ENVIRONMENTAL MANAGEMENT SYSTEM

EIMP.06.00.06

Subsidence Management Plan

Environmental Impact Management Plan (EIMP)

APPROVAL

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1. INTRODUCTION

Ensham Mine (EM) is an opencut and underground bord and pillar coal mine located approximately 35 km east of Emerald along the Nogoa River in Central Queensland.

Ensham currently undertakes underground mining using continuous miner operations, whilst utilizing the existing access and supporting infrastructure located within the current Mining Leases. The open cut portion of the mine is transiting from mining to rehabilitation. Mining extracts a portion of the combined Aries/Castor seam plies, typically leaving the higher ash, uppermost plies in the roof of the underground roadways.

Ensham is required to manage potential impacts of subsidence from underground mining activities in accordance with conditions within the following approvals:

- Regional Interests Development Approval (RIDA RPI22/002 Ensham – Life of Mine Extension Zones 2 and 3)
- Progressive Rehabilitation Closure Plan schedule PRCP_EMPL00732813_V4 (and future revisions)
- Environmental Protection and Biodiversity Conservation Approval (EPBC 2020/8669 - Zones 1, 2 & 3)

1.1 SCOPE

This Plan addresses the monitoring and management of subsidence impacts from Ensham's underground mining operation. This includes the triggers for investigation of potential subsidence impacts, specifications for LIDAR, guidance on inspections and photographic monitoring, groundwater monitoring, as well as mitigation and management measures.

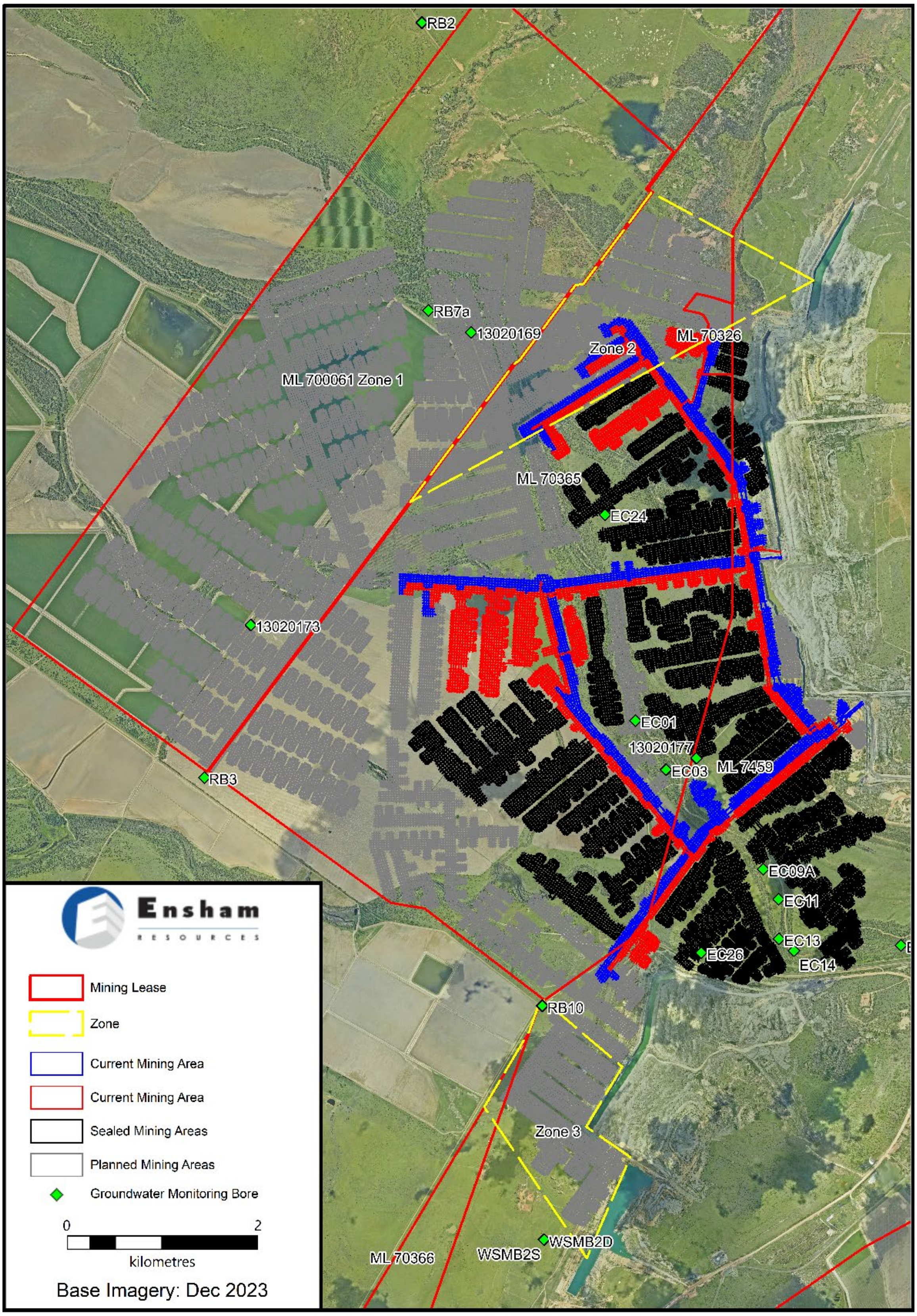

FIGURE 1-1 EXISTING OPERATIONS AND PROPOSED MINING PLAN FOR ZONES 1, 2 AND 3.

2. ENSHAM MINE OVERVIEW

2.1 MINING ACTIVITIES

The Ensham underground mine has been operating since 2011. The mine will continue to produce around 4.5 million tonnes per annum (Mtpa) of thermal coal with the addition of Zone 1 to the existing operation.

Coal from the underground mine is mined by five production units and transferred to the surface via the Ramp 4 drift conveyor.

2.2 TOPOGRAPHY AND DRAINAGE

The terrain in the Ensham area is generally low-lying, and the few hills within the area are capped by a hard layer formed on the surface known as duricrusts (Figure 2-1). The main drainage of the area is via the Nogoa River, which flows in an easterly and south-easterly direction through the Ensham mining leases before joining the Comet River to form the Mackenzie River near the town of Comet.

In the Ensham area, the elevation of the Nogoa River banks average 150 metres above Australian Height Datum. The Nogoa River is used for irrigation, drinking water and stock water supply, with flow maintained by releases from Fairbairn Dam, located south of Emerald. Due to the supply of water from the Fairbairn Dam to downstream users, the Nogoa River flows essentially all year round. The anabranch however is ephemeral and flows generally following a significant rain event.

The low-lying area includes floodplains and riparian zones along the Nogoa River and an anabranch, which runs to the north of the Nogoa River.

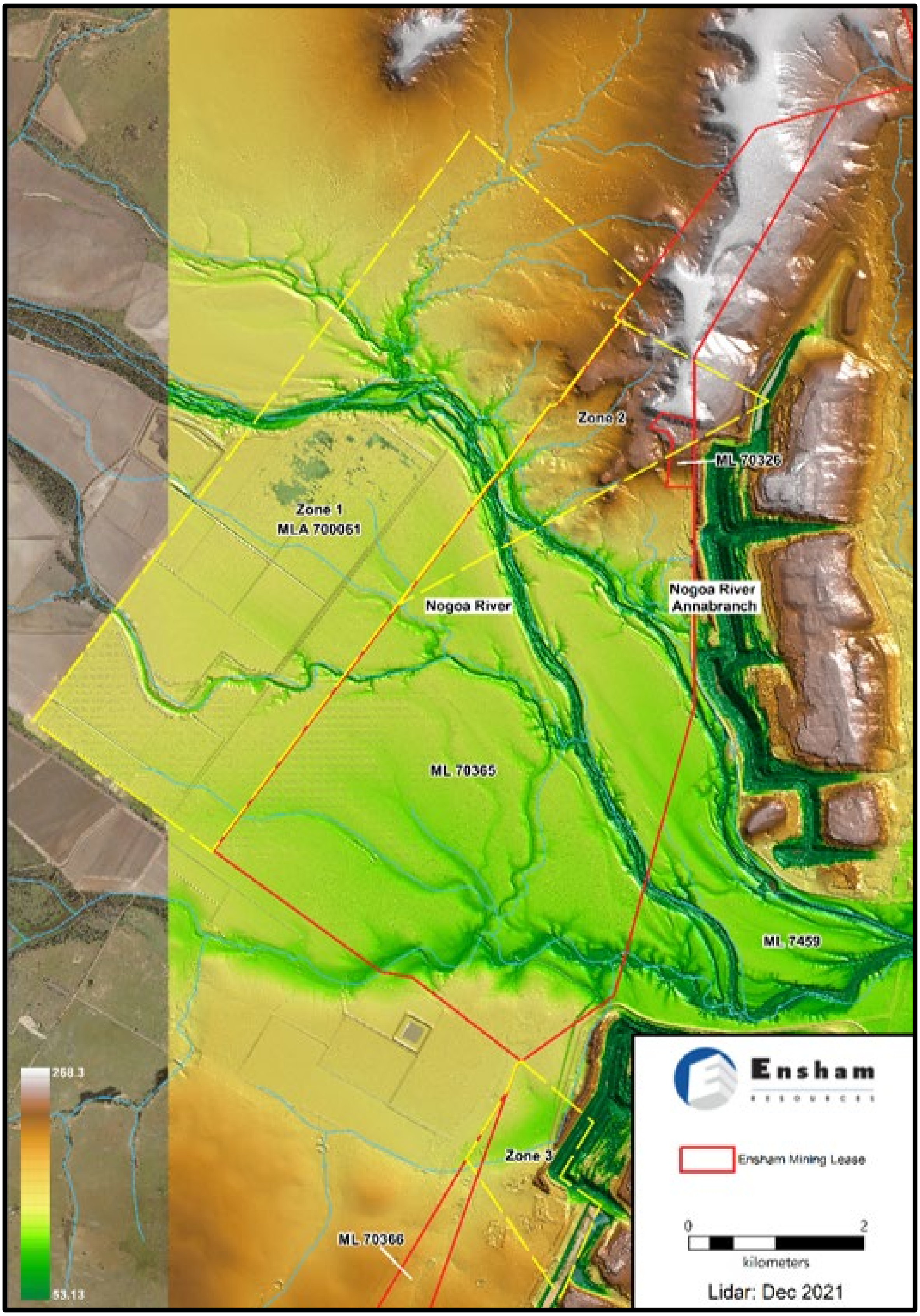

FIGURE 2-1 SURFACE TOPOGRAPHY AND DRAINAGE

2.3 SOILS

Soils in the areas above zones 1, 2 and 3 have been identified and are presented in Figure 2-1. The different soil types are known to not display a uniform reaction to climatic influences. The Vertosol is known to shrink and swell with varying moisture, which manifests as significant variation of surface elevation relative to Australian Height Datum.

The amount of natural movement of the soil surface exceeds the maximum predicted and measured subsidence movement. For this reason, RTK GPS monitors buried into the ground have been used to measure ground movement as opposed to the soil movement.

2.3.1 VERTOSOLS

These are soils with the following characteristics:

- A clay field texture or 35% or more clay throughout the solum except for a thin, surface crusty horizons 0.03 m or less thick,
- When dry, this soil exhibits cracking occasionally. These cracks are at least 5 mm wide and extend upward to the surface or to the base of any plough layer, peaty horizon, self-mulching horizon, or thin, surface crusty horizon, and
- Slickensides and/or lenticular peds occur at some depth in the solum.

The Vertosols generally consist of greyish brown medium clay A horizons (topsoil) with moderate structure, overlying a medium to medium-heavy clay B2 horizon with strong angular blocky structure. The topsoil showed strongly alkaline, non-sodic and low saline properties. The B2 horizon generally showed strongly alkaline, sodic and high saline properties.

FIGURE 2-2 VERTOSOL USED FOR GRAZING

FIGURE 2-3 VERTOSOL USED FOR CROPPING

2.3.2 DERMOSOLS

These are soils other than Vertosols, Hydrosols and Calcarosols which:

- Have B2 horizons with a structure more developed than weak throughout the major part of the horizon, and
- Do not have clear or abrupt textural B horizons.

The Dermosols generally consist of very dark brown to very dark greyish brown light clay to medium clay A horizons (topsoil) with weak to moderate structure, overlying a light medium clay to medium clay B2 horizon with moderate to strong angular to sub angular blocky structure. The topsoil and subsoils showed variable pH, sodicity, and salinity properties.

