, however due to the extensive vegetation cover and remote nature of the areas, new access tracks may be required. If required, new access tracks will be constructed so as to minimise the potential for impact on ecological features.

In the event that unpredicted, adverse impacts on ecological values are identified during management and monitoring of the continued underground mining area, WWC will respond to the issues identified. WWC will investigate appropriate remediation and mitigation requirements, in consultation with the relevant government authorities and in the event that significant impacts on identified ecological values are identified and cannot be adequately remediated, WWC will engage a suitably qualified and experienced ecologist to prepare a Biodiversity Offset Strategy in consultation with DECCW and DoP.

5.3.5 Summary of Net Ecological Impacts

As a result of the modifications made during mine planning that avoided and minimised impacts on ecological features (i.e. reducing the footprint of the mine plan), the nature of the proposed Project and the proposed impact mitigation and monitoring commitments, the Project is considered unlikely to significantly impact vegetation communities and fauna species, including identified threatened species and EECs.

As a result of the implementation of the Impact Mitigation Strategy it is considered likely that there will be no significant impact on threatened species, TECs or their habitats, and that the objective to maintain or improve the biodiversity values of the surrounding region in the medium to long term will be achieved.

5.4 Groundwater

A comprehensive hydrogeological assessment of the continued underground mining area has been completed by Aurecon. A summary of the key findings of the hydrogeological assessment is provided below, with the full report included in **Appendix 7**.

5.4.1 Methodology

A Subsidence Management Plan (SMP) was prepared by WWC (2007) for underground mining areas in both the Western and Southern domains in which the continued underground mining area is located. As part of the SMP process, a detailed assessment of the local hydrogeology within these two domains was completed. This assessment has been updated to consider the current mine plan.

The scope of the hydrogeological investigation completed by Aurecon included the following:

- providing a description of the local hydrogeological regime;
- confirming the extent of all alluvial areas, and mapping the extent of the alluvium;
- characterising existing groundwater usage patterns within the continued underground mining area;
- estimating the likely height of fracturing above the future extraction panels in the continued underground mining area;
- determining the likely impact of continued underground mining on the hydrogeological regime and groundwater utilisation in the continued underground mining area;
- making recommendations for any additional actions to monitor and/or protect groundwater resources within the continued underground mining area; and
- utilising the results of the study to make an assessment of the potential hydrogeological impact on a regional scale.

5.4.2 Existing Groundwater Environment

5.4.2.1 Local Geology

Near surface strata in the continued underground mining area form part of the Permian age Newcastle Coal Measures. The major influencing structure in this region is the Macquarie Syncline, which trends in a north-north-west – south-south-east direction bisecting the West Wallsend ML to the east of the continued underground mining area.

The Newcastle Coal Measures are thickest in the east, and thin significantly towards the west due largely to a decrease in the quantity of sediment. In the continued underground mining area the total thickness of Newcastle Coal Measure strata ranges from approximately 80 to 200 metres.

In the continued underground mining area, the Newcastle Coal Measures comprise four major formations (Moon Island Beach, Boolaroo, Adamstown and Lambton) separated by prominent tuff bands. The upper three formations (Moon Island Beach, Boolaroo and Adamstown) contain conglomerate and sandstone bands with interbedded shale, siltstone, tuffaceous claystone bands and high ash coal seams. Further detail of specific geological characteristics of these formations is provided in Section 3.1 of the hydrogeological assessment, included as **Appendix 7**.

The local stratigraphic sequence in the area is summarised in **Table 5.4** and shown in **Figure 2.2**.

Table 5.4 - Stratigraphic Sequence *

GROUP	FORMATION	COAL SEAMS	THICKNESS
NEWCASTLE COAL MEASURES	MOON ISLAND BEACH	Vales Point Wallarah Great Northern	
	AWABA TUFF		
	BOOLAROO	Fassifern Upper Pilot Lower Pilot Hartley Hill	60 - 75 m
	WARNERS BAY TUFF		up to 7 m
	ADAMSTOWN	Australasian Montrose Wave Hill Fern Valley Victoria Tunnel	65 - 100 m
	NOBBYS TUFF		0 – 3 m
Base of Coal Measures	LAMBTON	Nobbys, Dudley } Young Wallsend; Yard, Borehole } Borehole/Yard; Young Wallsend, Borehole/Yard } West Borehole Seam	
	WARATAH SANDSTONE		

* Based on revised Newcastle Coal Measures stratigraphy ratified in June 1992 by the Standing Committee on Coalfield Geology of NSW (Hawley & Brunton, 1995).

5.4.2.2 Hydrogeology

Historically, three potential sources of groundwater have been utilised within the Lake Macquarie area, namely:

- alluvial aquifers;
- near-surface weathered rock aquifer; and
- fractured rock aquifers (including coal seam aquifers).

A brief discussion on each of these aquifer types is provided below. Further detailed discussion is provided in the hydrogeological assessment, included in **Appendix 7**.

Alluvial Aquifers

Alluvial sediments potentially carry the most important groundwater resource in the Newcastle/Lake Macquarie area. These sediments cover low-lying areas adjacent to the lake system and fill the broad valleys of the creeks that flow into the lake. The alluvial areas identified within and surrounding the continued underground mining area are shown in **Figure 5.11**.

Two major catchment areas, Cockle Creek (and its tributaries including Burkes Creek and Diega Creek) and Palmers Creek (including Ryhope Creek and Central Creek) are located within the continued underground mining area.

Cockle Creek Catchment

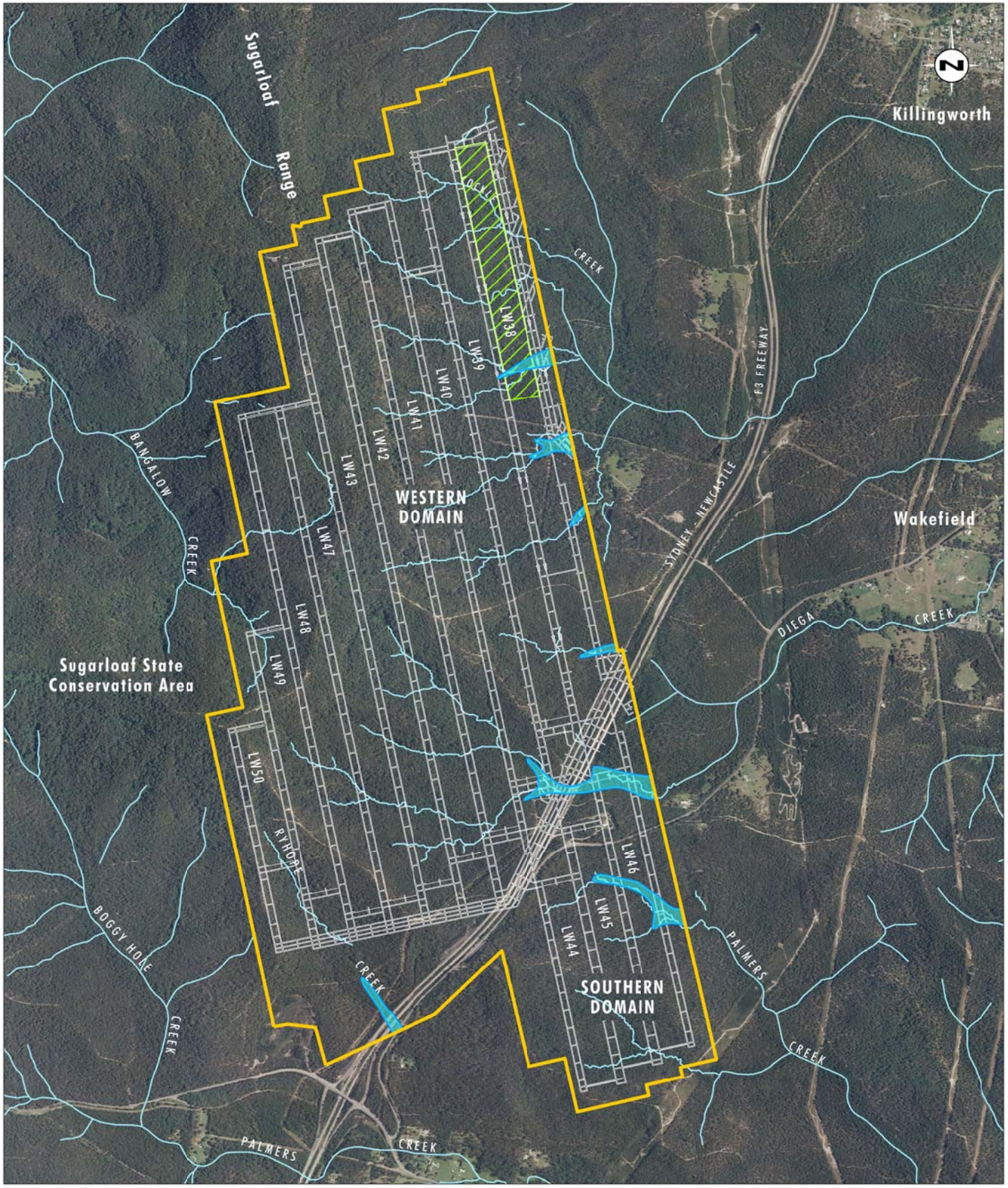
The Cockle Creek catchment covers an approximate area of 8000 hectares and drains into the northern end of Lake Macquarie. Within the WWC ML area, the upper reaches of Cockle Creek comprise a series of ephemeral channels, which only flow after consistent rainfall. Although stream flows in the continued underground mining area are intermittent, the creek beds are contained in broad, flat valleys, which are filled with alluvial deposits.

Previous investigations in Cockle Creek related to mining in the Northern domain. These investigations included drilling seven auger holes to the base of the alluvium above Longwalls 27 and 28. No single major aquifer was identified in the deposits; however the alluvium contains a series of water-bearing sand horizons, interbedded with less permeable clay lenses. Moreover sampling of groundwater in these bores indicated that generally it did not meet the standard for good quality drinking water for human consumption (TDS <500 mg/L).

The investigations concluded that the Cockle Creek alluvium within the continued underground mining area does not contain a significant aquifer and that the alluvial groundwater resource in this area is of minor significance, due to its variable quality and limited volume.

Palmers Creek Catchment

The Palmers Creek catchment is located to the south of the Cockle Creek catchment. The valley of Palmers Creek comprises a broad alluvial terrace which contains a significant aquifer. The groundwater in this aquifer is exploited in several bores for stock and domestic purposes. The mine plan for the continued underground mining area has been designed so that this aquifer is located outside of the continued underground mining area, to avoid potential subsidence impacts.



Source: OCAL, Google Earth 2008

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Legend

- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Extent of Alluvium within the Continued Underground Mining Area

FIGURE 5.11

Extent of Alluvium within Continued Underground Mining Area

The original groundwater investigation within the Palmers Creek catchment assessed the alluvium in an area that was to be undermined in the Southern domain. The investigation included a series of nine shallow hand augered bores, two in the valley of Palmers Creek and seven in the alluvium of Ryhope Creek, (a tributary of Palmers Creek). Results of the investigation confirmed that the alluvium in Ryhope Creek is relatively thin but is similar to that intersected in Cockle Creek. No single major aquifer was identified in the deposits; however the alluvium contains occasional water-bearing sand horizons, interbedded with less permeable clay lenses.

Weathered Rock Aquifers

On a regional scale, the groundwater resource in the underlying weathered rock aquifer is considered of minimal importance. Previous geotechnical investigations have confirmed that the Newcastle Coal Measures do not normally contain any significant quantities of groundwater, and the permeability of these rocks is generally less than 10^{-7}m/s.

The lack of groundwater flow in the coal measure strata is due to the extremely low primary permeability of the rock material. As a result, most groundwater flow through the overburden strata is due to secondary or fracture permeability (through interconnecting defects such as joints and bedding).

Fracture permeability is most common in the weathered zone and in near surface strata where joints and fractures are likely to be open. This can form a near surface unconfined aquifer, termed the weathered rock aquifer, which may be intersected above the bedrock. The weathered rock layer is generally in the order of 10 metres deep throughout the region, and hence the aquifer, where it occurs, is limited to this zone.

Occasionally, flow from this aquifer is significant, and may emerge at the ground surface in the form of a spring. There are no known springs derived from the weathered rock layer within the continued underground mining area confirming the weathered rock aquifer is generally poorly developed in the continued underground mining area. There are also no known groundwater dependant ecosystems reliant on this aquifer as a water source.

Available data indicates that the weathered rock aquifer is largely non-existent or of minor significance within the continued underground mining area. As a result, the risk of any adverse impacts from mining will be negligible.

Fractured Rock Aquifers

The aquifers that typically occur at depth in the Newcastle Coal Measures are usually fractured rock aquifers. These include jointed coal seams and localised jointed or fractured zones, often adjacent to major faults. These aquifers have the potential for higher flows than the weathered rock aquifer since they are confined aquifers and are at a higher pressure. Flows are often relatively small in these zones and water quality is generally poor, suitable only for stock use. Hitchcock (1995) concludes that the Newcastle Coal Measures ‘have a poor resource potential with low yielding aquifers of high salinity’.

The existence of water bearing zones in coal seams within the continued underground mining area was confirmed by water pressure testing at two shaft sites. These results indicate that, while the permeability in some of the coal seams is greater than in the surrounding rocks, there are no significant aquifer zones, as the maximum permeability is not sufficient to produce any significant groundwater flow. Testing of the salinity in the borehole at one of the shaft sites yielded an average Total Dissolved Solids (TDS) value of 1260 mg/L. Water of this quality is not suitable for human consumption, however it is suitable for stock use.

Based on previous mining experience at WWC and in addition to the results of recent exploratory boreholes carried out for the current Project, the conditions in the continued underground mining area are likely to be similar to the previous workings and there is no evidence of the existence of any significant fractured rock aquifers in the near-roof strata. Consequently, the risk of an adverse impact on any fractured rock aquifer is negligible.

Groundwater Dependent Ecosystems

GDEs were identified within the continued underground mining area and are discussed further in **Section 5.3**.

5.4.2.3 Groundwater Usage

The extent of existing usage of groundwater in the continued underground mining area was determined as part of the hydrogeological assessment. This was achieved primarily with reference to the database groundwater works reports held by NOW. This database lists details of registered bores and wells in NSW. Although it is recognised that many existing bores are not registered, the database does give an indication of the extent of groundwater usage in the State.

The database lists no registered groundwater bores within the continued underground mining area. There are three registered bores in the valley of Diega Creek approximately two kilometres to the east of the continued underground mining area. These bores have been undermined by previous longwall panels without any reported adverse impact on their yield.

Three bores are located outside of the southern edge of the continued underground mining area in the valley of Palmers Creek, details of these bores is presented in **Table 5.5**.

Table 5.5 - Details of Registered Bores in Palmers Creek

Reg. No.	Location	GWL (m)	Depth (m)	Water-Bearing Strata	Flow Rate (L/s)	Salinity (mg/L)
64067	Palmers Creek	4	12.8	Sand, gravel	0.4	2000
64025	Palmers Creek	6	12.19	Sandstone, coal	0.9	60
63752	Palmers Creek	6	12.2	Sand, gravel	0.46	20

Bores 64067 and 63752 both appear to intersect the alluvial aquifer in the valley of Palmers Creek, while bore 64025, located on the flank of the creek valley, intersects a coal aquifer that is most likely fed from the alluvium. The water quality in the bores 64025 and 63752 is very good and is suitable for human consumption. Even though the recorded flow rates from these bores are low, this water is considered to represent an important groundwater resource. The water in the remaining bore is of a lesser quality, suitable only for stock use. These existing bores will not be impacted as a result of the Project.

It is considered unlikely that additional unregistered bores are located within the continued underground mining area due to the limited groundwater resources available and that most of the area is covered by the SSCA. The field survey in the area did not discover any additional bores, other than those noted above.

The potential for future usage of groundwater resources within the continued underground mining area was considered as part of the hydrogeological study. Results indicated that:

- the current usage of groundwater within the continued underground mining area is negligible;
- it is highly unlikely that the alluvium within the continued underground mining area contains aquifers which would provide a significant groundwater source; and
- potential for future usage of weathered rock aquifers and fractured rock aquifers is considered to be negligible due to their generally poor yield, quality and continuity.

Although it is possible that groundwater in the alluvium in the continued underground mining area could be utilised, the previous study of the Cockle Creek alluvium indicated that the probability of this could be considered to be very low as:

- the aquifer zones in the alluvium are contained in discontinuous lenses;
- the flow rates from the aquifer zones in the alluvium are unlikely to be economic;
- the water quality in these zones is likely to be poor; and
- other higher quality sources of water are available (surface water and rainwater).

The only local alluvial water resource considered to be significant is located in the alluvium in Palmers Creek, which lies outside the southern fringe of the continued underground mining area. Future usage of this water resource is highly likely, due to its good quality and ready availability. Overall, the potential for future groundwater usage in the continued underground mining area is considered negligible.

5.4.2.4 Estimation of height of fracturing

The height of the fractured zone[1] above the proposed mine workings has been estimated to facilitate an understanding of the potential impact of the Project on the groundwater regime in the alluvium. As there is no quantitative measure of the height of the fractured zone, estimation is established based on previous experience in the local area, incorporation of empirical methodology along with a qualitative evaluation of local geological and mining conditions. These estimations are complex as the height of the fractured zone is dependent on many variables including seam thickness, rock type, rock strength and deformation properties, jointing and bedding, geological structures and depth of cover. WWC are installing an extensometer for sub-surface monitoring and management of groundwater resource impacts in areas with shallow depth of cover. The monitoring will provide greater detail on height of fracturing within the continued underground mining area.

As discussed further in **Section 2.3.2**, significant changes have been made to the current mine plan to avoid areas with a low depth of cover, below 70 metres, so as to minimise the potential for significant impacts from potential connective cracking.

Predictions

Previous studies in the Newcastle coalfields region (ECNSW, 1987, Forster & Enever, 1992) have suggested that interconnected fracturing may extend to a height of between 20 and 33 times the coal extraction thickness above supercritical extraction areas. As the strength properties of the rocks throughout this region are relatively uniform, it should be expected that the height of the significant fracturing in the continued underground mining area would be similar to elsewhere in the region.

[1] The fractured zone is defined as the height of interconnected fracturing that could transmit water from the strata to the mine opening, (goaf).

The factor most influencing the height of the fractured zone in the Newcastle coalfields region is the seam extraction height. In the continued underground mining area the maximum extraction height is 4.8 metres which is greater than for most other coal seam extraction in this region. The potential height of the fractured zone could therefore be greater than that measured above other mines at a similar depth.

In addition to the extraction height, rock type and strength of strata in the overburden are important factors in fractured zone estimations. Above the continued underground mining area, the strata comprises of a mix of interbedded fine and coarse-grained rocks. Rocks in the continued underground mining area will tend to inhibit the vertical extension of the zone of interconnected fracturing in the overburden above the mine.

The Adamstown Formation, which forms the immediate roof of the West Borehole Seam, has a relatively uniform thickness in the continued underground mining area. Therefore, the height of interconnected fracturing will most likely be reasonably consistent. Based on the analysis of geological data from previous studies in the area (Pacific Power International, 2002), it is evident that the high strength of the strata in the Adamstown Formation will have a significant influence on the height of the fractured zone. These strong strata in the upper part of the formation will act as a beam resting on the caved and fractured material below and serve to limit the subsidence.

Due primarily to the strength of the strata in the Adamstown Formation it is highly unlikely that continuous vertical fractures will form through the entire thickness of this unit, except perhaps where it thins to the west. Consequently, the fractured zone will most likely be wholly within the Adamstown Formation.

Due to the variable lithology in the upper part of the Adamstown Formation, predicting the exact height of fracturing is not possible with any certainty. Notwithstanding, the fractured zone will most likely extend somewhere into the upper part of the formation. This height is likely to be between 70 and 100 metres above the roof of the seam, depending on the extraction height and the vertical distribution of tuff layers. This is at the lower end of the fractured zone height measured in other areas but this is due to the presence of the high strength strata above the seam.

The height of fracturing will also vary slightly with depth of cover, since the additional overburden load at greater cover depths may result in greater fracturing in the massive sandstone/conglomerate layer. It is therefore expected that in the Western domain, where the depth of cover is shallowest and the extraction height lowest, the height of fracturing will be at the lower end of the estimated range. In addition, the height of interconnected fracturing may be restricted where the tuffaceous claystone bands in the strata above the mine are thicker. It is also possible that the height of fracturing in the vicinity of the major faults may be higher than that predicted, due to the influence of the fault structure.

Previous experience and monitoring

Previous experience of mining beneath surface water bodies at Wyee Colliery has confirmed the limited extent of interconnected fracturing in the overburden, in conditions similar to those at WWC. Monitoring at Wyee Colliery showed that there was no indication of any groundwater or surface water inflows to the mine. Conditions in the continued underground mining area are similar to those at Wyee, with the degree of subsidence at Wyee significantly greater than that which is predicted in the continued underground mining area. Extensive subaqueous mining experience at Wyee, along with an intensive monitoring program, has provided valuable data which is relevant to other mining in the region, including the continued underground mining area.

Data gathered was used to predict that there was unlikely to be any impact on the Cockle Creek alluvium from the extraction of Longwalls 27, 28 and 31 (WWC). Monitoring of groundwater observation bores in the Cockle Creek alluvium during the extraction of the Longwall 27, 28 and 31 confirmed the existence of an aquiclude zone above the fractured zone at WWC. Further, there was no indication from the observation bores of any connection between the mine and the alluvium, thus confirming the predictions.

Groundwater monitoring results indicated that any disruption to the groundwater levels attributable to the mining of Longwalls 27, 28 and 31 was temporary and generally limited to a period of a few months at most. In the majority of monitoring bores, the groundwater table returned to levels consistent with that which would be expected, given the climatic conditions. The major influence on groundwater levels during the first part of the monitoring period was the prevailing drought conditions. This effect has also been noted in groundwater bores on other monitoring projects. For further details of specific results of groundwater monitoring refer to **Appendix 7**.

Since June 2006, above average rainfall has resulted in a significant rise in groundwater levels to near pre-drought conditions. The post-mining groundwater gradient across the three longwalls is similar to the pre-mining gradient (1 per cent downstream), indicating that the groundwater regime has fully recovered. At no time was there total loss of groundwater from any bore, which would indicate significant drainage to the mine. This suggests that the disruption is probably mostly due to the changes in ground level induced by the mining, rather than any subsurface cracking.

In addition to Longwalls 27, 28 and 31, there have been numerous other longwall panels extracted beneath alluvial deposits at the WWC to date with no long-term adverse impacts evident on the groundwater regime. This gives a good indication that the likely height of fracturing above these workings is within the predicted range. In particular, there have been at least ten panels extracted from beneath the Cockle Creek alluvium and ten panels from beneath Diega Creek. In both of these creek valleys there have been minor temporary hydrogeological impacts observed, but the long-term hydrogeological regime in the alluvium in both creeks appears to be unaffected.

Previous mining experience in the region, in addition to the results of available monitoring, support the predictions of the likely height of the zone of interconnected fracturing above the mine.

5.4.3 Potential Groundwater Impacts

5.4.3.1 Local Groundwater Resources

Impact Assessment Methodology

The hydrogeological assessment identified that the primary hydrogeological risk associated with the Project was that ground surface movements and the fracturing of the overburden strata associated with the extraction of the West Borehole Seam has the potential to drain aquifers in the near-surface alluvial deposits and impact on the amenity of any current or future users of this groundwater source. Further, the probability of the Project resulting in an adverse impact on groundwater is dependent on the depth of cover between the mine and the base of the alluvium and the height of interconnected fracturing above the mine opening.

To assess the potential impacts associated with the Project a risk assessment methodology was adopted in the hydrogeological assessment. The depth of cover in the continued underground mining area was divided into sub-areas representing very high, high, medium or low probability of any impact on water resources in the surface alluvial aquifers, if they are undermined. Each probability category has a range which takes into account uncertainty in

estimating the height of fracturing in the overburden. They are also considered to represent a conservative approach as the medium probability category (adverse impact possible) covers the depth range in which previous testing at Cockle Creek has identified no adverse impacts. Additionally, at the higher end (100 metres) of the high probability category (adverse impact probable), it is conceivable that no impacts will be detected as there is a 10 metre barrier above the maximum predicted height of fracturing (100 metres). This conservatism has been deemed necessary due to the uncertainty in estimating the height of fracturing. For further details regarding the risk assessment methodology and detailed results refer to the hydrogeological assessment in **Appendix 7**.

The risk assessment approach identified that several very small zones within the continued underground mining area had a probability category of medium due to the limited depth of cover to the mine workings (refer to **Figure 5.11**). Alluvial areas in the medium probability category are located in Cockle Creek, Diega Creek and Central Creek. All of the alluvial areas in the continued underground mining area are very limited in extent and located in first and second order drainage lines at the upper end of the creek catchments. The occurrence of significant alluvial aquifers in such areas is virtually unknown. As a result, a more detailed investigation of the nature of the alluvium in these areas is unwarranted as experience indicates that the likelihood of a significant aquifer in these deposits in the continued underground mining area is negligible. Moreover, any alluvial aquifers in the continued underground mining area will be of minor importance given their poor quality, low yield and lack of use, so that the consequences of an adverse outcome are less than would be the case for extraction under a major aquifer.

The probability and consequences of an adverse impact in the continued underground mining area has been assessed for the alluvium in each creek valley and are presented below. This process allows an assessment of the relative risks to the alluvial groundwater regime in each area. To assist in the evaluation of the hydrogeological risks, a risk matrix was formulated to categorise the risks (refer to **Appendix 7**).

Impact Assessment

Cockle Creek

The two small fingers of Cockle Creek alluvium which overlie the continued underground mining area (undermined by Longwall 38), fall into the medium probability category for an adverse outcome (refer to **Figure 5.11**). A previous study in this area (Pacific Power International, 2002) indicated that the Cockle Creek alluvium further east over Longwalls 27 and 28 comprised mostly clayey sand and sandy clay with occasional clean sand and gravelly bands, and no major aquifer zones. Longwall 38 crosses the alluvium at the western extremity of the Cockle Creek alluvial deposit, where it is much thinner than over Longwalls 27 and 28. It is therefore highly unlikely that it contains a significant aquifer. In addition, the contribution of this area to the groundwater in the alluvial aquifer further to the east, located outside of the continued underground mining area is negligible. As a result, the potential risk is low as it is considered likely that there will be no adverse impacts on either the groundwater regime in this catchment or the potential for future groundwater usage.

Diega Creek

One small area of alluvium overlying the continued underground mining area, in the upper Diega Creek catchment, is considered to have a medium probability of being impacted by the Project (refer to **Figure 5.11**). This area is located on the boundary between the Western and Southern domains, at the southern end of Longwall 40. The remainder of the alluvium in Diega Creek is considered to have a low probability of any impact occurring including the area which crosses the northern end of Longwall 47 and a small finger at the head of Little Diega Creek which is underlain by the southern end of Longwall 38.

It is considered highly unlikely that this alluvium contains any significant aquifer due to its narrow width and distance upstream from Lake Macquarie. As the alluvial area at risk is at the upstream end of the catchment the probability that it contains a significant aquifer at this location is even lower and its contribution to the groundwater in the aquifer further downstream, outside of the continued underground mining area would be negligible. Consequently, the likely overall impact on the groundwater regime and the potential for future groundwater usage in the Diega Creek catchment is likely to be negligible. The risk is therefore rated as low for the alluvium over Longwall 40 and very low for the alluvium over Longwalls 38 and 47.

Central Creek

Central Creek, a tributary of Palmers Creek, contains alluvium which overlies the continued underground mining area that will be undermined by Longwalls 46 and 47. A small portion of this alluvium (over Longwall 46) is considered to have a medium probability of being impacted by the Project while the remainder is considered to have a low probability (refer to **Figure 5.11**). It is highly unlikely that this alluvium contains any significant aquifer zones due to its narrow width and distance upstream from Lake Macquarie. The overall impact of future mining on the groundwater regime and the potential for future groundwater usage in Central Creek is likely to be negligible. In addition, the contribution of the Central Creek groundwater to the Palmers Creek aquifer is insignificant. As a result, it is considered likely that there will be no adverse impacts on either the groundwater regime in this catchment or the potential for future groundwater usage and the overall risk is rated as low to very low.

Ryhope Creek

Alluvium in Ryhope Creek which flows into Palmers Creek would not be undermined as part of the Project and hence the potential for any adverse consequences on the alluvium is rated as negligible.

It should be noted that in the upper catchment of Ryhope Creek the minimum depth of cover is 70 metres. At this depth of cover there is a possibility of a direct hydraulic connection between the ground surface and the goaf. As discussed above, this area will not be undermined thus reducing the risk of such a connection. There is the potential that some runoff which would normally flow down the creek may be diverted underground before it reaches the alluvium. The likelihood of this having an impact on groundwater in the alluvium further downstream is extremely low, as there will still be adequate runoff from other parts of the catchment to replenish the groundwater in the alluvium following rainfall events.

Ryhope Creek is a source of water for at least one groundwater user. As a result, the precautionary principle has been adopted, and the risk has been elevated to low from negligible[2].

Palmers Creek

Following changes to the mine plan, no longwall panels are located beneath the alluvium of Palmers Creek. The southern end of Longwall 45 is located approximately 300 metres to the north of the main alluvial deposit. The main aquifer in the Palmers Creek alluvium is located to the south of the creek channel, approximately 500 metres from the end of Longwall 45 which is unlikely to cause any impact on the alluvial material. It is considered that no adverse impacts from the extraction of the proposed longwall on the groundwater in the Palmers Creek alluvium will occur. Notwithstanding, as the nearest operating groundwater bore is

[2] A rating of negligible would have been applied if this consequence had not been taken into account

500 metres from the southern end of Longwall 45, the precautionary principle should apply and the assessed risk to this groundwater resource has been elevated from negligible to low.

It was also noted above that there is a possibility of some alteration to the flow in Ryhope Creek which flows into Palmers Creek. This will have a negligible impact on the hydrological conditions in Palmers Creek as the affected area in Ryhope Creek forms a negligible proportion of the Palmers Creek catchment.

In summary, the continuous underground mining area includes minor areas of alluvium in the upper catchments of the stream valleys, but does not contain significant aquifers. Given the small volume of alluvial sediments affected and the absence of aquifer-quality strata, the volumes are highly likely to be very low.

The Project does not proposed to extract any groundwater from alluvial aquifers and it is not planned to increase dewatering from current levels. Consequently, the proposed mining activities are consistent with the requirements of the Hunter Unregulated and Alluvial Water Sources Sharing Plan 2009.

5.4.3.2 Regional (Cumulative) Impact Assessment

The results of the hydrogeological assessment were used to determine any potential risks to the regional hydrogeologic regime. The two regional risk factors identified during this process are:

1. Any mining-related loss of groundwater from aquifers in the near-surface alluvial deposits may impact on the groundwater supplies and users of this resource further downstream.

2. Any mining-related loss of groundwater from coal seam aquifers in the overburden above the West Borehole Seam may impact on the groundwater supplies in the coal seams and users of this resource in other parts of the basin.

The hydrogeological assessment determined that both of these risks are considered negligible.

1. Alluvial aquifers

The regional risk to the alluvial aquifers is deemed to be negligible as:

- the alluvial areas that will be undermined are located in first and second order drainage lines at the upper reaches of the Cockle Creek and Palmers Creek catchments, and contain relatively low volumes of groundwater;

- no major aquifer zones were identified in the alluvial areas that are to be undermined in the continued underground mining area;

- the probability of any adverse impacts on any alluvial aquifers in the continued underground mining area (if they exist) was determined to be low to negligible; and

- the total area of alluvium in the continued underground mining area relative to the total area of alluvium in the two catchments is very small.

2. Coal seam aquifers

The regional risk to the coal seam aquifers is deemed to be negligible as:

- coal seam aquifers in this region do not provide an important source of groundwater due to poor quality and yields, and are only utilised intermittently;
- no significant coal seam aquifers have been identified in the overburden above the West Borehole Seam in the continued underground mining area;
- there has already been significant coal extraction in the West Borehole Seam in this region which would have depleted any groundwater resource in that seam and the overlying coal seams if any resource existed;
- the affected seams subcrop immediately to the west of the continued underground mining area so that there is minimal chance for drainage of groundwater resources updip; and
- the continued underground mining area covers a relatively small area when compared to the total coal basin so that any additional regional impact would be negligible.

5.4.4 Management Strategies

Cockle Creek (LOW risk)

The current monitoring program for Longwall 27, 28 and 31 being carried out is recommended to be discontinued. No additional monitoring or mitigation measures were recommended in the hydrogeological assessment in respect of the alluvial aquifer as there are only two small areas of alluvium that will have already be undermined in the continued underground mining area by Longwall 38. Neither of these alluvial areas contained a significant alluvial aquifer.

Central Creek (LOW to VERY LOW risk)

The area with a medium probability of adverse impacts is very small. No actions are recommended in respect of the alluvial aquifer as:

- there is only one area of alluvium that will be undermined in the continued underground mining area by Longwalls 46 and 47;
- there is no significant alluvial aquifer in the area of the proposed continued underground mining area; and
- this area is considered in the hydrogeological assessment to have only a medium to low probability of being impacted by mining.

WWC will review the need for establishment of alluvial monitoring in Central Creek within the continued underground mining area prior to commencement of mining in Longwall 46 in consultation with NOW.

Diega Creek (LOW to VERY LOW risk)

The Diega Creek alluvium in the continued underground mining area is in the low to very low risk categories, and has a low potential for significant impact by the proposed extraction as:

- there are only two small areas of alluvium that will be undermined in the continued underground mining area by Longwalls 38, 40 and 47;
- this alluvium does not contain a significant alluvial aquifer; and
- this area is considered to have only a medium probability of being impacted by mining.

Diega Creek has been undermined extensively further to the east and concerns have been raised in the past by local residents over the impact of mining on the creek. Due to the previous mining history in this area, two monitoring bores have been constructed in the Diega Creek alluvium to confirm the conclusions of this assessment. Ongoing monitoring of these bores will continue. WWC will also review the need for establishment of further alluvial monitoring in Diega Creek prior to commencement of mining in Longwall 46 in consultation with NOW.

Ryhope Creek (LOW risk)

The alluvium in Ryhope Creek contains no major aquifer of significance and will not be undermined as part of the Project. However, further consideration is necessary as:

- it flows into Palmers Creek which contains a major alluvial aquifer;
- it is near several proposed longwall panels on the southern side of the continued underground mining area where the depth of cover to the coal seam is as low as 85 metres;
- there is a slight possibility that the flow in the creek may be impacted by mining at shallow depths of cover in the Western domain further upstream;
- a local nursery utilises groundwater from the alluvium in the creek.

Three monitoring bores have been installed in the creek to monitor the groundwater in the alluvium. One of these has been established near the groundwater-fed dam utilised by the Ryhope Nursery. Continued monitoring of these bores will be undertaken. If the monitoring indicates any adverse impact on the groundwater in the alluvial area downstream, investigations will be undertaken and remedial measures may be required to assist in restoring the flow in the creek from upstream. The necessary measures would most likely comprise grouting of any cracks in the drainage line, so that the normal flow regime is restored.

Palmers Creek (LOW risk)

Palmers Creek will not be undermined by any longwall panels, the nearest of which will be located more than 300 metres to the north. Nevertheless, because of the importance of the alluvial aquifer in the creek and the shallow depth of cover, one monitoring site has been established for ongoing monitoring. This site is the registered bore (No. 64025) that is closest to the proposed mine workings. Ongoing monitoring of this bore will continue as part of the project.

5.5 Surface Water

A comprehensive surface water assessment for the Project has been completed by Umwelt. A summary of the key findings of the surface water assessment is provided below, with the full report included in **Appendix 8**.

5.5.1 Existing Surface Water Environment

5.5.1.1 Biophysical

Regional and Catchment Setting

The project application area is located within the headwaters of the Cockle Creek, Palmers Creek, Bangalow Creek, Blue Gum Creek and Minmi Creek systems (refer to **Figure 5.2**).

One subcatchment of Cockle Creek (Diega Creek), one subcatchment of Palmers Creek (Boggy Hole Creek), Palmers Creek and Bangalow Creek are located within the continued underground mining area. Cockle Creek and Palmers Creek drain to Lake Macquarie while Bangalow Creek flows to the western side of the Sugarloaf Range and is part of the Wallis Creek system. Wallis Creek is a tributary of the Hunter River.

The WWC pit top facilities are located within the catchment area of Burkes Creek. The proposed Mining Services Facility, located on Wakefield Road (refer to **Figure 1.3**) is located within the catchment area of Palmers Creek.

The continued underground mining area is located within the Sugarloaf Range and Awaba Hills physiographic regions of the Lower Hunter (Matthei, 1995). These regions comprise two main landscape types: the steep slopes of the Sugarloaf Range and the lower slopes and foothills of the Sugarloaf Range and the Awaba Hills, as described in **Section 1.4.4**.

5.5.1.2 Soils and Land Use

The soil types occurring within the continued underground mining area and at the site of the existing WWC pit top facility and proposed Mining Services Facility are mapped on the Newcastle 1:100,000 Soil Landscapes Map Sheet (Matthei, 1995). Soil landscapes present within the continued underground mining area and existing pit top facility are discussed in **Section 5.15.1**.

The land use within and surrounding both the existing WWC pit top facilities and the continued underground mining area is discussed in **Section 1.4.3**.

5.5.1.3 Hydrology

Tributaries within the continued underground mine area are typically ephemeral creek systems with flows only occurring during storm events or after prolonged rainfall. Regular pools of permanent or semi-permanent water are present in the downstream reaches of most of the tributaries.

Sections of Cockle Creek and its tributary Diega Creek, tributaries of Palmers Creek, including Boggy Hole Creek, and Bangalow Creek are located within the predicted subsidence affectation zone, as shown in **Figure 5.2**.

Characteristics of key catchments within the continued underground mining area are presented in **Table 5.6**.

Table 5.6 - Key Catchment Areas within the Continued Underground Mining Area

Creek	Stream Category and Order[1]	Stream Order within Predicted Subsidence Affectation Zone	Total Catchment Area (ha)	Catchment Area within Predicted Subsidence Affectation Zone (ha)	Catchment Area within Predicted Subsidence Affectation Zone (%)
Cockle Creek[2]	3 (6th order)	1st order	2750	285	10%
Burkes Creek	2 (4th order)	-	1555	0	0%
Diega Creek	2 (4th order)	2nd order	1065	235	22%
Palmers Creek	3 (5th order)	2nd order	2630	105	4%
Boggy Hole Creek	2 (3rd order)	-	400	2	1%
Bangalow Creek	2 (4th order)	1st order	1115	85	8%

Note 1: DWE (undated) classifies streams using the Strahler stream order system in order to understand the potential catchment contribution of the stream. The Strahler ordering system begins in the headwaters of streams, with first order streams merging to form second order streams, second order streams merging to form third order streams, and so on. The stream order is based on the overall catchment, not the project area. DWE (undated) divides stream orders into three categories:

- Category 1 – usually intermittent and consisting of first or second order streams;
- Category 2 – third and higher order streams that drain into primary catchment rivers;
- Category 3 – these streams are major rivers and their primary tributaries and associated alluvial groundwater zones.

Note 2: Areas listed include all of the subcatchment areas of Cockle Creek.

For further detail regarding each of the creeks outlined in **Table 5.6**, refer to Section 2.4 of **Appendix 8**.

5.5.2 Water Management Systems and Infrastructure

5.5.2.1 Existing Water Management System

WWC has an existing water management system which includes mine dewatering systems, water storages, sediment dams, drains and earth bunding around the laydown hardstand areas and fuelling areas.

