



Dendrobium Mine

Subsidence Landscape Monitoring and Management Program – Area 3

Six Monthly Monitoring Report (February 2011 – July 2011)



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Executive Summary

This document fulfils the requirements for reporting the outcomes of the third six monthly monitoring of the land potentially affected by subsidence above Longwall 6 and Longwall 7 in Area 3A at Dendrobium Mine. It covers the monitoring period of February 2011 to July 2011 which included inspections of all monitoring sites established under the SLMMP above Longwall 6, Longwall 7 and Longwall 8. The inspections which are described in the report are up until the 15th July and any impacts reported after this date will be included in subsequent Subsidence Landscape Monitoring and Management Reports.

Coal extraction commenced in Longwall 6 in February 2010 and was completed on 2nd April 2011. Extraction of Longwall 7 commenced in late April and has progressed approximately 725m since this time (as at 23/7/2011). There have been 19 new impacts identified during this monitoring period related to the extraction of both Longwall 6 and Longwall 7. Re-activation of four previously reported impacts over the western end of Longwall 7 within watercourse A3-WC1 has also occurred. This has brought the total number of recorded surface impacts to 99 within Area 3A.

Five newly identified impacts (over this monitoring period) and the re-activation of the four previously identified impacts have occurred within the SLMMP creekline monitoring site A3-WC1. The impacts include seven rock fractures, one rock movement and one rockfall. The rock fractures have mainly occurred within the sandstone bedrock of the creekline. There has been no direct observed loss of surface water or direct flow diversion at each of the impact sites, however, compared to observations made during the baseline period, there is a section of the creek with reduced surface flow and ponding. Surface flow is observed to re-surface downstream and contains elevated levels of iron oxide staining. Some of the impacts are continuing to show movement and are recommended to be regularly monitored over the following months if safe to do so.

Due to access restrictions based on safety concerns, the rockfall which has occurred at an overhang on WC1 is yet to be closely inspected. Based on observations made from a safe distance away, the total volume of the rockfall is predicted to be approximately 240m³. There has been no further movement noted at the site since the initial fall was observed, with water continuing to flow over the rock overhang.

Seven of the newly identified impacts occurred over the western end of Longwall 6 during Longwall 6 extraction. All the impacts were fractures in outcropping sandstone boulders ranging from hairline to 35mm in width.

Rock fracture (Site ID DA3LW7_099) was identified over Longwall 6 near previously identified impacts. It is likely that the rock fracture resulted from residual movements of the Longwall 6 goaf during the extraction of Longwall 7. No other previously identified impacts from Longwall 6 were found to have become re-activated as a result of Longwall 7 extraction.

Four impacts were identified near the eastern end of the SLMMP monitoring steep slope site A3-SL3, above creekline A3-WC1. The area to the west of these impacts (which includes A3-SL3) is yet to be monitored due to safety concerns throughout this area. The area contains many steep rocky outcrops and rock ledges which were deemed unsafe to inspect due to recent undermining

and heavy rains potentially causing them to become unstable. This area will be inspected once restrictions are removed.

Some of the impacts described in this report are not well defined under the Landscape Impact Assessment Trigger Values or the Watercourse Management Plan TARP. In light of this issue, BHPBIC are currently undertaking a review of the relevant Impact Assessment Trigger Values and TARPs which will include consultation with stakeholders. In light of this process, it may result in re-consideration of the SLMMP triggers.

Corrective Management Actions are not required or recommended at this stage. Impact levels will be assigned to each impact once the review has been finalised.

It is recommended that monitoring continue in accordance with the SLMMP monitoring schedule. Additional regular inspections (subject to catchment access) of the impacts which have been identified along WC1 are recommended to be undertaken by the BHPBIC Field Team until such time that no further movement is observed. A closer inspection of the rockfall (DA3LW7_091) should also be undertaken once deemed safe to do so.

TABLE OF CONTENTS

1.0 INTRODUCTION	5
1.1 BACKGROUND	5
1.2 SCOPE AND OBJECTIVES	5
2.0 MONITORING AND MANAGEMENT METHODOLOGY	7
3.0 MONITORING SITES	8
4.0 MONITORING METHODS	9
4.1 GENERIC METHODS - ALL MONITORING SITES	9
4.2 SPECIFIC METHODS - WATERCOURSE SITES	10
4.3 LAND CAPABILITY	10
4.4 SCHEDULE	10
4.5 PERSONNEL	11
5.0 RESULTS	12
5.1 MONITORING RESULTS FOR SPECIFIC SLMMP MONITORING SITES	12
5.2 MONITORING RESULTS FOR THE GENERAL AREA	16
5.3 LAND CAPABILITY	18
6.0 RECOMMENDATIONS FOR MONITORING AND MANAGEMENT	19
7.0 REFERENCES	20

APPENDICES

Appendix A	Monitoring Schedule of SLMMP Monitoring Sites
Appendix B	Photos

ABBREVIATIONS

BHPBIC	BHP Billiton Illawarra Coal
CMA	Corrective Management Action
GSSE	GSS Environmental
SLMMP	Subsidence Landscape Monitoring and Management Program
SMP	Subsidence Management Plan
TARP	Trigger Action Response Plan

1.0 INTRODUCTION

1.1 Background

BHP Billiton Illawarra Coal (BHPBIC) received Development Consent to construct and operate the Dendrobium Underground Coal Project from the then Department of Urban Affairs and Planning on the 20th November 2001. The Consent was modified under Section 75W of the Environmental Planning and Assessment Act by the Minister for Planning on the 8th of December 2008. The Dendrobium Mine is near Wollongong and involves the underground mining of coal from three areas known as Areas 1, 2 and 3.