FIGURE 2-4 DERMOSOL

2.3.3 RUDOSOLS

Rudosols are other soils with negligible (rudimentary), if any, pedologic organisation apart from the minimal development of an A1 horizon or the presence of less than 10% of B horizon material. There is little or no texture or colour change with depth.

The Rudosols generally consisted of sandy clay loam A horizons (topsoil) with weak structure, overlying a sandy clay loam to clayey sand B2 horizon with weak sub angular blocky structure. The topsoil showed strongly acidic, non-sodic and very low saline properties. Similarly, the B2 horizon showed strongly acidic, non-sodic and very low saline properties.

FIGURE 2-5 RUDOSOL

2.3.4 KANDOSOLS

Kandosols are soils other than Hydrosols which lack a clear or abrupt texture contrast between the A horizon and a B horizon, with the major part of the B2 horizon consisting of a massive or weak pedality grade and a maximum clay content which exceeds 15%.

The Kandosols on site generally consisted of brown to black clayey sand to light medium clay A horizons (topsoil) with weak to strong structure, overlying a sandy clay loam to medium clay B2 horizon with weak to strong angular to sub angular blocky structure. The topsoil showed very strongly acidic, non-sodic and very low saline properties, similarly, the B2 horizon generally showed very strongly acidic, non-sodic and very low saline properties.

FIGURE 2-6 KANDOSOL

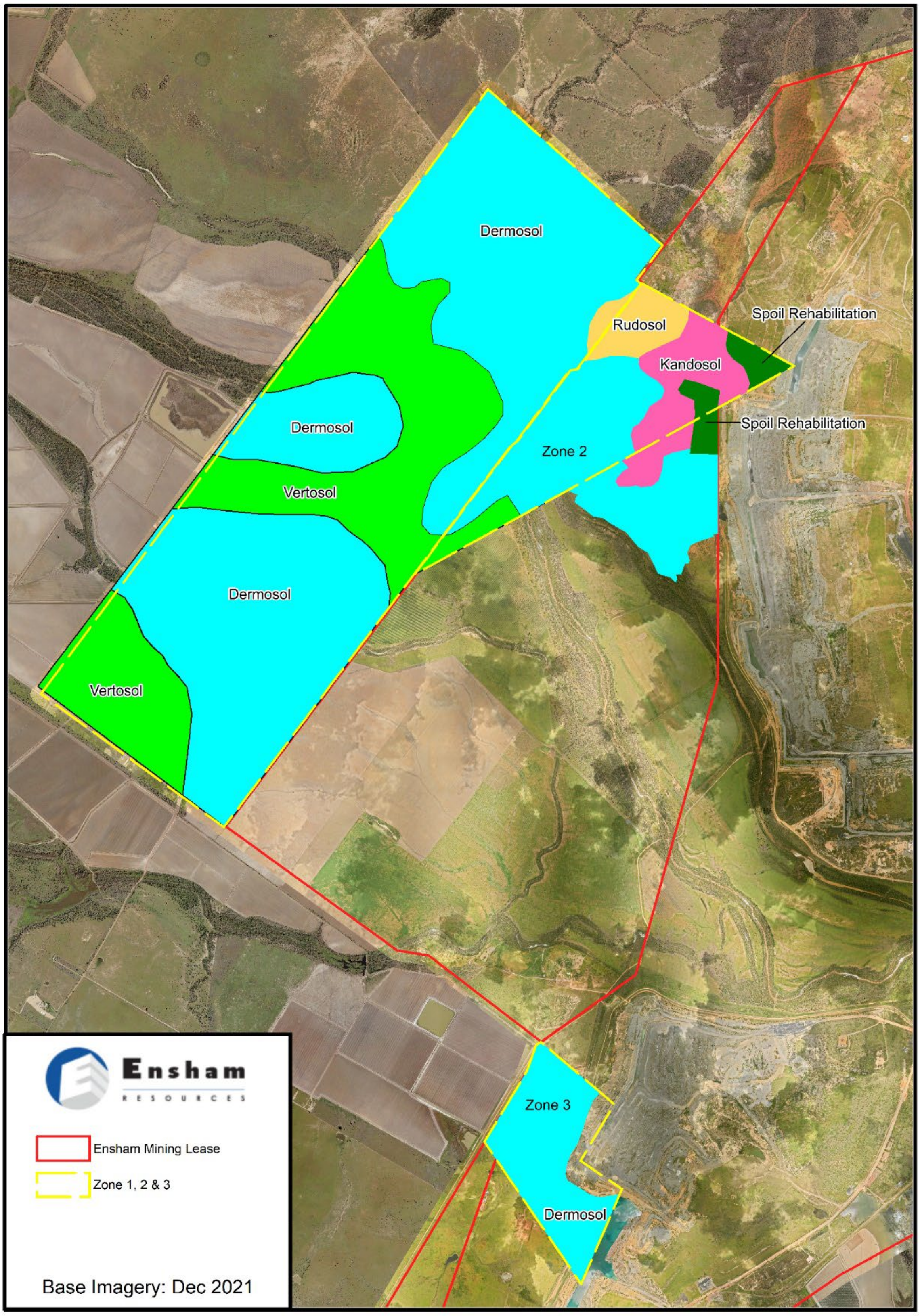

FIGURE 2-7 SOIL UNITS

2.4 GEOLOGY

Ensham mine is located in the western part of the Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin is the largest productive coal basin in Australia and stretches from Townsville to south of the Queensland-New South Wales border, in a north to south direction.

Table 2-1 provides a summary of the stratigraphic sequence in the Ensham area. This comprises unconsolidated Quaternary aged sediments, unconformably overlying consolidated Tertiary and Permian sediments.

TABLE 2-1 STRATIGRAPHY

Age	Unit	Maximum thickness[1] (m)	Description
Quaternary	-	25	Alluvium - silt, clay, sand and gravel
Tertiary	-	ND	Duricrusted palaeosols at the top of deep weathering profiles, including ferricrete and silcrete; duricrusted old land surfaces
	Emerald Formation	50	Fluviatile and lacustrine claystone and siltstone, quartzose sandstone, pebbly sandstone, gravel, lignite, oil shale, interbedded basalt; all deeply weathered in outcrop
	Basalt	ND	Tertiary volcanics (basalt) mapped as being present over 10 km west of the site
Triassic	Rewan Group	200	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base); deposited in a fluvial-lacustrine environment.
Permian	Rangal Coal Measures	125	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. Coal seams include the Aries, Castor, Pollux and Orion seams. The main economic seams at Ensham are the Aries 2 and Castor seams.
	Burngrove Formation	200	Sandstones, siltstones and mudstones, and banded coal seams frequently interbedded with tuff and tuffaceous mudstones - coal seams include the Virgo and Leo seams.
	Fair Hill Formation	150	Lithic and feldspathic labile sandstone, siltstone, mudstone and conglomerate
	Macmillan Formation	100	Lithic and feldspathic sublabile mudstone, siltstone and sandstone

1 Approximate maximum thickness based on available exploration holes and/or relevant literature
ND: not defined, not enough data available

The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular. The coal seams mined at Ensham Mine are found within the Rangal Coal Measures, which is the uppermost Permian unit of the portion of the Bowen Basin.

The Rewan Group aquitard overlies the Rangal Coal Measures and separates the Nogoa River and associated floodplain alluvium from the underground workings. Each are discussed in more detail in (Table 2-1).

The underground mine surface geology is dominated by the Nogoa River alluvium, with the Tertiary sediments mapped to the south and the north.

2.5 GROUNDWATER REGIME

The principal groundwater bearing formations in the Ensham area are associated with the Permian coal seams. The Triassic Rewan Group siltstones and sandstones are considered a regional scale aquitard. A conceptual hydrogeological model is shown in Figure 2-8.

Alluvial deposits are associated with the Nogoa River and its anabranch (Figure 2-8). The Quaternary aged alluvium comprises shallow sequences of clay, silty sand and sand, underlain by discontinuous basal sands and gravel. A comprehensive network of bores listed in the EA are located in the alluvium to monitor any impact of mining on the alluvial aquifers.

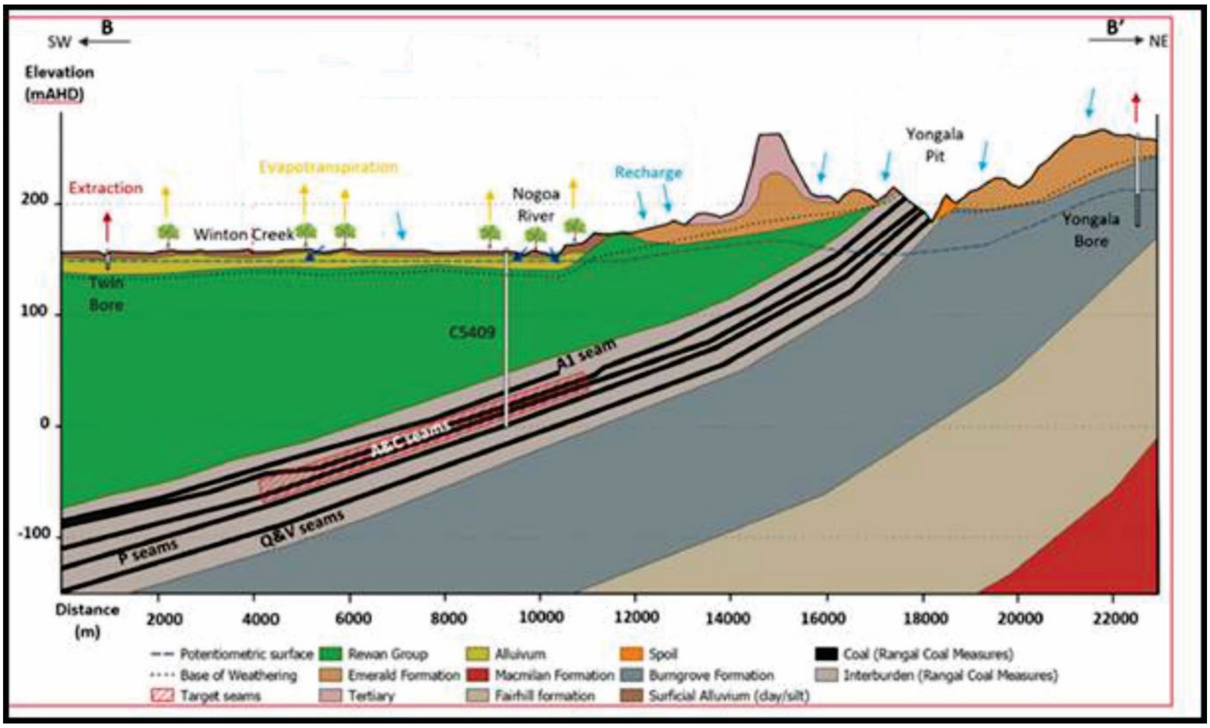

FIGURE 2-8 CONCEPTUAL HYDROGEOLOGICAL MODEL CROSS SECTION (EIS SUBMISSION, 2021).

2.6 LAND USE

Ensham mine is located within a rural setting, typical of the Central Queensland region, within the rural margins between a range of central township nodes. The largest nearby townships include Emerald, which is located approximately 35 km south-west, and Blackwater which is located 49 km south-east. The small township of Comet is located approximately 18 km south-east of the mine site.

The predominant land uses within the wider region include cropping, grazing and resource activities (Figure 2-9). The existing land uses include resource activities, cropping, grazing land and waterways with fringing riparian vegetation.

Adhering to the Cultural Heritage Management Plans, preservation areas have been established with the respective traditional owners' groups at Ensham in areas where significant amounts of culturally significant artefact materials has been located, (refer Figure 2-9). The two preservation areas are located above underground workings, both areas have been mined under, are fenced and are subject to periodic inspection.