The WWC Water Management System (WMS) has the following key functions:

- management of groundwater inflows into the underground mine workings;
- management of surface water runoff at the WWC pit top site, through:
  - collection and treatment of runoff from surface infrastructure areas where water may come into contact with contaminants;
  - treatment of water with flocculants to improve sedimentation prior to discharge;
- reducing the discharge of pollutants from the mine to the environment; and
- managing the approved water discharges to achieve compliance with licence conditions.

The existing WMS will continue to be used to control and treat runoff from the WWC pit top site with surface runoff directed to the water management system dams for use as dust suppression or discharge.

Water Sources

The main sources of water at the WWC pit top are potable water and runoff. Potable water is used in the administration buildings, bathhouse and truck wash. Disturbed runoff is collected in the site water management dams, while clean water runoff is diverted around dirty water catchments through diversion drains.

Within the underground mine workings, the main sources of water are intercepted groundwater and potable water. Potable water is supplied from HWC mains and is used as process water for the underground mining equipment and for dust suppression.

Water Storage

WWC has limited water storage areas with water storage available at the WWC pit top and within the underground workings. There are four dams located at the WWC pit top site that have a combined storage volume of approximately 12 ML and a total catchment area of approximately 10.9 hectares. The dams are maintained with minimal storage volumes to ensure the ability to capture and treat stormwater runoff events. The dams all have capacities in excess of the 5 day 95th percentile rainfall event (Landcom, 2004). Further specifications of these dams are provided in the Surface water assessment in **Appendix 8**.

Water Use

Approximately 14 ML of water per year is currently used at the WWC pit top for dust suppression and wash down water. Approximately 11 ML per year of potable water, imported from HWC mains, is also used at the WWC pit top for bathroom and drinking water.

Water is used in the underground mining operations for dust suppression, cooling of mining equipment, in wash down areas, human consumption and longwall process water. Water is also lost to the ROM coal and ventilation air in the underground mining operations. It is estimated that approximately 178 ML per year of water is required to support underground mining operations.

The total water demand for the WWC operations is currently in the order of 230 ML per year.

Site Water Balance

The primary factors, inflows and losses, affecting the site water balance are described below;

- Inflows:
  - catchment runoff and rainfall onto dam surfaces;
  - groundwater inflows into the underground operations; and
  - import of potable water for administration facilities and to support underground mining operations.
- Losses:
  - underground mining operations (i.e. water lost to ROM, emulsion mixing, dust suppression, ventilation air);
  - surface facilities (i.e. dust suppression and the WWC pit top site);
  - evaporation from dam surfaces;
  - water lost (i.e. bound) to ROM coal; and
  - treated sewage effluent pumped to MCPP.

A summary of the estimated site water balance for January 2009 to December 2009 is presented in **Table 5.7**. The January 2009 to December 2009 water balance is considered to be an accurate representation of the current water balance at WWC and is suitable to be used as a basis for determining the future (i.e. predicted) water balance for the Project.

Table 5.7 – Average Site Water Balance (January 2009 to December 2009)

Component	Volume (ML/year)
Inflows	
• Rainfall/runoff	64
• Groundwater inflows	901
• Potable water import	219
Total Inflows	**1184**
Losses	
• Lost to ROM coal	-148
• Equipment wash down and dust suppression	-14
• Evaporation from surface dams	-8
• Lost to humidity/ventilation in the underground	-29
Total Losses	**-199**
GROSS WATER BALANCE	**985**
Discharges and Transfers Off Site	
• Discharge via EPA point 2 (Burkes Creek)	-20
• Extracted at Westside Mine via LW11	-918
• Effluent transferred to MCPP	-11
Total Discharges and Transfers	**-949**
Net Difference in Measured and Estimated Flows	**36** (i.e. 3% of Inflows)

WWC is a gross water surplus site prior to discharge and transfer, with surplus water being generated within the underground workings and the surface facilities at the WWC pit top.

During January 2009 to December 2009, WWC had a gross water surplus of approximately 985 ML (refer to **Table 5.7**). Approximately 20 ML of this surplus was discharged to Burkes Creek under EPL No. 1360 from the WWC pit top area.

The remaining gross water make was either transferred as treated effluent to MCPP (approximately 11 ML) or extracted at Longwall 11 and transferred to Westside Mine (approximately 918 ML).

Approximately 219 ML of potable water was imported to site during January 2009 to December 2009. This potable water was used in the administration facilities and also in the underground and within WWCs surface facilities.

This analysis indicates a net difference between measured and estimated flows of approximately 36 ML. This is equivalent to approximately 3 per cent of the estimated inflows to the operations. WWC will continue to update and refine the site water balance, on an annual basis.

Water Transfer/Disposal

WWC currently has three options for the disposal and transfer of surplus water, as follows:

- treated effluent transfers to MCPP;
- the existing licensed discharge point under EPL No. 1360; and
- groundwater extraction and transfer to Westside Mine from Longwall 11 (20BL169793) under EPL No. 4033.

WWC has one licensed discharge point (EPA Point 2) under EPL No. 1360 (refer to **Figure 2.7**). The licensed discharge point (EPA Point 2) is only used for discharge of surplus site water runoff from the WWC pit top site, however, this EPA Point 2 is necessary as a contingency for mine water discharge if there are problems encountered within the Longwall 11 mine water discharge system.

The EPL No. 1360 allows discharge of up to 4 ML per day within the following water quality limits:

- electrical conductivity (EC) <10,000 µS/cm;
- pH between 6.5 and 9.0; and
- total suspended solids (TSS) <50 mg/L.

The licensed discharge facility is used to manage water levels within the water management dams in order to ensure that sufficient storage capacity is available during storm events. Sediment is periodically removed from the dams in order to maintain storage capacity.

The total volumes discharged via EPA Point 2 were 615 ML, 543 ML and 227 ML for 2006, 2007 and 2008 respectively. During this period (i.e. 2006 to 2008) there was one day where the licence limit of 4 ML per day was exceeded. This non-compliance was due to a significant rainfall event of 140 millimetres. Since this event, WWC has installed a siphon system to allow the site to maintain dams at an appropriate level.

Surplus water (including groundwater inflows) within the underground mining operations is extracted at a surface borehole above Longwall 11 for discharge at Westside Mine. The extraction of groundwater is licensed under Part 5 of the *Water Act 1912* (Licence No. 20BL169793) which currently provides for extraction of up to 360 ML per year. A licence variation has been submitted to NSW Office of Water to increase the annual extraction limit.

Pollution Reduction and Water Efficiency Program

In December 2000, DEC (now DECCW) added a Pollution Reduction Program (PRP) requirement to EPL No. 1360. The PRP has since been removed from the EPL. The aim of the PRP is to reduce the discharge of saline mine water to freshwater streams in the region, including Cockle Creek and Burkes Creek. In response to the PRP, WWC has undertaken detailed investigations into mine water management.

As a result of these investigations WWC is proposing to transfer excess mine water to Metromix Quarries, located on Rhondda Road at Teralba. Metromix propose to use the transferred mine water as process water which will result in a reduction in the combined water discharged into the Lake Macquarie catchment from WWC and Metromix.

A Development Application has been approved by LMCC for the construction of the transfer pipeline and discussions are currently being held with DECCW, Coal and Allied, Westside Mine and Metromix to determine the licensing arrangements for the transfer. The Development Consent would be relinquished as part of this project application, refer to **Section 2.2.2**.

In response to requests by DECCW and in accordance with Xstrata's environmental goals under the XCN sustainability program, WWC has also undertaken detailed investigations into options for reducing the use of potable water and discharge to Cockle Creek. The majority of the potable water demand on site is for process water in the underground mining operation. The water in the underground operations is used at the longwall (approximately 75 per cent), for longwall emulsions (approximately 4 per cent) and for development units and dust suppression (approximately 21 per cent).

WWC are currently assessing an option to reduce the volume of potable water used on site by shandying potable water with mine water for re-use on site. To date, WWC has reviewed the available data for underground mining water used at other Xstrata operations and has determined, based on electrical conductivity data that the most appropriate mixing percentage would be approximately 40/60 mine water to potable water. As a result, WWC has determined that shandying mine water to potable water is potentially sustainable.

WWC will complete a series of investigations within 12 months of Project Approval, including:

- a more detailed desktop investigation of the various salt concentrations at other Xstrata operations and relevance to WWC;
- trialling shandying percentages based on the more detailed investigations of salts; and
- determining the most appropriate shandying percentage taking into consideration potential water quality impacts on the life and maintenance of the underground mining equipment.

The optimal water re-use strategy confirmed by the investigations will be implemented within two years of Project Approval. If the investigations indicate that shandying potable water with mine water for re-use on site is not viable, WWC will investigate the feasibility of other options for mine water treatment and re-use, e.g. reverse osmosis.

The re-use of mine water as process water will also reduce the volume of water required to be discharged or transferred off site.

Sewage Management

Sewage treatment at WWC is provided by a biological Sewage Treatment Plant (STP) at the WWC pit top site. Effluent from the STP is pumped off site to the maturation ponds at the MCPP and used as process water within the MCPP.

Water Quality and Management

Water quality is monitored within the drain upstream of the EPA Point 2 discharge point. Water quality in Burkes Creek upstream and downstream of the discharge location is also monitored. Historical data for July 2006 to June 2008 indicates that pH and conductivity have historically been within the discharge limits discussed above. While the EPL does not stipulate any further water quality limits, additional monitoring is undertaken on a monthly basis. This additional monitoring has been undertaken at the request of DECCW and is part of a wider catchment investigation of the level of suspended solid, heavy metal and salt concentrations in mine water discharges to Lake Macquarie. WCC has monitored arsenic,

chromium, manganese, selenium and zinc upstream of the discharge location, downstream of the discharge location and in the discharge water (i.e. Drain A). A summary of the results of this monitoring are shown in **Table 5.8**.

Table 5.8 – Range in Surface Water Monitoring Results for Heavy Metals

Analyte	Burkes Creek Upstream (mg/L)	Drain A (mg/L)	Burkes Creek Downstream (mg/L)	ANZECC Guidelines[1] (mg/L)
Arsenic	<5	<5	<5	24
Chromium	<5 to 7	<5 to 6	<5 to 7	1
Manganese	24 to 849	12 to 42	18 to 811	1900
Selenium	<5	<5	<5	5
Zinc	16 to 40	13 to 35	12 to 55	8

Note 1: ANZECC Trigger values for slightly to moderately disturbed systems (ANZECC, 2000).

The monitoring results for heavy metals in Burkes Creek indicate that:

- arsenic levels are below ANZECC (2000) guidelines and do not appear to be influenced by discharges from WWC;
- chromium levels are above ANZECC (2000) guidelines, however these levels do not appear to be influenced by discharges from WWC as the monitoring for all three locations is similar;
- manganese levels are below ANZECC (2000) guidelines and these levels appear to decrease downstream of the discharge point;
- selenium levels are within ANZECC (2000) guidelines and do not appear to be influenced by discharges from WWC; and
- zinc levels are above ANZECC (2000) guidelines, however these levels do not appear to be influenced by discharges from WWC as the levels recorded in the discharges from WWC as less than those recorded in the creek system.

The variations in the monitoring results are considered to be the result of natural fluctuations in water quality. In summary, the monitoring indicates discharges from the WWC pit top facility have not influenced heavy metal concentrations in Burkes Creek. The anticipated discharges from WWC are expected to continue to meet relevant ANZECC Guidelines.

For a full review of water quality results from EPA Point 2 refer to **Appendix 8**.

Daily visual inspections of the dam system at the WWC pit top are undertaken to determine whether the flocculent dosing rate requires adjustment. In addition, a second flocculent dosing station has been commissioned on the inlet to the bottom settlement dam. The utilisation of the second station will reduce the level of TSS in the discharge from EPA Point 2 during high rainfall events.

The transfer of underground mine water to Westside Mine (via Longwall 11 borehole) has also reduced the possibility of exceedances, by removing mine water from the pit top dams, increasing their ability to accommodate storm events. In the future, the proposed water transfer program will assist in reducing the potential of overflows from the WWC pit top site dams.

5.5.2.2 Existing Surface Facilities

WWC underground will continue to be accessed using the existing pit top facilities located at Killingworth. The existing WWC pit top facilities will continue to be managed in accordance with the existing water monitoring and management procedures.

The existing water monitoring and management procedures include procedures for:

- monitoring of surface water in surrounding watercourses and discharges from the WWC pit top facilities;
- managing water levels and quality in on-site dams, including dam cleaning;
- pipeline management; and
- the relevant roles and responsibilities of on-site personnel.

5.5.3 Impact Assessment

5.5.3.1 Subsidence Impacts

Subsidence impacts associated with continued underground mining operations can include a change in local landform characteristics. These changes have the potential to impact surface water management structures including dams, roads and culverts. Natural hydrology features, such as creeks and drainage lines also have the potential to be impacted by subsidence. Analysis of subsidence predictions for the project indicates that some changes may occur in the alignment of minor drainage line channels, however catchment boundaries will not be significantly impacted.

There are several first and second order drainage lines located within the subsidence affectation zone of the continued underground mining area. Drainage lines within the continued underground mining area are currently in a range of conditions with erosion evident at some locations. Landform subsidence has the potential to impact peak flow velocities in drainage lines. An increase in flow velocity has the potential to damage or strip riparian vegetation within the drainage line. Further, increases in flow velocity would generally result in an increased sediment load. Modelling results indicate that drainage lines are typically subject to velocities in the range of approximately 1.0 m/s to approximately 2.5 m/s during major storm events (i.e. a 100 year Average Recurrence Interval (ARI) storm event) and approximately 0.5 m/s to approximately 1.5 m/s during minor storm events (i.e. a 5 year ARI storm event). Velocities lower than 1.5 m/s to 2.3 m/s are typically non-scouring in vegetated channels. Some scouring and erosion may occur with higher velocities or when vegetative cover is absent.

Modelling indicates that the maximum predicted increases in velocities range up to approximately 0.3 m/s during the 5 year ARI storm event and up to approximately 0.34 m/s during the 100 year ARI storm event.

Modelling of the typical drainage line indicates that there will be some minor changes to the predicted post-mining velocities during both major and minor storm events with the landform changes as a result of the predicted subsidence. The modelling indicates that underground mining may result in some areas of erosion and deposition occurring within the drainage lines. However, the potential impacts that these modelled changes could have on the creek channels are expected to be minor.

There is the potential for in-channel surface ponding to occur as a result of the continued underground mining operations. Based on local creek profiles, it is considered unlikely that any out-of-channel ponding will occur. As the slope of the land surrounding the channels is relatively steep, it is anticipated that if any out-of-channel ponding does occur, flow will immediately be directed back to the creek system resulting in no significant impact.

There is also the potential that minor bank slumping and head cut erosion may occur in drainage lines in the Western domain due to the existing incised nature of the drainage lines, although historical monitoring of drainage lines in similar topographies in the Northern domain has shown no evidence of significant bank or channel destabilisation related to subsidence.

Surface cracking associated with continued underground mining has the potential to create a direct hydraulic connection to the underground mining area, where depths of cover are less than 70 metres. Significant changes to the mine plan have been employed to reduce the potential for inter-connective cracking, as discussed in **Section 2.3.2**. Surface cracking resulting in a direct hydraulic connection can alter surface water flow regimes, redirecting water into the underground mining areas. A redirection of surface water flow has the potential to impact ecology in the area, refer to **Section 5.3** for further details.

Direct hydraulic connection could also increase the volume of water entering the existing water management system. An increase in the volume of water entering the water management system would impact the site water balance and associated management procedures. Surface cracking is most likely to occur in first and second order, ephemeral drainage lines, thus reducing the potential severity, should surface cracking occur.

Loss of surface water runoff as a result of subsidence cracking with direct hydraulic connection has the potential to reduce the surface water available for downstream users. In areas where surface cracking occurs, investigations will be undertaken to determine whether remediation works are required. Remediation works, including natural self healing mechanisms, surface tilling and grouting, will be undertaken to fill the cracks at the surface and limit potential ingress of surface runoff into the proposed underground mining operations, where required. These remediation works will be undertaken in a manner so as to minimise the potential for adverse environmental impacts through utilising the due diligence assessment process as outlined in **Section 5.3.4**.

As any cracking will appear very rapidly on the surface after longwall mining, regular inspections and resealing of in-channel cracks will be undertaken, if required. These progressive resealing works will significantly reduce the potential for loss of surface flows due to subsidence cracking. As the potential for interconnective cracking is limited to a small area and there is limited use of surface waters downstream of the continued underground mining area the potential impacts on downstream users are considered to be negligible.

5.5.3.2 Water Balance

The primary water sources identified for the Project are the potable water supply, catchment runoff and rainfall on dams within the mine water management system and groundwater inflows to the underground mine. Primary water losses include water lost to evaporation, potable water use and water exported with ROM coal to MCPP.

A water balance model was prepared as part of the surface water assessment, refer to **Appendix 8**. Risk analysis of the predictive model outputs enabled calculation of the probability of different water balance outcomes based on variability in the model input data. Three probable scenarios from the risk analysis included the 10th percentile (dry year), 50th percentile (average year) and 90th percentile (wet year) water balance predictions.

As the predicted groundwater inflows do not vary, the fluctuations in the predicted water balance are primarily due to changes in future production rates.

The predictive water balance model indicated that:

- if no mixing of potable water with mine water occurs, potable water import will range between approximately 210 ML per year to approximately 405 ML per year;
- if mixing of potable water with mine water occurs, it is predicted that there will be a reduction of potable water use to below approximately 250 ML per year;
- discharges from EPA Point 2 are driven by rainfall/runoff regimes and will range between approximately 20 ML per year to approximately 90 ML per year;
- mine water extraction from the underground operations via 20BL169793 will range between approximately 960 ML per year to approximately 1000 ML per year with approximately 800 ML of this water consisting of groundwater inflow to the underground mining operations;
- transfers of sewage effluent to MCPP will remain constant at approximately 20 ML per year as no increase in staffing is predicted to occur at WWC; and
- discharges of mine water from EPA Point 2 will occur if the WWC pump facility requires repairs and maintenance.

5.5.3.3 Construction Activities

Construction and operational activities, associated with the Mining Services Facility also has the potential to have a very minor impact on local hydrology. Earthworks would be undertaken in an area approximately 35 metres by 20 metres within a previously disturbed area. The works would also involve the construction of an access road entering the facility from Wakefield Road. Earthworks activities can facilitate sediment mobilisation in periods of rainfall. Earthworks can also alter surface water flow regimes through altering of current topographical conditions. The area proposed for the construction of the Mining Services Facility is previously disturbed, reducing vegetation acting as a natural erosion control. It is considered that a lack of vegetative cover in conjunction with proposed activity will increase the potential for the generation of sediment laden runoff being generated during periods of rainfall. Potential erosion and sediment impacts would be managed via the adoption of management procedures outlined in **Section 5.5.4**.

5.5.3.4 Summary of Impacts

The surface water assessment of the predicted subsidence impacts indicates that the catchment boundaries of the creek systems to be undermined will not change significantly. It is also considered unlikely that any significant ponding or storage of surface runoff will occur. A series of monitoring points have been identified to monitor potential surface water impacts.

Sediment and erosion control measures are proposed to ensure that there will be no significant impact on downstream water qualities if subsidence remediation works are required. Erosion and sediment controls will also be implemented during construction activities associated with the Mining Services Facility.

In terms of water quality, the only discharges from the WWC mine water management system other than clean water diversions will be from licensed DECCW discharge points which are monitored and controlled. Consequently, potential water quality impacts will be limited to that associated with the EPL.

WWC also propose to continue to transfer treated effluent from the on-site STP to MCPP for re-use. WWC will continue to review the use of potable water and methods to reduce this usage.

On this basis it is considered that the Project will not result in adverse cumulative impacts on water use, flows or qualities in the surrounding areas.

5.5.3.5 Contingency Measures

Water

The Project will continue to have water in excess of its operational needs. With the proposed increase in the licence extraction volume at Longwall 11 there will be a considerable buffer in WWC's ability to manage water surplus on site. Water sharing opportunities with the nearby Metromix quarry may provide additional discharge capacity and additional water storage opportunities may be available within the former underground workings if required. The mine water re-use project also has the effect of reducing mine water discharges to the local creek system and hence to Lake Macquarie.

Soil

If surface stabilisation during remediation works or earthworks for the Mining Services Facility is required due to surface rilling, tilling with gypsum or lime during reshaping and prior to revegetation may be required and additional erosion and sedimentation controls will be implemented.

5.5.4 Monitoring and Management

The proposed remediation and monitoring protocols will be included in the SMP/Extraction Management Plan (EMP) or equivalent process throughout the life of the Project to minimise surface water impacts.

Surface water quality monitoring at WWC will continue for the life of the Project. Existing water monitoring and reporting programs will be reviewed and incorporated into the Water Management Plan (WMP) for WWC should consent be granted for the Project. This plan will address all aspects of the ongoing management and monitoring of water at WWC and will include surface and groundwater monitoring programs and a sediment and erosion control plan.

5.5.4.1 Monitoring

General Monitoring

During the construction of the Mining Services Facility, all works and the erosion and sediment controls will be inspected on a regular basis to ensure that all required controls are in place and effective. Following the completion of construction works, the work area will be inspected in accordance with WWC's current inspection program (weekly) and after any rainfall events generating runoff until revegetation and stabilisation of drainage structures are complete.

During the operational phase of the Project, monitoring of the water management controls will be undertaken on a monthly basis and after major storm events.

The walls of all water management dams will be inspected biennially (every two years) for their structural integrity and for any maintenance requirements.

Surface water monitoring results will be reported in the WWC Annual Environmental Management Report (AEMR) which is distributed to DoP, DI&I, DECCW and other relevant government agencies and made available to the community through OCAL's website. The results of the water quality monitoring will be used to review the effectiveness of the WWC mine water management system on an ongoing basis.

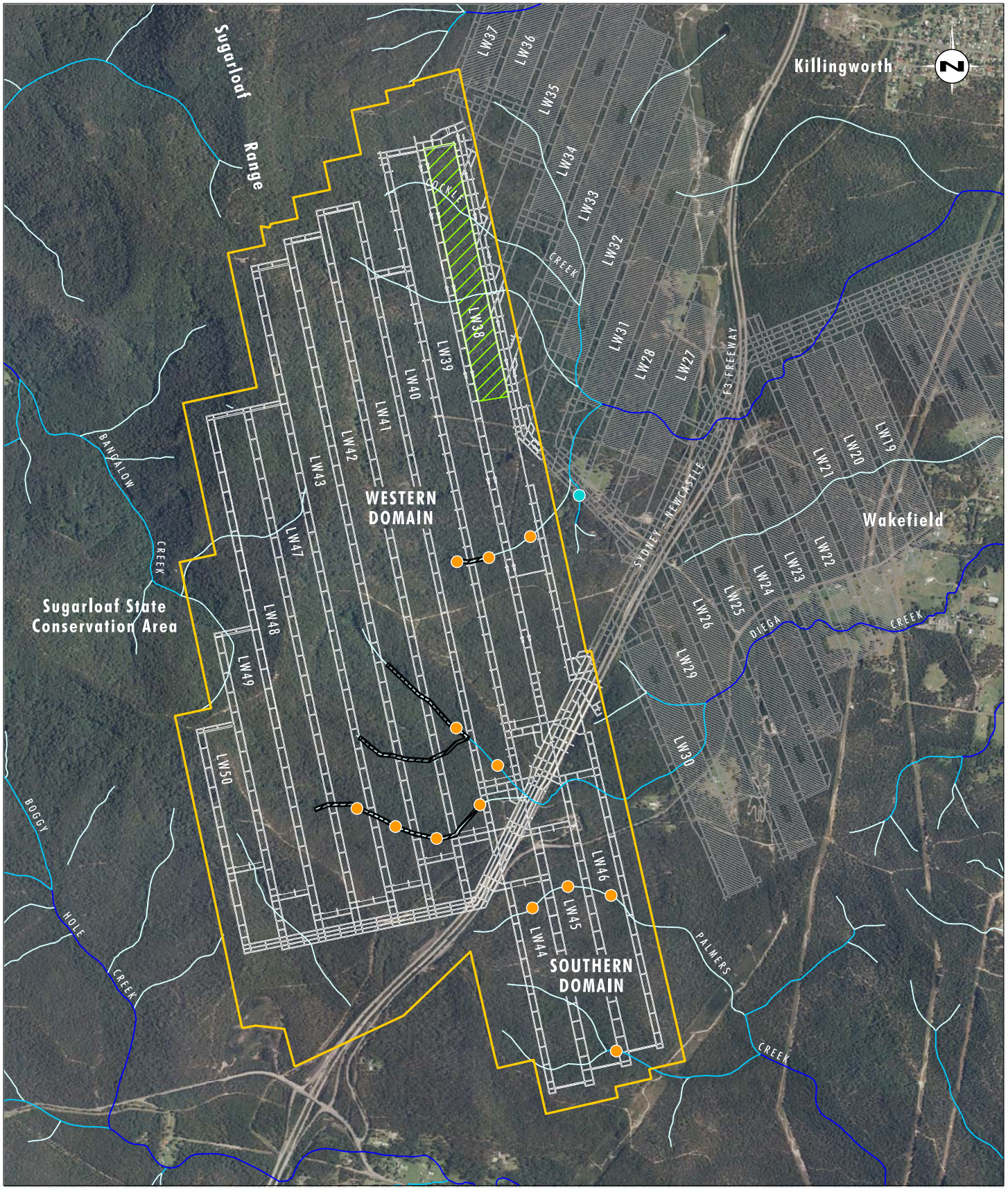
Water usage, rainfall, dam volumes and discharges (including transfers) at WWC will also continue to be monitored for the entire operation to assist in the management of the mine water management system.

Water management system dams will be monitored to ensure that any overflows or discharges are to an appropriate standard and in accordance with EPL conditions.

Subsidence Impact Monitoring

A comprehensive monitoring regime will be implemented to monitor drainage lines and the locations identified in **Figure 5.12** for potential subsidence impacts. Monitoring procedures will include:

- monitoring of vertical and horizontal subsidence along second order drainage lines as determined in consultation with the DI&I;
- monitoring, measuring and recording (e.g. photographic records) of the extent and magnitude of any surface cracking along the second order drainage line and first order drainage lines in depths of cover less than 100 metres that may occur during and post mining operations. If works are required (sealing of cracks), methods approved by the DECCW and DI&I would be adopted;
- visual inspection and recording of stream bed and bank condition and riparian vegetation along the second order drainage line, including collection of baseline data and monitoring during and post mining operations;
- monitoring of geomorphological response of each watercourse to the predicted subsidence, as follows:
    - prior to mining review the potential geomorphological response of each watercourse to the predicted subsidence using the guidelines included in *River Hydrology and Energy Relationships – Design Notes for the Mining Industry published by Department of Water and Energy* (November 2007) and the methods described below;
    - for each watercourse within the continued underground mining area:
        - describe the existing (i.e. pre-mining) watercourse characteristics including bed controls using approaches outlined in AUSRIVAS (Australian River Assessment System);
        - calculate the stream power for the existing and predicted subsidence conditions;
        - determine threshold limits of stream power for incision and bed load deflation, taking into consideration existing stream stability, surface and substrate soil conditions and stream grades;
        - refine the monitoring program, including monitoring of:



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines

0 0.5 1.0 1.5km
1:30 000

Legend

- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Ponding Monitoring Location
- Dam Monitoring Location
- Surface Cracking Area 1st Order Drainage line
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream

FIGURE 5.12

Subsidence Related Surface Water Monitoring

File Name (A4): R08_V1/2553_292.dgn

- any bed control points;
- areas where subsidence may increase the stream power above the determined threshold limits potentially causing channel erosion/instability;
- monitoring may include long section and cross section surveys, photographic records and/or methods outlined in AUSRIVAS;

- investigate and implement any remediation required to mitigate potential impacts of changes in stream power as a result of underground mining activities; and

- during and post mining, monitor watercourses, in accordance with the developed monitoring program;

- ongoing monitoring and maintenance will be necessary for any areas requiring surface mitigation works to facilitate effective rehabilitation.

5.5.4.2 Management

Subsidence Impact Management

With due consideration of existing surface water regimes, associated topography and depth of cover within the continued underground mining area, it is considered unlikely that significant remediation works will be required in areas with depths of cover greater than 100 metres. However, remediation works are likely to be required in areas with depths of cover less than 100 metres to minimise surface hydrology impacts and for mine safety issues.

Where remediation works are required, it is not considered practical to divert runoff from upstream catchment areas around potential impact areas due to the steepness of the catchment, surrounding topography and vegetation. Therefore, it is proposed that all remediation works be managed in stream. This situation is considered typical of the drainage lines within the continued underground mining area.

Subsidence impact management procedures include:

- management of surface water runoff post mining until completion of remediation. The volumes of runoff likely to be encountered in a rainfall event and how to control this water will need to be considered;

- erosion and sediment controls where required, including:

  - ensuring the erosion and sediment controls are installed as a first step within the works program;

  - limiting access tracks into works areas, including use of existing access tracks where possible;

  - where disturbance is required ensure that the disturbance is minimal;

  - construction and regular maintenance of sediment fences downslope of disturbed areas;

  - applying gypsum, where required, to reduce the dispersibility of subsoils;

- prompt revegetation of disturbed areas; and
- where new access tracks are required, construction of these in accordance with *Guidelines for the planning, construction and maintenance of tracks* published by Department of Land and Water Conservation (1994), including:
    - construction of access tracks along the contour where possible (i.e. limit grade changes);
    - minimising disturbance of existing ground, e.g. where possible limiting works to slashing vegetation when constructing tracks;
    - limiting construction of access tracks across existing drainage lines;
    - maintaining vegetation buffers between access tracks and watercourses where possible;
    - ensuring tracks are free draining; and
    - including cross fall and outfall drainage, where required, to prevent concentration of runoff.

WWC currently operates under a surface water monitoring plan which involves pre and post mining inspections of any subsided drainage lines. The plan was developed in consultation with the DECCW for the current SMP approval.

Water Management Systems

WWC is proposing to use the existing licensed discharge facility, EPA Point 2 under EPL No. 1360, continued use of the extraction of water from Longwall 11 under 20BL169793 and transfer of sewage effluent to MCPP for re-use to manage the predicted site water surplus. The transfer of surplus underground water to the Metromix quarry for re-use will also be undertaken. The re-use project facilitates a reduction of the overall potential impact on regional surface waters for the life of the Project.

Infrastructure Works Management

Erosion and sediment control measures will be carried out in accordance with relevant guidelines, including:

- *Managing Urban Stormwater Soils and Construction* (the Blue Book) *Volume 1* (Landcom, 2004) *and Volume 2E Mines and Quarries* (DECC, 2008); and
- *Draft Guidelines for the Design of Stable Drainage Lines on Rehabilitated Minesites in the Hunter Coalfields* (DIPNR, undated).

The erosion and sediment control measures proposed to be incorporated into infrastructure construction, primarily the proposed mining services facility, and potential subsidence remediation works during the Project include:

- clearly identifying and delineating areas required to be disturbed and ensuring that disturbance is limited only to those areas, clearing vegetation only as required to achieve the works and minimising machinery disturbance outside of these areas;
- construction of erosion and sediment controls prior to the commencement of any substantial construction or earth works;
- limiting the number of roads and tracks established;

- constructing diversion drains upslope of areas to be disturbed to convey clean runoff away from disturbed areas;
- construction and regular maintenance of sediment fences downslope of disturbed areas, including the construction sites for sediment dams, diversion drains and catch drains;
- seeding and controlled fertilising of disturbed areas to provide for rapid grass cover establishment. Areas will be seeded with a grass mix specific to the needs of the area to be revegetated;
- regular inspections of all works and immediately after significant rainfall events to ensure sediment and erosion controls are performing adequately;
- regular maintenance of erosion control works and rehabilitated areas; and
- provision for the repair or redesign of sediment and erosion controls that are not performing adequately, as soon as practicable.

Construction and remediation plans will detail the specific inspection, maintenance and revegetation requirements for the construction and remediation works proposed. These control measures will be set out in a detailed Erosion and Sediment Control Plan for the Project, to be prepared as part of the proposed water management plan.

The Mining Services Facility will be bunded in accordance with AS 1940 – 2004: *The Storage and Handling of Flammable and Combustible Liquids.* Clean water captured in the bund will be released to the downstream drainage systems. Any contaminated water will be removed by a licensed contractor. WWC will provide an onsite spill kit for use in a spill emergency. On site personnel will be trained in spill management techniques.

When the mine is decommissioned, water management dams will either remain in use as stormwater dams or will be removed. If the dams are to be retained, the capacity of the dams will be reviewed and the size/volume modified, if required. The proposed diversion drains, catch drains and site bunding will remain in place as part of the final landform.

5.6 Air Quality

The DGRs required the EA to include a detailed air quality assessment. The potential air quality impacts of the Project relate to dust emissions and greenhouse gas emissions. Dust emissions are assessed in this section, while greenhouse gas emissions are assessed in **Section 5.8**.

A comprehensive air quality assessment was completed for the Project by ENVIRON Australia Pty Ltd (ENVIRON) in accordance with relevant DECCW guidelines. A summary of the key findings of the assessment is included below, with the full assessment report included as **Appendix 9**.

5.6.1 Air Quality Criteria

The following section summarises the current air quality assessment criteria specified by DECCW for assessing impacts from mining activities. These criteria relate to dust deposition and dust concentration.

Dust deposition levels refer to the quantity of dust particles that settle out of the air as measured in grams per square metre per month (g/m²/month) at a particular location. DECCW expresses dust deposition criteria in terms of an acceptable increase in dust deposition over the existing background deposition levels as shown in **Table 5.9**.

Table 5.9 - DECCW Criteria for Dust Deposition

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

Dust concentration refers to airborne dust and is measured in micrograms per cubic metre (µg/m³). Criteria for dust concentration are defined as total suspended particulates (TSP) and PM_{10}.

TSP relates to all suspended particles which are up to 100 micrometres (µm) in size. Particle sizes larger than 100 µm are measured in dust deposition levels.

PM_{10} refers to particulate matter with a diameter less than 10 µm (considered to be inhalable particles). TSP measurements include PM_{10} particles.

Goals for dust concentration are referred to as long term (annual average) and short term (24 hour maximum) goals. The air quality goals (excluding 24 hour PM_{10} which is project specific) relate to the total dust contained in the air and not just the dust from the Project. Therefore, some consideration of background levels needs to be made when using these goals to assess impacts (refer to **Section 5.6.2**).

Relevant goals for TSP and PM_{10} are outlined in **Table 5.10**.

Table 5.10 - DECCW Assessment Criteria for Particulate Matter Concentrations

Pollutant	Standard/Goal	Averaging Period	Agency	Goal Type
Total suspended particulate matter (TSP)	90 µg/m^3	Annual mean	National Health & Medical Research Council	Cumulative
Particulate matter <10 µm (PM_{10})	50 µg/m^3	24-hour maximum	DECCW	Project Specific
	30 µg/m^3	Annual mean	DECCW long-term reporting goal	Cumulative
	50 µg/m^3	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Council	Project Specific

5.6.2 Existing Air Quality Environment

WWC operates in close proximity to a number of industrial and mining operations, including the MCPP, Westside Mine, Newstan Colliery, concrete batching and asphalt operations. These industrial and mining operations are the major potential sources of atmospheric emissions which will impact on local air quality. Other potential sources of emissions include vehicle movements on sealed and unsealed roads, vehicle exhaust and rail emissions, windblown dust from open areas, bushfires, agricultural activities and urban related activities.

In order to provide an understanding of the existing air quality environment, air quality monitoring data was sourced from relevant monitoring locations as part of the OCAL monitoring network, providing a network of 15 dust deposition gauges, one high volume air sampler measuring PM_{10} and one high volume air sampler measuring TSP. The locations of the monitoring points are shown on **Figure 5.13**.

Dust deposition rates were analysed for the period 2005 to 2008 and were found to vary significantly between sites, therefore data was analysed in spatial groupings to provide more meaningful results. Annual average dust deposition rates were lowest in Barnsley and Edgeworth (0.8 g/m^2/month), and highest in Wakefield (2.7 g/m^2/month), with Killingworth and within the vicinity of the WWC pit top area experiencing rates of 1.1 and 1.0 g/m^2/month, respectively.

Ambient PM_{10} concentrations were recorded at the Westside Mine PM_{10} monitoring station within the residential area of Wakefield over the period 2001 to 2009. The monitoring station is located in close proximity to active mining areas within the Westside Mine South Pit and is therefore expected to reflect the impacts of open cut mine generated dust.

The annual average PM_{10} concentrations over the period 2001 to 2009 were recorded in the range of 14 $\mu g/m^3$ to 18 $\mu g/m^3$, well below the DECCW goal of 30 $\mu g/m^3$. Maximum daily average PM_{10} concentrations were recorded in the range of 30 $\mu g/m^3$ to 82 $\mu g/m^3$, with exceedances of the DECCW daily goal of 50$\mu g/m^3$ occurring on three days in 2002, three days in 2007 (one of which was attributed to bushfires) and one day in 2008.

Ambient TSP concentrations were recorded at the Westside Mine High Volume Air Sampling station in the residential area of Killingworth over the period 2004 to 2008. Annual average TSP concentrations were found to be in the order of 30 to 34 $\mu g/m^3$, well below the DECCW goal of 90 $\mu g/m^3$.

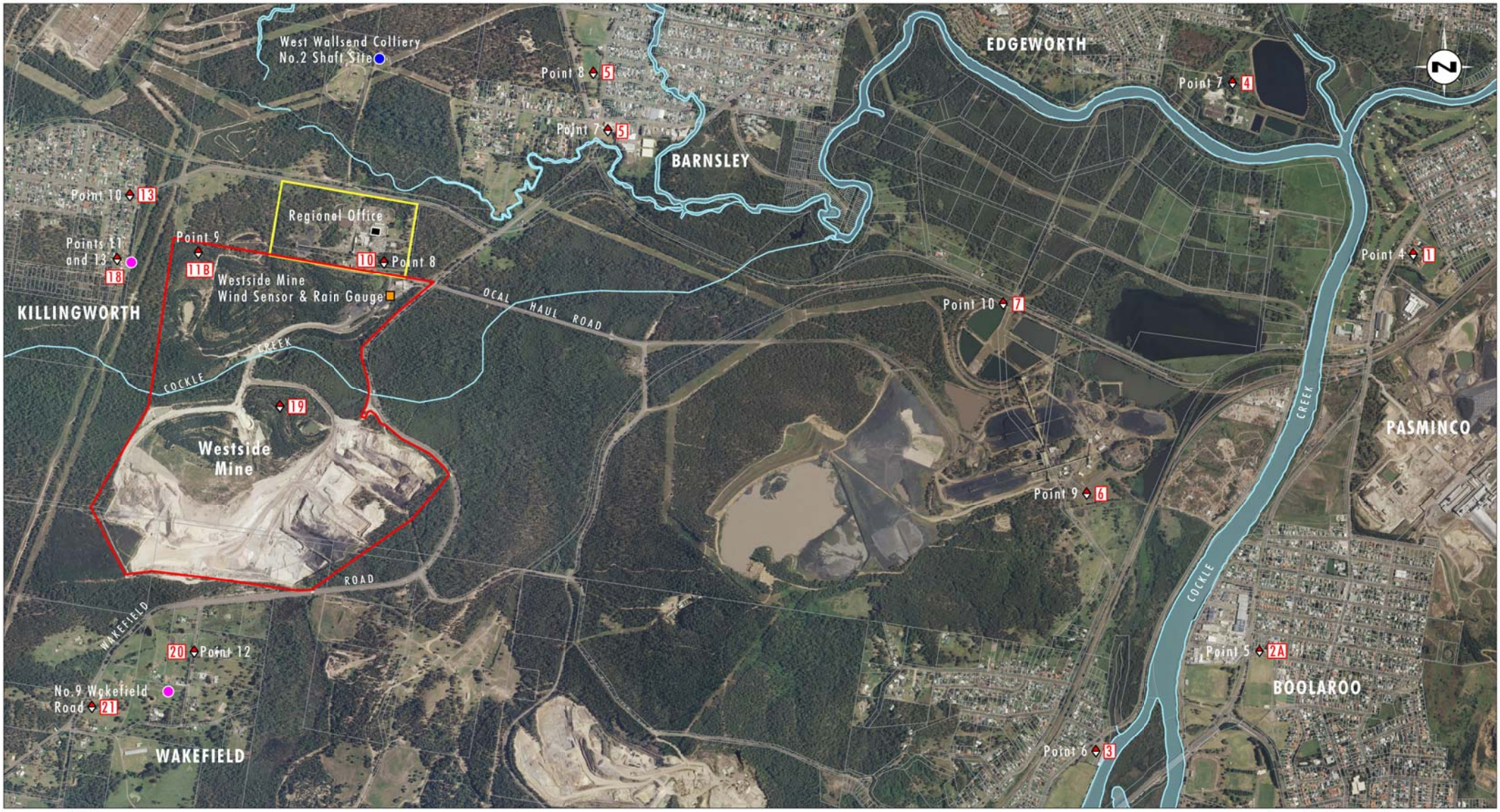
5.6.3 Assessment Methodology

The air quality assessment undertaken for the Project was based on procedures outlined in the DECC (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*. The assessment used a computer-based atmospheric dispersion model, AERMOD, to predict and compare off-site particulate concentrations and dust deposition rates due to the Project with current DECCW air quality goals. The dispersion modelling took account of local meteorology, regional topography and an emissions inventory to predict air quality impacts for current and future operations at WWC. Emission sources modelled included the pit top facility, Ventilation Shaft 2 and Ventilation Shaft 3. Potential dust impacts from construction and operation of the Mining Services Facility were also assessed.

