appendix 8

Surface Water Assessment

Oceanic Coal Australia Limited

Surface Water Assessment
West Wallsend Colliery
Continued Operations Project

July 2010

Umwelt
Environmental Consultants

Surface Water Assessment West Wallsend Colliery Continued Operations Project

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Oceanic Coal Australia Limited

Project Director:	Barbara Crossley		
Project Manager:	Paul Amidy		
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Umwelt
Environmental Consultants

2/20 The Boulevarde
PO Box 838
Toronto NSW 2283

Ph: 02 4950 5322
Fax: 02 4950 5737
Email: mail@umwelt.com.au
Website: www.umwelt.com.au

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1.0 Introduction

West Wallsend Colliery (WWC) is an underground coal mine located approximately 20 kilometres south-west of Newcastle, within the Newcastle Coalfields of New South Wales (refer to **Figure 1.1**). WWC pit top is located approximately 1 kilometre east of the residential area of Killingworth and approximately 1.25 kilometres south-west of the residential area of Barnsley (refer to **Figure 1.2**). Underground mining has previously extended to the north, south and west of the pit top and is currently progressing in a south-westerly direction beneath areas of bushland west of the Sydney to Newcastle F3 Freeway (refer to **Figure 1.2**).

WWC is operated by Oceanic Coal Australia Pty Limited (OCAL) on behalf of the Macquarie Coal Joint Venture (MCJV). OCAL, which also owns OCAL Macquarie Pty Ltd, is wholly-owned by Xstrata Coal Pty Limited (Xstrata).

As well as WWC, MCJV currently operates an open cut coal mine (Westside Mine) and a coal preparation plant (Macquarie Coal Preparation Plant (MCPP)). Westside Mine is located adjacent to the southern boundary of the WWC pit top, whilst the MCPP is located approximately 3 kilometres to the east (refer to **Figure 1.2**). A second underground coal mine owned by MCJV at Teralba is presently on a care and maintenance program, while potential operations for future mining are evaluated. These operations are collectively referred to as MCJV's Lake Macquarie Operations.

The underground mining operations at WWC target the Borehole seam and West Borehole seam using longwall mining techniques. Current mining operations comprise two main domains, Western and Southern domains (refer to **Figure 1.2**). Mining is currently being undertaken in the Western domain in Longwall 38.

WWC currently operates under a number of existing development approvals, dating back to 1969 when development consent was first issued by Lake Macquarie City Council (LMCC). Existing mining leases encompass the remaining Life of Mine (LOM) coal reserves and an approved Subsidence Management Plan (SMP) is in place for the current mining in the Western domain. OCAL is seeking to consolidate these approvals and provide for the continued operation of the WWC. This project covers the entire LOM coal reserves for WWC, the existing pit top and other related ancillary surface facilities.

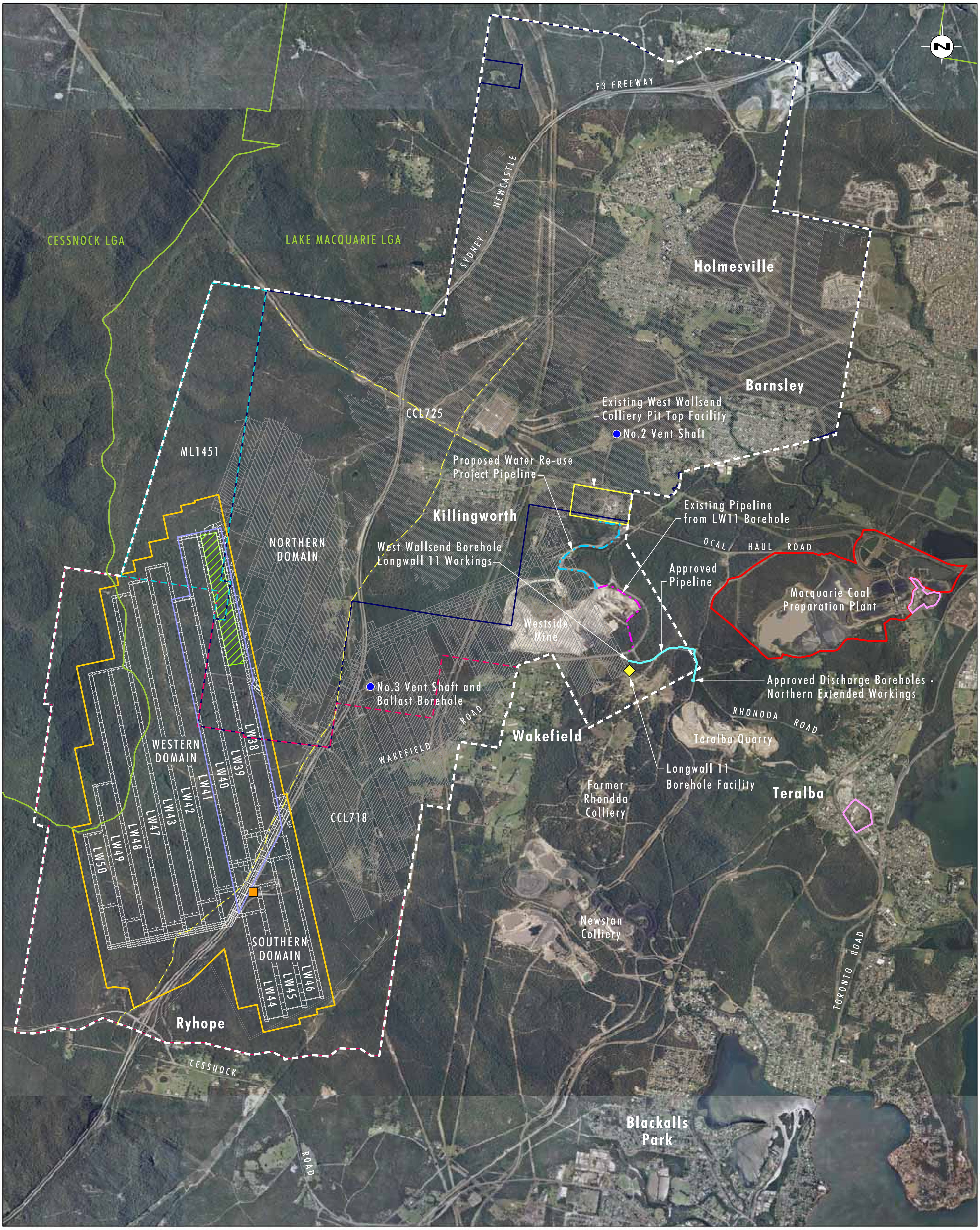
This Surface Water Assessment Report has been prepared to support an Environmental Assessment (EA) for the West Wallsend Colliery Continued Operations Project (the Project) under Part 3A of the *Environment Planning & Assessment Act 1979* (EP&A Act).

This surface water assessment has been undertaken in consideration of the Department of Planning (DoP) Director-General's Requirements (DGRs) for the Project relevant for surface water, as listed below:

- a detailed assessment of potential and cumulative surface and groundwater impacts (refer to **Section 6.3** for assessment of cumulative surface water impacts);
- a detailed assessment of water supply, water interception and water extraction with reference to the provisions of the Hunter Unregulated Rivers and Alluvial Water Sharing Plan (refer to **Section 1.2**);
- a detailed site water balance (refer to **Section 5.0**);

FIGURE 1.1

Location of West Wallsend Colliery



Source: OCAL, Google Earth 2008

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Legend

- CCL725
- CCL718
- ML1451
- 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
- Approved SMP Area
- Teralba Colliery Areas
- Local Government Area
- Project Application Area
- Proposed Mining Services Facility
- Longwall 11 Borehole Facility
- Services Easement

FIGURE 1.2

West Wallsend Colliery Continued Operations Project Area

- details of proposed erosion, sedimentation and pollution control measures and any other measures proposed to avoid and/or mitigate impacts to surface and groundwater (refer to **Section 4.3** for measures regarding surface water); and
- details of the proposed surface and groundwater monitoring program (refer to **Section 7.1**).

This surface water assessment takes into account the relevant aspects of the Aurecon (2010) Hydrogeological Assessment which is also included as an appendix to the EA.

1.1 Overview of the Continued Operations Project

Mining is currently being undertaken in the Western domain in Longwall 38. Average annual coal production is currently approximately 2.6 Mtpa Run-of-Mine (ROM) coal.

The Project consists of the continuation of mining in the currently approved Western and Southern domains. Concept mine plans for the Project are shown on **Figure 1.2**. Underground mining is proposed to occur at WWC for a further 12 years with a maximum annual production rate of 5.5 Mtpa.

The continued underground mining operations will be supported by the existing infrastructure and in part by proposed new infrastructure (refer to **Section 1.1.1**). The Project will continued to use the existing MCPP to process coal and will not result in any changes to existing approved production levels at the MCPP.

1.1.1 Mine Infrastructure

The Project has been designed to utilise the existing WWC infrastructure with no changes proposed (refer to **Figure 1.2**), including:

- the pit top facilities located on The Broadway at Killingworth; and
- the No. 2 and No. 3 vent shafts and ballast borehole.

Mains water is supplied from Hunter Water Corporation (HWC) and mains electricity is supplied from Energy Australia.

A new mining services facility is proposed to be constructed on land owned by LMCC (refer to **Figure 1.2**). The construction will involve minimal disturbance of an existing disturbed area, with a service road entering the site from Wakefield Road.

The proposed mining services facility will include the following infrastructure components:

- a ballast borehole;
- emergency egress borehole;
- solcenic mixing stations; and
- additional electricity supply.

1.2 Water Planning Context

The Project has been assessed against the relevant requirements of the following water planning policies/plans and legislation:

- State Water Management Outcomes Plan (SWMOP) (DNR, undated) (refer to **Section 6.4.1**);
- Hunter and Central Rivers Catchment Action Plan (CAP) (refer to **Section 6.4.1**);
- *Water Management Act 2000* (refer to **Section 6.4.2**);
- Hunter Unregulated Rivers and Alluvial Water Sharing Plan 2009 (HURAWSP) (refer to **Section 6.4.2**);
- *Protection of the Environment Operations Act 1997* (refer to **Section 7.3.1**);
- National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) (refer to **Section 4.1.4**);
- NSW Office of Water (NOW) Water Reporting Requirements for Mining Operations 2009 (refer to **Section 7.1**); and
- Draft Department of Water and Energy (DWE) Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region (undated) (refer to **Section 7.3**).

Although works approvals are not required under the *Water Management Act 2000* for approvals being assessed under Part 3A of the *EP&A Act 1979*, the details of the assessment against the *Water Management Act 2000* and associated licensing requirements are included in **Sections 6.4** and **7.3**.

1.3 Potential Surface Water Impacts

This document discusses potential surface water impacts arising from the Project which includes approved and continued operations for the next 12 to 15 years.

The following are the key features of the Project that have the potential to impact on the surface water management requirements for the Project:

- subsidence resulting from the underground mining of the Western domain and Southern domain (refer to **Section 3.0**);
- remediation works within mine subsidence areas (refer to **Sections 3.0** and **4.3**);
- surface water management for existing mine infrastructure areas and proposed mining services facility (refer to **Section 4.0**); and
- changes to the WWC site water balance associated with the Project (refer to **Section 5.0**).

The potential impacts of the proposed mining operation and proposed surface water management strategies have been developed considering the results of monitoring of the previous mining operations and are discussed in **Sections 3.0** to **5.0**.

2.0 Existing Environment

2.1 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 2.1**). Four subcatchments of Cockle Creek (Cocked Hat Creek, Slatey Creek, Burkes Creek and Diega Creek) are located within the project application area. One subcatchment of Palmers Creek, Boggy Hole Creek, is located within the project application 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 catchment areas and their creek systems are discussed further in **Section 2.4**.

The existing WWC pit top facilities at Killingworth are located within the catchment area of Burkes Creek. WWC also has an existing licensed discharge point (refer to **Section 4.1**) on Burkes Creek under Environment Protection Licence (EPL) No. 1360. The existing the No. 2 and No. 3 vent shafts are located within the catchment areas of Burkes Creek and Cockle Creek respectively (refer to **Figure 2.1**).

The proposed mining services facility, located on Wakefield Road (refer to **Figure 2.1**) is within the catchment area of Palmers Creek.

Previous underground mining domains, associated with WWC, are located within the catchments of Cockle Creek, Cocked Hat Creek, Slatey Creek, Burkes Creek, Palmers Creek, Blue Gum Creek and Minmi Creek (refer to **Figure 2.1**). No future underground mining is proposed to occur within the catchment areas of Cocked Hat Creek, Slatey Creek, Burkes Creek, Blue Gum Creek or Minmi Creek as part of the Project.

The Western and Southern domains are located within the catchment areas of Cockle Creek, Diega Creek, Palmers Creek (including Boggy Hole Creek) and Bangalow Creek (refer to **Figure 2.1**).

The Western and Southern domains are located within the Sugarloaf Range and Awaba Hills physiographic regions of the Lower Hunter (Matthei, 1995). These regions comprise three main landscape types: the steep slopes of the Sugarloaf Range, the lower slopes and foothills of the Sugarloaf Range and the Awaba Hills, and the Cockle Creek floodplain/flat.

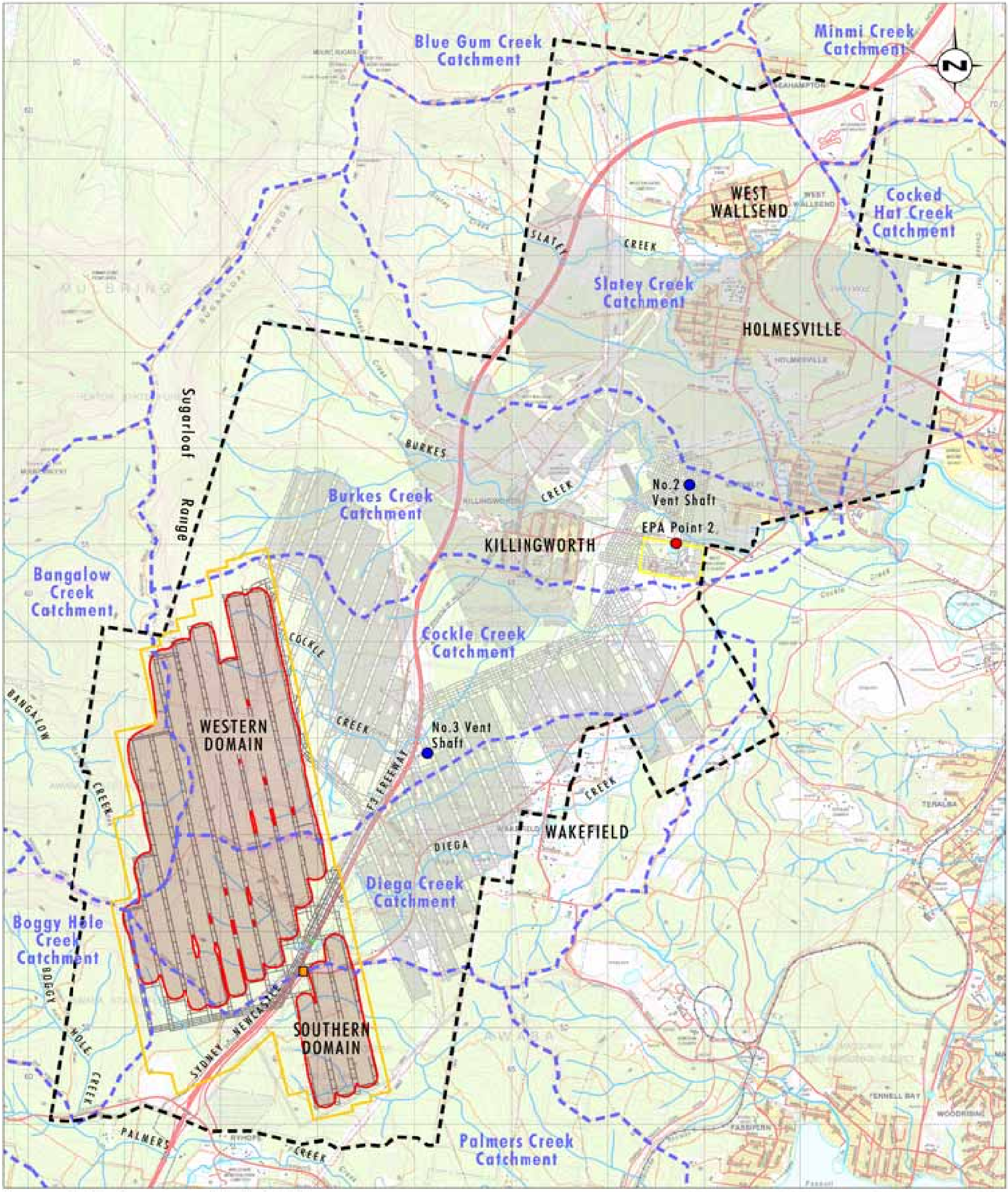
The main landscape types within the region of the Western and Southern domains are described as follows (Matthei, 1995):

- Steep upper slopes of the Sugarloaf Range

  These steep slopes generally vary in elevation between 100 mAHD and 300 mAHD. Gradients are generally more than 30 per cent. Valleys are generally steep with bedrock confined within cascades, waterfalls and pools. The majority of this landscape is uncleared and consists of open forest. The creeks within the continued underground mining area originate in this landscape, within the upper reaches of Cockle, Diega and Bangalow Creeks. As shown on **Figure 2.1**, these areas are in the western portion of the continued underground mining area.

