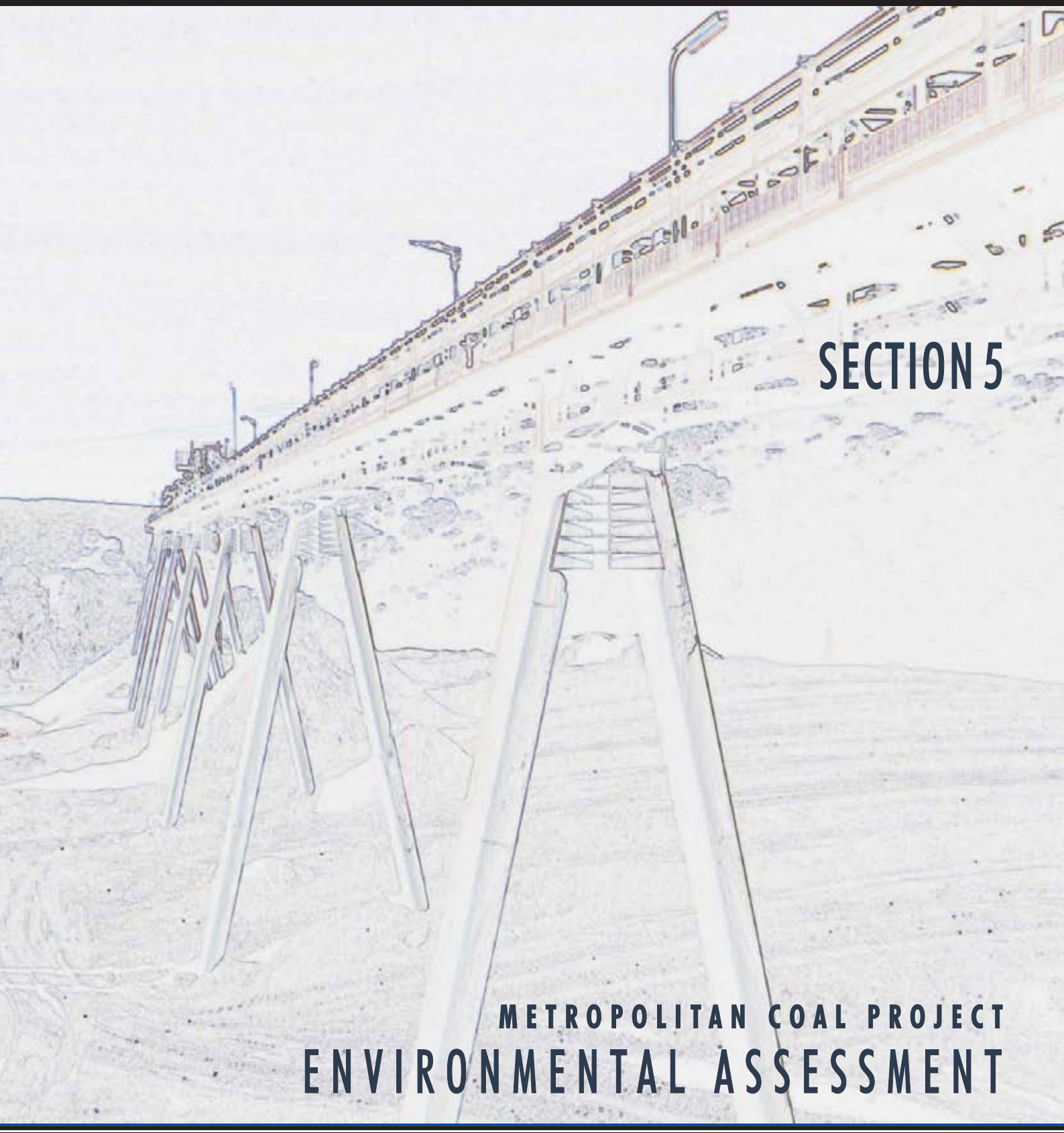

SECTION 5

METROPOLITAN COAL PROJECT

ENVIRONMENTAL ASSESSMENT

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5 ADAPTIVE MANAGEMENT AND REHABILITATION

This section provides a detailed description of the proposed rehabilitation strategy for the Project, including:

- an overview of stream restoration at the Metropolitan Colliery (Section 5.1);
- the adaptive management approach to key rock bars (significant natural features) on Waratah Rivulet (Section 5.2)
- the rehabilitation of Project surface disturbance areas (Section 5.3); and
- the rehabilitation of mine subsidence effects (Section 5.4).

Section 5.5 describes mine closure and lease relinquishment.

While stream restoration works have been demonstrated by HCPL to be successful at the Waratah Rivulet (Section 5.1) and surface disturbance areas are proposed to be rehabilitated, HCPL has committed to contribute an environmental offset (compensatory measures and ecological initiatives) for the residual effects that would occur during mining. These measures and initiatives are described in Section 5.6.

The adaptive management and rehabilitation programmes have been developed in consideration of relevant strategic landuse planning and resource management plans and policies (e.g. the Illawarra REP, Greater Metropolitan REP, Drinking Water Catchments REP, Wollongong LEP and the Special Areas Strategic Plan of Management 2007).

The adaptive management programmes have also been developed in consideration of the findings of the SCI.

In addition, the rehabilitation programme has been developed in consideration of the Commonwealth of Australia (2006b) *Mine Rehabilitation* and Commonwealth of Australia (2006c) *Mine Closure and Completion* documents.

5.1 STREAM RESTORATION AT THE METROPOLITAN COLLIERY

Mine subsidence has affected some rock bars and associated pools along Waratah Rivulet. These effects have included shallow cracking (i.e. less than 20 m in depth) of rock bars and a consequent increase in the hydraulic conductivity of the rock bars leading to some reductions in the persistence of pools. While the affected pools typically retain water during periods of moderate to high flow, diversion of surface water into the shallow fracture network (underflow) has resulted in a reduction in water levels in stream pools during periods of low or no flow.

HCPL conducted a restoration trial at a rock bar known as WRS4 on the Waratah Rivulet (approximately 200 m upstream of Flat Rock Crossing) in consultation with the SCA (Figure 5-1). The objective of the trial was to investigate the effectiveness of PUR grouting products and associated injection methods in reducing the hydraulic conductivity of the fractured rock mass. The restoration trial was conducted from March to May 2008.

Successful restoration of the WRS4 rock bar was confirmed through measurement of a substantial decrease in hydraulic conductivity and further evidenced by the return of normal water flows over the rock bar and Pool F (the pool behind the WRS4 rock bar) water level responses. Key outcomes of the restoration trial include (HCPL, 2008b):

- PUR injection can be conducted without environmental harm.
- Fracture spaces can be successfully filled from <1 mm fine cracks to larger (>100 mm) voids (Figure 5-2).
- The hydraulic conductivity of the overall rock mass was decreased to the extent that the rock bar once again acted as a natural weir to maintain the persistence of its upstream pool.
- The PUR products, method of injection, drilling equipment and drilling methods are technically feasible and transferable to other rock bars along the Waratah Rivulet, where future assessment indicates the need.

These outcomes are described further below.