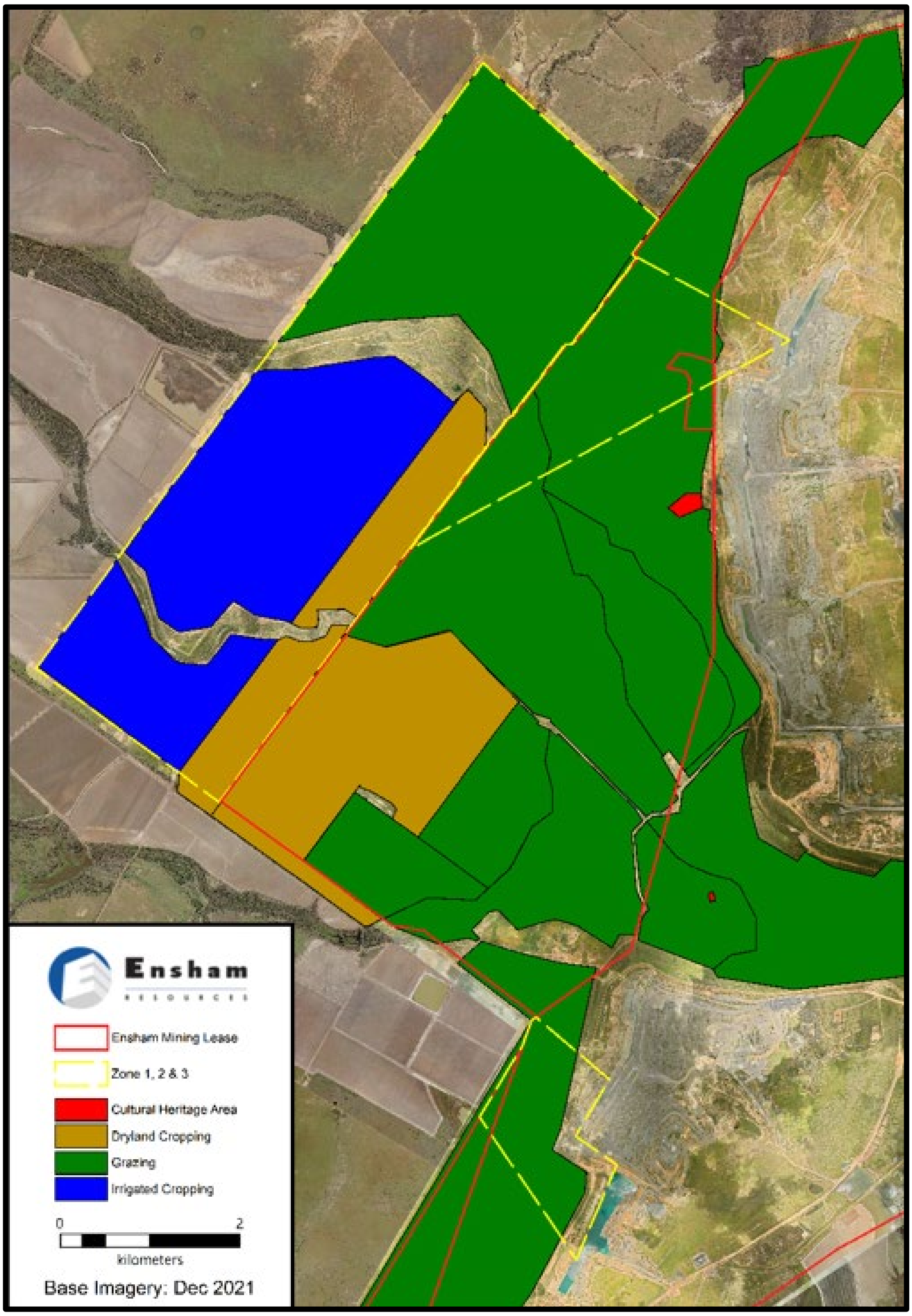

FIGURE 2-9 LAND USES AT ENSHAM MINE (2021).

2.7 BRIGALOW THREATENED ECOLOGICAL COMMUNITY

Within the mining leases and approval areas, the Brigalow (*Acacia harpophylla* dominated and co-dominated) threatened ecological community (Brigalow TEC) occurs. Brigalow TEC at the mine site is analogous with regional ecosystem (RE) 11.3.1 *Acacia harpophylla and/or Casuarina cristata* open forest on alluvial plains. It occurs as remnant and high value regrowth.

Across the Project area, there is a total of 63.66 ha Brigalow TEC occurring, with 46.1 ha in Zone 1. A total of 23.5 ha is located directly above the planned underground mining expansion area (Figure 2-10).

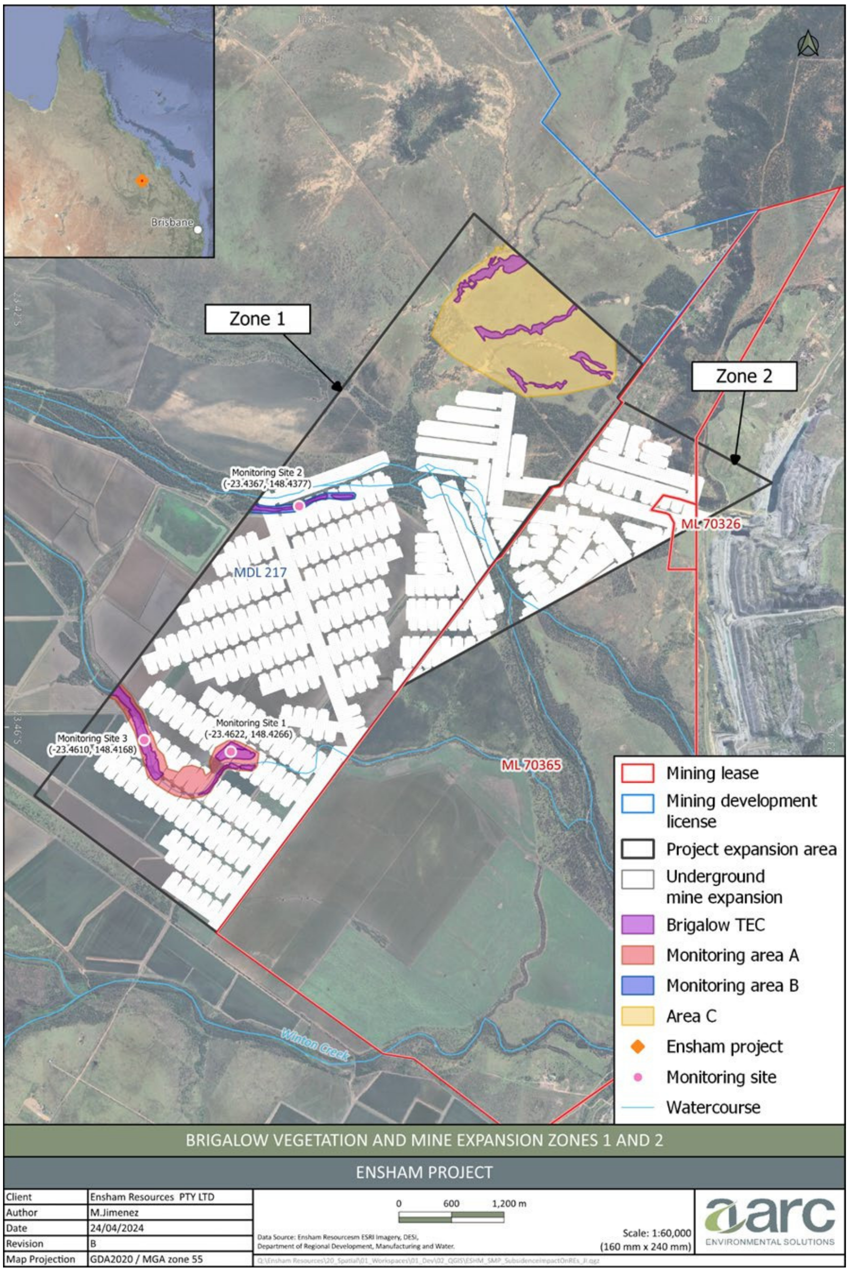

FIGURE 2-10 BRIGALOW TEC AREAS AND MONITORING LOCATIONS

3. PREDICTED SUBSIDENCE

3.1 INTRODUCTION

The bord and pillar mining layout at Ensham is specifically designed to prevent caving of the roof or collapse of the pillars. The long-term stability of the underground workings has been assessed using the design Factor of Safety (FoS), pillar dimensions (width to height ratio) and stability of the overburden.

Any subsidence that does occur will be due to strata compression. This typically results in low levels of surface lowering and minimal associated surface effects due to the associated low tilts, curvatures and strains.

The underground workings are designed where practical to avoid geological structures such as faults that may be associated with poorer mining conditions. This mining methodology minimises any potential impacts that geological structures may have on the subsidence behaviour. Seismic surveying is used to identify these structures prior to mining, allowing the optimization of the underground workings. For every panel that is mined, a hazard panel plan is produced that collates the available geological information such as:

- Location of geological structures.
- Depth of cover.
- Seam thickness.
- Seam levels.
- Roof strength.

Furthermore, the maximum excavation heights to maintain the required minimum FoS, in both the roadways and bell outs, are detailed on the Permit to Mine (PTM) for each mining area. The final roadway and pillar profiles are surveyed to confirm compliance with the design excavation heights. These checks are carried out by the Geotechnical Engineer and reported in the monthly geotechnical inspection report.

3.2 PILLAR DESIGN

The stability of the coal pillars in the Ensham underground mine are assessed using the industry accepted University of New South Wales Pillar Design Procedure to determine the design FoS as follows (Galvin et al, 1998):

FoS = Strength of Pillar/Load on Pillar

The strength and load carried by the pillars in the Ensham Area are calculated using the UNSW Pillar Design Power Strength Formulae and tributary area loading methodology respectively.

A minimum design FoS of 1.6 has been applied to ensure the long-term stability of the underground workings below the flood plain (Figure 3-1 Maximum Mining Height for a FoS of 1.6.). Where pillars are located below the flood plain, a conservative temporary flood depth of 4 m equating to an effective increase in depth of cover of 2.1 m should be applied to the load calculations in Figure 3-1.

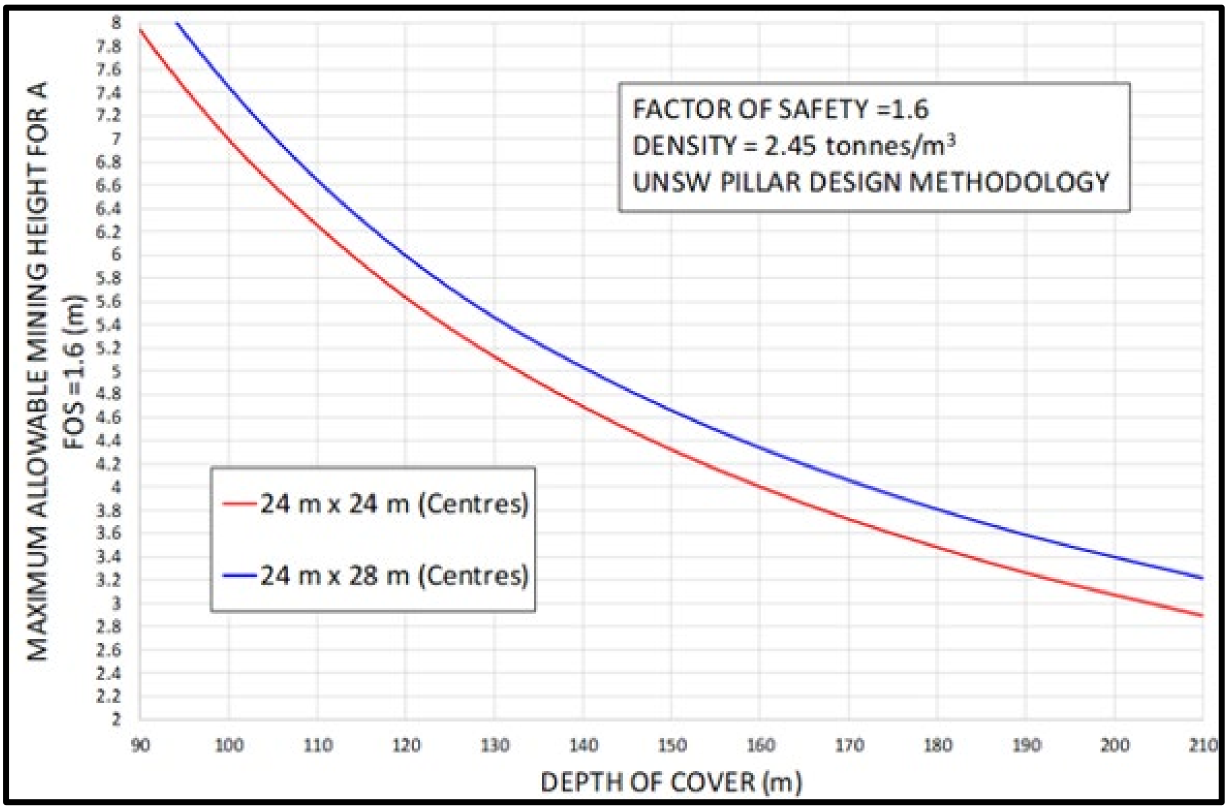

FIGURE 3-1 MAXIMUM MINING HEIGHT FOR A FOS OF 1.6.

