West Cliff Colliery Area 5 Longwalls 34 to 36

SUBSIDENCE MANAGEMENT PLAN

January 2008

Revision 1, November 2009 –

Incorporating the Georges River Management Plan

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Prepared for:

bhpbilliton

Name of company:	**BHP Billiton - Illawarra Coal**
Name of mine:	**West Cliff Colliery Area 5**
Titles/Mining Leases:	**CL767**
Plan Title:	**West Cliff Colliery Area 5 Longwalls 34 to 36 Subsidence Management Plan**
Title	Manager Approvals Mr Richard Walsh
Signature	
Date	11 January 2008

Revision and history:

Revision	**Date**	**Description**
P1	11.1.2008	Initial Draft SMP
0	14.1.2008	Final SMP
1	05.11.2009	Revised to meet requirements of Georges River Management Plan (Approval Condition 13)

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15. OVERVIEW OF SUBSIDENCE MANAGEMENT

15.1 THE SUBSIDENCE MANAGEMENT PLAN

This SMP presents the proposed monitoring and management for West Cliff Area 5 Longwalls 34 to 36. This volume of the plan relies on the subsidence impact characterisation and risk assessment undertaken and discussed in Volume 1. The SMP and associated Management Plans are considered adequate for the management of any impacts from the extraction of the proposed Longwalls 34 to 36 given the nature, magnitude, extent and causes of the expected subsidence impacts arising from the proposed mining.

15.1.1 Purpose

The purpose of the SMP is to provide for the adequate protection of important natural and built features (NSW DPIM, 2003). The SMP must be approved before extraction of the longwall 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 objective of this Plan and its associated documentation is to:

- Describe a system to adequately manage subsidence risks in a timely manner and to demonstrate Illawarra Coal's capability to manage subsidence;
- Clearly state the objectives of what is to be achieved for 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;
- Develop contingency measures.

15.1.2 Scope

This SMP has been developed in accordance with the 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, Appin Area Community Working Group, SCA, DPIM, Alinta, Gorodok, Integral Energy, Transgrid, Sydney Water, Macarthur Water, the MSB and Telstra.

The SMP applies to roadway development for the longwall and longwall extraction within the SMP Area. The extent of the application and this plan includes:

- The area on the surface enclosed by the 35^0 angle of draw from the limit of proposed mining or the predicted limit of subsidence (20mm);
- Other specific surface and sub-surface features that may be affected by mining induced ground movements and far field effects.

The SMP is based upon the experience from adjacent longwall mining and 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 plan relates to:

- Natural features, including:
  - Surface and sub-surface water;
  - Landscapes, including steep slopes, cliffs, land suitability and areas prone to erosion or flooding;
  - Terrestrial and aquatic ecology;
- Aboriginal archaeology and european heritage;
- Infrastructure;
- Landowners.

15.1.3 Limitations and Assumptions

This Plan targets the mining of the proposed West Cliff Area 5 Longwalls 34 to 36 only and should not be applied to other areas without review.

The assumptions used in this SMP are:

- Subsidence will generally be in accordance with the predictions in technical report MSEC326;

- Impacts will be similar to those previously observed in the adjacent comparable areas. Where previous impacts were greater than predicted, contingent measures are based on known anomalous events and detailed scenario analysis;
- Rigorous monitoring can identify anomalous subsidence movements which 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;
- Impact studies are comprehensive and accurate; and
- 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.

15.1.4 Performance Indicators

Indicators that the SMP is effective in managing subsidence impacts of the proposed West Cliff Area 5 Longwalls 34 to 36 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 MSEC326 are identified and managed appropriately;
- Performance will be monitored and reported in the AEMR. Should performance not be satisfactory, BHPBIC will liaise with the relevant authorities and stakeholders to address issues as they arise.

15.2 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 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, Illawarra Coal 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 subsidence impacts are detailed in **Appendix G**. A consolidated list of these is reproduced below:

- Impacts associated with changes in water flow and quality;
- Changes to surface and groundwater interaction;
- Gas releases in creeks due to subsidence and upsidence;
- Increased instability of rock ledges and steep slopes due to subsidence;
- Subsidence damage to SCA infrastructure such as the Upper Canal and Nepean Tunnel;
- Subsidence causing movement of survey marks;
- Subsidence damage to infrastructure such as dams, roads, culverts, gas & water pipelines, telecommunication and power transmission lines;
- Subsidence damage to residential/farm dwellings and properties;
- Subsidence damage to heritage sites;
- Environmental impacts due to implementation of monitoring, mitigation and remediation.

Where risk levels have been assessed as above a certain threshold (0.9 - see **Appendix G**) additional management controls are documented in the Risk Assessment. A full explanation of the risk assessment process is provided in **Appendix G**.

15.3 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 vicinity of the longwalls, including SCA infrastructure, steep slopes, roads, gas & water pipelines, 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 B, C, D, and E.** 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 – was completed for Natural Features, Ecology, Man Made Features and Other Potential Impacts in **Sections 8, 9 and 10** of **Volume 1**. The overall environmental impact of the proposal (**Section 14**) 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 - is based on knowledge gained from previous studies and management of subsidence associated with the extraction of adjacent longwalls in West Cliff Area 5. Monitoring techniques used in previous mining areas, including the Georges and Nepean Rivers 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 compared with monitoring results to determine any remediation that may be required. Descriptions of mitigation and rehabilitation options are detailed in this document.

There are existing management plans for all infrastructure over Longwalls 34 to 36 as they traverse previous longwalls. Existing infrastructure management plans for Longwalls 29 to 33 will be revised to manage the impacts of the proposed Longwalls 34 to 36 on infrastructure. Property Subsidence Management Plans are being developed with the landowners to manage any mining impacts on properties. 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 aspects.

15.4 RESOURCES REQUIRED AND AVAILABLE

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

15.4.1 The Role of the Regulator (DPIM)

The DPIM is the Government statutory body that is responsible for regulating mining in NSW. One of its functions is to review and approve this SMP to allow coal extraction in the proposed West Cliff Area 5 Longwalls 34 to 36. 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 West Cliff Area 5 Longwalls 34 to 36;
- 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 TARP controlling subsidence impacts provides for the DPIM to be notified and more closely involved at 'trigger points'.

15.4.2 BHP Billiton Illawarra Coal

Illawarra Coal has established the 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 below.

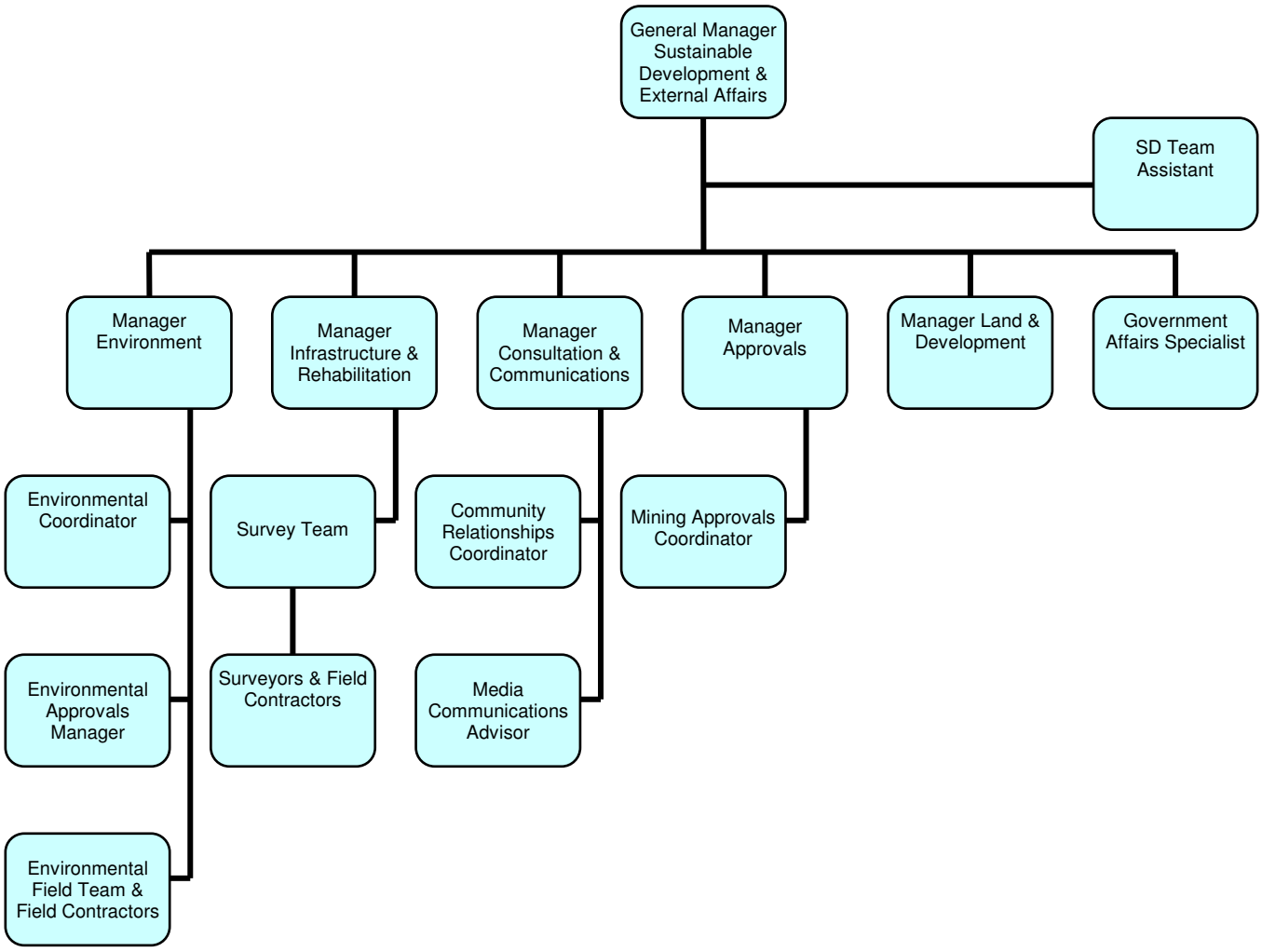


Figure 15.1 - Illawarra Coal Sustainable Development, Organisational Structure

In fulfilling this obligation Illawarra Coal has assigned the following resources to assist in compliance with the West Cliff Area 5 SMP for the proposed Longwalls 34 to 36:

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

There are a significant number of consultants that support Illawarra Coal including:

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

15.4.3 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;
- Department of Water and Energy;
- Department of Environment and Climate Change;
- Department of Primary Industries - Fisheries;
- Dams Safety Committee;
- Sydney Catchment Authority;
- Mine Subsidence Board;
- Other agencies where their interest is recognised by the Committee.

The Committee is chaired by the Chief Executive Officer of the MSB.

The approach taken in assessing SMP applications is 'open and transparent' 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.

15.4.4 Infrastructure Owners

Contact details for each of the infrastructure owners are available from Illawarra Coal 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.

15.4.5 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.

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 Illawarra Coal 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 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;
- All contractors must comply with Illawarra Coal HSEC and project management requirements.

15.5 PERSONNEL RESPONSIBILITIES

15.5.1 Illawarra Coal Review Team

The Review Team consists of the following regular members:

- Mine representative as required;
- Manager Approvals;
- Manager Survey;
- Manager Infrastructure and Rehabilitation;
- Manager Environment.

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

15.5.2 Mine Representative

The Mine Operations Manager or delegate will:

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

15.5.3 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;

- Ensure that the quality elements related to the ongoing effectiveness of this SMP are conducted and reported as required.

15.5.4 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;
- Ensure that the standards and frequencies related to the Monitoring Controls are adhered to.

15.5.5 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;
- Ensure that the standards and frequencies related to the Monitoring Controls are adhered to.

15.5.6 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.

15.5.7 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;
- 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.