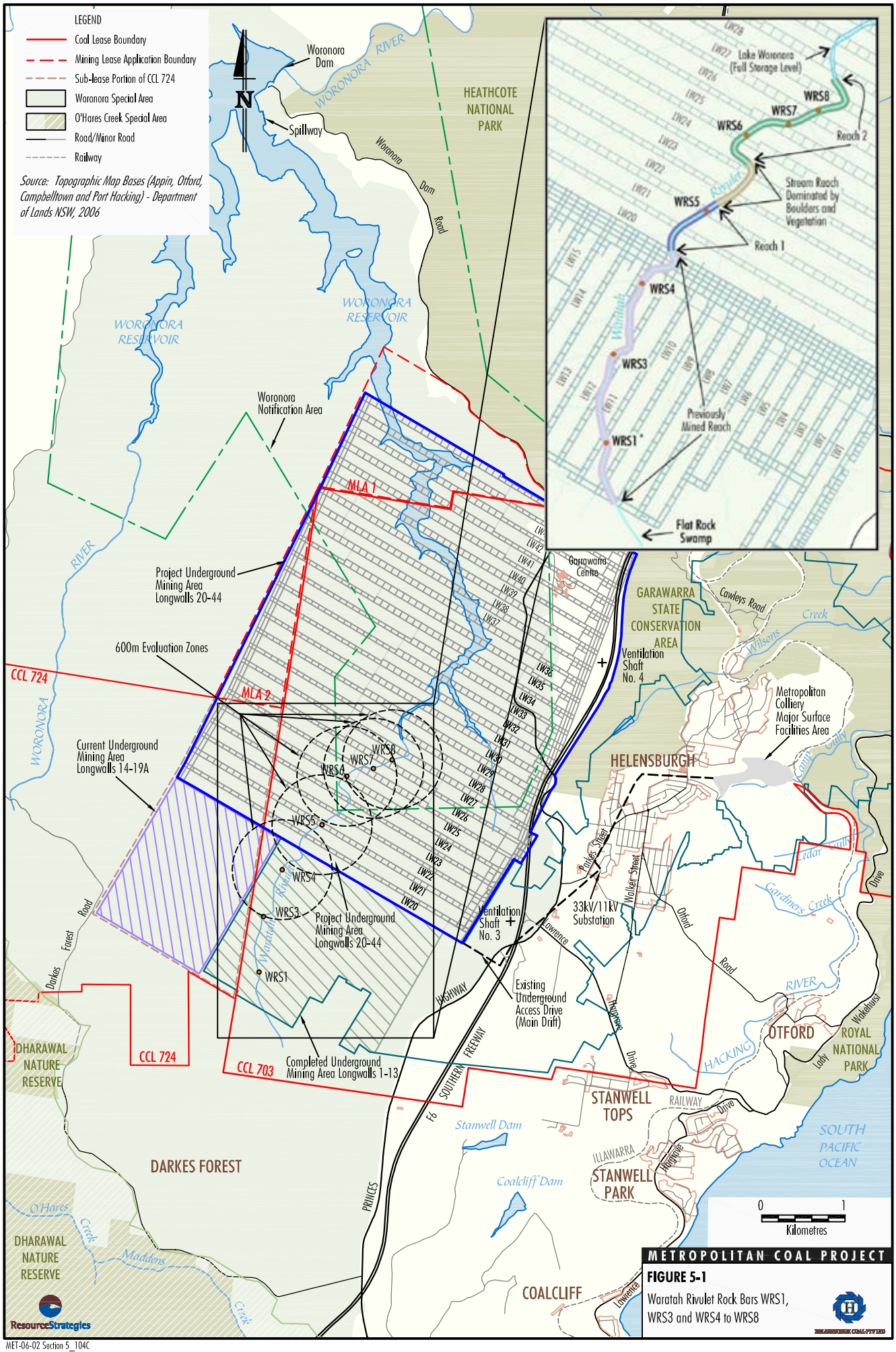

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FIGURE 5-1

Waratah Rivulet Rock Bars WRS1, WRS3 and WRS4 to WRS8

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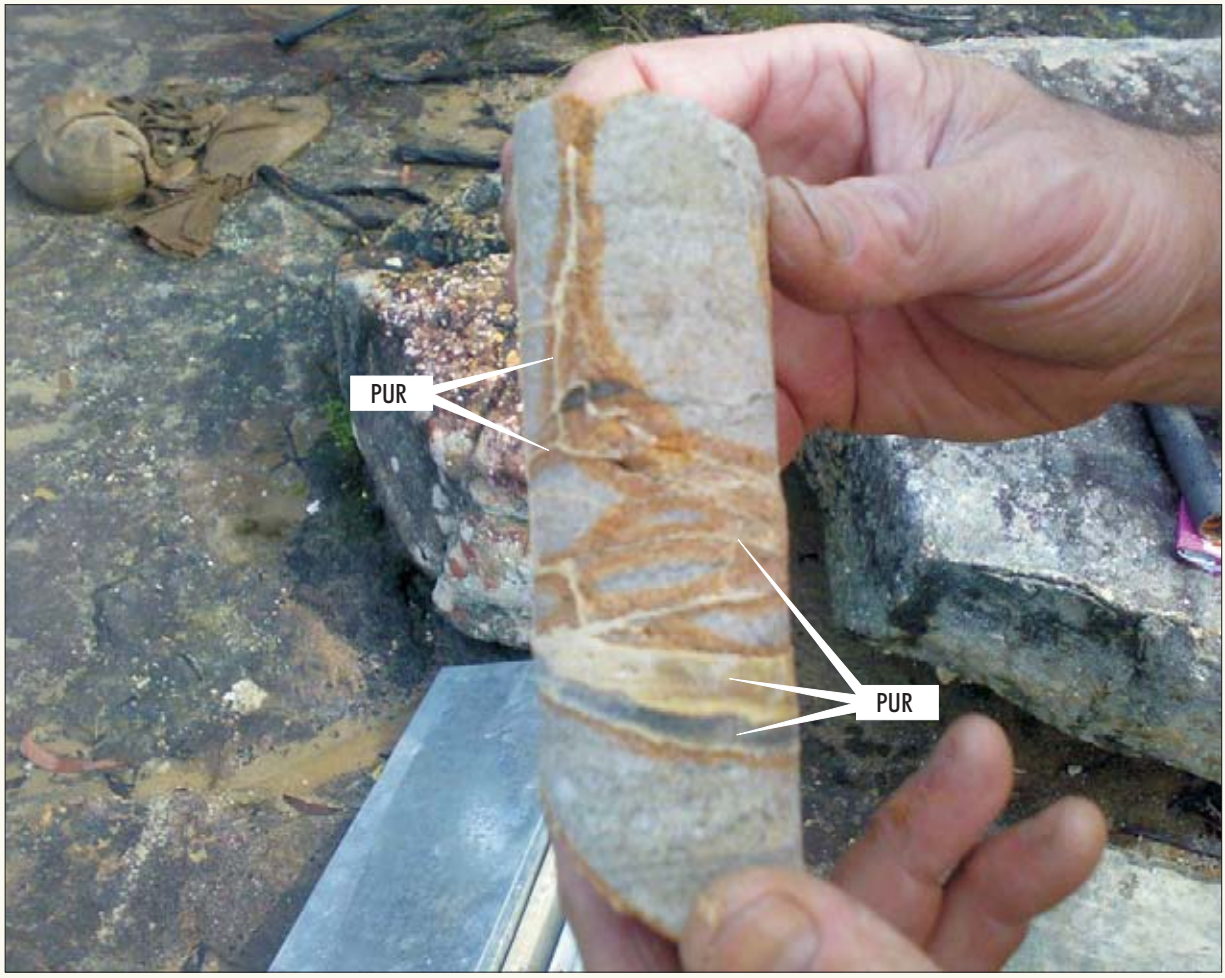

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FIGURE 5-2
Drill Core - Filling of Cracks with PUR

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5.1.1 Environmental Management and Monitoring

An Environmental Management Plan (HCPL, 2007b) was prepared and implemented for the restoration trial activities at the WRS4 rock bar. In addition to the drilling of holes and PUR injection into sub-surface fractures, the restoration trial works involved a range of associated activities (e.g. some surface disturbance).

Environmental management measures implemented included those relevant to soil management, vegetation management, erosion and sediment control, fuel and spill management, grout (i.e. PUR) handling, waste management, transport controls and bushfire preparedness. The environmental controls implemented during the restoration trial were considered by HCPL and the SCA to have worked effectively in providing the required control.

The Environmental Management Plan also included extensive field and laboratory water quality testing. The water quality monitoring conducted before, during, and after PUR injection indicated that there was no impact on water quality from the use of PUR products or injection methods (HCPL, 2008b).

Consistent with the recommendations of the SCPR (DoP, 2008), HCPL is currently investigating the potential use of cosmetic treatments (in the form of coloured grout or similar) to reduce any aesthetic effects of the grouting process. It is considered that the combination of timely PUR injection and cosmetic grouting greatly reduce the aesthetic and environmental effects of mining to this type of natural feature.

HCPL has SCA approval to trial cosmetic repair techniques at the WRS4 rock bar. Its applicability to other rock bars along Waratah Rivulet would be determined in consultation with the relevant authorities.

