15. SUMMARY AND ASSESSMENT OF ENVIRONMENTAL FACTORS

(SMP Guidelines Section 6.10.4)

15.1. ASSESSMENT OF IMPACTS ON NATURAL FEATURES

15.1.1. The Nepean River

The section of the Nepean River within the SMP Area is different to most other rivers in the Southern Coalfield, in that it is a flooded system, where the river water levels are predominantly controlled by the Menangle Weir, as opposed to ephemeral creeks and rivers where the pool water levels are controlled by natural rockbars.

The impacts observed during the mining of these previous longwalls provide a good indication of the likely impacts that might occur as a result of mining the proposed Longwalls 705 to 710. These include:

The Potential for Changes to Water Levels

Since Menangle Weir controls the water level along the Nepean River within the SMP Area and since no significant movements are expected at the weir, it is unlikely, therefore, that there would be any significant change in the water level along the Nepean River within the SMP Area resulting from the extraction of the proposed longwalls.

The Potential for Loss or Diversion of Surface Waters

There has been no reported or observed loss of surface water as a result of previous mining directly beneath or near the Nepean River by Tower Longwalls 15 to 20 and Appin Longwall 701. This includes observations at a monitoring site that was located directly above Tower Longwall 17, which directly mined beneath the river for a length of approximately 800 metres. The potential for diversion of surface water in the Nepean River is very low as the river bed is flooded and the gradient of the river is very flat. Any rockbars present along the river bed are completely submerged. Any fractures in the bedrock that develop as a result of mining are likely to be immediately filled by water or sediment. The volume of water that fills these fractures is likely to be an extremely small proportion of the total volume of water that is retained by the weir.

It is therefore assessed that the potential for surface water flow diversion to occur as a result of the extraction of the proposed longwalls is very low.

The Potential for Ground Water Inflows

There are no natural springs along the Nepean River within the SMP Area, although it is possible that some seepage occurs into the river. Although the proposed longwalls do not mine directly beneath the Nepean River, it is possible that mining-induced springs may develop following the extraction of the proposed longwalls. The chemical characteristics of mining-induced springs near previously mined longwalls in the Southern Coalfield suggest that the water passes through upland Wianamatta Shale areas and permeates through natural or mining-induced fractures into the Hawkesbury Sandstone before emerging in the valley (EcoEngineers, 2008).

Vertical dilation between Wianamatta Shale and Hawkesbury Sandstone is possible along the tributaries to the Nepean River, particularly if the thickness of the Shale is less than 10 to 15 metres, since field studies suggest that vertical dilation in creeks and rivers extend, as a maximum, to this depth (Mills and Huuskes, 2004). The confluence of the tributaries which flow into the Nepean River is not directly mined beneath and, in these locations, the vertical dilation is expected to be small. The upper reaches of these tributaries, however, are directly mined beneath by the proposed longwalls.

The Potential for Gas Emissions

It is likely that some mining-induced gas emissions will be observed during the extraction of the proposed Longwalls 705 to 710.

Gas emissions typically occur in isolated locations and the majority of gas emissions occur in areas that are directly mined beneath. These emissions are also typically the most vigorous. However, some gas emissions have occurred in areas that have not been directly mined beneath. Gas emissions have previously been observed in the Nepean River during the mining of Tower Longwalls 17 to 20 and Appin Longwall 701.

Recent estimates of gas emissions in the Nepean River during the mining of Longwall 701 indicate gas emissions of about 3 L/sec. It is possible, if substantial gas emissions occur at the surface, that these could result in localised vegetation dieback. These impacts have been limited to small areas of vegetation and local to the points of emission. The gas emissions have declined and the affected areas have successfully recovered. Such vegetation dieback is rare and has only been recorded in one location in the Southern Coalfield. Vegetation dieback has not been observed in areas that have not been directly mined beneath.