Extraction of coal from Area 1 commenced in April 2005 and concluded in January 2007. Extraction of coal from Area 2 commenced in March 2007 and concluded on the 18th December 2009. Extraction of coal from Area 3 commenced on the 9th February 2010 and is currently underway.

A Subsidence Landscape Monitoring and Management Program (SLMMP) has been prepared for all three areas of the Dendrobium Mine. Requirements of the SLMMP include undertaking a baseline survey to be completed prior to mining with subsequent monitoring and management during and following mining. For Area 3, the SLMMP is contained in Part B of the Subsidence Management Plan (SMP) (Cardno, 2007). The SMP was given conditional approval from the Department of Planning on the 24th of December 2009.

The proposed monitoring program detailed within the SLMMP includes, pre-mining baseline monitoring of all Area 3A sites, six monthly monitoring of sites above the panel currently being mined and previously mined under sites, and monthly monitoring of the active subsidence area.

This document fulfils the requirements for reporting the outcomes of the third, six monthly monitoring of the land potentially affected by subsidence above Longwall 6 and Longwall 7, and covers the period of February 2011 to July 2011. Longwall 6 was the first panel to be mined within Area 3A and was completed on 2nd April 2011. Extraction of Longwall 7 commenced in late April and has progressed approximately 725m since this time (as at 23/7/2011).

1.2 Scope and Objectives

The objective of this report is to provide the six monthly reporting required in accordance with the SLMMP. In particular:

- All monitoring and management is to be completed in a manner consistent with the methodology detailed within the SLMMP;
- All relevant sites identified in the SLMMP (and as subsequently modified) are to be monitored;
- The monitoring is to be undertaken in accordance with the methods described in the SLMMP; and
- The monitoring and management outcomes are to be documented in accordance with the reporting requirements described in the SLMMP.

The monitoring site locations have been updated to those presented in the SLMMP for Area 3 due to subsequent ground truthing. The sites presented in the SLMMP were based on desktop

information only and have been adjusted based on field observations during the first baseline survey. For example, some predicted steep slopes were found to be an outcrop of rock rather than a steep soil slope. For this reason, not all steep sloped monitoring sites presented suitable areas for detailed geomorphological monitoring via a steep slope quadrant. The adjusted SLMMP monitoring sites are presented in **Section 3** and supersede those presented in the SLMMP (Part B, Section 19.3.3 of the SMP for Area 3 (Cardno, 2007)).

This report describes the monitoring undertaken and the impacts that have been observed in the period of February 2011 to July 2011. **Table 1** below contains the monitoring reports that have been incorporated into this six monthly report.

Table 1 – Summary of Reports Used to Compile this Six Monthly Report

Monitoring Date:	Undertaken By:	Report Detailing Results of Monitoring:
Monthly SLMMP Monitoring		
10 th February 2011	BHPBIC Field Team	Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report February 2011 (BHP Billiton Illawarra Coal, February 2011);
11 th March 2011	BHPBIC Field Team	Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report March 2011 (BHP Billiton Illawarra Coal, March 2011);
12 th April 2011	GSSE	Dendrobium SLMMP - Area 3 Quarterly Monitoring Report February – April 2011 (GSSE, May 2011);
2 nd May 2011	BHPBIC Field Team	Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report May 2011 (BHP Billiton Illawarra Coal, May 2011);
21 st June 2011	BHPBIC Field Team	Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report June 2011 (BHP Billiton Illawarra Coal, June 2011);
13-15 th July 2011	GSSE	This six monthly report
Additional General Routine Inspections (outside requirements of SLMMP)		
24 th May 2011	BHPBIC Field Team	Dendrobium Area 3A Longwall 7 Impact Report – 24 th May 2011
7 th June 2011	BHPBIC Field Team	Dendrobium Area 3A Longwall 7 Impact Report – 7 th June 2011
21 st June 2011	BHPBIC Field Team	Dendrobium Area 3A Longwall 7 Impact Report – 22 nd June 2011
28 th June 2011	BHPBIC Field Team	Dendrobium Area 3A Longwall 7 Impact Report – 8 th July 2011
13 th July 2011	BHPBIC Field Team	Dendrobium Area 3A Longwall 7 Impact Report – 13 th July 2011

2.0 MONITORING AND MANAGEMENT METHODOLOGY

Monitoring Sites

A risk based approach was adopted as part of the SLMMP to identify those landscape features at greatest risk of impacts, including erosion and/or sedimentation resulting from mining induced subsidence. Monitoring sites were selected in the SLMMP to represent each landscape feature, based on the area having the highest risk of experiencing impacts as a result of subsidence. The monitoring sites are listed in **Section 3.0**.

Baseline Survey & Monitoring Program

The primary aim of this monitoring program is to record subsidence impacts such as cracking, mass movement, erosion and/or sedimentation within the mining area.

