

METROPOLITAN COAL

LONGWALLS 301-303

BUILT FEATURES MANAGEMENT PLAN SYDNEY WATER

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_SYDWATER-R01-A	Original – Draft for Consultation	Sydney Water, DRG and DP&E	-
Table 3, Section 8 and Figure 4	LW301-303 BFMP_SYDWATER-R01-B	Revised – Incorporating Sydney Water Review Comments (4 October 2016)	Sydney Water, DRG and DP&E	11 May 2017*
Tables 2, 3, 4 & 6 and Appendix 3	LW301-303 BFMP_SYDWATER-R01-C	Revised – Addressing DP&E and DRG requirements	Sydney Water, DRG and DP&E	-
All	LW301-303 BFMP_SYDWATER-R01-D	Update to include LW303	Sydney Water and DRG	

* The approval allows for the extraction of Longwalls 301 and 302 only.

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1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (<http://www.peabodyenergy.com>).

The Project comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302 and 303 (herein referred to as Longwalls 301-303) define the next mining sub-domain within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Sydney Water (Longwalls 301-303 BFMP-SYDNEY WATER) has been developed to manage the potential consequences of Longwalls 301-303 extraction on the Sydney Water assets.

The relationship of this Longwalls 301-303 BFMP-SYDNEY WATER to the Metropolitan Coal Environmental Management Structure and to the Metropolitan Coal Longwalls 301-303 Extraction Plan is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this Longwalls 301-303 BFMP-SYDNEY WATER, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E) on 6 June 2016. This Longwalls 301-303 BFMP-SYDNEY WATER has been prepared in consultation with Sydney Water, including consideration of prior consultation during the development of the previously approved Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303 Built Features Management Plans.

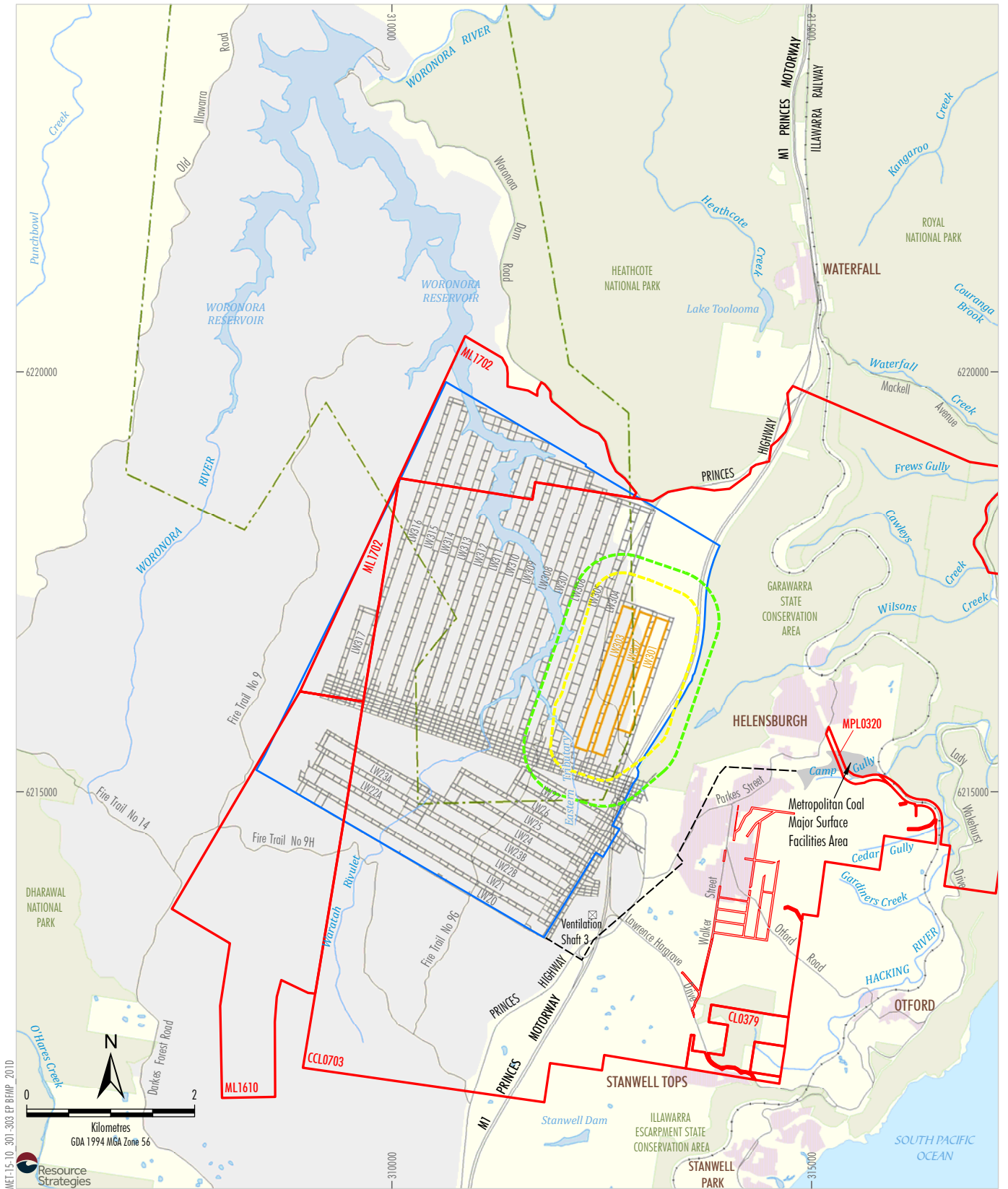
1.2 STRUCTURE OF THE LONGWALLS 301-303 BFMP-SYDNEY WATER

The remainder of the Longwalls 301-303 BFMP-SYDNEY WATER is structured as follows:

- Section 2: Describes the review and update of the Longwalls 301-303 BFMP-SYDNEY WATER.
- Section 3: Outlines the statutory requirements applicable to the Longwalls 301-303 BFMP-SYDNEY WATER.
- Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-303.
- Section 5: Details the performance measures and indicators that will be used to assess the Project.
- Section 6: Provides the detailed baseline data.

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- Section 7: Describes the monitoring program.
- Section 8: Describes the management measures that will be implemented.
- Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.
- Section 10: Describes the Trigger Action Response Plan (TARP) management tool.
- Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.
- Section 12: Describes the annual review and improvement of environmental performance.
- Section 13: Outlines the management and reporting of incidents.
- Section 14: Outlines the management and reporting of complaints.
- Section 15: Outlines the management and reporting of non-compliances with statutory requirements.
- Section 16: Lists the references cited in this Longwalls 301-303 BFMP-SYDNEY WATER.



MEF-15-10-301-303 EP BFMF 2010
Resource Strategies

LEGEND

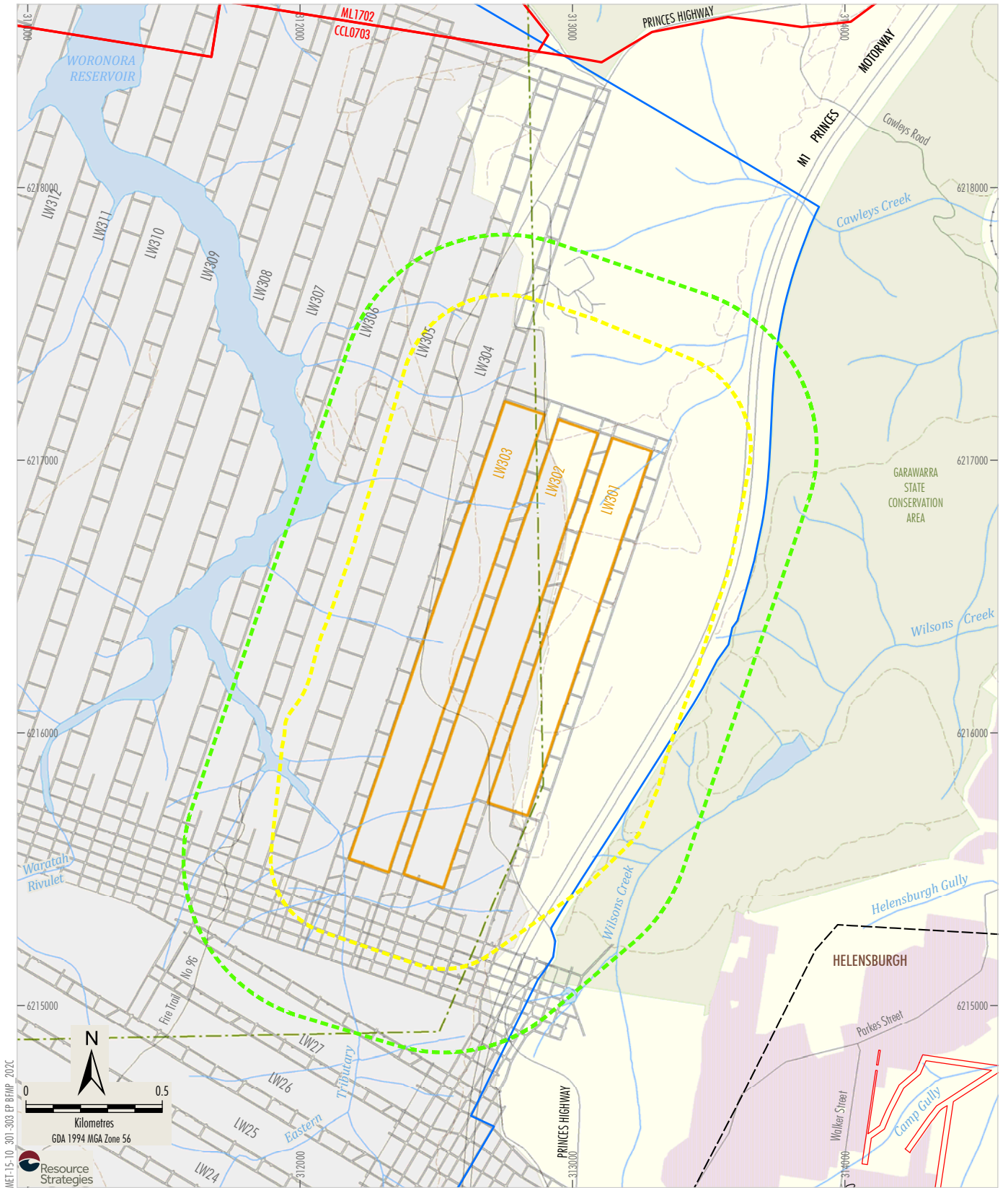
- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area
Longwalls 20-27 and 301-317
- Longwalls 301 - 303 Secondary Extraction
- 35° Angle of Draw and/or Predicted
20 mm Subsidence Contour
- 600 m from Secondary Extraction of
Longwalls 301-303
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015);
Metropolitan Coal (2016); MSEC (2016)



