



**GUJARAT NRE FCGL Pty Ltd**

## **WONGAWILLI COLLIERY LONGWALL 20 END OF PANEL REPORT**



**August 2012**

# DOCUMENT CONTROL

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NOTES	

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# 1 ABBREVIATIONS AND DEFINITIONS

**DECCW** – formerly the NSW Department of Environment, Climate Change and Water now known as the NSW Office of Environment and Heritage (OEH). OEH has been used as the modern reference to this Department.

**DRE** – Divisions of Resources and Energy

**EOP** – End of Panel Report

**ESSMP** - Environment, Subsidence and Safety Management Plan

**IIN** – formerly Industry and Investment NSW

**Limit of Subsidence** – also described as the Limit of Vertical Subsidence - the area extending beyond the 20mm/m subsidence contour line

**ML** – Mining Lease

**MSEC** – Mine Subsidence Engineering Consultants

**SMP** – Subsidence Management Plan

**SMP Area** – The area considered for the full SMP application for Longwalls 11,12,15,16 & 19 and 20

## 2 SUMMARY

This End of Panel (EOP) report has been prepared in accordance with Condition 17.1 (revised) of the NRE Wongawilli Colliery Longwalls 11, 12, 15, 16, 19 and 20 Subsidence Management Plan (SMP) Approval. This EOP only relates to Longwall 20.

This EOP report outlines the measured and observed impacts following the extraction of NRE Wongawilli Longwall 20 and compares any observed impacts with the relevant impact predictions outlined in the SMP and its supporting expert reports and accompanying documentation.

Longwall 20 occurs within Mining Lease (ML) 1596 and was extracted using conventional longwall mining techniques and equipment. Extraction of coal from Longwall 20 commenced on 18 December 2011 and concluded on 11 April 2012.

### ***Subsidence***

Subsidence movements resulting from the extraction of Longwall 20 were measured along the EF survey line. The EF survey line was established prior to the extraction of Longwalls 12 and 11 and therefore provides measured surface movements due to the extraction of Longwalls 12, 11 and 20.

For the EF survey line, the maximum observed total subsidence due to the extraction of Longwalls 12, 11 and 20 was 570 mm at survey mark EF49, which is greater than the maximum predicted total subsidence of 415 mm.

The maximum observed total strain due to the extraction of Longwalls 12, 11 and 20 is a compressive strain of 1.1mm/m which occurs between survey pegs EF58 and EF59. Measured strains along the EF survey line are predominately less than 0.5 mm/m, for both compressive and tensile strains, which is similar to the order of survey tolerance.

The maximum observed total tilt due to extraction of Longwalls 12, 11 and 20 is an incremental tilt of 5.0 mm/m and is greater than the predicted maximum of 1.7 mm/m.

### ***Impacts on Man Made Features***

#### ***Comparison between Predicted and Observed Impacts on Surface Infrastructure***

The observed impacts on man made features resulting from the extraction of Longwall 20 were similar to, or less than, the impacts predicted in the SMP. Surface infrastructure located above or adjacent to LW20 and observed impacts are shown in Table 5.1.

No subsidence impacts to Indigenous heritage sites were observed.

During extraction of LW20 there was also no increase to minor cracking and rock falls observed during the extraction of LW11 along the Maldon-Dombarton Corridor.

### ***Impacts on Natural Features***

The observed impacts on natural features resulting from the extraction of Longwall 20 were all less than or in accordance with impacts predicted in the SMP.

There have been no observed impacts to cliffs, steep slopes or rock outcrops as a result of the extraction of Longwall 20.

There have been no observed impacts to terrestrial or aquatic ecological values or habitats as a result of the extraction of Longwall 20.

Monitoring of groundwater identified the groundwater level within the Hawkesbury Sandstone fell by 8.92m since June 2010 in open piezometer EGW3 (over Longwall 11) as a result of the extraction of Longwall 11. To date the EGW3 water level has not recovered and the other EGW water levels remained static to slightly rising during extraction of Longwalls 19 and 20.

### ***Trigger Action Response Plans (TARP's)***

During extraction of Longwalls 20, no TARP triggers were exceeded.

Neither the SCA or TransGrid, the owner and operator of the 330kv transmission line located to the east of the SMP Area, have reported any environmental impacts related to Longwall 20.

### ***Conclusion***

The extraction of coal from NRE Wongawilli Colliery Longwall 20 has resulted in no unexpected impacts to natural or man made features. No remediation is currently considered to be required.

NRE Wongawilli Colliery Longwall 15 has commenced extraction. Monitoring of natural and man made features in accordance with the NRE Wongawilli Colliery Environment, Subsidence and Safety Management Plan (ESSMP) in relation to Longwall 15 will continue and be documented in the next end of panel report.

## 3 INTRODUCTION

### 3.1 Background

This End of Panel (EOP) report has been prepared to define impacts observed from subsidence associated with the extraction of coal from Longwall 20 of NRE Wongawilli Colliery. The EOP has been prepared in accordance with Condition 17(as revised) of the Subsidence Management Plan (SMP) approval.

Information in this EOP has been supplied by Gujarat NRE Wonga Pty Ltd (Gujarat NRE) and specialist consultants involved in monitoring the effects of mining within the limit of subsidence of Longwall 20.

Longwall 20 is located in Mining Lease (ML) 1596. The longwall was the fourth mined in a series of six longwalls (Longwalls 11,12,15,16 & 19 and 20). Longwalls 11, 12 and 19 have already been extracted and were subject to previous EOP reports.

Coal from Longwall 20 was extracted using conventional longwall mining techniques between the following dates:

- ❑ Longwall commencement: 18 December 2011.
- ❑ Longwall completion: 11 April 2012.

Longwall 20 is shown in **Figure 1**. Impact predictions associated with Longwall 20 as part of the larger application area are described in the following reports. Copies of these reports reside with the Division of Resources and Energy (DRE), formerly known as the Department of Industry and Investment.

- ❑ Gujarat NRE Minerals Limited 2008: Subsidence Management Plan for NRE Wongawilli Colliery (Longwall Panels 11, 12, 15, 16, & 19, and Pillar Extraction Area 1) – “Written Report”
- ❑ Mine Subsidence Engineering Consultants [MSEC] (2008) NRE Wongawilli Colliery; The Prediction of Subsidence Parameters and the Assessment of Subsidence Impacts on Natural Features and Surface Infrastructure due to Mining Longwalls 11, 12, 15, 16 & 19 & Pillar Extraction Area PE1 (MSEC 360).
- ❑ Wood, J (2008a) Indicative Hydrogeology NRE Wongawilli Colliery. Proposed Extraction of Longwalls 11, 12, 15, 16 & 19 and Pillar Extraction Area 1.
- ❑ Wood, J (2008b) Indicative Hydrology NRE Wongawilli Colliery. Proposed Extraction of Longwalls 11, 12, 15, 16 & 19 and Pillar Extraction Area 1.
- ❑ Biosis Research (2008a) Terrestrial Flora and Fauna Impact Assessment for Longwalls 11, 12, 15, 16, & 19 & Pillar Extraction Area 1; NRE Wongawilli Colliery.

- ❑ Biosis Research (2008b) Archaeological and Cultural Heritage Impact Assessment of Proposed Longwalls 11, 12, 15, 16, & 19 & Pillar Extraction Area 1; NRE Wongawilli Colliery.
- ❑ Biosis Research (2008c) Aquatic Ecology Impact Assessment for Proposed Longwalls 11, 12, 15, 16 & 19 & Pillar Extraction Area 1; NRE Wongawilli Colliery.
- ❑ Biosis Research (2009) Addendum to the Terrestrial Flora and Fauna Impact Assessment for Proposed Longwalls 11, 12, 15, 16, and 19 and Pillar Extraction Area 1 NRE Wongawilli Colliery.
- ❑ Biosis Research (2009) NRE Wongawilli Colliery Longwalls 11, 12, 15, 16 & 19, & Pillar Extraction Area 1 Cultural Heritage Management Plan and Baseline Recording & Monitoring Methodology.

### 3.2 Approval Conditions

Gujarat NRE Wonga Pty Ltd holds Mining Lease 1596 which includes the area to be mined at NRE Wongawilli Colliery (or in the case of Longwall 20, the area that has been mined). The lease was granted on 19 December 2007. Condition 8 of the Lease provides for the extraction of coal from the lease area subject to the preparation and approval of a Subsidence Management Plan (SMP).

Approval of the SMP for Longwalls 11, 12, 15, 16, 19 and Pillar Extraction Area 1 was granted for NRE Wongawilli Colliery on 16 July 2009.

Conditions of the SMP approval pertinent to this EOP report include:

- Condition 12: Subsidence Monitoring
- Condition 13: Environmental Management
- Condition 17: End of Panel Report

### 3.3 Report Outline and Contributors

The following specialists and experts have contributed to this EOP through the assessments of subsidence impacts from Longwall 20 on their area of specialisation:

#### **Southern Cross Consulting**

<b>Surveyors</b>	<b>Survey</b>
<b>MSEC</b>	Mine Subsidence <b>(Attachment A)</b>
<b>GeoTerra</b>	Groundwater & Surface Water <b>(Attachment B)</b>
<b>Biosis Research</b>	Aquatic & Terrestrial Ecology & Cultural Heritage <b>(Attachment C)</b>
<b>Gujarat NRE</b>	Landscape Assessment and EOP <b>(this report)</b>

Data and text from specialist reports have been incorporated into this EOP without further reference. Specialist reports are provided as attachments to this EOP.

This EOP is set out according to the following schedule:

**Section 4** outlines the subsidence movements observed during mining and compares those results with the predicted subsidence parameters.

**Section 5** outlines the impacts of mining associated with Longwall 20 on surface infrastructure.

**Section 6** outlines the impacts of mining associated with Longwall 20 on natural features.

**Sections 7** summarises the monitoring program and outlines the management and remediation of impacts associated with Longwall 20.

## 4 PREDICTED AND OBSERVED SUBSIDENCE

### 4.1 Monitoring Lines

The subsidence movements resulting from the extraction of Longwall 20 were measured along the EF survey line which is a 2D monitoring line. The locations of the longwalls at the Colliery and the monitoring lines are shown in **Figure 1**. A comparison of the observed and predicted movements resulting from the extraction of Longwall 20 has been prepared by MSEC and is provided in full in **Attachment A**.

The EF survey line was established on 20<sup>th</sup> July 2009, prior to the commencement of Longwalls 12 and 11, and therefore the survey results for the EF line provide measured surface movements due to the extraction of Longwalls 12, 11 and 20. The previously extracted Elouera Colliery Longwall 10, which is located immediately to the north of Longwall 20, was completed in June 2005. The survey monitoring results therefore include the influence of the previously extracted Elouera Colliery Longwalls on the subsidence resulting from the extraction of Longwalls 12, 11 and 20 but do not include the surface movements that occurred when the Elouera Colliery Longwalls were extracted. Longwall 10 is located approximately 185 metres from Longwall 20 at its nearest point and the influence from this longwall on Longwall 20 subsidence parameters is anticipated to be negligible.

Previous extraction was carried out in the Bulli seam above Longwall 12 and 20 and the finishing end of Longwall 11. Old pillar extraction workings within the Wongawilli Seam were also extracted beneath the Bulli Seam directly adjacent to the southern edges of Longwall 11 and Longwall 12 and to the east of Longwall 20. The areas of extraction in the Bulli Seam and the Wongawilli Seam are shown in **Drawing No. MSEC578-01** in **Appendix A**.

The predicted subsidence profile for the EF survey line was obtained using the Incremental Profile Method for the Southern Coalfield, which uses an empirical database based on monitoring data from the Bulli Seam. The effects of multi-seam mining conditions were also taken into account in the prediction model, as previous extraction was carried out above Longwall 20 in the Bulli Seam, and the method of calibration was described in Report No. MSEC360. Comparisons between predicted and observed subsidence movements along the monitoring line are provided in the following sections.

### 4.2 EF Survey Line

The EF monitoring line is located diagonally across the northern end of Longwall 20 as is shown in Drawing No. MSEC576-01 in **Attachment A**. The route of the monitoring line follows Fire Road 6H and a disused 33kV power line.

The survey line was last monitored on 16<sup>th</sup> July 2012 after the completion of Longwall 20. Survey results of the total subsidence, tilt and strain of the EF line resulting from the extraction of LW11, LW12 and LW20 are presented in **Fig. A.01** in **Attachment A**. The predicted profiles of total subsidence, tilt and strain along the EF

Line due to the extraction of Longwalls 11, 12 and 20 are also shown in **Fig. A.01** in **Attachment A**.

The maximum observed total subsidence due to the extraction of LW12, 11 and 20 is 570 mm at survey mark EF49, which is greater than the maximum predicted total subsidence of 415 mm. The maximum observed total tilt due to the extraction of LW12, 11 and 20 is 5.0 mm/m between survey mark EF44 and EF45, which is greater than the maximum predicted total tilt of 1.7 mm/m. The maximum observed total strain due to the extraction of LW12, 11 and 20 is a compressive strain of 1.1 mm/m which occurs between survey pegs EF58 and EF59, which are located over Longwall 20. Measured strains along the EF Line are predominantly less than 0.5 mm/m, for both compressive and tensile strain, which is similar to the order of survey tolerance.

Whilst the observed movements exceeded those predicted, it is noted that the monitoring line crosses the corner of Longwall 20, where the subsidence parameters are the most difficult to predict. The maximum predicted total subsidence directly above Longwall 20, due to the extraction of Longwalls 12, 11 and 20, was around 500 mm. The maximum observed total subsidence along the EF Line, of 570 mm, therefore, exceeds the maximum predicted total subsidence anywhere above the longwall by around 15 %.

The maximum observed total tilt along the monitoring line exceeded that predicted, as more low level subsidence was predicted to occur outside the extent of Longwall 20, as a result of the reactivation of the existing overlying workings and the adjacent longwalls. The observed subsidence profile indicates less reactivation of the existing workings, outside the extents of Longwall 20, than was predicted (i.e. predicted subsidence profile was broader than that observed). The maximum predicted total transverse tilt above Longwall 20, due to the extraction of Longwalls 12, 11 and 20, was around 3.5 mm/m. The maximum observed total tilt along the EF Line, of 5.0 mm/m, therefore, exceeds the maximum predicted total transverse tilt by around 1.5 mm/m.

## 5 IMPACTS ON MAN MADE FEATURES

### 5.1 Surface Infrastructure within the Application Area

The surface infrastructure that is located above or adjacent to Longwall 20 is shown in **Figure 1**.

There is no significant infrastructure above or adjacent to Longwall 20 however the following items are considered in this EOP:

- ☐ Survey control marks.
- ☐ Disused 33 kV power line
- ☐ 4WD access tracks.

### 5.2 Comparison between Predicted and Observed Impacts on Surface Infrastructure

Comparisons between the observed and the predicted impacts on the man made surface infrastructure above or adjacent to Longwall 20 are summarised in **Table 5.1**. The predicted impacts were detailed in MSEC (2008). Man made infrastructure was inspected as part of the subsidence monitoring program (by foot and from a vehicle).

It can be seen from **Table 5.1** that the only reported impacts on surface infrastructure resulting from the extraction of Longwall 20 were impacts on the survey control marks. Impacts were similar to, or less than predicted. Road works completed on Fire Road 6A resulted in the loss of survey pegs EF81, EF82, EF85 and EF86. The road works were unrelated to Longwall 20 extraction. An assessment will be made as to whether the pegs need to be replaced for the EF survey line.

**Table 5.1: Summary of Predicted and Observed Impacts from Longwall 20 on Surface Infrastructure**

Surface Infrastructure	Predicted Impacts	Observed Impacts
Survey Control Marks	Horizontal movements requiring re-establishment	Horizontal movements require re-establishment
Disused 33 kV Power Line	No predicted impacts	No observed impacts
4WD Access Tracks	Changes to surface drainage and some surface cracking of the unsealed road surfaces	No Observed Impacts

### **5.3 Indigenous Heritage Sites**

Biosis Research Pty. Ltd. (Biosis) prepared an End of Panel assessment on all Aboriginal heritage sites in the vicinity of Longwall 20 and the full report is provided in **Attachment D**.

Two previously recorded Aboriginal archaeological sites occur in the vicinity of Longwall 20. The archaeological sites considered in this EOP are:

- ☐ Browns Road Site 1;52-2-1616
- ☐ Upper Avon 2;52-2-1825

The risk of impact to these sites from subsidence related to extraction of Longwall 20 was considered to be low.

The sites and associated features were compared with photographs taken during the SMP application (Biosis Research 2008b). The condition of the sites as observed revealed no changes to either site or nearby joint and bedding planes.

No subsidence impacts to Indigenous heritage sites were observed and the monitoring program will continue in accordance with the requirements of the Environment, Subsidence and Safety Management Plan.

### **5.4 European Heritage Sites**

There are no historic sites within the limit of subsidence of Longwall 20.

## 6 IMPACTS TO NATURAL FEATURES

Longwall 20 is located within the Metropolitan Special Areas Water Catchment. By definition the catchment area is relatively undisturbed and therefore contains many important natural features, as discussed below relevant for Longwall 20.

### 6.1 Steep Slopes and Rock Outcrops

Areas of steep slopes and rock outcrops are identified in Figure MSEC 360-08 (MSEC 2008 – not reproduced in this report). No cliff lines or rock outcrops are located above Longwall 20. Small areas of steep slopes appear above Longwall 20.

#### ***Predicted Impacts***

Predicted impacts on the steep slopes that occur directly above longwalls and pillar extraction areas of NRE Wongawilli Colliery are defined in MSEC (2008) as:

- ☐ Minor slippage of soils down the steep slopes, resulting in the development of minor cracking in soils at the top of the slopes and minor compression ridges forming at the bottom of the slopes.
- ☐ Large scale slope failure was considered unlikely.
- ☐ Steep slopes which are not located directly above the longwall goaf were not predicted to experience any significant systematic subsidence movements.

#### ***Observed Impacts***

Inspections of the areas of steep slopes in the vicinity of Longwall 20 were undertaken during site inspections by Biosis Research and personnel from Gujarat NRE.

There have been no observed impacts on steep slopes associated with the extraction of Longwall 20.

### 6.2 Surface Water and Groundwater Impacts

There are no major waterways within the limit of subsidence of Longwall 20. Bellbird Creek overlies Longwall 20, along with the previously extracted Longwall 11.

One swamp piezometer (P20) is located within Swamp 20 that overlies Longwall 20. P20 is located above the previously extracted Longwall 11, adjacent to Longwall 20.

Locations of surface and groundwater monitoring sites for Longwall 20 are shown in **Figure 2**.

#### ***Predicted Impacts***

GeoTerra (**Attachment B**) have assessed the surface and groundwater monitoring results and prepared a comprehensive end of panel report for Longwall 20. Groundwater and Surface Water Impacts have been tabulated in **Table 6.1** below, which compares predicted impacts with actual observations or monitoring data analysis results.

**Table 6.1: Summary of Groundwater and Surface Water Impacts**

Predicted Impacts	Observed Impacts Due to Extraction of Longwall 20
Adverse interconnection of aquifers and aquitards is not anticipated within 20m of the surface	No adverse interconnection between aquifers and aquitards has been observed within 20m of the surface
Potential increased rate of recharge into the plateau	No increased rate of recharge has been observed
Temporary lowering of shallow Hawkesbury Sandstone piezometric surface by up to 10m which may stay at that level until maximum subsidence develops	Based on the available data, no above trigger lowering of the shallow Hawkesbury Sandstone piezometric surface has been observed in PWW1 in relation to extraction of Longwall 11, 12, 19 and 20; however EGW3 over Longwall 11 fell by 8.92m.
Shallow Hawkesbury Sandstone groundwater levels should recover over a few months	Based on the available data, the EGW3 water level has not yet recovered
No permanent post mining reduction in the shallow Hawkesbury Sandstone water levels unless a new outflow path develops	Based on the available data, the EGW3 water level has not yet recovered
Strata dilation and subsequent re-filling of secondary voids may temporarily lower the shallow Hawkesbury Sandstone standing water levels	Based on the available data, the EGW3 water level has not yet recovered
No observable lowering of the Upland Swamp piezometric surface due to subsidence, although there is expected to be a direct relationship between the lack of rainfall recharge and reduced water levels	Lowering of the piezometric surface has been observed in association with low rainfall periods, although no observable adverse effect on Swamp 20 water levels has been caused by LW 11, 12, 19 or 20
The shallow Hawkesbury Sandstone piezometers may experience increased iron / manganese hydroxide precipitation and / or lowering of pH	The water quality in the shallow Hawkesbury Sandstone piezometers have not been affected by subsidence related effects
Upland Swamp piezometers may experience increased iron / manganese hydroxide precipitation and / or lowering of pH	The Swamp 20 piezometer has not been adversely, or observably, affected by subsidence effects
Interface drainage, ferruginous, brackish seeps may be generated in streams	No interface drainage, ferruginous, brackish seeps have been generated in Bellbird Creek or the Wongawilli Creek tributaries
Ferruginous seeps may develop in the local creeks	No ferruginous seeps have developed in Bellbird Creek or the Wongawilli Creek tributaries
Increased basement groundwater seepage inflow into the workings should not occur	No increased rate of groundwater seepage into the workings has occurred
Strata gas discharge into piezometers may occur	No strata gas discharge has occurred
Stream flow in Bellbird Creek may be adversely affected by subsidence	Stream flow in Bellbird Creek and the Wongawilli Creek tributaries has not been adversely affected by subsidence related effects
Stream water quality in Bellbird Creek and Wongawilli Creek may be adversely affected by subsidence	Stream water quality in Bellbird Creek and the Wongawilli Creek tributaries has temporarily exceeded either the salinity and/or pH triggers, but has not been affected in the

	long term, with both pH and EC returning to its baseline, pre mining range.
Stream bed and bank stability in Bellbird Creek and Wongawilli Creek may be adversely affected by subsidence.	Stream bed and bank stability in Bellbird Creek and Wongawilli Creeks tributaries has not been adversely affected by subsidence related effects

## Summary of Results

During extraction of Longwalls 20, there were no TARP trigger levels exceeded for surface or groundwater impacts.

