Centennial Coal

Newstan Colliery

Subsidence Management Plan Application

Longwall Panels LW101 - LW103

SMP Written Report

August 2012

Centennial Coal
Environment Matters

1. EXECUTIVE SUMMARY

1.1. INTRODUCTION

Newstan Colliery (Newstan) is an underground coal mine owned and operated by Centennial Newstan Pty Limited (Centennial Newstan), part of Centennial Coal, a wholly owned subsidiary of Banpu Public Company Limited. This Subsidence Management Plan (SMP) Application has been prepared by Centennial Newstan for the development and extraction of longwall panels LW101 to LW103 in the combined Young Wallsend seam and part Yard seam at Newstan Colliery, which is located on the western side of Lake Macquarie NSW.

The SMP Application has been developed in accordance with the NSW Department of Trade, Investment, Regional Infrastructure and Services – Division of Resources and Energy (DTIRIS-DRE) *'Guideline for Applications for Subsidence Management Approvals'* (2003) (the *'SMP Guidelines')*.

1.2. BACKGROUND

Mining operations at Newstan commenced in 1887 and Newstan Colliery has since undertaken extensive mining within the Young Wallsend, Great Northern, Fassifern, Borehole and West Borehole coal seams using a range of mining methods including bord and pillar mining, and longwall mining. Newstan has approval to produce up to 4 Mtpa of run of mine (ROM) coal with coal being transported to either the Eraring Power Station for domestic power production or the Ports of Newcastle and Kembla for the export market. The long history of mining in the area provides a substantial ongoing platform of stakeholder engagement and subsidence management for the colliery.

In May 1999, Development Consent DA73-11-98 was granted under Part 4 of the Environmental Planning and Assessment Act (EP&A Act) to extend the life of the colliery in accordance with an Environmental Impact Statement (EIS) prepared in 1998, which defined the Life Extension Area (LEA). In summary, the mine currently operates under the following key approvals (as discussed further in **Section 4**):

- Development Consent DA73-11-98 (as modified);
- Mining Lease ML1452, Consolidated Coal Lease CCL746;
- Mining Operations Plan (MOP) (2005 -2012);
- Environment Protection Licence (EPL) 395;
- Water Licence 20SL050021; and
- various bore licences forming the integrated water management circuit for the mine.

Under the conditions of relevant Mining Leases, Centennial Newstan is required to prepare a Subsidence Management Plan (SMP) prior to commencing underground mining operations that potentially lead to subsidence. Accordingly, this SMP Application was prepared to seek approval from DTIRIS-DRE for the development and extraction of longwall panels LW101, LW102 and LW103, which are located wholly within ML1452 and DA 73-11-98.

1.3. SMP APPLICATION AREA

The SMP Application Area (herein referred to as the *SMP Study Area*) has been defined as the surface area within the predicted limit of vertical subsidence, determined by the greater of the 26.5 degree angle of draw from the limit of the proposed mining and the predicted 20 mm subsidence contour resulting from the extraction of the proposed longwalls. Additionally, the 26.5 degree angle of draw line has been conservatively taken around both the limit of proposed extraction (i.e. second workings) as well as the main headings (i.e. first workings).

The SMP Study Area is located within the West Lakes Mine Subsidence District, proclaimed in July 1979. Land ownership within the SMP Study Area is predominantly Crown land and Crown reserves under lease to various parties, and smaller portions of private freehold land.

1.4. CONSULTATION

As a well-established mine operating in the surrounding area for over 125 years, Centennial Newstan has built upon a well-established register of existing stakeholders in addition to stakeholder identification specifically undertaken for the SMP Study Area. A *Stakeholder Engagement Plan* (SEP) was prepared by Newstan Colliery in January 2011 which identified relevant stakeholders and consultation strategies. The mine has an active Community Consultation Committee (CCC) which has also been consulted throughout the preparation of the SMP.

Stakeholder analysis included the use of a risk based approach to identify key areas of environmental significance, built infrastructure and land ownership within the SMP Study Area so that appropriate stakeholders could be accurately identified and engaged. Stakeholders consulted included:

- Owners and/or users of the land, agricultural, industrial, commercial and business establishments and residential buildings in the Application Area;
- State and local government agencies whose interests or responsibility may be affected by the potential subsidence impacts arising from the proposed mining operation; and
- Aboriginal communities that may be affected by the potential subsidence impacts arising from the proposed mining operation.

The stakeholder engagement strategy employed a range of consultation mechanisms used throughout the process (particularly with potentially affected landowners and infrastructure owners given the substantial range of infrastructure items within the SMP Area), and is recorded in a dedicated stakeholder consultation log.

A detailed consultation process was undertaken with Lake Macquarie City Council (LMCC) specifically for the Awaba Waste Management Facility (AWMF), including meetings, establishment of a Joint Technical Team, exchange of information for impact assessments, and preliminary risk assessment process involving LMCC and their specialist consultants for the AWMF. The consultation process identified two (2) related projects by LMCC to extend services at the AWMF. The first of these being an expansion to landfill capacity through two addition cells (a project EIS is currently lodged for adequacy with the NSW Department of Planning and Infrastructure (DP&I). The second project is for an *Alternative Waste Technology (AWT)* facility to divert and recover organic waste from landfill, which will be located east of the existing landfill on a lot recently acquired by Council (project not yet lodged with DP&I as at time of submission of this SMP). Full details for these proposed projects and all related works are provided in **Section 10**.

Further to consultation undertaken with identified stakeholders, broader general community consultation was also undertaken via newspaper advertisements for the submission and exhibition of the SMP, and provision of the SMP Application on the company website for the general public.

Consultation will continue with potentially affected stakeholders during finalisation of related management plans ahead of undermining including various infrastructure plans and *Private Property Management Plans (PPMP)* as described within this SMP Application.

1.5. SUBSIDENCE PREDICTION

Centennial Newstan has taken a conservative, risk-based approach to subsidence prediction and management within the LW101-103 SMP Study Area. Detailed specialist investigations have been undertaken by Mine Subsidence Engineering Consultants (MSEC) for SMP Study Area. A copy of the detailed report by MSEC is contained in **Appendix 4**.

The predicted subsidence over the proposed longwalls was determined using the *Incremental Profile Method* (IPM) based on standard IPM prediction curves for the Newcastle Coalfield. No subsidence adjustment factors were adopted for any massive conglomerate units or inferred faulting in the mining area, based on a review of the available geological data and discussions with the Newstan geologist. These conglomerate units lens in and out over the proposed longwalls and were found to be generally less than 10 metres thick. No site specific calibration of the empirical model was carried out, based on the outcomes of the detailed review of the available ground monitoring data at Newstan and other nearby collieries.

The standard IPM model provides reasonable predictions when compared with observed movements along monitoring lines above previously extracted longwalls at Newstan, West Wallsend and Teralba Collieries (MSEC 2012). The IPM method employed is considered to provide realistic and possibly conservative predictions of conventional subsidence, tilt and curvature for the proposed longwalls. The **maximum predicted subsidence** resulting from the extraction of the proposed Longwalls 101 to 103 is **1200 mm**, as shown in Table (i) below.

Table (i) Maximum Predicted Total Conventional Subsidence After the Extraction of Each of the Proposed Longwalls

Longwalls	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
After LW101	800	10	0.20	0.20
After LW102	1000	13	0.25	0.45
After LW103	1200	16	0.40	0.60

Consultation and impact assessments conducted for the Awaba Waste Management Facility to date found that waste settlement within the landfill can be up to 30% of the fill height, and accordingly is significantly higher than vertical movements induced by mine subsidence. The significant subsidence parameters for assessment for the AWMF were determined to be ground strains (particularly tensile strains), and subsequently have been the focus of investigations.

Subsidence predictions will be compared and confirmed with actual subsidence by a detailed subsidence monitoring program proposed for LW101 as described further within the SMP Application. Conservatively, impact assessments for the SMP Application considered both predicted subsidence scenario as well as greater than predicted subsidence of twofold (two times predictions).

1.6. RISK ASSESSMENT

This SMP Application was developed using a risk-based approach specifically for the SMP Area in accordance with the SMP Guidelines. The risk assessment process comprised two key components. The first component was a primary ***SMP Risk Assessment*** undertaken at the commencement of the project. Subsequent to this, a secondary detailed but preliminary risk assessment was also

undertaken specifically for the *Awaba Waste Management Facility (AWMF),* which was undertaken in consultation with LMCC. The purpose of both risk assessments was to identify potential issues that, in the absence of further investigation to fill information gaps or inadequacies in existing management measures, had the potential to present a risk to the environment and surrounding natural and built features. Therefore, the risks identified do not necessarily reflect the final residual risks to natural and built features, but more importantly identified knowledge gaps at the start of the project which required further investigation in order to appropriately assess and manage potential subsidence impacts.

The first *SMP Risk Assessment* undertaken at the start of the project for the SMP Study Area identified a total of 21 potential risks (3 significant, 7 moderate and 11 low risks) to be investigated and managed within the SMP Application. Priority risks for investigation, consideration and management (ranked as significant or medium) have been listed below. Please refer to the full report in **Appendix 6** for all risks identified including final risk ranking definitions.

Potential Risks ranked as significant:

- Potential damage to roads or a public safety risk due to a damaged road;
- Potential damage to AWMF and
- Potential damage to power poles and power lines
- Potential damage to optic fibre (Telstra buried OF cable by LW103);

Potential Risks ranked as moderate:

- Public safety;
- Damage to privately owned infrastructure;
- Areas of high environmental, heritage or archaeological significance;
- Natural water features such as surface water and drainage lines;
- Catchment areas causing or exacerbating erosion and drainage pattern changes;
- Loss of groundwater affecting groundwater dependant ecosystems;
- The damage to private property.

Accordingly, the following studies were undertaken to assess and address potential risks:

- Infrastructure characterisation in support of the subsidence impact assessment by MSEC (Northrop Engineers and ACOR Appleyard Engineering Consultants);
- Subsidence predictions and impact assessment (MSEC) – refer to **Section 7** & **Section 11** and Appendix 4;
- SMP Groundwater Impact Assessment (GHD) – refer to **Section 11.3** and Appendix 8;
- SMP Surface Water Impact Assessment (GHD) – refer to **Section 11.3** and Appendix 10
- SMP Flora and Fauna Assessment (RPS) – refer **Section 11.3** and Appendix 7
- SMP Aboriginal and European Cultural Heritage Assessment (RPS) – refer **Section 11.3** and Appendix 9

Following the initial SMP Risk Assessment, a secondary risk assessment was undertaken specifically for the AWMF. This risk assessment was held in conjunction with LMCC representatives and their specialist consultants to form a Joint Technical Group. A conservative 'worst case' approach was undertaken using assumptions beyond predictions for fracturing of the surface and subsurface. A total of 74 potential risks aspects were identified and assessed. Whilst some of the risks identified included residual risks, a number of risks identified knowledge gaps requiring further investigations. Notwithstanding this, it was agreed by the Joint Technical Group that the potential subsidence impacts were all manageable, and that the further investigations would include assessment of a range of technical options for management to identify preferred paths for LMCC and Centennial Newstan.

Key priority risks for assessment and management identified for the AWMF have been listed below:

- Increased risk of localised cracking of the existing unlined waste cell.
    - This potential risk will be reassessed once knowledge gaps requiring further investigation are completed and subsidence monitoring of ground strains in LW101 confirm the accuracy of the subsidence predictions model for later mining under the landfill.
- Increased risk of cracking clay pond lining system of the existing secondary leachate storage pond;
- Increased risk of localised cracking of the existing lined waste cell; and
- Weighbridge going off-level;

The additional actions and investigations required arising from the risk process are feeding into an ***Action Plan*** for the AWMF with LMCC, from which a final plan of management for the facility developed with LMCC (AWMF Management Plan) ahead of undermining. A draft of the Action Plan is currently under development in consultation with LMCC. Part of the process will include a further detailed risk assessment undertaken specifically for LMCC's proposed *Alternative Waste Technology (AWT)* facility to be located east of the existing landfill. Routine progress meetings are scheduled between Centennial Newstan and LMCC to assist timely progress of the Action Plan.

Subsequently, identified potential risks for the AWMF have been considered within specialist reports and impact assessments presented within the SMP Application and further investigations with LMCC under the *Action Plan* ahead of preparation of the final *AWMF Management Plan* prior to undermining.

1.7. Surface Feature Characterisation, Impacts and Management

The SMP Application Area lies predominantly within Crown Lands under lease to Centennial Coal and other parties, and portions of privately owned (freehold) land. The SMP Application Area is located wholly within Mining Lease ML1452 and Consolidated Coal Lease CCL746, and the majority of the surface is natural bushland. Natural and built features within the SMP Application Area are outlined below.

Environmentally Sensitive Areas exist within the SMP Study Area as defined by the SMP Guidelines and shown in **Table (ii)** below.

Table (ii): Environmentally Sensitive Areas

Feature	Within SMP Study Area	Details	Section Where Addressed
Land reserved or dedicated under the *Crowns Land Act 1989* for the preservation of flora, fauna, geological formations or other environmental protection purposes	No	It is noted that LMCC currently has referrals under the EPBC Act to SEWPaC which propose vegetation offset areas (biobank). These have commenced assessment. Centennial Newstan will seek discussions with all parties to ensure resource recovery is maintained.	10.2, 3.2

Significant surface watercourses and groundwater resources identified through consultation with relevant government agencies	No No	There are a number of watercourses located within the SMP Study Area which includes six (6) Schedule 2 watercourses, four 3rd Order and two 4th Order streams located within or adjacent to the SMP Study Area.	10.3, 11.5.1 11.5.2
Lake foreshores and flood prone areas	No Yes	There are 3rd and 4th order creeks within the SMP Study Area located across LW101-103 which could be susceptible to localised flooding and inundation. It is noted that the SMP Study Area is located above/beyond the High Water Level Subsidence Control Zone (HWLSCZ).	11.5.1, 11.5.5
Cliffs, escarpments and other significant natural features	No	N/A	N/A
Areas containing significant ecological values	Yes	The SMP Study Area contains species and communities protected under the NSW Threatened Species Act (including EEC) and the Commonwealth Environmental Protection and Biodiversity Conservation (EPBC) Act.	11.5.6, 11.5.7
Major surface infrastructure	Yes	132 kV transmission Lines	11.2.1
	Yes	Optical Fibre Cable Telecommunications (AAPT aerial & Telstra buried); (for completeness also Telstra copper cable).	11.2.6
	Yes	Awaba Waste Management Facility	11.4
Surface features of community significance (including cultural, heritage or archaeological significance)	Yes	Isolated Finds located over AOD, LW101 first workings, LW101, LW102. Artefact Scatter located over LW101 first Workings and LW101. Grinding Groove located over first workings (mains). Rock shelter with possible grinding groove located over LW101.	11.5.8

Built Features:

ASPECT	POTENTIAL IMPACT	MANAGEMENT
Awaba Waste Management Facility	Centennial Newstan has worked closely with LMCC to characterise and assess potential impacts to the landfill. Preliminary risk assessment and impact assessment focus has included: • Increased risk of localised cracking of the existing unlined waste cell. • Increased risk of cracking clay pond lining system of the existing secondary leachate storage pond; • Increased risk of localised cracking of the existing lined waste cell; and • Weighbridge going off-level;	Refer risk assessment and *Action Plan* process in Sections 9 and 11. AWMF Management Plan Subsidence

	Preliminary impact assessment for these considerations has been included in the MSEC specialist assessment. Full details of subsidence predictions and impact assessments for the AWMF are presented in **Section 11.4**. It is noted that two (2) related but separate projects are currently underway for LMCC to expand landfill capacity and install an Alternative Waste Treatment Facility to the east of the existing landfill and detailed in Section 10.2. These proposals will be subject to design and construction for subsidence conditions. LMCC currently has referrals to SEWPaC under the EPBC Act for these, including offsets.	Management Plan
Powerlines and Electrical Substation (incl. transmission lines, high and low voltage powerlines)	Ausgrid 132kV transmission lines (twin poles, currently timber and proposed replacement with concrete) are located above LW101-102 which could experience maximum subsidence of 825mm and tilt of 6.5mm/m at the pole locations. The Ausgrid high and low voltage powerlines servicing the AWMF off Wilton Rd, and the TCC and TAC off Wangi Road, could experience the full range of subsidence movements. Assessment by MSEC concluded it is unlikely that the 132 kV transmission lines, high and low voltage powerlines would experience any adverse impacts resulting from proposed mining. Prudently, the lines will be managed and monitored in accordance with a plan developed in consultation with Ausgrid prior to undermining. The Ausgrid substation has been designed to accommodate subsidence movements and is located beyond the 20mm subsidence contour.	Electrical Surface Infrastructure Management Plan
Telecommunications – Aerial and buried fibre optic cable	AAPT aerial optic fibre cable attached to the eastern branch of the 132kV transmission line will experience similar subsidence to the transmission line, with subsidence of 725 mm and tilts of 6.5mm/m at the pole locations. Preventative measures may be required if strains in the cable approach allowable tolerances. Telstra buried fibre optic cable follows Wilton Road to the AWMF. Conventional subsidence of 200mm is predicted with tilts of 3.0mm/m, curvature of 0.07km^{-1} and compressive strains of 1 mm/m to 3 mm/m at the creek crossings, which could result in the reduction in capacity of the cable or transmission loss.	AAPT Infrastructure Management Plan Telstra Infrastructure Management Plan
Telecommunications – copper cable	Telstra copper cables along Wangi Road are located outside the predicted 20 mm subsidence contour. It is unlikely that these would experience any significant conventional or valley related movements (MSEC 2012).	Telstra Infrastructure Management Plan
Eraring Haul Road	Crosses northern ends of LW101-103. Predicted subsidence of 1175mm, conventional tilt of 13.0mm/m and curvature of 0.55 km^{-1}. It is expected that cracking and rippling of the road surface would occur, but within safe, serviceable and repairable limits. Removal of loose rock and highly weathered sections along the undercutting is proposed to be undertaken prior to undermining. A subsidence monitoring line along the road is proposed.	Private Road Management Plan Subsidence Monitoring Plan
Wangi Road	No predicted impact. The road is expected to experience subsidence <20mm, tilt <0.5mm/m and curvature of <0.01km^{-1}. The predicted subsidence is not expected to have significant impact on Wangi Road. Notwithstanding this, two subsidence monitoring points will be established at closest points to LW101 and prudently reported to RMS.	Subsidence Management Plan Subsidence Monitoring Plan
Wilton Road	Wilton Road crosses 800m of the southern ends of LW102-103. Total conventional subsidence is predicted to be 925mm. Maximum predicted conventional tilt is predicted to be 6.5mm/m, Maximum curvature of 0.15 km-1 for hogging and 0.35 km-1 for sagging (MSEC 2012). Post mining grades are expected to be similar to the existing grades along Wilton Road. Potential change in surface drainage could occur but is not expected to be significant. Whilst it is possible that localised ponding may occur, this can be remediated using normal road maintenance techniques.	Public Road Management Plan Subsidence Management Plan Subsidence Monitoring Plan

	Due to the nature of Wilton Road there are unlikely to be any specific points at which water can form areas of road side ponding. Due to the significant grade of the road as it passes through the SMP Study Area it is unlikely that the road will be any more susceptible to flooding impacts (GHD, 2012). It is expected that with the current predicted curvature and strains, that cracking and rippling of the road surfaces would occur. Previous experience of mining directly beneath roads in the NSW coalfields, with similar depths of cover and panel width to depth ratios, indicates that crack widths are typically between 10mm and 25mm along with heaving of around 25mm. It is expected that Wilton Road could be maintained in a safe and serviceable condition throughout the mining period by using normal road maintenance techniques. Pre and post mining ground survey is currently proposed with routine inspections during mining.	
Culverts	No significant impact to the 4 culverts on Wilton Road, 2 on Wangi road, and one culvert on the Private Haul Road within the SMP Study Area. Tilts <0.05%, change in grade <1% and in direction of flow, All culverts (except HR-C1) indicated a negligible change between the existing and the predicted post mining subsided surface condition headwater depths. HR-C1, is the only culvert to indicate a reduction in grade due to the subsidence predictions, however this is likely to be minimal with a maximum subsidence of less than 20 mm predicted.	Subsidence Management Plan Public Road Management Plan Private Road Management Plan
Bridges *(beyond SMP Study Area)*	No bridges are located within SMP Study Area. The nearest bridges are >500m from LW101-103, well outside predicted 20 mm subsidence contour. At these distances, bridges are not expected to experience any measurable conventional tilt, curvatures or strains. Bridges could experience small far-field horizontal movements. It is likely, that these small differential horizontal movements will not be measurable at bridges. It is likely bridges could tolerate potential movements and it is expected that bridges would not be adversely impacted.	Subsidence Management Plan Public Road Management Plan Private Road Management Plan
Survey Control Marks	Two State Survey Marks (SS77112, SS77113) and a Trig Station (TS666) are expected to experience the full range of predicted subsidence movements. Survey control marks located beyond the SMP Study Area nearby are also expected to experience small amounts of subsidence and small far-field horizontal movements up to 3km outside the SMP Study Area. Consultation with Surveyor General and management within SMP in accordance with Survey Act.	Subsidence Management Plan
Newcastle Lake Macquarie Clay Target Club	Demountable structures, small storage sheds, trap houses and the trap enclosures are founded on small piers, slabs on ground, or natural ground. Predicted curvatures and strains are very small (in the order of survey tolerance), and unlikely to be transferred into structures and result in any significant impacts. Whilst predicted tilts are extremely small, the clay target throwers and target survey markers could be sensitive to small movements. Clay target throwers can be adjusted in level. It may be necessary to develop preventive measures, if the predicted tilts exceed the available adjustments to re-level the clay target throwers, or to relocate the target survey markers. At the request of NLMCTC, routine survey of the throwers and markers will be undertaken and described within a PPMP for the property.	Newcastle Lake Macquarie Clay Target Club PPMP Subsidence Management Plan
Awaba & Westlakes Automobile Club (AwabaWAC)	Predicted curvatures and strains for the section of track directly above LW103 could be of sufficient magnitude to result in cracking, heaving, or stepping of the surface. Building structures and associated infrastructure predicted to experience <20 mm subsidence and unlikely to experience any adverse impacts.	Awaba & Westlakes Automobile Club PPMP Subsidence Management Plan

Toronto Adventist Centre (School and Church)	No predicted impact. Buildings and associated infrastructure <20mm subsidence and no significant conventional tilts, curvatures or strains,. Whilst no significant impact is predicted, prudently Centennial proposes to consult and manage the property via a PPMP developed with the landowner.	Toronto Adventist Centre PPMP Subsidence Management Plan
Toronto Country Club (Golf Club)	No predicted impact. Buildings and associated infrastructure <20mm subsidence and no significant conventional tilts, curvatures or strains. Whilst no significant impact is predicted, prudently Centennial proposes to consult and manage the property via a PPMP developed with the landowner.	Toronto Country Club PPMP Subsidence Management Plan

Natural Features:

ASPECT	POTENTIAL IMPACT	MANAGEMENT
Ecology & Vegetation Communities	Swamp Mahogany Paperbark Forest (EEC, Groundwater Dependant Ecosystem) may experience increased ponding along the flatter sections of the Schedule 2 streams where natural ponding is already evident due to flat grades. It is expected that the Groundwater Dependant Ecosystem will adjust over time to accommodate the changed levels through natural sedimentation of hollows, and the natural hydrology will be maintained	Flora and Fauna Management Plan
Archaeological Artefacts	One site considered at high risk of potential impact (rockshelter with possible grinding groove site AHIMS# 45-7-0310/45-7-0005. Grinding Groove site (AHIMS # 45-7-0260) is at a moderate risk of harm from subsidence. Predicted movement of 50 millimetres may lead to sandstone exfoliation and the subsequent damage to the groove complex.	Aboriginal Cultural Heritage Management Plan Section 90 applications where required
Surface Water & Drainage Lines	Some change may occur in alignment of minor drainage channels An increase in gradient and flow velocity is predicted as watercourses enter the subsidence area and a general reduction in gradient and flow velocity through the affected area. Waterways are densely vegetated (long native grass), so the modelled flow velocity increases are considered to be non-scouring and potential for instability is considered low. An increase in channel surface water ponding will occur in some waterway sections as a result of the subsided surface, most likely along WC5 and WC10 immediately upstream of where these exit the subsidence affection zone. Some fracturing and spalling of the exposed bedrock could likely occur in upper reaches of the watercourses which could drain local ponding immediately upstream. Due to steep slopes and depth of fracturing and dilation, diverted flow will re-emerge immediately downstream with no net loss.	Watercourse Management Plan Water Management Plan
Groundwater	Aquifer depressurisation is not anticipated to significantly impact registered stock, domestic or irrigation bores. Toronto Country Club's monitoring bore (GW064214) may experience some minor drawdown in the order of only 0.1 m. GDEs associated with Kilaben, Stockyard and Stony Creeks in the vicinity of the SMP Study Area may experience a drawdown of up to 0.2 m but not expected to be impacted Development and extraction of LW101, 102 and 103 is expected to intercept deeper Permian groundwater at a rate of approximately 200 – 280 ML/year. The movement of shallow groundwater into underlying strata is expected to be small, totalling only 0.2 ML/year throughout the entire SMP Study Area.	Water Management Plan

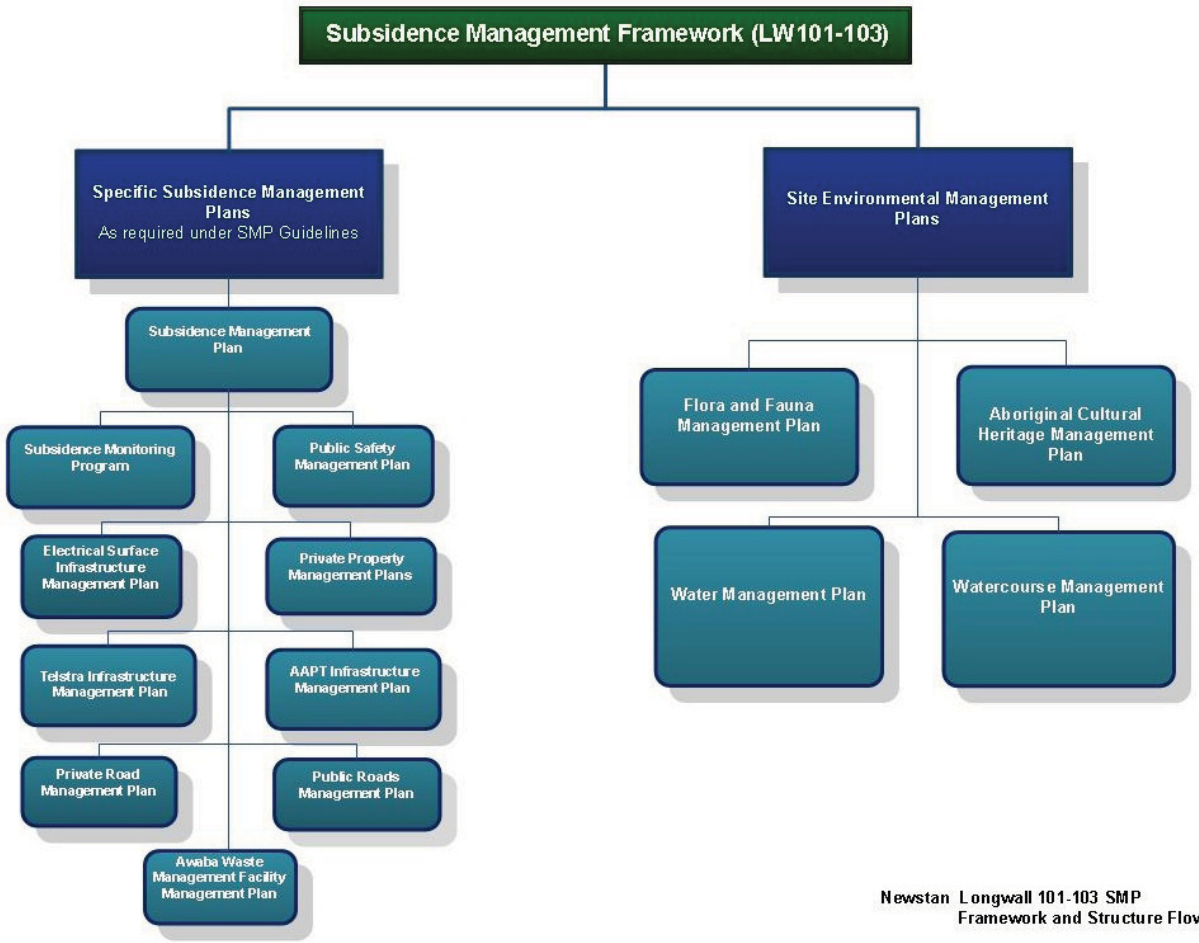
1.8. SUBSIDENCE MANAGEMENT FRAMEWORK

Following the risk-based approach to surface feature characterisation and detailed impact assessments undertaken for the SMP Application, the Subsidence Management Plan subsequently developed provides a suitable framework to coordinate Newstan Colliery's approach to subsidence management. The subsidence management framework of related management plans for natural and man-made surface features within LW101-103 SMP Area is illustrated below.

Based on the location of surface features and timing of undermining and potential subsidence impact, management plans will be progressively developed. The following management plans have been submitted in draft as part of the SMP Application and will be finalised in consultation with relevant stakeholders prior to commencement of LW101:

- ***Subsidence Management Plan*** (including general Trigger Action Response Plan (TARP));
- ***Subsidence Monitoring Program***;
- ***Public Safety Management Plan*** (including specific public safety TARP)

The remainder of management plans in the proposed framework for LW101-103 SMP Study Area will be developed ahead of potential impacts. Full details for all plans are provided in **Section 12**.



Newstan Longwall 101-103 SMP
Framework and Structure Flowchart

1.9. CONCLUSION

Centennial Newstan is committed to mining the resource in the SMP Application Area safely and with appropriate protection to the environment in the area.

Specialist subsidence assessment by MSEC and environmental impact assessments by RPS and GHD indicate that all aspects (including the AWMF) are manageable within the nominated plans of management. A conservative risk-based approach has prudently developed appropriate controls for both maximum expected subsidence and also unlikely worst case subsidence (two times subsidence conditions), with a general TARP within the *Subsidence Management Plan* and *Public Safety Management Plan*. As part of the risk management process subsidence predictions by specialists were independently verified for accuracy.

In conclusion, it is considered that with appropriate controls in place (including the final investigations for the AWMF), and the completion of relevant management plans ahead of mining, extraction of coal within the LW101-103 SMP Application Area can be safely and responsibly undertaken without significant impact to natural or man-made features, with all surface infrastructure maintained as safe, serviceable and repairable. Prudently, the application has been supported by specialist investigations for key risk aspects including subsidence, ecology, Aboriginal cultural heritage, surface water and groundwater.

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ABBREVIATIONS

ACHMP	Aboriginal Cultural Heritage Management Plan
AEMR	Annual Environmental Monitoring Report
AHD	Australian Height Datum
AWABAWAC	Awaba & West lakes Automobile Club
AWMF	Awaba Waste Management Facility
AWT	Alternative Waste Treatment
CCC	Community Consultative Committee
CCL	Consolidated Coal Lease
DA	Development Application/Approval
DECCW	(Former) NSW Department of Environment, Climate Change and Water
DoP	(Former) NSW Department of Planning
DP&I	NSW Department of Planning and Infrastructure
DTIRIS-DLC	Division of Catchments and Lands
DTIRIS-DRE	NSW Department of Trade and Investment, Regional Infrastructure and Services – Division of Resources and Energy
EIS	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environmental Protection Authority
EP&A Act	NSW Environmental Planning and Assessment Act
EPL	Environmental Protection Licence
FFMP	Flora and Fauna Management Plan

IPM	Incremental Profile Method
LEA	(Newstan) Life Extension Area (1998 EIS)
LGA	Local Government Area
LMCC	Lake Macquarie City Council
LPMA	Land and Property Management Authority
LW	Longwall
ML	Mining Lease
MOD	Modification
MOP	Mine Operations Plan
MSB	Mine Subsidence Board
Mtpa	Million Tonnes per Annum
NOW	NSW Office of Water
NPI	National Pollutant Inventory
OEH	NSW Office of Environment and Heritage
PPMP	Private Property Management Plan
PSMP	Public Safety Management Plan
ROM	Run of Mine
RMS	Roads and Maritime Services
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
SMP	Subsidence Management Plan
TARP	Trigger Action Response Plan
WSP	Water Sharing Plan

2. INTRODUCTION

Newstan Colliery (Newstan) is an underground coal mine which is owned and operated by Centennial Newstan Pty Limited (Centennial Newstan), part of Centennial Coal Company Limited (Centennial), a wholly owned subsidiary of Banpu Public Company Limited. Underground mining at Newstan is undertaken utilising both bord and pillar, and longwall mining methods. Newstan is regionally located approximately 25 kilometres south-west of Newcastle and approximately 140 kilometres north of Sydney within the Lake Macquarie Local Government Area (LGA). The Newstan pit top and surface facilities are located approximately four kilometres north of the township of Toronto as shown in **Figure 1.**

Mining operations at Newstan commenced in 1887 and Newstan Colliery has since undertaken extensive mining within the Young Wallsend, Great Northern, Fassifern, Borehole and West Borehole coal seams. Newstan has approval to produce up to 4 Mtpa of run of mine (ROM) coal with coal being transported to either the Eraring Power Station for domestic power production or the Port of Newcastle and Kembla for the export market. The long history of mining in the area provides a substantial ongoing platform of stakeholder engagement and subsidence management for the colliery.

The Newstan surface facilities consist of administration buildings, amenities buildings, workshops, and a range of coal handling facilities, including a coal preparation plant, stockpile areas, a rail loop, drifts and conveyors. The colliery employs up to 320 full time staff and contractors.

In 2009, Newstan ceased underground mining production but continued to operate the surface facilities for the handling and processing of coal from other Centennial operations. Newstan recommenced underground mining in July 2011.

This SMP Application has been prepared to seek approval from the Department of Trade and Investment, Regional Infrastructure and Services – Division of Resources and Energy (DTIRIS – DRE) for the development and extraction of Longwall Panels LW101 to 103 (herein referred to as the SMP Study Area) which is located within Mining Lease (ML) 1452 as shown in **Figure 1**.

Mining within the proposed SMP Study Area will be undertaken using the longwall method of mining, with gate roads developed by continuous miners. The SMP Study Area has not been subject to mining in the past. The proposed mining will be targeting the Young Wallsend seam (which comprises the Nobby's and Dudley seams) and part of the Yard seam with depth of cover ranging from 210m in the northwest to approximately 350m in the southeast. Longwall Panels 101 to 103 (LW101-LW103) are aligned northwest to southeast with mining proposed to progress outbye in a southeast to northwest direction.

2.1. RELATED APPROVALS AND DOCUMENTS

Newstan Colliery began mining operations in 1887, prior to the implementation of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act), and operated under continuing use rights pursuant to section 109 of the EP&A Act. On 14 May 1999 the (then) Minister for Urban Affairs and Planning granted development consent to Newstan Colliery under Part 4 of the EP&A Act for the Newstan Colliery Life Extension Area pursuant to Development Application 73-11-98 (DA 73-11-98). DA 73-11-98 is valid for a period of 21 years until 2020.

Subsequent modifications to DA 73-11-98 include:

- (Mod 1) Approval to allow for the continuation of underground mining within longwall panel 24 and the relocation of an approved, though not yet constructed, ventilation shaft and associated service corridors granted on 23 September 2007;

- (Mod 2) Approval to receive and wash up to 2 Mtpa of coal from the Centennial Mandalong Mine at the Newstan Colliery, granted on 27 November 2009;
- (Mod 3) Approval to receive and wash up to 880,000 tonnes per annum of coal from the Centennial Awaba Colliery, the acceptance of stone reject material from the Centennial Mandalong Mine at the Newstan Colliery, and the establishment of a 30,000 tonne emergency coal stockpile granted on 26 November 2010; and
- (Mod 4) Approval for the recommencement of bord and pillar mining in an area referred to as Main West granted on 16 March 2012.

Other approvals which are relevant to this SMP Application include:

- ML 1452;
- Consolidated Coal Lease (CCL) 746;
- Mining Operations Plan (MOP) (2005 - 2012); and
- Environment Protection Licence (EPL) 395.
- Water Licence 20SL050021; and
- various bore licences forming the integrated water management circuit for the mine

Under the conditions of ML 1452, Centennial Newstan is required to prepare a *Subsidence Management Plan* (SMP) prior to commencing underground mining operations which will potentially lead to subsidence. Accordingly, an SMP Application has been prepared to seek approval from the NSW DTIRIS – DRE for the development and extraction of longwall panels LW101, LW102 and LW103, which are located wholly within ML1452 and approved under DA 73-11-98. A copy of the relevant development consent conditions and mining leases can be found in **Appendices 2 and 3**.

A subsidence impact assessment has been carried out by MSEC (2012) which is summarised, where appropriate, throughout this document. The full report can be found in **Appendix 4**.

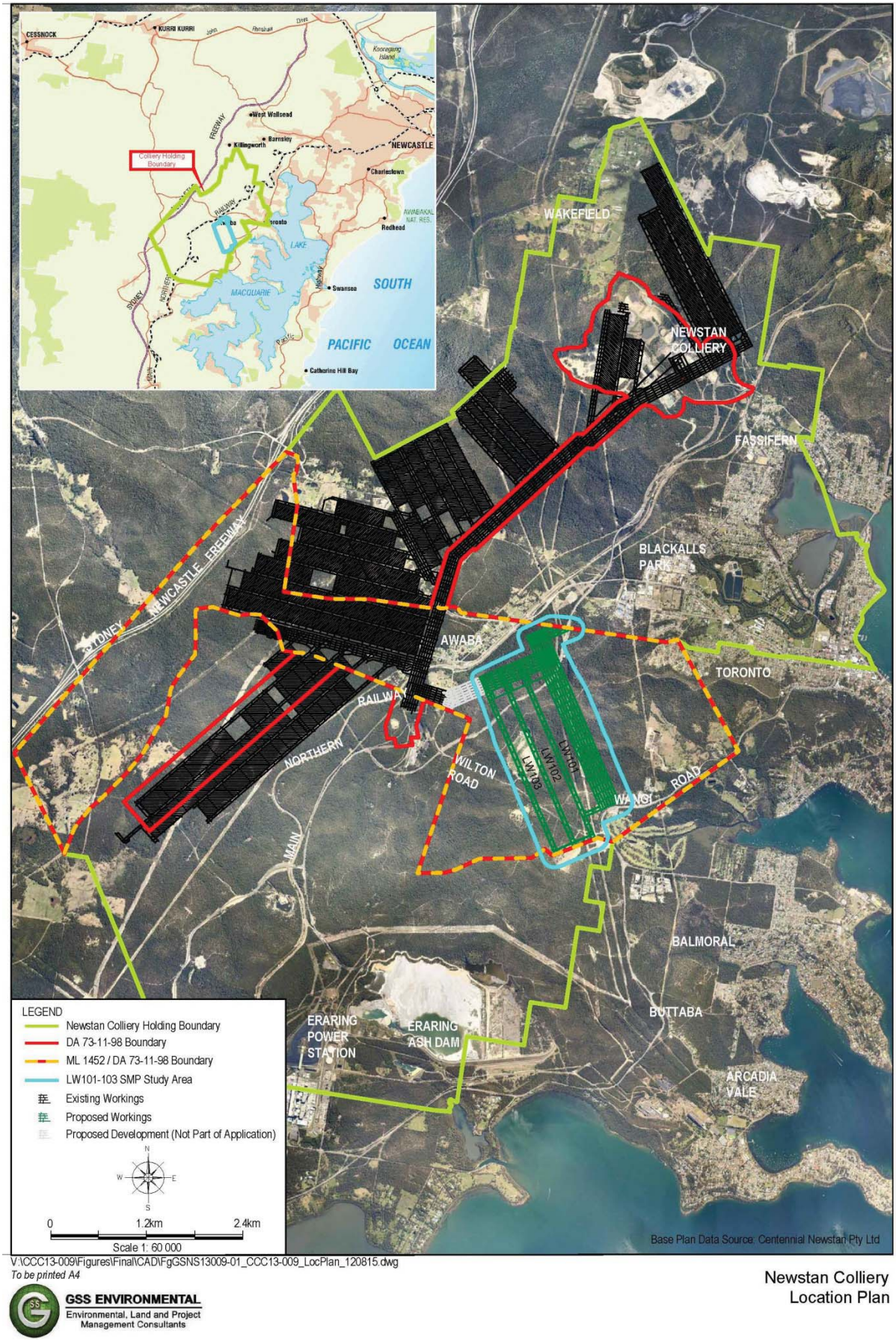


Figure 1 - Location Plan

2.2. STRUCTURE OF THE SMP APPLICATION

Figure 2 details the structure of the Newstan SMP Application. The Application consists of three separate volumes.

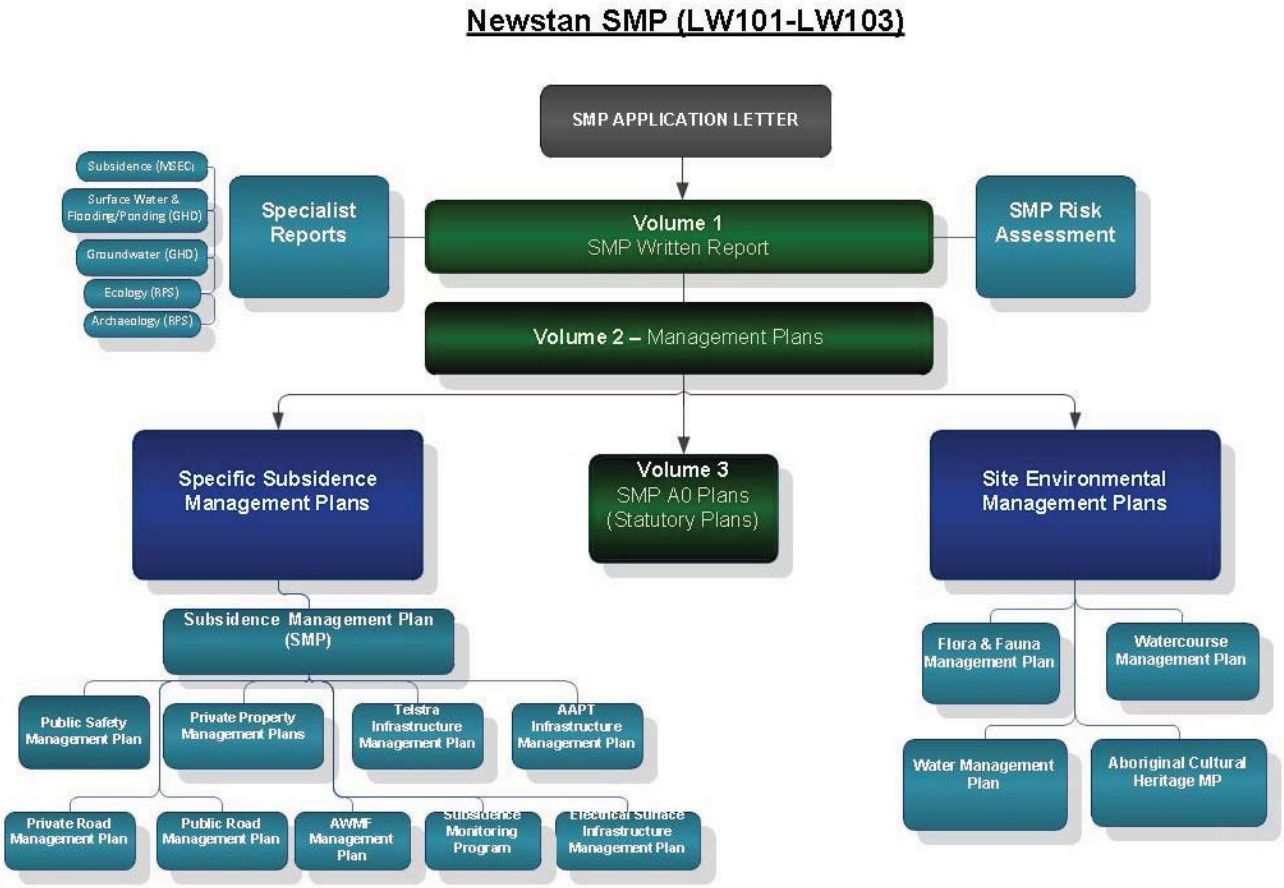


Figure 2 - Newstan SMP (LW101-LW103) Application Structure

3. THE APPLICATION AREA

3.1. SMP APPLICATION AREA

The SMP Application Area (herein referred to as the 'SMP Study Area') has been conservatively defined beyond the minimum requirements of the SMP Guidelines and is illustrated in **Figure 4.** The SMP Study Area incorporates the areas bounded by the following limits:

- A 26.5 degree angle of draw from the panel edge (limit of proposed extraction) of the proposed LW101, LW102 and LW103 for the depth of cover (as per Section 6.2 of the SMP Guidelines). Additionally, the study area also includes a 26.5 degree angle of draw from associated *first workings* (mains headings and associated mine development roads) adjacent to the longwalls, acknowledging that these areas do not significantly contribute to subsidence but have been conservatively included; and
- The predicted limit of vertical subsidence, taken as the 20mm subsidence contour resulting from the extraction of the proposed longwall panels (as per Appendix A of the SMP Guidelines). Additionally, the footprint of potential direct impact by subsidence parameters including tilt, strain and curvature has been considered in establishing the SMP Study Area.

LW101-LW103 are aligned in a northwest southeast direction with mining proposed to occur from the southeast (outbye) to the northwest direction. It is noted that the potential for 'far-field' effects beyond the SMP Study Area has been considered separately within the subsidence impact assessments for this SMP Application.