METROPOLITAN COAL
Project Longwalls 20 - 27 and
Longwalls 301 - 317 Layout

Figure 1



MEF15-10-301-303 EP BFMP 202C



Resource Strategies

LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area
Longwalls 20-27 and 301-317
- Longwalls 301 - 303 Secondary Extraction
- 35° Angle of Draw and/or Predicted
20 mm Subsidence Contour
- 600 m from Secondary Extraction of
Longwalls 301-303
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

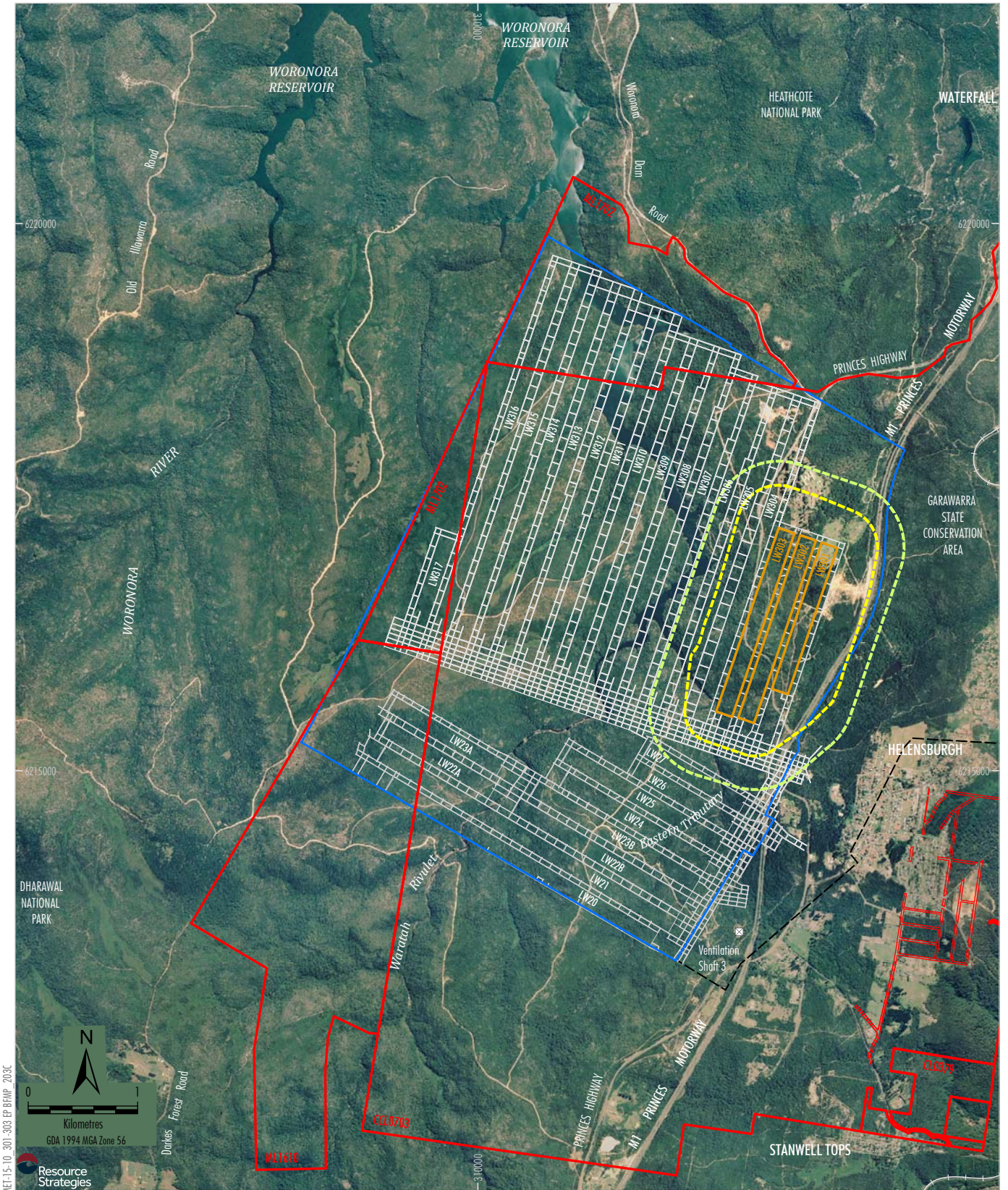
- Road
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015);
Metropolitan Coal (2016); MSEC (2016)



METROPOLITAN COAL
Longwalls 301 - 303 Layout

Figure 2



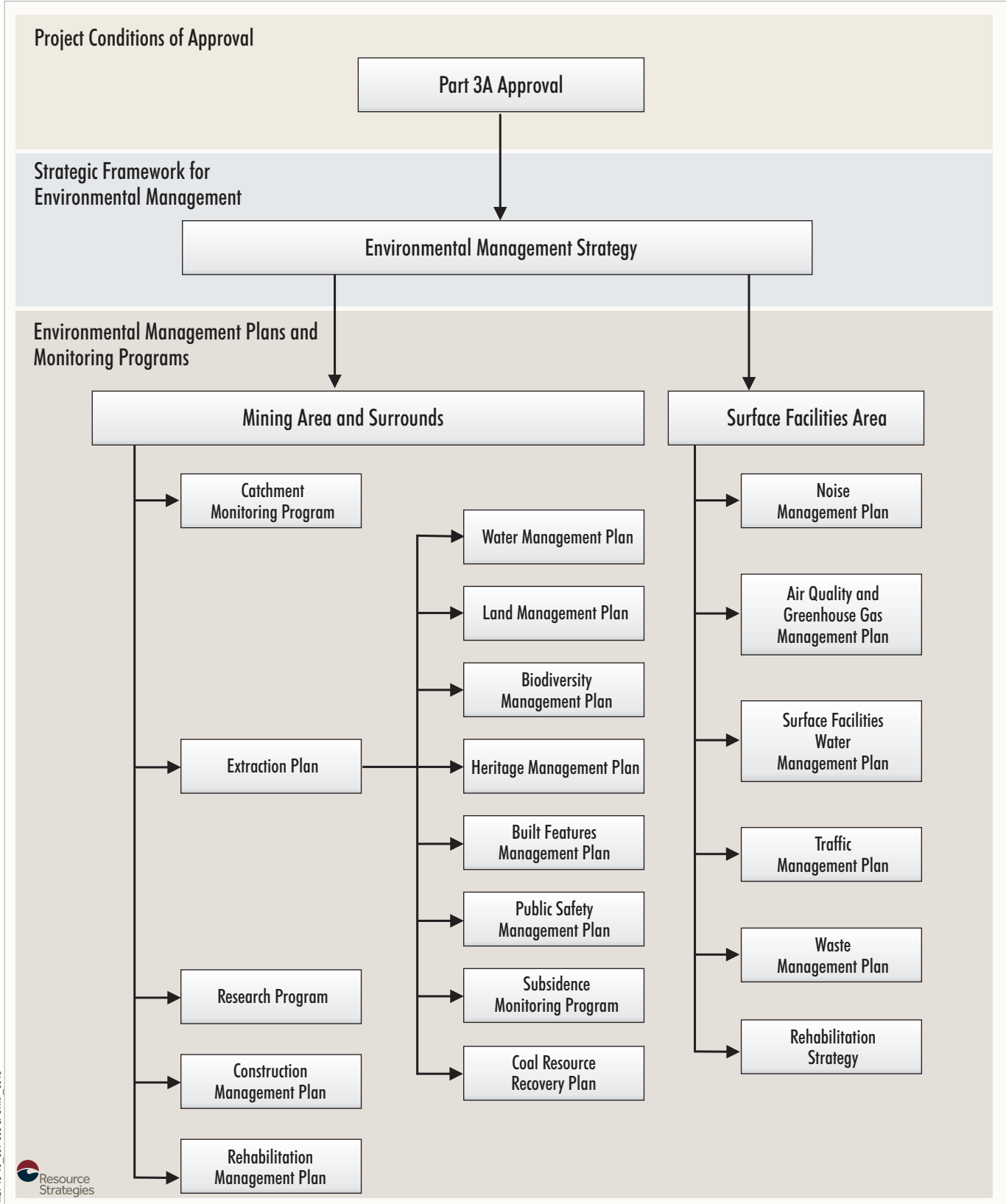
- LEGEND**
- Mining Lease Boundary
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Longwalls 20-27 and 301-317
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 - 35° Angle of Draw and/or Predicted
20 mm Subsidence Contour
 - 600 m from Secondary Extraction of
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 - Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998;
Department of Industry (2015); Metropolitan Coal (2016); MSEC (2016)



