UG1 Longwalls 104 to 105

Surface water technical report

Moolarben Coal Operations Pty Ltd

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1 Introduction

1.1 PROJECT OVERVIEW

The Moolarben Coal Complex is located approximately 40 kilometres (km) north of Mudgee in the Western Coalfields of New South Wales (NSW).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Sojitz Moolarben Resources Pty Ltd and a consortium of Korean power companies). MCO and MCM are wholly owned subsidiaries of Yancoal Australia Limited (Yancoal).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and would continue to be carried out in accordance with NSW Project Approval (05_0117) (Moolarben Coal Project Stage 1) as modified and NSW Project Approval (08_0135) (Moolarben Coal Project Stage 2) as modified.

Stage 1 at the Moolarben Coal Complex has been operating for several years and at full development will comprise three open cut mines (OC1, OC2 and OC3), a longwall underground mine (UG4) and mining related infrastructure (including coal processing and transport facilities). Stage 2 has been operating for several years and at full development will comprise one open cut mine (OC4), two longwall underground mines (UG1 and UG2) and mining related infrastructure.

Secondary extraction of coal by longwall mining methods at UG1 commenced in Quarter 4 of 2017 in accordance with the approved Longwalls 101-103 Extraction Plan. Since this time Longwalls 101 and 102 have been extracted. Underground mining operations are scheduled to complete Longwall 103 in June 2020. MCO is seeking approval to amend the UG1 Extraction Plan to include the remaining longwall panels 104 (LW104) and 105 (LW105). The location of UG1 is shown in Figure 1.1.

This surface water technical report has been written to support the UG1 Extraction Plan amendment.

1.2 SCOPE OF THIS REPORT

Surface water impacts were previously considered in a Surface Water Assessment Review (Appendix F of the Moolarben Coal Complex UG1 Optimisation Modification; WRM Water & Environment, 2015) and Subsidence Assessment (Appendix A of the Moolarben Coal Complex UG1 Optimisation Modification; MSEC, 2015). An updated subsidence assessment has been undertaken for LW104-105 (MSEC, 2020).

This surface water technical report summarises the key potential environmental risks related to surface water for LW104-105 (Additional Assessment Area), and presents proposed monitoring and management measures to minimise these surface water environmental risks.