Refer Error! Reference source not found. for detailed results.

Refer **Table 7.1** for the relevant monitoring obligations and TARPs (Trigger Action Response Protocols).

## 6.3 Aquatic Ecology

Biosis Research (Biosis 2008c) assessed the aquatic habitat of the NRE Wongawilli SMP Area and potential for that habitat to provide suitable values for threatened aquatic species in August 2008. Aquatic habitats within the limits of subsidence of LW 20 were again inspected by Biosis Research in autumn 2012. The results of the Biosis Research End of Panel assessment for aquatic ecological values are provided in **Attachment C**.

### 6.3.1 Predicted Impacts on Aquatic Ecology

Aquatic habitats in the vicinity of Longwall 20 included Bellbird Creek. There are also several small ephemeral drainage lines that are associated with Upland Swamps that are located above and adjacent to Longwall 20.

Habitat for three endangered aquatic species, Macquarie Perch (*Macquaria australasica*), Adam's Emerald Dragonfly (*Archaeophya adamsi*) and Sydney Hawk Dragonfly (*Austrocordulia leonardi*) was identified in the broad vicinity of the approved SMP Area (Biosis Research 2008c). Assessments of Significance concluded that the proposal was unlikely to have a significant impact on a local population of any of these species.

### 6.3.2 Observed Impacts on Aquatic Ecology

Field investigations have not observed any impacts to creeks or drainage lines as a result of the extraction of Longwall 20 (along with 11, 12 and 19). There has been no observed impact on aquatic ecological values.

Refer to **Attachment C** for further details on monitoring methodology and site locations.

## **6.4 Terrestrial Ecology**

Biosis Research (Biosis 2008a) assessed the terrestrial ecological values of the NRE Wongawilli SMP Area and potential for those values to provide suitable habitat for threatened aquatic species during several survey campaigns. Surveys were undertaken initially in the area in June 2006 as part of the assessment for Delta Colliery Longwalls. Further surveys have been undertaken in line with the ESSMP monitoring program.

Biosis have assessed the post-mining conditions with relation to aquatic and terrestrial ecology within the area potentially impacted by subsidence effects associated with mining of Longwall 20. The results of the Biosis End of Panel assessment for terrestrial ecological values are provided in **Attachment C**.

### **6.4.1 Predicted Impacts on Terrestrial Ecology**

Predicted impacts are summarised in **Attachment C**.

### **6.4.2 Observed Impacts on Terrestrial Ecology**

Ecological monitoring to date has not identified any impacts to flora and fauna as a result of subsidence associated with the extraction of Longwall 20 at the NRE Wongawilli Colliery. No other management actions have been triggered under the Trigger Action Response Plan.

### **6.4.3 Conclusion**

Vegetation communities, fauna habitats, threatened species, populations and ecological communities are not considered to have been affected by subsidence related impacts associated with the extraction of Longwall 20 (along with 11, 12 and 19).

Observational as well systematic ecological monitoring in this area will continue and any notable changes to the natural environment will be referred to specialist consultants for further consideration.

## 7 MANAGEMENT OF IMPACTS AND REMEDIATION

### 7.1 Trigger Action Response Plan

The monitoring and Trigger Action Response Plan (TARPs) for NRE Wongawilli Colliery Longwalls 11 – 20, are summarised in **Table 7.1**. Monitoring of man made and natural features within the SMP Area has identified no impacts as a result of the extraction of Longwall 20.

**Table 7.1** sets out the agreed actions to be implemented once a trigger has been met or exceeded. The first step is usually informing the relevant agencies. All agencies were informed of the identified impacts as per **Table 7.1** where required.

Neither the SCA, nor TransGrid the owner and operator of the 330kv transmission line, located to the east of the SMP Area, have reported any environmental impacts related to Longwall 20.

**Table 7.1: Monitoring and TARPs for NRE Wongawilli Colliery**

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
<b>Subsidence line EF (Pre and post mining)</b>	2D Survey once prior to mining (completed)	During mining - only if regular inspections identify greater than predicted impacts (not required)	Post mining 2D survey of EF line of: - Total subsidence; - Incremental subsidence; - Variation in horizontal strain.  • Survey measurement comparison with predictions  • Reported in Survey Reports	<input type="checkbox"/> As per MSEC predicted subsidence contours.	<input type="checkbox"/> Greater than predicted maximum observed total subsidence against predictions. Greater than predicted total tilt against predictions	<input type="checkbox"/> Major surface cracking (>10mm)	<input type="checkbox"/> Notify Principal Subsidence Engineer - DRE NSW; <input type="checkbox"/> Undertake subsidence survey and review against predictions; <input type="checkbox"/> Review mining options	<input type="checkbox"/> Assessment of prediction model for future longwalls based on observed data.
<b>330kv Transmission Line (Tower 37-6) (Visual inspections during mining and survey measurement post mining)</b>	Observation of tower condition and survey measurement for later comparison (not required – tower well beyond limit of subsidence of LW 19 as advised by TransGrid)	None required	Monitoring will be undertaken prior to, during and after extraction of LW's 15, 16, 19 and 20. NB. TransGrid will undertake monitoring responsibilities as per App 2 of ESSMP	<input type="checkbox"/> No predicted impacts	<input type="checkbox"/> No observed or reported effects	<input type="checkbox"/> Observation of unsafe tower conditions as noted by Transgrid (the owner and operator of the transmission line) who are responsible for observational monitoring	<input type="checkbox"/> Report condition to TransGrid and Mine Subsidence Board <input type="checkbox"/> TransGrid to undertake remediation as necessary	<input type="checkbox"/> None required
<b>Fire Roads and 4WD Tracks (Fortnightly visual inspection)</b>	Observation of road condition once prior to mining and reported in SMP (completed)	Fortnightly observation of roads, tracks and area within 200m of roads/tracks (complete)	Monthly observation of roads, tracks and area within 200m of roads/tracks for 6 months post mining (ongoing)	<input type="checkbox"/> Potential for minor some surface cracking and compressive rippling of the unsealed road surfaces	<input type="checkbox"/> No observed or reported effects	<input type="checkbox"/> Minor cracking on roads and tracks (<10mm)	<input type="checkbox"/> Notification to SCA within 24 hrs, using photographic record	<input type="checkbox"/> None required
						<input type="checkbox"/> Major cracking (>10mm) or traffic impedence	<input type="checkbox"/> Notification to SCA immediately, then to DRE NSW and MSB <input type="checkbox"/> Make area safe as soon as practicable including warning signs <input type="checkbox"/> Proposal for rectification within 1 week upon approval from SCA <input type="checkbox"/> Completion of works following approval from SCA <input type="checkbox"/> Additional daily monitoring	<input type="checkbox"/> None required
<b>Indigenous Heritage Sites (Inspect once prior to, during and post mining)</b>	Record significant heritage items once prior to mining (completed) Site nominated in CHMP are: - Browns Road Site 1 - Browns Road Site 2 - Upper Avon 2	Once for observed impacts such as: Cracking, opening of bedding planes, blockfalls, exfoliation, water seepage changes. For sites: - Browns Road Site 1 - Browns Road Site 2 - Upper Avon 2	<input type="checkbox"/> 3-6 months post mining <input type="checkbox"/> 2 years post mining For Sites: - Browns Road Site 1 - Browns Road Site 2 - Upper Avon 2	<input type="checkbox"/> Browns Road 1 - Moderate risk <input type="checkbox"/> Browns Road Site 2 – Very low risk <input type="checkbox"/> Upper Avon 2 - Very Low risk	<input type="checkbox"/> No observed or reported effects.	<input type="checkbox"/> Observation of unstable conditions (in the case of overhangs) or damage	<input type="checkbox"/> Implement the Cultural Heritage Management Plan (CHMP) <input type="checkbox"/> Report impacts as required <input type="checkbox"/> Notify OEH, DRE NSW, SCA <input type="checkbox"/> Review and undertake remediation options as appropriate	<input type="checkbox"/> None required

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
Cliffs, Steep Slopes and Rock Outcrops (Monthly)	Observation and documentation of cliff and steep slope condition including CL 19-02, CL 19-03, CL 19-04 and CL 19-05 – (Once prior to mining )	Monthly observations during mining	Monthly observations for 6 Months	<input type="checkbox"/> Potential for minor rockfalls to occur at the rock outcrops which are located above the extracted goaf areas of the proposed longwalls  <input type="checkbox"/> It is expected, however, that any rockfalls would be of a minor nature, as a majority of the predicted subsidence parameters are relatively small, and the rock outcrops are discontinuous and relatively low in height and, therefore, less susceptible to impact.	<input type="checkbox"/> No observed or reported effects.	<input type="checkbox"/> Minor cracking on roads and tracks (<10mm)	<input type="checkbox"/> Notification to SCA and DRE NSW within 24 hrs, using photographic record <input type="checkbox"/> Warning sign/s erection <input type="checkbox"/> Reported in AEMR	<input type="checkbox"/> None required
						<input type="checkbox"/> Major cracking (>10mm) or traffic impedance	<input type="checkbox"/> Notification to SCA immediately then DRE NSW <input type="checkbox"/> Make area safe immediately including erection of warning sign/s and barrier fencing <input type="checkbox"/> Reported in AEMR <input type="checkbox"/> Review mining options	<input type="checkbox"/> None required
						<input type="checkbox"/> Major cliff collapse or steep slope movement	<input type="checkbox"/> Notification to SCA immediately then I&I NSW <input type="checkbox"/> Make area safe immediately including warning sign/s erection and barrier fencing <input type="checkbox"/> Proposal for rectification within 1 week <input type="checkbox"/> Completion of works following approval from SCA <input type="checkbox"/> Additional monitoring <input type="checkbox"/> Reported in AEMR	<input type="checkbox"/> None required
Stream Water Quality and Flow	<input type="checkbox"/> Field Analysis (EC, pH, temp) <input type="checkbox"/> Laboratory Analysis TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Cs, Rb, Sr (filtered) <input type="checkbox"/> Observable iron or salinity staining using Photo Points <input type="checkbox"/> Monthly for at least two months prior to mining (for all parameters above)	<input type="checkbox"/> Weekly Field Analysis during active undermining of stream <input type="checkbox"/> Bi-monthly Lab analysis during active undermining of stream <input type="checkbox"/> Weekly observations during active undermining of stream using Photo points	<input type="checkbox"/> Bi-monthly Field Analysis for one year after subsidence ceases <input type="checkbox"/> Lab analysis Every four months for one year until subsidence ceases <input type="checkbox"/> Bi-monthly observations for one year after subsidence ceases using Photo points	<input type="checkbox"/> Possible tensile cracking in the bed of Native Dog Creek and Wongawilli Creek <input type="checkbox"/> Possible buckling and fracturing of the bedrock along Native Dog Creek, Bellbird Creek, Wongawilli Creek and the Tributaries to Wongawilli Creek, above and adjacent to the proposed longwalls <input type="checkbox"/> Gas emission could occur but significant emissions considered unlikely <input type="checkbox"/> Iron staining not predicted to occur <input type="checkbox"/> Water Quality: Lowering of pH in stream water due to iron staining (precipitate)	<input type="checkbox"/> No observed or reported effects.	<input type="checkbox"/> Observable increase from baseline in iron hydroxide precipitation (e.g. orange staining in water or on banks/bed) from comparison with pre-mining monitoring and photographs <input type="checkbox"/> Based on the baseline monitoring conducted since July 2005 the following triggers will be used: <input type="checkbox"/> EC > 200uS/cm <input type="checkbox"/> 4.2 > pH > 6.77 <input type="checkbox"/> Fe (Tot) > 6mg/L <input type="checkbox"/> Mn (tot) > 0.1mg/L <input type="checkbox"/> Al (tot) > 0.7mg/L <input type="checkbox"/> Zn (filt) > 0.04mg/L <input type="checkbox"/> SO4 (filt) > 8mg/L <input type="checkbox"/> Dissolved oxygen / ORP / temperature	<input type="checkbox"/> Repeat water quality sampling and initiate laboratory water quality sampling on a monthly basis <input type="checkbox"/> Contract hydrologist investigate and report on changes identified <input type="checkbox"/> Inform SCA, OEH & DRE NSW of results of investigation <input type="checkbox"/> Prepare and implement a site mitigation/action plan in consultation with key agencies and in accordance with Section 54 of the Water Management Act <input type="checkbox"/> Report in the End of Panel Report	<input type="checkbox"/> None required

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
Loss of Flow	<input type="checkbox"/> Monthly for at least two months prior to mining	<input type="checkbox"/> Weekly during active undermining of stream	<input type="checkbox"/> Bi-monthly for one year after subsidence ceases	<input type="checkbox"/> Possible diversion of surface water into dilated strata and the draining of pools	<input type="checkbox"/> No observed water quality impacts	<input type="checkbox"/> Observation of loss of flow connectivity within a flowing ephemeral stream (related to rainfall), compared to the flow regimes evident prior to the extraction of LW's 11-20	<input type="checkbox"/> Repeat water quality sampling and initiate laboratory water quality sampling on a monthly basis <input type="checkbox"/> Contract hydrologist investigate and report on changes identified <input type="checkbox"/> Inform SCA, OEH & DRE NSW of results of investigation <input type="checkbox"/> Prepare and implement a site mitigation/action plan in consultation with key agencies and in accordance with Section 54 of the Water Management Act <input type="checkbox"/> Report in the End of Panel Report	<input type="checkbox"/> None required
Areas of increased flooding	<input type="checkbox"/> Monthly for at least two months prior to mining	<input type="checkbox"/> Weekly during active undermining of stream	<input type="checkbox"/> Bi-monthly for one year after subsidence ceases	<input type="checkbox"/> Ponding, flooding and scouring considered unlikely to occur	<input type="checkbox"/> No observed increased flooding	<input type="checkbox"/> Observation of areas of flooded stream in excess of baseline conditions – identified by extended flooding within a terrestrial habitat and from comparison of pre-mining and post-mining photographs	<input type="checkbox"/> Survey area to identify whether earthworks are required <input type="checkbox"/> Contract hydrologist investigate and report on changes identified <input type="checkbox"/> Inform SCA / OEH of results of investigation <input type="checkbox"/> Prepare and implement a site mitigation/action plan in consultation with key agencies and in accordance with Section 54 of the Water Management Act if required <input type="checkbox"/> Report in the End of Panel Report	<input type="checkbox"/> None required
Erosion of stream bed and banks	<input type="checkbox"/> Monthly for at least two months prior to mining	<input type="checkbox"/> Weekly during active undermining of stream	<input type="checkbox"/> Bi-monthly for one year after subsidence ceases	<input type="checkbox"/> Scouring considered unlikely to occur	<input type="checkbox"/> No observed erosion of stream bed and banks	<input type="checkbox"/> Observation of erosion of stream bed and banks in excess of baseline conditions identified from comparison of pre-mining and post-mining photographs	<input type="checkbox"/> Contract hydrologist investigate and report on changes identified <input type="checkbox"/> Inform SCA, OEH & DRE NSW of results of investigation <input type="checkbox"/> Prepare and implement a site mitigation/action plan in consultation with key agencies and in accordance with Section 54 of the Water Management Act <input type="checkbox"/> Report in the End of Panel Report	<input type="checkbox"/> None required
<b>Groundwater – Hawkesbury Sandstone (water quality and water levels)</b> in four bores EGW2,	<input type="checkbox"/> Field water quality (EC, pH, temp)– bi monthly <input type="checkbox"/> Laboratory analysis – every four months	<input type="checkbox"/> Field water quality – monthly during extraction <input type="checkbox"/> Laboratory analysis –	<input type="checkbox"/> Field water quality – bi monthly <input type="checkbox"/> Laboratory analysis – every four months	<input type="checkbox"/> Adverse interconnection of aquifers and aquitards is not anticipated within 20m of the surface	<input type="checkbox"/> No observed or reported effects	<input type="checkbox"/> <b>Ground Water Quality</b> <input type="checkbox"/> 2 std deviation change, or distinctive diversion over at least 4 months from baseline	<input type="checkbox"/> Investigation initiated within one week of trigger <input type="checkbox"/> Repeat water quality sampling of impacted and adjacent	<input type="checkbox"/> None required

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
EGW3,EGW5 ,WW1	Lab Parameters- -TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Cs, Rb, Sr (filtered)	every two months		<input type="checkbox"/> Potential increased rate of recharge into the plateau <input type="checkbox"/> Piezometers may experience increased iron / manganese hydroxide precipitation and / or lowering of pH <input type="checkbox"/> Interface drainage, ferruginous, brackish seeps may be generated in streams <input type="checkbox"/> Shallow groundwater level within Swamp 20 will be dependent on rainfall recharge and will not be affected by mining <input type="checkbox"/> Strata gas discharge into piezometers may occur <input type="checkbox"/> Stream flow in Bellbird Creek may be adversely affected by subsidence from Longwall 20 <input type="checkbox"/> Stream water quality in Bellbird Creek may be adversely affected by subsidence from Longwall 20		levels for pH, EC, Fe, Mn, Al, Zn and SO4	bores if triggers exceeded, as required <input type="checkbox"/> If trigger is exceeded for at least 4 months, engage hydrogeologist to investigate and report on any identified adverse changes to water level / water quality <input type="checkbox"/> Inform SCA, OEH & DRE NSW of investigation outcomes <input type="checkbox"/> Investigation of possible mitigation measures in consultation with SCA / OEH <input type="checkbox"/> Prepare and implement a site mitigation/action plan in consultation with SCA / OEH if appropriate <input type="checkbox"/> Report in SMP / End of Panel reports to inform relevant agencies of results of monitoring	
<b>Ground Water Levels</b> (using pressure transducer and bores)	<input type="checkbox"/> Bi- monthly	<input type="checkbox"/> Monthly	<input type="checkbox"/> Bi -monthly	<input type="checkbox"/> Temporary lowering of piezometric surface by up to 10m which may stay at that level until maximum subsidence develops <input type="checkbox"/> Groundwater levels should recover over a few months <input type="checkbox"/> No permanent post mining reduction in water levels in bores on the plateau unless a new outflow path develops <input type="checkbox"/> Strata dilation and subsequent re-filling of secondary voids may temporarily lower standing water levels	<input type="checkbox"/> No observed or reported effects	<input type="checkbox"/> Continuous >5m ground water level reduction over a minimum 2 month period	<input type="checkbox"/> Instigate investigation within 1 week of trigger <input type="checkbox"/> Engage hydrogeologist to investigate and report on the cause of trigger exceedances where the cause may not be directly related to lack of rainfall recharge <input type="checkbox"/> Inform SCA, OEH & DRE of investigation outcomes <input type="checkbox"/> Investigation of possible mitigation measures in consultation with SCA / OEH <input type="checkbox"/> Prepare and implement a site mitigation/action plan in consultation with SCA / OEH if necessary <input type="checkbox"/> Report in End of Panel reports to inform relevant agencies of ongoing results of monitoring	<input type="checkbox"/> None required
<b>Inflow into mine workings (during all active mining) (daily monitoring)</b>	<input type="checkbox"/> Daily monitoring of mine discharge (completed) <input type="checkbox"/> Water quality sample of any measured inflow	<input type="checkbox"/> Daily monitoring of mine discharge (completed) <input type="checkbox"/> Water quality sample of any measured inflow	<input type="checkbox"/> Daily monitoring of mine discharge (ongoing) <input type="checkbox"/> Water quality sample of any measured inflow	<input type="checkbox"/> Increased groundwater seepage inflow into the workings should not occur	<input type="checkbox"/> No increase in mine water discharge recorded	<input type="checkbox"/> Increase in water discharge of > 1ML/day for 7 successive days from active longwall or pillar extraction areas, which	<input type="checkbox"/> Engage contract hydrogeologist to investigate and report on changes identified	<input type="checkbox"/> None required