Two baseline surveys (GSSE, 2010a) were undertaken for each monitoring site to establish their condition prior to mining. These baseline surveys are used as a reference when measuring any impacts during or following mining.

The Area 3A monitoring program will be implemented throughout the entire period of mining, and for a two year period following the completion of mining, or other period agreed to with relevant stakeholders.

This monitoring report is the third six monthly report for Area 3. Whilst primary extraction of coal (first workings) commenced in April 2008 it was not until February 2010 (when mining within Longwall 6) commenced that sufficient coal was extracted to result in subsidence movements at the surface.

Corrective Management Action (CMA)

The results of the monitoring program are used to determine whether CMAs are required. Trigger Levels have been established in the SLMMP, which if reached, require CMAs to be considered and implemented.

Reporting

The reporting requirements for all monitoring and management actions have been identified and documented in the SLMMP. All reporting will be consistent with the requirements of the Development Consent.

3.0 MONITORING SITES

This six monthly monitoring includes inspection of all monitoring sites within the area underlain by Longwalls 6, 7 and 8 established under the SLMMP, some of which have subsequently been modified during the baseline surveys.

In addition to the monitoring sites, the following areas are also subject to inspection and observation:

- Areas of steep slopes that are on route or near formal monitoring sites;
- Rock outcrops that are on route or near formal monitoring sites;
- Any other sites where impacts have been previously observed that warrant follow-up inspection; and
- The general areas above the current mining location.

Figure 1 shows the location of the monitoring sites and the general area inspected by GSSE during the period of February 2011 to July 2011. It should be noted that the general area inspected by the BHPBIC Field Team personnel during their routine monitoring is more extensive than that covered by GSSE and includes many areas not inspected by GSSE. This area is not shown on **Figure 1** as it includes both routine and ad-hoc inspections which are not always tracked by GPS.

Table A in **Appendix A** shows the sites monitored during the period of February 2011 to July 2011 for this six monthly monitoring, and all previous monitoring and baseline survey inspection events by both GSSE and the BHPBIC Field Team. It must be noted that due to access restrictions to steep slope SL3 for safety reasons, only photo point 3 was monitored during the June and July SLMMP monitoring inspections. The remaining sites will be monitored over following months once deemed safe to enter the area.

4.0 MONITORING METHODS

The monitoring methods described in this section allow for the measurement of any erosion and/or sedimentation impacts resulting from subsidence.

The monitoring sites are subject to comprehensive investigation as described below, and the wider area around the monitoring site is subject to inspection and visual observations during monitoring events.

Observations on landform and land surface at the monitoring sites have been recorded in accordance with the Australian Soil and Land Survey, Field Handbook, 2nd Edition (McDonald, Isbell, Speight, Walker and Hopkins, 1990). The generic survey methods that are implemented for all monitoring sites is described in **Section 4.1** below, and those additional methods specific to watercourse monitoring are described in **Section 4.2** below. Land Capability is assessed in accordance with the methods described in **Section 4.3**.

4.1 Generic Methods - All Monitoring Sites

An area large enough to cover the landform element has been surveyed. The Field Handbook recommends that an area of about 1,256m² (circle of 20m radius) be adopted to cover the attributes of a landform element. The extent of each monitoring site was determined during the first baseline survey, with consideration of the erosion and/or sedimentation potential, accessibility and visibility of the site. The extent of each site has been identified with semi-permanent markers (i.e. star pickets), and its location has been recorded using GPS coordinates. The GPS coordinates provided are approximate only, as the accuracy of the handheld GPS was significantly reduced as a result of the dense canopy cover at many monitoring locations.

Observations have been made of the landform elements in accordance with the Landform section of the Field Handbook. The landform element has generally been described in terms of the following attributes:

- Slope;
- Morphological type;
- Dimensions;
- Mode of geomorphological activity; and
- Geomorphological agent.

In addition, observation has been made of the land surface in accordance with the Land Surface section of the Field Handbook. The land surface has generally been described in terms of the following attributes:

- Aspect;
- Elevation;
- Drainage height;
- Disturbance of site;
- Micro relief;

- Erosion;
- Aggradations;
- Inundation;
- Coarse fragments;
- Rock outcrop;
- Depth to free water; and
- Runoff.

Attributes have been described in accordance with the methods in the Field Handbook. It should be noted that not all attributes for Landform Element and Land Surface referred to in the Field Handbook have been recorded for each monitoring site. The previous monitoring experience for Area 1 has shown that many of the attributes are of little importance to the SLMMP, and the monitoring for Area 2 and Area 3 has focused on recording those attributes and characteristics that are most relevant to the recording of erosion characteristics.

Photographic records of the sites have been taken in accordance with the techniques outlined in *Appendix C* of the SLMMP.

4.2 Specific Methods - Watercourse Sites

A watercourse reach of between ten and twenty times the channel width has been monitored so that the length will cover local geomorphological units (e.g. pool/riffle).

For each watercourse monitoring site, a range of measurements and observations of the watercourse characteristics have been recorded along with established photo points. Measurements and observations have been made which incorporate the relevant parts of the Field Handbook, and relevant parts of the Riparian-Channel-Environmental Assessment (RCE) (Peterson, 1992).