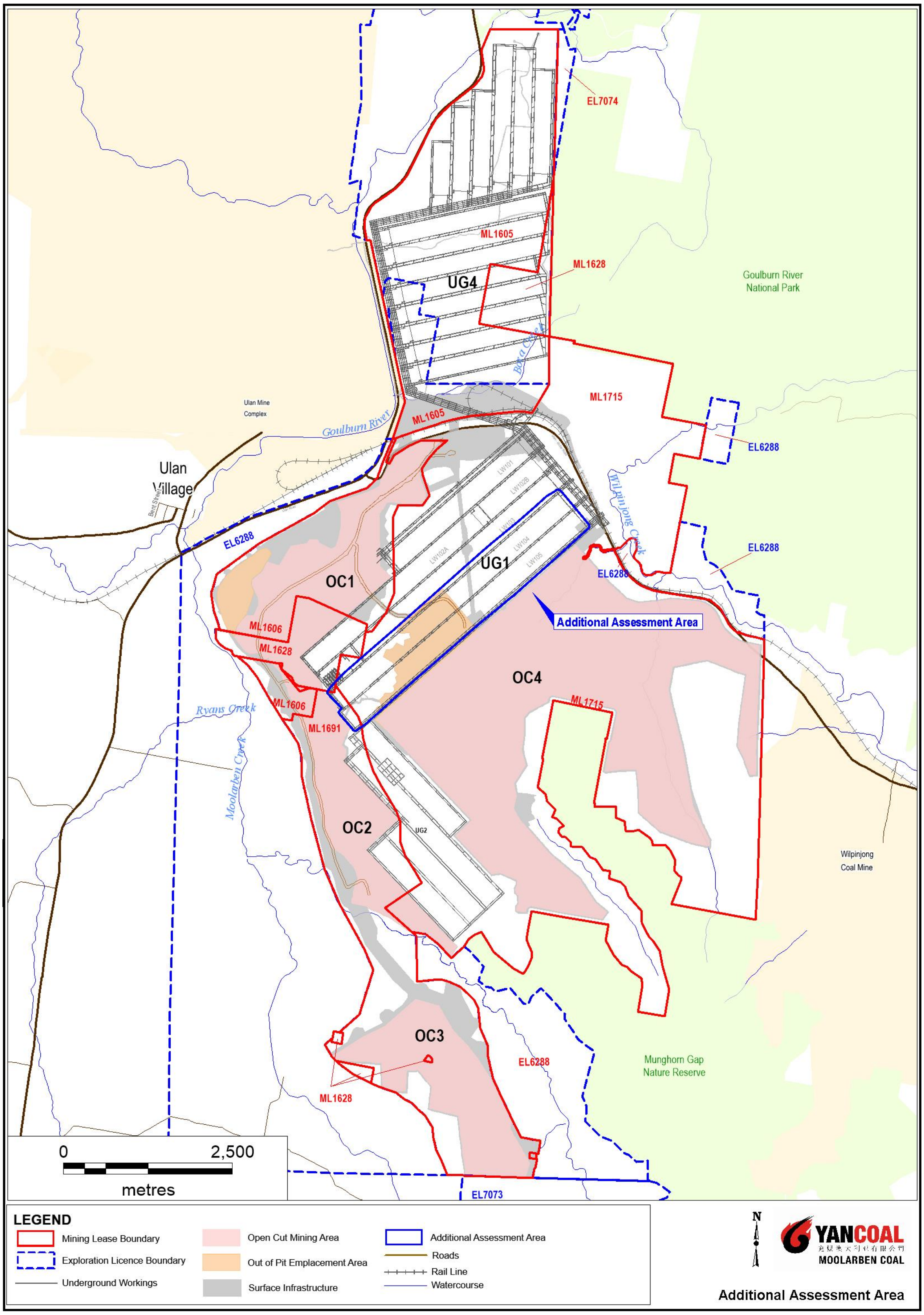

Figure 1.1 Locality plan – UG1, LW104 – 105

2 Baseline conditions

2.1 TOPOGRAPHY AND SURFACE DRAINAGE

LW104-105 are located south of a ridge that separates the catchment of Murragamba Creek to the south from the catchments of Bora Creek and Goulburn River to the north and Moolarben Creek to the west. Murragamba Creek is a tributary of Wilpinjong Creek.

Surface drainage over the area of LW104-105 is characterised by steep, first and second order gullies. The higher elevations are typically forested, draining to flatter floodplain areas that are mostly cleared of significant vegetation, as shown in Figure 2.1. Stream gradients in the area are typically in the range of 2% to 7%.

Gullies on the northern and western side of the ridge drain to the disturbed areas of OC1 and OC2 (including areas in various stages of rehabilitation), Bora Creek or Moolarben Creek. Gullies on the southern side of the ridge drain to OC4 and Murragamba Creek.

Figure 2.2 shows the various drainage lines (DL) overlying LW104-105, including the more significant drainage lines (DL4, DL5, DL6 and DL7). Drainage lines DL4 and DL5 are within the footprint of the OC4 out-of-pit emplacement and no longer exist.

2.2 VEGETATION AND GEOMORPHOLOGY ALONG GULLIES

In the upper reaches, the first order drainage lines typically consist of a shallow incised drainage path of low sinuosity with numerous trees and significant quantities of large woody debris. Figure 2.3 shows several photographs taken along DL6 (location of photographs shown in Figure 2.1). Soils appear to be shallow with underlying rock exposed at some locations. Understory vegetation is limited.

Despite the steep slopes and lack of vegetative cover, active bed and bank erosion appears minimal with rock bars and large woody debris providing bed control. Smaller woody debris and leaf litter also act to protect the bed against erosion.

In the lower reaches of the second order drainage lines, the main drainage path loses definition on the flatter slopes and flow spreads across a wide, poorly defined flow path. Clearing of trees and deeper soils on the flatter slopes has permitted better growth of grass cover. The combination of wide, shallow flow, good grass cover and flatter longitudinal gradient provides good protection against erosion.