The Potential for Surface Fracturing

The proposed Longwalls 705 to 710 do not mine directly beneath the Nepean River. Historical observations indicate that only minor fracturing may occur in the bed of the Nepean River as a result of the extraction of the proposed longwalls (Kay et al, 2006). The furthest distance of an observed fracture from a goaf edge is approximately 415 metres from Longwall 401 at the base of Broughtons Pass Weir. Any fracturing that may occur is expected to be minor in nature. Fractures may be visible within the base of the river valley in exposed areas such as river banks and alluvial flats, or be inferred from the emission of gas bubbles in the river.

The likelihood of fracturing is very low for bedrock that is located beyond the predicted limit of subsidence, although some minor fracturing may occur up to approximately 400 metres from the proposed longwalls. Mining-induced fracturing at these remote distances is unlikely to result in surface flow diversions or reduction in water quality.

The Potential Changes to the Levels of River Bed and Banks

Whilst the Nepean River water levels are not expected to change as the result of the extraction of the proposed longwalls, it is expected that the river bed could uplift by up to a maximum of 345 mm, as the result of the extraction of the proposed longwalls. This is because the maximum predicted upsidence of 380 mm exceeds the maximum predicted subsidence of 60 mm along the river, however, it should be noted that these predictions are

based on the conservative empirical predictions of upsidence and subsidence. As seen by the experience of Longwall 701, it is quite possible that the actual movements along the river could be significantly less than those predicted as the result of the extraction of the proposed longwalls.

The water levels in the Nepean River fluctuate in response to changes in water flow rates. It is apparent from relative water level surveys that the water level in the river generally rises and falls within a range of 150 mm, except at times of extreme water flows. For example, the maximum rise in water level that has been recorded at Menangle Weir since August 1990 is 10.1 metres on 11 June 1991. During these extreme flow events, significant changes occur to the bed and banks of the river.

In the sections of the Nepean River where the upsidence exceeds the subsidence, it is expected that these sections would experience a slight reduction in the frequency of water inundation.

The Potential for Water Quality Change

It is possible that the emission of strata gas emission into the Nepean River may give rise to a reduction in dissolved oxygen in the river at very low flows due to the microbiological consumption of methane. However, further monitoring and analysis of the possible influence of gas emissions in the river at low flow conditions is necessary to validate this possibility and quantify any subsequent dissolved oxygen reduction and aquatic ecology impacts. Additional monitoring has been proposed to investigate this issue.

Minor visible iron flocs are expected to occur in the Nepean River in association with gas release sites. No detectable change in water quality is predicted to occur from such minor iron staining, however minor aesthetic impacts may occur. The pre-existing total alkalinity in the river is adequate to fully neutralize any sulfuric acid produced from any increase in the dissolution of pyritic minerals in the underlying sandstone formation caused by mining.

The inducement of ferruginous springs due to mining has been occasionally observed in Bulli Seam mining areas, especially when they are in proximity to areas of Wianamatta Shale. However, mining to date in Appin area 7 has not led to the creation of any ferruginous spring, and it might be inferred that the catchments further to the north proposed to be mined under by Longwalls 705 to 710 are at a low probability of risk from this phenomenon. Such springs generally do not contain sufficient dissolved iron and manganese to cause a significant depression of river pHs through the oxidation and precipitation of hydrous iron and manganese oxides because the River water contains significant bicarbonate/carbonate alkalinity. Due to the low likelihood of ferruginous springs being induced and the inherent alkalinity of the river, any ecological consequence of ferruginous springs is predicted to be minor. However, the consequences of such a spring on aesthetics of the River would be major.

15.1.2. Creeks

It is possible that there could be very localised areas along the drainage lines which could experience a small increase in the levels of ponding and flooding, where the predicted maximum tilts occur in the locations where the natural gradients are low. As the predicted maximum systematic tilts are less than 1 %, however, any localised changes in ponding or flooding are expected to be minor and not result in a significant impact on the drainage lines.

Fracturing of the uppermost bedrock has been observed in the past, as a result of longwall mining, where the systematic tensile strains have been greater than 0.5 mm/m or where the systematic compressive strains have been greater than 2 mm/m. It is likely, therefore, that

some fracturing would occur in the uppermost bedrock based on the predicted maximum systematic strains. Whilst some pool water loss may occur from such fracturing, the environmental consequences are low given the lack of habitat and degraded nature of these ephemeral waterways.