For completeness, it is noted that, in accordance with Mining Lease conditions, panels LW101-103 are located beyond the 35 degree angle of draw from the Main Northern Railway (refer **Figure 3**)

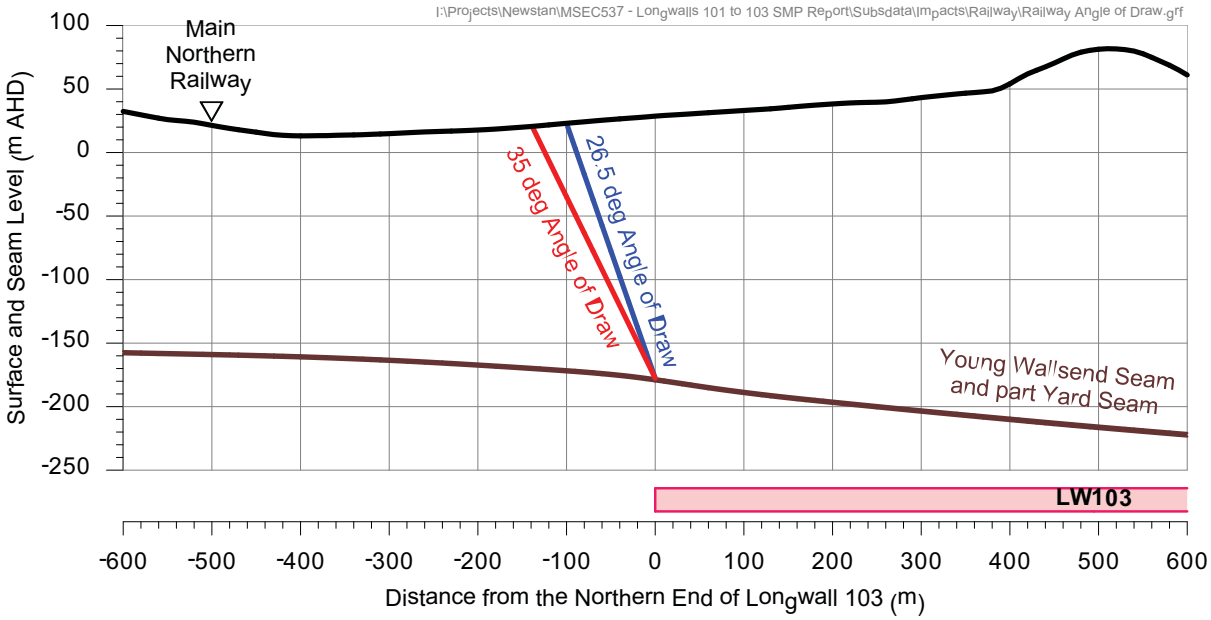
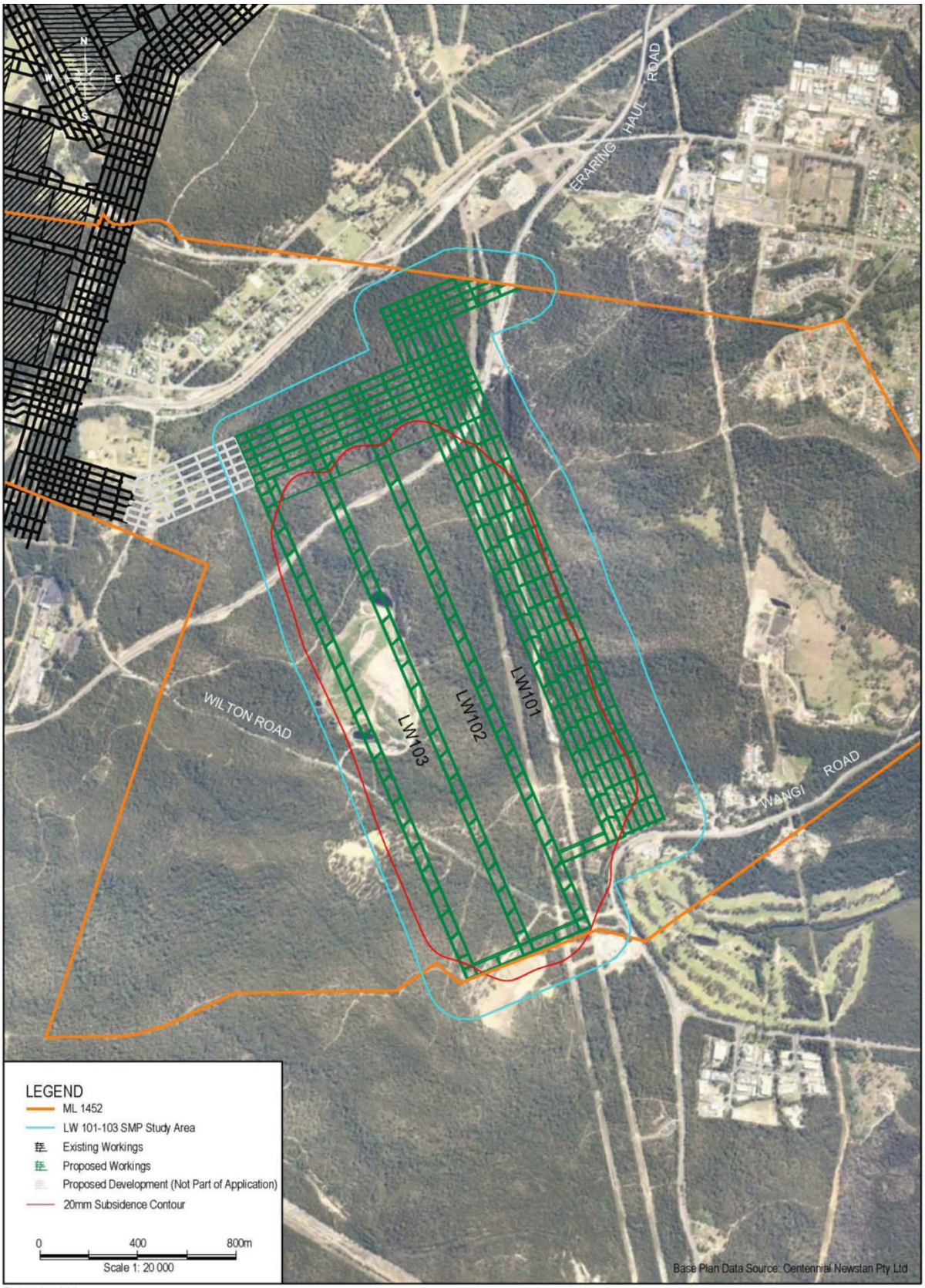


Figure 3 Cross-section of Main Northern Railway and LW103

The SMP Application Area and lease boundaries are shown in **SMP Plan 2** and **Figure 4.**



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SMP Study Area

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Figure 4 - SMP Study Area

3.2. LANDUSE AND OWNERSHIP

The SMP Study Area is located mainly within Crown land, with sections of privately owned land as illustrated in **Plan 5** and **Figure 5**. **Table 3.1** summarises the ownership and classification of the properties within the SMP Study Area.

Crown land within the SMP Study Area is managed by DTIRIS – Division of Catchments and Lands. The land within the SMP Study Area is largely made up of undisturbed bushland, sections of crown land under lease to private parties, and some portions of freehold land as outlined in **Table 3.1**.

The existing infrastructure located on crown lands leased to private parties or privately owned land within the SMP Study Area is described in detail in **Section 11** of this report. In summary, it consists of a Council waste management facility (including proposed landfill expansion), a clay target club, automobile club (rally track), private school and church, golf club, Ausgrid sub-station, power lines, haul road, public roads and telecommunication lines (copper cable and optic fibre). The NSW Aboriginal Land Council own a substantial area of land west of Wilton Road and a smaller portion of land located in the north of the SMP Study Area. There are **no private residences** identified within the SMP Study Area. Stakeholder identification and consultation for private land and infrastructure owners is discussed in detail in **Section 8**. A brief outline is provided below.

Directly above the proposed LW103 and verging just into LW102 lies the existing Awaba Waste Management Facility (AWMF). To the east of the existing AWMF, lies Lot 373 DP723259 which has recently been acquired by Lake Macquarie City Council (LMCC) for the proposed extension to the AWMF and the development of an Alternative Waste Treatment (AWT) Facility. The entirety of the proposed infrastructure lies within LW102 and LW103. Further information regarding land ownership and proposed development within the SMP Study Area is provided in **Sections 3.3** and **10.2.**

Westlakes Automobile Club (Awabawac) is located to the west of the proposed LW103, within the SMP Study Area. The Newcastle Lake Macquarie Clay Target Club is situated within the south-western region of the SMP Study Area. These facilities are detailed in **Section 11.3**.

The proposed mining of LW101-LW103 is such that longwall mining will not directly undermine Wangi Road (state managed), with LW101 commencing directly north of Wangi Road. Wilton Road (council managed) will be undermined by LW102 and LW103. The Eraring Private Haul Road, which transports coal from Newstan to Eraring Power Station and has been previously undermined successfully, transverses the northern sections of the SMP Study Area and will be undermined by LW101-LW103. Refer **Section 11.3** for further detail on all roads.

The Toronto Adventist Centre (school and church, refer **Section 11.3**) is located on freehold land north of Wangi Road to the east of the proposed main headings (first workings) and will not be undermined by secondary extraction.

South of Wangi Road is the Toronto Country Club (golf club) which is located south of the proposed main headings and LW101.

For completeness, it is noted that the Main Northern Railway is located north of the SMP Study Area beyond a 35 degree angle of draw (as conservatively required by the conditions of ML1452) and discussed further in **Section 11**.

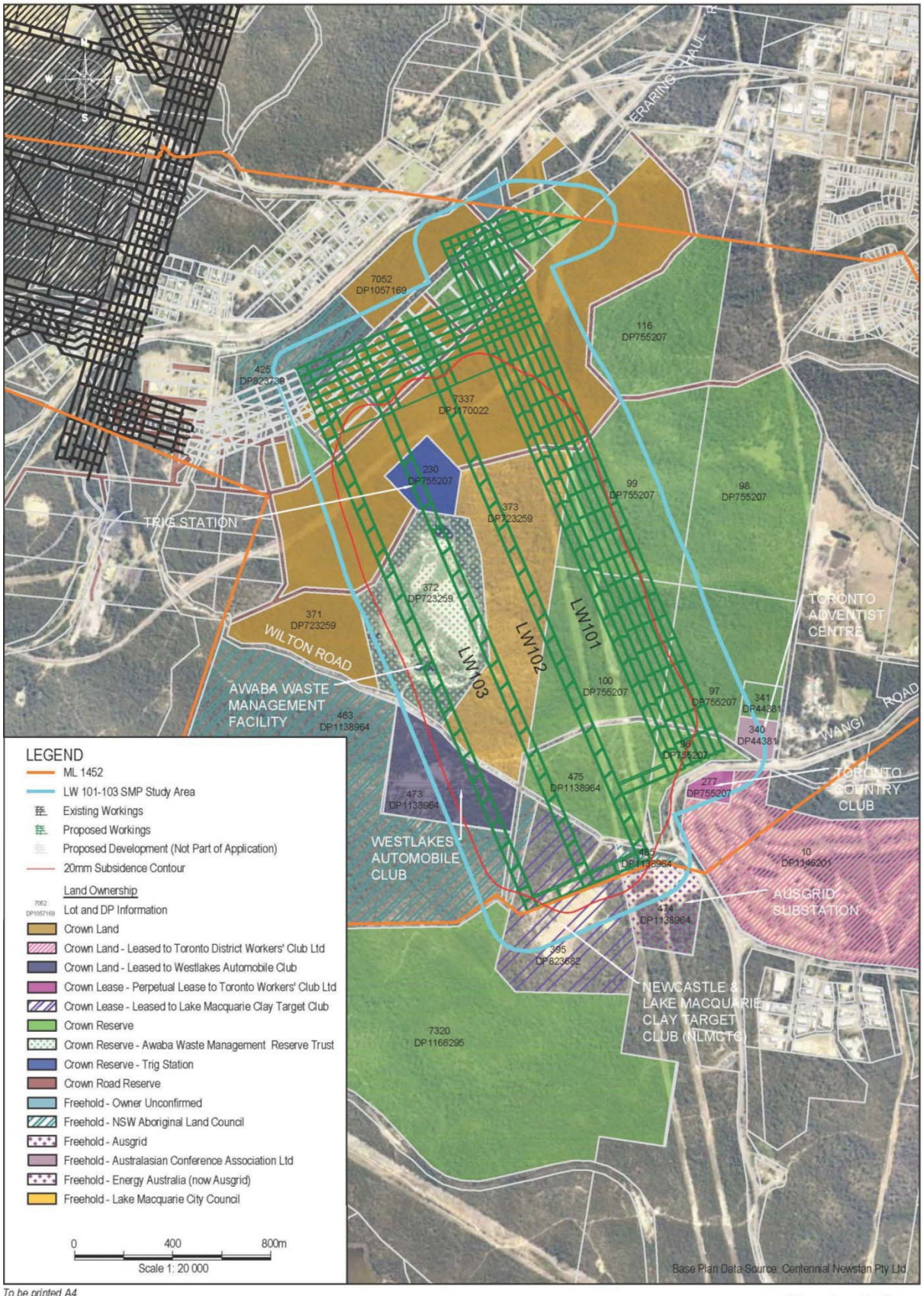
Consultation with infrastructure owners to ensure all potential aspects are adequately addressed has been a key focus during the development of this SMP Application, as outlined in detail in **Section 8.**

The main northern railway has also been prudently included even though it lies beyond the SMP Study Area and the relevant 35 degree angle of draw as described in ML1452.

Table 3.1 Properties within the SMP Study Area

REF	LOT and DP	LANDOWNER	CLASSIFICATION
0	ROAD	THE STATE OF NSW	CROWN ROAD
5	97//DP755207	THE STATE OF NSW	CROWN RESERVE
6	395//DP823682	THE STATE OF NSW Leased to NLM Clay Target Club	CROWN LEASE
7	473//DP1138964	THE STATE OF NSW	CROWN LAND
8	7063//DP1060426	THE STATE OF NSW	CROWN LAND
9	7/38/DP758041	THE STATE OF NSW	CROWN LAND
10	100//DP755207	THE STATE OF NSW	CROWN RESERVE
11	116//DP755207	THE STATE OF NSW	CROWN RESERVE
12	99//DP755207	THE STATE OF NSW	CROWN RESERVE
13	8/38/DP758041	THE STATE OF NSW	CROWN LAND
14	3/38/DP758041	THE STATE OF NSW	CROWN LAND
15	1/40/DP758041	THE STATE OF NSW	CROWN RESERVE
17	230//DP755207	THE STATE OF NSW	CROWN RESERVE (TRIG RESERVE)-
18	372//DP723259	AWABA WASTE MANAGEMENT (R170042) RESERVE TRUST	CROWN RESERVE
19	373//DP723259	LAKE MACQUARIE COUNCIL	FREEHOLD
20	475//DP1138964	THE STATE OF NSW	CROWN RESERVE
21	96//DP755207	THE STATE OF NSW	CROWN RESERVE
22	95//DP755207	THE STATE OF NSW	CROWN RESERVE
23	7062//DP1060426	THE STATE OF NSW	CROWN LAND
24	7062//DP1060425	THE STATE OF NSW	CROWN LAND
26	12/37/DP758041	THE STATE OF NSW	CROWN LAND
38	4/37/DP758041	THE STATE OF NSW	CROWN LAND
40	7/37/DP758041	THE STATE OF NSW	CROWN LAND
46	9/37/DP758041	THE STATE OF NSW	CROWN LAND
48	2/38/DP758041	THE STATE OF NSW	CROWN LAND
53	1/37/DP758041	THE STATE OF NSW	CROWN LAND
65	10/37/DP758041	THE STATE OF NSW	CROWN LAND
69	9/38/DP758041	THE STATE OF NSW	CROWN LAND
72	7061//DP1060425	THE STATE OF NSW	CROWN LAND
80	7068//DP1077183	THE STATE OF NSW	FREEHOLD
81	35//DP1126312	THE STATE OF NSW	CROWN RESERVE
82	3/37/DP758041	THE STATE OF NSW	CROWN LAND
84	425//DP823739	NSW ABORIGINAL LAND COUNCIL	FREEHOLD
88	10/38/DP758041	THE STATE OF NSW	CROWN LAND
93	2/37/DP758041	THE STATE OF NSW	CROWN LAND
105	371//DP723259	THE STATE OF NSW	CROWN LAND
120	11/37/DP758041	THE STATE OF NSW	CROWN LAND
125	6/37/DP758041	THE STATE OF NSW	CROWN LAND
126	1/38/DP758041	THE STATE OF NSW	CROWN LAND
128	8/37/DP758041	THE STATE OF NSW	CROWN LAND

REF	LOT and DP	LANDOWNER	CLASSIFICATION
131	5/37/DP758041	THE STATE OF NSW	CROWN LAND
147	7320//1166295	THE STATE OF NSW	CROWN RESERVE
156	7319//1166061	THE STATE OF NSW	CROWN LAND
165	465//DP1138964	NSW ABORIGINAL LAND COUNCIL	FREEHOLD
166	474//DP1138964	ENERGY AUSTRALIA	FREEHOLD
169	463//DP1138964	NSW ABORIGINAL LAND COUNCIL	FREEHOLD
179	340//44381	Australasian Conference Association Limited *(Toronto Adventist Centre)*	FREEHOLD
180	341//44381	THE STATE OF NSW	CROWN RESERVE
184	7052//1057169	THE STATE OF NSW	CROWN LAND
185	209//755207	THE STATE OF NSW	CROWN RESERVE
186	449//1064562	NSW ABORIGINAL LAND COUNCIL	FREEHOLD
187	7096//1060655	THE STATE OF NSW	CROWN RESERVE
188	7094//1060655	THE STATE OF NSW	CROWN RESERVE
189	1/42/758041	THE STATE OF NSW	CROWN RESERVE
190	7069//1077183	THE STATE OF NSW	CROWN LAND
191	4/38/758041	THE STATE OF NSW	CROWN LAND
192	6/38/758041	THE STATE OF NSW	CROWN LAND
193	5/38/758041	THE STATE OF NSW	CROWN LAND
194	208//755207	THE STATE OF NSW	CROWN RESERVE
195	211//755207	THE STATE OF NSW	CROWN RESERVE
196	210//755207	THE STATE OF NSW	CROWN RESERVE
232	464//1138964	NSW ABORIGINAL LAND COUNCIL	FREEHOLD
241	277//755207	Perpetual Lease to Toronto District Workers' Club Limited *(Toronto Country Club)*	CROWN LEASE
243	10//1146201	THE STATE OF NSW Leased to Toronto District Workers' Club Limited *(Toronto Country Club)*	CROWN LAND
244	7070//1077183	THE STATE OF NSW	CROWN LAND
245	7071//1077184	THE STATE OF NSW	CROWN RESERVE
246	7095//1060655	THE STATE OF NSW	CROWN RESERVE
247	7072//1077184	THE STATE OF NSW	CROWN RESERVE
248	7074//1077184	THE STATE OF NSW	CROWN RESERVE
249	7067//1077182	THE STATE OF NSW	CROWN LAND
250	7065//1077182	THE STATE OF NSW	CROWN LAND
251	7066//1077182	THE STATE OF NSW	CROWN LAND
261	7073//1077184	THE STATE OF NSW	CROWN RESERVE
276	207//755207	DEPARTMENT OF LANDS (CROWN)	CROWN LAND
282	7337//1170022	THE STATE OF NSW	CROWN LAND
283	450//1064562	NSW ABORIGINAL LAND COUNCIL	FREEHOLD
284	1//1147459	AUSGRID	FREEHOLD



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Land Ownership

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Figure 5 - Land Ownership

3.3. PROPERTY DESCRIPTION AND MINING TITLES

The SMP Study Area is located entirely within ML 1452 of which Consolidated Coal Lease (CCL) 746 forms part of the surface lease within the vicinity of the AWMF. The mining leases are held by Centennial Newstan. The relevant Lot and DP numbers within the SMP Study Area are provided in **Figure 5** with **Figure 6** showing the location of MLs and CCLs held by Centennial Newstan. Details of land ownership and mining titles are shown in **Plan 5.**

3.4. STATUTORY REQUIREMENTS

3.4.1. Statutory Controls

The operation of the mine is controlled by a variety of legislation that considers mining, safety and environmental management. **Table 3.2** summarises the site licences and approvals currently held by Centennial Newstan which are applicable to the SMP Study Area.

Table 3.2 Summary of Statutory Controls for Newstan Colliery

Control	Reference	Expiry/Renewal Date	Regulatory Authority
Development Consent	DA 73-11-98	May 2020	DP&I
Mining Lease	ML 1452	6 July 2020	DTIRIS - DRE.
Mining Lease	CCL 746	31 December 2028	DTIRIS - DRE.
Environmental Protection License	EPL 395	Issued 1 January 2006 (anniversary date)	Office of Environment and Heritage (OEH).
Water License	20SL050021	8 January 2011	NSW Office of Water (NOW).
Bore Licenses	Various*	Various dates*	NOW

* *Newstan holds multiple bore licences which all operate under the integrated water management circuit for the mine.*

3.4.2. Relevant Legislation

Table 3.3 outlines legislation and associated approvals that may be required prior to mining within the SMP Study Area.

Table 3.3 Legislative Requirements

Act	Relevance
Environmental Protection and Biodiversity Conservation Act 1999	Under the Act, the SMP Application will not have any significant impact on matters of National Environmental Significance (NES). As such, no EPBC referral will be required for the project.
Environmental Planning and Assessment (EP&A) Act 1979	In particular, DA73-11-98 providing planning development consent for longwall mining within the Newstan Life Extension Area (LEA) (including the SMP Area) was issued under Part 4 of the EP&A Act.
Mining Act 1992	The approved Newstan MOP covers the period between June 2005 and July 2012. A

Act	Relevance
	modification/extension to the MOP is currently being developed to replace the current MOP.
Coal Mines Health and Safety Act 2002	Once the SMP Application has been approved by the DTIRIS – DRE, Newstan will apply for a Clause 88 Approval under this Act to undertake secondary extraction of the proposed longwall panels.
Mines Subsidence Compensation Act 1961	The SMP Study Area is wholly located within the West Lakes Mines Subsidence District, with the act relevant to the SMP Application.
Water Management Act 2000	The Act is relevant as the SMP Study Area lies within the north and south Lake Macquarie sections of the Water Sharing Plan (WSP) for the Hunter Unregulated and Alluvial Water Sources.
Water Act 1912	Relates to licencing of all water monitoring or mine dewatering bores from the NSW Office of Water (NoW).
National Parks and Wildlife Act 1974	A Section 90 Permit is required prior to the destruction of any known Aboriginal archaeological sites. This Act is applicable to some of the identified Aboriginal heritage sites within the SMP Study Area.
Roads Act 1993	A licence under Section 138 of this Act will be required to undertake works within a road reserve.
Crown Lands Act 1989	Should any Crown land, including road reserves, require subsidence remediation works, the Land and Property Management Authority will be consulted.
Dams Safety Act 1978	There are no prescribed dams within the SMP Study Area.
Dangerous Goods Act 1975	This Act is not applicable as Newstan does not hold any dangerous goods on-site.
Native Title Act 1993	An Indigenous Land Use Agreement (ILUA) applies to the SMP Area as detailed in the specialist Aboriginal Cultural Heritage Assessment report for the SMP by RPS (2012).
Heritage Act 1977	The Act protects the natural and cultural history of NSW with emphasis on non-indigenous heritage.

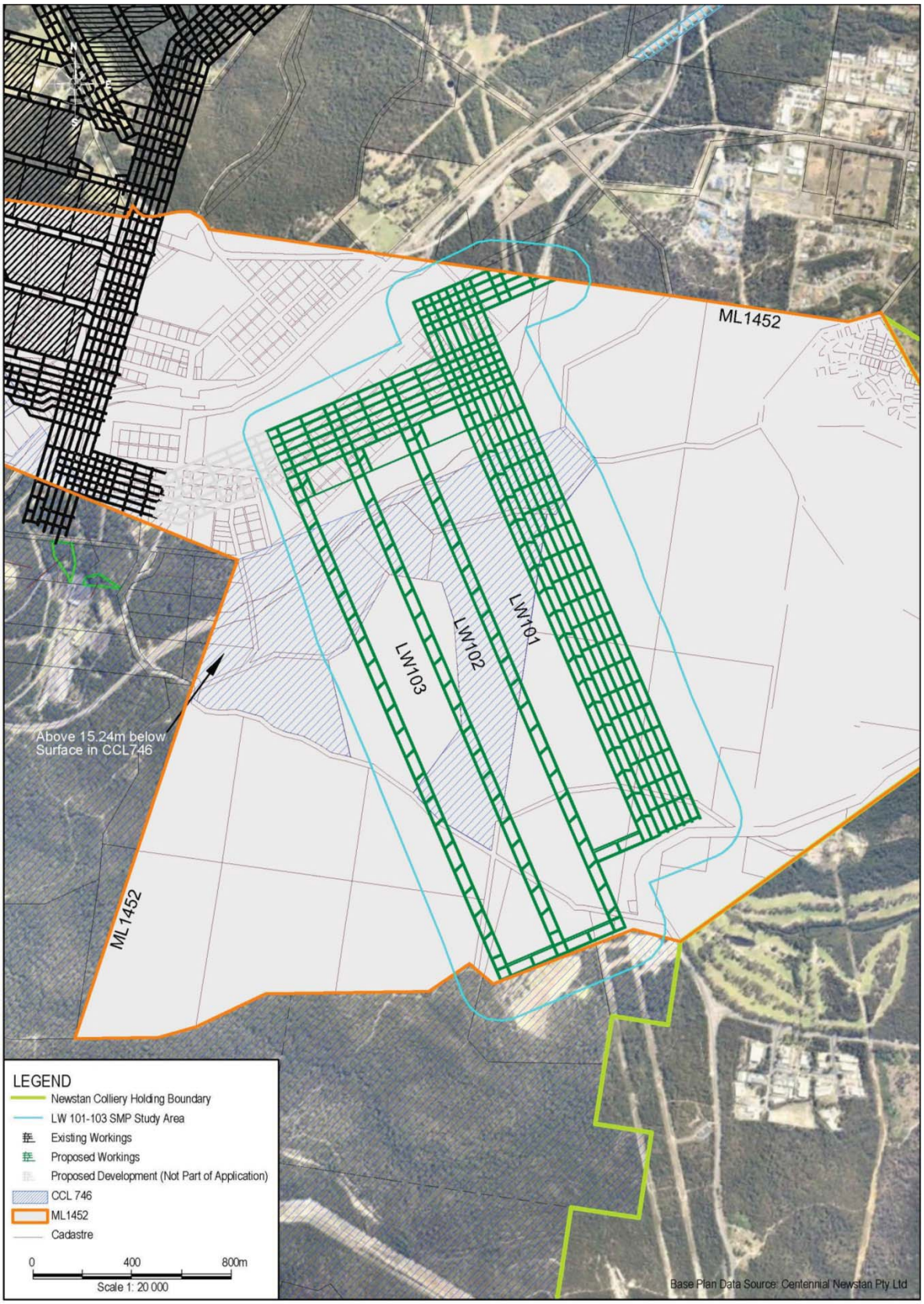
3.4.3.SMP Guidelines

This SMP Application has been prepared generally in accordance with the NSW DPI-MR *'Guideline for Applications for Subsidence Management Approvals'* (December 2003) (herein referred to as the SMP Guidelines).

This report addresses the requirements listed in the above mentioned SMP Guidelines (2003). **Table 3.4** (below) provides reference to the SMP Guidelines and the corresponding sections within this SMP Written Report and supporting application documentation.

Table 3.4 SMP Guidelines & References to this SMP Written Report

SMP Guideline Aspect	SMP Guidelines Section	SMP Written Report Reference
Letter of Application	Section 5	Enclosed with SMP Written Report as Volume 1
Mining system, recovery, statutory requirements, expected subsidence, potential subsidence impacts	Section 6.1	Section 3.4, 5, 7 and 11
Application area description	Section 6.2	Section 3
Mining method, system, seam details recovery, other seams	Section 6.3	Section 5
Site conditions, cover, stratigraphy, lithology, geology	Section 6.4	Section 4
Stability of workings, working height, detail of lithology, geotechnical, geology	Section 6.5	Sections 4 and 5
Surface structures, natural features, monitoring, identification	Section 6.6	Sections 10 and 11
Subsidence predictions, individual features subsidence	Section 6.7	Section 7
Community/Stakeholder consultation	Section 6.8	Section 8
Legislation, approvals, licences	Section 6.9	Section 3.4
Subsidence impacts, impact on increased subsidence, summary Risk Assessment	Section 6.10	Sections 9 and 11
Proposed Subsidence Management Plan	Section 7	See Volume 2 of the application
SMP Plans	Section 9	See Volume 3 of the application
SMP Approved Plan	Section 10	As above



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Mining Leases

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Figure 6 - Mining Lease and Consolidated Coal Leases

4. SITE CONDITIONS OF THE APPLICATION AREA

4.1. SURFACE TOPOGRAPHY

The SMP Study area is comprised mainly of fully forested land with the exception the existing AWMF and a number of power line easements, roads and recreational facilities. The surface levels directly above the longwalls vary from 10m to 120m AHD in elevation, with the highest point being above the northern ends of the proposed longwalls.

The site is located predominantly on the eastern slopes of a northeast-southwest ridgeline and subsequently the majority of runoff from the site flows into Stony Creek to the north, and in the south towards Unamed Creek and Kilaben Creek.

Further detail on the site topography and hydrology of the SMP Study Area and can be examined using the surface contours as contained on **Plan 2**. The watercourses on the site are discussed in more detail in **Section 11.3** of this report.

4.2. DEPTH OF COVER

The depth of cover varies from approximately 210m in the north-west of LW103 to 350m in the south east of LW101. The Young Wallsend and Yard seams generally dip to the south-east at grades of 1 in 20 and up to 1 in 10 in the western area due to localised seam rolls associated with paleochannels and seam splitting. Details of depths of cover are illustrated on **Plan 3**.

4.3. OVERBURDEN STRATIGRAPHY

The SMP Study Area is located in the central part of the Newcastle Coalfield which in turn occupies the north-eastern portion of the Sydney Basin. The strata associated with the coal seams in the project area were laid down during the Late Permian period and comprise the Moon Island Beach, Boolaroo, Adamstown and Lambton formations. Refer to **Table 4.1** for further information on SMP Study Area overburden stratigraphy.

Table 4.1 Overburden Stratigraphy of SMP Study Area

<table>
<tr><th>Group</th><th>Formation</th><th colspan="3">Coal Seams</th></tr>
<tr><td rowspan="9">Newcastle Coal Measures</td><td rowspan="2">Moon Island Beach</td><td colspan="3">Vales Point</td></tr>
<tr><td colspan="3">Wallarah
Great Northern</td></tr>
<tr><td>Awaba Tuff</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Boolaroo</td><td colspan="3">Fassifern
Upper Pilot
Lower Pilot
Hartley Hill</td></tr>
<tr><td>Warners Bay Tuff</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Adamstown</td><td colspan="3">Australasian
Montrose
Wave Hill
Fern Valley
Victoria Tunnel</td></tr>
<tr><td>Nobbys Tuff</td><td colspan="3"></td></tr>
<tr><td rowspan="4">Lambton</td><td rowspan="4">West Borehole</td><td rowspan="2">Young Wallsend</td><td>Nobbys</td></tr>
<tr><td>Dudley</td></tr>
<tr><td>Yard</td><td></td></tr>
<tr><td>Borehole</td><td></td></tr>
<tr><td></td><td colspan="4">Waratah Sandstone</td></tr>
</table>

4.4. Location of Proposed Mine Workings in Relation to Future Mine Workings

The combined Young Wallsend/Yard Seams are the only seams within the SMP Study Area that are considered to have any economical mining value and potential. Accordingly, the proposed mining within the SMP Area (current and future) within this combined seam is effectively 'single seam', with no proposed future workings in seams above or below.

The seams that lie above the Young Wallsend/Yard include: Great Northern; Fassifern; Pilot; Hartley Hill; Australasian; Montrose; Wave Hill; Fern Valley and Victoria Tunnel seams. Economic viability (or lack of) for these seams is outlined further in **Section 5.1.**

4.5. Lithological and Geotechnical Characteristics of the Overburden

The overburden consists of the Moon Island Beach, Boolaroo and Adamstown Formations of the Newcastle Coal Measures. The Formations contain sandstone, conglomerate, siltstone, shale and tuff interbedded with a large number of coal seams. The coal seams are highly banded, of inferior quality and are not considered suitable for underground extraction.

In stratigraphic order the Moon Island Beach Formation contains the Wallarah and Great Northern seams, which historically have produced the bulk of domestic thermal coal from the Newcastle Coal Measures. Within the SMP Study Area these seams have split and deteriorated due to the development of sandstone and conglomerate bodies.

The Teralba Conglomerate that sits directly above the Great Northern seam is a thick unit that has been proven to be a stable roof within the neighbouring Awaba Colliery. The conglomerate units contained within the Moon Island Beach Formation have thicknesses ranging from 50 – 90m. The Awaba Tuff that underlies the Great Northern Seam is a significant unit that separates the Moon Island Beach Formation and the Boolaroo Formation.

The Boolaroo Formation is characterised by inconsistent coal seams that are hard to correlate due to the development of alluvial and paleochannel sediments. The Fassifern, Pilot and Hartley Hill seams are high in ash due to deterioration and splitting within the SMP Study Area. The majority of the interburden sediments between the seams are conglomerate, sandstone and siltstone. A minor tuff unit known as the Mount Hutton Tuff lies between the Pilot and Hartley Hill Seams and ranges from 4 – 8m in thickness. The Warners Bay Tuff is a major stratigraphic marker that separates the Boolaroo Formation from the lower Adamstown Formation and ranges in thickness from 2 - 6m within the SMP Study Area.

The Adamstown Formation contains interbedded coal seams, tuff and conglomerates. The Australasian, Montrose, Wave Hill, Fern Valley and Victoria Tunnel seams are subject to splitting and deterioration within the SMP Study Area and in some places have been completely replaced by channel type sediments. The seams are highly banded and high in ash and are considered to have no mining potential. The majority of interburden sediments are conglomerate and sandstone ranging in thicknesses between 20 and 50m.

The Nobbys Tuff is a major stratigraphic marker that separates the Adamstown Formation and the Lambton Formation below, which contains the coal resource. The Nobbys Tuff is usually 1 - 2m thick, however within the SMP Study Area the Nobbys Tuff is generally less than 0.2m due to the introduction of alluvial and channel sediments.

4.6. Lithological and Geotechnical Characteristics of the Roof and Floor Strata

Geotechnical modelling of the floor strength for the SMP Study Area Main East indicates anticipated floor strength in a range between 30MPa and 70MPa which indicates competent working floor strength. Towards the eastern edge of LW103, moving out of the seam split zone, the floor is comprised of siltstones and mudstones of varying competencies.

The expected roof conditions for the SMP Study Area, as per the geotechnical model, are expected to be between 40MPa and 60MPa in strength which provides adequate roof strength.

There are no known massive units present in the SMP Study Area roof structure that could lead to periodic weighting issues for the longwall. It is expected that longwall support design will be sufficient to create a stable longwall working environment at the selected void width and depth parameters.

4.7. Existence and Characteristics of Geological Structures

Two igneous dykes have previously been encountered in the Newstan workings, one trending south-east and the other trending east-south-east. Several south-east trending dykes located adjacent to the eastern boundary of the SMP study area have been interpreted from historic marine magnetic surveys. To date no dykes have been identified within the SMP Study Area by ground magnetic surveys or exploration. Dykes are not expected to be encountered within the SMP Study Area. A review of mapped faults at Newstan and the adjacent Awaba and Myuna Collieries showed a

dominant north-westerly direction which is consistent with the regional trend in the Newcastle Coalfield.

The majority of these faults strike at 315 +/- 15 degrees and are normal in nature. Approximately 95% of these faults have vertical throws of less than 3m. This style and magnitude of faulting is expected to persist across the SMP Study Area. A fault with greater than 3m throw is possible within the area based on statistical analysis. There is a seven (7) metre fault running in a north to south direction on the eastern side of the SMP Study Area east of the mains. However, none of the exploration boreholes have encountered any other faults within the area at seam level. Geological structures applicable to the SMP Study Area are shown on **SMP Plan 5**, contained in Volume 3 of the SMP Application.

5. MINING SYSTEM AND RESOURCE RECOVERY

5.1. COAL RESOURCE

Geological exploration and mining operations at Newstan have historically targeted the Great Northern, Fassifern and West Borehole seams. They belong to the Moon Island Beach, Boolaroo and Lambton formations respectively which are located within the Newcastle Coal Measures. The target coal resources for the SMP Study Area occur within the lower part of the Newcastle Coal Measures and are a combination of the **Young Wallsend seam** (which comprises the Nobby's and Dudley seams) **and part Yard seam** as illustrated in **Figure 7**.

The seams which lie stratigraphically in the middle sections of the Newcastle Coal Measures (above the Young Wallsend/Yard Seam), including the Great Northern, Fassifern, Pilot, Hartley Hill, Australasian, Montrose, Wave Hill, Fern Valley and Victoria Tunnel seams, are considered to have little economic value as they are higher in ash and less continuous. Exploration drilling within the SMP Study Area, both historical and recent, have shown these seams have deteriorated, split and are of poor quality. Exploration drilling in the area has further confirmed this. Coal quality testing of the upper seams has been carried out in historic boreholes, with tests showing the seams to be high in ash (generally >40%) as they are highly banded and mostly contain coals that are dull tending to stony. complex patterns of splitting, convergence and deterioration. None of the upper seams are considered economically viable. Pockets of mineable coal may exist however the areas are small and isolated so are not considered economically viable. These are further clarified in **Section 5.6**. The continuity of the Great Northern and Fassifern seams is limited in the east by a north-south zone of deterioration and splitting, seam thinning to the west and south-west and an outcrop to the west and north-west. In the past Newstan has extensively mined both the Great Northern and Fassifern seams with coal reserves largely depleted.

At Newstan, the Young Wallsend and Yard seams generally dip to the southeast at grades of 1 in 20. In the western part of the SMP Study Area, localised seam rolls associated with paleochannels and seam splitting increase the seam grade to 1 in 10 in areas.

Depth of cover to Young Wallsend/Yard seam ranges from 210m in the northern end of LW103 up to 350m in eastern end of LW101. Seam thickness increases north-west to south-east with the inclusion of basal plies to the seam. Seam thickness in the SMP Study Area ranges from 2.2m to 3.2m. Proposed extraction heights are detailed in **Section 5.5** further below.

A summary of the dimensions of the proposed longwalls is provided in **Table 5.1.**

Table 5.1 Geometry of the Proposed Longwall Panels

Longwall	Overall Void Length (m)	Overall Void Width including Headings* (m)	Solid Chain Pillar Width (m)
LW101	1770	211	-
LW102	2055	211	40
LW103	2055	211	40

Note *: Overall longwall block secondary extraction width is 200m.

5.2. PROPOSED MINING METHODS AND LAYOUT

Within the SMP Study Area, Newstan proposes to use longwall mining extraction methods to mine the Young Wallsend/Yard seam within LW101 toLW103, in similar fashion to the development of the previously completed LW25. These mining methods have been practised and developed at Newstan since 1984 when longwall mining commenced in the Fassifern seam. In 1990 the longwall was relocated to the Young Wallsend seam where it produced over 38 million tonnes of coal during 18 years of production. Longwall mining has been the preferred mining method at Newstan since 1984 due to favourable extraction rates, caving properties and geological conditions. The proposed longwalls will be accessed via a set of main headings, which consist of seven roads in the Main East driveage and eight roadways in the Main South headings. Access to the SMP Study Area and specifically LW101-LW103 will be gained from the Main East Headings which joins the existing Southwest Headings

Two tunnels, approximately 45m apart, known as gate roads, are driven from the main headings. These gate roads are nominally connected every 100m. A row of pillars are created through this process (i.e. each pillar being approximately 40m wide by 100m long). The gate roads along one side of the panel are called the ‘maingate’. The maingate is used to transport employees and materials, along with ventilation air, to the longwall face. The gate roads on the other side of the panel are called the ‘tailgate’. The tailgate is used to carry return air away from the longwall face and provide a tertiary exit for employees.

There are eight headings proposed on the eastern side of the SMP Study Area to provide for future ventilation requirements of the mine and for flexibility in the mine plan with respect to projected faults in the vicinity. These main headings and gate roads, which are a form of primary extraction (‘first workings’) are designed to be long term stable such that they cause negligible surface subsidence or impacts. The coal in the development headings is cut by an electrically powered continuous miner. As gate roads proceed, the overlying rock strata is secured by roof bolts, which are anchored in holes drilled into the roof, for support after the coal is removed. This process is often referred to as bord and pillar mining.

Coal in the proposed longwall panels, between the gate roads, is extracted using a shearer. This process is referred to as longwall mining, which is a form of secondary extraction. The shearer moves along the longwall face, cutting off a slice of coal and loading it onto a face conveyor. Coal is continually removed during each pass of the shearer.

Large steel hydraulic roof chocks provide a safe working environment during coal extraction. As coal is removed from the longwall face, the roof supports are stepped forward, allowing the roof strata behind to collapse into the area that has been mined, known as the goaf. This process continues until the face of the longwall panel has retreated back to the main headings.

Justification of the mine design and potential constraints is presented in **Section 5.3**, with substantial supporting information and assessment discussed in further detail in **Section 11** and the various specialist investigations in **Appendices 6-10.**

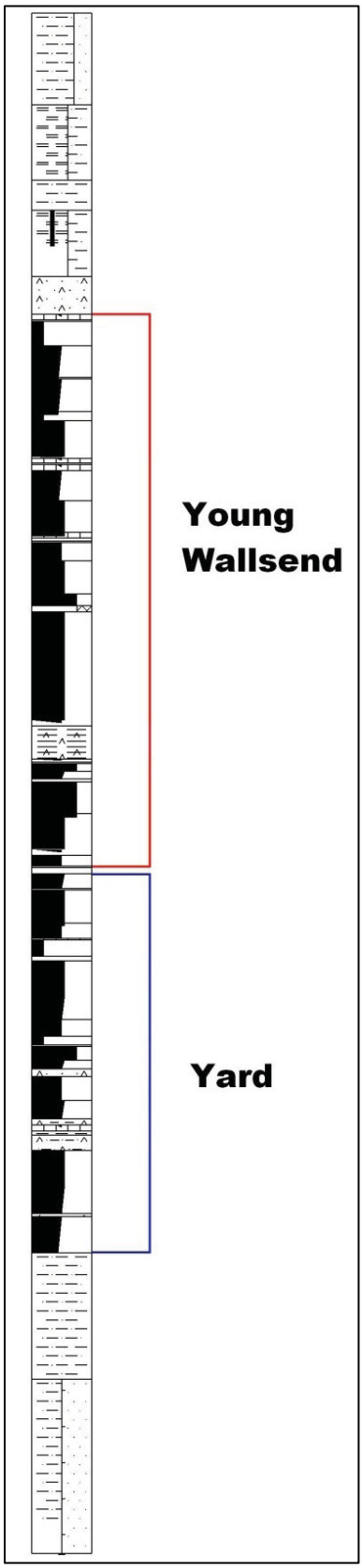


Figure 7 - Typical Geological Log from Newstan Colliery

5.3. JUSTIFICATION OF THE MINE PLAN AND LAYOUT

Longwall extraction is the preferred method for the SMP Study Area after consideration of safety, resource recovery, efficiency, and subsidence issues. This mining system has been performed successfully at Newstan previously for LW1 - LW25.

The proposed mine plan for the SMP Study Area has been selected to achieve the following:

- Provide safe mining conditions;
- Maximise productivity through 200 metre wide longwall;
- Maintain a buffer such that any impacts to infrastructure and the community can be appropriately managed and maintained in a safe, serviceable and repairable condition; and
- Prevent the unnecessary sterilisation of the resource.

Other major factors were considered during the design phase for the proposed longwall layout, including:

- A paleochannel and seam split running north to south through Main East, the access mains to LW101-103. The paleochannel and seam split are west of the proposed longwalls and create limitations to mining including seam height and ash content;
- A seven (7) metre fault running in a north to south direction on the eastern side of the SMP Study Area east of the mains; and
- Softer floor conditions in the east, limiting the use of continuous miner extraction methods.

It is important to note that the mine plan is based on the geological data available at the time of SMP Application and may require refinement upon commencement of operations within the SMP Study Area. The SMP process allows for changes in mine layout without the need for an SMP Application where these changes are not major and impacts are unchanged (DPI, 2003). Newstan intends to revisit the SMP Risk Assessment should changes in mine layout be required and consult with DTIRIS – DRE as to whether a variation is appropriate.

5.4. SCHEDULE OF PROPOSED MINING

The mining schedule for the application area, as determined in the 2012 business plan, is based on the anticipated commencement of main roadway development in Q1 2013. The development schedule indicates that the panel stubs to form the geometry of the longwall blocks will be driven from Q1 2013 and it may be needed to obtain first workings approval for these stubs. It is preferable to drive these stubs during the development cycle to prevent hazardous zone and ventilation issues in the future mine workings. The majority of MG101 is proposed to be developed from Q3 2013 to Q4 2014, ahead of longwall mining operations to commence in LW101 during Q4 2014.

This schedule takes into account development, access, coal clearance, and equipment requirements to provide the safest and most economical means of recovering the coal.

Within the SMP Study Area it is projected that the main headings will be developed on average at a rate of 190m per week, gateroads at 160-240m per week and install roads at 80m per week. Longwall retreat on average is expected to progress at 70m per week (75,000 tonnes per week). An estimated mining schedule including the development and extraction timelines for each longwall panel assuming reasonable mining conditions is depicted in Section **5.2.**

Table 5.2 Mining Schedule

Longwall	Development*	Extraction
LW101	Q3 2013 – Q4 2014**	Q4 2014 – Q3 2015
LW102	Q4 2014 – Q2 2015**	Q3 2015 – Q1 2016
LW103	Q3 2014 – Q2 2015**	Q1 2016 – Q3 2016

Notes:

* Includes the development of main headings and gateroads

** Initial panel stubs to form the geometry of longwall blocks LW101-103 in the northern end of the panels will be driven from Q1 2013 (see **Section 5.4** above)

5.5. Estimated Recovery of the Resource

The approximate total in-situ resource contained within the proposed layout, in the SMP Study Area, is 10.7Mt. The approximate total resource recovery is 6.65Mt, which is 62.15% of the total resource.

It is anticipated that the extraction thickness for LW101 will vary from 2.7m in the north to 3.2 m in the south. LW102 extraction thickness will vary from 2.4m to 3.0m and LW103 will vary between 2.2m and 2.8m. The tonnages depicted below in **Table 5.3** are based on these working heights, with development roadway widths of 5.2m.

Table 5.3 Approximate Extraction and Development Tonnages

Extraction Tonnes (t)	Development Tonnes (t)	Total Tonnes (t)
5,500,000	1,160,000	6,650,000
Note: Based on current geological model, maximum working height of 2.2m – 3.2m and relative density of 1.60t/m^3		

5.6. Mining Other Seams within the Application Area

As introduced in **Section 5.1**, the Young Wallsend/Yard Seam is the only seam within the SMP Study Area that is considered to have any economical mining potential. The remaining seams that lie above the Young Wallsend/Yard are known to be subject to complex patterns of splitting, convergence and deterioration. Coal quality testing of the upper seams has been carried out in historic boreholes. These tests have shown the seams to be high in ash (generally >40%) as they are highly banded and mostly contain coals that are dull tending to stony. None of the upper seams are considered economically viable within the SMP application area.

The Borehole Seam that lies approximately 8-10m below the Young Wallsend/Yard seams is known to be of good quality. However, due to the seam being mostly less than 1.5m in thickness, it is at this time not considered a potential resource.

Mining the Young Wallsend/Yard seam will sterilise all of the seams that lie above it. However, none of the upper seams within the SMP Study Area have been identified as potential resources that are economically viable to mine. As such no viable resources will be impacted upon by the mining of the Young Wallsend/Yard seam.

6. STABILITY OF THE UNDERGROUND WORKINGS

Newstan have not undertaken any previous mining within the proposed SMP Study Area (no existing workings above or below proposed workings). As discussed earlier, no further mining above or below the proposed panels is considered viable. Accordingly, there is no potential for interaction with other workings and the planned mining represents single-seam extraction conditions.

Main headings and gate roads, which are a form of primary extraction, are designed to be long term stable through geotechnical assessment and mine design of roadway dimensions, pillar size and roof support patterns such that they cause negligible surface impacts. This provides a safe work environment for Newstan employees. As gate roads proceed, the overlying rock strata is secured by roof bolts, which are anchored in holes drilled into the roof to create a support beam after the coal is removed.

Longwall mining within proposed panels LW101-103 (between the gateroads), is a form of secondary extraction which is designed to experience subsidence. As coal is removed from the longwall face by means of the shearer, hydraulic roof supports are progressed forward, allowing the controlled collapse of roof strata (caving) into the area that has been mined, known as the ‘goaf’. This process continues until the face of the longwall panel has retreated back to the main headings. Accordingly, potentially affected surface areas above proposed longwall mining are assessed and managed for subsidence within this SMP Application.

7. SUBSIDENCE PREDICTIONS

7.1. INTRODUCTION

Centennial Newstan commissioned specialist assessments for surface feature characterisation, subsidence prediction and impact assessment in support of this SMP Application. Mine Subsidence Engineering Consultants (MSEC), were engaged by Centennial Newstan to:

- provide subsidence predictions for the proposed Longwalls 101 to 103,
- review the natural features and items of surface infrastructure located in the vicinity of the proposed longwalls, details of which were provided by others,
- provide subsidence predictions for each of these natural features and items of surface infrastructure, and
- provide impact assessments, in conjunction with other specialist consultants, for each of these natural features and items of surface infrastructure.

As outlined further in **Section 11** and in **Appendix 4**, MSEC were supported by ACOR Appleyard structural engineering consultants, Northrop Engineers, and Pells Sullivan Meynink (PSM, geotechnical and waste specialists) who assisted in the collection and characterisation of surface infrastructure and building structures, literature reviews and the specialist impact assessments for some natural features and infrastructure (including the Awaba Waste Management Facility).

