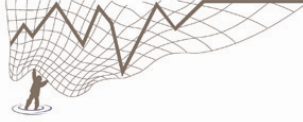




**Cardno
Ecology Lab**

Shaping the Future

Marine and Freshwater Studies



Appin Longwall 703

End of Panel Report: Aquatic Ecology

Job Number: EL1011071

Prepared for BHP Billiton Illawarra Coal

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1 Introduction

1.1 Aims

BHP Billiton, Illawarra Coal (BHPBIC) commenced extraction of Longwall 703 (LW703) in Appin Area 7 of the southern coalfield of NSW on 22 October 2009 and completed its mining on 8 March 2011. Cardno Ecology Lab (formally The Ecology Lab) has been commissioned to undertake baseline, during and post-extraction monitoring of aquatic ecology in accordance with the Subsidence Management Plan (SMP) for Appin Longwalls 701-704 (Hansen Consulting 2006a). This End of Panel report, prepared in accordance with Section 20 of the SMP approval conditions, considers the aquatic habitats and biota within the SMP area for LW703 and any impacts that may have occurred during or immediately after its extraction. The objective of the monitoring is to determine whether the observed impacts, if any, are consistent with the predictions made in the SMP and EIS (Hansen Consulting 2006b).

1.2 Background Information

Cardno Ecology Lab has prepared several reports on aquatic ecology in relation to potential mine subsidence in Appin Area 7 (see Section 1.3). These reports comprise the baseline and during-mining aquatic ecology monitoring proposed in the SMP for Longwalls 701-704, and include a review of existing information on aquatic habitats, water quality, aquatic macrophytes, macroinvertebrates, fish and threatened species that may occur in the area.

The main findings were:

- Aquatic habitat within the Nepean River consists essentially of a continuous, deep, slow flowing pool, created by the damming effect of Menangle Weir. The substratum is varied and includes sections of bedrock, boulder, sand and silt. The riparian vegetation consists of a mixture of native and exotic species, with some areas being dominated by grasses and others having overhanging trees. There are numerous beds of submerged aquatic macrophytes within the shallower sections of the river.
- Aquatic habitat within the ephemeral tributaries of the Nepean River situated within the study area have been highly disturbed by historical and current land use practices. These watercourses are considered to provide only minimal to moderate habitat for aquatic species.
- Between 2003 and 2010, seven species of submerged aquatic plants, hydrilla (*Hydrilla verticillata*), elodea water weed (*Elodea* sp), clasped pondweed (*Potamogeton perfoliatus*), floating pondweed (*Potamogeton tricarinatus*), ribbonweed (*Vallisneria* sp.), blunt pondweed (*Potamogeton ochreatus*) and curly pondweed (*Potamogeton crispus*) were recorded in the reach of the Nepean River within the study area. These species occur in dense, mixed beds and are considered to be in good health. The changes in extent and composition of these beds that occurred between baseline surveys, indicates a degree of natural variability prior to any mine subsidence impacts.
- Macroinvertebrate species sampled within the proposed mine area indicated the health of the Nepean River was poorer than the AusRivAS reference conditions, implying a moderately polluted system. No listed threatened species of invertebrates were found. It is possible that the Sydney Hawk Dragonfly (*Austrocordulia leonardi*) (listed as endangered under the Fisheries Management Act, 1996) may occur in this reach of the river as there is potential suitable habitat.
- Five species of native fish: Fire Tail Gudgeon (*Hypseleotris galii*), Flathead Gudgeon (*Philypnodon grandiceps*), Dwarf Flathead Gudgeon (*Philypnodon* sp.), Empire

Gudgeon (*Hypseleotris compressa*) and Australian Smelt (*Retropinna semoni*) were identified in the Nepean River using bait-trapping and seine netting methods. No listed threatened species of fish were found, however, it is possible that Macquarie Perch (*Macquaria australasica*), a species listed as vulnerable under the Fisheries Management Act, 1996 may occur in this reach of the river as there are known populations upstream and potential suitable habitat.

2 Monitoring Programme

2.1 Monitoring proposed in the SMP

The recommendations for during and post-extraction monitoring of aquatic ecology made by The Ecology Lab (2006) that were incorporated into the SMP for Longwalls 701-704 are summarised in Table 1.

Table 1: During and Post-extraction Aquatic Ecology Monitoring Proposed in the SMP for Longwalls 701-704

Attribute	Frequency
Aquatic Macrophyte mapping	Annually in Spring, twice during active Longwall mining and twice after the completion of mining
Fish sampling	
Macroinvertebrate sampling	
Habitat assessment	

The specific recommendations were that monitoring of these attributes should be undertaken twice during mine extraction and twice following the completion of mining in conjunction with monitoring of water quality and flow, and river morphology. Monitoring would also be undertaken in spring to allow comparison with the baseline data collected by The Ecology Lab (2006) and facilitate assessment of any impacts.