15.1.3. Cliffs and Steep Slopes

It is possible that minor isolated rock falls could occur as a result of the extraction of the Longwalls 705 to 710. It is not expected, however, that any large cliff instabilities would occur as a result of the extraction of the proposed longwalls. Any impacts on the cliffs within the SMP Area, resulting from the extraction of the proposed longwalls, are expected to represent in the order of 1 % to 3 % of the total length of cliffs within the SMP Area.

The aesthetics of the landscape could be temporarily altered by isolated rock falls, which would typically result in the exposure of a fresh face of rock and debris scattered around the base of the cliff or slope. As with naturally occurring instabilities, the exposed fresh rockface weathers and erodes over time to a point where it blends in with the remainder of the cliff face and vegetation below the cliff regenerates to cover the talus slope. If cliff instability were to occur, however, the appearance of the landscape could be restored, if necessary, by the remediation of the rockface and vegetation below the cliff.

Surface cracking in soils as the result of systematic subsidence movements is not commonly seen at depths of cover greater than 500 metres, such as in Appin Area 7, and any cracking that has been observed has generally been isolated and of a minor nature. It would be expected, therefore, that any surface cracking that occurs along the steep slopes, as a result of the extraction of the proposed longwalls, would be of a minor nature due to the relatively small magnitudes of predicted systematic strains and due to the relatively high depths of cover. Surface tensile cracking is generally limited to the top few metres of the surface soils. Minor surface cracking tends to fill naturally, especially during rain events. If any significant cracking were to be left untreated, however, erosion channels could develop along the steep slopes. In this case, it is recommended that appropriate mitigation measures should be undertaken, including infilling of surface cracks with soil or other suitable materials, or by locally regrading and recompacting the surface. With these remediation measures in place, it is unlikely that there would be a significant impact on the environment.

The steep slopes within the SMP Area have natural gradients typically less than 1 in 2 and the depths of cover greater than 500 metres. It is unlikely, therefore, that the predicted systematic strains would be of sufficient magnitudes to result in the slippage of soils down the steep slopes or the development of any significant tensile cracks at the tops of the slopes.

If movement of the surface soils were to occur during the extraction of the proposed longwalls, minor tension cracks at the tops of slopes and minor compression ridges at the bottoms of slopes may form. In some cases these cracks could lead to increased erosion of the surface and minor mitigation measures would be required, including infilling of the surface cracks with soil or other suitable materials and local regrading and recompacting of compression bumps. With these remediation measures in place, it is unlikely that there would be a significant impact on the environment.

15.2. ASSESSMENT OF IMPACTS ON ECOLOGY

The Ecology Lab undertook an assessment of the potential subsidence impacts of proposed mining of Longwalls 705 to 710 on aquatic flora and fauna (refer **Appendix C**).

Biosis Research undertook an assessment of the potential subsidence impacts of proposed mining of Longwalls 705 to 710 on terrestrial flora and fauna (refer **Appendix D**).

These reports assess the ecological values of the Study Area and the potential impacts of mining in this area in terms of threatened species, populations or ecological communities that occur, or have the potential to occur in the Study Area.

15.2.1. Assessment of Impacts on Aquatic Ecology

Subsidence impacts are unlikely to have a significant effect on important components of aquatic environment including flow characteristics, and habitat connectivity, which influence aquatic habitat and biota.

Alterations to Flow in Rivers and Creeks

Within small surface watercourses, predicted increases in ponding and flooding and potential water loss through surface fractures are not predicted to have a significant impact on the ephemeral nature of the flow of these watercourses.

Connectivity

Small ephemeral surface watercourses within the SMP Area are generally discontinuous, except during periods of high rainfall. Impacts including possible increased ponding and flooding and possible draining of pools are not considered likely to affect this connectivity.