4.3 Land Capability

A Land Capability assessment of the predicted subsidence zone above Area 3 has been undertaken in accordance with the DNR rural land capability assessment system. This system classifies land on the basis of increasing soil erosion hazard and decreasing versatility of use.

4.4 Schedule

To enable natural trends in erosion and/or sedimentation to be observed and recorded, two baseline surveys of each monitoring site were undertaken, scheduled approximately six months apart.

The monitoring program includes six monthly monitoring of sites above the panel being mined and previously mined under sites, and monthly monitoring of the active subsidence area.

Monitoring would continue to be conducted six monthly for two years following the completion of mining. The post-mining Land Capability assessment will be conducted two years after the completion of mining.

4.5 Personnel

GSSE completed the fieldwork for both the baseline surveys. Since this time GSSE have undertaken three quarterly and two six monthly monitoring rounds with the BHPBIC field team undertaking the required SLMMP monthly monitoring on remaining months. This monthly monitoring is also supplemented by routine (weekly subject to catchment access) subsidence inspections undertaken by the BHPBIC field team in areas overlying Longwall 6 and 7.

5.0 RESULTS

There have been a total of 19 new impacts identified during this monitoring period from February 2011 to 15th July 2011. This has brought the total number of recorded surface impacts to 99 associated with the extraction of Longwalls 6 and 7 in Area 3A. The majority of these impacts are located above Longwall 6, although there have been 14 impacts located over the first 520m of Longwall 7. Impacts DA3LW6_001 – DA3LW6_080 have been previously reported in the February 2010–July 2010 Six Monthly Monitoring Report (GSSE, 2010b) and the August 2010–January 2011 Six Monthly Monitoring Report (GSSE, 2011a). Of these 80 previous recorded impacts, four have been identified as being re-activated over the recent six month monitoring period, all of which are located within SLMMP monitoring site A3-WC1.

Note – Impacts with site IDs DA3LW6_041, DA3LW6_042, and DA3LW6_043 were incorrectly reported as not being impacts in the previous quarterly report produced by GSSE (GSSE, 2011b). This was due to a database error which has since been rectified.

A summary of the monitoring results during the period from February 2011 to July 2011 is discussed below. Select photos of sites where new impacts were observed, or existing impacts that have been identified as becoming re-activated during the monitoring period, have been included in **Appendix B. Figures 1, 2 and 3** show the locations of the observed impacts including previously reported impacts and impacts observed during this monitoring period. For further detail on the impacts which have been identified by the BHPBIC Field Team, refer to their impact reports.

5.1 Monitoring Results for Specific SLMMP Monitoring Sites

For each SLMMP monitoring site inspected, the observations and monitoring data have been compared to the baseline survey data to identify any subsidence related impacts.

Of the 19 new impacts identified during this monitoring period, five are located within the specific SLMMP monitoring sites and are detailed below. Those located outside the specific SLMMP sites are detailed in **Section 5.2**.

Steep Slopes – Rock Ledge Only

- **A3-SL2** – No impacts have been observed for this monitoring site.
- **A3-SL3** – No impacts have been observed for this monitoring site. For safety reasons, the only section of this steep slope monitored during the June and July SLMMP monitoring inspections was photo point 3 located at the far eastern end of the site. The remaining sites will be monitored over the following months once deemed safe to enter the area.

There have been four new impacts located in close proximity to the eastern end of A3-SL3 (as shown on **Figure 2**). These impacts are described below in **Section 5.2**.

- **A3-SL5** – No impacts have been observed for this monitoring site.

Steep Slopes

- **A3-SL1** – No impacts have been observed for this monitoring site.
- **A3-SL4** – No impacts have been observed for this monitoring site.

Creeklines

- **A3-WC1** – Five new impacts have been observed during the recent monitoring period in addition to the four impacts previously reported in the August 2010 to January 2011 six monthly report (GSSE, 2011a) bringing the total to nine. The impacts include one rockfall and eight rock fractures. Of the four previous reported impacts, three of these impacts have become re-activated as a result of Longwall 7 extraction. The impacts are shown on **Figure 2**. Of the nine impacts along the watercourse, seven have occurred at official photo sites set up along A3-WC1 which has assisted with identification of impacts and allowed comparison to baseline data. There has been no erosion or sedimentation observed as a result of the cracking.

It was noted during the site visit on 14th to 15th July 2011, based on visual observations only, that watercourses WC2, WC3 and WC4 were conveying a flow similar to that observed during the July 2009 baseline survey, however for WC1, it was observed that there was no flow within the mid-reaches of the monitored section of creekline. Surface flow was absent from photo point 4 to 80m downstream of photo point 5. The amount of ponded water within this section was also reduced. Surface flow was observed upstream of this section (including at photo point 1). Surface flow was observed downstream of this section (including at photo point 6), which is assumed to be a result of the re-emergence of sub-surface flow. This surface flow contained iron oxide staining which has been previously reported in the BHPBIC impact reports from the 7th June and 8th July. No individual impact has been found to be the direct cause of the reduction in surface flows, however, collectively the impacts are assumed to be associated with the reduction in surface flows. It is noted that BHPBIC are undertaking a review of the Watercourse Management Plan Trigger Action Response Plan (TARP) in consultation with stakeholders and following this review, impact levels will be assigned.