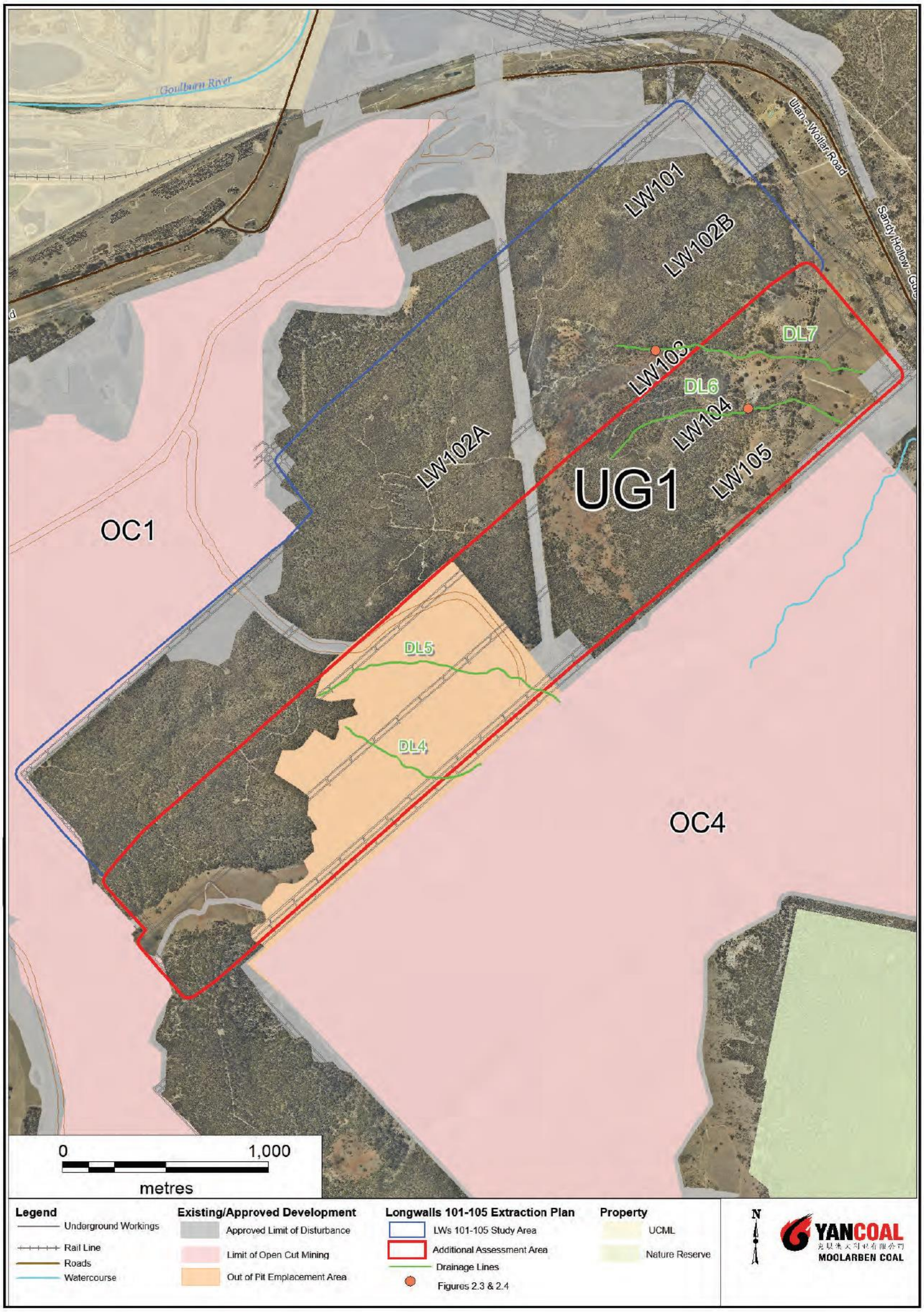

Figure 2.1 Aerial image showing significant drainage lines across LW104 – 105

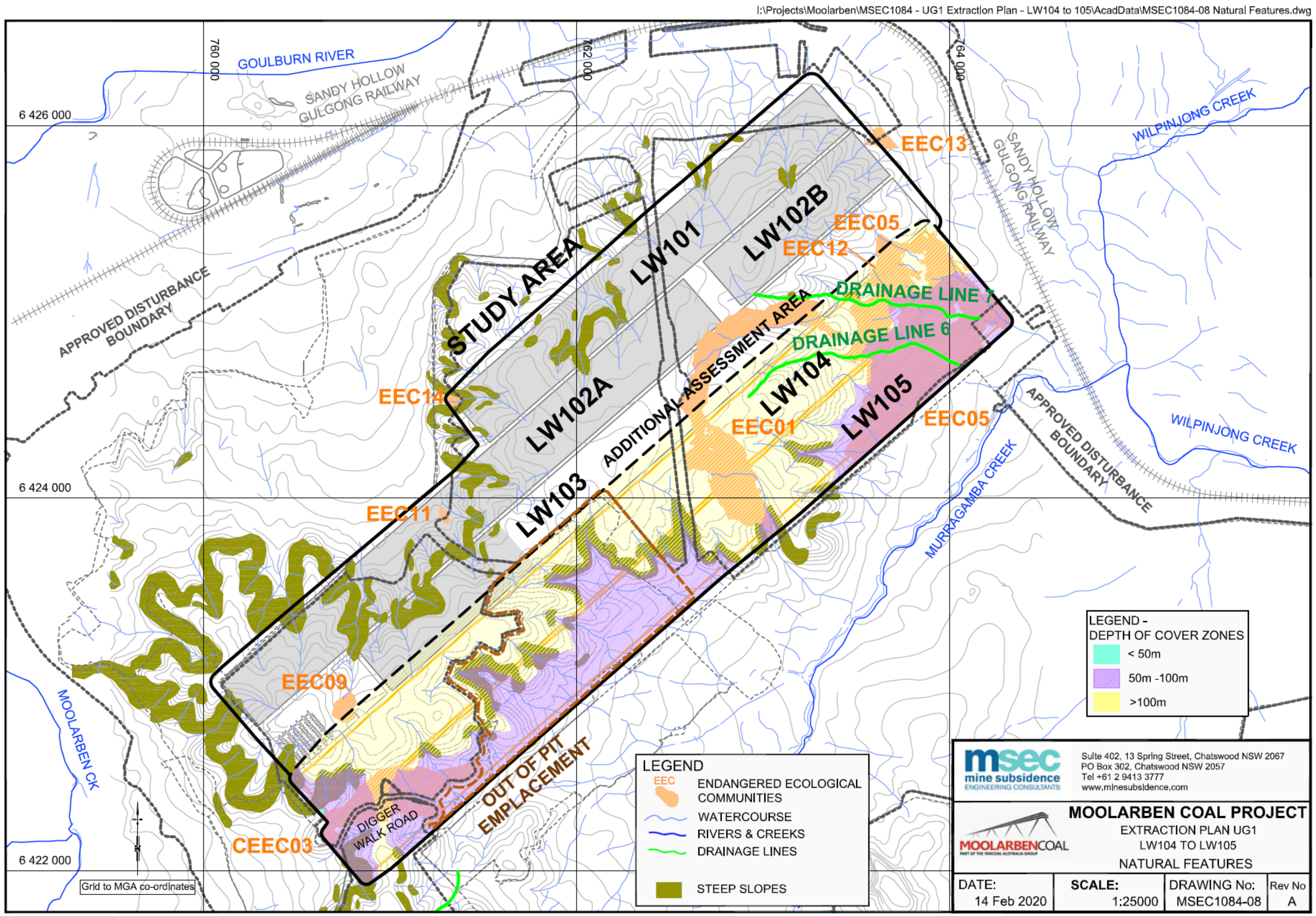

Figure 2.2 Ground level contours and drainage lines (Source: MSEC,2020)

Figure 2.3 Photographs looking upstream (top) and downstream (bottom) along DL6

Figure 2.4 Photographs looking upstream (top) and downstream (bottom) along DL7

2.3 FLOW, WATER QUALITY, STREAM HEALTH AND CHANNEL STABILITY

Surface water monitoring for receiving watercourses is undertaken for flow, water quality, stream health and channel stability as described in the site wide Surface Water Management Plan (MCO, 2018). The locations of flow, water quality and stream health monitoring are shown in Figure 2.5. Baseline channel stability monitoring locations are shown in Figure 2.6. A summary of baseline flow, water quality, stream health and channel stability data is provided in the site wide Surface Water Management Plan (MCO, 2018).

