

Appin Colliery Area 7 Longwalls 705 to 710

SUBSIDENCE MANAGEMENT PLAN APPLICATION

PROPOSED SUBSIDENCE MANAGEMENT PLAN

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Volume 2/3

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Prepared for:



SUBSIDENCE MANAGEMENT PLAN TITLE BLOCK

Name of company:	BHP Billiton - Illawarra Coal	
Name of mine:	Appin Colliery Area 7	
Titles/Mining Leases:	CCL767	
Plan Title:	Appin Colliery Area 7 Longwalls 705 to 710 Subsidence Management Plan	
Title	Manager Approvals Mr Richard Walsh	
Signature	
Date	
Revision history:	and	
Revision	Date	Description
		Initial Draft SMP
		Final SMP

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16. OVERVIEW OF SUBSIDENCE MANAGEMENT

16.1 THE SUBSIDENCE MANAGEMENT PLAN

This Subsidence Management Plan (SMP) presents the proposed monitoring and management for Appin Area 7 Longwalls 705 to 710. This volume of the plan relies on the subsidence impact characterisation and Risk Assessment which have been undertaken and discussed in **Volume 1**. The SMP and associated Monitoring and Management Plans are considered adequate for the management of any impacts from the extraction of the proposed longwalls given the nature, magnitude, extent and causes of the expected subsidence impacts arising from the proposed mining.

16.1.1 Purpose

The purpose of the SMP is to provide for the adequate protection of important natural and built features (DPIM, 2003). The SMP must be approved before extraction of the longwalls commences.

This SMP is considered appropriate to the nature and scale of the potential subsidence impacts, with the level of investigation and detail presented reflecting the scale of the impact and the sensitivity of the features affected.

The fundamental objectives of this SMP and its associated documentation are to:

- Describe a system to adequately manage subsidence risks in a timely manner and to demonstrate BHP Billiton Illawarra Coal's (IC's) capability to manage subsidence.
- Clearly state the objective of what is to be achieved, within both systems and individual plans.
- Outline the systems used to establish monitoring programs.
- Outline the systems to ensure ongoing analysis of monitoring information is used to implement management actions in a timely manner.
- Clearly define the necessary trigger levels and response actions.
- Demonstrate preparedness for impacts outside of predictions.

The mine plan has been optimised to maximise the extraction of the resource and ensure that the subsidence impacts to sensitive features are minimised and manageable.

The following management process is used by this SMP:

- Setting objectives;
- Monitoring to obtain data;
- Assessment of monitoring data;
- Decision making process;
- Timely implementation of adequate management measures;

- Review management decisions to identify actions;
- Assign responsibilities within an organisational structure;
- Communication of the SMP and outcomes; and
- Develop contingency measures.

16.1.2 Scope

This SMP has been developed in accordance with the Department of Primary Industries – Minerals (DPIM) SMP Guidelines. It describes a detailed and ongoing program of subsidence monitoring and management. The SMP has been developed in consultation with the affected residents, infrastructure owners and relevant government agencies. These include, the Appin Area Community Working Group, the Sydney Catchment Authority (SCA), the Department of Environment and Climate Change (DECC), DPI (Fisheries), DPI (Minerals), the Department of Water and Energy (DWE), Optus, the Roads and Traffic Authority (RTA), Telstra, Sydney Water, the Australian Rail Track Corporation (ARTC), the Mine Subsidence Board (MSB) and Integral Energy. This SMP applies to both the roadway development for the proposed longwalls and longwall extraction within the SMP Area. The extent of the application and this plan includes:

- The area on the surface enclosed by the 35 degree angle of draw from the limit of proposed mining or the predicted limit of subsidence (taken as 20 mm).
- Other specific surface and sub-surface features outside the above area that may be affected by mining induced ground movements and far field effects.

The SMP is based upon the experience from adjacent longwall mining. The SMP will be reviewed during mining operations and modified if necessary to more adequately identify and manage subsidence risk. This Plan provides the template to address the requirements of the approvals for mining within the SMP Area.

The implementation of the SMP relates to:

- Natural features, including:
 - Surface and sub-surface water;
 - Landscape features, including cliffs, steep slopes and areas prone to erosion; and
 - Terrestrial and aquatic ecology.
- Aboriginal archaeological and European heritage features;
- Infrastructure (with more detail in specific infrastructure plans); and
- Private landowners (with more detail in separate Property Subsidence Management Plans (PSMPs)).

16.1.3 Limitations and Assumptions

This SMP addresses the mining of the proposed Appin Area 7 Longwalls 705 to 710 only and should not be applied to other areas without review.

The assumptions of this SMP are:

- Subsidence will generally be in accordance with the predictions in technical report MSEC342.
- Impacts will be similar to those previously observed in adjacent comparable areas. Where previous impacts were greater than predicted, contingency measures are based on known anomalous events and detailed scenario analysis.
- Rigorous monitoring can identify anomalous subsidence movements and can be used to manage impacts through early intervention strategies. This monitoring is targeted at surface features susceptible to impacts from anomalous movements.
- Surface features and land use will remain substantially constant during the mining period.
- The applied impact studies are comprehensive and accurate.
- This SMP focuses on potential subsidence impacts only. Mining operational risks are not considered in detail in this SMP.

This SMP will be reviewed if any of these assumptions become invalid during the SMP's operational life. Any change to these assumptions will become apparent within an adequate timeframe due to the rigorous monitoring proposed in this SMP.

16.1.4 Performance Indicators

Indicators that the SMP is effective in managing subsidence impacts of the proposed Appin Area 7 Longwalls 705 to 710 include:

- Subsidence impacts and risks will be managed in consultation with key stakeholders.
- Subsidence monitoring mechanisms will provide appropriate data for ongoing analysis and implementation of management actions to the satisfaction of key stakeholders.
- Any impacts outside of the subsidence predictions, identified in technical report MSEC342, are identified and managed appropriately.
- Performance will be monitored and reported in the IC Annual Environmental Management Report (AEMR). Should performance not be satisfactory, IC will liaise with the relevant authorities and stakeholders to address issues as they arise.

16.2 IDENTIFIED HAZARDS

AXYS Consulting was engaged to facilitate a qualitative Risk Assessment to assess mine subsidence-related risk issues for the proposed longwalls. The Risk Assessment Report is attached as **Appendix G**.

The Risk Assessment considers potential impacts, including effects on strategic, business and operational objectives as well as third party and environmental aspects.

As well as this formal risk assessment, IC is required by corporate policy and standard procedures to develop and implement risk management plans with relevant stakeholders where the consequences of adverse impacts are considered high. This risk based approach to subsidence management will continue for all activities undertaken pursuant to this SMP.

Potential risk issues which may lead to impacts are detailed in **Appendix G**. A consolidated list of these is provided below:

- Impacts associated with changes in water flow and quality in rivers and creeks;
- Changes to surface and groundwater interaction and resultant effects on water quantities and quality;
- Aquatic and terrestrial strata gas release;
- Increased instability or movement of cliffs and steep slopes;
- Loss of protected flora, fauna or their habitat;
- Damage to SCA infrastructure such as the Upper Canal and Devines Tunnels
- Movement of permanent survey marks;
- Damage to infrastructure such as, roads, bridges, culverts, railways, telecommunication lines and towers and power transmission lines;
- Damage to residential/farm dwellings and properties;
- Damage to Aboriginal and European heritage sites; and
- Secondary environmental impacts due to implementation of monitoring, mitigation and remediation.

Where risk levels have been assessed as above a certain threshold (90 - refer **Appendix G**) additional management controls are documented in the Risk Assessment.

16.3 CONTROL PROCEDURES

Procedures developed to manage subsidence impacts fall into the following five categories:

Baseline Assessment

Natural features and infrastructure have been identified within the SMP Area and land subject to far field movements, including, the Nepean River, cliffs and steep slopes, roads, railways, SCA infrastructure, survey marks and transmission lines. A comprehensive description of the surface and subsurface features is provided in **Section 6 of Volume 1**.

Baseline Monitoring

Monitoring has been undertaken in accordance with the various baseline studies as summarised in **Volume 1** and provided in **Appendices A, B, C, D, E** and **H**. Baseline monitoring programs for water and climatic conditions as well as a range of ecological parameters have been revised and updated as part of the development of this SMP.

Impact Assessment

Impact assessments were completed for Natural Features, Hydrology, Terrestrial and Aquatic Ecology and Man Made Features in **Sections 8, 9, 10 and 11 of Volume 1**. The overall environmental impact of the proposal (**Section 15 Volume 1**) draws on the DoP Document, “Is an EIS required?” and the factors referred to in Clause 228 of the *Environmental Planning and Assessment Regulation 2000* as a basis for environmental impact assessment.

Impact Monitoring

The proposed impact monitoring is based on knowledge gained from previous studies and management of subsidence associated with the extraction of adjacent longwalls in Appin Area 7, Area 4 and West Cliff Area 5. Monitoring techniques used in previous mining areas, including for the Nepean River and major infrastructure, are applicable to the current SMP Application. The proposed monitoring program is provided in this document.

Subsidence Management

Provides a basis for the design and implementation of any mitigation and remediation. Monitoring provides key data when determining any requirement for mitigation or rehabilitation. Baseline data is then compared with monitoring results to determine any remediation that may be required. Descriptions of mitigation and rehabilitation options are detailed in this document.

16.4 RESOURCES REQUIRED AND AVAILABLE

Internal IC and external resources are available for the implementation of this SMP.

16.4.1 The Role of the Regulator (DPIM)

The Department of Primary Industries – Minerals (DPIM) is the Government agency responsible for the regulation of mining in NSW. One of its functions is to review and approve this SMP to allow coal extraction from the proposed Appin Area 7 Longwalls 705 to 710. The fundamental objective of this Plan and its associated documentation is to:

- Clearly define the protocols and procedures that will govern mining operations within the proposed Appin Area 7 Longwalls 705 to 710.
- Provide for the management of subsidence acceptable to the DPIM such that approval can be granted.

The ongoing role of the DPIM in this process is to regulate the operation of the SMP and its associated documentation in the fulfilment of its objective and to provide advice to the Interagency Review Committee and to the Minister.

The SMP application is assessed by a DPIM SMP Review Committee comprising the Director Sustainable Development (Chair), Assistant Director Environment, Chief Inspector of Coal Mines, Principal Subsidence Engineer, Manager Policy and Legislative Review and Chief Geologist Coal and Petroleum.

This SMP provides for the DPIM to receive regular updates of the status of this Plan so that it is readily able to fulfil its regulatory role. Furthermore, the Principal “Trigger Action Response Plans” (TARPs) controlling subsidence impacts provide for the DPIM to be notified and more closely involved at ‘trigger points’.

16.4.2 BHP Billiton Illawarra Coal

BHP Billiton Illawarra Coal has established a Sustainable Development (SD) Department to be the vehicle for all SMP applications, Government interactions and development of relationships with key stakeholders. The SMP and specific management plans are developed and primarily managed by the SD Department. The structure of this department is shown on the following page:

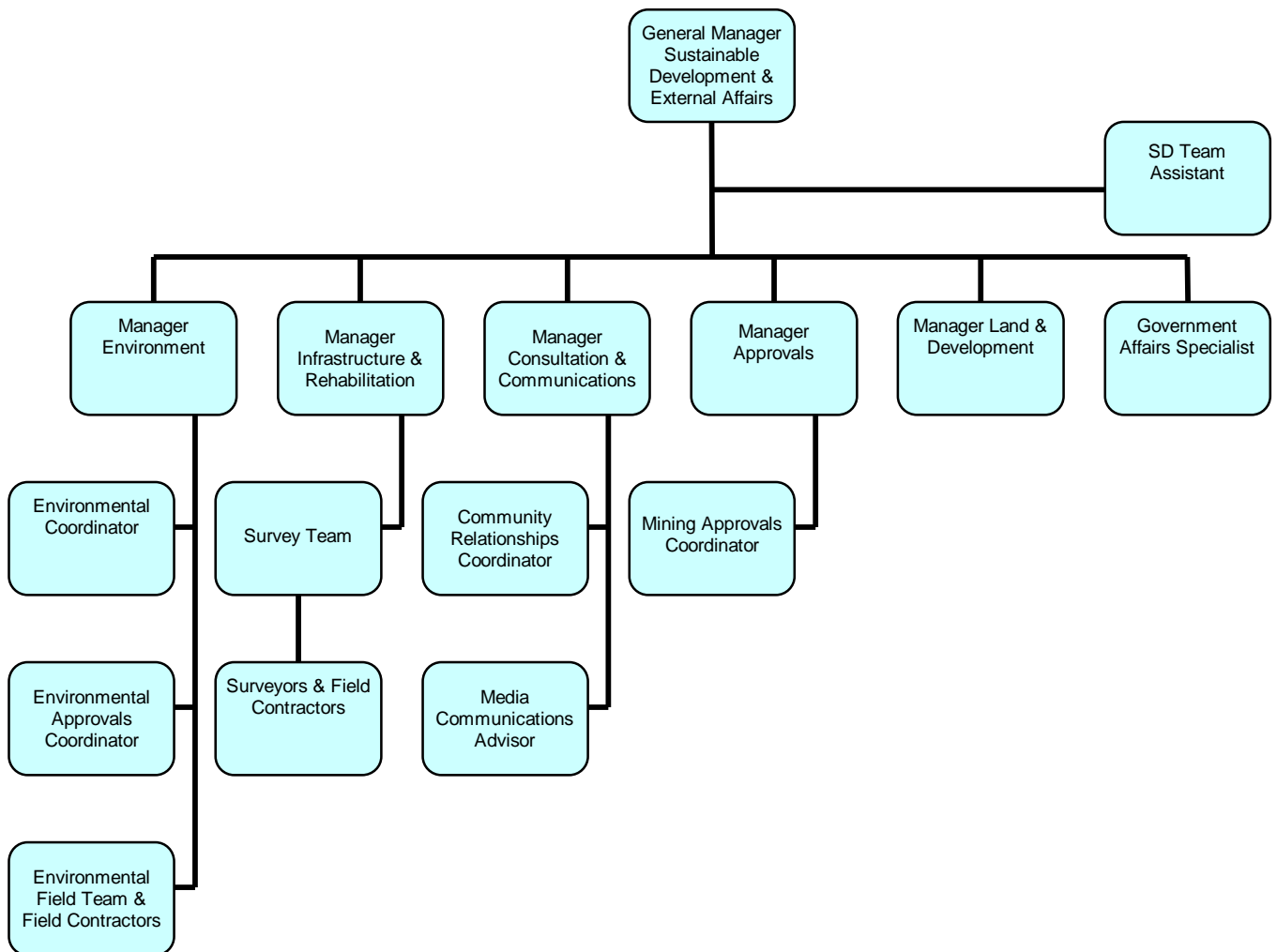


Figure 16.1 - Illawarra Coal Sustainable Development, Organisational Structure

In fulfilling this obligation IC has assigned the following resources to assist in compliance with the Appin Area 7 SMP for the proposed Longwalls 705 to 710:

- Manager Approvals;

- Mining Approvals Coordinator ;
- Manager Environment;
- Environmental Approvals Coordinator;
- Manager Infrastructure and Rehabilitation;
- Manager Survey;
- Survey Team; and
- Environmental Field Team.

There are a significant number of consultants that support IC including:

- MSEC – Subsidence Predictions and Review;
- Cardno Forbes Rigby – Environmental Planning, Structural & Civil Engineering, GIS services and Mine Rehabilitation;
- Ecoengineers – Surface Water Quality;
- Geoterra – Hydrogeology and Groundwater;
- The Ecology Lab – Aquatic Habitat and Biota;
- Biosis Research – Terrestrial Flora, Fauna and Archaeological and Cultural Heritage;
- NATA accredited testing laboratories; and
- AXYS Consulting – Risk Assessment.

16.4.3 The Role of Government Agencies

The SMP is assessed using a whole of Government approach which utilises an Interagency Review Committee. The DPIM is represented by the Director Sustainable Development, Director Environment and the Assistant Director Safety Operations. The Committee also includes representatives nominated by the CEO of each of the following agencies:

- Department of Planning (DoP);
- Department of Water and Energy (DWE);
- Department of Environment and Climate Change (DECC);
- Department of Primary Industries – Fisheries (DPIF);
- Dams Safety Committee (DSC);
- Sydney Catchment Authority (SCA);
- Mine Subsidence Board (MSB); and
- Other agencies where their interest is recognised by the Committee. The Committee is chaired by the Chief Executive Officer of the Mine Subsidence Board.

The approach taken in assessing SMP applications is 'open and transparent' and in consultation with all parties affected by the proposal. A consensus solution is always sought. However, where consensus is not possible, the Deputy Director-General (DPIM), or a delegate, will make a decision on the basis of all available information.

Appropriate Resource Managers provide advice to the Review Team in its interpretation of monitoring data and its response to the conclusions drawn from that data in the management of subsidence impacts.

16.4.4 Infrastructure Owners

Contact details for each of the infrastructure owners with potential to be impacted by the proposed longwalls are available from IC should rapid access to their services be required. Management plans for infrastructure are developed in consultation with owners and where appropriate other regulators e.g. DSC. Contact details and communication protocols are detailed within each management plan.

16.4.5 Mitigation Resources

The contractors used for implementation of mitigation and rehabilitation are readily available. The Manager Environment is responsible for the implementation of mitigation measures required for environmental aspects, and the Manager Infrastructure and Rehabilitation (with the relevant asset owner) is responsible for the mitigation and rehabilitation of infrastructure.

BHP Billiton Illawarra Coal has a successful history of implementing management strategies in relation to its mining areas. Mitigation resources are detailed in the specific Management Plans.

The acquisition of goods and services required for the implementation of both monitoring and remedial provisions of this plan are subject to IC purchasing requirements that include, but are not limited to:

- All tender documents to include detailed specification and scope of work;
- Tenderers to supply details of products, employee expertise, previous work undertaken and safety records;
- All chemicals used for projects must have Material Safety Data Sheets (MSDS) documents supplied;
- All equipment used for projects must have approval documents complete and complied with;
- All persons working on projects must comply with induction requirements; and
- All contractors must comply with Illawarra Coal Health, Safety, Environment and Community (HSEC) and project management requirements.

16.5 PERSONNEL RESPONSIBILITIES

16.5.1 BHP Billiton Illawarra Coal Review Team

The Review Team consists of the following regular members:

- Mine Representative as required;

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- Manager Approvals;
 - Manager Survey;
 - Manager Infrastructure and Rehabilitation; and
 - Manager Environment.

The team can request the attendance of additional personnel, stakeholders (e.g. DPIM) and technical specialists as it deemed necessary.

The Review Team will:

- Review all monitoring data generated as a result of the provisions of this SMP.
- Determine the need for any additional monitoring, inspections, tests, expert opinion or advice or otherwise to improve their knowledge and understanding of the situation at any time.
- Cause the implementation of an appropriate remedial response should any monitoring trigger level occur.
- Cause the immediate implementation of the responses specified within the relevant TARP and any other action that the team considers to be necessary.
- Ensure that all actions required as a result of this SMP are clearly communicated to those responsible for their implementation.
- Maintain records of each Review Team meeting.