- Lower slopes and foothills of the Sugarloaf Range and the Awaba Hills

  This landscape is characterised by east-west oriented spurs stemming to the east of the main Sugarloaf Range ridge. The elevation of the spurs is generally between 60 mAHD



Source: OCAL, Department of Lands (2006)

0 1.0 2.0 3.0km
1:55 000

Legend

- Continued Underground Mining Area
- Project Application Boundary
- West Wallsend Colliery Pit Top Facility
- Proposed Underground Workings in the West Borehole Seam
- Former Underground Workings
- Predicted Subsidence Affectation Zone
- Catchment Boundary
- Proposed Mining Services Facility
- Ventilation Shaft
- Drainage Lines

FIGURE 2.1

Catchment Boundaries

File Name (A4): R09_V1/2553_169.dgn

and 100 mAHD. The valleys between the spurs are around 20 mAHD and vary in width between 10 metres (in the upper catchment) to 400 metres (in the mid catchment). The upper section of this landscape is generally uncleared and consists of open forest. However, there are numerous four wheel drive (4WD) tracks and cleared powerline easements which display severe erosion and contribute increased sediment load to creeks. As shown on **Figure 2.1**, these areas are in the area east of the Sugarloaf Range and to the west of the Sydney to Newcastle F3 Freeway.

2.2 Land Use

The continued underground mining area is primarily open forest located within the Sugarloaf State Conversation Area (SSCA) (formerly the Awaba and Heaton State Forests) with several fire and access trails. However, the land uses within and surrounding the continued underground mining area also include coal mining and rural residential holdings.

The majority of the Western and Southern domains are located within the SSCA. In addition, there is some rural land use within the Western domain. The Sydney to Newcastle F3 Freeway traverses the underground mining area, between the Western and the Southern Domains (refer to **Figure 2.1**).

Westside Mine, also operated by OCAL, adjoins the WWC pit top facilities. Newstan Colliery and the former Rhondda Colliery are both located approximately 3.5 kilometres to the south-east of the WWC pit top. Two residential areas are located nearby: Killingworth is located approximately 1 kilometre to the west of the WWC pit top; and Barnsley is located approximately 1.25 kilometres to the north-east of the WWC pit top (refer to **Figure 1.2**).

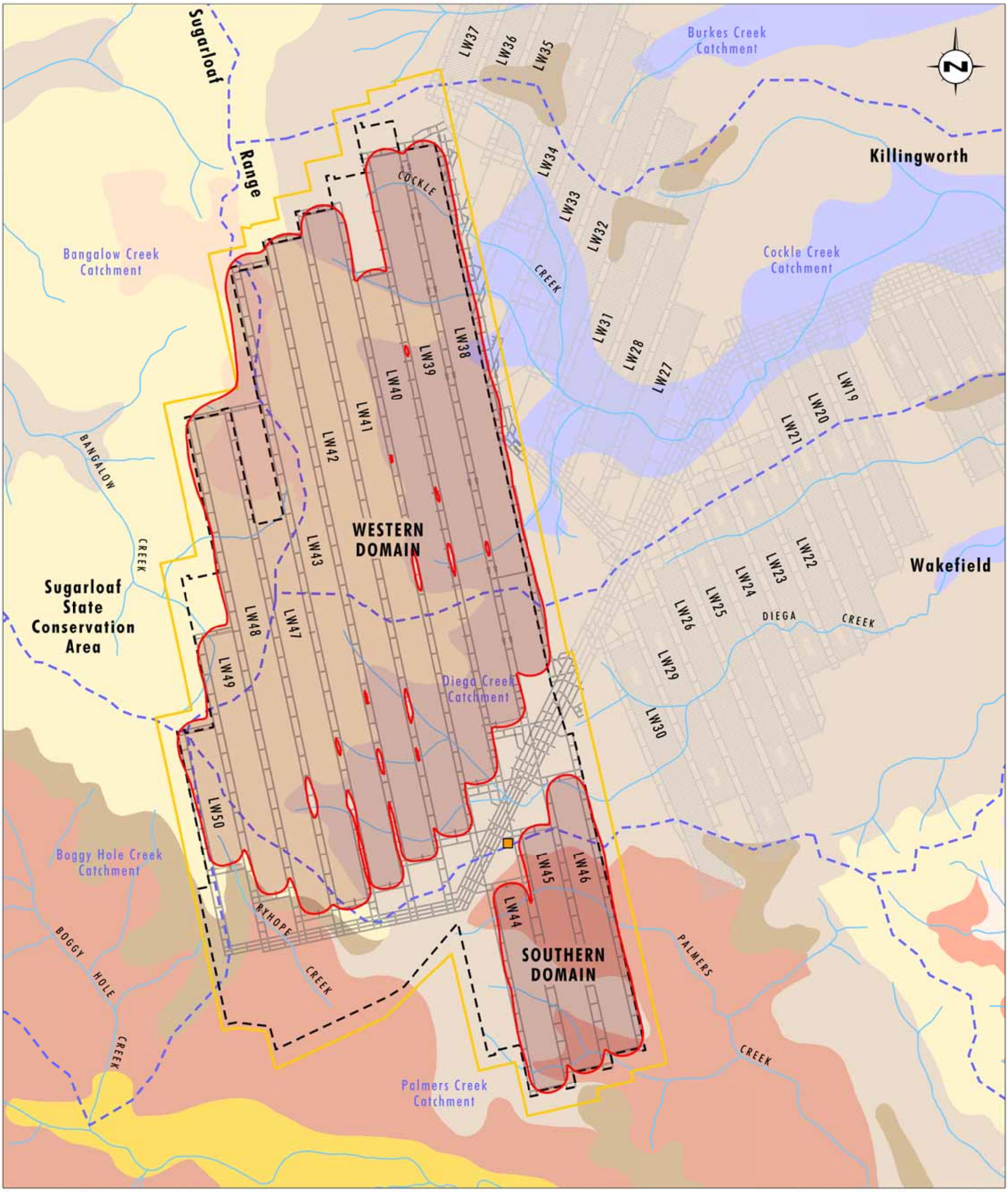
Any surface water licences within the vicinity of the project are controlled under the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan 2009 are currently managed under the *Water Management Act 2000*. Access to Surface Water Licence information is subject to privacy laws and as are not able to be supplied for the purposes of this assessment. However, it is understood that there are limited surface water users located downstream of the continued underground mining area.

The potential impacts of the proposed mining operation on land use and infrastructure are discussed in **Sections 3.0** to **5.0**.

2.3 Soil Landscapes

The Newcastle 1:100,000 Soil Landscapes Map Sheet (Matthei, 1995) indicates that the Killingworth (ki), Killingworth variant (kia), Sugarloaf (su), Sugarloaf variant (sua), Warners Bay (wa) and Cockle Creek (cc) soil landscape units occur within the continued underground mining area (refer to **Figure 2.2**).

Killingworth soils and Killingworth variant soils occur over approximately half of the continued underground mining area. Killingworth soils also occur at the proposed mining services facility on Wakefield Road (refer to **Figure 2.2**). Killingworth soils are located on rolling hills, whilst the Killingworth variant soils are restricted to small areas of steep hills. The soils are shallow (<60 centimetres) to moderately deep (<150 centimetres), 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. These soils are typically fine and in some areas, where clay and silt soils occur, potentially dispersive (Landcom, 2004).



Source: OCAL - Longwall Layout
LPI - Drainage Lines

0 0.5 1.0 1.5km
1:30 000

Legend

- Continued Underground Mining Area
- Previously Approved Longwall Layout Boundary in Western and Southern Domains
- Catchment Boundary
- Proposed Underground Workings in the West Borehole Seam
- Former Underground Workings
- Predicted Subsidence Affectation Zone
- Drainage Line
- Proposed Mining Services Facility

Soil Landscapes:
- Cockle Creek
- Gateshead
- Killingworth
- Killingworth Variant
- Sugarloaf
- Sugarloaf Variant
- Warners Bay

FIGURE 2.2

Soil Landscapes

File Name (A4): R09_V1/2553_166.dgn

Sugarloaf (su) soils and Sugarloaf variant (sua) soils occur over in nearly half of the predicted subsidence affectation zone. Sugarloaf (su) soils are located on rolling to steep hills with gradients greater than 30 per cent. Sugarloaf variant (sua) soils are located on the summit surfaces and crests. The soils are shallow to shallow to moderately deep (50 centimetres to 150 centimetres) 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 (su) and Sugarloaf variant (sua) soils have an extreme water erosion hazard, very strong acidity and low to very low fertility. These soils are typically fine and in some areas, where clayey and clayey sand soils occur, potentially dispersive (Landcom, 2004).

Warners Bay soils occur in the continued underground mining area of the Southern Domain. Warners Bay soils are located on undulating rises and lows hills with gradients of 3 per cent to 20 per cent. The soils are moderately deep (100 centimetres to >150 centimetres) imperfectly to poorly drained Gleyed Podzolic Soils, moderately well-drained Yellow Podzolic soils, and Yellow Soloths with moderately deep (>60 centimetres) 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. These soils are typically fine and consist of potentially dispersive silt and high plasticity clay soils (Landcom, 2004).

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 (>200 centimetres), 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 be infertile. These soils are typically fine and consist of potentially dispersive high plasticity clay soils (Landcom, 2004).

2.4 Existing Topography and Hydrology

The tributaries within the project application area are typically ephemeral creek systems with flows only occurring in the creeks during storm events or after prolonged rainfall, however 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 continued underground mining area (refer to **Figure 2.1**). These creeks are described in **Sections 2.4.1** to **2.4.3**.

The main channel of Palmers Creek and its tributary Boggy Hole Creek are both located outside the predicted subsidence affectation zone (refer to **Figure 2.1**). The proposed underground mine plan has been modified to avoid undermining of the main channel of Palmers Creek.

The boundaries of the key catchments and the creeks within the project application area are shown on **Figure 2.1** and the catchment areas and stream orders are listed in **Table 2.1**. Stream ordering has been carried out in accordance with the Strahler stream ordering system (refer to **Table 2.1**). Stream ordering is a hierarchical numbering system based on the degree of branching within a waterway and provides an indication of the complexity of a creek system and its potential catchment contribution.

Table 2.1 - Key Catchment Areas within the Project Application 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.

2.4.1 Cockle Creek

Cockle Creek is a sixth order (category three) stream and its upper reaches and one of its subcatchment areas, Diega Creek (refer to **Section 2.4.1.2**), are located above the Western and Southern domains (refer to **Figure 2.1**). Within the continued underground mining area Cockle Creek is an ephemeral creek with flow following relatively prolonged rainfall or storm events, although small semi-permanent pools are common in the lower reaches.

In the upper reaches, the tributaries of Cockle Creek are defined by steep, narrow valleys where the channels are approximately 0.5 metres wide and 0.5 metres deep. The channel bed and sides in the upper reaches comprise sandstone and sandstone boulders.

The channels in the lower reaches of Cockle Creek have gentle to moderate slopes and are approximately 1 metre to 2 metres wide and approximately 1 metre deep. Channel banks in the lower reaches, downstream of the continued underground mining area, are sandy while the channel beds consist of sandstone bedrock, sandstone boulders and sandy loam. Regular pools of permanent or semi-permanent water are present in the downstream reaches.

The downstream reaches of Cockle Creek, in the continued underground mining area, are broader and consist of a main channel and overbank flow areas of up to 50 metres wide. The reaches of the creek immediately upstream and downstream of the Sydney to Newcastle F3 Freeway consist of an engineered stable channel structure with gabion structures.

There is extensive riparian vegetation along the creeklines continuous with the surrounding open forest.

The bed and banks of Cockle Creek, within the continued underground mining area, are typically deeply incised and eroded. Erosion more typically occurs in areas where the vegetation on the creek bed and banks has been disturbed, for example by 4WD tracks.

The key subcatchment areas of Cockle Creek potentially affected by the Project are described in **Sections 2.4.1.1** and **2.4.1.2**.

2.4.1.1 Burkes Creek

Burkes Creek is a fourth order (category two) stream and flows in an easterly direction (refer to **Figure 2.1**). Burkes Creek is a tributary of Cockle Creek. Burkes Creek and its catchment area are not located within the predicted subsidence affectation zone. The existing WWC pit top facilities are located in the Burkes Creek catchment.

There is extensive riparian vegetation along the creekline continuous with the surrounding open forest. The bed and banks of Burkes Creek are typically in good condition.

WWC discharges surplus water from the pit top facility, via EPA Point 2, under Environment Protection Licence (EPL) No. 1360 to Burkes Creek (refer to **Figure 2.1** and **Section 4.0**).

2.4.1.2 Diega Creek

Diega Creek is a fourth order (category two) stream and one of its second order (and associated first order) tributaries flow in a south-easterly direction above the Western domain (refer to **Figure 2.1**). This second order tributary of Diega Creek is ephemeral and only flows for short periods following rainfall. Regular pools of permanent or semi-permanent water are present in the reaches downstream of the continued underground mining area.

The upper reaches of the tributaries of Diega Creek consist of steep bedrock confined gorges with a boulder and sand/gravel bedload. The channels are typically approximately 0.5 metres to 1.0 metres wide and approximately 2 metres to 3 metres deep in the upper reaches. The lower reaches of the tributaries consist of partly-confined valleys with the valleys widening as the creek gradients decrease. The channels in the lower reaches are approximately 3 metres to 4 metres wide and approximately 2 metres to 3 metres deep. Bed and banks in the lower reaches consist of sandy clay and sandy loam respectively. There is extensive riparian vegetation along the creeklines continuous with the surrounding open forest. There is evidence of active erosion in the downstream reaches.

The downstream reaches of Diega Creek, in the continued underground mining area, are broader and consist of a main channel and overbank flow areas of up to 50 metres wide. The reaches of the creek immediately upstream and downstream of the Sydney to Newcastle F3 Freeway consist of an engineered stable channel structure with gabion structures. Sediment basins have been constructed as part of the stormwater flow controls for the Sydney to Newcastle F3 Freeway within the catchment area of Diega Creek.

2.4.2 Palmers Creek

Palmers Creek is a fifth order (category 3) stream and two first order tributaries and one second order tributary flow in a south-easterly direction above the Southern domain within the predicted subsidence affectation zone (refer to **Figure 2.1**). The main channel of Palmers Creek will not be undermined as part of the continued underground mining operations. The Palmers Creek tributaries proposed to be undermined are ephemeral and only flow for short periods following rainfall, however some pools of semi-permanent water are present in the reaches downstream of the predicted subsidence affectation zone.