Aquatic Macroinvertabrates

The potential loss of macroinvertebrate edge habitat, however, is predicted to be relatively small in the context of the available habitat within the reach of the Nepean River within the SMP Area. No significant impact on macroinvertebrate assemblages is therefore predicted to occur as a result of mine subsidence.

Aquatic Macrophtyes

The distribution of submerged (attached) macrophytes within the SMP Area may change in response to the vertical movement of the riverbed. A reduction of macrophyte coverage could occur as a result of desiccation. This could occur if macrophyte beds are located in any shallow areas of riverbed subject to net upsidence which exceeds the water depth. As the maximum predicted net upsidence following extraction within the Nepean River is 345 mm (MSEC, 2008), and this is predicted to occur in the middle of the channel, the reduction of macrophyte beds resulting from desiccation is likely to be confined to a very small proportion of any shallow margins of existing beds.

An increase in the coverage of macrophyte beds is also possible as a result of mine induced upsidence. A reduction in water level due to upsidence could increase the substrata available for macrophyte colonisation along the margin of macrophyte beds defined by

available sunlight penetration. This effect is also likely to be proportionally very small compared with existing macrophyte coverage.

Variability in the spatial extent and species composition of macrophyte beds in the Nepean River has been observed between surveys conducted in 2003 and 2005, prior to the commencement of mine operations. It is expected that any change in macrophyte beds resulting from mine subsidence induced impacts will be minor and indistinguishable from the natural variability within the river. No significant impact on macrophyte composition or coverage is therefore predicted to occur as a result of mine subsidence.

Fish

The response of fish to the effects of mine subsidence impacts is dependent on changes in fish habitat resulting from changes in flow, connectivity, water quality, and aquatic macrophyte beds. Changes in most of these habitat components are not expected to be of sufficient magnitude to have a significant impact on the overall aquatic habitat within the Nepean River.

Any fish that utilise pool habitat within small ephemeral surface watercourses may be impacted by the draining of pools as a result of surface fractures. Some fish species (such as freshwater eels) may be able to relocate to nearby areas of aquatic habitat, however most species would perish as a result of desiccation and/or predation. This impact is considered as being of low significance because of the highly degraded existing aquatic habitat, and the temporary and limited nature of such impacts. This habitat is not considered as potential habitat for any listed threatened fish species.

Threatened Species

Sydney Hawk Dragonfly

There are no records for this species within the SMP Area, however, it has been recorded upstream in the Nepean River, at the Maldon Bridge near Wilton (NSW Fisheries, 2004).

The Nepean River within the SMP Area appears to contain extensive suitable habitat for the Sydney Hawk Dragonfly. Predicted impacts on this habitat resulting from mine subsidence are likely, if they occur at all, to affect a very small percentage of the total available habitat. The possible occurrence of a widespread, prolonged DO sag in the river under low flow condition could have a negative impact upon this species. Low DO conditions in the Nepean River can be caused from numerous natural and anthropogenic factors. These impacts are not likely to have a significant impact upon any local population of this species within the SMP Area or the greater regional setting. A species impact statement is therefore not recommended for the Sydney Hawk Dragonfly.

Adams Emerald Dragonfly

There does not appear to be suitable habitat within the SMP Area to support the Adam's Emerald Dragonfly, as the Nepean River does not contain appropriate riffle or cascade habitat. Foot Onslow Creek, Navigation Creek , Harris Creek and the small unnamed creeks do not have well defined riffle and pool habitat, and are likely to almost completely dry out during extended dry periods. These creeks are also highly altered in their upper reaches as a result of historical land clearing, farming and grazing. Furthermore, the sampling for this study and previous studies (The Ecology Lab, 2004; 2006), along with historical survey records for the Sydney area suggest the waterways in the SMP Area do not support an established population of Adam's Emerald Dragonfly, and therefore no further investigation is considered necessary.

Australian Grayling

The Australian Grayling is listed under the *EPBC Act* as a vulnerable species, and is protected from fishing under NSW legislation. It has been recorded within the Hawkesbury-Nepean catchment in the Grose River, however no records exist within the upper Nepean Catchment. The life cycle of the Australian Grayling is dependent upon migration to and from the sea and as such it would not be expected to occur in the upper Nepean System above barriers such as Menangle Weir which has no provision for fish passage. Given that it is highly unlikely that the Australian Grayling occurs within the study area further investigation of this species is not considered necessary.