15.6 PLAN QUALITY ELEMENTS

15.6.1 Training

Inspections and observations by Field Monitoring Personnel and Consultants facilitate the detection of events related to subsidence. This is a monitoring control, 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;
- 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;
- Surveyors – Manager Survey.

15.6.2 Communications and Reporting

The AEMR is the principle reporting tool for the SMP. The AEMR also summarise 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.

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 Illawarra Coal 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.

15.6.3 Audit and Review

A risk review of subsidence impacts, based on the latest data has been conducted for the extraction of the proposed West Cliff Area 5 Longwalls 34 to 36, and this is detailed in **Appendix G** of **Volume 1**. Should any significant unpredicted event occur that is capable of impacting on the ability of this Plan to achieve its fundamental objective (ie, 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.

15.6.4 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 and the triggers identified by monitoring components and corrective actions implemented that were applied during instances of 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 Illawarra Coal for a period of at least five years.

15.6.5 Document Control

This SMP shall be controlled as part of the Illawarra Coal 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;
- West Cliff Colliery;
- Field Monitoring and Survey Personnel;
- Key Consultants;
- DPIM;
- SMP Interagency Members;
- Council;
- 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.

16. INFRASTRUCTURE SUBSIDENCE MONITORING AND MANAGEMENT

16.1 OBJECTIVES

The objectives of the subsidence monitoring program are to:

- provide information on the magnitude and extent of subsidence over the 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 Illawarra Coal and infrastructure owners;
- meet the expectations of the community and Government with regard to monitoring subsidence.

16.2 SUBSIDENCE MONITORING OVERVIEW

Infrastructure monitoring has been occurring in the area for many years and management plans are currently in place for the key items of infrastructure as detailed below in section 16.2.

Discussions with infrastructure owners to determine appropriate management plans or revisions to current plans are being undertaken where necessary. Subsidence predictions will 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 for Longwalls 31 to 33 are expected to already 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, and

- management and monitoring plans will be updated as required in a collaborative process.

16.3 SPECIFIC INFRASTRUCTURE MANAGEMENT PLANS

The key items of infrastructure that have management plans in place are listed below. A summary of the monitoring and management plans are provided below:

- **Appin Road**. A visual inspection of the road will occur regularly when the longwalls are close to the road and feedback will be provided to Wollondilly Council and the RTA. The subsidence line established to monitor the Telstra Fibre Optic Cable follows the Appin Road and the monitoring frequency is heightened as subsidence occurs.

- **Local Water Distribution** including Sydney Water's service water main between Appin and Campbelltown. Following discussions with Sydney Water personnel on the predictions and risk associated with subsidence the existing monitoring plan will be updated and is likely to include trigger levels for exposing and monitoring pipe joints. Monitoring will occur weekly within the zone of influence and where required mitigation works will be implemented.

- **The United Utilities 1200 mm diameter treated water gravity main**, which is owned by United Utilities, is located within the pipeline easement which crosses the western ends of the proposed longwalls. The timing and frequency of ground monitoring will be determined in consultation with United Utilities.

- **The Transgrid 330 kV transmission line** is currently monitored over current Longwalls and may require mitigation measures. Transgid will determine the mitigation and monitoring requirements (as in previous areas).

- **Telstra Fibre Optic Cable**. A standard monitoring line along the fibre optic installation within the subsidence zone has been established in relation to earlier longwalls as part of the existing Management Plan. Ground movement monitoring and visual inspections will occur monthly and more frequently if required. Mitigation measures will be implemented if required and the effectiveness of measures will be monitored. A review the Management Plan taking into account the revised subsidence predictions is being undertaken.

- **Telstra Copper Cables**. Cables will be monitored visually as identified in the revised Management Plan.

- **Integral's low voltage transmission lines**. The tilts and subsidence movements of key poles identified by Integral through management plan discussions will be monitored.

- **Alinta EGP Natural Gas Pipeline**. The Alinta EGP Natural Gas Pipeline was designed to accommodate subsidence and was approved by the Mine Subsidence Board. The timing and frequency of ground monitoring will be determined in consultation with Alinta.

- **Alinta AGN Natural Gas Pipeline.** The timing and frequency of ground monitoring will be determined in consultation with Alinta.

- **Gorodok Ethane Pipeline.** The timing and frequency of ground monitoring

will be determined in consultation with Gorodok.

- **Inghams Farm Complex**: Inghams and IC will review the existing Management Plan taking into account the revised subsidence predictions. No mitigation measures are recommended and impacts are predicted to be minimal. It is expected that there will not be any significant changes required to the current management plan.

- **Buildings and dams.** An inspection of the rural properties and dams has been conducted in preparing the Property Subsidence Management Plans. Properties will be managed as agreed in the PSMPs. Refer to section 16.3.

Illawarra Coal is continuing to work closely with service providers and owners of infrastructure, to develop strategies and management plans for the protection of the 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 Illawarra Coal 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 hrs 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 Illawarra Coal 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.

16.4 PROPERTY SUBSIDENCE MANAGEMENT PLANS

All landowners and occupiers within the SMP Area have been personally contacted by Illawarra Coal to discuss plans for the proposed Longwalls 34 to 36 and an inspection of the rural properties and dams has been conducted. Property Subsidence Management Plans are being updated with the latest subsidence predictions and relevant structural observations from the recent consultation. The plans will be finalised and provided to the landowners/occupiers prior to mining. Copies are provided to the DPI and the Mine Subsidence Board.

16.5 PROPOSED GROUND MONITORING PROGRAM

The locations of proposed ground monitoring lines are shown in **Figure 16.1.** These are described briefly below:-

- **1200 mm Diameter Water Main**
  It is proposed that the existing survey line along the 1200 mm diameter water main be extended over Longwalls 34 to 36 and is monitored during the extraction of these longwalls. The timing and frequency of ground monitoring should be determined in consultation with United Utilities.

- **Gas Pipelines**
  It is proposed that the existing survey lines along the Alinta EGP and AGN Natural Gas Pipelines and along the Gorodok Ethane Pipeline be extended over Longwalls 34 to 36 and are monitored during the extraction of these longwalls. The timing and frequency of ground monitoring should be determined in consultation with Alinta and Gorodok.

- **330 kV Transmission Line**
  It is proposed that the existing monitoring points at towers along the 330 kV transmission line be extended to the towers above Longwalls 34 to 36 and are monitored during the extraction of these longwalls. The timing and frequency of ground monitoring should be determined in consultation with TransGrid.

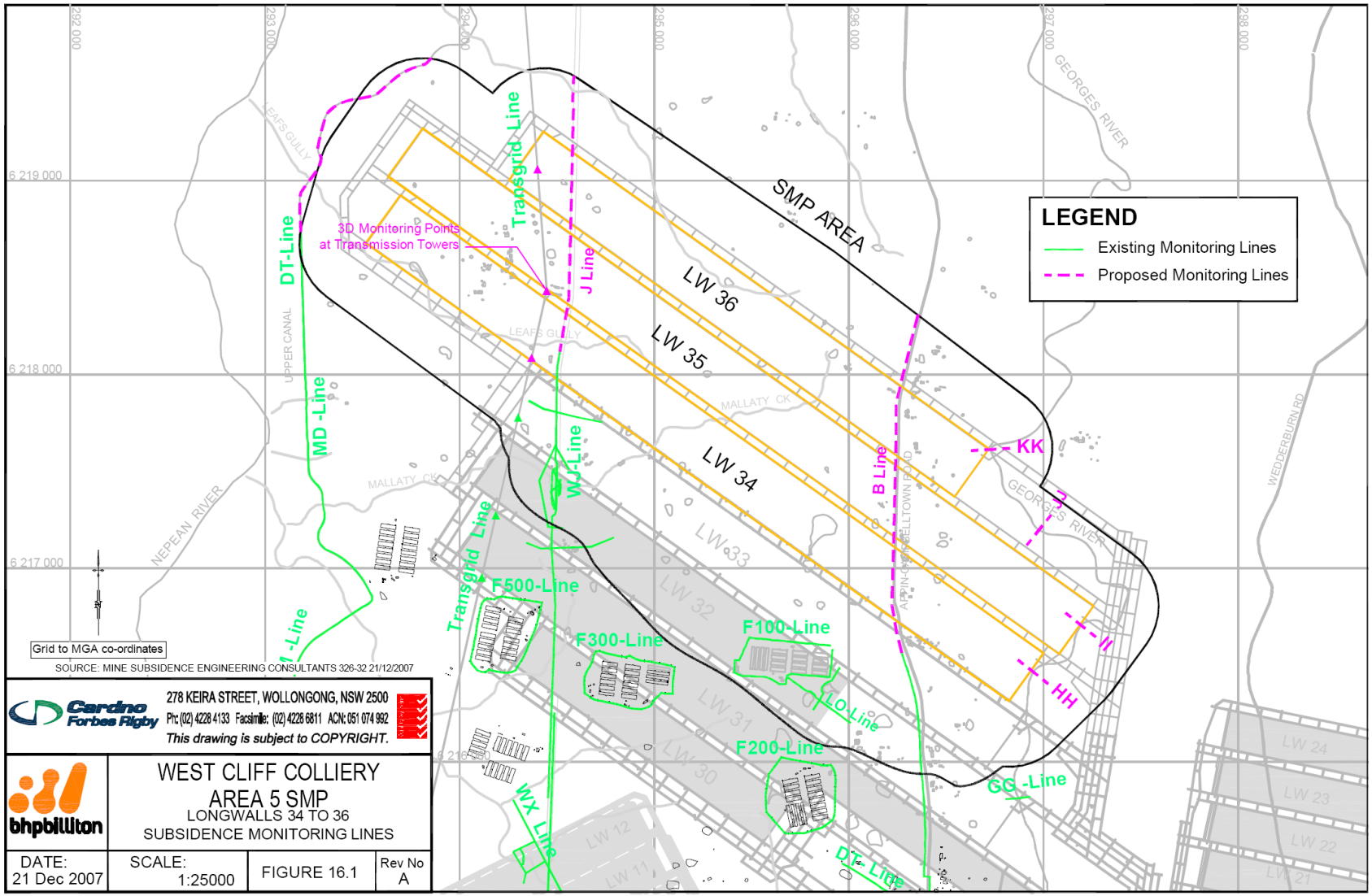
- **Optical Fibre Cable**
  It is proposed that the existing monitoring line along Appin Road be extended over Longwalls 34 to 36 and is monitored during the extraction of these longwalls. The timing and frequency of ground monitoring should be determined in consultation with Telstra.

- **The Georges River**
  It is proposed that ground movements are monitored along the Georges River. In addition to the existing E-Line, F-Line and G-Line, it is proposed that four additional monitoring lines are provided across the river, adjacent to the finishing ends of Longwalls 34 and 35, north of the maingate of Longwall 35 and at the north-eastern corner of Longwall 36.

- **Upper Canal**
  It is proposed that the existing monitoring line along the Upper Canal be extended as indicated in **Figure 16.1** and is monitored during the extraction of these longwalls. The timing and frequency of ground monitoring should be determined in consultation with SCA.

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.

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.


LEGEND
Existing Monitoring Lines
Proposed Monitoring Lines
SMP AREA
3D Monitoring Points at Transmission Towers
Transgrid Line
DT-Line
J Line
MD -Line
WJ-Line
B Line
KK
II
HH
LW 36
LW 35
LW 34
LW33
LW 32
LW 31
LW 30
F500-Line
F300-Line
F100-Line
F200-Line
LO-Line
GG -Line
WX Line
LEAFS GULLY
MALLATY CK
NEPEAN RIVER
GEORGES RIVER
UPPER CANAL
WEDDERBURN RD
Grid to MGA co-ordinates
SOURCE: MINE SUBSIDENCE ENGINEERING CONSULTANTS 326-32 21/12/2007
278 KEIRA STREET, WOLLONGONG, NSW 2500
Ph: (02) 4228 4133 Facsimile: (02) 4226 6811 ACN: 051 074 992
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WEST CLIFF COLLIERY
AREA 5 SMP
LONGWALLS 34 TO 36
SUBSIDENCE MONITORING LINES
DATE: 21 Dec 2007
SCALE: 1:25000
FIGURE 16.1
Rev No A

17. WATER MONITORING AND MANAGEMENT

17.1 OBJECTIVES

- To provide pre-mining baseline water quality, pool water levels and flow data for comparison with during and post-mining
- To identify any water quality, pool water level and flow impacts from mining.
- To identify water quality pool water level and flow impacts related to physical or chemical changes to the creeks and/or drainage lines during mining.
- To provide pre-mining baseline creek bed, bank and water quality observations for comparison with during and post-mining.
- To identify any creek bed, bank and water quality visual impacts related to physical or chemical changes to the creeks and/or drainage lines during mining.
- To provide pre-mining baseline shallow groundwater quality and levels for comparison with 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 quality during or post mining.
- To establish appropriate triggers, actions and responses related to identifying, assessing and responding to abnormal conditions related to subsidence impacts.

