



# BULLI SEAM OPERATIONS REGIONAL SEISMIC EVENT MONITORING PROGRAM

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## DOCUMENT REVISION LOG

### Persons authorising this Plan

Name	Title	Date
Gary Brassington	Manager Approvals	January 2023

### Document Revisions

Revision	Description of Changes	Date
<b>ICH Document</b>		
1.0	Original Document	July 2021
1.1	Minor administrative updates	January 2023

### Persons involved in the review of this Plan

Name	Title	Company	Exp (yrs)	Date
Cody Brady	Principal Approvals	South32	5	January 2023
Gary Brassington	Manager Approvals	South32	25	January 2023
Amanda Crehan	Manager Exploration and Technical Support	South32	16	January 2023

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## 1. INTRODUCTION

South32 Illawarra Metallurgical Coal (IMC) operates the Bulli Seam Operations (BSO) Appin Colliery, extracting hard coking coal used for steel production.

On 22 December 2011 the Planning and Assessment Commission (PAC), under delegation of the Minister for Planning, approved BSO (MP 08\_0150) under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to continue mining operations until 2041.

The approved BSO Area including leases and tenements is provided in Figure 2.

## 2. OBJECTIVES

The purpose of this Regional Seismic Event Monitoring Program (RSEMP) is to provide the framework of IMC's seismic monitoring across its Bulli Seam Operations in accordance with Condition 5(n), Schedule 3 of the BSO Approval.

The objectives of the RSEMP are to:

1. Monitor seismic events in the region of the BSO.
2. Analyse and locate seismic events in the region of BSO.
  - a) Earthquake magnitude.
  - b) Earthquake hypocentre (latitude, longitude and depth).
3. Assess the relationship between seismic events and mining.
4. Improve the understanding of the relationship between underground mining and seismic events.

## 3. STATUTORY REQUIREMENTS

Extraction of coal from Appin Mine will be in accordance with the conditions set out in the BSO Approval.

### 3.1 Consultation

This RSEMP has been developed in consultation with:

- Department of Planning and Environment (DPE);
- Mining, Exploration and Geosciences; and
- Resource Regulator.

Version 1.0 of the RSEMP was provided to agencies for comment during the consultation phase of the Appin Longwalls 709 to 711 and 905 Extraction Plan, in July 2021. No comments were received on the management plan.

South32 will make the RSEMP and associated documentation publicly available on the South32 website in accordance with Condition 11, Schedule 6 of the BSO Approval.

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### 3.2 BSO Approval

Condition 5 (n), Schedule 3 of the BSO Approval requires the preparation of a RSEMP which includes analysis of outcomes and proposed triggers for review of potential correlations with mining operations.

This RSEMP also addresses the requirements detailed in Condition 2, Schedule 6 of the BSO Approval as shown in

Table 1.

Due consideration has been given to all the BSO Approval Conditions in the preparation of this RSEMP, including those relating to auditing, review and environmental management.

The BSO RSEMP fits within the overall structure of IMC BSO Environmental Management Strategy (EMS) which is shown in Figure 1.

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Figure 1 BSO Environmental Management Strategy

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**Table 1 Management Plan Requirements**

Project Approval Conditions	Relevant RSEMP Section
<p><b>Condition 2, Schedule 6</b></p> <p>The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:</p> <ul style="list-style-type: none"> <li>(a) detailed baseline data;</li> <li>(b) a description of:                             <ul style="list-style-type: none"> <li>- the relevant statutory requirements (including any relevant approval, licence or lease conditions);</li> <li>- any relevant limits or performance measures/criteria;</li> <li>- the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;</li> </ul> </li> <li>(c) a description of the measures that would be implemented to comply with the relevant statutory, limits, requirements or performance measures/criteria;</li> <li>(d) a program to monitor and report on the:                             <ul style="list-style-type: none"> <li>- impacts and environmental performance of the project;</li> <li>- effectiveness of any management measures (see c above);</li> </ul> </li> <li>(e) a contingency plan to manage any predicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;</li> <li>(f) a program to investigate and implement ways to improve the environmental performance of the project over time;</li> <li>(g) a protocol for managing and reporting any:                             <ul style="list-style-type: none"> <li>- incidents;</li> <li>- complaints;</li> <li>- non-compliances with statutory requirements; and</li> <li>- exceedances of the impact assessment criteria and/or performance criteria; and</li> </ul> </li> <li>(h) a protocol for periodic review of the plan.</li> </ul>	<p>Section 3</p> <p>Section 6</p> <p>Section 6</p> <p>Section 6.3</p>



## 4. DEFINITIONS

The following section is sourced from the GA Earthquake Hazard website <https://www.ga.gov.au/scientific-topics/community-safety/earthquake>

### 4.1 Magnitude

The size or magnitude of earthquakes is determined by measuring the amplitude of the seismic waves recorded on a seismograph and the distance of the seismograph from the earthquake. These are converted to a magnitude, which is a measure of the energy released by the earthquake. For every unit increase in magnitude, there is roughly a thirty-fold increase in the energy released. For instance, a magnitude 6.0 earthquake releases approximately 30 times more energy than a magnitude 5.0 earthquake, while a magnitude 7.0 earthquake releases approximately 900 times (30x30) more energy than a magnitude 5.0.