7.2. GENERAL DESCRIPTION OF SUBSIDENCE PARAMETERS

Key parameters used in the description, prediction and assessment of surface movements resulting from underground mining include subsidence, tilt, curvature, strain, closure and upsidence. An explanation of these key terms is outlined below.

7.2.1. Subsidence

The term ‘subsidence’ usually refers to vertical displacement of a point, but subsidence of the ground actually includes both vertical and horizontal displacements. These horizontal displacements in some cases, where the subsidence is small beyond the longwall goaf edges, can be greater than the vertical subsidence.

Subsidence is usually expressed in units of millimetres (mm) (MSEC 2012). Vertical subsidence is the vertical distance (usually measured in mm) that the ground surface lowers as a result of mining, and depends on the depth of the coal seam, the thickness of the seam, the width of the extraction area and the characteristics of the overburden.

7.2.2. Tilt

Tilt is the change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.

7.2.3. Curvature

Curvature is the second derivative of subsidence, or the rate of change of tilt, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections.

Curvature is usually expressed as the inverse of the Radius of Curvature with the units of 1/kilometres (km^{-1}), but the value of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in kilometres (km) (MSEC 2012).

7.2.4.Strain

Strain results from horizontal movements in the strata. It is determined by calculating the horizontal change in length from two set points on the ground and dividing this by the original horizontal length of that section. The length of land (bay length) is also typically one twentieth of the depth of cover. If the section has been lengthened, the ground is in tension, referred to as tensile strain. If the section has been shortened, the ground is in compression, referred to as compressive strain. The unit adopted for strain is millimetres per metre (mm/m).

7.2.5.Valley Closure

Closure is the reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in mm, is the greatest reduction in the distance between any two points on the opposing valley sides (MSEC 2012).

7.2.6.Upsidence

Upsidence is the reduced subsidence, or relative uplift within a valley which results from the dilation or buckling of near surface strata at or near the base of the valley. The magnitude of upsidence, which is typically expressed in mm is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain (MSEC 2012).

7.2.7.Far-field Subsidence

The measured horizontal movements at survey marks which are located beyond the longwall goaf edges and over solid unmined coal areas are often much greater than the observed vertical movements at those marks. These movements are often referred to as far-field horizontal movements.

Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. These movements generally do not result in impacts on natural features or built environments, except where they are experienced by large structures which are very sensitive to differential horizontal movements.

In some cases, higher levels of far-field horizontal movements have been observed where steep slopes or surface incisions exist nearby, as these features influence both the magnitude and the direction of ground movement patterns. Similarly, increased observed horizontal movements are often observed around sudden changes in geology, or where blocks of coal are left between longwalls, or near other previously extracted series of longwalls. In these cases, the levels of observed subsidence can be slightly higher than normally predicted, but these increased movements are generally accompanied by very low levels of tilt, curvature and strain (MSEC 2012).

The features that are located outside of the SMP Study Area which may be sensitive to far-field movements may include the following:

- Main Northern Railway;
- Bridges; and
- Survey Control Marks.

7.2.8.Subsidence Prediction Methodology

The subsidence prediction methodology used by MSEC (2012, refer **Appendix 4**) is described below.

The predicted conventional subsidence parameters for the proposed longwalls were determined using the Incremental Profile Method (IPM), which was developed by MSEC. The standard IPM is an empirical model based on a large database of observed monitoring data from previous mining within

the Southern, Newcastle, Hunter and Western Coalfields of New South Wales. Subsidence predictions made using the standard IPM use the database of observed incremental subsidence profiles, the proposed longwall geometries, as well as local surface and seam information and geology.

The prediction of subsidence using the IPM is a three stage process where, firstly the magnitude of each increment is calculated, then, the shape of each incremental profile is determined, and finally the total subsidence profile is derived by adding the incremental for each longwall in the series (MSEC 2012). The shapes of the incremental subsidence profiles are then determined using the large empirical database of observed incremental subsidence profiles for the Newcastle Coalfield. Comparisons of the predicted total subsidence profiles, obtained using the IPM, with observed profiles, indicate that the method provides reasonably, if not, slightly conservative predictions where the mining geometry and overburden geology are within the range of the empirical database (MSEC 2012).

Early research shows that there were significant differences in subsidence behaviours within the Newcastle and Southern Coalfield's (Kapp 1984 and Holla 1987, cited in MSEC 2012). It was postulated that the presence of massive strata, especially conglomerate channel units, in the Newcastle Coal Measure resulted in lower subsidence for a given width to depth (W/H) ratio. The geology within the SMP Study Area were not found to have the near seam conglomerates adequately developed to seriously affect the longwall mining process. As a result, no subsidence reduction factors have been applied to the subsidence predictions, based on the geological review of the conglomerate units in the overburden (MSEC 2012).

MSEC initially developed the IPM subsidence prediction curves for the Newcastle Coalfield during 1996 – 1998, which was based on extensive data from the Newcastle Coalfield and since then extensive additional data pertaining to the Newcastle and Hunter Coalfields has been collected, which further supports the IPM subsidence prediction curves (MSEC 2012).

MSEC has reviewed the available monitoring data from previously extracted longwalls at nearby collieries of Teralba and West Wallsend, where the regional geology is reasonably similar, with specific attention to the West Borehole Seam and Young Wallsend Seam. Based on comparisons along the selected monitoring lines at Newstan, Teralba and West Wallsend Collieries, it appears that the IPM, based on the standard IPM subsidence prediction curves for the Newcastle Coalfield, provides reasonable predictions of subsidence, tilt and curvature. It has not been considered necessary to provide any specific calibration of the standard IPM subsidence prediction curves for the proposed longwalls LW101-LW103.

7.2.9. Prediction Reliability

The IPM is based upon a large database of observed subsidence movements in the Hunter and Newcastle Coalfields and has been found to give reasonable, if slightly conservative results in most cases (MSEC 2012). The IPM should, therefore, provide realistic and possibly conservative predictions of conventional subsidence, tilt and curvature for the proposed longwalls (MSEC 2012). The predicted profiles obtained using this method also reflect how each parameter varies over the mined area and indicates the movements that are likely to occur at any point on the surface.

The predictions for the proposed longwall panels LW101-LW103 were made using the IPM based on the standard IPM subsidence prediction curves for the Newcastle Coalfield. The standard model provides reasonable predictions when compared with observed movements along monitoring lines above previously extracted longwalls at Newstan, West Wallsend and Teralba Collieries (MSEC 2012).

The prediction of the conventional subsidence parameters at a specific point is more difficult. Variations between predicted and observed parameters at a point can occur where there is a lateral

shift between the predicted and observed subsidence profiles, which can result from seam dip or variations in topography. In these situations, the lateral shift can result in the observed parameters being greater than those predicted in some locations, whilst the observed parameters being less than those predicted in other locations (MSEC 2012).

The prediction of strain at a point is even more difficult as there tends to be a large scatter in observed strain profiles. It has been found that measured strains can vary considerably from those predicted at a point, not only in magnitude, but also in sign, that is, the tensile strains have been observed where compressive strains were predicted, and vice versa. For this reason, the prediction of strain in MSEC 2012 has been based upon a statistical approach.

The tilts, curvatures and strains observed at the streams are likely to be greater than the predicted conventional movements as a result of valley related movements. It is also likely that some localised irregularities will occur in the subsidence profiles due to near surface geological features. The irregular movements are accompanied by elevated tilts, curvatures and strains, which often exceed the conventional predictions. In most cases, it is not possible to predict the locations or magnitudes of these irregular movements. For this reason, the strain predictions provided in MSEC 2012 have been based upon a statistical analysis of measured strains at Newstan, as well as from other nearby collieries including West Wallsend and Teralba, including both conventional and nonconventional anomalous strains.

The IPM approach allows site specific predictions for each natural feature or item of infrastructure and hence provides a more realistic assessment of the subsidence impacts than by applying the maximum predicted parameters at every point, which would be overly conservative and would yield an excessively overstated assessment of the potential subsidence impacts (MSEC 2012).

7.3. RESULTS OF SUBSIDENCE PREDICTIONS

7.3.1. Subsidence

The predicted total conventional subsidence after the extraction of LW101-LW103 is expected to be to range from 800mm to 1200mm. The maximum predicted conventional subsidence of 1200mm represents 47% of the extraction height. The predicted conventional subsidence parameters vary across the SMP Study Area as the result of, amongst other factors, variations in the longwall geometry and the depth of cover.

Table 7.1 Maximum Predicted Total Conventional Subsidence After the Extraction of Each of the Proposed Longwalls

Longwalls	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
After LW101	800	10	0.20	0.20
After LW102	1000	13	0.25	0.45
After LW103	1200	16	0.40	0.60

7.3.2. Curvature

The predicted curvatures (hogging and sagging) are the maxima at any time during or after the extraction of each of the proposed longwalls. The maximum conventional hogging and sagging curvatures are 0.4 km^{-1} and 0.6 km^{-1} respectively. This represents minimum radii of curvature of 2.5 kilometres and 1.7 kilometres respectively (MSEC 2012).

7.3.3. Tilt

The predicted tilts are the maxima after the completion of each of the proposed longwalls. Therefore, the maximum predicted conventional tilt is 16mm/m (i.e. 1.6%), which represents a change in grade of 1 in 65.

7.3.4. Strain

The maximum predicted conventional strains, based on applying a factor of 10 to the maximum predicted curvatures, are 4mm/m tensile and 6mm/m compressive. It is expected, however, that localised and elevated strains will exceed the predicted conventional strains as a result of irregular ground movements. For this reason, a statistical distribution of strain has been provided in the report by MSEC (2012) to illustrate the range of potential strains.

7.3.5. Valley Closure and Upsidence

The valley related upsidence and closure for the project have been determined for the water courses using the method outlined in ACARP Research Project No. C9067 (MSEC 2012). An assessment of valley related movements has been segregated into two areas.

The steeper upper reaches of the watercourses (1st and 2nd order, but excluding Kilaben Creek) have maximum predicted valley related movements of 300mm upsidence and 400mm closure. The flatter lower leaches of the watercourses (3rd, 4th order and including Kilaben Creek) have maximum predicted valley related movements of 150mm upsidence and 200mm closure (MSEC 2012).

7.3.6. Far Field Horizontal Movements

In addition to the conventional subsidence movements that have been predicted above and adjacent to LW101 - LW103, it is also possible that far-field horizontal movements will be experienced during the extraction of the proposed LW101 - LW103 (MSEC 2012).

An empirical database of observed incremental far-field movements has been compiled using monitoring data from the NSW coalfields, but predominantly from the Southern Coalfield. The observed far-field horizontal movements resulting from longwall mining were generally observed to be orientated towards the extracted longwalls, with the magnitudes decreasing with distance from mining. At very low levels of far-field horizontal movements, however, there was a high scatter in the orientations of the observed movements (MSEC 2012).

7.3.7. Non-Conventional Ground Movements

It is likely that non-conventional ground movements will occur within the SMP Study Area, due to near surface geological conditions, steep topography and valley related movements. These non-conventional movements are often accompanied by elevated tilts, curvatures and strains which are likely to exceed the conventional predictions.

In most cases, it is not possible to predict the exact locations or magnitudes of the non-conventional anomalous movements due to near surface geological conditions. For this reason, the strain predictions provided in the MSEC report are based on a statistic analysis of measured strains in the Newcastle Coalfield, including both conventional and non-conventional anomalous strains.

7.4. IMPACT ASSESSMENT BASED ON INCREASED SUBSIDENCE

Section 6.10.3 of the SMP Guidelines outlines the following criterion for areas/surface features in the Application area that should be assessed based on increased subsidence predictions. This criterion is outlined below:

1. Where there are any significant uncertainties and/or significant potential deviations from the subsidence predictions and/or from the impacts assessment, due to factors such as topographic, geological/hydrogeological, geotechnical or any other site condition variations or uncertainties;
2. Where there are uncertainties in the assumptions used, which may significantly affect the outcome of subsidence predictions and/or impact assessments;
3. Where the consequences of the expected subsidence impacts are likely to be severe to the community and the environment, even though the probability for the expected impacts to occur may be low; and
4. Any other circumstances where the use of increased subsidence predictions is appropriate for the development of subsidence management and/or contingency plans.

The following natural and built features have been assessed based on increased subsidence predictions:

- Watercourses;
- Rock outcrops;
- Steep slopes;
- Roads;
- Bridges;
- Culverts;
- Water infrastructure;
- Electrical infrastructure;
- Telecommunications infrastructure;
- School;
- Private infrastructure (Country club, Target club, Automobile club);
- Dams;
- Waste Management Facility; and
- Archaeological sites.

It is noted, that many of these features did not require assessments based in increased predictions, in accordance with the requirements of Section 6.10.3 of the SMP Guidelines, but have been provided regardless.

8. CONSULTATION

Consultation in regards to mining first commenced for exploration from 2008 with subsequent consultation and modifications for infill drilling exploration and project development through to 2012. The following section outlines details of stakeholder consultation undertaken by Newstan Colliery during the preparation of this SMP Application. Consultation has been completed in accordance with Section 6.8 of the SMP Guidelines.

The definition of "Community" adopted for the purpose of developing the SMP community consultation strategy, is anyone with an interest in subsidence issues for the proposed SMP application, as outlined further in **Section 8.1**. This prudently includes potential stakeholders located both within and beyond the SMP Study Area conservatively established for the project (beyond the angle of draw for secondary extraction) as described earlier in **Section 3.1**of this report.

Accordingly, stakeholder engagement has conservatively included potentially directly affected stakeholders as well as some beyond the affected area. Consultation with government and the broader community has also been undertaken. The stakeholder identification and consultation process undertaken for this SMP is described in detail in the following sections, with a summary of the outcomes of consultation provided in **Appendix 5**.

8.1. STAKEHOLDER IDENTIFICATION

A Stakeholder Engagement Plan was prepared by Newstan Colliery in January 2011 which included consultation engagement for longwall mining within the current SMP Study Area. The Stakeholder Engagement Plan identified relevant stakeholders and consultation strategies. As a well-established mine operating in the surrounding area for over 125 years, in addition to stakeholder identification specifically for the SMP Study Area, Centennial Newstan has also built upon a well-established register of existing stakeholders generated during operations in surrounding areas. The mine has an active *Community Consultation Committee (CCC)* which has also been consulted throughout the preparation of the SMP.

Stakeholder analysis included the use of a risk based approach to identify key areas of environmental significance, built infrastructure and land ownership within the SMP Study Area so that appropriate stakeholders could be accurately identified and engaged. In accordance with the requirements of the SMP Guidelines, this analysis included consideration of stakeholders who have an interest or concern about subsidence issues related to the proposed mining project, including, where appropriate (but not limited to):

- Owners and/or users of the land, agricultural, industrial, commercial and business establishments and residential buildings in the Application Area;
- State and local government agencies whose interests or responsibility may be affected by the potential subsidence impacts arising from the proposed mining operation; and
- Aboriginal communities that may be affected by the potential subsidence impacts arising from the proposed mining operation.

Table 8.1 SMP Study Area Stakeholders

Organisation	Relevance to SMP Area	Affected Panel(s)
DTIRIS Division of Catchment and Lands (Previously Land and Property Management Authority (LPMA))	Crown Lands	LW101-103 and SMP Study Area
Lake Macquarie City Council (roads and culverts)	Wilton Road, Bridges and associated drainage	LW102-LW103
LMCC – Awaba Waste Management Facility	AWMF (including proposed expansion area)	LW102, LW103
NSW Aboriginal Land Council	Aboriginal-owned lands	LW103, SMP Study Area
Eraring Energy	Private Haul Road	LW101-103
Roads & Maritime Services (former RTA)	Wangi Road	LW101 (Beyond 20mm subsidence Contour
Railcorp	Main Northern Rail Line	Beyond SMP Study Area and 35^{o} Angle of Draw*
Ausgrid	132kV and high and low voltage powerlines, substation	LW101&102
AAPT	Optic Fibre (aerial)	LW101, 102
Telstra	Optic Fibre (buried) Copper Cable	LW 103 LW 101, 102
Newcastle Lake Macquarie Clay Target Club	Clay Target Club	LW102, 103
Westlakes Automobile Club	Automobile club	LW103
Toronto Country Club	Golf Club	LW101, 102 (beyond 20mm subsidence contour)
Toronto Adventist Centre	School and Church	LW101 SMP Study Area (beyond 20mm subsidence contour)
Hunter Water	Water and sewerage pipelines	LW101-103

Organisation	Relevance to SMP Area	Affected Panel(s)
Other Government & Community Stakeholders:		
Newstan Community Consultation Committee (CCC)		
DTIRIS – Division of Resources and Energy (DRE)		
Office of Environment and Heritage		
NSW Office of Water		
Mine Subsidence Board		

Note *: As described in ML1452

8.2. ABORIGINAL STAKEHOLDER GROUPS

Aboriginal groups were identified through the implementation of Aboriginal Cultural Heritage Consultation Requirements for Proponents (ACHCRs) (DECCW 2010). As a result of the implementation of the ACHCR process, five Aboriginal groups registered an interest in the consultation process regarding mining operations associated with Newstan as detailed below in **Table 8.2.**

Table 8.2 Aboriginal Stakeholder Groups

Aboriginal Stakeholder Groups*	Relevance to SMP Study Area
West Lakes Aboriginal Community (formerly the Koompahtoo LALC)	Aboriginal cultural heritage sites within the SMP Study Area
Awabakal Descendants Traditional Owners Aboriginal Corporation (ADTOAC)	Aboriginal cultural heritage sites within the SMP Study Area
Awabakal Traditional Owners Aboriginal Corporation (ATAO)	Aboriginal cultural heritage sites within the SMP Study Area
Cacatua Culture Consultants (CCC)	Aboriginal cultural heritage sites within the SMP Study Area
Wonnarua Nation Aboriginal Corporation	Aboriginal cultural heritage sites within the SMP Study Area and requirements of an Indigenous Land Use Agreement (ILUA)

* Note: the NSW Aboriginal Land Council is also listed as a stakeholder in **Section 8.1** with respect to land ownership within the SMP Study Area.

In addition to the ACHCR process, Centennial Newstan holds an Indigenous Land Use Agreement (ILUA) over the SMP Study Area with the Wonnarua People. The ILUA details specific consultation requirements with the Wonnarua People regarding Centennials operations. Centennial has and will continue to consult with the Wonnarua People in accordance with the requirements of the ILUA. Full details pertaining to consultation with Aboriginal stakeholders is provided within the specialist report by RPS contained in **Appendix 9**.

A telephone discussion was held with representatives from the NSW Aboriginal Land Council on 9 May 2012 to provide an introduction to the project with additional information provided by email on 9

May 2012. Opportunities were provided to the NSW Aboriginal Land Council to discuss any issues or concerns in more detail however no further meeting has been requested.

8.3. STAKEHOLDER CONSULTATION

Stakeholder consultation undertaken during the preparation of the SMP Application was undertaken in accordance with the requirements of the SMP Guidelines. Newstan Colliery has undertaken consultation with relevant State Government authorities, Local Government, Aboriginal groups and private stakeholders in preparation of the SMP Application as depicted above in **Table 8.2**.

8.3.1. Overview of SMP Consultation Strategy and Process

A stakeholder consultation strategy has been implemented by Newstan during the SMP Application process. This process has been summarised in **Table 8.3.**

Table 8.3 Stakeholder Consultation Strategy

Key Consultation Actions	Mode of Consultation
Develop stakeholder register to include relevant stakeholders as identified in stakeholder analysis.	-
Contact Stakeholders to discuss project in general and arrange a meeting where required to discuss proposed project in more detail.	Telephone/Email/Letter
Conduct face to face meeting with stakeholders to discuss the project which included: • PowerPoint presentation on background to mining and subsidence; and • Discussion of mine plan • Discussion of predicted impacts • Discussion of any issues or concerns	Face to face meeting with stakeholders Site Visits
Briefing of SMP Application to the Newstan Community Consultation Committee (CCC)	CCC Meetings
Advertise intent to submit and SMP Application for approval in a local & state newspaper in accordance with SMP Guidelines	Newspaper advertisements
Make SMP publicly available following submission in accordance with SMP Guidelines	Website, and hardcopy
Respond to any submissions once the SMP is available for stakeholder comment (as per SMP Guideline Requirements)	-

The following details the various aspects of the consultation strategy that has been implemented by Centennial Newstan with the parties listed in **Table 8.1 and 8.2**, and the outcomes are presented in **Appendix 5**.

Stakeholder Consultation Register and Log

A stakeholder register specific to the SMP Study Area was prepared following stakeholder analysis and identification. The stakeholder analysis undertaken included the use of a risk based approach to

establish potential stakeholders for the project. Additionally stakeholders were identified in accordance with the requirements of Section 6.8.1 of the SMP Guidelines and using the experience obtained by Newstan staff during consultation for past projects.

The register will be maintained and utilised during development and operations where appropriate in the implementation of related management plans (including notification requirements etc).

A detailed stakeholder consultation register was maintained detailing all consultation undertaken by Newstan throughout the preparation of the SMP Application. A summary of the outcomes of consultation is provided in **Appendix 5**.

Stakeholder Discussions and Meetings

Over the period since December 2011 to June 2012, Newstan conducted face-to-face meetings with a number of stakeholders to present the proposed SMP application.

The discussions typically included an overview of Newstan's operations, a background to longwall mining, details on the proposed mine plan, the predicted subsidence levels, potential impacts and proposed management, mitigation or remediation measures that could be considered for inclusion within related management plans.

Community Consultation Committee

Newstan Colliery has an established Community Consultation Committee that meets every 3 months. Centennial Newstan provides regular updates on the progress of all mining operations and projects to the CCC. Presentations to the CCC regarding the SMP application were provided on 15th November 2011, 28th February 2012 and 29th May 2012.

Briefing Session

On 14th March 2012 Centennial Coal held a briefing session at the Centennial Fassifern office to discuss a number of projects currently being investigated by the mine. The Briefing Session included a discussion on the Newstan SMP application and was attended by representatives from:

- NSW Office of Water
- Office of Environment and Heritage (OEH)/ Environmental Protection Authority (EPA)
- DTIRIS – Division of Resources and Energy (DRE)
- DTIRIS – Catchments and Lands (formerly LPMA)
- NSW Department of Planning and Infrastructure;

Newspaper Articles Centennial Coal provides regular project updates in the local Lakes Mail newspaper. Articles regarding the Newstan SMP application were provided in the Lakes Mail in March 2012, June 2012 and July 2012. Copies of the articles are provided in **Appendix 5**.

SMP Advertisements

In accordance with the requirements of the SMP Guidelines, Newstan Colliery prepared and posted an advertisement in a local and state newspaper. This advertisement was prepared in order to advertise Newstan's intent to submit an SMP Application for approval to DTIRIS – DRE and to seek community interest in the project. The advertisement included a map of the SMP Study Area, details stating where and when the SMP Application can be viewed and information about where submissions concerning the SMP Application may be sent.

The advertisement was displayed in *The Land* newspaper (state) and also the *Lakes Mail* newspaper (local) on Thursday 23rd August 2012. Copies of these advertisements have been attached in **Appendix 5**.

8.3.2.Consultation Outcomes

Key outcomes of the stakeholder consultation process undertaken by Centennial Newstan for the SMP are presented in **Appendix 5**.

It is noted that detailed consultation undertaken with LMCC specifically for the Awaba Waste Management Facility (AWMF) is discussed separately in **Section 8.3.3**.

8.3.3. Consultation Process for the Awaba Waste Management Facility

Newstan has undertaken extensive consultation with LMCC in relation to longwall mining, the SMP application and any potential impacts on the AWMF. A number of meetings have been held with LMCC and a technical team of personnel and specialists from both parties assembled to understand the landfill design criteria so that potential impacts from undermining can be appropriately assessed and managed. Following the characterisation meetings, Newstan engaged in a joint risk assessment with LMCC to determine the risk profile of the interaction between the two projects.

The consultation process with the LMCC and AWMF will continue through to the development and submission of the *Awaba Waste Management Facility Management Plan*.

Newstan have undertaken consultation with LMCC and directly with management from the AWMF with regard to potential impacts associated with undermining the AWMF. This process has been summarised in **Table 8.4** below.

Table 8.4 LMCC and AWMF Consultation Strategy

Key Consultation Actions	Mode of Consultation
Develop stakeholder register to include LMCC and AWMF.	
Contact LMCC and AWMF to arrange meeting to discuss proposed mine plan.	Telephone
Conduct face to face meeting with LMCC and AWMF to discuss the project which included: • PowerPoint presentation on background to mining and subsidence; and • Discussion of mine plan • Discussion of predicted impacts • Discussion of any issues or concerns	Face to face meeting with LMCC and AWMF.
Agreement to develop a project team which included representatives from LMCC, AWMF, Newstan and specialist consultants (**Table 9.1)**	Face to face meetings, telephone and emails
Undertake an initial technical team meeting with the AWMF project team to discuss potential impact from undermining AWMF and requests for further information.	Face to face meeting
Site inspection undertaken by MSEC, ACOR Appleyard, PSM, Newstan at AWMF to characterise infrastructure.	Face to face

Key Consultation Actions	Mode of Consultation
Exchange of information from each party's information request list	Exchange of information via electronic copies (incl email, CD and website) and hardcopies
Undertaken second technical meeting to discuss any issues further or provide additional information prior to commencement of combined AWMF risk assessment	Face to face
Conduct a combined preliminary risk assessment for the AWMF and AWT	Risk Workshop with stakeholder and specialists, Refer to **Section 9.2**

As an outcome from the above process and the preliminary risk assessment, an Action Plan for the AWMF is being developed with LMCC to formalise additional works required (primarily to address residual information gaps). Following the completion of the additional works described within the AWMF Action Plan (refer **Section 9 and Section 11.4** for details), it is intended that the technical teams will revise and update the preliminary risk assessment in order to prepare the *AWMF Management Plan* in consultation with LMCC prior to commencement of LW102. Further discussion is provided in **Sections 9.2** and **11** of this report.

9. RISK ASSESSMENT

This SMP Application for LW101-103 at Centennial Newstan was developed using a risk-based approach in accordance with Section 6.10.3 of the SMP Guidelines.

The risk assessment process undertaken specifically for the SMP Study Area comprised two key components. The first component is the primary SMP Risk Assessment undertaken at the commencement of the project which is detailed in **Section 9.1**.

Subsequent to this, a detailed but preliminary risk assessment was also undertaken specifically for the Awaba Waste Management Facility (AWMF) in consultation with LMCC, as detailed in **Section 9.2.**

The purpose of both risk assessments was to identify potential issues that, in the absence of further investigation or assessment to fill information gaps or inadequacies in existing management measures, had the potential to present a risk to the natural environment and built features. Therefore, the risks identified do not necessarily reflect the final residual risks to natural and built features, but more importantly identify the *knowledge gaps* associated with the identified risk at the start of the project which require further investigation in order to further assess and appropriately manage potential subsidence impacts whilst undermining an active waste management facility.

9.1. SMP STUDY AREA RISK ASSESSMENT

In accordance with the SMP Guidelines, a risk-based approach was specifically undertaken for the project, including a dedicated SMP Risk Assessment. As outlined above, the risk assessment for the LW101-103 SMP Study Area was undertaken at the start of the project to identify potential issues that, in the absence of further investigation or assessment to fill information gaps or inadequacies in existing management measures, had the potential to present a risk to the natural environment and built features. A copy of the risk assessment report is included in **Appendix 6**.

A risk assessment workshop for the SMP Study Area was originally undertaken by Centennial Newstan on 7th November 2011 to consider six (6) Longwall Panels (LW101-LW106). The mine plan for the SMP Application was subsequently updated to only incorporate LW101-103 to align with the 2012 Business Plan and specific commitments within the 1998 EIS. Upon update of the mine plan for the current SMP Application, the risk assessment was reviewed to only incorporate three (3) longwall panels LW101-LW103.

The risk assessment involved a team with wide ranging experience consisting of members from Centennial Coal, Newstan Colliery staff, key stakeholders and specialist consultants (a list of attendees is included in the SMP Risk Assessment Report in **Appendix 6**). The risk assessment was conducted in accordance with the following relevant guidelines and standards:

- AS/NZ ISO 31000:2009 Risk Management – Principles and Guidelines;
- SMP Guidelines (DTIRIS 2003) – Section 6.10.2 Risk Assessment;
- MDG1010 – Minerals industry safety and health risk management guideline;
- MDG 1014 – Guide to Reviewing a Risk Assessment of Mine Equipment and Operations;
- Centennial Coal's Risk Management Standard, implementing a Workplace Risk Assessment and Control (WRAC) method of assessment; and
- Dyadem Stature for Risk Assessment.

The risk assessment conservatively considered if there were any adverse consequences from the proposed project. The worst case scenario assessment allowed for focus on the key risk aspects if identified and, subsequently, consideration under the base case scenario (expected mining predicted

subsidence scenario) of whether the identified risks and controls required further consideration and assessment.

The risk assessment process undertaken at the start of the project identified at total of 21 potential risks (3 significant, 7 moderate and 11 low risks), from which aspects requiring further investigation to address knowledge gaps or mitigation measures were identified. As mentioned earlier above, it is noted that these are not actual *residual risks* posed to built features or the environment as they were undertaken as a screening level assessment for knowledge gaps prior to further detailed investigations. Priority risks for further investigation, consideration and management (ranked as significant or medium) have been listed below. Please refer to the full report in **Appendix 6** for all risks identified including final risk ranking definitions.

Potential Risks ranked as significant:

- Potential damage to roads or a public safety risk due to a damaged road;
- Potential damage to AWMF and
- Potential damage to power poles and power lines

Potential Risks ranked as moderate:

- Public safety;
- Damage to privately owned infrastructure;
- Areas of high environmental, heritage or archaeological significance;
- Natural water features such as surface water and drainage lines;
- Catchment areas causing or exacerbating erosion and drainage pattern changes;
- Loss of groundwater affecting groundwater dependant ecosystems;
- The damage to private property.

Accordingly, subsequent to the above process, detailed investigations were then undertaken to further investigate and address these identified potential risks which include the following:

- Infrastructure characterisation by civil-structural engineering consultants to assist subsidence impact assessment (Northrop and ACOR Appleyard). Characterisations are presented within the MSEC report below and **Sections 10 and 11** of this report;
- subsidence predictions and impact assessment (MSEC) – refer to **Section 7** & **Section 11** and **Appendix 4**;
- SMP Groundwater Impact Assessment (GHD) – refer to **Section 11.3** and **Appendix 8**;
- SMP Surface Water Impact Assessment (GHD) – refer to **Section 11.3** and **Appendix 10**
- SMP Flora and Fauna Assessment (RPS) – refer **Section 11.3** and **Appendix 7**
- SMP Aboriginal and European Cultural Heritage Assessment (RPS) – refer **Section 11.3** and **Appendix 9**

9.2. AWABA WASTE MANAGEMENT FACILITY PRELIMINARY RISK ASSESSMENT

The initial SMP project risk assessment detailed in **Section 9.1** showed that the potential risk to the AWMF was ranked as significant as a result of a knowledge gap with regard to the landfill design and previous practices undertaken at the landfill.

In order to adequately address the knowledge gaps of the landfill a project technical team was developed which included the following participants:

Table 9.1 AWMF Project Technical Team

Organisation	Project Role
Centennial Newstan	Mining proponent and project coordination
Lake Macquarie City Council	Existing facility owner, Planning and approvals for expansion of the AWMF (incl AWT)
Awaba Waste Management Facility (AWMF) - Site Representative	Site Operator
Mine Subsidence Engineering Consultants (MSEC)	Subsidence Specialists
Pells Sullivan Meynink (PSM)	Geotechnical, Subsidence and Landfill Specialist
ACOR Appleyard	Structural Engineering and Infrastructure Specialist
GHD – Waste Management and Resource Recovery	Landfill design and management specialists, Project Managers for the EIS for AWMF expansion & AWT
Mine Subsidence Board (MSB)	Consulted due to location within Mine Subsidence District
GHD – Water Services Group	Groundwater and Surface water specialists
GSS Environmental	Subsidence Management Approvals Consultants

It is noted that subsequent to the technical team investigations, further consultation with related stakeholders including DTIRIS - DCL is an ongoing process as part of actions toward the development of the *AWMF Management Plan* outlined further below.

A Preliminary Risk Assessment for the AWMF was undertaken in conjunction with Newstan, LMCC/AWMF and project consultants over a two day period on 15 May 2012 and 21 May 2012 to undertake a preliminary assessment of the potential subsidence impact of extraction of the longwalls on the existing facility.

The risk assessment also included assessing the potential impact of secondary extraction to the proposed extension of the landfill as well as on the proposed Alternative Waste Treatment (AWT) facility. This assessment considered risks associated with mine subsidence impacts on the AWMF and AWTF and assessed them based on conservative **worst case scenario** outcomes, and used to conservatively determine the need for further studies or the need to establish additional strategies to manage potential risks. A further risk assessment to determine the operational risk profile will be conducted once the AWT contractor is appointed.

For context, specialist studies by MSEC (2012) suggest that even if subsidence curvatures occur at double the rate predicted, it would be unlikely that continuous fracturing would occur from the seam to the surface (see MSEC 2012, **Appendix 4**). As discussed in consultation with DTIRIS, notwithstanding this the AWMF preliminary risk assessment still prudently assessed risks based on

the unpredicted and extremely unlikely scenario of ***assuming continuous fracturing*** to surface (worst case scenario assessment).

The risk assessment involved a team with wide ranging experience which was conducted in accordance with the following relevant guidelines and standards:

- LMCC Risk Matrix, implementing a Workplace Risk Assessment and Control (WRAC) method of assessment;
- AS/NZ ISO 31000:2009 Risk Management – Principles and Guidelines;
- SMP Guidelines (DTIRIS 2003) – Section 6.10.2 Risk Assessment;
- MDG1010 – Minerals industry safety and health risk management guideline;
- MDG 1014 - Guide to Reviewing a Risk Assessment of Mine Equipment and Operations; and
- Dyadem Stature for Risk Assessment

The risk assessment considered if there were any adverse impacts to the AWMF from the proposed longwall mining. . A conservative 'worst case' approach was undertaken using assumptions beyond predictions for fracturing of the surface and subsurface.

A total of 74 potential risks aspects were identified and assessed. Whilst some of the risks identified included residual risks, a number of risks identified knowledge gaps requiring further investigations. Notwithstanding this, it was agreed by the Joint Technical Group that the potential subsidence impacts were all manageable, and that the further investigations would include assessment of a range of technical options for management to identify preferred paths for LMCC and Centennial Newstan.

The range of investigations will form an *Action Plan* for the AWMF with LMCC, from which a final plan of management for the facility developed with LMCC (AWMF Management Plan) ahead of undermining.

Key priority risks for assessment and management identified for the AWMF have been listed below:

- Increased risk of localised cracking of the existing unlined waste cell.
    - This potential risk will be reassessed once knowledge gaps requiring further investigation are completed and subsidence monitoring of ground strains in LW101 confirm the accuracy of the subsidence predictions model for later mining under the landfill.
- Increased risk of cracking clay pond lining system of the existing secondary leachate storage pond;
- Increased risk of localised cracking of the existing lined waste cell; and
- Weighbridge going off-level;

Accordingly, these potential risks have been subject to impact assessments presented within the SMP Application and further investigations with LMCC under the *Action Plan* ahead of preparation of the final *AWMF Management Plan* prior to undermining.

Refer to Section 11.4 of the SMP Written Report for further information on the AWMF.

Refer to **Sections 11.4 and 10.2** for further information on the AWMF.

10. IDENTIFICATION OF SURFACE AND SUB-SURFACE FEATURES WITHIN THE APPLICATION AREA

The following sections identify and describe all significant natural and man-made features that lie within the SMP Study Area. These significant features have been identified in accordance with the SMP guidelines.

The following sources have been used to confirm the features present within the SMP Study Area:

- Recent Aerial Photography (2011);
- Centennial Newstan GIS database;
- Desktop review of available information;
- Surveys and inspections of waterways;
- Site surveys by mine surveyors;
- Visual surveys by Newstan staff and contractors (including GSSE, MSEC, Northrop Engineers, ACOR Appleyard, RPS, PSM and GHD);
- Flora and fauna surveys;
- Cultural heritage surveys;
- Stakeholder consultation;
- Dial Before You Dig (DBYD) search submission;
- Checks of development applications currently lodged with LMCC;
- Previous experience and local knowledge of the area by mine personnel; and
- Information provided by public utilities.

10.1. MINE SUBSIDENCE DISTRICTS

The SMP Study Area lies entirely within the West Lake Mine Subsidence District. Section 6.6.1 of the SMP Guidelines requires that all built structures constructed before the declaration of the Mine Subsidence District be identified, so far as practicable. It also requires the identification of any proposed developments within SMP Study Area which are known to be proposed within the next seven (7) years, as discussed separately in **Section 10.2** below.

The West Lake Mine Subsidence District was proclaimed on 11th July 1979. Consultation with the Mine Subsidence Board (MSB) and an assessment of the built structures located within the SMP Study area did not identify any structures approved by Council constructed prior to July 1979.

10.2. PROPOSED DEVELOPMENT

Identification of proposed developments within the next seven years within the SMP Study Area (as required by the SMP Guidelines) was undertaken by:

- Consultation with various stakeholders (via the Stakeholder Engagement Plan) during preparation of the SMP Application, including landowners, lessees and infrastructure owners within the SMP Study Area;
- Search of the Lake Macquarie City Council (LMCC) website for lodged Development Applications;
- Consultation with the Mine Subsidence Board;

Following the above, consultation with LMCC identified two key proposed projects relating to proposed additions to the Awaba Waste Management Facility (Council landfill) and a proposed Alternative Waste Treatment Facility east of the existing landfill as outlined in **Section 8** and described further in **Sections 10.2.1** and **10.2.2** below. Consultation with Ausgrid also identified that the existing timber 132kV transmission line poles within the SMP Area (refer **Section 11.3**) are being considered by Ausgrid for replacement with concrete poles. Further consultation with Ausgrid will be

conducted, with reference to the concrete poles, during the preparation of the *Electrical Surface Infrastructure Management Plan.* The Mine Subsidence Board will be notified, where required, if the decision to replace the timber poles is made. The search and consultation process did not identify any other applications currently lodged with LMCC or any other currently proposed developments.

10.2.1. Awaba Waste Management Facility Proposed Additions

The Awaba Waste Management Facility (AWMF) is a Category 1 landfill site, which was commissioned in 1986 and is licenced for 'waste disposal' and 'composting' (full details for the existing landfill, including existing leachate and landfill gas management systems, are provided in **Section 11.4**). LMCC's projections demonstrate that, as of 2010, the existing landfill has approximately 4-6 years of landfill volume remaining which constitutes approximately 880,000 m3 (LMCC 2010).

LMCC is proposing to expand the current landfill capacity primarily through the creation of two additional landfill cells. The proposed project footprint is illustrated on **Figure 8** and falls within the existing cadastral boundary on Lot 372//DP723259.

LMCC lodged a *Preliminary Environmental Assessment (PEA)* (DA10_0139) under Part 3A of the EP&A Act for additions to the AWMF with the NSW Department of Planning and Infrastructure (DP&I) in July 2010. Director General's Requirements (DGRs) were issued by DP&I on 22nd September 2010 (including requirement to consult with the Mine Subsidence Board (MSB)), following which LMCC has been preparing an Environmental Assessment (EA) to support the proposed additions to the landfill. As at the time of submission of this SMP Application, Centennial Newstan understands that the Environmental Assessment has been submitted to DP&I for adequacy review against the DGRs, prior to finalising the EA for formal public exhibition.

In summary, the AWMF extension project comprises the following elements (as proposed within the PEA lodged for the extension):

- Excavation of two areas within the boundaries of the site, to provide two additional landfill cells that will result in a higher maximum height for the entire landform on-site.
- The excavation of the two areas (Area A and Area B on **Figure 8** in **Section 11.4**), in combination with space provided over the existing landfill footprint, will provide approximately an overall additional combined airspace of 3,504,000m³ (4,080,000 tonnes) on-site, and extend the lifespan of the landfill by approximately 24 years;
- removal of native vegetation;
- retention of excavated soil on-site for daily cover;
- a leachate containment and management system;
- a surface water management system and quality control measures (including expansion of the existing sediment basin and an additional sediment basin in Area B);
- ground water and landfill gas monitoring network;
- landfill gas recovery for electricity generation or flaring;
- green waste processing areas; and,
- continuation of landfilling within the approved landfill cells and air space provisions, issued under Part 4 of EP& A Act, and infrastructure associated with existing on-site operations.

With respect to leachate management, it is understood that the existing secondary leachate pond (Area A on **Figure 18**) is proposed to be decommissioned, with construction of a new leachate pond to the south-west of the site with a 6 to 8 ML capacity supported by a new leachate management system to service the extension of Area A and Area B.

The proposed development also intends to maintain perimeter bush fire and maintenance tracks around the proposed landform as well as boundary buffer zones to adjoining lands. Additionally, the proposed development will improve and introduce further leachate containment and management,

and surface water infrastructure (LMCC, 2010). Consultation with LMCC identified that connection to mains sewerage (Hunter Water) is being considered for the facility.

The additions to the AWMF waste emplacement cells will extend primarily from northwest to northeast of the existing landfill (but within the cadastral boundary) as illustrated on **Figure 8**. For context, the existing landfill waste emplacement cells are located primarily over LW103 and fringe LW102 (not directly undermined but within the angle of draw). The extension will increase the disturbance footprint further eastward over secondary extraction areas of LW102.

The proposed changes will involve clearing of a portion of remnant native vegetation on the existing 32.5 hectare site. A referral was submitted by LMCC under the Commonwealth *Environmental Protection and Biodiversity Conservation (EPBC) Act* in May 2011 (with subsequent variation in November 2011) to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) to confirm if the proposed project is a *'Controlled Action'* (in relation to impacted threatened species) and identify Commonwealth assessment and approval requirements (Ref: 2011/5973). Centennial understands that SEWPaC has confirmed the project is a Controlled Action and therefore requires assessment and approval under the EPBC Act before it can proceed, and that the required assessment process will be in accordance with the NSW EP&A Act (ie the Environmental Assessment being prepared for the project). LMCC identified in the referral that it was exploring a suitable offset site in consultation with SEWPaC & NSW Office of Environment & Heritage (OEH), including the adjacent Lot 373 (recently acquired by LMCC). Centennial Newstan will consult with LMCC, SEWPaC and relevant agencies to ensure resource recovery for the mine is appropriately maintained.

As part of the proclaimed mine subsidence district, it is understood that the MSB will require LMCC to design the proposed extensions to specified subsidence parameters and design requirements (within the Environmental Assessment). Accordingly, whilst the proposed works by LMCC have been considered in this SMP application in context of forward planning and risk management, subsidence impact assessments for the AWMF presented within the SMP Application have conservatively assessed the existing AWMF, as described in detail in **Section 11.4**.

As discussed earlier in **Section 9**, Newstan has worked with LMCC and the MSB during the preparation of this SMP (and continues to) in establishing a detailed risk-based process for managing subsidence for both the existing landfill and the proposed extensions. This has been facilitated through a technical working group of representatives for both LMCC and Centennial Newstan as outlined in detail in **Section 9.2**. Details characterising the landfill and expected subsidence impacts are provided in **Section 11.4.**

10.2.2. Proposed Alternative Waste Treatment (AWT) Facility

During consultation for this SMP, LMCC has identified that a second and separate project has commenced to prepare and submit an Environmental Impact Statement (EIS) to accompany a Development Application to the NSW Department of Planning and Infrastructure (DP&I) under Part 4 of the EP&A Act for construction of an *Alternative Waste Treatment (AWT) Facility.*

The AWT Facility will provide organic resource recovery, and diversion of waste from landfill that will help extend the life of Council's landfill. It is understood that the proposed AWT will be situated above panels LW102 and LW103 within the SMP Study Area, in remnant native bushland located on Lot 373//DP723259 (immediately east of the existing landfill on Lot 372). Lot 373 was recently acquired by LMCC as identified in **Section 3.2**. The footprint of the existing and proposed landfill along with the proposed AWT is shown in **Figure 8.** As at the time of submission of this SMP Application, a formal Development Application and accompanying EIS has not yet been lodged with NSW DP&I.

Prior to commencing the NSW planning approval process, on 19th June 2012 LMCC has submitted a referral under the EPBC Act to SEWPaC to confirm Commonwealth approval requirements for the

proposed AWT project (Ref: 2012/6432). On 27th July 2012 SEWPaC confirmed the proposed AWT is a *'Controlled Action'* under the EPBC Act, and subsequently, assessment of environmental, heritage and biodiversity aspects will be required to satisfy Commonwealth requirements before it can proceed. SEWPaC have identified the project will be assessed by preliminary documentation. This process is separate and in addition to future NSW environmental planning requirements issued by DP&I and related agencies under the EP&A Act when a Development Application is ultimately lodged for the project.

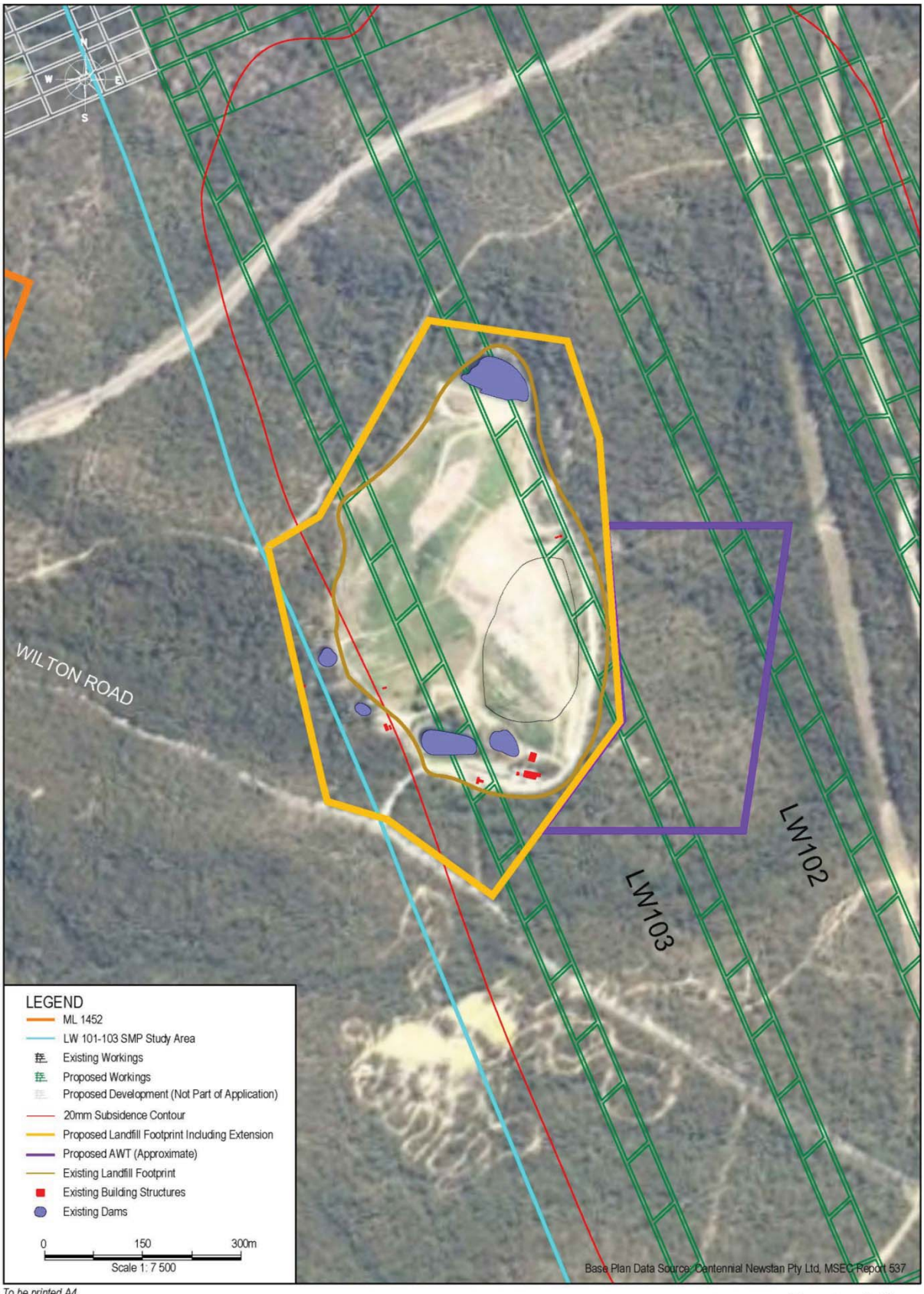
From preliminary information provided during consultation and within the EPBC referral documents by LMCC (2012), it is understood that the proposed AWT development includes the construction of a waste treatment facility to compost between 60,000-100,000 tonnes of source-separated organic waste annually utilising an aerobic in-vessel process. The proposed AWT facility in the EPBC referral is described as comprising:

- a weighbridge;
- covered or enclosed waste pre-sorting areas;
- covered compost rows or enclosed compost tunnels;
- a bio-filter for odour control;
- a maturation area, consisting mainly of a concrete pad for storage of product;
- storage area for garbage vehicles; and,
- a waste and resource recovery education facility.
- The project also includes the following ancillary infrastructure:
    - internal roadways;
    - stormwater and leachate management works;
    - amenities building and staff parking facilities; and
    - stormwater and process water storage ponds and bushfire management works.
- Proposed access to the site will be via the existing AWMF. A purpose built weighbridge may be constructed separate to the existing weighbridge for the landfill site (LMCC 2012).
- The proposed AWT is likely to require the removal of 6.64 hectares of existing vegetation to accommodate the development, earth batters and buffers to surrounding bushland.
- Levelling of the land will be required for the creation of the building pad and for roadwork.