17.2 OVERVIEW

The land in the eastern part of the SMP Area generally drains into the Georges River, while the land in the central and western parts of the SMP Area generally drain into Mallaty Creek, Leafs Gully or Nepean Creek, which in turn drain into the Nepean River. **Figure 6.1** shows the watercourses within and adjacent to the SMP area.

Georges River arises about 5 km south east of Appin, and flows broadly north towards Liverpool in a tortuous fashion through a shallow river valley that becomes increasingly incised as it proceeds north.

The section of the Georges River skirting around the eastern ends of Longwalls 34 – 36 within the SMP Area is moderately incised with Hawkesbury Sandstone outcropping to the east and Wianamatta Shale to the west (of the river) and the depth of the river valley varies between 20 and 35 m. The bedrock of the Georges River is invariably Hawkesbury Sandstone.

The natural gradient of the Georges River within the SMP Area varies between <1 mm/m and a maximum of 50 mm/m with an average of approximately 8 mm/m (0.8%).

The creeks draining to Nepean River are as follows:

Mallaty Creek is an ephemeral creek which is located directly above the proposed Longwalls 34 to 36. The creek generally flows in a westerly direction until it joins Ousedale Creek, approximately 1.4 kilometres south-west of Longwall 34. The

natural gradient of the creek within the general SMP Area varies between 10 mm/m and 100 mm/m, with an average gradient of approximately 30 mm/m.

Leafs Gully is an ephemeral creek which is located directly above proposed Longwalls 34 and 35. The creek flows in a north-westerly direction until it joins the Nepean River approximately 830 metres west of Longwall 36. The natural gradient of the gully within the general SMP Area varies between 10 mm/m and 125 mm/m, with an average gradient of approximately 50 mm/m.

Nepean Creek lies north of the SMP Area which enters Nepean River just above Menangle Weir. It is ephemeral in its upper reaches, one upper tributary of which runs along Longwall 35 in a south-easterly direction. This tributary flows northwest from a small farm dam (with an area of roughly 50 m^2) through cattle pasture. There is a thin riparian strip in the upper reaches, flowing through tea tree shrubbery within eucalypt woodland. The creek is ephemeral with only small standing pools. The natural gradient of the creek in the vicinity of the proposed longwalls varies between 10 mm/m and 150 mm/m, with an average gradient of approximately 40 mm/m.

There are also a number of minor tributaries of the abovementioned creeks within the SMP Area. The minor tributaries are located directly above and across the extents of the proposed longwalls.

The key monitoring parameters for these water ways and their tributaries include indicators of flow diversion and water quality changes.

Baseline environmental monitoring is required under the SMP Guidelines to identify seasonal and other variations in natural systems. It is noted that flows in these water ways are seasonally variable. It is also noted that the Georges River has flow variations dependant on licensed discharges into the river from the West Cliff and Appin Collieries.

The key components of the monitoring program provide a basis for the comparison of flow, pool level and water quality in the area before, during and after mining impacts as outlined below and summarised in **Table 17.3**. This monitoring program addresses the Georges River separately to the above-mentioned ephemeral watercourses to address the requirement to have a Georges River Management Plan under Condition 13 of the SMP Approval for Longwalls 34-36.

17.3 EXISTING BASELINE DATA

The Georges River, Mallaty Creek and the Nepean River are all currently monitored as required in the extraction of Longwalls 29-33.

The results from these conclude that flows are seasonal.

The Georges River flow depends on licensed discharges from the West Cliff and Appin Collieries. In the absence of these discharges, the river has been observed to cease flowing in dry conditions.

17.4 WATER MONITORING PROGRAM

Monitoring sites are visited on a weekly basis during active subsidence for the Georges River and a monthly basis for the ephemeral streams. Water quality profiler instruments are deployed to collect the following physico-chemical parameters - Temp (Deg), DO%, SpC (uS/cm), pH, ORP(mV), Depth(m), Time Sample, Pool Water Level (RL) also general comments are recorded.

On a monthly basis, samples are collected from the field and analysed in a NATA registered laboratory for the following parameters:

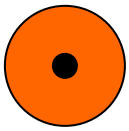
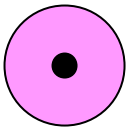
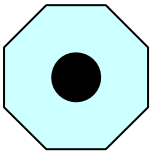
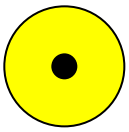
Table 17.1 - Table of Monthly Lab Analytes

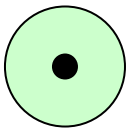
Water Quality Analytes

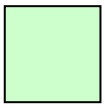
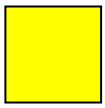
Metals (total/dissolved)	Ions	Other Analytes
Ca Filtered	Hydroxide as CaCO3	pH
Mg Filtered	Carbonate as CaCO3	SpC
Na Filtered	Bicarbonate as CaCO3	TDS
K Filtered	Alkalinity as CaCO3	TSS
Fe Filtered	Sulphate Filtered	DOC
Fe Total	Chloride	Br Filtered
Al Filtered	Ammonia as N	I Filtered
As Filtered	Nitrite as N	B Filtered
Cu Filtered	Nitrite and Nitrate as N	
Mn Filtered	Total Kjeldahl Nitrogen as N	
Ni Filtered	Total Nitrogen as N	
Pb Filtered	Total Phosphorus as P	
Se Filtered	Total Cations	
Zn Filtered	Total Anions	
Al Total	Actual (Anion/Cation) Diff	
Mn Total	Allowed (Anion/Cation) Diff	
	Ionic Difference %	

Tables illustrating the water sampling program are shown on the following pages. These summarise site type, and the sampling frequency and parameters monitored at each site. Refer to **Figure. 17.1** for the positions of these sites. For additional detail on site monitoring refer to the TARP's **Table 23.1**.

Table 17.2 Water Monitoring Site Summary

Legend (Refer to site Locations on **Figure 17.1**)	Frequency	Parameters
Proposed Deep Piezometer 	• Hourly data readings transmitted.	No water Quality Automatic data logging of piezometric pressure (water level) by vibrating wire piezometers. 8 piezometers will be installed in the hole with 2-3 targeting groundwater in the major sandstone units in the overburden ie Hawkesbury, Bulgo and Scarborough.
Proposed Shallow Piezometer (to be incorporated with site PDP1) 	• Hourly piezometer data readings transmitted where installed. Otherwise manual measurements monthly prior to mining, weekly during active subsidence, and monthly for 2 years post mining or as otherwise required • Water quality samples taken before mining to form a baseline. • Water quality samples taken after mining to form a basis for comparison.	Automatic data logging of water level by the vibrating wire piezometers or strain gauge Piezometers Under ground water pressure Manual measurement of water level by dip meter instrument. – For Water Quality testing, a full field parameter and a full laboratory parameter test is performed as detailed in table 17.1 and section 17.2
Existing Shallow Piezometer 		
Proposed Water Quality Site (field parameters) 	• Monthly Baseline monitoring 1 year prior to mining, monthly post mining. • Georges River - Weekly field parameters once	Field Parameter tests •Temperature •Dissolved oxygen •SpC •Depth

Legend (Refer to site Locations on **Figure 17.1**)	Frequency	Parameters
Existing Water Quality Site (field parameters) 	mining is within 400m of the Georges River and monthly for 2 months post mining or until parameters are within 2 standard deviations of baseline. • Ephemeral Water Courses – Monthly field parameters during active subsidence and monthly for 2 months post mining or until subsidence is complete. .	•Field pH •Time sample •Pool water level (RL) •ORP* •General comments
Proposed Water Quality Site (laboratory parameters) 	• Monthly Baseline monitoring 1 year prior to mining. • Georges River - For lab parameter sites monthly laboratory parameter tests once mining is within 400m of the Georges River and for 2 months post mining, or until parameters are within 2 standards deviations of baseline. • Ephemeral Water Courses – For lab parameter sites monthly laboratory parameter tests during active subsidence and monthly for 2 months post mining or until subsidence is complete.	Laboratory Parameter tests -**Metals filtered** Ca, Mg, Na, K, Fe, Al, As, Cu, Mn, Ni, Pb, Se, Zn, -**Metals Total** Fe, Al, Mn -**Ions** Hydroxide as CaCO3, Carbonate as CaCO3, Bicarbonate as CaCO3, Alkalinity as CaCO3, Sulphate Filtered, Chloride, Ammonia as N, Nitrite and Nitrate as N, Total Kjeldahl Nitrogen as N, Total Phosphorus as P, Total Cations, Total Anions, Actual (Anion/Cation) Diff, Allowed (Anion/Cation) Diff, Ionic Difference % -**Other Analytes** pH, SpC, TDS, TSS, DOC, Br Filtered, I Filtered
Existing Water Quality Site (laboratory Parameters) 		

Legend (Refer to site Locations on **Figure 17.1**)	Frequency	Parameters
Existing Flow Monitoring Point 	• Monthly baseline monitoring 1 year prior to mining. Georges River – • Weekly monitoring during mining within 400m of the Georges River. • Ongoing monthly monitoring for 2 months post mining or until flow characteristics are typical of baseline conditions. Ephemeral Water Courses • Monthly monitoring during active subsidence. • Ongoing monthly monitoring for 2 months post mining or until subsidence is complete.	The flow rate is measured using a pigmy flow meter when conditions allow.
Proposed Flow Monitoring Point 		

N.B. there are only flow sites in the Georges River as flow measurements are not possible during normal ephemeral conditions for Mallaty Creek, Leafs Gully and Nepean Creek

Additional sampling requirements will be developed in consultation with stakeholders on an as required basis. Additional monitoring will be linked to management reviews with resource managers resulting from Trigger Action Response Plans (TARPs). **Table 17.3** below summarises the proposed monitoring program.

Table 17.3 - Water Monitoring Program Summary

Monitoring Activity	Description	Frequency (Georges River)	Frequency (Ephemeral)	Reporting
Water levels in pools Flow Monitoring at designated flow control features (Refer **Figure17.1**)	Survey against reference points with reference to flow for all field parameter sites see TARPs table for full listing of sites. Flow rate measured using a pigmy flow meter (where flow conditions allow)	• Monthly Baseline monitoring 1 year prior to mining. • Weekly monitoring during mining within 400m of the Georges River. • Ongoing monthly monitoring for 2 months post mining or until flow characteristics are typical of baseline conditions.	• Monthly Baseline monitoring 1 year prior to mining. • Monthly monitoring during active subsidence. • Ongoing monthly monitoring for 2 months post mining or until subsidence is complete.	In annual reporting and as required as part of established technical groups. GR impacts reported to DPIM and Resource Managers within 24hrs of observed impacts greater than prediction.
Water Quality (Refer **Figure17.1**)	Water quality measurements: • Each field parameter site tested • Detailed Laboratory analysis of lab parameter sites • Refer TARPs Table 23.1 for full site listing	• Monthly Baseline monitoring 1 year prior to mining. • For lab parameter sites monthly laboratory parameter tests once mining is within 400m of the Georges River and monthly for 2 months post mining, or until parameters are within 2 standard deviations of baseline. • For field parameter sites weekly field parameters testing once mining is within 400m of the Georges River and monthly for 2 months post mining, or until parameters are within 2 standard deviations of baseline.	• Monthly Baseline monitoring 1 year prior to mining. • For lab parameter sites monthly laboratory parameter tests during active subsidence and monthly for 2 months post mining or until subsidence is complete. • For field parameter sites. Monthly field parameters testing during active subsidence and 2 months post mining or until subsidence is complete.	