Macquarie Perch

The Nepean River within the SMP Area is unlikely to support a viable population of Macquarie Perch due to the absence of suitable spawning habitat and existing barriers to upstream migration. However, individuals may move into this area from viable populations upstream in the Cataract and Nepean Rivers. Even if Macquarie Perch were present and did constitute a viable population, the predicted impacts on this habitat resulting from mine subsidence are likely, if they occur at all, to affect a very small proportion of the total available habitat. Changes in water quality resulting from mine subsidence-induced effects are predicted to be localised and within the existing water quality variability. Thus, these impacts are not likely to have a significant impact upon any local population of this species within the SMP Area or the greater regional setting. A species impact statement is therefore not recommended for Macquarie Perch for this proposal.

15.2.2. Assessment of Impacts on Terrestrial Flora and Fauna

Subsidence impacts within the Study Area may potentially result in; minor impacts to water quality in the Nepean River, the localised emission of gas, minor bank desiccation and scouring, and cracking in soils and fracturing of bedrock on the surface and possibly minor rockfalls and erosion events. However, these effects are not expected to represent a significant impact to the terrestrial flora and fauna values of the area.

Vegetation Communities

The Study Area contains five broad plant communities, four of which are EECs listed on the *TSC* and/or *EPBC Act:* Cumberland Plain Woodland, Shale Sandstone Transition Forest, Moist Shale Forest and River-flat Eucalypt Forest.

Potential surface fracturing, gas emissions or erosion events are considered unlikely to result in the broad scale alteration of species composition or distribution within the Study Area. For these reasons, it is considered unlikely that the proposed longwall mining activities and the associated subsidence impacts would have a significant impact on any plant community within the Study Area.

Flora

Potential habitat for three threatened plant species that could potentially be affected by the mechanisms of subsidence occurs within the Study Area. Impact assessments conclude that habitat for these species is unlikely to be significantly impacted by the proposed mining activities. It is therefore considered unlikely that the proposed longwall mining activities would have a significant impact on any threatened flora species within the Study Area.

Fauna

Actual or potential habitat for several threatened fauna species was recorded from the Study Area. Four species were considered likely to be dependent on habitat resources that may be impacted by subsidence. Based on the likely subsidence impacts to the Study Area and the extent of similar habitat in the region, it is considered unlikely that the proposed longwall mining activities would have a significant impact on any threatened fauna species within the Study Area.

15.3. ASSESSMENT OF IMPACTS ON SURFACE WATER

Based on the conservative predictions of upsidence and relatively small amounts of predicted subsidence, the maximum uplift along the river is expected to be between 255 and 345 mm. However, judging from the observations of mining-induced impacts on the recently mined Longwall 701 the actual fluctuation is not expected to be measurable. In general; water levels in the Nepean River fluctuate in response to changes in water flow rates. Water level data suggests that the river typically rises and falls within a range of ±150 mm. It has also been observed that water levels rise by 600 mm when flows reach a peak of approximately 730 ML/day at Maldon Weir (located approximately 13 km upriver from the proposed longwalls), which is an event that occurs only approximately 8% of the time. These observed changes in water levels are consistent with the predicted maximum of 345 mm uplift (MSEC, 2008) of the river banks.

The potential for sub-bed diversion of surface water in the Nepean River is very low as the river bed is flooded and the gradient of the river is very flat. This is consistent with subsidence predictions which have also shown that the potential for surface water flow diversion to occur as a result of the extraction of the proposed longwalls is very low. Any fractures in the bedrock that may develop as a result of mining (refer **Section 9.2**) are likely to be filled immediately by water or sediment, and the volumes of water that fill up these fractures are likely to be extremely small compared to the total volume of water that is retained by Menangle Weir.