The individual impacts identified within the creekline are described below with photos of all the impacts contained in **Appendix B** for reference:

- **Site ID DA3LW6_038:** Reactivation of this impact as a result of Longwall 7 extraction has occurred since originally identified in October 2010. Additional movement was first identified on the 7th June 2011 by the BHPBIC Field Team. Movement has been observed in the original fracture planes running along a bedding plane of a small sandstone step together with new fractures developing in the creekline bedrock nearby. The fracturing is between 1mm and 160mm wide. The widest fracture extends for approximately 2.5m and runs roughly parallel to the creekline. Some uplifting of the bedrock is present at the end of the widest fracture. No surface flow has been observed in this section of creek during June and July with no specific flow diversion observed at this location. The impact is considered active with changes in the fracturing observed when revisited on the 21st June and again on the 14th July.
- **Site ID DA3LW6_041:** There has been no further movement observed to the impact site as a result of Longwall 7 extraction. The impact is located in the section of the creek which has iron staining and was inundated with water. At the impact site there is no apparent redirection of surface flow or erosion;
- **Site ID DA3LW6_042:** Reactivation of this impact has occurred with the extraction of Longwall 7. The impact was originally identified in December 2010 as a

horizontal fracture extending across the face of a 1.2m sandstone step. During an inspection carried out 24th May 2011 by the BHPBIC Field Team, further movement has occurred at the site. The fracture had resulted in a slump of the sandstone bed. Further fracturing has been identified both immediately upstream and downstream of the dislodged rock ledge. The impact is considered active with changes continuing to be observed at the impact site. A summary of observations at the impact site is outlined below to demonstrate the movements observed;

- 24th May 2011 – fracturing immediately upstream of the sandstone step was first identified. The fracturing extended for around 2m and had a maximum open width of 10mm. The fracturing had resulted in minor flow diversion along approximately 4m of the stream with flow observed upstream and downstream of the fracturing. Iron staining was observed at the site;
 - 7th June 2011 – Further movement was observed in the upstream fracturing with compression movements resulting in a 1m length of shearing approximately 200m to 400mm wide. Additional fracturing was identified below the sandstone step both above and within a pool (BHPBIC Pool 12). Uplift and compression along bedding planes had resulted in a network of fractures between 1mm and 50mm wide. There was a reduction in the water level of the pool when compared with baseline monitoring at the site. Increase iron staining was observed at the site from a small spring;
 - 21st June 2011 – There was a continued decrease in the water level within the pool. Surface inflow and subsurface outflow was observed;
 - 28th June 2011 – No water was held within the pool with seepage observed around the monitoring site. Downstream flow was not affected however; and
 - 14th July 2011 – Further slight movement of certain fractures is believed to have occurred when comparing the photos taken of the impacts during late May and June. The pool was dry with no ponding or flow observed in this section of the creek. Surface flow did reappear approximately 130m downstream between SLMMP photo points 5 and 6. The iron staining had reduced with seepage close to stopping (area around the seep was still slightly damp).
- **Site DA3LW6_043:** This impact was first recorded as an impact in December 2010 associated with the extraction of Longwall 6. The impact consists of rock fracturing and displacement below a rock overhang (SLMMP photo point 5). Further shearing at the base of the overhang was observed by the BHPBIC Field Team on the 7th June 2011, believed to be caused by Longwall 7 extraction. There is no apparent loss in surface water or significant erosion at the site;
 - **Site DA3LW6_088 and DA3LW7_91:** Impact DA3LW6_088 was first identified on the 4th March 2011 and reported in the February 2011 to April 2011 Quarterly Monitoring Report (GSSE, 2011b). The impact site is located at SLMMP photo point 6. The impact was a hairline fracture which extended for approximately 2m along an existing joint line within the sandstone bedrock. The sandstone formed part of

an overhang which was approximately 10m high and up to 10m deep. On the 21st June, the BHPBIC field crew located a rockfall which had occurred at the overhang.

The rockfall has been given a new site ID number DA3LW7_091 to signify that the longwall of influence is Longwall 7, not Longwall 6 which is believed to have caused the original hairline fracture. Surface flow was observed over the rock ledge and could be heard flowing at the base of the rockfall when inspected by GSSE on the 14th July 2011. The rockfall is approximately 350m from Wongawilli Creek.

Due to safety concerns, the dimensions of the rockfall presented below are approximate only with observations made from a safe distance away. The length of the dislocation causing the rockfall is approximately 15m long with a vertical collapsed area of 4m. A section of the dislodgement is along the hairline fracture in the joint line of the sandstone rock (DA3LW6_088). Based on these observations, the volume of the rockfall is approximately 240m³. There have been some tree falls as a result of the fallen rock but the extent of the ground disturbance could not be determined due to obstructions in the view from safe vantage points. Further details and updates of the above estimated dimensions regarding the extent of the disturbance will be reported in future monitoring reports.