The long-term stability of the pillars (in excess of 200 years) has been confirmed by three separate industry recognized geotechnical consultants who have peer reviewed the subsidence assessment for the extension mining area. Below the Nogoa River channel and anabranch, a FoS of 2.11 will be adopted for mining, equating to a probability of pillar failure of 1 in 1 million. Similarly, a conservative temporary flood depth of 16 m in the channel and anabranch equates to an effective 7.5 m increase in the depth of cover and will be taken into account when undertaking pillar design.

The barrier pillars between panels and sub-panels are also designed to ensure FoS values greater than 2.11, equating to a probability of failure of 1 in 1 million.

3.3 COMPRESSION ANALYSIS

The deformation induced at the surface by bord and pillar mining due to strata compression can be estimated analytically by calculating the combined pillar, roof and floor compression using modulus values as follows.

The pillar compression is then calculated as follows using the methodology of Poulos and Davis (1974) for analysing rigid footings:

$$\text{Compression}_{pillar} = (\sigma c * h)/E$$

Where:

σc = Vertical stress change (MPa)

h = Pillar height (m)
E = Young's modulus of coal pillars (MPa)

The compression of the roof and floor is calculated as follows:

$$Compression_{roof\ or\ floor} = I_P*(\sigma_c * w/2)/E$$

Where:

σ_c = Vertical stress change (MPa)
I_P = Influence Factor (for a rigid footing) = 1.4
w = Pillar width (m)
E = Young's modulus of roof or floor (MPa)

The change in vertical stress on the pillars can be estimated as:

$$\sigma_c = \text{Tributary Area Stress} - \text{Virgin Stress}$$

3.4 PREDICTED SUBSIDENCE

LIDAR has been used to determine the existence of any subsidence over previously mined areas, with no trends or evidence of subsidence being observed. Subsidence predictions for future mining areas indicate levels less than 35 mm in Zones 2 and 3, and typically less than 40mm in Zone 1, which is less than the accuracy of LIDAR and less than natural ground movement of up to 50 mm according to the Commonwealth of Australia (2014 and 2015).

In 2021, more accurate RTK (Real Time Kinematic) - GPS monitoring (with an accuracy of + /- 5mm) above mined out bord and pillar panels at Ensham has confirmed the low levels of surface subsidence as discussed in Section 4.2. It is considered that the lower accuracy (± 50 mm) LIDAR surveys will still be applicable in assessing the possibility of pillar collapses or squeezes that may have occurred in previously mined out areas.

3.5 SURFACE AND SUBSURFACE CRACKING

No surface or sub-surface cracking relating to underground mining has been observed in the Ensham underground mined area since underground bord and pillar mining began in 2011.

3.6 SUBSIDENCE IMPACTS

Underground mining at Ensham considers potential impacts to the following aspects:

- Groundwater.
- Surface water - Nogoa and Anabranch and other creeks and flood plain.
- Flora and fauna.
- Surface infrastructure (mining).
- Agricultural infrastructure including laser levelled irrigation paddocks.

- Cultural Heritage.

The expected low levels of subsidence are unlikely to result in the formation of significant depressions in the surface topography where ponding of the surface drainage may occur. This subsidence is anticipated to form in a consistent and uniform manner, without significant undulations, as a result of elastic compression of the strata i.e. compression due to the additional load on the pillars after the coal is extracted.

Furthermore, based on mining experience at shallow depths of cover in the current Ensham underground workings, as well as experience at other mining operations around the world, the risk of sinkhole subsidence occurring in Zones 1 and Zones 2 and 3, where the depth of cover is greater than 120 m and 75 m respectively, is considered to be without known precedent.

4. SUBSIDENCE MONITORING

Subsidence monitoring at Ensham comprises:

- LIDAR (+/- 50 mm accuracy).
- Photographic monitoring at designated points
- Real Time Kinematic (RTK)-GPS monitoring (+/- 5 mm accuracy).
- General surface inspections if monitoring indicates exceedance of one or more subsidence trigger levels.

4.1 LIDAR MONITORING

LIDAR provides representation of surface elevation. The points derived during a LIDAR survey are classified according to the type of surface that was reflected, where “ground” points are selected to represent ground surface. Therefore, LIDAR requires a proportion of the ground surface to be visible in order to present a ground surface elevation. Generally, LIDAR provides vertical accuracy of +/- 0.05m. The LIDAR is referenced to a common Australian Datum which are aligned to permanent survey markers. LIDAR metadata is maintained by Ensham in Australian Geodetic Datum 1984 (AGD84).

LIDAR data was collected over the underground mine initially in 2009, then on an annual basis since 2016, including areas where bord and pillar has been or will be carried out. LIDAR is collected at or about year end, each year and done so in accordance with (but not limited to) ISO 19115 as a minimum. No discernible surface movement due to subsidence has been able to be detected to date by LIDAR.

4.2 REAL TIME MONITORING

Based on LIDAR monitoring to date and more recently, fixed monitoring RTK (Real Time Kinematic) GPS stations, any ground movements resulting from bord and pillar mining are shown to be less than natural soil movement. Mitigation measures have therefore not been necessary to date for the bord and pillar mined areas.

Fixed monitor GPS stations were installed in 2021 and provide a much higher level of accuracy of +/- 5 mm than LIDAR (Figure 4-1). These stations are installed 1.5-2 m into the ground surface to be able to better determine ground movement and minimise the impact of surface soil movement.

FIGURE 4-1 FIXED MONITORING STATION 114_2

Ensham has now installed nine of these remote GPS monitoring stations above 114, 500 Mains, 502, 503, WM07, 706, and the older mined out areas 201 and 404 Panels in the current underground area (as shown in Figure 4-2**)**. Five of the monitoring stations started recording data in mid-April 2021, one in July 2021 and the other three in September 2023. By August 2024, development mining (primary workings) and second workings had been completed under all except WM07 and 706 Panel stations (Figure 4-2). In September 2023 RTK stations were setup above old workings mined out in previous years (201 Panel 2014, 404 Panel 2019).

FIGURE 4-2 LOCATION OF REMOTE SUBSIDENCE MONITORING – ENSHAM UNDERGROUND AREA.

4.3 MONITORING SURVEYS

4.3.1 500 SERIES STATIONS

In the 500 Series Panel area, no mining has been carried out below station 502_3. The 14-day moving average curve indicates any vertical movement is less than the survey error of ±5 mm (Figure 4-3). Also of note, the rainfall events since April 2021 do not appear to have significantly affected the vertical movement measured by this station (Figure 4-3). These stations are all located on vertosol soils. Please note the change in data precision from January 2023 is due to improved GPS processing data scripts introduced.

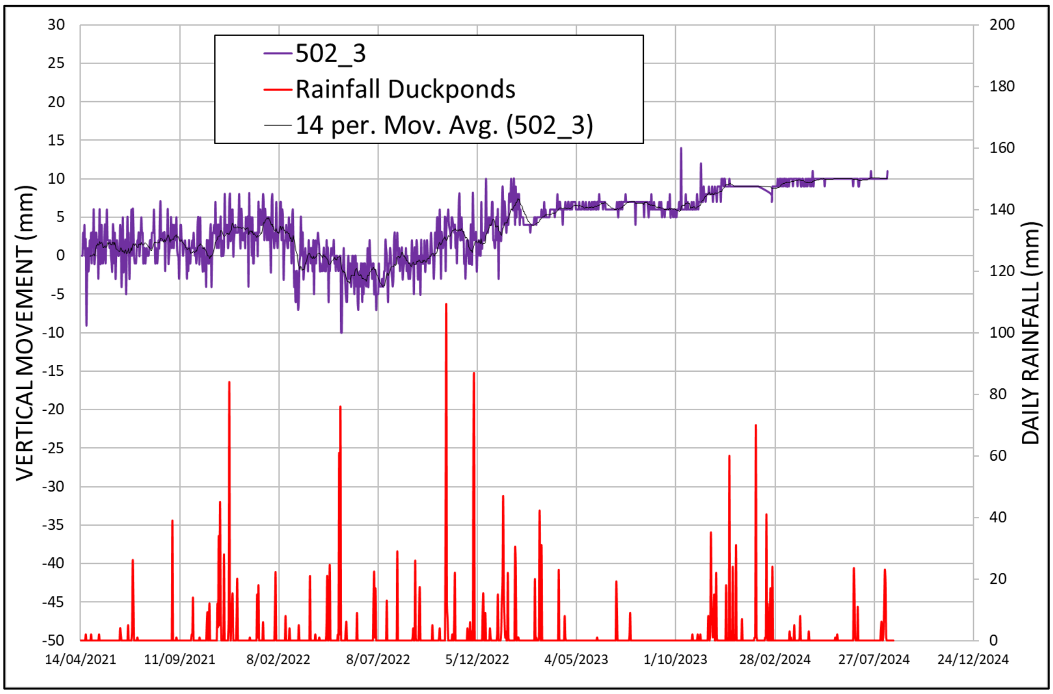

FIGURE 4-3 MONITORING DATA – 502_3 STATION.

FIGURE 4-4 MONITORING STATION 502_3

Similar observations are evident in station 503_1, where secondary extraction was carried out below this station in November 2022 (Figure 4-5). Any movement associated with mining below this station appears to be less than the survey error of ±5 mm (Figure 4-5).

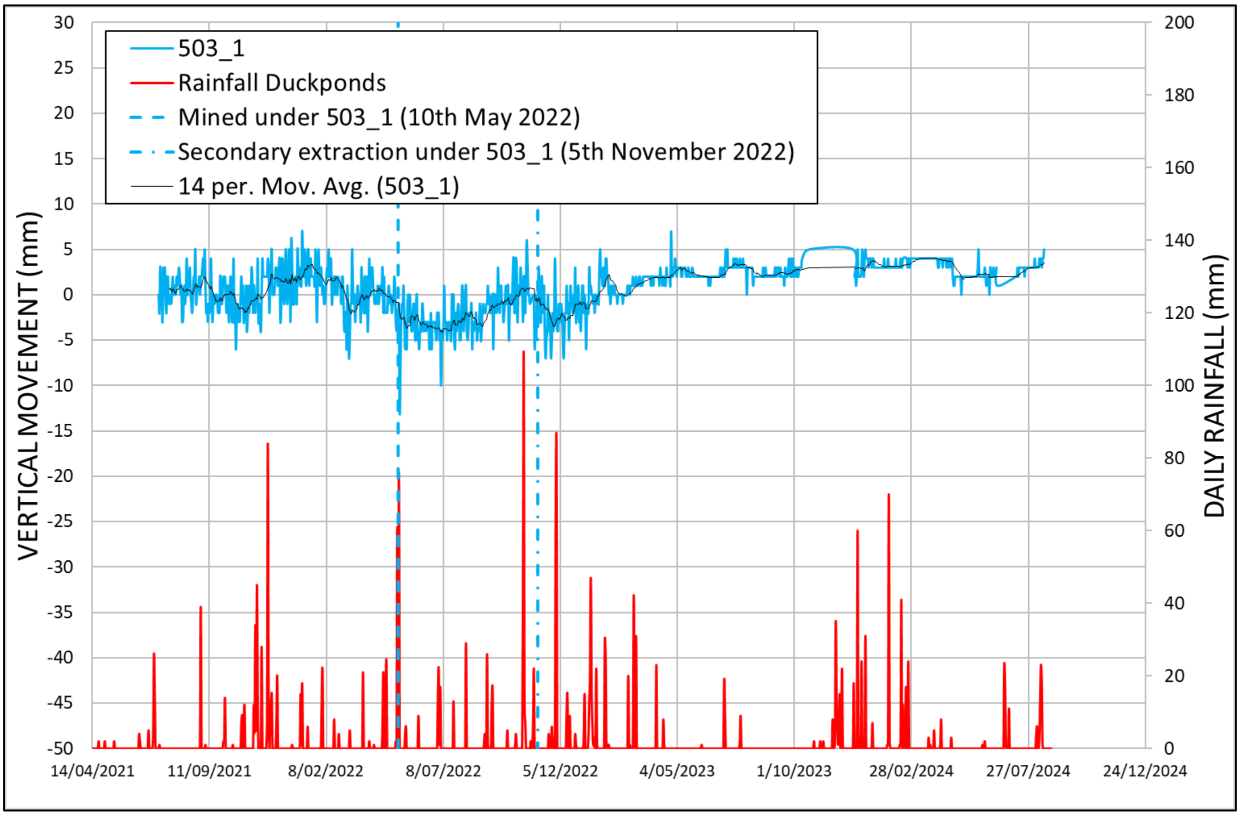

FIGURE 4-5 MONITORING DATA – 503_1 STATION

Development (primary workings) was carried out in the 500 Mains below station 502_1 in late May 2021. This mining appears to have been associated with approximately 5 mm of movement that occurred over a timeframe of a month (Figure 4-6). This timing is as anticipated based on the approximate 2 to 3 weeks required to mine the entire width of the panel below the survey station.