The eastern tributaries of Palmers Creek (referred to as Central Creek) originate in the lower, moderately steep slopes of the Sugarloaf Range. In the upper reaches, the tributaries are defined by small gullies approximately 1 metre to 2 metres wide. The channel bed and banks in the upper reaches are sandy with sandstone outcrops within the channels. The channels in the lower reaches of Palmers Creek have gentle to moderate slopes and are wider, swampier and less-defined.

Palmers Creek and its tributaries are typically in good condition with limited erosion. There is extensive riparian vegetation along the creeklines continuous with the surrounding open forest.

Boggy Hole Creek, a subcatchment of Palmers Creek, is described in **Section 2.4.2.1**.

2.4.2.1 Boggy Hole Creek

Boggy Hole Creek is a third order (category 2) stream and flows in a westerly direction above the Western Domain (refer to **Figure 2.1**). The main channel of Boggy Creek will not be undermined as part of the continued underground mining operations. The channel of Boggy Hole Creek is typically located within steep, narrow valleys where the channels are approximately 0.5 metres wide and 0.5 metres deep. The channel bed and sides in the upper reaches comprise sandstone and sandstone boulders.

There is extensive riparian vegetation along the creeklines continuous with the surrounding open forest.

The bed and banks of Boggy Hole Creek are, in some areas, incised and eroded. Erosion more typically occurs in areas where the vegetation on the creek bed and banks has been disturbed, for example by 4WD tracks.

2.4.3 Bangalow Creek

Bangalow Creek is a fourth order (category 2) stream. Two first order drainage lines of Bangalow Creek, which flow towards the west of the Sugarloaf Range, are located within the continued underground mining area (refer to **Figure 2.1**). The Bangalow Creek tributaries proposed to be undermined are ephemeral and only flow for short periods following rainfall,

The tributaries of Bangalow Creek, within the continued underground mining area, are defined by small gullies approximately 1 metre to 2 metres wide. Numerous rock boulders and rock structures lie along the channel bed and banks.

There is extensive riparian vegetation along the creeklines continuous with the surrounding open forest. The creek bed and banks are typically in good conditions with limited evidence of erosion.

3.0 Subsidence Impacts and Management

Subsidence predictions for the Project and the potential range of impacts resulting from the predicted subsidence have been assessed by Ditton Geotechnical Services Pty Ltd (DGS, 2009) (refer to Appendix 5 of the EA). The predicted subsidence affectation zone, defined by the 20 millimetres predicted subsidence line, is shown on **Figure 3.1**.

The subsidence predictions provided by DGS (2009) and historical subsidence monitoring results have been used to determine the potential impacts of the proposed underground mining operations on the surface drainage regime within the predicted subsidence affectation zone and downstream catchments. These potential impacts include:

- potential changes in drainage channel alignments and catchment boundaries;
- potential changes in surface ponding;
- potential for surface water capture to the underground goaf;
- potential impacts on the local flooding regime, including changes in peak flows and velocities within drainage channels; and
- potential changes in surface water quality.

The subsidence predictions and historical subsidence monitoring results from previous mining areas have been used to determine the potential management and mitigation measures that may need to be implemented as part of the Project.

Airborne laser scanning (ALS) survey data was sourced for the continued operations areas of West Wallsend Colliery during 2009. The ALS survey data was processed to create a digital terrain model (DTM) of the continued underground mining area. The ALS based DTM was subsided using the subsidence predictions provided by DGS (2009) to create a predicted post-subsidence landform. The existing (i.e. pre mining) and predicted post-subsidence DTMs were used in the assessment of potential subsidence impacts on surface waters.

The existing subsidence monitoring program and historical results are discussed in **Section 3.1**. An overview of the predicted subsidence within the Western and Southern domains is discussed in **Section 3.2**. The potential impacts of underground mining on surface water drainage and the proposed mitigation measures are discussed in **Sections 3.3** to **3.6** including potential impacts on catchment boundaries, infrastructure, drainage lines and downstream water users.

3.1 Existing Subsidence Monitoring Program

WWC has established an extensive subsidence monitoring network and undertakes regular subsidence surveys to assess the surface effects of its mining operation and to assist with the development of subsidence parameters for consideration in future mine planning. There is also an established monitoring plan in place, whereby WWC can respond to and ameliorate subsidence impacts quickly to reduce adverse impacts.

The existing subsidence monitoring program was established in consultation with landowners and NSW Department of Industry and Investment (DII). Subsidence monitoring involves various measurements including vertical subsidence, tilt and strain, as well as visual inspections and photographic records.

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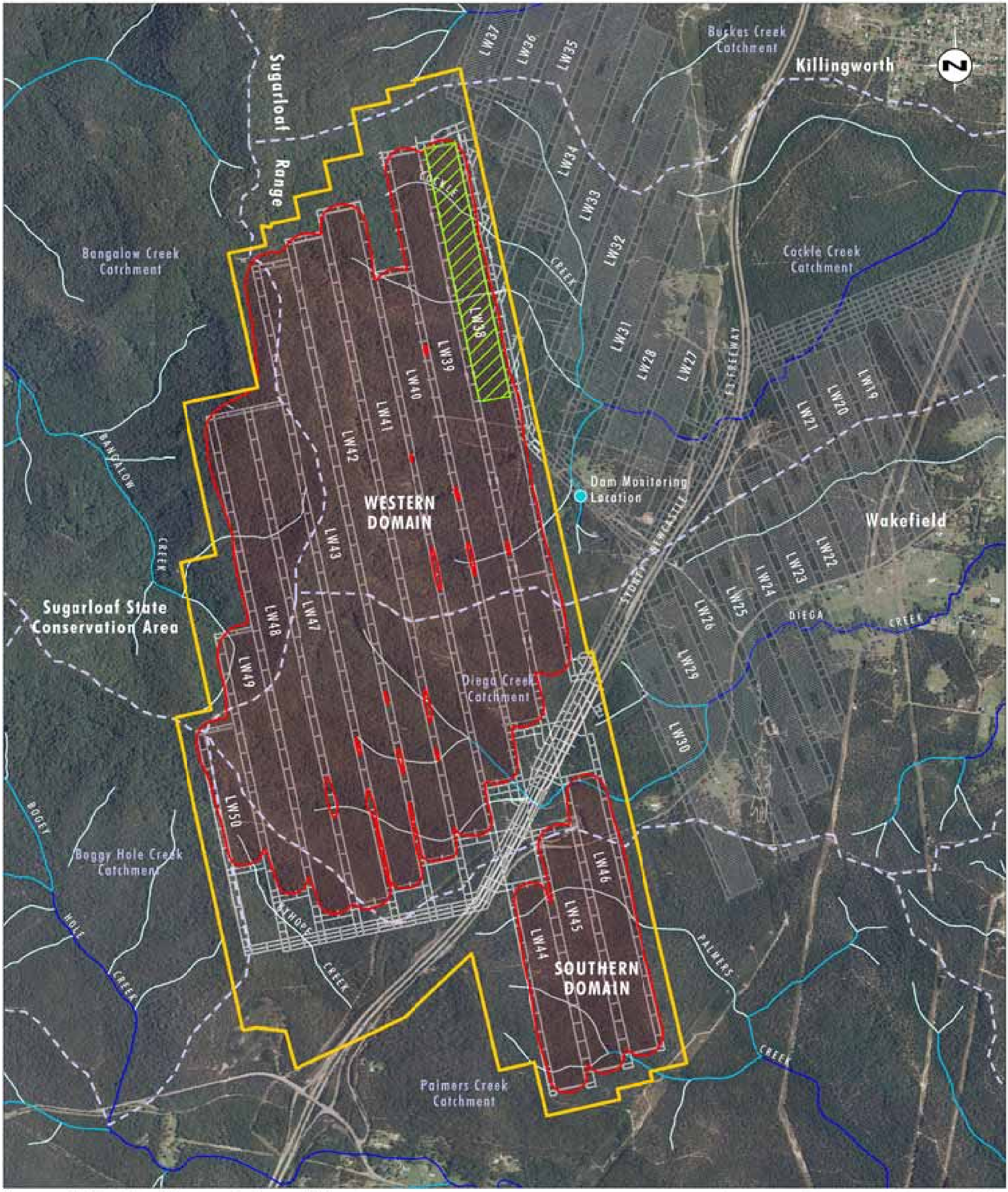


Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines

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
- Predicted Subsidence Affectation Zone
- Catchment Boundary
- 1st Stream Order
- 2nd Stream Order
- 3rd Stream Order

FIGURE 3.1

Predicted Subsidence Affectation Zone

File Name (A4): R09_V1/2553_172.dgn

The existing subsidence monitoring program includes monitoring requirements for Burkes and Cockle Creeks (which are undermined in the Northern domain, refer to **Figure 2.1**). The existing subsidence monitoring program for these creeks includes parameters such as creek cross-sections, longitudinal profile, geomorphic units, riparian vegetation, erosion or accretion, sediment type and the amount of exposed bedrock. The subsidence monitoring plan requires that monitoring be conducted prior to the commencement of mining, immediately after the first post-mining storm event, three months to six months post mining and 12 months to 18 months post mining.

WWC employs specialist consultants to review, assess and report on the likely impact of mining on sensitive surface structures, such as electricity transmission lines or major roads.

Results of all subsidence surveys are provided on a regular basis to the relevant stakeholders and monitoring and any remediation works undertaken are reported in the Annual Environmental Management Report (AEMR).

As discussed in the 2008 AEMR, previous subsidence surveys have identified surface cracking above Longwall 34 and minor ponding above Longwall 36. The identified surface cracking was remediated and the minor ponding has been reported to DII and the landowner.

Subsidence cracking remediation work was also undertaken during 2006 adjacent to Diega Creek. A surface crack of approximately 50 metres long and up to 200 millimetres wide was observed adjacent to Diega Creek during underground mining of Longwall 26. This surface crack provided a potential pathway for streamflow to migrate into the lower soil profiles. The surface crack was filled with cement, sand and flyash grout. Post remediation monitoring indicates that the surface cracking was sealed successfully and no damage to the surface water regime or ecological communities is apparent.

3.2 Predicted Subsidence Impacts

Longwall mining typically results in subsidence on the surface. The subsidence predictions (DGS, 2009) indicate that the proposed underground mining will result in maximum predicted vertical subsidence of up to approximately 2.6 metres in some areas.

The subsidence predictions (DGS, 2009) indicate that subsidence is expected to cause cracking and fracturing of the overburden strata throughout the overburden section. As a result a direct hydraulic connection may potentially be created through the overburden strata from the surface to the mining strata where cover depths are less than 70 metres and may possibly occur where cover depths are between 70 metres and 100 metres (DGS, 2009). When this type of cracking occurs, surface runoff may be provided with a hydraulic connection from the surface to the underground mining operation, resulting in potential capture of surface flows into the goaf. The potential for cracking and fracturing to extend to the surface is also partly dependent on the soil profile and geology of the area being undermined. As a result the mine plan has been modified to limit undermining of areas with depths of cover less than 70 metres where significant surface water or groundwater resources have been identified.

Further discussion regarding potential for interconnective cracking and downstream effects is provided in **Sections 3.5** and **3.6**.

3.3 Catchment Boundaries

The predicted subsidence affectation zone (refer to **Section 3.2**) is located within the catchments of Cockle Creek, Diega Creek, Palmers Creek, Boggy Hole Creek and Bangalow Creek (refer to **Section 2.0** and **Figure 3.1**).

Analysis of the subsidence predictions indicates some changes may occur in the alignment of minor drainage channels, however catchment boundaries will not be significantly different from those that currently exist as shown on **Figure 2.1**.

3.4 Farm Dams, Roads and Culverts

The predicted subsidence affectation zone is primarily open forest as part of the SSCA with several fire and access trails. Wakefield Road is located within the predicted subsidence affectation zone of the Southern domain.

A privately owned farm dam, approximately 5 ML in volume, is present within the predicted subsidence affectation area of the Western domain (refer to **Figure 3.1**).

The Sydney to Newcastle F3 Freeway crosses the proposed future longwall area between the Western Domain and Southern domain and is located outside the predicted subsidence affectation zone. The continued underground mine plan has been designed so as to not impact on the Sydney to Newcastle F3 Freeway.

Analysis has been undertaken of the likely drainage impacts on the existing infrastructure within the predicted subsidence affectation zone during the life of the Project. This analysis indicates that remediation works may include:

- reshaping of the farm dam embankments and repairs to the floor of the farm dam (refer to **Figure 3.2**) (DGS, 2009); and
- works as required to ensure that drainage is maintained at all roads, trails, tracks, and associated culverts and drainage.

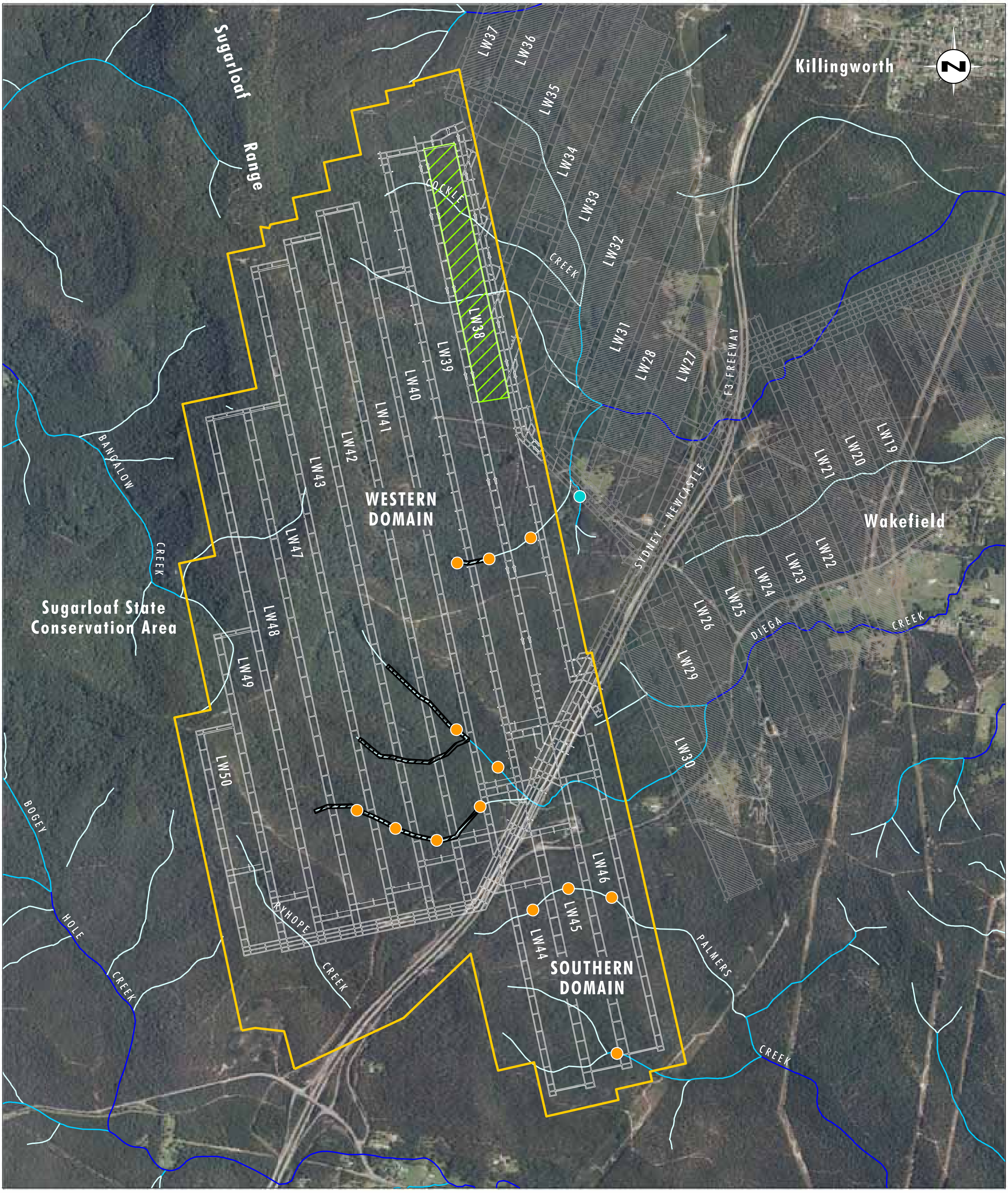
Reconstruction of access roads, trails, tracks and associated culverts, and reshaping of the farm dam is addressed in detail the Subsidence Assessment in Appendix 5 of the EA.