METROPOLITAN COAL
Project Longwalls 20 - 27 and
Longwalls 301 - 317 Layout -
Aerial Photograph

Figure 3



ME1-15-10-301-303 EP BRWP_001B



METROPOLITAN COAL
Environmental Management
Structure

Figure 4

2 LONGWALLS 301-303 BFMP-SYDNEY WATER REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this Longwalls 301-303 BFMP-SYDNEY WATER will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This Longwalls 301-303 BFMP-SYDNEY WATER will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the Longwalls 301-303 BFMP-SYDNEY WATER. The distribution register for controlled copies of the Longwalls 301-303 BFMP-SYDNEY WATER is described in Section 2.1.

Revisions to any documents listed within this Longwalls 301-303 BFMP-SYDNEY WATER will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the Longwalls 301-303 BFMP-SYDNEY WATER publicly available on the Peabody website. A hard copy of the Longwalls 301-303 BFMP-SYDNEY WATER will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the Longwalls 301-303 BFMP-SYDNEY WATER, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate. In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this Longwalls 301-303 BFMP-SYDNEY WATER on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

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3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

- (i) the conditions of the Project Approval;
- (ii) relevant licences and permits, including conditions attached to mining leases; and
- (iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

SECOND WORKINGS

Extraction Plan

6. *The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*

...

(f) include a:

...

- *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*

...

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the Longwalls 301-303 BFMP-SYDNEY WATER. Table 1 indicates where each component of the conditions is addressed within this Longwalls 301-303 BFMP-SYDNEY WATER.

**Table 1
Management Plan Requirements**

Project Approval Condition	Longwalls 301-303 BFMP-SYDNEY WATER Section
Condition 2 of Schedule 7	
<p>2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:</p> <p>a) detailed baseline data;</p> <p>b) a description of:</p> <ul style="list-style-type: none"> • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; <p>c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;</p> <p>d) a program to monitor and report on the:</p> <ul style="list-style-type: none"> • impacts and environmental performance of the project; • effectiveness of any management measures (see c above); <p>e) a contingency plan to manage any unpredicted impacts and their consequences;</p> <p>f) a program to investigate and implement ways to improve the environmental performance of the project over time;</p> <p>g) a protocol for managing and reporting any:</p> <ul style="list-style-type: none"> • incidents; • complaints; • non-compliances with statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and <p>h) a protocol for periodic review of the plan.</p>	<p align="center">Section 6</p> <p align="center">Section 3</p> <p align="center">Section 5</p> <p align="center">Section 5</p> <p align="center">Sections 7, 8, 9 and 10</p> <p align="center">Sections 7, 8 and 12</p> <p align="center">Section 9 and Appendix 3</p> <p align="center">Sections 7 and 12</p> <p align="center">Section 13</p> <p align="center">Section 14</p> <p align="center">Section 15</p> <p align="center">Section 9 and Appendix 3</p> <p align="center">Section 2</p>
Condition 7 of Schedule 3	
<p>7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:</p> <p>a) a program to collect sufficient baseline data for future Extraction Plans;</p> <p>b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;</p> <p>c) a detailed description of the measures that would be implemented to remediate predicted impacts; and</p> <p>d) a contingency plan that expressly provides for adaptive management.</p>	<p align="center">Section 11</p> <p align="center">Section 4</p> <p align="center">Section 8</p> <p align="center">Section 9 and Appendix 3</p>

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with Metropolitan Coal will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue.

- The conditions of mining leases issued by the NSW Division of Resources and Energy (DRE), within the NSW Department of Industry, Skills and Regional Development (NSW Department of Industry) under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The *Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019* approved by NSW Department of Industry.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (DPI Water) (now the Department of Industry – Crown Lands and Water Division [CLWD]) under the NSW Water Management Act, 2000, including WAL 36475 under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 and WAL 25410 under the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW (previously the Sydney Catchment Authority [SCA]) for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008):

- *Biodiversity Conservation Act, 2016*;
- *Contaminated Land Management Act, 1997*;
- *Crown Lands Act, 1989*;
- *Dams Safety Act, 1978*;
- *Dangerous Goods (Road and Rail Transport) Act, 2008*;
- *Energy and Utilities Administration Act, 1987*;
- *Fisheries Management Act, 1994*;
- *Mining Act, 1992*;

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- *Noxious Weeds Act, 1993;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011;* and
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 LONGWALLS 301-303 EXTRACTION LAYOUT

Longwalls 301-303 and the area of land within 600 metres (m) of Longwalls 301-303 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layout includes 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-303 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2017	7 months	October 2018
303	November 2018	7 months	May 2019

The layout for Longwalls 301-303 (i.e. 163 m panel widths [void] and 45 m pillars [solid]) will be trialed to build on the experience and dataset obtained from Longwalls 20-27. The outcomes of the trial will be used to inform the potential for a similar mine layout to be applied to the next Extraction Plan (i.e. Longwall 304 onwards). The assessment of the trial longwall layout is described in Section 11.1.

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Sydney Water Assets

Figure 5 illustrates the Sydney Water assets in relation to Longwalls 301-303 extraction. The assets include two 300 millimetre (mm) diameter cast iron cement lined (CICL) potable water supply pipelines (referred in this BFMP as 'Water Main 1' and 'Water Main 2').

It is understood that while the water storage tanks within the Garrawarra Centre Complex (including Garrawarra Reservoir WSO406 and connecting pipelines) are used by Sydney Water, the assets are owned by NSW Health. The water storage tanks and connecting pipelines are therefore considered separately in the BFMP for the Garrawarra Centre Complex (BFMP-GAR).

Other networks of potable water and sewer pipelines are located within the township of Helensburgh approximately 900 m to the south-east from the nearest Longwall 301, as well as sewer mains to the north of the Longwalls 301-303.

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

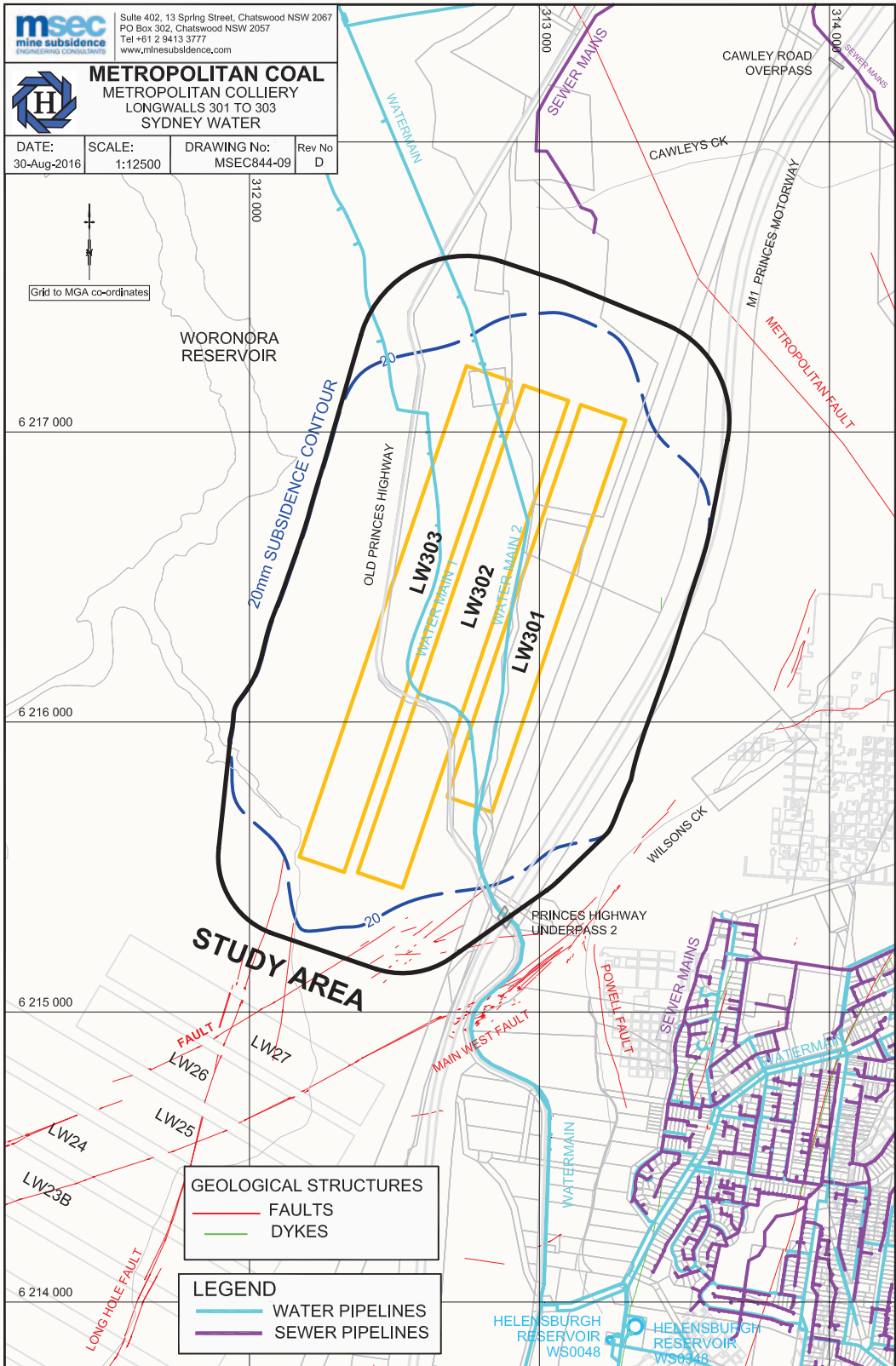
Subsidence predictions for Longwalls 20-44 in relation to the Sydney Water assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 on Sydney Water assets were conducted by MSEC and reported in MSEC (2016) (Appendix 1).