The reserve recovery in the 500 Mains below station 502_1 is 38.5%, at 195 m depth of cover. The FoS of the 500 Mains pillars for a 3.5 m mining height in this area is 1.90, equivalent to a probability of failure of 1 in 90,000.

502 Panel developed under station 502_2 in late August 2021, extracting coal to around 3.3 m high. Similar subsidence behaviour to 502_1 was noted on the 502_2 station (Figure 4-7). Secondary workings of an additional 1 m of floor coal were completed under this station by late September 2021, with no additional vertical movement measured (Figure 4-7). This is consistent with the methodology of the strata compression analysis, which predicts a small amount of increased settlement (less than 2 mm) at the surface due to the increase in pillar height. Similarly, rainfall events do not appear to be significantly affecting the vertical movement measurements in this area.

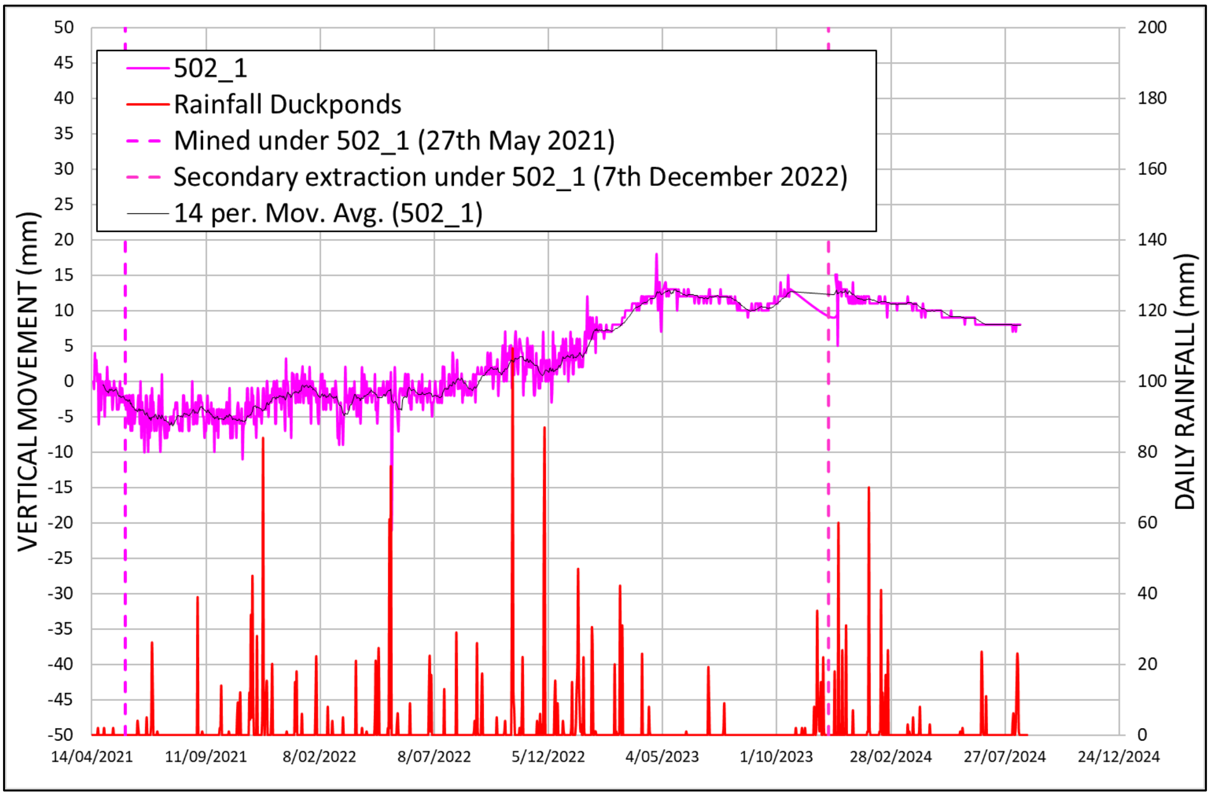

FIGURE 4-6 MONITORING DATA – 502_1 STATION.

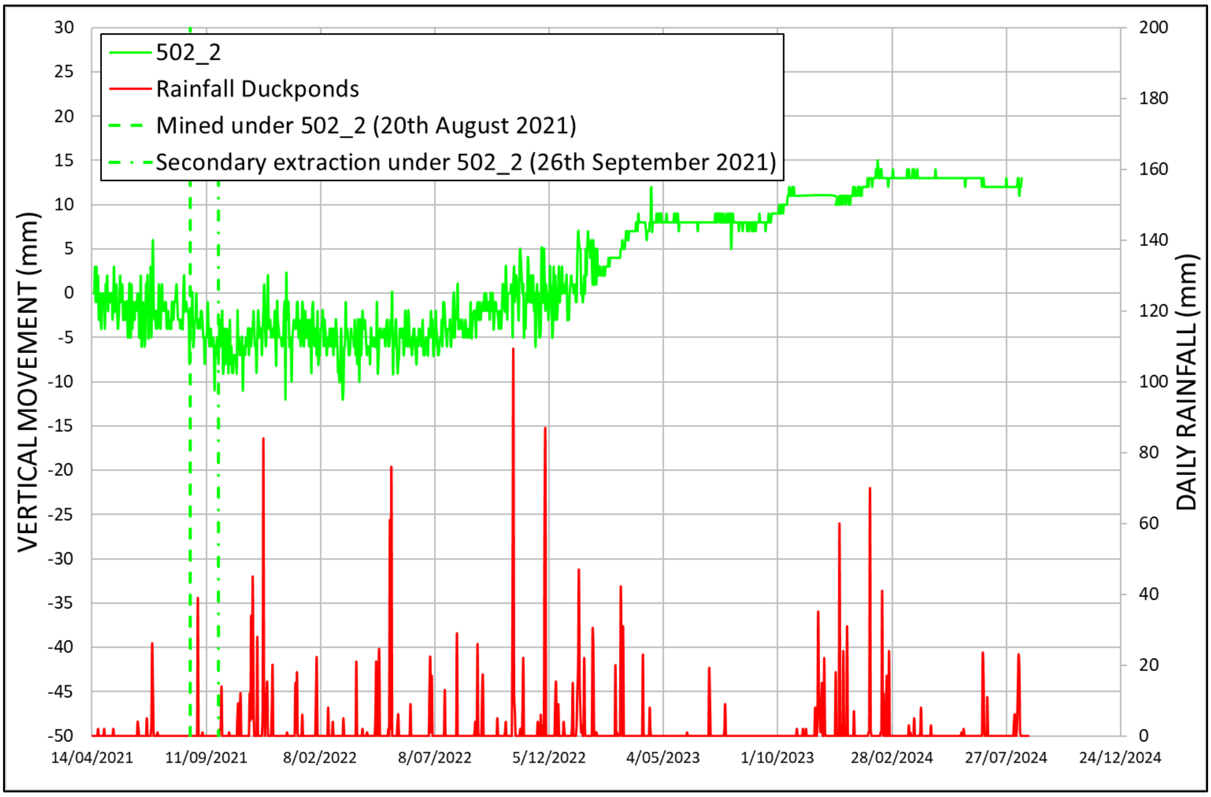

FIGURE 4-7 MONITORING DATA –502_2 STATION.

4.3.2 114 PANEL STATIONS

Mining of development roadways (primary workings) at 3.3 m high was carried out below survey stations 114_1 and 114_2 in mid-August and mid-September 2021 respectively (Figure 4-8 and Figure 4-10). Secondary extraction was completed below these stations in December 2021 and January 2022 respectively.

Prior to mining under station 114_1 (Figure 4-9), a greater amount of scatter in the data was evident (Figure 4-8). This station also appears more susceptible to changes during rainfall events, such as those in in November 2021 and May 2022, which can be attributed to the type of material in which the station is anchored. It is located higher up the slope on Kandosol soil. This RTK station was relocated to another location and is no longer monitored.

The data from station 114_2 appears less affected by rainfall and indicates around a two-week period for the maximum 8 mm of subsidence to occur (Figure 4-10). Station 114_2 is located further down the slope on Dermosol soil.

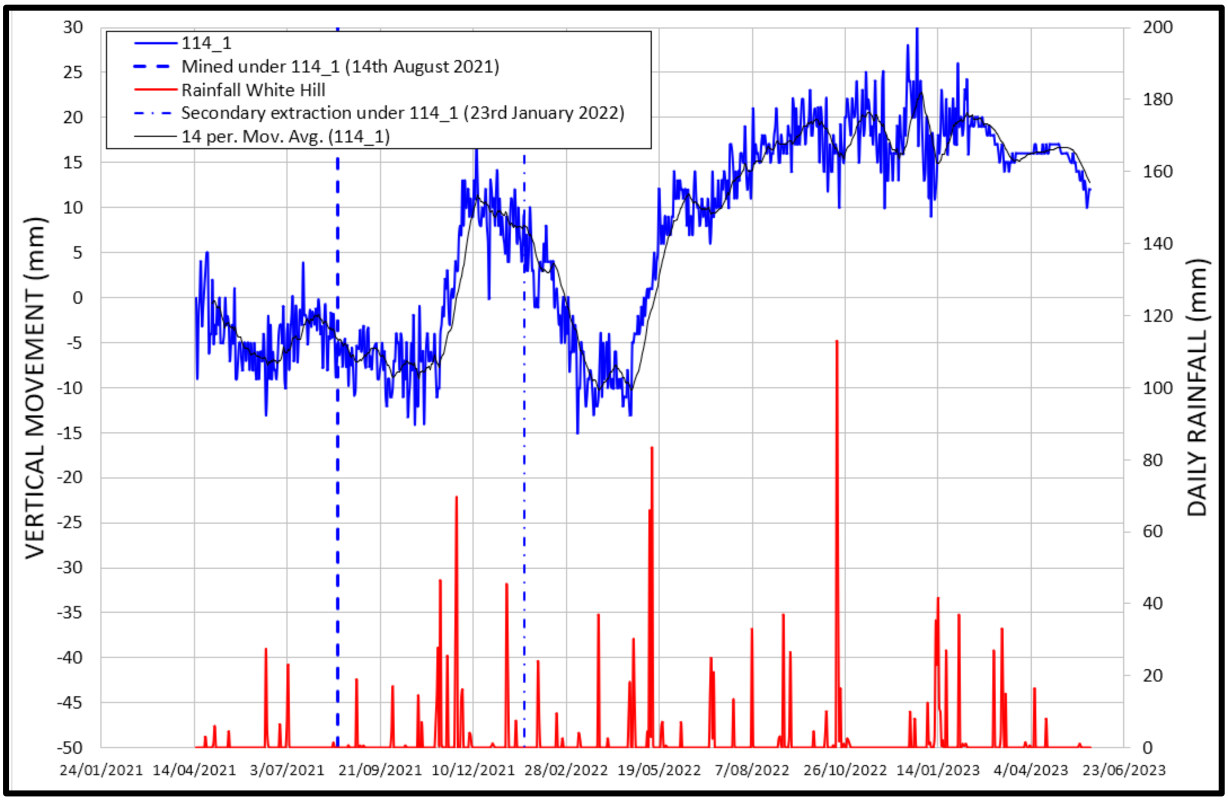

FIGURE 4-8 MONITORING DATA – 114_1 PANEL STATION.