5.1.2 Hydraulic Conductivity of the Rock Bar and Pool Behaviour

The change in hydraulic conductivity of the rock mass before and after PUR injection was quantified. The trial demonstrated that the injection of PUR substantially decreased the gross hydraulic conductivity of the rock bar (HCPL, 2008b).

The overall decrease in the hydraulic conductivity of the rock bar was further evidenced by the changed hydraulic characteristics of the pool behind the WRS4 rock bar (Pool F).

As described in Section 4.4, during periods of significant rainfall and runoff in Waratah Rivulet, the water level in subsidence impacted pools is similar to pools unaffected by subsidence. Under these flow conditions pools and their downstream rock bars become “drowned out”.

During dry periods when flows in the rivulet are in a low, recessionary regime, the water level in pools affected by subsidence in some cases recedes much faster than is the case in unaffected pools.

Comparison of recorded water level behaviour in three pools (Pools A, F and H) on Waratah Rivulet before and after the restoration trial at WRS4 also provides a means of assessing the success of the trial. Pools A and F have been affected by mine subsidence, while Pool H is located a distance downstream of the Completed Underground Mining Area and has not been affected by mine subsidence (HCPL, 2008b). A comparison of the behaviour of the three pools is provided on Figure 5-3a and shown in red (Pool A), orange (Pool F) and green (Pool H). The location of the pools is shown on Figure 4-6.

It is readily apparent that water levels in both Pools A and F have declined rapidly on a regular basis during low flow periods, while water levels in Pool H have generally remained near the cease to flow level (Appendix C) (i.e. the level at which the pool no longer overflows). Water levels in Pool A have receded to a lower level because the pool is significantly deeper than Pool F.

Figure 5-3b shows the last six months of recorded pool water level data. The restoration trial commenced on 17 March 2008 and was completed on 13 May 2008. There is a clear difference in the water level response in Pool F prior to 18 April 2008 and after this date (shown in orange in Figure 5-3b). Figure 5-3b confirms that water level responses in Pool F mirrored those in Pool H (i.e. were similar to natural pool behaviour) (shown in green in Figure 5-3b) after 18 April 2008, whilst water levels in Pool A continued to show the effects of subsidence related underflows (i.e. significant rapid drops in pool level) (Appendix C).

The rainfall over this period is also shown on Figures 5-3a and 5-3b. Little to no rain was recorded from 28 April to 29 May 2008. Since the completion of the PUR trial, the pool water level responses in Pool F were indistinguishable from those recorded in Pool H.

Based on this dataset, it can be concluded that water level responses in Pool F have changed markedly as a result of the restoration trial (Appendix C).

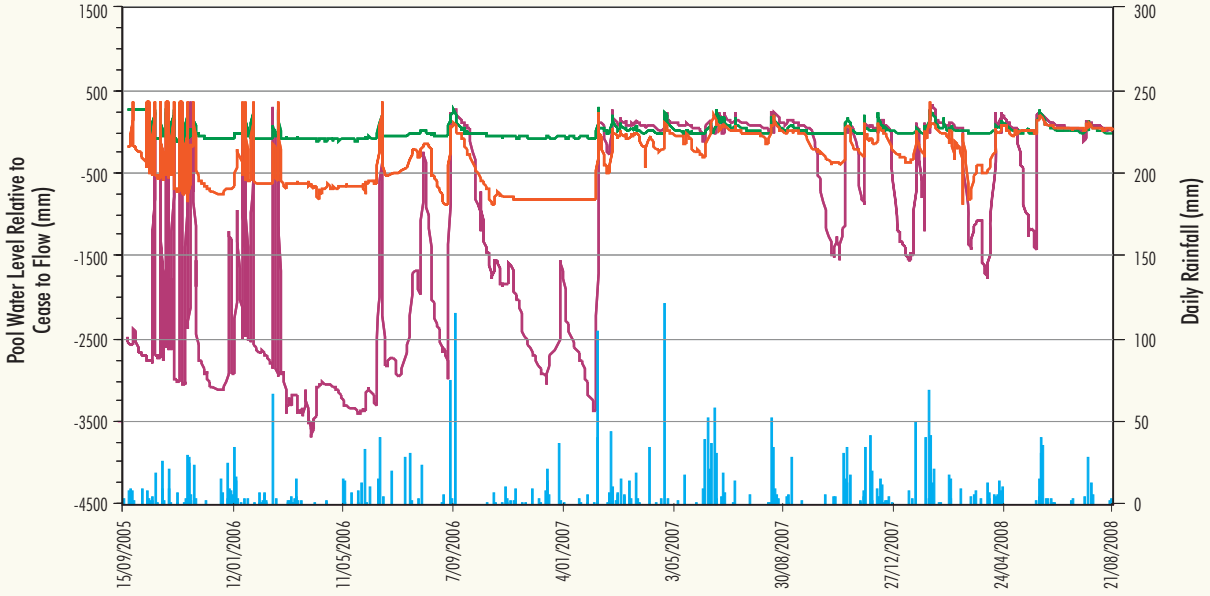


Figure 5-3a Pool Water Levels (2005 - 2008)

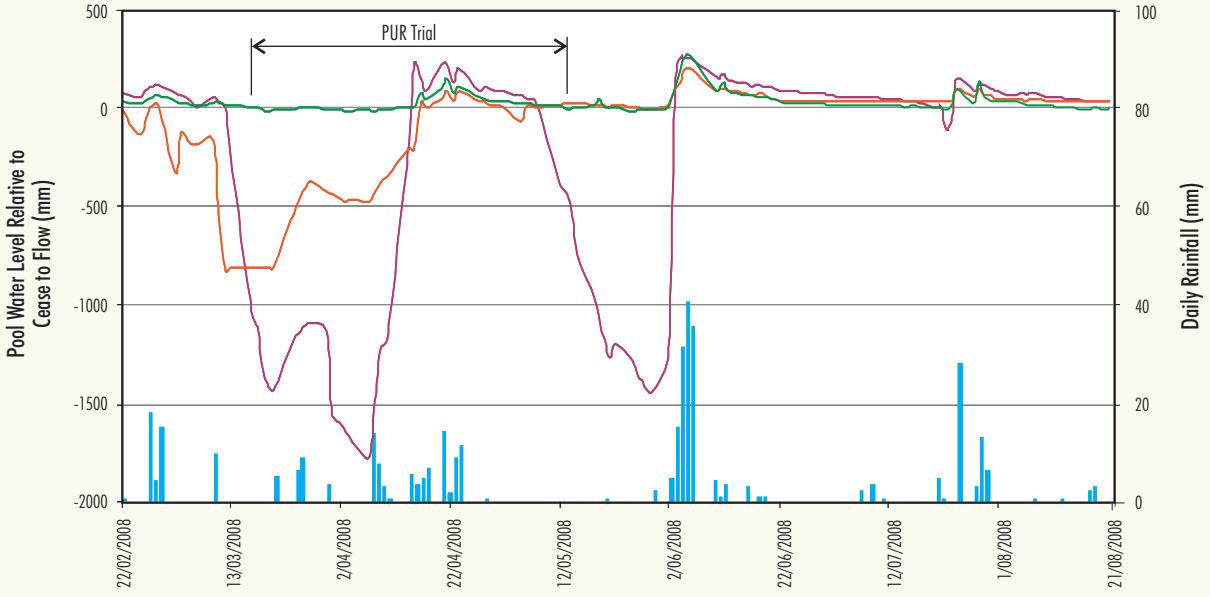
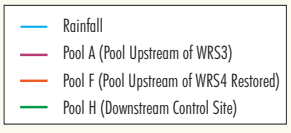


Figure 5-3b Pool Water Levels (2008)



Source: Gilbert and Associates (2008)

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FIGURE 5-3
PUR Restoration Graphs - Pools A, F and H

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HCPL continues to collect data regarding the hydrological characteristics of Pools A, F and H.

5.1.3 Peer Review

The outcomes of the WRS4 restoration trial were peer reviewed by Gilbert and Associates (Appendix C) and Dr Walter Boughton. The peer reviews supported HCPL's assessment of restoration success.