- **Site DA3LW6_092:** Rock fracturing was observed in a section of the creek sandstone bedrock, slightly upstream of SLMMP photo point 4. It was identified by the BHPBIC Field Team on the 21st June and was reinspected by GSSE again on the 14th July. There was no additional movement observed to that first reported with the fracturing 5m long with a maximum uplift of 10mm. No specific surface flow diversion was observed at this location as a result of the fracturing.
- **Site DA3LW6_093:** A hairline rock fracture had caused a small slab of rock to displace from underneath a small step. When identified by the BHPBIC Field Team on the 21st June, no specific surface flow diversion was observed at this location as a result of the fracture; and
- **Site DA3LW6_097:** A hairline fracture less than 5mm wide was observed in a small step above SLMMP photo point 3. The BHPBIC Field Team identified the crack on the 13th July and recorded seepage over the step with no specific flow diversion observed at this location. GSSE inspected the impact the following day and the crack appeared to have extended horizontally into the neighbouring rock by approximately 25cm. There was no flow or seepage observed by GSSE.
- **A3-WC2** – No impacts have been observed for this monitoring site.
- **A3-WC3** – No impacts have been observed for this monitoring site. Only the northern sites located to the western end of Longwalls 7 and 8 were monitored (A3-WC3-pt1 to A3-WC4-pt4).
- **A3-WC4** – No impacts have been observed for this monitoring site.

Clifflines

No SLMMP cliff-line monitoring locations were located within the area above Longwalls 6, 7 and 8.

Fire Trails

- **A3-FR1** – No new subsidence related impacts have been observed at this monitoring site. The soil crack impact (Site ID DA3LW6_034) previously reported in the last six monthly report (GSSE, 2011a) was no longer visible.
- **A3-FR2** – No new subsidence related impacts have been observed at this monitoring site. GSSE did inspect the discontinuous soil crack (Site ID DA3LW6_062) which was first identified in late December 2010. The crack has been monitored since it was first identified and in April 2011, it was found to have continued to collapse with additional slumping extending onto the trafficable area of the Fire Road. As reported in the previous quarterly report (GSSE, 2011b), the cracking was considered (or had potential to) impede access along this Fire Road (6C). As a result, BHPBIC had requested and was granted approval from the Sydney Catchment Authority (SCA) for the remediation of this surface crack.

The impact was again revisited by GSSE in July 2011 following the remediation works. The crack is now closed along the serviceable width of the Fire Road and appears stable. Photos of the crack prior to and following the remediation works are contained in **Appendix B** for reference.

5.2 Monitoring Results for the General Area

The remaining 14 new impacts identified over the previous six months of monitoring are described below. They are located away from specific SLMMP monitoring sites in the general area over Longwall 6 and Longwall 7.

General Area above Longwall 6

A zone of five new impacts were identified in close proximity to previously reported impacts (GSSE, 2011a). The area is characterised by numerous rocky outcrops and ledges along the top of a ridgeline. The new impacts located in late January 2011 and February 2011 were revisited during July 2011 by GSSE and were found to have no notable changes compared to when they were first identified. The impacts are:

- **DA3LW6_081:** A rock fracture that has multiple (connected) arms. The main arm extends 6m before branching into two arms at the northern margin of a rocky outcrop. The west arm extends 4m and east arm extends 5m. The width is up to 18mm. The impact was identified on 31st January 2011 by the BHPBIC Field Team;
- **DA3LW6_082:** A rock fracture resulting in a rock displacement. A small slab of boulder, approximately 50cm³, has been dislodged with debris scattered down the rock. The impact was identified on 9th February 2011 by the BHPBIC Field Team;
- **DA3LW6_083:** Rock fracturing with associated rock displacement. The displacement is located beneath a step and runs for 4.5m in an east-west direction; the maximum width of the displacement is 35mm. The fracturing is located in the rocky outcrop above, and is 1.2m long and 5mm wide. Another fracture located to the right is greater than 1m long and continues under the rock step. The width of this fracture is less than 14mm. The impact was identified on 9th February 2011 by the BHPBIC Field Team;
- **DA3LW6_084:** A rock fracture running down a ledge and continuing underneath a small overhang in a rock outcrop. The fracture is greater than 4m long and less than 14mm wide. The impact was identified on 9th February 2011 by the BHPBIC Field Team; and

- **DA3LW6_085:** A rock fracture with rock displacement. The fracture occurs across the edge of a rock outcrop and is 15mm wide, extending for 4.5m (exposed). The displacement is located at the eastern margin of the rock outcrop and is up to 30mm wide. The impact was identified on 9th February 2011 by the BHPBIC Field Team.

The five rock fracture impacts described above are not causing any significant erosion and have resulted in negligible soil exposure. Photos of each of the fractures are contained in **Appendix B**.

There are four other rock fracture impacts located over Longwall 6 identified during the recent monitoring period. The impacts are:

- **DA3LW6_086:** A rock fracture with an exposed length of 1.1m and a width of up to 30mm. The impact was identified on 9th February 2011 by the BHPBIC Field Team;
- **DA3LW6_087:** A rock fracture occurring on an exposed sandstone outcrop. The fracture is 18m long with a maximum width of 10mm. The up-slope end of the fracture is not visible through the vegetation and sediment. The down-slope end of the fracture continues through a natural joint line in the sandstone. The impact was identified on the 18th February 2011 by the BHPBIC Field Team;
- **DA3LW6_089:** A small network of rock fracturing resulting in a small uplifted slab. The fracture is located within a drainage line which reports into A3-WC1. The fracturing is up to 30mm wide. The site was identified on the 11th April 2011 by the BHPBIC Field Team; and
- **DA3LW7_099:** This impact was identified recently on the 15th July 2011 by GSSE. The impact is located near SLMMP photo point 1 of fire road A3-FR1 near other impacts which were identified in July 2010. The small fracture which is 10-15mm wide, 2m long and has a depth of approximately 30cm is located across an old seismic track in outcropping sandstone. It is likely that the rock fracture was caused by residual movements of the Longwall 6 goaf during the extraction of Longwall 7.