16.5.2 Mine Representative

The Mine Operations Manager or delegate will:

- Act as a member of the Review Team;
- Represent the Colliery as required; and
- Inform mine personal of any requirements under this Plan.

16.5.3 Manager Approvals

The Manager Approvals will:

- Act as a member of the Review Team;
- Take the specific actions defined within TARPs as trigger levels are reached; and
- Ensure that the quality elements related to the ongoing effectiveness of this SMP are conducted and reported as required.

16.5.4 Manager Infrastructure and Rehabilitation

The Manager Infrastructure and Rehabilitation will:

- Act as a member of the Review Team;
- Ensure that monitoring data related to, and triggers generated by, the SMP are made available for assessment by the Review Team at its meetings;
- Take the specific actions defined within the TARPs as trigger levels are reached; and

- Ensure that the standards and frequencies related to the Monitoring Controls are adhered to.

16.5.5 Manager Environment

The Manager Environment will:

- Act as a member of the Review Team;
- Ensure that monitoring data related to, and triggers generated by, the SMP are made available for assessment by the Review Team at its meetings;
- Take the specific actions defined within the TARPs as trigger levels are reached; and
- Ensure that the standards and frequencies related to the Monitoring Controls are adhered to.

16.5.6 Manager Survey

The Manager Survey will generate and update plans and any other data that falls within the scope of his duties and experience that may be required by the provisions of this SMP or as directed by the Review Team or Manager Infrastructure and Rehabilitation.

16.5.7 Field Monitoring Personnel, Surveyors and Consultants

The Field Monitoring Personnel, Surveyors and Consultants engaged to contribute to elements of this SMP will:

- Expedite the assessment of any sampling and analyses required;
- Immediately bring to the attention of the Review Team any anomaly or trigger level identified as a result of the assessment of results; and
- Ensure that all testing is undertaken by appropriately trained and qualified personnel.

All samples are to be collected and prepared, at all times, using the correct methodology for obtaining, labelling and transporting samples for the analysis used. Members of the Field Team will be trained in such requirements or under the supervision of a person that has been appropriately trained.

16.6 PLAN QUALITY ELEMENTS

16.6.1 Training

Inspections and observations by Field Monitoring Personnel and Consultants facilitate the detection of events related to subsidence. This monitoring control is fundamental to the success of this SMP.

All Field Monitoring and Monitoring Program activities are conducted in line with developed procedures which include competency-based training relating to:

- Subsidence impact identification assessment and reporting;
- General awareness of the critical nature of subsidence management and this SMP;
- The need to follow formal plans and reporting requirements;
- The need to ensure that information is forwarded to the technical specialists and other relevant personnel; and
- Regular toolbox talks and re-assessment of understanding, especially in relation to safety.

The following responsibilities for training exist for key personnel:

- Field Monitoring Personnel – Manager Environment;
- Consultants – Consultant Project Manager; and
- Surveyors – Manager Survey.

16.6.2 Communications and Reporting

The AEMR is the principle reporting tool for the SMP. The AEMR also summarises monitoring results on an annual basis.

During the implementation of this SMP the Manager Approvals will ensure that all personnel are advised of their responsibilities under this plan and will ensure that each understands the nature and requirements of the role.

BHP Billiton Illawarra Coal maintains a comprehensive system of forums for communication that will be used, among other things, to regularly review monitoring results, assess subsidence impacts as they arise and maintain up to date knowledge of the system status. These forums are outlined below.

- Regular Meetings with Field Monitoring Personnel and Surveyors which are held as a form of general communication on a weekly basis and include any issues relating to monitoring. Where any situation involves subsidence of a serious nature outside predictions, the Field Monitoring Personnel or Surveyor will contact the relevant Manager immediately.
- Regular meetings are held between the Consultant Project Manager and the appropriate IC Manager. Reporting requirements are clearly stated in each contract with the Consultant.

The SMP Review Team will meet regularly to discuss the status of the SMP. Periodic reporting of the results of the monitoring programs to Government will be undertaken in accordance with the commitment in the Monitoring and Triggers Sections.

16.6.3 Audit and Review

A Risk Assessment of subsidence impacts, based on the latest data has been conducted for the extraction of the proposed Appin Area 7 Longwalls 705 to 710, and this is detailed in **Appendix G**. Should any significant unpredicted event occur that is capable of impacting on the ability of this Plan to achieve its fundamental objective (i.e. to monitor, assess and control impacts in accordance with the established TARPs) a review of the Risk Assessment will be conducted. Such events may include subsidence impacts outside of predictions or a significant change in the mining plan. The Manager Approvals will discuss the nature of any such event with the DPIM to determine if a review of risk is warranted and whether the DPIM wishes to be involved in that assessment.

An internal audit of this Plan shall be conducted following the completion of the proposed longwall blocks. Audits and reviews of this plan will include personnel with appropriate skills, knowledge or experience to contribute effectively to the conduct of each.

16.6.4 Record Keeping and Control for Process Reliability

The processes defined within this Plan must be demonstrated as being effective over time in managing subsidence. To achieve this, a history needs to be established of normal conditions, triggers that have been identified by monitoring and corrective actions that have been implemented during instances of a subsidence impact.

Data derived from the monitoring system will be archived and stored for a period of at least five years.

Statutory reports, databases, planning documents, relevant correspondence, notification and approvals, training records, records of communication, audit reports and review recommendations shall be maintained for a period of at least two years.

Reports relating to the actions taken, including any subsequent assessment/investigation, in response to any trigger shall be kept by IC for a period of at least five years.

16.6.5 Document Control

This SMP shall be controlled as part of the IC Environmental Management System which is certified to ISO14001. Modifications to this Plan or the Standards and Procedures that are referenced by this plan may occur as a result of the auditing and review process, the assessment and implementation of a corrective action or as a result of system improvements or modifications. The Manager Approvals will approve all modifications and amendments to this Plan (following discussion with and agreement by the DPIM) or associated documentation.

Copies of the SMP are provided to:

- BHP Billiton Illawarra Coal;
- Appin Colliery;
- Field Monitoring and Survey Personnel;

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- Key Consultants;
 - DPIM;
 - SMP Interagency Members;
 - Council; and
 - Other key stakeholders.

Any amendments to the SMP will be completed in consultation with and the approval of DPIM. Appropriate measures to update stakeholders of any amendments to the SMP will be completed as required by the DPIM Approval Conditions. Persons utilising uncontrolled copies of the SMP must ensure that they have the most up-to-date version before they apply any provisions.

17. INFRASTRUCTURE MONITORING AND MANAGEMENT

17.1 OBJECTIVES

The objectives of the subsidence monitoring program are to:

- Provide information on the magnitude and extent of subsidence over each longwall panel with particular focus on each item of infrastructure;
- Enable comparison of actual ground movements with predicted ground movements;
- Monitor ground movements at or near surface infrastructure at risk;
- Provide an indication of any non-systematic movements within the subsidence zone;
- Satisfy the objectives of the Subsidence Management Plan;
- Satisfy the objectives of agreed management plans between IC and infrastructure owners; and
- Meet the expectations of the community and Government with regard to monitoring subsidence.

17.2 SUBSIDENCE MONITORING OVERVIEW

Infrastructure monitoring has been conducted in the area for many years and management plans are currently in place for the key items of infrastructure as detailed below.

Discussions with infrastructure owners to determine appropriate management plans or revisions to current plans are being undertaken where necessary and all infrastructure owners were invited to attend the Risk Assessment (refer **Appendix G**). Subsidence predictions will also be forwarded to infrastructure owners for review.

Subsidence predictions for the current SMP Application Area are not significantly different to previous mining areas that have been effectively managed with the current management plans in place. The existing infrastructure management plans are expected to accommodate the proposed mining in this area; however a review has been undertaken in a number of stages:

- Subsidence predictions have been prepared for review by infrastructure owners to ensure that all assets are appropriately covered and that data is provided in a useful form. This subsidence information has been provided so that comments on subsidence data can be sought from infrastructure owners.
- Revised impact assessments in relation to infrastructure have been prepared and made available to stakeholders. Specific monitoring and management measures are updated from the above assessment.
- Management and monitoring plans will be updated as required in a collaborative process.

17.3 SPECIFIC INFRASTRUCTURE MANAGEMENT PLANS

There are existing management plans in place for infrastructure over Appin Area 7 Longwalls 701 to 704 and these plans will be revised and amended to manage the impacts of the proposed Longwalls 705 to 710. Property Subsidence Management Plans (PSMPs) are also being developed with the landowners to manage any subsidence impacts on private property. Due to the detailed nature of these Management Plans it is expected that these will be submitted separately to the DPIM. This SMP contains indicative monitoring and management programmes for these features and a summary is provided below.

Roads (HW2 Hume Highway)

The Hume Highway runs approximately southwest/northeast across the proposed longwalls on the northern side of the Nepean River. Subsidence predictions have been provided to the RTA and discussions have commenced. Representatives from the RTA also attended the Risk Assessment held on 15 May 2008 and discussed issues about potential effects from subsidence on their infrastructure. It was agreed that the monitoring and management plan adopted for Longwalls 701 to 704 would be reviewed and adapted to include Longwalls 705 to 710. The revised plan will include detailed monitoring of subsidence movements and impacts. Important components of the strategy include detailed ground monitoring surveys, visual inspection and real time monitoring of movement. The frequency of scheduled monitoring is likely to increase when the longwalls are close to the road and this will be regularly reviewed with the RTA as the longwall mining progresses.

Local roads

Local roads including Moreton Park Road and Menangle Road also traverse the SMP Area. The management plan currently in place for these roads over Longwalls 701 to 704 will be reviewed and updated to include Longwalls 705 to 710 in consultation with the RTA and Wollondilly Shire Council. The visual monitoring of local roads during the active mining period is primary method of ensuring mining impacts are managed.

RTA Bridges

One bridge, Moreton Park Road Bridge (North), has been identified within the General SMP Area. Moreton Park Road Bridge (South) and the Twin Bridges at Douglas Park have also been identified as features that may be affected by far-field horizontal movements. A monitoring and management plan is being developed for these bridges with the RTA. Important components of the strategy include detailed survey, visual inspection and real time monitoring of movement. The frequency of scheduled monitoring is likely to increase when the longwalls are close to the bridges and this will be regularly reviewed with the RTA as the longwall mining progresses. Remediation works have been successfully undertaken on the Twin Bridges in the past due to the effects of mining Tower Longwalls 16 and 17. Bridges associated with the Upper Canal will be managed along with the other SCA infrastructure.

RTA Rest Area and Associated Structures

Buildings and sewerage treatment works at the Rest Area have been designed to mitigate the impact of subsidence on them and are approved by the MSB. The RTA Rest Area and amenities will be monitored by the RTA throughout mining. Remediation of any impacts on

these structures is expected to be minimal can could be achieved using well established techniques.

Main Southern Railway

The Main Southern Railway runs roughly southwest/northeast across the proposed longwalls on the northern side of the Nepean River. Subsidence predictions have been provided to the ARTC and discussions have commenced. Representatives from the ARTC also attended the Risk Assessment held on 15 May 2008. A detailed management plan is being developed with the ARTC to manage any potential impacts from subsidence. This plan will include detailed monitoring of subsidence movements and impacts. Important components of the strategy are likely to include detailed survey, visual inspection and real time monitoring of movement. The frequency of scheduled monitoring is likely to increase when the longwalls are close to the rail line and this will be regularly reviewed with the infrastructure owner as the longwall mining progresses.

SCA Infrastructure

There is no Sydney Catchment Authority (SCA) infrastructure within the General SMP Area. However, some SCA infrastructure exists within the area that is likely to be affected by far-field horizontal movements. These include the Upper Canal, Devines Tunnels 1 and 2 and their associated infrastructure. Subsidence predictions have been provided to the SCA and discussions have commenced. Representatives from the SCA also attended the Risk Assessment held on 15 May 2008. A management plan has been developed for this infrastructure for West Cliff Longwalls 29 to 33 and this will be reviewed and extended to cover the proposed Appin Longwalls 705 to 710. Mitigation works have previously been performed on the Mallaty Creek wrought iron aquaduct and concrete aquaducts C and D. Mitigation measures should be applied to any other SCA infrastructure as deemed necessary by the SCA prior to the commencement of mining.

Electricity Transmission Lines

All electrical infrastructure in the SMP Area is owned by Integral Energy and the management plan in place for Longwalls 701 to 704 is expected to be reviewed and updated to include the proposed Longwalls 705 to 710. The potential impacts of tilts and subsidence movements on poles and transmission lines have been identified and discussed with Integral Energy. It is recommended that powerlines be visually inspected by a qualified person and that any necessary mitigation works be taken out prior to mining. Any effects from subsidence will be visually monitored as the proposed longwalls mine beneath each infrastructure item.

Telecommunication Lines and Towers

Telecommunications infrastructure within the SMP Area includes fibre optic cables, subterranean and aerial copper cables and two mobile phone towers. Current management plans for Telstra and Optus cables over Longwalls 701 to 704 will be reviewed and updated to include the proposed Longwalls 705 to 710. Management plans also need to be established for the Powertel and NextGen cables that run through the SMP Area. It is recommended that standard monitoring lines and Optical Time Domain Reflector monitoring be used to monitor the fibre optic installations within the subsidence zone. Mobile phone towers should be inspected prior to mining and necessary mitigation measures undertaken. Telstra Copper Cables will be monitored visually on a regular basis. Ground movement

monitoring and visual inspections will occur monthly and more frequently if required. Management measures may be required and the effectiveness of those measures will be monitored.

Permanent Survey Control Marks

A baseline assessment has been completed (MSEC 2008) and all survey control marks are located at known sites within the SMP area. IC will liaise with Land and Property Information (LPI) until mining has ceased and permanent survey Control marks can be re-established.

Houses, Farm Buildings, Sheds, Fences and Dams

These features will be managed in accordance with the PSMPs detailed below in **Section 17.5**.

17.4 ASSESSMENT AND REPORTING OF INFRASTRUCTURE MONITORING

BHP Billiton Illawarra Coal is continuing to work closely with service providers and owners of infrastructure, to develop strategies and management plans for the protection of infrastructure and to ensure that any impacts are not significant. These plans will be in place prior to longwall mining commencing.

Regular meetings will occur between IC and infrastructure owners where necessary. Owners will be notified of impacts greater than predicted or other appropriate trigger points as agreed within the specific management plans, this generally occurs within 24 hours of identification.

Specific reporting requirements relating to infrastructure monitoring will be determined in consultation with the individual owners. Typically, monitoring information is provided within a week of being collected as included in current management plans IC has with infrastructure owners.

Reports will be provided comparing predicted and observed movements / impacts as required under the SMP guidelines. There will also be reports to infrastructure owners on a regular basis where it has been identified and agreed as part of the ongoing management strategy.

17.5 PROPERTY SUBSIDENCE MANAGEMENT PLANS

All landowners and occupiers within the SMP Area are being personally contacted by IC to discuss plans for the proposed Longwalls 705 to 710 and to arrange an inspection of the rural properties and dams. Property Subsidence Management Plans (PSMPs) are being developed from the initial consultation. The plans will be finalised and provided to the landowners/occupiers prior to mining. Copies will also be provided to the DPIM and the Mine Subsidence Board. Due to the detailed nature of these management plans it is expected they will be submitted to the DPIM separate to this SMP application.

17.6 PROPOSED GROUND MONITORING PROGRAM

17.6.1 Monitoring Objectives

The objectives of a ground monitoring program are envisaged as follows:

- Provide general information on the magnitude and extent of subsidence over the longwall panels;
- Compare actual ground movements with predicted ground movements;
- Monitor ground movements at or near surface infrastructure at risk;
- Provide early detection of non-systematic movements within the subsidence zone;
- Satisfy the objectives of the Subsidence Management Plan;
- Satisfy the objectives of agreed management plans between IC and infrastructure owners; and
- Meet the expectations of the community with regard to monitoring subsidence.

It should be noted that ground monitoring is one component of an overall management strategy. Other forms of monitoring include visual monitoring, and specific monitoring related to items of infrastructure. These other forms of monitoring can be very effective in identifying impacts, or the potential for impacts relating to subsidence.

Subsidence monitoring supports the SMP. This monitoring is important for impact assessment, mitigation and rehabilitation. Regular reviews of subsidence data will be undertaken and a report on subsidence in the area will be developed at the completion of all significant subsidence movements.

17.6.2 Monitoring Locations

The locations of proposed ground monitoring lines are shown in **Figure 17.1**. These are described briefly below.

The Nepean River

It is recommended that ground monitoring should measure horizontal and vertical movements across the Nepean River in a number of locations, subject to approval from land owners. This monitoring will determine the magnitude of any upsidence and valley closure that has occurred.

Main Southern Railway

It is recommended that one ground monitoring survey line be installed alongside the Main Southern Railway.

HW2 Hume Highway

It has been recommended that survey marks be installed alongside the Highway in the natural ground alongside each carriageway (total of two lines).

Nepean Twin Bridges

Ground and bridge monitoring is proposed for the Twin Bridges over the Nepean River at Douglas Park.

Moreton Park Road and Moreton Park Road Bridges North and South

Ground and bridge monitoring is proposed for the Moreton Park Road and Bridges North and South. A monitoring line has been proposed along Moreton Park Road over Longwalls 702 to 704. It is recommended that this line be monitored during the extraction of Longwalls 705 to 710 where the data assists in providing an early indication of the likely subsidence ground movements at the freeway and the railway and as a record of the ground movements at the houses, structures, and services infrastructure that are located near this road.

The Upper Canal

It is recommended that ground monitoring should measure horizontal and vertical movements at along the Upper Canal and creek crossings.