5.1.4 Technology Transfer of Restoration Techniques

The successful application of PUR products, method of injection, drilling equipment and drilling methods confirm their technical feasibility. Importantly, the WRS4 trial included the use of equipment of a type that would be utilised at more remote sites (HCPL, 2008b). The local conditions at rock bars WRS5, 6, 7 and 8 (Figure 5-1) are considered amenable to PUR injection methods (Section 5.2).

5.1.5 Southern Coalfield Panel Report and Stream Restoration

At the time of reporting, the SCPR considered the level of confidence associated with the current restoration measures for natural features to be low to moderate. However, the SCPR noted:

> *The capacity of mining companies to undertake successful remediation of stream bed cracking within the Special Areas has been limited, until recently, by SCA restrictions on materials permitted to be transported into or used within these areas. The Panel supports SCA's recent decision to permit the use of polyurethane resin (PUR) in injection grouting to remediate stream bed cracking within the Special Areas.*

The results of the WRS4 restoration trial described in Sections 5.1.1 and 5.1.2 indicate that the use of PUR products at the WRS4 rock bar has been successful in restoring the upstream pool (HCPL, 2008b).

The SCPR indicates that HCPL had recently completed remediation of the WRS4 rock bar using this type of grout, but noted that:

> *Helensburgh Coal has claimed a high measure of success for this operation, but this view has not yet been independently verified.*

As described in Section 5.1.3, the results of the WRS4 restoration trial have now been verified by specialist hydrologists. The peer reviews support HCPL's position that this technology can successfully restore the hydraulic characteristics of subsidence affected rock bars.

While the SCPR states in one part that based on current understanding, remediation should not be relied upon as a forward management strategy for highly-significant features[1], the Panel clearly envisaged the use of remediation as the SCPR states:

> *Due to the extent of current knowledge gaps, the Panel considers that a precautionary approach should be applied to mining which might unacceptably impact highly-significant natural features …. The predicted impacts would have to be 'acceptable' to Government. Alternatively, mitigation and/or remediation strategies (offering sufficient certainty of outcome and effectiveness), could be proposed.*

In addition, recommendation 10 of the SCPR states:

> *Consideration should be given to the increased use within Part 3A project approvals of conditions requiring environmental offsets to compensate for either predicted or non-predicted impacts on significant natural features, where such impacts are non-remediable.*

Recommendation 10 anticipates scenarios where remediation strategies would be used for predicted impacts on significant natural features. Section 5.6 presents HCPL's proposed environmental offsets for potential non-remediable residual impacts as assessed in Section 4.

The SCPR also states:

> *There are a number of rehabilitation (or remediation) techniques which are available for the remediation of significant natural features impacted by mining subsidence. These include backfilling and/or grouting of cracks and fracture networks at strategic locations, stabilisation of slopes and drainage and erosion control measures.*

The SCPR encourages mining companies to provide detailed information concerning proposed remediation measures and evidence as to their likely effectiveness and their secondary/ consequential impacts in project applications and SMP applications.

[1] As described in Section 3.7.1, the SCPR does not clearly define *highly-significant natural features*.

The potential secondary effects of restoration works (e.g. vegetation clearance, water quality management and the aesthetic effect of grouts) are addressed in the relevant sections of this EA.

The SCPR also recognises that research by the industry into techniques for remediating natural features may allow a greater degree of proactive remediation as a control strategy in the future. Recommendation 14 of the SCPR encourages the coal mining industry to undertake additional research into means of remediating stream bed cracking. HCPL is committed to such research (Section 5.6).

5.2 WARATAH RIVULET ADAPTIVE MANAGEMENT

This section describes the adaptive management approach proposed by HCPL for rock bars WRS5, 6, 7 and 8 on the Waratah Rivulet (Figure 5-1). This approach is considered to be consistent with the RMZ concept recommended by the SCPR (DoP, 2008).

Rock bars WRS5, 6, 7 and 8 on the Waratah Rivulet are associated with large pools that are similar in nature to those observed further upstream on the previously mined reach of Waratah Rivulet and contain similar habitat and aesthetic value (although not visible from existing fire trails).

If approved, it is anticipated that the Project Approval, read in conjunction with this EA, would determine the authorised level of subsidence effect to rock bars WRS5, 6, 7 and 8 as a result of the Project. To ensure that the authorised level of effect is not exceeded, HCPL proposes an adaptive management approach. This is consistent with the SCPR and a risk based management approach.

If subsidence effects are trending so as to potentially exceed that authorised by the Project Approval and/or the implementation of restoration commitments is not performing adequately (including the time scale within which they are undertaken), then the adaptive management approach would lead to various responses. These include: further restoration works in the first instance; or in the case of the need for contingency measures, a reduction in the causal subsidence magnitudes (achieved by options including reduced thickness of seam mined, narrowed longwall width, and/or longwall set-backs from the rivulet).

This risk based management approach would be centred around the application of recognised risk based techniques (NSW DPI-MR Guideline MDG1010 Risk Management Handbook for the Mining Industry). This includes:

- Consultation with a cross-section of stakeholders in the application of this process.
- Analytical measures to evaluate the probability of the impacts occurring.
- Monitoring requirements to measure trends and impacts are within predictions.
- Actions, controls and responsibilities if impacts are not as predicted.

A Trigger and Response Plan (TARP) within the adaptive management approach would be developed in consultation with recognised experts in the relevant fields.

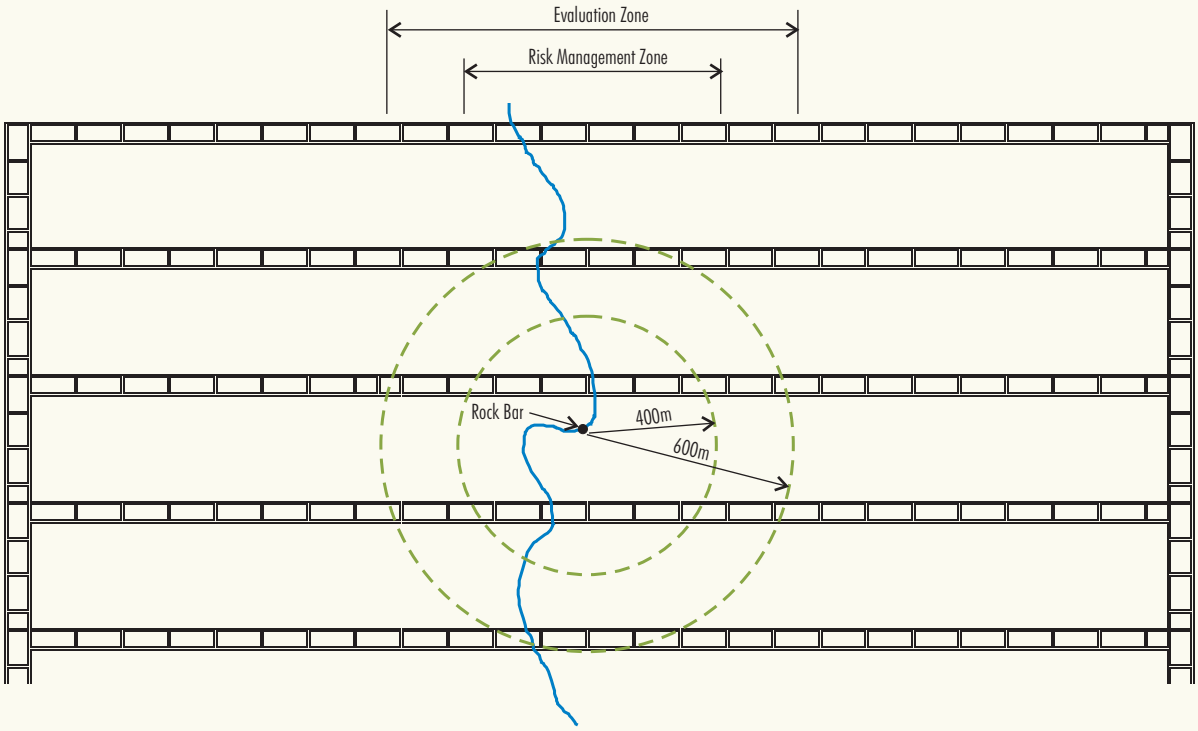
The framework of the TARP and the practicalities of the implementation of any response measures should they be required are described in the following sub-sections.