Earthquake magnitude was traditionally measured on the Richter scale. It is often now calculated from seismic movement, which is proportional to the fault area multiplied by the average displacement on the fault.

### 4.2 Location

The earthquake location is also known as its focus or hypocentre which is represented by the latitude, longitude and depth below the surface.

### 4.3 Effects

The amplitude of the shaking caused by an earthquake depends on many factors, such as the magnitude, distance from the epicentre, depth of focus, topography and the local ground conditions.

Earthquake effects, based on human observation, are rated using the Modified Mercalli (MM) intensity scale, which ranges from I (imperceptible) up to XII (total destruction) (Table 2).

In Australia, earthquakes with magnitudes of less than 3.5 seldom cause damage, and the smallest magnitude earthquake known to have caused fatalities is the magnitude  $M_w$  5.4 ( $M_L$  5.6) Newcastle earthquake in 1989. However, magnitude 4.0 earthquakes occasionally topple chimneys or result in other damage which could potentially cause injuries or fatalities.

**Table 2 The Modified Mercalli Intensity (MMI) scale**

Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.

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Intensity	Shaking	Description/Damage
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns,



Intensity	Shaking	Description/Damage
		monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.





## 5. SCOPE

The Australian plate is the fastest moving continental land mass on Earth and is colliding into the Pacific plate to Australia's north and east, and the Eurasian Plate to the northwest. This generates mainly compressive stress in the interior of the Australian continent, which is slowly building up across the plate as it moves northeast about 7 cm per year. Australia's earthquakes are caused by the sudden release of this stress when rocks deep underground break and move along a fault line.

The scope of this Monitoring Plan is to locate seismic events in the vicinity of BSO and assess if there is any correlation between events and mining.

## 6. REGIONAL SEISMIC MONITORING PROGRAM

This RSEMP consists of:

- Seismic Monitoring
- Analysis
- Reporting

### 6.1 Seismic Monitoring

The earthquake monitoring network installed for South32 by the Seismology Research Centre (SRC) comprises eight seismic monitoring stations. Five sites were installed at Appin (APPIN), Cawdor (CAWDR), Finns Rd (FINNS), Gilead (GLEAD) and Maldon (MALDN) between late November 2013 and mid-February 2014.

In April 2018 the South32 seismic network was upgraded further with three additional stations installed and the site at APPIN relocated. These newer stations are located closer to the currently working areas of the mine and are named LW703, LW707 (Ex-APPIN), LW710 and LW903 after the longwalls they are located above. These new sites have been installed with the latest Kelunji Gecko recorders and Lennartz MkIII seismometer/accelerometers.

Table 3 below specifies the equipment installed at each site in addition to ancillary equipment such as solar/power equipment and enclosures.

**Table 3 Monitoring Site Details**

Site	Recorder	Sensor (s)	Modem
CAWDR, FINNS, GLEAD, LW707, MALDN	Kelunji EchoPro 6-channel seismic recorder	Guralp CMG-6T-1 weak motion seismometer Guralp CMG-5TC strong motion accelerometer	Netcomm NTC-6000 cellular router
LW703, LW710, LW903	Kelunji Gecko Seismic Recorder	Lennartz Le 3D lite MkIII seismometer	GT-HE910-EUG cellular router