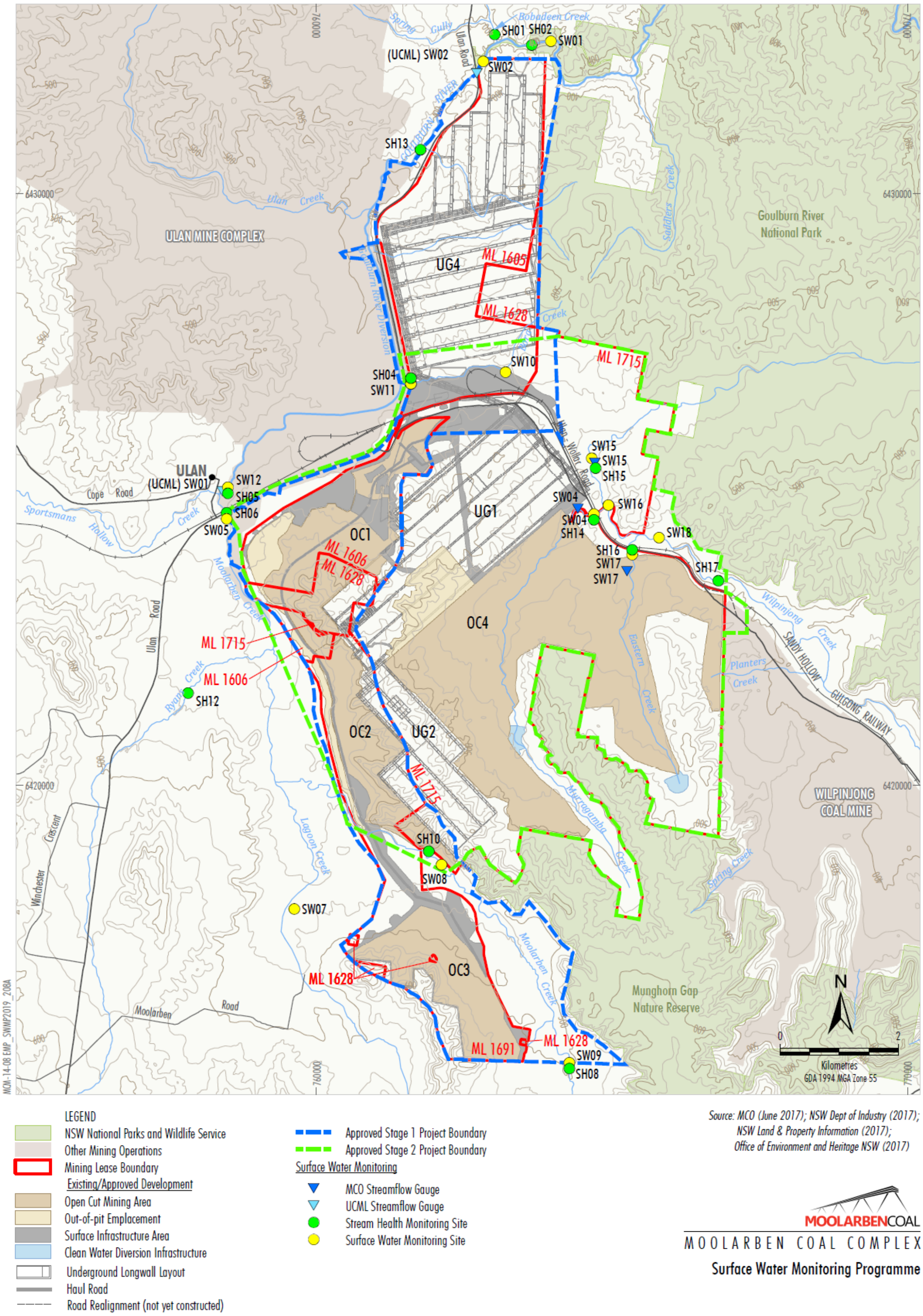

Figure 2.5 Surface water flow, water quality and stream health monitoring locations