In relation to subsidence predictions, MSEC (2016) make the following conclusions:

- Water Main 1 and Water Main 2 are pressure mains located above the longwalls and are therefore unlikely to be impacted by mining induced vertical subsidence or tilt.
- The predicted strains for the water mains are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar pipelines. It has been found from this previous experience that the impacts on CICL pipelines in the Southern Coalfield are rare and generally of minor nature.
- It is expected that the potential impacts on the Sydney Water infrastructure (e.g. minor leakages) can be managed with the implementation of appropriate monitoring and management strategies. However the incidence of impacts is likely to be very low and of a minor nature.
- It is unlikely that adverse impacts would occur for the water and sewer mains located outside the extent of Longwalls 301-303 (i.e. the PVC sewer main or other networks of potable water and sewer pipelines).



METROPOLITAN COAL
Sydney Water Assets

Figure 5

4.2.2 Risk Assessment Meeting

In accordance with the draft *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2014) a risk assessment meeting was held on 15 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Sydney Water, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- preliminary identification of Sydney Water assets¹;
- review of the revised subsidence predictions and potential impacts on Sydney Water assets (including consideration of past experience in the Southern Coalfield); and
- Development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the Sydney Water assets, and are summarised as follows:

Baseline Data / Validation

1. Carry out an audit of the Sydney Water pipelines and valve chambers within the Study area to confirm physical access is available if the need to carry out repairs was required.
2. Install surface indicators (markers) that identify the location of the pipelines (where appropriate) so that the pipelines are easily located if the need to carry out repairs was required.

Management / Monitoring / Response Measures

3. Include acoustic monitoring as an additional monitoring system to monitor for leakage during the mining of Longwalls 301-303.
4. Investigate and develop a Trigger Action Response Plan (TARP) utilising the results of acoustic monitoring.

Contingency Planning

5. Include in the BFMP a table of key contacts of water suppliers that could assist to provide additional water for Sydney Water customers (if required).

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

¹ During the risk assessment meeting, Sydney Water confirmed that the water storage tanks and connecting pipelines at the Garrawarra Centre Complex (initially considered during the Sydney Water risk assessment) were not a Sydney Water asset and are therefore managed separately in the Garrawarra Centre Complex BFMP (BFMP-GAR).

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

Risk Control Measure / Procedure		BFMP Section	Timing
<i>Baseline Data / Validation</i>			
1	Carry out an audit of Sydney Water pipelines and valve chambers to confirm physical access is available	Section 6	Completed
2	Install surface indicators (markers) so that pipelines are easily located	Section 6	Completed
<i>Management / Monitoring / Response Measures</i>			
3	Include acoustic monitoring to monitor for leakage in water mains during mining of Longwalls 301-303	Section 7 / Table 4	Under consideration with Sydney Water
4	Investigate and develop a TARP utilising the results of acoustic monitoring	Section 10 / Table 6	Under consideration with Sydney Water
<i>Contingency Planning</i>			
5	Include a list of key contacts of water suppliers that could assist to provide additional water for Sydney Water customers.	Section 8	Complete

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.

The performance indicators proposed to ensure that the above performance measure is achieved include:

- no more than repairable (minor) leakages of the water pipelines occur due to mining; and
- no more than repairable (minor) defects (cracks, etc.) in the structural integrity of the pipes and associated connections occur due to mining.

Section 7 of this Longwalls 301-303 BFMP-SYDNEY WATER describes the monitoring that will be conducted to assess the Project against the above performance measure. Sections 8 and 9 of this Longwalls 301-303 BFMP-SYDNEY WATER provide management measures and a Contingency Plan in the event the performance indicators are triggered or the performance measure is exceeded, respectively.

6 BASELINE DATA

A site inspection and audit of the pipelines occurred prior to commencement of secondary extraction of Longwall 301 to establish the pre-mining condition of the lines. The inspection will include:

- confirmation of physical access to the pipeline and valve chambers;
- recording of any existing pipeline defects (cracking, etc.);
- recording of any existing pipeline leaks;
- inspections of fittings (valves and hydrants) along the water mains in the vicinity of the longwalls for operability and condition. Water mains (size varies from 150 to 300 mm) to be checked.

The site inspection and audit will be conducted by representative(s) from Sydney Water and Metropolitan Coal. The inspections conducted as part of baseline data will include photographic records where appropriate.

Surface indicators (markers) were installed by Metropolitan Coal so that pipelines are easily located if the need to carry out repairs was required. Tracks were restored near pipeline to allow easier access for monitoring with vegetation removal and road repairs.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Sydney Water during the development and implementation of this BFMP are provided in Table 4.

Table 4
List of Key Contacts

Company / Agency	Peabody (Metropolitan Coal)	Sydney Water
Position	Manager – Technical Services	Networks Manager South
Name	Jon Degotardi	David Cantlon
Contact	Control Room 24hr 02 4294 7333	24hr Contact 13 20 90

7 MONITORING

A monitoring program has been implemented to monitor the impacts of the Project on the Sydney Water assets. Table 4 summarises the Longwalls 301-303 BFMP-SYDNEY WATER monitoring components.

**Table 4
Longwalls 301-303 BFMP-SYDNEY WATER Monitoring Program Overview**

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Pipelines	Survey	Adjacent optic / water subsidence monitoring points at approximately 20 m spacing	Establish base condition	Prior to Longwall 301 extraction	Once
		Visual inspection	Identify evidence of pre-existing cracks or leaks in the pipelines or fittings			
During Mining	Pipelines	Survey	Adjacent optic / water subsidence monitoring points at approximately 20 m spacing	Monitor subsidence effects during mining (subsidence, tilt, strain)	At the completion of each longwall	At end of each longwall extraction
		Visual inspection (Metropolitan Coal)	Identify evidence of subsidence effects (surface ground cracks), or cracks or leaks in the pipelines or fittings		Weekly when longwall within 400m of passing under pipeline	
		Visual inspection (Sydney Water)	Identify evidence of subsidence effects (surface ground cracks), or cracks or leaks in the pipelines or fittings		As per Sydney Water routine inspection program	
		Acoustic Monitoring – <i>additional option to be confirmed in consultation with Sydney Water</i>	Monitor for leak detection	Monitoring to occur in consultation with Sydney Water access to pipeline		
	Reservoir	Storage Levels (Sydney Water)	Monitor for sudden reduction in water levels	24 hours, 7 days per week (Sydney Water)		
Post Mining	Pipelines	Visual inspection (Sydney Water)		Validation	Next scheduled post mining	Once

Metropolitan Coal understands that Sydney Water monitors the nearby reservoir storage levels 24 hours, 7 days per week to operate as an indicator of significant water loss.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this Longwalls 301-303 BFMP-SYDNEY WATER.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records. Sydney Water or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Sydney Water or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured by Metropolitan Coal in accordance with the Longwalls 301-303 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Sydney Water assets include the survey lines along the Old Princes Highway and the Optic / Water Line. The surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the pipelines (by comparison between measured and predicted movements).

7.2 SUBSIDENCE IMPACTS

7.2.1 Pipelines

Routine visual inspections by Sydney Water will also be conducted of the pipelines in accordance with the Sydney Water inspection program. For pipelines, this generally includes:

- assessment of the condition of water mains and associated fittings;
- inspection on fittings (valves and hydrants); and
- detection of leaks, breaks or water pressure drops in the pipeline reported by Sydney Water customers.