The approach adopted for the air quality assessment involved:

- quantification and modelling of existing WWC emissions;
- quantification and modelling of potential Project emissions at maximum operational capacity; and
- determination of whether the incremental increase in emissions could result in non-compliance with DECCW air quality goals.

Analysis of the modelling results identified a general over-estimation of predicted air quality impacts from existing WWC operations when compared with actual air quality monitoring results. Therefore the results presented in the air quality assessment are considered to be conservative.



Source: OCAL

Legend

- Existing West Wallsend Colliery Pit Top Facilities
- Westside Mine
- Dust Deposition Monitor
- High Volume Air Sampler Location
- Wind Sensor and Rain Gauge

FIGURE 5.13

Existing Dust Monitoring Locations

5.6.4 Air Quality Impact Assessment

5.6.4.1 Project Specific Emissions

The air quality assessment sought to estimate incremental emissions and associated impacts due to the proposed Project. The Project comprises the continuation of existing surface operations at WWC, but makes provision for a maximum production capacity of 5.5 Mtpa ROM coal. This proposed maximum production limit is based on the capacity of WWC's mining equipment and facilities. WWC does not currently have a production limit but produced approximately 2.8 Mtpa in 2009.

The results of the air quality assessment have identified that the Project will meet the relevant air quality criteria at all residential receiver locations. The dust emissions from the Project are relatively small due to coal production being sourced from underground operations. Emissions from underground operations are typically lower than open cut mines due to:

- the minimal ground surface disturbance area associated with the underground operation;
- the minor intensity of surface operations required, i.e. earthworks; and
- the higher coal moisture content of underground coal when delivered to the surface.

A summary of the predicted maximum air quality emissions for the Project is as follows:

- the maximum annual average dust deposition contribution from the Project predicted at a privately owned residence is in the order of 0.09 g/m^2/month, significantly less than DECCW criterion of 2 g/m^2/month;
- the maximum 24-hour average PM_{10} concentration contribution from the Project predicted at a privately owned residence is in the order of 4.7 $\mu g/m^3$. This is significantly less than DECCW criterion of 50 $\mu g/m^3$;
- the maximum annual average PM_{10} concentration contribution from the Project predicted at a privately owned residence is up to 1.3 $\mu g/m^3$, significantly less than DECCW criterion of 30 $\mu g/m^3$; and
- the maximum annual average TSP concentration contribution from the Project at a privately owned residence is up to 1.7 $\mu g/m^3$, significantly less than DECCW criterion of 90 $\mu g/m^3$.

The air quality assessment also found that the construction and operation of the proposed Mining Services Facility is expected to generate negligible emissions and will not result in any significant air quality impacts.

To provide an assessment of the incremental impact of the predicted dust emissions from the Project on total local dust levels, the calculated dust levels for each mining scenario were added to the measured background dust levels for the local area.

5.6.4.2 Cumulative Emissions

An assessment of the cumulative air quality impacts associated with the Project was undertaken as part of the air quality assessment. In order to assess the incremental impact of the Project, it was necessary to compile an emissions inventory for the existing WWC operations which could be used to simulate the existing contribution of WWC to ambient

suspended particulate concentrations and dust deposition rates. This emissions inventory was then revised to reflect the maximum ROM throughput of the Project and summed with measured background levels in order to identify the potential cumulative impacts of the Project and allow comparison of these impacts with DECCW air quality goals.

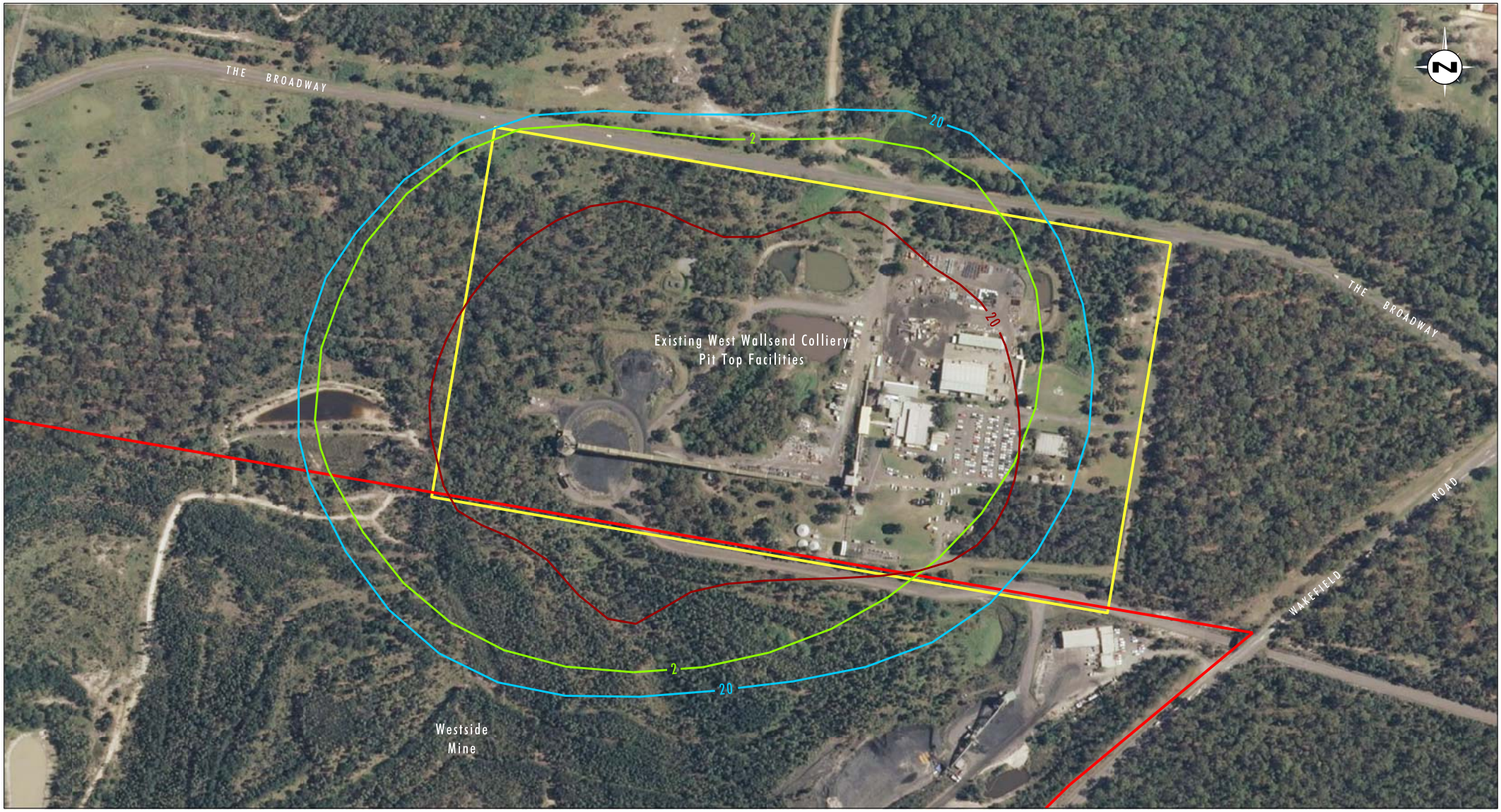
The results of the predictive air quality modelling have identified that the proposed Project will readily meet the DECCW cumulative air quality goals at all sensitive receiver locations. The results of the assessment are summarised in **Table 5.11**. The results are included in **Appendix 9**, including representative worst case dust contours for each DECCW criteria. **Figure 5.14** presents the worst-case air quality contours for the entire project life.

Table 5.11 - Summary of Air Quality Cumulative Impact Assessment Findings

Emission Type	Location	Measured Background Level	Predicted Worst Case Increment due to Project-Related Emissions	Predicted Worst-Case Cumulative Concentration due to Project-Related Emissions	Goal
Annual Average TSP	Killingworth	34 µg/m^3	0.8 µg/m^3	34.8 µg/m^3	90 µg/m^3
	Barnsley	34 µg/m^3	0.8 µg/m^3	34.8 µg/m^3	
	Wakefield	34 µg/m^3	0.2 µg/m^3	34.2 µg/m^3	
Annual Average PM_{10}	Killingworth	17.6 µg/m^3	0.7 µg/m^3	18.3 µg/m^3	30 µg/m^3
	Barnsley	17.6 µg/m^3	0.6 µg/m^3	18.3 µg/m^3	
	Wakefield	17.6 µg/m^3	0.1 µg/m^3	17.8 µg/m^3	
Annual Average Dust Deposition	Killingworth	1.1 g/m^2/month	0.1 g/m^2/month	1.2 g/m^2/month	4 g/m^2/month
	Barnsley	0.8 g/m^2/month	0.1 g/m^2/month	0.8 g/m^2/month	
	Wakefield	2.7 g/m^2/month	0.01 g/m^2/month	2.7 g/m^2/month	

As described in **Section 5.6.2**, monitoring records show that up to three exceedances of the daily average PM_{10} goal have been recorded in Wakefield in previous years. In instances where the daily PM_{10} goal is already exceeded, DECCW require that a proposed development will not result in any additional exceedances of the goal. In order to determine whether the Project will result in any additional exceedances of the goal, the air quality assessment analysed project-related emissions in combination with background PM_{10} concentrations and found that the predicted project-related 24-hour PM_{10} concentrations are not expected to result in any additional exceedances of the DECCW goal. Therefore the Project is predicted to comply with DECCW requirements for maximum 24-hour PM_{10}. Furthermore, mining at Westside Mine is expected to be completed in 2012.

Dispersion modelling undertaken for the Project therefore shows that the predicted suspended particulate concentrations and dust deposition levels associated with the proposed Project comply with DECCW air quality goals at all surrounding non-project related residences.



Source: OCAL - Aerial Photograph, Longwall Layout, Air Quality Contour

0 100 200 250m
1:5000

Legend

- Existing West Wallsend Colliery Pit Top Facilities
- Westside Mine
- Average Annual Dust Deposition ($g/m^2/month$) Contour
- Average Annual TSP ($\mu g/m^3$) Contour
- Average Annual PM_{10} ($\mu g/m^3$) Contour

FIGURE 5.14

Project Specific Worst Case Air Quality Contours

5.6.5 Air Quality Management

A range of dust control measures are currently employed at WWC and have been incorporated into this air quality assessment. These control measures include:

- the use of manually-operated water sprays for unpaved areas and for the paved ring road at the WWC pit top, used by trucks transporting coal to MCPP via the private haul road;
- periodic sweeping of the haul road and other paved areas including the car park area to reduce road surface silt loadings; and
- use of loading flaps during truck loading at the surface bin to restrict dust.

These dust management strategies will continue to be implemented for the life of the Project.

In accordance with the recommendations of the air quality assessment, OCAL will continue dust deposition monitoring at existing stations located at WWC, and within Barnsley and Killingworth for the life of the Project to track changes in on-site and ambient dust deposition rates. OCAL will also undertake 24-hour PM_{10} monitoring for the life of the Project using the existing Westside Mine PM_{10} HVAS monitor at Wakefield.

5.7 Noise

A comprehensive noise impact assessment (NIA) was completed for the Project by Umwelt. The NIA has been undertaken in accordance with the *NSW Industrial Noise Policy* (INP) (Environment Protection Authority (EPA), 2000). A summary of the key findings of the assessment is provided below, with the full assessment report included in **Appendix 10**.

The NIA was based on the noise levels predicted by the ENM model of the existing operations. The NIA was undertaken in accordance with *Section 10 – Applying the policy to existing industrial premises* of the Industrial Noise Policy (EPA, 2000). For a detailed description of the NIA methodology, refer to **Appendix 10**.

5.7.1 Existing Noise Environment

The nearest potential noise sensitive residential receivers to WWC pit top are located in The Trongate, Killingworth (approximately 1 kilometre) to the west of WWC and in Charlton Street, Barnsley (approximately 1 kilometre) to the north-east of WWC, refer to **Figure 5.15**. The nearest residential receiver to the Mining Services Facility is approximately 750 metres to the east.

The existing noise environment in the area surrounding the WWC was assessed in accordance with Section 3 of the INP (EPA 2000) using a combination of Acoustic Research Laboratories environmental noise loggers and attended noise monitoring. Monitoring locations M1 to M5 (**Figure 5.15**) were located to represent the nearest and/or most potentially affected residences to the west and north-east of WWC pit top facility. The results of the monitoring program, reported as the underlying Rating Background Level (RBL)[3] and the Mean $L_{Aeq,\ period}$ (where period = day, evening and night) are presented **Table 5.12**. The underlying level of noise present, representing the ambient noise level excluding the noise source under investigation, was determined in accordance with Section 3 of the INP.

[3] The RBL is defined as the overall single-figure background level representing each measurement period (day, evening and night) over the whole monitoring period.

Source: OCAL

0 0.5 1.0 1.5km

1:30 000

Legend

- West Wallsend Colliery Pit Top Facility
- Monitoring Location
- Receiver Location
- Proposed Mining Services Facility

FIGURE 5.15

West Wallsend Colliery Operations
Noise Monitoring and Receiver Locations

Table 5.12 – Monitoring Results, RBL and Mean $L_{Aeq, period}$ dB(A)

Monitoring Location	Time Period[1]	RBL	Mean $L_{Aeq, period}$
M1 - The Trongate (South) Killingworth	Day	33.7	47.4
	Evening	38.9	45.1
	Night	34.4	43.7
M2 - The Trongate (North) Killingworth	Day	35.2	49.9
	Evening	36.8	48.8
	Night	34.4	47.9
M3 - Bendigo Street Barnsley	Day	36.1	54.3
	Evening	37.6	52.9
	Night	33.5	46.7
M4 - Wakefield Road Barnsley	Day	41.4	67.7
	Evening	37.5	59.5
	Night	35.5	58.2
M5 - Wakefield Road Wakefield	Day	35.5	60
	Evening	40	61
	Night	42	52

Note 1: Monday to Saturday Day is 7.00 am to 6.00 pm, Evening 6.00 pm to 10.00 pm and Night 10.00 pm to 7.00 am; on Sundays and Public Holidays Day is 8.00 am to 6.00 pm, Evening 6.00 pm to 10.00 pm and Night 10.00 pm to 8.00 am.

Attended noise monitoring was undertaken in the region surrounding the WWC pit top facility during the evening and night-time over the period 2 to 4 March 2009 and during the night time on 4 December 2009. Attended noise monitoring was undertaken in the region surrounding to the east of the proposed Mining Services Facility during the day-time and evening of 20 January 2010 and the night-time of 22 January 2010.

Results of the attended noise monitoring results are presented in **Table 5.13**.

Table 5.13 – Attended Noise Monitoring Results, dB(A)

Monitoring Location	Time Period	$L_{A90, 15min}$	$L_{Aeq, 15min}$	Industrial Contribution
M1 - The Trongate (South) Killingworth	Evening2/03/2009	38.5	41.0	37.0
	Night 2/03/2009	37.5	39.0	37.0
M2 - The Trongate (North) Killingworth	Evening	43.0	46.0	40.0
	Night 2/03/2009 4/12/2009	37.0 44.3	39.0 47.9	35.0 44.0 [1]
M3 - Bendigo Street Barnsley	Night 2/032009 4/12/2009	36.0 45.6	43.0 [2] 42.4	30.0 [2] 40.0 [1]
M5 - Wakefield Road Wakefield[3]	Day 20/1/2010	45	60	0
	Evening 20/1/2010	40	61	0
	Night 22/1/2010	42	52	0

Note 1: Industrial noise from WWC Pit top

Note 2: Monitoring data affected by traffic noise

Note 3: Within 100 metres of proposed mining services facility

The monitoring results presented in **Table 5.13** indicate that the region surrounding the WWC pit top area, including the No. 2 vent shaft, are influenced by a range of local noise sources including the facility itself, local traffic and traffic on the F3 Freeway. Bi-annual noise monitoring results indicate the ambient noise levels in Wakefield are also influenced by a range of local noise sources including local traffic and traffic on the F3 Freeway.

Monitoring results presented in **Table 5.13** indicate the ambient noise levels in the region surrounding the No. 3 vent shaft and the proposed Mining Services Facility on Wakefield Road are also influenced by a range of local noise sources including local traffic and traffic on the F3 Freeway. During the monitoring period there were no observed industrial noise sources influencing the ambient noise levels in the region to the east of the proposed Wakefield Road Mining Services Facility.

5.7.2 Assessment Criteria

5.7.2.1 Operational Noise

The INP sets out two forms of noise criterion; intrusiveness and amenity. The intrusiveness criterion specifies that the L_{Aeq} 15 minute noise level from any new source should not exceed the RBL by more than 5 dB(A). The amenity criteria is intended to ensure that the total L_{Aeq} noise level from all industrial sources does not exceed specified levels. For suburban residences, the relevant recommended acceptable amenity levels are:

- Daytime (7.00 am – 6.00 pm) 55 dB(A) L_{Aeq}
- Evening (6.00 pm – 10.00 pm) 45 dB(A) L_{Aeq}
- Night (10.00 pm – 7.00 am) 40 dB(A) L_{Aeq}.

The project specific intrusive and amenity criteria for the nearest potential noise sensitive residential receivers, derived from the assessed RBLs are presented in **Table 5.14**.

Table 5.14 - Intrusive and Amenity Assessment Criteria

Location	Time Period	Noise Criterion (dB(A))	
		Intrusiveness $L_{Aeq, 15min}$	Amenity $L_{Aeq, Period}$
M1 - The Trongate (South) Killingworth	Day	39	55
	Evening	39	45
	Night	39	40
M2 - The Trongate (North) Killingworth	Day	40	55
	Evening	40	45
	Night	39	40
M3 - Bendigo Street Barnsley	Day	41	55
	Evening	41	45
	Night	39	40
M5 – Wakefield Road, Wakefield	Day	50	55
	Evening	45	45
	Night	45	40

* Day period is 7.00 am – 6.00 pm; Evening is 6.00 pm – 10.00 pm; Night is 10.00 pm – 7.00 am

Project Specific Noise Levels (PSNLs) reflect the most stringent noise level requirements from the noise levels derived from both the intrusive and amenity criteria. They set the benchmark against which noise impacts and the need for noise mitigation are assessed. When setting the PSNL the INP recommends the application of the most stringent requirement so that the applicable PSNL both limits intrusive noise and protects noise amenity.

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

- negligible noise level increase (less than 1 dB(A)) (not noticeable by all people);
- marginal noise level increase (between 1 dB(A) and 2 dB(A)) (not noticeable by most people);
- moderate noise level increase (between 3 dB(A) and 5 dB(A)) (not noticeable by some people and may be noticeable by others); and
- appreciable noise level increase (greater than 5 dB(A)) (noticeable by most people).

It should be noted that the INP does not set mandatory limits, but requires operations to seek to achieve the criteria. Where INP criteria cannot be achieved by applying feasible and reasonable measures, there is scope to apply alternative criteria.

The assumed project specific noise criteria are outlined in **Table 5.15**.

Table 5.15 – Project Specific Noise Criteria

Location	Time Period	Project Specific Noise Criteria (dB(A))
M1 - The Trongate (South) Killingworth	Day	39 $L_{Aeq, 15\ min}$
	Evening	39 $L_{Aeq, 15\ min}$
	Night	39 $L_{Aeq, 15\ min}$
M2 - The Trongate (North) Killingworth	Day	40 $L_{Aeq, 15\ min}$
	Evening	40 $L_{Aeq, 15\ min}$
	Night	39 $L_{Aeq, 15\ min}$
M3 - Bendigo Street Barnsley	Day	41 $L_{Aeq, 15\ min}$
	Evening	41 $L_{Aeq, 15\ min}$
	Night	39 $L_{Aeq, 15\ min}$
M5 – Wakefield Road, Wakefield	Day	50 $L_{Aeq, 15\ min}$
	Evening	45 $L_{Aeq, 15\ min}$
	Night	40 $L_{Aeq, 15\ min}$

* Day period is 7.00 am – 6.00 pm; Evening is 6.00 pm – 10.00 pm; Night is 10.00 pm – 7.00 am

As a 24 hour 7 days per week operation, activities associated with the Project would be essentially the same during the day-time, evening and night-time. That is, the sources of noise at WWC are independent of the time of day and the day of the week. Therefore, under normal operating conditions, achieving the night-time criteria will result in the day-time and evening criteria also being achieved.

5.7.2.2 Construction Noise Criteria

The DECCW recognises that construction activities could potentially generate higher noise levels than those of actual operation. Section 171 of the *Environmental Noise Control Manual* (EPA, 1994) allows the criteria presented in **Table 5.16** to be applied.

Table 5.16 - EPA Construction Noise Criteria, dB(A)

Length of Construction Time [1]	Construction Noise Criterion
Up to 4 weeks	$LA_{10,\ 15\ minute} < L_{A90}$ plus 20 dB
4 to 26 weeks	$L_{A10,\ 15\ minute} < L_{A90}$ plus 10 dB
Greater than 26 weeks	$L_{A10,\ 15\ minute} < L_{A90}$ plus 5 dB

Note 1: Time restrictions Monday to Friday 7.00 am to 6.00 pm
Saturday 7.00 am to 1.00 pm
No construction on Sunday or Public Holidays

Source: *Environmental Noise Control Manual* (EPA, 1994)

The construction activities associated with the Mining Services Facility are expected to occur over a period of 3 to 6 months. As such the 4 to 26 weeks construction criterion of L_{A90} plus 10 dB would apply to the residential receivers in the vicinity of the proposed Mining Services Facility. Background noise monitoring from 20 and 22 January 2010 indicated the ambient day-time, evening and night-time RBLs adjacent to Wakefield Road were 45, 40 and 40 dB(A) respectively.

Construction activities for the proposed Mining Services Facility will occur during day-time hours, Monday to Friday and possibly Saturday to 1.00pm. The project specific criteria for construction related noise at the closest affected residence is 55 dB(A).

5.7.2.3 Sleep Disturbance

DECC has not developed a specific criteria to address sleep disturbance. However, in a noise guide for local government, DECC identified that sleep may be disturbed if the $L_{A1,60\ seconds}$ or L_{Amax} noise level exceeds the L_{A90} background noise level by more than 15 dB(A) when measured outside the bedroom window. Further guidance on the potential for 'awakening reactions' is provided in DECC's Environmental Criteria for Road Traffic Noise (EPA, 1999), which states that internal maximum noise levels below 50-55 dB(A) are unlikely to cause awakening reactions. Based on the adopted night time RBL, the sleep disturbance criterion is 45 dB(A) L_{Amax} for the Project.

5.7.2.4 Road Traffic Noise

The Project will not generate any additional road traffic associated with the WWC pit top facilities. Haulage of coal is covered under a separate existing development consent, which does not form part of this Project Application.

The proposed mining services facility will result in minor additional traffic movements during both the construction period and operation. The proposed mining services facility is located in an existing disturbed area between Wakefield Road and the F3 Freeway. The proposed site is influenced by road traffic primarily from the F3 Freeway.

All access to the proposed mining services facility will be from Wakefield Road, which is a rural collector road. Under the EPA Environmental Criteria for Road Traffic Noise 1999 (ECRTN), land use developments with potential to create additional traffic on a collector road should not lead to an increase in exiting noise levels of more than 2 dB.

The proposed mining services facility will generate up to two heavy vehicles per day delivering stone and other materials. WWC operations offices will also access the proposed mining services facility (up to three vehicles per day) for general operational supervision. Based on existing traffic volumes, an additional 10 vehicle movements per day generated by the proposed mining services facility will equate to an increase of approximately 0.03 dB.

The construction period for the proposed mining services facility will be approximately six months and will not generate significant traffic movements. Any potential noise generation from the construction of the proposed mining services facility would be minor and not impact on road traffic noise levels.

5.7.3 Noise Modelling

5.7.3.1 Noise Modelling Methodology

The methodology used in the assessment of the Project is a combination of measuring actual impacts and to model the noise sources using an appropriate commercially available software package. The model used for this assessment was Environmental Noise Model (ENM), developed by RTA Technology Pty Ltd. ENM is recognised and accepted by the DECCW as a computer modelling program suited to predicting noise impacts from industrial noise sources. This model was then used to assess the feasible and reasonable noise control measures that could be applied to the operation.

5.7.3.2 Calibration of Noise Model

A validation assessment was undertaken at Killingworth (equivalent M1 and M2) and Barnsley (equivalent to M3) to calibrate the noise model. The noise levels predicted using the Single Point calculation feature of ENM and the corresponding noise monitoring results are presented in **Table 5.17**.

Table 5.17 – Calibration of ENM Model Representing the Current Operations

Receiver Area	Description	Estimated Contribution $L_{Aeq, 15\ minute}$	Predicted Noise Level $L_{Aeq, 15\ minute}$
Killingworth	48 The Trongate, Killingworth	36 to 37 dB(A)	37 dB(A)
Killingworth	2 The Broadway, Killingworth	35 to 40 dB(A)	38 dB(A)
Barnsley	51 Charlton St, Barnsley	35 dB(A)	36 dB(A)

The predicted levels were found to be within 1 to 3 dB(A) of the estimated contribution of existing operation, based on measured noise levels. Therefore, the model is considered to be an accurate prediction of likely future noise levels from the Project.

5.7.4 Noise Impact Assessment

The Project proposes to operate continuously 7 days per week 24 hours per day. As a result, the most stringent noise criteria that the mining operation will need to achieve is the night-time project-specific noise level. Based on the analysis of the existing noise environment surrounding the Project this equates to a night-time target noise level criteria of 38 dB(A) in Killingworth, 39 dB(A) in Barnsley and 40 dB(A) in Wakefield to the east of the Mining Services Facility.

WWC plant noise emissions were modelled using four representative meteorological scenarios to determine compliance with the PSNLs.

5.7.4.1 Operational Noise Impacts

Predicted noise levels from the noise model are presented in **Table 5.18** and are compared to the respective PSNLs.

Table 5.18 - Predicted Noise Levels Under Representative Operating Conditions

Locality	Period	Predicted Noise Level, dB(A) LAeq, 15 minute under specified meteorological scenarios							Target LAeq, 15minute Noise Criteria
		Calm	South wind	WNW wind	NE wind	ENE wind	Inversion	Inversion+ Drainage Flow	
Killingworth The Trongate (South)	Day	33	31	30	-	-	-	-	39
	Evening	34	-	-	38	39	-	-	39
	Night	34	-	-	-	-	39	39	39
Killingworth The Trongate (North)	Day	38	**42**	36	-	-	-	-	40
	Evening	38	-	-	**41**	**43**	-	-	40
	Night	39	-	-	-	-	**43**	**44**	39
Barnsley Bendigo St,	Day	37	40	41	-	-	-	-	41
	Evening	37	-	-	35	35	-	-	41
	Night	38	-	-	-	-	**41**	**41**	39
Barnsley - Charlton St,	Day	36	39	38	-	-	-	-	41
	Evening	36	-	-	34	34	-	-	41
	Night	37	-	-	-	-	39	**40**	39
Barnsley Northville Dr	Day	<30	33	34	-	-	-	-	41
	Evening	<30	-	-	<30	<30	-	-	41
	Night	30	-	-	-	-	34	35	39
R7 - Barnsley Charlton St (West)	Day	**45**	**46**	**45**	-	-	-	-	41
	Evening	**45**	-	-	**45**	**45**	-	-	41
	Night	**45**	-	-	-	-	**46**	**46**	39
Wakefield Rd	Day	<30	<30	<30	-	-	-	-	50
	Evening	<30	-	-	<30	<30	-	-	45
	Night	<30	-	-	-	-	<30	<30	40

Note: Predicted noise levels in bold indicate predicted exceedances of the PSNLs

As indicated the existing WWC pit top facilities have the potential to exceed the target PSNLs in both Killingworth and Barnsley under meteorological conditions that propagate noise from WWC towards these receiver areas. The magnitude of the exceedances at the closest residential receiver areas is up to 6 dB under the worst case meteorological conditions considered by the INP (EPA, 2000). The magnitude of the exceedance in the single residential receiver (R7) adjacent to the No. 2 vent fan, is up to 7 dB under the worst case meteorological conditions

To address this predicted exceedance, WWC is committed to mitigating the noise impact from the coal breaker and other key noise contributors, including the No. 2 Vent Fan. Following the completion of this work, the achievable noise goal for Killingworth would be 41 dB(A) (3 dB(A) over the PSNL), and the WWC pit top facility would achieve the target Project-specific Noise Levels in Barnsley. Further discussion of the proposed measures is described in **Section 5.7.5**.

5.7.4.2 Sleep Disturbance

The predicted noise levels meet the recommended sleep disturbance noise goals at all residential receivers.

5.7.4.3 Construction Noise Impacts

The noise model was also used to determine noise levels at the nearest residential receiver locations for the construction phase of the Mining Services Facility activities under calm and adverse weather conditions The predicted $L_{Aeq,\ 15\ minute}$ construction noise levels are presented in **Table 5.19** and are compared to the relevant construction noise criteria.

Table 5.19 – Predicted Construction Noise Levels, dB(A)

Locality	Predicted Noise Level			Construction Noise Goal $L_{Aeq,15minute}$
	Calm	WNW wind	NE wind	
Wakefield Wakefield Rd	< 30	< 30	< 30	55

The predicted noise levels in **Table 5.19** meet the construction noise goal at all residential receivers.

5.7.4.4 Cumulative Noise Impacts

The INP (2000) allows assessment of the potential cumulative noise impacts associated with existing and future developments by defining appropriate noise emission criteria with respect to maintaining the noise amenity at residential receivers and considering applicable consent limits. The cumulative impact of the Project has been assessed in relation to preserving the noise amenity at the nearest residential receivers localities.

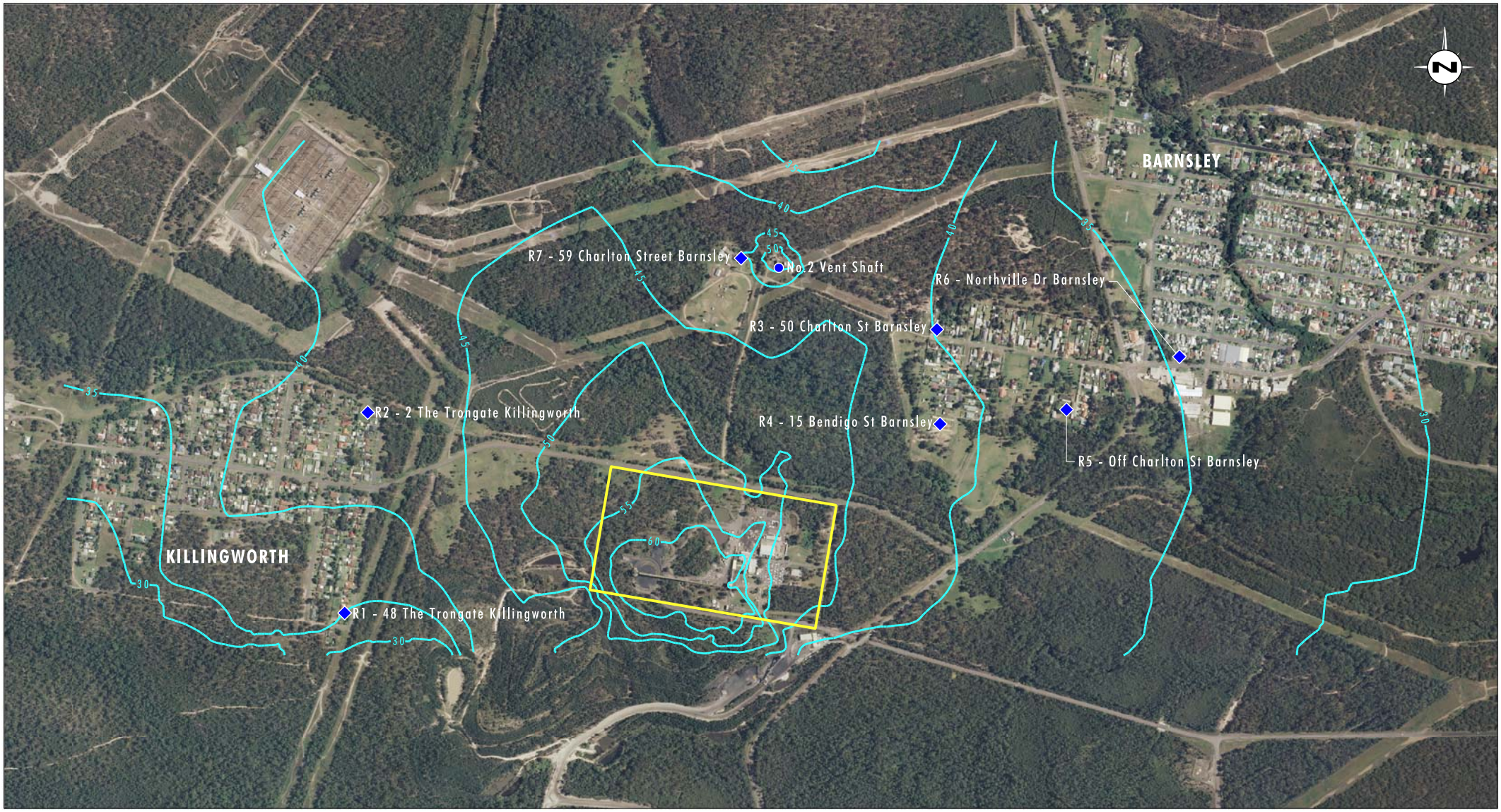
Potential cumulative noise impacts from existing and future developments is then addressed by the INP by ensuring that the appropriate noise emission criteria (and approved limits) are established with a view to maintaining acceptable noise amenity levels for residences.

From modelling undertaken the predicted cumulative noise levels are less than the recommended acceptable noise levels at all the potential receiver locations in the region surrounding WWC, as shown in **Figure 5.16**.

5.7.5 Noise Management, Mitigation and Ongoing management

5.7.5.1 WWC Pit Top Facilities

Noise emissions from the WWC pit top have the greatest potential to impact along the eastern edge of Killingworth, with predicted exceedances of the target night-time Project-specific Noise levels by up to 6 dB during the presence of a temperature inversion and associated drainage wind.



Source: OCAL

0 200 400 800m
1:15 000

Legend

- Existing West Wallsend Colliery Pit Top Facility
- Night Time Noise Contour
- Receiver Location

FIGURE 5.16

Predicted Noise Contours - Temperature Inversion and Drainage Flow

The dominant noise sources include:

- the coal breaker, especially when handling rock;
- the load out from the raw coal bin;
- service conveyors, especially in elevated positions; and
- the coal trucks hauling the raw coal to the MCPP.

Of these, the coal breaker is the highest contributor.

A reduction in the order of 10 dB in the noise level from the coal breaker is predicted to achieve a 3.1 dB reduction in the overall noise impact of the WWC pit top facility. A reduction in the order of 15 dB in the noise level from coal breaker is predicted to achieve a 3.5 dB reduction.

A reduction in the order of 5 dB in the noise level from the coal bin loadout or from one of the conveyors is predicted to achieve less than a 0.5 dB reduction in the overall noise impact of the WWC pit top facility. However, combined with a reduction in the order of 15 dB in the noise level from the coal breaker the predicted reduction in the overall noise impact of the WWC pit top facility would be up to 5 dB.

To reduce noise levels from the WWC in the Killingworth receiver area during the evening and night-time periods, noise mitigation works on the coal breaker, service conveyors and bin loadout will result in the overall noise level from WWC achieving the evening and night-time PSNLs for the area of 38 dB(A). While the implementation of these noise mitigation works would enable WWC to achieve compliance with the target project-specific noise goals the economic feasibility of these mitigation works needs to be considered.

WWC is committed to mitigating the noise impact from the coal breaker by approximately 10 dB by enclosing the existing coal breaker. Following the completion of this work, the achievable noise goal for Killingworth would be 41 dB(A) (3 dB(A) over PSNLs) and the WWC pit top facility would achieve the target Project-specific Noise Levels in Barnsley.

WCC will also investigate whether there are any feasible opportunities for further noise reduction at Killingworth in relation to:

- noise mitigation of the service conveyors from the crusher through the systematic replacement of noisy conveyor idlers;
- noise mitigation of the bin loadout operations by managing the level of raw coal in the bin or by providing sound attenuation to the bin;
- review of loading procedures and operator training; and
- review of bin design and the coal truck loading facility.

5.7.5.2 The No. 2 Vent Fan

The No. 2 Vent Fan currently operates at approximately 30 per cent of its operational capacity. The results outlined in **Table 5.18** indicate that mitigation work would be required to reduce the noise emissions from the No. 2 Vent Fan by up to 7 dB in order to achieve the target night-time Project-specific Noise Levels at the residential receiver immediately adjacent to the vent shaft.

The operation of the No. 2 Vent Fan at full capacity would increase the noise levels at the residential receiver immediately adjacent to the vent shaft by approximately 13 dB. The noise level in Killingworth would be increased by approximately 1 dB and while the noise levels in Barnsley would be increased by 4 to 5 dB

Attenuation of the No. 2 Vent Fan by 13 dB would enable the No. 2 Vent Fan to achieve 100 per cent capacity without increasing the noise levels in the region surrounding the WWC pit top except at the residential receiver immediately adjacent to the vent shaft. A 10 dB reduction in the noise from the No. 2 Vent Fan would enable the vent fan to run at 70 per cent capacity.