Presence and magnitude of rock bar or bedrock fracturing as indicated through observational monitoring or gas release.	Rockbars and pools in: • The SMP area will be checked concurrently with the water quality tests through observational monitoring at each field parameter site	• Monthly baseline monitoring for 1 year prior to mining. • Weekly monitoring within 400m of the Georges River and monthly for 2 months post mining or until subsidence is complete.	• Monthly baseline monitoring for 1 year prior to mining. • Monthly monitoring during active subsidence and monthly for 2 months post mining or until subsidence is complete.	
Shallow Groundwater	• Automatic hourly data logging of water level by vibrating wire piezometers or strain gauge Piezometers • Full Laboratory parameter water quality analysis	• Continuous hourly logging of water level or manual measurements of water level monthly prior to mining, weekly during active subsidence, and monthly until groundwater levels recharge to baseline conditions. • Water quality samples taken before mining to form a baseline. • Water quality samples taken after mining to form a basis for comparison.	• Continuous hourly logging of water level or manual measurements of water level monthly prior to mining, weekly during active subsidence, and monthly until groundwater levels recharge to baseline conditions. • Three water quality samples taken before mining to form a baseline. • Three water quality samples taken after mining to form a basis for comparison.	

17.5 RESPONSE TO MONITORING

The Principal "Trigger- Action- Response Plans" (TARPs) relate to identifying, assessing and responding to abnormal conditions related to subsidence impacts are presented in **Table 23.1.**

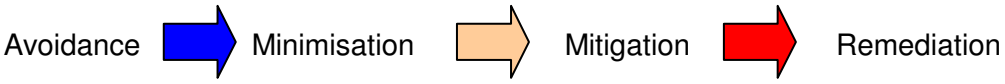
The following is a list of actions that will be considered in response to alerts:

- Variance of natural pool water levels will represent triggers for increased investigation, mitigation and rehabilitation;
- All key stakeholders will be informed of the variance and proposed investigation, mitigation and rehabilitation, if required;
- Illawarra Coal and its consultants and contractors are responsible for acting on alerts;
- Investigative, mitigation and rehabilitation actions will be taken in response to alerts after consultation with key stakeholders and appropriate approvals are in place;

- Water quality effects of remediation measures will be taken into account when designing and implementing any program. These issues will be addressed during any approval process;
- The effectiveness of remediation will be further discussed with approval agencies for each program but will be based on returning the area to as similar to pre-mining conditions as is practicable or as otherwise negotiated with relevant stakeholders.
- Observed impacts on the Georges River from the current longwall will be considered before subsequent longwalls approach the Georges River. If impacts exceed 'predicted' levels, then an 'adaptive management' approach will be considered for future longwalls (i.e. Longwalls 35 and/or 36) to prevent further instances of exceedance of predicted impacts. Adaptive management may include, but not be limited to, relocating the finishing line of the longwall away from the Georges River. Figure 17.5 is indicative of which longwalls and what aspects of Longwalls 34-36 would be considered, should adaptive management be required.

17.6 HEIRACHY OF CONTINGENCY CONTROLS

As outlined in the Subsidence Monitoring and Management Program, a hierarchical process is implemented by Illawarra Coal to reduce and manage subsidence impacts to the Georges River.



During the planning process Illawarra Coal designed the mine plan to avoid or minimise potential impacts due to mining and, therefore, attempt to avoid impacts that would require mitigation or remedial work.

It should be noted that where the longwall has progressed past the last cut-through , it would not be feasible to safely stop the longwall until it reaches the designed finish line due to access and stability issues.

Further information on various contingency and adaptive management options is discussed in Section 23.3. The heirachy of contingency controls will be considered in the development of any response where impacts to the Georges River exceed those that are predicted.

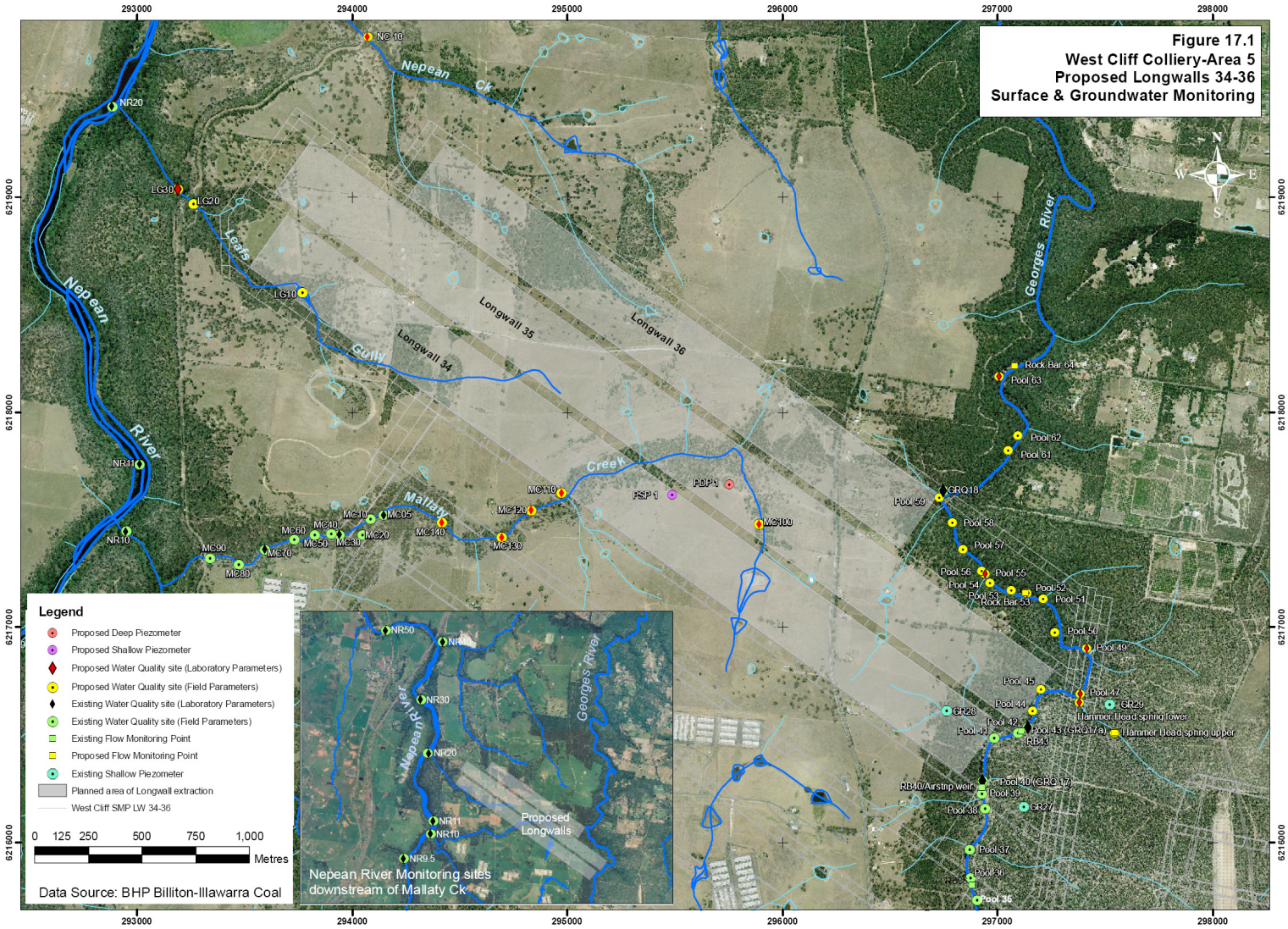
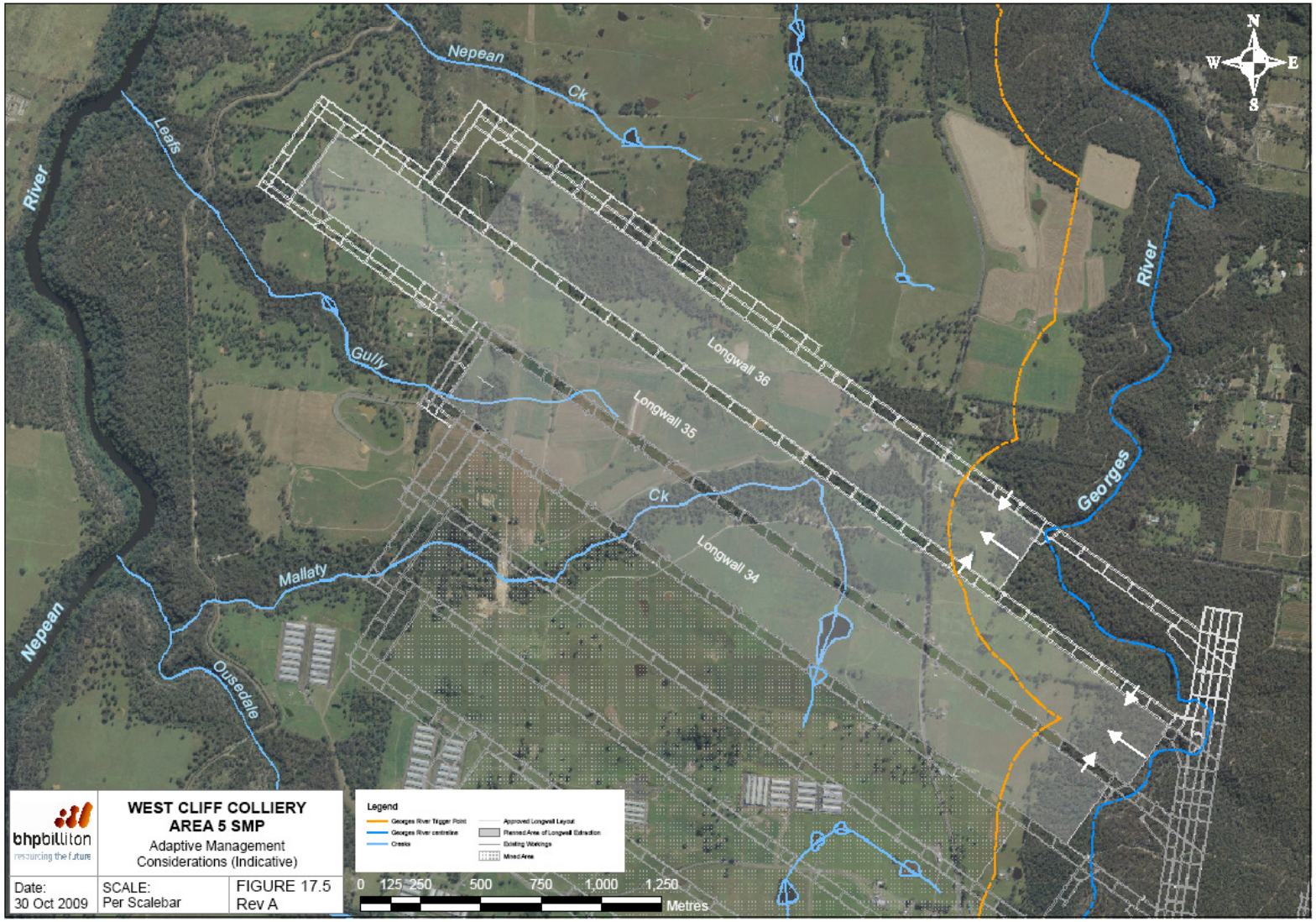