FIGURE 4-9 MONITORING STATION 114_1 PANEL.

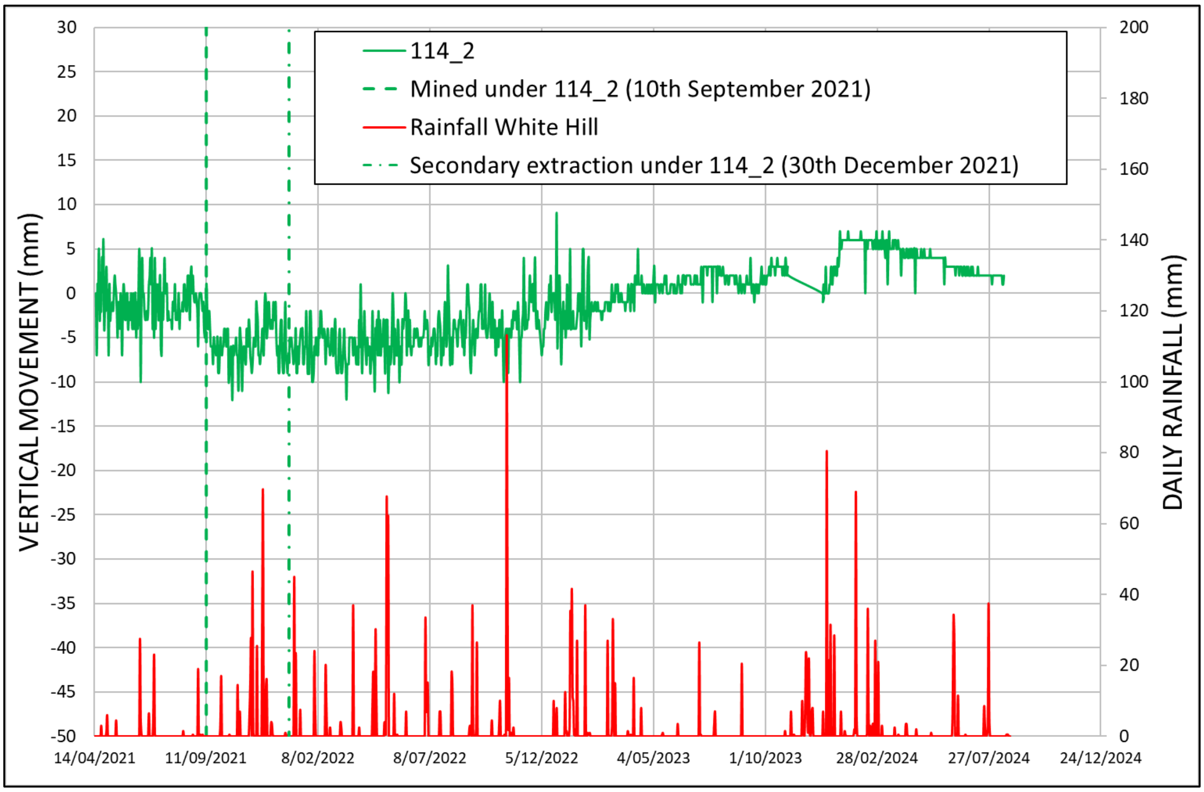

FIGURE 4-10 MONITORING DATA – 114_2 PANEL STATION.

4.3.3 OLD MINED OUT AREAS – 404 AND 201 PANELS

Mining of 201 Panel commenced in January 2014, moving to secondary extraction in April 2014 and completed in early June 2014. The 201 Panel is located adjacent to the Open Cut (OC) highwall from pit C and off ramp 3. A RTK station was setup over 201 Panel in September 2023 to monitor the long-term stability of the older workings, Figure 4-11 shows a relatively stable variation with some noise associated around rainfall.

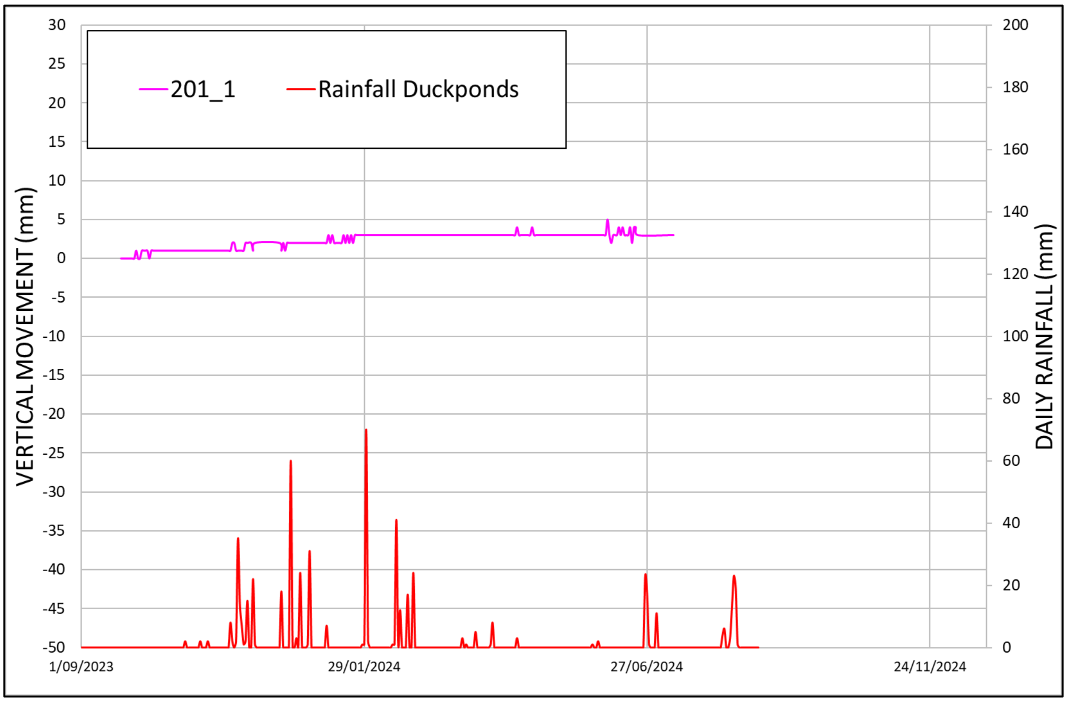

FIGURE 4-11: MONITORING DATA – 201_1 PANEL STATION.

Mining of 404 Panel commenced in August 2018, primary mining was completed early October 2018, and secondary extraction commenced March 2019 and finished in early May 2019. The 404 Panel is located adjacent to the Open Cut (OC) highwall from pit B and off ramp 3. A RTK station was setup over 201 Panel in September 2023 to monitor the long-term stability of the older workings, Figure 4-12 shows more variation with some noise associated around rainfall. The data is consistent with natural variation across the soils.

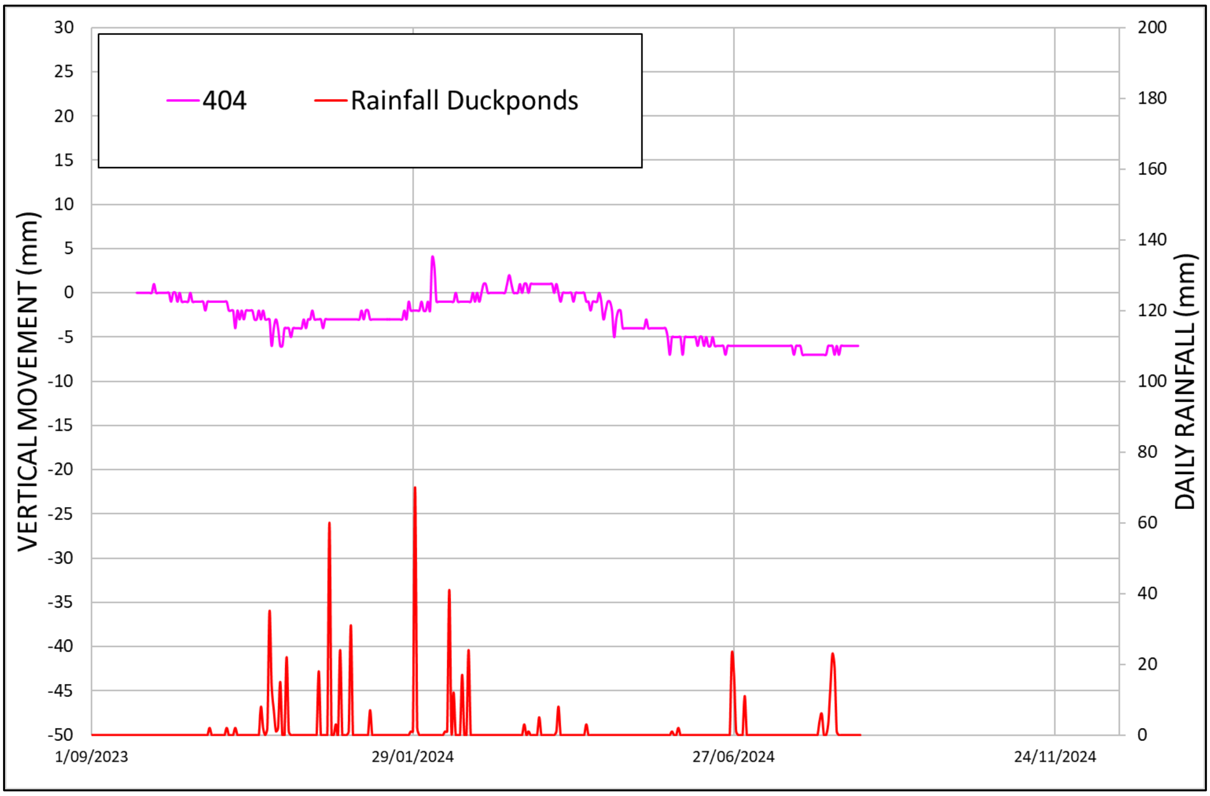

FIGURE 4-12: MONITORING DATA – 404 PANEL STATION.

4.3.4 NON-MINED AREAS – WM07 AND 706 PANELS

Mining has not been conducted within the areas of these two RTK monitors, the WM07 monitor has had mining conducted within 80 m of the location in June 2024, and the 706 Panel RTK station is located ~ 270 m from underground workings. Figure 4-13 and Figure 4-14 show movement in these two non-mining areas with variations with rainfall and more indicative of natural ground swells within the soils than mining induced changes.

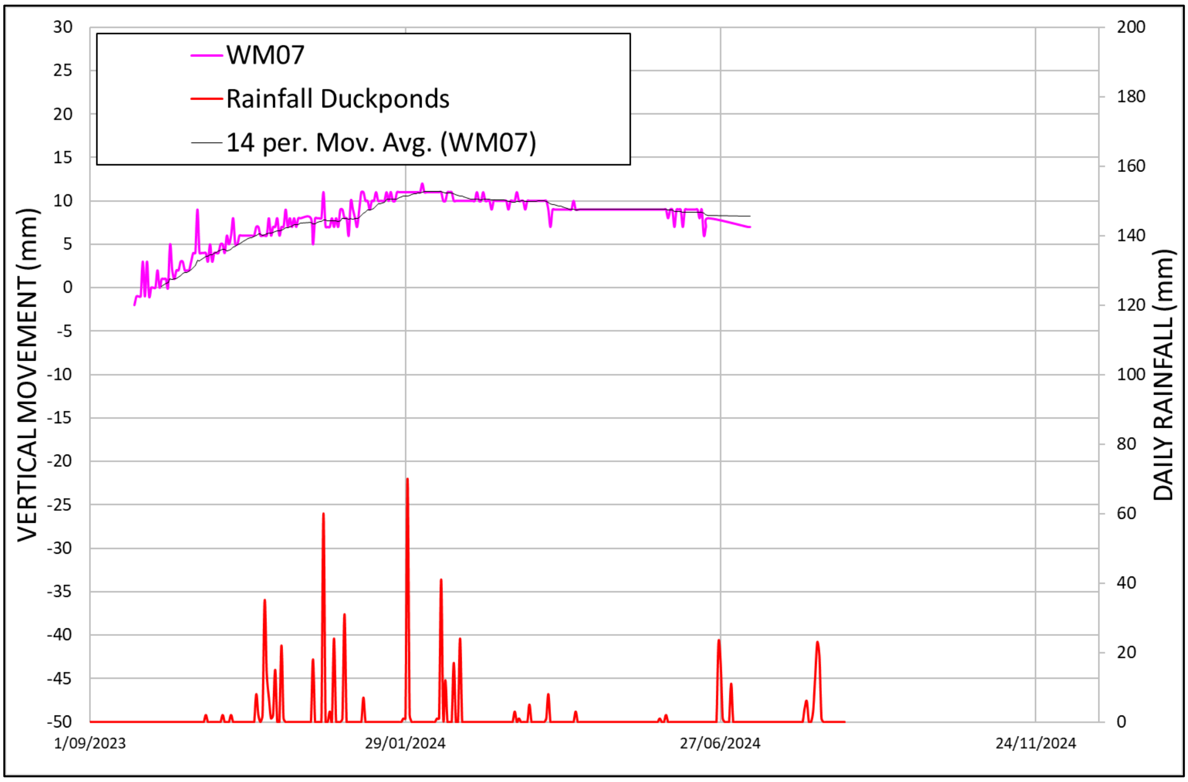

FIGURE 4-13: MONITORING DATA – 404 PANEL STATION.