WWC is committed to managing the noise impact from the No. 2 Vent Shaft through the installation and maintenance of appropriate noise control measures on the vent shaft fan and motor room and, as appropriate, through negotiation with the adjacent affected landowners. The selection and installation of noise mitigation controls on the No. 2 Vent Fan will be dependent on the future operational requirements of the No. 2 Vent Fan and performance of the vent fan against the target PSNLs for each of the receiver locations in the surrounding region. The performance/noise impacts of the No. 2 Vent Fan will be assessed if the operational requirements of No. 2 Vent Fan change as a result of changes in ventilation needs the WWC underground workings or as a result of the No. 3 Vent Fan undergoing maintenance.

If the noise impacts from the No. 2 Vent Fan are found to be unacceptable, WWC will enter into a Pollution Reduction Program regarding the attenuation of the No. 2 Vent Fan as a part of WWC's EPL.

5.7.5.3 Proposed Mining Services Facility

The noise assessment found that the proposed Mining Services Facility on Wakefield Road would achieve the PSNLs for the nearest potentially effected receiver and would also achieve the construction noise goals at the nearest potentially effected receiver.

Following the completion of any noise mitigation works it is recommended that WWC implement a monitoring program that will specifically address:

- compliance with the project-specific noise level $L_{Aeq,\ 15\ minute}$ descriptor; and
- measurement and assessment of any transient noise levels using the sleep disturbance criteria descriptor of $L_{A1,\ 1\ minute}$.

The noise monitoring will be based around an attended monitoring program that:

- measures $L_{A90,15\ minute}$ and $L_{Aeq,15\ minute}$ ambient noise levels;
- measures and/or calculates the contributed noise level from the operation;
- measures other statistical noise levels representative of the noise environment including the maximum and minimum noise levels measured during the interval; and
- records weather conditions at the monitoring site.

The monitoring program should be undertaken during periods of normal production with the objective of confirming the acoustic performance of the facility.

5.8 Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions and climate change concerns were raised during consultation undertaken for the Project (refer to **Section 3.0**) and identified as a key issue in the DGRs. The DGRs require a full GHG assessment, including a quantitative analysis of the Scope 1, 2 and 3 GHG emissions from the Project, and a qualitative assessment of the impacts of these GHG emissions. Umwelt has undertaken a detailed GHG and energy impact assessment (GHGEIA) for the Project (refer to **Appendix 11**).

This section provides a summary of the detailed GHGEIA along with a qualitative assessment of impacts of the GHG emissions and details of the mitigation and management strategies associated with the Project.

5.8.1 Greenhouse Assessment Policy Context and Methodologies

The standard approach to coverage of sources of GHG emissions, energy consumed and energy produced, is set out in the *National Greenhouse and Energy Reporting Act 2007* (the NGER Act) and the National Greenhouse and Energy Determination (the NGER Determination 2009). The National Greenhouse Accounts Factors (NGAF) (DCC, 2009a), as proposed by the Project DGRs, refer to the default methodology (Method 1) of the NGER Determination. The specified Scope 1, Scope 2 and Scope 3 emission categories are assessed as follows (DCC, 2009):

Scope 1 Scope 1 (direct) emissions are the GHG emissions which occur as a direct result of activities at a Project. Direct emissions are emissions over which entities have a high level of control. Point source emissions from the proposed Project are considered as to be occurring within the boundary of WWC.

Scope 2 Scope 2 (energy indirect) emissions cover GHG emissions from the generation of purchased electricity, steam, heating or cooling consumed by a Project. These indirect emissions can be readily measured and can be significantly influenced through energy efficiency measures.

Scope 3 Scope 3 covers all indirect emissions that are not included in Scope 2. Scope 3 emissions are a consequence of the activities of the Project, but occur at sources or facilities not owned or controlled by the entity. Scope 3 emissions or life cycle emissions are an estimate only with a relatively high level of uncertainty, unreliability and variability.

A detailed description of the national, international and industry methodology used in this GHGEIA to calculate energy produced, energy consumed and GHG emissions, is provided in **Appendix 11**.

Xstrata Coal has also developed a standard methodology and calculator for estimating Scope 3 energy consumption and GHG emissions based on an analysis of all potential Scope 3 emissions from coal mines (Xstrata Coal, 2010). The document is referred to as the XC Scope 3 emissions calculator. This calculator has been verified by SEE Sustainability Pty Limited (SEE Sustainability) and is used in this GHGEIA for the calculation of Scope 3 emissions. The Xstrata Coal analysis determined the only material sources of Scope 3 energy consumption and GHG emissions arise from (Xstrata Coal, 2010):

- emissions associated with infrastructure development;
- emissions associated from product transport; and
- emissions from the end use of the product.

5.8.2 Summary of Greenhouse Gas and Energy Assessment

The assessment was undertaken over the total life of the Project on an annual basis. The full results of the assessment are provided in the GHGEIA in **Appendix 11**.

5.8.2.1 Energy Consumption and Production

The Project will consume an estimated total of approximately 314,000 GJ per annum and an estimated total of approximately 2,828,000 GJ of energy content in the combustion of diesel and the purchase of offsite electricity for the life of the Project.

Based on average ROM per year of approximately 4 Mt, it is estimated that the Project will produce thermal and coking coal that will have the potential energy production of approximately 107,909,000 GJ annually and approximately 971,180,145 GJ of total energy for the life of the mine.

5.8.3 Greenhouse Gas Emissions

The methodology used in the detailed calculations of the Project GHG emissions, energy consumption and energy production are provided in **Appendix 11**. A summary of the Greenhouse and Energy Impact Assessment results are as follows.

The estimated GHG emissions that are expected to result from the Project are as follows:

Scope 1 Total predicted direct (Scope 1) GHG emissions from the proposed WWC operations are 4,296,964 t CO_2-e. WWC has direct influence over these emissions and they will be the subject of management and mitigation plans, including the ongoing implementation of the existing Energy Savings Action Plan (ESAP). The GHG emissions that occur onsite that are a direct result of Project operations account for only 5.4 per cent of the estimated total direct and indirect WWC operations.

Scope 2 Total predicted indirect (Scope 2) GHG emissions that are also required to operate the Project are 557,525 t CO_2-e. WWC has no direct influence over how efficiently these emissions are generated. Management and mitigation measures, however, can include energy reduction and energy efficiency measures to reduce this indirect emission. Such measures are included in the existing WWC ESAP.

Scope 3 Total predicted indirect and downstream (Scope 3) GHG emissions over which WWC has no management or mitigation control are 74,501,679 t CO_2-e. These emissions can be divided into 'transport of the product', which accounts for 2.9 per cent of total indirect Scope 3 emissions and "use of product" which accounts for 97.1 per cent of total indirect Scope 3 emissions. These emission totals are also expected to be captured by national and global GHG emissions inventories.

Total The total predicted GHG emissions from the Project are 79,356,167 t CO_2-e. WWC has no direct management or control over the combustion, management

efficiency or mitigation measures of 94.6 per cent of the GHG emissions that result from the Project. The proposed Project GHG emissions (Scope 1, Scope 2 and Scope 3 emissions) will contribute 1.48 per cent to current global GHG emissions.

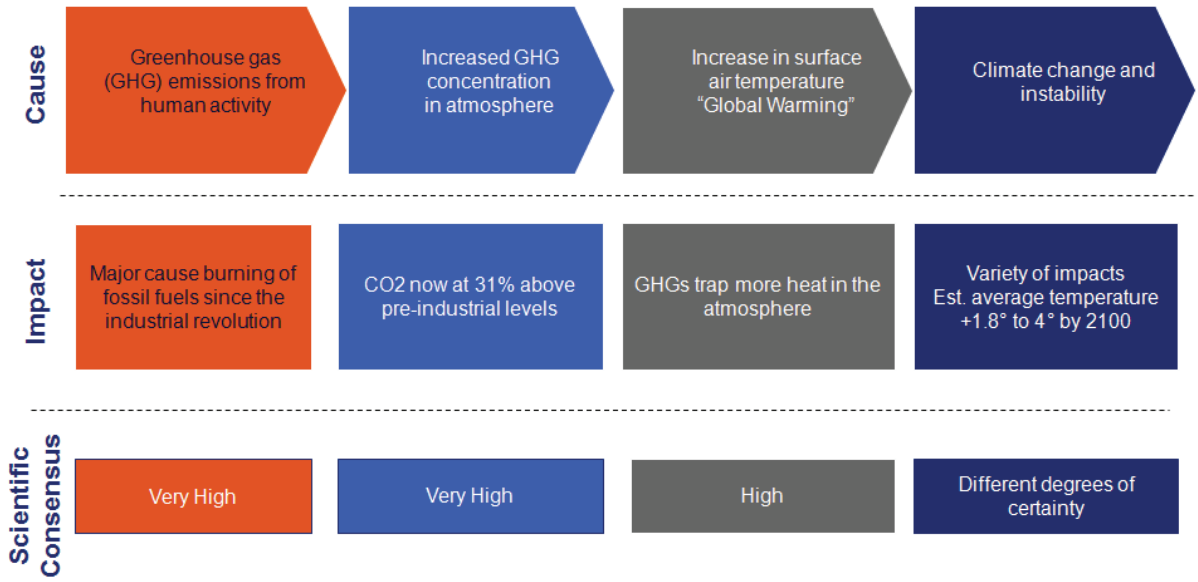
5.8.4 Greenhouse Impact Assessment

The weight of scientific opinion supports the generally held view that the world is warming due to the release of emissions of GHG from human activities, including industrial processes, fossil fuel combustion and changes in land use, such as deforestation (Intergovernmental Panel on Climate Change 2007).

In 2007, the Intergovernmental Panel on Climate Change (IPCC) published the first three instalments of the Fourth Assessment Report. The IPCC assesses worldwide climate change science in three working groups and in the context of three broad categories: 1) the physical science, 2) climate change impacts, adaptation and vulnerability, and 3) mitigation of climate change. This work was approved by governments participating in the UNFCCC and has become the foundation for the current international government decision-making framework on climate change.

Main conclusions from the IPCC 2007 Report include:

- the majority of scientists believe that emissions of greenhouse gases from human activities are leading to global warming and climate change;
- significant increases in carbon emissions during the last 150 years have resulted in rising concentrations of atmospheric CO_2. These increases in atmospheric CO_2 are the result of an imbalance between emission and absorption in the natural carbon cycle – the largest contributor to this imbalance is the burning of fossil fuels;
- while there have been natural variations in global surface temperature over many centuries, a significant rise in temperature has occurred over the last 75-150 years;
- the world faces an average temperature rise of around 3°C this century if greenhouse gas emissions continue to rise at their current pace and are allowed to double from their pre-industrial level;
- continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.



Source: IPCC: Fourth Assessment, Summary for Policy Makers (May 2007)
CSIRO website (June 2007)

As there are no accepted methods for undertaking an assessment of the impacts that these emissions may have on the global climate, a comparative analysis of Project related emissions to global emissions has been undertaken.

The proposed total Project GHG emissions (Scope 1, Scope 2 and Scope 3) for the LOM will make a minor total contribution of 0.03 per cent to the global GHG inventory, as detailed by the International Energy Outlook, 2009 (EIA, 2009). The contribution to national GHG inventory of 1.48 per cent is equally minor, as detailed by the National Greenhouse Inventory: Kyoto Protocol Accounting Framework, 2009 (DCC, 2009b).

When considering the principles of intergenerational equity, it is worthwhile noting that as there are no significant changes to the existing operations of the Project, all GHG emissions estimates provided in this report are already captured and managed as part of existing WWC operations.

In assessing any impact there must be consideration of the benefits brought by the Project. A range of benefits including state and local economic and employment impacts are discussed in **Section 5.14**.

5.8.5 Management and Mitigation

As an Xstrata Coal operation, WWC is subject to the Xstrata Coal Climate Change Position Statement (Xstrata Coal, 2008). Coal has long played a leading role in helping meet global energy needs. Given the ever increasing demand for energy in both the developed and developing world and international concerns about energy security and costs of power, coal will continue to be an integral part of the energy mix well into the future (Xstrata Coal, 2008).

Xstrata Coal believes that access to an affordable, reliable and secure energy supply is fundamental to economic and social development but, at the same time, fully recognises its role and responsibility to help address climate change. The company believes that emission reductions resulting from the production and use of coal are both required and achievable. Increased energy efficiencies within the built environment, industrial and power generation sectors, together with carbon capture and storage and other low emission power generation technologies, will enable the deep cuts in greenhouse emissions to be realised.

Xstrata Coal is committed to the highest standards of health, safety and environmental performance community cooperation and to the principles of sustainable development. Through its approach to climate change, Xstrata Coal:

- is committed to playing its part in the international collaborative effort to implement solutions to the challenge of climate change;
- recognises the future will be a carbon constrained world and is working with governments, researchers and industry around the world to develop a portfolio of options for reducing greenhouse gas emissions for the use of coal in power generation;
- is a major contributor to the A$1 billion COAL 21 Fund, through the imposition of a voluntary levy on its production. The Fund will financially support the research, development and deployment of low emission power generation technologies in Australia;
- collaborates in research and development programs and provides both technical and financial support to dedicated Cooperative Research Centres focused on near zero emission technologies;
- supports additional research into CO_2 capture and storage to enable this technology to be commercialised worldwide as rapidly as possible;
- works continually for the more efficient use of energy and reduction of greenhouse gas emissions through a dedicated energy efficiency program at all operations;
- looks to collaborate with its customers, both domestic and international, towards the sustainable use of coal through new power generation technologies;
- seeks to effectively reduce fugitive emissions from its operations through the capture and use of methane wherever possible from coal seams to generate electricity; and
- contributes to the development of effective climate change policy (Xstrata Coal, 2008a).

WWC has prepared an Energy Savings Action Plan (ESAP) as part of their requirements under the NSW Government's ESAP legislation (DEUS, 2005). The purpose of the ESAP was to review energy usage, identify energy savings opportunities, and implement on-going energy management activities. Actions that have been implemented or identified for further investigation include (WWC, 2008):

- baseline assessment of energy usage across WWC operations, including a change of mine plan and a review of the production cycle;
- identification and tracking of energy use per ROM tonne of coal as a key performance indicator;
- improved energy metering and data logging capacity on site;
- water management – including an assessment of water re-use underground and a new underground water pump;
- power factor correction;
- compressor system review and audit;

- conveyor review – including a plan to reduce energy use from conveyor drives and No. 2 Ventilation Fan;
- hydraulic circuits at the longwall;
- voltage study and potential regulation on site;
- alternative energy sources for the bathhouse (potential use of gas);
- energy efficiency opportunities in the administration offices; and
- high efficiency motor review and variable speed drive review.

Most of these opportunities for improving energy efficiency and reducing GHG emissions from the current operations are directly applicable to the Project. The ongoing mitigation measures for the Project will be largely focused on energy management, energy efficiency and the potential reduction in automotive diesel oil consumption for mine plant and equipment.

The Project will seek to provide for maximum resource extraction with maximum efficiency. WWC will also assess and consider implementation, where feasible, of further GHG and energy management and mitigation initiatives during the design, operation and decommissioning of the Project.

WWC, as part of Xstrata Coal, also acknowledges that climate change is a major challenge and that accelerated action is required to stabilise greenhouse gas concentrations in the atmosphere at levels guided by the research of the United Nations Intergovernmental Panel on Climate Change.

As part of Xstrata Coal, WWC will also participate in Xstrata Coal's response to the following programs:

- The National Greenhouse and Energy Reporting System (NGERS);
- The Energy Efficiency Opportunities (EEO) Program; and
- The proposed Carbon Pollution Reduction System (CPRS).

5.9 Aboriginal Archaeology

A comprehensive Aboriginal cultural heritage and archaeological assessment was undertaken for the Project by Umwelt in consultation with five registered Aboriginal stakeholder groups. The registered Aboriginal community groups are Awabakal Descendants Traditional Owners Aboriginal Corporation (ADTOAC), Awabakal Local Aboriginal Land Council (ALALC), Awabakal Traditional Owners Aboriginal Corporation (ATOAC), Cacatua Culture Consultants (CCC) and Koompahtoo Local Aboriginal Land Council (KLALC). The detailed assessment report is included as **Appendix 12**, with a summary included in this section.

The principal aims of the Aboriginal cultural heritage assessment were to identify and record the Aboriginal cultural heritage and archaeological values of the continued underground mining area and to assess the significance and any potential impacts of the proposal on these values.

The Aboriginal cultural heritage assessment and consultation program was undertaken in compliance with DECCW *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DECC 2005), DECCW *Interim Community Consultation Requirements for Applicants* (ICCRs – 2004) and *NPWS Draft Standards and Guidelines for Archaeological Report Writing* (1997). The registered Aboriginal stakeholders were involved in all facets of the assessment including consultation during development of the survey strategy and participation in field survey, site identification and recording and provision of advice to WWC which was taken into account in the early mine planning stage. The registered Aboriginal stakeholders participated in the preparation of the report and their comments and advice have been incorporated directly into the text at a working draft and final draft stage. Aboriginal stakeholder feedback and comments were considered and incorporated in the development of the conservation and management strategy.

Following initial consultation with the registered Aboriginal stakeholders, significant changes were made to the proposed mine plan in order to protect two sites of extremely high and one site of very high cultural significance and four landscape features of extremely high cultural significance Modification to the mine plan have also lessened the level of impact to a fourth site of extremely high cultural significance. The modifications to the mine plan have been made with careful consideration to developing a mine plan which WWC believes is both economically feasible and also sensitive to the surface features above the proposed longwall mining area.

In early March 2010, a 'working draft' report was provided to the Aboriginal stakeholder groups and meetings held throughout March and April 2010 with the aim of having the Aboriginal stakeholders assist with preparing the sections of the report related to Aboriginal oral history, Aboriginal cultural significance of the Sugarloaf Range area and the site and landscape features recorded during the survey, and the provision of input into the proposed management outcomes. Advice was also provided by the registered Aboriginal stakeholders on the use of culturally appropriate language and terminology and many sections of the report were revised and the report was reconfigured substantially in response to this advice. Following input of all Aboriginal stakeholders registered for the Project, the draft report was circulated for further Aboriginal stakeholder feedback in April 2010.

Each of the registered Aboriginal stakeholders provided comments on the draft Aboriginal heritage assessment and these comments were provided directly into the detailed report in **Appendix 12**. The Aboriginal stakeholder comments clearly demonstrate the Aboriginal cultural significance of the continued underground mining area and the Aboriginal archaeological sites and landscape features of cultural value it contains. Based on this significance and a cultural responsibility to care for Country, there was a lack of support for any mine related works that would cause impact to the Aboriginal archaeological sites and landscape features of cultural value within the continued underground mining area. However, the Aboriginal stakeholders did provide management recommendations for the sites and landscape features of cultural value that they felt were the 'least objectionable', if the project was approved.

5.9.1 Survey Methodology

A comprehensive field survey was undertaken with full participation of representatives of the registered Aboriginal stakeholders between 9 February and 21 April 2009. One additional half day was undertaken on 23 October 2009 to inspect the area proposed for the Mining Services Facility and an adjacent road reserve proposed for the installation of four to five power poles.

The field survey for the proposed continued underground mining area included a pedestrian field survey of areas within the project boundary. The survey strategy targeted creeklines,

lower slopes/footslopes adjacent to creeks and areas which afforded good ground surface visibility such as roads, animal and motorcycle tracks. The aim of the survey was to identify Aboriginal archaeological sites and landscape features of Aboriginal cultural value within the proposed continued underground mining area with a specific focus on identifying sites/features which were most likely to be impacted adversely by subsidence caused by underground mining and any subsequent associated remediation works. The location of transects were selected by all fieldworkers collaboratively during the field program.

While it is possible that Aboriginal archaeological sites may exist within the proposed continued underground mining area which may not have been detected during the field survey, these are most likely to be comprised of isolated finds and small artefact scatters located on the slopes. These site types are unlikely to be adversely impacted through subsidence (including cracking and tilt) or through subsidence remediation works which are most likely to be restricted to creeklines and roads, both of which were targeted for the survey.

5.9.2 Previous Survey and Assessment

A number of Aboriginal cultural heritage and archaeological assessments have been conducted within the proposed continued underground mining area and immediate surrounds, including assessments pertaining to previous phases of continued operations at WWC. A search of the DECCW Aboriginal Heritage Information Management System (AHIMS), indicated that prior to the current survey, 62 Aboriginal sites were registered within a 6 kilometre radius of the centre of the proposed continued underground mining area. These consisted of 33 sites with stone artefacts (isolated finds and artefact scatters), 24 sets of grinding grooves, 1 set of grinding grooves associated with a waterhole/well, 1 set of grinding grooves in association with a rockshelter with potential archaeological deposit (PAD), 1 set of grinding grooves possibly associated with art (a possible macropod track), 1 scarred tree and 1 potential archaeological deposit. Thirteen of the previously recorded sites occurred within the proposed continued underground mining area including; 3 grinding groove sites, 5 isolated finds, 4 artefact scatters and the Western Domain 5 site (#38-4-0993 - wet soak with artefact scatter site).

In the broader Sugarloaf Range area and within the SSCA it was found that grinding groove sites were the dominant site type listed on the DECCW/AHIMS. Grinding of axes, adzes and hatchets was indicated by the dimensions of the grooves recorded. In total 52 grinding groove sites were registered within the Sugarloaf Range and 34 of these were within the SSCA and under the management of the NPWS/DECCW. The grinding groove sites were predominantly located on the eastern fall of the Sugarloaf Range (28 sites) and within the very upper catchment of creeklines on the western fall of the Sugarloaf Range (24 sites). Only one of the grinding groove sites (Cockle Creek 1 #38-4-0118) was known to have been impacted by previous mining/development.

Three stone arrangements sites (consisting of four stone circular arrangements) were also registered within the Sugarloaf Range area but none of these were within the SSCA. Two of the stone arrangement sites will be protected within a conservation area during the construction of the Hunter Expressway, however, no long term conservation is currently proposed for any of these sites.

There were no scarred trees recorded within the Sugarloaf Range area or SSCA, and there were no registered Aboriginal archaeological rockshelter sites within the Sugarloaf Range area or within the SSCA. However, Brayshaw (1994, 2001) did report a rockshelter with PAD in Burnt Creek in the north-eastern extent of the Sugarloaf Range (outside the SSCA) and numerous rockshelters without evidence of occupation are known from the Aboriginal oral history and previous survey to occur in the area.

5.9.3 Survey Results

A total of 62 Aboriginal archaeological sites were recorded within and in proximity to the proposed continued underground mining area during the survey. These sites consist of:

- 19 sets grinding grooves;
- a set of grinding grooves associated with a rockshelter with an isolated find;
- a rockshelter with artefacts and PAD;
- 36 artefact scatters and isolated finds;
- 3 scarred trees; and
- 2 stone arrangements.

The sites recorded within the continued underground mining area are shown on **Figure 5.6**.

Overall, from the site analysis it appeared that the Cockle Creek and Diega Creek catchments were important resource areas/occupation areas that were favoured for most activities (with the exception of stone implement grinding in the Cockle Creek catchment). Bangalow Creek and Palmers Creek catchments, while being favoured areas for the grinding of stone implements, appear to have been less favoured for other activities. However, it should be noted that a much larger area of the Cockle Creek and Diega Creek catchments are within the proposed continued underground mining area while only the very upper reaches of Bangalow Creek, Palmers Creek and Boggy Hole Creek were within the proposed continued underground mining area. Thus the differences observed in site types, site occurrence and site density are most likely being biased by the differences in landforms/area being surveyed between the catchments.

5.9.4 Significance Assessment

The assessment of significance of Aboriginal sites has two components: Aboriginal cultural significance, which is determined by the Aboriginal stakeholders, and archaeological significance, which is determined by an archaeologist based on the ability of the site to contribute to the scientific understanding of Aboriginal use of the landscape. These two components are not always interrelated, with sites potentially having different cultural and archaeological values.

5.9.4.1 Aboriginal Cultural Significance

Detailed statements relating to the significance of the landscape features identified as having cultural value and the Aboriginal archaeological sites were provided by the registered Aboriginal stakeholders (refer to **Appendix 12**). In relation to the landscape features it was assessed that:

- the stone arch had extremely high Aboriginal cultural significance;
- 'Kangaroo Rock', the pigment source, the spring, the second wet soak and the 11 rockshelters had high to very high Aboriginal cultural significance; and
- the stone cairns/stacks were assessed a having low to moderate Aboriginal cultural significance.

In relation to the Aboriginal archaeological sites it was assessed that:

- the stone arrangements had extremely high Aboriginal cultural significance;
- the grinding groove sites had from very high to extremely high Aboriginal cultural significance;
- the Cockle Creek Rockshelter with Artefacts and PAD had extremely high Aboriginal cultural significance;
- the scarred trees had very high to extremely high Aboriginal cultural significance;
- the Western Domain 5, Brunkerville Trail and GNW artefact scatter sites had very high to extremely high Aboriginal cultural significance; and
- the remainder of the artefact scatters and isolated finds had moderate to very high Aboriginal cultural significance.

Overall the continued underground mining area and the identified landscape features and Aboriginal archaeological sites it contains were assessed as having high to extremely high Aboriginal cultural significance.

5.9.4.2 Archaeological Significance

The archaeological significance of Aboriginal archaeological sites is assessed according to their research potential. Six criteria were taken into account when assessing archaeological significance: rarity, representativeness, integrity, connectedness, complexity and potential for archaeological deposit. These criteria were assessed within a local and regional context. In summary:

- 33 isolated finds and artefact scatters were assessed as having low overall archaeological significance (53 per cent of the assessed sites);
- seven grinding groove sites and three artefact scatters were assessed as having overall low to moderate archaeological significance (16 per cent of the assessed sites);
- two grinding groove sites and three scarred trees were assessed as having overall moderate archaeological significance (8 per cent of the assessed sites);
- five grinding groove sites and two stone arrangements were assessed as having overall moderate to high archaeological significance (11 per cent of the assessed sites); and
- six grinding groove sites (including #38-4-0462 Grinding Grooves and Associated Rockshelter site) and one rockshelter with artefacts and PAD were assessed as having overall high archaeological significance (11 per cent of the assessed sites).
- High levels of prior disturbance and erosion (related mainly to historic impacts by logging practices followed by erosion and track construction, maintenance and use) were the main factors that led to the high percentage of the artefact scatter and isolated find sites being assessed as having low overall archaeological significance.

As discussed in **Section 2.3.2**, following the survey the mine plans were modified to avoid impact to the Palmers Creek 1 (#38-4-1007) and 2 Grinding Groove sites of extremely high Aboriginal cultural and high archaeological significance and the Western Domain 5 (#38-4-0993 - wet soak with artefact scatter site) of very high Aboriginal cultural and low to moderate archaeological significance. The mine plan modifications also reduced the impact predicted

to the Palmers Creek 3 Grinding Groove site of extremely high Aboriginal cultural and high archaeological significance.

5.9.5 Impact Assessment

All 62 Aboriginal archaeological sites assessed for their Aboriginal cultural and archaeological significance were assessed for potential to be impacted directly or indirectly by subsidence or directly by subsidence remediation works. No impacts to Aboriginal sites/landscape features of Aboriginal cultural value are proposed to be impacted by surface infrastructure.

The potential impacts arising from subsidence and subsidence remediation works to Aboriginal archaeological sites was assessed by DGS (2009) (refer to **Appendix 5**). DGS assessed the potential for damage to the Aboriginal archaeological sites and landscape features based on predictions for 'final subsidence, tilt, strain and surface gradient change contours'.

In relation to artefact scatters, isolated finds, scarred trees and the stone arrangements direct impacts are possible from ground surface cracking and subsequent remediation works. Direct impacts from the cracking of the sandstone platforms, benches or creekbeds on which the grinding grooves are located is possible for 15 grinding groove sites within the proposed continued underground mining area. Similarly, cracking of the walls, floor, deposit and roof fall is possible for the one rockshelter recorded as an Aboriginal archaeological site (Cockle Creek Rockshelter with Artefacts and PAD). Indirect impact in the form of increased erosion and/or sedimentation is possible for all site types.

Of the 62 sites assessed, it is considered that the Project has the potential to impact to varying extents on 49 of the sites. Of these sites, 11 have extremely high Aboriginal cultural value and 17 sites have moderate, moderate to high or high archaeological significance. The Palmers Creek Grinding Grooves 1 (#38-4-1007) and Palmers Creek Grinding Grooves 2 sites of extremely high Aboriginal cultural and high archaeological significance and the Western Domain 5 (#38-4-0993 - wet soak with artefact scatter site) of very high Aboriginal cultural and low to moderate archaeological significance have been protected due to mine plan modifications. An additional grinding groove site (Palmers Creek Grinding Grooves 3) has a lower assessed potential for impact by cracking (reduced from >25 per cent to between 5 and 15 per cent) due to the revision of the mine plan to increase the width of the chain pillar proposed beneath the site from 30 metres in width to 45 metres in width. The Bangalow Creek Grinding Grooves 7 site is located outside the predicted subsidence impact area. This site will not be directly impacted by subsidence and providing indirect impacts from the addition of sediment to Bangalow Creek is managed upstream, should not be subject to indirect impacts. Similarly the previously recorded #38-4-0462 Grinding Grooves and Associated Rockshelter site is just outside the continued underground mining area and provided appropriate upstream sediment control is implemented on Bangalow Creek, this site should not be subject to indirect impacts.

In relation to the landscape features assessed for impact, four of these (a spring and three rockshelters) are outside the proposed continued underground mining area), three rockshelters and the stone arch will not be impacted due to mine plan changes in recognition of their Aboriginal cultural significance, and one feature, a free standing boulder (Kangaroo Rock), will not be impacted by subsidence.

The assessment identified that damage is predicted to the remaining eight of the landscape features (stone cairns/stacks, five rockshelters, the pigment source in the bank of Bangalow Creek and a second wet soak in the Diega Creek catchment of low to moderate to high to very high Aboriginal cultural significance.

In summary, mine plan modifications have protected two significant grinding groove sites and one artefact scatter site associated with a wet soak and four landscape features (a stone arch and three rockshelters). Mine plan modifications have also reduced the likelihood of impact to a third significant grinding groove site. In addition, nine landscape features of cultural value will not be impacted due to four being outside the impact area (the spring and Rockshelters 5, 6 and 9), four being protected by mine plan modification (Rockshelters 1, 2 and 8 and the stone arch) and as one is a freestanding boulder (Kangaroo Rock). One grinding groove site and one grinding groove site with an associated rockshelter may be indirectly impacted if sediment controls are not implemented upstream. The remaining 47 sites and eight landscape features within the proposed continued underground mining area may be subject to various levels of impact following undermining and/or subsidence remediation works.

5.9.6 Management Strategy

The continuation of underground mining within the continued underground mining area has the potential to impact 49 (79 per cent) Aboriginal archaeological sites and eight (47 per cent) landscape features identified as having Aboriginal cultural heritage value within the proposed continued underground mining area.

From an Aboriginal cultural heritage and an archaeological perspective, Aboriginal archaeological sites are a finite and irreplaceable resource that has already been heavily impacted. Thus DECCW requires proposals for site damage/destruction to be accompanied by appropriate mitigation (site salvage and/or management) and balanced by site and/or other conservation offset measures. Therefore, the management options considered spanned conservation, conservation offsets and impact mitigation (for details refer to **Appendix 12**).

It is noted that the registered Aboriginal stakeholders voiced their concern with having to consider endorsing damage to any of the landscape features and Aboriginal archaeological sites within the proposed continued underground mining area and the legacy this left for their descendants and the lack of respect they felt this showed for the ancestral Awabakal people (refer to **Appendix 12**). In considering management options for the landscape features of Aboriginal cultural value and the Aboriginal archaeological sites, ADTOAC and ATOAC identified that it was not culturally appropriate for them, as custodians of Aboriginal cultural heritage for this area, to endorse any impacts that may result in damage to the landscape features of Aboriginal cultural value or the Aboriginal archaeological sites within the continued underground mining area. Thus 'no impact' and 'total conservation' was the preferred management option from the perspective of these registered Aboriginal stakeholders. CCC supported the ADTOAC and ATOAC recommendations (refer to **Appendix 12**).

Similarly, ALALC identified that as the organisation with the 'responsibility' for 'the ongoing protection and conservation of the Aboriginal Culture and Heritage' within their Land Council area, that they were 'strongly opposed to the proposed underground mining and other impacts associated with this project' (ALALC correspondence dated 18 June 2010 – refer to **Appendix 12**). KLALC stated that the proposed continued underground mining areas was very important culturally and that the KLALC wanted 'the sites and places up there looked after properly so that future generations can visit the sites and learn more about the Aboriginal past of this area' (refer to **Appendix 12**).

Having noted that total conservation of all sites and landscape features of Aboriginal cultural value was the desired outcome of all registered Aboriginal stakeholders, ADTOAC, ATOAC, ALALC, KLALC and CCC provided comments on the management options they felt were the least objectionable if mining was to proceed and no impact/total conservation was not possible (refer to **Appendix 12**). It is further noted that ADTOAC and ATOAC are not saying

that underground mining should not go ahead, but that if it does go ahead, they request it be undertaken in a way that allows the landscape features of Aboriginal cultural value and the Aboriginal archaeological sites to remain undamaged.

The necessity for this assessment to consider Intergenerational Equity was outlined as part of the DECCW's requirements for the Project (correspondence dated 11 November 2009). The final management strategy has been prepared taking into account the need for the project outcomes to demonstrate Intergenerational Equity (for details refer to **Appendix 12**). As noted above, during the working draft report consultation period, it was noted that the requirements for meeting Intergenerational Equity placed WWC in the position where the feasibility of the continued underground mining project was put in doubt due to a lack of certainty in relation to approval for undermining one of the sites (Diega Creek Grinding Grooves 1). In order to address this lack of certainty and to address the requirements of Intergenerational Equity, WWC committed to setting aside for protection another five sets of grinding grooves in the Burkes Creek catchment to act as an offset for any potential damage from undermining of the Diega Creek Grinding Grooves 1 site (for details refer to **Appendix 12**). The registered Aboriginal stakeholders, however, did not assess that this was an appropriate offset. In light of the Aboriginal stakeholder comments WWC do not propose to utilise the management option of protecting the Burkes Creek sites but would like to retain the option to conserve the Burkes Creek area for future assessment if deemed appropriate by the registered Aboriginal stakeholders, DECCW and DoP.

5.9.6.1 Landscape Features of Aboriginal Cultural Value

Six principal management outcomes are included in the strategy for the management of the landscape features of cultural value. WWC has committed to:

- modification of the mine plan to protect the stone arch and one rockshelter site in the Bangalow Creek catchment and two rockshelter sites in the Cockle Creek catchment;

- following subsidence the inspection of the second wet soak feature recorded in the Diega Creek catchment and the infilling of any cracks caused by subsidence with imported fill and if required and feasible, erosion control works upslope to prevent infilling of the wet soak if subsidence results in any slope destabilisation;

- following subsidence the collection of loose fragments of clay pigment (if any) from the pigment source identified by the registered Aboriginal stakeholders in the upper tributary system of Bangalow Creek;

- prior to subsidence two stone cairns/stacks in the Bangalow Creek catchment are photographed from each side. Following undermining the replacement of any stones dislodged during subsidence by the registered Aboriginal stakeholders using the photographs as a reference, and the infilling of any cracks caused by subsidence with imported fill;

- following subsidence the inspection of the boulder identified as 'Kangaroo Rock' and the infilling of any cracks in the topsoil caused by subsidence with imported fill; and

- following subsidence the inspection of the five known rockshelters (not recorded as Aboriginal archaeological sites) within the proposed continued underground mining area and repairs to the roof, walls and floor in a culturally appropriate manner (where necessary, safe and feasible).

Following undermining, information will be recorded in relation to the impacts of subsidence on the various landscape features. This information will be used to inform future underground

mining projects. The details of how this information will be recorded/reported are discussed in **Appendix 12**).

In relation to the six principal management outcomes, ADTOAC, ATOAC, ALALC, KLALC and CCC have indicated that they do not endorse any impacts to the landscape features of Aboriginal cultural value within the proposed continued underground mining area. Therefore they applaud WWC for modifying its mine plan to avoid impact to the stone arch and two rockshelters in the Cockle Creek catchment. Having indicated that it is not culturally appropriate to endorse any impact that may damage the identified landscape features of cultural value, the registered Aboriginal stakeholders have indicated that if Project Approval is obtained by WWC they would support the remaining five management outcomes in the dot points listed above as these are the least objectionable to them.

5.9.6.2 Aboriginal Archaeological Sites

Seven principal management outcomes are included in the strategy for the management of Aboriginal archaeological sites within the proposed continued underground mining area if longwall mining is approved (these are detailed in **Appendix 12**). It is recommended that the management strategy be implemented as a staged process as longwall mining progresses and in compliance with an ACHMP prepared in consultation with the relevant registered Aboriginal stakeholders, NPWS/DECCW and approved by DoP.

The management outcomes proposed for Aboriginal archaeological sites are:

- modification of the mine plan to protect the Palmers Creek 1 Grinding Grooves 1 #38-4-1007 and Palmers Creek Grinding Grooves 2 sites and the Western Domain 5 (#38-4-0993 - wet soak with artefact scatter site);

- modification of the mine plan to lessen the probability of impact to the Palmers Creek Grinding Grooves 3 site, and mitigation of impacts due to subsidence (if any);

- prior to undermining of the Diega Creek Grinding Grooves 1 site to monitor the impacts of subsidence on the Diega Creek Grinding Grooves 2 to 6 sites and if more than 50 per cent of these sites are cracked following subsidence to revise the management strategy in relation to Diega Creek Grinding Grooves 1;

- prior to undermining the manual excavation of 30 per cent of the deposit from the Cockle Creek 1 Rockshelter with Artefacts and PAD and the propping of the roof of the rockshelter (if safe and feasible); and following subsidence repairs to any cracks in the walls, floor and roof (if necessary safe and feasible) and the return of any excavated material (if safe and feasible);

- prior to undermining the preparation of a photographic record and scale drawing of the two stone arrangement sites. Following undermining the inspection of the stone arrangements and if any movement of stones has been caused by subsidence, the registered Aboriginal stakeholders to replace the stones in their original arrangement. Any remediation works in the area to consist of infilling cracks in the topsoil with imported fill to avoid further site impact;

- prior to undermining the preparation of a photographic record and scale drawing of three scarred tree sites. Following undermining the inspection of the three Aboriginal scarred trees and the infilling of any cracks in the topsoil caused by subsidence with imported fill; and

- the provision of offsets for potential loss of Aboriginal cultural and archaeological values that may arise due to subsidence within the proposed continued underground mining

impact area (refer to **Section 5.9.7**); and if required following subsidence, the mitigation of any subsidence impacts using protocols and procedures detailed in an ACHMP prepared in consultation with the relevant registered Aboriginal stakeholders and the DECCW).

In relation to the seven principal management outcomes, ADTOAC, ATOAC, ALALC, KLALC and CCC have indicated that they do not endorse any impacts to the Aboriginal archaeological sites within the proposed continued underground mining area. Therefore they applaud WWC for modifying its mine plan to avoid impact to Palmers Creek Grinding Grooves 1 #38-4-1007 and Palmers Creek Grinding Grooves 2 sites and the Western Domain 5 (#38-4- 0993 - wet soak with artefact scatter site). Having indicated that it is not culturally appropriate to endorse any impact that may damage the Aboriginal archaeological sites, ADTOAC, ATOAC, ALALC, KLALC and CCC have indicated that if Project Approval is obtained by WWC they would support the remaining six management outcomes in the dot points listed above as these are the least objectionable to them.