Figure 17.1
West Cliff Colliery-Area 5
Proposed Longwalls 34-36
Surface & Groundwater Monitoring
293000
294000
295000
296000
297000
298000
6219000
6218000
6217000
6216000
N
S
E
W
NC 10
NR20
LG30
LG20
LG10
NR11
NR10
MC90
MC80
MC70
MC60
MC50
MC40
MC30
MC20
MC10
MC05
MC110
MC120
MC130
MC140
MC100
FSP 1
PDP1
GRQ18
Pool 63
Rock Bar 64
Pool 62
Pool 61
Pool 59
Pool 58
Pool 57
Pool 56
Pool 55
Pool 54
Pool 53
Rock Bar 53
Pool 52
Pool 51
Pool 50
Pool 49
Pool 45
Pool 44
Pool 42
Pool 41
Pool 43 (GRQ17a)
Pool 40 (GRQ17)
Pool 39
Pool 38
Pool 37
Pool 36
Pool 35
GR28
GR29
GR27
RB43
RB40/Airstrip weir
Hammer Head spring lower
Hammer Head Spring upper
Nepean Ck
Nepean River
Georges River
Leafs Gully
Mallaty Creek
Longwall 34
Longwall 35
Longwall 36
Legend
Proposed Deep Piezometer
Proposed Shallow Piezometer
Proposed Water Quality site (Laboratory Parameters)
Proposed Water Quality site (Field Parameters)
Existing Water Quality site (Laboratory Parameters)
Existing Water Quality site (Field Parameters)
Existing Flow Monitoring Point
Proposed Flow Monitoring Point
Existing Shallow Piezometer
Planned area of Longwall extraction
West Cliff SMP LW 34-36
0 125 250 500 750 1,000
Metres
Data Source: BHP Billiton-Illawarra Coal
NR50
NR40
NR30
NR20
NR11
NR10
NR9.5
Proposed Longwalls
Nepean River Monitoring sites downstream of Mallaty Ck


Nepean
Ck
Leafs
River
Gully
Longwall 36
Longwall 35
Ck
Longwall 34
Georges
River
Mallaty
Nepean
Ousedale
N
W
E
S
WEST CLIFF COLLIERY
AREA 5 SMP
Adaptive Management
Considerations (Indicative)
bhpbilliton
resourcing the future
Date:
30 Oct 2009
SCALE:
Per Scalebar
FIGURE 17.5
Rev A
Legend
Georges River Trigger Point
Georges River centreline
Creeks
Approved Longwall Layout
Planned Area of Longwall Extraction
Existing Workings
Mined Area
0 125 250 500 750 1,000 1,250
Metres

18. LANDSCAPE MONITORING AND MANAGEMENT

Monitoring that is currently underway for West Cliff Area 5 will be extended to include the proposed Longwalls 34 to 36. The monitoring proposed will contribute to the Baseline Assessment and form a basis for routine and expanded monitoring programs during mining.

Cliffs and steep slopes have been identified along the alignment of the Georges River, the locations of which are shown in **Figure 18.1**.

18.1 LANDSCAPE MONITORING OBJECTIVES

This part of the SMP incorporates the monitoring and management of subsidence related surface impacts in cliffs, steep slopes, creeks and land capability, with specific emphasis on erosion and/or sedimentation impacts. The key objectives of the plan are to:

- identify the significant landscape features that are at risk of experiencing adverse stability, erosion and/or sedimentation impacts associated with subsidence from mining;
- outline a monitoring program that will record any actual erosion and/or sedimentation impacts for the landscape features identified above and will record any impact on land capability;
- outline the monitoring Trigger Levels that will require responsive action and the Corrective Management Action (CMA) options to be implemented when required.

18.2 MONITORING LOCATIONS

The general location of observational monitoring is shown in **Figure 18.1.** The area to be monitored includes:

- ***Cliffs*** - Two low rocky outcrops 5-10 metres high have been identified along the Georges River. Observational monitoring will occur along these minor cliff lines.
- ***Steep Slopes*** - Steep slope monitoring will occur along the Georges River, Mallaty creek and the Nepean River as indicated in **Figure 18.1**.
- ***Watercourses -*** Monitoring will occur along the Georges River, Nepean River, Mallaty Creek Leafs Gully and Nepean Creek as indicated in **Figure 18.1**.

In addition to the detailed monitoring, regular observational monitoring will be conducted across large portions of the area potentially affected by subsidence. Observations from other persons in the area will be actively sought, reported and considered. Where erosion and/or sedimentation is reported, additional monitoring and mitigation will be implemented if warranted.

18.3 MONITORING PROGRAM

For all sites, monitoring will be conducted prior to mining, at least once during mining, and at least once following mining.

Table 19.1 – Summary of Landscape Monitoring Schedule

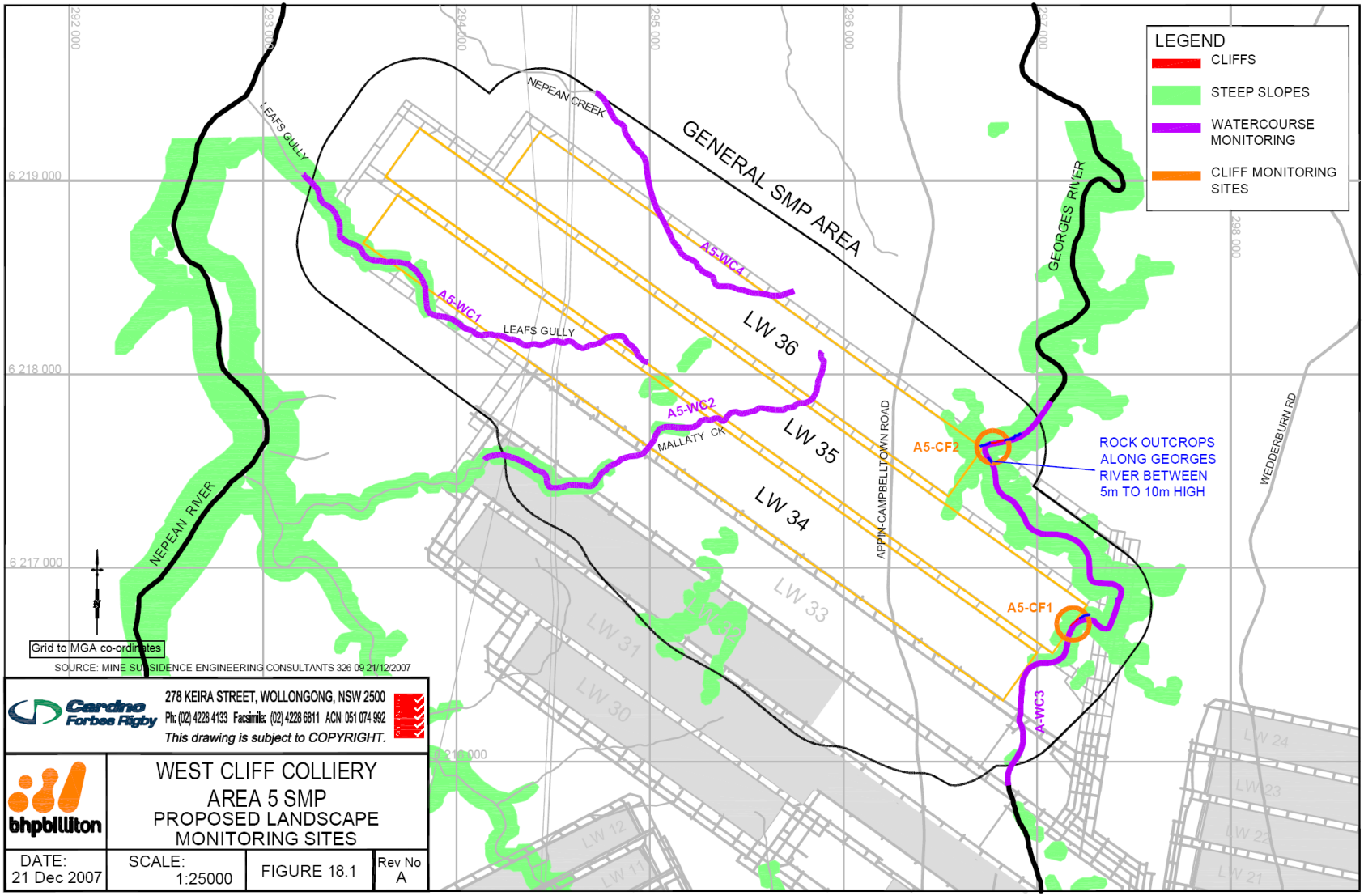
Environmental Aspect	Pre-Mining Baseline Survey Frequency	Monitoring Frequency During Mining	Monitoring Frequency Post-Mining	Reporting
Cliffs	Two	Monthly within 400m of the Georges River or during active subsidence of the ephemeral water course	Four	Via annual reports, strategy and management group meetings
Steep Slopes	Two		Four	
Watercourses	Two		Four	
		And in response to third party observations, where necessary.		

18.4 ASSESSMENT OF MONITORING RESULTS

Monitoring results will be compared against the baseline survey. Where an impact is observed the results will be subject to further assessment to determine any actions required. **Table 23.1** at the end of this document provides Trigger Levels that observations will be assessed against to determine whether an impact is within predictions (*minor)*, or exceeding predictions. This table will be considered for all monitoring sites (i.e. cliffs, steep slopes, and watercourses).

The results of the monitoring program will be used to determine whether Corrective Management Actions (CMAs) are required. If the established Trigger Levels are reached, CMAs are to be implemented. Options for CMAs consist of a number of different tools such as basic erosion controls outlined in the “blue book”, to detailed and specialist investigation of specific areas. The nature of the CMA will be determined by the trigger level.

Results of monitoring studies will be presented in separate reports and summarised in the AEMR and via strategy and management group meetings.


LEGEND
CLIFFS
STEEP SLOPES
WATERCOURSE MONITORING
CLIFF MONITORING SITES
GENERAL SMP AREA
NEPEAN CREEK
LEAFS GULLY
A5-WC4
A5-WC1
LEAFS GULLY
LW 36
A5-WC2
MALLATY CK
LW 35
LW 34
LW 33
LW 32
LW 31
LW 30
LW 12
LW 11
LW 24
LW 23
LW 22
LW 21
GEORGES RIVER
APPIN-CAMPBELLTOWN ROAD
WEDDERBURN RD
NEPEAN RIVER
A5-CF2
A5-CF1
A5-WC3
ROCK OUTCROPS ALONG GEORGES RIVER BETWEEN 5m TO 10m HIGH
292 000
293 000
294 000
295 000
296 000
297 000
298 000
6 219 000
6 218 000
6 217 000
Grid to MGA co-ordinates
SOURCE: MINE SUBSIDENCE ENGINEERING CONSULTANTS 326-09 21/12/2007
278 KEIRA STREET, WOLLONGONG, NSW 2500
Ph: (02) 4228 4133 Facsimile: (02) 4228 6811 ACN: 051 074 992
This drawing is subject to COPYRIGHT.
WEST CLIFF COLLIERY
AREA 5 SMP
PROPOSED LANDSCAPE MONITORING SITES
DATE: 21 Dec 2007
SCALE: 1:25000
FIGURE 18.1
Rev No A

19. AQUATIC ECOLOGICAL MONITORING AND MANAGEMENT

Impact assessment and monitoring of aquatic habitats and biota will be conducted in program is detailed in **Appendix C** and summarised below.

19.1 OBJECTIVES

The key objectives with respect to aquatic ecology are to:

- Recommend methods for monitoring impacts from mine subsidence on watercourses.
- Identify the potential impacts on species and aquatic habitat from potential water loss or quality changes within the SMP Area.
- Describe the physical characteristics of watercourses subject to the effects of subsidence.
- To establish appropriate triggers, actions and responses related to identifying, assessing and responding to abnormal conditions related to subsidence impacts.