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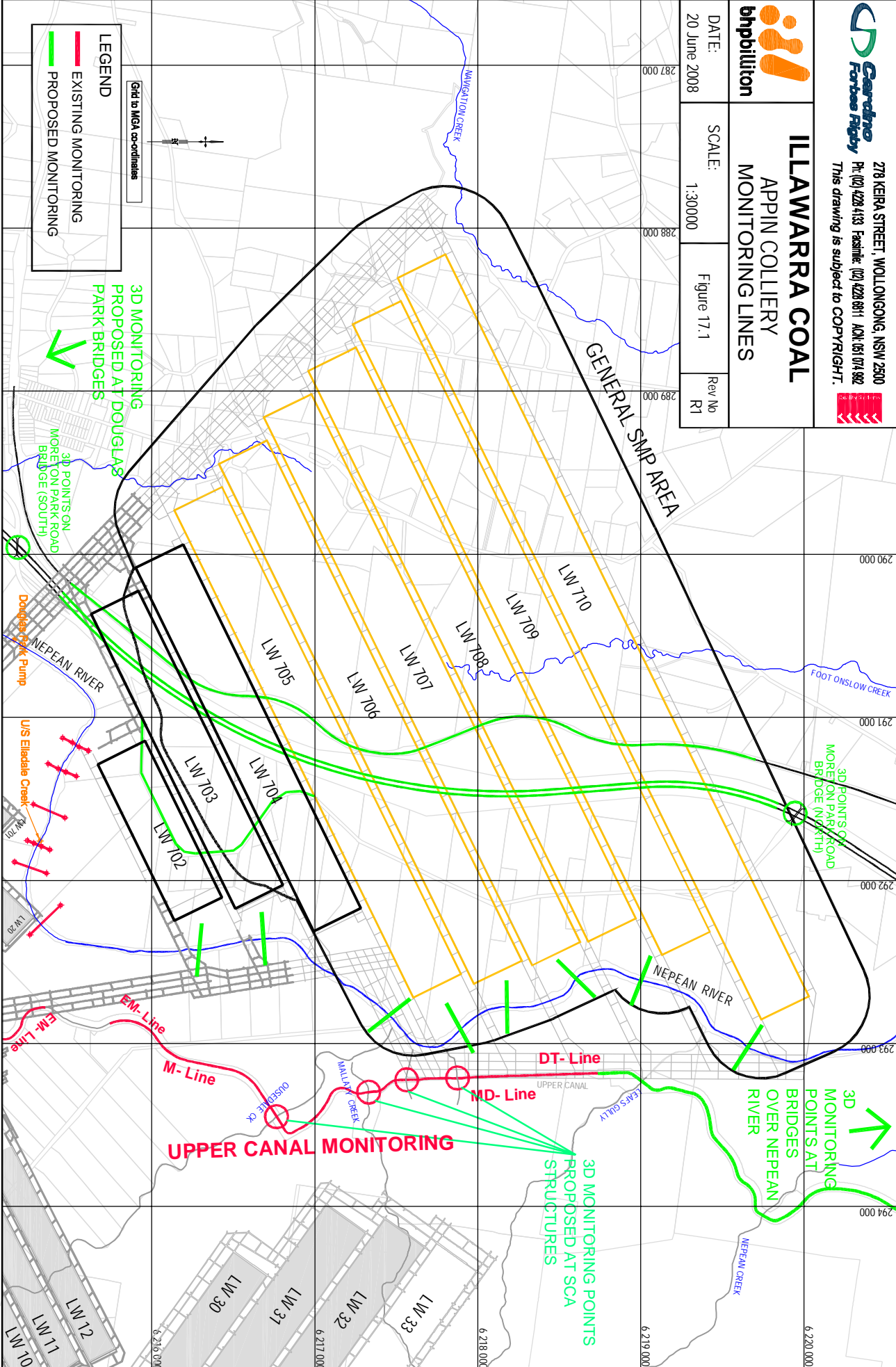
ILLAWARRA COAL
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18. WATER MONITORING AND MANAGEMENT

18.1 MONITORING OBJECTIVES

- To provide pre-mining baseline water quality, flow and appearance data for the Nepean River for comparison with data collected during and post-mining;
- To provide pre-mining baseline creek bed, bank and water quality observations for comparison with data collected during and post-mining;
- To provide pre-mining baseline groundwater quality data and levels for comparison with data collected during and post-mining;
- To identify water quality, water level and flow impacts related to physical or chemical changes to the Nepean River, creeks and/or drainage lines due to mine subsidence;
- To identify any creek bed, bank and water quality impacts related to physical or chemical changes to the creeks and/or drainage lines due to mine subsidence;
- To identify any lowering of groundwater levels or changes in the chemical composition of surface and groundwater owing to increased interactions between surface and groundwater due to mine subsidence; and
- Establish appropriate triggers, actions and responses (TARPs) to identify, assess and respond to subsidence impacts.

18.2 OVERVIEW AND BASELINE DATA

The Appin Area 7 Water Monitoring Program, (prepared as part of the SMP for Appin Longwalls 701 to 704) provides a basis for water monitoring for the proposed Longwalls 705 to 710. This monitoring will allow the comparison of flow, water level and water quality for both surface and groundwater within the SMP Area before, during and after mining. The baseline data obtained from the current monitoring program is outlined below.

18.2.1 Nepean River

The Nepean River is the largest watercourse in the SMP Area and the only river. The Nepean River is not directly mined under by the proposed longwalls, which are offset from the edge the river by at least 180 metres. Approximately 3.6 km of the river flows from the southwest to the northeast through the SMP Area. The river flows through a gorge, which is naturally very rocky with steep sandstone cliffs. Weirs along the Nepean River at Douglas Park, Maldon and Menangle significantly change the water level in the river from its natural state. The Nepean River within the SMP Area is, therefore, essentially a flooded valley.

The flows in the river vary greatly and are highly responsive to rain events and maximum flow rates can reach very high levels during sustained storm events. The river has also ceased to flow on a small number of occasions when the rate of pumping out of the river exceeds the rate of inflow. The median flow rate in the Nepean River above the General SMP Area is likely to be much more than the median flow rate at Maldon Weir, which is 15 ML/day, by about 85% (i.e. approximately 28 ML/day) and a little less than the median flow rate at Menangle Weir, which is 34 ML/day. Maximum flow rates can reach very high levels

during sustained rainfall events and storms, whilst minimum flow past the SMP area is rarely likely to be less than 1.5 ML/day (5 percentile flow).

Water level along the Nepean River was surveyed by IC in 2003 and has been monitored weekly since September 2004. The 2003 survey showed that the water level falls slightly from a point immediately downstream of Douglas Park Weir (RL 61.10 AHD) to a point immediately upstream of Menangle Weir (RL 60.84 AHD), which represents a gradual fall of approximately 260 mm over a length of approximately 14 km. The slight fall in water level most likely represents friction and head losses occurring along the river.

Subsequent monitoring has shown that water levels vary depending on the flows in the river, but do not fall below a certain baseline level during periods of low flow. This observation is consistent with the conclusion that water levels in the river are predominantly controlled by the Menangle Weir. However, during periods of higher flows, the water levels rise. The maximum difference between the lowest and highest recorded water levels at the five nail sites monitored by IC has been approximately 100 mm. Water levels at Menangle Weir typically vary between 0.30 and 0.45 m, which suggests that water levels typically rise and fall within a 150 mm range. The median monthly variance in water level was approximately 74 mm for the period between the 3 July 1990 and the 20 December 2005.

Illawarra Coal has been also been conducting water quality monitoring in the Nepean River for many years. This data has been analysed by EcoEngineers (2008) in relation to the current SMP application and is presented in **Appendix B**. A summary is provided below.

There is a distinctive depth stratification in dissolved oxygen (DO) levels and to a lesser degree salinity within Nepean River. Deeper stretches show low to very low DO, particularly in summer months or during low flow periods where limited turbulent mixing occurs.

Some slightly high pH values of between 8.25 and 9.5 have also been recorded during low flows and when the weather is warm. High levels of total phosphorus (TP) and total nitrogen (TN) have also been detected since 2002 and have been attributed to agricultural activities in the catchment. It is therefore likely that these pH values are not uncommon and the local biota is accustomed to them. Levels of Salinity in the Nepean River and associated tributaries are high by ANZECC standards but are also highly variable.

There are inputs into the Nepean River of more acidic water from Cataract River and Menangle Creek and inputs of more alkaline water from Harris, Elladale and Ousedale Creeks. There are inputs of more saline water from Harris, Elladale and Ousedale Creeks but these have negligible bulk effect on overall river salinity. There is a consistent input of low DO water from Cataract River and this is the primary driver of DO in the River immediately downstream of the Cataract River confluence. The river appears to have a relatively low degree of re-aeration downriver of this point i.e. the (flooded) geomorphology of the river is such that it has a low Re-aeration Coefficient (RAC) adjacent to the General SMP Area. There are consistent inputs of Fe and Mn to the river from Cataract River, Elladale Creek and Menangle Creek.

18.2.2 Creeks and Tributaries

There are three creeks (Harris Creek, Navigation Creek and Foot Onslow Creek) and several unnamed drainages within the SMP Area. These are ephemeral watercourses which are unlikely to support any permanent pools. They are gently sloping with typical

grades of 1% in their upper reaches, but steepen rapidly on approach into the Nepean River gorge. Ecological assessment of these creeks has been conducted by The Ecology Lab and details are provided in **Section 20**. Baseline surface flow and water quality monitoring is already occurring in Lower Lower Harris, Elladale, Ousedale and Menangle Creeks as part of the Nepean River monitoring program for Longwalls 701 to 704 and this monitoring will continue. Minor iron staining has been reported in Elladale Creek during the extraction of Longwall 701 and was found not to be having a significant effect on water quality or aquatic ecology.

18.2.3 Groundwater

The baseline groundwater assessment for this SMP was conducted by GeoTerra (2008) and a detailed report is provided in **Appendix H**. Groundwater monitoring is also currently being carried out in accordance with the Appin Area 7 water monitoring program. Groundwater monitoring sites have been established and a full physio/chemical suite of analytes taken. Groundwater levels within the monitoring bores is logged hourly using vibrating wire piezometers. It is apparent, thus far, that the strata are relatively homogeneous with the standing water table at approximately 25 m coinciding with a zone of weathering. Cores from the holes are available and strength, bedding plane shear and other tests will be conducted as required. Carbonaceous material has been identified in the sandstone cores, indicating that it will be gas bearing if fractured by mining.

The Nepean River is a 'gaining' system, where groundwater flows from the plateau under a regional hydraulic gradient to the river. These flows are dominantly horizontal, and are determined by confined flow along discrete layers underlain by fine grained or relatively impermeable strata. Groundwater sampling and detailed laboratory analysis was conducted in selected BHPB Area 7 piezometers in November / December 2007. Sampling of the NGW piezometers indicates that all bores exceed the ANZECC salinity guidelines for South East Australian Upland Rivers in all bores, as well as generally for total phosphorous and occasionally for pH and total nitrates.

18.3 MONITORING LOCATIONS

The locations of the pre existing Appin Area 7 water monitoring sites are shown in **Figure 18.1**.

Further monitoring sites have been proposed to be implemented before the extraction of Longwalls 705 to 710. These include:

- At least two additional water level and quality sites between NR11 and NR20 in the Nepean River (on either side of the small tributary which enters the Nepean from the western side);
- Surface flow and water quality sites in Upper Harris Creek, Foot Onslow Creek and Navigation Creeks;
- The additional BHPB sealed vibrating wire piezometer array in the bore (EAW5) installed to the Bulli Seam above Longwall 710 in May 2008; and
- Six further piezometers adjacent to Longwalls 704 to 710 on either side of the Nepean River.

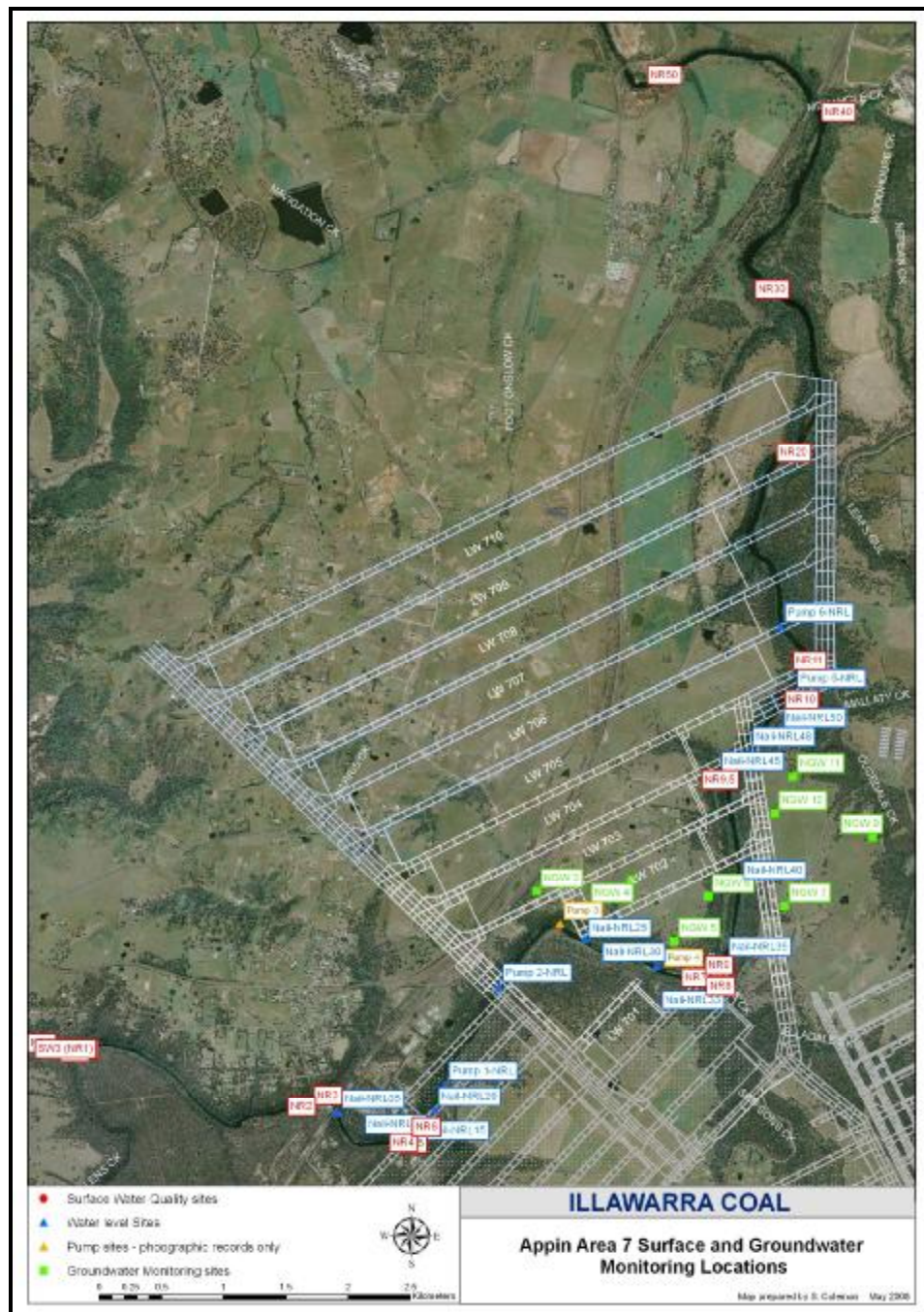


Figure 18.1 - Current Appin Area 7 Surface and Groundwater Monitoring Sites (this figure does show the recently installed EAW5)

18.4 MONITORING PROGRAM

18.4.1 Nepean River

All water quality monitoring sites along the Nepean River have field and lab water quality samples taken monthly. As per the Appin Area 7 Water Monitoring Plan monitoring sites

within an active SMP Area (currently those for Appin Longwalls 701 to 704, i.e. NR2 to NR20) are visited on a weekly basis to measure Temperature (°C), Dissolved Oxygen (%), Specific Conductivity (uS/cm), pH and Oxidation Reduction Potential (mV). An inspection is also carried out for any physical changes, such as cracking of the bed or banks, iron staining or release of strata gas. If detected, these phenomena are reported with general notes and photographic records taken. The laboratory water quality samples, collected monthly, are sent to be analysed in a NATA registered laboratory for the parameters listed in **Table 18.1**.

Table 18.1 - Table of Monthly Laboratory Analytes

Water Quality Analytes		
Metals (total/dissolved)	Ions	Other Analytes
Na Filtered	Total Alkalinity	pH
K Filtered	Cl Filtered	EC
Ca Filtered	Br Filtered	TSS
Mg Filtered	I Filtered	TDS
Fe Total	Sulphate (SO ₄) Filtered	DOC
Mn Total	Total Kjeldahl Nitrogen as N	CH ₄ (Methane)*
Al Total	Ammonia as N (NH ₃ N)	C ₂ H ₆ (Ethane)*
As Filtered	Nitrite and Nitrate as N (NO _x N)	Trace phenols**
Cu Filtered	Dissolved Phosphorus (FRP)	Sulphide**
Pb Filtered	Total Phosphorus as P	
Ni Filtered		
Se Filtered		
Zn Filtered		
Fe Filtered		
Mn Filtered		
Al Filtered		

* Dissolved gas samples taken only at select locations- commenced April 2008

**To be added to sampling as of June 2008

18.4.2 Creeks and Tributaries

Monitoring in these ephemeral watercourses will be undertaken opportunistically during rainfall events. At this time field water quality measurements will be taken, as above, and any physical changes will also be recorded. Flow between pools will be assessed and areas of increased flooding, desiccation of banks or erosion will be recorded. These creeks will also be monitored as part of the aquatic ecology monitoring program detailed in **Section 20**.

18.4.3 Groundwater

Water levels have been recorded at IC bores since September 2004. This data is downloaded monthly and this monitoring will continue throughout the mining of Longwalls 705 to 710 and for at least 12 months post mining.

Water quality will also be tested at IC monitoring bores prior to the extraction of an underlying longwall or adjacent longwall and following the incremental subsidence of each longwall that is likely to impact on the bore. Water quality data may also be collected from these bores as part of any investigation into groundwater quality or if any physical impacts to the bore are identified. Analytes collected are the same as for those taken for surface water detailed in **Table 18.1**.

18.5 REPORTING AND ASSESSMENT OF MONITORING RESULTS

Monitoring results will be compared to the baseline survey data. Where an impact is observed the results will be assessed against the trigger levels presented in **Table 24.1** to determine if any actions are required.

If the established trigger levels are reached, investigations may be initiated and Corrective Management Actions (CMAs) may be implemented. There are a number of different CMA options available and the nature of the CMA will be determined by the trigger level reached.

Results of monitoring studies will be reported and summarised in the AEMR and through strategy and management group meetings. Monitoring results will be reported to DPIM in regular reporting. Surface water monitoring results are also to be provided to The Ecology Lab so any impact on aquatic ecology can be assessed and CMAs can be initiated as detailed in the TARPs in **Table 24.1**.

19. LANDSCAPE MONITORING AND MANAGEMENT

This section of the SMP outlines the monitoring plan which has been developed to prevent environmental damage and personal injuries as a result of cliff and steep slope instability due to mine subsidence. Monitoring of cliffs and steep slopes will continue as outlined in the Cliffs and Steep Slopes Safety Management Plan for Appin Area 7.

19.1 MONITORING OBJECTIVES

The key objectives of the monitoring and management plan are to:

- Contribute to the baseline assessment and provide a basis for routine and expanded monitoring programs during mining;
- Outline initial controls, in particular warning signs that may be needed;
- Identify any erosion and/or sedimentation impacts for the landscape features identified above due to mining;
- Identify any adverse environmental impacts or threats to public safety arising from instabilities or erosion due to the proposed mining; and
- Establish appropriate triggers, actions and response plans (TARPs) to identify, assess and respond to subsidence impacts.

19.2 OVERVIEW AND BASELINE DATA

A baseline assessment has been conducted of cliffs, rock outcrops and steep slopes within the SMP Area and some photographic baseline records have been taken (MSEC, 2008). Cliffs, rock outcrops and steep slopes have been identified along the Nepean River, and some steep slopes have been identified on private property as shown in **Figure 19.1**. Steep slopes located on private property will be managed in accordance with the relevant PSMPs. Monitoring will also be conducted in the hills over the western end of the proposed longwalls where access is possible. Investigations will also take place in response to third party reports of cliff or steep slope instabilities.