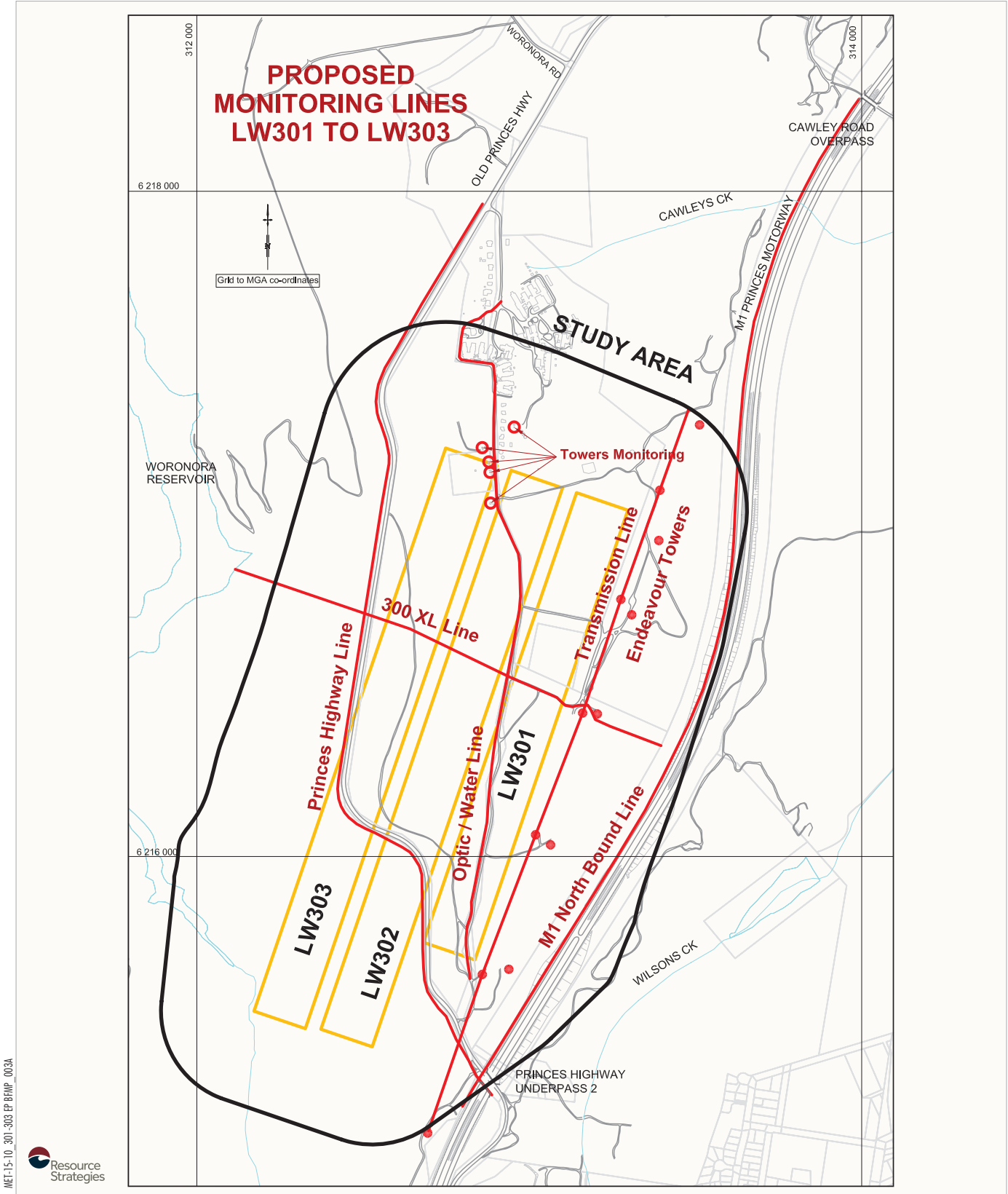
A visual inspection by Metropolitan Coal of the pipeline routes will occur prior to the longwall face approaching within 400 m of the pipelines, then weekly within 400m zone.

Additional observations of subsidence impacts will be conducted during routine works. Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

Acoustic monitoring will be considered to monitor for leakage in the Sydney Water pipelines.

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METROPOLITAN COAL
 Longwalls 301-303 Subsidence Monitoring
 Layout

Figure 6

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Sydney Water will compare the results of the subsidence impact monitoring against the built features performance indicators and performance measure. In the event the observed subsidence impacts exceed the performance measure, Metropolitan Coal and Sydney Water will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to pipelines are considered to be applicable. These include:

- repair of broken pipes or fittings by Sydney Water maintenance staff; and
- if major adjustment is required to re-align pipe, the pipe can be temporarily end capped to maintain supply to customers either side of break and/or alternative water supply provided to service properties while repair of the water main is in progress².

A list of potential water suppliers (and key contact details) to temporarily supply water to Sydney Water customers (if required) is provided below:

- Aquarius (02 4776 2496); and
- CAC Transport (0418 386 177).

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure detailed in Section 5 of this Longwalls 301-303 BFMP–SYDNEY WATER, Metropolitan Coal will implement the following Contingency Plan (Appendix 3):

- The observation will be reported to the Manager – Technical Services within 24 hours.
- The observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 2) consistent with the monitoring program described in Section 7 of this Longwalls 301-303 BFMP-SYDNEY WATER.
- Metropolitan Coal will report any exceedance of the performance measure to the DP&E and Sydney Water as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwalls 301-303 Public Safety Management Plan;

² It is understood that water supply via reservoirs at Helensburgh, Stanwell Tops and Stanwell Park is available for a period of up to 12 hours.

- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
 - include the re-survey of relevant subsidence monitoring lines;
 - compare and critically analyse measured versus predicted subsidence parameters;
 - review measured subsidence parameters against the observed impact; and
 - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
 - a program to review the effectiveness of the contingency measures; and
 - consideration of adaptive management.

Contingency measures are provided in Section 9.1.

- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Bill, 2017* in the event that property damages occur as a result of mining Longwalls 301-303.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Contingency measures that could be considered in the event the performance measure for the pipelines is exceeded are summarised in Table 5. The decision tree for the contingency measures are shown in Appendix 3.

Table 5
Contingency Measures – Pipelines

Environmental Consequence	Contingency Measures	
	Measure	Description
Impact on Pipelines	Re-install water main.	<ul style="list-style-type: none"> • Construction of new section of water main.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the Longwalls 301-303 BFMP-SYDNEY WATER are summarised in the Longwalls 301-303 BFMP-SYDNEY WATER TARP shown in Table 6. The Longwalls 301-303 BFMP-SYDNEY WATER TARP shows how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

**Table 6
Longwalls 301-303 BFMP-SYDNEY WATER Trigger Action Response Plan**

SYDNEY WATER Pipelines		
<i>Risk: Subsidence effect on pipelines resulting in impact to structural integrity and leakage / loss of water.</i>		
TRIGGER LEVEL		RESPONSE
Level 1 - Normal		
Expected subsidence conditions (at M1 Princes Motorway)		
Subsidence LW301 & 302 <ul style="list-style-type: none"> less than 700 mm Tilt <ul style="list-style-type: none"> less than 4.0 mm/m Tensile strain <ul style="list-style-type: none"> less than 0.9 mm/m Compressive strain <ul style="list-style-type: none"> less than 1.6 mm/m 	Subsidence LW303 <ul style="list-style-type: none"> less than 875 mm Tilt <ul style="list-style-type: none"> less than 4.0 mm/m Tensile strain <ul style="list-style-type: none"> less than 0.9 mm/m Compressive strain <ul style="list-style-type: none"> less than 1.6 mm/m 	<u>Normal Operations</u> <ul style="list-style-type: none"> Pipelines are safe and serviceable. Negligible impact to Sydney Water infrastructure. Continue monitoring activities as planned.
Level 2 - Monitor		
Subsidence elevated up to +15% of predicted but pipeline condition normal		
Subsidence LW301 & 302 <ul style="list-style-type: none"> between 700 and 805 mm Tensile strain <ul style="list-style-type: none"> between 0.9 mm/m and 1.0 mm/m Compressive strain <ul style="list-style-type: none"> between 1.6 mm/m and 1.8 mm/m 	Subsidence LW303 <ul style="list-style-type: none"> between 875 and 1006 mm Tensile strain <ul style="list-style-type: none"> between 0.9 mm/m and 1.0 mm/m Compressive strain <ul style="list-style-type: none"> between 1.6 mm/m and 1.8 mm/m 	<u>Continue operations but report on subsidence anomaly</u> <ul style="list-style-type: none"> Pipelines are safe and serviceable. Negligible impact to Sydney Water infrastructure. <u>Metropolitan Coal</u> <ul style="list-style-type: none"> Immediately resurvey subsidence line in affected area to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with adjacent subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to Sydney Water of subsidence results. Collaboratively share information with Sydney Water to monitor situation. <u>Sydney Water</u> <ul style="list-style-type: none"> Assess information provided by Metropolitan Coal. Continue to conduct routine inspection program.