19.2 MONITORING

The main area of aquatic habitat within the SMP Area is approximately 2 km of the Georges River. This is a reach of permanent aquatic habitat with a variety of fish and macroinvertebrate fauna including native and exotic species. Other surface waterbodies within the SMP application area include small, unnamed drainages flowing to the Georges River and the headwaters of Leafs Gully, Nepean Creek and Mallaty Creek which flow to the Nepean River. These ephemeral waterbodies have been highly modified by the construction of farm dams and the removal of riparian vegetation and as such contain little permanent aquatic habitat.

The monitoring program consists of three sites within the Georges River along the reach of the predicted mine subsidence area and another site on the Georges River North (downstream) of the predicted mine subsidence area. The last site is in Mallaty creek inside of the predicted mine subsidence area. Replication of sampling occurs within each site appropriate to sampling methods used.

The following habitat features are recorded:

- instream features such as sequence of pools, runs and riffles,
- stream substratum,
- presence, type and extent of aquatic vegetation,
- presence of barriers to fish passage into and beyond the study area, and
- a photographic record of the habitat.

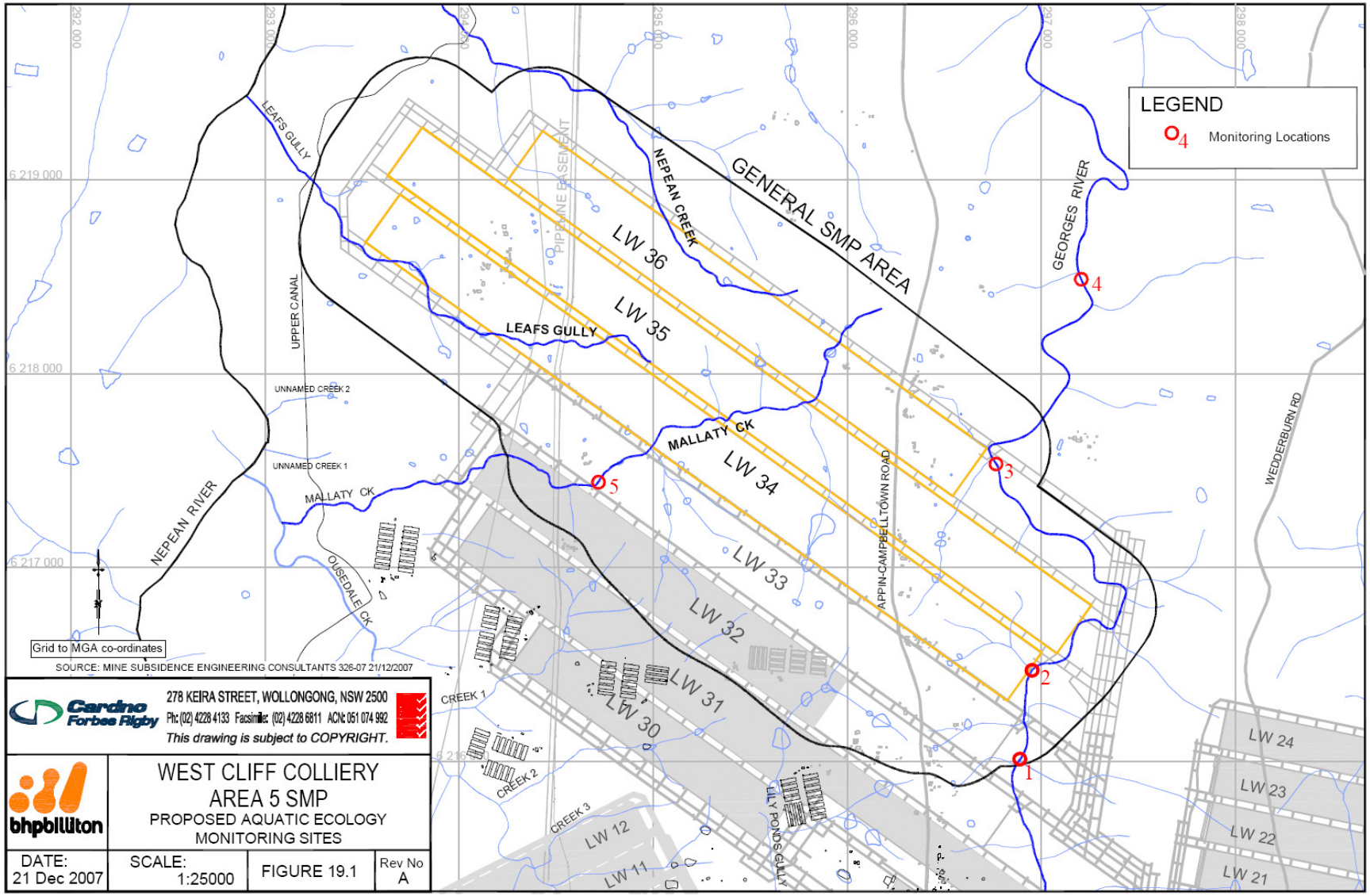
Water quality will be measured at each site using a water quality probe. Variables to be measured include; pH, dissolved oxygen, oxidation-reduction potential, temperature, turbidity and conductivity. Where applicable, the results will be compared to ANZECC (2000) water quality guidelines for the protection of aquatic ecosystems.

Fish will be sampled using a back-pack electrofisher and baited traps. At each site, six baited traps are to be deployed in a variety of habitats such as amongst aquatic plants and snags, in deep holes and over bare substratum. The back-pack electrofisher is to be operated around the edge of pools and in riffles. At each site, four, two minute shots are to be performed. Fish are to be collected in a scoop net, identified and measured. Native species are to be released unharmed whilst exotics are not to be returned to the water.

At each site macroinvertebrates will be sampled using the AusRivAS protocol developed under the National River Health Program. Where available, riffle and edge habitats will be sampled using a dip net along a 10m stretch of habitat. Samples will be sorted in the field, preserved in alcohol and transported to a laboratory for identification. Taxa will be identified to levels required for calculating SIGNAL2 values according to the AusRivAS protocol.

Reports will be produced at the conclusion of each survey that provide sufficient information to describe the habitats and biota that may be affected by subsidence.

The Principal "Trigger- Action- Response Plans" (TARPs) relate to identifying, assessing and responding to abnormal conditions related to subsidence impacts are presented in **Table 23.1.**


LEGEND
4 Monitoring Locations
GENERAL SMP AREA
LW 36
LW 35
LW 34
LW 33
LW 32
LW 31
LW 30
LW 24
LW 23
LW 22
LW 21
LW 12
LW 11
LEAFS GULLY
NEPEAN CREEK
PIPELINE EASEMENT
UPPER CANAL
UNNAMED CREEK 2
UNNAMED CREEK 1
MALLATY CK
NEPEAN RIVER
OUSEDALE CK
GEORGES RIVER
APPIN-CAMPBELLTOWN ROAD
WEDDERBURN RD
CREEK 1
CREEK 2
CREEK 3
LILY PONDS GULLY
6 219 000
6 218 000
6 217 000
282 000
283 000
284 000
285 000
286 000
287 000
288 000
Grid to MGA co-ordinates
SOURCE: MINE SUBSIDENCE ENGINEERING CONSULTANTS 326-07 21/12/2007
278 KEIRA STREET, WOLLONGONG, NSW 2500
Ph: (02) 4228 4133 Facsimile: (02) 4228 6811 ACN: 051 074 992
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WEST CLIFF COLLIERY
AREA 5 SMP
PROPOSED AQUATIC ECOLOGY
MONITORING SITES
DATE: 21 Dec 2007
SCALE: 1:25000
FIGURE 19.1
Rev No A

20. TERRESTRIAL ECOLOGY

20.1 TFFMMP OBJECTIVES

The broad objectives of Terrestrial Flora and Fauna Monitoring and Management are to:

- Detail baseline studies for terrestrial ecological values undertaken prior to mining;
- Detail monitoring programs that will be undertaken throughout the life of mining and for a time after mining.

20.2 MONITORING

Terrestrial flora and fauna monitoring is habitat based and is detailed in **Appendix D** of the SMP Application. It follows the outline below:

- threatened species database searches for a 10km radius of the study area;
- habitat level assessment and survey of the study area;
- targeted surveys for any threatened species of particular concern;
- apply subsidence predictions to the study area;
- reporting of conditions of the study area and an impact assessment for any threatened species considered likely to occur within the study area;
- seven-part tests for threatened species, populations or ecological communities and Matters of National Environmental Significance.

The monitoring program focuses on threatened species and Endangered Ecological Communities that occur within habitats that may be altered by subsidence. Based on experience within other creeks and rivers in the region that have been mined beneath it is likely that this would include species dependent on permanent flows or permanent standing water. No threatened terrestrial species reliant on such habitats have been identified within the study area. Should such species be recorded during subsequent surveys 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 it is unlikely to impact riparian vegetation and fauna habitat. The liberation of gas into the river or riparian areas will be monitored in association with the water sampling program.

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

20.3 BASE LINE STUDIES

Two baseline studies have been completed in the study area by Biosis before the commencement of mining in Refer **Appendix D**.

Seven Part Tests for threatened species listed on the TSC Act and Assessments of significance for threatened species listed on the EPBC Act were not required for flora as they do not occur in the study area. Fauna Seven Part Tests conducted by Biosis concluded that the proposed activity would be unlikely to have a significant impact on any threatened species, population or ecological community listed on the TSC or EPBC Acts. A Species Impact Statement or a Referral was not recommended for the proposed mining activities.

20.4 ENVIRONMENTAL TRIGGERS AND MANAGEMENT RESPONSE

Triggers and key management actions for terrestrial ecological values are described in **Table 23.1**.

21. HERITAGE MONITORING AND MANAGEMENT

21.1 OBJECTIVES

The objectives of the Heritage Monitoring and Management Program (HMMP) are to:

- 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 the site due to mining subsidence;
- Propose management options for any sites that may be affected by the mining proposal.

Heritage items on the site include the six Aboriginal archeological sites which will be monitored. Five of these are located along the Georges River and include four shelters with art and a shelter with art and deposit. The last Aboriginal site is located along Mallaty Creek and is a shelter with art and deposit.

The European Heritage sites include WH1-Bridge and road remains, WH2-Grave Site, WH3-House Site, WH4-Pub/cellar site. WH2 WH3 and WH4 are to have detailed recordings taken prior to mining. WH1 will be monitored prior during and after subsidence occurs.

21.2 ARCHAEOLOGICAL MONITORING

The following general schedule is proposed for the monitoring of the sites within the SMP Areas:

- *Baseline archival* recording*:* Prior to mining Longwalls 34 to 36;
- *First* impact *assessment recording:* Following initial subsidence movement of the site;
- Further *impact assessment recording:* Six months after mining under the site or final predicted subsidence movement;
- *Final* impact *assessment recording:* Twelve months after mining under the site or final subsidence movement;
- Develop an ongoing management program for any structures that may be impacted.

As discussed in the Infrastructure monitoring section, site-specific monitoring programs will be developed for the Aboriginal heritage sites along the Georges River and Mallaty Creek and the European Heritage sites near the Georges River. This will include accurate baseline recording of pre-mining condition including a detailed dilapidation assessment for any structures considered likely to be impacted.

Any impacts will be assessed by comparing the results of the impact recording stages with the baseline data. Movement at and around the site will be monitored by comparing survey results with the established array.

21.3 ABORIGINAL CONSULTATION

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.

21.4 BASELINE MONITORING

Biosis conducted baseline surveys recently for both items of European heritage significance and Aboriginal heritage significance in March 2007 (**Refer Appendix E**).

There are two aboriginal archaeological sites located on private land which have been identified within the SMP Area, the locations of which are shown in **Figure 21.1.** They are both on Sebastian holdings land are designated 52-2-2237 and 52-2-2244. These sites are described in Volume 1 of this SMP. The positions of the archaeological sites were determined using GPS and details of the sites are provided in **Table 21.1**. The remaining four aboriginal archaeological sites are located on State land.

There are four European heritage sites in total all of which are on land administered by the Department of Planning.