Following consultation, it is understood that LMCC is considering options for biodiversity offset requirements for the disturbance footprint (expansion) into native bushland on Lot 373 for the AWT, including proposing offset areas within the remainder of Lot 373, part of adjacent Lot 372 (existing AWMF) and all of Lot 463 (south side of Wilton Road). Centennial Newstan will consult with LMCC, SEWPaC and relevant agencies to ensure resource recovery for the mine is appropriately maintained. **Figure 8**shows the footprint of the currently proposed AWT is predominantly located within LW102-103 (north-eastern corner located on the gateroad between LW101 and LW102).

As part of the proclaimed mine subsidence district, when the project is lodged with DP&I, the MSB will require LMCC to design the proposed AWT to specified subsidence parameters and design requirements. Accordingly, whilst the proposed works by LMCC have been considered in context of forward planning and risk management in this SMP Application, subsidence impact assessments for the AWMF presented within the SMP Application have focused on the existing AWMF, as described in detail in **Section 11.4**.

As noted earlier above, Newstan has worked closely with LMCC and the MSB during the preparation of this SMP (and continues to) in establishing a detailed risk-based process for managing subsidence for both the existing landfill and the proposed changes presented within **Section 10.2**. This has been facilitated through a technical working group of representatives for both LMCC and Centennial Newstan as outlined in detail in **Section 9.2**. Details characterising the existing landfill and expected subsidence impacts are provided in **Section 11.4.**



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Newstan Colliery
Awaba Waste Management Facility Existing & Proposed Landfill Footprint

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Environmental, Land and Project Management Consultants

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Figure 8 - Existing and Proposed footprint of AWMF

10.3. SURFACE AND SUB-SURFACE FEATURES

During the preparation of this SMP Application, an assessment was undertaken to identify any surface and sub-surface features that may be affected by underground coal mining within the SMP Study Area. The following list has been compiled in accordance with Appendix B of the SMP Guidelines.

The results of this assessment are provided in **Table 10.1** below. It is noted that the Study Area conservatively established for the LW101-103 SMP extended beyond the minimum angle of draw and predicted subsidence zone and subsequently some features lying just within the Study Area may not necessarily be impacted (particularly in the east and southeast). All features have been considered regardless and these are characterised and assessed for potential subsidence impact in detail in **Section 11** of this report (including further specialist investigations for the SMP where appropriate).

Table 10.1 Surface and Sub-surface Features within the SMP Study Area

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
Item 1 - Natural Features			
Catchment areas and declared special areas	No	The SMP Study Area is not within a drinking water catchment or declared special area. The SMP Study Area lies within the catchment of Lake Macquarie (saline).	
Rivers and creeks	Yes	There are a number of watercourses located within the SMP Study Area which includes six (6) Schedule 2 watercourses, four 3rd Order and two 4th Order streams located within or adjacent to the SMP Study Area.	11.4.1 Appendix 10
Aquifers, known groundwater resources	Yes	The groundwater resources in the vicinity of LW101-103 occur in low yielding shallow alluvium, underlying fractured rock and coal seams with groundwater depths ranging from 1-3 metres and aquifer thickness generally less than five metres. The groundwater varies from brackish to slightly acidic with anticipated minimal beneficial use and low yields.	11.4.2 Appendix 8
Springs	No	There are no natural springs located within the SMP Study Area	
Sea/lake	No		
Shorelines	No		
Natural dams	No		
Cliff/pagodas	No	There are a number of rock outcrops identified within the SMP Study Area,	11.4.3

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
		mainly across the northern ends of the proposed longwalls, however there are no defined cliff lines or pagodas.	
Steep slopes	Yes	The steep slopes are generally located along the ridgeline located in the northern part of the SMP Study Area predominantly over LW101-102. The grade of the steep slopes typically ranges between 1 in 3 to 1 in 2 with isolated areas having natural grades of 1 in 1.5.	11.4.4
Escarpments	No		
Land prone to flooding or inundation	Yes	There are 3rd and 4th order creeks within the SMP Study Area located across LW101-103 which could be susceptible to localised flooding and inundation	11.4.5
Swamps, wetlands, water related ecosystems	Yes	Swamp Mahogany Paperbark Forest (EEC located over the southern end LW101-103. may potentially be influenced by groundwater or be partially groundwater dependent.	11.4.7
Threatened and protected species	Yes	A total of five (5) threatened fauna species and four (4) flora species have been identified within the SMP Study Area.	11.4.6
National parks	No		
State recreation areas	No		
State Forests particularly areas zoned FMZ 1, 2 and 3	No		
Natural vegetation	Yes	A total of four (4) vegetation communities (plus cleared land) were found to occur within the SMP Study Area, with Swamp Mahogany / Paperbark Forest vegetation community listed under the TSC Act (1985) as an Endangered Ecological Community (EEC). This EEC is located across the southern end of all 3 panels.	11.1.2, 11.4.7
Areas of significant	No		

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
geological interest			
Any other feature considered significant	No		
Item 2 - Public Utilities			
Railway	No	It is noted that the Main Northern Railway lies beyond the 35 degree angle of draw (as per Mining Lease conditions) to the north of the SMP Study Area. Prudently assessment for far-field effects has still been included (refer MSEC 2012).	Appendix 4 (MSEC 2012)
Roads (all types)	Yes	There are two sealed public roads within the SMP Study Area. These include Wangi Road (state managed and located beyond 20mm subsidence contour south of LW101), and Wilton Road (LMCC managed, located over LW102 and LW103). There is one sealed private haul road (owned by Eraring Energy) located within the SMP Study Area traversing LW101-103. There are minor access tracks and driveways within the SMP Study Area for which service the Newcastle Lake Macquarie Clay Target Club and the Westlakes Automobile Club.	11.3.1
Bridges	No	There are no bridges located within the SMP Study Area. There are road bridges beyond the SMP Study Area in the local vicinity of the proposed longwalls (Wilton Rd, Eraring Haul Rd) which may experience far field horizontal movements and have been considered within this SMP.	11.3.2
Tunnels	No		
Culverts	Yes	There are a total of seven (7) culverts located within the SMP Study Area One is located on the private haul road (owned by Eraring energy), but beyond the 20mm subsidence contour. Four culverts are located on Wilton Road (LMCC managed), three of which are located above longwalls 102	11.3.3

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
		and 103, with the fourth located outside of the 20mm subsidence contour. Two culverts are located on Wangi Rd (state managed), however both are beyond the 20mm subsidence contour.	
Water / gas / sewerage pipelines	Yes	A temporary 50mm polyethylene pipeline is located at along the western gateroads of LW103 which provides town water to the AWMF. Another temporary 50mm polyethylene pipeline is located alongside Wangi Road which services the Toronto Adventist Centre and the Toronto Country Club which is located outside of the 20mm subsidence contour.	11.3.4
Liquid fuel pipelines	No		
Electricity transmission lines (overhead / underground) and associated plants	Yes	There are 132kV transmission lines owned by Ausgrid which cross directly over LW101-102 which are supported by dual timber poles. Some of these poles are proposed to be replaced with concrete poles best able to cope with the subsidence profile. The Rathmines 132/11kV Substation, owned by Ausgrid, is located partially within the SMP Study Area, south of LW101-102, and west of Wangi Rd, however it is located outside the 20mm subsidence contour.	11.3.5
Telecommunication lines (overhead / underground) and associated plants	Yes	There is an aerial optic fibre cable owned by AAPT located along the eastern branch of the 132kV transmission line. There is a buried optic fibre cable owned by Telstra which follows Wilton Road and provides services to the AWMF. A Telstra owned buried copper communications cable is located north of Wangi Road which provides services to the Toronto Country Club and the Newcastle Lake Macquarie Clay target Club.	11.3.6
Water tanks, water and	No	There are no public water tanks, water	Section 11

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
sewerage treatment works		or sewerage treatment works. There are private (business)properties within the SMP Study Area that have private water tanks and septic systems	(including 11.3.7-11.3.9, 11.3.11-12, 11.4)
Dams, reservoirs and associated works	No	There are no public dams, reservoirs or associated works. There are three farm dams within the SMP Study Area	Section 11 (including 11.3.11-11.3.14, 11.4)
Air strips	No		
Any other infrastructure items	No		
Item 3 – Public Amenities			
Hospitals	No		
Places of worship	Yes	The Toronto Adventist Centre has a church which is located 300m east of LW101 beyond the predicted limit of vertical subsidence.	11.3.7
Schools	Yes	The Toronto Adventist Centre has a school which is located ~300m east of LW101 beyond the predicted limit of vertical subsidence.	11.3.9
Shopping centres	No		
Community centres	No		
Office buildings	No		
Swimming pools	No		
Bowling greens	No		
Ovals or cricket grounds	No		
Race courses	No		
Golf courses	Yes	The Toronto Country Club is located ~120m south-east of LW101 beyond the predicted limit of vertical subsidence.	11.3.10
Tennis courts	No		
Any other public amenities	Yes	The Newcastle and Lake Macquarie Clay Target Club are partially located above the southern ends of LW102-103. The Westlakes Automobile Club is located above the southern end of	11.3.11, 11.3.12

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
		LW103.	
Item 4 – Farm Land and Facilities			
Agricultural utilisation or agricultural suitability of farm land	No	There is no land currently used for farming within SMP Study Area, however bushland private properties with small dams and fence lines do exist.	
Farm buildings or sheds	No		
Tanks	No		
Gas or fuel storages	No		
Poultry sheds	No		
Glass houses	No		
Hydroponic systems	No		
Irrigation systems	No		
Fences	Yes	There are a number of fences located within the SMP Study Area	11.3.13
Farm dams	Yes	There are three farm dams located above main headings on the southern end of LW101 within the SMP Study Area, ranging in area from 30m^2 to 300m^2.	11.3.14
Wells or bores	No	There are no registered groundwater bores within the SMP Study Area, the closest is located at the Toronto Country Club outside the SMP Study Area.	11.3.15
Any other farm features	No		
Item 5 – Industrial, Commercial and Business Premises			
Factories	No		
Workshops	No		
Business or commercial premises	Yes	Business establishments within the SMP Study Area include the Toronto Country Club, Newcastle Lake Macquarie Clay Target Club and the AWMF	11.3.10-11.3.12, 11.4
Gas and / or fuel storage and associated plants	No	It is noted that landfill gas from the AWMF is managed onsite by LMS who generate power from gas engines under contract to LMCC as detailed in	11.4

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
		Section 11.3.4.	
Waste storages and associated plants	Yes	The AWMF is located directly above LW103 which comprises landfill cells which are both unlined and lined	11.4
Buildings, equipment and operations that are sensitive to surface movements	Yes	The AWMF includes a weigh bridge sensitive to ground movements which has been considered in the SMP. The NLM Clay Target Club includes targeting equipment that is sensitive to ground movements.	11.4 11.3.11
Surface mining (open cut) voids and rehabilitated areas	No		
Mine infrastructure including tailings dams and emplacement areas	Yes	The Eraring Energy owned private haul road that connects the Newstan and Awaba Collieries to the Eraring Power Station crosses the northern sections of LW101-103.	11.3.1
Any other feature considered significant	No		
Item 6 – Areas of archaeological and / or heritage significance (including aboriginal)			
Areas of archaeological and / or heritage significance (including aboriginal)	Yes	There are a total of nine (9) registered archaeological sites located within the SMP Study Area. These include five (5) isolated finds, two (2) artefact scatters, one (1) axe grinding groove, and one (1) shelter with possible grinding grooves. There are also three recently identified sites and a culturally sensitive site in the SMP Study Area that are currently being registered with OEH.	11.4.8
Item 7 - Items of Architectural significance			
Items of architectural significance	No		
Item 8 - Permanent survey control marks			
Permanent survey control marks	Yes	There are permanent survey control marks located within the SMP Study Area, with SS77112 located above LW103 and SS77113 located above the southern end of LW102. There is	11.3.19

Feature	Within SMP Study Area*	Detail	SMP Written Report Reference
		one Trigonometrical Station (TS666) located above LW102.	
Item 9 – Residential Establishments			
Houses	No		
Flats or units	No		
Caravan parks	No		
Retirement or aged care villages	No	For reference, the Leisure Life Village retirement facility is located east of the SMP Study Area and well outside the predicted limit of vertical subsidence.	
Associated structures such as workshops, garages, on-site waste water systems, water or gas tanks, swimming pools or tennis courts	No	The business properties within the SMP Study Area have private water tanks and septic systems. The AWMF includes a methane gas recovery system run under contract to LMCC by LMS. There are no residential properties within the SMP Study Area.	11.3.10-11.3.12, 11.4
Any other residential features	No		
Item 10 – Any Other Item of Significance			
Any other Item of Significance	No		
Item 11 – Any Known Future Developments			
Any known future developments	Yes	The AWMF is currently seeking approval for the extension of the landfill area and also for the development of an Alternative Waste Treatment (AWT) facility with associated buildings and infrastructure (east of AWMF).	10.2.1, 11.4

11. CHARACTERISATION AND IMPACT ASSESSMENT OF SURFACE AND SUB-SURFACE FEATURES

11.1. AREAS OF ENVIRONMENTAL SENSITIVITY

Table 11.1 has been provided in order to effectively identify areas of environmental sensitivity within the SMP Study Area as required by Section 6.6.3 of the SMP Guidelines.

Table 11.1 Areas of Environmental Sensitivity

Feature	Within SMP Study Area	Details	Section Reference Number
Land reserved as State conservation area under *National Parks and Wildlife Act 1974*	No	N/A	N/A
Land declared as an Aboriginal Place under the *National Parks and Wildlife Act 1974*	No	N/A	N/A
Land identified as wilderness by the Director NPWS under the *Wilderness Act 1987*	No	N/A	N/A
Land subject to a conservation agreement under *NPWA74*	No	N/A	N/A
Land acquired by Minister for the Environment under *Part 11 of the NPWA74*	No	N/A	N/A
Land within State Forests mapped as Forestry Management Zones 1, 2 or 3	No	N/A	N/A
Wetlands mapped under SEPP14 – Coastal Wetlands	No	N/A	N/A
Wetlands listed under the Ramsar Wetlands Convention	No	N/A	N/A
Lands mapped under SEPP 26 – Coastal Rainforests	No	N/A	N/A

Feature	Within SMP Study Area	Details	Section Reference Number
Areas listed on the Register of National Estate	No	N/A	N/A
Areas listed under the *Heritage Act 1977* for which a plan of management has been prepared	No	N/A	N/A
Land declared as critical habitat under the *Threatened Species Conservation Act 1995*	No	N/A	N/A
Land within a restricted area prescribed by a controlling water authority	No	N/A	N/A
Land reserved or dedicated under the *Crowns Land Act 1989* for the preservation of flora, fauna, geological formations or other environmental protection purposes	No	It is noted that LMCC currently has referrals under the EPBC Act to SEWPaC which propose vegetation offset areas (biobank). These have commenced assessment. Centennial Newstan will seek discussions with all parties to ensure resource recovery is maintained.	3.2, 10.2
Significant surface watercourses and groundwater resources identified through consultation with relevant government agencies	No No	There are a number of watercourses located within the SMP Study Area which includes six (6) Schedule 2 watercourses, four 3rd Order and two 4th Order streams located within or adjacent to the SMP Study Area.	10.3, 11.5.1 11.5.2

Feature	Within SMP Study Area	Details	Section Reference Number
Lake foreshores and flood prone areas	No Yes	There are 3rd and 4th order creeks within the SMP Study Area located across LW101-103 which could be susceptible to localised flooding and inundation. It is noted that the SMP Study Area is located above/beyond the High Water Level Subsidence Control Zone	11.5.1, 11.5.5
Cliffs, escarpments and other significant natural features	No	N/A	N/A
Areas containing significant ecological values	Yes	The SMP Study Area contains species and communities protected under the NSW Threatened Species Act (including EEC) and the Commonwealth Environmental Protection and Biodiversity Conservation (EPBC) Act.	11.5.6, 11.5.7
Major surface infrastructure	Yes	132 kV transmission Lines	11.2.1
	Yes	Optical Fibre Cable Telecommunications (AAPT aerial & Telstra buried); (for completeness also Telstra copper cable).	11.2.6
	Yes	Awaba Waste Management Facility	11.4
Surface features of community significance (including cultural, heritage or archaeological significance)	Yes	Isolated Finds located over AOD, LW101 first workings, LW101, LW102. Artefact Scatter located over LW101 first Workings and LW101. Grinding Groove located over first workings (mains). Rock shelter with possible grinding groove located over LW101.	11.5.8

Feature	Within SMP Study Area	Details	Section Reference Number
Any other land identified by the Department to the titleholder	No		

The following sections provide a brief introduction and overview of each of the identified areas of environmental significance listed in **Table 11.1** above, with further detailed characterisation is referenced throughout **Section 11**.

11.2. MAJOR INFRASTRUCTURE

Within the SMP Study Area, a number of major items of infrastructure have been identified. A brief outline is provided below and details provided in relevant sections within **Section 11.3** and **11.4**.

The major infrastructure identified within the SMP Study Area includes the 132kV transmission lines (LW101-103), electrical substation (outside predicated 20mm subsidence contour near LW103), aerial optic fibre cable (LW101-103), buried optic fibre cable (LW103), buried copper communications cable (LW101-103), Wangi Road (beyond 20mm subsidence contour), Wilton Road (LW102-103), Eraring Private Haul Road (LW101-103), and, in particular, the Awaba Waste Management Facility (LW103, LW102).

The location of the 132kV transmission lines and optical fibre cables (both aerial and buried) are shown in **Figure 9**. The two parallel transmission lines which are owned by Ausgrid, cross directly above LW101 and LW102 with the aerial three phase conductors supported by dual timber poles (refer to **Plate 1**) An optical fibre cable owned by AAPT crosses directly above the proposed LW101. The cable is aerial which is supported by the eastern branch of the 132kV transmission line (MSEC 2012). A second (separate) buried optical fibre cable owned by Telstra is located over LW103 to the AWMF as illustrated on **Figure 9.** The cable runs south from Awaba village alongside Wilton Road to service the Awaba Waste Management Facility (cable understood to terminate there, no downstream users expected). The cable is characterised in further detail in **Section 11.3.6.**

Plate 1 - Photograph of a 132 kV Transmission Line (courtesy of MSEC)

The Awaba Waste Disposal Facility (AWMF) is a Category 1 landfill site operated by the Lake Macquarie City Council. The existing facility is located directly above LW103 and a small portion over LW102. Proposed changes to the AWMF are described in detail in **Section 10.2**. The facility disposes of household wastes, privately transported residential rubbish, construction and municipal wastes and some industrial wastes. The AWMF has been a key aspect of the SMP and is detailed within a dedicated section as presented in **Section 11.4**.

Further detailed characterisation and potential subsidence related impacts for these features are discussed in **Sections 11.3.5** (Transmission Lines), **Section 11.3.6** (Telecommunication lines/ Fibre Optic Cables), and **Section 11.4** (Awaba Waste Management Facility).

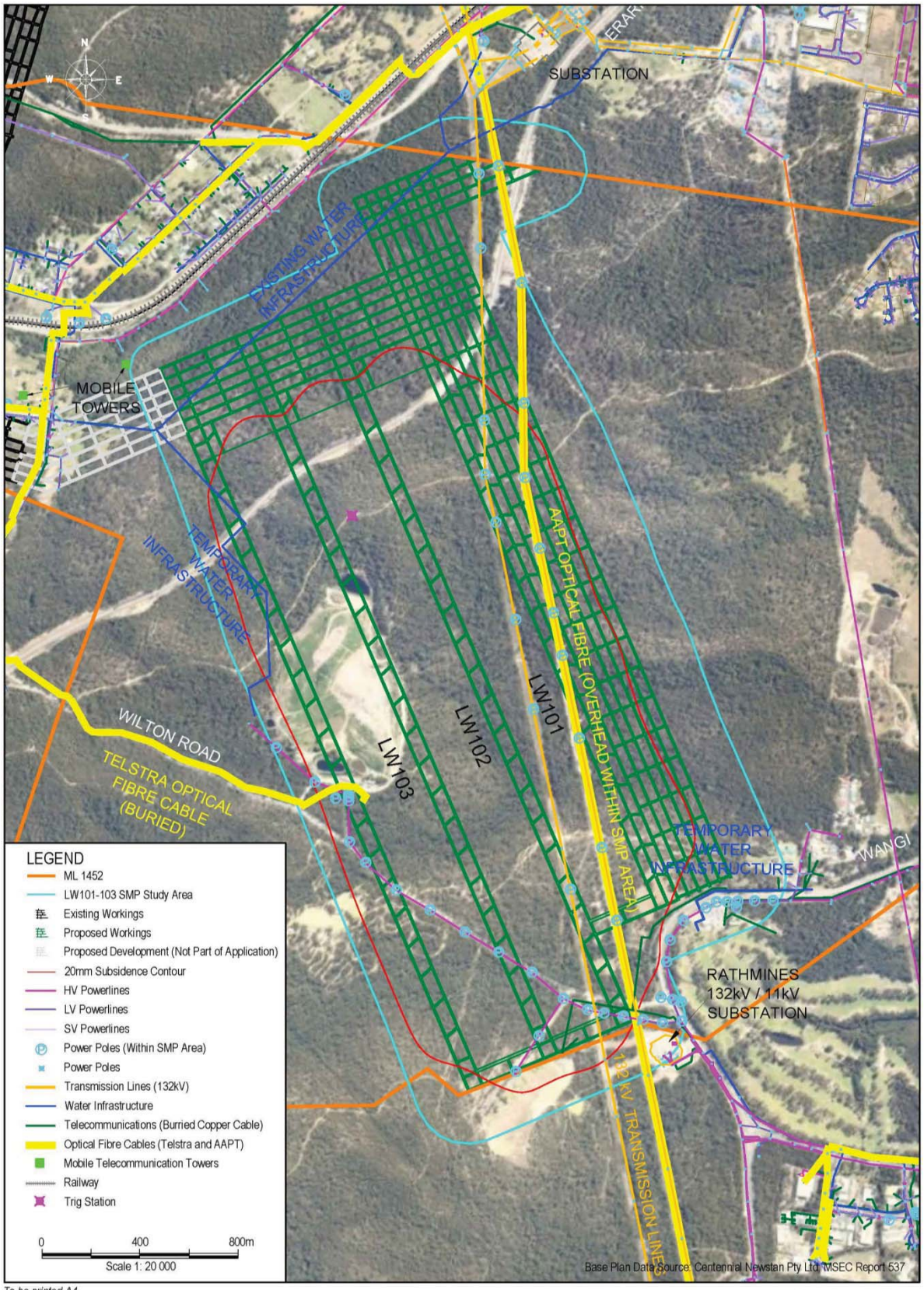


Figure 9 - Man Made Features- Infrastructure (utilities)

11.3. BUILT FEATURES

This section outlines built features relevant to the SMP Study Area in accordance with Appendix B of the SMP Guidelines. Built features primarily include all infrastructure, including roads, culverts, electricity transmission lines and substations, telecommunication lines, the church, school, golf course, clay target club, automobile club and a waste management facility (refer to **Figure 13**). Built features relevant to the SMP Study Area have been identified through the use of the following: Newstan GIS database, literature review, aerial photographs, a 'Dial Before You Dig' search, ground truthing, risk assessment process, and stakeholder consultation. It is noted that whilst some infrastructure items are located within the conservatively established Study Area for the SMP, not all items are located within the predicted potential subsidence impact zone (e.g. substation, church and school as noted in **Table 10.1** in **Section 10**). These are clarified in detail in the following sections.

Extensive investigations were undertaken for the SMP Study Area by civil-structural engineering consultants ACOR Appleyard and Northrop Engineers as part of the SMP Subsidence Assessment (MSEC 2012, refer **Appendix 4**) to appropriately characterise all built features for assessment of potential subsidence impact by MSEC. ACOR Appleyard were commissioned to characterise major infrastructure in the SMP Study Area and Northrop Engineers to characterise other infrastructure, as outlined in **Table 11.2** below. Characterisation works undertaken typically included:

- Desktop 'Dial Before You Dig' buried services searches;
- Data acquisition direct from private or public authorities;
- Detailed liaison with MSEC to satisfy data requirements for subsidence impact assessment;
- Field inspection by engineers for detailed data acquisition in consultation with stakeholders where required.
- Photographic record of infrastructure (baseline where appropriate);
- Development and provision of mapping of infrastructure locations to MSEC and Centennial.

Table 11.2 Built Features Characterisation

Major Infrastructure Characterisation (Acor Appleyard for MSEC)	**Other Infrastructure Characterisation** (Northrop Engineers for MSEC)
Roads, Bridges and associated drainage culverts, (incl public and private roads).	Toronto Country Club (golf club)
Powerlines (including pole construction and footings), Electrical Substation	Awaba & West Lakes Automobile Club WAC
Communications (copper cable and fibre optic)	Toronto Adventist Centre (school and church)
Water and wastewater utilities	Newcastle and Lake Macquarie Clay Target Club
Awaba Waste Management Facility (supported by specialist advice from PSM)	Any other supporting utilities & services infrastructure identified during DBYD searches on each property.
Any other major infrastructure identified during DBYD searches.	

11.3.1. Sealed Roads

Characterisation

There are a total of two public roads (Wilton Rd and Wangi Rd) and one private road (Eraring Haul Rd) that lie within the SMP Study Area (refer to **Figure 10**). There are also other minor unsealed roads and access tracks located across the SMP Study Area (including maintenance access tracks within powerline easements), which could experience the full range of predicted subsidence movements.

An outline of the stakeholder consultation process with Eraring Energy, RMS and LMCC pertaining to the presence and management of roads within the SMP Study Area that was undertaken during the preparation of this SMP Application has been described in **Section 8**.

Public Roads:

Wangi Road which is administered by the RMS (Roads Maritime Services, formerly Roads & Traffic Authority (RTA)) is located within the conservative angle of draw directly south of the main headings and approximately 100m south of LW101, with no proposed longwall mining to be undertaken directly beneath it. The road consists of bitumen seal with concrete kerb and guttering.

Plate 2 - Wilton Road (Courtesy of MSEC)

Plate 3 - The Eraring Haul Road (Courtesy of ACOR Appleyard)

Wilton Road crosses the southern ends of LW102-103 in a general SE/NW direction with a total length of approximately 800 metres located directly above LW102-103. Wilton Road has a bitumen seal with grass verges.

Private Roads:

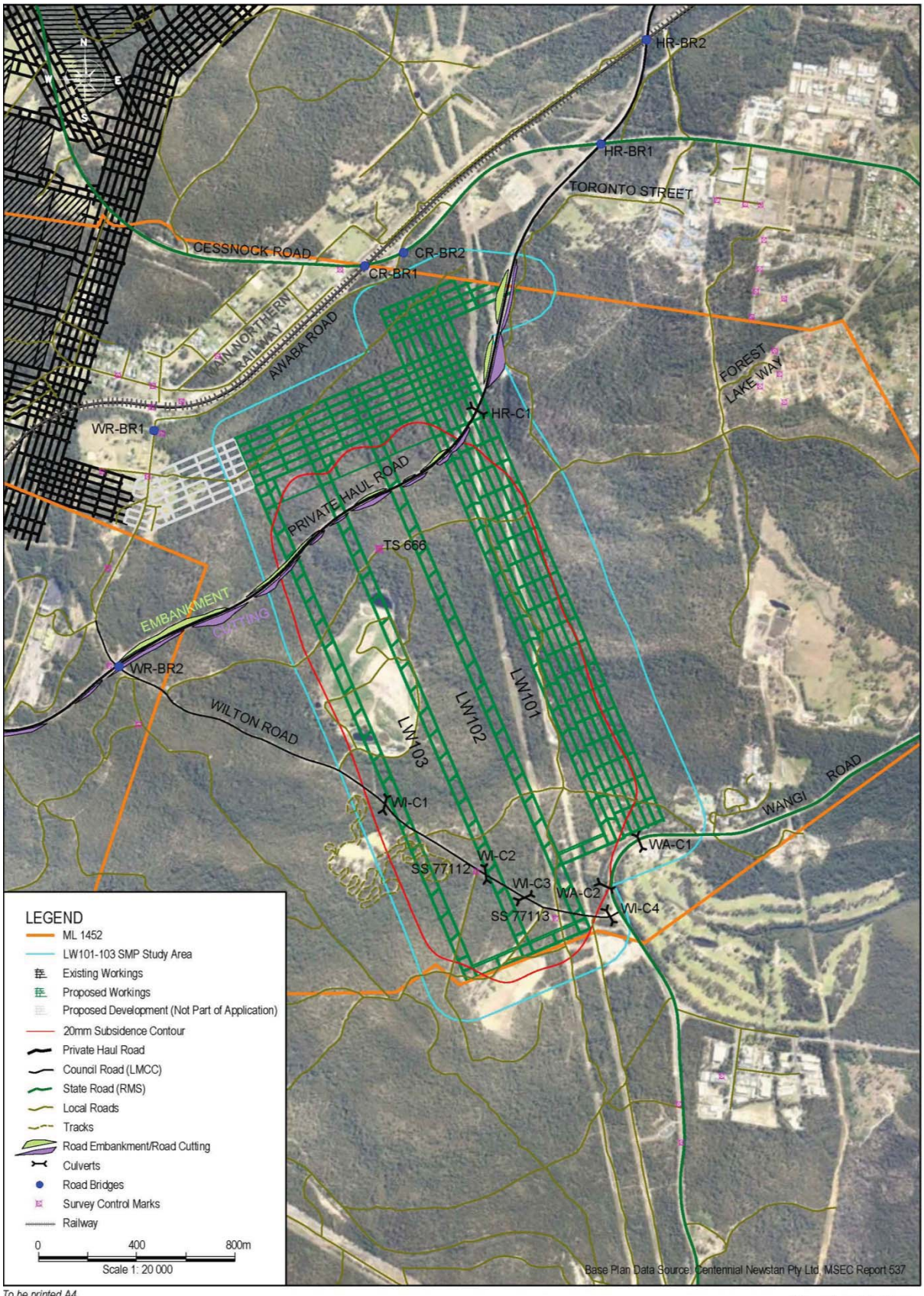
The Newstan to Eraring private haul road is owned by Eraring Energy and traverses the northern ends of LW101-103. Approximately 800m of the haul road is located directly above the proposed longwalls (MSEC 2012). The haul road has a bitumen seal with grass verges and there are a number of cuttings and embankments within the SMP Study Area (MSEC 2012).

Baseline Monitoring

Further to the detailed characterisation investigations undertaken by ACOR Appleyard to support the subsidence report by MSEC (2012), further baseline monitoring of roads within the SMP Study Area will be undertaken through a combination of ground survey conducted before mining and visual inspections including photographic records. As detailed within the Subsidence Monitoring Program, survey lines will be installed along appropriate sections of Wangi Rd, Wilton Rd and the Private Haul Road, subject to landowner approval, to obtain baseline data prior to mining. Further details on baseline monitoring will be detailed within the relevant *Private Property Management Plans*.

Impact Assessment

Wangi Road lies within the conservative angle of draw directly south of the main headings and approximately 100m south of LW101. Wangi Road is predicted to experience less than 20 mm of conventional subsidence resulting from the extraction of the proposed longwalls. The predicted strains for Wangi Road are less than 0.5mm/m (which is in the order of survey tolerance) along with a maximum curvature less than 0.01 km^{-1} for both hogging and sagging. Whilst it is still possible that the road could experience subsidence slightly greater than 20 mm, it would not be expected to experience any significant conventional tilts, curvatures or strains. It is unlikely that Wangi Road would experience any adverse impacts resulting from the proposed longwall mining (MSEC 2012).



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Newstan Colliery
Infrastructure (Roads)

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Figure 10 - Roads, Bridges and Drainage Culvert Infrastructure

Wilton Road crossed the southern ends of LW102-103 with a total length of approximately 800 metres located directly above LW102-103. The total conventional subsidence resulting from extraction of the proposed longwalls is predicted to be 925mm. The maximum predicted conventional tilt for Wilton Road after the extraction of LW101-103 is predicted to be 6.5mm/m, with a maximum curvature of 0.15 km^{-1} for hogging and 0.35 km^{-1} for sagging (MSEC 2012).

The private haul road traverses the northern ends of LW101-103, with a total length of approximately 800m located directly above the proposed longwalls. The total conventional subsidence resulting from extraction of the proposed longwalls is predicted to be 1175mm. The maximum predicted conventional tilt for the Eraring Haul Road is predicted to be 13.0mm/m, with a maximum curvature of 0.25 km^{-1} for hogging and 0.55 km^{-1} for sagging (MSEC 2012)

Vertical subsidence and tilt can potentially affect the drainage of surface water for roads which are located directly above the extracted longwalls. The existing and the predicted post-mining surface levels and grades along Wilton Road and the Haul Road are illustrated in **Figure 11** and **Figure 12** respectively.

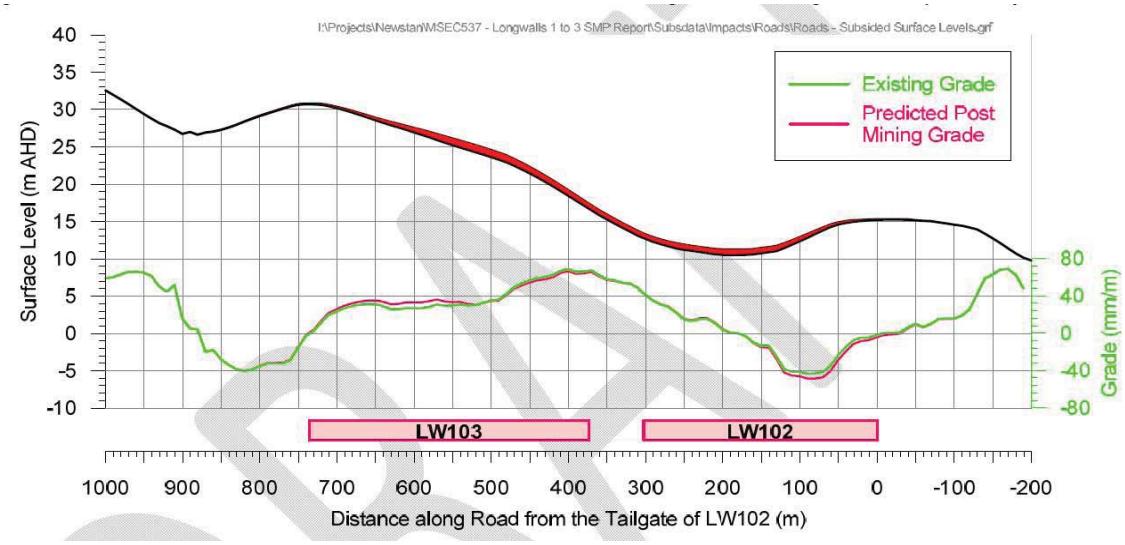


Figure 11 - Initial and Predicted Subsidence Surface Levels along Wilton Road (MSEC 2012)

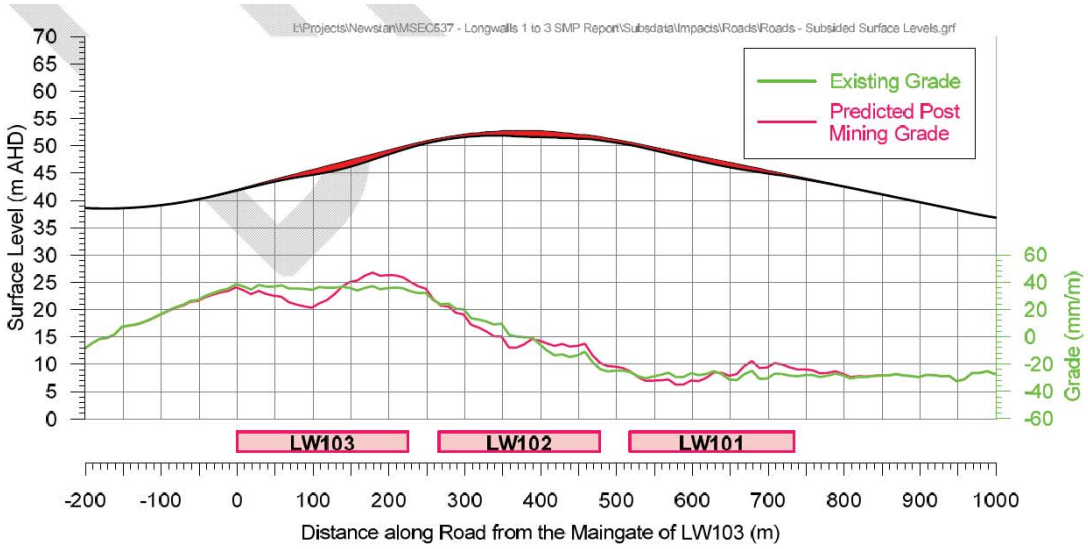


Figure 12 - Initial and Predicted Subsidence Surface Levels along the Haul Road (MSEC 2012)

As shown above in **Figure 11** and **Figure 12**, the post mining grades are expected to be similar to the existing grades along Wilton Road and the Haul Road (MSEC 2012). The potential change in surface drainage could occur but is not expected to be significant. Whilst it is possible that localised ponding may occur above the proposed longwalls, this can be remediated using normal road maintenance techniques.

Due to the nature of Wilton Road there are unlikely to be any specific points at which water can form areas of road side ponding. Ponding may occur on the surface of the road, in localised areas, but due to the significant grade of the road as it passes through the SMP Study Area it is unlikely that the road will be any more susceptible to flooding impacts (GHD, 2012).

It is expected that with the current predicted curvature and strains, that cracking and rippling of the road surfaces would occur. Previous experience of mining directly beneath roads in the NSW coalfields, with similar depths of cover and panel width to depth ratios, indicates that crack widths are typically between 10mm and 25mm along with heaving of around 25mm. It is expected that Wilton Road and the Haul Road could be maintained in a safe and serviceable condition throughout the mining period by using normal road maintenance techniques (MSEC 2012).

The haul road contains a cut to fill profile for a large majority of the subsidence-affected section of road. Prior to mining, the table drain on the cut side will be assessed for potential increases in flow velocities associated with any steepening of road grade post mining. The estimated grade increase to approximately 50 mm/m from 40 mm/m is unlikely to cause a management issue, for what is typically a concrete table drain along the Mine Haul Roads (GHD 2012).

If the actual subsidence along Wangi Road exceeded that predicted by a factor of 2 times, the tilts, curvatures and strains would still be expected to be small and unlikely to result in any adverse impacts.

If the actual subsidence along Wilton or the Haul Road exceeded those predicted by a factor of 2 times, it would still be expected that any impacts would be minor and could be remediated using normal road maintenance techniques.

Monitoring, Mitigation and Management

Public Roads:

As outlined above, whilst Wilton Road lies within the potential subsidence impact zone of LW102 and LW103, Wangi Road lies beyond the predicted 20mm subsidence contour of LW101 (and 102) and is not expected to be significantly impacted. Prudently, a ground survey line will be established prior to mining along appropriate sections of both Wangi Road and Wilton Road, subject to landowner approval, to routinely monitor mine subsidence movements within the active subsidence zone and confirm subsidence predictions, as detailed within the *Subsidence Monitoring Program* (refer to Volume 2 of the SMP Application) which will be finalised prior to commencement of secondary extraction LW101.Ground surveys will be conducted pre and post-mining with and routine visual inspections of the roads are proposed to be undertaken during the active subsidence period (MSEC 2012). The monitoring information will feed into a Trigger Action Response Plan (TARP) developed within the *Public Road Management Plan* and the *Subsidence Management Plan* developed in consultation with Council.

Newstan Colliery will manage subsidence related impacts to Wilton Road by LW102 in accordance with a *Public Road Management Plan* developed in consultation with Lake Macquarie City Council (LMCC) and finalised prior to secondary extraction of LW102. A copy of the final management plan will be provided to DTIRIS – DRE. Whilst there is no predicted impact to Wangi Road by LW101, conservatively the road has been included within the *Subsidence Management Plan* (including TARP) which will be finalised in consultation with potentially affected stakeholders prior to commencement of secondary extraction in LW101 and revised ahead of LW102.

Private Haul Road (Eraring Energy):

Loose rocks and highly weathered sections of the cuttings along the mine haul road will be removed where appropriate prior to undermining. This should be coupled with visual inspections during the active subsidence period so that any loose rocks or spalling can be removed (MSEC 2012). A ground survey line along the Eraring Haul Road will also be established to monitor subsidence movements within the active subsidence zone.

The private haul road will be managed in accordance with the *Private Road Management Plan*. This management plan will be provided to Eraring Energy for comment as part of the consultation process prior to secondary extraction under the haul road by LW101. A copy of the final management plan will be provided to DTIRIS – DRE.

11.3.2. Bridges

Characterisation

There are no bridges located within the SMP Study Area (**Figure 10**). There are, however, road bridges in the regional vicinity of the proposed longwalls which may experience far-field horizontal movements and could be sensitive to these movements. An outline of the stakeholder consultation process in relation to the presence and management of bridges that was undertaken during the preparation of this SMP Application has been described in **Section 8**.

The bridge closest to the proposed longwalls is WR-BR1, located approximately 570 metres north-west of LW103. This bridge is a timber structure where Wilton Road crosses Stony Creek and is administered by Lake Macquarie City Council. A photograph of WR-BR1 is provided in **Plate 4** below.

Plate 4 - WR-BR1 where Wilton Road Crosses Stony Creek (Courtesy of ACOR Appleyard)

A second bridge WR-BR2 is located where Wilton Road crosses the Eraring Energy owned private haul road. The bridge is located approximately 850 metres west of LW103 and is administered by Lake Macquarie City Council. The bridge comprises a concrete deck supported on concrete abutments with wingwalls and two intermediate concrete headstocks with tri-column supports. A photograph of the Bridge WR-BR2 is provided in **Plate 5**.

Plate 5 - Bridge WR-BR2 where the Wilton Road crosses the Haul Road

There are two bridges CR-BR1 and CR-BR2 where Cessnock Road crosses over the Main Northern Railway and Awaba Road, respectively. These bridges are both located around 750 metres north of LW101, at their closest points to the proposed longwalls. The bridges comprise of concrete decks on precast concrete girders which are supported on concrete abutments with wingwalls and intermediate cast in situ concrete headstocks with dual-column supports. A photograph of Bridge CR-BR2 is provided is **Plate 6**.

Plate 6 - Bridge CR-BR2 along Cessnock Road (Courtesy of ACOR Appleyard)

Further afield, there are also bridges where the private haul road crosses Awaba Road and the Main Northern Railway at distances of approximately 1.4 kilometres and 1.8 kilometres, respectively, to the north-east of the proposed longwalls. Further details are provided within the SMP Subsidence Assessment (MSEC 2012) where required.

Baseline Monitoring

In addition to characterisation inspections undertaken to date, baseline monitoring of bridges within the SMP Study Area will be managed in the relevant private and public road management plans to be developed in consultation with stakeholders. Baseline monitoring of bridges will also be undertaken in accordance with the *LW101-103 Subsidence Monitoring Program*. Baseline monitoring will be undertaken by way of visual inspections and will be detailed within the public and private road management plans. Baseline visual inspections will take place to identify the absence or presence of damage to the structure including functionality of bridge expansion joints (MSEC 2012). Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

The bridges are located at distances greater than 500 metres from the proposed longwalls, which is well outside the predicted 20 mm subsidence contour (i.e. predicted limit of vertical subsidence). At these distances, the bridges are not expected to experience any measurable conventional tilt, curvatures or strains. Specialist subsidence impact assessment by MSEC (2012) found that the bridges could experience small far-field horizontal movements resulting from the proposed mining.

The maximum predicted differential horizontal movement for the timber Bridge WR-BR1, resulting from the proposed mining, is ±6 mm. It is noted, that this movement was determined using a statistical analysis of observed horizontal movements and, hence, includes a proportion of survey tolerance, which is in the order of ±3 mm. The timber bridge is of flexible construction and, therefore, is expected to accommodate these small differential horizontal movements without adverse impacts. The maximum predicted differential horizontal movements for the concrete Bridges CR-BR1, CR-BR2 and WR-BR2, resulting from the proposed mining, is ±5 mm or less (which also includes a proportion of survey tolerance in the order of ±3 mm). It is likely, therefore, that the differential horizontal movements resulting from mining will not be measurable at these bridges. It is likely that these bridges could tolerate the potential movements resulting from mining, and it is expected that these bridges would not be adversely impacted as a result of the proposed mining (MSEC 2012).

The predicted differential horizontal movements for the other concrete bridges along the mine haul road, located around 1.4 kilometres and 1.8 kilometres from the proposed longwalls, are in the order of survey tolerance (i.e. not measurable) and these predicted measurements have been provided to LMCC.

Whilst not predicted, if the actual movements exceeded those predicted by a factor of 2 times, the maximum differential horizontal movement at the concrete bridges would be ±10 mm, and ±12 mm at the timber bridge. Differential movements of this magnitude could be accommodated by the expansion joints in the concrete bridges, however they may reduce the allowable capacities of the joints and bearings. The other concrete bridges in the vicinity of the proposed longwalls are located at distances of 1.4 kilometres, or greater, and are not expected to experience any measurable differential movements.

Monitoring, Mitigation and Management

These bridges will be monitored during active subsidence and, if required, remedial measures will be implemented. A *Public Road Management Plan* and *Private Road Management Plan* which includes bridges are in the process of being developed, in consultation with LMCC and Eraring Energy (respectively), and includes monitoring the predicted movements of the above-mentioned bridges. The *Public Road Management Plan* will be developed prior to secondary extraction of LW101. The *Private Road Management Plan* will be developed prior to secondary extraction under the private haul road. A copy of the final management plan will be provided to DTIRIS – DRE.

11.3.3. Culverts

Characterisation

Concrete drainage culverts have been constructed where various local public and private sealed roads cross the watercourses as shown in **Figure 10**. These are listed in **Table 11.3** below.