3.5 Drainage Lines

There are several drainage lines within the predicted subsidence affectation zone (refer to **Figure 3.1**). These drainage lines form part of the catchment areas discussed in **Section 2.0**. As indicated on **Figure 3.1** and in **Table 2.1**, the drainage lines occurring within the predicted subsidence affectation zone are first and second order.

As discussed in **Section 2.3**, the soil characteristics and site inspections indicate that the creek lines are potentially all subject to erosion with the potential for erosion being increased where vegetation cover is absent.

As discussed in **Section 2.4**, the drainage lines in the predicted subsidence affectation zone range in condition with some sections of drainage lines currently showing signs of significant erosion.



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 Stream Order
- 2nd Stream Order
- 3rd Stream Order

FIGURE 3.2

Subsidence Related Surface Water Monitoring

File Name (A4): R09_V1/2553_192.dgn

3.5.1 Potential Changes in Peak Velocities

A tributary of Diega Creek was modelled in order to determine potential changes in peak velocities that may occur as a result of the predicted subsidence. The Diega Creek tributary that was modelled is considered representative of the drainage lines within the predicted subsidence affectation zone based on the range in grades and channel characteristics, including the first order tributaries of Cockle Creek, Palmers Creek and Bangalow Creek.

The one dimensional (1D) hydrodynamic model XP-Storm was used to model the flows in the tributary of Diega Creek. XP-Storm can be used to model stormwater flows in watercourses, culverts and street drainage systems. XP-Storm is suitable to calculate overland runoff generated from small or large natural or developed catchments and to simulate the hydraulics of a drainage system. Consequently XP-Storm is a suitable model for determining the potential impact of the proposed development may have on peak flows, velocities and flood levels in the Diega Creek catchment.

XP-Storm models a watercourse as a series of nodes along a channel, connected by drainage links. Nodes are the locations at which sub-catchment information may be entered into the model, including sub-catchment area, slope and percentage impervious area. Drainage links are characterised by a channel length, slope, cross section, maximum water depth, upstream and downstream channel inverts and Mannings ‘n’.

The XP-Storm model of the Diega Creek catchment is shown on **Figure 3.3**. Nodes were placed along the watercourses at points of interest, including the downslope boundary of the continued underground mining area, stream confluences, and the locations where streams crossed the proposed locations of the middle of each longwall and the centre of each chain pillar. The elevations of the nodes and links and the stream cross sections for the existing (i.e. pre-mining) and predicted post-subsidence landform were generated directly from the developed digital terrain models.

Modelling results indicate that the 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. The modelling results for each link of the XP-Storm model for the 5 year and 100 year ARI storm events are summarised in **Tables 3.1** and **3.2**.

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

0 250 500 750m
1:15 000

Legend

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

FIGURE 3.3

XP-Storm Model Layout

File Name (A4): R09_V1/2553_389.dgn

Table 3.1 – Modelled Velocities
(5 year ARI Storm Event)

Link	Longwall	Velocity (m/s)		
		Existing Scenario	Subsided Scenario	Change
1	42	1.30	1.32	+0.02
2		1.09	1.01	-0.08
3	41	1.03	0.94	-0.09
4		0.78	0.33	-0.45
5		0.75	0.53	-0.22
6	43	1.12	1.14	+0.02
7		0.88	0.87	-0.01
8	42	0.52	0.68	+0.16
9		0.84	0.59	-0.25
10	41	0.75	0.59	-0.16
11		0.63	0.14	-0.49
12	40	1.05	0.95	-0.10
13		0.50	0.16	-0.34
14	48	1.06	1.01	-0.05
15	47	0.83	0.86	+0.03
16		0.68	0.55	-0.13
17	43	0.86	0.88	+0.02
18		0.82	0.40	-0.42
19	42	0.81	0.71	-0.10
20		0.97	0.30	-0.67
21	41	0.79	0.92	+0.13
22		0.91	0.41	-0.50
23	-	0.59	0.69	+0.10
24	-	0.66	0.65	-0.01
25	-	1.45	1.33	-0.12
26	-	0.54	0.82	+0.28
27	-	0.96	0.76	-0.20
28	46	0.80	1.04	+0.24
29		1.04	0.76	-0.28
33	-	0.91	0.91	-

Table 3.2 – Modelled Velocities
(100 year ARI Storm Event)

Link	Longwall	Velocity (m/s)		
		Existing Scenario	Subsided Scenario	Change
1	42	2.48	2.52	+0.04
2		2.05	1.89	-0.16
3	41	1.91	1.82	-0.09
4		1.42	0.73	-0.69
5		1.33	1.04	-0.29
6	43	2.13	2.15	+0.02
7		1.66	1.65	-0.01
8	42	0.95	1.28	+0.33
9		1.58	1.10	-0.48
10	41	1.38	1.27	-0.11
11		1.13	0.40	-0.73
12	40	1.87	1.67	-0.20
13		0.96	0.21	-0.75
14	48	2.00	1.92	-0.08
15	47	1.56	1.63	0.07
16		1.26	1.01	-0.25
17	43	1.58	1.67	0.09
18		1.51	0.85	-0.66
19	42	1.49	1.51	+0.02
20		1.76	0.82	-0.94
21	41	1.43	1.73	+0.30
22		1.61	0.84	-0.77
23	-	0.95	1.12	+0.17
24	-	1.09	1.05	-0.04
25	-	2.45	2.42	-0.03
26	-	1.04	1.37	+0.33
27	-	1.73	1.45	-0.28
28	46	1.52	1.86	+0.34
29		1.85	1.37	-0.48
33	-	1.66	1.68	+0.02

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.

The predicted maximum increases in modelled velocities during the 5 year ARI storm event occur at Link 26, under the Newcastle to Sydney F3 Freeway and Link 28, downstream of the Newcastle to Sydney F3 Freeway (refer to **Figure 3.3**). The predicted post-subsidence velocities in these links remain less than 1.1 m/s during the 5 year ARI storm event and as such the modelled increases are considered to be non-scouring and minor.

The predicted maximum increases in modelled velocities during the 100 year ARI storm event occur at Link 8, Link 21, Link 26 and Link 28 (refer to **Figure 3.3**). The predicted post-subsidence velocities in these links range up to 1.86 m/s during the 100 year ARI storm event and as such the modelled increases are considered to be non-scouring and minor assuming adequate channel vegetation is maintained.

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, based on the modelling, are expected to be minor.

Long sections of each of the drainage lines located within the continued underground mining area are shown on **Figures 3.4** to **3.9**.

3.5.2 Potential Ponding and Drainage Realignment

Analysis of the predicted subsidence indicates that some in-channel surface water ponding may occur in sections of the creek channels as a result of the continued underground mining. The creek profiles indicate, however, that it is unlikely that any out-of-channel ponding will occur. 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.

Due to the incised nature of the channels in the vicinity of the Western domain, there is some potential that minor bank slumping and head cut erosion may occur. However, monitoring undertaken following extraction for earlier longwall panels, which occurred in similar topography in the Northern domain, has shown minimal evidence of significant bank or channel destabilisation.

In accordance with existing management procedures it is proposed to continue to monitor areas where potential ponding, bank slumping, head cut erosion or drainage realignment may occur. These locations have been identified through topographical analysis (refer to **Figure 3.2**). If monitoring indicates that remediation works are required, remediation works will need to maintain channel grades and take into consideration channel stabilities and existing channel characteristics.

3.5.3 Surface Cracking

Surface cracking with direct hydraulic connection to the underground mining area is most likely to occur below ephemeral drainage lines where overburden depths are less than 70 metres and may possibly occur where overburden depths are between 70 metres and 100 metres (DGS, 2009).

Surface cracking within creek beds will be monitored as part of ongoing subsidence monitoring (refer to **Section 3.5.4**).

If cracking does occur through the surface soil layers this cracking may potentially be self healing as over time as it is likely that fine grained material will gradually fill surface cracks and reduce the hydraulic conductivity of immediate surface strata. Self healing of cracks has occurred previously after mining in the Northern domain and currently forms one of the remediation strategies used by WWC.

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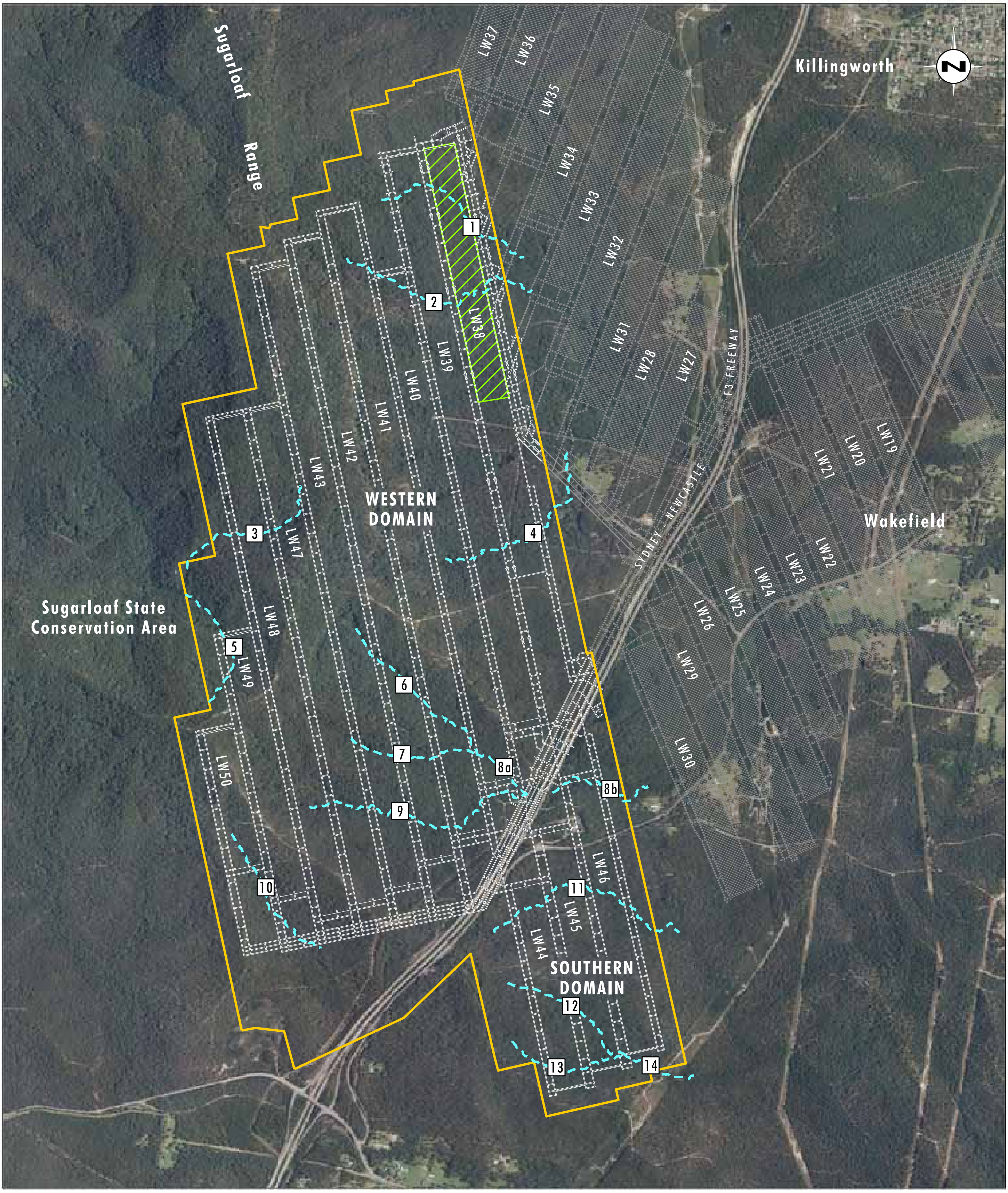


Source: OCAL - Aerial Photograph, Longwall Layout
LPI - Drainage Lines
Note: Refer to Figures 3.5, 3.6, 3.7, 3.8 & 3.9 for Profile Details

0 0.5 1.0 1.5km
1:30 000

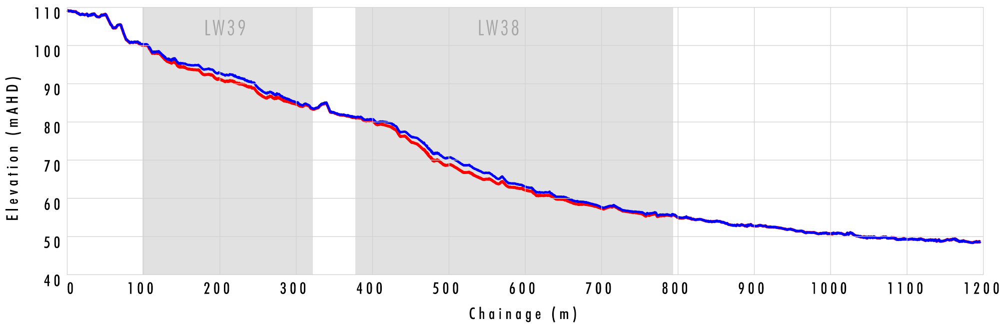
Legend

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

FIGURE 3.4

Drainage Line Profile Locations

File Name (A4): R09_V1/2553_390.dgn



Drainage Profile 1
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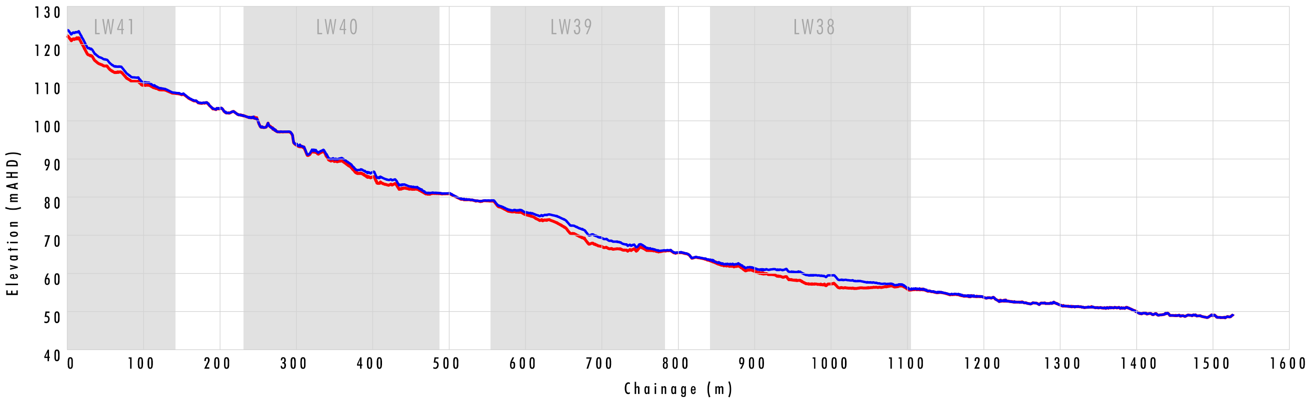
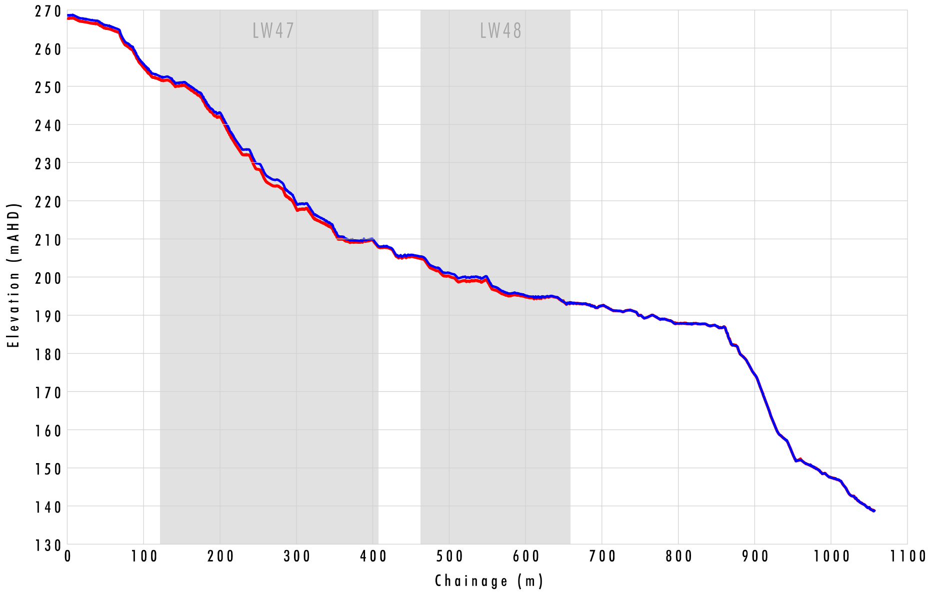
1:2 000 (V)