A WRMP would be developed in consultation with the relevant authorities to reflect the adaptive management approach. The WRMP would be developed to the satisfaction of the DoP prior to longwall mining within 600 m of WRS5 (Figure 5-1). The TARP would be a management tool used to achieve the objectives of the WRMP.

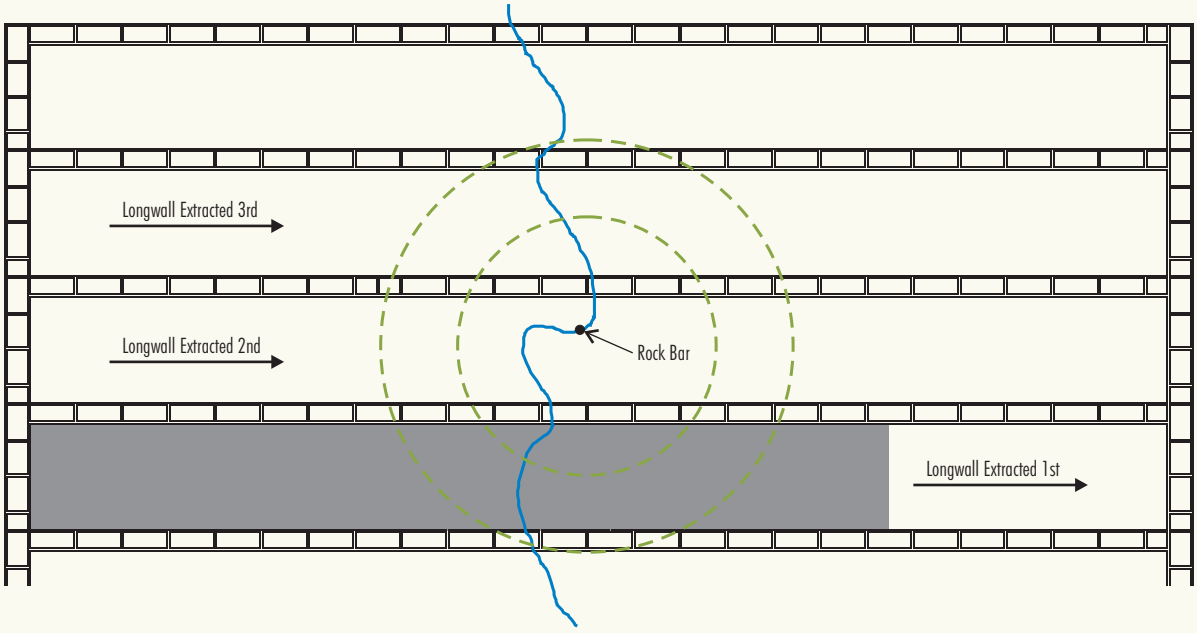
The WRMP would be an operational document that would be reviewed and updated to reflect the status of longwall mining, revised subsidence predictions and any advances in stream restoration methods.

The WRMP would comprise the following elements:

- identification of evaluation zones where the adaptive management approach would be implemented (i.e. within 600 m of rock bars WRS5, 6, 7 and 8) (Figure 5-1);
- specific incremental subsidence assessment for each longwall panel within 600 m of these rock bars (Figure 5-4);
- subsidence measurement for comparison with predictions;
- a TARP with trigger mechanisms that initiate a range of responses (e.g. a higher intensity of monitoring and/or the implementation of response measures) and that identify personnel responsible for implementation of the response measures;
- iterative stream restoration phases at WRS5, 6, 7 and 8 and aesthetic measures that are planned prior to entering each evaluation zone;



Establish Risk Management Zones - WRS5, 6, 7 & 8



Normal Mining

Source: HCPL (2008)

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FIGURE 5-4
Adaptive Management Approach - Risk Management Zones

Not to Scale

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- environmental monitoring, environmental control measures and reporting for stream restoration works; and
- contingency measures in the event that observed subsidence effects are significantly greater than predicted or if the restoration performance criteria are not being achieved.

Each of the above elements is described in more detail below.

5.2.1 Evaluation Zones

Waratah Rivulet can be divided into three reaches between the Completed Underground Mining Area and the Full Supply Level of the Woronora Reservoir. The upper most reach contains WRS5; the central reach is dominated by boulders and vegetation without any significant pools; and the lower reach contains rock bars WRS6, 7 and 8 (Figure 5-1).

Evaluation zones and RMZs would be established for rock bars WRS5, 6, 7 and 8 (Figure 5-1). Similar zones would also be established for WRS4 as Longwall 20 would be extracted within 400 m of the rock bar. The location of mining relative to these zones would determine: the adaptive management planning and implementation status; monitoring parameters and frequency; and reporting requirements.

Evaluation zones and RMZs would apply to each longwall panel that is within 600 m and 400 m, respectively, of rock bars WRS5, 6, 7 and 8. Each time a longwall panel enters the 600 m evaluation zone, the requirement for a response and/or contingency measures would be evaluated via the WRMP and TARP. This would require that actual subsidence and environmental effects are measured and analysed on a frequent basis.

Trigger and Response Plan (TARP)

The TARP would be used as a management tool to achieve the objectives of the WRMP. The generic framework of the TARP is shown in Table 5-1 and comprises the following key elements:

- Identification of the current status, including:
  - Condition normal indicating that normal conditions currently prevail.
  - Level 1 indicating that subsidence effects have been moderately exceeded or are trending towards an exceedance.
  - Level 2 indicating that subsidence effects are significantly above predictions.
  - Level 3 indicating that subsidence effects have not been controlled by Level 2 actions.
- Feedback mechanism which typically comprises the type and frequency of monitoring to appropriately inform the condition status.
- Response or actions appropriate for each condition status which also clearly identifies the person(s) responsible for authorising the action.

The TARP functions both forwards and backwards in that a change to a lesser condition status must be authorised.

The TARP would be considered a 'live' management tool in that the condition status of each evaluation zone and RMZ would be known at any given time.

The details within the TARP framework would be determined as part of the SMP process, however, various elements informing the TARP are described below.

Table 5-1
Generic Trigger and Response Plan

Condition	Normal (Green)	Level 1 (Yellow)	Level 2 (Orange)	Level 3 (Red)
Trigger	Trigger(s) within limits.	Trigger exceeded normal limits.	Trigger exceeded Level 1 limits.	Trigger exceeded Level 2 limits.
Frequency	Normal monitoring frequency.	Monitoring frequency increased.	Monitoring frequency increased.	Monitoring frequency increased.
Action/ Response	As per normal conditions.	Appropriate for Level 1 condition.	Appropriate for Level 2 condition.	Appropriate for Level 3 condition.
Responsibility	Environment and Community Manager and/or Technical Services Manager	Environment and Community Manager and/or Technical Services Manager	Corporate/General Manager	Incident Management Team

5.2.2 Subsidence Assessment

The Subsidence Assessment (Appendix A) employed the upper bound prediction method to estimate valley closure and upsidence magnitudes as a result of the Project. Following detailed mine design and as part of the SMP process, specific incremental subsidence assessment for each longwall panel which mines within 600 m of rock bars WRS5, 6, 7 and 8 would be conducted (Section 3.3.1). These quantitative SMP subsidence predictions would form the basis for comparing actual versus predicted subsidence effects and inform the trigger levels in the TARP.

5.2.3 Monitoring

As mining progresses, subsidence and environmental monitoring would be continued to validate that subsidence predictions and environmental effects are within that authorised by the Project Approval.

Detailed subsidence monitoring requirements would be determined by the SMPs. These may include, an appropriate frequency of monitoring subsidence cross lines to inform the current magnitude of closure and trend in closure development.

Qualitative monitoring of subsidence effects would also include visual inspection of crack development. Detailed environmental monitoring of parameters such as pool water levels, stream flow, groundwater levels, surface water quality, aquatic ecology characteristics and vegetation condition would be undertaken under the WRMP (Section 6).

Such monitoring would include:

- measurement of flow parameters upstream and downstream of the rock bar;
- comparative monitoring of stream pools that are and are not affected by mine subsidence;
- measurement of water quality upstream and downstream of the rock bar;
- sampling of aquatic biota and habitat characteristics; and
- visual monitoring of cracking and surface subsidence effects.