Table 11.3 Drainage Culvert Identified Within the SMP Study Area

Road	Culvert Ref.	Type	Location
Wilton Road	WI-C1	3 x ϕ1500 Concrete Culverts	Watercourse WC6
	WI-C2	1 x ϕ600 Concrete Culvert	Tributary to WC5
	WI-C3	3 x 1.8W x 0.9H Box Culverts	Watercourse to WC5
	WI-C4	1 x ϕ375 Concrete Culvert	Minor drainage line
Wangi Road	WA-C1	2 x ϕ450 Concrete Culverts	Minor drainage line
	WA-C2	4 x ϕ1200 Concrete Culverts	Watercourse WC5
Eraring Haul Road	HR-C1	1 x ϕ1200 Concrete Culvert	Minor drainage line

Baseline Monitoring

In addition to characterisation inspections undertaken to date, baseline monitoring of culverts within the SMP Study Area will be managed in the relevant private and public road management plans to be developed in consultation with stakeholders. Baseline survey monitoring prior to the commencement of mining of relevant longwall panels will be undertaken along Wilton Road, Wangi Road and the Private Haul Road respectively, which will incorporate a number of culverts. Baseline visual inspections, including taking photographs will also be undertaken for culverts along Wangi Road, Wilton Road and the haul road to identify the absence or presence of damage to the structure. Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

A summary of the maximum predicted total conventional subsidence parameters for the public and private road drainage culverts, resulting from the extraction of the proposed longwalls, is provided in **Table 11.4** below.

Table 11.4 Maximum Predicted Total Conventional Subsidence Parameters at the Drainage Culverts Resulting from the Extraction of the Proposed Longwalls

Road	Culvert Ref.	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Wilton Road	WI-C1	75	1.0	0.02	0.01
	WI-C2	800	3.0	0.05	0.09
	WI-C3	775	5.0	0.04	0.12
	WI-C4	<20	<0.5	<0.01	<0.01
Wangi	WA-C1	<20	<0.5	<0.01	<0.01

Road	WA-C2	25	<0.5	<0.01	<0.01
Private Haul Road	HR-C1	<20	<0.5	<0.01	<0.01

The maximum predicted tilt at the drainage culverts is 5.0 mm/m (i.e. 0.5 %), at Culvert WI-C3, which represents a change in grade of 1 in 200. The maximum predicted change in grade is small, less than 1 % and is in the direction of flow (i.e. slightly increases the grade) and, therefore, unlikely to adversely impact the serviceability of this culvert. The predicted tilts at the remaining culverts within the SMP are 3.0 mm/m (i.e. 0.3 %), or less, which is very small and unlikely to adversely impact the serviceability of these culverts.

The predicted curvatures and strains at the drainage culverts are small and, in most cases, will not be orientated along the main axes of the culverts. The concrete culverts are expected to tolerate the curvatures and strains, of these magnitudes, without adverse impacts on the stabilities or structural integrities of the culverts.

Culvert WI-C2 currently does not appear to provide a drainage function, and for this reason drainage impact on this culvert was not specifically assessed. It is not expected that the stability of the culvert will be affected as a result of longwall mining and will not present a public safety risk. The position of Culvert WI-C3, within the subsidence affection zone, indicates that it is unlikely that the drainage function of the culvert is to be compromised. The culvert would most likely have a uniform subsidence or a slight increase of grade in the direction of flow. The predicted tilts will have very minimal impact in terms of hydraulic function. Photographs of the box culvert WI-C3, where Wilton Road crosses Watercourse WC5 (i.e. Kilaben Creek), are provided in **Plate 7**.

Plate 7 - Photographs of Box Culvert WI-C3 along Wilton Road

All culverts (except HR-C1) indicated a negligible change between the existing and the predicted post mining subsided surface condition headwater depths. HR-C1, is the only culvert to indicate a reduction in grade due to the subsidence predictions, however this is likely to be minimal with a maximum subsidence of less than 20 mm predicted. A photograph of culvert HR-C1 is provided in **Plate 8**.

Plate 8 - Photograph of Culvert HR-C1 along the Mine Haul Road (Courtesy of ACOR Appleyard)

Impact Assessment for Greater Than Predicted Subsidence Scenario:

Whilst not predicted to occur, if the actual subsidence exceeded that predicted by a factor of 2 times, the potential impacts on the serviceability and surface water drainage through the culverts would not be expected to significantly increase, and it would not be expected to affect the structural capacity or stability of the culverts.

Monitoring, Mitigation and Management

The drainage culverts will be periodically visually inspected during the active subsidence period which will form part of the *Private Road Management Plan* and the *Public Road Management Plan*, which will be also referenced by the *LW101-103 Subsidence Monitoring Program*. As mentioned above in **Section 11.2**, both management plans will be completed in consultation with LMCC, RMS and Eraring Energy. Monitoring will be undertaken via a combination of survey monitoring and visual inspections. If any adverse impacts were to occur as a result of mining, the affected culverts would be replaced in consultation with the relevant stakeholder. The *Public Road Management Plan* will be submitted to DTIRIS – DRE prior to commencement of secondary extraction of LW102. The *Private Road Management Plan* will be submitted to DTIRIS - DRE prior to undermining the Haul Road.

11.3.4. Water/Gas/Sewage Pipelines

Characterisation

The water infrastructure within the SMP Study Area comprises temporary 50 mm diameter polyethylene pipelines (**Figure 9**). The pipelines are owned by Hunter Water and provide potable water to the Awaba Waste Management Facility, the Toronto Country Club and the Toronto Adventist Centre. An outline of the stakeholder consultation process pertaining to the presence and management of water, gas and sewerage pipelines within the SMP Study Area that was undertaken during the preparation of this SMP Application has been described in **Section 8**.

The pipeline which services the Awaba Waste Management Facility comes from the township of Awaba which then crosses above the maingate of Longwall 103 then to the AWMF.

Another section of pipeline follows Wangi Road and services the Toronto Country Club and Adventist Centre. This pipeline is located 130 metres east of LW101, at its closest point to the proposed longwalls.

Baseline Monitoring

In addition to characterisation inspections undertaken to date, baseline monitoring of pipelines within the SMP Study Area will be managed in the relevant management plans to be developed in consultation with stakeholders. Baseline monitoring of the 50mm polyethylene pipelines within the

SMP Study Area will be undertaken by consultation with stakeholders and visual inspections for signs of impact (leakage, reported pressure loss and service etc.). Visual inspections will also be used to identify the absence or presence of damage to any sections of surface structure (taps, valves etc.) or signs of leakage to buried sections of pipelines. Photographic records will be obtained and stored in the Newstan EMS for future reference. Baseline monitoring will be undertaken in accordance with the *Subsidence Management Plan*, relevant PPMP's, the *AWMF Management Plan* (in future) and referenced within the *LW101-103 Subsidence Monitoring Program* (refer Volume 2 of the SMP Application).

Impact Assessment

The section of pipeline owned by Hunter Water which services the Awaba Waste Management Facility crosses above the maingate of LW103. A summary of the maximum predicted subsidence parameters for this pipeline is provided in **Table 11.5** and discussed further below based on subsidence predictions and impact assessments by MSEC (2012, refer **Appendix 4**).

Table 11.5 Maximum Predicted Total Conventional Subsidence Parameters for the Water Pipeline Which Services the Awaba Waste Management Facility (MSEC 2012)

Longwall	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
After LW101	< 20	< 0.5	< 0.01	< 0.01
After LW102	< 20	< 0.5	< 0.01	< 0.01
After LW103	150	3.5	0.08	0.02

The maximum predicted conventional curvatures for the pipeline are 0.08 km^{-1} hogging and 0.02 km^{-1} sagging, which represent minimum radii of curvature of 13 kilometres and 50 kilometres, respectively after secondary extraction of LW103. The maximum predicted conventional strains for the pipeline, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 1.0 mm/m tensile and less than 0.5 mm/m compressive (i.e. in the order of survey tolerance).

This pipeline crosses three first order tributaries adjacent to LW103 and could experience valley related movements in these locations. The equivalent valley heights in these locations are small, less than 5 metres and the predicted maximum movements are 20 mm upsidence and 20 mm closure.

It is possible, although unlikely, that minor impacts could occur to the section of pipeline located above the proposed Longwall 103, if it is anchored to the ground and the strains are fully transferred into the pipeline. Any impacts to the polyethylene pipeline are expected to be of a minor nature which could be readily remediated.

The other sections of pipeline along Copeland Street and Wangi Road are located well outside the proposed longwalls and 20mm subsidence contour, and are not expected to experience any significant conventional or valley related movements, and subsequently no adverse impacts resulting from mining.

Whilst not predicted to occur, if the actual subsidence exceeded that predicted by a factor of 2 times, the potential impacts on pipeline located directly above the proposed longwalls would increase. It is expected that any impacts would still be expected to be minor and readily remediated (MSEC 2012).

Monitoring, Mitigation and Management

The management of potable water for the Toronto Adventist Centre, Toronto Country Club and the Awaba Waste Management Facility will be managed within the *Private Property Management Plans* (PPMP) for each of the above-mentioned stakeholders. Subsidence prediction for the 50mm polyethylene pipelines will be provided to Hunter Water for their assessment. Preparation of each management plan will be undertaken in consultation with Hunter Water, Toronto Golf Club and the Awaba Waste Management Facility. The *Private Property Management Plans* will be submitted prior to secondary extraction of the relevant longwall panel (LW101 and LW103 respectively).

11.3.5. Electricity Transmission Lines

Characterisation

There are two parallel 132 kV high voltage transmission lines, owned by Ausgrid, which cross directly above the proposed LW101-102 (refer to **Figure 9**). The aerial three phase conductors are supported by dual timber poles (refer to **Plate 1**).

There are also high and low voltage powerlines owned by Ausgrid which are located within the SMP Study Area. These powerlines follow the alignments of the roads and service the Awaba Waste Management Facility, the Toronto Country Club and the Toronto Adventist Centre.

The Rathmines 132/11 kV Substation, which is also owned by Ausgrid, is located in the south-eastern corner of the SMP Study Area (Refer to **Figure 9**). The fenced perimeter of the substation is located 140 metres south-east of LW102, at its closest point to the proposed longwalls.

An outline of the stakeholder consultation process with Ausgrid pertaining to the management of electrical transmission lines that was undertaken during the preparation of this SMP Application has been described in **Section 8**.

Plate 9 - Photograph of the 132/11 kV Substation

Baseline Monitoring

Baseline monitoring of the powerlines within the SMP Study Area will be undertaken via a combination of stakeholder consultation, survey monitoring and visual inspections. The visual inspections will identify the absence or presence of damage to the power poles and associated footings. Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

Summaries of the maximum predicted subsidence and tilts for the 132 kV transmission lines, and the substation are provided in **Table 11.6** below.

Table 11.6 Maximum Predicted Total Conventional Subsidence, Tilts Along and Tilts Across the 132 kV Transmission Lines (MSEC 2012)

Longwall	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Western Branch				
After LW101	750	2.0	6.0	6.0
After LW102	825	4.5	6.0	6.0
After LW103	825	4.5	6.5	6.5
Eastern Branch				
After LW101	650	5.5	6.0	6.5
After LW102	725	5.0	6.5	7.0
After LW103	725	5.0	6.5	7.0
132/11KV SUBSTATION				
Substation	<20	<0.5	<0.01	<0.01

The maximum predicted final tilts at the transmission pole locations, after the completion of the proposed longwalls, are 5.0 mm/m (western branch) and 6.5 mm/m (eastern branch). Some poles will experience transient tilts greater than their predicted final tilts, due to the longwall travelling wave, with the maximum predicted transient tilt being 6.5 mm/m.

The high and low voltage powerlines are located across the SMP Study Area and, therefore, are expected to experience the full range of predicted mine subsidence movements.

The maximum predicted tilt at the high and low voltage powerlines is 16 mm/m (i.e. 1.6 %), which represents a change in grade of 1 in 65.

It is unlikely that the 132 kV transmission lines, high and low voltage powerlines would experience any adverse impacts resulting from the proposed mining (MSEC 2012).

The 132/11kV substation is predicted to experience less than 20 mm subsidence, therefore it is unlikely that the substation will experience any adverse impacts resulting from the proposed mining.

Subsidence impacts on waterway crossings for the existing electrical easement maintenance track for the powerlines have also been assessed. Under predicted post mining subsidence conditions, crossings EA-C1 and EA-C2 indicate key areas where both depth and velocity afflux occur, however the significance of this impact is considered minor as these access tracks are private and understood

to be rarely used by Ausgrid. Additionally, the existing condition and serviceability of these crossings are predicted to be poor. The indicated level of afflux in both depth and velocity has been defined as manageable in this case as flooding is maintained within the banks of the waterways (GHD, 2012) and is temporary/transient.

Impact Assessment for Greater Than Predicted Subsidence Scenario:

Impacts based on increased subsidence are addressed in the MSEC report (2012), however if the actual tilts exceeded those predicted by a factor of 2 times, it would be possible that some remediation measures would be required for the transmission lines, which could include the adjustment of the timber poles or the installation of guy ropes.

If actual subsidence at the substation exceeded the predicted by a factor of 2, the tilts, curvature and strains would be in the order of survey tolerance. It would be unlikely that the substation would experience any adverse impacts from the proposed mining (MSEC 2012).

Monitoring, Mitigation and Measurement

The predicted mine subsidence movements for the electrical infrastructure will be provided to Ausgrid, so that any necessary preventive measures can be developed.

Newstan Colliery will be managing subsidence related impacts to electrical infrastructure in accordance with a *Electrical Surface Infrastructure Management Plan*. This management plan will be provided to Ausgrid for comments during the consultation process. The *Electrical Surface Infrastructure Management Plan* will be submitted to DTIRIS – DRE prior to secondary extraction of LW101.

11.3.6. Telecommunication Lines

Characterisation

Two optic fibre cables are located within the SMP Study Area, one aerial (AAPT) and one buried (Telstra), and buried copper cables (Telstra). The optical fibre cable owned by AAPT crosses directly above Longwall 101 as shown in **Figure 9**. The cable is aerial (i.e. not direct buried) within the 20mm subsidence zone, being supported on the transmission poles along the 132 kV transmission line (eastern branch) as shown in **Figure 9** and **Plate 10**. The Telstra buried optical fibre cable along Wilton Road is only partially located above the proposed LW103.

Cable loops were observed on poles near the Ausgrid substation. An underground optic fibre cable owned by Telstra services the Awaba Waste Management Facility over LW103, and branches into the AWMF from the north along Wilton Road. The cable is understood to terminate at the AWMF (no further downstream users).

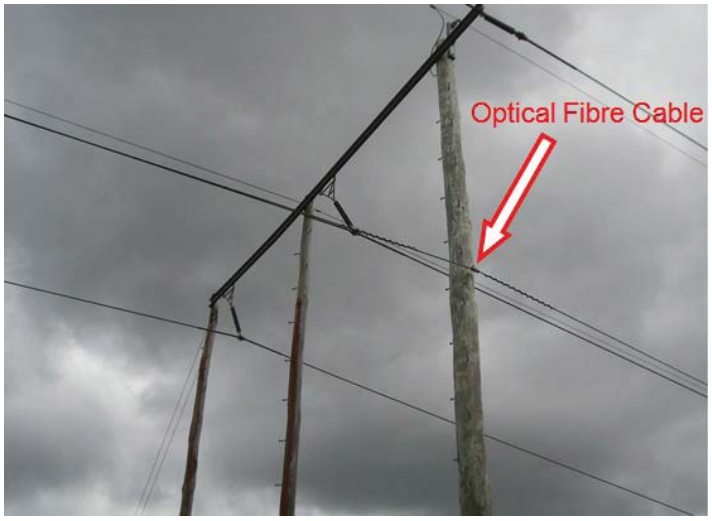


Plate 10 - Connection of the AAPT Optical Fibre Cable to a Transmission Pole

There are also direct buried copper telecommunications cables, owned by Telstra, which generally follow the alignments of Wilton and Wangi Roads. The copper cables service the Awaba Waste Management Facility, the Toronto Country Club and the Toronto Adventist Primary School.

An outline of the stakeholder consultation process with Telstra and AAPT for the presence and management of telecommunication lines that was undertaken during the preparation of this SMP Application has been described in **Section 8**.

Baseline Monitoring

Baseline monitoring of telecommunication lines within the SMP Study Area will be undertaken via a combination of stakeholder consultation, targeted survey monitoring, pre-mining communication line condition tests such as Optical time Domain Reflectometry (OTDR), as well as visual inspections in consultation with Telstra and AAPT. Photographic records will be obtained and stored in the Newstan EMS for future reference. Combined with inspections, baseline line condition tests will provide a basis for cross-reference during and post mining to monitor functionality of telecommunications to identify any need for responsive action in accordance with a Trigger Action Response Plan (TARP) within the *Telstra* and *AAPT Infrastructure Management Plans*.

Impact Assessment

A summary of the maximum predicted subsidence and tilts for the AAPT Aerial Optic Fibre cable is provided in **Table 11.7.** The tilts are the maximum predicted values which occur anywhere along or across alignment after the completion of each of the proposed longwalls.

Table 11.7 Maximum Predicted Total Conventional Subsidence, Tilts Along and Tilts Across the AAPT Optical Fibre Cable

Longwall	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Tilt Across Alignment (mm/m)	Maximum Predicted Total Conventional Tilt in any Direction (mm/m)
AERIAL OPTICAL FIBRE CABLE (AAPT)				
After LW101	650	5.5	6.0	6.5
After LW102	725	5.0	6.5	7.0
After LW103	725	5.0	6.5	7.0

Summaries of the total predicted subsidence parameters for both Telstra buried fibre optic cable and copper communications cable after extraction of each of the longwalls are provided below in **Table 11.8.** Tilts are the maximum predicted values which occur at the completion of the proposed panel and the curvatures are the maximum predicted values which occur at any time during or after the extraction of each of the proposed longwalls (MSEC 2012).

Table 11.8 Maximum Predicted Total Conventional Subsidence, Tilts and Curvatures for Telecommunications within the SMP Study Area

Longwall	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
BURRIED OPTICAL FIBRE CABLE (TELSTRA)				
After LW101	<20	<0.5	<0.01	<0.01
After LW102	<20	<0.5	<0.01	<0.01
After LW103	200	3.0	0.07	0.01
COPPER TELECOMMUNICATIONS CABLE (TELSTRA)				
After LW101	<20	<0.5	<0.01	<0.01
After LW102	450	6.0	0.1	0.05
After LW103	500	6.5	0.1	0.05

The support poles for the aerial optic fibre cable owned by APPT are separated at distances between 150 metres and 400 metres within the SMP Study Area. The maximum predicted mining induced tensile strain in the aerial optical fibre cable, therefore, is around 1.5 mm/m, which is based on dividing the predicted differential horizontal movement between the poles of 200 mm by the minimum pole spacing of 150 metres (MSEC 2012). This strain is additional to the tensile strain in the cable resulting from the cable catenary, which is expected to be greater than the mining induced strain. Experience in undermining has shown that optical fibre cables can typically tolerate tensile strains of 4 mm/m without adverse impacts (MSEC 2012). It is unlikely that the aerial optical fibre cable will be adversely impacted as a result of the proposed mining.

The buried Telstra optical fibre cable along Wilton Road crosses two 1st order tributaries adjacent to LW103 and, therefore, could experience valley related movements in these locations. The maximum predicted movements in these locations are 50 mm upsidence and 100 mm closure.

The maximum predicted conventional strains for the buried Telstra optic fibre cable are 0.7mm/m tensile and less than 0.3mm/m compressive. The cable could also experience elevated compressive strains at the tributary crossings, located adjacent to the maingate of LW103, which could be in the order of 1-3 mm/m. It is possible that the resultant compressive strains at the tributary crossing could be sufficient to result in reduced capacity of the cable or transmission loss.

The copper telecommunications cables along Wangi Road are located outside the predicted 20 mm subsidence contour. It is unlikely, therefore, that these cables would experience any significant conventional or valley related movements.

Impacts based on increased subsidence are discussed in the MSEC report (2012). If the actual mine subsidence movements exceeded those predicted by a factor of 2 times, the additional strain in the

AAPT cable would still be less than the strains which optical fibre cables can typically tolerate. Whilst the Telstra optical fibre cable could experience elevated compressive strains at the tributary crossings, west of the proposed Longwall 103, it is unlikely that these strains would exceed the predictions by a factor of 2 times, as the crossings are located outside the proposed longwalls. It is therefore unlikely that the telecommunications cables will be adversely impacted as a result of the proposed mining.

Monitoring, Mitigation and Measurement

Predicted movements for both the aerial and buried optical fibre cables will be provided to AAPT and Telstra to facilitate the development of a management plan for the cables so that, if necessary, preventive measures can be undertaken if the strains in the cable approach allowable tolerances. Management strategies will also be developed in consultation with Telstra for the copper telecommunications cables within the SMP Study Area (MSEC 2012).

Newstan Colliery will manage subsidence related impacts to telecommunications infrastructure in accordance with the *Telstra* and *AAPT Infrastructure Management Plan*s (refer **Volume 2** of the SMP Application). The plan includes monitoring and inspections (baseline pre-mining, during and post-mining) linked to a Trigger Action Response Plan (TARP) which provides appropriate responsive action. These management plans will be provided to both AAPT and Telstra for comments during the consultation process. The *Telstra* and *AAPT Infrastructure Management Plans* will be submitted to DTIRIS – DRE prior to secondary extraction of LW101. Aspects relating to the buried Telstra optical fibre cable located over LW103 (servicing the AWMF) will be addressed in an update to the management plan prior to commencement of LW103, in consultation with Telstra.

11.3.7. Places of Worship

Characterisation

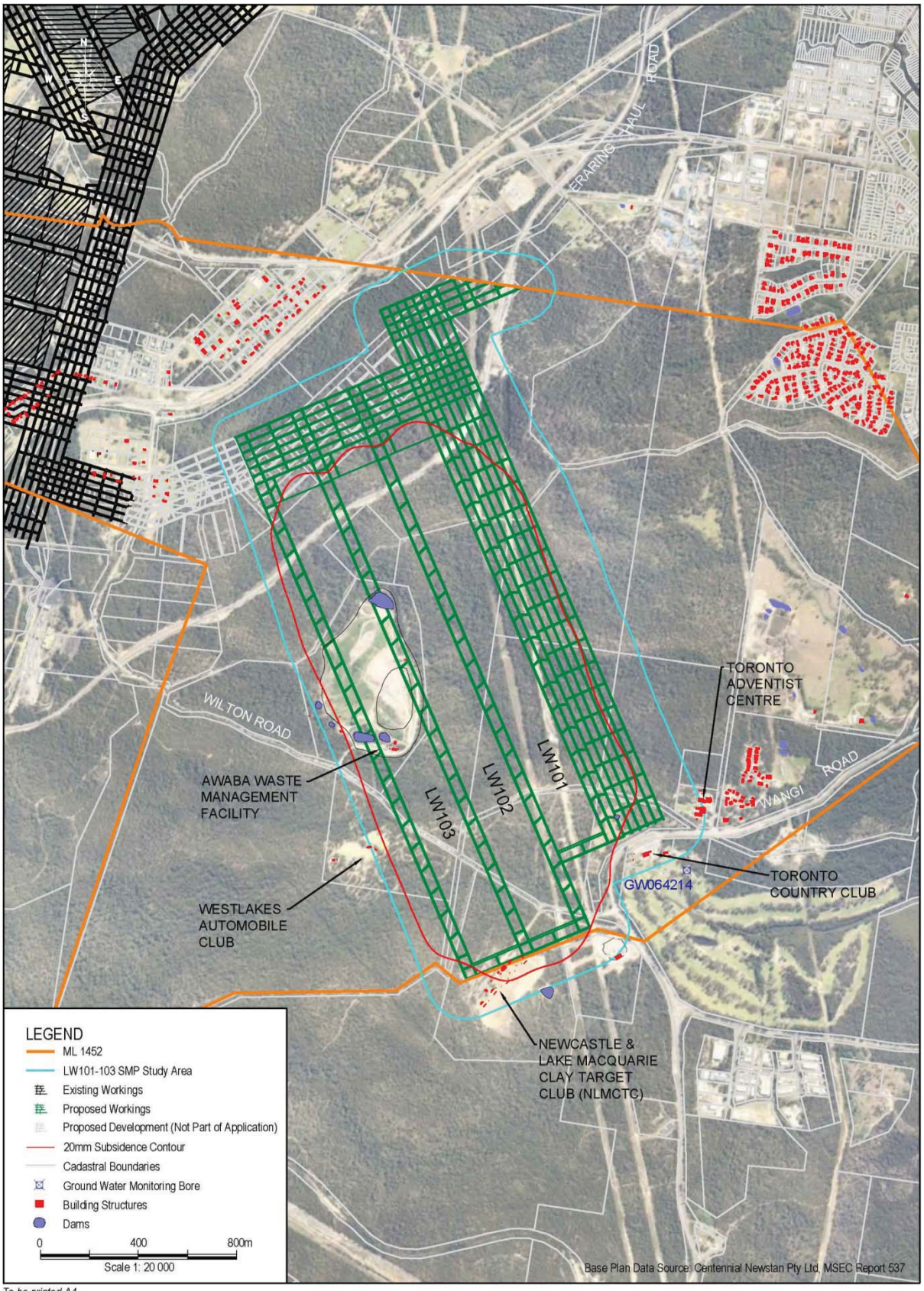
The Toronto Adventist Centre includes a church and school which is located approximately 300 metres east of LW101, at its closest point to the proposed longwalls as shown in **Figure 13** and **Figure 14**. The construction drawings for the building structures were approved by the Mine Subsidence Board on the 3rd July 2000.

An outline of the stakeholder consultation process with the Toronto Adventist Centre for the management of infrastructure and the identification primary subsidence-sensitive aspects of the facility that was undertaken during the preparation of this SMP Application has been described in **Section 8.**

The Toronto Adventist Centre is located on private land owned by the Australasian Conference Association Limited and was inspected by Northrop Engineers in 9th March 2012 for characterisation for the SMP in consultation with members of the Toronto Adventist Centre. The church is constructed on sloping ground with a main floor and a partial subfloor on the downslope side. The structure comprises a suspended concrete slab supported on load bearing brickwalls and brick piers on strip footings. The walls above the concrete slab have light-weight internal frames with brick external cladding on the lower part and light-weight cladding on the upper part. Photographs of the church are provided in **Plate 11**

Plate 11 - Photographs of the Church (Ref. TR003_pa02)
(Courtesy of Northrop Engineers)

The services and other features on the property include consumer powerlines and telephone lines, above ground water storage tanks, in-ground septic tanks, retaining walls and external concrete pavements.



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Newstan Colliery
Man Made Features (Buildings)

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Figure 13 – Man Made Features (Buildings)

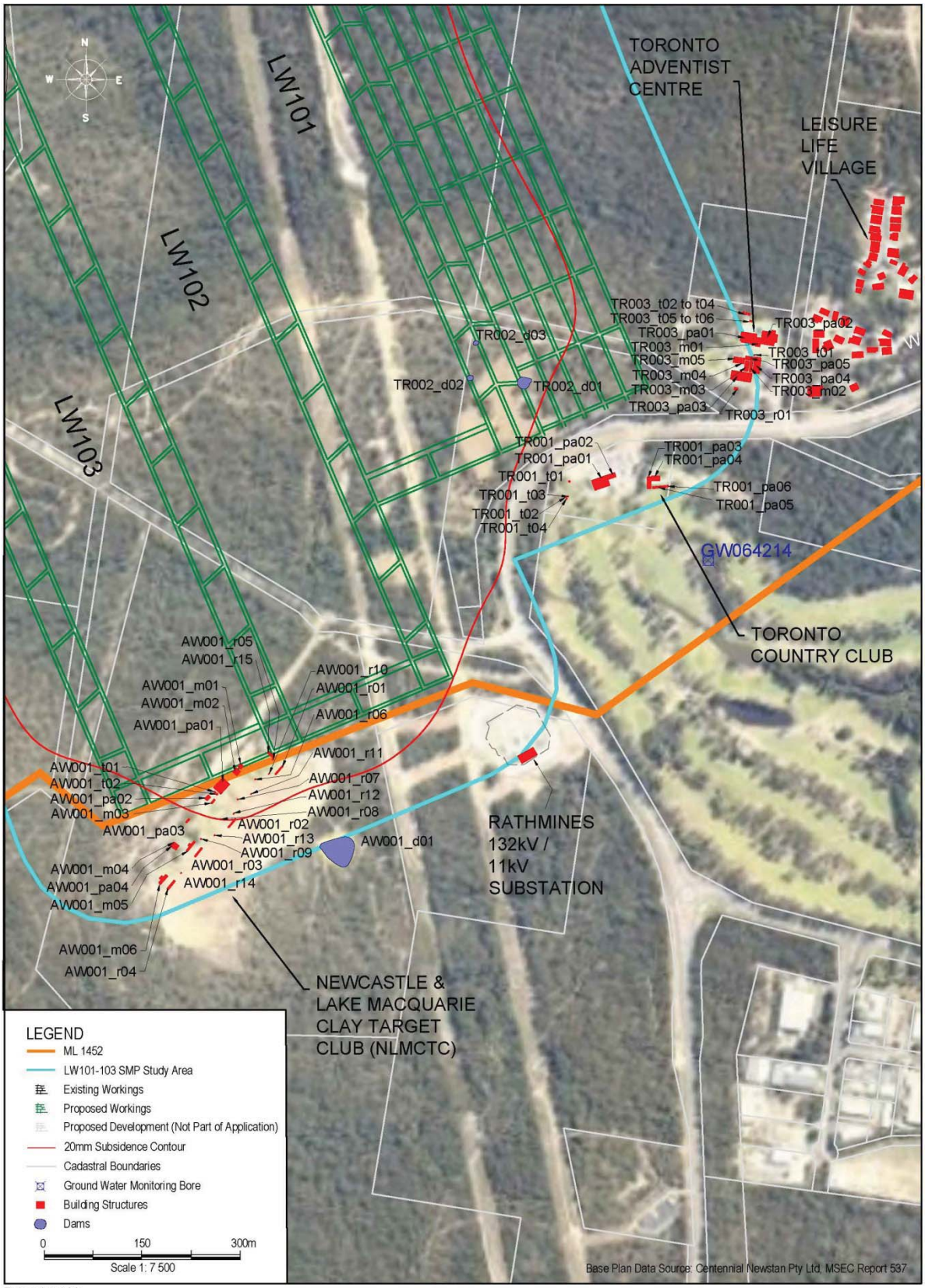


Figure 14 - Man Made Features (Detailed Buildings)

Baseline Monitoring

Further to the detailed characterisation investigations undertaken by Northrop Engineers to support the subsidence report by MSEC (2012), further baseline monitoring will be undertaken in accordance with a *Private Property Management Plan (PPMP)* developed in consultation with the Toronto Adventist Centre, as referenced by the *LW101-103 Subsidence Monitoring Program*. Baseline Monitoring will include, but not necessarily be limited to visual inspections and photos prior to the installation of main roads (first workings) within the area east of the Toronto Adventist Centre. Additionally, it is also understood that the MSB may undertake an independent (separate) pre-mining visual inspection of the centre's buildings.

Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

A summary of the maximum predicted subsidence parameters for the Church (TR003_pa02) is provided in **Table 11.9** below.

Table 11.9 Maximum Predicted Total Conventional Subsidence Parameters for the Toronto Adventist Church (MSEC 2012)

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
TR003_pa02	< 20	< 0.5	< 0.01	< 0.01

The maximum predicted conventional curvatures for the building is less than 0.01 km^{-1} hogging and sagging, which represents a minimum radius of curvature greater than 100 kilometres. The maximum predicted conventional strains for the building, based on applying a factor of 10 to the maximum predicted conventional curvatures, are less than 0.5 mm/m (i.e. in the order of survey tolerance).

The building is predicted to experience less than 20mm subsidence resulting from the proposed mining. It is not expected to experience any significant conventional tilts, curvatures or strains, and it is unlikely the building would experience any adverse impacts resulting from the proposed mining.

If the actual mine subsidence movements exceeded those predicted by a factor of 2 times, this feature is still not expected to experience any significant conventional tilts, curvatures or strains and, hence, unlikely to experience any adverse impacts.

Monitoring, Mitigation and Management

The proposed mine plan by Centennial Newstan is a primary mitigation measure for minimising potential from subsidence impact to the centre as it positions the centre directly above the mains headings (first workings supported ground) beyond the secondary extraction and 20mm subsidence contour (i.e. not directly above longwall mining). Subsidence monitoring at the Toronto Adventist Centre is proposed to be undertaken by way of visual inspections including photographic records and survey monitoring if/where required. Photographic records will be obtained and stored in the Newstan EMS for future reference.

A *Private Property Management Plan (PPMP)* is currently being developed in consultation with the Toronto Adventist Centre which details the relevant monitoring, mitigation and management measures required. The PPMP will be finalised in consultation with the landowner and a copy provided to DTIRIS-DRE prior to commencement of secondary extraction for LW101.

11.3.8. Public Amenities

The public amenities within the SMP Study Area include the Toronto Adventist Centre (church and school), Toronto Country Club (refer to **Section 11.3.10**), the Newcastle Lake Macquarie Clay Target Club (refer to **Section 11.3.11**) and the Westlakes Automobile Club (refer to **Section 11.3.12**) as shown in **Figure 13** and **Figure 14**. Characterisation, subsidence impact assessment and management for these aspects are described within the above referenced sections of this report.

11.3.9. Schools

Characterisation

The Toronto Adventist Primary School is located within the Toronto Adventist Centre at a distance of approximately 300 metres east of LW101 (**Figure 14**), at its closest point to the proposed longwalls. The construction drawings for the building structures were approved by the Mine Subsidence Board on the 3rd July 2000. The school is located on private land owned by the Australasian Conference Association Limited and was inspected by Northrop Engineers on 9th March 2012 during characterisation inspections for the Subsidence Predictions and Impact Assessment Report (MSEC 2012, refer **Appendix 4**).

An outline of the stakeholder consultation process with the Toronto Adventist Primary School for the management of infrastructure and the identification primary subsidence-sensitive aspects of the facility that was undertaken during the preparation of this SMP Application has been described in **Section 8.**

The main hall is a single storey building which is elevated above the sloping natural ground. The structure comprises a suspended concrete slab supported on load bearing brick walls on strip footings. The walls above the concrete slab have light-weight internal frames with brickwork external cladding on the lower part and light-weight cladding on the upper part. Photographs of the main hall are provided in **Plate 12.**

Plate 12 - Photographs of the Main Hall (Ref. TR003_pa01)
(Courtesy of Northrop Engineers)

The classrooms, administration building and toilet block are single storey structures with double brick or brick-veneer walls founded on concrete ground slabs and with metal roofs.

At the main entry to the centre, feature wall constructed of composite double brickwork and blockwork, approximately 2.8 metres high, founded on a reinforced concrete strip footing. The main brickwork section contains three reinforced brick piers and the blockwork ends are core filled but unreinforced.

Associated services and other surface features on the property include consumer powerlines and telephone lines, above ground water storage tanks, inground septic tanks, retaining walls and external concrete pavements.

Baseline Monitoring

Further to the detailed characterisation investigations undertaken by Northrop Engineers to support the subsidence report by MSEC (2012), further baseline monitoring will be undertaken in accordance with a *Private Property Management Plan (PPMP)* developed in consultation with the Toronto Adventist Centre, as referenced by the *LW101-103 Subsidence Monitoring Program*. Baseline Monitoring will include, but not necessarily be limited to visual inspections and photos prior to the installation of main headings (first workings). Additionally, it is also understood that the MSB may undertake (separate) pre-mining visual inspection of the school's buildings if required.

Impact Assessment

A summary of the maximum predicted subsidence parameters for the building structures associated with the school is provided in **Table 11.10** below and depicted in **Figure 13** and **Figure 14.** Maximum predicted ground strains for the school infrastructure and impact assessment discussion are provided separately below the table.

Table 11.10 Maximum Predicted Total Conventional Subsidence Parameters for the Building Structures at the Toronto Adventist Primary School (MSEC 2012)

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
TR003_pa01 (Main Hall)	< 20	< 0.5	< 0.01	< 0.01
TR003_pa03 (Classrooms)	< 20	< 0.5	< 0.01	< 0.01
TR003_pa04 (Administration Building)	< 20	< 0.5	< 0.01	< 0.01
TR003_pa05 (Toilet Block)	< 20	< 0.5	< 0.01	< 0.01

The maximum predicted conventional curvatures for the building structures are less than 0.01 km^{-1} hogging and sagging, which represents a minimum radius of curvature greater than 100 kilometres. The maximum predicted conventional strains for the building structures, based on applying a factor of 10 to the maximum predicted conventional curvatures, are less than 0.5 mm/m (i.e. in the order of survey tolerance).

The building structures and associated infrastructure are all predicted to experience less than 20 mm subsidence, therefore it is unlikely that building structures and associated infrastructure would experience any adverse impacts resulting from the proposed mining.

If the actual mine subsidence movements exceeded those predicted by a factor of 2 times, these features would still not be expected to experience any significant conventional tilts, curvatures or strains and, hence, unlikely to experience any adverse impacts.

Monitoring, Mitigation and Management

The proposed mine plan by Centennial Newstan is a primary mitigation measure for minimising potential from subsidence impact to the centre as it positions the centre directly above the mains headings (first workings supported ground) beyond the secondary extraction and 20mm subsidence contour (.i.e. not directly above longwall mining).

Subsidence monitoring at the Toronto Adventist Centre will be undertaken by way of visual inspections including photographic records and survey monitoring if/where required. Photographic records will be obtained and stored in the Newstan EMS for future reference.

A Private Property Management Plan (PPMP) is currently being developed in consultation with the Toronto Adventist Centre. The Toronto Adventist Centre PPMP will detail the relevant monitoring, mitigation and management measures and once finalised with the landowner a copy will be provided to DTIRIS – DRE prior to secondary extraction of LW101.

11.3.10. Golf Courses

Characterisation

The Toronto Country Club (Toronto Workers' Club) is located approximately 120 metres southeast of LW101 as shown in **Figure 14**, at its closest point to the proposed longwalls. The construction drawings for the building structures were approved by the Mine Subsidence Board on the 25th August 2009. The club is located on Crown land leased by Toronto Workers' Club Limited and was inspected by Northrop Engineers in 2012 during characterisation inspections for the SMP Subsidence Report (MSEC 2012, refer **Appendix 4**) in consultation with the Toronto Country Club.

An outline of the stakeholder consultation process with the Toronto Country Club for the management of infrastructure and the identification primary subsidence-sensitive aspects of the facility that was undertaken during the preparation of this SMP Application has been described in **Section 8.**

The main club house (Ref. TR001_pa01) is a double storey building structure. The lower storey comprises load bearing brick walls and brick piers supported on a slab on ground. The upper storey comprises a suspended concrete floor with lightweight walls and roof. The structure also includes a porte cochere steel framed awning (Ref. TR001_pa02), at the main entrance, as well as besser block retaining walls, stone clad feature walls and shade sails. Photographs of this building are shown in **Plate 13**.

Plate 13 - Photographs of the Main Club House (Refs. TR001_pa01 and TR001_pa02) (Courtesy of Northrop Engineers)

The property also has a number of metal sheds founded on slabs on ground (Ref. TR001_pa03 to TR001_pa06) which are used for storage and machinery and equipment.

The club has an 18 hole golf course and, in addition to the fairways, greens, bunkers and water traps, the infrastructure includes pathways, timber pedestrian bridges, concrete drainage culverts and an irrigation system. There is also one registered groundwater bore on the property, which is described in **Section 11.3.15** (Wells and Bores).

Baseline Monitoring

Further to the detailed characterisation investigations undertaken by Northrop Engineers to support the subsidence report by MSEC (2012), additional baseline monitoring will be undertaken in accordance with a *Private Property Management Plan (PPMP)* developed in consultation with the Toronto Country Club, as referenced by the *LW101-103 Subsidence Monitoring Program*. Baseline monitoring will include, but not necessarily be limited to visual inspections and photos which will be undertaken prior to secondary extraction of LW101. Photographic records will be obtained and stored in the Newstan EMS for future reference. Additionally, the MSB may undertake separate pre-mining visual inspection surveys of buildings where appropriate.

Impact Assessment

A summary of the maximum predicted subsidence parameters for the building structures associated with the golf course is provided in **Table 11.11** below.

Table 11.11 Maximum Predicted Total Conventional Subsidence Parameters for the Building Structures at The Toronto Country Club (MSEC 2012)

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
TR001_pa01 (Main Club House)	< 20	< 0.5	< 0.01	< 0.01
TR001_pa02 (Porte Cochere)	< 20	< 0.5	< 0.01	< 0.01
TR001_pa03 (Metal Shed)	< 20	< 0.5	< 0.01	< 0.01
TR001_pa04 (Metal Shed)	< 20	< 0.5	< 0.01	< 0.01
TR001_pa05 (Metal Shed)	< 20	< 0.5	< 0.01	< 0.01
TR001_pa06 (Metal Shed)	< 20	< 0.5	< 0.01	< 0.01

The maximum predicted conventional curvatures for the building structures are less than 0.01 km^{-1} hogging and sagging, which represents a minimum radius of curvature greater than 100 kilometres. The maximum predicted conventional strains for the building structures, based on applying a factor of 10 to the maximum predicted conventional curvatures, are less than 0.5 mm/m (i.e. in the order of survey tolerance).

The golf course, itself, is located 150 metres southeast of LW101, at its closest point to the proposed longwalls. At this distance, the golf course is predicted to experience less than 20 mm subsidence and the associated tilts, curvatures and strains are expected to be less than the order of survey tolerance.

The building structures, golf course and associated infrastructure are all predicted to experience less than 20 mm subsidence, therefore it is unlikely that building structures, golf course and associated infrastructure would experience any adverse impacts resulting from the proposed mining.

If the actual tilts exceeded those predicted by a factor of 2 times, the changes in grade would still be extremely small (i.e. less than 0.1%) and are unlikely to result in any serviceability impacts on the building structures, golf course or associated infrastructure.

The curvatures and strains would still be in the order of survey tolerance and unlikely, therefore, to result in any adverse impacts on the building structures, golf course or associated infrastructure.

Monitoring, Mitigation and Management

Further to the detailed baseline characterisation inspections by Northrop Engineers for the SMP Subsidence Report (MSEC 2012), Pre-mining visual inspections will be undertaken on the building structures at the Toronto Country Club, immediately prior to the extraction LW101.

Subsidence monitoring at the Toronto Country Club will be undertaken by way of visual inspections including photographic records post-mining (and during mining upon request of the stakeholder at such time). Photographic records will be obtained and stored in the Newstan EMS for future reference.

A *Private Property Management Plan* is currently being developed in consultation with the Toronto Country Club. The *Toronto Country Club Private Property Management Plan* details the relevant monitoring, mitigation and management measures required and a copy will be provided to DTIRIS - DRE once finalised with the TCC prior to commencement of secondary extraction of LW101.

11.3.11. Newcastle and Lake Macquarie Clay Target Club

Characterisation

The Newcastle Lake Macquarie Clay Target Club (NLMCTC) is partially located above the southern ends of the proposed LW102-103 as shown in **Figure 13** and **Figure 14**. The property includes a number of building structures and associated infrastructure, which are located immediately to the south of the proposed longwalls. The NLMCTC is located on Crown land leased by NLMCTC and was inspected by Northrop Engineers in 2012 during characterisation studies for the SMP Subsidence Report (MSEC 2012, refer **Appendix 4**) in consultation with NLMCTC.

An outline of the stakeholder consultation process with NLMCTC for the management of infrastructure and the identification of the primary subsidence-sensitive aspects of the facility that was undertaken during the preparation of this SMP Application has been described in **Section 8.**

The main club house (Ref. AW001_pa01) is a single storey mixed brickwork and timber framed structure founded on a slab on ground with a metal roof. This structure is located 50 metres south of the proposed LW103. A photograph of the club house is provided in **Plate 14.**

Plate 14 - Main Club House (Ref. AW001_pa01)
(Courtesy of Northrop Engineers)

Other building structures on the property include a single storey timber cottage on brick piers with a metal roof (AW001_pa02) and demountable structures on mini piers or slab on ground (AW001_pa03, AW001_pa04 and AW001_r15). The trap enclosures (AW001_r01 to AW001_r04) are fabricated steel structures founded on natural ground with timber or concrete retaining walls. The enclosures contain the clay target throwers. Photographs of the enclosures and throwers are provided in **Plate 15**.

Plate 15 - Trap Enclosure AW001_r04 (LHS) and Clay Target Thrower (RHS)
(Courtesy of Northrop Engineers)

There are four brick trap houses (AW001_r05 to AW001_r08) which are approximately 2 metre square brick structures, up to approximately 4.5 metres tall, founded on slabs on ground with metal roofs. The taller structures also have steel framed stairs. Photographs of the trap houses are provided in **Plate 16**.

Plate 16 - Trap Houses AW001_r05 (LHS) and AW001_r08 (RHS)
(Courtesy of Northrop Engineers)

Other features include free standing roof structures, a playground and other small storage sheds. The services on the property include low voltage powerlines, lighting, inground and above ground water storage tanks, and retaining walls. There is a dam located on the edge of the 26.5 ^{o} AOD and beyond the 20mm subsidence contour.

Baseline Monitoring

Further to the detailed characterisation investigations undertaken by Northrop Engineers to support the subsidence report by MSEC (2012), further baseline monitoring of infrastructure and grounds located at the Newcastle Lake Macquarie Clay Target Club will be undertaken through a combination of land survey and visual inspections including photographic records. Survey monitoring will include specific measurement of the required clay target release machines identified by the NLMCTC within a *Private Property Management Plan (PPMP)* developed in consultation with the NLMCTC.

The baseline visual inspections will identify the absence or presence of damage to the structures on-site including the club house, associated buildings and storage tanks. Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

A summary of the maximum predicted subsidence parameters for the building structures associated with the target club is provided in **Table 11.12** below and depicted in **Figure 14**.

Table 11.12 Maximum Predicted Total Conventional Subsidence Parameters for the Building Structures at the Newcastle Lake Macquarie Clay Target Club

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Main Clubhouse AW001_pa01	75	1.0	0.01	0.01
Timber Cottage AW001_pa02	50	1.0	<0.01	<0.01
Demountable AW001_pa03	25	<0.5	<0.01	<0.01
Demountable AW001_pa04	<20	<0.5	<0.01	<0.01
Trap Enclosure AW001_r01	50	0.5	<0.01	<0.01
Trap Enclosure AW001_r02	25	<0.5	<0.01	<0.01
Trap Enclosure AW001_r03	<20	<0.5	<0.01	<0.01
Trap Enclosure	<20	<0.5	<0.01	<0.01

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
AW001_r04				
Brick Trap House AW001_r05	75	1.0	0.01	<0.01
Brick Trap House AW001_r06	50	0.5	<0.01	<0.01
Brick Trap House AW001_r07	50	0.5	<0.01	<0.01
Brick Trap House AW001_r08	25	<0.5	<0.01	<0.01
AW001_r09	<20	<0.5	<0.01	<0.01
AW001_r10	50	0.5	<0.01	<0.01
AW001_r11	50	0.5	<0.01	<0.01
AW001_r12	25	<0.5	<0.01	<0.01
AW001_r13	<20	<0.5	<0.01	<0.01
AW001_r14	<20	<0.5	<0.01	<0.01
AW001_r15	75	1.0	0.02	<0.01
DAM AT THE NEWCASTLE LAKE MACQUARIE TARGET CLUB				
AW001_d01	<20	<0.5	<0.01	<0.01

The maximum predicted conventional curvatures for the building structures are 0.02 km^{-1} hogging and 0.01 km^{-1} sagging, which represent minimum radii of curvature of 50 kilometres and 100 kilometres, respectively.

The maximum predicted conventional curvatures for the dam are less than 0.01 km^{-1} hogging and sagging, which represents a minimum radius of curvature greater than 100 kilometres. The maximum predicted conventional strains for the dam, based on applying a factor of 10 to the maximum predicted conventional curvatures, are less than 0.5 mm/m (i.e. in the order of survey tolerance).