Drainage Profile 2
1:10 000(H)
1:2 000 (V)



Drainage Profile 3
1:10 000(H)
1:2 000 (V)

Note: Vertical exaggeration 1:5

0 20 50 100m
1:2 000 (Vertical Scale)

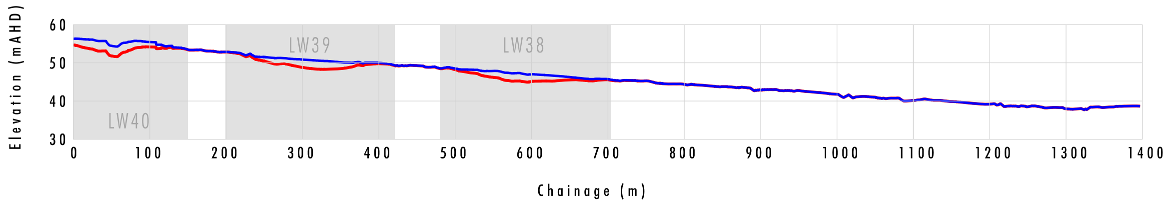
0 100 250 500m
1:10 000 (Horizontal Scale)

Legend

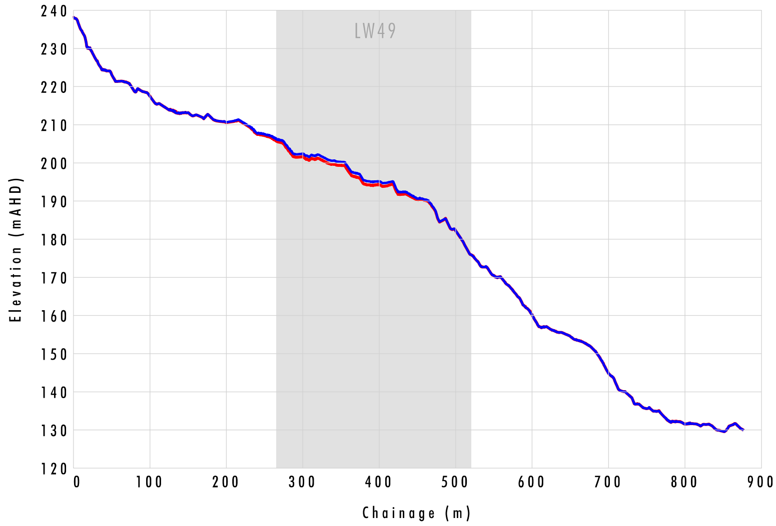
- Existing (Pre-mining) Landform
- Predicted Post-Subsidence Landform

FIGURE 3.5

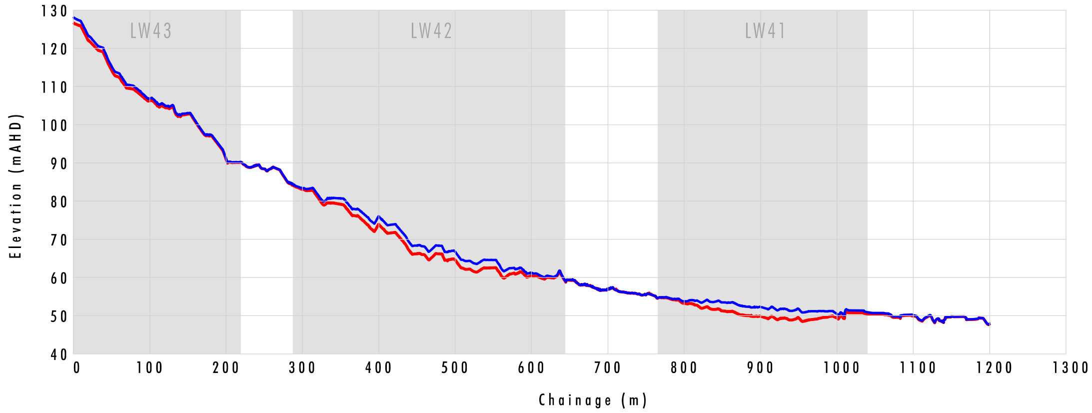
Drainage Profiles 1, 2 & 3



Drainage Profile 4
1:10 000(H)
1:2 000 (V)



Drainage Profile 5
1:10 000(H)
1:2 000 (V)



Drainage Profile 6
1:10 000(H)
1:2 000 (V)

Note: Vertical exaggeration 1:5

0 20 50 100m
1:2 000 (Vertical Scale)

0 100 250 500m
1:10 000 (Horizontal Scale)

Legend

- Existing (Pre-mining) Landform
- Predicted Post-Subsidence Landform

FIGURE 3.6

Drainage Profiles 4, 5 & 6

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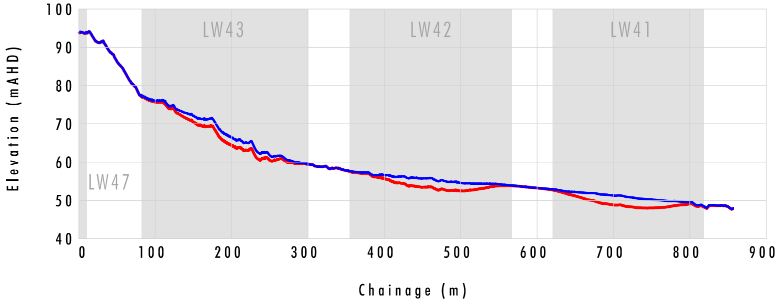
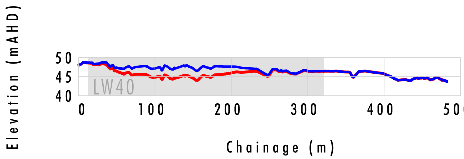


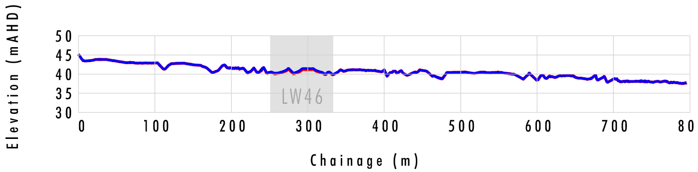
Drainage Profile 7

1:10 000(H)
1:2 000 (V)



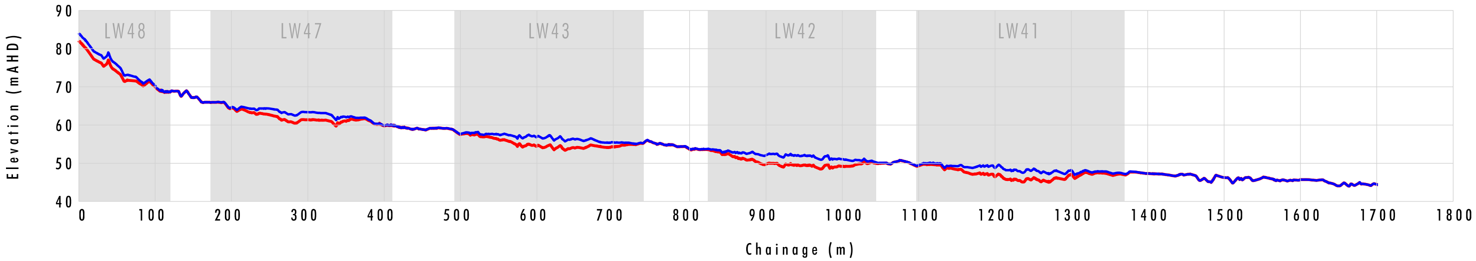
Drainage Profile 8a

1:10 000(H)
1:2 000 (V)



Drainage Profile 8b

1:10 000(H)
1:2 000 (V)



Drainage Profile 9

1:10 000(H)
1:2 000 (V)

Note: Vertical exaggeration 1:5

0 20 50 100m
1:2 000 (Vertical Scale)

0 100 250 500m
1:10 000 (Horizontal Scale)

Legend

Existing (Pre-mining) Landform
Predicted Post-Subsidence Landform

FIGURE 3.7

Drainage Profiles 7, 8a, 8b & 9

File Name (A4): R09_V1/2553_393.dgn

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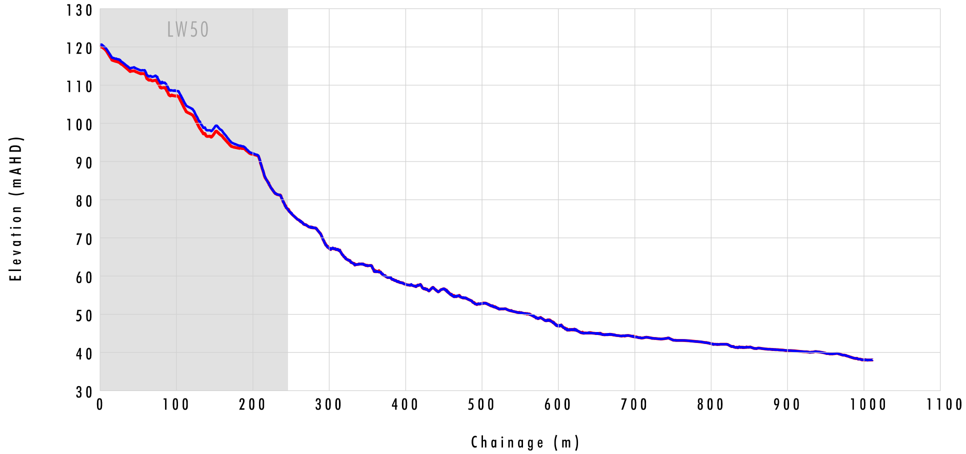
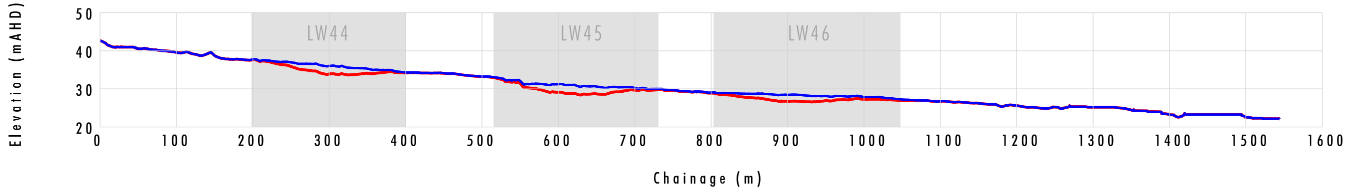


Drainage Profile 10

1:10 000(H)
1:2 000 (V)



Drainage Profile 11

1:10 000(H)
1:2 000 (V)

Note: Vertical exaggeration 1:5

0 20 50 100m
1:2 000 (Vertical Scale)

0 100 250 500m
1:10 000 (Horizontal Scale)

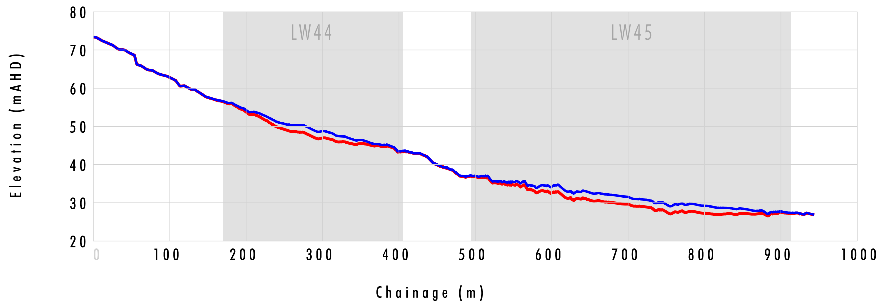
Legend

- Existing (Pre-mining) Landform
- Predicted Post-Subsidence Landform

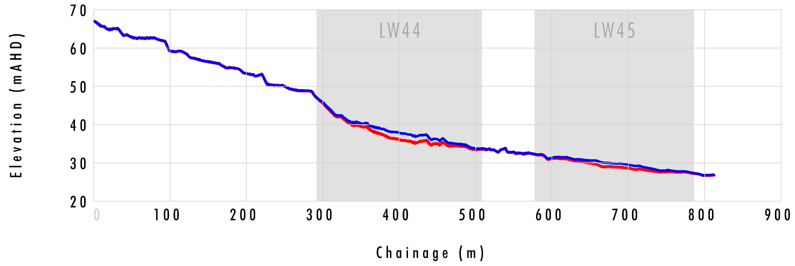
FIGURE 3.8

Drainage Profiles 10 & 11

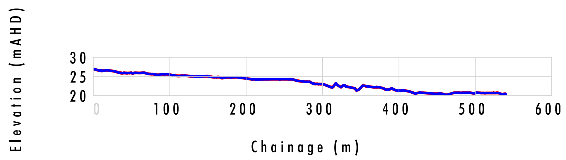
File Name (A4): R09_V1/2553_394.dgn



Drainage Profile 12
1:10 000(H)
1:2 000 (V)



Drainage Profile 13
1:10 000(H)
1:2 000 (V)



Drainage Profile 14
1:10 000(H)
1:2 000 (V)

Note: Vertical exaggeration 1:5

0 20 50 100m
1:2 000 (Vertical Scale)

0 100 250 500m
1:10 000 (Horizontal Scale)

Legend
Existing (Pre-mining) Landform
Predicted Post-Subsidence Landform

FIGURE 3.9

Drainage Profiles 12, 13 & 14

3.5.4 Proposed Monitoring and Remediation Protocols

Taking into consideration the existing surface water regime, associated topography and depth of cover of the predicted subsidence affectation zone and previous experience at WWC, it is considered unlikely that remediation works will be required, except potentially in areas with depths of cover less than 100 metres (refer to **Figure 3.2**). However, a comprehensive monitoring regime will be implemented to monitor drainage lines and the locations identified in **Figure 3.2** for potential subsidence impacts.

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

The proposed monitoring and remediation protocols are consistent with the existing monitoring strategies used on site and will be included in the new Subsidence Management Plan (SMP) or equivalent process for the continued underground mining area to ensure that surface water impacts are minimised. Specific monitoring locations are highlighted on **Figure 3.2**. The monitoring and remediation procedures may include but not be limited to:

- monitoring of vertical and horizontal subsidence along second order drainage lines as determined in consultation with the DII;
- monitoring, measuring and recording (e.g. photographic records) of 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 these may include self healing of cracks (refer to **Section 3.5.3**) and manual sealing of cracks, using methods approved by the Department of Environment, Climate Change and Water (DECCW) and DII;
- visual inspection and recording (including photographic records at least every 50 metres) 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 detailed 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;
  - during and post mining, monitor watercourses, in accordance with the detailed monitoring program;
- 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 (refer to **Section 4.3**), 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 is currently in discussions with the DECCW regarding an access agreement for the proposed subsidence monitoring and potential remediation works within the SSCA.