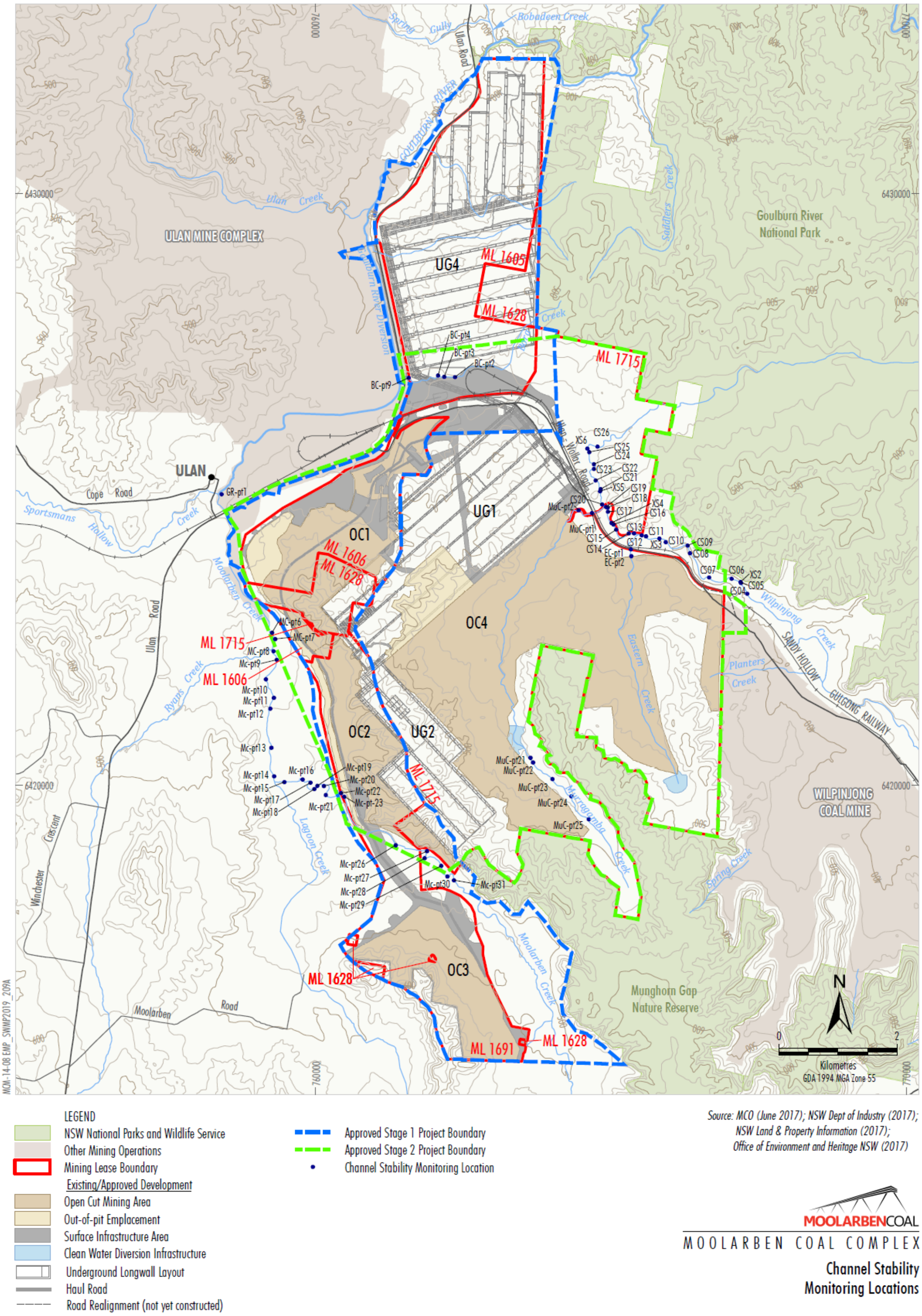

Figure 2.6 Channel stability monitoring locations

3 Subsidence impacts

3.1 OVERVIEW

A summary of relevant potential subsidence impacts to surface water features is provided in the following sections.

3.2 DRAINAGE LINES

The drainage lines affected by LW104-105 are DL6 and the downstream portions of DL7, as shown in Figure 2.2.

DL4 and DL5 are located within the footprint of the approved out of pit emplacement area and have been buried beneath overburden. DL4 and DL5 are not contemplated further in this report.

DL6 crosses LW104 and LW105. DL7 directly overlies LW103, LW104 and LW105. The maximum predicted conventional subsidence and tilt due to the extraction of LW104 and LW105 are as follows (MSEC, 2020):

- Maximum predicted total subsidence: DL6 = 2200 millimetres (mm)

  DL7 = 2200 mm
- Maximum predicted total tilt: DL6 = 65 mm per metre (mm/m)

  DL7 = 60mm per metre (mm/m)

These maximum predicted subsidence characteristics are consistent with those predicted for the approved layout for the Moolarben Coal Complex UG1 Optimisation Modification.

Both DL6 and DL7 are ephemeral, so water typically flows during and for short periods after a rainfall event.

Ponding naturally develops along some sections of the drainage lines, for short periods of time, after major rainfall events. Additional ponding may occur along DL6 and DL7 as a result of subsidence from LW104-105.

The predicted changes in grade along the drainage lines are generally less than most of the natural grades, which vary from approximately 20 mm/m to 500 mm/m. DL6 and DL7 contain predominantly alluvial and colluvial deposits and it is expected that sections of beds downstream of the additional ponding areas may erode during subsequent rain events, especially during times of high flow. The predicted changes in grade are expected to increase the risk of erosion over a reach length of about 100 metres (m) immediately downstream of the chain pillar and increase the potential for ponding over a similar length immediately upstream of the chain pillar. The areas of DL6 and DL7 predicted to be at increased risk of erosion or ponding are shown in Figure 3.1 and Figure 3.2.

It is expected over time that the gradients along the drainage lines would approach grades similar to those which existed before mining. The extent of additional ponding along the drainage lines would therefore be expected to decrease with time.

The maximum predicted systematic tensile and compressive strains at the drainage lines, at any time during or after the extraction of the proposed longwalls is greater than 33 mm/m. Non-conventional ground movements may cause the drainage lines to experience higher strains. The minimum radii of curvatures associated with the maximum predicted systematic tensile and compressive strains is 0.33 km. It is expected, at strains of these magnitudes, that fracturing and dilation of the bedrock would occur as a result of the extraction of the proposed longwalls. The drainage lines may have relatively thin alluvial and colluvial deposits above the bedrock but it is still expected that fracturing in the bedrock would be observed at the surface, especially around the locations of natural jointing in the bedrock and where the depths of soil above the bedrock are the shallowest.

In times of heavy rainfall, the majority of the surface water runoff would be expected to flow over the surface cracking in the beds and only a small proportion of the flow would be diverted into the fractured and dilated strata below. In times of low flow, however, a larger proportion of the surface water flow could be diverted into the strata below the beds and this could affect the quality and quantity of this water flowing through the cracked strata beds. Nevertheless, during high flow or low flow times this small quantity is expected to have little impact on the overall quality of water flowing out of the drainage lines.