The maximum predicted tilt for the **main club house** (AW001_pa01) and timber cottage (AW001_pa02) is 1.0 mm/m (i.e. 0.1 %), which represents a change in grade of 1 in 1000. Tilts less than 7 mm/m generally do not result in any significant serviceability issues for building structures. It is unlikely, therefore, that these structures would experience any adverse impacts resulting from the mining induced tilt.

The maximum predicted curvatures for the main club house and timber cottage is 0.01 km^{-1} hogging and sagging, which represents a minimum radius of curvature of 100 kilometres. The maximum predicted conventional strains for these structures, based on applying a factor of 10 to the maximum predicted conventional curvatures, are less than 0.5 mm/m (i.e. in the order of survey tolerance). The

predicted curvatures and strains are very small, in the order of survey tolerance, and unlikely to result in any significant impacts on these structures.

The demountable structures, small storage sheds, **trap houses and the trap enclosures**, themselves, are founded on small piers, slabs on ground, or the natural ground. The predicted curvatures and strains for these structures are very small, in the order of survey tolerance, and are unlikely to be transferred into these structures and, hence, result in any significant impacts.

The maximum predicted tilt for the target throwers is less than 0.5 mm/m (i.e. less than 0.1 %), which represents a change in grade less than 1 in 2,000. The predicted tilts are extremely small, being less than the order of survey tolerance. Whilst the predicted tilts are extremely small, the clay target throwers and the target survey markers could be sensitive to these small movements. It is understood that the clay target throwers can be adjusted in level. It may be necessary to develop preventive measures, if the predicted tilts exceed the available adjustments to relevel the clay target throwers, or to relocate the target survey markers.

The remaining structures are light-weight and unlikely, therefore, to be adversely impacted by the predicted tilts and curvatures. It is also unlikely that the services would be adversely impacted as a result of the proposed mining.

The dam (AW001_d01) is predicted to experience subsidence less than 20 mm. It is unlikely, therefore, that the dam would experience any adverse impacts resulting from the proposed mining.

Impacts based on increased subsidence are discussed in the MSEC report (2012). If the actual tilts, curvatures or subsidence exceeded those predicted by a factor of 2 times, they would be unlikely to result in any serviceability impacts on the building structures or associated infrastructure. It is possible that the clay throwers could be sensitive to these small movements.

Monitoring, Mitigation and Management

Management strategies will be developed in consultation with the NLMCTC so that the clay target throwers can be re-levelled if required. It may be necessary to develop preventative measures, if the predicted tilts are greater than the adjustments available to re-level the clay target throwers (MSEC 2012). These are accommodated within the Trigger Action Response Plan (TARP) components of the *Private Property Management Plan (PPMP)* developed for the NLMCTC.

Subsidence monitoring at the Newcastle Lake Macquarie Clay Target Club will be undertaken by way of visual inspections including photographic records and survey monitoring (particularly of sensitive clay target throwing enclosures as required). Photographic records will be obtained and stored in the Newstan EMS for future reference.

A draft *Private Property Management Plan* is currently being developed in consultation with the Newcastle Lake Macquarie Clay Target Club which will be finalised and submitted to DTIRIS - DRE prior to commencement of secondary extraction of LW103. In this way, subsidence monitoring results from LW101-LW102 can be used to update the management plan if required given the substantial time period between LW101 and LW103.

11.3.12. Westlakes Automobile Club (Awabawac Park)

Characterisation

The Westlakes Automobile Club (Awabawac Park) is partially located above the southern end of the proposed LW103 as shown in **Figure 13**. The property (Ref. AW003) includes a number of dirt (i.e. unsealed) tracks which are used for various motorsport events (e.g. rally). The Awabawac facility is located on Crown land and was inspected by Northrop Engineers in 2012 during characterisation studies for the SMP Subsidence Report (MSEC 2012, refer **Appendix 4**) in consultation with Awabawac.

An outline of the stakeholder consultation process with the Westlakes Automobile Club for the management of tracks and infrastructure and the identification primary subsidence-sensitive aspects of the facility that was undertaken during the preparation of this SMP Application has been described in **Section 8.**

The building structures on the property (AW003_pa01 to AW003_pa03) are demountable structures founded on concrete pads or besser blocks on natural ground. Photographs of these structures are provided in **Plate 17.**

Plate 17 - Building Structures at Westlakes Automobile Club (Courtesy of Northrop Engineers)

The services on the property include low voltage powerlines, lighting and a water tank.

Baseline Monitoring

Further to the detailed characterisation investigations undertaken by Northrop Engineers to support the subsidence report by MSEC (2012), further baseline monitoring of infrastructure and tracks located at the Westlakes Automobile Club will be undertaken in accordance with a *Private Property Management Plan (PPMP)* developed in consultation with Westlakes Automobile Club and referenced by the *LW101-103 Subsidence Monitoring Program*. Baseline Monitoring will include, but not necessarily be limited to visual inspections including photographic records. Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

The unsealed tracks are partially located above the proposed LW103. A summary of the maximum predicted subsidence parameters for this section of track is provided in **Table 11.13** below. The tilts are the maximum predicted values which occur after the completion of each of the proposed longwalls. The curvatures are the maximum predicted values which occur at any time during or after the extraction of each of the proposed longwalls.

Table 11.13 Maximum Predicted Total Conventional Subsidence Parameters for the Section of Track Located Directly Above Longwall 103

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
After LW101	< 20	< 0.5	< 0.01	< 0.01
After LW102	< 20	< 0.5	< 0.01	< 0.01
After LW103	800	10	0.15	0.25

A summary of the maximum predicted subsidence parameters for the building structures associated with the Westlakes Automotive club is provided in **Table 11.14** below.

Table 11.14 Maximum Predicted Total Conventional Subsidence Parameters for the Building Structures at the Westlakes Automobile Club

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Demountable Structure AW003_pa01	< 20	< 0.5	< 0.01	< 0.01
Demountable Structure AW003_pa02	< 20	< 0.5	< 0.01	< 0.01
Demountable Structure AW003_pa03	< 20	< 0.5	< 0.01	< 0.01

The maximum predicted conventional curvatures for the building structures less than 0.01 km^{-1} hogging and sagging, which represents a minimum radius of curvature greater than 100 kilometres. The maximum predicted conventional strains for the building structures, based on applying a factor of 10 to the maximum predicted conventional curvatures, are less than 0.5 mm/m (i.e. in the order of survey tolerance).

The maximum predicted tilt for the section of track located directly above the proposed LW103 is 10 mm/m, which represents a change in grade of 1 in 100. The predicted change in grade is extremely small (i.e. 1 %) and unlikely, therefore, to result in any adverse impacts on the surface water drainage.

The predicted curvatures and strains for the section of track located directly above the proposed LW103 could be of sufficient magnitude to result in cracking, heaving, or stepping of the surface. These impacts accordingly will be a key focus for management as outlined further below.

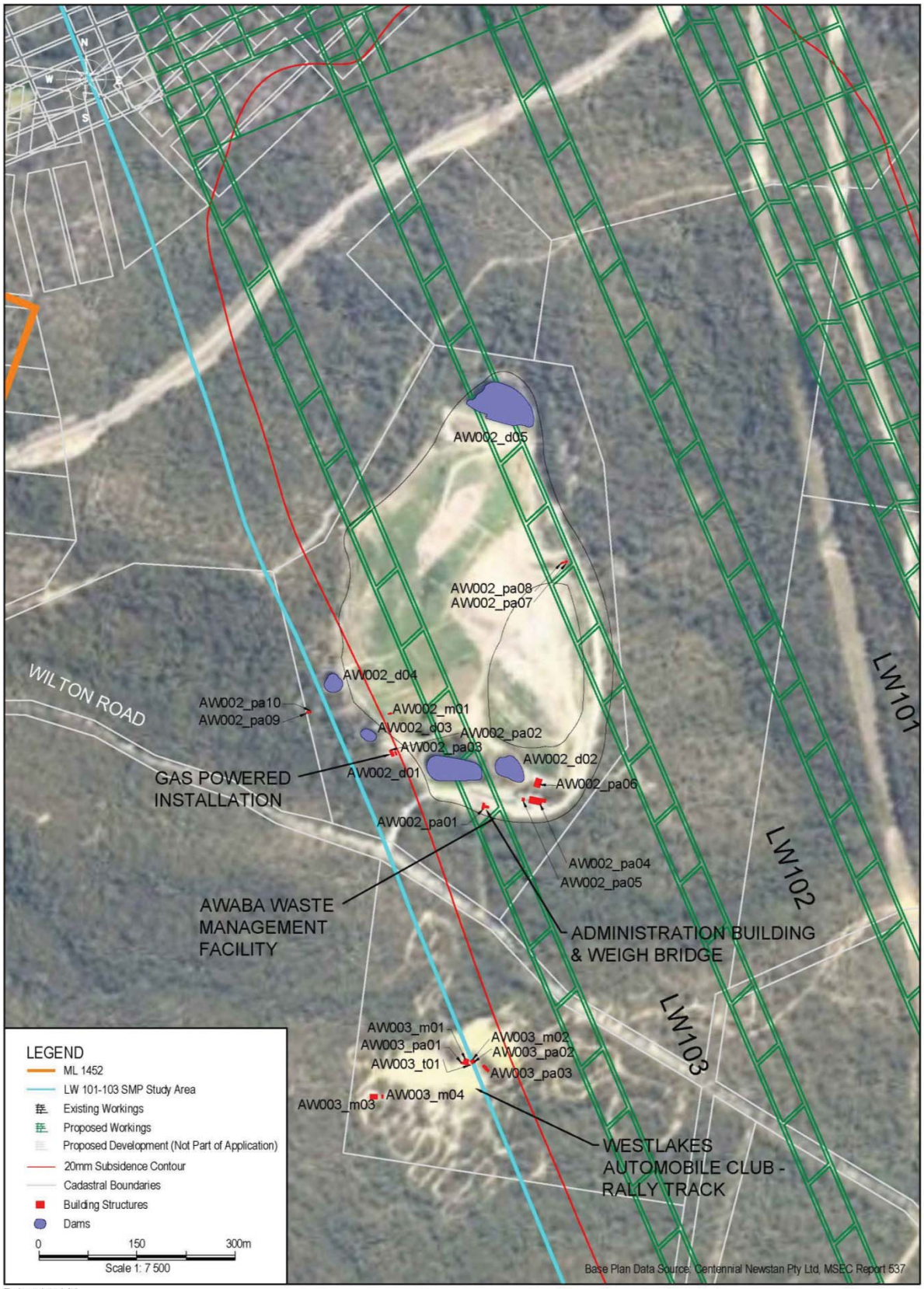


Figure 15 - Man Made Features – Detailed (above LW103)

The building structures and associated infrastructure are all predicted to experience less than 20 mm subsidence therefore it is unlikely that building structures and associated infrastructure would experience any adverse impacts resulting from the proposed mining.

Impacts based on increased subsidence are discussed further in the MSEC report (2012). If the actual tilts exceeded those predicted by a factor of 2 times, it would still be unlikely to result in any adverse impacts on the surface water drainage, or result in any serviceability impacts on the building structures or associated infrastructure.

If the actual curvatures exceeded those predicted by a factor of 2 times, the likelihood and extent of surface cracking, heaving and stepping would increase for the section of track above LW103, however, the building structures and associated infrastructure would still be unlikely to experience any adverse impacts.

Monitoring, Mitigation and Management

A Private Property Management Plan (PPMP) will be developed in consultation with the Westlakes Automobile Club and submitted to DTIRIS - DRE prior to commencement of secondary extraction of LW103. Subsidence monitoring results from LW101 and LW102 could then be used to update the management plan if required. The section of track located directly above the proposed LW103 will be visually inspected immediately prior to undermining and periodically throughout the active subsidence period (particularly immediately prior to use of the track). A *Trigger Action Response Plan (TARP)* will be developed within the plan to appropriately manage key risks including surface cracking and stepping to ensure public safety is appropriately maintained. Visual inspections of buildings will be undertaken prior to and following secondary extraction of LW103.

Subsidence monitoring at the Westlakes Automobile Club will be undertaken by way of visual inspections including photographic records. Photographic records will be obtained and stored in the Newstan EMS for future reference.

11.3.13. Fences

There are fences located across the SMP Study Area, including perimeter wire fencing for the Augsrid electrical substation (refer **Section 11.3.5**), brick fencing entry to the Toronto Adventist Centre (**Plate 18**), and wire fencing along the Wilton Road entry to the AWMF (**Plate 19**) in particular. Accordingly, these fences are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence parameters within the SMP Study Area is provided in **Table 7.1**.

Wire fences can be affected by tilting of the fence posts and by changes of tension in the fence wires due to strain as mining occurs. These types of fences are generally flexible in construction and can usually tolerate tilts of up to 10 mm/m and strains of up to 5 mm/m without significant impacts. Colorbond and timber paling fences are more rigid than wire fences and, therefore, are more susceptible to impacts resulting from mine subsidence movements.

It is expected, at the predicted magnitudes of tilt, curvature and strain, that some sections of the fences within the SMP Study Area would be impacted as a result of the extraction of the proposed longwalls.

Plate 18 - Photographs of the Main Entry Feature Wall at Toronto Adventist Centre (Courtesy of Northrop Engineers)

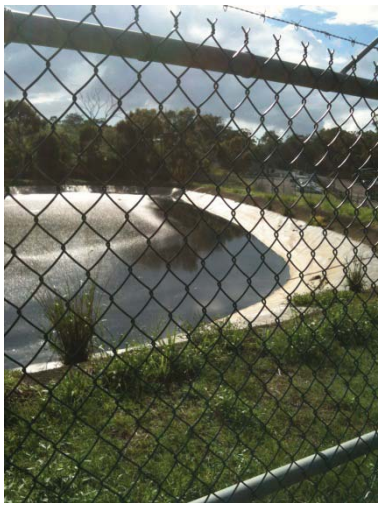


Plate 19 – Photograph of fencing at Awaba Waste Management Facility

Monitoring, Mitigation and Management

The monitoring and management of fences within the SMP Study area will typically be undertaken by inclusion into the relevant *Private Property Management Plan (PPMP)* or specific infrastructure management plans (e.g. AWMF, Ausgrid electrical substation) which will be developed prior to undermining, as well as the *Public Safety Management Plan*.

11.3.14. Farm Dams

Characterisation

The majority of land within the SMP Study Area is well vegetated natural bushland on crown land or private land. Stakeholder consultation and land ownership investigations for the SMP did not identify any actively farmed land within the SMP Study Area, nor any dams utilised for stock water.

Minor dams within the SMP Study Area were further identified during detailed infrastructure characterisation investigations by ACOR Appleyard, Northrop Engineers and MSEC for the SMP Subsidence Report (MSEC 2012, refer **Appendix 4**).

An outline of the stakeholder consultation process for the management of farm dams that was undertaken during the preparation of this SMP Application has been described in **Section 8.** No issues pertaining to subsidence related impacts to dams have been raised during consultation.

The minor dams identified within the SMP Study Area primarily include:

- Leachate and sediment ponds associated with the Awaba Waste Disposal Facility, as discussed in **Section 11.3.17;**
- A dam located in the south of the Newcastle Lake Macquarie Clay Target Club is discussed in **Section 11.3.11.**
- Three other minor dams within the SMP Study Area (TR002_d01 to TR002_d03) as outlined further below,

The three minor dams (TR002_d01 to TR002_d03) are located adjacent to the southern end of the proposed Longwall 101, either above gate roads for LW101 or above first workings as shown in **Figure 14**.

The dams are of earthen construction and range in area between 30 m^2 and 300 m^2, and in maximum plan dimension of between 5 metres and 25 metres. The dams are located on Crown land managed by DTIRIS – Division of Catchments and Lands (formerly Land and Property Management Authority (LPMA)).

Baseline Monitoring

Further to the detailed characterisation investigations undertaken by Northrop Engineers to support the subsidence report by MSEC (2012), additional baseline monitoring of the dams mentioned above will be undertaken prior to mining in accordance with the *Subsidence Management Plan (SMP)* (refer **Volume 2** of the SMP Application) through visual inspections including photographic records. Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

A summary of the maximum predicted subsidence parameters for the farm dams is provided in **Table 11.15** below.

Table 11.15 Maximum Predicted Total Conventional Subsidence Parameters for Farm Dams

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
TRI002_d01	75	1.5	0.03	< 0.01
TRI002_d02	300	5.0	0.04	0.04
TRI002_d03	250	4.0	0.04	0.03

The maximum predicted tilt for the farm dams is 5.0 mm/m (i.e. 0.5 %), which represents a change in grade of 1 in 200. The maximum predicted change in freeboard, based on a maximum plan dimension of 25 metres, is less than ±100 mm. The predicted changes in freeboard are small and, therefore, are unlikely to have any significant impact on the storage capacities of the farm dams.

Surface cracking or heaving is rarely observed, where the ground strains are less than 0.5 mm/m, especially outside the extents of extracted longwalls. Also, it has been found that the incidence of impacts to farm dams in the Newcastle and Hunter Coalfields is extremely low, where the dams are located outside the extents of extracted longwalls and where there is a reasonable depth of cover, say greater than 250 metres, which is the case for the proposed longwalls. Based on this experience, it is unlikely that the farm dams within the SMP Study Area would be adversely impacted as a result of the proposed mining.

If the actual tilts exceeded those predicted by a factor of 2 times, these would still be unlikely to have any significant impact on the storage capacities of the farm dams. If the actual curvatures exceeded those predicted by a factor of 2 times, it is possible, that surface cracking could occur at the farm dam TR002_d02, but at these magnitudes of movement, any surface cracking would still be expected to be of a minor nature and could be easily repaired. It would still be unlikely that there would be any loss of water from the dams.

Monitoring, Mitigation and Management

The monitoring and management of dams within the SMP Study Area will be included into relevant *Private Property Management Plans* and relevant plans of management for infrastructure (e.g. *AWMF Management Plan*) as well as the *Public Safety Management Plan*.

11.3.15. Wells or Bores

There were no registered groundwater bores identified within the SMP Study Area, however, there are 26 registered bores within a 5 km radius of the SMP Study Area, with the majority (17) being registered for domestic, irrigation and / or stock use and the remainder registered as monitoring/test bores (6), general use (1), waste disposal (1) and unknown (1).

There are two registered groundwater bore located outside the SMP Study Area but within the grounds of the Toronto Country Club, with the closest (GW064214), located, approximately 360 metres south-east of the proposed LW101 and GW064213 located beyond ML1452 at the southeasten end of the Toronto Country Club. The closest monitoring bore (GW064214) is located well outside the predicted 20 mm subsidence contour and, therefore, is unlikely to experience any significant conventional subsidence movements. The groundwater table could be affected by the proposed mining and, therefore, may lower piezometric surface at the bore.

The registered domestic and stock bores that were identified primarily extract groundwater from the sandstone and conglomerate formations, with yields generally less than 2 L/s. Only three alluvial bores for stock and domestic use were identified (GW063752, GW064025 and GW064067) and these extract groundwater from the Palmers Creek alluvium above existing LW14 and 17 to the north west of the SMP Study Area. These bores reportedly yield less than 1 L/s. No registered bores within Kilaben Creek or Stony Creek alluvium were identified.

Overall, groundwater usage and reliance for domestic, irrigation and stock watering purposes is generally limited in the vicinity of the SMP Study Area.

An outline of the stakeholder consultation process for the management of wells and/or dams that was undertaken during the preparation of this SMP Application has been described in **Section 8.** No issues pertaining to subsidence related impacts to groundwater monitoring bore have been raised during consultation.

Impact Assessment:

Statistical analysis of existing groundwater monitoring data and predictions from a preliminary hydrogeological model was undertaken to assess groundwater impacts for the development and extraction of LW101, 102 and 103 at Newstan. The Groundwater Impact assessment conducted by GHD (2012) has made a number of conclusions including:

- Aquifer depressurisation is not anticipated to impact registered stock, domestic or irrigation bores. The groundwater monitoring bore at the Toronto Country Club (GW064214) may experience some minor drawdown associated with mining however this is expected to be in the order of 0.1 m and negligible compared to climatic variation.

Monitoring, Mitigation and Management

Monitoring and management strategies implemented for the groundwater monitoring well located at the Toronto Country Club will be included in the *Water Management Plan* which will be submitted prior to secondary extraction of LW101, and incorporated within the *Private Property Management Plan (PPMP)* where required in consultation with the TCC.

11.3.16. Business or Commercial Premises

The business establishments within the SMP Study Area include the Toronto Country Club (refer to **Section 11.3.10**), the Newcastle Lake Macquarie Clay Target Club (refer to **Section 11.3.11**) Westlakes Automobile Club (refer to **Section 11.3.12** and the Awaba Waste Management Facility (refer to **Section 11.3.17**).

11.3.17. Waste Storages and Associated Plants

The Awaba Waste Management Facility (AWMF) operated by Lake Macquarie City Council (LMCC) is located off Wilton Road and is described in detail in dedicated **Section 11.4** of this report.

11.3.18. Railways

There are no railways located within the SMP Study Area. The Main Northern Railway is located 500m north of LW103, at its closest point to the proposed longwalls. At this distance, the railway and the associated infrastructure are not predicted to experience any significant conventional subsidence movements (MSEC 2012), prudently however, any potential for far field effects on the railway was specifically considered within the SMP Subsidence Assessment by MSEC.

A cross-section through the Main Northern Railway and LW103, where the railway is closest to the proposed longwalls, is provided in **0** which shows that the railway is located well outside both the 26.5 degree angle of draw from the extent of secondary extraction (standard SMP Guidelines requirement) and the 35 degree angle of draw, as required by conditions of the Mining Lease.

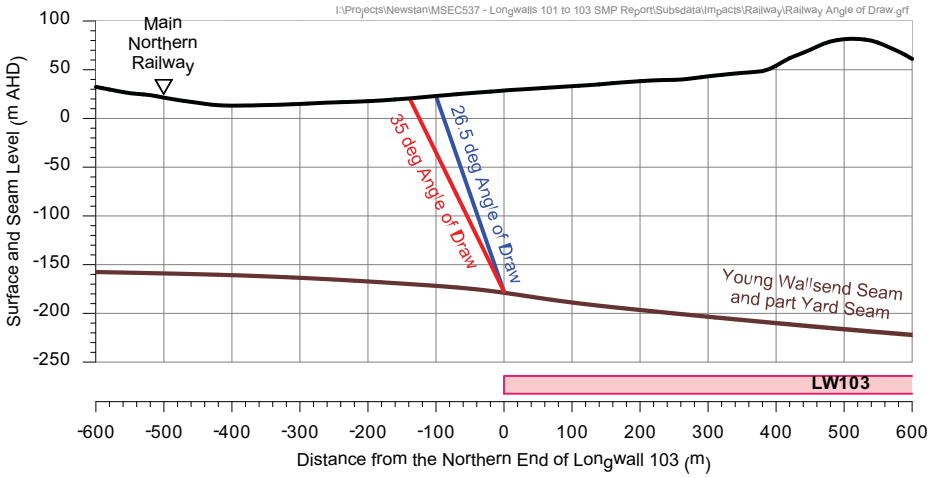


Figure 16 - Cross-section through Railway and LW103.

The railway and associated infrastructure are likely to experience far-field horizontal movements. The incremental far field movements on 100mm have been observed at distances of 500m from previously extracted longwalls. These movements tend to be bodily movements towards the extracted goaf area, which result in very low levels of strain, generally less than the order of survey tolerance (MSEC 2012).

It is therefore unlikely that the railway and associated infrastructure would experience any adverse impacts resulting from the proposed mining.

11.3.19. Permanent Survey Control Marks

Survey control marks are located across the SMP Study Area as illustrated on **SMP Plan 2** and are expected to experience the full range of predicted subsidence movements (MSEC 2012) which includes two State Survey Marks and one Trigonometrical Station. These include:

- Two State Survey Marks (SS77112, SS77113);
- One (1) Trig Station (TS666).

Survey control marks located outside and in the vicinity of the SMP Study Area are also expected to experience small amounts of subsidence and small far-field horizontal movements up to 3km outside the SMP Study Area.

It will be necessary on the completion of the longwalls, when the ground has stabilised, to re-establish survey control marks that are required for future use. Consultation between Centennial and the Department of Lands will be undertaken to ensure that these survey control marks are reinstated at the appropriate time, as required. Management of survey marks will be undertaken in accordance with the *LW101-103 Subsidence Management Plan (SMP)*.

11.4. AWABA WASTE MANAGEMENT FACILITY

This section provides detailed characterisation and assessment specifically for the existing Awaba Waste Management Facility (AWMF), including detailed consultation with Lake Macquarie City Council (LMCC) and the risk based approach to assessing and addressing potential subsidence impacts.

11.4.1. Characterisation

Overview:

The existing Awaba Waste Management Facility (AWMF) is operated by the Lake Macquarie City Council (LMCC) and is located over secondary extraction areas of LW103, on lands classified as Crown Reserve. The majority of the existing AWMF footprint includes MG102 (maingate 102, located between LW102-103) with the exception of the secondary leachate dam which is also located over a small section of LW102. The AWMF also lies within the angle of draw for LW102, as illustrated on **Figure 13** and **Figure 15** (property ref AW002).

The facility is a Category 1 putrescible landfill site which receives "household wastes, privately transported residential rubbish, construction and municipal wastes and some industrial wastes" (LMCC, 2010, cited in MSEC 2012).

The existing AWMF comprises the waste disposal area, leachate and sediment ponds, leachate collection and spray systems, gas drainage and flare infrastructure, a gas powered generator installation, weighbridge, administration building and storage structures. The general layout of the facility is shown in **Figure 17** below.

Detailed consultation has been appropriately undertaken with LMCC as a primary focus of this SMP Application. This includes the establishment of a technical team of specialists from both parties working closely together to assess and appropriately manage subsidence for the AWMF. Initial supporting studies (outlined below) have been undertaken to feed into a preliminary assessment of subsidence-related risks which identified any existing knowledge gaps. A program of further works was then identified to appropriately address these for mitigation and management (refer **Section 11.3.17**). The further investigations identified will be utilised in a detailed review of the preliminary risk assessment and the development of a dedicated plan of management for the facility (*AWMF Management Plan*) prior to impact by longwall mining within LW102.

Detailed characterisation of the existing AWMF is provided further below.

Background:

The AWMF was commissioned in 1986. The Mine Subsidence Board reviewed the proposal at that time and had no objection to the use of the site for solid waste disposal based on the AWMF being complete/ closed by the time mining was expected to pass through. It appears that the original facility was not designed for specific mine subsidence parameters or requirements. In 1995 approval was granted to increase the fill height of emplacement areas.

In 1998 an Environmental Impact Statement was prepared for the Newstan Life Extension Area. The facility was expected to have closed by the time mining arrived, commitment to functionality of the facility was provided in the scenario where the AWMF is still operating at the time of mining with further detailed investigations to be undertaken (process commenced during this SMP).

The AWMF was expanded in 2005 with the construction of an additional cell in the south-eastern corner of the area. The new lined cell was designed for mine subsidence, however, the specific mine subsidence parameters were not available at the time of preparing this report.

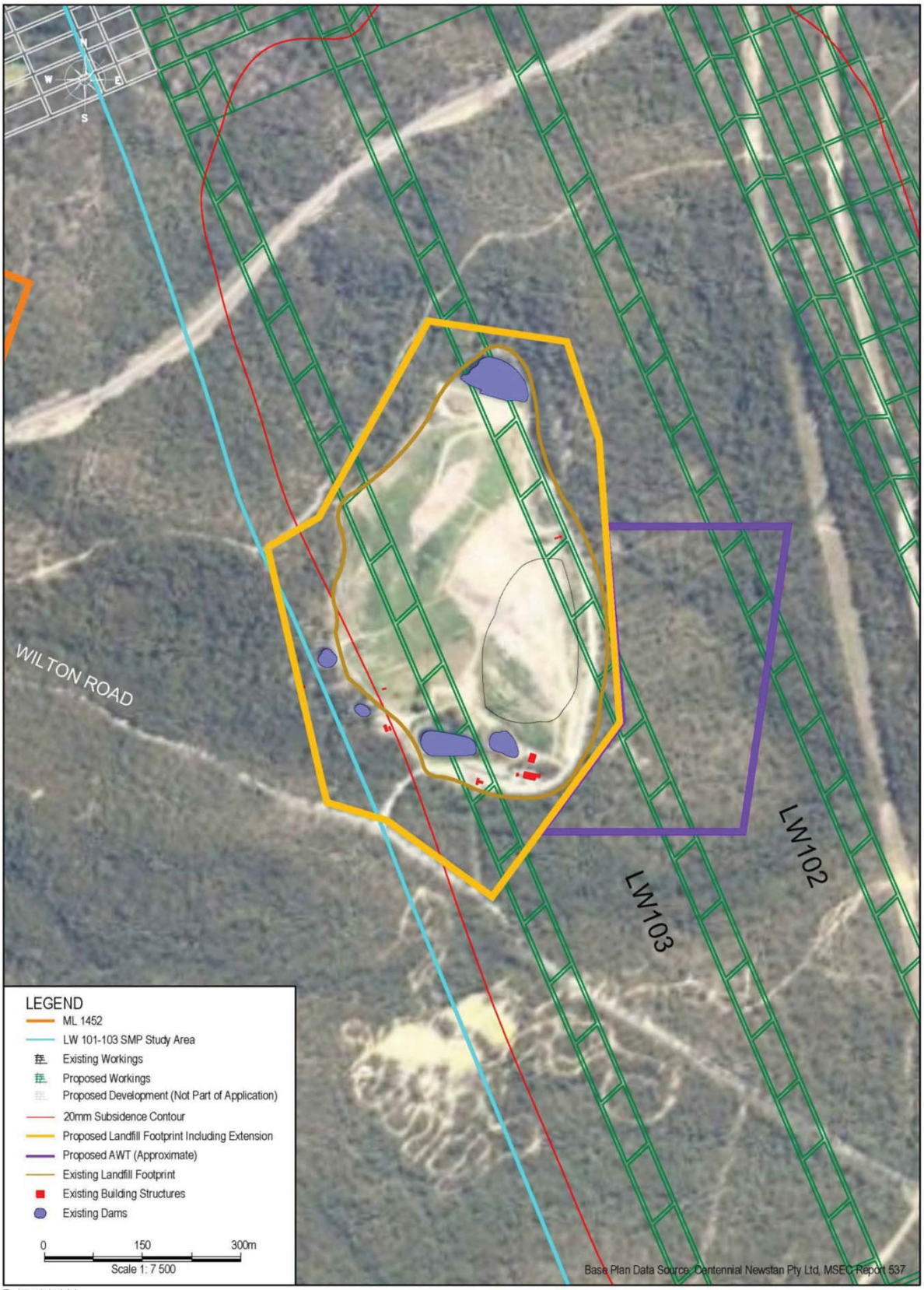


Figure 17 - Awaba Waste Management Facility: Existing & Proposed Footprints

Detailed Characterisation

Detailed investigations to characterise the existing facility were undertaken by ACOR Applyard, PSM and MSEC on behalf of Centennial Newstan in consultation with LMCC and their specialist consultants GHD. Meetings to identify and share key required information between both sides were established in late 2011 and continue to date. The outcomes of this process are described in detail within the SMP Subsidence Report by MSEC (2012) in **Appendix 4** and supporting investigations mentioned below.

The original **waste emplacement areas** ('cells') established in 1986 were unlined with waste emplaced directly over the original surface. The extent of area which consists of the unlined cell (Area D) is shown in **Figure 14**. The cell in Area C was constructed in 2005, in the south-eastern corner and was constructed with a liner as detailed below. The tender document for the construction of the current waste cell in 2005 provided the following requirements for the liner, from the bottom layer to the top layer as follows (RCA 2005):

- Geotextile Protection Layer comprising non-woven continuous filament needle punched polyester geotextile with nominal mass of 200 g/m^2 and nominal thickness of 5 mm,
- Geosynthetic Clay Liner (GCL) with dry thickness of 6 mm, Bentonite layer mass of 4500 g/m^2, single non-woven geotextile protection layer with nominal mass of 220 g/m^2, carrier woven mass of 110 g/m^2 and minimum mass per unit area of 4830 g/m^2,
- Geotextile Separation Layer with a nominal mass of 200 g/m^2,
- Compacted Clay Layer (CCL) constructed from ripped and reworked siltstone won from the excavation of the northern end of the quarry. The minimum requirements of the CCL was a thickness of 300 mm ± 25 mm, maximum permeability of 1x10^{-6} m/s, relative density ratio of 95 % (AS1289 5.1.1), less than 20 % particles coarser than 20 mm with no particles coarser than 40 mm and moisture range when compacted 60 % to 95 % of optimum moisture content (AS1289 5.1.1),
- Geotextile Separation Layer with a nominal mass of 200 g/m^2,
- Leachate Collection Layer with minimum thickness of 300 mm, minimum permeability of 1x10^{-3} m/s, sufficiently large pore space > 20 mm to prevent encrustation, uniform, rounded, smooth surfaced with stone size > 20 mm, non-reactive in mildly acidic conditions and free of carbonates, and
- Geotextile Separation Layer with a nominal mass of 200 g/m^2.

The **leachate collection system** within the unlined cell waste emplacement area consists of a collection well downslope at bedrock level. The well enters the base of the leachate pit, where a submersible pump transfers leachate to the main leachate pond. A 600mm buried Victaulic pipe allows the transfer of leachate from the main leachate pond to the secondary leachate pond. A buried 150 mm diameter PN16 PE pipeline (RCA, 2005, cited in MSEC 2012) within gravel backfill collects leachate from the existing lined cell area.

The **main leachate pond** (Ref. AW002_d01) is located at the base of the natural valley, downslope of the waste disposal area. The pond has an HDPE lining (estimated 1.5 mm thick) and has a capacity of around 6 ML. As noted above, leachate is delivered to the pond via the well located at the base of the natural valley from the unlined area, and via the buried 150 mm diameter PN16 PE pipeline from the existing lined cell area.

A **secondary leachate pond** (AW002_d05) is located in the northern part of the facility. A buried Victaulic pipe at 600 mm cover with bolted connections (RCA, 2005, cited in MSEC 2012), which follows the unsealed access road, allows leachate to be pumped between the main and secondary leachate ponds. Sediment ponds (AW002_d02 to AW002_d04) are also located at the southern end of the site. These ponds store surface water runoff which is captured using the surface drains around the perimeter of the waste disposal area.

Gas wells and associated pipelines have been established in the waste disposal area to collect the landfill gas (LFG) generated by the breakdown of organic waste. The gas wells comprise vertical pipes in oversized boreholes within the emplaced waste. The upper sections of the pipes are solid metal casings in soil backfill and the lower sections are perforated PVC casings in gravel backfill. Polyethylene pipelines are connected to the wellheads which transport the captured LFG to the flare installation and the gas powered generation installation. It is understood that the gas management system (including gas powered generation described below) is operated under contract to LMCC by LMS. During consultation for this SMP Application LMCC was invited to involve LMS. Council advised that it will represent all aspects of the AWMF for the SMP Application.

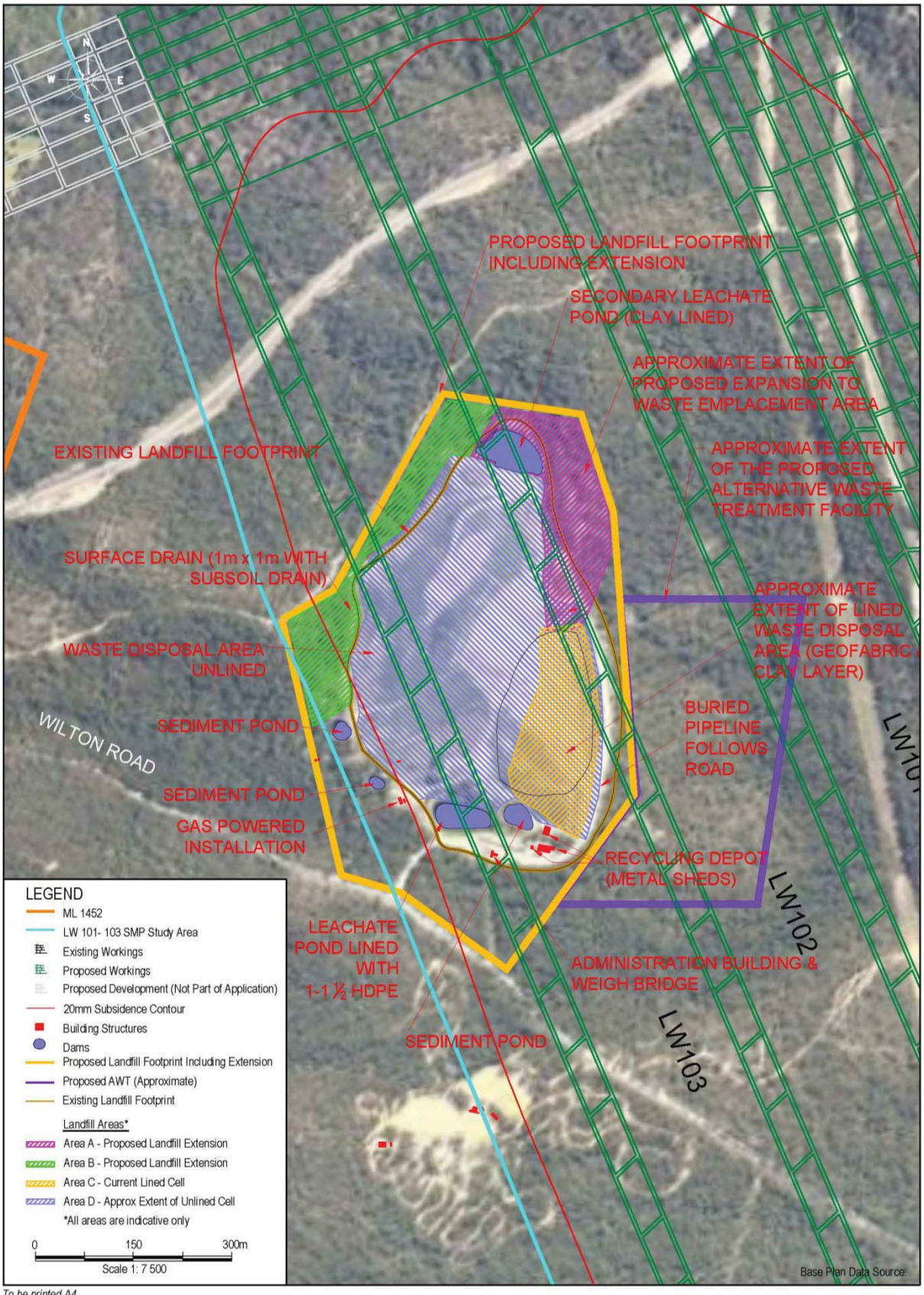
The **gas powered generation installation** (AW002_pa02 and AW002_pa03) is operated by LMS Energy within the AWMF site. The installation generates around 9,000 MWh of electricity per year using the LFG captured by the gas wells. The plant and building structures are founded on concrete ground slabs or concrete plinths. Other features include the buried gas pipework, lightning protection and fencing.

There are also a number of **building structures and associated infrastructure** located near the entry to the AWMF site. The **administration building** (AW002_pa01) is a single-storey brick structure founded on a slab on ground and with metal roof. **Two weigh bridges** are also located at the entry, which comprise suspended reinforced concrete slabs, supported by steel beams, sitting between concrete upstands. The recycling depot has three metal storage sheds (AW002_pa04 to AW002_pa06) which are founded on concrete slabs on ground.

Further details on the facility are provided with the SMP Subsidence Report by MSEC (2012) contained in **Appendix 4**.

11.4.2. Proposed Expansion of the AWMF

LMCC is currently proposing to expand the waste emplacement area to extend capacity and life of the facility and (separately) to construct an Alternative Waste Treatment (AWT) facility east of the existing AWMF, as illustrated on **Figure 17** and **Figure 18**and outlined further in **Section 10.2.1** and **10.2.2** respectively of this report.



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Current and Proposed Infrastructure - Awaba Waste Management Facility

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Figure 18 - Existing & Proposed Landfill Cells at AWMF

11.4.3. Consultation with LMCC

An outline of the stakeholder consultation process undertaken during the preparation of this SMP Application has been described in **Section 8**. It is understood that the gas management system at the AWMF (including gas powered generation described below) is operated under contract to LMCC by LMS. During consultation for development of this SMP Application LMCC was invited to involve LMS if required. Council advised that it represented all aspects of the AWMF for the SMP Application.

Detailed consultation has been appropriately undertaken with LMCC as a primary focus of this SMP Application. This includes the establishment of a technical team of specialists from both parties working closely together to assess and appropriately manage subsidence for the AWMF. Initial supporting studies (as outlined earlier above) undertaken were fed into a preliminary assessment of subsidence-related risks which identified any existing knowledge gaps, in order to establish a program of further works to appropriately address these for mitigation and management (refer **Section 11.4.6**).

The further investigations identified will then be utilised in a review of the risk assessment and the development of a dedicated plan of management for the facility (*AWMF Management Plan*) prior to potential subsidence impact to the AWMF caused by secondary extraction of LW102.

A summary of consultation, combined investigation and assessments are depicted below:

- Initial Consultation and inception meeting with LMCC Planning Dept and AWMF;
- Initial technical meeting held with LMCC, AWMF and specialist consultants;
- Initial site inspection of the AWMF;
- Exchange of technical information from LMCC/AWMF and Newstan;
- Literature review and assessment of longwall mining under landfills;
- Second technical meeting with LMCC and AWMF and specialist consultants;
- Two day risk assessment with LMCC, AWMF and specialist consultants; and
- Ongoing actions as derived from recommendations of the Risk Assessment and specialist investigations.

For further details on the consultation process refer to **Section 8** and **Appendix 5.**

11.4.4. Baseline Monitoring for the AWMF

Further to the detailed characterisation investigations undertaken by the technical team to support the subsidence report by MSEC (2012) and groundwater assessment (GHD, 2012), further baseline monitoring of the AWMF will be developed as part of a program of further works identified within an AWMF Action Plan (currently under development with LMCC).

The baseline monitoring options being considered may include a combination of ground survey, groundwater monitoring, extensometers and visual inspections including photographic records. Subsidence predictions for LW101 will be reviewed against ground survey monitoring results from LW101 ahead of commencement of LW102 to validate subsidence impact assessment and management for LW102 and LW103. This will also be supported by review of baseline monitoring for other parameters (including groundwater) prior to and following secondary extraction of LW103. For further details on leachate and groundwater monitoring and mitigation refer to **Section 11.5.3**.

11.4.5. Impact Assessment for the AWMF

Potential risks associated with subsidence impact for the SMP Application were considered within the SMP Risk Assessment undertaken for LW101-103 (refer **Section 9.1** and **Appendix 6**). As a result of this, a specific risk assessment was then undertaken for the AWMF in consultation with LMCC and GHD, as outlined in **Section 9.2**. The process helped identify priority aspects associated with the AWMF for impact assessment as presented within this section.

For context in interpreting overall ground movements for impact assessment, it was noted during the process that waste emplacements typically experience significant amounts of settlement within the emplaced waste (consolidation over time), which subsides the final landform of the waste cells. This process is separate to mining induced subsidence, and indeed is typically of substantially greater magnitude (can be greater than 30% of the fill height (PSM 2012, cited in MSEC 2012)). This process has been considered in the impact assessments as detailed further below.

A summary of the maximum predicted subsidence parameters, at the natural ground level (below waste emplacement cells) is provided in **Table 11.16**.

Table 11.16 Maximum Predicted Total Conventional Subsidence Parameters at the Natural Ground Level for the Waste Disposal Area (MSEC 2012)

Longwall	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
After LW101	<20	<0.5	0.01	<0.01
After LW102	375	7.5	0.15	0.02
After LW103	1075	12.0	0.20	0.40

Waste emplaced is only partially compacted and, therefore, additional consolidation may occur as a result of mine subsidence movements. Similar behaviour is observed when unconsolidated spoil heaps are directly mined beneath. As there is limited subsidence monitoring data over waste emplacements areas, which were directly mined beneath, the empirical relationships that have been developed for unconsolidated spoil heaps has been used (MSEC 2012).

The maximum predicted subsidence at the natural surface, beneath the waste emplacement area, is 1075 mm and the minimum depth of cover between the seam and natural surface is 270 metres. The ratio of subsidence to depth of cover at the waste emplacement area is 0.004. The predicted additional settlement of the waste emplacement, based on the empirical relationship for unconsolidated spoil heaps proposed by Whittaker and Reddish, is approximately 10 mm/m, or 1 % of the height of the emplacement (MSEC 2012).

Based on a maximum height of 50 metres, the additional consolidation of the waste emplacement is predicted to be around 500mm. It is noted, that the consolidation due to mine subsidence movements is additional to the natural consolidation of the waste emplacement.

The waste emplacement is located within a natural valley which could also experience valley related movements as the result of mining. The maximum predicted movements for the valley, based on a natural valley height of 30 metres, are 200 mm upsidence and 400 mm closure (MSEC 2012). Further discussion on waste emplacement areas from specialist investigations by PSM (2012) is provided further below.

A summary of the maximum predicted subsidence parameters for the building structures associated with the AWMF is provided in **Table 11.17**. The predicted movements are the maxima within a distance of 20 metres of each structure, at any time during or after the extraction of the proposed longwalls.

Table 11.17 Maximum Predicted Total Conventional Subsidence Parameters for the Building Structures at the Awaba Waste Disposal Facility

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Administration Building AW002_pa01	100	2.0	0.04	< 0.01
LMS Substation AW002_pa02	25	<0.5	< 0.01	< 0.01
LMS Substation Container AW002_pa03	25	<0.5	< 0.01	< 0.01
Shed AW002_pa04	650	10.5	0.15	0.05
Shed AW002_pa05	350	7.0	0.14	0.03
Shed AW002_pa06	700	10.5	0.15	0.05
Tank AW002_pa07	650	3.5	0.08	0.05
Shed AW002_pa08	700	4.0	0.08	0.05

The maximum predicted conventional curvatures for the building structures are 0.15 km^{-1} hogging and 0.05 km^{-1} sagging, which represents minimum radii of curvature of 7 kilometres and 20 kilometres, respectively. The maximum predicted conventional strains for the building structures, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 1.5 mm/m tensile and 0.5 mm/m compressive.

A summary of the maximum predicted subsidence parameters for the leachate and sediment ponds associated with the AWMF is provided in **Table 11.18** below.

Table 11.18 Maximum Predicted Total Conventional Subsidence Parameters for the Ponds at the Awaba Waste Disposal Facility (MSEC 2012)

Building Reference	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Main Leachate Pond AW002_d01	150	2.5	0.06	0.01
Sediment Pond AW002_d02	450	9.0	0.15	0.04
Sediment Pond AW002_d03	<20	<0.5	<0.01	<0.01
Sediment Pond AW002_d04	<20	<0.5	<0.01	<0.01
AW002_d05	850	6.0	0.18	0.06

The maximum predicted conventional curvatures for the ponds are 0.18 km^{-1} hogging and 0.06 km^{-1} sagging, which represents minimum radii of curvature of 6 kilometres and 17 kilometres, respectively. The maximum predicted conventional strains for the ponds, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 2.0 mm/m tensile and 0.5 mm/m compressive.

Waste Emplacement Areas

The maximum predicted conventional subsidence at the natural rock surface beneath the waste disposal area is 1075 mm. It has been estimated, that around 500 mm of additional settlement could occur at the top of the waste disposal as a result of additional consolidation of the waste material due to the mine subsidence movements.

These subsidence movements are additional to the natural settlement of the waste emplacement which occurs over a long period of time. It has been estimated that the waste could naturally settle around 20% to 30% of its height, which equates to around 12 metres (PSM, 2012). The predicted mine subsidence movements due to the extraction of the proposed longwalls, therefore, is less than the estimated natural settlement of the waste emplacement.

Impacts based on increased subsidence are discussed further in the MSEC report (2012). If the actual subsidence at the waste emplacement exceeded that predicted by a factor of 2, the potential for cracking and slumping of the capping layer would increase, these impacts can be managed using the established procedures to maintain the integrity of the surface capping layer due to the natural settlement.