3.6 Potential Impact on Downstream Water Users

The regions downstream of the continued underground mining area include areas of coal mining, SSCA, rural residential holdings approximately 1 kilometre downstream, residential developments and industrial/commercial developments.

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, remediation works, including 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.

As any cracking will appear very rapidly on the surface after longwall mining, regular checking and resealing of in channel cracks will be undertaken. 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 (refer to **Figure 3.2**) 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.

4.0 Water Management Systems

WWC underground will continue to be accessed using the existing pit top facilities located at Killingworth (refer to **Figure 1.2**). 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.

WWC propose to construct a new mining services facility (refer to **Figure 1.2**) adjacent to Wakefield Road.

The existing water management system, including the integration of water management between the underground and surface facilities, is discussed in **Section 4.1**.

The conceptual water management controls for the proposed mining services facility are discussed in **Section 4.2**.

The erosion and sediment controls for the continued operations, associated the surface facilities and subsidence remediation works, are discussed in **Section 4.3**.

4.1 Existing Water Management System

4.1.1 Overview

The WWC water management system includes mine dewatering systems, water storages, sediment basins, 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 facility, including:
  - collection and treatment of runoff from surface infrastructure area 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 water discharges to meet licence conditions.

The WWC pit top facilities are located to the north of the underground mining area (refer to **Figure 1.2**). A schematic of the existing WWC water management system is shown on **Figure 4.1**. The layout at the WWC pit top is shown on **Figure 4.2**.

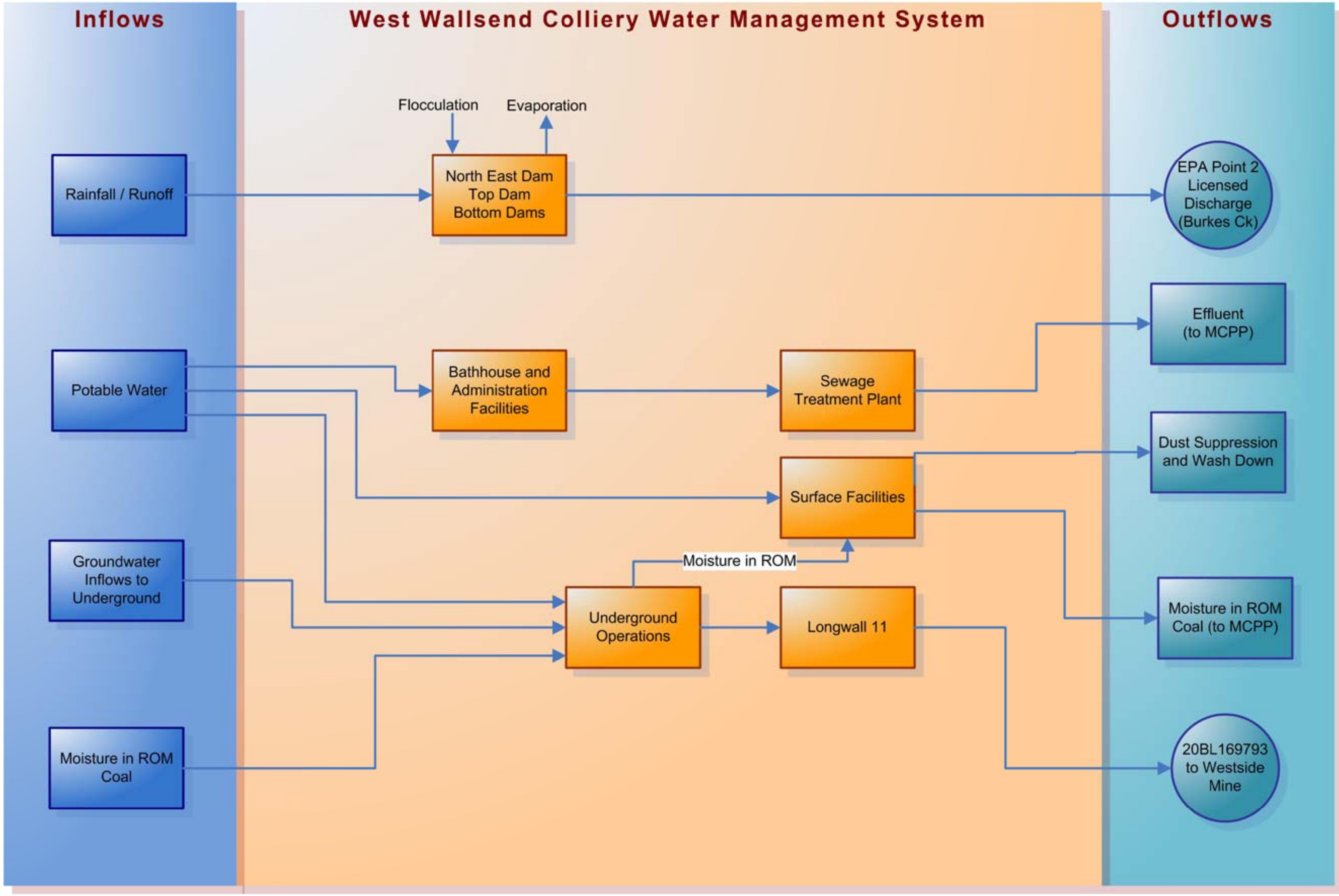
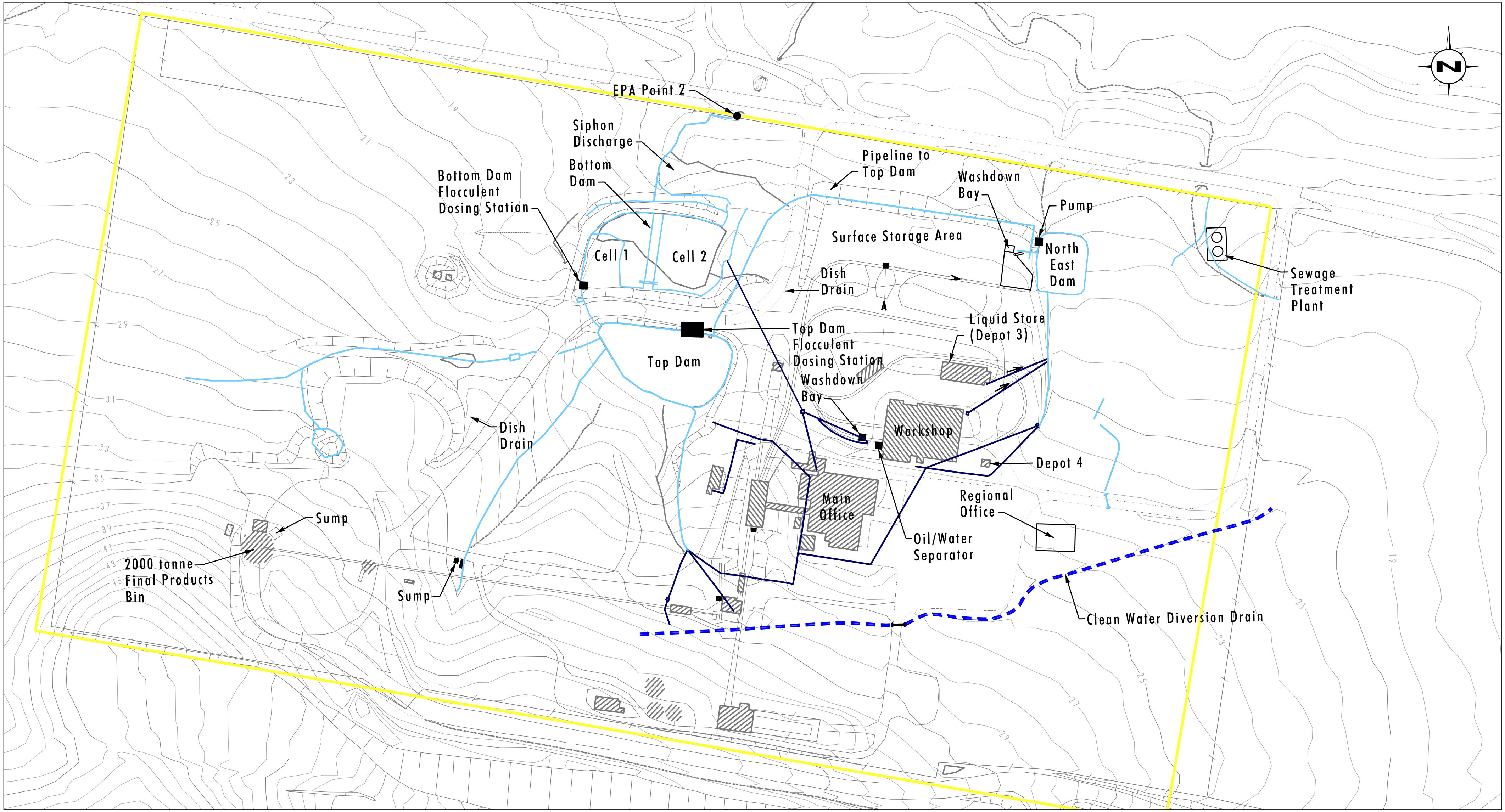


FIGURE 4.1

Existing West Wallsend Colliery
Water Management System

Umwelt
Environmental Consultants



Source: OCAL
Note: Contour Interval 1m

0 50 100 150m
1:3 000

Legend

- West Wallsend Colliery Pit Top Facility
- Pipeline
- Diversion Drain
- Drainage Line

FIGURE 4.2

West Wallsend Colliery Pit Top Water Management System

File Name (A4): R09_V1/2553_193.dgn

At the WWC pit top facilities ROM coal is crushed and transferred via conveyor to the truck loading facility for transport to MCPP. 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. Runoff is collected in the water management dams.

Surplus water from the WCC pit top site is discharged under EPL No. 1360 to Burkes Creek via EPA Point 2 (refer to **Figure 1.2** and **Section 4.1.3**). Discharge from the WWC pit top site has occurred to Burkes Creek since 1969 with no significant impacts identified. The licensed discharge point 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 and disposed at MCPP (refer to **Section 4.1.2**).

Sewage treatment at WWC is provided by a 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.

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

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

Surplus water (including groundwater inflows) within the underground mining operations is extracted at the Longwall 11 borehole at Westside Mine for discharge off site (refer to **Section 4.1.3**). 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.

4.1.2 Water Storage and Usage

WWC has limited water storage areas available at the WWC pit top facilities, with the majority of the water storage available within the underground workings.

Runoff from the WWC pit top facility and a small area of upstream catchment area is captured and treated in a series of four water management dams located at the pit top facilities (refer to **Figure 4.2**). These dams are used to store and treat water prior to discharge via EPA Point 2 (refer to **Section 4.1.3**). The dams 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 95^{th} percentile rainfall event (Landcom, 2004) (refer to **Table 4.1**).

Table 4.1 – WWC Surface Facility Storage Dams

Dam	Catchment Area (ha)	Dam Volume (ML)	5 Day 95th Percentile Rainfall Volume (ML)[1]	10 year ARI Storm Event Volume (ML)	
				12 hour	24 hour
North East Dam	2.6	2.5	1.8	1.8	2.4
Top Dam	6.6	4.5	4.1	4.0	5.4
Bottom Dam (cells 1 & 2)	2.3	5.0	1.6	1.5	2.1
Total	**10.9**	**12.0**	**7.5**	**7.3**	**9.8**

Note 1: Based on 76.7 mm rainfall with 90% runoff.

Note 2: Based on rational method from AR&R (IEAust, 1997).

The North East Dam and the Bottom Dam have capacity to capture runoff from the 10 year 24 hour Average Recurrence Interval (ARI) storm event. The Top Dam has capacity to capture runoff from the 10 year 12 hour ARI storm event. In combination the dams have capacity to capture runoff from the 10 year ARI 24 hour storm event from the total catchment area (refer to **Table 4.1**).

Runoff in excess of the stormwater surcharge capacities of the dam system will overflow to Burkes Creek (refer to **Figure 4.2**). The management of on-site water will be incorporated into the Water Management Plan (WMP) for WWC should consent be granted for the project (refer to **Section 7.1**).

The surface water management dams at the WCC pit top are regularly cleaned out with any sediment extracted being transported to the MCPP for disposal.

Water is currently used at the WWC pit top for dust suppression and machinery wash down water. Approximately 22 ML per year is used for these purposes. Approximately 11 ML per year of potable water, imported from HWC mains, is also used at the WWC pit top for bathhouse use and drinking water.

Water is used in the underground mining operations for dust suppression and longwall process water. Some 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.

4.1.3 Water Transfer and Disposal

WWC currently transfers/disposes of water from site by three methods, as follows:

- effluent transfers to MCPP;
- licensed discharge point under EPL No. 1360; and
- groundwater extraction under 20BL169793 and transfer to Westside Mine.

WWC has one licensed discharge point (EPA Point 2) under EPL No. 1360 (refer to **Figure 1.2**). The licensed discharge point (EPA Point 2) is currently only used for discharge of surplus site water runoff from the WWC pit top site (refer to **Figure 1.2**).

Historical discharges via EPA Point 2 are shown on **Figure 4.3**. The total volumes discharged via EPA Point 2 were 615 ML, 543 ML and 227 ML for 2006, 2007 and 2008 respectively. The reduction in annual volumes is a result of changes to operations with more water being extracted via the Longwall 11 borehole (refer to **Figure 4.3**).

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 to 9.0; and
- total suspended solids (TSS) < 50 mg/L.

During this period (i.e. 2006 to 2008) there has been only one day where the licence limit of 4 ML per day was exceeded. This was on 5 June 2008 with a daily discharge of 4015 kL. This non-compliance was due to a significant rainfall event of 140 millimetres and was reported in both the annual return for EPL No. 1360 and the 2008 AEMR. Since this event WWC has installed a siphon system to allow the site to maintain dams at an appropriate level.

Presently, surplus underground mine water is pumped via the Longwall 11 borehole to Westside Mine (refer to **Figure 4.1**). This water is extracted from the underground operations under licence 20BL169793 which allows for extraction of up to 360 ML per year. This water is then discharged to Cockle Creek via the Westside EPL. This transfer is a temporary arrangement which has been established as part of the water transfer project with Metromix Quarry (refer to **Section 5.4**).

Historical extraction volumes for 20BL169793 are shown on **Figure 4.3**. The average daily extraction from Longwall 11 during July 2008 to June 2009 was approximately 2.2 ML per day. WWC currently has an application with DECCW to increase the allowable extraction from Longwall 11 from 360 ML per year to 1000 ML per year.

4.1.4 Water Quality and Management

Water quality is monitored at EPA Point 2 discharge point (Drain A), and upstream of and downstream of the discharge point in Burkes Creek. Historical water quality monitoring data for pH, EC and TSS are shown on **Figure 4.4**. Historical data for July 2006 to June 2008 indicates that pH and conductivity have historically been within the discharge limits (refer to **Section 4.1.3**).

As shown in **Figure 4.4**, there was one water quality exceedance at EPA Point 2 (i.e. Drain A) in August 2006, when 100 mg/L of total suspended solids (TSS) was recorded. This exceedance was the result of a significant rainfall event in the preceding days. This exceedance was reported to the Department of Environment and Conservation (DEC) (now DECCW) and in the 2006 AEMR.

To reduce the potential for further non-compliances, daily visual inspections of the dam system at the WWC pit top are undertaken by the surface foreman 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. Since the installation of the secondary flocculent station, there have been no further non-compliances with the TSS criteria at EPA Point 2.