The potential for infiltration of water into the groundwater system is also very low as the Nepean River represents the regional low point in the water table. The potential for loss of surface water into the mine is also unlikely due to the depth of cover, the offset of the longwalls in relation to the river, and the presence of Bald Hill Claystone aquitard in the regional stratigraphy, which as discussed below acts as an aquiclude between the river and the mine and will thus prevent vertical connectivity between them.

Any acid released by oxidation of the marcasite in the Sandstone will be largely attenuated naturally in the river water further downstream principally by dilution, and by reactions with the low concentrations of carbonate / bicarbonate ions released by iron and manganese carbonates from soils derived from Wianamatta Shale as they dissolve in the creek or river water. These sources of continuous alkalinity in water afford an augmented acid buffering potential in the Nepean River, and thus there is a natural mitigation measure for small pH changes already in place.

The formation of ferruginous springs due to mining has previously been observed in the Bulli Seam mining areas, especially when they are in proximity to areas of Wianamatta Shale, although their occurrences are rare. Mining to date in Appin Area 7 (Longwalls 701 to 702) has not led to the creation of any ferruginous springs, and it is therefore most likely that the catchments further to the north of these longwalls where the proposed Longwalls 705 to 710 are to be mined will not be affected. In general terms it has been estimated that longwall mining-induced subsidence effects on Shale-mantled upland catchments in the Southern

Coalfield might generate ferruginous springs, from upland catchments discharging to Nepean River, up to a maximum recharge/discharge rate of approximately 0.2 ML/day and a mean recharge/discharge rate of approximately 0.1 ML/day.

Modelling has been conducted using this information and the observed iron and manganese ion concentrations in order to obtain probabilistic information on the impact of ferruginous springs discharging directly into Nepean River. It has been found that for all discrete spring flows into Nepean River below approximately 0.2 ML/day and above approximately 4.0 ML/day i.e. above 50 percentile flows, the DO in the water will be consistent with the default guideline for DO in the national water quality guidelines for NSW lowland rivers.

A minor consequence of ferruginous spring formation by oxidation of iron and manganese ions is the lowering of DO in river and creek water, and the problem could be exacerbated if the receiving water bodies have low re-aeration coefficient which is the case for the section of the Nepean River adjacent to the General SMP Area. However, on the basis of field observations, such ferruginous springs would be more prone to arise, or if pre-existing, enhanced in draining catchments in the general SMP Area i.e. Harris Creek, Upper Foot Onslow Creek and Upper Navigation Creek rather than in the Nepean River itself. Given that the volumes of low DO level water discharged from the creeks will be small compared to the volume and larger flow rates of water in Nepean River, DO levels should recover to normal values quite quickly.

Emissions of methane gas during longwall mining may be linked to some extent to the reduced DO levels but this is known to occur only at very low flow rates. The concentrations will depend on a number of factors; (i) whether full saturation of methane will ever be reached when the water will be depleted of majority of the dissolved oxygen, (ii) that biological consumption of the dissolved methane does not occur, and (iii) the rate of methane bubbling relative to the flow rate of the water and the presence of rock formations in the flow path which can provide surfaces where methane gas release into the atmosphere can occur. DO levels measured within the Nepean River at low flow conditions during baseline monitoring and during Longwall 701 extraction have revealed that DO conditions can fall below 60% independent of any impacts associated with gas releases from mining. Field based water quality parameter monitoring undertaken by Illawarra Coal during Longwall 701 has identified minor DO changes associated with gas emissions in the Nepean River at low flow rates.

The reduced DO levels observed to data cannot be definitively attributed to methane gas releases from mining only. Other sources such as agricultural/nutrient runoff and discharge of low DO water from tributaries such as the Cataract River Backwater are more likely to be the reasons for the observation. Currently limited measured data investigating the numerous factors that contribute to the reduced DO levels in water exist, and further validation of any such effect is warranted.