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
	event (not required)	event (not required)	event (as required)			are suspected to be as a result of mine subsidence <input type="checkbox"/> Note: the typical discharge from U/G is 6ML/day	<input type="checkbox"/> Inform relevant agencies of results of investigation <input type="checkbox"/> Report in Subsidence Management Status Report <input type="checkbox"/> Report in End of Panel Report <input type="checkbox"/> Investigation initiated within one week of trigger <input type="checkbox"/> Monthly updates of investigation process	
Potential Mine inflow events	<input type="checkbox"/> Daily monitoring of mine discharge (completed) <input type="checkbox"/> Water quality sample of any measured inflow event (not required)	<input type="checkbox"/> Daily monitoring of mine discharge (completed) <input type="checkbox"/> Water quality sample of any measured inflow event (not required)	<input type="checkbox"/> Daily monitoring of mine discharge (ongoing) <input type="checkbox"/> Water quality sample of any measured inflow event (as required)	<input type="checkbox"/> Mine inflow events should not occur	<input type="checkbox"/> No increase in mine water discharge recorded	<input type="checkbox"/> Inflow event from mining area requiring notification to the mining inspectorate	<input type="checkbox"/> Engage contract hydrogeologist to investigate and report on changes identified <input type="checkbox"/> Inform SCA, OEH & DRE of investigation outcomes <input type="checkbox"/> Report in Subsidence Management Status Report <input type="checkbox"/> Report in End of Panel Report <input type="checkbox"/> Investigation initiated within one week of trigger <input type="checkbox"/> Monthly updates of investigation process	<input type="checkbox"/> None required
Mine water connectivity to the surface	<input type="checkbox"/> Daily monitoring of mine discharge (completed) <input type="checkbox"/> Water quality sample of any measured inflow event (not required)	<input type="checkbox"/> Daily monitoring of mine discharge (completed) <input type="checkbox"/> Water quality sample of any measured inflow event (not required)	<input type="checkbox"/> Daily monitoring of mine discharge (ongoing) <input type="checkbox"/> Water quality sample of any measured inflow event (as required)	<input type="checkbox"/> Mine water connectivity to the surface should not occur	<input type="checkbox"/> No increase in mine water discharge recorded	<input type="checkbox"/> Water Chemistry or age indicates connectivity to the surface <input type="checkbox"/> NB: this trigger must be derived from a hydrogeologist's investigation report	<input type="checkbox"/> Inform SCA, OEH & DRE of this change <input type="checkbox"/> Commence preparation of mitigation/action plan within the timeframe agreed with relevant government agencies <input type="checkbox"/> Inform SCA, OEH & DRE within 24hrs <input type="checkbox"/> Commence preparation of mitigation/action plan within timeframe agreed with relevant agencies <input type="checkbox"/> Monthly updates of investigation progress <input type="checkbox"/> Report in Subsidence Management Status Report <input type="checkbox"/> Report in the End of Panel Report	<input type="checkbox"/> None required
Aquatic Ecology (twice a year)	<input type="checkbox"/> Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime (completed) <input type="checkbox"/> Targeted surveys for threatened aquatic biota in major drainage lines	<input type="checkbox"/> Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime (completed) <input type="checkbox"/> AUSRIVAS sampling of reference and impact sites in the broader	<input type="checkbox"/> Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime (ongoing) <input type="checkbox"/> AUSRIVAS sampling of reference and impact sites in the broader	<input type="checkbox"/> Unlikely that any threatened aquatic species would be significantly impacted by subsidence resulting from Longwall mining <input type="checkbox"/> Unlikely to be impacts to aquatic ecology or loss of aquatic habitat	<input type="checkbox"/> No impact to aquatic ecology or habitats observed	<input type="checkbox"/> None anticipated insofar as aquatic biota are concerned. Water flow and quality triggers would appropriate a response for aquatic biota	<input type="checkbox"/> None anticipated	<input type="checkbox"/> None required

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
	(completed) <input type="checkbox"/> AUSRIVAS sampling of reference and impact sites in the broader ESSMP area (completed for LW 11,15,16,19 and 20 only)	ESSMP area (completed)	ESSMP area (ongoing)					
<b>Terrestrial Ecology (twice a year)</b> General				<input type="checkbox"/> Potential for some minor surface cracking and compressive rippling	<input type="checkbox"/> No effects reported to date	<input type="checkbox"/> Observation of mining related impacts to surface	<input type="checkbox"/> Notification to SCA/NPWS within 24 hrs, using photographic record	<input type="checkbox"/> None required
Threatened species	<input type="checkbox"/> Observational monitoring of identified threatened species – once (completed)	<input type="checkbox"/> Observational monitoring of identified threatened species – twice annually during entire extraction (ongoing)	<input type="checkbox"/> Observational monitoring of identified threatened species – annually for one year (ongoing)	<input type="checkbox"/> Unlikely that any threatened flora would be significantly impacted by subsidence resulting from Longwall mining. <input type="checkbox"/> Impacts to threatened amphibian species as reported below.	<input type="checkbox"/> No effects reported to date	<input type="checkbox"/> Major impacts to threatened species to include: <input type="checkbox"/> Their habitat; and/or a decline in numbers from baseline observed; and/or <input type="checkbox"/> Change in species composition	<input type="checkbox"/> Notification to SCA/NPWS immediately <input type="checkbox"/> Proposal for threatened species management within 1 week <input type="checkbox"/> Completion of management task following approval from SCA/NPWS	<input type="checkbox"/> None required
Amphibians	<input type="checkbox"/> Once prior to mining (completed)	<input type="checkbox"/> Twice annually during entire extraction period (ongoing)	<input type="checkbox"/> Annually for one year (ongoing)	<input type="checkbox"/> Threatened amphibian species (Littlejohn's Tree Frog, Red-crowned Toadlet and Giant Burrowing Frog) – potential alteration to breeding, sheltering and foraging habitat.	<input type="checkbox"/> None observed or reported.		<input type="checkbox"/> Additional monitoring as required by the relevant government agencies	
Swamp and riparian vegetation	Once prior to mining (completed)	Twice annually during entire extraction period (ongoing)	Annually for one year (ongoing)	<input type="checkbox"/> Minor impacts to Upland Swamp vegetation through change in water levels, and the cracking of soils	<input type="checkbox"/> None observed or reported.			
Ridge top vegetation	Once prior to mining (completed)	Twice annually during entire extraction period (ongoing)	Annually for one year (ongoing)	<input type="checkbox"/> Rock shelves, outcrops and overhang structures unlikely to be impacted.	<input type="checkbox"/> None observed or reported.			
General Upland Swamp observations (every second month during mining)	Twice per year (not required due to the relatively small size of the longwall)	Every second month (not required due to the relatively small size of the longwall)	Twice per year for one year post mining	<input type="checkbox"/> Minor impacts to Upland Swamp vegetation through change in water levels, and the cracking of soils.	<input type="checkbox"/> No effects noted in Upland Swamps to date	<input type="checkbox"/> Minor cracking (<10mm)  <input type="checkbox"/> Major cracking (>10mm) <input type="checkbox"/> Water loss <input type="checkbox"/> Flora/Fauna changes <input type="checkbox"/> Increased erosion	<input type="checkbox"/> Report to SCA <input type="checkbox"/> Additional studies as required <input type="checkbox"/> Photographic record <input type="checkbox"/> Review of swamp piezometer data  <input type="checkbox"/> Notification to SCA <input type="checkbox"/> Remediation options developed in consultation with SCA, which may include further mining limitations <input type="checkbox"/> Proposal for rectification within	<input type="checkbox"/> None required          <input type="checkbox"/> None required

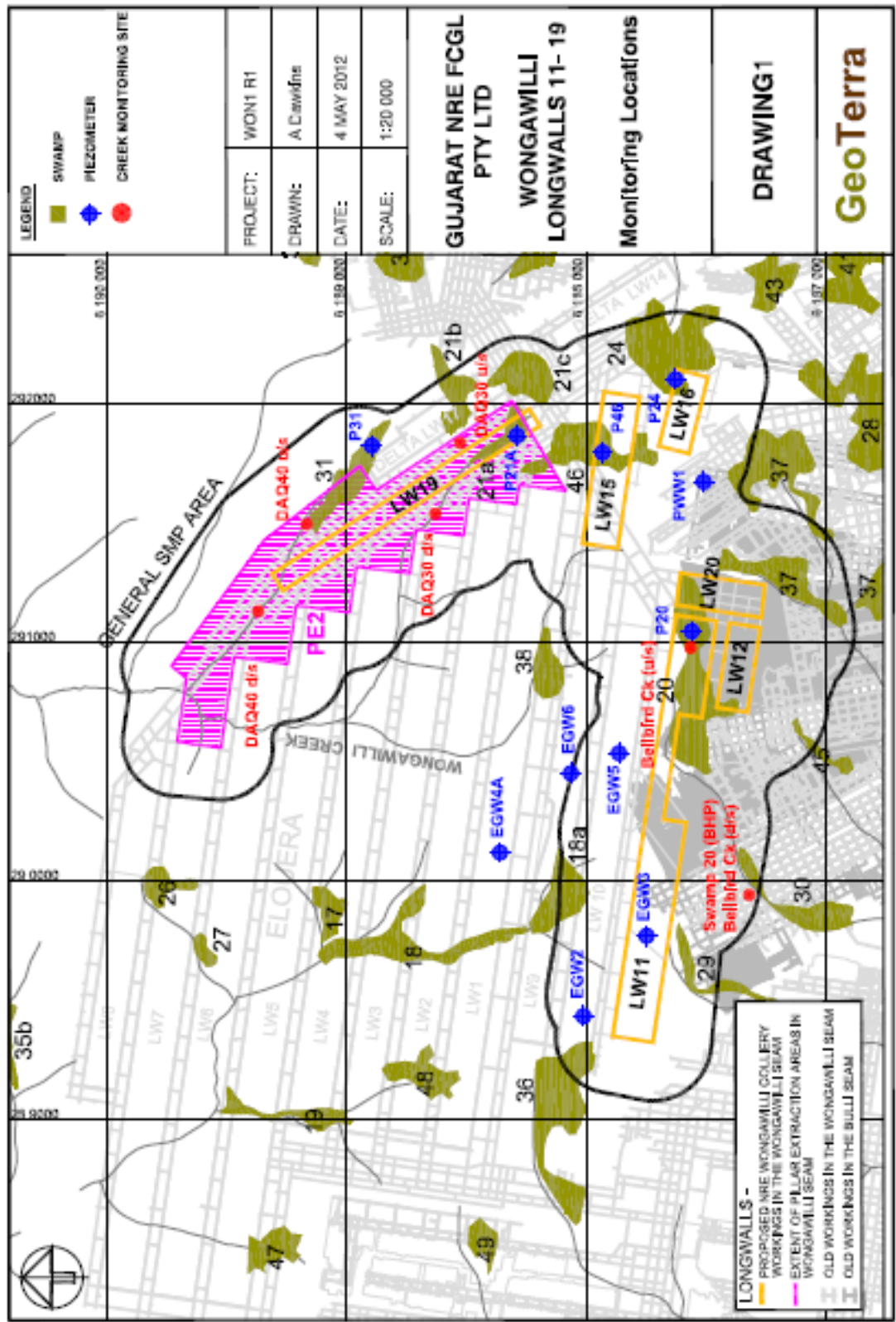
Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
							one month <input type="checkbox"/> Completion of works following approval from SCA <input type="checkbox"/> Additional monitoring as required	
Public Safety (fortnightly during extraction)	<input type="checkbox"/> Observation of Cliffs and steep slopes; Fire roads; 4WD tracks; Rocky outcrops and cuttings	<input type="checkbox"/> Fortnightly during extraction	<input type="checkbox"/> Monthly following mining for 6 months	<input type="checkbox"/> Potential for some minor surface cracking and compressive rippling of the unsealed road surfaces	<input type="checkbox"/> No effects observed	<input type="checkbox"/> Minor cracking (<10mm)	<input type="checkbox"/> Notification to SCA within 24 hrs, using photographic record	<input type="checkbox"/> None required
	<input type="checkbox"/> Once prior to mining					<input type="checkbox"/> Major Cracking (>10mm), noticeable instability or traffic impedance	<input type="checkbox"/> Notification to SCA immediately <input type="checkbox"/> Make area safe as soon as practicable <input type="checkbox"/> Proposal for rectification within 1 week <input type="checkbox"/> Completion of works following approval from SCA <input type="checkbox"/> Additional monitoring	<input type="checkbox"/> None required

# FIGURES

**Figure 1: Longwall 20, Monitoring and Surface Infrastructure (Source – MSEC 554-01)**



Figure 2: Monitoring Locations, Wongawilli Longwalls (Source – GeoTerra WON2-R1)



# ATTACHMENTS

# **ATTACHMENT A**

**Subsidence Report: End of Panel Report for Wongawilli  
Longwall 20. Mine Subsidence Engineering Consultants  
(MSEC) Report # MSEC576 – Revision A. August 2012**



GUJARAT NRE WONGA PTY LTD

**NRE Wongawilli Colliery**

End of Panel Monitoring Report For Longwall 20

## DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	End of Panel Report for Wongawilli Longwall 20 - Draft	PD	JB	30 <sup>th</sup> Jul 12
A	End of Panel Report for Wongawilli Longwall 20 - Final	PD	CI	23 <sup>rd</sup> Aug 12

Report produced to:- Support the End of Panel Report for Longwall 20 which will be issued to the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS).

Previous reports:- MSEC360 (September 2008) – The Prediction of Subsidence Parameters and the Assessment of Subsidence Impacts on Natural Features and Surface Infrastructure Due to Mining Longwalls 11, 12, 15, 16 & 19 and due to Pillar Extraction Areas 1 & 2 (In Support of a SMP Application).

MSEC449 (April 2010) – The Effects of Modifying the Layout of Pillar Extraction Area 1 at NRE Wongawilli Colliery on the Subsidence Predictions and Impact Assessments. (In Support of a Modification Report).

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### Tables

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### Figures

The figures are provided in Appendix A at the end of this report.

<i>Figure</i>	<i>Description</i>
Fig. A.01	Observed and Predicted Profiles of Subsidence, Tilt and Strain along the EF Line resulting from LW20 Extraction

### Drawings

The drawings are provided in Appendix A at the end of this report.

<i>Drawing No.</i>	<i>Description</i>
MSEC576-01	Wongawilli Colliery, LW20 End of Panel, Monitoring and Surface Infrastructure

## 1. BACKGROUND

### 1.1. Introduction

Gujarat NRE FCGL Pty Ltd (NRE) has completed the extraction of Longwall 20 at NRE Wongawilli Colliery in the Southern Coalfield of New South Wales. NRE Wongawilli Colliery was previously operated as Elouera Colliery and Delta Colliery. The location of Longwall 20 is shown in Drawing No. MSEC576-01 in Appendix A.

The extraction of Longwall 20 commenced on the 18<sup>th</sup> December 2011 and was completed on 11<sup>th</sup> April 2012.

In accordance with approval conditions detailed in the Environmental Subsidence and Safety Management Plan, (ESSMP), this report provides a comparison between the predicted and observed subsidence movements along the monitoring lines at Wongawilli Colliery resulting from the extraction of Longwall 20 and an analysis of these monitoring results.

This report also details the observed impacts on the built surface infrastructure within the Application Area resulting from the extraction of Longwall 20. Descriptions of impacts on natural features within the Application Area are provided in the reports by other consultants, and the observations provided in this report should be read in conjunction with all other relevant reports.

## 2. COMPARISON BETWEEN PREDICTED AND OBSERVED SUBSIDENCE MOVEMENTS

### 2.1. Monitoring Lines

The subsidence movements resulting from the extraction of Longwall 20 were measured along the EF Line which is a 2D monitoring line. The location of the longwalls at the Colliery and the monitoring lines are shown in Drawing No. MSEC576-01 in Appendix A.

The EF Line was established 20<sup>th</sup> July 2009, prior to the commencement of Longwalls 12 and 11 (extracted in that order), and therefore the survey results for the EF line provide measured surface movements due to the extraction of Longwalls 12, 11 and 20. The previously extracted Elouera Colliery Longwall 10, which is located immediately to the north of Longwall 11, was completed in June 2005. The survey monitoring results therefore include the influence of the previously extracted Elouera Colliery longwalls on the subsidence resulting from the extraction of Longwalls 12, 11 and 20 but do not include the surface movements that occurred when the Elouera Colliery Longwalls were extracted. Longwall 10 is located approximately 185 metres from Longwall 20 at its nearest point and the influence from this longwall on Longwall 20 subsidence parameters is anticipated to be negligible.

Previous extraction was carried out in the Bulli seam above Longwall 12 and 20 and the finishing end of Longwall 11. Old pillar extraction workings within the Wongawilli Seam were also extracted beneath the Bulli Seam directly adjacent to the southern edges of Longwall 11 and Longwall 12 and to the east of Longwall 20. The areas of extraction in the Bulli seam and the Wongawilli Seam are shown in Drawing No. MSEC578-01 in Appendix A.

The predicted subsidence profiles along the monitoring lines were obtained using the Incremental Profile Method for the Southern Coalfield, which uses an empirical database based on monitoring data from the Bulli Seam. The effects of multi-seam mining conditions were also taken into account in the prediction model, as previous extraction was carried out above Longwall 20 in the Bulli seam, and the method of calibration was described in Report No. MSEC360. Comparisons between predicted and observed subsidence movements along the monitoring line are provided in the following sections.

#### EF Monitoring Line

The EF monitoring line is located diagonally across the northern end of Longwall 20 as is shown in Drawing No. MSEC576-01. The route of the monitoring line follows Fire Road 6H and a disused 33kV power line.

The survey line was last monitored on 16<sup>th</sup> July 2012 after the completion of Longwall 20. Survey results of the total subsidence, tilt and strain of the EF line resulting from the extraction of LW11, LW12 and LW20 are presented in Fig. A.01. The predicted profiles of total subsidence, tilt and strain along the EF Line due to the extraction of Longwalls 11, 12 and 20 are also shown in Fig. A.01.

The maximum observed total subsidence due to the extraction of LW12, 11 and 20 is 570 mm at survey mark EF49, which is greater than the maximum predicted total subsidence of 415 mm. The maximum observed total tilt due to the extraction of LW12, 11 and 20 is 5.0 mm/m between survey mark EF44 and EF45, which is greater than the maximum predicted total tilt of 1.7 mm/m. The maximum observed total strain due to the extraction of LW12, 11 and 20 is a compressive strain of 1.1 mm/m which occurs between survey pegs EF58 and EF59, which are located over Longwall 20. Measured strains along the EF Line are predominantly less than 0.5 mm/m, for both compressive and tensile strain, which is similar to the order of survey tolerance.

Whilst the observed movements exceeded those predicted, it is noted that the monitoring line crosses the corner of Longwall 20, where the subsidence parameters are the most difficult to predict. The maximum predicted total subsidence directly above the Longwall 20, due to the extraction of Longwalls 12, 11 and 20, was around 500 mm. The maximum observed total subsidence along the EF Line, of 570 mm, therefore, exceeds the maximum predicted total subsidence anywhere above the longwall by around 15 %.

The maximum observed total tilt along the monitoring line exceeded that predicted, as more low level subsidence was predicted to occur outside the extent of Longwall 20, as a result of the reactivation of the existing overlying workings and the adjacent longwalls. The observed subsidence profile indicates less reactivation of the existing workings, outside the extents of Longwall 20, than was predicted (i.e. predicted subsidence profile was broader than that observed). The maximum predicted total transverse tilt above Longwall 20, due to the extraction of Longwalls 12, 11 and 20, was around 3.5 mm/m. The maximum observed total tilt along the EF Line, of 5.0 mm/m, therefore, exceeds the maximum predicted total transverse tilt by around 1.5 mm/m.

### 3. IMPACTS ON SURFACE INFRASTRUCTURE

#### Surface Infrastructure within the Application Area

The surface infrastructure that is located above or adjacent to Longwall 20 is shown in Drawing No. MSEC576-01 and are listed below:-

- Fire trails 6A which passes to the north of Longwall 20,
- Disused 33 kV powerline passing over Longwall 20,
- Survey control marks.