It is also expected that with time the fracturing in the bedrock would be filled with alluvial and colluvial materials during subsequent flow events, reducing the diversion of surface water flows into subsurface flows. It may be necessary, however, that some remediation of the beds of the drainage line would be required, such as the infilling of surface cracks with materials comprising a high clay content, or by locally regrading and re-compacting the surface.

It is recommended that the drainage lines are visually monitored prior to the proposed longwalls mine beneath them, within 3months of mining beneath them and then at approximately 6 and 12 months following mining. It is also recommended that management strategies (refer Section 4) are developed for the drainage lines, such that the impacts can be identified and remediated, as and if they are required.

3.3 OUT OF PIT EMPLACEMENT AREA

The predicted subsidence at the natural ground surface and additional settlement of the emplacement area can initiate downhill slumping of the soils in the emplacement area. Other factors such as the presence of natural steep ground slopes, and surface water ingress may increase the risk of downhill slumping of the sides of the emplacement area. Longwall extraction will create depressions in the flat areas of the emplacement and surface cracks, which will increase the risk of water ingress into the emplacement soils during rain periods.

The Subsidence Assessment (MSEC, 2020) recommends that management strategies are developed for the LW101 to 103 Extraction Plan are updated to include LW104 and 105. Such management should include surface crack repair and remediation of the ground surface to ensure that adequate surface water drainage is maintained.

On the uphill sides of the emplacement area, drainage lines will flow towards the emplacement area. Measures should be incorporated to provide for the adequate management of the flows in these drainage lines around or over the emplacement area, including preventing the erosion of the emplacement area and preventing unplanned ponding on the surface following extraction of the longwalls.

The emplacement area is subject to slumping as the emplaced material settles. As such, inspections of drainage around and over the area occur as required as part of MCO’s operations to confirm the functionality of the drainage lines.

3.4 ENVIRONMENTAL RISK ASSESSMENT

A quantitative environmental risk assessment for LW104-105 is presented in the Moolarben Coal UG1 – Longwalls 104 to 105 Subsidence Risk Assessment Report (Risk Mentor [RM], 2020). The following surface water issues were identified by the risk assessment as Low risk:

- potential changes to the gradients of drainage lines and the corresponding impact on erosion risk; and
- changes in water quality due to a potential increase in erosion.
- potential changes to water quality and flow resulting from subsidence impacts associated with extraction of LWs 104 and 105.