5.9.7 Conservation Offset Strategy

WWC proposes a multi-faceted approach to providing a conservation offset strategy for its project. **Sections 5.9.7.1** to **5.9.7.5** outline the conservation offsets proposed by WWC as part of its overall management strategy which aims to meet the requirements of Intergenerational Equity and offset any loss of Aboriginal cultural heritage and archaeological values that may arise as an outcome of subsidence.

5.9.7.1 Mine Plan Modifications

WWC has committed to modifying its mine plans to avoid impact to the Palmers Creek 1 (#38-4-1007) and Palmers Creek 2 Grinding Groove sites and the Western Domain 5 (#38-4-0993 - wet soak with artefact scatter site). The mine modifications are proposed in recognition of the Aboriginal cultural value and archaeological significance of these sites.

The mine plan has also been modified to reduce the potential impact of subsidence on the Palmers Creek 3 Grinding Groove site from >25 per cent to 5 to 15 per cent probability of cracking in recognition of its Aboriginal cultural value and archaeological significance.

WWC has committed to modifying its mine plans to avoid impact to the ‘stone arch’. This mine plan modification is proposed in recognition of the Aboriginal cultural value of this landscape feature.

The mine plan modifications have also acted to protect three rockshelters (Rockshelters 1, 2 and 8) recorded as landscape features of high Aboriginal cultural value.

The mine plan modifications proposed will sterilise 2.04 Mt of coal resource. This has a current economic value of $150 million.

Following ongoing consultation with the registered Aboriginal stakeholders during the working draft and final draft report process it was assessed that WWC was not meeting the requirements of Intergenerational Equity in relation to one of the grinding groove sites (Diega Creek Grinding Grooves 1). In order to address this inequity WWC also offered to protect six additional grinding groove sites (Burkes Creek Grinding Groove 1, #38-4-0607, #38-4-0608; #38-4-0622, #38-4-0636 and #38-4-0599 Grinding Grooves and Possible Art) within ML 1451 from any future mining impacts as an offset for the potential loss of Aboriginal cultural and archaeological values associated with the undermining of Diega Creek Grinding Grooves 1. In protecting these sites WWC would also afford protection to a newly recorded scarred tree (Burkes Creek ST1). However, this proposed offset has been rejected by the registered Aboriginal stakeholders (refer to **Appendix 12**).

5.9.7.2 Funding for Management of Cultural Heritage in SSCA

To offset the potential loss of Aboriginal cultural and archaeological values that may arise as a result of subsidence impacts within the proposed continued underground mining area, WWC has committed to providing $200,000 over the life of the proposed continued underground mine project to assist with the management of Aboriginal cultural and archaeological sites/values within the SSCA.

WWC will set aside the $200,000 prior to mining commencing and will administer the funds. The funds will be allocated on a project basis. All projects will be undertaken in consultation with the relevant registered Aboriginal stakeholders and the NPWS/DECCW.

5.9.7.3 Funding for Ongoing Monitoring/Reporting of Subsidence Impacts

To offset the potential loss of Aboriginal cultural and archaeological values that may arise as a result of subsidence impacts within the proposed continued underground mining area, WWC has committed to fund a program of monitoring and reporting of subsidence impacts on landscape features of Aboriginal cultural value and Aboriginal archaeological sites recorded within the proposed continued underground mining area.

It is proposed that following the cessation of subsidence related to each longwall WWC will fund an inspection of the subsided sites/landscape features of Aboriginal cultural heritage value in order to collect a detailed database on exactly how each of the sites is impacted. The inspection and reporting will be undertaken by the relevant registered Aboriginal stakeholders and a suitably qualified archaeologist. The purpose of the monitoring is threefold. Initially it is to observe:

- What percentage of the sites do/do not crack?
- What is the level and nature of the impact?
- How does this relate to the location of the site relative to longwalls/chain pillars and their situation (e.g. on a slope, on a sandstone bench, within a sandstone creek bed, in a cliffline, pre-existing cracking and jointing)?
- Does this information allow refinement of the predicted impacts and therefore management of subsidence on the sites within the proposed continued underground mining area?
- If so, does this information allow the revision of the management strategy for the remainder of the grinding groove sites for which subsidence is proposed?

The second aim of the monitoring is to provide a more detailed database for use for future mining assessments and to monitor the success of remediation works (where required) on all site types within the proposed continued underground mining area. This level of recording is rarely undertaken in relation to Aboriginal archaeological sites and landscape features of Aboriginal cultural value and will be extremely informative to WWC, registered Aboriginal stakeholders, archaeologists, NPWS/DECCW and DoP for undertaking and evaluating future assessments. A database of this nature would be an extremely valuable resource.

The third aim is to ensure compliance with the various aspects of the management strategy that relate to monitoring either before or after subsidence. In this regard it is proposed to record the:

- impacts of subsidence (if any);
- requirements for remediation (if any);
- nature and extent of the remediation works;
- suitability of the remediation works;
- success of remediation works; and
- project approval compliance.

It is proposed that full pictorial records will be prepared for each landscape feature/site to inform the reporting process for the DECCW and DoP.

One aspect of the monitoring process will be to ascertain if more than 50 per cent of the Diega Creek Grinding Grooves 2 to 6 sites have been impacted by cracking due to subsidence. This monitoring will be undertaken prior to any longwall mining that may impact the Diega Creek Grinding Grooves 1 site. If more than 50 per cent (3 or more) of these sites crack WWC has committed to revising its management strategy in consultation with the registered Aboriginal stakeholders and the NPWS/DECCW. Revisions to the management strategy may include conservation of the site or to further survey to locate other sites that could be conserved as an appropriate offset for any potential damage to Diega Creek Grinding Grooves 1.

5.9.7.4 Funding for Further Survey of the SSCA

For WWC to be able to meet the requirements of Intergenerational Equity without further modifications to the mine plan, WWC must demonstrate that Aboriginal archaeological sites of equal cultural heritage and archaeological significance and research potential to the Bangalow Creek 1, 2, 3, 4, 5, 6 and #38-4-0461 Grinding Grooves sites exist within the broader SSCA and outside of mine leases and that these sites can be managed in a culturally appropriate way that will ensure their long-term conservation and availability for teaching purposes to present and future generations of Awabakal people and Aboriginal people that live in, and/or visit the area. In this regard WWC has committed to funding a program of survey within the SSCA in consultation with the registered Aboriginal stakeholders and the NPWS/DECCW. The information recorded during the survey will be provided to the NPWS/DECCW to assist in the preparation of the POM for the SSCA.

It is proposed that:

- during the approval process a meeting will be arranged by WWC with NPWS/DECCW, in consultation with ADTOAC, ALALC, ATOAC, CCC, NSWALC (an archaeologist may be included in this meeting if thought appropriate by WWC, ADTOAC, ALALC, ATOAC, CCC and NSWALC) to discuss:
  - WWC setting up a fund which they will administer for survey within the SSCA (outside the proposed continued underground mining area and outside ML areas);
  - the nature of the survey strategy; and
  - the requirements of the POM being prepared by the NPWS/DECCW for the SSCA so that the requisite information can be recorded during the survey;

- the survey will include at least 20 days of survey and recording of sites and landscape values/resources within the SSCA by the relevant registered Aboriginal stakeholders and an archaeologist (the breakdown of this time between the ALALC and KLALC boundaries will be subject to consultation between the Aboriginal stakeholder groups and WWC);

- funding will also be provided for the preparation and production of site cards (including the production of maps, plans, photographs); and

- following the completion of the survey and the compilation of the site cards, additional funding will be provided to commission a suitably qualified person to assist WWC to prepare a statement, in consultation with the relevant registered Aboriginal stakeholders, for provision to DoP and NPWS/DECCW in relation to the suitability (in terms of their Aboriginal cultural and archaeological significance and conservation value) of the sites located outside MLs and within the SSCA as an offset (in terms of Intergenerational Equity) for the impact predicted from subsidence to the Bangalow Creek 1, 2, 3, 4, 5, 6 and #38-4-0461 Grinding Grooves 3 sites.

WWC will commit to revising the management strategy for the Bangalow Creek 1, 2, 3, 4, 5, 6 and #38-4-0461 Grinding Grooves sites if it cannot be demonstrated that:

- there are suitable sites outside the proposed continued underground mining area and outside MLs in the SSCA that can be managed/conserved into the future to meet the requirements of Intergenerational Equity for all or some of the Bangalow Creek 1, 2, 3, 4, 5, 6 and #38-4-0461 Grinding Grooves sites (this will be site specific and depend on the outcomes of the survey and further consultation with NPWS/DECCW).

The revisions to the management strategy may include further survey or alternative offsets assessed as appropriate from an Aboriginal cultural and archaeological perspective and endorsed by DECCW and DoP.

While the strategy above proposes a start date for the survey within 24 months of site impact, WWC may commence work on the strategy at an earlier date if it would prefer to know the outcome of the survey sooner and to obtain more certainty for the proposed continued underground mining project.

5.9.7.5 Additional Conservation Offsets

Each of the registered Aboriginal stakeholder groups has requested an additional cultural heritage conservation offset package which they assess as necessary for WWC to balance the requirements of Intergenerational Equity.

As some groups requested that the supply of details related to their additional offset requests be restricted to the Aboriginal stakeholders, WWC, NPWS/DECCW and DoP, the information has been included in Appendix L of **Appendix 12**, which will not be available for public review.

As part of its overall conservation offset strategy WWC has committed to the provision of $25,000 to four of the registered Aboriginal stakeholders and $10,000 to a fifth Aboriginal stakeholder as an additional offset for specific cultural heritage projects.

5.9.8 Aboriginal Cultural Heritage Management Plan (ACHMP)

WWC will prepare an ACHMP for the project that is consistent with the Aboriginal cultural and archaeological management commitments made in this report. The ACHMP will provide detailed management strategies for all identified Aboriginal archaeological sites and

landscape features of Aboriginal cultural value located within the proposed continued underground mining area.

The ACHMP will also review and revise as required/where appropriate, Aboriginal heritage management protocols from previous consents and approvals, to provide WWC with a single, consolidated framework for managing Aboriginal cultural heritage (for details please refer to Appendix H of **Appendix 12**). The ACHMP will also clearly identify the responsibilities of all parties involved; WWC, registered Aboriginal stakeholders, archaeologists, NPWS/DECCW; and designate timeframes for required Aboriginal heritage management works.

The ACHMP will be in operation throughout the life of the proposed continued underground mining project. The aim of the ACHMP is to ensure WWC meet the requirements of the Project Approval which it is proposed should include a request for:

- details of the proposed implementation of, and methodology for, the conservation offset strategy;
- a detailed salvage program for Aboriginal archaeological sites within the proposed continued underground mining area including isolated finds, artefact scatters (if subsidence remediation works are required in the site areas) and the Cockle Creek Rockshelter with Artefacts and PAD (refer to **Appendix 12** for a detailed Research Design and Methodology);
- a detailed description of the mitigation measures that would be undertaken for all Aboriginal archaeological sites and landscape features of Aboriginal cultural value within the proposed continued underground mining area prior to and/or following subsidence;
- a detailed description of the measures that would be implemented to protect Aboriginal archaeological sites and landscape features of Aboriginal cultural value for the life of the project;
- a detailed methodology for inspection of locations proposed for surface ventilation infrastructure construction and future exploration boreholes (for further details refer to **Appendix 12**);
- a description of the measures that would be implemented if any new Aboriginal sites/artefacts or skeletal remains are discovered during works associated with the Project;
- the provision of Aboriginal cultural awareness training for WWC personnel and for contractors as part of the induction process; and
- a protocol for the ongoing consultation and involvement of the Aboriginal stakeholder groups and NPWS/DECCW in the conservation and management of Aboriginal cultural heritage within the proposed continued underground mining area.

Endorsement of the proposal for an ACHMP has been provided by the relevant registered Aboriginal stakeholders.

5.10 Historic Heritage

A Historical Heritage assessment has been undertaken for the Project by Umwelt. The assessment has been undertaken in accordance with guidelines set out in the *NSW Heritage Manual 1996*, produced by the Heritage Branch, Department of Planning (DoP), including *Archaeological Assessments* and *Assessing Heritage Significance* and with consideration of

the principles contained in the *Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance*. The assessment included a review of:

- the Australian Heritage Database maintained by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA);
- the State Heritage Register (SHR) and State Heritage Inventory maintained by the NSW Heritage Council;
- the Register of the National Estate (RNE);
- the Register of the National Trust (NSW);
- Schedule 3 (Items of the environmental heritage) of Cessnock Local Environmental Plan 1989;
- Schedule 4 (Heritage items other than of indigenous origins and including potential archaeological sites) of Lake Macquarie Local Environmental Plan 2004; and
- Hunter Regional Environmental Plan 1989 (Heritage).

The detailed Historical Heritage Assessment report is included in **Appendix 13**, with an overview of the main findings, provided in this section.

5.10.1 Historical Context

The continued underground mining area of the Project forms part of a landscape that was historically closely linked to both mining and forestry. The Sugarloaf Range was the traditional country of the Awabakal people prior to European contact and continues to be highly valued by Aboriginal people. The Aboriginal Heritage Assessment is discussed further in **Section 5.9**.

In 1800 Captain William Reid first discovered the coal resources of the Lake Macquarie area. Settlement in the area was not permitted by Governor Macquarie for security reasons until after the closure of the Newcastle penal settlement in favour of one at Port Macquarie. Apart from escaped convicts and their pursuers and hunting parties, few Europeans would have visited the area until the mid 1820s.

As the Lake Macquarie region did not offer the best conditions for agricultural development, by 1833 only 13 grants had been made to settlers. The first village to appear in the region of Lake Macquarie was Newport at the mouth of Dora Creek where farmers and timber getters formed a community in the early 1840s. In the 1860s there were several new subdivisions of Crown Lands under the Robertson Land Acts of 1861 which led to a number of new villages appearing as landowners were attracted to the areas opportunities to acquire a small holding and employment in the timber, mining, shipping or fishing industries.

The area that covers the present West Wallsend residential area was granted to the West Wallsend Coal Co. on 8 January 1889. West Wallsend was founded on coal mining and in July 1888 the West Wallsend Coal Co. colliery commenced production after several years of preparation. During 1886 and 1888 approximately 40 workers were employed on shaft sinking and foundation work for the start of the coal mines.

The timber industry was also historically regarded to be of high importance as the demand for timber in the Lake Macquarie area increased with the establishment of coal mining. The start of the railway system in NSW in 1855 also created an immediate demand for timber. The majority of timber was supplied to local underground mines for pit props, however with

the advent of open cut mining and longwall mining techniques eventually arising, there became a substantial decrease in the demand for mining timbers (DECC 2008:2). If present, evidence of former sleeper cutting activities generally relates to the period between 1890 and 1930 during the peak period of railway expansion in NSW.

5.10.2 Survey Results and Impact Assessment

A comprehensive historical heritage site survey of the continued underground mining area was undertaken by Umwelt in conjunction with the Aboriginal heritage investigation conducted by Umwelt and representatives of Aboriginal stakeholder groups.

Several trees with potential historical wounds, scars or surveyor's marks were the only potential historical heritage sites identified within the continued underground mining area. The locations of the sites are illustrated in **Figure 5.17**. These wounds, scars or surveyor's marks comprise:

- a surveyor's blaze on a tree near Diega Creek (Tree 10/Diega Creek);
- a surveyor's blaze on a tree near Bangalow Creek (Tree 2/Bangalow Creek ST1);
- a wound likely made by timber getters for food storage on a tree near Diega Creek (Tree 6/Diega Creek ST3); and
- a burl removal wound on a tree near Bangalow Creek (Tree 9/Bangalow Creek ST3).

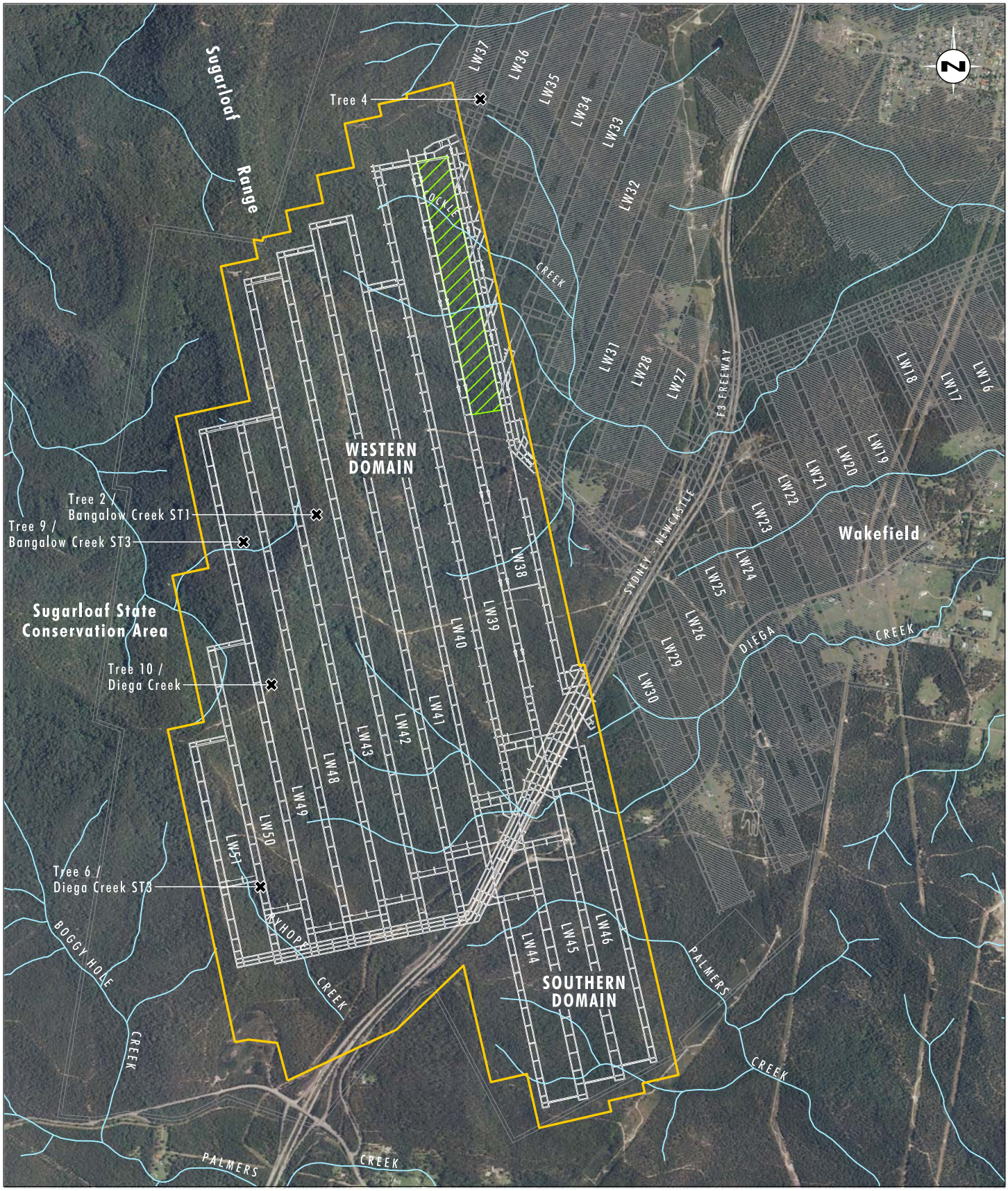
Of the recorded historical heritage sites, one site has been assessed as having a high potential for subsidence impact and three have a very low to low potential for subsidence impact from the proposed continued underground mining. The site considered to have a high potential for subsidence impact is Tree 2/Bangalow Creek ST1. The potential for any subsidence cracking that may occur as a result of mining activities is unlikely to further adversely affect the tree. As a result, there are unlikely to be any significant impacts to Tree 2/Bangalow Creek ST1, or any of the other sites, or their heritage significance as a result of subsidence during the continued underground mining operations.

Although a comprehensive survey for historic heritage sites was completed, there is some potential for previously unidentified sites to exist given the intact nature of the vegetation in the continued underground mining area. Any additional, as yet unidentified, potential heritage sites/items that may be present within the continued underground mining area are likely to comprise of evidence of timber getting camps and logging or additional survey marks and fencing. If present, these sites/items are likely to be typical of those found throughout the Hunter Valley and rural NSW and at best be of local significance.

5.10.3 Significance Assessment

The continued underground mining area is typical of a rural landscape within the Lower Hunter region of NSW. The history of the area from the mid nineteenth century, including its settlement and use by Europeans through to its exploitation for timber and mineral resources and dedication as part of state forests is reflected in the low potential of the historical heritage resource.

In general terms, with the exception of Tree 6/Diega Creek ST3, the identified and potential heritage sites of the continued underground mining area are of nil to low local significance with nil to low research potential. Tree 6/Diega Creek ST3 however, is considered to be of local significance, as the wound identified was likely made by timber getters for food storage and was assessed as potentially dating to the late nineteenth century when railway expansion in NSW was at its peak. It is also believed this site has potential associations with



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines,DEC AHIMS

0 0.5 1.0 1.5km
1:30 000

Legend

- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Drainage Line
- ✖ Heritage Tree

File Name (A4): R08_V1/2553_259.dgn

FIGURE 5.17

Historic Heritage Sites within the Continued Underground Mining Area

interactions between the timber getters and the local Aboriginal people. As discussed in **Section 5.10.2**, this site has a very low to low potential for subsidence impact as a result of the Project.

5.10.4 Management Strategy

A number of management strategies will be implemented to ensure that impacts associated with the Project on sites of historical heritage significance are mitigated. As previously discussed, subsidence has low potential to result in significant impacts on historic heritage sites within the continued underground mining area.

The following management measures will be implemented for the Project:

- the recorded historic heritage items will be mapped on relevant project drawings and plans used during subsidence remediation works to provide that their presence is considered in planning such works;

- WWC personnel involved in subsidence remediation works will be briefed about the location of the recorded heritage items and their heritage status in an induction prior to conducting work in the continued underground mining area; and

- inspections will be undertaken following completion of undermining the recorded historic heritage sites to determine if any remediation works are necessary.

In the unlikely event that unexpected archaeological remains or potential heritage items not identified as part of this report are discovered during the continuation of underground mining, all surface works in the immediate area would cease, the remains and potential impacts would be assessed by a qualified archaeologist or heritage consultant and, if necessary, the Heritage Branch, Department of Planning notified in accordance with Section 146 of the *Heritage Act 1977* (NSW).

5.11 Traffic and Transport

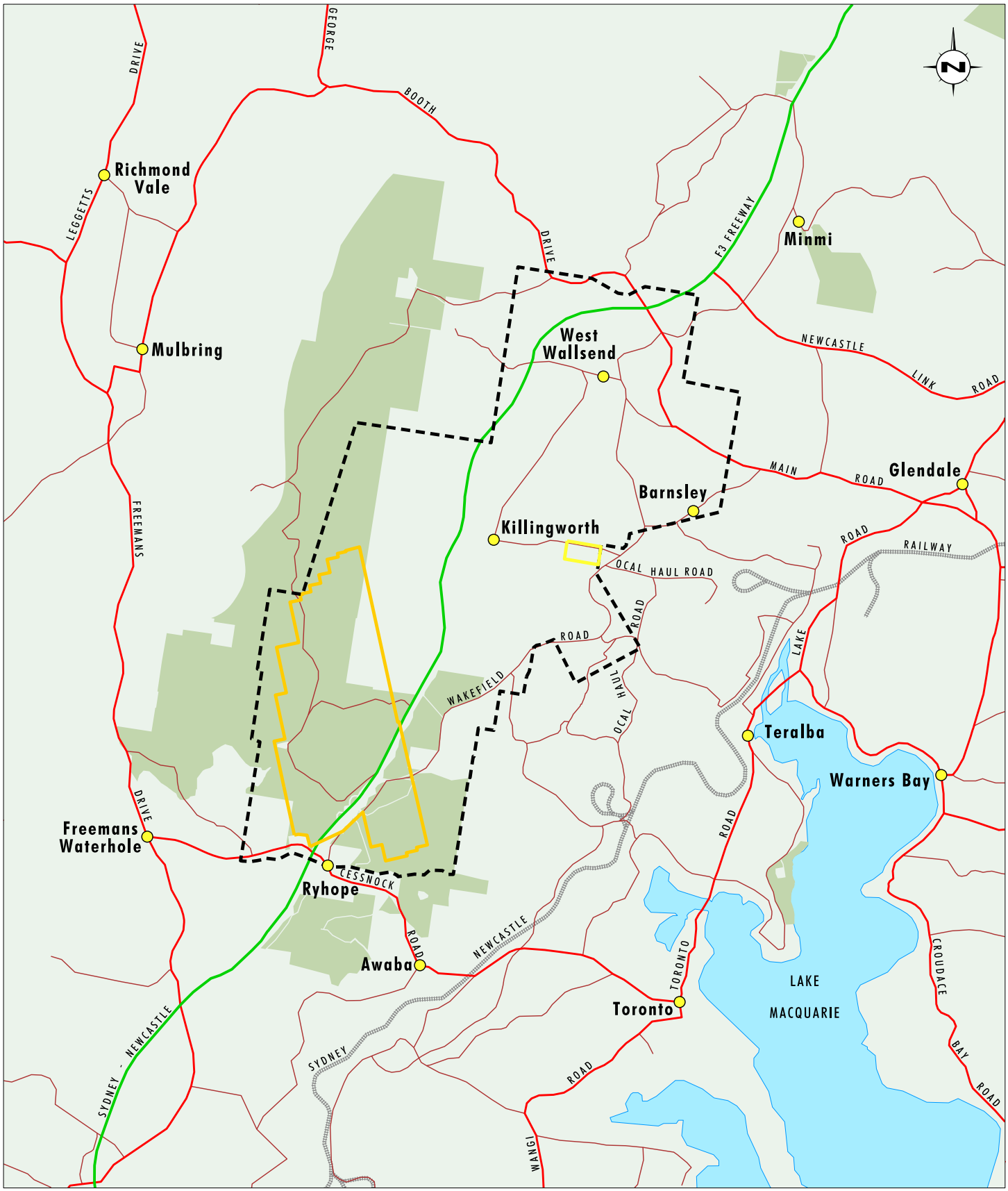
A comprehensive assessment of the traffic impacts associated with the Project was undertaken by Stapleton Transportation & Planning Pty Ltd. This assessment considered both the traffic associated with the WWC pit top facility and the potential traffic impacts of the proposed new Mining Services Facility. The full assessment report is included in **Appendix 14**, and the key findings are outlined in the following sections.

5.11.1 Existing Traffic Conditions

The existing road network surrounding and servicing WWC is shown on **Figure 5.18** and a brief description of the relevant roads is provided below. Traffic volume data for the local road system has been determined by traffic counts undertaken during October 2009 as part of the traffic assessment. RTA data has also been sourced for traffic volumes on the roads surrounding the WWC complex.

Sydney to Newcastle Freeway (F3)

The F3 Freeway is a major regional arterial road that connects Sydney and Newcastle. Connections to the sub-regional and then local network relevant to the project area are available at either Cessnock Road to the south of the continued underground mining area, or at George Booth Drive to the north of the site.



Source: OCAL, Department of Lands 2006

Legend

- Existing West Wallsend Colliery Pit Top Facility
- Continued Underground Mining area
- Project Application Boundary
- State Conservation Area
- F3 Freeway
- Major Road
- Secondary Road
- Railway
- Town / Suburb

FIGURE 5.18

Existing Road Network

George Booth Drive

George Booth Drive links the F3 Freeway with south and western Newcastle and is a sub-arterial road.

Northville Drive

Northville Drive is a collector road that links the local suburbs located north of the site, including Holmesville and Barnsley, through to the regional network at George Booth Drive, and south to Wakefield Road.

Wakefield Road

Wakefield Road is a rural collector road and links Barnsley through to Cessnock Road at Ryhope, and also includes links to local roads linking rural residential settlements.

The speed limit varies along Wakefield Road, being 90 km/h north from Cessnock Road, 80 km/h from Archery Road to north of The Broadway, and then 60 km/h on the approach to Barnsley. The road is considered to be in good (rural) condition, appropriate for the current traffic flow.

The Broadway

The Broadway is also a local collector road which provides access between Killingworth and Wakefield Road, and access to the WWC pit top facility. The speed limit is 80 km/h between Wakefield Road and the eastern outskirts of Killingworth, west of which has a local speed limit of 50 km/h.

Killingworth Road

Killingworth Road is a local access road allowing residents of Killingworth to travel north to George Booth Drive.

5.11.1.1 Principal Intersections

The principal intersections relevant to the Project include:

- Northville Drive/Wakefield Road;
- Wakefield Road/The Broadway;
- The Broadway/WWC pit top Site Access Roads;
- Wakefield Road/Rhondda Road; and
- Wakefield Road/Cessnock Road.

Traffic counts were completed on key intersections relevant to the project to provide appropriate data for completion of the traffic assessment. The traffic assessment found that all of these intersections operate at a high level of service, with very low average delays and significant spare capacity. The assessment also found that all local intersections are all designed appropriately with regard to sight distances, turning and general approach lanes, and that the speeds assigned to each road/intersection meet the traffic and turning demands.

Northville Drive/Wakefield Road

The Northville Drive / Wakefield Road intersection comprises a roundabout that operates at a high level of service due to its good geometry and sight distances.

Wakefield Road/The Broadway

This priority control intersection provides a deceleration lane for vehicles turning left from Wakefield Road to The Broadway. The intersection also consists of a turning lane for vehicles turning right from Wakefield Road to The Broadway. The traffic assessment found that this intersection operates at a high level of service due to its excellent geometry, sight distance and low traffic flows.

The assessment found that the intersection markings, specifically on the approach from The Broadway, have faded considerably. This issue is addressed by the recommendations in **Section 5.11.4**.

The Broadway/Site Access Roads

The two pit top Site Access roads each provide simple priority intersection with The Broadway. The eastern access road is designated for light vehicles and the western access site is primarily for heavy vehicles. Sight distances are also appropriate to the speed of traffic.

Wakefield Road/Rhondda Road

The Wakefield Road/Rhondda Road intersection is a priority intersection that has been previously upgraded to accommodate heavy vehicles and general traffic flows associated with a previous approval for the Westside mine, west of Rhondda Road.

The intersection provides a deceleration lane for vehicles turning left from Wakefield Road to Rhondda Road and a turning lane for vehicles turning right from Wakefield Road to Rhondda Road. Additionally, a short acceleration lane is provided for vehicles turning left from Rhondda Road to Wakefield Road.

Wakefield Road/Cessnock Road

The Wakefield Road/Cessnock Road intersection is a priority controlled seagull intersection which provides excellent separation and turning points, due to a recent upgrade. The traffic assessment found that this intersection operates at a very high level of service due to its turning capacity, geometry and low traffic flows.

5.11.2 Traffic Contribution of Existing Operations

Traffic generated by WWC consists of employee, contractor, visitor and supply delivery traffic. Based on the findings of an employee survey completed for this EA, the majority of staff live within the local sub-region, and commute to WWC by car. Based on the employee surveys, traffic generation from WWC can be calculated on a trip per employee basis for the shift arrival and departure peaks. Traffic counts were also completed for these intersections to confirm data from WWC and the employee survey.

Peak traffic generation from the existing WWC operations occur between 5.30 am and 6.30 am and between 3.00 pm and 4.00 pm, coinciding with shift time changes. The AM peak period generates approximately 80 to 100 vehicles per hour, primarily being arrival trips. The PM peak period generates approximately 60 to 70 vehicles per hours, primarily

being departure trips. The WWC generated peak traffic generation periods do not overlap with morning or afternoon commuter peak generation periods on the local road network.

The Annual Average Daily Traffic (AADT) volumes of the primary roads serving WWC are generally low. The existing wide traffic lanes and verges also appropriately meet the existing traffic demands with reference to the relevant AustRoads design guide (refer to **Appendix 14**).

The pit top facility generates only a minor heavy vehicle demand, specifically being deliveries of equipment and light materials, maintenance vehicles and occasionally machinery. The site generates approximately five smaller delivery vehicles and five large delivery vehicles per day, a total of 20 trips. Additionally, two articulated vehicles deliver stone dust each week and there is typically one diesel tanker delivery each month.

Coal is currently exclusively transported via a private haul road to the nearby MCPP in Teralba. Occasionally coal is transported by private haul road to Eraring Power Station. The coal transported to the MCPP is subsequently loaded onto trains for export via the Port of Newcastle. Therefore, WWC does not result in any coal carrying heavy vehicles on the local road network. The transport of coal is covered under a separate existing development consent which is not part of this Project Application.

5.11.3 Project Traffic Impacts

The Project is not expected to generate additional long term access, traffic or parking demand at WWC. As there is no proposal to increase the existing operational staff or service demand, there is consequently not expected to be any additional vehicle generation associated with the project at the pit top site than what currently occurs.

The Project does include the establishment of the proposed Mining Services Facility, located adjacent to Wakefield Road. It is estimated that the Mining Services Facility could generate up to 10 vehicle trips per day, consisting of four heavy vehicle trips (i.e. two loads) and six staff vehicles. The Mining Services Facility will generate a very minor amount of daily traffic and access to the Mining Services Facility has been carefully designed following discussions with LMCC and the RTA to ensure appropriate safety and efficiency of movement (refer to **Section 5.11.4**).

Traffic modelling and general traffic assessment indicates that the Project would have no impact on the operation of local roads and intersections. Specifically, the modelling indicates that there is no predicted significant change to the operation of the local intersections over a 10 year forecast period, and no change to average delays and levels of service. Based on future forecasts, which includes average annual increases in local and sub-regional traffic generation, the local traffic network will continue to operate at a high level of service through the continued mining operations at WWC. Overall, the assessment concludes that the Project would not have a significant impact on the local traffic and transport network.

With no planned increases in staffing levels at the WWC, or changes to shift times, administration or contract staff levels as part of the Project, the parking currently provided at WWC will continue to appropriately provide for all demand on site.

5.11.4 Traffic Management

As discussed above, the traffic assessment found that the Project will not result in any increase in traffic generation associated with WWC. The traffic conditions are expected to remain satisfactory with good conditions being maintained on the road network and at principal intersections.

All coal will continue to be exclusively transported from WWC via the existing private haulage road to the MCPP in Teralba or Eraring Power Station. No coal will be transported by local public roads.

As identified in **Section 5.11.1.1**, intersection markings, specifically on the approach from The Broadway, have considerably faded. WWC will consult with LMCC to have the road markings at the intersection of Wakefield Road and The Broadway repainted to appropriately delineate control and lane lines.

The proposed Mining Services Facility will require the construction of a new intersection with Wakefield Road. In accordance with the recommendations of the traffic assessment, the design and operation of the Mining Services Facility intersection will provide for:

- onsite turning and parking provisions to ensure all vehicles are stopped away from the deceleration and merge lanes, and to ensure that all vehicles enter and depart the Mining Services Facility in a forward direction;
- a 60 to 70 metre deceleration lane and 50 to 60 metre merge lane be provided;
- access restriction, specifically that heavy vehicles enter the Mining Services Facility exclusively from the south, and depart exclusively to the north. Light vehicle access from the north will be provided, based on the very low number of turning vehicles; and
- signage on both approaches to the Mining Services Facility notifying of Warning: Truck Entering, and Truck Access Ahead.

The final design of the new intersections associated with the Mining Services Facility will be prepared in consultation with LMCC and will require an approval from LMCC under the Roads Act (refer to **Section 4.2.4**).

5.12 Visual Impact

5.12.1 Existing Visual Amenity

The visual character of the Project area is diverse, with a range of landforms, vegetative cover patterns and land uses resulting in considerable variations in scenic quality. The continued underground mining area is a mixture of steeper slopes and rocky escarpments of the Sugarloaf Range.

The dominant land uses within and adjacent to the continued underground mining area and the existing surface facilities, include mining, the SSCA, rural residential holdings and the residential areas of Killingworth, Barnsley, Wakefield and Ryhope.

The major land use within the continued underground mining area is the SSCA, managed by DECCW. This area is accessed by various stakeholders mainly for recreational purposes, such as bushwalking and recreational vehicle use.

Views of WWC existing operations are generally restricted to the pit top facilities and surface infrastructure. The local topography and vegetation heavily restrict the visibility of the mine. Views of the WWC existing surface operations are present from surrounding roads.

5.12.2 Visibility of the Project

The Project involves underground mining, which has very little surface visibility, other than relatively minor components of infrastructure required to support underground mining such as potential additional ventilation infrastructure. The Project does not propose to modify the existing WWC pit top facility. The most significant addition associated with the Project is the proposed Mining Services Facility. The Mining Services Facility will be comprised of a 20 metre by 35 metre compound housing the facility and a constructed access road off Wakefield Road. The proposed Mining Services Facility will be located in an existing disturbed area between Wakefield Road and the F3 Freeway, the site is currently comprised of an access area and regrowth vegetation. Power to the services facility will be provided by an extension of the existing powerline which is adjacent to Wakefield Road.

In addition to the existing WWC surface facilities, the proposed Mining Services Facility is the only element of the Project that will be visible from public viewing locations. The Mining Services Facility is considered to be consistent with surrounding rural infrastructure and will not be visually intrusive.

5.12.3 Viewing Points and Assessment Methodology

There will be limited potential for additional visual impact associated with the Project given the Project predominantly involves underground mining and the continued use of the existing surface facilities.

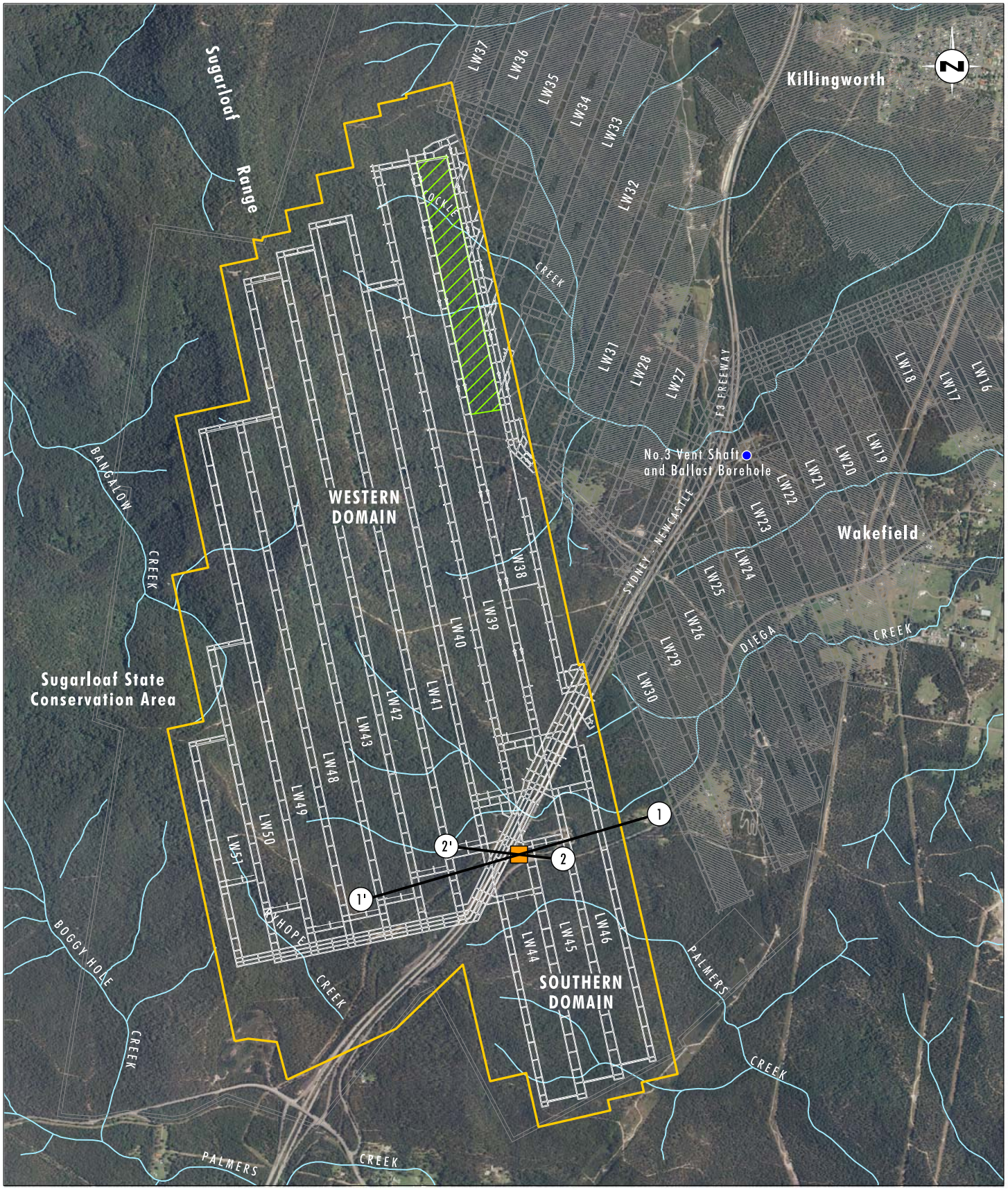
The proposed Mining Services Facility is the only addition to the existing visual environment. The visual analysis undertaken for the Project included the identification of locations from which views of the Mining Services Facility may be possible. A radial topographic analysis technique was used to identify locations where views of the Mining Services Facility may be possible based on ground topography alone (i.e. no allowance was included for screening vegetation).