#### Comparison between Assessed and Observed Impacts on Surface Infrastructure

A comparison between the observed and the assessed (i.e. predicted) impacts on the manmade surface infrastructure above or adjacent to Longwall 20 is summarised in Table 3.1. The assessed impacts were detailed in the reports MSEC360 (September 2008) – *The Prediction of Subsidence Parameters and the Assessment of Subsidence Impacts on Natural Features and Surface Infrastructure Due to Mining Longwalls 11, 12, 15, 16 & 19 and due to Pillar Extraction Areas 1 & 2 (In Support of a SMP Application)*, and MSEC449 (April 2010) – *The Effects of Modifying the Layout of Pillar Extraction Area 1 at NRE Wongawilli Colliery on the Subsidence Predictions and Impact Assessments. (In Support of a Modification Report)*.

Comparisons between assessed (i.e. predicted) and observed impacts on the natural features above or adjacent to the Longwall 20 are provided in other consultant reports.

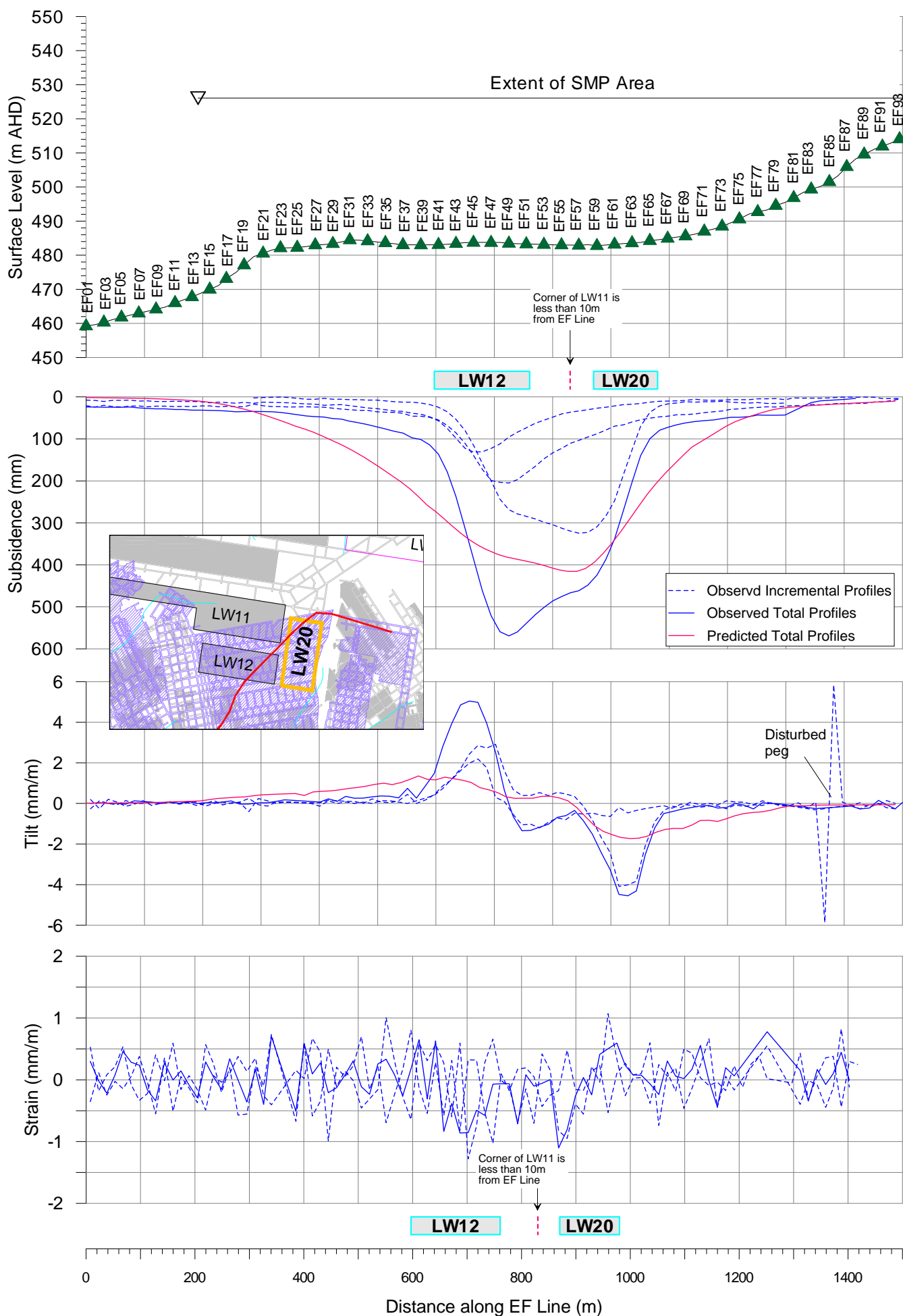
**Table 3.1 Summary of Assessed and Observed Impacts Resulting from Longwall 20**

Surface Infrastructure	Assessed Impacts	Observed Impacts
Fire trails and 4WD tracks	Changes to surface drainage and some surface cracking of the unsealed road surfaces	No reported impacts
Disused 33 kV powerline	No predicted impact	No reported impact
Survey control marks	Horizontal movements requiring re-establishment	Horizontal movements requiring re-establishment

It can be seen from Table 3.1, that reported impacts were similar to or less than those assessed.

## **APPENDIX A. FIGURES AND DRAWINGS**

# Observed and Predicted Profiles of Subsidence, Tilt and Strain along the EF-Line resulting from LW20 Extraction

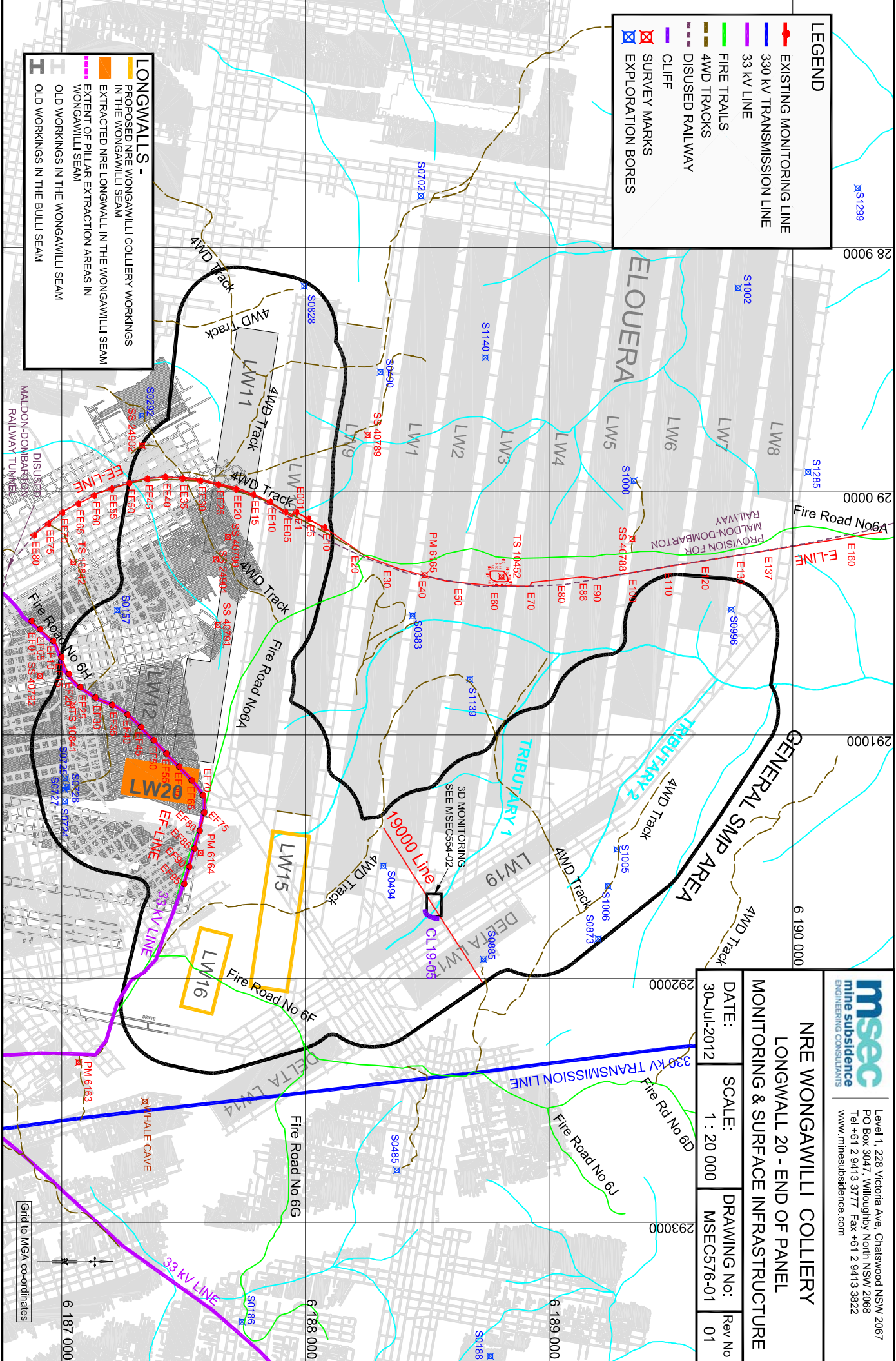




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**LONGWALL 20 - END OF PANEL**  
**MONITORING & SURFACE INFRASTRUCTURE**

DATE:	SCALE:	DRAWING NO:	Rev No
30-Jul-2012	1 : 20 000	MSEC576-01	01



## **ATTACHMENT B**

**Groundwater and Surface Water: Wongawilli Colliery End of  
Longwall 20 Groundwater & Surface Water Monitoring  
Assessment. GeoTerra Report: WON3-R1, August 2012**



**GUJARAT NRE WONGA PTY LTD**  
**WONGAWILLI COLLIERY**  
**END OF LONGWALL 20**  
**GROUNDWATER & SURFACE WATER**  
**MONITORING ASSESSMENT**  
Wollongong, NSW


WON3-R1  
22 AUGUST 2012

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Date	Rev	Comments
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## 1. INTRODUCTION

Extraction of the Wongawilli Seam in Longwalls 11, 12 19 and 20 has been conducted as shown in **Table 1**.

A modification to extract the proposed bord and pillar area PE1 as Longwall 20 was approved in June 2010.

Longwall 15 is currently being extracted, with the panel anticipated to be finished in November 2012.

**Table 1 Wongawilli Panel Extraction Summary**

Longwall	Start	Finish	Depth of Cover (mbgl)	Width (m)	Length (m)
Longwall 12	25/8/2009	26/11/2009	320 - 340	130	358
Longwall 11	29/1/2010	13/5/2011	310 - 360	171	1785
Longwall 19	26/6/2011	20/11/2011	320 - 350	84	1280
Longwall 20	18/12/2011	11/04/2012	330 - 340	190	670
Longwall 15	24/5/2012	ongoing	310 - 350	141	640

The overlying Bulli Seam has previously been mined in the vicinity of Longwalls 11, 12 and 20 by bord and pillar extraction as shown in **Drawing 1**.

## 2. SCOPE OF WORK

Geoterra were commissioned by Gujarat NRE Wonga Pty Ltd (Gujarat) to report on any observed groundwater system or surface water changes resulting from extraction of Longwall 20 in accordance with the SMP Approval Conditions for Longwalls 11, 12, 15, 16, 19 and PE1, as well as the Environmental Subsidence and Safety Management Plan (ESSMP).

This report follows on from a previous end of Panel 19 assessment (Geoterra, 2012).

## 3. WATER MONITORING DESCRIPTIONS

### 3.1 Surface Water

As shown in **Table 2**, Bellbird Creek (initially called "Swamp 20") field water pH and electrical conductivity was monitored by BHPBIC using hand held field meters between March 2005 and the present at a culvert underneath the decommissioned Dombarton railway line.

Monitoring by Gujarat at the re-named site Bellbird Ck (d/s) as well as Bellbird Creek (u/s) commenced in March 2010.

It should be noted that the BHP "Swamp 20" monitoring site is not actually within Swamp 20.

BHPBIC started monitoring at sites DAQ30 and DAQ40, which are in the headwaters of Wongawilli Creek over Longwall 19, in March 2006.

Gujarat took over monitoring these two sites in February 2011.

**Table 2 Longwalls 11 to 20 Surface Water Monitoring Sites**

BELLBIRD Ck	E	N	Commenced	Location
Bellbird Ck up	292795	6187560	02.03.2010	In Swamp 20 d/s of P20
Bellbird Ck ds	289962	6187290	19.07.2005	culvert under railway
DAQ30	291855	6188500	01.03.2006	Wongawilli Ck headwater over LW19
DAQ40	291327	6189226	02.03.2006	Wongawilli Ck headwater upstm of LW19

## 3.2 Groundwater

### 3.2.1 Upland Swamps

One swamp piezometer (P20) is located approximately 100m east of Longwall 20, and overlies the eastern end of Longwall 11.

Four other shallow piezometers are located within the overall Project Area, but are not directly relevant to Longwall 20 (P21A, P24, P31, P46) and are therefore not discussed further in this report.

All swamp piezometers are used to measure groundwater levels via data loggers and to enable sampling and assessment of field and laboratory water quality parameters.

In addition, BHPIC conduct regular water level and water quality monitoring in Swamps 18 and 36, however as they are outside the subsidence influence of Longwall 20, they are not discussed further in this report.

### 3.2.2 Basement Piezometers

Outside of the 20mm subsidence zone related to Longwall 20, although within the overall Project Area are;

- a vibrating wire piezometer array (PWW1 or PE1) installed in November 2009 which is approximately 385m east of Longwall 20 with intakes located in the Hawkesbury Sandstone at 90m and 135m below surface, Bald Hill Claystone at 150m and Bulgo Sandstone at 165m. During drilling, the first water make was at 23m below surface;
- five (35.1 - 51.5m deep) open standpipe Hawkesbury Sandstone piezometers (EGW2, 3, 4A, 5 and 6) installed by BHPBIC in February 2004 over the decommissioned southern Eloura workings and Longwall 11, as summarised in **Table 3** and shown in **Drawing 1**, which measure water levels.

No NOW registered private bores are located within the SMP area as it is a restricted access water catchment area that is administered by the SCA.

Apart from PE1, the open standpipe basement and shallow swamp piezometers not directly overlying, or within the 20mm subsidence zone of Longwall 20 are not discussed further in this report.

**Table 3 Longwalls 11 to 20 Piezometers**

GW	E	N	Intake Depth (mbgl)	SWL (m)	Commenced	Lithology
<b>BASEMENT PIEZO.</b>						
<b>PE1</b>	291677	6187507	90	See plot	19.11.09	Hawkes. Sandstone
	-	-	135	See plot	19.11.09	Hawkes. Sandstone
	-	-	150	See plot	19.11.09	Bald Hill Claystone
	-	-	165	See plot	19.11.09	Bulgo Sandstone
<b>EGW2</b>	289434	6188008	0 – 45.67	See plot	19.02.04	Hawkes. Sandstone
<b>EGW3</b>	289773	6187749	0 – 35.10	See plot	27.02.04	Hawkes. Sandstone
<b>EGW4A</b>	290122	6188359	0 – 48.45	See plot	09.03.04	Hawkes. Sandstone
<b>EGW5</b>	290538	6187861	0 – 51.51	See plot	09.02.04	Hawkes. Sandstone
<b>EGW6</b>	290453	6188065	0 – 39.55	See plot	16.02.04	Hawkes. Sandstone
<b>SWAMP PIEZO.</b>						
<b>P20</b>	291144	6187583	0.3 – 0.85	See plot	18.09.09	Swamp Alluvium
<b>P21A</b>	291860	6188293	0.3 – 1.72	See plot	01.07.11	Swamp Alluvium
<b>P24</b>	292076	6187585	0.3 – 0.81	See plot	11.06.10	Swamp Alluvium
<b>P31</b>	291867	6188897	0.3 – 0.87	See plot	09.06.11	Swamp Alluvium
<b>P46</b>	291875	6187988	0.3 – 1.14	See plot	15.06.10	Swamp Alluvium

#### 4. PIEZOMETER INSTALLATION AND HYDRAULIC TESTING

The hydrogeology of the Longwall 11 to 20 Project Area was investigated by water intersection observations during drilling in addition to packer testing and piezometer installation in PE1 as well as during hand installation of the swamp piezometers.

Further details of the packer testing on PE1 will be outlined in the overall Longwall 11 to 20 End of Extraction report.

#### 5. PREDICTED AND OBSERVED GROUNDWATER IMPACTS

A full discussion on the Gujarat VWP and the BHP (EGW series) open standpipe piezometers will be outlined in the Longwall 11 to 20 End of Extraction Report.

The following discussion only relates to the extraction of Longwalls 11, 12, 19 and 20.

##### 5.1 Piezometer Subsidence

Up to 140mm of subsidence was predicted along Subsidence Line EF, with a maximum of 321mm of subsidence being observed over Longwall 12 and 126mm over Longwall 11.

As measured on the 19000 Line, Longwall 19 was subsided by a maximum of 28mm, along with a tilt of 0.3mm/m and tensile strain of 0.6m/m.

Up to 570mm of subsidence was observed along subsidence line EF after extraction of Longwall 20 as shown in **Table 4**.

Previous extraction in the overlying Bulli Seam occurred above Longwalls 12 and 20 and the finishing end of Longwall 11, along with previous pillar extraction in the Bulli Seam over the southern edge of Longwalls 11 and 12 and to the east of Longwall 20 as shown in **Drawing 1**.

**Table 4 Wongawilli Panel Subsidence Summary**

Longwall	Maximum Subsidence (mm)	Maximum Strain (mm/m)	Maximum Tilt (mm/m)	Survey Line
Longwall 12	130	0.6	1.5	EF
Longwall 11	320	1.5	3.2	EF
Longwall 19	28	0.6	0.3	19000
Longwall 20	570	1.1	5.0	EF

No subsidence related TARP trigger levels have been reached or exceeded during extraction of Longwalls 11, 12, 19 and 20 and no ameliorative actions are required.

## 5.2 Aquifer / Aquitard Interconnection

### 5.2.1 Potential Impacts

- no adverse interconnection of aquifers and aquitards was anticipated within 20m of the surface;
- a potential increase in the rate of groundwater recharge into the Hawkesbury Sandstone following rainfall due to the increased porosity and permeability of the fractured strata was possible.

### 5.2.2 Aquifer / Aquitard Interconnection Observations

No adverse aquitard / aquifer interconnection or increased recharge has been observed in the vicinity of, or resulting from, extraction of Longwalls 11, 12, 19 and 20.

No aquifer / aquitard interconnection TARP trigger levels have been reached or exceeded during extraction of Longwalls 11, 12, 19 or 20 and no ameliorative actions are required.

## 5.3 Groundwater Levels

The piezometer suite has been used to determine the pre, during and post Longwall 11, 12, 19 and 20 groundwater levels and head pressures.

In addition the data is used to indicate variations in groundwater systems within the upland swamps, Hawkesbury Sandstone, Bald Hill Claystone and upper Bulgo Sandstone to a maximum depth of 165m below surface.

Groundwater levels are logged using vibrating wire piezometers in the EGW series and PE1 bores and by pressure transducer in the swamp piezometers.

### 5.3.1 Potential Impacts

The following groundwater level impacts could potentially occur;

- no significant change in swamp piezometric levels due to subsidence outside of the effects of the current climatic variability;
- Hawkesbury Sandstone groundwater levels may reduce by up to 10m, and may stay at that reduced level until maximum subsidence develops at a specific location;
- Hawkesbury Sandstone groundwater levels should recover over a few months as the newly developed secondary porosity is recharged by rainfall;
- no permanent post mining reduction in Hawkesbury Sandstone groundwater levels unless a new outflow path develops, and;
- temporary lowering of the deep piezometric surface over the subsidence area due to horizontal dilation of strata and resultant increase in secondary porosity;

### 5.3.2 Basement Groundwater Level Observations

Standing water levels in the BHP piezometers range from 29.42m to 48.50m below surface. Note that the **Figure 1** plot shows groundwater depths as relative levels to the Australian Height datum (AHD), not depth below surface.