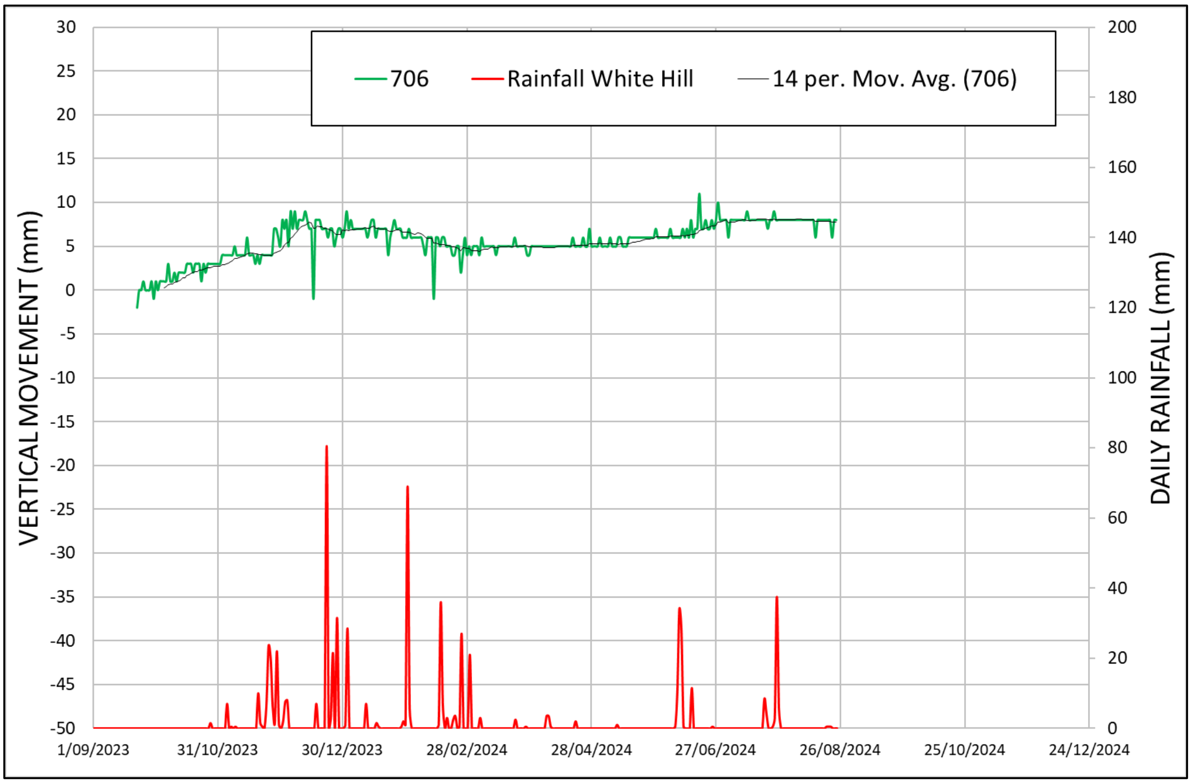

FIGURE 4-14: MONITORING DATA – 706 PANEL STATION.

4.3.5 SUMMARY

By August 2024, more than three years of higher accuracy (± 5 mm) monitoring survey data has been collected over the Ensham underground workings. This data indicates that underground mining has been associated with surface movements less than 10 mm, which is within the accuracy of the survey monitoring and validates the subsidence predictions.

It is anticipated that prior to mining in Zones 1 more data of the natural surface movement will allow interpretation to determine any subsidence movement component. This data will be reviewed in conjunction with rainfall records and the location of underground mining, to provide some guidance on the proportion of movement due to both mining induced subsidence and the seasonal variation in ground levels due to changes in moisture content.

Nine monitoring stations are installed within the mining footprint, both planned and mined. Some of the stations will be used as a control and will be located within an area which will not be subject to mining as discussed in Section 4.2. Additional monitoring stations are planned to be installed in Zone 1.

LIDAR surveys will still be required to assess surface movements over larger areas and verification with compliance conditions.

This monitoring (LIDAR and RTK) should confirm the subsidence predictions and any significant changes in subsidence will trigger a review of the relevant impact assessments and associated mitigation and management measures, as discussed further in Section 4.9.

This review will also provide additional calibration data for any future subsidence predictions and assessments of subsidence effects.

A subsidence monitoring report will be produced as required for compliance and monitoring of subsidence impacts and will be continued until rehabilitation milestones are achieved.

4.4 UNDERGROUND SURVEYING

As well as the surface monitoring, underground surveying of the completed mined roadways and pillar dimensions is carried out. The FoS and width: height ratio of the as-mined pillars can be calculated and checked against the design values.

These values can be referenced when reviewing the subsidence predictions.

4.5 SURFACE INSPECTIONS

Detailed surface inspections will be carried out on areas that have been identified through LIDAR or fixed GPS monitoring as having triggered an investigation as discussed in Section 4.8.

Any underground crossings under the Nogoa River within Zones 1 and 2 will be subject to an annual inspection of the bed and banks adjacent to the crossing to identify any visible subsidence as a result of mining operations that may impede on fish passage.

4.6 COMPLIANCE

4.6.1 PRCP APPLIES TO ALL UG MINING AREAS

The PRCP requires that:

- The extent and frequency of surface cracking and ponding of the mined land is comparable to the unmined land.
- Drainage features within the subsided areas is comparable with the pre-mining drainage features of the land as confirmed by a LIDAR Survey.

Photographic monitoring within mined panels and adjacent unmined areas will be used to confirm that cracking and ponding is comparable between the two areas as proof towards achievement of PRCP Schedule Milestone RM12.

Annually a drainage map will be produced from LIDAR over mined areas and compared to pre-mine drainage to confirm no change to drainage features, as proof towards achievement of PRCP Schedule Milestone RM12.

4.6.2 RIDA APPLIES TO ZONES 2 AND 3

The RIDA requires that:

- LIDAR is based on common geodetic datum.
- LIDAR metadata must be collected to any relevant Australian Standard.
- LIDAR data must be captured at the same time each year.
- Levels of subsidence must not exceed:
    - 100 mm of vertical subsidence.
    - A tilt of less than 5mm/m measured over 20 metres.
- An Erosion and Sediment Control Plan is developed and implemented.
- Photographs of flare sites – date and GPS stamped of:
    - Pre-disturbance site conditions.
    - Post-restoration site conditions.
- A report is lodged within 3 months of removal of bore casing.

Annually the LIDAR surface for Zones 2 & 3 will be collected (in accordance with Section 4.1) and compared with the LIDAR surface from the previous year with the threshold set at 100mm. Any areas where the surface has greater than 100mm difference will be investigated to determine if it could be related to underground mining activities or is natural or agricultural processes. If the subsidence is less than 100mm than the tilt must be within acceptable criteria.

Strategies and actions outlined within the Erosion and Sediment Control Plan will be carried out at the flare locations. This will also include photographic records.

Photographic monitoring points within Zones 2 & 3 will be established and recorded over the duration of mining activities to detect and record any changes due to mining activities over time. The photographs are to be date and GPS stamped.

4.6.1 EPBC 2020/8669 APPLIES TO ZONES 1, 2 AND 3

The EPBC approval requires:

- This SMP must reliability predict subsidence that may cause harm to protected matters i.e. Brigalow.
- Subsidence levels must not exceed 500mm compared to pre-mining levels.

This is detailed more in Section 5.

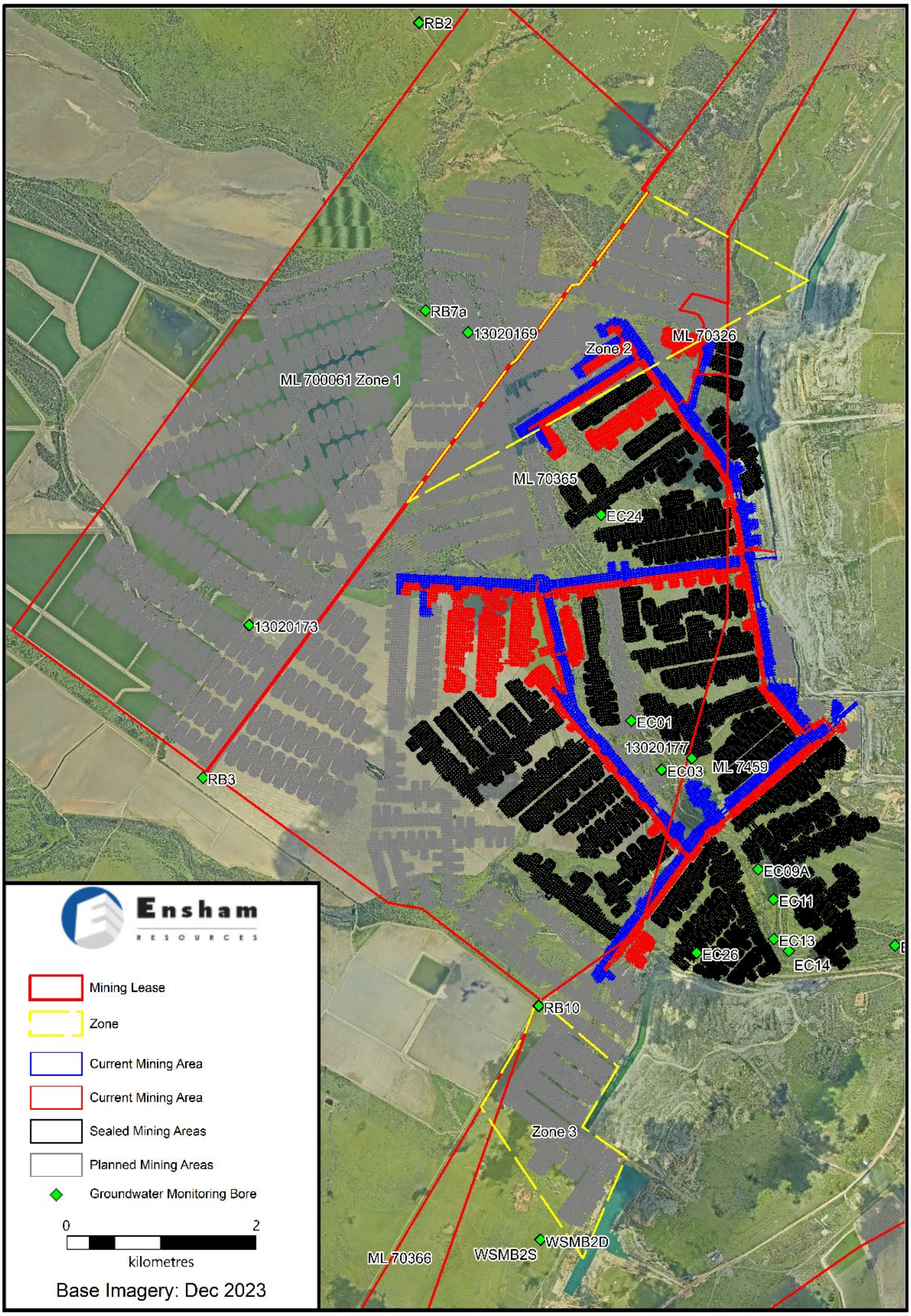

FIGURE 4-15 GROUNDWATER MONITORING BORES.