The type and frequency of each monitoring element would be appropriate to the condition status as indicated in the TARP.

All monitoring data would be compiled, validated and analysed by HCPL at the appropriate frequency. The results of this process would be reported to all relevant regulatory authorities at a frequency determined under the WRMP. Technical peer review by recognised experts in the relevant fields would also be undertaken at the critical milestones in this process.

Where the trend of actual subsidence effect indicates that a substantial variance (i.e. exceedances) of subsidence effect is occurring or considered likely to occur, then the implementation of response measures would be triggered.

5.2.4 Trigger Mechanisms

Multiple triggers would be incorporated in the TARP to determine the need for further critical analysis of the datasets and based on this the implementation of response or contingency measures. The observation of a trigger being exceeded would result in the TARP reaction being intensified. Monitoring against these triggers would be continued for the whole of each longwall, not just when mining within the evaluation zones.

Evaluation Zone Triggers

Prior to longwall mining entering an evaluation zone (i.e. 600 m from rock bars WRS5, 6, 7 or 8), HCPL would:

- have completed a rock bar restoration design (including environmental management controls to be implemented for stream restoration works) based on the expected level of effect as determined by the Project Approval and SMP subsidence assessment;
- submitted the rock bar restoration design for regulatory review and/or approval;
- confirmed that suitable environmental and subsidence monitoring measures are in place; and
- actioned resources for the works.

When mining in a longwall panel leaves the evaluation zone, HCPL would continue to monitor and: review the level of observed subsidence and environmental effect; undertake a final review of the rock bar restoration design based on this data; and undertake the stream restoration works within a period of six months following the receipt of any necessary final approvals and once suitably low flow conditions occur (i.e. restoration works cannot be undertaken during periods of high stream flows).

Observed Subsidence Triggers

Regular monitoring of subsidence cross lines would inform the current magnitude and trend in development of subsidence.

Where the trend of actual subsidence effect indicates that a substantial variance (i.e. exceedances) of subsidence effect is occurring or considered likely to occur, then the implementation of response measures would be triggered.

Flow/Pool Level Triggers

Reduction in pool water levels and the reduction of flow-over some rock bars is an expected consequence of mine subsidence (Section 4.4.2) until restoration has occurred. Monitoring of the flow regime and pool levels would be used to evaluate the success of rock bar restoration works. If the restoration works were not successful, then response and/or contingency measures would be implemented in accordance with the WRMP.

Water Quantity/Quality

No measurable detrimental effect on the quality or quantity of the yield of Woronora Reservoir is expected as a result of the Project. Localised diversion of a portion of surface flow and localised temporary effects on water quality are an expected consequence of mine subsidence effects (Section 4.4.2).

If a mine subsidence induced effect on the water quality or quantity of the yield of Woronora Reservoir is detected as a result of the Project, then response and/or contingency measures would be implemented in accordance with the WRMP.

Completion of Rock Bar Restoration Works

At the completion of rock bar restoration works, evaluation of the requirement to implement any additional aesthetic remediation works would be considered. Such works include cosmetic grouting and/or capping of drill holes and cracks using landscaping specialists.

5.2.5 Stream Restoration Commitment

Successful restoration of the WRS4 rock bar has been completed at the Metropolitan Colliery (Section 5.1). HCPL is committed to undertaking restoration of rock bars WRS5, 6, 7 and 8 (Figure 5-1), in the case that mine subsidence results in a measurable increase in rock bar leakage rates at these locations.

HCPL has evaluated each rock bar in terms of its suitability for restoration activities, including:

- access for drill rigs by helicopter lift;
- access for materials by helicopter lift;
- personnel access by foot;
- availability of a suitable remote pumping station for the use of PUR (i.e. a fire trail within 2 km and at a higher elevation than the rock bar); and
- vegetation disturbance potential.

Based on these evaluations, HCPL considers that WRS5, 6, 7 and 8 would be amenable to restoration using the general injection methods, drilling techniques and environmental controls developed at the WRS4 rock bar (Section 5.1).

The WRS5 rock bar is situated some 600 m from WRS6 and therefore provides an opportunity to further review and refine the adaptive management approach at Waratah Rivulet.

Restoration works would be undertaken at rock bars WRS5, 6, 7 and 8 following each successive longwall panel within the 600 m evaluation zone if required to retain pools upstream of these rock bars. It is expected that there would be primary, secondary and final restoration works following each phase of subsidence effect.

This recognises that each longwall has an incremental subsidence effect and that longwalls may affect rock bars prior to undermining, during undermining, or from mining in adjacent panels that are not directly beneath the rock bar.

Such an approach would minimise the temporal extent of subsidence effects on pool behaviour.

5.2.6 Environmental Control Measures and Reporting

The WRMP would include a description of relevant environment monitoring of relevance to the rock bars and associated stream features. The frequency of each monitoring element would vary in accordance with the condition status in the TARP (Section 5.2.3).

Environmental control measures applicable to the stream restoration works (and installation of monitoring equipment where applicable) would be detailed in the WRMP, including:

- management of any soil and vegetation disturbance;

- erosion and sediment controls to minimise the potential for any downstream effects;
- stream flow diversion and reduction of sub-surface flows during the application of PUR grout products;
- drill cuttings containment and disposal;
- fuel management;
- management of grouting products and injection operations;
- waste management;
- transport and handling of equipment and materials; and
- hazards and risk identification and management.

Each of the above environmental control measures has been developed in detail for the WRS4 restoration works and successfully implemented by HCPL in consultation with the SCA.

The WRMP would include reporting requirements in accordance with any Project Approval and/or SMP approval conditions. Such reporting is likely to include subsidence monitoring results, analysis of subsidence trends, notification of entry and exit of the evaluation zones and RMZs, and completion of each phase of stream restoration works.

5.2.7 Response and Contingency Measures

TARP Response Measures

In the event that monitoring data indicates that rock bar restoration works have not met the predetermined performance criteria then restoration works would be repeated by HCPL until such time as the works are deemed to be successful.

Other response measures may be implemented, subject to detailed technical investigation and peer review to inform their need, extent and/or design.

TARP Contingency Measure - Modified Longwall Extraction Geometry

In the event that stream restoration performance criteria are not achieved (including the timeframe within which the works are completed) then modifications to the longwall extraction geometry would be implemented for subsequent longwall panels so as to reduce the cumulative subsidence effect.

Such modifications include:

- reducing the thickness of coal seam extracted;
- narrowing of the longwall panels; and/or
- setback (i.e. not mining beneath or as close to Waratah Rivulet).

In addition, in the event that there is a measurable reduction in the quality or quantity of the yield of Woronora Reservoir as a result of the Project, modification of the longwall extraction geometry would be undertaken.

One of the major issues in relation to modification of longwall extraction geometry is having appropriate roadway development to enable a setback or to narrow the panel width.

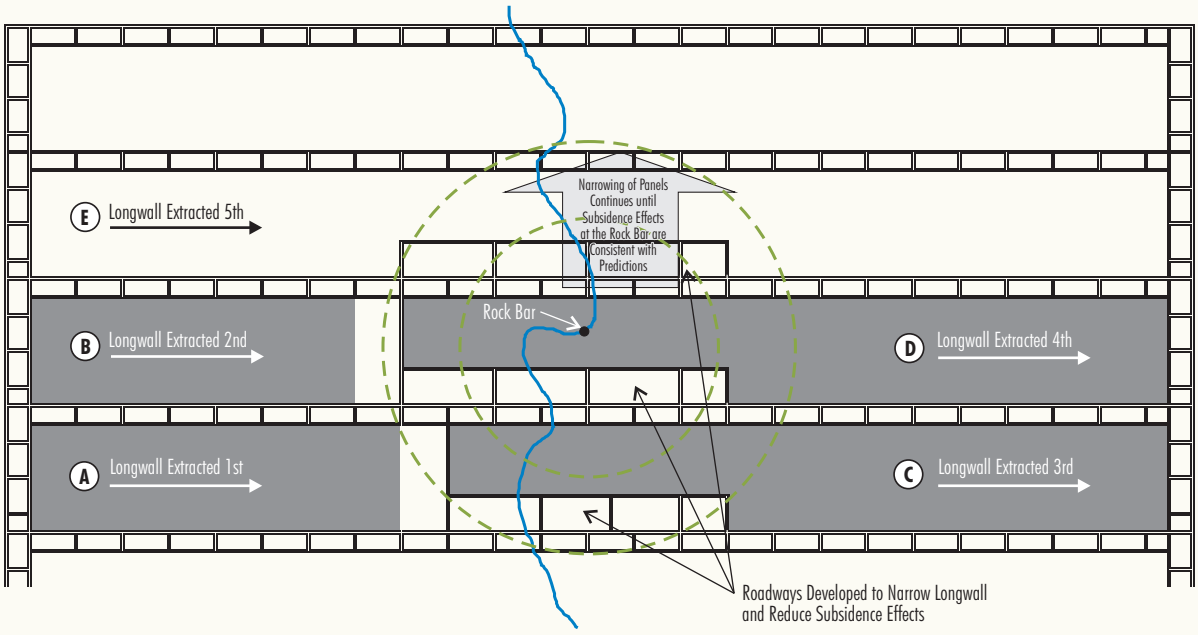
In the case of reduced panel width, a new tailgate would be required over the affected section in addition to a new installation roadway (Figure 5-5). In the case of a setback a new installation roadway would be required (Figure 5-5).