19.3 MONITORING LOCATIONS

The general locations of features that will be subject to observational monitoring are summarised below and are shown in **Figure 19.1**

Cliffs and Rock Outcrops

More than 30 sections of cliff and rock outcrop have been identified within the SMP Area. All of these features are at known locations along the length of the Nepean River and will be assessed regularly via monitoring from a safe remote location. Details of the characteristics of these features are provided in **Volume 1**.

Steep Slopes

Monitoring of steep slopes will occur along the Nepean River and its associated tributaries and creeks, including Harris Creek, Foot Onslow Creek and Navigation Creek.



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ILLAWARRA COAL APPIN COLLIERY CLIFFS & STEEP SLOPES

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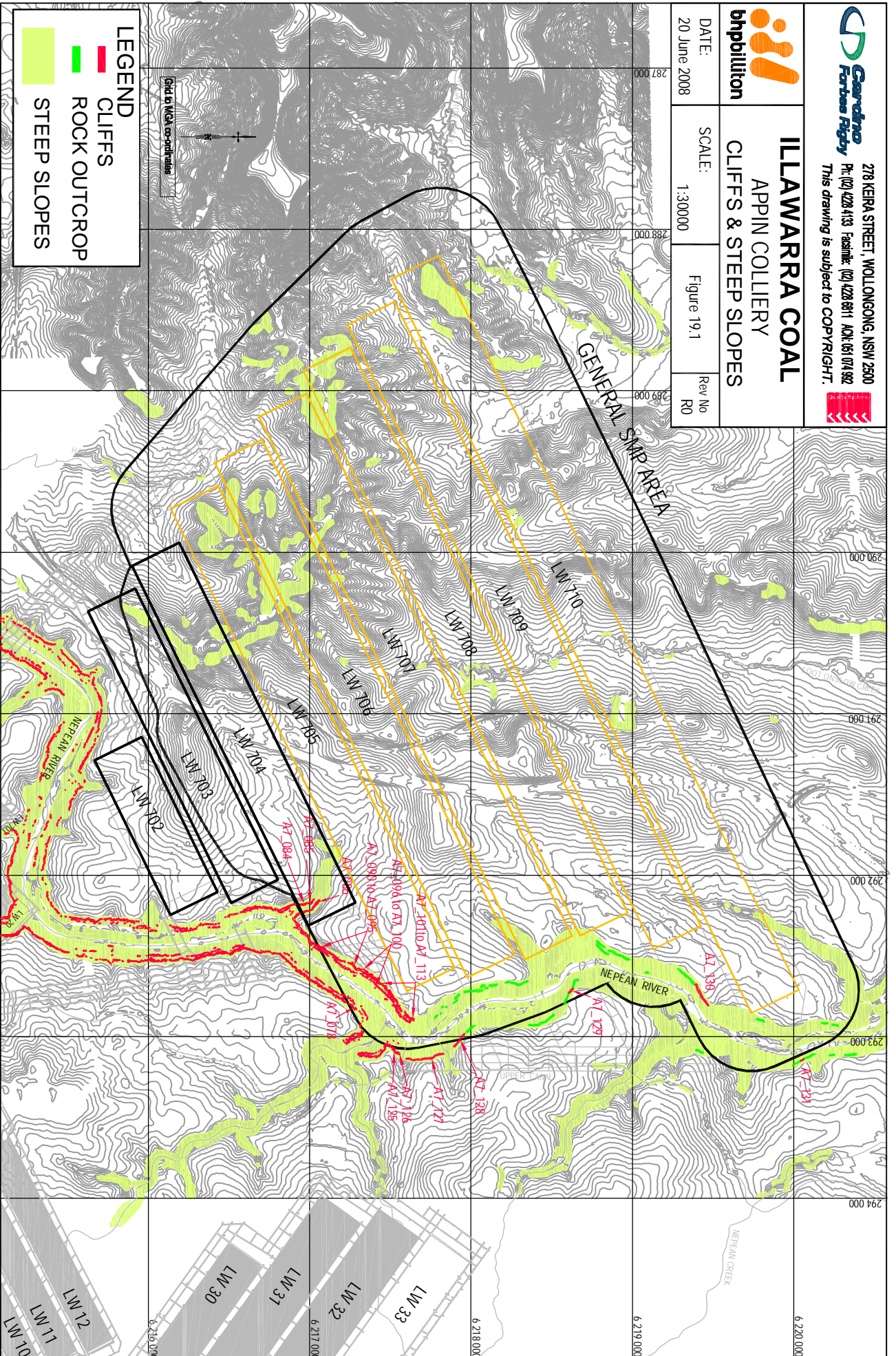
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- █ CLIFFS
- █ ROCK OUTCROP
- █ STEEP SLOPES



19.4 MONITORING PROGRAM

19.4.1 Initial Control Measures

The Nepean River is not mined directly under by Longwalls 705 to 710. However as their extraction will result in some movement within the river gorge the following control measures shall be established:

- Where practical, a baseline inspection of the cliff faces and edges likely to be affected by Longwalls 705 to 710 will be conducted prior to mining. It will include photographing any existing deterioration to establish the natural risk associated with such locations. A file of these locations, their initial condition and photographic evidence shall be established for comparison during the mining period.
- Any rock or cliff face identified in the baseline inspection as being at high risk of falling shall be fenced and signposted to warn specifically of the danger.
- The location of all signs, other remedial or warning provisions established and the location of all falls in the area potentially affected by Longwalls 705 to 710, or previous longwall blocks in the current area shall be marked on a Plan. This Plan shall be maintained during mining and include any remedial measures instituted.
- Signs shall be prominently displayed at each key access point to the Nepean River gorge, and at prominent locations within the gorge warning of the potential instability associated with the cliff faces and edges.

19.4.2 Field Inspections

Baseline inspections of the cliff faces and edges likely to be affected by the passage of Longwalls 705 to 710 will be conducted where practical. Monthly inspections will follow the baseline assessment during mining. The frequency of monitoring will increase to weekly during critical periods during mining when extraction is close to or under the cliff. Inspections will include visual observations and photographs of any deterioration of cliff faces with the potential to result in a major fall. These inspections shall be performed by appropriately skilled and qualified persons(s) and shall be conducted, as far as practical, by the same person(s) each month. If any remediation is required monitoring will continue until remediation is completed.

Ground movements and any disturbance of cliff faces will be regularly assessed. This will contribute to an improved understanding of the effects of mining on steep slopes, cliffs and gorges, and assist in the management of the area to minimise risk to landowners, members of the public and monitoring personnel.

Observations from other persons in the area will be sought, considered and reported on. Where erosion and/or sedimentation are reported, additional monitoring and mitigation will be implemented if warranted.

19.5 REPORTING AND ASSESSMENT OF MONITORING RESULTS

Monitoring results will be compared to the baseline survey data. Where an impact is observed the results will be assessed against the trigger levels presented in **Table 24.1** to determine if any actions are required.

If the established trigger levels are reached investigations may be initiated and Corrective Management Actions (CMAs) may be implemented. There are a number of different CMA options from basic erosion controls, outlined in the “blue book”, to the installation of safety signage and/or detailed and specialist investigations of specific areas. The nature of the CMA will be determined by the trigger level reached.

Results of monitoring studies will be reported and summarised in the AEMR and through strategy and management group meetings. Monitoring results will also be reported to DPIM.

20. AQUATIC ECOLOGY MONITORING AND MANAGEMENT

Methods for the initial assessment and continued monitoring of aquatic habitats are detailed in **Appendix C** and summarised below.

20.1 MONITORING OBJECTIVES

The key objectives of the aquatic ecology monitoring are to:

- Describe the physical characteristics and ecological composition of watercourses potentially subject to the effects of subsidence to be used as baseline data;
- Identify impacts on aquatic habitat and biota from water loss, water quality changes or any other subsidence related changes within the SMP Area; and
- Establish appropriate triggers, actions and responses (TARPs) to identify, assess and respond to subsidence impacts.

20.2 OVERVIEW AND EXISTING BASELINE DATA

Baseline data has been collected by The Ecology Lab as part of the monitoring program for Appin Area 7, Longwalls 701 to 704, and for this application. Details can be found in **Appendix C** and a summary is provided below.

The main aquatic feature within the potential mine subsidence area is the reach of the Nepean River downstream of Douglas Park Weir and upstream of the Menangle Weir. This is a reach of permanent aquatic habitat with fish, invertebrates and other flora and fauna and has been classified as significant aquatic habitat. Smaller surface watercourses within the SMP Area, including; Foot Onslow Creek, Navigation Creek, Harris Creek, Ousedale Creek, Leafs Gully and small unnamed drainages are all ephemeral, being reduced to isolated pools during dry periods and only having continuous flow following significant rainfall. These watercourses provide minimal to moderate aquatic habitat and are generally highly disturbed with extensive stock access, degraded riparian vegetation, high levels of erosion, and extensive flow interruption from the construction of farm dams.

20.3 MONITORING LOCATIONS

There are ten aquatic ecology monitoring sites in the Nepean River relevant to the current SMP Area, as well as three monitoring sites established in ephemeral watercourses, which are shown in **Figure 20.1**. Eight of the sites in the Nepean River are currently being monitored by The Ecology Lab as part of the monitoring program for Longwalls 701 to 704 and the other two have been introduced to assess downstream impacts from the mining of Longwalls 705 to 710. The monitoring sites in Foot Onslow and Navigation Creeks have been established as part of the monitoring program for Longwalls 705 to 710.

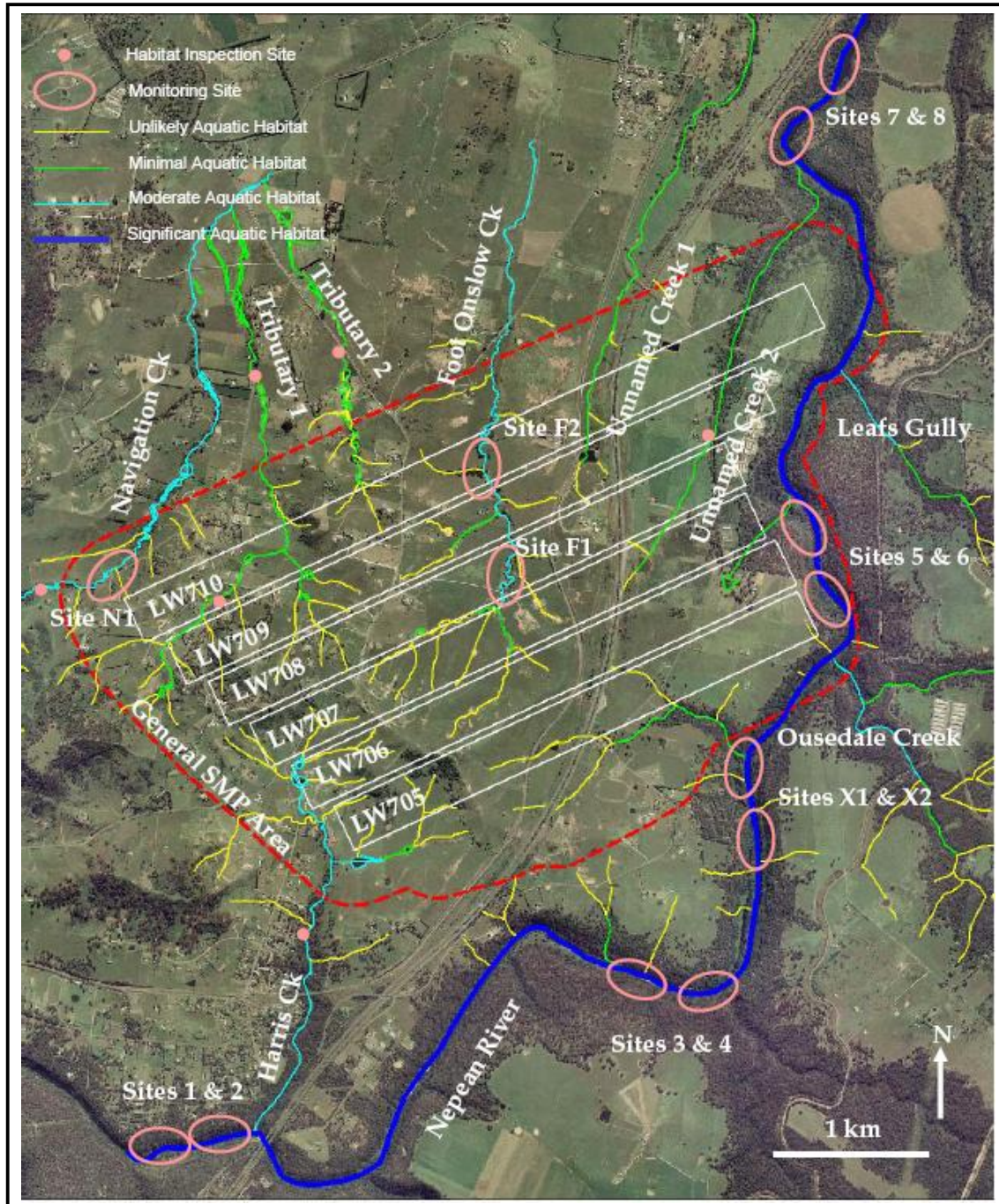


Figure 20.1 - Locations of Aquatic Ecology Monitoring Sites for Proposed Longwalls 705 to 710 in the Nepean River and Other Watercourses

20.4 MONITORING PROGRAM

Details of The Ecology Lab’s monitoring program for Appin Area 7 (an extended version of the program for Longwalls 701 to 704) are described in **Table 20.1** and the monitoring methods presented in more detail below.

Table 20.1 - Aquatic Monitoring For Appin Area 7 Longwalls 701 - 710

Watercourse	Site	Longwall Reference	Monitoring to Date	Future Monitoring	Components of Monitoring
Nepean River	1 & 2	Upstream control sites for LW 701-704 and LW 705-710	Sept 03 (pre-mining) and Sept 05 (pre-mining)	During mining (Sept 08) and future during and post mining monitoring	<ul style="list-style-type: none"> • Macrophyte mapping • WQ • Fish sampling • AusRivAS macroinvertebrate
Nepean River	3 & 4	Impact sites for LW 701-702	Sept 03 (pre-mining) and Sept 05 (pre-mining)	During mining (Sept 08) and future during and post mining monitoring	<ul style="list-style-type: none"> • Macrophyte mapping • WQ • Fish sampling • AusRivAS macroinvertebrate
Nepean River	X1 & X2	Impact sites for LW 702-704	Sept 05 (pre-mining)	During mining (Sept 08) and future during and post mining monitoring	<ul style="list-style-type: none"> • Macrophyte mapping • WQ • Fish sampling • AusRivAS macroinvertebrate
Nepean River	5 & 6	Downstream control sites for LW 701-704 Impact sites for LW 705-710	Sept 05 (pre-mining)	Pre/during mining (Sept 08) and future during and post mining monitoring	<ul style="list-style-type: none"> • Macrophyte mapping • WQ • Fish sampling • AusRivAS macroinvertebrate
Nepean River	7 & 8	Downstream control sites for LW 705-710		Pre mining (Sept 08) and future during and post mining monitoring	<ul style="list-style-type: none"> • Macrophyte mapping • WQ • Fish sampling • AusRivAS macroinvertebrate
Foot Creek	Onslow F1 & F2	Impact sites for small watercourses above LW 705-710	April 08 (pre-mining)	Future during and post mining monitoring (if physical /chemical impacts detected)	<ul style="list-style-type: none"> • AusRivAS macroinvertebrate • WQ
Navigation Creek	N1	Impact site for small watercourse above LW 705-710	April 08 (pre-mining)	Future during and post mining monitoring (if physical /chemical impacts detected)	<ul style="list-style-type: none"> • AusRivAS macroinvertebrate • WQ

20.4.1 Monitoring Methods

Habitat Assessment

Habitat features to be recorded and monitored include:

- Watercourse setting including riparian vegetation and surrounding land-use;
- Stream dimensions and morphology (pools, riffles, rock bars, substratum composition, channel and bank form);
- Flow characteristics;
- Habitat features such as the presence, type and extent of snags, aquatic vegetation etc.; and
- Height and location of barriers to fish passage (natural or artificial) in and beyond the study area.

Mapping of Aquatic Macrophytes

Beds of aquatic macrophytes have been identified at sites within reaches of the Nepean River potentially subject to mine subsidence impacts. Control sites upstream and downstream of the predicted mine subsidence area with comparable beds of macrophytes have also been selected. Species composition was recorded and mapping was carried out driving the perimeter of the bed in a boat and mapping the edge with a Differential Global Positioning System (DGPS). This methodology allows for statistical comparison of macrophyte bed composition and extent before, during and after mine extraction with reference to control sites subject to similar environmental conditions including flow, water quality and climate.

Fish Sampling

Fish will be sampled in the Nepean River using baited traps and Seine nets. Fish sampling will not be conducted in ephemeral watercourses as no fish were found in these watercourses during the baseline assessment.

Macroinvertebrate Sampling

Macroinvertebrates will be sampled in the Nepean River, Foot Onslow Creek and Navigation Creek according to the AusRivAS protocol (Turak and Waddell, 2001). Macroinvertebrates are to be sampled using a dip net agitated along the pool edge over a bank length of about 10 m. The contents of the dip net are then sorted and placed in 70% alcohol, in labelled containers and transported to the laboratory for identification. Identifications are to be resolved to the taxonomic level of family. The exceptions being chironomids (sub-family); oligochaetes, ostracods and hydracarinae which are to be identified to Class/Order and odonates, which are to be identified to their lowest possible taxonomic resolution due to the listing of a dragonfly in the *FM Act 1994*.

Water Quality Monitoring

Water quality will be measured at each site at the time of fish sampling and macrophyte mapping to give an indication of the conditions at the time of sampling. Samples will be taken using a Yeo-Kal 611 probe and the variables to be measured are: pH, dissolved oxygen, oxidation-reduction potential, temperature, turbidity and conductivity. Where applicable, the results will be compared to ANZECC (2000) water quality guidelines for the protection of aquatic ecosystems.

20.5 REPORTING AND ASSESSMENT OF MONITORING RESULTS

Monitoring results will be compared against the baseline survey data. Where an impact is observed the results will be assessed against the trigger levels presented in **Table 24.1** to determine if any actions are required.

If the established trigger levels are reached investigations may be initiated and Corrective Management Actions (CMAs) may be implemented. There are a number of different CMA options available and the nature of the CMA will be determined by the trigger level reached.

Results of monitoring studies will be reported and summarised in the AEMR and through strategy and management group meetings. Monitoring results will also be reported to DPIM.

21. TERRESTRIAL ECOLOGY MONITORING AND MANAGEMENT

Impact assessment and monitoring of terrestrial habitats and biota will be conducted according to the methods detailed in **Appendix D** and summarised below.

21.1 MONITORING OBJECTIVES

The broad objectives of the terrestrial flora and fauna monitoring and management program are to:

- Provide baseline data for the terrestrial ecological values of the SMP area prior to mining;
- Identify any possible effects from subsidence on the terrestrial flora and fauna within the SMP area; and
- Establish appropriate triggers, actions and responses (TARPs) to identify, assess and respond to abnormal conditions related to subsidence impacts.