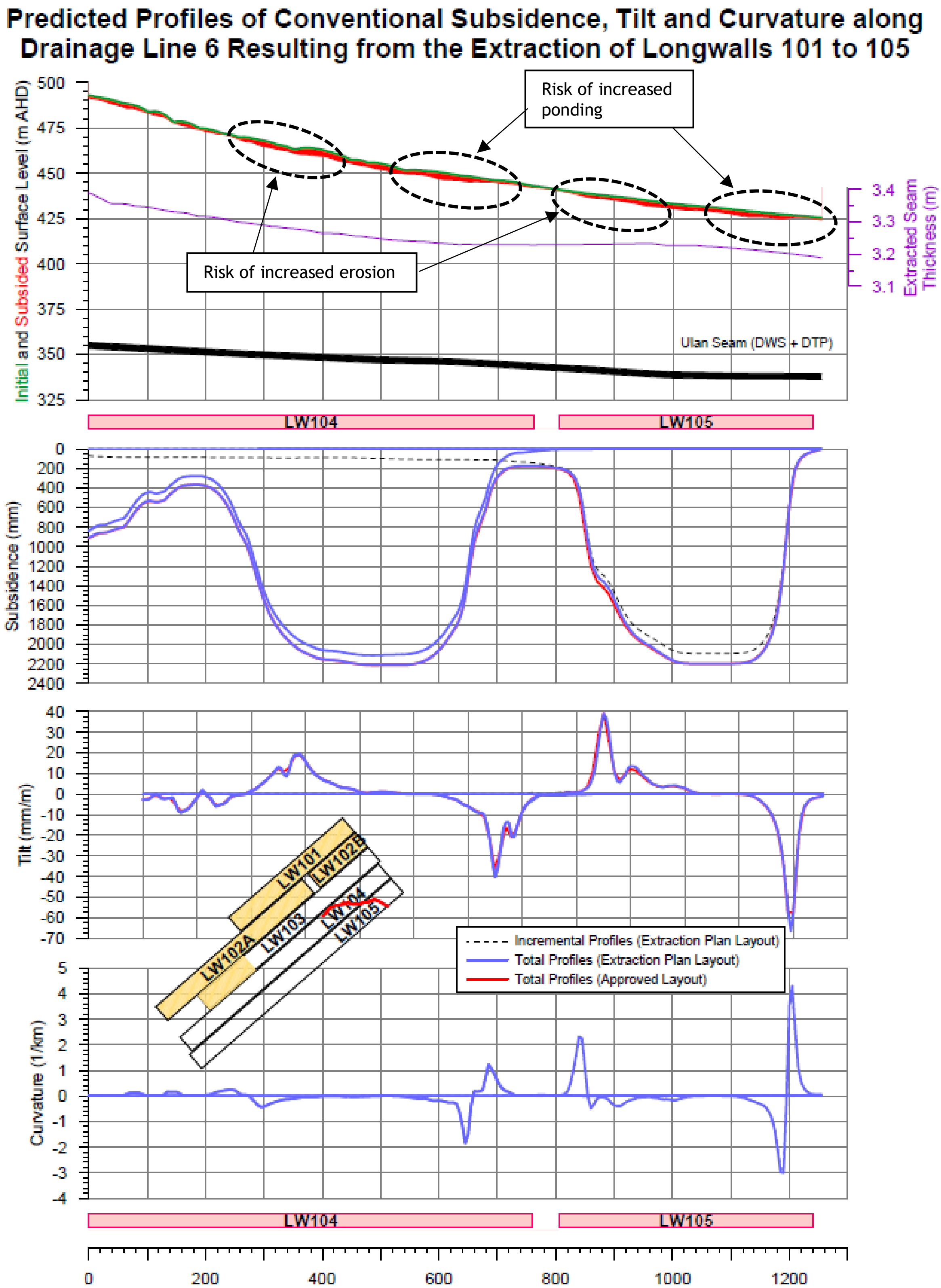

Figure 3.1 Subsidence impacts on Drainage Line 6 (Source: MSEC, 2020)

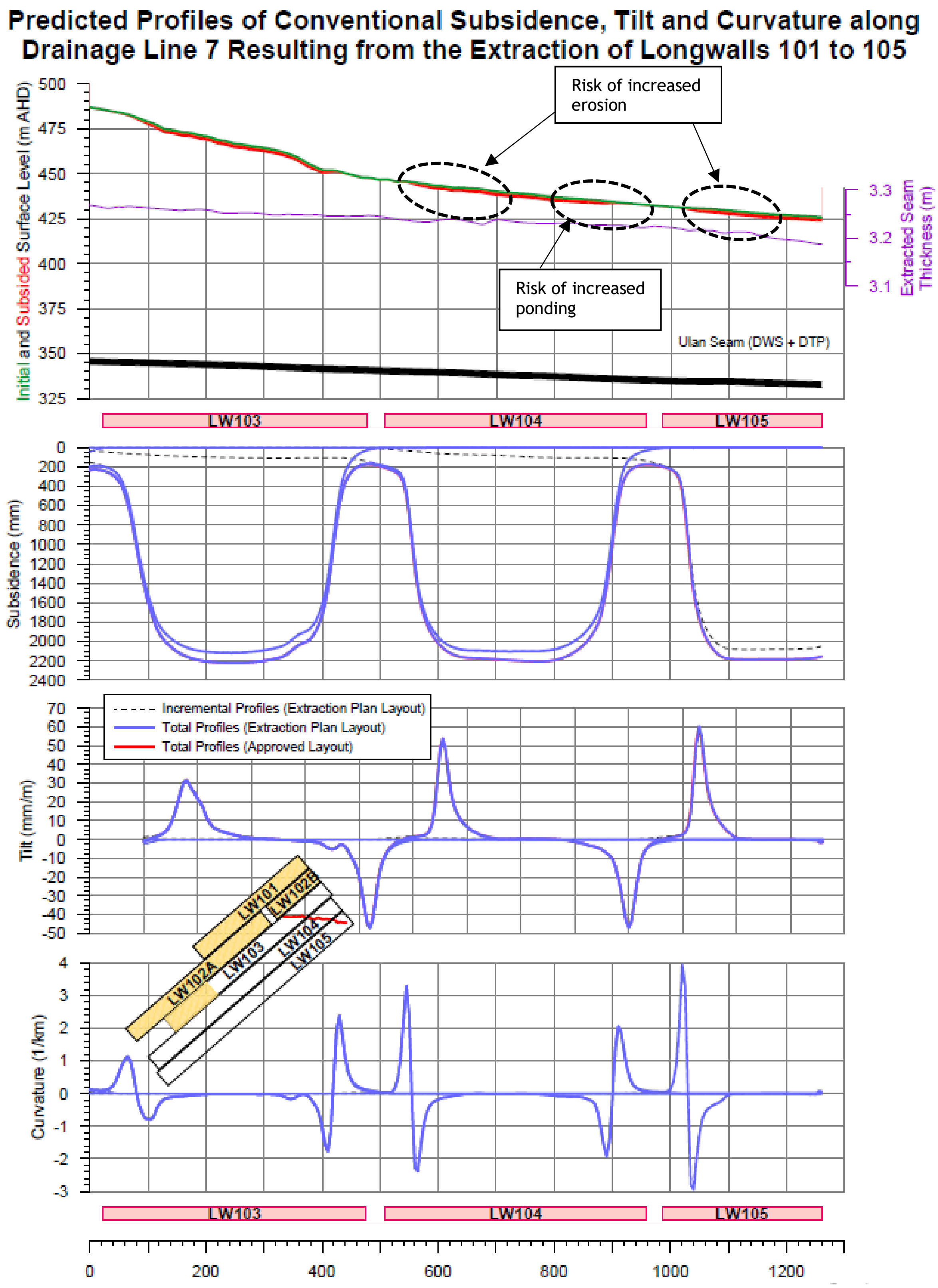

Figure 3.2 Subsidence impacts on Drainage Line 7 (Source: MSEC, 2020)

4 Monitoring and management measures

4.1 SUBSIDENCE IMPACT PERFORMANCE MEASURES

Schedule 4 of the Project Approval (08_0135) lists the following performance measure for subsidence impacts on water resources:

- Drainage Lines (DL1-DL7):
    - No greater subsidence impacts or environmental consequences than predicted in the EA.

Subsidence impacts and potential environmental consequences for surface drainage features are discussed in Section 3 of this report and are consistent with those previously predicted.