These additional lengths of development would typically require some weeks to months to develop. To allow time to develop the new roadways and minimise the potential impact on mine production, in the case that this contingency measure is required, the longwall miner would be relocated to the start of the next longwall (Figure 5-5). During extraction of the subsequent longwall, the additional roadways would then be developed to allow the modified extraction of the initial longwall. Once extraction of the adjacent longwall was completed, then the previous panel would be completed in its modified form (sequence A, B, C and D on Figure 5-5).

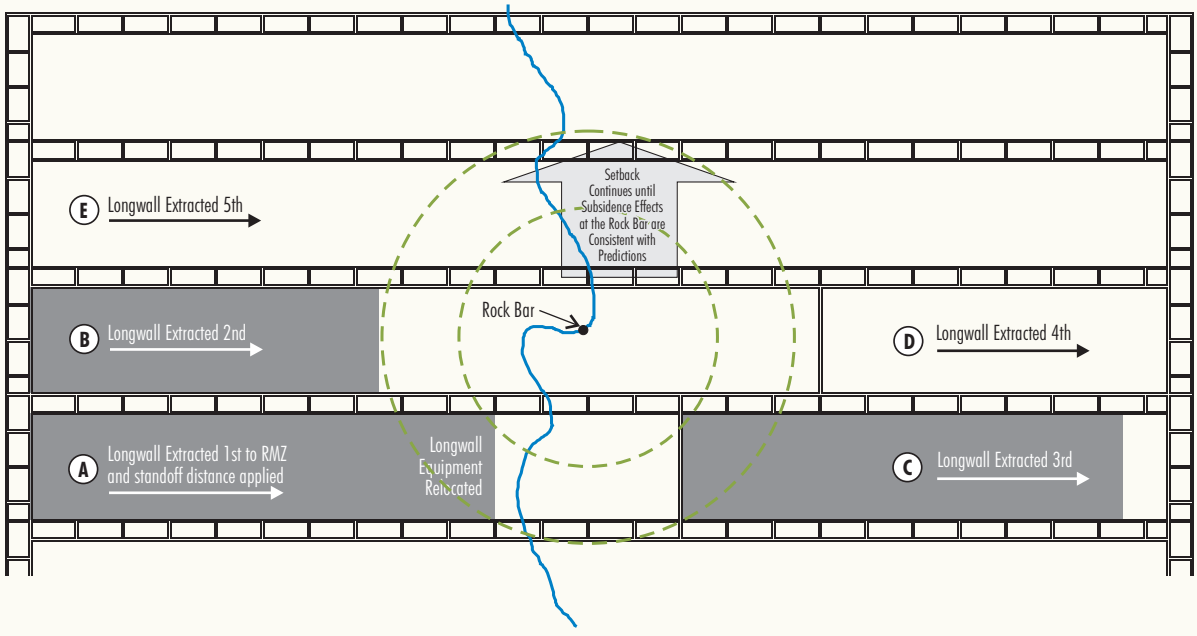
The costs of modifying longwall extraction geometry would be significant. The relative cost of narrowing the panel, versus setback off a feature, would depend on the extent of modification to the longwall panel that would be required as informed by the upper bound limit method of subsidence prediction.

In the event that a modification to the extraction was determined to be necessary on reaching the evaluation zone, the panel geometry would be modified within the next 200 m of longwall advance (i.e. the mine would be able to modify the longwall geometry prior to entering the RMZ within 400 m of the Waratah Rivulet [Figure 5-5]). This reflects the practical implications of deciding to recover the longwall machine from an unplanned location.

To effect a longwall recovery, a cut-through is required for movement of equipment and access to the longwall faceline. The area between the 600 m and 400 m distance from the Waratah Rivulet would generally contain three cut-throughs. The most suitable in terms of factors such as geology, roof conditions and logistics would be selected to recover the longwall machine.



Contingency Measure - Narrowing of Longwall



Contingency Measure - Setback of Longwall

Source: HCPL (2008)

METROPOLITAN COAL PROJECT

FIGURE 5-5
Adaptive Management Approach - Contingency Measures

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5.3 REHABILITATION OF SURFACE DISTURBANCE AREAS

The Project rehabilitation programme would include:

- the progressive rehabilitation of minor Project surface disturbance areas; and
- the rehabilitation of surface disturbance areas remaining at the cessation of the Project (e.g. the Major Surface Facilities Area).

Minor Project surface disturbance areas that would be progressively rehabilitated include those associated with surface exploration activities, access tracks, environmental monitoring and management activities (e.g. installation of monitoring equipment), surface disturbance associated with stream restoration activities and other minor Project-related surface activities.

As described in Section 4.6 and consistent with HCPL's existing approach, surface works would be sited, where practicable, to minimise the amount of disturbance and vegetation clearance required (e.g. the positioning of sites to avoid the removal of trees or the siting of infrastructure in previously disturbed areas such as the slashed verges of existing SCA roads/tracks).

Surface disturbance areas requiring rehabilitation at the cessation of the Project would include the Major Surface Facilities Area, Ventilation Shaft No. 3, Ventilation Shaft No. 4 and any residual minor surface disturbance areas.

In accordance with the *Mining Act, 1992*, rehabilitation would be subject to regulatory authority agreement and approval as part of the MREMP administered by the DPI (Section 3.3.1).

Rehabilitation planning would include the following steps:

- the production and periodic updating of rehabilitation plans as part of the relevant MOP and/or SMP (Section 6);
- the preparation and revision of goals and corresponding budgets by a site team that includes the Environment and Community Manager, the Technical Services Manager and the General Manager;
- the development of implementation schedules to guide the execution of the rehabilitation works; and
- annual reporting in the AEMR (Section 6).

The MREMP reporting requirements are described in Section 5.3.3 and further in Section 6.

The rehabilitation programme would be developed in consultation with key government authorities and other relevant stakeholders.

The Project rehabilitation objectives and strategies are described in the following sections.

5.3.1 Erosion and Sediment Control

As described in Section 4.1, erosion and sediment control strategies for the Project would be based on accepted practices established for the existing Metropolitan Colliery and would be further documented in the FFMP and WRMP for surface works that have the potential to result in erosion or sedimentation.

Erosion and sediment control measures would be prepared in general accordance with the manual *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

Erosion and sediment controls would remain in place until such time as ground disturbed by the works has been stabilised and rehabilitated.

5.3.2 Revegetation

As described above, Project rehabilitation works would include activities that would be undertaken progressively (e.g. rehabilitation of minor surface disturbance activities) and activities that would be undertaken at the cessation of the Project (e.g. the rehabilitation of the Major Surface Facilities Area). Revegetation of these disturbance areas is described below.

Revegetation of the majority of the minor Project surface disturbance areas would be progressive over the life of the Project (i.e. at any one time some small areas are likely to be disturbed [in the order of two hectares] by the Project, while previously disturbed areas would be in various stages of rehabilitation).