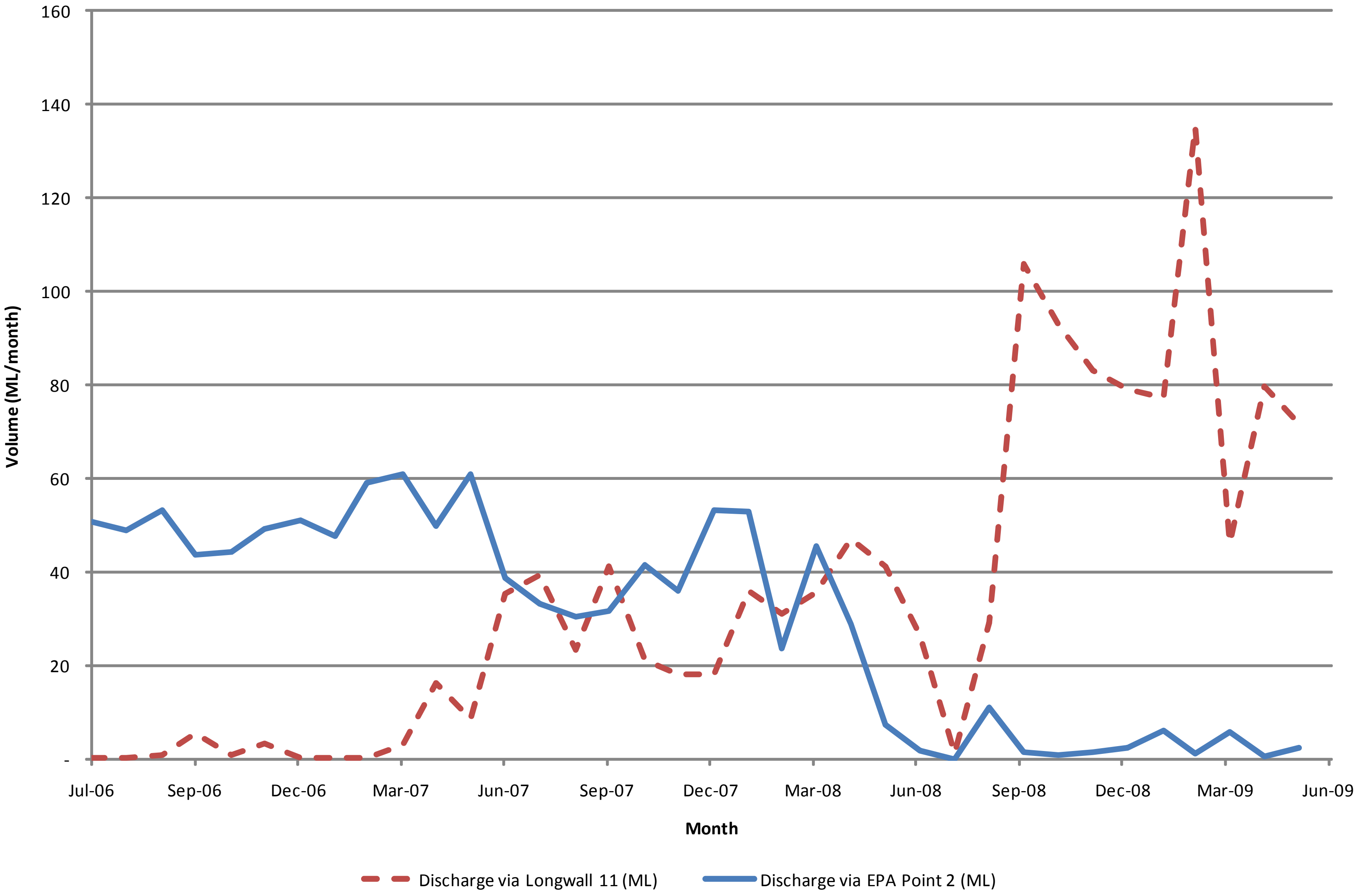
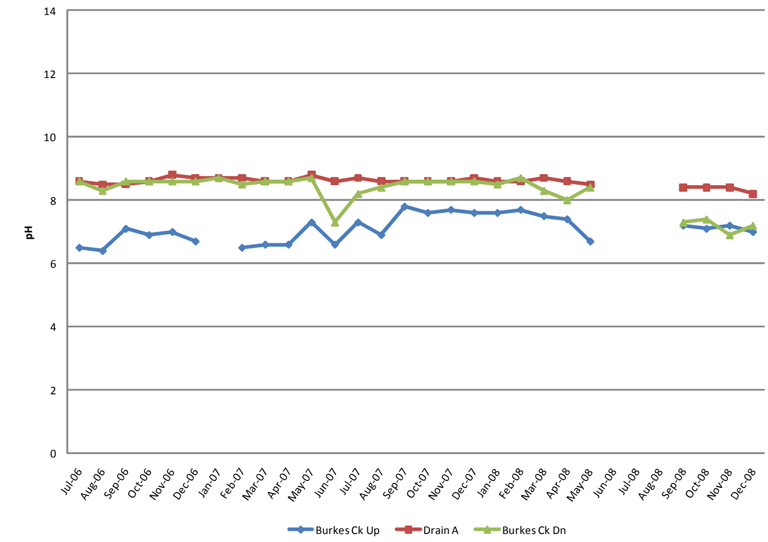
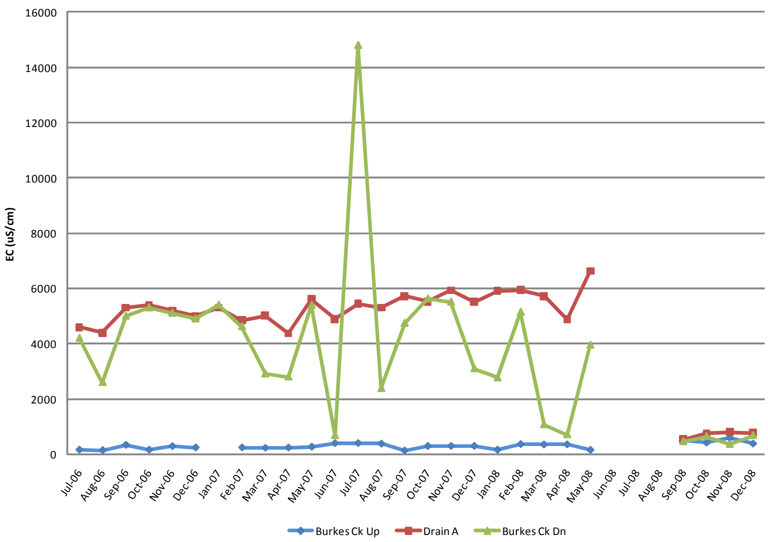


FIGURE 4.3

Historical Mine Water Volumes





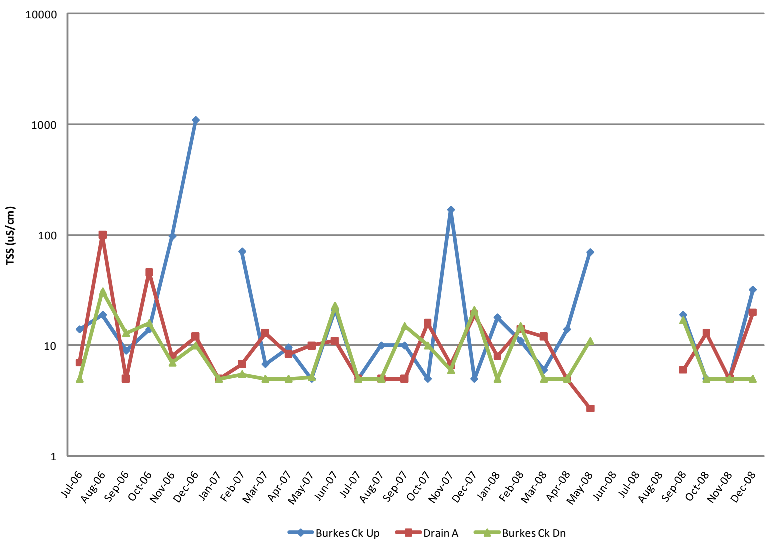


FIGURE 4.4

EPA Point 2
Water Quality Monitoring Results

The transfer of underground mine water to Westside Mine (via Longwall 11 borehole) has also reduced the possibility of future 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 (refer to **Section 5.4**) may potentially also assist in reducing the potential of overflows from the WWC pit top site dams.

Additional monitoring at the WWC pit top site has been undertaken on a monthly basis from May 2009 to October 2009 to determine the levels of heavy metals in Burkes Creek. 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 4.2**.

Table 4.2 – 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.

4.2 Proposed Mining Services Facility

The site for the proposed mining services facility is within the Palmers Creek catchment area. The proposed site has a footprint of approximately 700 m^2 and is located adjacent to Wakefield Road (refer to **Figure 1.2**). The proposed site layout is shown on **Figure 4.5**. Vehicle access to the site will be via Wakefield Road.

The proposed mining services facility will include compounds containing a ballast borehole, a borehole for delivering solcenic oil and the solcenic mixing station (refer to **Figure 4.5**).

The conceptual surface water management strategy for the site of the proposed mining services facility has been designed to minimise the potential impacts on the surrounding environment and downstream catchment areas. The objectives of the water management strategy are to:

- divert clean water runoff around the site;
- maintain water quality in downstream watercourses;
- provide the necessary facilities to prevent release of any oil, fuel or chemical spills to downstream catchment areas and watercourses;
- minimise the erosion potential of the site; and
- minimise the amount of sediment transported off the site.

Key components of the concept surface water management strategy are shown on **Figure 4.5**.

Surface water runoff from areas outside the footprint of the proposed mining services facility site will be managed via the construction of a series of low earth bunds on the upslope side of the site. Runoff will be directed around the site to existing table drains and culverts under Wakefield Road which currently convey runoff to the natural downstream drainage systems. Stable vegetative cover will be established on all disturbed areas of the site that are not sealed.

The proposed access road/deceleration/acceleration lanes will be sealed and constructed with formalised road batters and drainage systems. Runoff from the road surface will be directed to existing table drains and culverts under Wakefield Road which currently convey runoff to the natural downstream drainage systems.

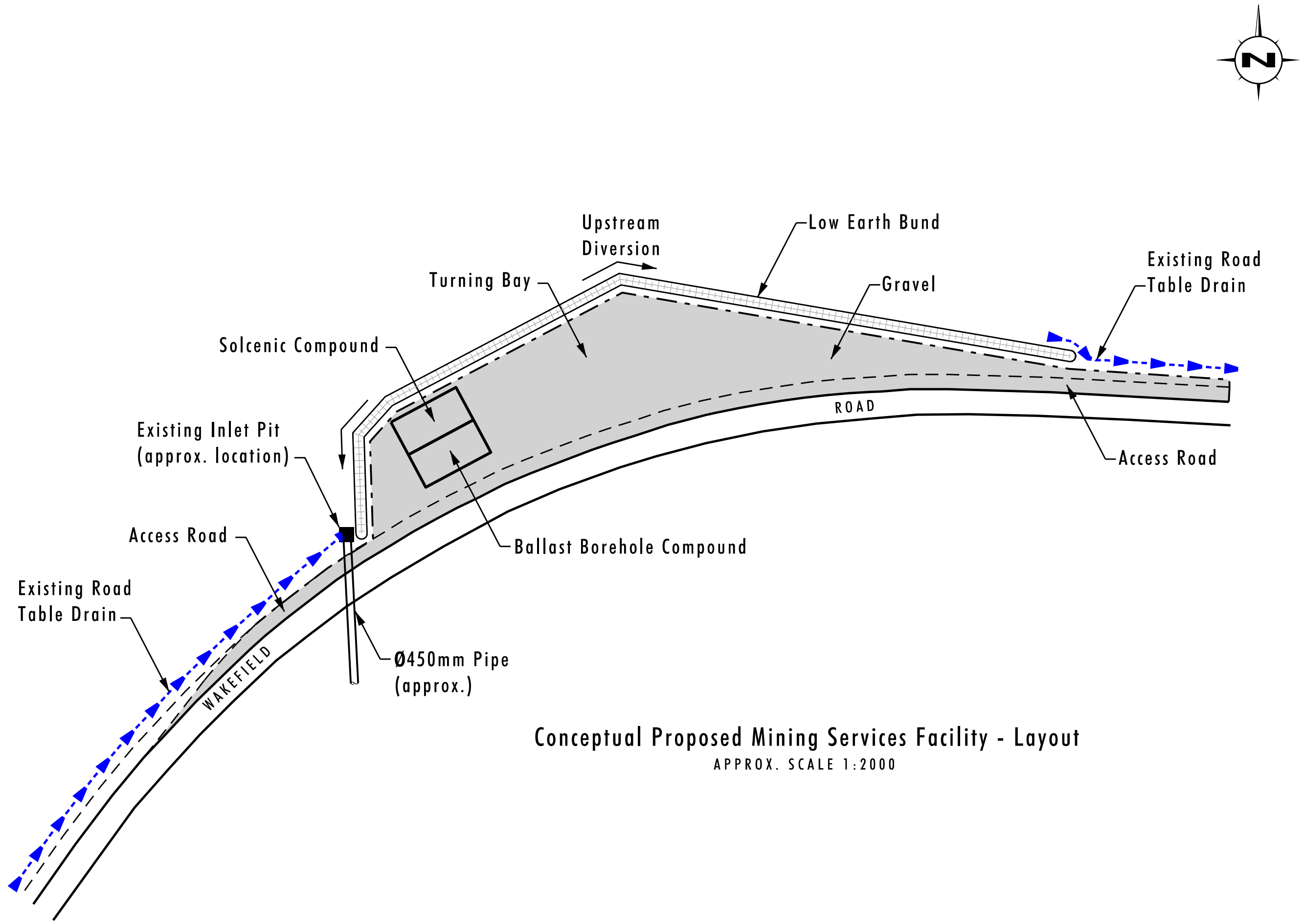
Runoff from hardstand and turning bay areas within the proposed mining services facility will be directed to a hydrocarbon and sediment trap for the removal of potential contaminants.

The solcenic mixing stations will supply hydraulic fluid to the underground workings for use in the longwall mining equipment. The hydraulic fluids will be stored in two 40 kL tanks. The solcenic tanks and associated mixing station will be fully bunded in accordance with AS 1940 – 2004: *The Storage and Handling of Flammable and Combustible Liquids.*

All stormwater runoff captured in the bunded area will be visually inspected for the presence of oil and grease. Clean water captured in the bund will be released to the downstream drainage systems. Any contaminated water will be removed by a licensed contractor.

Typical sediment and erosion controls required during the construction phase are outlined in **Section 4.3**.

Proposed Mining Services Facility - Locality
SCALE 1:400



Conceptual Proposed Mining Services Facility - Layout
APPROX. SCALE 1:2000

Source: OCAL, 2009

0 5 10 20m
1:400

0 25 50 100m
1:2000

Legend

Proposed Mining Services Facility

FIGURE 4.5

Proposed Mining Services Facility
Surface Water Management Concept

4.3 Erosion and Sediment Control

The surface water assessment has been conducted on the basis that erosion and sediment control measures will continue to be incorporated into the detailed construction plans for, and built as a part of the additional infrastructure to be constructed as a part of the Project and for all subsidence remediation works.

All erosion and sediment control measures will be carried out in accordance with relevant guidelines for erosion and sediment control, 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 and potential subsidence remediation works during the Project to control the quality of runoff include:

- construction of erosion and sediment controls prior to the commencement of any substantial construction or earth works;
- constructing diversion drains upslope of areas to be disturbed to convey clean runoff away from disturbed areas;
- 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;
- limiting the number of roads and tracks established;
- construction and regular maintenance of sediment fences downslope of disturbed areas, including the construction sites for sediment dams, diversion drains and catch drains;
- applying gypsum, where required, to reduce the dispersibility of the subsoils that will be disturbed and to minimise the potential for tunnel erosion and surface rilling of disturbed or reshaped areas. The application rate to be determined by site specific soil testing as required;
- seeding and controlled fertilising of disturbed areas to provide for rapid grass cover established. Areas will be seeded with a grass mix specific to the needs of the area to be revegetated;
- inspection of all works daily and immediately after storm events to ensure sediment and erosion controls are performing adequately;
- regular maintenance of erosion control works and rehabilitated areas;
- provision for the immediate repair or redesign of sediment and erosion controls that are not performing adequately;

- the placement and maintenance of oil management systems downslope of key infrastructure and high traffic hardstand areas; and
- prompt revegetation of areas as soon as earthworks are complete.