2.2 Completed and Proposed Monitoring

The baseline and during-extraction monitoring of aquatic ecology undertaken at sites relevant to LW703 in the Appin and Douglas Park areas are summarised in Table 2. Preliminary baseline monitoring for Longwalls 701-704 was undertaken by The Ecology Lab in September 2003 and 2005 (The Ecology Lab 2004; 2006). The findings from these reports were incorporated into the monitoring programme proposed in the SMP and further baseline data relevant to LW703 was collected by Cardno Ecology Lab during 2008 and 2009 (see Table 2). The sites incorporated into the monitoring programme included upstream (1 and 3) and downstream (5 and 6) control sites relevant to Longwalls 701-704 and 705-710, and potential impact sites for Longwall 701 (3 and 4) and Longwalls 702-704 (X1 and X2) (Figure 1).

In accordance with the monitoring proposed in the SMP, during-extraction monitoring was undertaken by Cardno Ecology Lab in late spring 2010 (Cardno Ecology Lab 2011). At present, post-extraction monitoring for LW703 in accordance with the SMP is planned for spring 2011 and 2012.

Table 2: Completed and Proposed Aquatic Ecology Monitoring for LW703

Baseline Monitoring			
Report	Survey Date	Sites	Sampling Component
The Ecology Lab (2004)	September 2003	1-6	Macrophytes, fish, macroinvertebrates, habitat assessment
The Ecology Lab (2006)	September 2005	1-6, X1, X2	Macrophytes, fish, macroinvertebrates, habitat assessment
The Ecology Lab (2008a)	March/April 2008	1-6, X1, X2	Habitat assessment
		3-6, X1, X2	Fish
Cardno Ecology Lab (2009a)	October / November 2008	1-8, X1, X2	Macrophytes, fish, macroinvertebrates, habitat assessment
Cardno Ecology Lab (2009b)	June 2009	3,4, X1, X2	Fish, habitat assessment
During-Extraction Monitoring			
Report	Survey Date	Sites	Sampling Component
Cardno Ecology Lab (2011)	November / December 2010	1-6, X1, X2	Macrophytes, fish, macroinvertebrates, habitat assessment
Proposed Post-Extraction Monitoring			
Report	Survey Date	Sites	Sampling Component
Following survey completion	Spring 2011	1-6, X1, X2	Macrophytes, fish, macroinvertebrates, habitat assessment
Following survey completion	Spring 2012	1-6, X1, X2	Macrophytes, fish, macroinvertebrates, habitat assessment

3 Assessment of Impacts

The possible impacts on aquatic ecology due to predicted subsidence associated with extraction of Longwalls 701-704 identified by The Ecology Lab (2006) that were incorporated into the SMP and EIS are listed in Table 3 along with the observed effects.

Table 3: Predicted and Observed Impacts on Aquatic Ecology Associated with Extraction of LW703

Impacts on Aquatic Ecology Associated with LW703 Extraction	
Predicted	Observed
Exposure of wetted substrata in some limited shallow areas of the river, potentially arising due to minor reductions in water depth caused by net uplift of the river bed.	No reported change in water level apart from the normal fluctuations associated with rainfall and Sydney Catchment Authority releases (IC 2011). No exposed wetted substrata observed by Cardno Ecology Lab.
Potential water loss or reduced flow due to fracturing of the river bed. However, this was not expected to result in significant water loss or reduced flow due to the flooded nature of this reach.	No visible fracturing observed by the IC Environmental Field Team (IC 2011) or Cardno Ecology Lab in the Nepean River or any other watercourse in the SMP area, however gas releases suggest some fracturing may have occurred in the bed of the river.
Components of aquatic ecology such as flow characteristics, connectivity and water quality should not be impacted by any predicted subsidence.	No reported surface water flow diversions, impacts on water quality or connectivity of aquatic habitat components (IC 2011; Ecoengineers 2011; Cardno Ecology Lab 2011).
Alterations to the composition of macrophyte beds due to small reductions in water depth. However, this is not expected to have a significant impact on the overall habitat in the survey area.	Observed variation in macrophyte coverage and composition is consistent with natural variation. There is no evidence that mining has had any impact on macrophyte populations.
Possible that gas emissions may have impacts on water quality.	Four new gas release zones were identified during extraction, three in the Nepean River and one in the backwaters of Ousedale Creek, together with reactivation of three existing gas release zones (IC 2011). No evidence of impacts on water quality due to gas releases (Ecoengineers 2011).
Potential impacts on fish and macroinvertebrates due to mine subsidence are considered unlikely in the SMP area.	No evidence of any mining induced impact on either fish or macroinvertebrates (Cardno Ecology Lab 2011).

Mine subsidence predictions for the project indicated the reach of the Nepean River within the SMP area would experience a combination of subsidence, upsidence and valley closure effects that could result in a net vertical uplift (<300 mm) of the river bed. Reductions in water depth and wetted width could have minor effects on components of aquatic ecology including flow, connectivity and water quality and could also reduce the availability of aquatic habitat. The reach of the Nepean River within the SMP area generally comprises a deep,

continuous slow-flowing pool that is created by the damming effect of Menangle Weir. This would minimise / negate potential impacts on aspects of aquatic ecology resulting from reduced water flow and/or depth caused by any net uplift to the river bed. Any impacts on water flow and water loss caused by fracturing would also be expected to be minimal due to the flooded nature of the river system. The potential impacts on aquatic ecology due to these effects were therefore predicted to be non-existent to minor.