Table 21.1 – Archaeological Sites within or Adjacent to the SMP Area

Site ID	Site Name	Site Types
52-2-2242	Georges River No. 4	Shelter with art
52-2-2244	Georges River No 3	Shelter with art
52-2-2243	Georges River No 2	Shelter with art and deposit
52-2-2241	Georges River No 5	Shelter with art
52-2-2234	Georges River No 1	Shelter with art
52-2-2237	Ousedale Creek No 3	Shelter with art and deposit
WH1	Bridge and road remains	Transport Infrastructure
WH2	Grave site	Domestic
WH3	House site	Building Remains
WH4	Pub/cellar site	Building Remains

21.5 CONTINGENCIES

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 DEC *Guidelines for Aboriginal Heritage Impact Assessment* (Draft). The advice of the identified Aboriginal communities regarding appropriate management methodologies will form an integral part of the development of the management strategies.

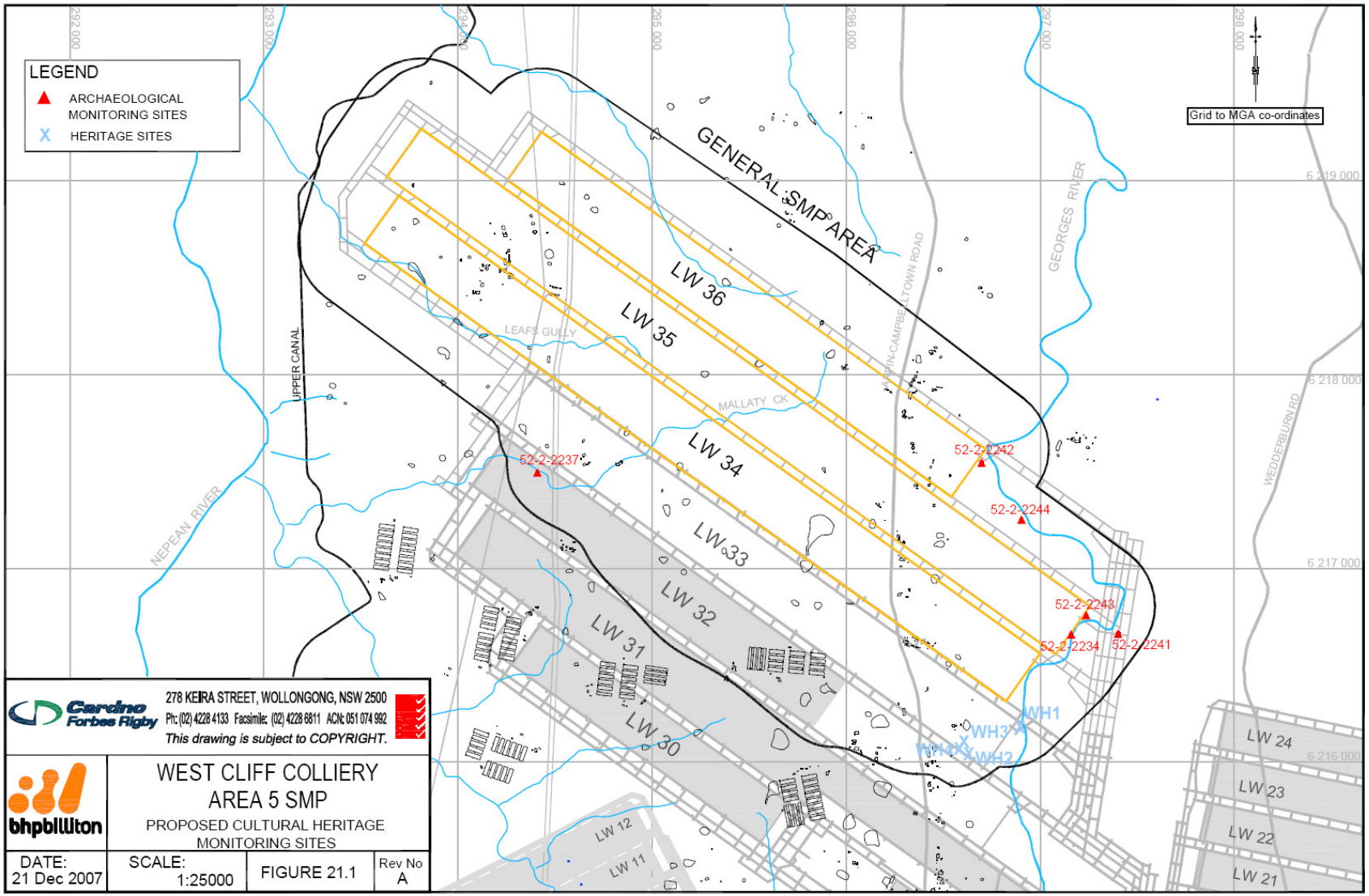
All contingent management strategies will be developed in consultation with relevant stakeholders.

21.6 REPORTING

Reports will be prepared subsequent to the completion of each work segment. The following reports will be produced in consultation with relevant stakeholders:

- findings of the comprehensive survey works;
- baseline and archival records;
- impact assessment subsequent to each monitoring activity.

The reports will include site and impact specific recommendations for management. Results of archaeological assessments will be included in the AEMR.


LEGEND
ARCHAEOLOGICAL MONITORING SITES
HERITAGE SITES
Grid to MGA co-ordinates
GENERAL SMP AREA
LW 36
LW 35
LW 34
LW 33
LW 32
LW 31
LW 30
LW 24
LW 23
LW 22
LW 21
LW 12
LW 11
LEAFS GULLY
MALLATY CK
UPPER CANAL
NEPEAN RIVER
GEORGES RIVER
WEDDERBURN RD
52-2-2237
52-2-2242
52-2-2244
52-2-2243
52-2-2234
52-2-2241
WH1
WH2
WH3
278 KEIRA STREET, WOLLONGONG, NSW 2500
Ph: (02) 4228 4133 Facsimile: (02) 4228 6811 ACN: 051 074 992
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WEST CLIFF COLLIERY
AREA 5 SMP
PROPOSED CULTURAL HERITAGE MONITORING SITES
DATE: 21 Dec 2007
SCALE: 1:25000
FIGURE 21.1
Rev No A

22. MANAGEMENT AND REHABILITATION

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

- natural features including creeks and drainage lines and associated ecosystems;
- infrastructure (particularly the gas lines and treated water gravity main and possibly the 330Kv transmission line);
- Aboriginal heritage 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. The implementation of remedial or adaptive management measures would be assessed through the results of the monitoring programs outlined in the SMP and additional detailed assessments as required. 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.

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 substantial rehabilitation works, nor would adaptive management measures such as changes to the mine plan for subsequent longwalls be required. Notwithstanding this, Illawarra Coal recognises that the mitigation, rehabilitation and monitoring measures proposed in this SMP are an integral part of the proposed mining activity.

22.1 OBJECTIVES OF MITIGATION, MANAGEMENT AND REMEDIATION MEASURES

The aims of the mitigation, management and remediation measures include:

- carrying out remediation works in a manner that protects to the greatest practicable extent the ecological values of the area;
- 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 and pools functioning in a similar manner to the pre-impact state;

- having surface flows and pool 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;
- monitoring and reporting effectiveness of the program.

To achieve these aims, mitigation, management and remediation techniques have been incorporated into the mining activity proposed by Illawarra Coal.

22.2 SUMMARY OF IMPACTS AND MANAGEMENT/REMEDIATION MEASURES

Subsidence levels and potential impacts for key natural features are provided below, together with a summary of the avoidance, mitigation and contingent measures proposed to manage impacts where predicted impacts are exceeded. Specific details on contingent remediation measures are provided in the Section 23.1.

Table 22.1 - Predicted Maximum Subsidence and Potential Impacts and Mitigation to Natural Features

Description of Item	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
Georges River ***(Flow)***	Maximum subsidence 200mm, maximum upsidence 210mm	**Predicted Impacts** Minor fracturing in the bed. **Impacts Exceeding Those Predicted** Major fracturing in the bed or rockbars leading to significant surface water loss.	**Avoidance & Mitigation** Avoid mining directly under the Georges River to avoid major fracturing and loss of surface flow. **Contingent Measure** Grouting and repair of significant surface water controlling features where it is appropriate to do so in consultation with DPIM, DECC and other stakeholders. If impacts exceed 'predicted' levels, then an 'adaptive management' approach will be considered for future longwalls to prevent further instances of exceedance of predicted impacts. Adaptive management may include, but not be limited to, relocating the finishing line

Description of Item	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
			of the longwall away from the Georges River.
Ephemeral watercourses ***(Flow)***	Maximum cumulative subsidence 1185mm, maximum upsidence 660mm	**Predicted Impacts** Loss of water from pools to the near surface sub-strata in some areas. **Impacts Exceeding Those Predicted** Major fracturing in the creek beds leading to total surface water loss.	**Contingent Measure** Grouting and repair of significant surface water controlling features where it is appropriate to do so in consultation with DPIM, DECC and other stakeholders.
Cliffs	Maximum subsidence at the two cliffs: GR-CF01 - 135mm GR-CF02 - 30mm	**Predicted Impacts** Infrequent isolated rock falls estimated to occur along 10% of the cliff lines. **Impacts Exceeding Those Predicted** Frequent rock falls occurring along >10% of the cliff lines or large /massive cliff failures.	**Avoidance & Mitigation** Monthly monitoring during subsidence **Contingent Measure** Scaling rocks loosened by subsidence where they present safety risks. Signage & Fencing where they present safety risks. Communication strategy to stakeholders where they present safety risks 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.

Description of Item	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
Steep slopes	Maximum predicted subsidence 1250mm	**Predicted Impacts** Some impacts such as minor cracking and erosion are possible if slopes are marginally stable. **Impacts Exceeding Those Predicted** Large cracks, large compressive ridges or mass movements causing significant erosion if left untreated	**Avoidance & Mitigation** Monthly monitoring during subsidence **Contingent Measure** 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. Signage & Fencing where they present safety risks. Communication strategy to stakeholders where they present safety risks Monitoring – event specific mitigation and rehabilitation. If impacts exceed 'predicted' levels, then an 'adaptive management' approach will be considered for future longwalls to prevent further instances of exceedance of predicted impacts. Adaptive management may include, but not be limited to, relocating the finishing line of the longwall away from the Georges River.
Aquatic fauna and flora	Indirect effect from subsidence. -Permanent Maximum subsidence 200mm, maximum upsidence 210mm -Ephemeral Maximum cumulative subsidence 1185mm, maximum upsidence 660mm	**Predicted Impacts** Impacts on fauna are possible due to 'loss' of water from pools. Impacts on vegetation expected to be very small. **Impacts Exceeding Those Predicted** Major reduction in pool water level or complete loss of pool water. Major reduction in aquatic habitat for an extended timeframe or complete loss of habitat.	**Avoidance & Mitigation** Avoid mining directly under the Georges River to avoid major fracturing and loss of surface flow. **Contingent Measure** Grouting and repair of significant surface water controlling features where it is appropriate to do so in consultation with DPIM, DECC and other stakeholders. Active preservation of life such as relocation of stranded fish.