If the actual curvatures at the waste emplacement exceeded those predicted by a factor of 2 times, the extents and widths of surface cracking would increase, but it would still be expected that the depths of fracturing in the bedrock would be less than 10 metres to 15 metres.

The natural settlement of the waste emplacement results in differential settlement and cracking of the surface confinement layers over the waste deposits (Jessberger and Stone, 1991 cited in MSEC 2012). The mining induced subsidence movements could, therefore, result in the development of

additional surface cracking and slumping (i.e. downslope movements) which could then increase permeability of the capping layer (Kumar, 1999, cited in MSEC 2012).

The AWMF has established procedures with the aim of maintaining the integrity of the capping layer which is subject to significant natural settlement of the waste. It is recommended that the existing AWMF facility management procedures should be reviewed by LMCC to ensure that potential additional movement from mine subsidence is catered for within the operational procedures.

Lining and Leachate Collection System

The original waste disposal area (pre 2005 areas) was unlined (refer Area D on **Figure 18**). The newer cell in the south eastern corner of the area was constructed in 2005 with a liner (refer Area C on **Figure 18**). The potential impacts on the liner were considered by PSM (2012).

The **unlined section** of the waste disposal area uses the natural bedrock levels to funnel leachate downslope to the leachate collection well. The extraction of the proposed longwalls will result in fracturing and dilation of the topmost bedrock layers which will increase permeability of these near surface strata layers.

The **lined section** of the waste disposal area includes a designed leachate collection system comprised of polyethylene pipes which collect leachate from the lined cell, draining downslope to the leachate pit which is then pumped to the leachate dam.

It has been observed in the past, that the depth of fracturing and dilation of the uppermost bedrock, resulting from longwall mining, is generally less than 10 metres to 15 metres (Mills 2003, Mills 2007 and Mills and Huuskes 2004, cited in MSEC 2012). This was also supported by the Independent Inquiry into the Impacts of Potential Underground Coal Mining in the Wyong Local Government Area (DoP, 2008) which stated that “The main fracture network extends to a depth of about 12 m and bed separation extends to a depth of some 20 m” (DoP 2008, cited in MSEC 2012).

The extent of these mining induced valley related ground movements are dependent on a number of factors, which include the size of the valley, the local geology, the magnitude of mining induced subsidence movements and the proximity of the longwalls to the valley. The method (ACARP, 2001) has been designed to generally provide conservative predictions and, therefore, it is expected that the actual valley related movements would be less than those forecast.

It is unlikely that continuous fracturing would extend from the seam up to the surface. The estimated height of continuous cracking (i.e. A Horizon) is 130 metres to 160 metres. The minimum depth of cover beneath the AWMF is around 270 metres and, therefore, the thickness of the constrained zone is estimated to be between 110 metres and 140 metres (MSEC 2012).

It is expected, therefore, that the leachate would remain confined to the near surface strata. It is recommended that ground monitoring lines and subsurface monitoring (i.e. extensometers) are established above LW101-102 allowing the comparison between observed and predicted movements and review of the impact assessments based on the measured data (MSEC 2012). The outcomes of these studies will better define the potential depth of leachate ingress and, hence, the adequacy of the existing leachate collection system after mining.

Historical observations suggest fracturing of the uppermost bedrock above LW103 will extend to depths of no more than 10 – 15 m below the ground surface (Mills 2003, Mills 2007 and Mills& Huuskes 2004, cited in MSEC 2012).

Therefore, it is not expected that leachate from the AWMF would be able to migrate downwards to the mine. However, the hydraulic conductivity of the uppermost bedrock may increase, resulting in an increased potential for leachate to migrate to groundwater, particularly from the original waste disposal area, and for the spatial extent of any existing leachate plume to expand. Subsequently, further investigations will be considered in consultation with LMCC to confirm and delineate any

existing leachate impact to groundwater (as indicated by preliminary studies), and the likely increase to these impacts/risks (if any) resulting from subsidence cracking and appropriate controls required (GHD, 2012).

Leachate and Sediment Ponds

The **main leachate pond** (AW002_d01) is located on the north side of the access road to the AWMF over a chain pillar (MG103) for LW103 as illustrated on **Figure 18**. The pond is predicted to experience a maximum subsidence of 150 mm, which occurs along its eastern side. The predicted differential subsidence along the main length of the pond is around 100 mm and, therefore, could result in a reduction in capacity of around 150 kL, which could be considered negligible when compared with its capacity of around 6 ML.

The maximum predicted curvatures for the main leachate pond are 0.06 km^{-1} hogging and 0.01 km^{-1} sagging, which represent minimum radii of curvature of 17 kilometres and 100 kilometres, respectively. The maximum predicted conventional strains for the pond, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 0.5 mm/m tensile and less than 0.5 mm/m compressive.

An assessment of the potential impacts on the HDPE liner in the main leachate pond is provided in the report by PSM (2012). However, the HDPE liner is expected to be able to withstand curvatures and strains of the above-mentioned magnitudes without adverse impacts (PSM 2012).

The maximum predicted subsidence at the **sediment pond** (Ref. AW002_d02, located over LW103 as shown in **Figure 15** and **Figure 18**) and the **secondary leachate pond** (Ref. AW002_d05, located over across a chain pillar of LW102 (MG102) and extends partially into panel LW102 as illustrated on **Figure 15** and **Figure 18**) are 450 mm and 850 mm, respectively. The predicted differential subsidence at these ponds is up to 150 mm which could result in reductions in capacities around 200 kL for AW002_d02 and 350 kL for AW002_d05, which could be considered small when compared with the existing capacities.

The maximum predicted curvatures for the sediment pond Ref. AW002_d02 and the secondary leachate pond Ref. AW002_d05 are 0.18 km^{-1} hogging and 0.06 km^{-1} sagging, which represent minimum radii of curvature of 6 kilometres and 17 kilometres, respectively. The maximum predicted conventional strains for these ponds, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 2 mm/m tensile and 0.5 mm/m compressive.

The predicted strains could be of sufficient magnitudes to result in cracking of the clay linings of the **sediment pond** AW002_d02 and the **secondary leachate pond** AW002_d05. There is extensive experience of mining directly beneath dams and ponds in the NSW Coalfields, at similar depths of cover, which indicates that the incidence of impacts on these features is low.

The predicted maximum vertical subsidence at the **remaining AWMF sediment ponds** (Refs. AW002_d03 and AW002_d04 as illustrated on **Figure 15**) is less than 20 mm. Whilst these ponds could experience subsidence slightly greater than 20 mm, they would not be expected to experience any significant conventional tilts, curvatures or strains. It is unlikely, therefore, that these ponds would be adversely impacted as the result of mining.

If the actual tilts at the leachate and sediment ponds exceeded those predicted by a factor of 2 times, the storage capacities of the ponds located directly above the proposed longwalls (i.e. AW002_d02 and AW002_d05) could be reduced slightly, but it would still be unlikely to result in any instability of the pond walls.

If the actual curvatures at the main leachate pond exceeded those predicted by a factor of 2 times, the curvatures and strains would still be less than the capacity of the HDPE liner and, therefore, it would still be unlikely that any adverse impacts would occur.

If the actual curvatures at the secondary leachate pond or the sediment ponds exceeded those predicted by a factor of 2 times, the likelihood and extent of surface cracking at the ponds located above the proposed longwalls (i.e. AW002_d02 and AW002_d05) would increase, however it would still be unlikely that there would be any loss of stored waters from these ponds.

Gas Drainage Infrastructure

The gas drainage infrastructure is established in the top of the waste emplacement and is designed for accommodating the significant waste settlement movements of the landfill. As described previously under "Waste Emplacement Area", the predicted subsidence at the top of the emplacement around 1.6 metres (i.e. 1075 mm at the natural surface plus additional settlement around 500 mm) is less than the estimated natural settle of the emplacement of around 12 metres (PSM, 2012).

It is likely, therefore, that the gas drainage infrastructure could tolerate the predicted subsidence resulting from the extraction of the proposed longwalls. Management strategies will be developed to remediate any impacts on the wells or pipework resulting from the extraction of the proposed longwalls.

Gas Powered Generation Plant

The structures associated with the gas powered generation plant (Refs. AW002_pa02 and AW002_pa03 on **Figure 15**) are predicted to experience around 25 mm of subsidence resulting from the extraction of the proposed longwalls. Whilst it is still possible that the structures could experience subsidence slightly greater than 25 mm, they would not be expected to experience any significant conventional tilts, curvatures or strains. It is unlikely, therefore, that the structures and associated infrastructure at this site would be adversely impacted as the result of mining.

Building Structures

The administration building (Ref. AW002_pa01 on **Figure 15**) is predicted to experience a maximum tilt of 2 mm/m (i.e. 0.2 %), which represents a change in grade of 1 in 500. Tilts less than 7 mm/m generally do not result in any significant impacts on building structures and, therefore, the administration building is unlikely to be adversely impacted by the mining induced tilt in this case.

The maximum predicted curvatures for the administration building are 0.04 km^{-1} hogging and less than 0.01 km^{-1} sagging, which represent minimum radii of curvature of 25 kilometres and greater than 100 kilometres, respectively. The maximum predicted conventional strains for the building, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 0.5 mm/m tensile and less than 0.5 mm/m compressive.

The potential impacts on the administration building have been determined using the method outlined in ACARP Research Project C12015 (ACARP, 2009).

Table 11.19 Assessment Impacts for the Administration Building

Repair Category	Assessed Likelihood	Description of Potential Impacts
Nil or R0	80%	Door or window jams, or movements at joints in internal finishes
R1 or R2	15%	Cracks in brick mortar, isolated cracks in brickwork, or cracks or movement in internal finishes, typically less than 5 mm in width.
R3 or greater	5%	Cracks in external brickwork or internal finishes between 5 mm and 15 mm and, possibly in some locations, greater than 15 mm.

It is expected that any impacts on the administration building could be repaired using normal building maintenance techniques.

The sheds associated with the **recycling depot** (Refs. AW002_pa04 to AW002_pa06 on **Figure 15**) and the sheds located directly above the proposed longwalls (Refs. AW002_pa07 and AW002_pa08) are predicted to experience tilts up to 10.5 mm/m (i.e. 1.1 %), which represents a change in grade of 1 in 95. It is possible that some of these sheds could experience minor serviceability impacts, including door swings and issues with roof gutter drainage, which could be repaired using normal building maintenance techniques.

The maximum predicted curvatures for these sheds are 0.15 km^{-1} hogging and 0.05 km^{-1} sagging, which represents minimum radii of curvature of 7 kilometres and 20 kilometres, respectively. The maximum predicted conventional strains for these structures, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 1.5 mm/m tensile and 0.5 mm/m compressive.

The sheds are of flexible construction and it is expected, therefore, that these structures could tolerate curvatures and strains of these magnitudes without significant impacts. There is extensive experience of mining directly beneath steel framed sheds in the NSW Coalfields, at similar depths of cover, which indicates that the incidence of impacts on these structures is very low. It is expected that any impacts on the sheds could be repaired using normal building maintenance techniques.

It is possible, although unlikely (i.e. less than 1 %), that these sheds could experience impacts as the result of irregular ground movements. It is unlikely, that these types of structure would become unstable, in this case, but more extensive repairs may be required.

If the actual tilts at the building structures exceeded those predicted by a factor of 2 times, serviceability impacts could occur at the sheds located directly above the proposed longwalls, however these could be repaired using normal building maintenance techniques.

If the actual curvatures at the building structures exceeded those predicted by a factor of 2 times, the sizes and extents of cracking in the brickwalls of the administration building would increase, however these could be remediated using normal building maintenance techniques. The incidence of impacts on the sheds, which are of flexible construction, are expected to be low. It would still be unlikely that any of the building structures would become unsafe, even if the movements exceeded those predicted by a factor of 2 times.

Weigh Bridges

Whilst it has been proposed by LMCC that the weighbridge be replaced as part of the AWMF extension prior to longwall mining beneath them, the following impacts have been made based on the existing facility.

The maximum predicted tilt at the weight bridges is 2.0 mm/m (i.e. 0.2 %), which represents a change in grade of 1 in 500. Tilting, if sufficiently large, can displace the centre of gravity of the vehicle which can then reduce the accuracy of the measurement. In this case, however, the predicted tilt is very small (i.e. less than 1 %) and unlikely, therefore, to result in any adverse impact on the bridges.

The maximum predicted curvature for the weight bridges is 0.04 km^{-1} hogging, which represent minimum radius of curvature of 25 kilometres. The predicted hogging curvature could result in an uplift of around 2 mm at the expansion joints at the ends of the weigh bridges, based on a bridge length of 20 metres. The predicted differential vertical movement is very small and, if necessary, some adjustment of the weight bridge structure may be required. If the uplift exceeds the allowable tolerances, it may be necessary to modify the levels of the concrete ramp approach and steel angle.

The maximum predicted conventional strains for the weigh bridges, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 0.5 mm/m tensile and less than 0.5 mm/m compressive.

The predicted strains could result in an opening of 10 mm or closure of less than 10 mm across the weigh bridges, based on a bridge length of 20 metres. If the opening or closure movements exceed the allowable tolerances, it may be necessary to modify the levels of the concrete ramp approach and steel angle.

11.4.6. Monitoring, Mitigation and Management

Management strategies for the AWMF will be developed through the ongoing consultation with LMCC and the technical team established for the project. In order to ensure the effective management strategies are implemented for the AWMF, an Action Plan is currently being developed with LMCC which will consider, but may not necessarily be limited to, the following further investigations:

- Establish the appropriate monitoring above the earlier LW101-102, to confirm the outcomes of the impact assessments, prior to mining directly beneath the facility, which could include:-
    - Extensometers and/or piezometers in equivalent locations above the earlier longwalls to confirm the height of fracturing above the seam and the changes in the hydraulic conductivity of the near surface strata, and
    - Ground monitoring lines above the earlier longwalls, so that the observed surface movements can be compared with those predicted and, so that, the impact assessments can be reviewed in light of the measured data.
- Develop the appropriate preventive or remediation measures, if the outcomes of the detailed studies or monitoring over earlier longwalls indicate potential impacts, which could include:-
    - Methods of reducing the permeability of the capping layer over the waste emplacement area and, hence, to reduce the ingress of water and production of leachate, and/or
    - Upgrade the existing leachate collection well, if required, or the establishment of additional leachate collection wells downslope of the waste emplacement area;
- Develop a Trigger Action Response Plan (TARP), in consultation with the LMCC and its consultants, based on the outcomes of the detailed studies, monitoring above earlier longwalls and the established preventive or remediation measures.
- Install the appropriate monitoring at the AWMF site to measure the subsidence movements resulting from mining, which could include:-
    - Extensometers or/and piezometers to monitor the heights of fracturing and changes in hydraulic conductivity,
    - Ground monitoring in areas as agreed to in consultation with LMCC and contained in the *AWMF Management Plan* to measure the movements at the natural surface level, and/or

    - Monitoring line over the completed area of waste emplacement to measure the movements resulting from both mine subsidence and immediate settlement.
- Continued monitoring of groundwater levels and quality at the existing monitoring locations at the AWMF;
- Confirm and delineate potential existing impacts (pre-mining) to groundwater from leachate at the AWMF, and the likely increase to these impacts/risks (if any) resulting from subsidence cracking and appropriate controls required; and
- The preliminary AWMF risk assessment showed that it is technically feasible to undermine the AWMF, with further studies required to confirm preferred methodologies (as per the Action Plan).

The further actions to be employed will be developed in consultation with LMCC and formalised within an *Action Plan* for the AWMF. As noted earlier, outcomes of the Action Plan will be considered within a revised detailed risk assessment.

Following the outcomes of the Action Plan and revised detailed risk assessment, the AWMF will be managed through the development of an *Awaba Waste Management Facility Management Plan (AWMF Management Plan)*. This management plan will be developed in consultation with LMCC and submitted prior to the potential for subsidence impact to the AWMF caused by secondary extraction of LW102

11.5. NATURAL FEATURES

11.5.1. Previous Investigations

A detailed *Environmental Impact Statement (EIS)* prepared in 1998 by Umwelt for the *Newstan Life Extension Area* included assessment of key natural features within the EIS project area, which encapsulates the current LW101-103 SMP Study Area. Subsequently, a range of previous investigations were undertaken for the EIS that provided a substantial basis for the current investigations to build upon (Umwelt, 1998). These reports were referenced by all current specialist reports prepared for this SMP, and included:

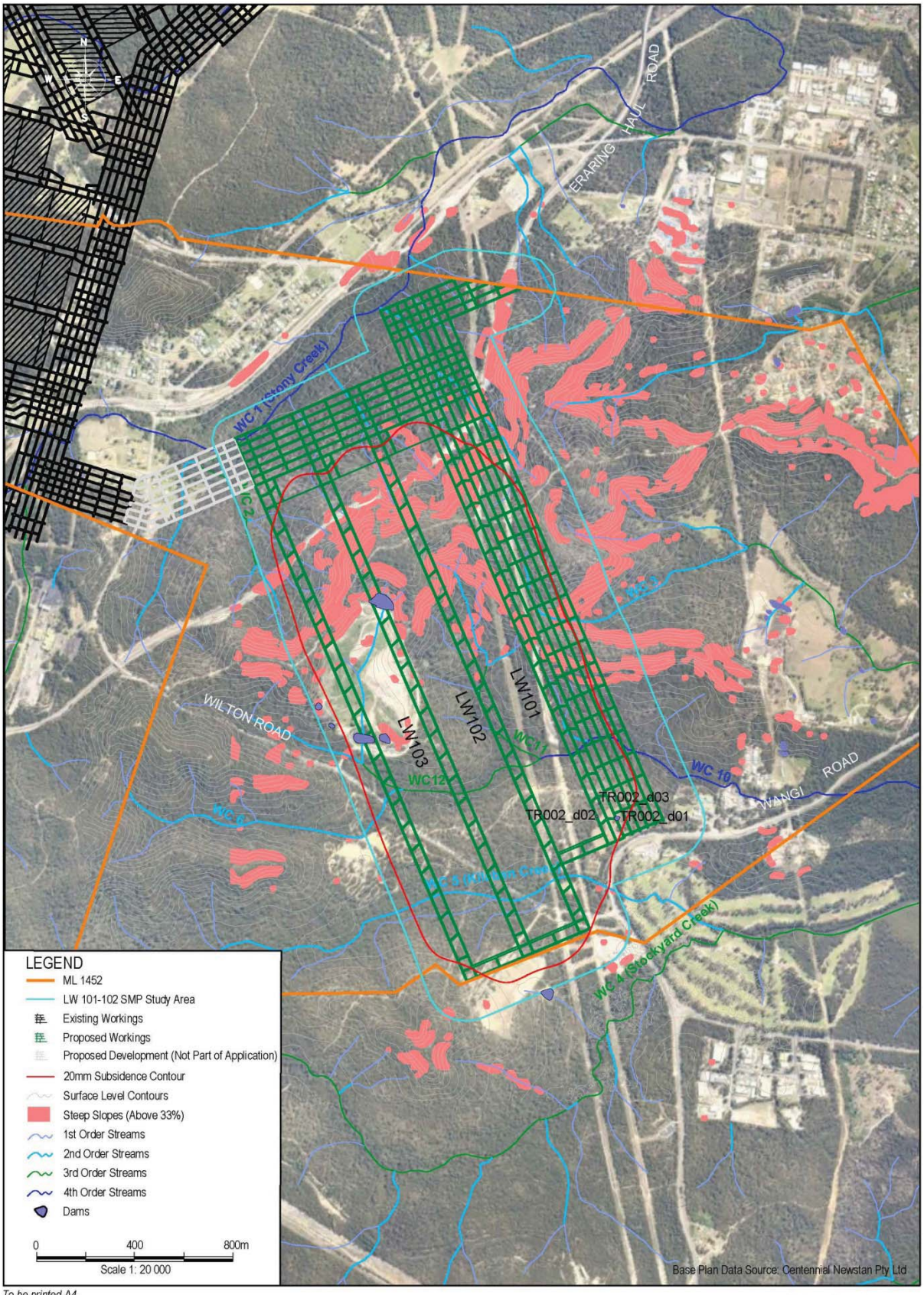
- Characterisation and subsidence impact assessment for:
    - Infrastructure including the AWMF, clay target club, golf club, AwabaWAC, roads and tracks (including Wangi and Wilton Roads), utility services (eg water, power, communications);
    - Natural features including (but not limited to) specialist assessments for flora and fauna, groundwater, surface water, and Aboriginal and Cultural Heritage.
- Community and Stakeholder Consultation (including LMCC and MSB in relation to the AWMF and roads).

These detailed references can be referenced for full details where required.

11.5.2. Rivers and Creeks

Characterisation

There are a number of watercourses within the SMP Study Area as shown in **Figure 19**. Surface waters within the SMP Study Area were characterised by GHD within the LW101-103 SMP Surface Water Assessment (2012).



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Newstan Colliery
Topography and Drainage

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Figure 19 – Topography and Drainage

A summary of the watercourses which are located within or immediately adjacent to the SMP Study Area is provided in **Table 11.20** below**.**

Table 11.20 Watercourses Within or Adjacent to the SMP Study Area

Stream Name	Strahler Stream Order	Inside 20mm Subsidence Contour?	Description
WC2	3rd Order	Yes	Located 125 metres west of Longwall 103, at its closest point to the proposed longwalls. Not directly mined beneath.
WC10	4th Order	Yes	Located directly above Longwall 101, downstream of the junction of WC11 and WC12. Approximately 130 metres of 4th order stream located directly above the proposed longwalls.
WC11	3rd Order	Yes	Located directly above Longwalls 101 and 102. Approximately 520 metres of 3rd order stream located directly above the proposed longwalls.
WC12	3rd Order	Yes	Located directly above Longwalls 101 to 103. Approximately 650 metres of 3rd order stream located directly above the proposed longwalls.
WC1 (Stony Creek)	4th Order	No	Located 300 metres north of Longwall 103, at its closest point to the proposed longwalls. Not directly mined beneath.
WC4 (Stockyard Creek)	3rd Order	No	Located 330 metres south-east of Longwall 102, at its closest point to the proposed longwalls. Not directly mined beneath.

Kilaben Creek is a 2nd order stream which crosses the southern ends of Longwalls 102 and 103. The total length of creek located directly above the proposed longwalls is approximately 500 metres. There are also other 1st and 2nd order streams within the SMP Study Area.

The watercourses within the SMP Study Area are ephemeral, but have ponds in the flatter sections along the lower reaches of the streams as illustrated in **Plate 20**. The lower reaches of the watercourses (i.e. 3rd and 4th order, but including Kilaben Creek) have small incisions into the natural surface soils, however, in some locations, the drainage channels are not well defined due to the thick vegetation growth and soil accumulations. The natural gradients along these sections of the watercourses are very flat, typically less than 10 mm/m (i.e. 1 %, or 1 in 100).

Plate 20 – Photograph of chain of ponds along the lower reaches of Kilaben Creek in the SMP Study Area

The upper reaches of the watercourses (i.e. 1st and 2nd order, excluding Kilaben Creek) have steeper natural gradients, which are typically greater than 100 mm/m (i.e. 10 %, or 1 in 10). These sections of streams have sandstone outcropping which forms a series of steps or drop downs in the steeper sections. There is also significant debris accumulation which comprise of boulders and tree branches. A photograph of creek headwaters is provided in **Plate 21**.

Plate 21 – Creek headwaters generally have steep gradient

Baseline Monitoring

Water quality monitoring of streams within the Newstan Colliery holdings has been ongoing since 1995 and are reported in the AEMR. Baseline water quality monitoring of the streams that pass specifically through the SMP Study Area has been undertaken for a period of approximately 7 months. A total of ten (10) locations (including upstream and downstream of the SMP Study Area) have been sampled and analysed for a number of parameters including: pH, electrical conductivity, total suspended solids, oil & grease, turbidity and total metals (GHD, 2012a). Prior to secondary extraction of LW101, it is anticipated that approximately 24 rounds of monitoring will have been undertaken. These water quality monitoring points are illustrated in **Figure 20.** Baseline inspections of creeks within the SMP Study Area have been completed to determine the creek type and condition. Further baseline monitoring will be undertaken at specific monitoring locations along the sections of the creek prior to undermining with a photographic record of their pre mining condition obtained.

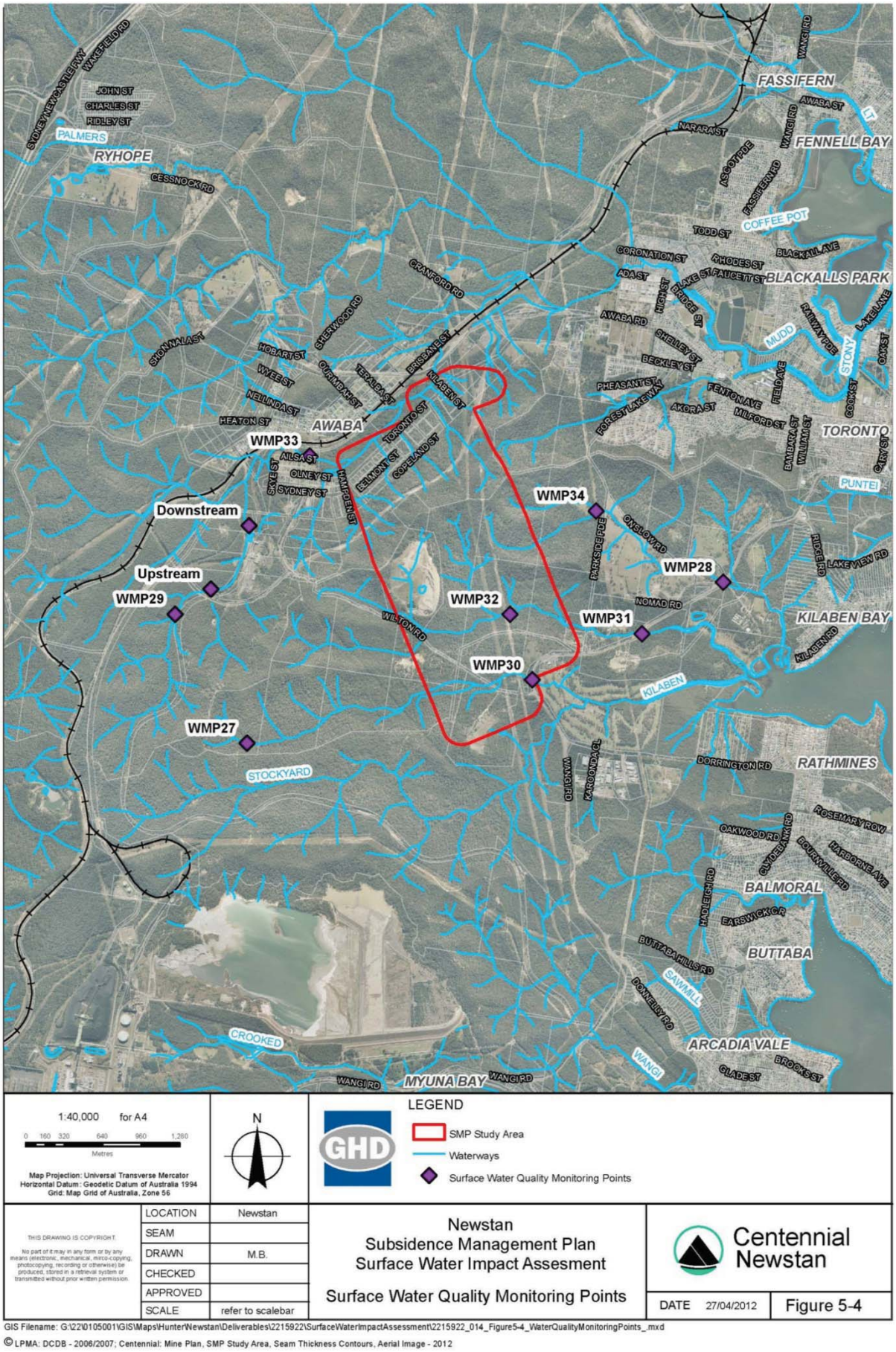


Figure 20 – Surface Water Quality Monitoring Points

Impact Assessment

Predicted subsidence for the watercourses within the SMP Study Area has been provided by MSEC (2012). A specific assessment of potential subsidence impacts to surface water resources within the SMP Study Area was undertaken by GHD (2012a), which also included hydrological and hydraulic assessment for potential impacts to surface water drainage including potential for flow loss, ponding, flooding and scouring (refer full report in **Appendix 10**).

A summary of the maximum predicted subsidence, tilts and curvatures for the watercourses, after the extraction of each of the proposed longwalls, is provided in **Table 11.21** below.

Table 11.21 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Watercourses within the SMP Study Area (MSEC 2012)

Water Course	Longwall	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
WC3	After LW101	100	0.5	0.02	0.01
	After LW102	100	0.5	0.02	0.01
	After LW103	100	0.5	0.02	0.01
WC5	After LW101	<20	<0.5	<0.01	<0.01
	After LW102	750	6.0	0.05	0.15
	After LW103	975	10.0	0.15	0.35
WC11	After LW101	700	4.5	0.05	0.10
	After LW102	825	2.0	0.10	0.10
	After LW103	850	2.0	0.10	0.10
WC12 (incl. WC6 and WC10)	After LW101	750	6.0	0.05	0.15
	After LW102	975	10.5	0.15	0.35
	After LW103	1075	10.5	0.15	0.40

The maximum predicted conventional strains for the watercourses, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 4 mm/m tensile and 6 mm/m compressive. The watercourses are also likely to experience elevated compressive strains resulting from the valley related movements.

The upper reaches of the watercourses (i.e. 1st and 2nd order, but excluding Kilaben Creek) have steeper gradients and also have higher equivalent valley heights. The maximum predicted valley related movements for these streams are 300 mm upsidence and 400 mm closure. Compressive

strains between 15 mm/m and 20 mm/m have been observed, in the past, at these magnitudes of upsidence and closure movements.

The lower reaches of the watercourses (i.e. 3rd and 4th order, but including Kilaben Creek) have relatively flat gradients and the valleys and generally comprise shallow incisions into the natural surface soils. The maximum predicted valley related movements for these streams are 150 mm upsidence and 200 mm closure. Compressive strains between 10 mm/m and 15 mm/mm have been observed, in the past, at these magnitudes of upsidence and closure movements.

The impact assessments for the watercourses are provided in the following sections as provided by GHD (2012a).

Impact Assessment

Impact assessments of surface waters have been undertaken by GHD (2012a) and MSEC (2012) for this SMP Application. A summary of specific impacts is discussed in the following sections.

Potential for Increased Levels of Ponding, Flooding and Scouring

The maximum predicted tilt within the SMP Study Area is 16 mm/m, which represents a change in grade of 1 in 60. The predicted changes in grade are small when compared with the natural gradients along the upper reaches of the streams which are typically greater than 100 mm/m and, therefore, are unlikely to have a significant impact on the surface water flows.

The hydrological model completed by GHD (2012a) indicates that hydraulic conditions following subsidence remain unchanged compared to existing conditions for WC1 (Stony Creek) and WC2.

For WC11, while the water levels drop for subsided conditions, the surrounding landscape will subside a similar amount and the water levels will remain unchanged relative to the immediate terrain. Flow velocities along WC11 remain unchanged following subsidence. This is due to the fact that WC11 runs parallel to the proposed underlying longwalls and will experience a uniform drop such that little to no change in stream grade are likely along its length as a result of subsidence.

The waterways WC5 and the combined reaches of WC6, WC10 and WC12 cross the subsidence affected area perpendicular to the underlying proposed longwall panels. In response to subsidence, these waterways exhibited an increase in gradient and flow velocity as they enter the subsidence affected area and a general reduction in gradient and flow velocity through the affected area.

Given the subject waterways are densely vegetated, particularly with the long native grass Gahnia sp., the modelled flow velocity increases for subsided conditions are considered to be non-scouring. Hence, assuming riparian vegetation conditions are maintained, the potential for increased instability along the waterway sections subject to a gradient increase, is considered to be low.

Additionally the reach of WC5, which is subject to a gradient increase, is a chain of ponds system, which are known to exist within the area on gradients of up to 2.5%. Given the post subsidence gradients are lower than this value, it is not expected that the chain of ponds that reach along WC5 will be subject to incision as result of the predicted maximum subsidence if existing vegetation associations are maintained.

Analysis of the predicted subsidence indicates that it is likely that an increase in channel surface water ponding will occur in waterway sections as a result of the subsided surface. This is most likely to occur along waterways WC5 and WC10 immediately upstream of where these waterways exit the subsidence affection zone. It is unlikely that any out-of-channel ponding will occur, as these waterways are channelised systems at these locations and the land surrounding the channels will subside an equal amount. Any aggradation of suspended sediment along the waterways as a result of subsidence is expected to be minimal.

Potential for Cracking in the Creek Beds and Fracturing of Bedrock

It is likely that fracturing of the uppermost bedrock would occur based on the predicted maximum strains. It has been observed in the past, that the depth of buckling and dilation of the uppermost bedrock, resulting from longwall mining, is generally less than 10 metres to 15 metres.

Fracturing in the underlying bedrock is unlikely to be visible in the lower reaches of the watercourses, due to the overlying surface soils and alluvial deposits, and the fractures are likely to be filled with soil and other materials during subsequent flow events.

The upper reaches of the watercourses have sandstone outcropping which forms a series of steps or drop downs. Fracturing of the exposed bedrock could result in spalling or dislodgement of rocks from the sandstone outcrops. There could also be some diversion of the surface water flows into the dilated strata beneath the beds, which could drain any ponded surface water upstream of the outcropping. It is unlikely that there would be any net loss of water from the catchment, however, as the depth of dilation and fracturing is expected to be less than 10 metres to 15 metres and, because of the high natural grades, any diverted surface water is expected to re-emerge immediately downstream (MSEC 2012).

It is not expected that the surface water would be diverted into the mine workings because continuous cracking (i.e. the A Horizon) is not predicted to extend up to the surface. Vertical fracturing in the upper stratum is expected to be discontinuous and unlikely, therefore, to result in increased hydraulic conductivity (GHD 2012a).

It is not expected that there would be any adverse impacts on the surface water flows resulting from the extraction of the proposed LW101 to 103. It is likely, however, that some fracturing and spalling of the exposed bedrock would occur in the upper reaches of the watercourses.

If the actual conventional subsidence movements exceeded those predicted by a factor of 2 times, increased levels of ponding are likely to occur immediately upstream of the longwall tailgates along the lower reaches of the watercourses. The increased ponding is estimated to be less than 100 metres long and less than 0.1 metres deep, except for WC12 upstream of the tailgate of LW102, which is estimated to be around 150 metres long and up to 0.2 metres deep.

If the actual curvatures, strains or valley related movements exceeded those predicted by a factor of 2 times, the extent of fracturing in the uppermost bedrock would increase along the sections of the watercourses located directly above the proposed longwalls, however no loss of surface water from the catchment would be anticipated.

In this case, the extent of visible fracturing and spalling of the exposed bedrock along the upper reaches of the watercourses would increase, however it would still be unlikely that fracturing in the underlying bedrock would be visible at the surface along the lower reaches of the watercourses.

Monitoring, Mitigation and Management

The Surface Water Impact Assessment (GHD 2012a) has a number of monitoring, remediation and reporting recommendations. A *Watercourse Management Plan* will be developed in consultation with DTIRIS - DCL, OEH and NOW addressing recommendations made by GHD where appropriate. Some of the requirements of the management plan include visual inspections including photographic records of first and second order drainage lines. Other recommendations include the visual inspection, including photographic evidence of stream bed and bank condition, inspection of riparian vegetation along waterways WC5, WC6, WC10 and WC12 (GHD 2012a). The *Watercourse Management Plan* will also include mitigation and management measures and will be submitted to DTIRIS - DRE prior to commencement of secondary extraction of LW101.

11.5.3. Aquifers and Known Groundwater Resources

Characterisation

Groundwater within the SMP Study Area were characterised by GHD within the *LW101-103 SMP Groundwater Assessment* (2012b, refer **Appendix 8**). A summary of findings from the investigations is provided below, the report should be referenced for further details where required.

Centennial Newstan met with DTIRIS - DRE representatives to discuss the SMP Application. With respect to natural features such as clifflines, rock outcrops and steep slopes, appropriate identification, assessment and management for subsidence management was discussed.

There are no statutory Groundwater Management Areas, as defined by the Department of Environment, Climate Change and Water, within the SMP Study Area.

The alluvium in the vicinity of the SMP Study Area forms a shallow aquifer with groundwater ranging in depth from less than 1m to about 3m below ground level (bgl), and aquifer thicknesses generally less than 5m. Due to the thin alluvial deposits, clay content and minimal beneficial use it is anticipated that groundwater yields are low. The alluvial groundwater is generally brackish and slightly acidic.

Further to the west, alluvial groundwater associated with Lords Creek has been monitored by Centennial Newstan since 2005 to monitor potential impacts from LW 24. The thickness of this alluvium exceeds 10 m in some areas and the depth to groundwater is typically less than 5 m bgl. The Lords Creek alluvial groundwater is fresh to brackish and slightly acidic.

Groundwater flow within the coal seams tends to follow the orientation and dip of the seams or move towards the areas of depressurisation. Where coal seam groundwater has not been depressurised, the groundwater head tends to be in the order of 0 m AHD. Packer testing undertaken as part of the Newstan exploration program indicates that the hydraulic conductivities of the Young Wallsend seam and overlying seams are generally in the order of 10-8 to 10-7 m/s (GHD 2012b).

Centennial Newstan's existing workings within the West Borehole Seam currently receive groundwater inflow of 1.4 to 3.0 ML/day (average 2.3 ML/day). This water is brackish and slightly alkaline, and sodium bicarbonate-chloride dominant. Underground water within the existing workings flows under gravity to underground dams, where they are transferred to the 19 cut through and/or 80 cut through dams and may be pumped to either the Newstan Colliery Fassifern seam underground water storage or Awaba Colliery Great Northern seam underground water storage (GHD 2012b). The overburden and interseam strata within the Newcastle Coalfield tend to have very low hydraulic conductivities (in the order of 10-11 to 10-9 m/s), unless joints or fracturing creates a secondary permeability.

One vegetation unit mapped by RPS (2012) within the SMP Study Area (Swamp Mahogany Paperbark Forest as illustrated on **Figure 22**) may potentially be influenced by groundwater or be partially groundwater dependent (for further information refer Figure 3-6 of the SMP Groundwater Assessment by GHD in **Appendix 8**). This vegetation type is associated with drainage lines and floodplains within the site.

There are no registered bores within the SMP Study Area, although two licenced monitoring bores (GW064213 and GW064214) are located within the Toronto Country Club to the south east of LW101. These monitoring wells are screened in rock at depths of approximately 20 m to 24 m bgl.

Further discussions on the groundwater resources are provided by the specialised groundwater consultant in the report by GHD (2012b).

Baseline Monitoring

Baseline monitoring of groundwater levels is undertaken via a groundwater monitoring network of 12 monitoring bores across the SMP Study Area. The monitoring network has been progressively established at Newstan since 2005 and consists of monitoring bores installed in alluvial and coal seam aquifers. Groundwater levels within the alluvial groundwater monitoring bores show a direct correlation between depth and rainfall levels.

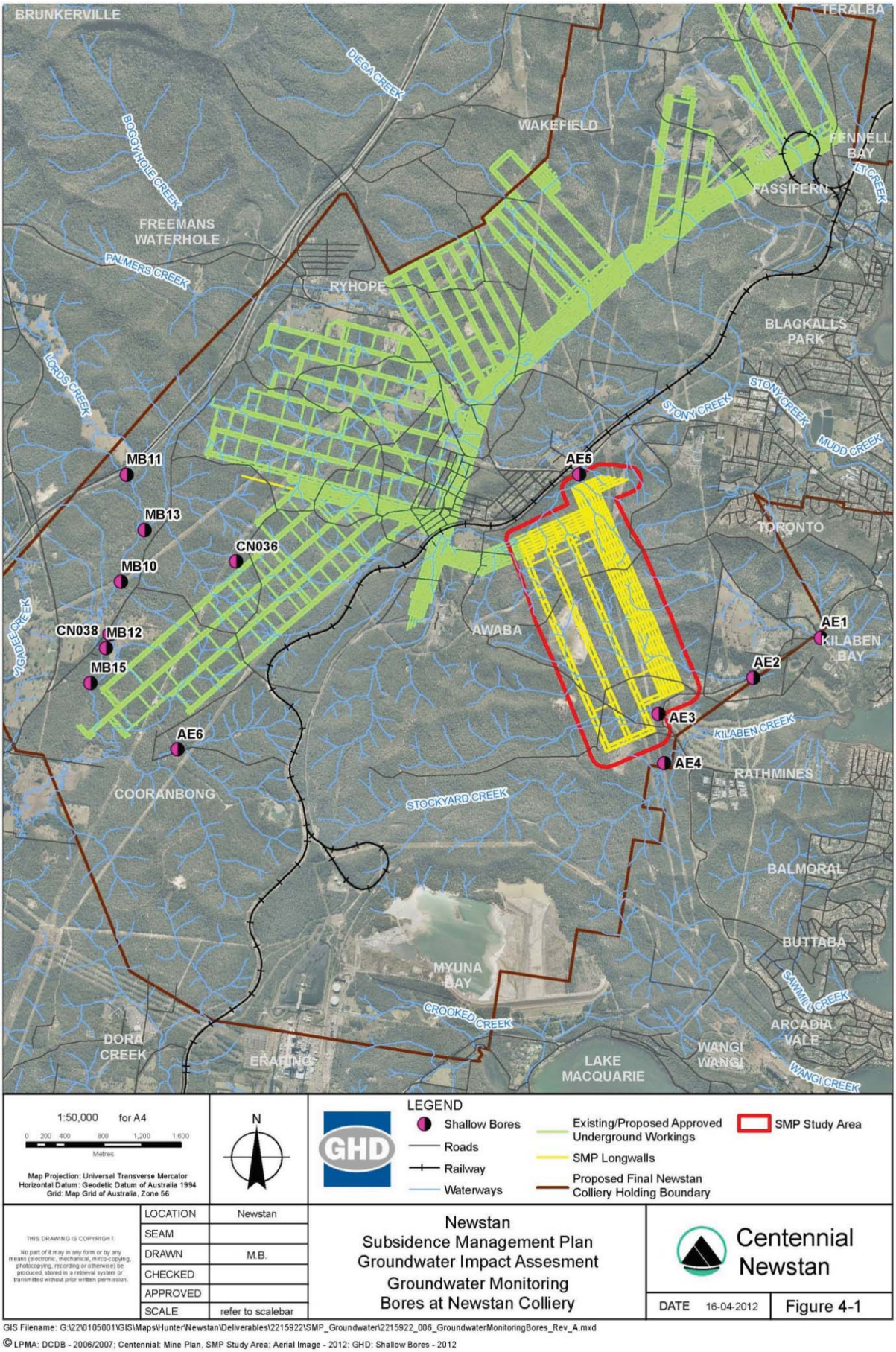


Figure 21 – Groundwater Monitoring Bores at Newstan Colliery (GHDb, 2012)

Impact Assessment

The groundwater sources in the vicinity of the SMP Study Area are generally low yielding and limited to shallow alluvium, underlying fractured rock and coal seams. There is minimal use and reliance on this groundwater for stock, domestic and irrigation purposes (GHD 2012b).

The groundwater impact assessment undertaken by GHD (2012b) for the development and extraction of LW101, 102 and 103 is based on statistical trend analyses of existing groundwater monitoring data and predictions from a preliminary the hydrogeological model. The development and extraction is expected to intercept deeper Permian groundwater at a rate of approximately 200 – 280 ML/year. The movement of shallow groundwater into underlying strata as a result of mining operations is expected to be small, totalling only 0.2 ML/year throughout the entire SMP Study Area.

No continuous fracturing between shallow aquifers and the mine workings are expected (refer MSEC discussions on the extent of the constrained zone and height of fracturing in **Section 7** and in detail in their report in **Appendix 4**). The additional groundwater inflow will be transferred to either the Fassifern seam underground water storage at Newstan or the Great Northern seam underground water storage at Awaba Colliery (GHD 2012b).

Aquifer depressurisation is **not** anticipated to impact registered stock, domestic or irrigation bores. The groundwater monitoring bore at the Toronto Country Club (GW064214) may experience some minor drawdown associated with mining although this is expected to be in the order of 0.1 m and negligible compared to climatic variation.

GDEs associated with Kilaben, Stockyard and Stony Creeks are located in the vicinity of the SMP Study Area. These potential GDEs may experience a drawdown of up to 0.2 m as a result of mining. It is not anticipated that GDEs located outside the SMP Study Area will be impacted, as discussed in further detail by the SMP Flora and Fauna Assessment (RPS, 2012, refer **Appendix 7**) and outlined in **Section 11.5.7** and **11.5.8**.

Based on the available data, there is evidence of existing interaction of leachate with groundwater at the AWMF. An increase in hydraulic conductivity of the uppermost bedrock due to subsidence cracking may increase the movement of leachate within the upper 10 – 15 m of rock, however it is not expected that leachate would move downwards to the mine.

Additional potential groundwater impacts have been considered, should actual conventional subsidence movements exceed predicted subsidence movements by a factor of two times. In this case, it is not expected that continuous cracking would extend from the seam to the ground surface based on actual historical observations. It is expected that the depth of subsidence cracking of the uppermost bedrock would remain less than 10 to 15 m (although the extents and widths of surface cracking would increase, leading to increased hydraulic conductivities).

Under the greater than predicted subsidence scenario, groundwater inflows into the mine workings and depressurisation of deeper aquifers would remain the same, as these predictions are based on observed inflows into existing workings and not on subsidence parameters.

Groundwater drawdown in shallow aquifers within the SMP Study Area may be higher than predicted due to an increase in the hydraulic conductivity of the uppermost bedrock caused by greater subsidence cracking.

Additionally, for the *greater than predicted* subsidence scenario, the movement of leachate from the AWMF within the upper 10 – 15 m of rock may increase due to an increase in the hydraulic conductivity of the uppermost bedrock caused by greater subsidence cracking.

The GHD Groundwater Impact Assessment (GHD 2012b) proposed the following management actions:

- The existing Newstan water balance be modified to incorporate the additional groundwater from LW101, 102 and 103. Centennial Newstan is currently undertaking this work as part of the Environmental Impact Statement (EIS) for the Newstan project. As part of this water balance modification, options for water reuse and underground transfers will be explored to reduce the volume of water required to be discharged from site;
- Develop a Trigger, Action and Response Plan (TARP) for monitoring potential groundwater impacts associated with LW101, 102 and 103. Groundwater monitoring will focus on groundwater levels and quality at the existing AWMF monitoring locations, and monitoring of groundwater levels within alluvium in the vicinity of GDEs. Additional alluvial monitoring bores may be installed within the SMP Study Area if deemed necessary. This TARP will form part of the Newstan *Water Management Plan*;
- Undertake groundwater monitoring to confirm whether there are existing impacts to groundwater from leachate at the AWMF and, identify the migration pathways, the spatial extent of any leachate plume, and any potential risks to the environment and human health; and
- Ground monitoring data from LW101 and LW102 should be utilised to confirm the magnitude of changes in hydraulic conductivity of the near surface strata, and this information will be used to refine predictions regarding any increase in leachate impact to groundwater resulting from LW103.

Monitoring, Mitigation and Management

The Groundwater Impact Assessment (GHD 2012b) has a number of recommended monitoring, remediation and reporting recommendations as detailed above. A *Water Management Plan* will be developed addressing all of the recommendations made by GHD. The *Water Management Plan* will include visual inspections along with surface water and groundwater monitoring. The plan will include a TARP, mitigation and management measures and will be submitted to DTIRIS – DRE prior to commencement of secondary extraction of LW101.