21.2 OVERVIEW AND BASLINE DATA

Baseline data has been collected by Biosis Research for Appin Area 7, and is presented in **Appendix D**.

Four Endangered Ecological Communities (EECs) were recorded within the SMP Area: Cumberland Plain Woodland, Shale Sandstone Transition Forest, River-flat Eucalypt Forest and Moist Shale Woodland. These communities are listed as EECs under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This assessment has concluded that the proposal is unlikely to have a significant impact on any of these EEC's.

Twenty one threatened flora species are considered in this report. No threatened flora species were recorded in the SMP Area; however *Pultenaea pedunculata* has previously been recorded in the SMP Area. The SMP Area provides potential habitat for three threatened flora species: *Eucalyptus benthamii*, *Pomaderris brunnea* and *Pterostylis saxicola*. The proposal has the potential to alter habitat for these species. This assessment has concluded that the proposal is unlikely to have a significant impact on any of these threatened plant species.

The SMP Area contains limited potential habitat for a total of 42 threatened and/or migratory animal species. As possible impacts from subsidence are likely to be restricted to changes in surface flow and water quality in the Nepean River and its tributaries, only animal species which rely on these natural features for their survival were considered in the detailed impact assessment. Four of the 42 threatened and/or migratory animal species with potential habitat in the SMP Area are likely to be dependent on surface water for breeding or foraging. This assessment has concluded that the proposal is unlikely to have a significant impact on any of these threatened and/or migratory animal species

21.3 MONITORING LOCATIONS

No specific monitoring sites have been established. Monitoring is habitat based and will consist of a general survey of the SMP Area as part of regular Landscape Monitoring (refer **Section 19.1**). If an impact on terrestrial ecology occurs or a threatened species is found to exist in the SMP Area a review of monitoring procedures will be conducted as detailed in **Table 24.1**.

21.4 MONITORING PROGRAM

Initial assessment of the SMP Area included:

- Threatened species database searches for species known to occur within a 10 km radius of the SMP Area;
- Review of relevant legislation for threatened species, habitats and communities;
- Habitat assessment and survey of the SMP Area;
- Targeted surveys for any threatened species of particular concern;
- Reporting of conditions of the SMP Area and an impact assessment for threatened species considered likely to occur within the SMP Area; and
- Seven-part tests for threatened species, populations or ecological communities and matters of national environmental significance.

Although there is no predetermined ongoing monitoring program for terrestrial flora and fauna a general habitat assessment will be conducted as part of the Landscape Monitoring program (refer **Section 19**) as mining progresses. This monitoring program is an extension of and consistent with the approved River Flat Eucalypt Forest management Plan for Appin Area 7. As detailed below, the detection of any impacts will instigate a more structured and regular monitoring program.

Based on experience within other creeks and rivers in the region that have been mined beneath, it is likely any species potentially impacted by subsidence initiated by changes to the environment would be to species dependent on permanent flows or permanent standing water. Although mine subsidence effects are likely to occur in the SMP Area, no impacts have been predicted that are of sufficient magnitude to give rise to a significant impact to threatened species within the SMP Area. Should any species dependent on such habitat be recorded a monitoring program for these species will be developed.

Other effects associated with mining include the liberation of methane and this may result in vegetation die back within the riparian zone. Subsidence predictions indicate that methane liberation may occur, but is unlikely to have a significant impact riparian vegetation and fauna habitat. The liberation of gas into the river or riparian areas will be monitored in association with the water monitoring program.

If vegetation is impacted, additional monitoring will be implemented to determine that any natural revegetation is occurring at a satisfactory rate or if this is not the case, to identify the need for active revegetation.

21.5 REPORTING AND ASSESMENT OF MONITORING RESULTS

Where an impact is observed the results will be assessed against the trigger levels presented in **Table 24.1** to determine if any actions are required.

If the established trigger levels are reached an investigation may be initiated and Corrective Management Actions (CMAs) may be implemented. There are a number of different CMA options available and the nature of the CMA will be determined by the trigger level.

Results of any monitoring studies initiated will be reported and summarised in the AEMR and through strategy and management group meetings. Monitoring results will also be reported to DPIM.

22. ARCHAEOLOGICAL AND HERITAGE MONITORING AND MANAGEMENT

22.1 OBJECTIVES

The objectives of the Archaeological and Heritage Monitoring and Management Program are to:

- Identify any features of Aboriginal or European heritage significance within the SMP Area;
- Assess the likelihood and scale of impact and any requirements for statutory approvals;
- Establish and conduct a monitoring program to detect and measure any changes at sites of significance due to mining subsidence; and
- Propose management options for any sites that may be affected by the mining proposal.

22.2 OVERVIEW AND BASELINE DATA

Biosis Research conducted baseline surveys for items of both European heritage significance and Aboriginal heritage significance within and around the SMP Area and the results are detailed in **Appendix E**.

Biosis (2008b) identified nineteen Aboriginal sites within the General SMP Area. These sites comprise 12 stone artefact scatter sites or isolated artefact occurrences, four shelters with deposit sites, one scarred tree, one axe grinding groove and one shelter with a hand stencil that is not considered to be Aboriginal in origin and is therefore not an archaeological site. Eighteen of these sites are registered on the Aboriginal Heritage Information Management System at DECC.

Three previously identified historic heritage items are located within the General SMP Area of Longwalls 705 to 710. These include the Mountbatten Group (historic buildings and associated features), the Gilbulla Group (historic buildings), and the Upper Canal Sydney Water Supply.

It was predicted that the Upper Canal would not be impacted by the proposed longwalls. Pending SCA review of the subsidence predictions, no further archaeological or heritage assessment work is required and there is no requirement for statutory approvals. In all matters relating to the Upper Canal the existing CMP should be followed at all times.

No further archaeological or heritage assessment work is required at the Mountbatten Group or at the Gilbulla Conference Centre. No permits will be required from the NSW Heritage Office for the proposed longwall mining to proceed. While there are no impacts predicted to any historical heritage items identified in this assessment the Mountbatten Group and the Gilbulla Conference Centre items will be included into a monitoring regime under PSMPs that has been developed in consultation with the property owners.

22.3 MONITORING LOCATIONS

As detailed above, no monitoring is proposed for European cultural heritage sites. Based on the subsidence predictions provided by MSEC (2008), it also is unlikely that there will be impacts to Aboriginal archaeological sites resulting from the proposed longwall mining. However unlikely, Aboriginal archaeological sites that have some potential to be impacted by the proposed longwall mining, will be subject to monitoring. Shelter sites can potentially be impacted by mine subsidence movements including the fracturing of sandstone, rock falls, or water seepage through joints which may affect any artwork. The main mechanisms which could potentially result in impacts on sandstone shelters are the systematic strains and curvatures. The sites to be monitored (where access can be attained), with locations shown in **Figure 22.1** are:

- Upper Nepean Hand Stencils (Possible Shelter with Art);
- Nepean River No. 8 (Shelter with Deposit);
- Nepean River 4 (Shelter with Midden);
- Nepean River 5 (Shelter with Deposit); and
- Nepean River 6 (Shelter with Deposit).

If any notable ground surface impacts are detected as part of other monitoring programs such impacts should be considered against the location of all Aboriginal archaeological sites recorded within the SMP Area. No such impacts have ever been recorded in the past and it is extremely unlikely that impacts on surface Aboriginal sites will occur.



Figure 22.1 - Locations of the Cultural Heritage Monitoring Sites for Proposed Longwalls 705 to 710

22.4 MONITORING PROGRAM

Detailed monitoring is not recommended for the shelter sites on the Nepean River, however each site should be subject to a pre and post mining inspection as follows:

- *Baseline archival recording* three months prior to the extraction of an underlying or adjacent longwall;
- *Final impact assessment recording* within twelve months of mining under the site or after final subsidence movement; and
- Develop an ongoing management program for any structures that may be impacted.

In the event that there are subsidence impacts to any site being monitored, management strategies specific to the impact will be developed. The management strategies will be implemented in accordance with current conservation practice and principles contained within the Australia International Council on Monuments and Sites (ICOMOS) *Burra Charter*, and the DECC *Guidelines for Aboriginal Heritage Impact Assessment*. The advice of the identified Aboriginal communities regarding appropriate management methodologies will form an integral part of the development of the management strategies. All contingent management strategies will be developed in consultation with relevant stakeholders.

22.5 REPORTING AND ASSESSMENT OF MONITORING RESULTS

Monitoring results will be compared against the baseline survey photos and observations. Where an impact is observed the results will be assessed against the trigger levels presented in **Table 24.1** to determine if any actions are required.

If the established trigger levels are reached investigations may be initiated and Corrective Management Actions (CMAs) may be implemented. There are a number of different CMA options from basic erosion controls to detailed and specialist investigations of specific areas. The nature of the CMA will be determined by the trigger level reached.

Results of monitoring studies will be reported and summarised in the AEMR and through strategy and management group meetings. Monitoring results will also be reported to DPIM.

Consultation with all relevant Aboriginal groups will be undertaken for the duration of the project. This consultation will detail the scheduled monitoring dates and analysis of the data that has been collected during monitoring. A copy of any relevant reports should be distributed to the Registered Stakeholder Aboriginal communities for their review and comment.

23. MANAGEMENT AND REHABILITATION

The following natural features may require preventive, mitigative, and/or remedial measures as mining occurs or on completion of mining to reduce impacts to the environment:

- The Nepean River;
- Creeks, drainage lines and associated banks;
- Groundwater systems;
- Cliffs, steep slopes or other surface features affected by cracking or erosion;
- Affected terrestrial or aquatic ecological features (vegetation, habitat etc.); and
- Aboriginal archaeological sites.

IC has developed a strategy that sets out the history, objectives, key technical constraints and opportunities, and options available to manage subsidence impacts to natural features (BHP Billiton, 2005). This section of the SMP draws on this strategy and would be used to assess the need for specific preventative or mitigative measures. If required, remedial measures would be assessed through the results of the monitoring programs outlined in the SMP and additional detailed assessments. The focus of the SMP is on the natural environment and the subsequent sections deal primarily with these aspects. Mitigation and management of the built environment is briefly discussed below and considered in more detail in specific infrastructure plans outlined in **Section 17**.

A number of remedial measures and rehabilitation options are available to address impacts to the environmental values of the SMP Area. Some of these are implemented prior to disturbance to reduce a known effect of subsidence while others are implemented following subsidence to repair impacts. Rehabilitation of impacts can be actively undertaken or occur through natural processes. In some circumstances, a combination of natural, active, pre-mining and post-mining rehabilitation may be required.

This section outlines some of the techniques and processes that can be used for mitigation and rehabilitation. However, it is important to note that based on the predicted subsidence levels and subsidence effects, it is envisaged that potential impacts would not require rehabilitation works. Notwithstanding this, IC recognises that the mitigation, rehabilitation and monitoring measures proposed in this SMP are an integral part of the proposed mining activity.

23.1 OBJECTIVES OF MITIGATION AND REMEDIATION MEASURES

The aims of the mitigation and remediation measures include:

- Carrying out remediation works in a manner that protects the ecological values of the area to the greatest practicable extent;
- Repairing the aesthetic values of the area where necessary;
- Reducing the interaction of surface and groundwater flow where it has been enhanced through mining;

- Having creeks functioning in a similar manner to the pre-impact state;
- Having surface flows and water quality continue to provide suitable aquatic habitat;
- Re-establishing the ecological values of the area to a similar state to that existing before mining;
- Having creeks and catchments yielding similar water quantity and quality following mining; and
- Monitoring and reporting effectiveness of the program.

23.2 SUMMARY OF IMPACTS AND REMEDIATION MEASURES

Subsidence levels and potential impacts for key natural features are outlined below, together with a summary of the avoidance, mitigation and contingency measures proposed to manage impacts where predicted impacts are exceeded. Refer **Table 23.1**.

Table 23.1 - Predicted Maximum Subsidence, Potential Impacts and Mitigation and Rehabilitation Measures for Natural Features

Feature	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
Nepean River	<p>Maximum subsidence 60 mm</p> <p>Maximum upsidence 380 mm</p> <p>(cumulative and including the predicted movement from associated Longwalls 702-704)</p>	<p>Predicted Impacts</p> <p>Minor fracturing in the bed. No reduced flow. Potential increased interaction of ground and surface water.</p> <p>Strata gas emissions.</p> <p>Creation of new ferruginous springs and associated iron staining.</p> <p>Impacts Exceeding Those Predicted</p> <p>Major fracturing in the bed leading to significant surface water loss.</p> <p>Significant strata gas release leading to changes in water quality.</p> <p>Significant iron staining leading to changes in water quality.</p> <p>A >2 standard deviation reduction in water quality apparent at a downstream monitoring site compared to an upstream site or compared to pre-mining to baseline data.</p>	<p>Avoidance & Mitigation</p> <p>Nepean River not mined directly under. Longwalls are offset by at least 180 m from edge of Nepean River to avoid major fracturing and loss of surface flow.</p> <p>Nepean River will be monitored regularly during mining to facilitate early detection and minimisation of effects.</p> <p>Contingency Measures</p> <p>Grouting and repair of surface water controlling features and the beds of streams where major fracturing is evident.</p> <p>Investigate possible remediation measures for impacts to water quality resulting from subsidence.</p> <p>All works will be carried out in consultation with SCA, DPIM, DECC and other stakeholders.</p>
Ephemeral Watercourses	<p>Maximum subsidence 1495 mm</p> <p>Maximum upsidence 350 mm</p> <p>(cumulative and including the predicted movement from associated Longwalls 702-704)</p>	<p>Predicted Impacts</p> <p>Small increases in ponding and flooding in localised areas due to change of gradient in creeks.</p> <p>Minor fracturing in the bed leading to minor reduction in flow and/or an increased interaction of ground and surface water.</p> <p>Strata gas emissions.</p> <p>Creation of new ferruginous springs and associated iron staining.</p>	<p>Avoidance & Mitigation</p> <p>Watercourses will be monitored regularly during mining to facilitate early detection and minimisation of effects.</p>

Feature	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
		<p>Impacts Exceeding Those Predicted</p> <p>Major fracturing in the creek beds leading to total surface water loss and flow on effects to water quality.</p> <p>Significant strata gas release leading to changes in water quality.</p> <p>Significant iron staining leading to changes in water quality.</p> <p>A >2 standard deviation reduction in water quality apparent at a downstream monitoring site compared to an upstream site or compared to pre-mining to baseline data.</p>	<p>Contingency Measures</p> <p>Grouting and repair of significant surface water controlling features or minor earthworks.</p> <p>Investigate possible remediation measures for impacts to water quality resulting from subsidence.</p> <p>All works will be carried out in consultation with SCA, DPIM, DECC and other stakeholders.</p>
<p>Groundwater Levels and Quality</p>	<p>Effects due to subsurface subsidence or surface and bedrock fracturing.</p> <p>Maximum Subsidence within SMP Area</p> <p>1510 mm</p>	<p>Predicted Impacts</p> <p>Short term reductions in groundwater level of up to 10 m until maximum subsidence develops.</p> <p>Some impairment to function or water quality in private bores.</p> <p>Possible increased iron and manganese hydroxide precipitation and a lowering of pH in discharged bore water.</p> <p>Impacts Exceeding Those Predicted</p> <p>Major reduction in groundwater level (monitoring bore dry where it has not been prior to mining) at the majority of bores within any particular aquifer or complete loss of groundwater.</p> <p>A >2 standard deviation change in a water quality parameter in private and IC bores as compared to baseline data</p>	<p>Avoidance & Mitigation</p> <p>Ground water level and quality will be monitored regularly during mining to facilitate early detection and minimisation of effects.</p> <p>Contingent Measure</p> <p>Redrilling of bores or lowering of pumps in order to reach clean groundwater supplies.</p> <p>All works will be carried out in consultation with SCA, DPIM, DECC and other stakeholders.</p>

Feature	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
Cliffs	<p>Maximum subsidence</p> <p>135 mm</p> <p>(Predicted at cliffs A7_078 through A7_087)</p>	<p>Predicted Impacts</p> <p>Rock falls estimated to occur along 1% to 3% of the cliff lines.</p> <p>Impacts Exceeding Those Predicted</p> <p>Frequent rock falls occurring along >3% of the cliff lines or large /massive cliff failures.</p>	<p>Avoidance & Mitigation</p> <p>Cliffs will be monitored regularly during mining to facilitate early detection and minimisation of effects.</p> <p>Signage and fencing erected and stakeholders informed where there is a safety risk.</p> <p>Contingency Measures</p> <p>Scaling rocks loosened by subsidence where they present safety risks.</p> <p>Minor civil/earthworks to prevent erosions such as overland flow diversion works, establishment of banks, smoothing and re-contouring, where this is practical.</p> <p>Revegetation works such as planting, seeding, mulching, weed control and plant maintenance, where this is practical.</p>
Steep Slopes and Surface of the Land	<p>Steep slopes</p> <p>-Nepean Gorge</p> <p>Maximum subsidence</p> <p>1070 mm</p> <p>-Hills to the western ends of longwalls</p> <p>Maximum subsidence</p> <p>1480 mm</p> <p>Surface of the land with in the SMP area</p> <p>Maximum Subsidence</p> <p>1510mm</p>	<p>Predicted Impacts</p> <p>Fracturing of uppermost bedrock leading to minor surface cracking and erosion.</p> <p>Minor strata gas emissions.</p> <p>Impacts Exceeding Those Predicted</p> <p>Large cracks, large compressive ridges or mass movements causing significant erosion if left untreated.</p> <p>Significant strata gas emissions.</p>	<p>Avoidance & Mitigation</p> <p>Steep slopes and surfaces will be monitored regularly during mining to facilitate early detection and minimisation of effects.</p> <p>Signage and fencing erected and stakeholders informed where there is a safety risk.</p> <p>Contingency Measures</p> <p>Minor civil/earthworks to prevent erosions such as overland flow diversion works, establishment of banks, smoothing and re-contouring, where this is practical.</p> <p>Revegetation works such as planting, seeding, mulching, weed control and plant maintenance.</p> <p>Installation of erosion and sediment controls where appropriate.</p>
Aquatic Fauna and Flora	<p>Indirect affects from subsidence on watercourses</p> <p>- The Nepean River</p> <p>Maximum subsidence</p> <p>60 mm</p> <p>Maximum upside</p>	<p>Predicted Impacts</p> <p>Minor impacts on fauna are possible due to 'loss' of water, especially in ephemeral watercourses.</p> <p>Impacts on vegetation are possible due to changes in bed desiccation or inundation.</p> <p>Possible impacts on both flora and fauna due to</p>	<p>Avoidance & Mitigation</p> <p>Nepean River not mined directly under. Longwalls offset by at least 180 m from edge of Nepean river to avoid major fracturing and loss of surface flow.</p> <p>Aquatic flora and fauna will be monitored regularly during mining to facilitate early detection and minimisation of effects.</p>