The EGW series water levels have varied by;

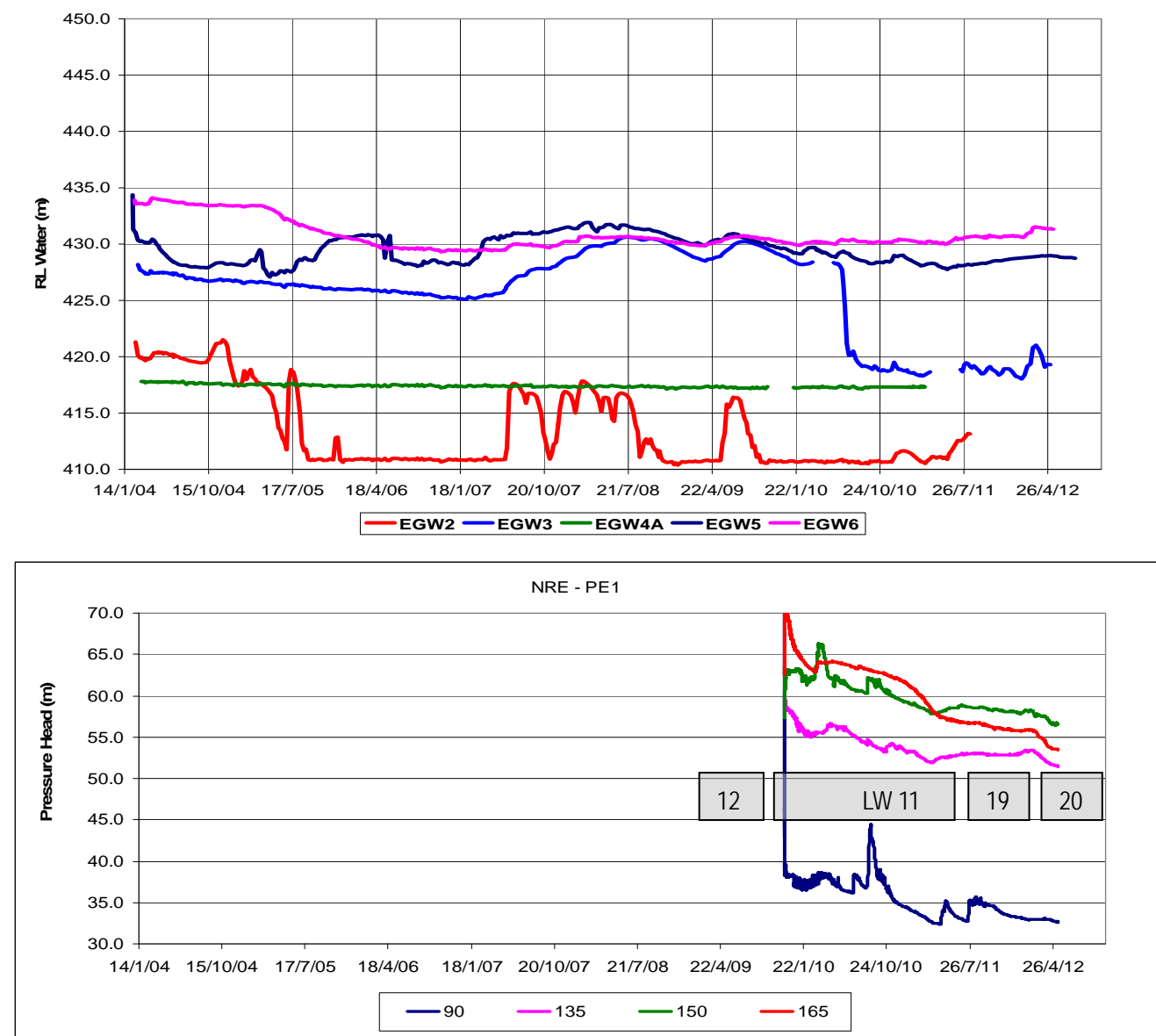
- being undermined by the old BHP Elouera Longwalls, or
- where they have not been undermined or have previously been undermined, by seasonal and longer term climatic variations in rainfall recharge.

The water level in EGW3, which directly overlies Longwall 11, dropped by 8.92m around mid June 2010 after it was undermined, whereas no significant fall in the other EGW series piezometers has occurred.

To date the EGW3 water level has not recovered and the other EGW water levels have remained static to slightly rising up to the end of mining Longwall 20.

A gradual depressurisation has been monitored in the Hawkesbury Sandstone (90m and 135m), Bald Hill Claystone (150m) and upper Bulgo Sandstone (165m) since the VWP array was installed in late November 2009 as shown in **Table 5**.

No basement groundwater level related TARP triggers were exceeded during extraction of Longwalls 11, 12, 19 or 20.



**Figure 1 Groundwater Levels and Head Pressure**

### 5.3.3 Swamp 20 Groundwater Level Observations

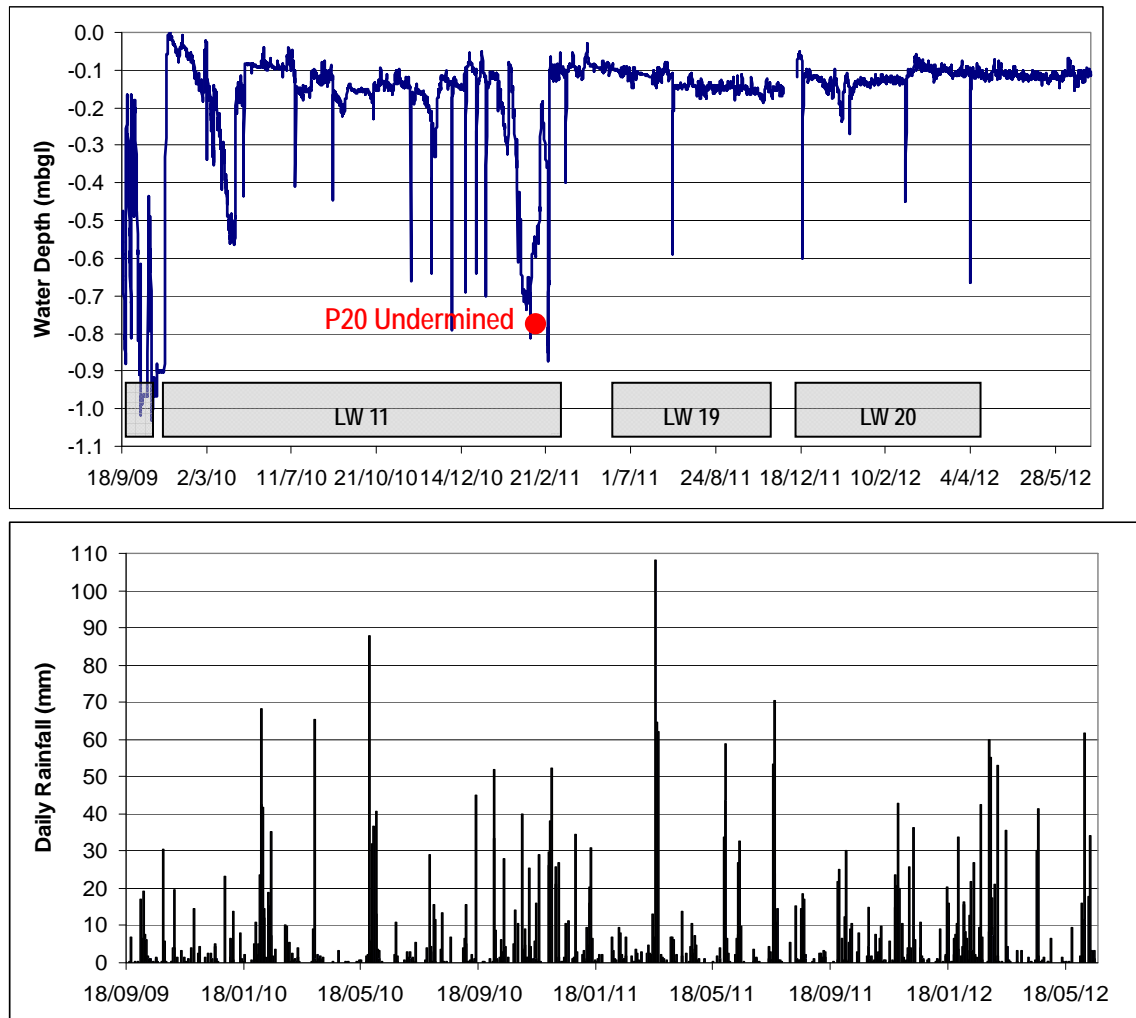
Groundwater levels in the Wongawilli swamps are shown in **Figure 2**.

Water levels in the perched Quaternary swamp aquifers are predominantly influenced by the frequency and quantum of rainfall that occurs during the monitoring period, where the water levels have a direct relationship with the amount of infiltration following rainfall recharge.

No sustained change in groundwater levels in Swamp 20 due to subsidence induced impacts from extraction of Longwalls 11, 12, 19 and 20 has been observed, although a potentially subsidence induced, short term water level drop of up to 0.63m was observed toward the end of the Longwall 11 extraction period.

It should be noted, however, that water level falls of up to 0.55m were previously observed, prior to extraction of Longwall 11 in the vicinity of swamp piezometer P20.

No evidence of swamp desiccation that could potentially be due to mining induced subsidence in Swamp 20 has been observed.



**Figure 2 Swamp P20 Groundwater Level and Rainfall**

No swamp groundwater level TARP trigger levels were reached or exceeded during extraction of Longwalls 11, 12, 19 or 20 and no ameliorative actions are required.

## 5.4 Groundwater Quality

### 5.4.1 Potential Impacts

- increased iron and manganese hydroxide precipitation in groundwater, and;
- lowering (acidification) of pH.

### 5.4.2 Swamp P20 Observations

During and after extraction of Longwalls 11 to 20, the field water quality in P20 has not changed markedly due to subsidence, although variations in response to the quantum and duration of rainfall recharge in the perched aquifer have been observed.

The peak in electrical conductivity monitored between 23<sup>rd</sup> September to 12<sup>th</sup> November 2010, along with the acidification during 25<sup>th</sup> November 2010, was not due to subsidence, as the piezometer was not undermined during that period, and is interpreted to be a result of lower rainfall recharge to the swamp.

Field groundwater quality monitoring at the P20 piezometer in Swamp 20 is shown in **Figure 3**.

Field monitoring and laboratory analyses indicate that its perched groundwater can exceed the ANZECC 2000 Upland Streams criteria for total nitrogen, total phosphorous, copper, lead, zinc, nickel and aluminium.

During the monitoring period, a 2 standard deviation change, or distinctive diversion over at least 4 months from baseline levels for pH, EC, Fe, Mn, Al, Zn and SO<sub>4</sub> has not occurred.

No adverse effects on groundwater quality in Swamp 20 due to subsidence effects from extraction of Longwalls 11, 12, 19 or 20 have been observed.

No TARP water quality trigger levels have been exceeded and no ameliorative actions are required.

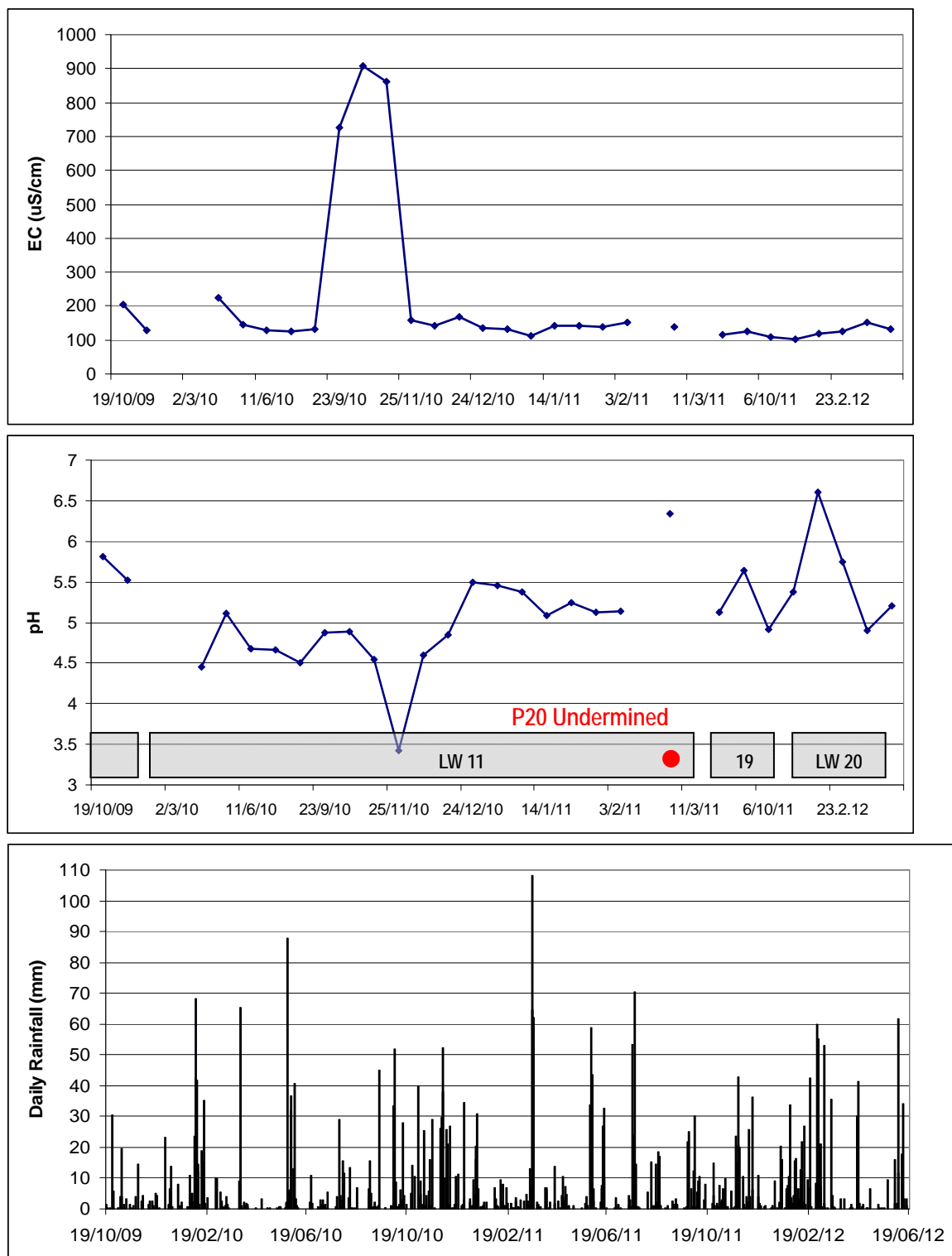


Figure 3 Swamp Piezometer P20 EC, pH and Rainfall

### 5.4.3 Hawkesbury Sandstone

The BHPBIC supplied water quality data from the Hawkesbury Sandstone EGW piezometers that were installed from 23 - 53m below surface indicates the groundwater was within ANZECC 2000 Freshwater Stream guidelines.

No ongoing groundwater quality data is available from the BHPB EGW series piezometers.

No ongoing water quality measurements are available in PE1 as the bore has been sealed, with vibrating wire piezometers permanently installed in the bore.

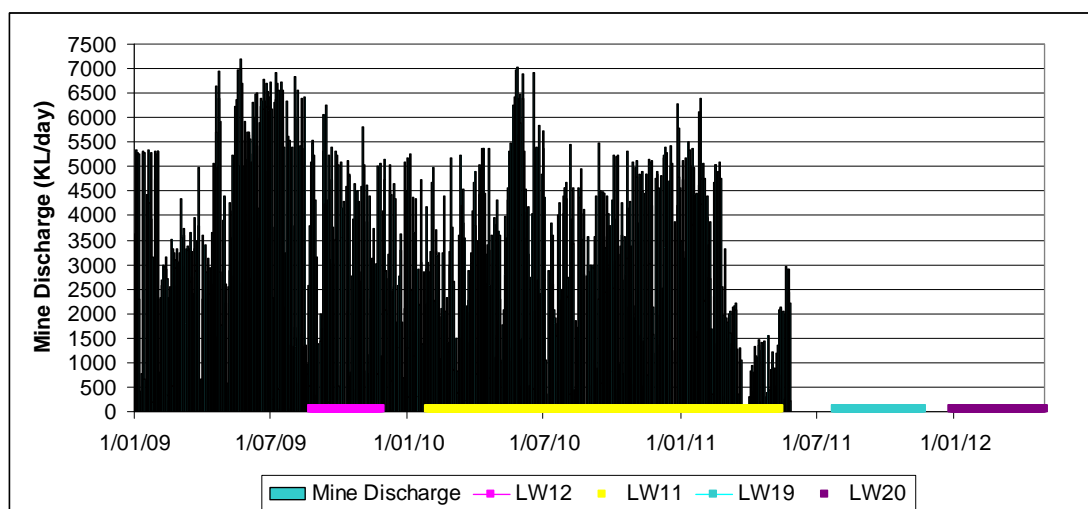
## 5.5 Inflow to Mine Workings

### 5.5.1 Predicted Impacts

- No observable increase in mine workings groundwater inflow.

### 5.5.2 Mine Inflow Observations

A plot of mine water discharges from the Wongawilli workings, which includes the decommissioned Eloura and associated workings, is shown in **Figure 4**.



**Figure 4 Wongawilli Workings Mine Water Extraction**

The significant drop off in water pumped out in the last few months of pumping is due to access to underground water storages being blocked due to panel development for LW19 as well as a shortage of water in the underground during extraction of Longwalls 19 and 20.

The underground now has a limited water supply and has continued to use all available water until new storages can be created underground.

Based on mine pump out data records, no observable increased inflow to the Wongawilli mine workings following extraction of Longwall 11, 12, 19 and 20 has occurred and no TARP trigger levels have been reached or exceeded.

## 6. PREDICTED AND OBSERVED SURFACE WATER IMPACTS

The observed impacts discuss general observations from Bellbird Creek that overlies Longwalls 11 and 20.

### 6.1 Creek Subsidence

#### 6.1.1 Potential Impacts

Maximum subsidence of;

- <100mm along line EE, to the west of Bellbird Creek;
- 405mm along Line EF, which overlies Longwalls 12 and 20, as well as the headwaters of Bellbird Creek;
- 45mm along line 19000 under Wongawilli Tributary DAQ30

#### 6.1.2 Creek Subsidence Observations

Maximum subsidence of;

- 673mm along Line EE, which does not intersect Bellbird Creek;
- 570mm along Line EF, and;
- 20mm along line 19000, under Wongawilli Creek Tributary DAQ30

It should be noted that no direct subsidence measurements have been conducted on the channel of Bellbird Creek or the DAQ40 tributary of Wongawilli Creek.

### 6.2 Stream Flow

#### 6.2.1 Potential Impacts

- No anticipated adverse effect on stream flow in Bellbird Creek or the tributaries of Wongawilli Creek.

#### 6.2.2 Stream Flow Observations

No observed adverse effect on Bellbird Creek or the tributaries of Wongawilli Creek resulting from extraction of Longwalls 11 to 20.

No stream flow related TARP trigger levels have been reached or exceeded and no ameliorative actions are required due to extraction of Longwalls 11, 12, 19 and 20.

### 6.3 Stream Water Quality

#### 6.3.1 Potential Impacts

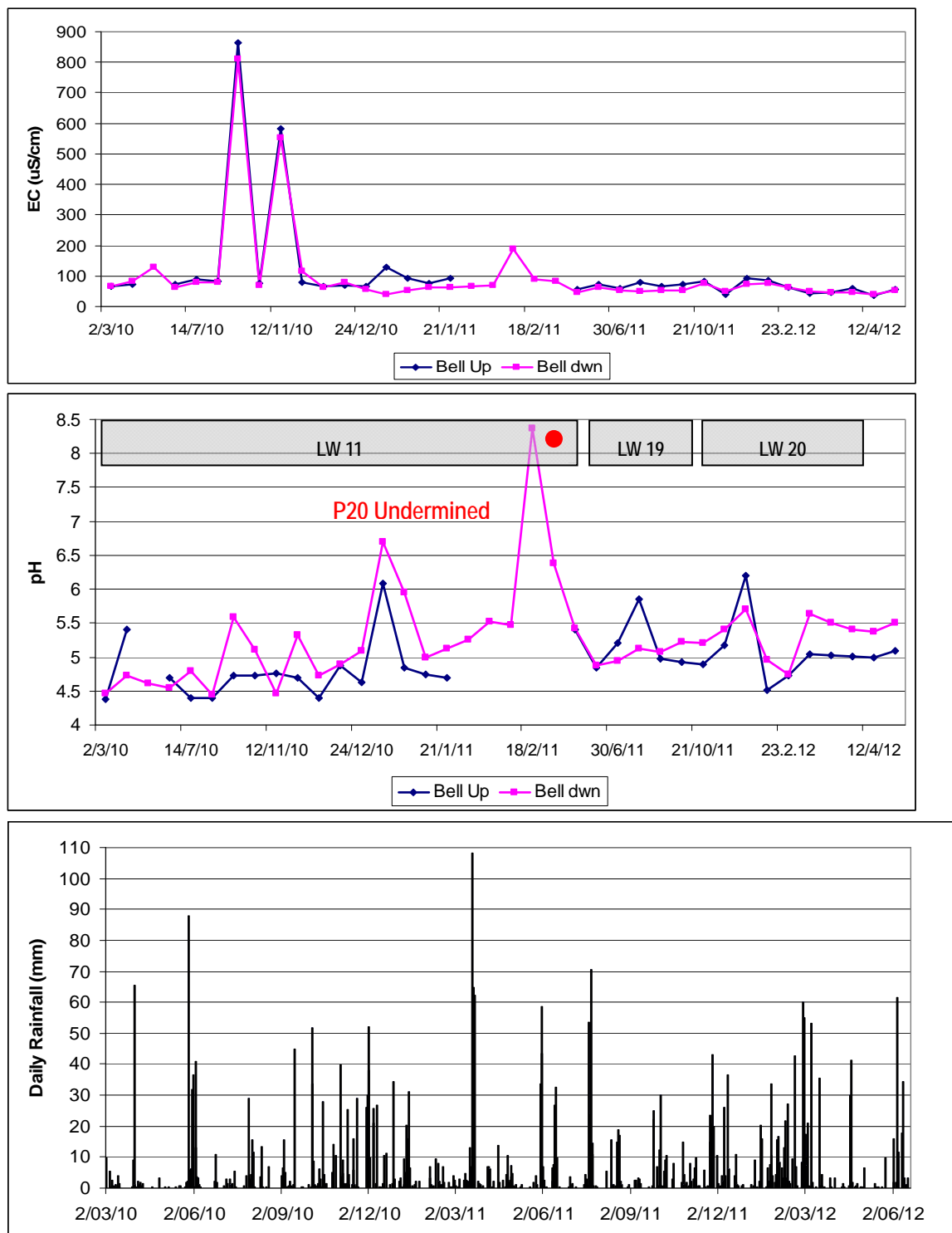
- increased iron hydroxide precipitation, and;
- lowering (acidification) of pH.