As described in Section 4.6, natural regeneration would be encouraged in the minor surface disturbance areas. It is anticipated that some disturbance areas would be of a size that revegetation of the disturbed area would occur naturally from adjacent native vegetation. In other disturbance areas (e.g. temporary access tracks), measures may be implemented to encourage natural regeneration (e.g. placing stockpiled vegetative material over cleared areas).

The implementation of weed management measures would also encourage natural revegetation.

Active revegetation of native vegetation (e.g. planting and/or direct seeding) would be implemented in the event natural regeneration is not considered to be progressing in the minor surface disturbance areas. Active revegetation would also be implemented in areas where the extent of prior disturbance is likely to limit successful natural revegetation, for example, at the ventilation shaft sites and at the Major Surface Facilities Area.

The selection of species for active planting and/or direct seeding would be determined in consideration of the site characteristics (e.g. slope, elevation and soil) and vegetation communities at, or in the vicinity of, the disturbance area.

The active revegetation programme would utilise endemic plant species. Specifically, any active revegetation in the Woronora Special Area would utilise seed collected from the Woronora Special Area. Active revegetation activities would include the seeding and/or planting of upper, mid and lower storey native species.

A Mine Closure Plan (MCP) would be developed (Section 6) for the Project to present the revegetation concepts for the Major Surface Facilities Area and any other remaining disturbance areas and would be subject to consultation with regulatory authorities. The overriding objective of the revegetation programme would be to establish self-sustaining vegetation appropriate to the landforms being revegetated.

Monitoring of rehabilitated areas would be conducted on a regular basis to ensure that the rehabilitation objectives are being achieved and to identify the need for any maintenance and/or contingency measures (e.g. weed control or re-planting), as described in Section 5.3.3 below.

5.3.3 Rehabilitation Monitoring, Maintenance and Reporting

Monitoring of rehabilitation areas would be conducted on a regular basis to confirm that vegetation is establishing and to determine the need for any maintenance and/or contingency measures (e.g. the need for weed control, erosion and sediment control or active revegetation measures).

Monitoring and maintenance of the rehabilitation areas would be described in MOP(s) to be prepared for the Project and the status of rehabilitation areas and activities would be reported annually in the AEMR (Section 6).

Prior to the completion of mining operations, a MCP would be developed in consultation with relevant authorities and the Project CRG. The MCP would include details of the final rehabilitation works and post-closure maintenance and monitoring requirements appropriate to established completion criteria. It is anticipated that the monitoring and maintenance measures would include those relevant to the mine closure and lease relinquishment criteria described in Section 5.5 below.

5.4 REHABILITATION OF MINE SUBSIDENCE EFFECTS

In addition to the adaptive management approach described for the Waratah Rivulet in Section 5.2, rehabilitation may be undertaken to remediate mine subsidence effects (e.g. surface cracking and erosion) on other natural surface features.

As described in Section 4.2, the magnitudes of the predicted systematic and valley related movements have the potential to cause surface cracking, including surface tension cracking near the tops of slopes. To date, the only surface tension crack reported at Metropolitan Colliery is adjacent to Fire Road 9H which is near the top of a steep slope. The size and extent of surface cracking on slopes is expected to be minor, which is consistent with that observed during the extraction of previous longwalls at the Metropolitan Colliery.

Notwithstanding, fire roads in the Project Underground Mining Area would be periodically monitored for subsidence-induced impacts. Where significant cracks are detected, they would be repaired/filled as soon as practicable. This may include the use of earthmoving equipment if considered (in consultation with the SCA) the most appropriate method of crack repair.

Flat Rock Crossing would be monitored as some subsidence effects are expected. Cracking at this location would be repaired in consultation with the SCA. Appropriate sedimentation controls would be implemented during the implementation of repair works.

Regular visual monitoring (particularly along Waratah Rivulet) would be conducted to identify areas subject to excessive erosion and sedimentation. Where monitoring indicates the potential for excessive erosion or sediment migration, specific mitigation measures would be employed. Potential management measures include:

- filling of cracks and minor erosion holes in the bed or banks of watercourses;
- installation of sediment fences downslope of subsidence-induced erosion areas;
- stabilisation of erosion areas using rock or other appropriate materials;
- stabilisation of banks subject to soil slumping; and
- implementation of vegetation management measures.

Potential rehabilitation measures for impacts on vegetation include the implementation of weed control measures (e.g. mechanical removal or the application of approved herbicides) and the planting of endemic plant species. Any active planting would utilise flora species characteristic of the particular vegetation community in that area and would utilise seed collected from the Woronora Special Area.

In addition, consultation would be undertaken with the DoP and the SCA for any proposed revegetation works associated with subsidence impacts (e.g. impacts to riparian vegetation), should monitoring indicate the need.

5.5 MINE CLOSURE AND LEASE RELINQUISHMENT

Prior to the completion of mining operations, a MCP would be developed in consultation with the relevant authorities and stakeholders. The MCP would document the final mine closure process, final rehabilitation works and post-closure maintenance and monitoring requirements appropriate to established completion criteria.

The MCP would also address the long-term landuse for the Major Surface Facilities Area. A detailed MCP would be prepared to meet legislative requirements including stakeholder consultation.

The MCP would be developed in consideration of relevant strategic landuse planning and resource management plans and policies. Consideration would also be given to rehabilitation and mine closure guidelines (e.g. the Commonwealth of Australia [2006b] *Mine Rehabilitation* and Commonwealth of Australia [2006c] *Mine Closure and Completion* documents).

Upon cessation of mining operations, it would be expected that tenure of the mining and coal leases would be maintained by HCPL until such time as lease relinquishment criteria were satisfied. These criteria would be formulated and prescribed in consultation with relevant authorities and stakeholders.

It is anticipated that mine relinquishment criteria would include, but not necessarily be limited to the following:

- removal of infrastructure, where appropriate and required;
- landform stability and public safety;
- maintenance of downstream water quality;
- establishment of self-sustaining vegetation; and
- fulfilment of mining and coal lease and other statutory approval conditions.

Lease relinquishment criteria would be detailed in the MCP.

The MCP is described further in Section 6 and would include other considerations such as heritage and socio-economic aspects of mine closure.

5.6 COMPENSATORY MEASURES AND ECOLOGICAL INITIATIVES

A range of mitigation, management and monitoring measures would be implemented for the Project to maintain or improve the biodiversity values of the surrounding region in the medium to long-term. These compensatory measures and ecological initiatives are summarised in Table 5-2.

Table 5-2
Metropolitan Coal Project Compensatory Measures and Ecological Initiatives

Compensatory Measure or Ecological Initiative	Comment	Financial Contribution
Research Programmes		$250,000
• Research into subsidence effects on streams.	Consistent with SCPR.	
• Research on techniques for remediating stream bed cracking, including:	Consistent with SCPR Recommendation 14.	
- Crack network identification and monitoring techniques.		
- Technical aspects of remediation, such as matters relating to environmental impacts of grouting operations and grout injection products, life spans of grouts, grouting beneath surfaces which cannot be accessed or disturbed, techniques for the remote placement of grout, cosmetic treatments of surface expressions of cracks and grouting boreholes.		
• Research comparing the outcomes of interventionist remediation with natural processes of remediation.	Consistent with SCPR.	
• Research into the refinement of the prediction of non-conventional subsidence effects in the Southern Coalfield and the link to environmental effect. This would focus on valley closure and upsidence mechanisms.	Consistent with SCPR Recommendation 17.	
	Sub-total Contribution	**$250,000**
Catchment Condition Work		$50,000/year for life of Project
• Financial contribution towards rehabilitation and revegetation works within the Woronora catchment and/or other SCA controlled catchments. This would include project management services as required.	Catchment residual impact offset.	
• Pest Control	Biodiversity initiative.	
- Financial contribution to pest control programmes for pests such as the Red Fox, European Rabbit, Feral Deer, Feral Pig and Feral Cat within the Woronora catchment and/or other SCA controlled catchment.		
• Weed Control	Biodiversity initiative.	
- Financial contribution to weed control programmes for weeds such as Pampas Grass, African Love Grass, Lantana, African Boxthorn, Bridal Veil Creeper, Prickly Pear, Onion Grass and Blackberry within the Woronora catchment and/or other SCA controlled catchment.		
	Subtotal Contribution	**$1,150,000**
Total HCPL Contribution		**$1,400,000**