The initial assessment found that based on topography alone, the major viewing points were restricted to areas immediately surrounding the proposed Mining Services Facility and to the east and north-east, predominantly along the F3 Freeway and Wakefield Road. Following the initial radial analysis, existing vegetation was also considered. The immediate area surrounding the proposed Mining Services Facility is primarily comprised of the SSCA. As such, the surrounding area is heavily vegetated which significantly shields the proposed Mining Services Facility from potential views.

Due to the restricted potential for views associated with the proposed Mining Services Facility, two representative viewing location were selected for further detailed visual assessment completed using transect analysis. The visual transect locations are shown in **Figure 5.19** and are briefly described as follows:

- Transect 1 – view from the private residence located approximately 600 metres to the east of the proposed Mining Services Facility; and

- Transect 2 – view from Wakefield Road, approximately 250 metres to the east of the proposed Mining Services Facility.



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines, DEC AHIMS

0 0.5 1.0 1.5km
1:30 000

Legend

- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Visual Transect Line
- Drainage Line
- Proposed Mining Services Facility

File Name (A4): R08_V1/2553_240.dgn

FIGURE 5.19

Visual Transect Location

5.12.4 Visual Impacts

The proposed Mining Services Facility and ancillary infrastructure will not significantly impact on the visual amenity of the surrounding area. Due to existing vegetation and topography, views of the proposed Mining Services Facility are significantly restricted to the immediate area.

Transect 1 represents the view from the closest private residence to the propose Mining Services Facility. As shown in **Figure 5.20**, views from the closest private residence are shielded from the proposed Mining Services Facility by topography and existing vegetation. There will be no impact on visual amenity at the private residence represented by Transect 1, or any other private residence location.

Views of the proposed Mining Services Facility will generally be restricted to commuters travelling along the F3 Freeway or Wakefield Road. Transect 2 indicates that views of the proposed Mining Services Facility will be available from Wakefield Road, refer to **Figure 5.21**. Due to the proximity of Wakefield Road to the proposed Mining Services Facility site and the lack of established vegetation due to previous clearing, views of the site are expected. The available views of the proposed Mining Services Facility are not expected to significantly impact on road commuters.

Based on a speed limit of 80 km/h along Wakefield Road, road commuters would experience views of the proposed Mining Services Facility for approximately 10 seconds. Similarly, commuters on the F3 Freeway, travelling at 110 km/h, would have views of the proposed Mining Services Facility for approximately 5 seconds. The duration of the potential views are considered to be short and will not significantly impact on the visual amenity for commuters using either Wakefield Road or the F3 Freeway.

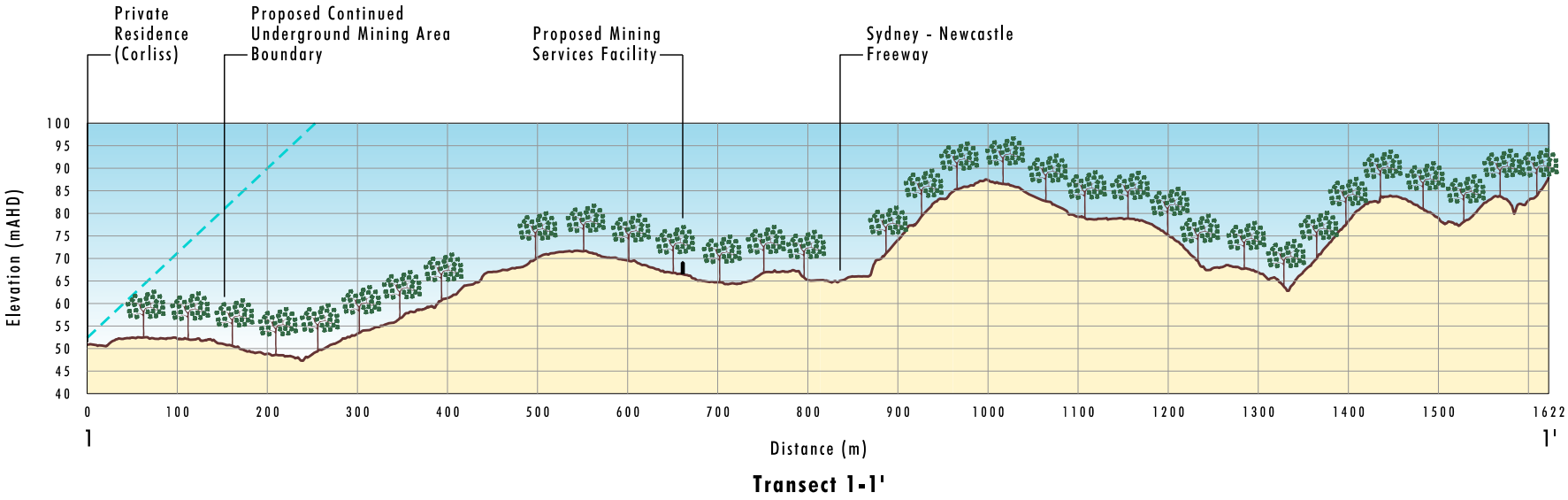
Infrastructure required to support underground mining such as potential additional ventilation infrastructure is expected to be relatively minor and will not significantly impact on visual amenity. Any potential ancillary infrastructure will be located, where possible, to minimise potential visual impacts.

The proposed Mining Services Facility will not be visually intrusive and is considered consistent with the surrounding visual environment. Any visual impacts to road commuters will be short in duration and are not considered inconsistent with the current visual amenity from public roads.

5.12.5 Proposed Visual Controls

The Project is expected to have minimal impact on the visual amenity of the area. WWC proposes to maintain and implement a range of visual controls to screen views of the Mining Services Facility and minimise the visual impacts. These include:

- where possible, trees are retained to maintain visual amenity;
- planting of vegetation screening, where necessary, to shield the proposed Mining Services Facility and future ancillary infrastructure; and
- the Mining Services Facility and future ancillary infrastructure will be coloured in suitable natural tones.



Transect 1-1'

Legend

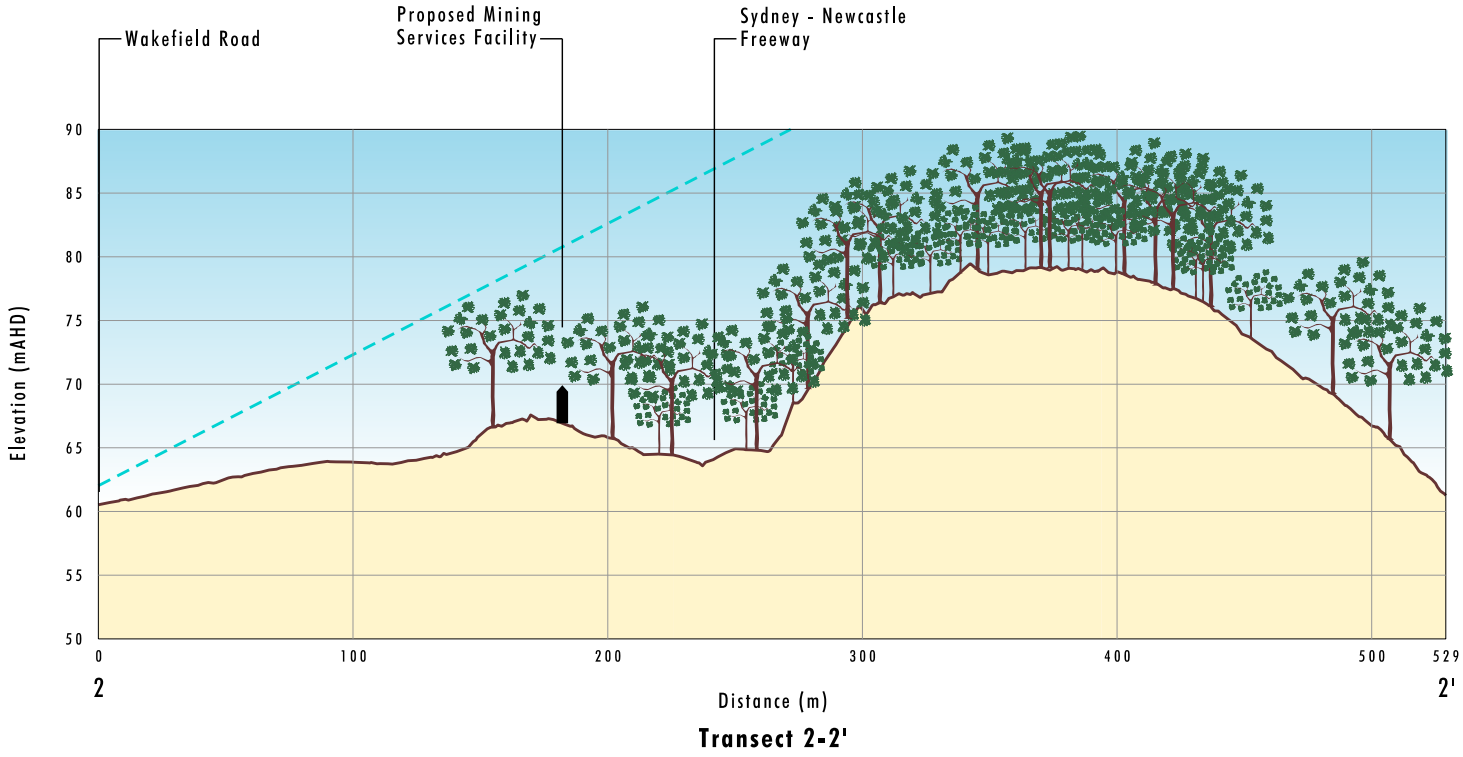
- Existing Landform
- Existing Tree
- Line of Sight

0 20 40 80m
Vertical 1:1 500

0 100 200 400m
Horizontal 1:7 500

FIGURE 5.20

Visual Transect 1-1'



Legend

- Existing Landform
- Existing Tree
- Line of Sight

0 10 20 30m
Vertical Scale 1:3 000

0 50 100 150m
Horizontal Scale 1:3 000

FIGURE 5.21

Visual Transect 2-2'

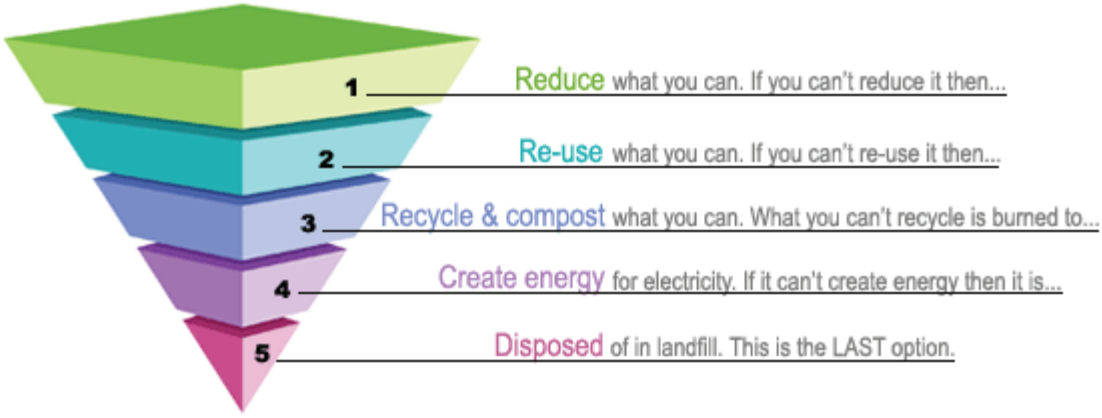
5.13 Waste

The DGRs for the Project identified waste management as a key issue to be addressed in the EA. WWC Colliery currently operates under a waste management system based on the management principles outlined in **Section 5.13.1**. The existing waste management system aims to ensure sound waste management at WWC.

This section focuses on identification and management of waste material produced as part of continued operations.

5.13.1 Management Principles

Waste management is currently based around the hierarchy of waste management, as shown below.



WWC currently operates under a Waste Management Plan. The following management principles are applied to allow for the management of waste materials generated by the continued operations of WWC:

- waste avoidance;
- waste re-use;
- waste recycling; and
- waste removal and disposal.

The underpinning strategy for waste management is minimisation and segregation of waste at the source. The management principles above will be addressed through the following processes:

- detailed project design to minimise the potential for wastage;
- procurement of materials including consideration of packaging and potential for re-use or recycling;
- establishment of contracts and purchasing of equipment and supplies in such a manner that minimises waste generation (e.g. waste packaging);
- identification and segregation of re-usable and recyclable materials;

- education of workforce on waste avoidance, waste stream segregation and recycling;
- processing materials for recycling;
- considering environmental impacts for waste removal and disposal processes; and
- monitoring and inspection regimes.

Waste generated from the Project falls into the following waste classes (DECCW 2008 Waste Classification Guidelines):

- general solid waste (putrescible and non-putrescible) including construction waste, general office waste and domestic waste;
- liquid waste including construction waste, ablution waste and operational waste (e.g. waste oil); and
- hazardous waste including construction and operational waste (e.g. waste oil).

5.13.2 Predicted Waste Streams

Whilst no major changes to the existing WWC surface infrastructure are proposed as part of the Project, a new Mining Services Facility and potential gas ventilation infrastructure are also proposed to be constructed. No major modification to the existing pit top facility will be required for this Project. Therefore, there are no significant changes in waste type or volumes predicted from the Project.

The construction of the Mining Services Facility will involve predominantly modular/prefabricated components, which are assembled off site and transported to the site for installation. These construction activities are therefore not expected to generate a significant amount of waste materials. The excavated material generated during the earthworks phase of construction will be re-used on site. Inert waste such as concrete will be disposed of in approved areas on site.

Other waste that may be generated during the operation phase of the existing and proposed facilities will include office, domestic and sewage treatment and disposal waste, as well as a small amount of waste associated with general maintenance and workshop activities (see below).

Office Waste

The main type of office waste is waste paper, comprising general office paper, photocopy paper, office stationery and paper from other sources. Paper recycling bins are provided at the WWC offices and workshops, which are disposed of by licences contractors. Other office waste includes cardboard and packaging, toner cartridges from printers, photocopiers and facsimile machines. Toner cartridges are removed by a licensed contractor for recycling. The quantity of office waste generated by the Project will be minimal and the majority will be recycled.

Domestic Waste

Domestic waste includes food scraps, aluminium cans, glass bottles, plastic and paper containers and putrescible waste. Domestic waste will be generated by employees and contractors at the site and recycled where practicable. Bulk bins are provided onsite and disposed of by a licensed contractor.

Sewage Treatment and Disposal

Sewage and bathhouse wastewater generated at WWC is treated on site through the biological sewage treatment plant (STP). Sewage and bathhouse wastewater will continue to include waste from toilets, bathhouses, kitchen sinks and basins.

Treated sewage effluent is pumped approximately 3.2 kilometres to the maturation ponds at the MCPP and subsequently used as process water. Sewage sludge from the treatment plant is pumped out and disposed of by a licensed contractor, as required.

Portable lavatory facilities are provided for employees working underground. These portable lavatories are serviced and replaced by a licensed sanitary contractor.

Operational Waste

Workshop and maintenance activities associated with the operation of the mine generate wastes such as rags, gloves, general packing material, empty drums, used replacement parts, oils, lubricants and paints. Labelled bins, which are disposed of by a licensed contractor, are available at the workshop for operational waste. These wastes will be recycled where possible and otherwise disposed of via a licensed landfill facility.

Fuel, Oil and Grease Containment and Disposal

The bulk diesel storage facility at the pit top has a maximum storage capacity of 55,000 litres and is bunded in accordance with relevant Australian Standards and DECCW requirements. The bulk facility transfers diesel via a pipeline to a smaller storage tank located in the underground workings approximately 180 metres below the surface.

The proposed Mining Services Facility will contain a solcenic mixing station, which will supply pre-mixed solcenic oil to the underground operations. The mixing station will be bunded in accordance with relevant Australian Standards and DECCW requirements.

All oils, greases and detergents stored on-site are contained within bunded, covered concrete storage areas. There are approximately 10,000 litres of oils and greases stored on the site at any one time. The primary machine wash down area is located so that wash down water drains through an oil containment pit, which is serviced by an oil/water separator. Treated water is then discharged to the sites dirty water treatment system. A licensed waste contractor collects any oil captured by the separator, along with other waste oil on a regular basis. The secondary machine wash down area drains to a containment sump which subsequently overflows via a concrete drain into the North East Dam. An oil boom is located within the drain to prevent any potential oily water from entering the dam. Water from the North East dam is pumped back to the main surface dams and treated as part of the sites dirty water treatment system.

The waste management program at WWC involves the collection and disposal of waste oil, waste coolant, 20 litre waste oil drums, oil filters, oil absorbents, oil rags and used oil-absorbent materials. A licensed waste contractor is engaged to manage these wastes in accordance with the waste provisions of the POEO Act.

5.14 Socio-Economic Assessment

The DGRs require that a social and economic assessment be undertaken for the Project. An analysis of the potential social impacts of the Project on local and regional communities has been undertaken and is provided in **Section 5.14.1**. A detailed assessment of the potential economic impacts of the Project was undertaken by Gillespie Economics and is summarised in **Section 5.14.2**.

The social assessment is concerned with assessing benefits and impacts associated with the Project in non-monetary terms, whereas the economic assessment considers the monetary effects of the Project. For a socio-economic assessment it is important to understand the impacts from the perspectives of those involved in a personal, community, social or cultural sense. Together, the socio-economic and economic assessment processes provide a complete picture of impacts and a better understanding of their meaning.

5.14.1 Social Assessment

5.14.1.1 Community Profiling

The following section provides an overview of the social context in which the Project is based. The social profile provides for the consideration of the key attributes of an area and its communities and provides baseline information from which impacts may be predicted and measured.

It is important to understand that elements of the social context (in which people live, work and play) drives how communities respond to change and that the behaviour of individual people may be shaped by the setting or social context in which they function.

The Project is located in the long term mining areas of Killingworth, Wakefield and West Wallsend. Mining is currently being undertaken within existing planning approvals. As outlined in **Section 1.0**, due to changes in planning legislation, an updated approval is required for the continuation of underground mining operations. Whilst the updated approval is only required for two small portions of the continued mining areas, WWC is using this opportunity to consolidate and update the approvals for all existing mining areas and surface facilities to provide a modern, comprehensive approval for future mining at WWC. As such, the Project will provide for long term continuity in coal production and employment opportunities.

The development of this profile is based on an analysis of relevant census data, time series data (such as employment sectors over time), analysis of local media sources, and a review of other relevant secondary sources.

Population Statistics and Trends

Lake Macquarie LGA is located approximately 150 kilometres north of Sydney and is located immediately adjacent to the Newcastle LGA (LMCC 2009). The Lake Macquarie LGA covers an area of 752.9 km^2 and had an estimated residential population of 195,559 as at June 2008 (Regional Population Growth, Australia, 2007–08 (cat. no. 3218.0)). Lake Macquarie has a diverse economic base with leading industries as a proportion of employment including retail trade, manufacturing, and health and community services.

The Lake Macquarie LGA has experienced a steady population growth over the past 10 years, with a growth of approximately 7.3 per cent (0.7 per cent in annual average terms) (ABS 2006). From 1996 to 2006, the population increased from 172,725 to 183,139. Median growth population projections for the Lake Macquarie LGA suggest that there will be an

average annual growth rate of 0.43 per cent from 2006 – 2026 (Hunter Valley Research Foundation 2009). The age structure of the Lake Macquarie population shows some variation from that of the Upper Hunter and NSW, with the majority of the population aged between 40 and 54 years (ABS 2006).

A trend analysis of the Lake Macquarie LGA is provided in **Table 5.20**, which illustrates the majority of the population is increasing at a constant rate. Between 2001 and 2006, the number of people employed in Lake Macquarie showed an increase of 5351 persons and the number unemployed showed a decrease of 1919 persons.

Table 5.20 – Lake Macquarie LGA Summary Demographic Profile (2001 – 2006)

	2001	2006	Trend 2001-2006
Population	180, 315	183,139	Increasing
Age structure			
Per cent aged 14 and below	21.26%	19.59%	Decreasing
Per cent aged 15-64 (workforce population)	63.3%	63.6%	Constant
Per cent aged 65 and above	15%	16.8%	Increasing
Employment			
Unemployment rate	4%	3%	Decreasing
Employment rate	39.5%	42%	Increasing
Family Composition			
Couple family with children	22,931	14,577	Decreasing
Couple family with no children	18,777	7,815	Decreasing
One parent family	8,101	4,810	Decreasing
Dwellings			
Separate house	57,647	58,821	Increasing
Semi-detached	4,859	4,631	Decreasing
Flat, unit or apartment	2,614	3,030	Increasing
Tenure			
Fully owned	30,446	26,625	Decreasing
Being purchased	18,297	23,094	Increasing
Rented	14,105	15,054	Increasing

Source: Australian Bureau of Statistics Census 2001 and 2006.

In 2006, the Lake Macquarie LGA had a total of 67,443 dwellings of which 5418 were unoccupied dwellings. The majority (88 per cent) of dwellings are separate houses and this statistic has remained relatively constant over the last 5 years. Thirty four per cent of tenure in the Lake Macquarie LGA is currently being purchased whereas the majority (39 per cent) are already fully owned (ABS 2006).

As the Project provides for long term ongoing coal operations within an established coal mining area, it is expected that a large proportion of the employment will be sourced from existing labour resources within the region (refer to **Section 5.14.1.1**).

Economic Activity

There are currently 10 mining operations based within the Lake Macquarie LGA. The mining industry currently accounts for approximately 2.4 per cent of employment within the Lake Macquarie LGA (LMCC 2008a), with approximately 1160 people of the workforce employed directly in the industry (ABS 2006). Furthermore, approximately 54 businesses in the Lake Macquarie area provide support for the mining industry (LMCC 2008a).

At the time of the 2006 Census, 93.3 per cent (82,228 persons) of the labour force of the Lake Macquarie LGA were employed (ABS 2006). The unemployment rate in the Lake Macquarie LGA is considered to be the lowest unemployment rate in the Lower Hunter region of approximately 4.3 per cent. In 2006, the median weekly income for individuals was $394, for a household the weekly income was $922 and the family income was $1102 (ABS 2006).

WWC and its employees make a significant contribution annually to the local economy by expenditure on goods and services. The local mines are also major ratepayers, providing economic benefits to the Council as well as funding some significant improvements in community facilities.

Social Infrastructure

A series of interacting social systems – family, neighbourhood/community, workplace, institutions (e.g. health, education) form the basis of social infrastructure. Therefore, changes in particular social systems may influence other social systems. For example, changes in the demographic composition of families in a community (e.g. greater degree of couples with young children) will influence the types of institutions required to service the community, e.g. childcare, health and education services, etc.

Lake Macquarie has a variety of community and personal services and facilities available to people living within the local area. As there is no proposed increase in employee numbers for the Project, it is expected that the existing services will continue to cater for the employees at WWC. Existing services catering for the current work force of WWC (LMCC 2008b & 2009), include:

- accommodation;
- aged and disability services;
- children's services;
- community services;
- education;
- government departments;
- media services;
- health services;
- emergency services;
- legal services;

- recreation; and
- transport services.

5.14.1.2 Community Involvement

As outlined in **Section 3.0**, community consultation has been undertaken for the Project. To date, community consultation has involved consultation meetings with residents within the continued underground mining area, and the distribution of community newsletters.

Throughout the EA process, the key aims of the consultation process were to inform stakeholders about the Project, identify any issues of concern or interest to be investigated and addressed, and to provide an opportunity for input into the Project. The details of the authority consultation program and the key issues identified during the consultation process are included in **Section 3.0**.

To ensure the wider community was aware of the status of the Project, two Newsletters were distributed (May 2009 and February 2010) to inform, update and explain the Project and status of the environmental assessment to the community.

A further newsletter advising of the EA outcomes was distributed in May 2010. The community newsletter provided details of the assessment outcomes and sought feedback on the Project and the environmental assessment findings. Any feedback received in relation to the Project or the EA findings will be documented in the EA prior to exhibition. As outlined in **Section 3.0**, WWC will continue to consult with key stakeholders throughout the approval process.

WWC is also currently operating under an established Social Involvement Plan (SIP) as part of its EMS for its existing operations. The SIP identifies the stakeholders with an interest in the WWC operations, assesses stakeholder needs and outlines the sites Stakeholder Engagement Strategy. The Stakeholder Engagement Strategy also incorporates the sites annual face to face consultation program and annual community donation and support programs. Consultation with relevant stakeholders includes affected landholders, the surrounding community, relevant government agencies, service providers and Aboriginal stakeholder groups (refer to **Section 3.0**).

As part of Xstrata Coal's annual corporate social involvement program, Xstrata has committed financial support to over 20 community projects across the Hunter Region (Xstrata Coal 2009). This will provide financial assistance to a range of community, health, environment, education and arts based initiatives throughout the local area.

5.14.1.3 Evaluation of Social Impacts

WWC will continue to maximise the use of existing operations and surface facilities, with limited changes proposed to the existing facilities. The current workforce is not expected to change significantly, and therefore, existing services in the area that currently cater for the existing workforce will continue to provide their services without pressure or increased demand.

After a number of community consultation meetings, it has been noted that no issues regarding the Project have been raised by the community, nor were there any community complaints received during the period from January 2008 to December 2008 by WWC as stated in the 2009 AEMR.

However, there are a number of potential issues of concern for the local communities, including noise, vibration and subsidence which have been addressed in **Section 5.0**. WWC

recognises that the local environmental impacts of dust, noise, vibration and subsidence will be a primary focus for the local rural residents. These environmental issues raised by the community as part of the consultation program have been subject to specific specialist assessment as part of this EA. Management and monitoring measures relating to all environmental issues associated with the Project have been outlined in the relevant sections of this EA (refer to **Section 5.0**).

5.14.2 Economic Impact Assessment

The key benefits of the WWC Project include the significant economic benefit to the state and region associated with job creation, capital expenditure, ongoing operational expenditure, and stable employee population associated with the Project.

To clearly identify the economic benefits of the Project, a detailed economic analysis has been completed for the Project by Gillespie Economics (refer to **Appendix 15**). Economic analysis is primarily concerned with weighing up the potential economic benefits and costs of a Project to the community (that is, consideration of economic efficiency). This also includes the benefits and costs to the environment. There are two important aspects of the Project that can be considered, the economic efficiency of the Project using the benefit cost analysis (BCA), and the economic impacts of the Project which can be evaluated using input-output analysis. As detailed in the Economic Assessment presented in **Appendix 15**, a BCA and an input-output analysis were undertaken for the Project.

From an economic perspective, the continued operation of WWC will deliver benefits to the local, regional and state economy. In total the Project is anticipated to contribute:

- $448 million and $644 million in annual direct and indirect output or business turnover at a regional and state level, respectively;
- $214 million and $318 million in annual direct and indirect value added to regional and state level, respectively;
- $83 million and $143 million in annual direct and indirect household income at a regional and state level, respectively; and
- indirect and direct employment of approximately 775 and 1634 people at a regional and state level, respectively, over the life of the Project.

This stimulus would be felt across a range of sectors in the regional economy including the mining services sector, technical services sector, retail trade sector, financial services sectors, health sectors, wholesale trade sector, law/accounting and marketing sectors and other business services sectors.

The BCA identifies a range of potential economic benefits and costs of the Project and places indicative values on the production benefits and costs. The main external costs associated with the Project relate to greenhouse gas generation and potential Aboriginal heritage impacts. All other potential external impacts (air quality, noise, ecology, groundwater, historic heritage etc.) were considered to be negligible and therefore not included in the analysis. The BCA indicates that the net production benefits of the Project (after full incorporation of environmental and cultural impacts) would be in the order of $399 million. Overall, the Project is estimated to have net benefits of over $563 million. This net benefit would be distributed amongst a range of stakeholders including:

- MCJV
- the NSW Government via royalties and payroll tax; and
- the Commonwealth Government in the form of Company tax.

The estimated net production benefit of the Project represents the opportunity cost to society compared to that of not proceeding with the Project. Therefore, any environmental costs of the Project, after mitigation by WWC, would need to be costed at greater than $563 million to make the Project questionable from an economic efficiency (net community welfare) perspective.

On cessation of mining, the economic stimulus provided by the Project will predominantly cease. The significance of these Project cessation impacts will depend on:

- the degree to which any displaced workers and their families remain within the region;
- the economic structure and trends in the regional economy at the time; and
- whether other mining developments or other opportunities in the region arise that allow employment of displaced workers.

5.14.3 Management and Ongoing Community Involvement

WWC is committed to the implementation of a Social Involvement Plan. Should the Project be approved, WWC will continue to engage the community in consultation for the purposes of providing the community with information relating to the Project and operations in general and to gain feedback. This will also enable the community to provide feedback to WWC and raise any issues or concerns. It is currently anticipated that consultation will include the following:

- distribution of a community newsletter as appropriate;
- continued operation of a 24 hour community hotline for receipt of community complaints. WWC undertakes to respond to community complaints promptly following receipt. All complaints will be investigated and the results of the investigation reported to the complainant in a timely manner; and
- reporting of all community complaints in the sites AEMR and DECCW Annual Return.

The Project will also result in significant economic benefits to the Hunter Region, contributing an average of approximately $448 Million in direct economic benefit due to employee and operating expenditure.

The Project appears to be in line with the Council's strategic plan, which identifies the need to facilitate economic development. One of Lake Macquarie City Council's Community Plan 2008 – 2018 key focus areas aims to enhance urban and economic development within the LGA. This will be achieved by increasing employment opportunities and investment within the city, building stronger partnerships with business developers, and representatives of the community and ensuring new development provides adequate facilities for the increasing population (LMCC 2008b).

5.15 Land Management, Decommissioning and Rehabilitation

The DGRs for the EA require a detailed description of the proposed rehabilitation and mine closure strategy for the mine. This section provides a further description of soils and land capability, prior to detailing the proposed rehabilitation and closure strategy.

5.15.1 Soils

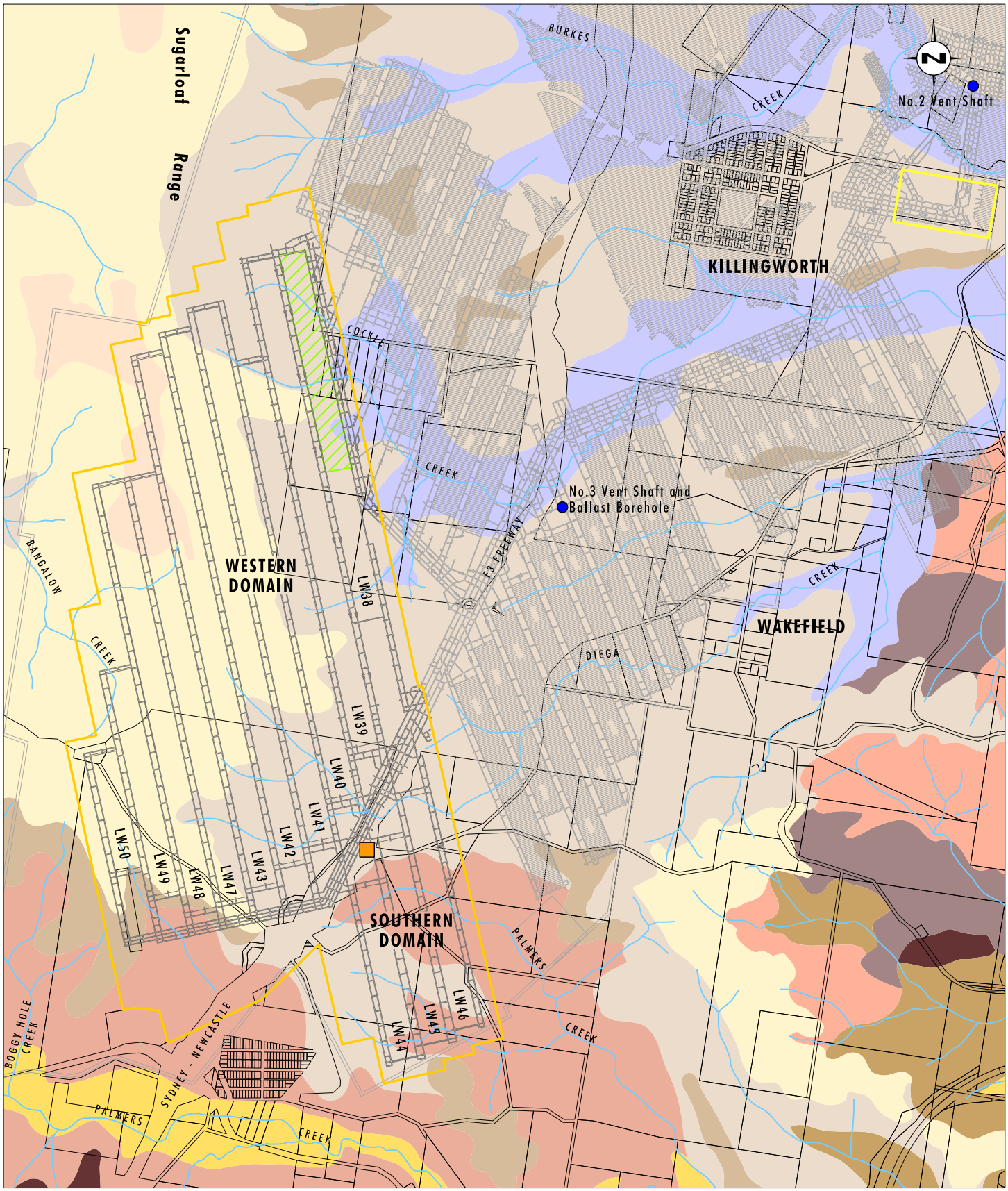
The soil types occurring within the continued underground mining area and at the site of the existing pit top facility are mapped on the Newcastle 1:100,000 Soil Landscapes Map Sheet (Matthei, 1995). Soil landscapes present within the continued underground mining area and existing pit top facility are presented in **Figure 5.22** and include:

- Sugarloaf Soil Landscape;
- Sugarloaf Variant Soil Landscape;
- Killingworth Soil Landscape;
- Killingworth Variant Landscape;
- Cockle Creek Soil Landscape; and
- Warners Bay Soil Landscape.

The following discussion of soil landscape properties is based on the descriptions provided in (Matthei, 1995). The continued underground mining area is primarily composed of the Killingworth and Sugarloaf Soil Landscapes. The Sugarloaf Soil Landscape unit is present throughout the west of the continued underground mining area (refer to **Figure 5.22**). Sugarloaf soils are located on rolling to steep hills with gradients greater than 30 per cent. Sugarloaf variant soils are located on the summit surfaces and crests. The soils are shallow to moderately deep, well to imperfectly drained Yellow Soloths, Yellow Earths and Lithosols on summit surfaces, with moderately deep to deep Yellow Podzolic soils, Yellow Soloths, Red Podzolic soils and Yellow Earths on step side slopes. The Sugarloaf and Sugarloaf Variant soils have an extreme water erosion hazard, very strong acidity and low to very low fertility.

The Killingworth Soil Landscape unit is present within the eastern portion of the continued underground mining area (refer to **Figure 5.22**). Killingworth and Killingworth Variant soils are located on rolling hills, whilst the Killingworth variant soils are restricted to small areas of steep hills. The soils are generally shallow to moderately deep, well to imperfectly drained Yellow Podzolic Soils, Yellow Soloths, Gleyed Podzolic Soils and Gleyed Soloths on the crests and hillslopes, with shallow well-drained Structured Loams, Bleached Loams and Lithosols on some crests. The Killingworth and Killingworth variant soils have a high water erosion hazard, very strong acidity and low to very low fertility.

Some minor areas of the Warners Bay and Cockle Creek Soil Landscapes also occur within the continued underground mining area (refer to **Figure 5.22**). Warners Bay soils occur in the south-western portion of the Southern domain. The soils are moderately deep to deep, imperfectly to poorly drained Gleyed Podzolic Soils, moderately well-drained Yellow Podzolic soils, and yellow Soloths with moderately deep, poorly drained Structured Loams in drainage lines. Water erosion hazard is moderate, with moderate gully erosion occurring in unvegetated drainage lines and moderate sheet and rill erosion occurring in disturbed, cleared areas. The Warners Bay soils have low to very low nutrient storage capacity and are extremely acidic.



Source: OCAL, Department of Lands (2006)

Legend

- Existing West Wallsend Colliery Pit Top Facilities
- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Proposed Mining Services Facility
- Ventilation Shaft
- Drainage Lines

Soil Landscapes:

- Awaba
- Disturbed Terrain
- Doyalson
- Cockle Creek
- Gateshead
- Killingworth
- Killingworth Variant
- Sugarloaf
- Sugarloaf Variant
- Warners Bay
- Wyong

FIGURE 5.22

Soil Landscapes within the Continued Underground Mining Area and Pit Top Facility

File Name (A4): R08_V1/2553_184.dgn

Cockle Creek soils are located along the narrow floodplains of Cockle Creek, which traverse the northern portion of the continued underground mining area. The soils are deep, poorly drained yellow Soloths and Yellow Podzolic Soils on the floodplains. Water erosion hazard for the Cockle Creek soils are described as being moderate to high with soils being sodic, dispersible soils of low wet strength. The soils are also considered to have low fertility.