The following sections provide:

- detailed objectives and performance indicators for potential subsidence impacts on surface drainage;
- proposed monitoring activities for potential surface water subsidence impacts;
- proposed remedial measures and contingencies; and
- triggers for proposed management actions.

4.2 OBJECTIVES AND PERFORMANCE INDICATORS

Table 4.1 shows the objectives and performance indicators for potential surface water related issues.

Table 4.1 - Surface water subsidence management objectives and performance indicators

Risk issue	Objective	Performance indicator	Proposed monitoring
Drainage lines	No increase in active erosion of bed and banks in DL6 & DL7	• Change in visible bed or bank erosion • Development of, or change in, headcut erosion	• Walkover visual inspection of DL6 & DL7 • Photographic record of higher-risk reaches of DL6 & DL7
	No change in stream character for DL6 & DL7	• Change in vegetation character such as vegetation loss through erosion or drowning by ponded water • Extent and duration of water ponding	• Walkover visual inspection of DL6 & DL7 • Photographic record of higher-risk reaches of DL6 & DL7
	No measurable change in downstream water quality	• Downstream water quality	• Continue current water quality monitoring program within Wilpinjong Creek as described in the site wide Surface Water Management Plan (MCO, 2018)
	Minimise change in catchment hydrology caused by loss of surface flow in cracks caused by subsidence	• Appearance of unsealed surface cracking across the bed of DL6 & DL7	• Walkover visual inspection of DL6 & DL7 • Photographic record of higher-risk reaches of DL6 & DL7

4.3 MONITORING OF IMPACTS

As described in Section 3, the potential surface water impacts of subsidence for LW104-105 are likely to be limited in spatial extent. Hence, monitoring of potential impacts will be focused on higher risk locations (100m up and down slope from chain pillars).

Due to the small catchment areas of the affected drainage lines, surface runoff will occur infrequently and only for a very short time during and immediately after significant rainfall. Water quality sampling under these conditions is not a reliable method to assess impacts because:

- runoff occurs infrequently;
- baseline water quality is likely to be highly variable depending on the magnitude of rainfall; and
- accessing sampling locations in the upper catchments during the very short time that surface runoff is flowing is likely to be extremely difficult.

For these reasons, water quality sampling of the minor drainage lines is not proposed.

Water quality sampling of receiving streams will continue to be undertaken in Wilpinjong Creek in accordance with the site wide Surface Water Management Plan (MCO, 2018). However, it is unlikely that this sampling could detect any impacts due to subsidence because the expected impacts on runoff quality are minimal and the receiving watercourses collect runoff from large catchments that include significant areas of land disturbing activities that pose a significantly larger risk of affecting water quality.

Due to the difficulty in detecting subsidence impacts by water quality monitoring, the primary monitoring activity for surface water subsidence impacts will be visual inspection of higher risk locations, including collection of photographic records to confirm changes in erosion and vegetation over time. Details of the proposed monitoring activities are given in Table 4.2.

4.4 TRIGGER ACTION RESPONSE

Table 4.3 shows trigger events for each of the performance indicators, as well as required actions to manage the potential impacts. A key principle for the remediation of surface water impacts due to subsidence is to minimise land disturbance associated with intervention measures. Hence, if an issue is identified, it is recommended that specialist advice be obtained to ensure that any proposed intervention is effective. Wherever possible, proposed remediation works should be undertaken using soft engineering measures that minimise land disturbance and maximise vegetative cover.

Table 4.2 – Proposed monitoring for surface water impacts

Monitoring task	Methodology	Timing
Water quality monitoring	As per the site wide Surface Water Management Plan (MCO, 2018)	As per the site wide Surface Water Management Plan (MCO, 2018)
Walkover visual inspection and photographic record of DL6 & DL7	Identify and mark the upstream and downstream limits of LW104 & LW105 along DL6 & DL7	Prior to undermining of DL6 & DL7
	Undertake a baseline inspection by walking along DL6 & DL7 over LW104 & LW105 and noting the condition of vegetation in the channel and any areas of active erosion, sediment deposition, water ponding or streambed cracking	Prior to undermining of DL6 & DL7
	Collect baseline photographic record of channel condition along DL6 & DL7 over LW104 & LW105	Prior to undermining of DL6 & DL7
	Undertake periodic walkover inspections and compare against the baseline photographic record	Within 3 months of undermining of DL6 or DL7 Ongoing inspections every 6 months. Minimum of 2 inspections per year for 1 year after undermining

Table 4.3 – Surface water response actions

Issue	Performance indicator	Trigger event	Action
Drainage lines	• Change in visible bed or bank erosion	• Noticeable new areas of erosion or expansion of existing erosion	• Obtain specialist advice on appropriate remediation works. Disturbance of existing vegetation increases the risk of erosion. Hence, machinery access for remediation works can potentially cause greater impacts than those caused by subsidence.
	• Development of or change in headcut erosion along DL6 or DL7	• Initiation of headcut or noticeable upstream advance of existing headcut	• Obtain specialist advice on appropriate remediation works. Preferred management strategies would include slope stabilisation, revegetation and bed control using natural materials such as local rock and large woody debris.
	• Extent and duration of water ponding	• Development of new pools or drainage of existing pools	• Obtain survey of ponded area to identify ponding depth and extent. • Investigate potential drainage works to restore existing drainage characteristics.
	• Downstream water quality	• Downstream turbidity exceeds trigger values in the site wide Surface Water Management Plan (MCO, 2018)	• Proceed with response actions for downstream surface water quality in the site wide Surface Water Management Plan (MCO, 2018).

5 References

MCO, 2018 — *'Surface Water Management Plan'*, Version 4, March 2018.

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