Feature	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
	380 mm	strata gas emissions.	
	-Ephemeral Watercourses	Effects are expected to be minor and isolated.	
	Maximum subsidence 1495 mm	Impacts Exceeding Those Predicted	Contingency Measures
	Maximum upsidence 350 mm	Major reduction in water level or complete loss of water from permanent pools due to mining.	Grouting and repair of significant surface water controlling features where it is appropriate to do so in consultation with DPIM, DECC and other stakeholders.
		Major reduction in aquatic habitat for an extended timeframe or complete loss of habitat.	Active preservation of life such as relocation of stranded fish.
		Identified mortality of fauna/flora in proximity to identified mining impact.	Temporary ecosystem maintenance such as watering aquatic plants until final rehabilitation completed, where this is practical.
			Investigate possible remediation measures for impacts to water quality resulting from subsidence.
Terrestrial Fauna and Flora including EECs	Subsidence varies greatly over the SMP Area.	Predicted Impacts	Avoidance & Mitigation
	Maximum subsidence 1510 mm	Minor impacts on fauna are possible due to 'loss' of water from creeks and rivers.	Monthly monitoring during subsidence. Increased to weekly during critical periods as part of the Landscape Monitoring Program.
	(cumulative and including the predicted movement from associated Longwalls 702-704)	Impacts on vegetation are possible due to rock falls, surface cracking, strata gas release and/or desiccation or flooding of river and creek banks.	
		Impacts Exceeding Those Predicted	Contingency Measures
		Large areas of impacted vegetation (by rockfalls, soil slippage) that is unlikely to commence natural regeneration within 6 months.	Site rehabilitation to reinstate habitat values – increased monitoring until habitat is returned to former condition.
		Significant surface soil cracking or fracturing resulting in loss of standing water and or erosion in creeks.	Remediation of subsidence related fracturing or dilation within creek beds and surface cracks where it is appropriate to do so.
		Gas emissions with extensive vegetation die off and no evidence of self regeneration.	Minor civil/ earthworks to prevent erosions such as overland flow diversion works, establishment of banks, smoothing and re-contouring, where this is practical.
			Revegetation works such as planting, seeding, mulching, weed control and plant maintenance, where this is practical.
			Active preservation of life such as relocation of stranded fauna and watering of exposed vegetation where

Feature	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
			<p>this is practical.</p> <p>Temporary ecosystem maintenance such as watering plants until final rehabilitation completed, where this is practical.</p> <p>All the above works carried out in consultation with SCA, DPIM, DECC and other stakeholders.</p>
<p>Aboriginal Sites</p>	<p>The area contains 5 rock shelter sites with various subsidence predictions</p> <p>Upper Nepean Hand Stencils 125mm</p> <p>Nepean River 8 <20 mm</p> <p>Nepean River 4 95 mm</p> <p>Nepean River 5 70 mm</p> <p>Nepean River 6 120mm</p>	<p>Predicted Impacts</p> <p>Unlikely that the shelters will sustain any structural impacts.</p> <p>Impacts Exceeding Those Predicted</p> <p>Change in shelter conditions not attributable to natural weathering or preservation – cracking or exfoliation of art panel, movement of existing planes and joints at panel, block fall within shelter or overhang, shelter or overhang collapse.</p>	<p>Avoidance & Mitigation</p> <p>Baseline, active subsidence and post mining monitoring. .</p> <p>Contingency Measures</p> <p>Site and event specific mitigation and rehabilitation will be developed with appropriate Aboriginal representatives, DECC and DPIM.</p> <p>Techniques may involve installing artificial drip lines, detailed recording of art, stabilising and cleaning rock faces.</p>

23.3 PREVENTATIVE OPTIONS

Most of the management actions listed above in **Table 23.1** would be implemented after the subsidence impact has been identified. Some measures, such as grouting, would be implemented following the completion of subsidence movements. Other preventative options are discussed in the Illawarra Coal Natural Features Subsidence Management Strategy (BHPBIC, 2005).

The most applicable pre-emptive measure for reduction of impact is through the reduction of subsidence. At this stage, the most appropriate method of reducing subsidence is by leaving barriers of coal to support the surface. This is achieved through modifications to the mine layout.

The mine layouts at Appin Area 7 have been modified to reduce the potential for impacts to surface features, particularly the Nepean River. As the proposed longwalls do not mine directly beneath the Nepean River and are located at least 180 m from the River it is unlikely that significant impacts, such as major fracturing or draining of surface water will occur.

This monitoring and management process adopts the hierarchy of avoid/minimise/mitigate as requested by the DoP and DECC during consultation with IC.

23.4 REHABILITATION

23.4.1 Natural Remediation

Cracking due to subsidence will tend to seal as the natural processes of erosion and deposition act on them. The characteristics of the surface materials and the dynamics of a specific area will determine the rate of self-healing.

Cracks that occur in drainage paths are more likely to have the erosion and deposition processes acting to facilitate natural sealing. It is also possible that the erosion/deposition equilibrium will be disrupted and one process could dominate, leading to additional surface impacts. Where a stream or water channel is ephemeral, it is important to note that the potential for natural sealing and or additional impacts may be temporally offset to the initial impact.

While sealing of surface fractures will occur naturally in some instances and over time, it is recognised that this may not provide sufficient mitigation in some situations and that active sealing of watercourses may be required in some locations.

23.4.2 Hand Mortaring

Where water transfer is observed through well-defined joints or fractures, the joints and fractures will be sealed using a variety of products, some of which can be applied in wet conditions and under water. These materials are normally applied using small held-held equipment and in localised situations. Should large fractures occur in the base of the pools they will be sealed over with hand placed cement grout and natural oxides.

23.4.3 Injection Grouting

Where creeks fracture as a result of subsidence and there is limited ability for them to naturally seal it would be necessary to carry out remedial measures. Remedial measures have been implemented at other locations in the Illawarra and usually include grouting to return ground water to the surface or reduce pool water loss. Grout can be delivered by small handheld equipment or truck-mounted equipment for deeper holes. Angled and horizontal drilling techniques can be utilised to position grout remotely from the site. The engineering techniques on which this type of rehabilitation is based are well established. They have been used in the mining and construction industries but can be applied in these circumstances.

A number of grouts are available including cement, pulverised ash and chemical grouts, with or without fillers. The fillers can include sand and gravel or vegetable fibres. The choice of grout will be determined based on the nature and extent of the fracturing, the surface/ground water interaction and the objectives of the rehabilitation program.

These rehabilitation operations have the potential to cause adverse environmental impacts through the materials used and the disturbance associated with access. They will, therefore, be carefully planned to avoid contamination of watercourses. Bunds will be used to contain any spillage at mixing points. The materials used are non-toxic, environmentally inert and do not significantly impact upon the natural habitats of aquatic species.

23.4.4 Permeation Grouting

This involves the introduction of grouting and filling materials into an individual pool or a stream flow, in such a manner that the material will be drawn into cracks and thereby seals the voids in the bed of the creek.

23.4.5 Impermeable Blankets or Linings

This involves the installation of a waterproof lining to a pool to prevent loss of water into the voids below. A variety of materials are available with the choice dependent on site-specific circumstances.

23.4.6 Joint Sealing

Where water is leaking from a creek or riverbed through well-defined joints or fractures, the joints and fractures can be sealed using a variety of products, some of which can be applied in wet conditions and under water.

23.4.7 Surface Treatment

Surface impacts may display as cracks of varying depths and widths, erosion scars or deposition areas. The treatment of these areas will be planned taking into account specific site conditions and impacts.

Where cracking develops in significant areas and natural sealing is not progressing, the cracks may require forking over and compacting to prevent subsequent erosion. Larger cracks may require more work to repair them, for example, mulch or other protection to prevent the development of erosion channels. Surface protection will remain in place until revegetation covers the disturbed area. In some cases, if the cracks are wider they may require gravel or sand filling up to surface level and revegetation using local native plants. Such rehabilitation measures have the potential to cause impact through the materials used and the disturbance associated with access. Considerable care and relevant approvals will be obtained to ensure the protection of the environment as such works are implemented.

23.4.8 Land Stability

Landslips and slides are to be monitored and reported and any remedial actions carried out are to be to the satisfaction of the DPIM. Specific actions to address subsidence impacts on cliffs and steep slopes will be developed and implemented where adverse subsidence impacts occur.

Rock falls from cliff lines and some slippage could be precipitated by the levels of movement that have been predicted, particularly where rocks and slopes are marginally stable.

Measures considered may include:

- Surface water management measures to minimise sediment mobilisation;
- Erosion and sedimentation control measures to minimise downstream effects;
- Revegetation of disturbed areas;
- Preventive measures such as removal or stabilisation of loose boulders and scaling of loose rocks from cliff faces; and
- Filling and mulching over large cracks to prevent the development of erosion channels.

23.4.9 Gas Release

A typical driver of gas release at the surface is fracturing of the rock mass and associated release with groundwater flows to the surface. Grouting techniques discussed above typically reduce these associated gas flows. In all identified circumstances in the Southern Coalfields the gas releases have diminished over a number of months, but it can take a number of years. Where vegetation is impacted by gas releases the areas affected will be revegetated once monitoring determines the gas releases have ceased or reduced to an extent that vegetation is no longer affected. Replanting could be conducted if necessary.

24. PRINCIPAL TARPS

The Principal “Trigger Action Response Plans” (TARPs) relate to identifying, assessing and responding to abnormal conditions related to subsidence impacts.

It should be noted that the Principal TARPs represent actions to be taken as each defined trigger level is reached. Corrective Management Actions (CMAs) will be developed in consultation with stakeholders to manage any observed impacts in accordance with the relevant approvals. The management programme provides a basis for the design and implementation of any mitigation and remediation. Example CMAs are provided in **Table 23.1** and **Sections 23.3 to 23.4**.

Monitoring of environmental aspects of the area will provide key data when determining any requirement for mitigation or rehabilitation. The triggers are based on comparison of baseline data with monitoring results and the proposed triggers are presented in **Table 24.1**. Specific triggers will continue to develop as the impact monitoring phase of the SMP matures. Refinement of triggers will be in consultation with key stakeholders and subject to approval by DPIM.

Table 24.1 – Potential Impacts, Key Monitoring, Triggers, Response and Responsibilities

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
• NEPEAN RIVER								
Water Quality and Appearance	<p>Ref Fig 18.1</p> <ul style="list-style-type: none"> Current monitoring <ul style="list-style-type: none"> -NR0 -SW2 -SW3 -SW4 -NR2 -NR3 -NR4 -NR5 -NR6 -NR7 -NR8 -NR9 -NR9.5 -NR10 -NR11 -NR20 -NR30 -NR40 -NR50 Two new monitoring sites proposed between NR11 and NR20. Visual observations along the length of the Nepean River within the active mining area. 	<ul style="list-style-type: none"> Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps). Evidence of springs in Nepean River. Visual signs of impacts (i.e., cracking, vegetation changes, increased erosion, changes in water colour etc.). Impacts determined from photo points taken prior to, during and post mining. Field measurements of <ul style="list-style-type: none"> -Temperature -Dissolved Oxygen (DO) -Specific Conductivity -pH -ORP -Time -General comments. Laboratory analysis of: <ul style="list-style-type: none"> -pH -EC -Na Filtered -K Filtered -Ca Filtered -Mg Filtered -Cl Filtered -Br Filtered -I Filtered -As Filtered -Cu Filtered -Pb Filtered -Ni Filtered -Se Filtered -Zn Filtered -Fe Filtered -Mn Filtered -Al Filtered -SO₄ Filtered -Fe Total 	<ul style="list-style-type: none"> Monthly baseline monitoring prior to mining. Weekly observations and field analysis during mining. Monthly detailed laboratory analysis during mining. Monthly monitoring for 2 years post mining. As required by report from a third party. 	<ul style="list-style-type: none"> To provide pre-mining baseline of water quality and river bed and bank condition for comparison with post-mining data. To identify physical or chemical changes to water quality in the Nepean River due to mining. 	<p>Minor</p> <ul style="list-style-type: none"> Temporary reduction in water quality (observed for 2 months) at any site when comparing baseline period to mining period and/or upstream samples. Small crack/s with no observable loss of surface water flow. Slight increase in turbidity, iron staining, algal growth, or other visible water quality parameters associated with mining activity. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p>	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Continue with approved monitoring program. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to river water level. Investigate any mitigation measures required and implement in consultation with key agencies. Keep stakeholders and agencies informed of any impacts, investigations or results.
					<p>Moderate</p> <ul style="list-style-type: none"> Moderate reduction in water quality (observed for more than 2 months) at any site when comparing baseline period to mining period and/or upstream samples. A >1 standard deviation but <2 standard deviation change a water quality parameter apparent at downstream monitoring site when comparing pre-mining to baseline data and/or upstream samples. Crack in a watercourse which does not appear to result in visible loss of surface water, but may result in significant erosion. Moderate increase in turbidity, iron staining, algal growth, or other visible water quality parameters associated with mining activity. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of</p>	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Contract specialists within 1 week to investigate and report on changes identified. Collect additional laboratory samples within 2 weeks. Implement additional monitoring or increase frequency if required within 1 month. Monthly updates from specialists on investigation process. Inform relevant stakeholders and agencies of results of investigation within 1 week of completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Water Consultants 	

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
		-Mn Total -Al Total -TKN -NH ₃ -N -NOx-N -FRP -TP -Total Alkalinity -TSS -TDS -DOC -CH ₄ -C ₂ H ₆ -Trace Phenols -Sulphide.			natural variability within the pre-mining baseline data. Severe <ul style="list-style-type: none"> A 2 standard deviation or greater reduction in any water quality parameter apparent at downstream monitoring site when comparing pre-mining to baseline data and/or upstream samples. Crack in a watercourse that is resulting in visible loss of surface water. Major increase in turbidity, iron staining, algal growth, or other visible water quality parameters associated with mining activity. Significant increase in erosion. These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Conduct site visits with stakeholders as required. Contract specialists engaged to investigate and report on changes identified within 1 week. Collect additional laboratory samples within 1 week. Review sampling program within 2 weeks. Implement additional monitoring or increase frequency if required within 2 weeks. Monthly updates from specialists on investigation process. Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Develop CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Water Consultants 	
Level / Flow	Ref Fig 18.1 <ul style="list-style-type: none"> At Water Quality sites as above At nail and water pump sites: <ul style="list-style-type: none"> -NRL05 -NRL10 	<ul style="list-style-type: none"> Field measurement of water height compared with time and river flow at Menangle Weir. Areas of dry riverbed compared with time and flow measured at Menangle Weir. Areas of flooded riverbed compared with time and flow measured at Menangle Weir. Erosion of banks 	<ul style="list-style-type: none"> Monthly baseline monitoring 1 year prior to mining. Weekly manual monitoring at nails during mining. Daily flow monitoring at weirs (data supplied by SCA). Ongoing monthly monitoring for 2 years post mining. 	<ul style="list-style-type: none"> To provide pre-mining baseline water levels/flows for comparison with post-mining. To identify any water levels/flow impacts from mining. To identify water levels/flow impacts related to physical changes to the Nepean River during mining. 	Minor <ul style="list-style-type: none"> Temporary (< 2 months) and minor (>150 and <400 mm) reduction in water level compared with pre-mining baseline measurements and with similar flows in river. Observation of small areas of dry riverbed by comparing with pre-mining baseline 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Continue with approved monitoring program. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to river water level or flow in the Nepean River. Investigate any mitigation measures required and implement in consultation with key agencies. Keep stakeholders and agencies informed of any impacts, investigations or results.

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
	<ul style="list-style-type: none"> -NRL15 -NRL20 -Pump 1 -Pump 2 -NRL25 -NRL30 -NRL33 -NRL35 -NRL40 -NRL45 -NRL48 -NRL50 -Pump 5 -Pump 6 <ul style="list-style-type: none"> Visual observations along the length of the Nepean River within the active mining area. Cross river subsidence movement monitoring sites identified on the approved subsidence movement monitoring 	<p>compared with time and flow measured at Menangle Weir.</p> <ul style="list-style-type: none"> Photo points. Monitoring of closure and associated movements along the Nepean River. 		<ul style="list-style-type: none"> To identify any flow-on impacts from changes in river water level. Use interlinked private bore, BHPB Piezometer, mine inflow and river flow monitoring to assess if triggers are reached, and if CMA need development. 	<p>observations with similar flows in river.</p> <ul style="list-style-type: none"> Observation of small areas of flooded riverbed in excess of baseline conditions when comparing pre-mining baseline observations. Subsidence movements at the DPI Approved cross river monitoring lines greater than predicted at that location <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p> <p>Moderate</p> <ul style="list-style-type: none"> Prolonged (>2 months) and/ or significant (>400 and <600 mm) drop in water level compared with pre-mining baseline measurements and with similar flows in river. Observation of substantial areas of dry riverbed by comparing pre-mining baseline observations with post mining with similar flows in river. Observation of substantial areas of flooded riverbed in excess of baseline conditions by comparing pre-mining baseline observations with post mining with similar flows in river. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p> <p>Severe</p> <ul style="list-style-type: none"> Prolonged (> 2 months and/or severe (>600 mm) drop in water level compared with pre-mining baseline measurements and with similar flows in river Observation of large areas of dry riverbed by 	<p>Capture photographic record immediately, if required.</p> <ul style="list-style-type: none"> Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Contract specialists within 1 week to investigate and report on changes identified. Review monitoring program within 1 month. Implement additional monitoring or increase within 1 month frequency if required. Monthly updates from specialists on investigation process. Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Water Consultants. 	

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
					comparing pre-mining baseline observations with post mining with similar flows in river. <ul style="list-style-type: none"> Observation of large areas of flooded riverbed in excess of baseline conditions by comparing pre-mining baseline observations with post mining with similar flows in river. These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	<ul style="list-style-type: none"> Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Develop site CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 		
Aquatic Ecology	<p>Ref Fig 20.1</p> <ul style="list-style-type: none"> Sites 1 and 2 are located upstream of Longwall 701 near Douglas Park Weir. Sites 3 and 4 are located adjacent to Longwalls 701 and 702 near the confluence of the Nepean River and Elladale Creek. Sites X1 and X2 are located adjacent to Longwalls 703 and 704. Sites 5 and 6 are located adjacent to Longwalls 705 and 706 just downstream of the confluences with Mallaty and Ouesdale creeks. Sites 7 and 8 are located downstream of all proposed longwalls 701-710. 	<ul style="list-style-type: none"> Photographic records Aquatic macrophyte mapping Macro-invertebrate Assessment Fish Sampling Water Quality Monitored in conjunction with; <ul style="list-style-type: none"> -Flow -River Morphology 	<ul style="list-style-type: none"> Prior to mining (As part of 701-704 monitoring). Yearly during mining (in Spring) Yearly for 2 years post mining 	<ul style="list-style-type: none"> To provide pre-mining baseline aquatic ecology survey data for comparison with during and post-mining monitoring data. Identify any impacts on aquatic habitat and biota during mining. 	<p>Minor</p> <ul style="list-style-type: none"> Change in WQ parameters (<1standard deviation) from BHPB IC monitoring that is deemed unlikely have an impact on aquatic ecology. Minor and temporary reduction in aquatic habitat observed during BHPB IC Nepean River monitoring. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p> <p>Moderate</p> <ul style="list-style-type: none"> Significant reduction in aquatic habitat (i.e. desiccation of macrophyte beds as compared to baseline assessment or control site. Change in WQ (>1sd but <2sd) parameters from BHPB monitoring that is deemed possible to have an impact on aquatic ecology. Threatened species detected in the area and mining impacts occur. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p>	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Contract specialists within 1 week to investigate and report on changes identified. Collect water quality samples within 2 weeks. Conduct targeted fish and aquatic invertebrate sampling within 2 weeks. Review monitoring program within 1 month. Implement additional monitoring or increase frequency if required within 1 month. Monthly updates from specialists on investigation process. Inform relevant stakeholders and agencies of results of investigation within 1 week of completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Manager Environment (IC) Expert Aquatic Ecology Consultants. 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to aquatic ecology. Investigate any mitigation measures required and implement in consultation with key agencies Keep stakeholders and agencies informed of any impacts, investigations or results.