Description of Item	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
		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. If impacts exceed 'predicted' levels, then an 'adaptive management' approach will be considered for future longwalls to prevent further instances of exceedance of predicted impacts. Adaptive management may include, but not be limited to, relocating the finishing line of the longwall away from the Georges River.
Terrestrial fauna and flora including endangered ecological communities	Subsidence varies greatly over the subsidence area. Maximum Subsidence 1250mm	**Predicted Impacts** Impacts on fauna are possible due to 'loss' of water in creeks. Impacts on vegetation expected to be very small. The area has been extensively studied. Two endangered ecological communities have been identified. **Impacts Exceeding Those Predicted** Large areas of impacted vegetation (by rockfalls, soil slippage) that is unlikely to commence natural regeneration within 6 months. Significant surface soil cracking or rock bar fracturing resulting in loss of standing water and or erosion in creeks or swamps. Gas emissions with extensive vegetation die off and no evidence of self regeneration.	**Avoidance & Mitigation** Monthly monitoring during subsidence. **Contingent Measure** Site rehabilitation to reinstate habitat values – increased monitoring. Remediation of subsidence related fracturing or dilation within creek beds and surface cracks where it is appropriate to do so in consultation with SCA, DPIM, DECC and other stakeholders. 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 this is practical. Temporary ecosystem maintenance such as

Description of Item	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
			watering plants until final rehabilitation completed, where this is practical. If impacts exceed 'predicted' levels, then an 'adaptive management' approach will be considered for future longwalls to prevent further instances of exceedance of predicted impacts. Adaptive management may include, but not be limited to, relocating the finishing line of the longwall away from the Georges River.
Aboriginal Places of Cultural Significance - Archaeological sites	The area contains 6 rock shelter sites with various subsidence predictions 52-2-0021 - 890mm, 52-2-2234 - 125mm, 52-2-2237 - 760mm, 52-2-1682 - < 20mm, 52-2-2242 - 70mm, 52-2-2243 - 55mm, 52-2-2244 - 40mm, 52-2-2265 - 760mm, 52-2-2266 - 225mm	**Predicted Impacts** Unlikely that the site will sustain any structural impacts. Past experience suggests the probability of impacts is less than 10%. **Impacts Exceeding Those Predicted** 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.	**Avoidance & Mitigation** Baseline, active subsidence and post mining monitoring. Appropriate consultation and approvals. **Contingent Measure** Site and event specific mitigation and rehabilitation will be developed with appropriate Aboriginal representatives, DECC and DPI. Techniques may involve installing artificial drip lines, detailed recording of art, stabilising and cleaning rock faces. Application for Section 90 Consents will be made to DECC for sites that may be impacted.
Water quality– ***Permanently Flowing Rivers (Georges River)*** ***and Ephemeral water ways*** ***-Mallaty Creek*** ***-Leafs Gully*** ***-Nepean***	Indirect effects from subsidence -Permanent Maximum subsidence 200mm, maximum upsidence 210mm -Ephemeral Maximum cumulative subsidence 1185mm, maximum upsidence 660mm	**Predicted Impacts** Impacts on water quality are possible due to reduced flow and/or increased interaction of ground and surface water. These impacts are likely to include reduced oxygen, higher dissolved ions and precipitates. There is also a possibility of lower pH and lower temperature variation as a result of groundwater inflows. **Impacts Exceeding**	**Avoidance & Mitigation** Effects are expected to be much less as a result of the longwall layout in the area that does not mine under the Georges River. **Contingent Measure** Grouting and repair of surface water controlling features and the beds of streams where fracturing is evident where it is appropriate to do so in

Description of Item	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
Creek		**Those Predicted** Major reduction in water quality when comparing baseline period to mining period, ie a > 2 standard deviation reduction in water quality apparent at downstream monitoring site when comparing pre-mining to baseline data and/or upstream samples.	consultation with SCA, DPIM, DECC and other stakeholders. Limestone emplacement down stream of emergent springs to raise pH and DO where it is appropriate to do so in consultation with DPIM, DECC and other stakeholders. If impacts exceed 'predicted' levels, then an 'adaptive management' approach will be considered for future longwalls to prevent further instances of exceedance of predicted impacts. Adaptive management may include, but not be limited to, relocating the finishing line of the longwall away from the Georges River.
Groundwater quality, quantity and levels	Effect of subsurface subsidence.	**Predicted Impacts** Impacts on groundwater are possible due to increased interaction of ground and surface water as well as increased interaction of groundwater with existing and freshly created fractures within the rock and soil mass. These impacts are likely to include reduced oxygen, higher dissolved ions and lower pH. Shallow groundwater systems are likely to be depressed by increased permeability as a result of fracturing. **Impacts Exceeding Those Predicted** Major reduction (monitoring bore dry where it has not been prior to mining) in groundwater level at the majority of bores within any particular aquifer or swamp system or complete loss of groundwater.	**Avoidance & Mitigation** Monitoring and measurement. **Contingent Measure** Mitigation of any flow-on ecological effects as described above.
Surface of the land	Subsidence varies greatly over the subsidence area. Maximum Subsidence	**Predicted Impacts** Some surface cracking and methane emissions. **Impacts Exceeding**	**Avoidance & Mitigation** Monitoring during active subsidence.

Description of Item	Predicted Subsidence	Key Potential Impacts	Avoidance, Mitigation and Rehabilitation
	1250mm	**Those Predicted** Major surface cracking and methane emissions.	**Contingent Measure** Minor civil/earthworks to prevent erosions such as overland flow diversion works, establishment of banks, smoothing and re-contouring, where this is practical. Forking over of cracks with mulching and revegetation where appropriate to prevent erosion and sedimentation impacts. Install temporary erosion and sediment controls where appropriate.
European Places of Cultural Significance	WH1-Predicted Maximum cumulative subsidence 150mm WH2- Predicted Maximum cumulative subsidence 530mm WH3- Predicted Maximum cumulative subsidence 755mm WH4- Predicted Maximum cumulative subsidence 700mm	Impacts considered to be negligible.	**Avoidance & Mitigation** Mine layouts avoid undermining the Bridge remains at WH1. Monitoring and detailed recordings to be taken. **Contingent Measure** Site and event specific mitigation and rehabilitation would be developed with appropriate stakeholders if required. This is very unlikely.

22.3 PREVENTATIVE OPTIONS

Most of the management actions listed in **Table 22.1** would be implemented after the subsidence impact has been identified. Some measures, such as grouting, would be implemented following the completion of most 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 West Cliff Area 5 have been modified to reduce the potential for impacts to surface features, particularly the Georges River. The proposed longwalls do not mine directly beneath the Georges River such that it is unlikely that significant impacts, such as major fracturing or draining of pools would occur. Longwall 34 and 36 have been shortened to avoid mining under the Georges River. Should impacts

observed on the Georges River exceed predicted levels, adaptive management techniques will be considered, such as adjustments to the length of future longwalls (i.e. Longwalls 35 and 36).

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

22.4 REHABILITATION

22.4.1 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 is 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 the streams may be required in some locations.

22.4.2 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.

22.4.3 Injection Grouting

Where creeks are fractured as a result of subsidence and there is limited ability for them to naturally seal it would be necessary to carry out remedial measures. Such remedial measures have been implemented at other locations in the Illawarra region. These measures usually include grouting to return ground water to the surface or reduce pool water loss. Grout can be delivered by small handheld equipment of 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 and used in the mining and construction industries and can be applied in these circumstances.

A number of grouts are available for use in such situations 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 and will be carefully planned to avoid contamination of watercourses. Bunds will be used to contain any spillage at mixing points. The materials used in these processes are non-toxic, environmentally inert and do not significantly impact upon the natural habitats of aquatic species.

22.4.4 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.

22.4.5 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.

22.4.6 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.

22.4.7 Surface Treatment

Surface impacts may display as cracks of varying depths and widths, erosion scares 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.

22.4.8 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;
- Filling and mulching over large cracks to prevent the development of erosion channels.

22.4.9 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.

23. PRINCIPAL TARPS

The Principal "Trigger- Action- Response Plans" (TARPs) relate to identifying, assessing and responding to abnormal conditions related to subsidence impact.

It should be noted that the Principal TARPs represent actions to be taken as each defined trigger level is reached. A **CMA** is a *corrective management action* developed in consultation with stakeholders in order to manage an observed impact in accordance with the relevant approvals. The management programme provides a basis for the design and implementation of any mitigation and remediation.

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 with monitoring results and the proposed triggers are presented in **Table 23.1**. 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.

Explanatory Notes for Proposed TARP's in Table 23.1

1. The TARP's should be read in conjunction with the West Cliff Longwall 34-36 SMP Parts A & B.

2. The TARP structure has been revised to more effectively address Condition 13 of the SMP Approval for the West Cliff Area 5 Longwalls 34 to 36 Subsidence Management Plan. As such it addressed the ephemeral streams located to the west of the Georges River Trigger Point and the Georges River separately.
3. 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 DPI.
4. Access to any monitoring site is subject to landowner authorisation and restrictions they may impose such as wet weather access. Proposed monitoring frequencies may be delayed due to wet weather.
5. Stated notification and investigation timeframes are from when triggers have been confirmed by the Manager Environment.
6. This TARP will be reviewed and any improvement opportunities will be proposed within each End of Panel report.

Specialist investigations and reports will include:

1. Scope of the study.
2. Consider any relevant aspect from this plan.
3. Analysis of trends.
4. Assessment of any impacts against prediction.
5. Root cause analysis of any change or impact.
6. Options for management and mitigation.
7. Assessment for the need for contingent measures.
8. Any recommended changes to this plan.
9. Appropriate consultation.

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

1. A description of the impact to be managed.
2. Results of the investigations.
3. Aims and objections for the plan.
4. Specific actions required to mitigate/manage.
5. Timeframes for implementation.
6. Roles and responsibilities.
7. Identification of and gaining appropriate approvals from landholders and government agencies.
8. Consultation and communication plan.

Example ***corrective management actions*** are provided in **Table 23.1** and sections 22.3 to 22.4.

23.1 CONTINGENCY PLAN AND EMERGENCY RESPONSE

The monitoring programs outlined in this SMP will identify subsidence impacts. Predicted impacts will be managed as outlined in this SMP. Contingency and emergency response options are available and will be implemented if environmental, infrastructure or public safety impacts are demonstrated to be greater than predictions. This SMP details the actions that will be undertaken to respond to adverse subsidence impacts and this is summarised in **Tables 22.1 and 23.1**. The following framework will be used to implement these actions.

The subsidence management framework involves the following components:

- Identifying features/values of significance and impact prediction – to determine the range of possible events and impacts;
- Risk assessment – in terms of determining the probability and consequence of an event occurring;
- Defining triggers and trigger levels for features/values affected and/or the identified events/impacts;
- Defining and implementing environmental monitoring;
- Identifying responses/actions to be taken when different triggers and trigger levels are reached. These include response measures and actions relating to avoidance, minimization, mitigation and compensation and contingency plans and emergency responses;
- Identifying roles and responsibilities of various stakeholders;
- Assessing measured with predicted impacts as mining progresses for features/values affected and implement responses/actions identified based on triggers and various pre-defined 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 and, if in exceedance of impact predictions, prevention of further exceedances.

23.2 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;
- Specific information in the AEMR.

A key aspect of the specific infrastructure management plans eg Public Road and Pipelines and the Property Subsidence Management Plans is the management of public safety.

23.3 ENVIRONMENT

The impacts resulting from subsidence occur gradually and affect a relatively small area of the surface above the longwall. 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 colliery licensed discharges
- Relocation of fauna and fish.
- Temporary maintenance of individual species such as watering aquatic plants.
- Provision of compensatory habitat.
- Timing of works.
- Staged work programs.
- 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 watercourse 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.

24. STAKEHOLDER CONSULTATION PROCESS

This plan has been prepared in consultation with key stakeholders. Consultation with infrastructure owners has been ongoing for a number of years in relation to mining in West Cliff Area 5.

There will also 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.

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.

25. REFERENCES

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The Ecology Lab (2008). *West Cliff Colliery Area 5 Longwalls 34 to 36 Assessment of Mine Subsidence Impacts on Aquatic Habitat and Biota.*

26. BASELINE DATA – GEORGES RIVER

See attached baseline data files in attached CD. Statistical anaysis of these data has been undertaken to determine the mean and standard deviations of baseline water quality data.:

- Georges River ALS (laboratory parameters) results
- Georges River Field Data
- Georges River Flows
- Leafs Gully ALS (laboratory parameters) results
- Leafs Gully Field Data
- Mallaty Creek (laboratory parameters) results
- Mallaty Creek Field data
- Nepean River Field data
- Nepean River (laboratory parameters) results
- Nepean River Field data