11.5.4. Cliffs and Rock Outcrops

Characterisation

For the purposes of this report, a cliff has been defined as a continuous rockface having a minimum height of 10 metres, a minimum length of 20 metres and a minimum slope of 2 to 1, i.e. having a minimum angle to the horizontal of 63°. Rock outcrops have been defined as isolated rockfaces generally having heights less than 10 metres (MSEC 2012).

The locations of any cliffs were determined using the 1 metre surface level contours which were generated from the Lidar survey dated January 2011. **There were no cliffs identified within the SMP Study Area.**

There a number of rock outcrops within the SMP Study Area which have been identified. The rock outcropping is predominately located along the hill above the northern ends of the proposed longwalls. An example of rock outcropping is illustrated in **Plate 22**.

Plate 22 – Photograph of Rock Outcropping

Baseline Monitoring

Baseline monitoring of the rock outcrops identified will be undertaken through visual inspections including photographic records. Photographic records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

The rock outcrops are located across the northern ends of the proposed longwalls and, therefore, could experience the full range of predicted subsidence movements. The maximum predicted conventional tilt within the SMP Study Area is 16 mm/m (i.e. 1.6 %), which represents a change in grade of 1 in 65. The maximum predicted conventional hogging and sagging curvatures are 0.40 km^{-1} and 0.60 km^{-1}, respectively, which represent minimum radii of curvature of 2.5 kilometres and 1.7 kilometres, respectively (MSEC 2012).

The secondary extraction of the proposed longwalls is likely to result in fracturing in some rock outcrops and where the rock is marginally stable, could then result in instabilities. However, previous mining beneath rocks outcrops in NSW Coalfields indicates that the percentage of rock outcrops likely to be impacted is minimal (MSEC 2012).

If the subsidence movements were increased by a factor of 2, the incidence of impacts would increase for the rock outcrops located directly above the proposed longwalls. Based on previous experience, it would still be expected that the incidence of impacts on the rock outcrops in the SMP Study Area would be relatively low (MSEC 2012).

Monitoring, Mitigation and Management

Rock outcrops will be visually inspected prior to, during the mining period, and for a period after the completion of mining to monitor stability.

Subsidence monitoring of rock outcrops will be undertaken by way of visual inspections including photographic records and potentially survey monitoring. Photographic records will be obtained and stored in the Newstan EMS for future reference.

A Public Safety Management Plan will be prepared in consultation with the DTIRIS – Division of Catchments and Lands (DTIRIS-DCL) (former LPMA), and submitted to DTIRIS - DRE prior to commencement of secondary extraction of LW101. The plan will detail the relevant monitoring,

mitigation and management measures to ensure public safety (refer **Volume 2** of the SMP Application).

11.5.5. Steep Slopes

Characterisation

Steep slopes (land having a natural gradient greater than 1 in 3) were identified from the 1 metre surface level contours which were generated from the Lidar scan of the area (MSEC 2012). The locations of the steep slopes within the SMP Area are shown in **Figure 19**.

The steep slopes are primarily located along the hill in the northern part of the SMP Study Area. The natural grades of the steep slopes typically range between 1 in 3 (i.e. 33 % or 18º) and 1 in 2 (i.e. 50 % or 27º), with isolated areas having natural grades up to 1 in 1.5 (i.e. 67 % or 34º).

The surface soils along the steep slopes are derived from weathered sandstone from the Narrabeen Group (Rn), and the majority of the slopes are stabilised by the natural vegetation.

Baseline Monitoring

Baseline monitoring of steep slopes mentioned above will be undertaken through visual inspections. Records will be obtained and stored in the Newstan EMS for future reference.

Impact Assessment

The steep slopes are located across the northern ends of the proposed longwalls and, therefore, may experience the full range of predicted subsidence movements. The maximum predicted conventional tilt within the SMP Study Area is 16 mm/m (i.e. 1.6 %), which represents a change in grade of 1 in 65. The maximum predicted conventional hogging and sagging curvatures are 0.40 km^{-1} and 0.60 km^{-1}, respectively, which represent minimum radii of curvature of 2.5 kilometres and 1.7 kilometres, respectively.

The maximum predicted conventional strains within the SMP Study Area, based on applying a factor of 10 to the maximum predicted conventional curvatures, are 4 mm/m tensile and 6 mm/m compressive. The maximum predicted tilt for the steep slopes of 16 mm/m (i.e. 1.6 %, or 1 in 65) is small when compared to the natural grades of the steep slopes, which are greater than 1 in 3. It is unlikely; therefore, that the mining induced tilts themselves would result in any significant impact on the stability of the steep slopes.

Impacts based on increased subsidence are discussed further in the MSEC report (2012). If the actual tilts exceeded those predicted by a factor of 2 times, the tilts at the steep slopes would still be small in comparison with the existing natural grades. If the actual curvatures exceeded those predicted by a factor of 2 times, more extensive surface cracking would be anticipated, however this could be remediated by infilling of surface cracks with soil or other suitable materials, or by locally regrading and recompacting the surface.

Accordingly, steep slopes will be visually monitored throughout the mining period and until any necessary rehabilitation measures are complete. Any significant surface cracking which could result in increased erosion or restrict access to areas will be remediated where appropriate by infilling with soil or other suitable materials, or by locally regrading and compacting the surface (MSEC 2012).

With appropriate management strategies in place, it is unlikely that there would be a significant long term impacts on the steep slopes resulting from the proposed mining (MSEC 2012).

Monitoring, Mitigation and Management

Subsidence monitoring of steep slopes will be undertaken by way of visual inspections prior to, during and post mining where appropriate, with a focus on identifying any areas of surface cracking. Records will be obtained and stored in the Newstan EMS for future reference.

The *Public Safety Management Plan* will be finalised in consultation with the DTIRIS – DCL, and submitted to DTIRIS - DRE prior to commencement of secondary extraction of LW101. The plan details the relevant monitoring, mitigation and management measures to ensure public safety (refer **Volume 2** of the SMP Application).

11.5.6. Land Prone to Flooding or Inundation

Characterisation

Whilst there are no major perennial waterways or defined floodplains within the SMP Study Area, potential changes in surface drainage with respect to localised flooding and inundation have been prudently assessed within this SMP Application by GHD (2012a, refer **Appendix 10**). This included potential impacts on surface drainage for built features (e.g. road culverts) as well as natural drainage areas.

The natural grades along the lower reaches of the watercourses (i.e. 3rd and 4th order, but including Kilaben Creek) are relatively flat and natural ponding is evident. It is likely that these areas within the SMP Study Area would be susceptible to flooding and inundation.

Discussions on the potential for increased ponding along the watercourses were provided in **Section 11.4.1.**

Centennial Newstan has consulted with key land and infrastructure owners (including LMCC and the DTIRIS - DCL) and provided them with the predicted subsidence movements for the SMP Study Area.

Baseline Monitoring

A geomorphic investigation was based upon a series of field investigations which looked at existing waterway type and condition. This was accompanied by a desktop assessment which determined stream order and significance to the environment. To support the geomorphic investigation a hydraulic assessment was undertaken on a regional and individual creek scale. A flood model was developed to assess the regional flooding characteristics of the project area. This formed a baseline for which impacts of the project could be identified.

Impact Assessment

Detailed assessment and modelling of potential subsidence impacts to surface water flows and drainage in the SMP Study Area was undertaken by GHD (refer SMP Surface Water Report in **Appendix 10)**. This included assessment for any potential changes in flow or ponding.

The impact of the change in surface levels on the hydrology of the waterways is minor and not readily measurable (GHD 2012a). The peak flow rates in the watercourses WC10, WC4, WC1 and WC3 remain unaltered for the subsided condition compared to the existing condition for all Average Recurrence Interval (ARI) events assessed. The impact on flood depth, due to predicted subsidence, was found to be greatest in the 2 year ARI event. This indicated that the flooding inundation had a maximum increase of 3.7% within the subsidence project area. The areas indicating the greatest impact were identified as Kilaben Creek and the unnamed creek.

The Surface Water Assessment (GHD, 2012a) indicated that at the receiving waters of each of the creeks, as they exit the SMP Study Area, there is no change in flooding depths or velocities. This indicates the likelihood that flow volumes, for the 100 year ARI event, have remained constant between the existing and subsided flooding scenarios.

The predicted subsidence affectation zone is located within the catchments of Stony Creek (WC1), Kilaben Creek (WC5), Stockyard Creek (WC4), and two unnamed creeks identified as WC10 and WC3. The Surface Water Assessment (GHD, 2012a) indicates some change may occur in the alignment of minor drainage channels in upper catchment positions, though these changes are unlikely to change existing catchment boundaries.

Flood velocities were assessed for change between the existing and subsided model. Velocities remained consistent in the subsided surface with some instances of increases and decrease in velocity. Change in velocity was greatest within Kilaben Creek and the unnamed watercourse. These instances are both attributed to the presence and effect of the Electrical Easement and Access Track along the Eastern Branch.

The effect of the subsidence and tilt predictions on Wilton Roads produced by MSEC showed a similarity in existing and predicted post mining grades. In the vicinity of the Culvert WI-C3, subsidence predictions suggest a uniform change in surface with minimal increase in grades around the point at which the Culvert crosses Wilton Road. Due to the nature of Wilton Road there are unlikely to be any specific points at which water can form areas of road side ponding.

The ridge line stretching across the SMP Study Area from east to west were determined to have not changed considering a post mining subsidence surface, however ridges that branch off this though heading to the north and south were shown to vary slightly.

Waterways within the SMP Study Area were assessed indicating that subsidence may vary the alignment of minor drainage channels within the upper catchment positions, but catchment boundaries are unlikely to change. The GHD Surface Water Impact Assessment (2012) determined that though items of surface infrastructure will subside by some distance, the impact on the appropriate management of surface water and flooding characteristics will be minimal. Some areas of infrastructure that are currently in a poor condition, such as the access tracks of the electrical easements, indicate that with subsidence their condition is likely to be exacerbated.

Monitoring, Management and Mitigation

As discussed in **Section 11.3.1,** a *Watercourse Management Plan* and *Public Road Management Plan* will be developed addressing key recommendations made by GHD. The *Watercourse Management Plan* will also include mitigation and management measures and will be submitted to DTIRIS-DRE prior to commencement of secondary extraction of LW101.

11.5.7. Threatened and Protected Species

Characterisation

A Flora and Fauna Assessment was undertaken by RPS (2012a) for the LW101-103 SMP Application. Full details of investigations to identify, characterise and undertake impact assessments for flora and fauna within the SMP Study Area are provided in the full report contained in **Appendix 7**. This section provides assessment of protected species of flora and fauna. Ecological communities of protected native vegetation are addressed separately in **Section 11.5.8** further below.

Four threatened flora species were recorded within the SMP Study Area:

- *Acacia bynoeana* (Bynoe's Wattle) (Endangered under the TSC Act 1995 and Vulnerable under the EPBC Act 1999);
- *Angophora inopina* (Charmhaven Apple) (Vulnerable under the TSC Act 1995 and the EPBC Act 1999);
- *Grevillea parviflora* subsp. Parviflora (Vulnerable under the TSC Act 1995 and the EPBC Act 1999) and
- *Tetratheca juncea* (Black-eyed Susan) (Vulnerable under the TSC Act 1995).

A total five threatened species were identified within the SMP Study Area:

- Masked Owl (*Tyto novaehollandiae*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- East-coast Freetail-bat (*Mormopterus norfolkensis*);
- Little Bentwing-bat (*Miniopterus australis*), and
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*).

Baseline Monitoring

A number of comprehensive flora and fauna studies have been previously been conducted across the SMP Study Area. These surveys were considered along with new ecological surveys conducted by RPS. A range of flora and fauna survey methods were employed within the site to detect a representative sample of species present within the SMP Study area and adjoining lands. Baseline monitoring involved:

Flora Survey:

- Vegetation mapping; and
- Significant flora survey

Habitat Survey

Fauna Survey:

- Arboreal trapping;
- Terrestrial trapping;
- Hair funnels;
- Bat trapping (harp trap);
- Bat echolocation call recording;
- Avifauna survey;
- Herpetofauna survey;
- Spotlighting;
- Owl call playback; and
- Secondary indications and incidental observations.

Impact Assessment

The Ecology Assessment undertaken by RPS (2012a) concluded that while the proposed SMP Application would result in longwall subsidence of up to 1200 mm, no significant impacts would occur to any threatened flora or fauna species.

Monitoring, Mitigation and Management

RPS recommended the following mitigation measures to minimise the potential impacts of the mine:

- Monitoring of stream bed morphology within the Swamp Mahogany / Paperbark Forest should be undertaken to detect any changes in the stream bed from subsidence. Likely indicators are the formation of new cracks, changes in direction of the stream bed and ponded areas;
- Newstan Colliery will develop a *Watercourse Management Plan* for the SMP study area (or adopt equivalent principles in the Newstan *Flora and Fauna Management Plan* - FFMP); and
- Where subsidence cracks are found that require remediation, then remediation will be undertaken in accordance with the Newstan Colliery *Watercourse Management Plan* or FFMP and in consultation with relevant regulatory agencies.

Whilst assessment by RPS concluded that no significant impact is expected to individual species of protected flora and fauna that require further management, the existing *Flora and Fauna Management Plan* for the mine will be updated in relation to managing ecological communities as outlined in **Section 11.3.7** below.

11.5.8. Natural Vegetation and Ecological Communities

Characterisation

Specialist studies by RPS (ecological consultants) were commissioned by Centennial Newstan to identify, characterise and undertake impact assessments for flora and fauna within the SMP Study Area, including ecological communities. The full report is provided in **Appendix 7.**

Four vegetation communities were found to occur within the SMP Study Area (RPS, 2012a), namely:

- MU 15 Coastal Foothills Spotted Gum Ironbark Forest;
- MU 30 Coastal Plains Smooth-barked Apple Woodland;
- MU 31 Coastal Plains Scribbly Gum Woodland;
- MU 37 Swamp Mahogany/ Paperbark Forest; and
- Cleared Land.

The Swamp Mahogany/ Paperbark Forest vegetation community is commensurate with the 'Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions' Endangered Ecological Community (EEC) listed under the TSC Act 1995. The Swamp Mahogany/ Paperbark Forest is the only vegetation community within the SMP Study Area considered to have potential to be a Groundwater Dependent Ecosystem (GDE) or be partially dependent on groundwater. Specialist assessment of groundwater for the SMP was undertaken by GHD (2012b, refer **Section 11.5.3** and **Appendix 8**) and was referenced for the consideration of potential impacts to the EEC.

Baseline Monitoring

A number of comprehensive flora and fauna studies have been previously been conducted across the SMP Study Area. These surveys were considered along with new ecological surveys conducted by RPS. A range of flora and fauna survey methods were employed within the site to detect a representative sample of species present within the SMP Study area and adjoining lands. Baseline monitoring involved:

Flora Survey:

- Vegetation mapping; and
- Significant flora survey

Habitat Survey

Impact Assessment

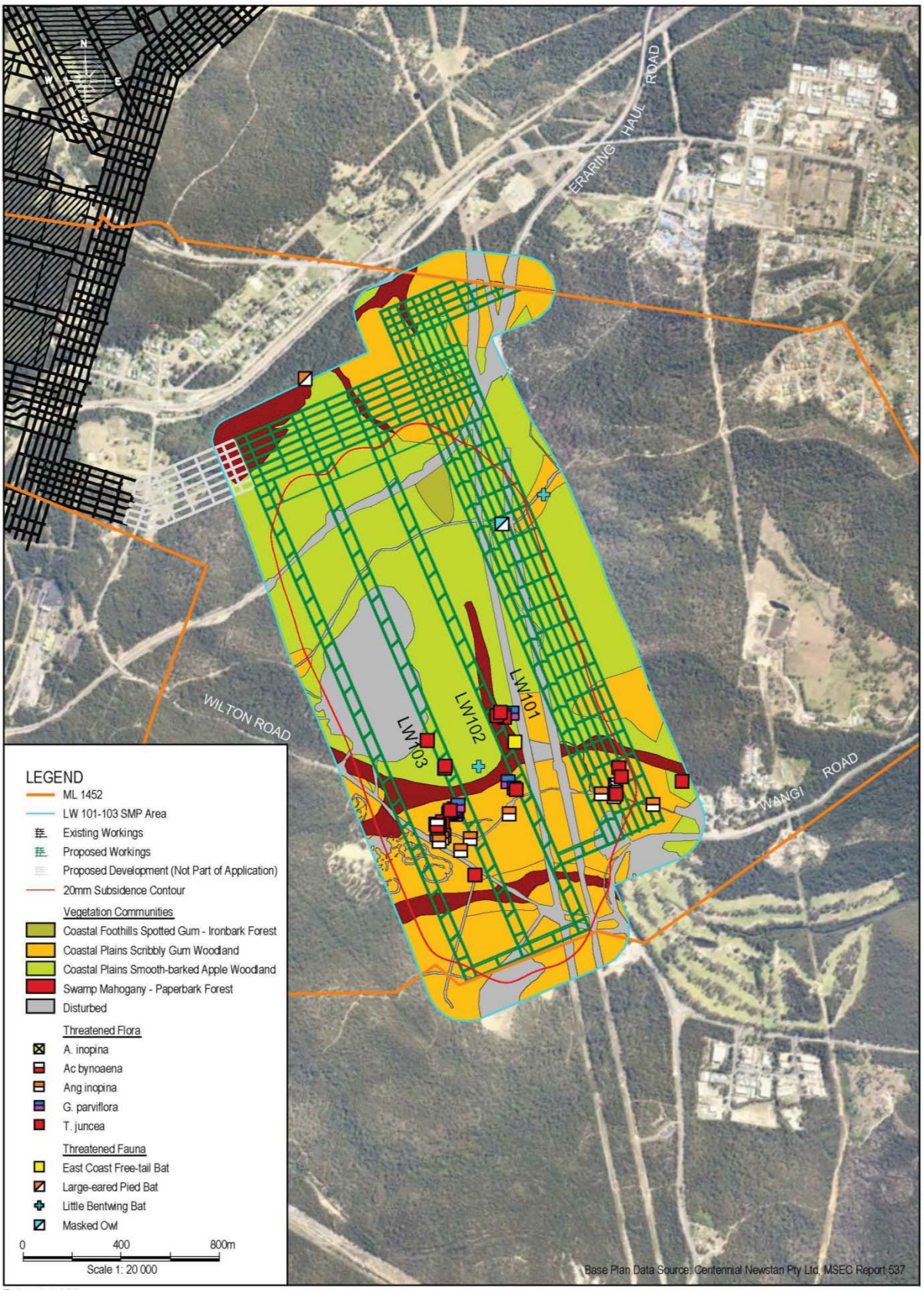
Longwall mining under the Endangered Ecological Community Swamp Mahogany Paperbark Forest (Groundwater Dependant Ecosystem) may result in increased ponding along the flatter sections of the Schedule 2 streams however natural ponding is already evident along these watercourses due to the relatively flat natural grades. It is expected that the Groundwater Dependant Ecosystem will adjust over time to accommodate the changed levels through natural sedimentation of hollows, and the natural hydrology will be maintained (RPSa, 2012).

Monitoring, Mitigation and Management

In order to monitor and manage the impacts to the Swamp Mahogany / Paperbark Forest EEC, Newstan Colliery will develop a *Watercourse Management Plan* and update the mine's *Flora and Fauna Management Plan* for the SMP Study Area.

Monitoring of stream bed morphology within the Swamp Mahogany / Paperbark Forest (and the EEC itself) will be undertaken to detect any impacts caused by subsidence. Where impacts are identified that require remediation, then remediation will be undertaken in accordance with the Newstan Colliery *Watercourse Management Plan* and in consultation with relevant regulatory agencies.

Both the *Watercourse Management Plan* and the *Flora and Fauna Management Plan* will be developed and submitted to DTIRIS - DRE prior to secondary extraction of LW101.



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Newstan Colliery
Natural Features - Vegetation Communities and Threatened Flora and Fauna

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Figure 22 - Vegetation Communities and Threatened Flora and Fauna

11.5.9. Surface features of community significance (including Aboriginal Heritage)

Characterisation:

A detailed assessment for potential Aboriginal and European heritage sites of significance was undertaken for the LW101-103 SMP by RPS (2012b, refer **Appendix 9**). This section presents a summary of those investigations, the report should be referenced for full details where required.

There are no lands within the proposed SMP Study Area declared as an Aboriginal Place under the National Parks and Wildlife Act 1974 (RPS, 2012b).

The Aboriginal and European Cultural Heritage Assessment report completed for this SMP (RPS, 2012b, herein referred to as the SMP Archaeological Heritage Report), identified nine (9) archaeological sites within the SMP Study Area.

There are three other additional new sites located within the SMP Study Area which have recently been identified and are currently in the process of being registered with OEH. The additional sites were identified during recent surveys commissioned by LMCC for the expansion of the AWMF and include three scarred trees located immediately west of the AWMF. There is also a culturally sensitive site south of AHIMS #457-0303 that is in the process of being registered with OEH.

The monitoring/management measures for these sites will be addressed in the Centennial Northern Holdings *Aboriginal Cultural Heritage Management Plan* (ACHMP) currently being developed in consultation with the Aboriginal stakeholders.

A summary of these sites, their locations in context of the proposed development and secondary extraction of LW101-103, and their predicted impacts is provided in **Table 11.22** below. The locations of the sites listed are illustrated on **Figure 23**.

Table 11.22 Registered Aboriginal Heritage Sites Identified Within the SMP Study Area

Recording Code	Site Name	Site Type	Location	Maximum Vertical Subsidence Prediction (mm)	Maximum Total Tilt Prediction (mm/m)	Maximum Predicted Conventional Hogging Curvature (km^{-1})	Likelihood of Harm
45-7-0260	LEA10	Grinding Groove Complex	Main Headings Roadways (First Workings)	50	0.5	0.01	Moderate
45-7-0295	RPS Newst 02	Isolated Find	Main Headings Roadways (First Workings)	100	1.5	0.02	Low
45-7-0296	RPS Newst 03	Isolated Find	LW101 Roadways First Workings	200	2	0.04	Low
45-7-0297	RPS Newst 04	Artefact Scatter	LW101 Roadways First Workings	200	2	0.03	Low
45-7-0298	RPS Newst 05	Isolated Find	Angle of Draw	150	2	0.03	Low

Recording Code	Site Name	Site Type	Location	Maximum Vertical Subsidence Prediction (mm)	Maximum Total Tilt Prediction (mm/m)	Maximum Predicted Conventional Hogging Curvature (km^{-1})	Likelihood of Harm
45-7-0299	RPS Newst 06	Artefact Scatter	LW101	800	6	0.07	Low-Moderate
45-7-0303	RPS Newst 10	Isolated Find	Angle of Draw	50	0.5	<0.01	Low
45-7-0309	RPS Newst 16	Isolated Find	LW102	850	10	0.17	Low-Moderate
45-7-0310 - 45-7-0005	RPS Newst 17	Rockshelter	LW101-	650	1	0.06	High

Stakeholder Consultation

Centennial Newstan implemented the Aboriginal Cultural Heritage Consultation Requirements (ACHCR) in 2010 and in the consultation requirements of the Indigenous Land Use Agreement (ILUA). Centennial Newstan is currently consulting with the registered Aboriginal stakeholder groups to develop an *Aboriginal Cultural Heritage Management Plan* (ACHMP) for the Northern Holdings (RPS, 2012b).

Baseline Monitoring

Field surveys over the SMP Study Area were completed in 2010/11 by RPS representatives of the registered Aboriginal stakeholder groups. A cultural mapping and significance workshop was conducted on the 23rd of March at Newstan. The workshop identified areas of cultural sensitivity that could not be determined through standard archaeological methods.

Impact Assessment

RPS (2012b) has provided a detailed assessment of potential impacts to Aboriginal and Cultural Heritage sites within the SMP Study Area (refer **Appendix 9** for full details). A summary of potential impacts identified is provided below.

Sites Subjected to Low Risk of Impact

Isolated finds (AHIMS # 45-7-0296; 45-7-0303; 45-7-0295; 45-7-0298) and artefact scatter (AHIMS # 45-7-0297) are at low risk of subsidence impact caused by longwall coal extraction. The sites are located either within the angle of draw or above the main roadways, therefore subsidence impact has been predicted to range between 50 – 200 millimetres. The integrity of the sites will not be harmed by minor levels of ground displacement.

The waterhole site identified during the cultural significance meeting is yet to be formally recorded and registered with AHIMS. Further investigation will be undertaken to develop a full understanding of the cultural and scientific significance of the site. However, the waterhole is predicted to experience less than 20 millimetres of subsidence and it is therefore unlikely that the waterhole would experience any adverse impact resulting from proposed mining, even if the predictions were exceeded by a factor of 2 times.

Sites Subjected to Low – Moderate Risk of Impact

Artefact scatter (AHIMS # 45-7-0299) and isolated find (AHIMS # 45-7-0309) have been identified as low-moderate risk of subsidence impact. Due to the subsidence predicted, there is a small possibility

that cracking of the surface soils may occur, however the likelihood of harm to the artefacts has been assessed as minimal, even if the predicted subsidence were exceeded by a factor of 2 times.

Site Subjected to Moderate Risk of Impact (Grinding Groove -AHIMS # 45-7-0260)

Grinding Groove site (AHIMS # 45-7-0260) is at a moderate risk of harm from subsidence impact, as this site is made from sandstone that is physically attached to the landscape and is susceptible to surface movement irregularities.

Centennial Newstan has designed the mine layout to locate mains headings under the grinding grooves site to minimise potential impacts to site. The predicted movement of 50 millimetres may lead to sandstone exfoliation and the subsequent damage to the groove complex. If subsidence predictions were exceeded, the potential for the associated impacts discussed previously to site AHIMS # 45-7-0260 will also increase.

Sites Subjected to High Risk of Impact (Rockshelter with possible grinding groove) - AHIMS # 45-7-0310/45-7-0005)

The sandstone rockshelter with possible grinding groove site (AHIMS # 45-7-0310/45-7-0005) which is located adjacent to gate roads between LW101-102 is at a high risk of harm, with predicted subsidence of 650 millimetres, and predicted conventional tensile strain of 0.6 mm/m.

Based on previous experience of mining beneath rockshelters similar to these site types, RPS has suggested that there is at least a 10% probability this site could be impacted by ground subsidence. The probability that the site will be impacted by subsidence increases if the subsidence predictions are exceeded.

Monitoring, Mitigation and Management

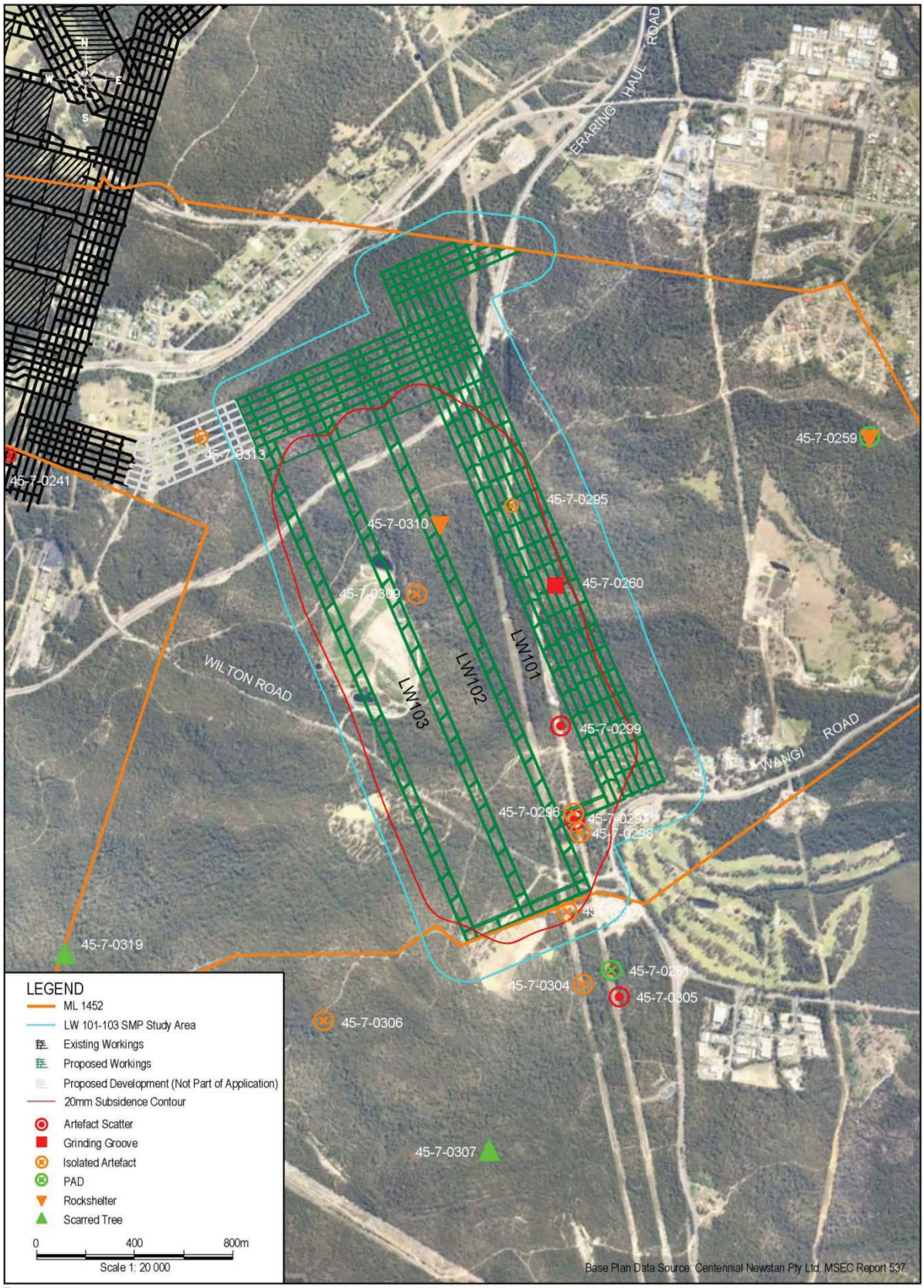
The RPS (2012b) Assessment resulted in a number of recommendations which are detailed below:

- Centennial Newstan will complete the development of the Northern Holdings *Aboriginal Cultural Heritage Management Plan (ACHMP)* which is currently being prepared in consultation with the registered Aboriginal stakeholders. The ACHMP, once completed, will identify on-going consultation requirements between Newstan and the registered Aboriginal stakeholders, Aboriginal site monitoring, Aboriginal site management and, where applicable, cultural heritage offsets to be implemented at Newstan;
- Grinding Groove Site (AHIMS #45-7-0260) has been assessed to be at moderate risk of harm from subsidence as a result of the extraction of LW101. It is recommended that Centennial Newstan must monitor the site according to the protocols set for rockshelters in the Northern Holdings ACHMP. If a risk of impact is identified during the monitoring process, Centennial Newstan must apply for and gain approval for a Section 90 Aboriginal Heritage Impact Permit (AHIP) from the Office of Environment and Heritage (OEH) (Director-General) to destroy the site prior to the commencement of proposed works.
- Rockshelter with possible grinding groove site (AHIMS # 45-7-0310/45-7-0005) has been assessed to be at high risk of subsidence impact. Centennial Newstan must apply for and gain approval for a Section 90 Aboriginal Heritage Impact Permit (AHIP) application prior to secondary extraction under the site so that the appropriate recording and mitigation measures can be implemented in the case that the site is partially or completely destroyed;
- It is recommended that Newstan ensures that a due diligence monitoring program for the Northern Holdings ACHMP (currently being prepared) be followed for the three scarred trees identified by Mr Shane Frost (currently being registered with OEH-) and the sites within the Newstan SMP Study Area as follows: AHIMS # 45-7-0296, AHIMS # 45-7-0303, AHIMS # 45-

7-0295, AHIMS # 45-7-0298, AHIMS # 45-7-0297, AHIMS # 45-7-0299 and AHIMS # 45-7-0309;

- All relevant Centennial staff should be made aware of their statutory obligations for heritage under NSW *NPW Act (1974)* and the NSW *Heritage Act (1977)*, which may be implemented as a heritage induction;
- If more Aboriginal site/s are identified in the Study Area, Centennial Newstan is advised to refer to the Northern Holdings ACHMP (currently being prepared) for mitigation measures for newly identified sites. All newly identified site/s are also required to undergo an Aboriginal cultural assessment prior to the commencement of secondary workings beneath the site; and
- If human remains are located, Centennial Newstan is advised to refer to the Centennial Northern Holdings ACHMP currently being prepared which, once completed, will identify the consultation, monitoring and management requirements for newly identified sites.

As mentioned above, an *Aboriginal Cultural Heritage Management Plan* is in the process of being developed for the Northern Holdings which incorporates the SMP Study Area. Key recommendations listed above by RPS will be included in the management plan which will be prepared in consultation with the relevant Aboriginal groups and relevant government authorities. The *Aboriginal Cultural Heritage Management Plan* will be submitted to DTIRIS – DRE prior to commencement of secondary extraction for LW101, and any Section 90 approvals required will be obtained prior to undermining of protected heritage sites.



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Natural Features - Aboriginal and Cultural Heritage Sites

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Figure 23 - Aboriginal and Cultural Heritage Sites

12. SUMMARY AND MANAGEMENT OF POTENTIAL SUBSIDENCE IMPACTS

This SMP Written Report has been completed in accordance with the requirements of DA 73-11-98 MOD 4 2012 and the SMP Guidelines. This section provides a summary and overview of the priority areas of potential impacts for management identified during detailed investigations for the SMP Application. Full details are provided in the specialist reports for the SMP Study Area (see **Appendices 4 and 7-10**). An overview of potential subsidence impacts is presented throughout **Sections 10** and **11**.

Table 12.1summarises the priority areas for subsidence management as identified through a risk based management process for the SMP Study Area. The findings and recommendations for management and mitigation of potential impacts from investigations into subsidence impacts and management have been considered in the preparation of the relevant management plans applicable to the SMP Study Area as part of this SMP Application. **Table 12.1** summarises the management plans to address these potential impacts associated with mine induced subsidence. In general, management plans have been developed/updated where relevant for LW101 and included in the submission of this SMP Application. Aspects relevant only to later panels will be submitted for approval following this as detailed in **Table 12.1**.

Recommendations for monitoring, management and mitigation measures are provided during specialist investigations and assessments of potential subsidence and environmental impacts within the SMP Study Area for key risk aspects (both natural and built environments). In accordance with the requirement of Section 6.10.3 of the SMP Guidelines, impact assessments include the potential for increased impact due to subsidence levels greater than as predicted. Specialist report recommendations are accordingly considered during the preparation of management plans during SMP Applications.

Table 12.1 Summary of Priority Potential Impact Issues for Subsidence Management

Key Features	Potential Impact (As Predicted)	Where Addressed / Managed
Awaba Waste Management Facility	Preliminary risk assessment and impact assessment focus included: • Increased risk of localised cracking of the existing unlined waste cell. • Increased risk of cracking clay pond lining system of the existing secondary leachate storage pond; • Increased risk of localised cracking of the existing lined waste cell; and • Weighbridge going off-level; Full details of subsidence predictions and impact assessments for the AWMF are presented in **Section 11.4**.	Refer risk assessment and *Action Plan* process in Sections 9 and 11. AWMF Management Plan Subsidence Managemnt Plan
Powerlines and Electrical Substation (incl. transmission lines, high and low	132kV transmission lines are located above LW101-102 which could experience maximum subsidence of 825mm and tilt of 6.5mm/m at the pole locations. The high and low voltage powerlines could experience the full range of	Electrical Surface Infrastructure Management Plan

Key Features	Potential Impact (As Predicted)	Where Addressed / Managed
voltage powerlines)	subsidence movements. Assessment by MSEC concluded it is unlikely that the 132 kV transmission lines, high and low voltage powerlines would experience any adverse impacts resulting from the proposed mining. The Ausgrid substation has been designed to accommodate subsidence movements and is located beyond the 20mm subsidence contour.	
Telecommunications – Aerial and buried fibre optic cable	AAPT aerial optic fibre cable attached to the eastern branch of the 132kV transmission line will experience similar subsidence to the transmission line, with subsidence of 725 mm and tilts of 6.5mm/m at the pole locations. Preventative measures may be required if strains in the cable approach allowable tolerances. Telstra buried fibre optic cable follows Wilton Road to the AWMF. Conventional subsidence of 200mm is predicted with tilts of 3.0mm/m, curvature of 0.07km^{-1} and compressive strains of 1 mm/m to 3 mm/m at the creek crossings, which could result in the reduction in capacity of the cable or transmission loss.	AAPT Infrastructure Management Plan Telstra Infrastructure Management Plan
Telecommunications – copper cable	The Telstra copper telecommunications cables along Wangi Road are located outside the predicted 20 mm subsidence contour. It is unlikely that these would experience any significant conventional or valley related movements (MSEC 2012).	Telstra Infrastructure Management Plan
Eraring Haul Road	Predicted subsidence of 1175mm is expected above the longwalls, conventional tilt of 13.0mm/m and curvature of 0.55 km^{-1}. It is expected that cracking and rippling of the road surface would occur, but within safe, serviceable and repairable limits. Removal of loose rock and highly weathered sections along the undercutting is proposed to be undertaken prior to undermining.	Private Road Management Plan Subsidence Monitoring Program
Wangi Road and Wilton Road	Wangi Road – Nil. The road is expected to experience subsidence of less than 20mm, tilt of less than 0.5mm/m and curvature of less than 0.01km^{-1}. The predicted subsidence is not expected to have significant impact on Wangi Road. Wilton Road crosses the southern ends of LW102-103 with a total length of approximately 800m directly above LW102-103. Total	Subsidence Management Plan Public Safety Management Plan Public Road Management Plan Subsidence Monitoring Program

Key Features	Potential Impact (As Predicted)	Where Addressed / Managed
	conventional subsidence is predicted to be 925mm. The maximum predicted conventional tilt for Wilton Road is predicted to be 6.5mm/m, with a maximum curvature of 0.15 km-1 for hogging and 0.35 km-1 for sagging (MSEC 2012). Post mining grades are expected to be similar to the existing grades along Wilton Road. Potential change in surface drainage could occur but is not expected to be significant. Whilst it is possible that localised ponding may occur, this can be remediated using normal road maintenance techniques. Due to the nature of Wilton Road there are unlikely to be any specific points at which water can form areas of road side ponding. Due to the significant grade of the road as it passes through the SMP Study Area it is unlikely that the road will be any more susceptible to flooding impacts (GHD, 2012). It is expected that with the current predicted curvature and strains, that cracking and rippling of the road surfaces would occur. Previous experience of mining directly beneath roads in the NSW coalfields, with similar depths of cover and panel width to depth ratios, indicates that crack widths are typically between 10mm and 25mm along with heaving of around 25mm. It is expected that Wilton Road could be maintained in a safe and serviceable condition throughout the mining period by using normal road maintenance techniques.	
Culverts	No significant impact to the 4 culverts on Wilton Road, 2 on Wangi road, and one culvert on the Private Haul Road within the SMP Study Area. Tilts <0.05%, change in grade <1% and in direction of flow, All culverts (except HR-C1) indicated a negligible change between the existing and the predicted post mining subsided surface condition headwater depths. HR-C1, is the only culvert to indicate a reduction in grade due to the subsidence predictions, however this is likely to be minimal with a maximum subsidence of less than 20 mm predicted.	Subsidence Management Plan Public Road Management Plan Private Road Management Plan
Bridges	No bridges within SMP Study Area (bridges >500m from proposed longwalls, well outside predicted 20 mm subsidence contour). At these distances, the bridges are not expected to experience any measurable conventional tilt, curvatures or strains. Bridges could experience small far-field horizontal movements. It is likely, that these small differential horizontal movements will not be measurable at bridges. It	Subsidence Management Plan Public Road Management Plan Private Road Management Plan

Key Features	Potential Impact (As Predicted)	Where Addressed / Managed
	is likely bridges could tolerate potential movements and it is expected that bridges would not be adversely impacted.	
Survey Control Marks	Two State Survey Marks (SS77112, SS77113) and One (1) Trig Station (TS666) are are expected to experience the full range of predicted subsidence movements. Survey control marks located outside and in the vicinity of the SMP Study Area are also expected to experience small amounts of subsidence and small far-field horizontal movements up to 3km outside the SMP Study Area	Subsidence Management Plan
Newcastle Lake Macquarie Clay Target Club	Demountable structures, small storage sheds, trap houses and the trap enclosures, themselves, are founded on small piers, slabs on ground, or the natural ground. Predicted curvatures and strains are very small, in the order of survey tolerance, and are unlikely to be transferred into structures and result in any significant impacts. Whilst predicted tilts are extremely small, the clay target throwers and target survey markers could be sensitive to small movements. It is understood that the clay target throwers can be adjusted in level. It may be necessary to develop preventive measures, if the predicted tilts exceed the available adjustments to re-level the clay target throwers, or to relocate the target survey markers.	Newcastle Lake Macquarie Clay Target Club PPMP Subsidence Management Plan
Awaba & Westlakes Automobile Club (AwabaWAC)	The predicted curvatures and strains for the section of track located directly above the proposed LW103 could be of sufficient magnitude to result in cracking, heaving, or stepping of the surface. Building structures and associated infrastructure are all predicted to experience less than 20 mm subsidence and therefore unlikely to experience any adverse impacts.	Awaba & Westlakes Automobile Club PPMP Subsidence Management Plan
Toronto Adventist Centre (School and Church)	Nil. The buildings and associated infrastructure are all predicted to experience less than 20mm subsidence and not expected to experience any significant conventional tilts, curvatures or strains, and are unlikely to experience any adverse impacts. Whilst no significant impact is predicted, prudently Centennial proposes to consult and manage the TAC via a PPMP developed with the landowner.	Toronto Adventist Centre PPMP Subsidence Management Plan

Key Features	Potential Impact (As Predicted)	Where Addressed / Managed
Toronto Country Club (Golf Club)	Nil. The buildings and associated infrastructure are all predicted to experience less than 20mm subsidence and not expected to experience any significant conventional tilts, curvatures or strains, and are unlikely to experience any adverse impacts. Whilst no significant impact is predicted, prudently Centennial proposes to consult and manage the TCC via a PPMP developed with the landowner.	Toronto Country Club PPMP Subsidence Management Plan
Surface Water & Drainage Lines	Some change may occur in alignment of minor drainage channels An increase in gradient and flow velocity is predicted as watercourses enter the subsidence area and a general reduction in gradient and flow velocity through the affected area. Waterways are densely vegetated (long native grass), so the modelled flow velocity increases are considered to be non-scouring and potential for instability is considered low. An increase in channel surface water ponding will occur in some waterway sections as a result of the subsided surface, most likely along WC5 and WC10 immediately upstream of where these exit the subsidence affection zone. Some fracturing and spalling of the exposed bedrock could likely occur in upper reaches of the watercourses which could drain local ponding immediately upstream. Due to steep slopes and depth of fracturing and dilation, diverted flow will re-emerge immediately downstream with no net loss.	Watercourse Management Plan Water Management Plan
Groundwater	Aquifer depressurisation is not anticipated to significantly impact registered stock, domestic or irrigation bores. Toronto Country Club's monitoring bore (GW064214) may experience some minor drawdown in the order of only 0.1 m and negligible compared to climatic variation. GDEs associated with Kilaben, Stockyard and Stony Creeks in the vicinity of the SMP Study Area may experience a drawdown of up to 0.2 m as a result of mining but not expected to be impacted (see Ecology below). With respect to mine water make, development and extraction of LW101, 102 and 103 is expected to intercept deeper Permian groundwater at a rate of approximately 200 – 280 ML/year. The movement of shallow groundwater into underlying strata as a result of	Water Management Plan

Key Features	Potential Impact (As Predicted)	Where Addressed / Managed
	mining operations is expected to be small, totalling only 0.2 ML/year throughout the entire SMP Study Area (GHD, 2012).	
Ecology & Vegetation Communities	Swamp Mahogany Paperbark Forest (EEC, Groundwater Dependant Ecosystem) may experience increased ponding along the flatter sections of the Schedule 2 streams however natural ponding is already evident along these watercourses due to the relatively flat natural grades. It is expected that the Groundwater Dependant Ecosystem will adjust over time to accommodate the changed levels through natural sedimentation of hollows, and the natural hydrology will be maintained (RPSa, 2012)	Flora and Fauna Management Plan
Rock outcrops and Steep Slopes	Potential for fracturing in some rock outcrops and where the rock is marginally stable is predicted to be likely, which could result in instabilities. However, previous mining beneath rocks outcrops in NSW Coalfields indicates that the percentage of rock outcrops likely to be impacted is minimal (MSEC 2012).	Public Safety Management Plan Subsidence Management Plan
Archaeological Artefacts	One site considered at high risk of potential impact (rockshelter with possible grinding groove site AHIMS# 45-7-0310/45-7-0005,. Based on previous experience of mining beneath rockshelters similar to these site types, RPS suggests there is at least a 10% probability the site could be impacted. Grinding Groove site (AHIMS # 45-7-0260) is at a moderate risk of harm from subsidence, being sandstone physically attached to the landscape and susceptible to surface movement irregularities. The predicted movement of 50 millimetres may lead to sandstone exfoliation and the subsequent damage to the groove complex. Four (4) isolate finds and an artefact scatter are considered at low risk of impact, one(1) artefact scatter considered at low-moderate risk of impact. The recently identified (yet to be registered) culturally significant site is predicted to experience less than 20 millimetres of subsidence and unlikely to experience adverse impact.	Aboriginal Cultural Heritage Management Plan Section 90 applications where required

Table 12.2 Management of Subsidence Related Impacts and Document Status

Management Plan	Status	Comments
Subsidence Management Plan	Draft plan submitted with SMP	To be finalised in consultation with relevant stakeholders (in context of related plans) prior to commencement of secondary extraction in LW101.
Electrical Surface Infrastructure Management Plan	Commenced, In progress	Draft document to be finalised in consultation with stakeholders prior to commencement of secondary extraction in LW101
Telstra Infrastructure Management Plan	Commenced, In progress	Draft document to be finalised in consultation with stakeholders prior to commencement of secondary extraction in LW101
AAPT Infrastructure Management Plan	Commenced, In progress	Draft document to be finalised in consultation with stakeholders prior to commencement of secondary extraction in LW101
Public Road Management Plan	Commenced, In Progress	Draft document to be finalised in consultation with stakeholders prior to commencement of secondary extraction in LW101
Private Road Management Plan	Commenced, In Progress	Draft document to be finalised in consultation with stakeholders prior to commencement of secondary extraction in LW101
Public Safety Management Plan	Draft plan submitted with SMP	To be finalised in consultation with relevant stakeholders (in context of related plans) prior to commencement of secondary extraction in LW101.
Private Property Management Plans	Commenced, in progress	Whilst no impact is predicted, PPMP's for the Toronto Adventist Centre and Toronto Country Club will conservatively befinalised in consultation with stakeholders prior to commencement of secondary extraction in LW101. . Other PPMP's for AWABAWAC and Newcastle Lake Macquarie Clay Target Club will be developed and submitted prior to commencement of secondary extraction of the relevant longwall (e.g. LW103).
Subsidence Monitoring Program	Draft submitted to DTIRIS with SMP Application. To	Subsidence Monitoring Program will be revised and updated where

Management Plan	Status	Comments
	be finalised prior to commencement of secondary extraction in LW101.	required prior to commencement of LW102
Aboriginal Cultural Heritage Management Plan	Currently being finalised with stakeholders	In the process of being updated in consultation with relevant stakeholders and will be submitted prior to secondary extraction of LW101.
Flora & Fauna Management Plan	Currently being finalised with stakeholders	In the process of being developed and will be submitted prior to secondary extraction of LW101.
Watercourse Management Plan	Currently being finalised with stakeholders	In the process of being developed and will be submitted prior to secondary extraction of LW101.
Water Management Plan	Currently being finalised with stakeholders	A detailed regional review of water management for the entire mine is currently in progress (including revised water balance) and will include LW101-103. This is being undertaken in consultation with relevant stakeholders and will be submitted prior to secondary extraction of LW101.

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