5.15.2 Land Capability

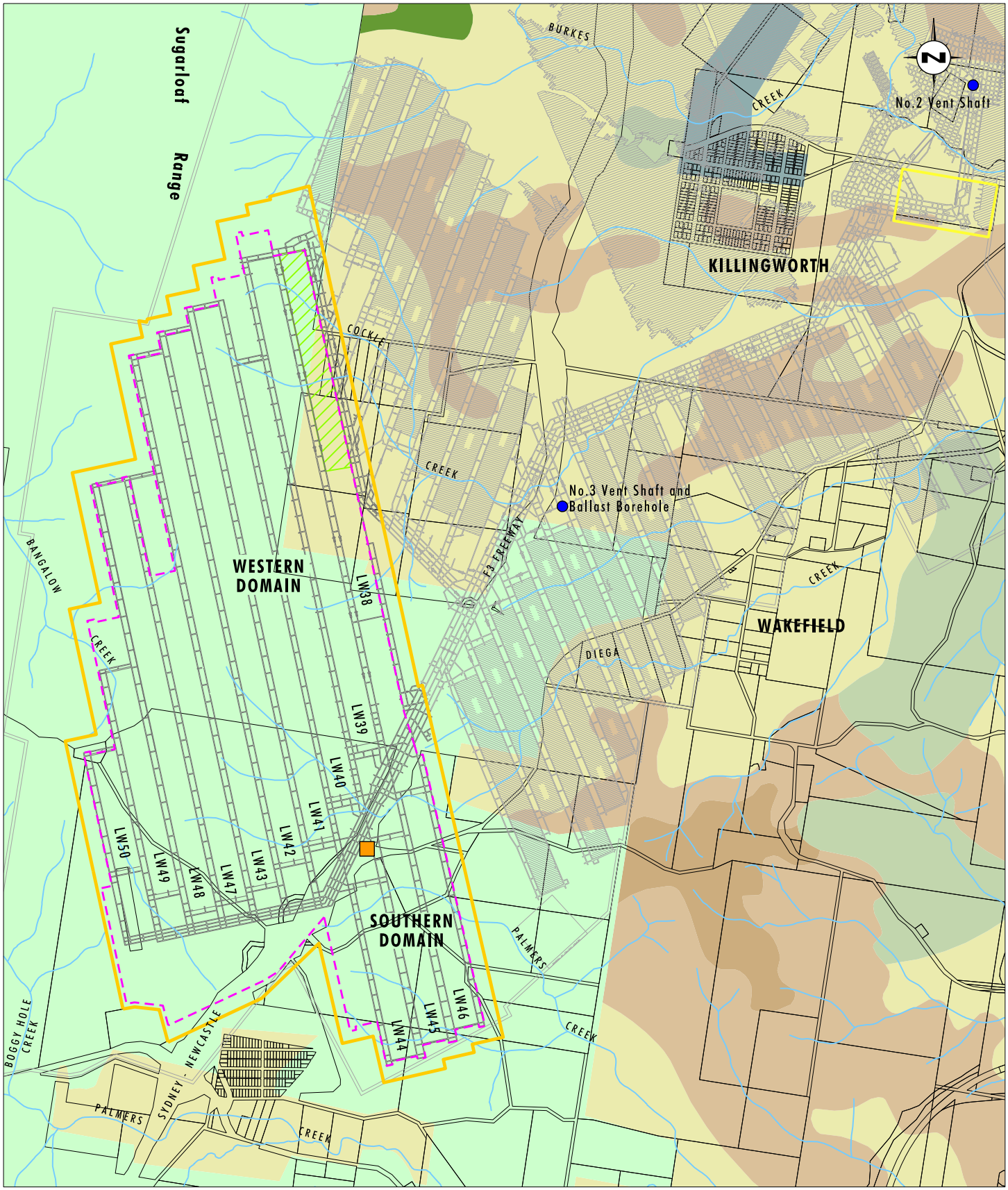
Land capability is the ability of the land to maintain its productive potential under a specified use, without degradation. Climate, soils, geology, geomorphology, soil erosion, site and soil drainage characteristics and current land use data are all considered in determining land capability (Emery, 1986). Eight classes of Rural Land Capability were defined by the then Soil Conservation Service for mapping rural lands (refer to **Table 5.21**). Land Capability in the continued underground mining area and existing pit top facility is shown on **Figure 5.23**.

Table 5.21 – Rural Land Capability Classes

General Capability	Land Capability Classes	Interpretations and Implication
Suitable for regular cultivation	I	Suitable for a wide variety of uses. Where solids are fertile, has the highest potential for agriculture. Includes 'prime agricultural land.
	II	Usually gently sloping land suitable for a wide variety of agricultural uses. Includes 'prime agricultural land'.
	III	Sloping land suitable for cropping on a rotational basis. Soil erosion problems are severe. Generally fair to good agricultural land
Suitable for grazing and occasional cultivation	IV	Land not suitable for cultivation on a regular basis owing to limitations of slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Comprises the better classes of gazing land.
	V	Land not suitable for cultivation on a regular basis owing to considerable limitations of a slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Soil erosion problems are often severe. Production is generally lower than for grazing lands in Class IV.
Suitable for grazing but not for cultivation	VI	Productivity will vary due to soil depth and fertility. Comprises areas of steep slopes, shallow soils and/or rock outcrop.
Land best protected by green timber	VII	Generally comprises areas of steep slopes, shallow soils and/or rock outcrop.
Unsuitable for agricultural or pastoral uses	VIII	Cliffs, lakes or swamps and other lands unsuitable for agricultural and pastoral production.

Land within the continued underground mining area is primarily part of the SSCA with a small portion of Class IV land located in the north-east of the Western domain (refer to **Figure 5.23**). Class IV land is potentially suitable for grazing purposes but not suitable for cultivation on a regular basis. Following underground mining, the land capability within the subsidence affectation zone will remain unchanged.

The proposed Mining Services Facility will be located in previously disturbed areas, as discussed in **Section 2.3** and will therefore not impact on land capability.



Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines

0 0.5 1.0 1.5km
1:30 000

Legend

- Existing West Wallsend Colliery Pit Top Facilities
- Continued Underground Mining Area
- Proposed Underground Workings in the West Borehole Seam
- Longwall Progression as of 1st March 2010
- Former Underground Workings
- Previously Approved Longwall Layout Boundary in Western and Southern Domains
- Drainage Line
- Proposed Mining Services Facility

Land Capability:

- Mining and Quarrying Areas
- Other
- State Conservation Area
- Class IV - Suitable for Grazing with Occasional Cultivation
- Class V - Suitable for Grazing with Occasional Cultivation
- Class VI - Suitable for Grazing with No Cultivation
- Urban Area

FIGURE 5.23

Existing Land Capability within the Continued Underground Mining Area and Pit Top Facility

File Name (A4): R08_V1/2553_185.dgn

5.15.3 Mine Closure and Rehabilitation Strategy

The following mine closure and rehabilitation strategy addresses the WWC Pit Top and associated surface facilities at the planned completion of mining. As the extent of the WWC additional surface disturbance footprint for this Project is limited to the proposed Mining Services Facility, there is limited scope for progressive rehabilitation throughout the life of mine. The three components of the existing WWC surface facilities are shown in **Figure 1.3** and include the following:

- WWC pit top area;
- No. 2 Ventilation Shaft;
- No. 3 Ventilation Shaft and ballast borehole facility; and
- Longwall 11 borehole facility.

It is expected that as part of the mine closure process some minor rehabilitation may be required to be undertaken on the surface to remediate potential subsidence cracking and associated impacts in the continued underground mining area. These activities are outlined in **Section 5.15.3.8**. However, as discussed in **Section 5.2** subsidence remediation works will be undertaken progressively throughout the life of the Project.

5.15.3.1 Xstrata Coal NSW Mine Closure Planning Process

Xstrata Coal NSW (XCN) has implemented a pro-active approach to rehabilitation and mine closure by developing a range of standards that are to be implemented across its business units, including WWC. In particular, the XCN Mine Closure Planning Standard (XCN Closure Standard) (XCN 2009) has been developed so that planning for closure is an integrated part of the life of mine planning process. The XCN Closure Standard provides specific guidance for developing, implementing and reviewing mine closure plans taking into consideration economic, social and environmental factors so that each of XCN's operations meet statutory requirements and achieves a sustainable post-closure land use.

The XCN Closure Standard includes the scope of mine closure activities required at each phase of mining, with closure planning commencing at the exploration phase, continuing through the operational phase and eventually to sign-off of rehabilitation and successful ML relinquishment. The level of detail required in a closure plan increases as the operation proceeds towards the planned closure date. Specially, the standard requires that when a mine is within five years from the planned closure date that a Detailed Closure Planning process is to be undertaken. This process requires detailed investigations so that final land use options are confirmed, the full scope of closure issues are identified, appropriate solutions (e.g. engineering solutions) are developed and adequate provisions are accrued so that post mining land use objectives are met following the execution of the Final Closure Plan.

WWC has developed a Conceptual Closure Plan in accordance with the XCN Closure Standard. This plan includes details regarding preliminary final land use objectives and closure criteria, rehabilitation and final void management strategies as well as the process for engaging relevant stakeholders in the closure planning process to be adopted throughout the mine life. It is the intention that this Conceptual Closure Plan will form the basis of the Detailed Closure Plan, which is to be developed following the completion of the detailed mine closure planning process and be submitted to the relevant government authorities at least two years prior to the planned closure date.

5.15.3.2 Proposed Post Mining Land Use

There are a number of final land use options that may be applicable to the WWC pit top including residential, light industrial or a return to native bushland. As part of the development of a detailed mine closure plan, an analysis will be conducted to determine the most appropriate final land use for each of the sites associated with WWC within five years of the planned completion of mining. This analysis will be carried out in accordance with XCN Closure Standard, and will include:

- the development of post-mining land use options for each site associated with WWC;
- selection of potential land use options in consultation with XCN;
- a detailed analysis of XCN approved land use options from above;
- identification of scope and cost of decommissioning works and completion criteria to achieve objectives of each approved land use;
- an independent evaluation of each land use option; and
- a cost-benefit analysis of each land use option to determine most feasible land use option.

The outcomes of this study will influence the design of the final landform for the sites and the development of detailed completion criteria for the Detailed Mine Closure Plan. Land use options for the other domains, including the No. 2 and No. 3 Ventilation shafts and the Mining Services Facility will most likely be returned to native bushland.

However, in recognition of the approximate 12 to 15 years of operational life of the Project, the potential for other sustainable and economically productive post-closure land uses will be investigated in light of any local and state government land use strategies that may have further evolved towards the end of the mine life. This process will be undertaken as part of the detailed mine closure process (refer to **Section 5.15.2.1**) in consultation with the relevant government and community stakeholders.

Following the cessation of mining activities, the land above the continued underground mining area will remain as the Sugarloaf State Conservation Area.

5.15.3.3 Proposed Post Mining Landform

The extent of land occupied by WWC's surface facilities is approximately 14 hectares. A conceptual final landform for the areas will be designed following the selection of a post-mining land use for each site associated with WWC and will be included in the Detailed Mine Closure Plan. An overview of the general reshaping works that are likely to be undertaken is outlined in **Section 5.15.3.6**.

5.15.3.4 Closure and Rehabilitation Principles and Objectives

The primary objectives of the closure, decommissioning and rehabilitation of WWC will be to:

- return land affected by the operations to a condition suitable for a range of sustainable future land uses;
- minimise the potential for long-term environmental impact and liability; and

- provide for the safety of employees and the public during and following mine closure.

Secondary objectives will be to:

- prevent access to disused underground workings;
- minimise the potential impacts from closure activities;
- comply with relevant regulatory requirements and attain regulatory consensus on the successful closure and rehabilitation of the site;
- complete the closure, decommissioning and rehabilitation works as quickly and cost effectively as possible whilst achieving the objectives outlined above;
- provide for recovery of the security bond held by the DI&I;
- ensure that the rehabilitated post-closure landform, including remaining structures will be physically and chemically stable and will not present a hazard to public health and safety;
- through rehabilitation of disturbed areas, provide a sustainable vegetation cover;
- implement appropriate control and remediation strategies in the event that contamination sources are identified, so as to prevent off-site impacts; and
- ensure that the design periods and factors of safety for all site works take into account extreme events and other natural processes such as erosion.

5.15.3.5 Preliminary Closure and Rehabilitation Criteria

Completion criteria, determined in consultation with the relevant agencies, will be utilised to demonstrate achievement of rehabilitation objectives developed in accordance with the XCN Closure Criteria Development and Rehabilitation Monitoring standard. The achievement of the completion criteria will be monitored and reported within relevant internal and external reports including the AEMR.

Preliminary rehabilitation completion criteria have been established as part of the WWC Conceptual Closure Plan in order to guide site activities to ensure the rehabilitation objectives are met. To ensure completion criteria are achievable, the site has been split into a number of ‘closure domains’.

The preliminary closure and rehabilitation criteria developed for the Project are outlined in **Table 5.22**.

Table 5.22 – West Wallsend Colliery Preliminary Closure Criteria

Domain	Aspect	Preliminary Closure Criteria
West Wallsend Colliery Pit Top	Landform	● No significant erosion is present that would constitute a safety hazard, compromise the capability of supporting the end land use or affect the surrounding environment; and ● Provide acceptable levels of rock according to regulatory and land capability standards.
	Soil	● Any contamination will be appropriately remediated so that appropriate guidelines for sensitive land use are met, e.g. Health Investigation Level A (HIL 'A') of the National Environment Protection (Assessment of Site Contamination) Measure (1999); ● Where practical, carbonaceous material will be removed from the site or suitably capped; and ● Topsoil or a suitable alternative has been spread uniformly over the rehabilitated surface.
	Water	● Runoff water quality from rehabilitation areas is within the range of water quality data recorded from analogue sites and does not pose a threat to downstream water quality.
	Vegetation	● Sufficient ground cover will be established over the footprint of the disturbed area associated with surface infrastructure to provide stability and prevent erosion; and ● There is no significant weed infestation such that that weeds do not compromise a significant proportion of species in any stratum. ● Note that if the pit top is proposed to be returned to natural vegetation, specific ecological completion criteria will be developed.
	Bushfire Hazard	● Appropriate bushfire hazard controls have been implemented following advice from the NSW Rural Fire Service.
	Heritage	● Potential items of European or Aboriginal Heritage will be managed in accordance with heritage management plans developed for WWC.
	Engineering	● Where residential development is proposed, areas where fill material has been emplaced will be compacted to suitable standards; and ● Boreholes and drift openings will be sealed in accordance with DI&I guidelines. The design of the fill and seals will consider final land use options.
No. 2 and No. 3 Ventilation Shaft sites	Landform	● No significant erosion is present that would constitute a safety hazard, compromise the capability of supporting the end land use or affect the surrounding environment; and ● Provide acceptable levels of surface rock according to regulatory and land capability standards.
	Soil	● Any contamination will be appropriately remediated so that appropriate guidelines for sensitive land use are met, e.g. HIL 'A' of the National Environment Protection (Assessment of Site Contamination) Measure (1999); ● Where practical, any carbonaceous material will be removed from the site or suitably capped; and ● Topsoil or a suitable alternative has been spread uniformly over the rehabilitation surface.

Table 5.22 – West Wallsend Colliery Preliminary Closure Criteria (cont)

Domain	Aspect	Preliminary Closure Criteria
No. 2 and No. 3 Ventilation Shaft sites (cont)	Water	● Runoff water quality from rehabilitation areas is within the range of water quality data recorded from analogue sites and does not pose a threat to downstream water quality.
	Vegetation	● Revegetation areas contain flora species assemblages characteristic of the desired native vegetation community and meet defined ecological completion criteria; ● Second generation tree seedlings are present or likely to be, based on monitoring in comparable older rehabilitation sites; ● More than 75% of trees are healthy and growing as indicated by long term monitoring; and ● There is no significant weed infestation such that weeds do not compromise a significant proportion of species in any stratum.
	Fauna	● Rehabilitated areas provide a range of vegetation structural habitats (e.g. eucalypts, shrubs, ground cover, developing litter layer etc.).
	Bushfire Hazard	● Appropriate bushfire hazard controls have been implemented following advice from the NSW Rural Fire Service.
	Heritage	● Potential items of European or Aboriginal Heritage will be managed in accordance with the approved heritage management plans developed for WWC.
	Engineering	● Ventilation shafts and boreholes will be sealed in accordance with DI&I guidelines. The design of the fill and seals will consider final land use options.
Mining Services Facility	Landform	● No significant erosion is present that would constitute a safety hazard, compromise the capability of supporting the end land use or affect the surrounding environment; and ● Provide acceptable levels of surface rock according to regulatory and land capability standards.
	Soil	● Any contamination will be appropriately remediated so that appropriate guidelines for sensitive land use are met, e.g. HIL 'A' of the National Environment Protection (Assessment of Site Contamination) Measure (1999); ● Where practical, carbonaceous material will be removed from the site or suitably capped; and ● Topsoil or a suitable alternative has been spread uniformly over the rehabilitation surface.
	Water	● Runoff water quality from rehabilitation areas is within the range of water quality data recorded from analogue sites and does not pose a threat to downstream water quality.
	Vegetation	● Revegetation areas contain flora species assemblages characteristic of the desired native vegetation community and meet defined ecological completion criteria; ● Second generation tree seedlings are present or likely to be, based on monitoring in comparable older rehabilitation sites; ● More than 75% of trees are healthy and growing as indicated by long term monitoring; and ● There is no significant weed infestation such that weeds do not compromise a significant proportion of species in any stratum.

Table 5.22 – West Wallsend Colliery Preliminary Closure Criteria (cont)

Domain	Aspect	Preliminary Closure Criteria
Mining Services Facility (cont)	Fauna	● Rehabilitated areas provide a range of vegetation structural habitats (e.g. eucalypts, shrubs, ground cover, developing litter layer etc.).
	Bushfire Hazard	● Appropriate bushfire hazard controls have been implemented following advice from the NSW Rural Fire Service.
	Heritage	● Potential items of European or Aboriginal Heritage will be managed in accordance with heritage management plans developed for WWC.
	Engineering	● Boreholes be sealed in accordance with DI&I guidelines. The design of the fill and seals will consider final land use options.

The preliminary rehabilitation criteria have been developed to meet the mine closure objectives described in **Section 5.15.3.4**. The preliminary closure criteria will be reviewed and revised throughout the life of the mine and used as the basis for further refinement following the commencement of rehabilitation activities and consideration of stakeholder feedback. It is envisaged that this process will occur as part of the revision of the MOP and subsequent AEMRs that are submitted to DoP, DI&I, LMCC and other key agencies.

Xstrata operations undertake a holistic approach to rehabilitation and mine closure planning from a conceptual project planning phase through to the preparation of detailed rehabilitation and mine closure plans. Detailed rehabilitation design is undertaken as part of the preparation or revision of the existing MOP for an operation and approved by DI&I. The MOP approval also provides for the monitoring of performance against rehabilitation objectives over the life of an operation as well as the requirement to submit and periodically review a rehabilitation security bond held by the DI&I. Prior to the commencement of decommissioning and rehabilitation works at WWC, a Decommissioning MOP will be submitted to DI&I for approval.

An overview of the likely decommissioning and rehabilitation works to be undertaken as part of the closure of WWC are outlined in **Sections 5.15.3.6** and **5.15.3.7**, respectively.

5.15.3.6 Scope of Mine Closure Decommissioning Works

Site Services

Electricity services to the underground mine will be removed upon completion of mine sealing at which time the ventilation fans are no longer required. Power to the buildings, including power lines, will be removed prior to demolition. Depending upon the outcomes of the final land use study, electricity supply may be retained to the site to support the proposed post mining land use option.

It is envisaged that the 11kV powerline to the No. 3 Ventilation Fan site will be removed as part of the decommissioning of this site, however this will be confirmed as part of the final land use analysis. The same situation exists for the Mining Services Facility, with the proposed powerline to be removed unless otherwise required.

Buildings and Fixed Plant

All buildings and fixed plant (including conveyors, transfer stations, breaker bins, etc) will be demolished and removed from the site. Where appropriate the materials recovered in the demolition will be sold for re-use or recycled. All concrete footings and pads will be broken up and removed with the waste material being buried in the MCPP tailings dam, used for filling ventilation shafts, or other locations deemed appropriate on the WWC site. These locations will be determined based on the final land use and will be selected in consultation with the appropriate government agencies (e.g. DI&I).

Provided that it does not pose a constraint to the proposed final land use, there may be circumstances where structures such as footings, underground water pipelines and disconnected power cables may be left *in situ*. Such circumstances may include where it is not practical to retrieve the structures or where their removal may lead to environmental damage (e.g. erosion or loss of vegetation through clearing). In such circumstances, the location of these remaining structures will be surveyed and recorded on a plan.

Roadways, Car Parks and Rail Lines

If not required by the post mining land use, the bitumen roadways, car parks and hardstand areas around the administration building, stores area and workshop will be ripped up with the waste material being placed in the drift and shafts and buried. Bitumen will be broken up and removed with the waste material being buried in the MCPP tailings dam or other locations deemed appropriate on the WWC site. These locations will be determined based on the final land use and will be selected in consultation with the appropriate government agencies (e.g. DI&I).

The railway lines on the pit top area around the store and workshop will be ripped up where appropriate and will be sold for re-use, recycled or disposed of at an authorised waste facility.

Salvage and Removal of Mine Equipment

In consideration that the mine commenced operations in 1969 and that mine closure is not anticipated until approximately 2022, the assessment of end of mine life rehabilitation liability assumed that the majority of machinery and equipment would not be worth salvaging and therefore would be left underground. The decision to salvage selected machinery and equipment will be made based on the outcome of an environmental and safety risk assessment and will be undertaken in consultation with the relevant stakeholders.

Plant and equipment that is salvaged from the mine will be cleaned and temporarily stored at the pit top prior to removal off site. Prior to storage, all equipment and machinery will be inspected for any actual or potential hydrocarbon or fluid leakages, which will be appropriately contained and treated. Regular inspections will continue whilst the machinery/equipment is stored on site.

Hazardous Materials Management

<u>Hydrocarbon Storage Tanks</u>

Leading up to the cessation of mining activities, hydrocarbon stocks will be depleted and additional stocks only ordered as required. Upon cessation of operations, all remaining hydrocarbons stored in tanks such as diesel, lubricants and soluble oil will be drained and either utilised or disposed of via an authorised contractor. The storage tanks will be removed and depending on their condition either sold or disposed of appropriately.

Dangerous Goods

In the lead up to the cessation of mining activities, stocks of dangerous goods on-site will be depleted, with new stock being purchased only as required. It is envisaged that the majority of dangerous goods remaining on-site will include gas bottles and cleaning agents, which will be utilised during decommissioning activities or disposed of off-site via an authorised waste contractor.

Sewage Treatment Infrastructure

Following the demolition of all surface buildings, the on-site sewage treatment system will be decommissioned. The decommissioning of the system will involve the following:

- the removal and disposal of sewage sludge from the tanks by a licensed waste contractor;
- the removal of the aeration tanks for either off-site disposal at an authorised landfill or depending on their condition, for re-use at another site; and
- at least partial removal of the buried effluent pipeline from WWC to the MCPP. It is envisaged that the pipeline will be removed in areas where it may be exposed or where there may be a risk to future exposure as a result of erosion (e.g. creek crossings). Sections of the pipeline may be left where their removal would cause more environmental disturbance then leaving them in place.

Water Management Infrastructure

The final design of the water management system will be dependent upon the outcomes of the final land use study and will be detailed in the closure and decommissioning MOP. However, depending on the chosen final land use, issues that will need to be considered as part of future water management system may include:

- the removal of the oily water treatment system following the demolition of the workshop and associated facilities;
- removal of excess sediment from the pit top dams for future use by the subsequent land owner or alternatively filling and shaping of the dams if they are no longer required;
- where dams are to be retained, provide that drainage structures are designed to capture runoff from sufficient catchment area so that the dam can be utilised for its intended use; and
- the installation of sediment and erosion control measures for areas where drainage by-passes the surface dams and is discharged off site.

ROM Coal Stockpile Area

The carbonaceous material (coal) on the base of the emergency ROM pad and emergency storage area will be stripped and removed. Once this has been completed, the area will be suitably capped with inert material in consultation with DI&I prior to being rehabilitated.

5.15.3.7 Removal of Carbonaceous/Contaminated Material

Excess coal material remaining at closure will be scraped-up and either reprocessed or disposed of within the MCPP tailings/coarse reject emplacement areas on site.

Where potential contamination may have occurred as a result of site activities (e.g. re-fuelling areas, workshops, etc), appropriate investigations will be undertaken to determine the presence and extent of any contamination. Where it is identified, contaminated material will be either bioremediated on site or disposed of off site at an authorised waste facility. Further investigations involving sampling will be undertaken to validate that contamination has been remediated to acceptable levels.

Underground Infrastructure

One of the key considerations of the closure, decommissioning and rehabilitation of WWC will be the sealing of shafts, drifts and boreholes which are associated with its mining operations. A list of these mine openings and their associated ML as well as the status of each is outlined in **Table 5.23**.

Table 5.23 - Status of Mine Openings at WWC

Mine Opening	Location	Description	Lease	Coal Seam	Status
Elevator Shaft	Main Pit Top Killingworth	Depth 250 metre, Diameter 4.72 m	CCL 725	Young Wallsend/ Borehole	Downcast Shaft and personnel access
Main Drift	Main Pit Top Killingworth	Width 5.5 metre, Height 3.1 m, Distance to 15 m solid roof cover – 60 m	CCL 725	Young Wallsend/ Borehole	Men & materials conveyor
Diesel & Hydraulic Borehole	Main Pit Top Killingworth	Depth 245 metre, Diameter 150 mm	CCL 725	Young Wallsend/ Borehole	Diesel fuel and LW support hydraulic fluid in separate lines
Minewater Borehole	Main Pit Top Killingworth	Depth 253 metre, Diameter 150 mm	CCL 725	Young Wallsend/ Borehole	150mm victaulic pump line to surface
Mine Dewatering Borehole	Wakefield, above LW11 workings	Depth 254 metre, Diameter 430mm	CCL 718	Young Wallsend/ Borehole	Mine dewatering bore for water transfer system
Gaswell 15B	E 352378.630 N 1352864.470	Depth 235 metre, Diameter 300 mm	PLL 153	Borehole	Free flow – engine not in use
Gaswell 17	E 352329.656 N 1352250.347	Depth 229 metre, Diameter 300 mm	CCL 718	West Borehole	Locked closed, no engine
No. 2 Shaft	Barnsley	Depth 224 metre, Diameter 4.72 m	CCL 725	Young Wallsend/ Borehole	Decommissioned fan shaft – open
No. 3 Shaft	Wakefield	Depth 198 metre, Diameter 4.00 m	CCL 725	West Borehole	Upcast fan shaft
Ballast Borehole	Wakefield	Depth 195 metre, Diameter 450 mm	CCL 725	West Borehole	U/G road maintenance

The general strategy for sealing each of these mine openings will be developed by WWC in consideration of the latest DI&I guidelines for mine sealing (refer to **Section 2.1.3**). Engineered drawings of the proposed mine seals will be submitted to the DI&I for review and consensus of the design prior to the commencement of mine sealing activities.

The construction of the mine seals will be verified by an appropriately qualified engineer in consultation with the DI&I. As-constructed drawings will then be subsequently submitted to DI&I to be included as part of the record tracings for the mine.

Reshaping Works

Following the demolition of the buildings and site infrastructure, it is expected that any concrete slabs and footings will be broken-up and either incorporated into the shaft fill material, buried on site or disposed of at the MCPP tailings dam. Reshaping works may also include the removal of sedimentation dams, which may no longer be required following rehabilitation. In regards to the WWC pit top area, reshaping works will also be required along the embankment of the storage pad adjacent to The Broadway to provide that it is of a suitable grade for long term stability.

The entire area will then be trimmed to facilitate the appropriate drainage of surface runoff from the site, rock raked to reduce surface rock and subsequently ripped to promote rainfall infiltration and plant root development whilst minimising the potential for erosion. The area will be covered with topsoil material, or a suitable alternative, and a pasture grass and/or native tree mix will be applied to the entire site.

5.15.3.8 Rehabilitation Strategy

A rehabilitation strategy will be developed in consideration of a range of factors including the following:

- characteristics of the WWC surface areas including the opportunities and constraints associated with existing land resources in relation to soils and land capability (refer to **Section 5.15.1**);
- key environmental features of the WWC surface areas and surrounds including ecological features;
- relevant government strategic land use objectives for the area and surrounds;
- the Strategic Framework for Mine Closure (ANZMEC/MEC); and
- the pit top is to be returned to a condition where its landforms, soils, hydrology, flora and fauna are self-sustaining, and compatible with the surrounding land use.

The rehabilitation process that will be employed to achieve the aims of the conceptual closure strategy is described in detail in below and is summarised as follows:

- stabilising disturbed landforms and ensuring they are free-draining;
- revegetating these areas in accordance with their planned final land use; and
- ongoing monitoring and maintenance of rehabilitated areas to ensure rehabilitation is meeting the designated objectives and criteria, which will enable lease relinquishment.

Proposed Rehabilitation Techniques

The range of rehabilitation techniques to be adopted is described in the following sections.

Use of Topsoil and Organic Material

Due to the limited availability of topsoil on site, topsoil or a suitable alternative will need to be sourced from external sources for rehabilitation purposes.

Substrate Preparation

The general surface preparation activities to be undertaken at WWC include:

- prior to revegetation activities, soils will be characterised to determine the type and application rate that may be required for the addition of soil ameliorants (e.g. gypsum, lime, fertiliser, biosolids, etc.);
- appropriate soil ameliorants will be applied for incorporation into the final shaped surface;
- where direct tree seeding is planned, final shaped surfaces will be deep ripped parallel with the contour prior to the application of seed to provide for an adequate seed bed;
- where grass seeding is planned the surface will be harrowed/tilled across the contour to provide for an adequate seed bed;
- suitable erosion control measures (e.g. catch drains, sediment dams, silt fences, mulches, etc.) will be implemented to minimise soil loss from areas undergoing rehabilitation;
- where appropriate and practical, structures such as tree hollows, logs and other woody debris will be incorporated into the final landform to augment the habitat value of the site (whether or not this is an appropriate measure will depend on the final land use); and
- the installation of appropriate habitat structures (e.g. ponds) where practical and where consistent with the final land use.

Revegetation

Revegetation techniques utilised at WWC will be dependent upon the final land use option selected for each site. Further details regarding revegetation activities will be specified in the Detailed Mine Closure Plan and will be consistent with industry techniques for the establishment of either open grassland or native ecosystems.

Where appropriate, revegetation activities will be undertaken during spring and autumn. However, opportunistic revegetation may be practised if areas become available for seeding or planting in summer and winter. After surface soil amelioration and tillage is completed for any given area, revegetation will commence as soon as practical.

5.15.3.9 Proposed Rehabilitation Monitoring

As per the XCN Closure Criteria and Rehabilitation Monitoring Standard, WWC will implement a rehabilitation monitoring program to include but not be limited to the aspects outlined below.

Active Mining Records

During active mining operations, WWC will maintain active records as to processes that may impact upon the rehabilitation of the site. This will provide the basis for interpretation of later rehabilitation monitoring outcomes. Amongst these records to be maintained include the following:

- detailed rehabilitation procedures;
- register of any contaminated sites including bioremediation areas;
- records of production wastes and other waste streams and where they are located on site;
- environmental monitoring records, including surface and groundwater quality; and
- environmental incident records.

Rehabilitation Methodology Records

WWC will record the details of each rehabilitation campaign during the decommissioning process, so that they are available for later interpretation of rehabilitation monitoring results with the aim of continually improving rehabilitation standards on site. Amongst the key monitoring parameters to be included in the program relate to the following:

- landform design details;
- drainage design details;
- substrate characterisation;
- site preparation techniques (e.g. topsoil and source, time of sowing, soil ameliorants used etc.);
- revegetation methodologies (e.g. rate and type of fertiliser, cover crop and rate, seed viability);
- weather conditions;
- photographic records; and
- initial follow-up care and maintenance works.

Such records from other OCAL operations will also be utilised when designing rehabilitation campaigns at WWC.

Annual Rehabilitation Inspection

At least annual inspections of rehabilitated areas will be undertaken to assess soil conditions and erosion, drainage and sediment control structures, runoff water quality, revegetation germination rates, plant health and weed infestation. Outcomes of the annual rehabilitation inspection will be recorded and any required management actions that are identified as part of the inspection implemented as soon as practical. Where necessary, rehabilitation procedures will be amended accordingly with the aim of continually improving rehabilitation standards.

Long Term Rehabilitation Monitoring

The objective of this monitoring is to evaluate the progress of rehabilitation towards fulfilling long term land use objectives. The monitoring program will be continued within rehabilitated areas until it can be demonstrated that rehabilitation has satisfied the closure criteria. Information from this monitoring program will also be used to refine closure criteria as required.

The exact scope of the long term rehabilitation monitoring program will be included as part of the detailed closure plan, which will be developed in consultation with DoP, DECCW and DI&I. Broadly, the long term rehabilitation monitoring program will include vegetation monitoring, habitat assessment and fauna monitoring where the post mining land use objective is to return to native ecosystem. Whilst the program will be designed to be comparable between monitoring periods, the program will also be flexible to enable the incorporation of a range of industry accepted techniques that will enable sites to be tracked against meeting the closure criteria.

Long term monitoring programs for other post-mining land use options will be developed as required.

5.15.3.10 Revegetation Care and Maintenance

Depending upon the outcomes of the rehabilitation monitoring programs as outlined above, the scope of the rehabilitation care and maintenance phase may include the following:

- weed and feral animal control of rehabilitation;
- erosion control works;
- re-seeding/planting of rehabilitation areas that may have failed;
- maintenance fertilising; and
- repair of fence lines, access tracks and other general related land management activities.

It is envisaged that this program will be continued as required until it can be demonstrated that the rehabilitation has satisfied the closure criteria.

5.16 Cumulative Impacts

The DGRs for the Project require the EA to include an assessment of the potential impacts of the Project, including any cumulative impacts. Assessment and management of cumulative impacts has been a consideration in conducting the detailed studies for the EA and is discussed for each relevant issue in preceding parts of **Section 5.0**. This section provides an overview of the assessment of cumulative impacts in relation to each relevant issue.

5.16.1 Relevant Existing and Approved Mining Operations

The existing and approved OCAL mining operations are relevant to cumulative considerations. This includes the former underground workings of WWC, the Westside open cut, MCPP and Teralba Colliery which is currently on care and maintenance. The aspects of existing and approved OCAL mining operations that will continue during the life of this Project have been assessed as part of this EA. Other relevant industrial and mining activities operating in the vicinity of WWC include:

- Newstan Colliery (under project development), approximately 5 kilometres south of WWC (currently on care and maintenance);
- Tasman Colliery, approximately 10 kilometres north of WWC;
- Awaba Colliery, approximately 10 kilometres south of WWC;
- Boral Resources (Metromix Quarry), approximately 5 kilometres east of WWC; and
- Incitec Pivot Cockle Creek, approximately 7 kilometres east of WWC (former fertilizer manufacturer proposed for remediation).

The following sections provide an overview of potential cumulative impacts for each relevant issue.

5.16.2 Potential Cumulative Impacts

Ecology

As discussed in **Section 5.3**, the continued underground mining area lies beneath an expansive tract of native vegetation associated with the Sugarloaf Range linking the Watagan Mountains to Mount Sugarloaf. Approximately 91 per cent of the continued underground mining area occurs within the SSCA. However, the area of SCA proposed to be undermined represents only 25 per cent of the total area of the SSCA with the Project not predicted to significantly impact the ecological values of the SCA. On a regional scale, this large remnant links with larger remnant vegetation areas to the south including the Olney State Forest and Watagan National Park.

The ecological survey identified the presence of a diversity of threatened flora and fauna species and two EECs within the continued underground mining area. Cumulative impact assessment is inherent in the ecological impact assessment process, particularly in considering the regional conservation status of relevant communities and species, and applying the test of significance in accordance with both state and national legislation. One of the key goals of the impact mitigation measures is to maintain or improve ecological features and functions within the continued underground mining area, in order to mitigate the impacts associated with continued mining. The detailed ecological assessment has confirmed that this project will have a low cumulative impact on ecological values.

Groundwater

The assessment of cumulative impacts on groundwater is discussed in **Section 5.4**. The hydrogeological assessment identified two potential regional risk factors:

- Any mining-related loss of groundwater from aquifers in the near-surface alluvial deposits could impact on the groundwater supplies and users of this resource further downstream.
- Any mining-related loss of groundwater from coal seam aquifers in the overburden above the West Borehole Seam could impact on the groundwater supplies in the coal seams and users of this resource in other parts of the region.

The hydrogeological assessment determined that both of these potential risks are negligible. WWC will continue to monitor groundwater as the Project progresses. Should review of the monitoring data identify unexpected and/or unusual results and these relate to cumulative

interactions, WWC will investigate and liaise with relevant government agencies to determine an appropriate groundwater management response.

Surface Water

As discussed in **Section 5.5**, potential cumulative surface water impacts associated with the Project relate to surface disturbance associated with construction for the Mining Services Facility and operational works, subsidence potentially resulting in increased ponding and reduced catchment runoff and discharge of excess mine water.

The surface water assessment of the predicted subsidence impacts indicates that the catchment boundaries of the creek systems to be undermined will not change significantly. It is also considered unlikely that any significant ponding or storage of surface runoff will occur. A series of monitoring points have been identified to monitor potential surface water impacts.

Sediment and erosion control measures are proposed to ensure that there will be no significant impact on downstream water quality if subsidence remediation works are required.

WWC is currently undertaking trials as part of a PRP to improve efficiencies in the site WMS to reduce the discharge of saline mine water to surrounding watercourses and to reduce the use of potable water on site. An opportunity exists to transfer surplus underground water to a nearby quarry for re-use. This opportunity would facilitate a reduction of the overall potential impact on regional surface waters for the life of the Project.

It is considered that the Project will not result in adverse cumulative impacts on water use, flows or quality in the surrounding areas.

Air Quality

An assessment of the cumulative air quality impacts associated with the Project and other major sources was undertaken as part of the air quality assessment and is included in **Section 5.6**. There are no private residences predicted to be impacted by dust levels above the relevant criteria as a result of the Project alone. The results of the predictive air quality modelling have also identified that the proposed Project will readily meet the DECCW cumulative air quality goals at all sensitive receiver locations.

Noise

An assessment of the cumulative noise impacts associated with the Project and other sources was undertaken as part of the noise assessment and is included in **Section 5.7**. The INP allows assessment of the potential cumulative noise impacts associated with existing and future developments by defining appropriate noise emission criteria with respect to maintaining the noise amenity at residential receivers and considering applicable consent limits. The cumulative assessment assumes that all sources simultaneously emit their maximum noise levels to a common receiver, and therefore it is considered a worst case assessment.

The cumulative noise levels are predicted to be less than the recommended acceptable noise levels at all the potential receiver locations in the area surrounding WWC. As discussed in **Section 5.7**, WWC proposes to implement further noise control of the existing breaker at the surface facilities, and existing No. 2 ventilation fan, which will substantially reduce project specific noise emissions and therefore reduce WWC's contribution to cumulative noise levels.

Greenhouse Gas

The environmental consequences of global warming from the release of emissions of GHG from human activities has the potential to result in sea-level rise, changes in precipitation patterns, increased risk of droughts and floods, threats to biodiversity, and a number of potential challenges for public health (CSIRO 2004).

As there are no accepted methods for undertaking an assessment of the impacts that these emissions may have on the global climate, a comparative analysis of Project related emissions to global emissions has been undertaken. The direct and indirect emissions (including the end use of the coal) of GHG from the Project equate to approximately 1.48 per cent of Australia's GHG emissions. This is equivalent to 0.03 per cent of annual global greenhouse gas emissions. Although insignificant in a global context, all GHG emissions may contribute to climate change. However, it should also be noted that the coal produced by the Project will be meeting market demand and that should the Project not proceed, this demand will be met from other sources. These sources may have poorer quality coal or less energy efficient operations (such as occur in some other countries) and may result in increased GHG emissions per unit of energy. However, it is recognised that global warming is the result of the cumulative effect of many such small contributions.