Table 6 (Continued)
Longwalls 301-303 BFMP-SYDNEY WATER Trigger Action Response Plan

SYDNEY WATER Pipelines		
<i>Risk: Subsidence effect on pipelines resulting in impact to structural integrity and leakage / loss of water.</i>		
TRIGGER LEVEL	RESPONSE	
Level 3 - Cautionary		
Anomalous service condition detected or Subsidence beyond +15% of predicted		
Subsidence LW301 and LW302 <ul style="list-style-type: none"> greater than 805 mm Tensile strain <ul style="list-style-type: none"> greater than 1.0 mm/m Compressive strain <ul style="list-style-type: none"> greater than 1.8 mm/m Observable subsidence ground deformations or surface cracks at/near pipelines Cracks or leaks in the pipelines or fittings Loss of flow /pressure (acoustic monitoring for leakage)	Subsidence LW303 <ul style="list-style-type: none"> greater than 1006 mm Tensile strain <ul style="list-style-type: none"> greater than 1.0 mm/m Compressive strain <ul style="list-style-type: none"> greater than 1.8 mm/m Observable subsidence ground deformations or surface cracks at/near pipelines Cracks or leaks in the pipelines or fittings Loss of flow /pressure (acoustic monitoring for leakage)	<u>Investigate & Resolve</u> <ul style="list-style-type: none"> Pipelines are safe and serviceable. Indication of impact (cracks / leakage) to Sydney Water infrastructure. <u>Metropolitan Coal</u> <ul style="list-style-type: none"> Steps as per Level 2 event, plus: <ul style="list-style-type: none"> Inform Sydney Water and NSW Principal Subsidence Engineer of subsidence results (immediately following awareness of trigger). Increase frequency of subsidence line surveys to weekly in affected area. In conjunction with Sydney Water identify impact location and have Sydney Water assess pipeline condition. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both Sydney Water and DP&E. <u>Sydney Water</u> <ul style="list-style-type: none"> Inform Metropolitan Coal of deformations, cracks or leaks observed during routine monitoring inspections. In conjunction with Metropolitan Coal identify impact location, inspect pipeline infrastructure, assess condition and determine appropriate response (e.g. greater monitoring data or frequency, or schedule maintenance on the pipeline infrastructure). Make determination if other measures necessary to avoid further impact.
Level 4 – Restoration		
Fault occurs (Significant flow/water loss)		
Fault Occurs <ul style="list-style-type: none"> Sudden water loss at nearby reservoir storage levels 	<u>Implement Contingency Plan</u> <ul style="list-style-type: none"> As per BFMP Section 9 and Appendix 3. <u>Metropolitan Coal</u> As per Level 3 event, plus: <ul style="list-style-type: none"> General Manager to be involved in all decision-making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwalls 301-303 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E and Sydney Water as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. Investigate circumstances of the fault / flow loss and determine requirement for adaptive management of mining operations prior to future operations. <u>Sydney Water</u> As per Level 3 event, plus: <ul style="list-style-type: none"> Sydney Water to enact emergency measures (e.g. temporary supply of water to customers) and determine restoration works required. Complete restoration works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures. 	

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the future Extraction Plan (e.g. Longwall 304 onward). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-303. Where possible, the baseline (and post-mining) data collected for Longwalls 301-303 will be used as baseline for Longwalls 304 onward as longwall mining progressively moves further away from the Sydney Water assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this Longwalls 301-303 BFMP-SYDNEY WATER will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

11.1 ASSESSMENT OF TRIAL LONGWALL LAYOUT FOR LONGWALLS 301-303

As described in Section 4.1, the layout for Longwalls 301-303 (i.e. 163 m panel widths [void] and 45 m pillars [solid]) will be trialled to build on the experience and dataset obtained from Longwalls 20 to 27. The outcomes of the trial will be used to inform the potential for a similar mine layout to be applied to the next Extraction Plan (i.e. Longwall 304 onwards).

Following the completion of Longwall 301, and during the mining of Longwall 302, Metropolitan Coal will review the available subsidence monitoring results and assess the changes to, and impacts on, Sydney Water assets.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
 - relevant statutory requirements, limits or performance measures/criteria;
 - monitoring results of previous years; and
 - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

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As described in Section 2, this Longwalls 301-303 BFMP-SYDNEY WATER will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Sydney Water will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

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The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of the Metropolitan Coal Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licences will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

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16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2014) *Guidelines for the Preparation of Extraction Plans*. Draft.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report*.

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application*.

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Sydney Water Infrastructure, dated 1 September 2016*.

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APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303
- SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS
FOR THE SYDNEY WATER INFRASTRUCTURE, DATED 1 SEPTEMBER 2016

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1st September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-09

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Sydney Water Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Sydney Water infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the Sydney Water infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-09. There are two potable water supply pipelines located above the longwalls. Water main 1 is a 300 mm diameter Cast Iron Cement Lined (CICL) pipeline and Water Main 2 is a 300 mm diameter CICL pipeline.

A sewer main is located outside the Study Area to the north of the longwalls. This pipeline is 150 mm PVC pressure main. There are also networks of potable water and sewer pipelines located outside and in the vicinity of the Study Area, within the township of Helensburgh to the south-east of the longwalls. These networks are located at a minimum distance of 0.9 kilometres from Longwall 301.

The predictions and impact assessments for the Sydney Water infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Sydney Water Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Sydney Water infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of incremental and total conventional subsidence, tilt and curvature along the alignments of the two potable water mains, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Figs. A.1 and A.2. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

Summaries of the maximum predicted values of incremental subsidence, tilt and curvature for the water mains, due to the extraction of each of the Longwalls 301 to 303, are provided in Table 1 and Table 2. The values are the maxima anywhere along the pipelines at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Incremental Subsidence, Tilt and Curvature for Water Main 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km ⁻¹)	Maximum Predicted Incremental Sagging Curvature (km ⁻¹)
Due To LW301	70	< 0.5	< 0.01	0.01
Due To LW302	650	4.0	0.05	0.07
Due To LW303	625	3.0	0.06	0.06

Table 2 Maximum Predicted Incremental Subsidence, Tilt and Curvature for Water Main 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km ⁻¹)	Maximum Predicted Incremental Sagging Curvature (km ⁻¹)
Due To LW301	80	< 0.5	< 0.01	0.01
Due To LW302	625	2.0	0.04	0.12
Due To LW303	500	2.5	0.06	0.07

The maximum predicted incremental subsidence for the water mains, due to the extraction of each of the Longwalls 301 to 303, varies between 70 mm to 650 mm.

Summaries of the maximum predicted values of total subsidence, tilt and curvature for the water mains, resulting from the extraction of Longwalls 301 to 303, are provided in Table 3 and Table 4. The values are the maxima anywhere along the pipelines at any time during or after the extraction of the longwalls.

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for Water Main 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km ⁻¹)	Maximum Predicted Total Sagging Curvature (km ⁻¹)
After LW301	70	< 0.5	< 0.01	0.01
After LW302	700	4.0	0.05	0.06
After LW303	900	2.5	0.05	0.09

Table 4 Maximum Predicted Total Subsidence, Tilt and Curvature for Water Main 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km ⁻¹)	Maximum Predicted Total Sagging Curvature (km ⁻¹)
After LW301	80	< 0.5	< 0.01	0.01
After LW302	675	2.5	0.04	0.11
After LW303	875	3.0	0.04	0.13

The maximum predicted total subsidence for the water mains, resulting from the extraction of Longwalls 301 to 303, are 900 mm for Water Main 1 and 875 mm for Water Main 2. The maximum predicted conventional tilt for these pipelines is 3.0 mm/m (i.e. 0.3 %, or 1 in 333). The maximum predicted conventional curvatures are 0.05 km⁻¹ hogging and 0.13 km⁻¹ sagging, which equate to minimum radii of curvature of 20 kilometres and 8 kilometres, respectively.

The sewer main and networks of water and sewerage pipelines located within the township of Helensburgh are not expected to experience any measurable vertical subsidence, tilts, curvatures or strains. The pipelines could experience low level far-field horizontal movements. However, these absolute horizontal movements tend to be bodily movements that are not associated with measurable strains.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. The reason for this is that strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, in cases where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the average relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values.

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones.