In addition to the above erosion and sediment control measures, construction and remediation plans will detail the specific inspection, maintenance and revegetation requirements for each works area based on the construction program schedule and remediation works requirements. These control measures will be set out in a detailed Erosion and Sediment Control Plan for the Project.

5.0 Site Water Balance

5.1 Historical Water Balance

The primary factors affecting the WWC water balance are:

- 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 make up, dust suppression, ventilation air);
  - surface facilities (i.e. dust suppression and the WWC pit top site);
  - evaporation from dam surfaces; and
  - water lost (i.e. bound) to ROM coal.

Surplus water is transferred/discharged from site by three methods (refer to **Section 4.1.3**).

The site water balance for January 2009 to December 2009 was compiled using coal processing data, meteorological data from the Bureau of Meteorology (BoM) and on-site measurements including telemetry data of flow rates. The net water balance is the difference between the water sources, losses and discharges.

A summary of the estimated site water balance for January 2009 to December 2009 is presented in **Table 5.1**. The transfer of mine water from the underground operations to the surface facilities at the WWC pit top was discontinued during June 2008. The January 2009 to December 2009 water balance is considered to be an accurate representation of the current water balance at WWC and suitable to be used as a basis for determining the future (i.e. predicted) water balance for the Project.

Table 5.1 – 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 washdown and dust suppression	-14
• Evaporation from surface dams	-8
• Lost to humidity/ventilation in the underground	-29
Total Losses	**-199**
GROSS WATER BALANCE	**985**

Table 5.1 – Average Site Water Balance (January 2009 to December 2009) (cont)

Component	Volume (ML/year)
Discharges and Transfers Off Site	
• Discharge via EPA point 2 (Burkes Creek)	-11
• Extracted at Westside Mine via LW11	-918
• Effluent transferred to MCPP	-20
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 5.1**). Approximately 11 ML of this surplus was discharged to Burkes Creek under EPL No. 1360.

The remaining gross water make was either transferred as effluent to MCPP (approximately 20 ML) or extracted at the Longwall 11 borehole 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 above ground operations.

The analysis indicates a net difference in measured and estimated flows of approximately 36 ML. This is equivalent to approximately 3% of the estimated inflows to the operations. WWC will continue to update and refine the site water balance on an annual basis, which will be reported in the AEMR process.

5.2 Predicted Site Water Balance

The predictive water balance model for the Project is based on the model developed for the existing water balance (refer to **Section 5.1**).

The main water sources identified for the Project are catchment runoff and rainfall on dams within the mine water management system, groundwater inflows to the underground mine, and the potable water supply.

Historical meteorological data from the Williamtown BoM station was used to predict the range in potential future rainfall, runoff and evaporation characteristics for the Project and is considered to adequately represent the rainfall and evaporation rates experienced at WWC.

Estimates of future groundwater make were based on historical data. Historical data indicates, based on pumping records, that groundwater inflows into the underground mining operations are not increasing. A groundwater inflow rate of approximately 900 ML per year (i.e. 2.5 ML per day) was used in the predictive water balance model.

The main water losses identified for the Project include water lost to evaporation, potable water use and water exported with ROM coal to MCPP. Historical evaporation rates were used to estimate the water lost to evaporation from dam surfaces. Future potable water use was based on historical usage and predicted ongoing staffing levels for the Project.

Risk analysis software was applied to the predictive model outputs to calculate the probability of different water balance outcomes based on variability in the model input data, e.g. rainfall, runoff and production water demands. The three probable scenarios from the risk analysis that are included in the report are for the 10th percentile (dry year), 50th percentile (average year) and 90th percentile (wet year) water balance predictions.

The predictive water balance model and risk analysis output provide information on the demand and supply variations for the Project and identify storage and discharge requirements for the mine water management system over the life of the Project.

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 indicates:

- if no shandying 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 shandying of potable water with mine water occurs, at a rate of approximately 60/40 (i.e. 40% mine water), potable water import will range between approximately 130 ML per year to 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;
- 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; and
- transfers of sewage effluent to MCPP will remain constant at approximately 20 ML per year as no increase in staffing are predicted to occur at WWC.

5.3 Management of Surplus Water

WWC is proposing to use the existing licensed discharge facility EPA Point 2 under EPL No. 1360 (refer to **Section 4.1**), the continued use of the extraction of water from the borehole at Longwall 11 (20BL169793) and transfer of sewage effluent to MCPP for re-use to manage the predicted site water surplus.

WWC also propose to pursue transfer options to other coal mining and industrial operations in the region (refer to **Section 5.4**).

5.4 Pollution Reduction and Water Efficiency Projects

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 are proposing to transfer excess mine water to Metromix Quarries, located on Rhondda Road at Teralba (refer to **Figure 1.2**). Metromix propose to use the transferred mine water as process water for washing stone with the remainder being discharged via the Rhondda/Metromix licensed discharge point to Lake Macquarie. This will result in a reduction in the combined water discharged into the Lake Macquarie catchment from WWC and Metromix as a result of the proposed mine water re-use.

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.

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. The majority of the potable water demand on site is used as 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 proposing to reduce the volume of potable water used on site by shandying potable water with mine water for re-use on site. To date OCAL has reviewed the available data for longwall water used at other Xstrata operations and has determined, based on electrical conductivity data, that the most appropriate mixing percentage would be 40/60 mine water to potable water. As a result OCAL has determined that shandying mine water to potable water is potentially sustainable.

WWC propose to continue a series of investigations in the future, 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 re-use of mine water as process water will also reduce the volume of water required to be discharged or transferred off site.

6.0 Summary of Potential Impacts

6.1 Underground Mining Areas

It is considered that the predicted subsidence impacts will not result in any substantial ponding or drainage realignment within the predicted subsidence affectation zone and are not predicted to have a significant impact on flood flows within the predicted subsidence affectation zone or downstream. However, a number of subsidence monitoring points have been identified where, based on the topography, potential impacts are more likely (refer to **Figure 3.2**).

If remediation works are required, these works have the potential to generate short term impacts in terms of water quality while the remediation works are being undertaken and stable vegetated post mining landforms are being achieved. Potential water quality impacts in terms of downstream users and downstream ecosystems will principally be due to the potential for increased sediment generation and export of sediment off site to occur during subsidence remediation works. To mitigate this potential impact it is proposed to implement a number of erosion and sediment control measures if ground disturbance occurs during subsidence remediation works (refer to **Section 4.3**).

The low fertility and potential dispersibility of the soils also means that ongoing monitoring and maintenance will be necessary for any areas requiring surface mitigation works to ensure that rehabilitation is effective.

The implementation of the proposed erosion and sediment control measures will ensure that underground mining and surface remediation works do not have a significant adverse impact on downstream water users or on downstream ecosystems.

6.2 Water Management Systems

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. There is currently only one licensed discharge point at WWC, EPA Point 2 (refer to **Figure 1.2**).

As a result it is considered that the Project will not significantly alter water quality or ecology of downstream systems. It is also considered that the Project will not adversely impact on the potential use of water for downstream users on the local creek systems or rivers (refer to **Section 3.6**).

WWC proposes to continue the current temporary water transfer scheme with surplus underground mine water being extracted at Westside Mine under 20BL169793 and either re-used at Westside Mine or discharged Cockle Creek under the Westside Mine EPL. Once approval has been granted, WWC propose to transfer surplus underground water to Metromix for re-use (refer to **Section 5.4**). As such it is considered that water sharing between WWC and Metromix will assist in reducing the overall potential impact on regional surface waters for the life of the Project.

WWC also proposes 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 the volume of potable water used on site.

6.3 Cumulative 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.

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

6.4 Planning and Legislation Requirements

6.4.1 State Water Management Outcomes Plan and Catchment Action Plan

The State Water Management Outcomes Plan (SWMOP) and the Hunter-Central Rivers Catchment Action Plan (CAP) provides guidelines for water management in NSW and the Hunter Valley respectively and is therefore relevant to the Project.

The introduction of the *Water Management Act 2000* led to the development of a statewide policy on water management known as the SWMOP. This plan provides direction for all water management actions in NSW by setting out the overarching policy context, targets and strategic outcomes for NSW water management.

The intent of CAPs is to identify the key natural resource features of the catchment that the community and government wish to see protected or improved, and then to determine the best way to achieve these outcomes. The CAPs guide how improvements in natural resources will be achieved in the next ten years and define where effort and funding should be focussed to get the best protection and improvement in natural resources and the most benefits for the community. The CAPs build on planning and activities defined in the catchment blueprints, regional vegetation management and water sharing plans.

The Hunter-Central Rivers CAP commenced in 2006 and has a term of ten years.

The Project is consistent with the SWMOP and the CAP objectives both within the project application area and on potential downstream interactions. This will be achieved as:

- the majority of surface infrastructure will continue to be located within the WWC pit top site water management system minimising the potential for off-site impacts;

- the Project will result in only minor disturbance of land outside of the WWC pit top site. The proposed monitoring and potential surface remediation measures and associated erosion and sediment controls will effectively minimise environmental impacts (refer to **Sections 3.5.4** and **4.3**);

- to meet surplus water management requirements, water sharing arrangements have been negotiated with Metromix. Water sharing will potentially reduce impacts on surface water quality of the region (refer to **Section 5.4**); and

- water will be discharged from the site via licensed discharge points and extracted under licence at Westside Mine (refer to **Section 5.3**).

6.4.2 Water Management Act 2000 and Hunter Unregulated and Alluvial Water Sources Water Sharing Plan 2009

The *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* commenced on 1 August 2009. The *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* is a 'macro' water sharing plan. That is, a plan that applies to a number of water sources across catchments or different types of aquifers. The plan is broken into a number of extraction management units (EMU). The sections of the project application area that lie to the east of the Sugarloaf Range fall within the North Lake Macquarie Water Source EMU and the sections of the project application area that lie to the west of the Sugarloaf Range fall within the Wallis Creek EMU.

Key aspects of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* are listed below and commented on in regard to the surface water interactions with the Project.

- The Plan provides for no new growth in water entitlements with the annual extraction limit typically set to the current annual extraction limits.

- The Project does not propose to extract surface water from the surrounding streams or rivers.

- Extraction of water from a runoff harvesting dam requires an unregulated river access license nominating an approval for a runoff harvesting dam, unless the dam is within the maximum harvestable right dam capacity for the property on which it is located, in which case no licences or approvals are required.

There are several existing dams located at the WWC pit top site. These dams include clean water catch dams for control of upstream runoff/flooding and sediment dams. The water captured in the sediment dams will either be used for dust suppression or discharged to downstream watercourses.

No new runoff harvesting dams are proposed for the Project.

7.0 Monitoring, Licensing and Reporting Procedures

7.1 Surface Water Monitoring and Reporting

WWC will continue monitor the water management systems and associated erosion and sediment control measures in accordance with the existing strategies and plans. This monitoring will be undertaken on a monthly basis and after storm events.

The existing and proposed subsidence monitoring and reporting mechanisms for the Project are discussed in **Section 3.5.4**, with the proposed subsidence related surface water monitoring locations shown on **Figure 3.2**.

During the construction of the proposed mining services facility, all works and their 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 areas will be inspected in accordance with WWC's current inspection program and after any rainfall events generating runoff until revegetation and stabilisation of drainage structures are complete.

All erosion and sediment controls and their monitoring and maintenance requirements for the construction phase of the proposed mining services facility will be detailed in a construction plan.

The existing surface water quality monitoring network for WWC will be continued for the Project (refer to **Section 4.0**). 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.

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

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. The water management dams will continue to be monitored to ensure that any overflows or discharges are to an appropriate standard and in accordance with licence conditions.

All monitoring results will continue to be reported in the WWC AEMR which is distributed to DoP, NSW I&I (formerly Department of Primary Industries), DECCW (formerly DECC and DWE) and other relevant government agencies. All monitoring data will continue to be retained in an appropriate database.

The results of the water quality monitoring will continue to be used to review the effectiveness of the WWC mine water management system on an ongoing basis.

7.2 Decommissioning

Assuming that the mine is decommissioned at the end of the Project water management dams will either remain in use as farm dams or will be removed (refer to **Figures 4.2** and **4.5**). 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. All buildings/workshops and associated hardstand and sealed areas will be removed and revegetated. During the decommissioning phase all access and ventilation shafts to the underground workings will be sealed and landscaped appropriate to the surrounding area.

Any future development application beyond the life of the Project will include a revision of the existing soil and mine water management system.

7.3 Licensing Requirements

7.3.1 Protection of the Environment Operations Act

The proposed mine water management system will continue to be licensed under the *Protection of the Environment Operations Act 1997* Section 120, with the existing licence (EPL No. 1360) varied as required to include new activities associated with the Project.

7.3.2 Water Act 1912 and Water Management Act 2000

There is only one water sharing plan, *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* commenced for the areas in the vicinity of the project area including surface water and groundwater. Therefore the surface waters of the project area are governed by the *Water Management Act 2000* and the groundwater associated with the hardrock aquifers (i.e. coal seams) is governed under the *Water Act 1912.*

The potential implications of the *Water Sharing Plan Hunter Unregulated and Alluvial Water Sources 2009* are considered in **Section 6.4**.

Groundwater that flows into the underground mines will continue to be pumped from the mine under the existing Part 5 licence of the *Water Act 1912*. A variation to the existing Part 5 licence has been requested to allow for increase extraction in accordance with existing and predicted groundwater inflows.

Potable water needs for the site will continue to be provided from the HWC mains supply. WWC will continue to monitor the potable water supply and explore methods to reduce the potable water demands for the site (refer to **Section 5.4**).

The areas proposed to be monitored for potential subsidence impacts on the surface water regime (refer to **Figure 3.2**) lie within CCL 725. CCL 725 is an underground mining lease, and a controlled activity permits under the *Water Management Act 2000* will therefore be required for any surface mitigation works that are undertaken within 40 metres of the top of bank of defined creek systems. Where surface mitigation works are required to be undertaken, appropriate erosion and sediment control measures will be designed and implemented during site works and establishment of vegetation. All surface mitigation works will be undertaken in consultation with DECCW and NSW I&I when within the Sugarloaf State Conservation Area.

7.4 Contingency Measures

Various contingencies measures have been identified for the site in regard to the management of surface water impacts associated with the continuing operations. These contingencies are outlined briefly in **Sections 7.4.1** and **7.4.2**.

7.4.1 Water

WWC will continue to have water in excess of its operational needs. With the proposed increase in the licence extraction volume from the borehole at Longwall 11 there will be a considerable buffer in WWC's ability to manage water surplus on site. Water sharing opportunities with Metromix may provide additional discharge capacity and additional water storage opportunities may be available within the former underground workings if required.

7.4.2 Soil

If surface stabilisation during remediation works 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 (refer to **Section 4.3**).

8.0 References

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OCEANIC COAL AUSTRALIA LIMITED
ACN 003 856 782

Managed by

xstrata coal

Business Hour Contact Number
OCAL Environment and Community Coordinator: +61 2 4941 2115

24 Hour Contact Number:
West Wallsend Colliery: +61 2 4941 2100

Mailing Details:
Oceanic Coal Australia Pty Ltd
PO Box 4186
Edgeworth NSW 2285
Fax Oceanic Coal: +61 2 4955 2314

Umwelt
Environmental Consultants

Umwelt (Australia) Pty Limited
2/20 The Boulevarde
PO Box 838
Toronto NSW 2283

Ph. 02 4950 5322
Fax 02 4950 5737

www.umwelt.com.au