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
					<p>Severe</p> <ul style="list-style-type: none"> Major reduction in aquatic habitat (i.e. desiccation of microphyte beds). or complete loss of habitat. Change in WQ (>2 standard deviation) parameters from BHPB monitoring that is deemed possible to have an impact on aquatic ecology. Identified mortality of a threatened species or any other species of fish. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p>	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Conduct site visits with stakeholders as required. Contract specialists engaged to investigate and report on changes identified within 1 week. Collect water quality samples within 1 week. Conduct targeted fish and aquatic invertebrate sampling within 1 week. Review sampling program within 2 weeks. Implement additional monitoring or increase frequency if required within 2 weeks. Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Develop CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Aquatic Ecology Consultants. 	
<p>Water Pumps</p>	<p>Ref Fig 18.1</p> <ul style="list-style-type: none"> There are six pumps in Nepean River which will be monitored for the effects from subsidence. -Pump 1NRL -Pump 2NRL -Pump 3 -Pump 4 -Pump 5NRL -Pump 6NRL 	<ul style="list-style-type: none"> Pump submergence and function 	<ul style="list-style-type: none"> Pre mining photographs Weekly visual inspection In response to third party reports as required 	<ul style="list-style-type: none"> To identify any flow-on impacts from changes in river water level to pumps. To identify any physical disturbance or loss of function to pumps from subsidence movement. 	<ul style="list-style-type: none"> Pump intake not submerged. Pump not functioning due to physical disturbance from subsidence. 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Inform landholder and relevant agencies of event within 24 hours. Provide alternate water supply if required Undertake repairs as soon as they can be arranged. Complete review of river level and observational data within 1 week. Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to river water level and/or pump function. Provide alternate water supplies where required due to impacts to pumps.
EPHEMERAL WATERCOURSES								
<p>Water Quality and Appearance</p>	<p>Ref Fig 18.1</p> <ul style="list-style-type: none"> Tributaries currently monitored as part of Nepean River Monitoring program described above -Lower Harris Creek (NR3) -Elladale Creek 	<ul style="list-style-type: none"> Observable iron or salinity staining Photo points Field analysis of -EC -Eh -pH -Temperature -DO Lab sample analytes for Nepean River sites and as otherwise required 	<ul style="list-style-type: none"> Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall. Following the development of incremental subsidence for each longwall that will impact on the feature. Opportunistic monitoring of flow in ephemeral streams 	<ul style="list-style-type: none"> To provide pre-mining baseline water quality in ephemeral creeks for comparison with post-mining To identify any water quality impacts in ephemeral creeks from mining. To identify water quality impacts in ephemeral creeks related to physical changes (e.g. groundwater spring, 	<p>Minor</p> <ul style="list-style-type: none"> Temporary reduction in water quality (< 2 months) at any site when comparing baseline period to mining period and/or upstream samples. Small crack/s with no observable loss of surface water flow. Slight increase in turbidity, iron staining, 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts from mining on ephemeral stream water quality and appearance. Investigate any mitigation measures required and implement in consultation with key agencies and landholders. Keep stakeholders and agencies informed of any impacts, investigations or

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
	<ul style="list-style-type: none"> (NR8) -Ousedale Creek (NR10) -Menangle Creek (NR40) <p>Proposed monitoring sites in</p> <ul style="list-style-type: none"> -Upper Harris Creek -Foot Onslow Creek -Navigation Creek 	as described above.	<p>during rainfall events where access is suitable.</p> <ul style="list-style-type: none"> For Nepean River sites as described in Nepean River section above. 	gas release).	<p>algal growth, or other visible water quality parameters associated with mining activity.</p> <ul style="list-style-type: none"> These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data. 			results.
					<p>Moderate</p> <ul style="list-style-type: none"> Moderate reduction in water quality (observed for > 2 months) at any site when comparing baseline period to mining period and/or upstream samples. A >1 standard deviation but <2 standard deviation change a water quality parameter apparent at downstream monitoring site when comparing pre-mining to baseline data and/or upstream samples. Crack in a watercourse which does not appear to result in visible loss of surface water, but may result in significant erosion. Moderate increase in turbidity, iron staining, algal growth, or other visible water quality parameters associated with mining activity. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p>	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Contract specialists within 1 week to investigate and report on changes identified. Collect laboratory samples within 2 weeks. Review sampling program within 1 month. Implement additional monitoring or increase frequency within 1 month if required. Monthly updates from specialists on investigation progress. Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Water Consultants 	
					<p>Severe</p> <ul style="list-style-type: none"> A 2 standard deviation or greater reduction in any water quality parameter apparent at downstream monitoring site when comparing pre-mining to baseline data and/or upstream samples. Crack in a watercourse that is resulting in visible loss of surface water. Major increase in turbidity, iron staining, 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Conduct site visits with stakeholders as required. Collect laboratory samples within 1 week. Contract specialists within 1 week to investigate and report on changes identified. Review sampling program within 2 weeks. Implement additional monitoring or increase frequency within 2 weeks if required. Monthly updates from specialists on investigation progress. Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Develop site CMA in consultation with key stakeholders if 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Water Consultants 	

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
					algal growth, or other visible water quality parameters associated with mining activity. <ul style="list-style-type: none"> Severe erosion. These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	required within 1 month, (pending stakeholder availability) and seek approvals. <ul style="list-style-type: none"> Implement CMA if required as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 		
Water Level/ Flow	Ref Fig 18.1 <ul style="list-style-type: none"> Tributaries currently monitored as part of Nepean River Monitoring program described above -Lower Harris Creek (NR3) -Elladale Creek (NR8) -Ousedale Creek (NR10) -Menangle Creeks (NR40) Proposed monitoring sites in <ul style="list-style-type: none"> -Upper Harris Creek -Foot Onslow Creek -Navigation Creek 	<ul style="list-style-type: none"> Photo points Areas of increased flooding in ephemeral streams Erosion of stream banks Flow data for Nepean River sites as described above. 	<ul style="list-style-type: none"> Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall. Following the development of incremental subsidence for each longwall that will impact on the feature. Opportunistic monitoring of flow in ephemeral streams during rainfall events where access is suitable. For Nepean River sites as described in Nepean River section above 	<ul style="list-style-type: none"> To provide pre-mining baseline water levels for comparison with post-mining. To identify any water level impact from mining. To identify water level impacts related to physical changes within ephemeral streams. To identify any flow-on impacts from changes in water level. 	Minor <ul style="list-style-type: none"> Temporary loss of flow connectivity within a flowing ephemeral stream (rainfall dependent). Observation of areas of flooded stream in excess of baseline conditions under similar upstream flow conditions – identified by minor, short term flooding within a terrestrial habitat. Minor erosion of stream banks in excess of baseline conditions. 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to ephemeral stream water level and flow. Investigate any mitigation measures required and implement in consultation with key agencies. Keep stakeholders and agencies informed of any impacts, investigations or results.
					Moderate <ul style="list-style-type: none"> Prolonged loss of flow connectivity within a flowing ephemeral stream (rainfall dependent). Observation of areas of flooded stream in excess of baseline conditions under similar upstream flow conditions – identified by extended flooding within a terrestrial habitat. Erosion of stream banks in excess of baseline conditions. 	<ul style="list-style-type: none"> Capture photographic record immediately. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Contract specialists within 1 week to investigate and report on changes identified. Review monitoring program within 1 month. Implement additional monitoring or increase within 1 month frequency, if required. Monthly updates from specialists on investigation process. Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Water Consultants 	
					Severe <ul style="list-style-type: none"> Complete loss of flow connectivity within a flowing ephemeral stream (rainfall dependent). Observation of areas of flooded stream in excess of baseline conditions under similar upstream flow conditions – identified by major destructive flooding within a 	<ul style="list-style-type: none"> Capture photographic record immediately. Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours. Conduct site visits with stakeholders as required. Contract specialists within 1 week to investigate and report on changes identified. Review monitoring program within 2 weeks. Implement additional monitoring or increase frequency within 2 weeks if required. Monthly updates from specialists on investigation process. Inform relevant agencies and stakeholders of results of investigation within 1 week of completion. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Water Consultants 	

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
					terrestrial habitat. • Observation of major erosion requiring mediation of stream banks.	• Develop site CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. • Implement CMA as agreed with stakeholders following approvals. • Conduct initial follow up monitoring and reporting within 2 months of CMA completion. • Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR.		
Aquatic Ecology	Ref Figure 20.1 • Sites F1 and F2 are on Foot Onslow Creek over Longwalls 708 and 710 respectively. • Site N1 is on Navigator Creek within the SMP area to the northeast of Longwall 710. • General observation of all other watercourses in active mining areas.	• Macroinvertebrate assessment • Water quality • Monitored in conjunction with; • -Flow • -Stream morphology	• Prior to mining (As part of 701-704 monitoring). • Yearly during mining (in Spring) • Yearly for 2 years post mining	• To provide pre-mining baseline aquatic ecology survey for comparison with post-mining. • Identify any impacts on aquatic habitat and biota during mining.	Minor • Temporary reduction in water quality (observed for 2 months) at any site when comparing baseline period to mining period and/or upstream samples that is deemed unlikely have an impact on aquatic ecology. • Minor and temporary reduction in aquatic habitat observed during BHPB IC Nepean River monitoring. These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	• Capture photographic record immediately, if required. • Notify relevant stakeholders within 24 hours. • Continue with approved monitoring program • Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR.	• Manager Environment (IC)	• Identify, investigate and report on impacts to aquatic ecology. • Investigate any mitigation measures required and implement in consultation with key agencies. • Keep stakeholders and agencies informed of any impacts, investigations or results.
					Moderate • Significant reduction in aquatic habitat as compared to baseline assessment or control site. • Change in water quality (>1sd but <2sd) parameters that is deemed possible to have an impact on aquatic ecology. • Threatened species detected in the area and mining impacts occur. These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	• Notify relevant stakeholders within 24 hours. • Notify relevant agencies and specialists within 24 hours • Contract specialists within 1 week to investigate and report on changes identified • Collect water quality samples within 2 weeks. • Conduct targeted aquatic invertebrate and fish sampling within 2 weeks. • Review monitoring program within 1 month. • Implement additional monitoring or increase frequency if required within 1 month. • Monthly updates from specialists on investigation process • Inform relevant stakeholders and agencies of results of investigation within 1 week of completion • Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR.		

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
					<p>Severe</p> <ul style="list-style-type: none"> Major reduction in aquatic habitat or complete loss of habitat. Change in WQ (>2 standard deviation) that is deemed possible to have an impact on aquatic ecology. Identified mortality of a threatened species or any other species of fish. <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p>	<ul style="list-style-type: none"> Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours Conduct site visits with stakeholders as required. Contract specialists engaged to investigate and report on changes identified within 1 week Collect water quality samples within 1 week Conduct targeted fish and aquatic invertebrate sampling within 1 week. Review sampling program within 2 weeks Implement additional monitoring or increase frequency if required within 2 weeks Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of investigation within 1 week of completion Develop CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals Conduct initial follow up monitoring and reporting within 2 months of CMA completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Aquatic Consultants. 	
GROUNDWATER								
Groundwater Level	<p>Ref Fig 18.1</p> <ul style="list-style-type: none"> IC monitoring bores NGW3 NGW4 NGW6 NGW5 NGW7 NGW8 NGW9 NGW10 NGW11 <p>Also at 6 proposed new piezometer sites to the east of Longwalls 705-710 along the Nepean River.</p> <p>There are also 12 registered private bores within the SMP Area</p>	<ul style="list-style-type: none"> Standing groundwater level in bore using vibrating wire piezometer and logger – 1hr recording. 	<p>IC Bores</p> <ul style="list-style-type: none"> Pre-mining – data has been recorded since September 2004. Post-mining - following the development of incremental subsidence for each longwall that will impact on the feature (i.e. each longwall) Monitoring to continue for at least 12 months post mining <p>Private Bores</p> <ul style="list-style-type: none"> Pre-mining - prior to mining of longwall underlying bore or mining of any immediately adjacent longwall Post-mining - following the development of incremental subsidence for each longwall that will impact on the feature (i.e. each longwall) 	<ul style="list-style-type: none"> To provide pre-mining baseline groundwater level for comparison with post-mining To identify any groundwater level impact from mining To identify groundwater level impacts related to physical changes to the bore during mining Use interlinked private bore, BHPB Piezometer, mine inflow and river flow monitoring to assess if triggers are reached, and if CMA need development 	<p>Minor</p> <ul style="list-style-type: none"> Temporary (not persisting after significant groundwater recharge rainfall event) reduction in groundwater levels in any of the boreholes (beyond the variability determined in baseline monitoring due to rainfall). Consistent trend toward water level trigger as measured over time (<3 data points). <p>Significant</p> <ul style="list-style-type: none"> >5 m water level reduction over 2 month period Proportional loss of head in unmined Hawkesbury Sandstone aquifer not greater than 10% of saturated thickness. Major reduction (monitoring bore dry) 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. <ul style="list-style-type: none"> Notify relevant stakeholders within 24 hours Notify relevant agencies and specialists within 24 hours Conduct site visits with stakeholders as required. Contract specialists within 1 week to investigate and report on changes identified Collect lab samples within 2 weeks Review sampling program within 2 weeks. Implement additional monitoring or increase frequency within 2 weeks .if required Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of 	<ul style="list-style-type: none"> Manager Environment (IC) <ul style="list-style-type: none"> Manager Environment (IC) Expert Groundwater Consultants. 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to bore water levels. Provide alternate water supplies where required due to groundwater level impacts Keep stakeholders and agencies informed of any impacts, investigations or results.

ASPECT	MONITORING					MANAGEMENT		
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
			<ul style="list-style-type: none"> As requested by landholder or if physical impacts to bore identified (PSMP) Landholder to observe during use of bore (PSMP) 		<ul style="list-style-type: none"> where it has not been prior to mining) in groundwater level at the majority of bores within any particular aquifer system or complete loss of groundwater. Consistent trend toward water level trigger as measured over time (using at least 3 data points with trend to reach trigger within the mining period) Relate changes to saturated thickness of the monitored aquifer Any of above triggers identified in adjacent private or IC bore 	<ul style="list-style-type: none"> investigation within 1 week of completion Develop site CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 		
Groundwater Quality	<p>Ref Fig 18.1</p> <ul style="list-style-type: none"> IC monitoring bores NGW3 NGW4 NGW6 NGW5 NGW7 NGW8 NGW9 NGW10 	<ul style="list-style-type: none"> Standing groundwater level in bore using bore dip metre (where access inside bore is available) Observable iron or salinity staining determined from comparison of pre-mining and post mining photographs Water quality field and lab parameters as outlined in the Nepean River Water Quality section. 	<p>IC Bores</p> <ul style="list-style-type: none"> Pre-mining - prior to mining of longwall underlying bore or mining of any immediately adjacent longwall Post-mining - following the development of incremental subsidence for each longwall that will impact on the feature (i.e. each longwall) As required to provide additional data for any 	<ul style="list-style-type: none"> To provide pre-mining baseline shallow groundwater quality and levels data for comparison with data from during and post-mining. To identify any lowering of groundwater levels or increased interactions between surface and groundwater during or post mining. To identify any significant changes in shallow groundwater 	<p>Minor</p> <ul style="list-style-type: none"> Temporary (not persisting after significant groundwater recharge rainfall event) affect on water quality in any bore. Minor iron or salinity staining in excess of pre-mining conditions <p>This may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p>	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours. Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to bore water quality. Provide alternate water supplies where required due to groundwater level impacts Keep stakeholders and agencies informed of any impacts, investigations or results.

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
	<ul style="list-style-type: none"> NGW11 Also at 6 proposed new piezometer sites to the east of Longwalls 705-710 along the Nepean River. There are also 12 registered private bores within the SMP Area 		<p>landholder bore impact investigation or if physical impacts to bore identified.</p> <p>Private Bores</p> <ul style="list-style-type: none"> As above but also: Landholder to observe private bores during use of bore (PSMP) Monitoring as requested by landholder or if physical impacts to bore identified (PSMP) 	quality during or post mining.	<p>Significant</p> <ul style="list-style-type: none"> Significant change in iron or salinity staining in excess of pre-mining conditions that are likely to affect water quality or make bore unfit for use. A 2 standard deviation or greater change from pre-mining groundwater quality parameters – using all available data from private and IC monitoring bores for statistical analysis In private bore water is not fit for purpose based on pre-mining quality and ANZECC Water Quality Guidelines Any of above triggers identified in adjacent private or IC bore <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.</p>	<ul style="list-style-type: none"> Notify relevant stakeholders within 24 hours Notify relevant agencies and specialists within 24 hours Conduct site visits with stakeholders as required. Contract specialists within 1 week to investigate and report on changes identified Collect lab samples within 2 weeks Review sampling program within 2 weeks. Implement additional monitoring or increase frequency within 2 weeks .if required Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of investigation within 1 week of completion Develop site CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Groundwater Consultants. 	
STRATA GAS								
Terrestrial or Aquatic Release of Strata Gas	<ul style="list-style-type: none"> Nepean River within the Study Area Creek monitoring sites IC Bores Private bores No defined terrestrial sites. Monitored as part of Flora and Fauna and Landscape Features monitoring 	<ul style="list-style-type: none"> Strata gas detected from visual or audible signs e.g. hissing, bubbles, plume Strata gas odour detected 	<ul style="list-style-type: none"> River and bank observations weekly as part of water quality assessment Opportunistic monitoring in ephemeral streams where access is suitable For bores prior to mining of the underlying longwall or longwall immediately adjacent and post-mining, following the incremental subsidence for each longwall that will impact on the feature For private bores as requested by landholder or required by PSMP. Landholder to observe during mining As required by any report from a third party IC bore monitoring to 	<ul style="list-style-type: none"> To identify potential impact to ground water quality or to terrestrial or aquatic ecology due to strata gas release To identify any safety hazards due to terrestrial or aquatic gas release 	<p>Minor</p> <ul style="list-style-type: none"> Strata gas detected to be released from bore, creek, river or banks Strata gas odour detected within the mining area <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data</p> <p>Moderate</p> <ul style="list-style-type: none"> Moderate strata gas plumes are detected in bore, creek, river or banks Strata gas odour detected within mining area <p>These may be revised in consultation with DPI and</p>	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. <ul style="list-style-type: none"> Capture photographic record immediately, if appropriate. If release is terrestrial make area safe with barriers and signage immediately Notify relevant stakeholders within 24 hours. Notify relevant agencies and specialists within 24 hours For private bores or dams provide alternate water supply Contract specialists within 1 week to investigate and report on changes identified Measure gas flow rates and chemical composition 	<ul style="list-style-type: none"> Manager Environment (IC) <ul style="list-style-type: none"> Manager Environment (IC) Hydrogeology and Ecology Specialists 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to the terrestrial ecosystems, the Nepean River, creeks and bores from gas releases. To manage any safety hazards created by gas release. Provide alternate water supplies where required due to impacts of gas releases Investigate any mitigation measures required and implement in consultation with key agencies Keep stakeholders and agencies informed of any impacts, investigations or results.