The four rock fracture impacts described above are not causing any significant erosion and have resulted in negligible soil exposure. Photos of each of the fractures are contained in **Appendix B**.

General Area above Longwall 7

The remaining five new impacts identified over the general monitoring area in the past six months are located above Longwall 7. Four of these impacts are located in a zone between SLMMP monitoring sites A3-WC1 and A3-SL3. The area contains rocky outcrops and ledges on a relatively steep slope immediately below the eastern extent of A3-SL3. The impacts are:

- **DA3LW7_090:** Rock fracturing and associated soil cracking within a rock outcrop was observed on 18th June 2011 by the BHPBIC Field Team. The fracturing occurred from the base of a 6m rocky outcrop and extended approximately 2m in height. Soil cracking and minor fallen debris was observed at the base of the overhang. A subsequent visit by the BHPBIC field team on the 28th June identified that a small slab of approximately 0.35m³ and other smaller rock debris had become dislodged from the lower section of the rock outcrop. The fallen material had settled at the base of the step with minimal ground disturbance. The impact was again visited on the 14th June 2011 by GSSE and there had been no further notable changes or movement at the impact site;
- **DA3LW7_094:** Fracturing was observed on a small rock step by the BHPBIC Field Team on the 13th July 2011. The main arm of the fracture had a maximum width of

approximately 25mm. There were other small fractures adjacent the main arm. The extent of the fracturing was obscured by leaf litter with the visible section less than 1m long;

- **DA3LW7_095:** Rock movement was observed along a joint between rock outcrops by the BHPBIC Field Team on the 13th July 2011. The movement is visible for approximately 8m and extends along the top of a 4m high step. The joint has displaced up to 100mm and is around 1.5m deep. Other fracturing was observed at the western margin of the impact however for safety reasons, was inaccessible due to its proximity to the edge of a rock outcrop step; and
- **DA3LW7_098:** A discontinuous impact strike line consisting of surface cracking, rock fracturing and rock movement was identified by GSSE on the 14th July 2011. The rock fracturing ran through an outcropping rock shelf which was less than 1m in height. The fractures ranged in width from hairline through to approximately 25mm in width. The surface cracking was discontinuous, shallow (<100mm deep) and ran across an old seismic track in one section. The rock movement consisted of soil slumping away from a rock outcrop up to 70mm in width and had a maximum depth of 500mm. The total length of the impact line was approximately 40m.

The fifth impact is located on a step below the upper section of an upland swamp (Dendrobium Swamp 12) to the south of SLMMP monitoring site A3-WC1:

- **DA3LW7_096:** The impact was identified by the BHPBIC Field Team on the 13th July 2011. The impact consists of two vertical rock fractures up to 7mm wide across the horizontal bedding in a 2m high step. The fractures are 0.5m apart and separated from one another by a pre-existing joint. Seepage was recorded over the step. No water was observed to be diverted through either of the fractures.

Photos of each of the impacts are contained in **Appendix B**.

Rockfalls

The two previously identified and reported rockfalls (Site ID DA3LW6_004 and DA3LW76) were re-visited during the recent inspection by GSSE in July. Both sites appeared relatively stable with no further movement identified. The disturbance areas had minimal exposed soil and there has been no significant erosion, sedimentation or ground disturbance. Photos of the impacts from when they were first identified and the recent July inspection are contained in **Appendix B**.

Note – The impact with site ID DA3LW6_025 was incorrectly reported as a rockfall in the Longwall 6 End of Panel report due to a database error. The impact has previously been reported in the February 2010-July 2010 Six Monthly Monitoring Report (GSSE, 2010b) as a rock fracture. The fracture had resulted in a total of ~1-2m³ of fallen rock fragments from a 0.6m high overhang with minimal ground disturbance.

5.3 Land Capability

A pre-mining Land Capability assessment of the proposed study area was undertaken in December 2009 as part of the baseline survey report (GSSE, 2010a). The post-mining Land Capability assessment will be conducted two years after the completion of mining.

6.0 RECOMMENDATIONS FOR MONITORING AND MANAGEMENT

Monitoring Methods

The methods from the SLMMP are appropriate and should continue as the basis for future monitoring.

Monitoring Schedule

The monitoring schedule outlined in the SLMMP for the monitoring sites is considered appropriate and should be continued.

GSSE will continue to monitor SLMMP sites over the current extraction panel and all previous extraction panels of Area 3A every six months, with individual sites inspected monthly during active subsidence by either GSSE or the BHPBIC Field Team. The BHPBIC Field Team will also continue to undertake weekly inspections of the general area above the active subsidence, when catchment access allows.

Additional regular inspections (subject to catchment access) of the impacts which have been identified along WC1 are recommended to be undertaken by the BHPBIC Field Team until such time that no further movement is observed. A closer inspection of the rockfall (DA3LW7_091) should also be undertaken once deemed safe to do so.