No impacts on water depth or flow, or any flooding ponding or desiccation were observed by the The Illawarra Coal Field Investigation Team during or immediately after LW703 extraction (IC 2011). Some subsidence / upsidence in the Nepean River was recorded during extraction (MSEC 2011), however, there has been no observed fracturing of the river bed or any additional iron staining as a result of LW703 extraction (IC 2011).

Four gas release zones were identified during extraction of LW703 (three in the Nepean River and one in Ousedale Creek. There was also a reactivation of the three existing gas release zones observed during extraction of Longwall 702 (IC 2011). The gas releases do not appear to have had any detectable or significant impact upon the aquatic ecology within the Nepean River to date. The iron stain zones identified in Elladale Creek during extraction of Longwall 701 were still evident, but no additional iron staining zones/seeps were identified.

No significant sag in dissolved oxygen levels were observed by Ecoengineers in the Nepean River (Steve Short Pers. Comm. 2/4/11). This could be in part attributed to relatively wet weather and high flows experienced during extraction of LW703. On the 17 occasions that WQ transects were monitored on Nepean River, the flows were fairly high with only one occasion (08/03/10) out of the 17 when a percentile flow less than 50% applied (43% - 14 ML/day at Maldon Weir).

No evidence of subsidence, upsidence, fracturing or any impacts on water depth, flow or connectivity were observed in the 2010 survey (Cardno Ecology Lab 2011). Aquatic macroinvertebrate assemblages surveyed during extraction were comparable to those sampled in the baseline surveys. Similarly, fish assemblages were broadly comparable to those observed in baseline surveys, with any fluctuations in species abundance / composition attributed to natural variation. The fluctuations in macrophyte coverage and composition recorded between the baseline and during-extraction surveys were also considered to be within the natural variation experienced in this type of system. There is no suggestion that any changes in physical or chemical conditions that may have resulted from mining of LW703 have had any significant impact on aquatic macroinvertebrate fauna, fish or macrophyte populations or aquatic habitat within the SMP area. Water quality parameters measured by Cardno Ecology Lab were also comparable to baseline surveys.

Table 4: Comparisons of Aquatic Ecology Attributes between Baseline and During-extraction Monitoring Associated with LW703

Comparison of Baseline and During-extraction Aquatic Ecology Attributes	
Baseline	During-extraction
<p>Aquatic macrophytes</p> <p>Numerous dense beds of submerged aquatic macrophytes occur throughout the monitoring area.</p> <p>Differences in distribution, extent and composition were evident between baseline surveys. This variation was attributed to natural variation.</p>	<p>Similar patterns of variation were observed, but with increased abundance of hydrilla, a native macrophyte associated with balanced aquatic communities.</p>
<p>Fish</p> <p>Flathead gudgeon and fire tail gudgeon were present across the entire stretch of the Nepean monitored during each sampling event. Dwarf flathead gudgeon, empire gudgeon, Australian smelt and mosquito fish were present during at least one monitoring event.</p>	<p>Flathead gudgeon and fire tail gudgeon were present across the entire stretch. All other species, apart from empire gudgeon, that were sampled during baseline monitoring were recorded. This species was also absent during some of the baseline surveys.</p>
<p>Macroinvertebrates</p> <p>AusRivAS results assessed the ecological health at each monitoring site to be below reference conditions.</p>	<p>In general, the health of the Nepean River, as indicated by AusRivAS sampling, has improved since the baseline period of monitoring. However, some sites were still considered below reference conditions.</p>
<p>Habitat Assessment</p> <p>Water quality considered to be average to good, although ANZECC (2000) guidelines for pH, conductivity, DO and turbidity were exceeded on some occasions.</p> <p>Aquatic habitat of the Nepean River in the monitoring area consists of continuous, deep, slow flowing pool with varied substrata. Riparian vegetation consists of a mixture of native and exotic species</p>	<p>Water quality was comparable to baseline monitoring, although pH was the only variable constantly within ANZECC (2000) guidelines.</p> <p>No observed changes to aspects of aquatic ecology such as water flow, depth or connectivity, or any changes in the availability of aquatic habitat.</p>

4 Conclusion and Recommendations

There is no evidence of any impact on aquatic ecology in the SMP area due to extraction of LW703. Although new gas release zones have been observed, suggesting that fracturing of the river bed or reactivation of existing jointing has taken place, these do not appear to have had any observable impact on any aspect of aquatic ecology. This is consistent with predictions of impacts made prior to commencement of mining.

To fulfil the requirements of the SMP for Longwalls 701-704, it is recommended that post-extraction monitoring of aquatic ecology at the sites adjacent to LW703 be undertaken in spring 2011 and 2012. This monitoring would be incorporated into the ongoing monitoring programme for Longwalls 701-704 and 705-710.

5 Acknowledgements

This report was written by Dan Pygas and reviewed by Dr Theresa Dye.

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7 Figure

Figure 1: Aerial photo of the study area showing aquatic ecology monitoring sites in and around the Nepean River relative to Appin Longwalls 701-704.