15.4. ASSESSMENT OF IMPACTS ON GROUNDWATER

Groundwater systems in the general SMP area may experience standing water level changes due to mining-induced bedrock fracturing especially if this is accompanied with changes in the permeability in the bedrock. It is known that the regional piezometric surface lies beneath the potential fracture zone (20 m from the plateau surface) and there may be a temporary lowering of the piezometric surface over the subsidence area due to horizontal dilation of strata and resultant increase in secondary porosity. However, this effect will only be notable directly over the area of greatest subsidence and dilation, and will dissipate laterally out to the edge of the subsidence zone. Based on previous observations in the Southern Coalfield, groundwater levels may reduce by up to 10 m, and may stay at that

reduced level until maximum subsidence develops at a specific location. The duration of the reduced levels will depend on the time:

- it will take to develop maximum subsidence;
- for subsidence effects to migrate away from a location as mining advances; and
- required to recharge the secondary voids by rainfall.

It is predicted there will be no permanent reduction in groundwater levels underneath the Nepean River. Once any subsidence-induced cracks are filled with water, there will be no vertical discharge path through which the groundwater can flow out of the system, so there will be no ongoing water flow into the cracked basement of the gorge and riverbed. Any water loss that does potentially occur would be replenished by the large volume of water in the river pond (a minimum of approximately 1,400 ML) and the daily flow down the river (a minimum of 3 ML/day). Therefore, due to the short term nature of any groundwater level reductions, any impact to groundwater resources in the plateau areas resulting from the proposed extraction is likely to be insignificant.

The overall groundwater quality in the general SMP area is not expected to be adversely affected based on previous observations in the Southern Coalfield, and due to the proposed mitigation measures to be put in place during mining. During the mining phase, iron and manganese hydroxide precipitation may occur if the aquifer is exposed to “fresh” manganese carbonates in the strata. A lowering of pH (by about 1 pH unit) in the discharged water can occur if there is exposure to iron sulfides (marcasite) which will cause dissolution of unweathered minerals. The extent to which these effects will change the groundwater quality will depend on the balance between the mining-induced pH changes and the availability of the neutralizing carbonate / bicarbonate ion levels already present in the groundwater. Since the Southern Coalfield already has significant iron hydroxide levels a comparison of the baseline data acquired in the pre-mining survey with the groundwater quality data acquired during the mining phase will provide an on-going assessment of the water quality and which will readily detect any significant changes. The appropriate action, as proposed in the trigger / action / response / plan (TARPs) refer **Table 24.1** in **Volume 2**, will be used to manage and mitigate any changes detected.

An assessment of the effect of subsidence on seeps, springs and baseflow to the Nepean River will occur if subsidence causes fracturing in the low permeability layers in the plateau strata. No large seeps were identified during the study along the potentially affected stretch of river. The current intermittent seeps which occur after rainfall are generally short lived, with the volume and duration of flow directly related to the amount and intensity of rainfall.

No plateau springs have been identified in the area that will be affected by subsidence. However, based on observations on the western plateau associated with previous longwall mining, it is possible that interface drainage of ferruginous (brackish to saline) seeps may be generated in streams on the plateau over Longwalls 705 to 710.

The low order creeks on the plateau will be subjected to relatively low tensile strains and are not expected to be significantly impacted by subsidence related surface cracking. Similarly, it is not expected that observable loss of water from the creeks will occur, although individual pools within creeks may be drained by subsidence induced cracks in creek beds. It is not expected that any observable change to creek flows or ponding will occur due to the low predicted tilts, which are notably less than the natural gradient of the creeks. The creeks within the general SMP area are generally degraded and have low potential for aquatic habitat. Due to the low levels of strain on the plateau area and limited potential for fracturing

of rock, cracking of soil and water loss, it is unlikely that the proposed mining will significantly impact lower order streams, seeps, springs and flow to the Nepean River.