#### 6.3.2 Bellbird Creek Observations

During and after extraction of Longwalls 11 to 20, field water quality in the main channel of Bellbird Creek did not observably change, although minor variations in

response to the quantum and duration of rainfall recharge in the catchment were observed as shown in **Figure 5**.

It should be noted that the two salinity peaks observed in mid to late 2010 were not related to subsidence of Bellbird Creek, as the channel had not been undermined at that time.



**Figure 5** Bellbird Creek EC, pH and Rainfall

The stream water quality related TARP trigger levels in Bellbird Creek were not exceeded during extraction of Longwalls 11, 12 19 and 20.

## 6.4 Stream Bed and Bank Stability

### 6.4.1 Potential Impacts

- increased stream bed or bank instability;
- cracking of exposed sandstone rock faces;
- no anticipated adverse effect on Bellbird Creek or the tributaries of Wongawilli Creek resulting from extraction of Longwalls 11 to 20.

### 6.4.2 Observed Impacts

No observed adverse effect has been observed on Bellbird Creek or the tributaries of Wongawilli Creek resulting from extraction of Longwalls 11 to 20.

No stream bed or bank stability TARP trigger levels have been reached or exceeded and no ameliorative actions are required due to extraction of Longwalls 11 to 20.

## 6.5 Gas Emission

### 6.5.1 Predicted Impacts

- Potential discharge of strata gas into private bores.

### 6.5.2 Observed Impacts

No discharge of strata gas has been observed to be discharging at surface or in the open standpipe piezometers in the monitoring area following extraction of Longwalls 11 to 20.

No gas emission related TARP trigger levels have been reached or exceeded due to extraction of Longwalls 11 to 20.

## 7. SUMMARY OF RESULTS

During extraction of Longwalls 11 to 20, no surface water or groundwater TARP triggers have been exceeded.

**Table 5** summarises the predicted and observed effects on the Longwalls 11 to 20 SMP area surface water and groundwater systems.

**Table 5 Summary of Groundwater and Surface Water Impacts**

<b>Predicted Impacts</b>	<b>Observed Impacts Due to Extraction of Longwalls 11 to 20</b>
<i>Adverse interconnection of aquifers and aquitards is not anticipated within 20m of the surface</i>	No adverse interconnection between aquifers and aquitards has been observed within 20m of the surface
<i>Potential increased rate of recharge into the plateau</i>	No increased rate of recharge has been observed
<i>Temporary lowering of shallow Hawkesbury Sandstone piezometric surface by up to 10m which may stay at that level until maximum subsidence develops</i>	Based on the available data, no above trigger lowering of the shallow Hawkesbury Sandstone piezometric surface has been observed in PE1 in relation to extraction of Longwalls 11, 12, 19 and 20, however EGW3 over Longwall 11 fell by 8.92m during extraction of LW11.
<i>Shallow Hawkesbury Sandstone groundwater levels should recover over a few months</i>	Based on the available data, the EGW3 water level has not yet recovered
<i>No permanent post mining reduction in the shallow Hawkesbury Sandstone water levels unless a new outflow path develops</i>	Based on the available data, the EGW3 water level has not yet recovered
<i>Strata dilation and subsequent re-filling of secondary voids may temporarily lower the shallow Hawkesbury Sandstone standing water levels</i>	Based on the available data, the EGW3 water level has not yet recovered
<i>No observable lowering of the Upland Swamp piezometric surface due to subsidence, although there is expected to be a direct relationship between the lack of rainfall recharge and reduced water levels</i>	Lowering of the piezometric surface has been observed in association with low rainfall periods, although no observable adverse effect on P20 water level has been caused by LW11, 12, 19 or 20
<i>The shallow Hawkesbury Sandstone piezometers may experience increased iron / manganese hydroxide precipitation and / or lowering of pH</i>	The water quality in the shallow Hawkesbury Sandstone piezometers have not been affected by subsidence related effects
<i>Upland Swamp piezometers may experience increased iron / manganese hydroxide precipitation and / or lowering of pH</i>	The Swamp 20 piezometer have not been adversely, or observably, affected by subsidence effects
<i>Interface drainage, ferruginous, brackish seeps may be generated in streams</i>	No interface drainage, ferruginous, brackish seeps have been generated in Bellbird Creek of the Wongawilli Creek tributaries
<i>Ferruginous seeps may develop in the local creeks</i>	No ferruginous seeps have developed in Bellbird Creek or Wongawilli Creek tributaries
<i>Increased basement groundwater seepage inflow into the workings should not occur</i>	No increased rate of groundwater seepage into the workings has occurred
<i>Strata gas discharge into piezometers may occur</i>	No strata gas discharge has occurred
<i>Stream flow in Bellbird Creek may be adversely affected by subsidence</i>	Stream flow in Bellbird Creek and the Wongawilli Creek tributaries has not been adversely affected by subsidence related effects
<i>Stream water quality in Bellbird or Wongawilli Creek may be adversely affected by subsidence</i>	Stream water quality in Bellbird Creek and the Wongawilli Creek tributaries has temporarily exceeded either the salinity and/or pH triggers, but has not been affected in the long term, with both pH and EC returning to its baseline, pre mining range
<i>Stream bed and bank stability in Bellbird or Wongawilli Creek may be adversely affected by subsidence</i>	Stream bed and bank stability in Bellbird and Wongawilli Creek tributaries has not been adversely affected by subsidence related effects

## 8. PROPOSED AND ONGOING MONITORING

Swamp and basement groundwater as well as swamp and stream based surface water monitoring proposed for the Longwall 11 to 20 SMP Area was detailed in the ESSMP.

Future monitoring will be in accordance with the ESSMP and its contained Trigger Action Response Plan (TARP) for each component of the plan.

The monitoring program has been clarified since the ESSMP was produced to include the components outlined in **Tables 6 and 7**.

**Table 6 Current and Proposed Groundwater Monitoring**

SMP Commitment	Monitoring To Date	Future Monitoring
<b>Aspect: Piezometer Baseline Data</b>		
Assess piezometer location, depth drilled, date drilled, aquifer depth, lithologies, yield and purpose for piezometers within LW11 to 20 SMP area	Piezometer database compilation completed	No additional baseline database compilation required
<b>Aspect: Piezometer Water Quality</b>		
Sample and monitor open standpipe piezometer water iron, field parameters and selected laboratory analytes for piezometers within LW11 to 20 SMP area	Longwalls 11, 12, 19 and 20 extraction period monitoring and laboratory analysis conducted	Sample and monitor open standpipe piezometer iron, field parameters and selected laboratory analytes prior to and after each piezometer is undermined, or extraction is in the vicinity of an active panel, on a panel by panel basis
<b>Aspect: Piezometer Water Levels</b>		
Monitor standing water levels in open standpipe and multi level vibrating wire piezometers within the LW11 to 20 SMP area	Water level monitoring in all swamp and basement piezometers initiated	Monitor pressure heads in VWP multi level piezometers and standing water levels in open standpipe piezometers prior to and after each piezometer is undermined on a panel by panel basis
<b>Aspect: Strata Gas</b>		
Monitor strata gas discharges (if any) in piezometers within the LW11 to 20 SMP area	All piezometers monitored at the time of longwall extraction	Report any strata gas discharges (if any)

**Table 7 Current and Proposed Surface Water Monitoring**

<b>SMP Commitment</b>	<b>Monitoring To Date</b>	<b>Future Monitoring</b>
<b>Aspect: Stream Flow and Swamp Water Levels</b>		
Assess stream location within LW11 to 20 SMP area	Stream database completed	No additional data compilation required
<b>Aspect: Stream and Swamp Water Quality</b>		
Sample and monitor Bellbird Ck, Wongawilli Creek tributaries, as well as Swamps 20, 21A, 24, 31 and 46 iron, field parameters and selected laboratory analytes in the SMP area	Longwalls 11, 12, 19 and 20 sampling / monitoring completed.	Sample and monitor Bellbird Ck and Wongawilli Ck (headwaters) as well as Swamps 20, 21A, 24, 31 and 46 iron, field parameters and selected laboratory analytes
<b>Aspect: Stream and Swamp Bed and Bank Stability</b>		
Monitor Bellbird Ck, Wongawilli Creek tributaries, as well as Swamps 20, 21A, 24, 31 and 46 stream bed and bank stability and presence of cracking	Monitoring conducted in Swamps 20, 21A, 24, 31 and 46, Bellbird Ck and Wongawilli Creek tributaries	Monitor Bellbird Ck and Wongawilli Ck (headwaters) as well as Swamps 20, 21A, 24, 31 and 46 stream bed and bank stability and presence of cracking
<b>Aspect: Strata Gas</b>		
Monitor strata gas discharges (if any) within LW 11 to 20 SMP area	Strata gas discharges (if any) being monitored when stream and swamp samples collected	Continue to monitor strata gas discharges (if any) when stream and swamp samples collected

## 9. REFERENCES

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The findings contained in this report are the result of discrete / specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site / sites in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site / sites at all points. Should information become available regarding conditions at the site, Geoterra reserve the right to review the report in the context of the additional information.

In preparing this report, Geoterra has relied upon certain verbal information and documentation provided by the client and / or third parties. Geoterra did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Geoterra assume

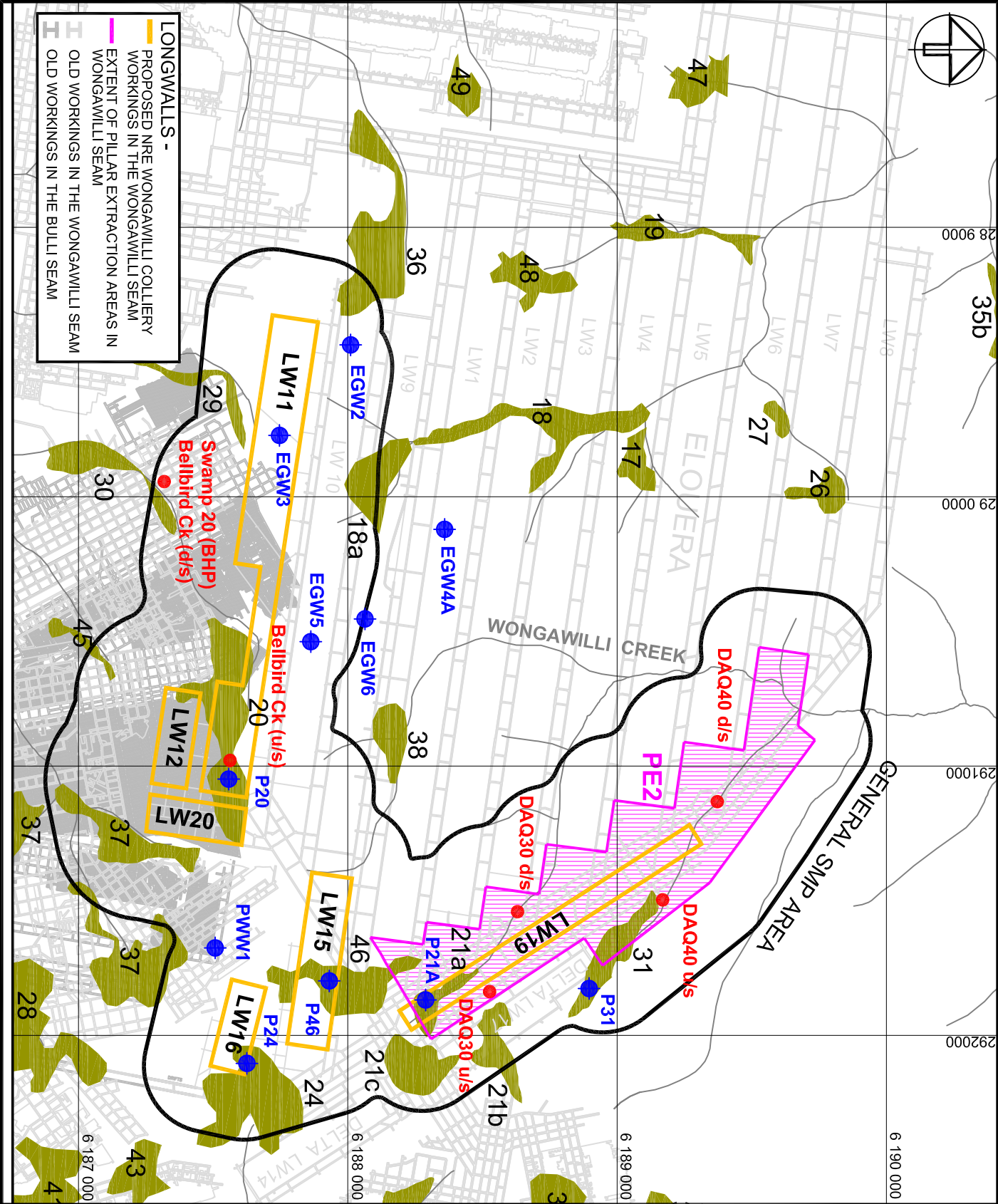
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Interpretations and recommendations provided in this report are opinions provided for our Client's sole use in accordance with the specified brief. As such they do not necessarily address all aspects of water, soil or rock conditions on the subject site. The responsibility of Geoterra is solely to its client and it is not intended that this report be relied upon by any third party, who should make their own enquiries.

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LEGEND	
	SWAMP
	PIEZOMETER
	CREEK MONITORING SITE

PROJECT:	WON3 R1
DRAWN:	A Dawkins
DATE:	6 AUG 2012
SCALE:	1:20 000

GUJARAT NRE WONGA PTY LTD WONGAWILLI LONGWALLS 11-20 Monitoring Locations DRAWING 1
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GeoTerra
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## **ATTACHMENT C**

**Terrestrial and Aquatic Ecology: NRE Wongawilli Colliery –  
Longwall 20 End of Panel Report: Ecology and Cultural  
Heritage. Biosis Research Pty. Ltd. August 2012**



Chris Irving  
Environment and Community Manager  
Gujarat NRE Wonga Pty. Ltd.  
PO Box 924  
Dapto NSW 2530

3 August 2012

Dear Chris,

**NRE Wongawilli Colliery - Longwall 20 End of Panel Report: Ecology and Cultural Heritage**

This report assesses the post-mining conditions with relation to aquatic and terrestrial ecology as well as cultural heritage within the area potentially impacted by subsidence effects associated with mining of Longwall 20 at the Wongawilli Colliery (Figure 1). Coal was extracted from Longwall 20 between the 18<sup>th</sup> December 2011 and the 11th April 2012.

This report includes;

- An outline of monitoring conducted to date;
- Any visual impacts to flora and fauna, aquatic environments and cultural heritage sites noted during monitoring; and,
- An updated Monitoring Actions and TARP table.

Please note an end of panel field inspection has not been conducted. Observations are based on monitoring undertaken to date.

**Monitoring to Date**

Biosis Research Pty. Ltd. was commissioned by Gujarat NRE Wonga Pty. Ltd. to undertake terrestrial and aquatic flora and fauna monitoring and monitoring of cultural heritage sites for the Wongawilli Colliery.

The terrestrial ecological monitoring program commenced in September 2009 and has been completed for;

- Spring 2009;
- Autumn and spring 2010;

- Autumn and spring 2011; and
- Autumn 2012.

The aquatic ecological monitoring commenced in March 2010 and has been completed for;

- Autumn and spring 2010;
- Autumn and spring 2011; and,
- Autumn 2012.

Threatened frog surveys have been completed for 2010 and 2011.

The terrestrial and aquatic ecological monitoring programs employ a Before-After Control-Impact (BACI) design, comparing sites pre- and post-mining and comparing undermined sites (impact sites) with sites that have not been undermined (reference sites).

Cultural heritage monitoring consist of monitoring during mining (conducted within 3 months of the closest point of approach) and within six months of the completion of all mining likely to impact a site. During mining monitoring of cultural heritage sites potentially impacted by LW 20 was completed on the 26<sup>th</sup> June 2012.

Table 1 below provides an outline of the ecological and cultural heritage monitoring survey methodology.

**Table 1 Summary of the monitoring survey methodology**

Survey	Creeklines		Upland Swamps		Ridgelines	
	Sites	Methods	Sites	Methods	Sites	Methods
<b>Vegetation</b>	Three 20 m x 20 m quadrats ~150-200m apart per creekline	Species inventory and modified Braun Blanquette cover abundance score for each species	Three 15 m transects of thirty 0.5m x 0.5m quadrats within each swamp ~150-200m apart	Record presence of all plant species in each quadrat to indicate species abundance along transect	Three 20 m x 20 m quadrats per ridgeline	Species inventory and modified Braun Blanquette cover abundance score for each species in autumn only
<b>Amphibians</b>	Three locations ~150-200m apart along each creekline conducted twice per season	50 m nocturnal stream searches and tadpole surveys for 30 person-minutes	Three locations 150-200m apart within each swamp, preferentially sited along creeklines. Surveys are conducted twice per survey	30 m x 30 m area surveys for 30 person-minutes	N/A	N/A

Survey	Creeklines		Upland Swamps		Ridgelines	
	Sites	Methods	Sites	Methods	Sites	Methods
			season			
<b>Winter Threatened Amphibian Surveys*</b>	Suitable creeklines	Nocturnal stream searches and tadpole survey along length of creekline	N/A (except where suitable creeklines flow through upland swamp communities)	N/A	N/A	N/A
<b>Ridgeline flora and fauna survey (e.g. rocky outcrops)</b>	N/A	N/A	N/A	N/A	Three 40 m x 40 m quadrats per ridgeline	Habitat assessments and rock turning and timed searches for 30 person-minutes
<b>Aquatic ecology surveys</b>	One sample per creekline. The survey reach for each creekline ranges from 50-150 m depending on the breadth of the waterway.	Macroinvertebrate sampling as per AUSRIVAS methodology.  Surveys are conducted twice a year and are conducted once during spring and once during autumn.	N/A	N/A	N/A	N/A
Survey	Survey Sites					Method
<b>Aboriginal heritage sites</b>	Browns Road Site 1 Upper Avon 2					Visual observation

Table 2 lists the survey sites used. Monitoring sites are shown in Figures 2, 3 and 4.

**Table 2 Monitoring sites used in the program**

Vegetation, amphibian , reptile and aquatic monitoring	
Impact sites for LW 20	Reference sites (Figure 2e)
Creek lines (Figure 2a)	
Bellbird Creek (BBC)	Electricity Easement Creek (WC 10)
	Fern Tree Creek (SC 8)
	Sandy Creek (SC)
	Sandy Creek Trib B (SC 7)
Upland swamps (Figure 2b)	
Swamp 20 (S20)	Swamp 22
Swamp 37A (S37A)	Swamp 33
	Donalds Castle Swamp A (DC 10)

Ridgelines (Figure 2c)	
LW 11 ridge	Wattalli Ridge (WTR)
LW 15 ridge	8I Ridge
Winter threatened frog surveys (Figure 2d)	
Bellbird Creek	Electricity Easement Creek (WC 10)
	Swamp 11 Creek
	Wongawilli Creek Tributary (WC 21)
	Swamp 33 Creek
	Cordeaux River Tributary
Aquatic Monitoring	
Impact Sites (Figure 3a)	Reference Sites (Figure 3b)
Bellbird Creek (BBC-AQ1) downstream of LW 11, 12 and 20	8I Creek (8IC-AQ1)
Wongawilli Creek (WWC-AQ1) downstream of LW 15, 16, 19 and 20	Easement Creek (EAC-AQ1)
Wongawilli Creek (WWC-AQ2) downstream of LW 15, 16, 19 and 20 (established during spring 2011)	Donald's Castle Tributary (DCT-AQ1)
Flying Fox Creek (FFC-AQ1) downstream of LW12 and 20	
Aboriginal Cultural Heritage Sites (Figure 4)	
Browns Road Site 1 (AHIMS 52-2-1616)	
Upper Avon 2 (AHIMS 52-2-1825)	

## Results of Monitoring

Visual observations undertaken during all monitoring listed in Table 2 have not detected any subsidence effects such as cracking, water loss in creeks or swamps or iron staining in creeks.