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
			continue for at least 12 months post mining		<p>other key stakeholders following analysis of natural variability within the pre-mining baseline data</p> <p>Severe</p> <ul style="list-style-type: none"> Major strata gas plumes are detected in bore, creek, river or banks Strata gas odour detected within mining area <p>These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data</p>	<ul style="list-style-type: none"> For bores review groundwater level and quality data in private and IC bores Collect water quality sample in vicinity of release where applicable Implement additional monitoring or increase frequency within 1 month if required. Take monthly samples of dissolved methane, sulphide and phenols in surface waters above significant gas plumes Monthly updates from specialists on investigation process Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. <ul style="list-style-type: none"> Capture photographic record immediately, if appropriate. If release is terrestrial make area safe with barriers and signage immediately Notify relevant stakeholders within 24 hours Notify relevant agencies and specialists within 24 hours Conduct site visits with stakeholders as required. For private bores or dams provide alternate water supply Contract specialists within 1 week to investigate and report on changes identified Measure gas flow rates and chemical composition For bores review groundwater level and quality data in private and IC bores Collect water quality sample in vicinity of release where applicable Review sampling program within 2 weeks. Implement additional monitoring or increase frequency within 2 weeks if required Take monthly samples of dissolved methane, sulphide and phenols in surface waters above major gas plumes Monthly updates from specialists on investigation process Inform relevant agencies of results of investigation within 1 week of completion Develop site CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Hydrogeology and Ecology Specialists 	
LANDSCAPE FEATURES								
Cliffs and Steep Slopes	<p>Refer to Fig. 19.1</p> <ul style="list-style-type: none"> Cliffs -Along Nepean Gorge Steep Slopes -Along Nepean Gorge, associated tributaries and above the western end of 	<ul style="list-style-type: none"> Cliffs and steep slopes will be observed for any instability (e.g., rock falls, mass movement) The presence and duration of observable cliff seeps within the study area will be photographically and semi-quantitatively recorded during field monitoring. Where accessible, seep water 	<ul style="list-style-type: none"> Once prior to mining. Photographic records taken. During mining, monthly visual inspections, increased to weekly inspections during critical periods. Monitoring to continue 6 monthly for 2 years following the completion of mining. 	<ul style="list-style-type: none"> Identify significant landscape features at risk of experiencing adverse erosion and/or sedimentation impacts associated with subsidence from mining. To provide pre-mining baseline survey of landscape features for comparison with post-mining. 	<p>Minor</p> <ul style="list-style-type: none"> Rock fall from a cliff which is left mostly intact, resulting in insignificant ground disturbance. Insignificant erosion at any location localised to a small area and should naturally stabilise in the future Minor surface 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to landscape features To manage any safety hazards created cliff or steep slope failure. Investigate any mitigation measures required and implement in consultation with key agencies Keep stakeholders and agencies informed of any

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
	the proposed longwalls	samples will be collected and analysed.	<ul style="list-style-type: none"> As required when specific impacts are identified or when concern is raised by a landowner. Photographic records taken. As required in accordance with PSMPs 	<ul style="list-style-type: none"> Identify any impacts on landscape features during and after mining. Identify any safety hazards 	<p>movement with negligible soil surface exposed.</p> <p>Moderate</p> <ul style="list-style-type: none"> Rock fall or overhang collapse where the appearance of the cliff has changed and ground disturbance is likely to stabilise naturally. Significant erosion at any location likely to naturally stabilise in the near future. Surface movement or rock displacement that exposes significant areas of soil. <p>Severe</p> <ul style="list-style-type: none"> Major cliff collapse or rock fall where the characteristics of the cliff change significantly and there is a significant ground disturbance that is unlikely to stabilise naturally. Mass movement of a slope causing large areas of exposed soil. Any form of rockfall or erosion that poses a threat to public safety 	<ul style="list-style-type: none"> Capture photographic record immediately. Notify relevant stakeholders within 24 hours Notify relevant agencies and specialists within 24 hours Contract specialists within 1 week to investigate and report on changes identified Condition assessment to record impacts completed within 2 weeks. Establish weekly monitoring frequency until stabilised. Implement additional monitoring or increase within 1 month frequency if required. Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of investigation within 1 week of completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Principal Geoscientist (IC) Expert Landscape Consultants 	impacts, investigations or results.
TERRESTRIAL ECOLOGY								
Stressed or dead vegetation not readily explained by natural	<ul style="list-style-type: none"> No specific monitoring sites have been allocated. A general survey of the 	<ul style="list-style-type: none"> Vegetation communities. Vegetation condition. Changes in vegetation. 	<ul style="list-style-type: none"> Two Baseline monitoring campaigns 1 year prior to mining During mining, (as part of Landscape Features 	<ul style="list-style-type: none"> To provide pre-mining baseline survey of vegetation communities and threatened flora populations for 	<p>Minor</p> <ul style="list-style-type: none"> Small areas (<100m²) of vegetation effected by rockfall or surface cracking that would 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours Continue with approved monitoring program Report in the End of Panel Report within 4 months of 	<ul style="list-style-type: none"> Manager Environment (IC) 	<ul style="list-style-type: none"> Identify, investigate and report on impacts to terrestrial ecology. Investigate any mitigation measures required and

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
<p>processes.</p> <p>Causes may include rock / cliff falls or mass movement, gas emissions, changes in flooding/ ponding.</p>	<p>area will be conducted as outlined in the Landscape Features section.</p>	<ul style="list-style-type: none"> Tree health. Threatened species. 	<p>Monitoring) monthly visual inspections, increased to weekly inspections during critical periods.</p> <ul style="list-style-type: none"> Post mining, (as part of Landscape Features Monitoring) 6 monthly monitoring for two years As otherwise required. General observation of active mining areas during all other monitoring. 	<p>comparison with post-mining.</p> <ul style="list-style-type: none"> Identify any impacts on vegetation communities and threatened flora populations during mining. Identify any impacts of threatened fauna if they are observed. 	<p>commence natural regeneration within 6 months.</p> <p>Moderate</p> <ul style="list-style-type: none"> Minor damage to habitat relied upon by a threatened species or classified as an EEC. Small areas (<100m²) of vegetation effected by rockfall or surface cracking that is unlikely to commence natural regeneration within 6 months. Larger areas (>100m²) vegetation effected by rockfall or surface cracking that is likely to commence natural regeneration within 6 months. Gas emissions with minor vegetation die off and evidence of natural regeneration. 	<p>longwall completion and annually with AEMR.</p> <ul style="list-style-type: none"> Capture photographic record immediately. Notify relevant stakeholders within 24 hours Notify relevant agencies and specialists within 24 hours Contract specialists within 1 week to investigate and report on changes identified Condition assessment to record impacts completed within 2 weeks. Establish weekly monitoring frequency until stabilised. Implement additional monitoring or increase within 1 month frequency if required. Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of investigation within 1 week of completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Flora Consultants. 	<p>implement in consultation with key agencies.</p> <ul style="list-style-type: none"> Keep stakeholders and agencies informed of any impacts, investigations or results.
					<p>Severe</p> <ul style="list-style-type: none"> Significant damage to habitat relied upon by a threatened species or classified as an EEC. Large areas (>100m²) vegetation effected by rockfall or surface cracking that is unlikely to commence natural regeneration within 6 months. Gas emissions with extensive vegetation die off and no evidence of self regeneration. 	<ul style="list-style-type: none"> Capture photographic record immediately. Make area safe with barriers and signage immediately Notify relevant stakeholders within 24 hours Notify relevant agencies and specialists within 24 hours Conduct site visits with stakeholders as required. Contract specialists within 1 week to investigate and report on changes identified Condition assessment to record impacts completed within 2 weeks. Establish weekly monitoring frequency until stabilised. Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of investigation within 1 week of completion Develop site CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. Implement CMA as agreed with stakeholders following approvals. Conduct initial follow up monitoring and reporting within 2 months of CMA completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 		
ABORIGINAL ARCHAEOLOGY AND CULTURAL HERITAGE								
<p>Subsidence Impacts to Shelter Sites</p>	<p>Refer to Fig. 22.1</p> <ul style="list-style-type: none"> Nepean River 4 Nepean River 5 Nepean River 6 	<ul style="list-style-type: none"> Macro and micro recording using digital photography Detailed elevation plans of shelter walls recording structural and surface features including but not limited 	<ul style="list-style-type: none"> <i>Baseline archival recording:</i> prior to longwall mining. <i>Final impact assessment recording:</i> Twelve months after undermining or final subsidence movement 	<ul style="list-style-type: none"> To provide pre-mining baseline survey of Aboriginal archaeological sites for comparison with post-mining. Identify any impacts on or changes to 	<p>Minor</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation – mineral growth or micro-organism growth (as 	<ul style="list-style-type: none"> Capture photographic record immediately, if required. Notify relevant stakeholders within 24 hours Continue with approved monitoring program Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<p>Manager Environment (IC)</p>	<ul style="list-style-type: none"> Identify, investigate and report on impacts to aboriginal archaeology and heritage sites. Investigate any mitigation measures required and implement in consultation with key agencies.

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
	<ul style="list-style-type: none"> Nepean River 8 Upper Nepean Hand Stencils 	to the art itself, graffiti, joints, bedding planes, exfoliation scars, cracks, mineral and micro-organism growth, drip line and water seepage locations.	at the site.	Aboriginal Archaeological sites during mining.	<p>observed by comparing pre-mining photographs with post-subsidence/mining photographs).</p> <p>Moderate</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation – change in drip line or seepage, cracking or exfoliation of overhang or shelter, movement or opening of existing planes and joints. Observed by comparing pre-mining photographs with post-subsidence/mining photographs. <p>Severe</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation –block fall within shelter or overhang, shelter or overhang collapse. Observed by comparing pre-mining photographs with post-subsidence/mining photographs. 	<ul style="list-style-type: none"> Capture photographic record immediately. Notify relevant stakeholders within 24 hours Notify relevant agencies and specialists within 24 hours Contract specialists within 1 week to investigate and report on changes identified Condition assessment to record impacts completed within 2 weeks. Establish weekly monitoring frequency until stabilised. Implement additional monitoring or increase within 1 month frequency if required. Monthly updates from specialists on investigation process Inform relevant agencies and stakeholders of results of investigation within 1 week of completion Report in the End of Panel Report within 4 months of longwall completion and annually with AEMR. 	<ul style="list-style-type: none"> Manager Environment (IC) Expert Archaeology Consultants. 	<ul style="list-style-type: none"> Keep stakeholders and agencies informed of any impacts, investigations or results.
<p><i>If impacts are identified, monitoring and mitigation will continue until determined unwarranted in consultation with SMP Stakeholders</i></p> <p>*NOTE: ORP = Oxidation Reduction Potential.</p> <p>NOTE: CMA is a <i>corrective management action</i> developed in consultation with stakeholders in order to manage an observed impact in accordance with the relevant approvals.</p>								

24.1 EXPLANATORY NOTES FOR PROPOSED TARPS

- The TARP's table should be read in conjunction with the Appin Longwall 705 to 710 SMP Volumes 1 and 2.
- The stated monitoring and triggers are likely to cater for most events related to subsidence within the SMP Area. Should additional monitoring or triggers be identified as appropriate they will be implemented in consultation with DPIM.
- Access to any monitoring site is subject to landowner authorisation and restrictions to they may impose such as wet weather access. Proposed monitoring frequencies may be delayed due to wet weather.
- Stated notification and investigation timeframes are from when triggers have been confirmed by the Manager Environment.
- These TARPs will be reviewed and any improvement opportunities will be proposed within each End of Panel report.

24.2 INVESTIGATIONS AND REPORTING

Specialist investigations and reports will include:

- Scope of the study;
- Consideration of any relevant aspect from this plan;
- Analysis of trends;
- Assessment of any impacts against baseline data and predicted impacts;
- Root cause analysis of any change or impact;
- Options for management and mitigation;
- Assessment for the need for contingency measures;
- Any recommended changes to this plan; and
- Appropriate consultation.

Site specific corrective management action (CMA) plans will include:

- A description of the impact to be managed;
- Results of the specialist investigations into observed impact;
- Aims and objections of the plan;
- Specific actions required to manage the impact;
- Timeframes for implementation;
- Roles and responsibilities;
- Identification and gaining of appropriate approvals from landholders and government agencies; and

- Consultation and communication plan.

24.3 CONTINGENCY PLANS AND EMERGENCY RESPONSE

The monitoring programs outlined in this SMP are designed to identify subsidence impacts. Contingency and emergency response options are available and will be implemented if environmental, infrastructure or public safety impacts are demonstrated to be greater than predicted. It is within the scope of this SMP to detail the actions that will be undertaken to respond to predicted subsidence impacts and these are summarised in **Tables 23.1** and **24.1**.

The subsidence management framework involves the following components:

- Identifying features/values of significance and making impact predictions to determine the range of possible events and impacts.
- A Risk Assessment is conducted to determine the probability and consequences of an event occurring.
- Defining triggers and setting trigger levels for features and values affected and/or any identified events/impacts.
- Defining and implementing environmental monitoring.
- Identifying responses/actions to be taken when trigger levels are reached. These include response measures and actions relating to avoidance, minimisation, mitigation, compensation, contingency plans and emergency responses.
- Identifying roles and responsibilities of various stakeholders.
- Assessing measured impacts against predicted impacts as mining progresses for affected features or values.
- Implementing the responses/actions identified based on trigger levels being exceeded. Impacts need to be assessed based on the significance, extent, scale or longevity of impact and practical aspects of mitigation/rehabilitation.

24.4 PUBLIC SAFETY

Illawarra Coal will make all reasonable efforts to ensure that any member of the public entering an area affected by subsidence in the mining area is aware of any danger caused by subsidence, including impacts on roads, cliff lines and rock overhangs. Dissemination of this information will be through a structured campaign using a variety of methods. The program is likely to include:

- Signs at critical areas;
- Newsletters;
- Regular updates at Appin Area Community Working Group, and other scheduled meetings;
- Provision of information to infrastructure owners and interested groups; and
- Specific information in the AEMR.

There are limited public facilities in the SMP Area, with the Nepean River and Public Roads being the only publicly accessible parts of the SMP Area. The Cliff Management Plan and the Nepean River Visual Monitoring programs are the key methods for managing the potential safety risks associated with the Nepean River gorge. The Public Road Management Plan, for local roads, and the specific management plan for the Hume Highway are primarily plans to manage public safety and the serviceability of these features. In addition to these specific management plans IC undertakes extensive monitoring by ecologists, geologists, surveyors, engineers in order to identify subsidence impacts and manage risks to public safety. Based on experience in previous mining areas the intensity of monitoring undertaken identifies emerging issues prior to any safety incident.

The SMP Area is predominantly privately owned land and IC develops a Property Subsidence Management Plan with each landowner to monitor and manage the effects of subsidence. The PSMPs detail the roles and responsibilities of IC and the MSB and key contacts within each organisation. IC believes that the PSMP address public safety issues on the privately owned land within the SMP Area.

The specific infrastructure management plans developed for telecommunications and power are not written to address public safety, but rather the serviceability of the infrastructure. However, the continuity of such services is an important aspect of ensuring public safety.

IC is committed to ensuring that there are no public safety issues associated with the mining of Longwalls 705 to 710 and believes the extensive monitoring and management plans adequately address public safety.

24.5 ENVIRONMENT

The impacts resulting from subsidence occur gradually and are likely to affect a relatively small area of the surface above the proposed longwalls. It is possible that a longwall could affect only a small area and that the remainder, being unaffected, will continue to provide unaffected habitats for terrestrial and aquatic species immediately adjacent to impacted areas.

It may be impractical to carry out final remedial measures (if required) until all longwalls in an area have been mined. In such cases it may be necessary to temporarily support ecological systems until rehabilitation can be completed where it is appropriate to do so and in consultation with relevant stakeholders.

To minimise the impacts associated with subsidence and rehabilitation works a number of measures can be implemented. These include:

- Provision of environmental flows from upstream discharges;
- Relocation of fauna including fish;
- Temporary maintenance of individual species such as by watering aquatic plants;
- Provision of compensatory habitat;
- Timing of works;
- Staged work programs; and

- Altering mining methods or modifying the mining area.

If pools are substantially drained, large aquatic fauna could be relocated to ensure that they are not significantly impacted prior to rehabilitation being completed. This work would be done in consultation with DPI Fisheries and other agencies as required.

If rehabilitation of aquatic habitats is required, a catalogue of the habitat will be developed and used in site preparation to assist with rehabilitation. Boulders and logs could be removed from the area during site preparation and returned to pre-disturbance positions. Stockpiling rocks and logs adjacent to the watercourse and marking pre-disturbance positions with a non-toxic marking paint would assist this process. Larger aquatic plants can be removed from watercourses during site preparation in a non-destructive manner (i.e. by shovel). This allows the macrophytes to be stored off-site and replanted on completion of works. Patches of aquatic vegetation that do not need to be removed, but are left stranded by a fall in water level could be watered until water levels are restored.

With the provision of contingency and emergency measures, there is the potential to cause secondary impacts through the introduction of materials to the area or any disturbance associated with the activity. Considerable care and relevant approvals will be obtained to ensure the protection of the environment as such works are executed. Contingency and emergency measures would be monitored to confirm maintenance of the ecological values of the area and to confirm that measures in place to manage secondary impacts are effective.

25. STAKEHOLDER CONSULTATION PROCESS

This Plan has been prepared in consultation with key stakeholders. Consultation with infrastructure owners has also been ongoing for a number of years in relation to mining in Appin Area 7.

There will be regular meetings between Illawarra Coal, SCA, DPIM and infrastructure owners. Other agencies will be consulted as required and outlined throughout the SMP. The occurrence of any impacts greater than predicted will be communicated to appropriate stakeholders within 24 hours of detection.

The location of the proposed longwalls will be emailed to infrastructure owners, Government and interested stakeholders on a weekly basis.

A community consultation program is underway. It includes liaison with the Appin Area Community Working Group, local residents and property owners, and respondents to advertisements in local and state newspapers. One-on-one discussions have been held with all available property owners within the SMP Area.

Discussions have occurred with the owners of key items of infrastructure. The purpose of these discussions was to set the basis for ongoing consultation and development of final monitoring and management programs. All stakeholders were invited to attend and contribute to the Risk Assessment held on 15 May 2008.

Illawarra Coal is committed to working with the community in conducting its mining operations within this locality. The company has built a strong partnership with the community and contributes to the long-term wellbeing and social fabric of surrounding areas.

26. REFERENCES

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