Potential water inflow from streams and groundwater to mine workings were assessed although no previous observations of such flows have been recorded in any of the mines in the Southern Coalfield at similar depths of cover to that of the proposed Longwalls 705 to 710. Modelling by CSIRO and Coffey Partners International Pty Ltd. has indicated that the horizontal permeability above the Bald Hill Claystone in the regional stratigraphy of the SMP area may be enhanced after subsidence. However, there will not be any additional vertical permeability connectivity and that the hydrologic systems above and below the Claystone will remain separate, noting that the upper level flow is dominantly horizontal and flows to the valley floor or locally upwards from below the river bed. Since this claystone layer acts as a confining layer then vertical hydraulic connection to the mine workings will not occur. It is highly unlikely that this layer would be breached after subsidence as it is from 150 to 200 m below the surface and well below the depth of any surface cracking and overburden dilation.

Very limited reports of gas evolution from the coal seams having an adverse effect on groundwater supply have been documented in the Southern Coalfield over longwall subsided areas. Hence, it is not anticipated that any significant gas effects will be observed in the private bores over Longwalls 705 to 710.

15.5. ASSESSMENT OF OTHER POTENTIAL IMPACTS

The proposal to extract Longwalls 705 to 710:

- Does not include any plans to use groundwater or surface water from a natural water body. There are no plans to store water in a dam or artificial water body.
- Is not expected to significantly affect flooding and will not affect tidal waters.
- Does not use, store, dispose or transport hazardous substances, use or generate pesticides, herbicides, fertilisers or other chemicals, which may build up as residues in the environment. It is noted that fertilisers and herbicides may be required to assist revegetation of small areas of surface disturbance. Appropriate approvals will be sought if required and the most appropriate methods of usage will ensure minimal impact.
- Does not emit significant amounts of dust, odours, noise, vibrations, blasts, electromagnetic fields or radiation from the longwall area, in the proximity of residential areas or land uses likely to be affected.
- Involves appropriate disposal of waste generated.
- Does not introduce noxious weeds, vermin, feral species or disease or release genetically modified organisms. It is noted that potential to introduce weeds can result from vehicles accessing the area for monitoring or inspection activities. Bare areas that may result from vegetation removal or die back could encourage the germination and establishment of weed species that may already be present. This effect is not expected to be significant.
- Does not result in the creation of barriers to movement or the removal of remnant vegetation or wildlife corridors.
- Does not involve any activity that affects revegetation or replenishment of native species following disturbance.
- Does not introduce unmanageable fire risks.

- Methane drained from the coal seam prior to longwall extraction is beneficially used at the EDL Appin gas fired power station. This generation of electricity significantly abates the greenhouse emissions from Appin Colliery.

The proposal to extract Longwalls 705 to 710 does not significantly effect:

- Wetlands or flood prone areas;
- Groundwater recharge areas or areas with a high water table;
- Significant areas of acid sulphate or sodic soils;
- Areas with degraded air quality;
- Known areas with degraded or contaminated soils or water;
- Fishing grounds and commercial fish breeding or nursery areas or; and
- Any other sensitive areas or areas allocated for Conservation Purposes.

There are no other issues identified likely to affect the biological aspects of the environment and accordingly there will not be a significant impact on the environment.

Therefore, providing the proposed mitigatory measures are in place, there will be no significant adverse environmental effects on any areas that are sensitive because of biological factors.

15.6. EVALUATION OF POTENTIAL IMPACT SIGNIFICANCE

This section evaluates the likely significance of any potential impacts. Likely environmental significance is evaluated using DoP criteria and criteria based on Land and Environment Court decisions and findings. The final determination regarding significance is made by the determining authority.

The DoP Document, “Is an EIS Required?” recommends the following criteria for evaluating the likely environmental significance of impacts:

- How extensive are the impacts? Extensive impacts are likely to be significant.
- How adverse are the impacts on environmentally sensitive areas? Impacts which adversely impact on environmentally sensitive areas are likely to be significant.
- How acceptable are the impacts considering the nature of the impacts? Impacts with a low level of acceptability because of the nature of the impacts are likely to be significant.

Particular emphasis has been placed on determining whether the proposal is likely to significantly affect the environment. After considering the relatively localised extent of the potential impacts, together with the acceptable nature of the impacts, it is considered that the application to extract Longwalls 705 to 710, is not likely to significantly affect the environment, providing that the proposed management measures, which are part of the Activity, are implemented.

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