Statistical analysis of data obtained from ecological monitoring programs has been completed for the 2010/11 monitoring period, including all data up until autumn 2011. No changes in species richness or composition for flora or fauna have been detected. The results of the statistical analysis do not show any impact to terrestrial flora or fauna has resulted from mining at the Wongawilli Colliery.

With regard to aquatic ecology there does not appear to be any observable differences in the macroinvertebrate communities sampled between control and impact sites over the survey period. The data collected indicates that a natural variability in stream condition occurs between autumn and spring and current results indicate that there does not appear to be any observable difference from the baseline established prior to when mining commenced.

No subsidence impacts to Aboriginal heritage sites were observed. Monitoring will continue in accordance with the requirements of the Environment, Subsidence and Safety Management Plan (Gujarat NRE 2009). No other management actions have been triggered under the Trigger Action Response Plan (TARP, see Table 3).

## **Conclusion**

Monitoring to date has not identified any impacts to flora and fauna, aquatic ecology and cultural heritage sites as a result of subsidence associated with mining of Longwall 20 at the Wongawilli Colliery. No other management actions have been triggered under the Trigger Action Response Plan (see Table 3).

If you have any questions please do not hesitate to contact me.

Kind regards,

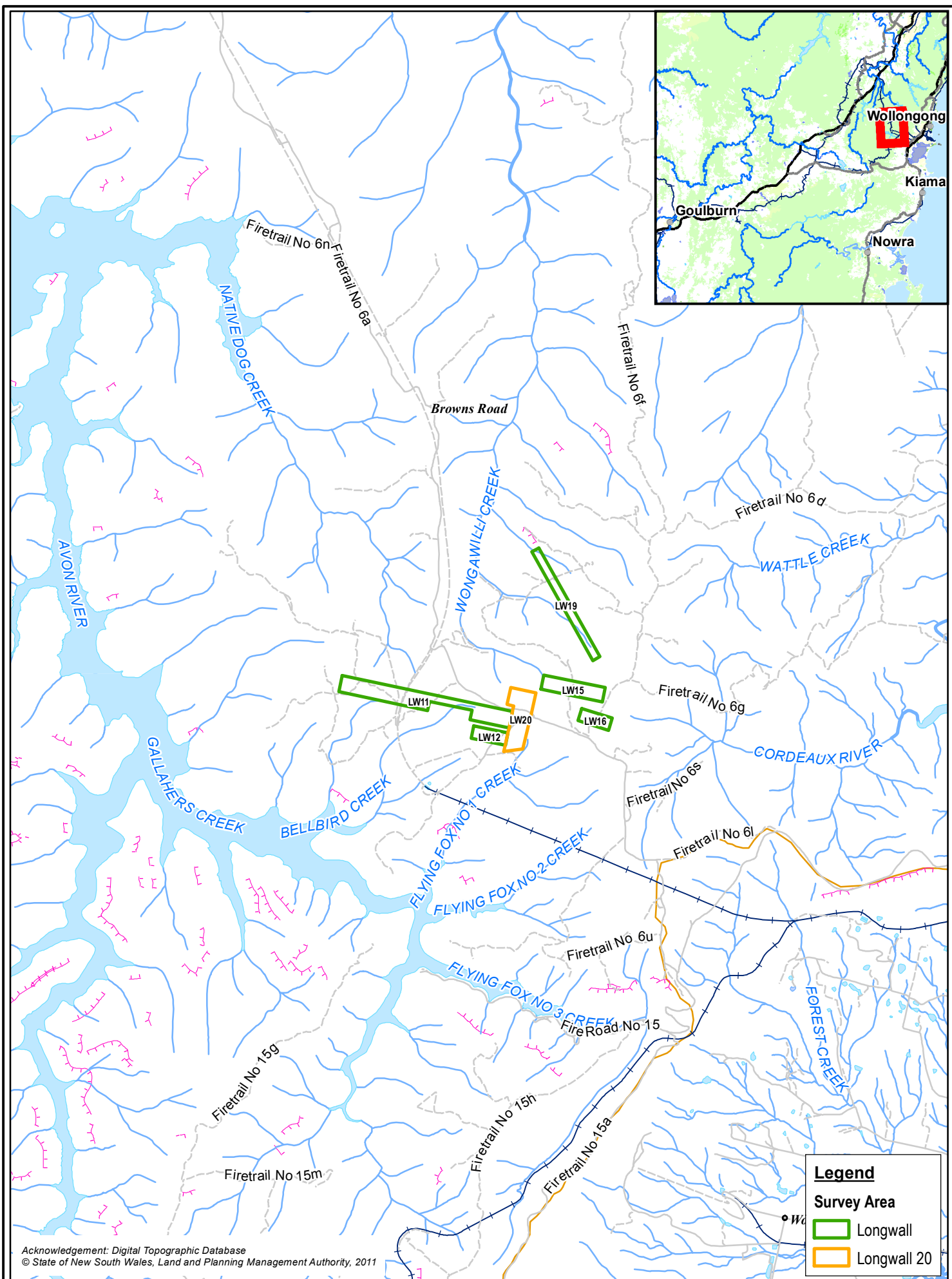
A handwritten signature in black ink, reading "B Coddington". The signature is written in a cursive style with a large, stylized 'B'.

Ben Coddington  
Botanist, Biosis Research

**Table 3 TARP and Monitoring Action Table**

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
<b>Aquatic Ecology</b> (twice a year)	Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime  (completed)  Surveys for habitat of threatened aquatic biota in major drainage lines  (completed)  AUSRIVAS sampling of reference and impact sites in the broader ESSMP Area  (completed for LW 11, 15, 16, 19 and LW 20 only)	Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime  (completed)  AUSRIVAS sampling of reference and impact sites in the broader ESSMP Area  (ongoing)	Observational monitoring for presence/absence of aquatic habitat during water quality monitoring regime  (ongoing)  AUSRIVAS sampling of reference and impact sites in the broader ESSMP Area  (ongoing)	<input type="checkbox"/> Unlikely that any threatened aquatic species would be significantly impacted by subsidence resulting from Longwall mining.  <input type="checkbox"/> Unlikely to be impacts to aquatic ecology or loss of aquatic habitat	<input type="checkbox"/> No impact to aquatic ecology or habitats observed to date	<input type="checkbox"/> None anticipated insofar as aquatic biota are concerned. Water flow and quality triggers would appropriate a response for aquatic biota	<input type="checkbox"/> None anticipated	<input type="checkbox"/> None required
<b>Terrestrial Ecology</b> (twice a year)				<input type="checkbox"/>	<input type="checkbox"/> No impacts observed to date	<input type="checkbox"/> Observation of mining related impacts to surface	<input type="checkbox"/> Notification to SCA/NPWS within 24 hrs, using photographic record	<input type="checkbox"/> None required
<b>Threatened species</b>	Observational monitoring of identified threatened species – once  (completed)	Observational monitoring of identified threatened species – twice annually during entire extraction  (ongoing)	Observational monitoring of identified threatened species – annually for one year  (ongoing)	<input type="checkbox"/> Unlikely that any threatened flora would be significantly impacted by subsidence resulting from Longwall mining.  <input type="checkbox"/> Impacts to threatened amphibian species as reported below .	<input type="checkbox"/> No impacts observed to date	<input type="checkbox"/> Major impacts to threatened species to include:  <input type="checkbox"/> Their habitat; and/or a decline in numbers from baseline observed; and/or  <input type="checkbox"/> Change in species composition	<input type="checkbox"/> Notification to SCA/NPWS immediately  <input type="checkbox"/> Proposal for threatened species management within 1 week  <input type="checkbox"/> Completion of management task following approval from SCA/NPWS  <input type="checkbox"/> Additional monitoring as required by the relevant government agencies	<input type="checkbox"/> None required
<b>Amphibians</b>	Once prior to mining  (completed)	Twice annually during entire extraction period  (ongoing)	Annually for one year  (ongoing)	<input type="checkbox"/> Threatened amphibian species (Littlejohn's Tree Frog, Red-crowned Toadlet and Giant Burrowing Frog) – potential alteration to breeding, sheltering and foraging habitat.	<input type="checkbox"/> No impacts observed to date			
<b>Swamp and riparian vegetation</b>	Once prior to mining  (completed)	Twice annually during entire extraction period  (ongoing)	Annually for one year  (ongoing)	<input type="checkbox"/> Minor impacts to Upland Swamp vegetation through change in water levels, and the cracking of soils.	<input type="checkbox"/> No impacts observed to date			

Feature	ESSMP Monitoring Commitments			Impact Assessment		TARPS		
	Prior to Mining	During Mining	Post Mining and Future Monitoring	Predicted Impacts	Observed Impacts	Trigger	Response	Action as a Result of Longwall 20
Ridge top vegetation	Once prior to mining (completed)	Twice annually during entire extraction period (ongoing)	Annually for one year (ongoing)	<input type="checkbox"/> Rock shelves, outcrops and overhang structures unlikely to be impacted	<input type="checkbox"/> No impacts observed to date			
General Upland Swamp observations  (every second month during mining)	Twice per year  (Not required due to the relatively small size of the longwall)	Every second month  (Not required due to the relatively small size of the longwall)	Twice per year for one year post mining	<input type="checkbox"/> Minor impacts to Upland Swamp vegetation through change in water levels, and the cracking of soils	<input type="checkbox"/> No impacts observed to date	<input type="checkbox"/> Minor cracking (<10mm)	<input type="checkbox"/> Report to SCA <input type="checkbox"/> Additional studies as required <input type="checkbox"/> Photographic record <input type="checkbox"/> Review of swamp piezometer data	<input type="checkbox"/> None required
						<input type="checkbox"/> Major cracking (>10mm) <input type="checkbox"/> Water loss <input type="checkbox"/> Flora/Fauna changes <input type="checkbox"/> Increased erosion	<input type="checkbox"/> Notification to SCA <input type="checkbox"/> Remediation options developed in consultation with SCA, which may include further mining limitations <input type="checkbox"/> Proposal for rectification within one month <input type="checkbox"/> Completion of works following approval from SCA <input type="checkbox"/> Additional monitoring as required	<input type="checkbox"/> None required
Indigenous Heritage Sites  (Inspect once prior to, during and post mining)	Record significant heritage items once prior to mining (completed) Site nominated in CHMP are: - Browns Road Site 1 - Browns Road Site 2 - Upper Avon 2	Once for observed impacts such as: Cracking, opening of bedding planes, blockfalls, exfoliation, water seepage changes. For sites: - Browns Road Site 1 - Browns Road Site 2 - Browns Road Site 1 - Upper Avon 2	<input type="checkbox"/> 6 months post mining <input type="checkbox"/> 2 years post mining For sites: - Browns Road Site 1 - Browns Road Site 2 - Upper Avon 2	<input type="checkbox"/> Browns Road Site 1- Moderate risk <input type="checkbox"/> Browns Road Site 2— Very low risk <input type="checkbox"/> Upper Avon 2 – Vey low risk	<input type="checkbox"/> No impacts observed or reported.	<input type="checkbox"/> Observation of unstable conditions (in the case of overhangs) or damage	<input type="checkbox"/> Implement the Cultural Heritage Management Plan (CHMP) <input type="checkbox"/> Report impacts as required <input type="checkbox"/> Notify DECCW, DRE NSW, SCA <input type="checkbox"/> Review and undertake remediation options as appropriate	<input type="checkbox"/> None required

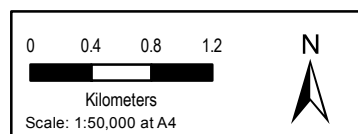


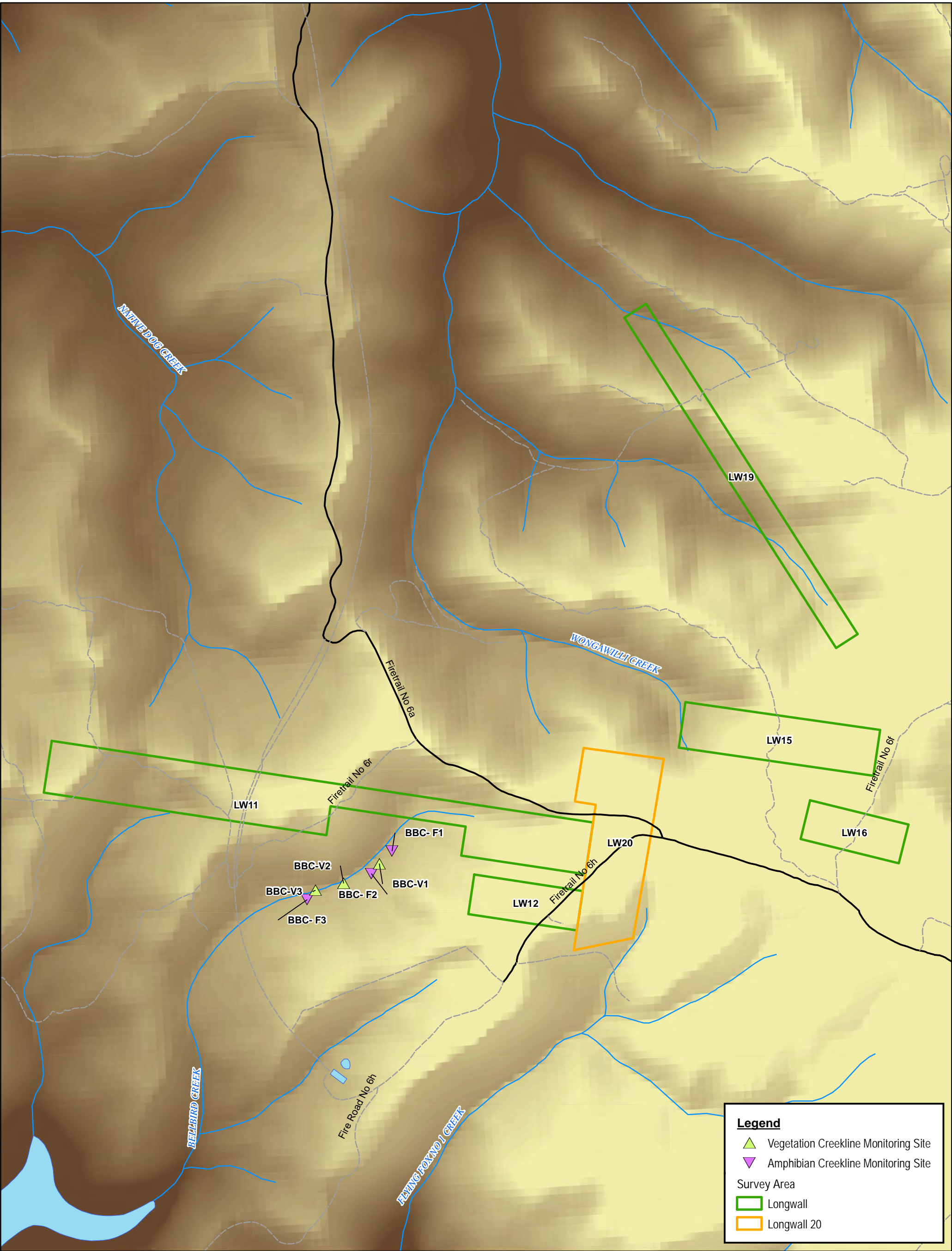
**Figure 1: Location of the Study Area within a regional context**

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Figure 2a: Vegetation and Amphibian Creekline Monitoring Sites.

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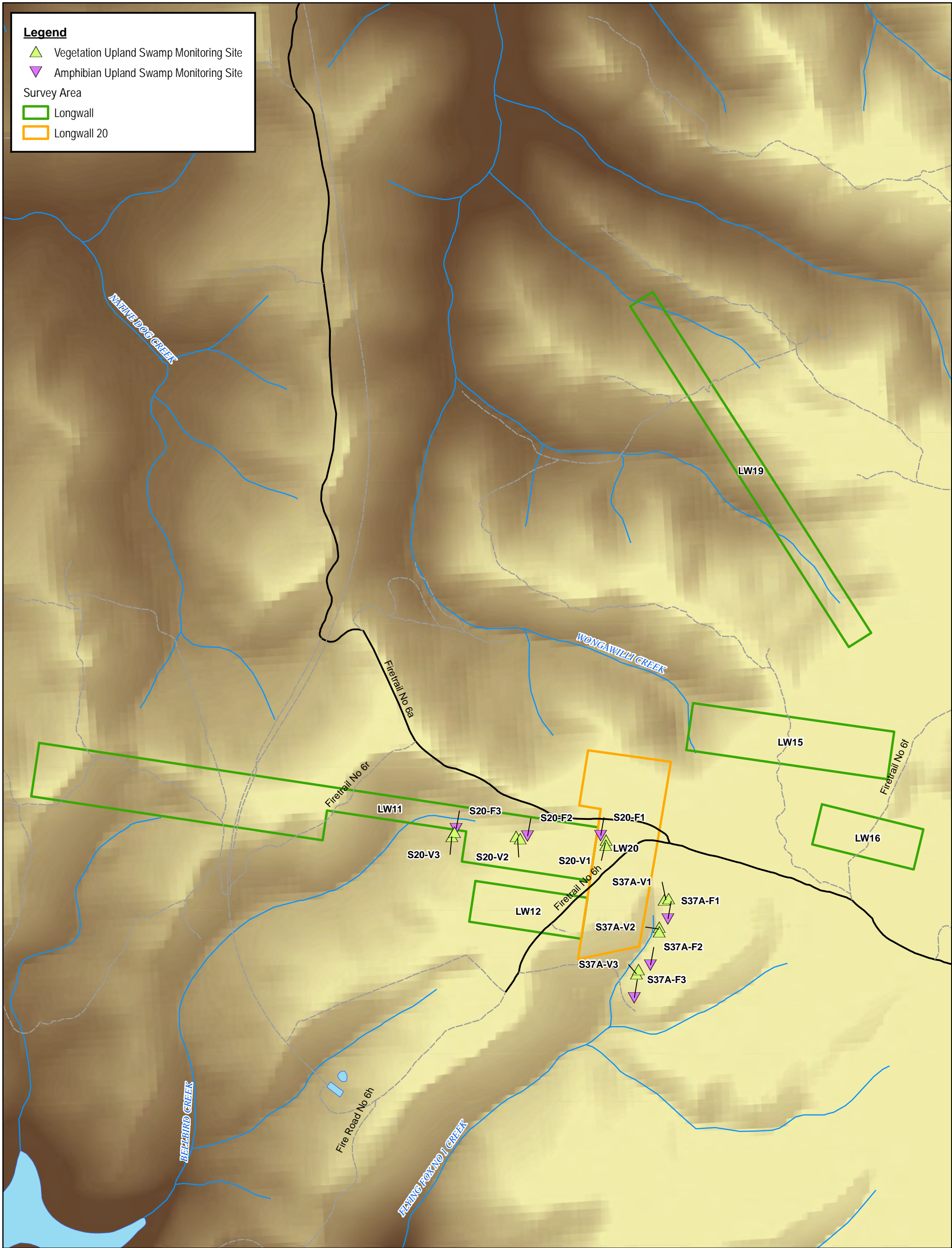
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Map Projection: Transverse Mercator  
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Figure 2a



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Figure 2b: Vegetation and Amphibian Upland Swamp Monitoring Sites.