At a point however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Sydney Water infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Sydney Water infrastructure is partially located above Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

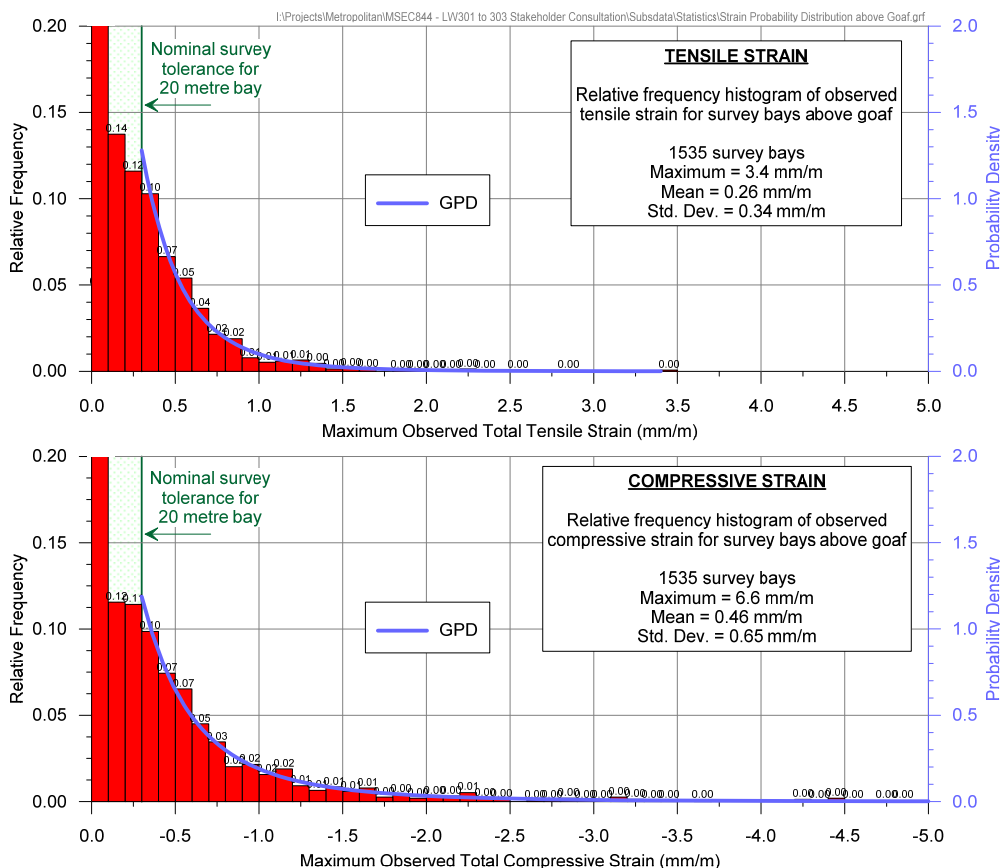


Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 5.

Table 5 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as ‘anomalous’ movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-09.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The water mains do not cross any major streams within the Study Area. These pipelines, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Water Pipelines

The two potable water mains located above the longwalls are pressure mains and, therefore, are unlikely to be adversely impacted by the mining induced vertical subsidence or tilt. These pipelines are direct buried and are likely to experience the curvatures and ground strains resulting from the extraction of these longwalls.

The maximum predicted conventional curvatures for the water mains are 0.05 km⁻¹ hogging and 0.13 km⁻¹ sagging, which equate to minimum radii of curvature of 20 kilometres and 8 kilometres, respectively. Localised and elevated curvatures could develop along the pipelines due to non-conventional movements resulting from near surface geological structures (i.e. anomalies).

The predicted curvatures and strains for the water mains are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar pipelines. It has been found from this previous experience that the impacts on CICL pipelines in the Southern Coalfield are rare and generally of a minor nature.

Some examples of mining beneath water mains in the Southern Coalfield are provided in Table 6.

Table 6 Examples of Mining Beneath Water Mains in the Southern Coalfield

Colliery and Longwalls	Pipelines	Observed Movements	Observed Impacts
Appin LW301 and LW302	0.6 km of 150 dia DICL 0.6 km of 300 dia CICL 0.6 km of 1200 dia SCL	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	Leakage of the 150 mm and 300 mm CICL pipelines at a creek crossing, elsewhere no other reported impacts
Tahmoor LW22 to LW25	2.7 km DICL pipes 7.3 km CICL pipes	1200 mm Subsidence 6 mm/m Tilt 1.5 mm Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain (Extensive street monitoring)	One reported impact to the distribution network and a very small number of minor leaks in the consumer connection pipes
West Cliff LW5A3, LW5A4 & LW29 to LW34	2.8 km of 100 dia CICL pipe directly mined beneath	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No reported impacts

Based on this experience, it is possible that some minor leakages of the water mains could occur as the result of the extraction of Longwalls 301 to 303. However, the incidence of impacts is likely to be very low and of a minor nature. It is expected that any impacts could be remediated by locally exposing the pipeline and repairing or replacing the affected section.

It is recommended that monitoring and management strategies are developed, in consultation with Sydney Water, to manage the potential impacts on the water mains that are located directly above the longwalls. It is expected that these pipelines can be maintained in serviceable conditions with the implementation of the appropriate monitoring and management strategies.


The sewer main in the northern part of the Study Area and the networks of water and sewer pipelines located within the township of Helensburgh are all located outside of the predicted 20 mm subsidence contour. It is unlikely that these pipelines would experience adverse impacts as a result of Longwalls 301 to 303.

Summary

The potable water mains are located directly above Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on these types of pipelines can be managed with the implementation of suitable monitoring and management strategies. It is unlikely that adverse impacts would occur for the water and sewer mains located outside the extents of the longwalls.

It is expected that the potential impacts on the Sydney Water infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely



Peter DeBono

Attachments:

Drawing No. MSEC844-09 – Longwalls 301 to 303 – Sydney Water Infrastructure

- Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for Water Main (1) due to LW301 to LW303
- Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt and Curvature Water Main (2) due to LW301 to LW303



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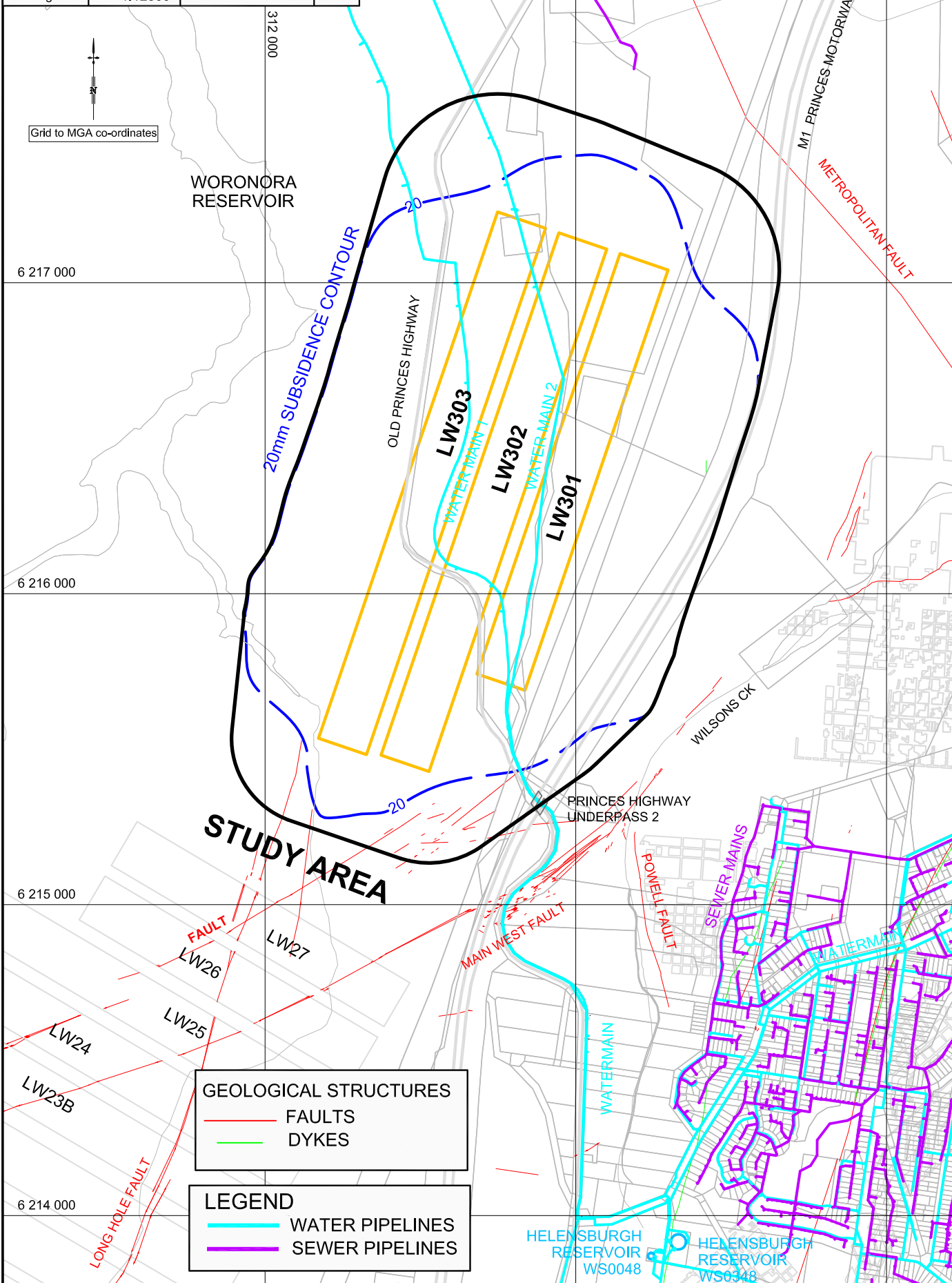


METROPOLITAN COAL
 METROPOLITAN COLLIERY
 LONGWALLS 301 TO 303
 SYDNEY WATER

DATE: 30-Aug-2016	SCALE: 1:12500	DRAWING No: MSEC844-09	Rev No D
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Grid to MGA co-ordinates