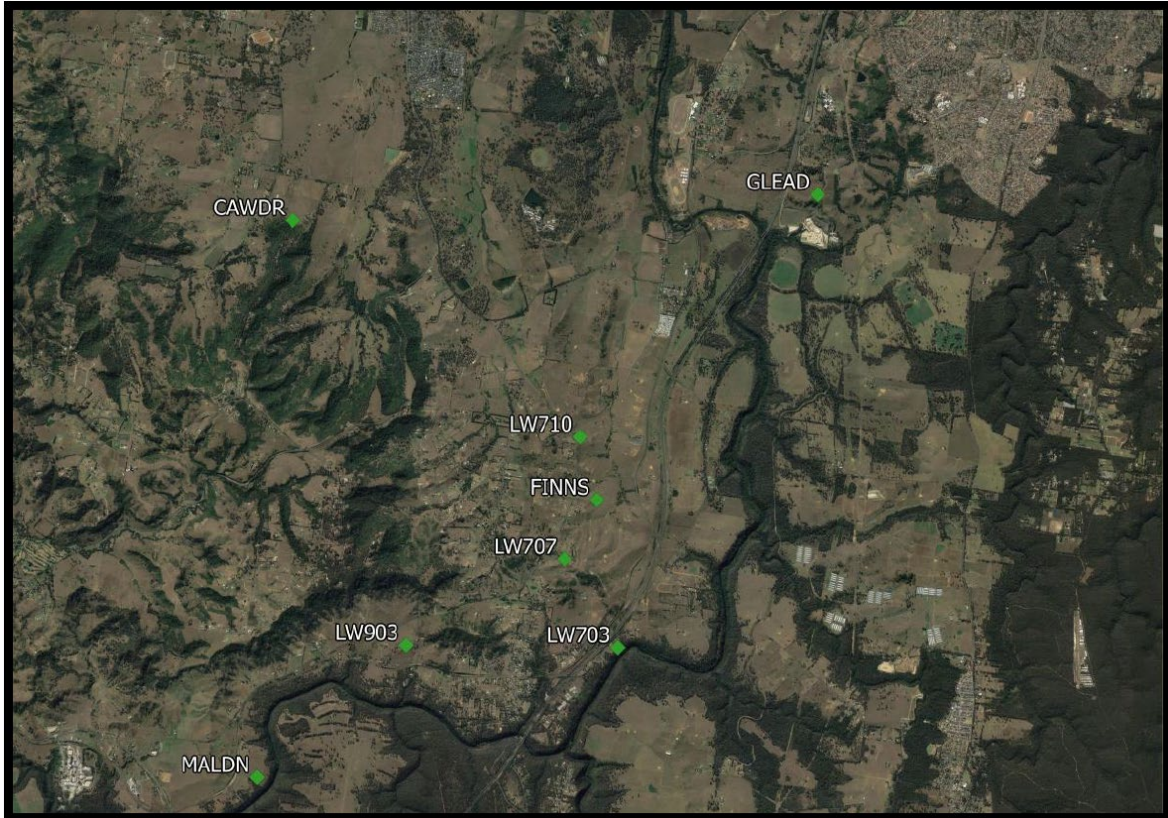
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Seismic and state of health data is sent from all stations back to the SRC observatory and is used in conjunction with other seismic networks that feed into our observatory to locate local earthquakes.

Figure 3 is a map showing the location of the recorders that make up the South32 seismic network.



**Figure 3 IMC Seismic Monitoring Network**

## 6.2 Analysis

South32 engage SRC who are qualified seismologists to analyse the seismic events and provide the location of the locus. Micro-seismic events associated with the formation of the goaf as part of the longwall mining process will be located, as well as significant events, earthquakes (Magnitude >1). SRC report the location of the events to IMC on a monthly basis.

SRC also analyse the distribution of events and the locations of mining to determine if there is any relationship between mining and the seismic events.

## 6.3 Reporting

South32 will use qualified seismologists to monitor and analyse seismic events in the region of the BSO. The report will summarise the seismic events located during the period and the relationship to mining, based on the analysis. The incidence of seismic activity and the relationship to mining is dependent on the analysis of events over a period of time. It is not expected that a relationship can be determined based on a single event. A summary of the annual report will be included in the Annual Review for BSO.

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## 7. PLAN ADMINISTRATION

This RSEMP will be administered in accordance with the requirements of the Appin Mine Environmental Management Strategy (EMS) and the BSO Approval Conditions. A summary of the administrative requirements is provided below.

### 7.1 Roles and Responsibilities

Statutory obligations applicable to this Plan are identified and managed via an online compliance management system (TICKIT). The online system can be accessed from the link below:

<https://illawarracoal.tod.net.au/login>.

The overall responsibility for the implementation of this Plan resides with the Manager Approvals who shall be the Plan’s authorising officer.

#### Manager Approvals

- Ensure that the requisite personnel and equipment are provided to enable this Plan to be implemented effectively.
- Authorise the Plan and any amendments thereto.

#### Manager Exploration and Technical Support

- Implement monitoring and analysis of seismic events.
- Reporting on the implementation and progress of the RSEMP to the relevant Government authorities.

### 7.2 Resources Required

The Manager Approvals provides resources sufficient to support this Plan.

Equipment may be needed for this Plan. Where this equipment is of a specialised nature, it will be provided by the supplier of the relevant service. All equipment is to be appropriately maintained, calibrated and serviced as required in operation manuals.

It shall be the responsibility of the Manager Approvals to ensure that personnel and equipment are provided as required to allow the provisions of this Plan to be implemented.

In accordance with Condition 5 of Schedule 6 of the BSO Approval, the RSEMP will be reviewed, and if necessary revised, within three months, of:

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an Independent Environmental Audit (IEA) report; or
- any modification to the conditions of the BSO Approval (unless the conditions require otherwise).

If deficiencies in this PSEMP are identified in the interim period, the Plan will be modified as required. This process has been designed to ensure that documentation continues to meet current requirements, including changes in technology and operational practice, and expectations of stakeholders.

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