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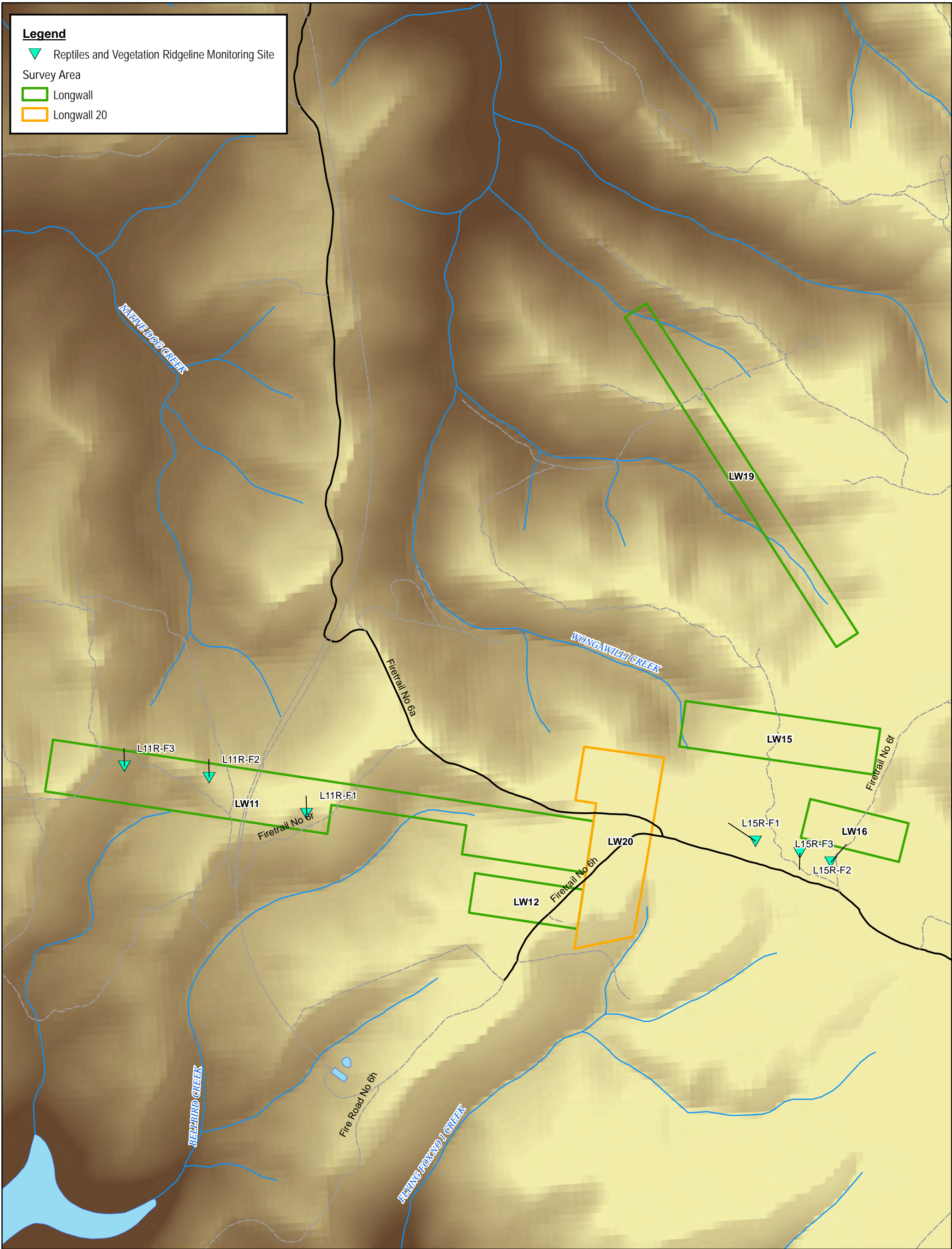
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Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 56



Figure 2b



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Figure 2c: Vegetation and Reptile Ridgeline Monitoring Sites.

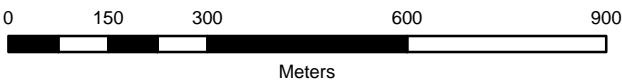
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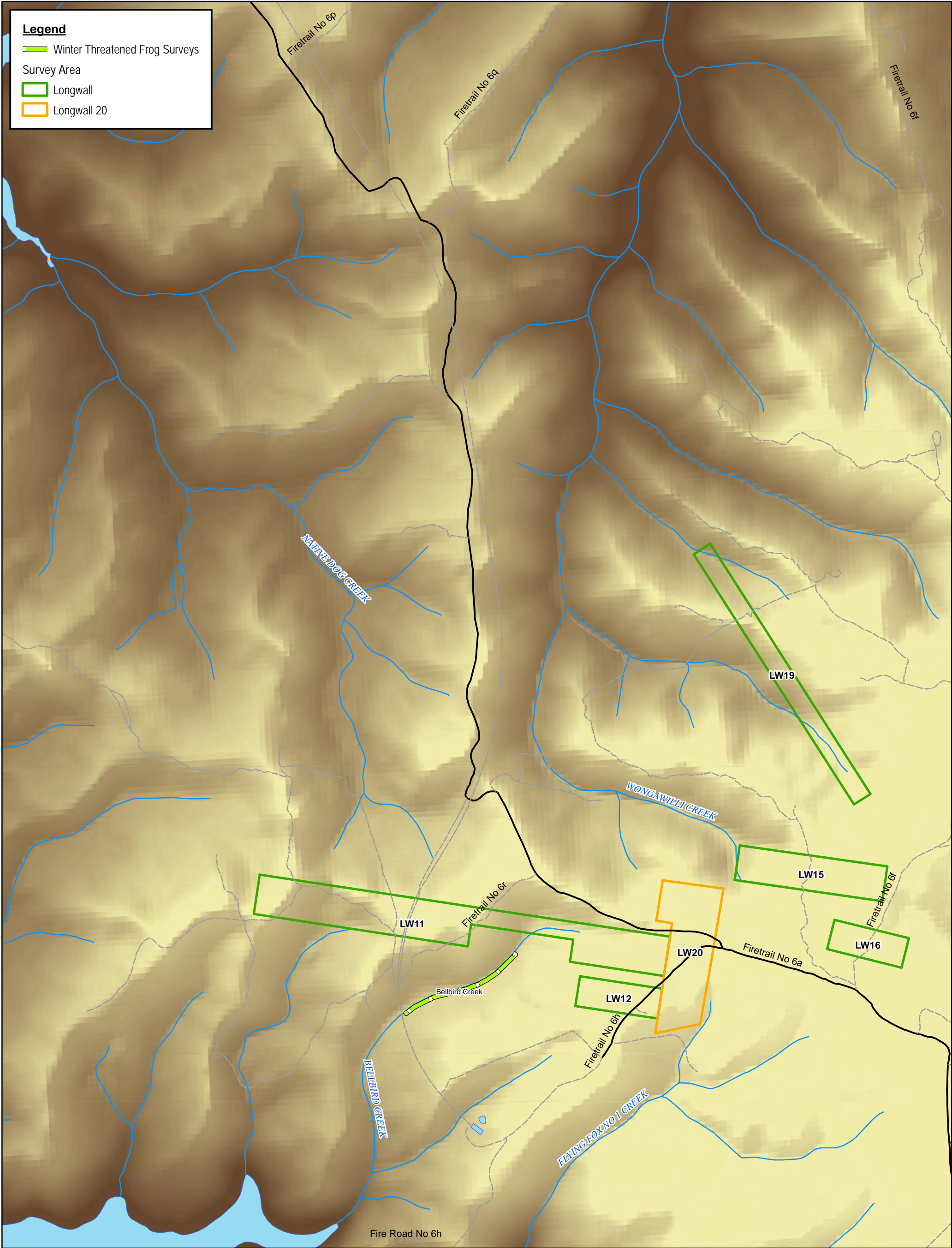
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Map Projection: Transverse Mercator  
Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 56



Figure 2c



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Figure 2d: Vegetation and Amphibian Creekline Monitoring Sites.

Date: 02 August 2012

Drawn by: ANP

File number: 15072

Checked by: NMG

Location:P:\15000s\15072\mapping\Report Figures\  
15072 F2d\_Monitoring.mxd

0 150 300 600 900  
Meters

Map Projection: Transverse Mercator  
Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 56



Figure 2d



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Figure 2e: Vegetation, amphibian and reptile monitoring reference sites.

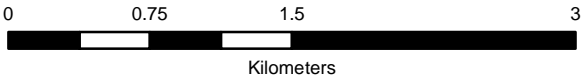
Date: 03 August 2012

Drawn by: ANP

File number: 15072

Checked by: NMG

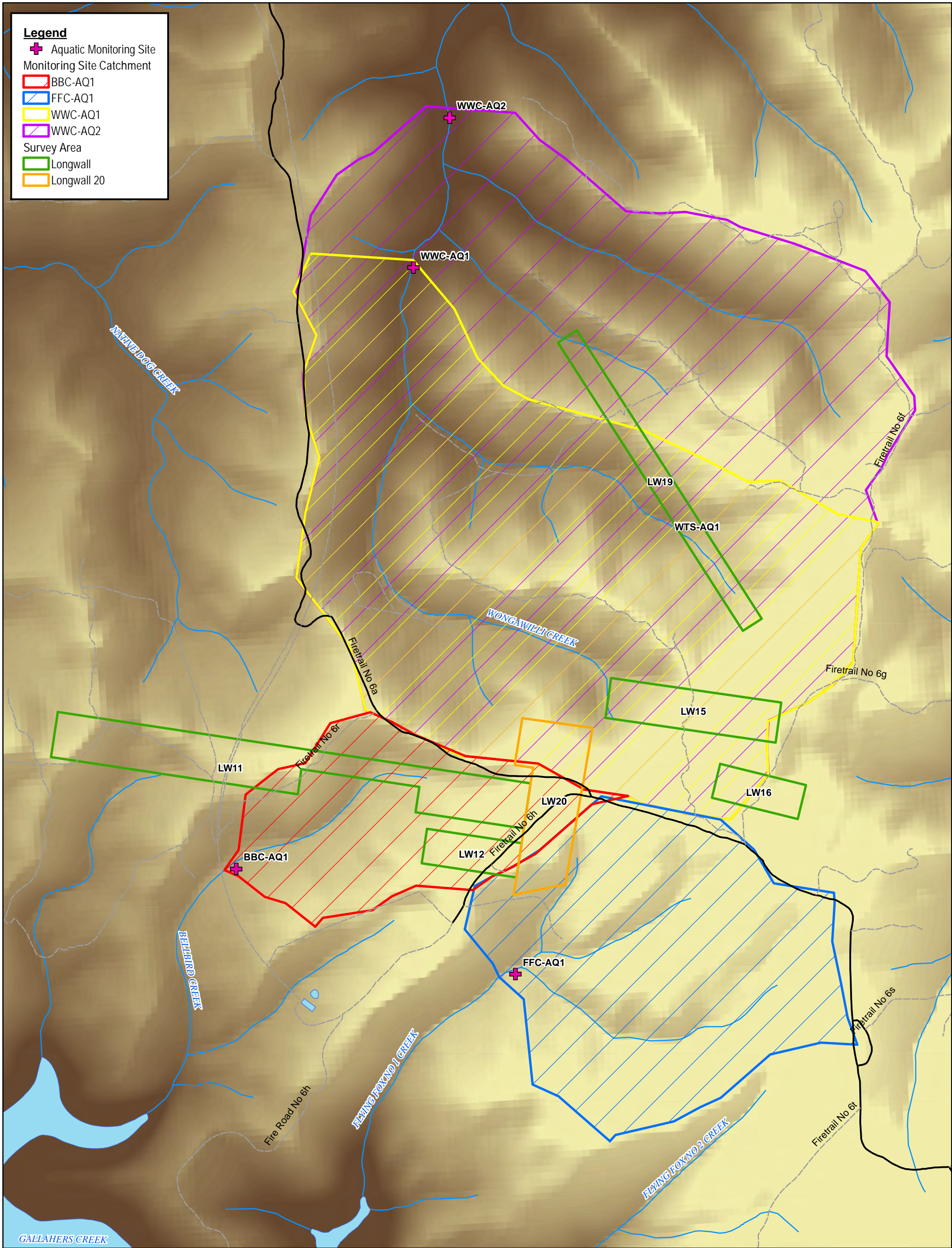
Location:P:\15000s\15072\Mapping\Report Figures\  
15072 F2e\_Monitoring.mxd



Map Projection: Transverse Mercator  
Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 56



Figure 2e



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Figure 3a: Aquatic Monitoring Sites.

Date: 03 August 2012

Drawn by: JMS/ANP

File number: 15072

Checked by: NMG

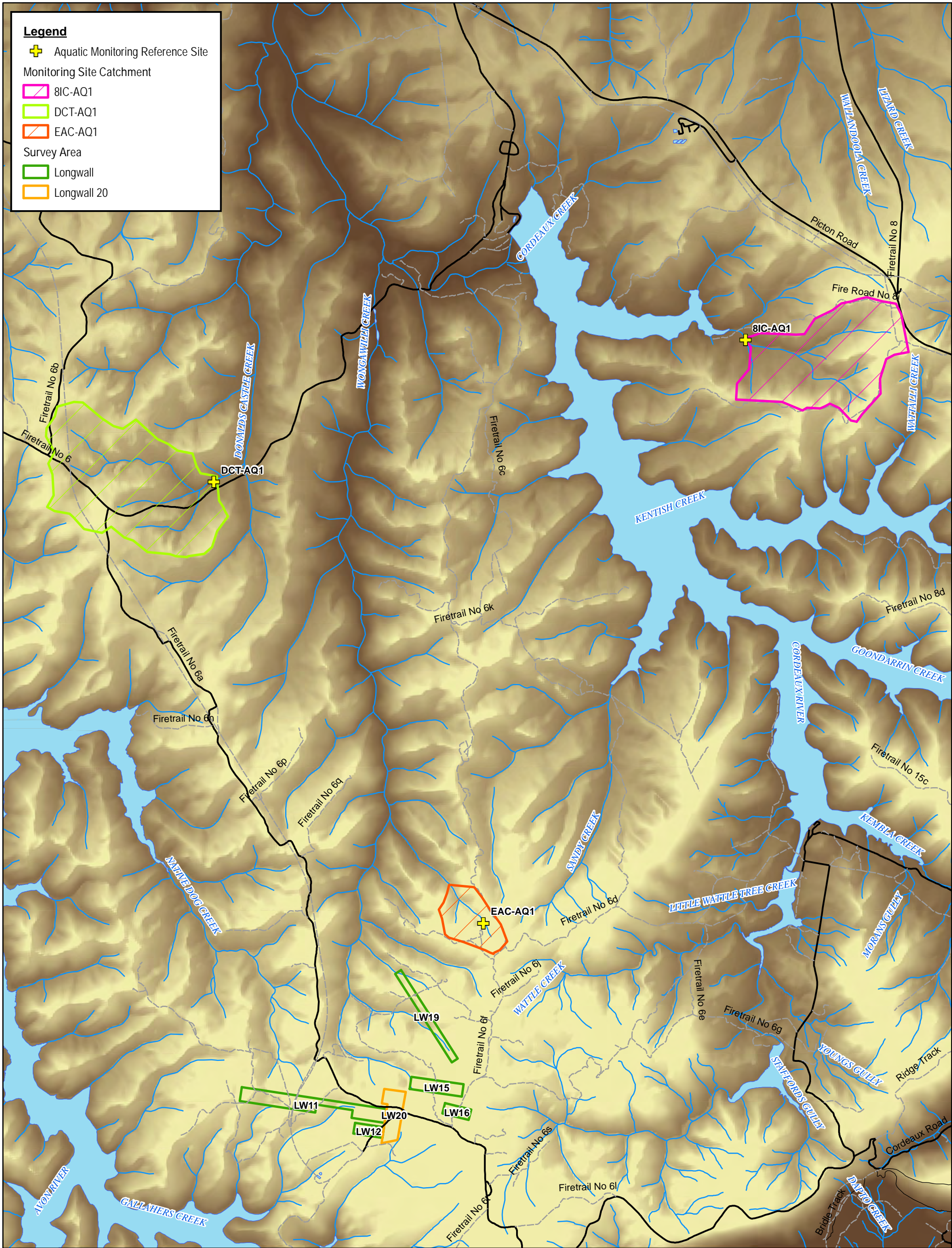
Location: P:\15000s\15072\Mapping\Report Figures\  
15072 F3a\_Aquatic Monitoring.mxd



Map Projection: Transverse Mercator  
Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 56



Figure 3a



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Figure 3b: Aquatic Monitoring Reference Sites.

Date: 03 August 2012

Drawn by: JMS/ANP

File number: 15072

Checked by: NMG

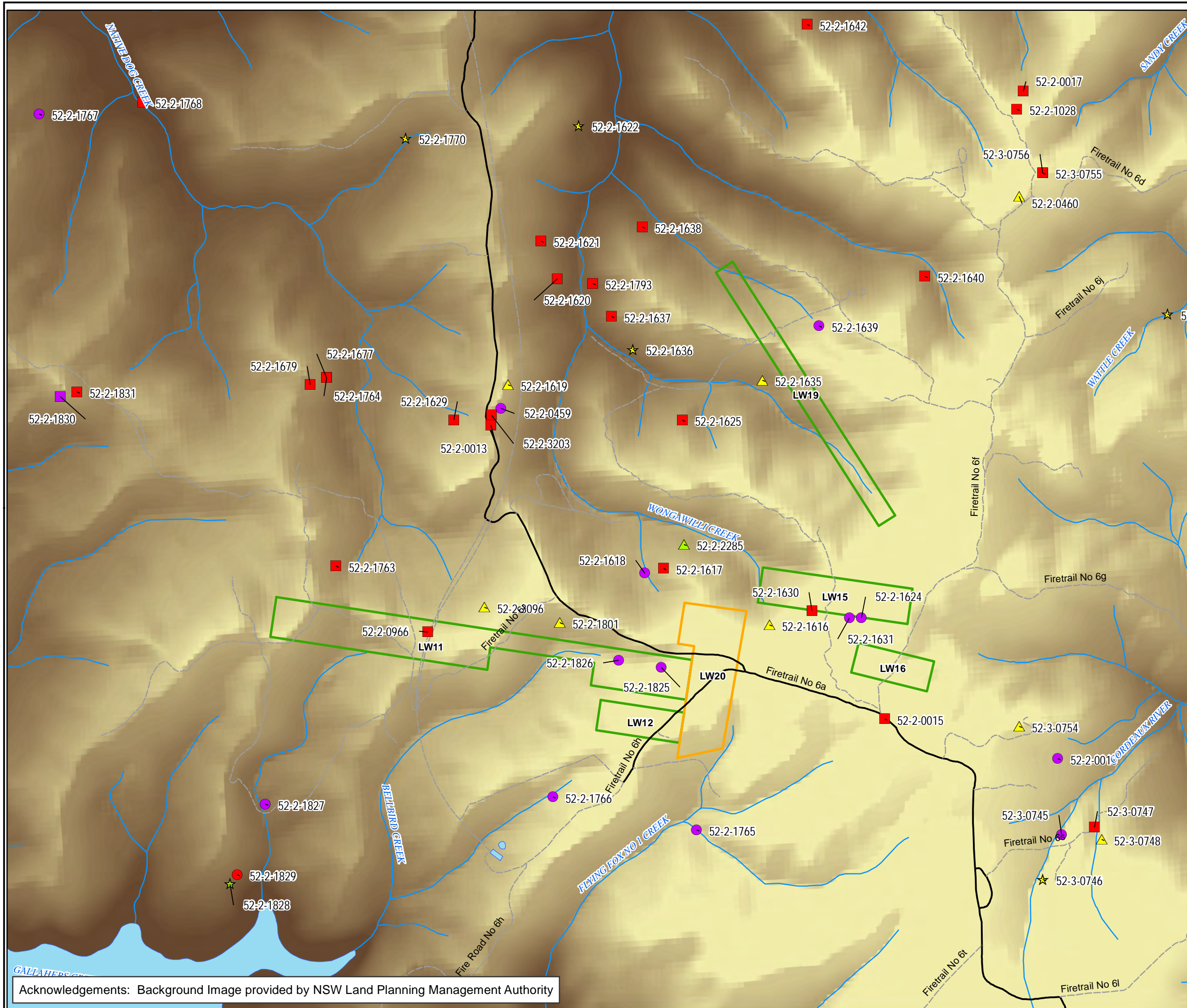
Location: P:\15000s\15072\Mapping\Report Figures\  
15072 F3b\_Aquatic Monitoring.mxd

0 0.38 0.76 1.52 2.28

Kilometers  
Map Projection: Transverse Mercator  
Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 56



Figure 3b



**Legend**

AHIMS Site

- Axe Grinding Groove
- Open Camp Site
- ▲ Potential Archaeological Deposit
- ★ Shelter With Art, Shelter With Deposit
- Shelter With Deposit
- Shelter with Art
- ▲ Shelter with Art, Shelter with Deposit
- ★ Shelter with Deposit

Survey Area

- Longwall
- Longwall 20

**Figure 4: AHIMS Results**

0 140 280 420 560 700

Metres

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56



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Date: 03 August 2012, File number: 15072  
Checked by: AJ, Drawn by: ANP  
Location: P:\15000s\15072\Mapping\Report Figures\15072 F4\_AHIMS.mxd

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