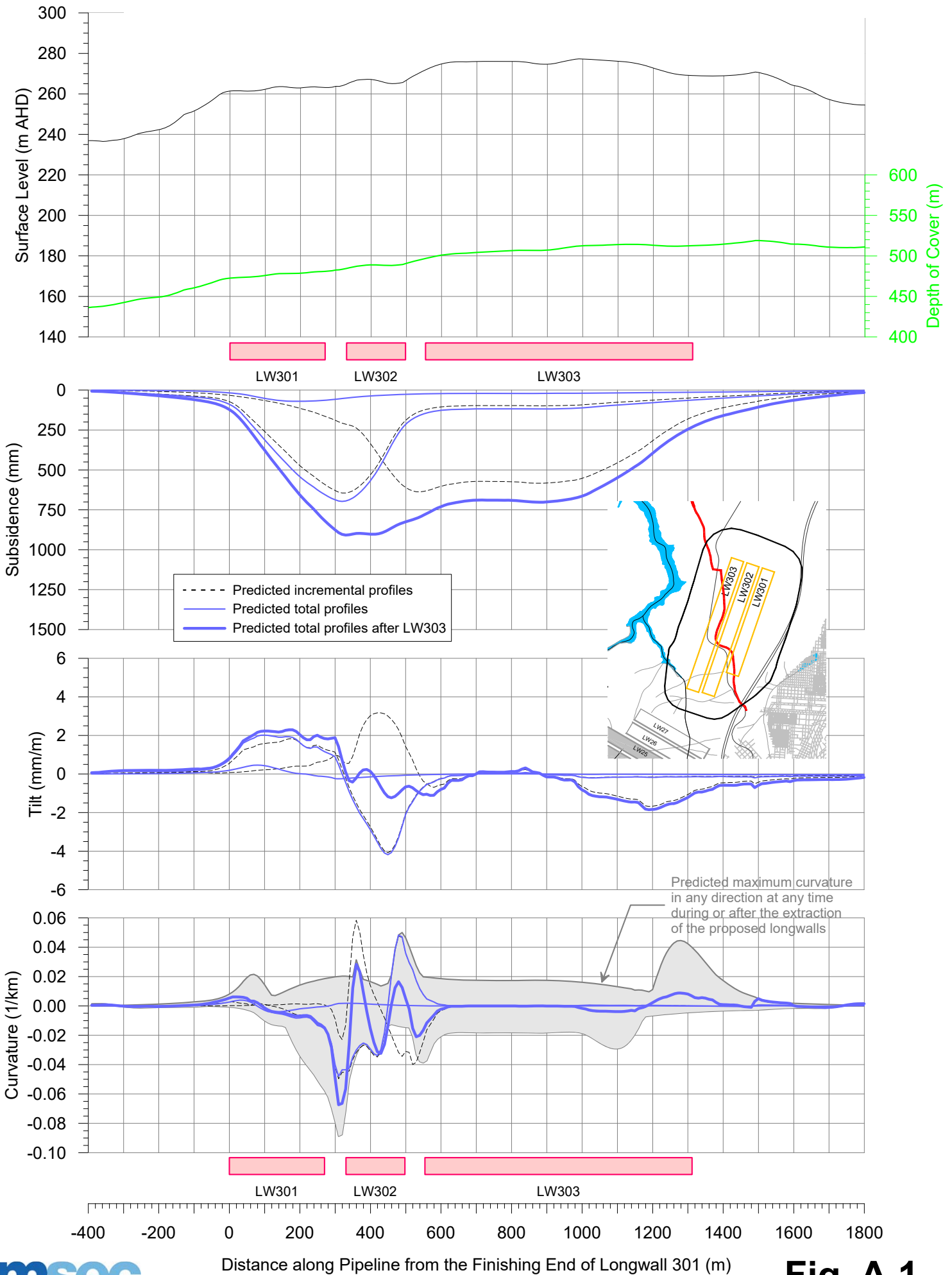
GEOLOGICAL STRUCTURES

	FAULTS
	DYKES

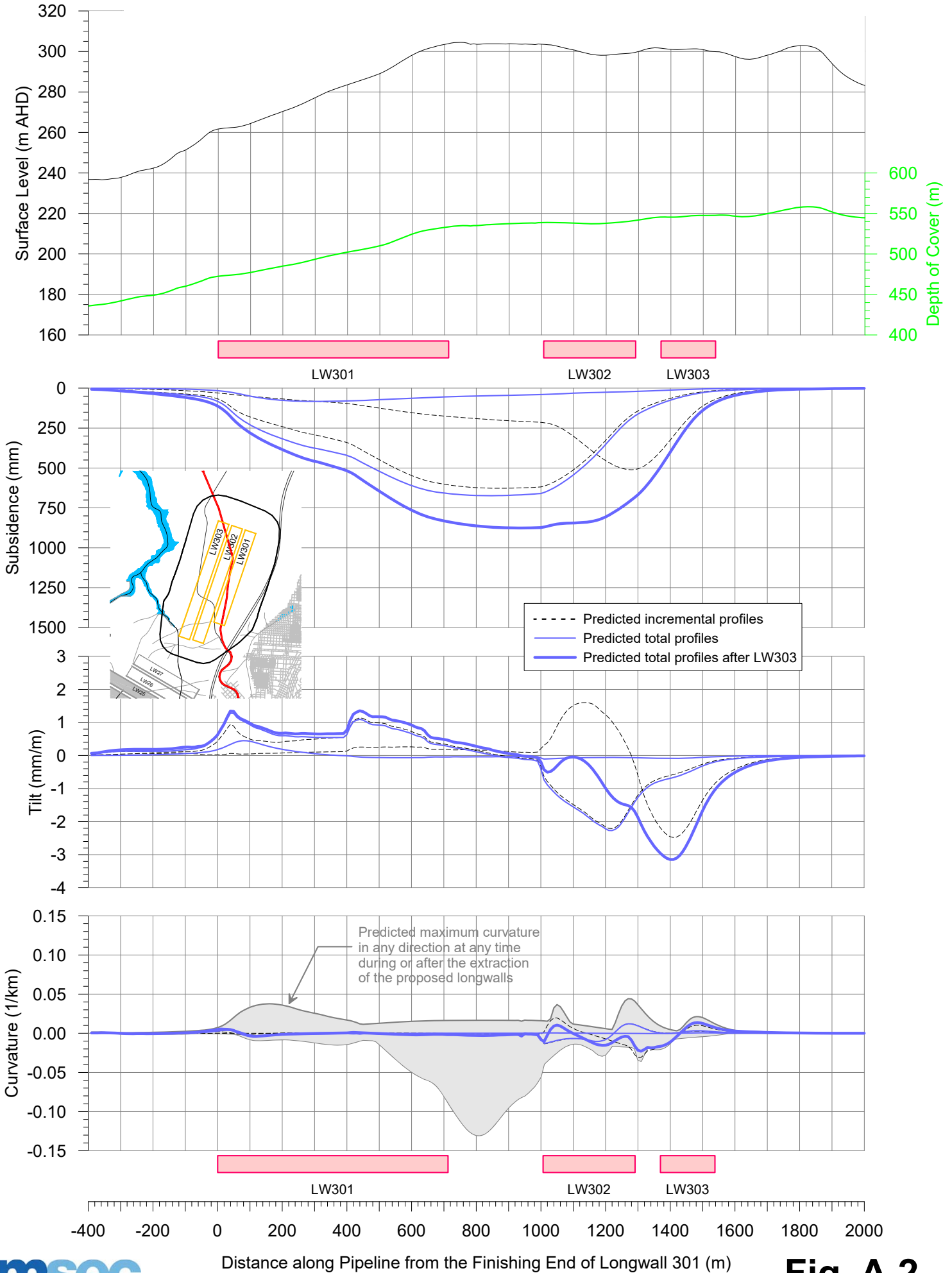
LEGEND

	WATER PIPELINES
	SEWER PIPELINES

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Water Main (1) due to LW301 to LW303



Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Water Main (2) due to LW301 to LW303



APPENDIX 2

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Metropolitan Coal – Built Features Management Plan – Sydney Water	
Revision No. LW301-303 BFMP_SYDWATER-R01-D	
Document ID : Built Features Management Plan – Sydney Water	

Built Features Management Plan - Subsidence Impact Register

Impact Register Number ¹	Built Feature ²	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

- 1: Fill out all details in the Assessment Form and record the register number here.
- 2: Built feature (e.g. pipeline, etc.).

**Built Feature Management Plan – Subsidence Impact Register
Assessment Form**

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of tank, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified: Manager - Technical Services

Description of Photographs:

Actions Required:

Contingency Plan Initiated	<input type="checkbox"/>
Incident Notification	<input type="checkbox"/>
Safety Measures/Public Safety Management Plan Requirements	<input type="checkbox"/>

Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 3

CONTINGENCY PLAN PROCEDURE AND DECISION TREE

Metropolitan Coal – Built Features Management Plan – Sydney Water	
Revision No. LW301-303 BFMP_SYDWATER-R01-D	
Document ID : Built Features Management Plan – Sydney Water	