As an Xstrata Coal operation, WWC is also committed to the Xstrata Coal Climate Change Position Statement (Xstrata Coal, 2008). Xstrata Coal also participates in the Energy Efficiency Opportunities (EEO) Program (Xstrata Coal, 2008). WWC also has a number of greenhouse gas and energy management systems in place at the site level, as discussed in **Section 5.8**.

Aboriginal Archaeology

As discussed in **Section 5.9**, a total of 62 Aboriginal heritage sites are known to occur within and in proximity to the proposed continued underground mining area. The cumulative assessment for cultural heritage is taken into account as part of the detailed significance assessment. The majority of these sites (69 per cent) are assessed as being of low or low to moderate archaeological significance in a regional context. The Project had the potential to impact on significant Aboriginal sites through both direct and indirect impacts.

Significant modifications to the mine plan have been made to avoid or minimise impact on a number of significant archaeological sites. To mitigate the impacts of the Project, Aboriginal heritage and archaeological management strategies have been developed in consultation with the relevant Aboriginal stakeholder groups. The strategies will be outlined in an Aboriginal Cultural Heritage Management Plan which will also be developed in consultation with DECCW and Aboriginal stakeholder groups for the ongoing management of Aboriginal heritage at WWC.

Traffic

Traffic generated by WWC consists of employee, contractor, visitor and supply delivery traffic. As discussed in **Section 5.11**, the Project is not expected to generate additional long term access, traffic or parking demand at WWC. As there is no proposal to increase the existing operational staff or service demand, there is consequently not expected to be any additional vehicle generation associated with the Project at the pit top site.

The Project does include the establishment of the proposed Mining Services Facility, located adjacent to Wakefield Road. It is estimated that the Mining Services Facility could generate up to 10 vehicle trips per day, consisting of four heavy vehicle trips (i.e. two loads) and six staff vehicles.

Based on future forecasts, which includes average annual increases in local and sub-regional traffic generation, the local traffic network will continue to operate at a high level of service through the continued mining operations at WWC. Overall, the assessment concludes that the Project would not have a significant impact on the local traffic and transport network.

Visual

Views of WWC existing operations are restricted to the pit top facilities and surface infrastructure, as discussed in **Section 5.12**. The local topography and vegetation heavily restrict the visibility of the mine. Views of the WWC existing surface operations are present from surrounding roads.

The Project involves underground mining, which has very little surface visibility, other than relatively minor components of infrastructure required to support underground mining such as potential additional ventilation infrastructure. The most significant addition associated with the Project is the proposed Mining Services Facility.

The proposed Mining Services Facility will not be visually intrusive and is considered consistent with the surrounding visual environment. There are limited views from surrounding residences and any visual impacts to road commuters will be short in duration and are not considered inconsistent with the current visual amenity.

Socio-Economic Considerations

An assessment of the cumulative social impacts associated with the Project was undertaken as part of the socio-economic assessment and is included in **Section 5.14**. WWC will continue to create a number of benefits for the local and wider communities through direct means such as employment and wages, and indirect processes such as spending and use of services.

From an economic perspective, the continued operation of WWC will deliver significant benefits to the local, regional and state economies. This stimulus would be felt across a range of sectors in the regional economy including the mining services sector, technical services sector, retail trade sector, financial services sectors, health sectors, wholesale trade sector, law/accounting and marketing sectors and other business services sectors.

section 6.0

Statement of Commitments

6.0 Statement of Commitments

The DGRs for the Project require that the EA includes a Statement of Commitments which details the measures proposed by WWC for environmental mitigation, management and monitoring of the Project.

If approval is granted under Part 3A of the EP&A Act for the proposed Project, WWC will commit to the following controls.

6.1 Compliance with the EA

6.1.1 To carry out the development for the Project generally in accordance with the Project Application and this EA report.

Surrender of Redundant Development Consents

6.1.2 On completion of underground mining of the currently approved SMP area, WWC will seek to surrender all other development consents that relate to activities that are adequately covered in the new Project Approval.

6.2 Life of Mine Operations, Production and Concept Mine Plan

Project Life

6.2.1 The project approval life will be for 15 years from Project Approval. Closure and rehabilitation activities will be undertaken in accordance with an approved Mining Operations Plan, or other relevant approval under the Mining Act or equivalent, at the time of closure. These works may extend beyond the 15 year operations approval life.

Production Limits

6.2.2 The Project will produce up to 5.5 Mtpa of ROM coal.

Hours of Operation

6.2.3 Mining and associated activities for the Project may be undertaken 24 hours a day, seven days a week.

6.2.4 Construction of the Mining Surfaces Facility will generally be undertaken between 7.00 am and 6.00 pm daily. Construction activities may occur outside these hours when WWC is satisfied that such activities are inaudible at nearest private residences.

Refinement of Mine Plan

6.2.5 Any refinements to the conceptual mine plan outlined in this EA report will be detailed and assessed as part of SMPs and MOPs or other relevant process.

6.2.6 The locations of ancillary surface infrastructure required to support underground mining will be documented and detailed within the SMPs and MOPs (or other relevant process) required for WWC to continue its mining and associated activities, in consultation with relevant stakeholders.

6.3 Subsidence

6.3.1 A comprehensive SMP (or Extraction Plan) will be developed for the Project to provide detailed guidance for subsidence management. This plan will be developed based on the existing SMP and will cover subsidence predictions, provide detailed subsidence management measures to be implemented as part of the ongoing operations and monitoring strategies for the continued underground mining area.

6.3.2 The SMP will also include revised stakeholder SMPs that have been established with each of the identified stakeholders within the continued underground mining area. These plans will be prepared in consultation with relevant stakeholders and specify subsidence predictions and specific management measures for natural and man-made surface features.

6.3.3 Remediation and rehabilitation of mining related subsidence impacts will be carried out, as detailed in **Section 5.2.4**, as soon as practicable following subsidence using methods specified in relevant SMPs.

6.3.4 A detailed Subsidence Survey Monitoring Program has been developed for the Project and is outlined in **Appendix 5**. The monitoring program will be implemented and the results used to refine the ongoing management of subsidence as the Project progresses.

6.4 Ecology

6.4.1 WWC will develop a Biodiversity and Land Management Plan which will be implemented and include the commitments in the Ecological Assessment impact mitigation strategy (refer to **Appendix 6**) and to guide the ongoing management of ecological values identified in the continued underground mining area.

6.4.2 Minor surface infrastructure facilities such as ventilation infrastructure and associated services may require some areas of native vegetation to be disturbed. Where this is unavoidable, all effort will be made to avoid areas containing significant ecological features such as known threatened species habitat, or hollow-bearing trees. Where it will be necessary to disturb areas of native vegetation for these types of infrastructure, the following due diligence processes will be implemented:

- due-diligence inspections will be completed by a suitably qualified ecologist;
- disturbance to native vegetation communities will be limited to the minimum area required;
- areas of known ecological significance will be avoided where possible (that is, areas containing known records of threatened species, Endangered Populations and TECs. Hollow-bearing trees will be retained, where possible);
- appropriate disturbance setbacks to known or identified significant ecological features will be established where possible;

- pre-clearance surveys of any sites containing hollow-bearing trees or significant habitat features; and

- should such infrastructure be required in the SSCA, the placement of such infrastructure will be determined in consultation with DECCW.

6.4.3 The results of the ecological monitoring and management measures will be reviewed annually and reported in the AEMR. Management measures will be adapted, as required, on the basis of monitoring outcomes.

6.5 Groundwater

6.5.1 WWC will continue to maintain the existing groundwater monitoring network and also undertake regular analysis of groundwater monitoring data to compare predicted and actual groundwater impacts. This will include groundwater make in the underground operations.

6.5.2 Prior to commencement of longwall mining in Longwall 46, WWC will review the need for establishment of alluvial monitoring in Diega Creek and Central Creek in consultation with NOW and to the satisfaction of DoP.

6.5.3 Within 12 months of project approval, WWC will submit for the approval of the Director General an updated Groundwater Monitoring Program for the Project. The program will be prepared in consultation with NOW and will include development of relevant trigger levels and response procedures to manage identified monitoring and/or predicted trends.

6.5.4 The monitoring network and monitoring program will be reviewed on an annual basis to determine ongoing suitability and any proposed changes will be discussed in the Annual Environmental Management Report (AEMR).

6.6 Surface Water

6.6.1 Within 12 months of project approval, WWC will submit for the approval of the Director General an updated Surface Water Management Plan for the Project. The Plan will be prepared in consultation with NOW and will include a Surface Water Monitoring Program, Groundwater Monitoring Program, Sediment and Erosion Control Plan and Subsidence Remediation Monitoring Program.

6.6.2 The existing Water Management System will continue to be used to control and treat runoff from the WWC pit top site with surface runoff directed to the water management system dams for use as dust suppression or discharge.

6.6.3 WWC will complete a series of investigations within 12 months of Project Approval, including:

- a more detailed desktop investigation of the various salt concentrations at other Xstrata operations and relevance to WWC;

- trialling shandying percentages based on the more detailed investigations of salts; and

- determining the most appropriate shandying percentage taking into consideration potential water quality impacts on the life and maintenance of the underground mining equipment.

6.6.4 The optimal water re-use strategy confirmed by the investigations will be implemented within two years of Project Approval. If the investigations indicate that shandying potable water with mine water for re-use on site is not viable, WWC will investigate the feasibility of other options for mine water treatment and re-use e.g. reverse osmosis.

6.6.5 A comprehensive monitoring regime will be implemented to monitor drainage lines and the locations identified in **Figure 5.12** for potential subsidence impacts. Monitoring procedures will include:

- monitoring of vertical and horizontal subsidence along second order drainage lines as determined in consultation with the DI&I;

- monitoring, measuring and recording (e.g. photographic records) of the extent and magnitude of any surface cracking along the second order drainage line and first order drainage lines in depths of cover less than 100 metres that may occur during and post mining operations. If works are required (sealing of cracks), methods approved by the DECCW and DI&I would be adopted;

- visual inspection and recording of stream bed and bank condition and riparian vegetation along the second order drainage line, including collection of baseline data and monitoring during and post mining operations;

- monitoring of geomorphological response of each watercourse to the predicted subsidence, as follows:

  - prior to mining review the potential geomorphological response of each watercourse to the predicted subsidence using the guidelines included in River Hydrology and Energy Relationships – Design Notes for the Mining Industry published by Department of Water and Energy (November 2007) and the methods described below;

  - for each watercourse within the continued underground mining area:

    - describe the existing (i.e. pre-mining) watercourse characteristics including bed controls using approaches outlined in AUSRIVAS (Australian River Assessment System);
    - calculate the stream power for the existing and predicted subsidence conditions;
    - determine threshold limits of stream power for incision and bed load deflation, taking into consideration existing stream stability, surface and substrate soil conditions and stream grades;
    - refine the monitoring program, including monitoring of:
      - any bed control points;
      - areas where subsidence may increase the stream power above the determined threshold limits potentially causing channel erosion/instability;
      - monitoring may include long section and cross section surveys, photographic records and/or methods outlined in AUSRIVAS;

  - investigate and implement any remediation required to mitigate potential impacts of changes in stream power as a result of underground mining activities; and
- during and post mining, monitor watercourses, in accordance with the developed monitoring program;

- ongoing monitoring and maintenance will be necessary for any areas requiring surface mitigation works to facilitate effective rehabilitation.

6.7 Air Quality

6.7.1 WWC will continue to implement existing dust controls, including:

- the use of manually-operated water sprays for unpaved areas and for the paved ring road at the WWC pit top, used by trucks transporting coal to MCPP via the private haul road;

- periodic sweeping of the haul road and other paved areas to reduce road surface silt loadings; and

- use of loading flaps during truck loading at the surface bin to restrict dust.

6.7.2 Within 12 months of project approval, WWC will submit for the approval of the Director General an Environmental Monitoring Program for the Project, which will include an Air Quality Monitoring Program. The Air Quality Monitoring Program will include dust deposition, TSP and PM_{10} monitoring at existing stations located at WWC, and within Barnsley and Killingworth for the life of the Project.

6.7.3 WWC will also undertake 24-hour PM_{10} monitoring for the life of the project using the existing Westside Mine PM_{10} HVAS monitor at Wakefield or an alternate location, otherwise agreed with DoP.

6.8 Noise

6.8.1 Noise emissions from the Project, when measured within 30 metres of a private residence, will not exceed the predicted worst case noise levels as outlined in **Section 5.7** unless a specific agreement is reached with the landholder in regard to noise impacts at that residence.

6.8.2 WWC will undertake mitigation of the breaker and No. 2 ventilation shaft to improve existing noise impacts associated with its operation. WWC will also investigate whether there are any feasible opportunities for further noise reduction at Killingworth.

6.8.3 Within 12 months of project approval, WWC will submit for the approval of the Director General an Environmental Monitoring Program for the Project, which will include a Noise Monitoring Program. The Noise Monitoring Program will include attended monitoring to assess compliance with the Project Specific Noise Levels.

6.9 Greenhouse Gases

6.9.1 WWC will continue to implement its ESAP, to investigate and implement, where feasible, GHG and energy management and mitigation initiatives during the operation and decommissioning of the Project.

6.9.2 WWC will report its greenhouse and energy performance via legislative reporting requirements.

6.10 Aboriginal Archaeology

6.10.1 WWC has committed to modify the mine plan to protect the following sites of Aboriginal cultural and archaeological significance;

- the stone arch;
- one rockshelter site in the Bangalow Creek catchment;
- two rockshelter sites in the Cockle Creek catchment;
- Palmers Creek Grinding Grooves 1 and 2;
- the Western Domain 5 (#38-4-0993 - wet soak with artefact scatter site);
- modification of the mine plan to lessen the probability of impact to the Palmers Creek Grinding Grooves 3 site.

6.10.2 WWC has committed to providing $200,000.00 over the life of the project to assist with the management of Aboriginal cultural and archaeological sites/values within the SSCA.

6.10.3 WWC has committed to fund a program of monitoring and reporting of subsidence impacts on landscape features of Aboriginal cultural value and Aboriginal archaeological sites recorded within the proposed continued underground mining area.

6.10.4 WWC has committed to funding a program of further survey within the SSCA in consultation with the Aboriginal stakeholders and the NPWS/DECCW, the purpose of the survey is to meet the requirements of Intergenerational Equity in relation to the potential subsidence impacts to Bangalow Creek 1, 2, 3, 4, 5, 6 and #38-4-0461 Grinding Grooves.

6.10.5 WWC is committed to providing each of the registered stakeholders a further offset package.

6.10.6 WWC will prepare an ACHMP for the project that is consistent with the Aboriginal cultural and archaeological management commitments made in this report.

6.11 Historic Heritage

6.11.1 WWC will map the recorded historic heritage sites on relevant project drawings and plans used during subsidence remediation works to provide that their presence is considered in planning such works. Impacts to such sites will be avoided during subsidence remediation works.

6.11.2 WWC personnel involved in subsidence remediation works will be briefed about the location of the recorded heritage items and their heritage status in an induction prior to conducting work in the continued underground mining area.

6.11.3 WWC will undertake inspections of historical heritage sites following the completion of undermining the recorded historic heritage sites. If subsidence cracks are identified in the vicinity of the identified sites they will be remediated as soon as practicable, except where any remediation works may result in further adverse impacts.

6.12 Traffic and Transport

6.12.1 WWC will consult with LMCC on the final design of the new intersection associated with the proposed Mining Services Facility. This intersection will require LMCC approval under the Roads Act. The intersection design will include appropriate deceleration and merge lanes, and signage.

6.12.2 Prior to the commencement of construction activities associated with the Mining Services Facility, WWC will prepare a construction traffic management plan in consultation with LMCC and the CCC.

6.12.3 WWC will consult with LMCC to determine relevant funding to have the road markings at the intersection of Wakefield Road and The Broadway repainted to appropriately delineate control and lane lines.

6.12.4 No haulage of coal will be undertaken on public roads, except in the case of emergency and as approved by the Director General.

6.13 Visual

6.13.1 WWC will maintain and implement a range of visual controls to screen views of the Mining Services Facility and minimise the visual impacts, including:

- where possible, trees will be retained to maintain visual amenity;
- planting of vegetation screening, where necessary, to shield the proposed Mining Services Facility; and
- all buildings and infrastructure potentially visible to the public, including the proposed Mining Services Facility, will be coloured in suitably natural tones, where practicable.

6.14 Waste

6.14.1 The management of waste materials generated by the construction and operation of the Project will be managed through the design; procurement of materials and purchasing; identification and segregation of reusable and recyclable materials; processing materials for recycling; and considering environmental impacts for waste removal processes, as outlined in the existing Waste Management Plan.

6.15 Community

6.15.1 WWC will continue to prepare and distribute a community newsletter to surrounding residences every six months.

6.15.2 WWC will continue to engage the community regarding the Project and operations in general through a Community Consultative Committee, as considered appropriate by Department of Planning.

6.16 Decommissioning and Mine Closure

6.16.1 A detailed closure planning process will be undertaken for the Project five years prior to cessation of mining.

6.16.2 Decommissioning of the mining operations and surface facilities associated with the Project will occur progressively throughout the life of the Project, in accordance with conditions of the relevant mining titles and existing closure plan. This will include progressive decommissioning of mine entries, ventilation fans, ventilation shafts, borehole facilities and associated surface facilities, where no longer required. A decommissioning plan will be prepared for each stage as part of the MOP process and provided to DI&I for approval prior to the commencement of decommissioning works.

6.17 Environmental Management, Monitoring, Auditing and Reporting

Annual Environmental Management Report

6.17.1 WWC will prepare an Annual Environmental Management Report for the Project.

Independent Environmental Audit

6.17.2 Three years after commencement of the Project mining operations, and every five years thereafter, WWC will commission and pay the full cost of an Independent Environmental Audit of the Project in consultation with the Director-General of DoP. A copy of the audit report will be provided to the Director-General of DoP, DI&I, DECCW.

section 7.0

Conclusion and Ecologically Sustainable Development

7.0 Conclusion and Ecologically Sustainable Development

7.1 Environmental Impacts

As detailed in **Section 5.0**, potential environmental impacts associated with the Project have been identified and were the subject of a detailed environmental assessment based on:

- assessment of the characteristics of the site and surrounds (existing environment);
- consultation with local community and other stakeholders;
- consultation with government agencies; and
- expert technical assessment.

Comprehensive specialist assessments were undertaken to address all of the key issues identified. The potential impacts of the Project on the existing environment are detailed in **Section 5.0** and further in the appendices to this document.

Whilst there are many complex aspects which must be read in their entirety to fully understand these assessments, **Table 7.1** provides a broad overview of the key outcomes of this EA.

Table 7.1 – Overview of Environmental and Social Impacts

Environmental/Social Issue	Overview of Key Outcomes (After proposed Management and Mitigation)
Subsidence impacts on the Built Environment	• Surface cracking due to subsidence has the potential to impact upon a range of surface features, both natural and built. • All predicted subsidence impacts can be successfully managed. • The F3 Freeway and major services easement are positioned outside the angle of draw and is designed to be protected from adverse impact. • Impacts on the Great North Walk will be managed in consultation with the Land and Property Management Authority. • Wakefield Road is expected to be exposed to subsidence impacts. Subsidence impacts on Wakefield Road will be managed in consultation with LMCC. • Impacts on services (e.g. communication towers and power lines) will be managed in consultation with the relevant stakeholders.
Ecology	• Only very minor surface disturbance will be required. • Subsidence is not expected to significantly impact the structure and floristic composition of vegetation communities. • The Project will not cause significant impacts to listed threatened species, populations, EECs or migratory species. • Impacts to flora and fauna will be minimised through an update of the existing West Wallsend Biodiversity and Land Management Plan to include the commitments in the ecological assessment impact mitigation strategy.

Table 7.1 – Overview of Environmental and Social Impacts (cont)

Environmental/Social Issue	Overview of Key Outcomes (After proposed Management and Mitigation)
Surface and groundwater	• No significant adverse impacts are expected to occur to surface drainage within the catchments of Cockle Creek, Palmers Creek and Bangalow Creek or other minor creeks within the continued underground mining area. • Detailed analysis confirms that significant ponding or storage of surface runoff is unlikely to occur as a result of subsidence. • The Project will not have a significant impact on the limited groundwater resources within the continued underground mining area.
Air Quality	• The Project is not predicted to result in exceedances of air quality criteria at any private residences. • Project will readily meet the DECCW cumulative air quality goals at all sensitive receiver locations.
Greenhouse	• Direct and indirect greenhouse gas emissions from the Project will result in a minor contribution of greenhouse gases when compared to national and global emissions.
Noise	• Project Specific Noise Criteria have the potential to be exceeded in both Killingworth and Barnsley under meteorological conditions that propagate noise from WWC towards these receiver areas. • The existing breaker has been identified as the key noise source for the Project. Attenuation will be fitted to the existing breaker to mitigate noise impacts enabling continued operations to meet current noise goals. • A range of noise control measures will continue to be implemented at WWC to mitigate potential noise impacts. • Predicted cumulative intrusive noise levels from the Project meet the recommended acceptable noise levels at all potential receiver locations surrounding WWC. • WWC will undertake ongoing noise monitoring and reporting as part of the Project.
Aboriginal Heritage	• Substantial mine plan modifications have protected two significant grinding groove sites and one artefact scatter site associated with a wet soak and four landscape features. These mine plan modifications have resulted in sterilisation in approximately 2.4 Mt of coal reserves. • Mine plan modifications have also reduced the likelihood of impact to a third grinding groove site. • Archaeological sites and landscape features within the proposed continued underground mining area may be subject to various levels of impact by subsidence and/or subsidence remediation works. • Further site recording, investigation and salvage will be undertaken in partnership with the local Aboriginal community.
Historic Heritage	• In general terms, the identified and potential heritage sites of the continued underground mining area are of nil to low local significance. • There are no significant impacts to the recorded heritage items or their heritage significance expected as a result of subsidence during the continued underground mining operations.
Traffic and transport	• The Project is not expected to generate additional long term access, traffic or parking demand at WWC. • The Project would have no impact on the operation of local roads and intersections.

Table 7.1 – Overview of Environmental and Social Impacts (cont)

Environmental/Social Issue	Overview of Key Outcomes (After proposed Management and Mitigation)
Visual Amenity	• The Project will result in a limited potential for additional visual impact as it involves underground mining, which has very little surface visibility, other than relatively minor components of infrastructure. • There are no significant changes proposed to the existing pit tip facility. • The proposed Mining Services Facility is located in an area surrounded by bushland and there are limited views to the site. The facility will not significantly impact the visual amenity of the surrounding area.
Waste	• Any waste generated by the Project will be managed through WWCs existing waste management system.
Socio Economic	• WWC will provide ongoing employment, with more indirect jobs created through flow-on effects. • WWC will continue to refine existing programs in relation to long term partnerships with local organisations through its Social Involvement Plan.

The impacts of the Project have been minimised through:

- obtaining a detailed understanding of the issues and impacts by scientific evaluation;
- proactive and appropriate strategies to avoid, minimise and mitigate or manage; and
- a thorough Statement of Commitments (refer to **Section 6.0**).

7.2 Suitability of the Site

Coal mining activities at WWC have been undertaken since 1969. WWC is a well established mining complex, with surface facilities to support underground mining activities. Current approvals allow mining operations within the continued underground mining area until 2021.

The existing land uses of the continued underground mining area and surrounding areas are described in **Section 1.4**. A detailed analysis of potential on-site and off-site impacts is provided in **Section 5.0** and an overview of environmental impacts in **Section 7.1**. As discussed in **Section 2.3.2**, the original mine plan was amended to avoid impacts to a number of environmental constraints identified early in the planning process. The comprehensive environmental impact assessment, considering the aforementioned amendments to the original mine plan, demonstrates that there are no major environmental constraints to the Project.

7.3 Benefits of the Project

Through the Project, WWC will continue to create a number of benefits for the local and wider communities through direct means such as employment and wages, and indirect processes such as spending and use of services. The key benefits of the Project are summarised below:

- ongoing employment of approximately 390 people, with many more indirect jobs created through flow-on effects;
- economic recovery of approximately 36 million tonnes (MT) of coal over the life of the operation;
- average annual economic contribution of $448 million to the regional economy during mining operations;
- average annual economic contribution of $644 million to the NSW economy during mining operations;
- payment of significant royalties ($29.5 million during 2008 and 2009) to the State of NSW;
- significant export earnings for Australia; and
- significant economic benefits to the local community through ongoing local employment, purchase of goods and services, and local expenditure both directly and through employee wages.

7.4 Ecologically Sustainable Development

One of the objectives of the EP&A Act is *'to encourage ecologically sustainable development'*. The definition of Ecologically Sustainable Development (ESD) adopted for the EP&A Act is detailed in Section 6(2) of the *Protection of the Environment Administration Act 1991*. The four principles of ESD defined under this act are:

- the precautionary principle – if there are any threats of serious or irreversible environmental damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- inter-generational equity – the present generation should ensure the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations;
- conservation of biological diversity and ecological integrity – this is a fundamental consideration; and
- improved valuation, pricing and incentive mechanisms – environmental factors should be included in the valuation of assets and services.

Table 7.2 outlines the way these principles have been considered for the project.

Table 7.2 – Incorporation of the Principles of Ecologically Sustainable Development

ESD principle	Relationship to the Proposal
Precautionary principle	• a detailed analysis of available scientific information has been undertaken for the EA and consideration has been given to the extent of scientific certainty relating to any potential impacts; • potential threats of serious or irreversible environmental damage were identified by a risk assessment undertaken for the initial stages of the EA process. Any potential impacts are identified and assessed throughout the EA (refer to **Section 5.0**); • consultation was undertaken with government authorities and potentially affected landholders to manage potential environmental impacts; and • measures to mitigate potential impacts associated with the Project have been developed and are discussed in **Section 5.0**.
Inter-generational equity	• potential social impacts associated with the Project were considered as part of the EA (refer to **Section 5.0**); • a number of mitigation measures will be implemented to minimise any potential impacts to the local community (refer to **Section 5.0**); • the Project will not sterilise any land from any potential future land uses; • the mine plan is designed to protect the F3 Freeway and adjacent services from adverse impact; • changes to the mine plan to protect significant Aboriginal heritage sites and reduce potential for impacts on water resources; • the Project will continue to provide direct employment for up to 390 people plus flow on employment; and • areas of land disturbed by the pit top facility and surface infrastructure will be rehabilitated to provide areas that can be utilised by future generations.
Conservation of biological diversity and ecological integrity	• potential impacts to flora and fauna species and vegetation communities of local, regional, state and national significance were identified and mitigation measures were developed to minimise any potential impacts (refer to **Section 5.3**); and • significant impacts to threatened or endangered flora and fauna species and communities are not expected.
Improved valuation, pricing and incentive mechanisms	• the Project is a continuation of existing operations and therefore maximises use of existing equipment and infrastructure. Continued operation at this site is of significant improved value in comparison to production from a greenfields site; and • mine planning has been undertaken so that the efficiency of the Project has been maximised and any isolation or sterilisation of coal is minimised, this has been achieved through appropriate mine design considering environmental and other constraints and location of site infrastructure.

7.5 Conclusion

The DGRs seek a conclusion justifying the Project on economic, social and environmental grounds, taking into consideration whether the Project is consistent with the objectives of the EP&A Act.

There are substantial socio-economic benefits associated with the Project at a regional, state and national level. The key benefits of the Project have been outlined in **Section 5.14** and **Section 7.3**.

As outlined in **Section 7.1**, the potential impacts associated with the Project have been kept to a minimum through obtaining detailed understanding of the issues and impacts by scientific evaluation. In addition, WWC will continue to implement a range of environmental management strategies to effectively mitigate the potential impacts of the Project on the surrounding environment and community.

The Project is consistent with relevant objectives of the EP&A Act. As discussed in **Section 4.2**, it is considered that the Project meets these objectives as it relates to planning for the safe and economic recovery of the state's coal resource whilst effectively managing impacts on the environment and community.

section 8.0

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8.0 References

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section 9.0

Abbreviations and Glossary

9.0 Abbreviations and Glossary

9.1 Abbreviations

AADT	Annual Average Daily Traffic
ACARP	Australian Coal Association Research Program
ACHMP	Aboriginal Cultural Heritage Management Plan
ADTOAC	Awabakal Descendants Traditional Owners Aboriginal Corporation
AEMR	Annual Environmental Management Report
AGO	Australian Greenhouse Office
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ALALC	Awabakal Local Aboriginal Land Council
ANZMEC/MEC	Australian and New Zealand Minerals and Energy Council
AOD	Angle of Draw
ARI	Average Recurrence Interval
ATOAC	Awabakal Traditional Owners Aboriginal Corporation
CCC	Community Consultative Committee
CCC	Cacatua Culture Consultants
CCL	Consolidated Coal Lease
CCO	Chemical Control Order
CHPP	Coal Handling and Preparation Plant
CPRS	Carbon Pollution Reduction System
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DA	Development Application
dB	Decibel
dB(A)	A-weighted Decibel
DECCW	Department of Environment, Climate Change and Water
DEWHA	Australian Government Department of Environment, Water, Heritage and the Arts

DGRs	Director General's Requirements
DGS	Ditton Geotechnical Services Pty Ltd
DI&I	Department of Industry and Investment
DIPNR	Department of Planning and Natural Resources
DOC	Depth of Cover
DoCC	Australian Government Department of Climate Change
DoP	Department of Planning
DWE	Department of Water and Energy
EA	Environmental Assessment
EC	Electrical Conductivity
EEC	Endangered Ecological Community
EEO	Energy Efficiency Opportunities
EIS	Environmental Impact Statement
EL	Exploration Licence
EMP	Extraction Management Plan
EMS	Environmental Management System
ENM	Environmental Noise Model
ENVIRON	ENVIRON Australia Pty Ltd
EPA	Environment Protection Authority of NSW (former, now DECCW)
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EP&A Regulation	Environmental Planning and Assessment Regulation 2000 (NSW)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
EPL	Environment Protection Licence
ESAP	Energy Savings Action Plan
ESD	Ecologically Sustainable Development
FM Act	Fisheries Management Act 1994
FOCs	Fibre Optic Cables

GHG	Greenhouse Gas
GHGEIA	Greenhouse Gas and Energy Impact Assessment
GHG Protocol	Greenhouse Gas Protocol 2004
GNW	Great North Walk
HDC	Hunter Development Corporation
HSEC	Health Safety Environment and Community
HWC	Hunter Water Corporation
HVAS	High Volume Air Sampler
INP	NSW Industrial Noise Policy
IPCC	Intergovernmental Panel on Climate Change
KLALC	Koompahtoo Local Aboriginal Land Council
KPI	Key Performance Indicators
Kv	Kilovolt
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
LMCC	Lake Macquarie City Council
LOM	Life of Mine
LPMA	Department of Land and Property Management Authority
LW	Longwall
MCPP	Macquarie Coal Preparation Plant
MCJV	Macquarie Coal Joint Venture
ML	Mining Lease
MOP	Mining Operations Plan
MSB	Mine Subsidence Board
MSEC	Mine Subsidence Engineering Consultants Pty Ltd
MSF	Mine Service Facility
Mt	Million Tonnes

Mtpa	Million Tonnes Per Annum
NGA	National Greenhouse Accounts
NGERS	National Greenhouse and Energy Reporting System
NIA	Noise Impact Assessment
NOW	NSW Office of Water
NP	National Park
NPI	National Pollutant Inventory
NPWS	National Parks and Wildlife Service
OCAL	Oceanic Coal Australia Pty Limited
OH&S Act	Occupational Health and Safety Act 2000
PAD	Potential Archaeological Deposit
PEA	Preliminary Environmental Assessment
PM_{10}	Particulate Matter less than 10 micro metres in diameter
PoEO Act	Protection of the Environment Operations Act 1997
POM	Plan of Management
PRP	Pollution Reduction Program
PSNL	Project Specific Noise Levels
PSSMP	Public Safety Subsidence Management Plan
RB	Rating Background Level
RNE	Register of the National Estate
ROM	Run-of-mine
RTA	Roads and Traffic Authority
SCA	State Conservation Area
SEPP	State Environmental Planning Policy
SF	State Forest
SIA	Socio-economic Impact Assessment
SIP	Social Involvement Plan
SHR	State Heritage Register

SMP	Subsidence Management Plan
SRP	Subsidence Reduction Potential
STAP	Stapleton Transportation and Planning Pty Ltd
STP	Sewage Treatment Plant
SSCA	Sugarloaf State Conservation Area
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
TEOM	Tapered Element Oscillating Microbalance
TSC Act	Threatened Species Conservation Act 1995 (NSW)
TSP	Total Suspended Particulates
U95%CL	Upper 95% Confidence Limit
WBCSD	World Business Council for Sustainable Development
WBH	West Borehole
WMP	Water Management Plan
WMS	Water Management System
WP Act	Water Management Act 2000
WRI	World Resources Institute
WSP	Water Sharing Plan
WWC	West Wallsend Colliery
WWCCOP	West Wallsend Colliery Continued Operations Project
XC	Xstrata Coal
XCN	Xstrata Coal NSW

9.2 Glossary

Alluvium: Sediment deposited by a flowing stream, e.g., clay, silt, sand, etc.

Amenities: Lunch room, showers, toilets.

Amenity: An agreeable feature, facility or service which makes for a comfortable and pleasant life.

Aquifer: A water-bearing rock formation.

Arboreal: Adapted for living and moving around in trees.

Archaeological: Pertaining to the study of culture and description of its remains.

Attenuation: The reduction in magnitude of some variable in a transmission system, for example, the reduction of noise with distance as it travels through air.

Average Recurrence Interval (ARI): The statistically calculated interval likely to be exceeded once in a given period of time. A term used in hydrology, also known as return period.

Background Noise: Existing noise in the absence of the sound under investigation and all other extraneous sounds.

Catchment Area: The area from which a river or stream receives its water.

Coal Reserves: Those parts of the Coal Resources for which sufficient information is available to enable detailed or conceptual mine planning and for which such planning has been undertaken.

Coal Resources: All of the potentially useable coal in a defined area, based on geological data at certain points and extrapolations from these points.

Coarse Reject: Lumps of carbonaceous shale up to 200 mm in size separated in the coal preparation process.

Conservation: The management of natural resources in a way that will preserve them for the benefit of both present and future generations.

dB (Decibel): A unit for expressing the relative intensity of sounds on a logarithmic scale from zero (for average least perceptible sound) to about 130 (for the average pain level).

dB(A): A modified decibel scale which is weighted to take account of the frequency response of the normal human ear.

Dip: The direction in which rock strata is inclined.

Drift: A tunnel used to access coal resources.

Ecology: The science dealing with the relationships between organisms and their environment.

Ecosystem:	Organisms of a community together with its non-living components through which energy and matter flow.
Effluent:	The liquid waste of sewage and industrial processes.
Electrical Conductivity:	The measure of electrical conduction through water or a soil-water suspension generally measured in millisiemens per centimetre or microsiemens per centimetre. An approximate measure of soil or water salinity.
Environmental Planning and Assessment Act 1979:	NSW Government Act to provide for the orderly development of land in NSW.
Environment Protection and Biodiversity Conservation Act 1999:	Commonwealth legislation that regulates development proposals that have an actual or potential impact on matters of national environmental significance.
Fault:	A fracture or fracture zone along which there has been displacement of the sides relative to one another. Displacement can be vertical and/or horizontal.
Fauna:	All vertebrate animal life of a given time and place.
Floodplain:	Large flat area of land adjacent to a stream which has been deposited during previous stream flow events and is inundated during times of high flow.
Flora:	All vascular plant life of a given time and place.
Geology:	Science relating to the earth, the rocks of which it is composed and the changes it undergoes.
Geomorphic:	Relating to the formation of the earth's surface features.
Geotechnical:	Relates to the form, arrangement and structure of geology.
Groundwater:	Sub-surface water which is within the saturated zone and can supply wells and springs. The upper surface of this saturated zone is called the water table.
Habitat:	The environment in which a plant or animal lives; often described in terms of geography and climate.
***In situ*:**	In its original place.
Indigenous:	Native to, or originating in, a particular region or country.
kV (Kilo Volt)	One thousand volts
L_{A1} Noise Level:	The noise level exceeded for one per cent of the time. It is used in assessment of sleep disturbance.

L_{A90} Noise Level: The noise level, measured in dB(A), exceeded for 90 per cent of the time, which is approximately the average of the minimum noise levels. The L_{90} level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes.

L_{Aeq} Noise Level: The equivalent continuous noise level, measured in dB(A), during a measurement period.

L_{AMax} Noise Level: The maximum noise energy, measured in dB(A), during a measurement period.

Land Capability: The ability of a parcel of land to be used in a sustainable manner (that is without permanent damage) for a given land use.

Landform: Sections of the earth's surface which have a definable appearance (e.g. cliff, valley, mountain range, plain, etc).

Longwall Mining: A form of underground mining. A panel of coal is removed by shearing machinery, which travels back and forth across the coal face. The area immediately in front of the coal face is supported by a series of hydraulic roof supports providing working space.

Mean: The average value of a particular set of numbers.

Megalitre (ML): One million litres.

Meteorology: Science dealing with atmospheric phenomena and weather.

Mitigate: To lessen in force, intensity or harshness. To moderate in severity.

Native: Belonging to the natural flora or fauna in a region.

Outcrop: Bedrock exposed at the ground surface.

Particulates: Fine solid particles which remain individually dispersed in gases.

pH: Scale used to express acidity and alkalinity. Values range from 0-14 with seven representing neutrality. Numbers from seven to zero represent increasing acidity whilst seven to fourteen represent increasing alkalinity.

Piezometer: A small diameter bore lined with a slotted tube used for determining the standing water level of groundwaters.

Protection of the Environment Operations Act 1997: NSW legislation administered by DECC that regulates discharges to land, air and water.

Rating Background Level (RBL): A period (day, evening or night) background noise level determined in accordance with chapter 3 of the NSW Industrial Noise Policy (EPA, 2000).

Rehabilitation:	The process of restoring to a condition of usefulness. In regard to mining, relates to restoration of land from a degraded or mined condition to a stable and vegetated landform.
Revegetation:	The process of re-establishing vegetation cover.
Run-of-mine (ROM):	Bulk material extracted from a mine, before it is processed in any way.
Salinity:	A measure of the concentration of dissolved solids in water.
Seam:	An identifiable discrete coal unit.
Sedimentation:	Deposition or settling of materials by means of water, ice or wind action.
Sediment Dam:	A dam built to retard dirty runoff to allow sediment to settle out before allowing clean water discharge.
Site Specific:	Relating to conditions existing at a particular location.
Socio-economic:	Combination of social and economic factors.
Spontaneous Combustion:	Spontaneous ignition of some or all of a combustible material.
Subsidence:	The vertical movement of a point on the surface of the ground as it settles above a coal panel extracted by underground mining.
Subsidence affectation area:	The ground surface area affected by subsidence, defined by: • the area bounded by the 26.5 degree angle of draw (i.e. the angle of the line connecting the edge of underground workings and the limit of subsidence at the surface); and • the predicted vertical limit of measurable subsidence, taken as the 20 mm subsidence contour.
Surface Infrastructure:	Any man made object, facility or structure on the surface of the land.
Thermal Coal:	Includes medium to high ash, low sulphur coals used for domestic power generation and medium to low ash energy coals which are exported.
Topography:	Description of all the physical features of an area of land and their relative positions, either in words or by way of a map.
Total Dissolved Solids (TDS):	A measure of salinity expressed in milligrams per litre (mg/L).
Total Suspended Particulates (TSP):	A measure of the total amount of un-dissolved matter in a volume of water or air usually expressed in milligrams per litre (mg/L) (for water) or micrograms per cubic metre ($\mu g/m^3$) for air.