Trigger Levels & CMA's

Some of the recent impacts described in this report are not well defined in the Landscape Impact Assessment Trigger Values or the Watercourse Management Plan TARP. In light of this issue, BHPBIC are currently undertaking a review of the relevant Impact Assessment Trigger Values and TARPs which will include consultation with stakeholders. Impact levels will be assigned to each impact once the review has been finalised.

It is recommended that no Corrective Management Actions are required at this stage.

7.0 REFERENCES

- BHP Billiton Illawarra Coal (February 2011) - report titled *Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report February 2011*
- BHP Billiton Illawarra Coal (March 2011) - report titled *Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report March 2011*
- BHP Billiton Illawarra Coal (May 2011) - report titled *Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report May 2011*
- BHP Billiton Illawarra Coal (June 2011) - report titled *Dendrobium Mine SLMMP - Area 3 Monthly Monitoring Report June 2011*
- BHP Billiton Illawarra Coal (24 May 2011), report titled *Dendrobium Area 3A Longwall 7 Impact Report*
- BHP Billiton Illawarra Coal (7 June 2011), report titled *Dendrobium Area 3A Longwall 7 Impact Report*
- BHP Billiton Illawarra Coal (22 June 2011), report titled *Dendrobium Area 3A Longwall 7 Impact Report*
- BHP Billiton Illawarra Coal (8 July 2011), report titled *Dendrobium Area 3A Longwall 7 Impact Report*
- BHP Billiton Illawarra Coal (13 July 2011), report titled *Dendrobium Area 3A Longwall 7 Impact Report*
- Cardno Forbes Rigby, November 2007, report titled *Dendrobium Colliery Area 3A Longwalls 6 – 10 Part B Subsidence Management Plan*
- GSS Environmental (2010a), report titled *Baseline and Pre-Land Capability Survey-Dendrobium Mine Area 3A, January 2010*
- GSS Environmental, (2010b), report titled *Dendrobium Mine SLMMP Area 3 – Six Monthly Monitoring Report – February - July 2010.*
- GSS Environmental, (2011a), report titled *Dendrobium Mine SLMMP Area 3 – Six Monthly Monitoring Report – August 2010 - January 2011.*
- GSS Environmental, (2011b), report titled *Dendrobium Mine SLMMP Area 3 – Quarterly Monitoring Report – February 2011 - April 2011.*
- Landcom, (March 2004), *Managing Urban Stormwater - Soils and Construction “Bluebook”, Volume 1, 4th Edition.*
- McDonald, Isbell, Speight, Walker and Hopkins, 1990, *Australian Soil and Land Survey, Field Handbook, 2nd Edition.*
- Petersen, 1992, *The RCE: A Riparian, Channel, Environmental Inventory for Small Inventory for Small Streams in the Agricultural Landscape, Freshwater Biology.*

Monitoring Schedule of SLMMP Monitoring Sites



APPENDIX A

Table A – Monitoring Schedule of SLMMP Monitoring Sites – Area 3A

Monitoring Site No.	Baseline Survey		Monitoring (During Mining)															Number of Baseline & Monitoring Events			
	June / July 2009	Nov / Dec 2009	12-Feb-10	10-Mar-10	15-Apr-10	04-May-10	01-Jul-10	13-Jul-10	12-Aug-10	11-Oct-10	11-Nov-10	01-Dec-10	20-Jan-11	10-Feb-11	11-Mar-11	12-Apr-11	02-May-11		21-Jun-11	13-Jul-11	
A3-CL1 (Cliff)	Yes	Yes																			2
A3-CL2 (Cliff)	Yes	Yes																			2
A3-CL3 (Cliff)	Yes	Yes																			2
A3-CL4 (Cliff)	Yes	Yes																			2
A3-CL5 (Cliff)	Yes	Yes																			2
A3-SL1 (Steep Slope)	Yes	Yes						Yes					Yes	Yes	Yes	Yes				Yes	8
A3-SL2 (Steep Slope)	Yes	Yes						Yes					Yes		Yes	Yes				Yes	7
A3-SL3 (Steep Slope)	Yes	Yes			Yes	Yes	Yes	Yes					Yes			Yes	Yes	Yes*	Yes*		11
A3-SL4 (Steep Slope)	Yes	Yes						Yes					Yes							Yes	5
A3-SL5 (Steep Slope)	Yes	Yes											Yes							Yes	4
A3-SL6 (Steep Slope)	Yes	Yes						Yes					Yes							Yes	5
A3-SL7 (Steep Slope)	Yes	Yes																			2
A3-SL8 (Steep Slope)	Yes	Yes																			2
A3-SL9 (Steep Slope)	Yes	Yes																			2
A3-WC1 (W'course)	Yes	Yes						Yes	Yes				Yes			Yes	Yes	Yes	Yes		9
A3-WC2 (W'course)	Yes	Yes						Yes					Yes							Yes	5
A3-WC3 (W'course)	Yes	Yes						Yes					Yes							Yes*	5
A3-WC4 (W'course)	Yes	Yes						Yes					Yes							Yes	5
A2-FR1 (Fire Road)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes		Yes	Yes		Yes				Yes	14
A2-FR2 (Fire Road)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes		Yes				Yes	14

* Full length of the monitoring site not inspected.



Photos

APPENDIX B