4.7 MONITORING SCHEDULE AND TRIGGER LEVELS

The monitoring schedule for the various aspects detailed in this SMP are summarized in Table 4-1. This schedule also includes the frequency and responsible department. Trigger levels based on various approvals for Zones 1 2 and 3 have also been specified to initiate a review. The Fixed GPS trigger is slightly higher in Zone 1 compared to Zones 2 and 3 due to the increased depth of cover.

TABLE 4-1 MONITORING SCHEDULE FOR SUBSIDENCE.

Monitoring/ Survey	Who by	How often	Trigger Levels – Zone 1	RIDA Trigger Levels – Zones 2 and 3	EPBC Trigger Levels – Zones 1, 2 & 3
LIDAR	Technical Services/Survey	Annual	>100 mm movement when LIDAR surfaces are compared on an annual basis	>100 mm movement when LIDAR surfaces are compared on an annual basis	500mm
Fixed GPS	Technical Services/Survey	Real Time	40 mm	35 mm	500mm
Surface Surveying	Technical Services/Survey	As per land compensation agreements	As per land compensation agreements	As per land compensation agreements	As per land compensation agreements
Underground Surveying	Survey	Daily	As per Strata Control Management Plan	As per Strata Control Management Plan	As per Strata Control Management Plan
Surface Inspections	Environmental	Annual or if investigation is triggered	Surface inspections will be instigated from LIDAR results. Water ponding, new gully erosion or changes to Nogoa Riverbed and banks (that may indicate an impact to fish passage) not	Surface inspections will be instigated from LIDAR results. Water ponding, new gully erosion or changes to Nogoa Riverbed and banks (that may indicate an impact to fish passage) not attributed to natural processes at	As required when the subsidence trigger is reached.

			attributed to natural processes at locations where underground mining has occurred	locations where underground mining has occurred	

4.7.1 SUBSIDENCE TRIGGER LEVELS

Based upon the accuracy of LIDAR (+/-50 mm) and the natural soil variation of 50 mm (Commonwealth of Australia, 2014 and 2015), a LIDAR trigger level of 100 mm lower than the previous annual LIDAR surface survey is considered a realistic value for cracking clay soils and other soils located on slopes to investigate.

Similarly, a 35 mm variation in the more accurate fixed pole RTK-GPS ground monitoring is considered a valid trigger level based on the initial monitoring over 114, 500 Mains, and 502 Panels (Figure 4-3 to Figure 4-10), which is based on the magnitude of the predicted subsidence as per the Subsidence Report for the Ensham Life of Mine Extension – Zones 2 and 3, February 2022, and the Subsidence Report for the Ensham Life of Mine Extension – Zone 1, June 2022.

4.8 SUBSIDENCE MANAGEMENT MEASURES

Due to the low-level subsidence effects measured and observed as a result of bord and pillar mining at Ensham, remedial management measures are presently not required unless a significant deviation in the level of subsidence is identified from future monitoring. The subsidence monitoring results detailed in Section 4.3, confirm the surface movements due to mining of less than 10 mm. This level of movement requires no remediation in view of the natural soil variation, which may exceed 50 mm (Commonwealth of Australia, 2014 and 2015).

Any significant detection of subsidence (i.e. where the level of subsidence exceeds the trigger levels) will trigger a review of underground mining activities as detailed in Section 4.8. Depending on the land use and risk involved in the activity, different mitigation measures may be required:

- Grazing – rip to eliminate risk to stock.
- Dry land cropping – plough out if effecting crop yield.
- Irrigated cropping – re-level to ensure continued drainage.
- Brigalow TEC – offsets.

Where surface levels indicate a difference in elevation greater than the trigger levels in Table 4-1 an investigation will be undertaken by Ensham. Where the RIDA trigger levels are exceeded, the investigation undertaken must identify if the subsidence is likely a result of mining activities. If the investigation supports that the elevation change is associated with mining, then a detailed investigation will be completed by a suitably qualified person and, where warranted, an investigation report will be prepared and submitted to the Administering Authority and to the landowner/land occupier. The investigation will nominate the necessary rehabilitation (which may include monitoring and management of soil erosion) to be undertaken if necessary. Land will be rehabilitated in accordance with the approved PRCP and the current Environmental Authority.

If subsidence monitoring identifies a potential impact to fish passage within the Nogoa River as a result of mining activities, then rehabilitation and restoration works would be undertaken. The trigger levels based on monitoring, surveying and inspection are detailed in Table 4-1. These trigger levels would be reviewed annually (or following an investigation) to ensure that there are no impacts to fish passage in the Nogoa River. Furthermore, the stability of the underground workings is checked by regular inspections. In the current underground workings, the thickness of floor coal is controlled during the mining process by spray painting the rib side to ensure the mined thickness does not exceed the amount specified on the sequence plan and Permit to Mine document (Figure 4-16).

The actions to be taken after exceedance of the EPBC trigger are detailed in Section 5.

Ensham's existing design, processes and monitoring target management of subsidence by prevention. In regard to long-term stability, after mining is completed and the workings are flooded with groundwater, the buoyancy effect of the groundwater will reduce the vertical load on the pillars by up to 40%. For a pillar below the Nogoa River anabranch, designed with a FoS of 2.11, at 140 m depth of cover, reducing the vertical load on the pillar by a conservative 25%, to account for any potential strength loss in the coal and surrounding strata, increases the FoS to 2.82. This FoS has a probability of failure in excess of 1 in 10,000,000. As well as the factor of safety approach, the long-term life expectancy of pillars can be estimated using empirical studies from South Africa. Using this methodology, the pillars are calculated to be stable well in excess of 200 years.

Furthermore, as detailed in Section 3.1, underground surveying of the completed mined roadways, bell outs and pillars is carried out. The FoS and width: height ratio of the as-mined pillars can be calculated and checked against the design values. These checks are carried out by the Geotechnical Engineer and reported in the monthly geotechnical inspection report. Experience to date has shown that there have been no exceedances of the planned mining heights in the secondary workings' panels at Ensham.

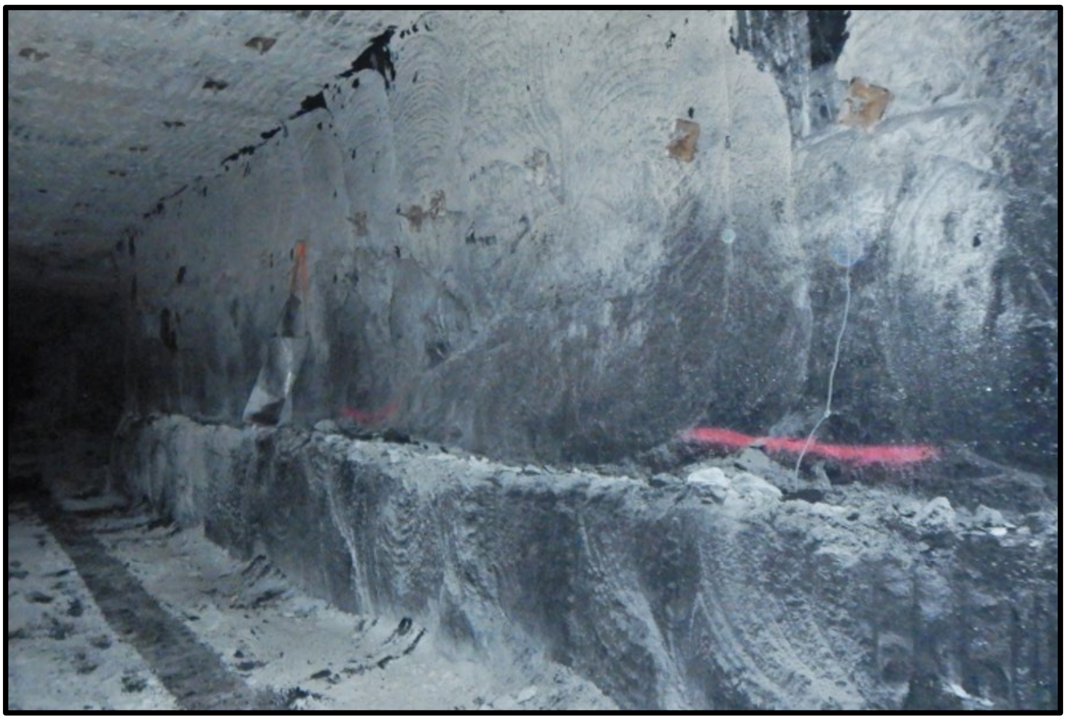

FIGURE 4-16 PAINT MARKS TO CONTROL THE THICKNESS OF FLOOR COAL MINED.

Underground mining is proposed beneath the Nogoa River main channel, with mining only to occur at FoS of 2.11 (Figure 1-1). Surface inspections for impacts from subsidence on the Nogoa River will be completed. Some underground mining is planned under the Nogoa River anabranch in Zone 2; however, this channel only holds water at times of flooding and therefore provides limited fish passage compared to the Nogoa River main channel.

4.9 EMERGENCY PROCEDURES

A principal hazard management plan, PHMP (UG PHMP.09.17.01 Precautions Against Inrush Principal Hazard Management Plan) defines the requirements for the effective control of the risks associated with Inrush and the principal hazard of inundation due to water, gas, or material that flows, in the underground workings of Ensham Coal Mine. It applies to all aspects, activities and personnel associated with underground coal mining at Ensham Resources Pty Ltd. The objective is to identify areas where inrush or inundation could occur, and to prevent such occurrences. It also provides for the requirements of the Coal Mining Safety and Health Regulation 2017 (CMSHR) Sections 292, 293, 294, 295. The management plan is underpinned by Risk Assessment (RA.BT014 Inrush into underground workings) and Trigger Action Response Plan, TARP (UG TARP.09.17.01-01 Potential for Inrush Underground TARP).

Non-routine situations such as an incident or natural disaster that has the potential to impact Brigalow vegetation is discussed in Section 5.5.2.

5. POTENTIAL IMPACTS ON BRIGALOW TEC

5.1 Introduction

The mining activities are approved under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), with approval requirements to manage the impact of subsidence on Brigalow Threatened Ecological Community (Brigalow TEC). This plan includes requirements to address the condition requirements of EPBC 2020/8669 approval, being to develop a subsidence monitoring and management plan. The risk of Brigalow TEC being impacted by subsidence attributed to the Project is low (likelihood is rare, with minor environmental consequences). This is due to the limited subsidence depths expected. The main requirements to manage the subsidence impact associated with mining activities on Brigalow TEC will be:

- Monitoring to demonstrate no significant impacts on Brigalow have occurred despite Project subsidence levels; and
- Implementing correction actions to be taken if nominated trigger values are achieved.

5.2 Potential Impacts

The risk of Brigalow TEC experiencing a significant impact from the Project subsidence is low. This is based on studies investigating subsidence impacts on Brigalow and other vegetation in the brigalow belt of Queensland. No significant impacts have been observed, despite the subsidence levels being greater than 3 m (BHP 2023a, 2023b; Eco Logical Australia 2015). In the Project, the potential impact on Brigalow TEC, if any, would be in the area along the Nogoa River and a patch in the southwest corner of Zone 1. The two locations are described as area A and B in Figure 2-10.

5.2.1 Subsidence Trigger Value to Monitor for a Significant Impact to Brigalow TEC

Studies from the literature review have indicated that Brigalow has not been impacted by subsidence movements of up to 3 m, with similar findings from studies assessing subsidence movements of between 2.4 and 2.9 m. As a highly conservative measure, it is proposed that a subsidence trigger value of 500 mm is selected for Ensham mine. This depth substantially exceeds the predicted subsidence depth for the Project and is significantly lower than the depth addressed in related studies that did not result in any impact to Brigalow.

The trigger value is considered appropriate to differentiate between normal ground movement, whilst capturing any potential impact from subsidence. As no impacts have been recorded where 3 m of subsidence has occurred, 500mm is considered appropriate to identify potential impacts from the Project subsidence on Brigalow TEC.

5.3 Brigalow Monitoring

Brigalow vegetation monitoring is proposed to consist of monitoring for two different purposes: pre-activity condition/baseline assessment; and Brigalow TEC impact monitoring when the subsidence is exceeded (Sections 5.3.1 and 5.3.2). The timing for each monitoring purpose is outlined in Figure 5-1.

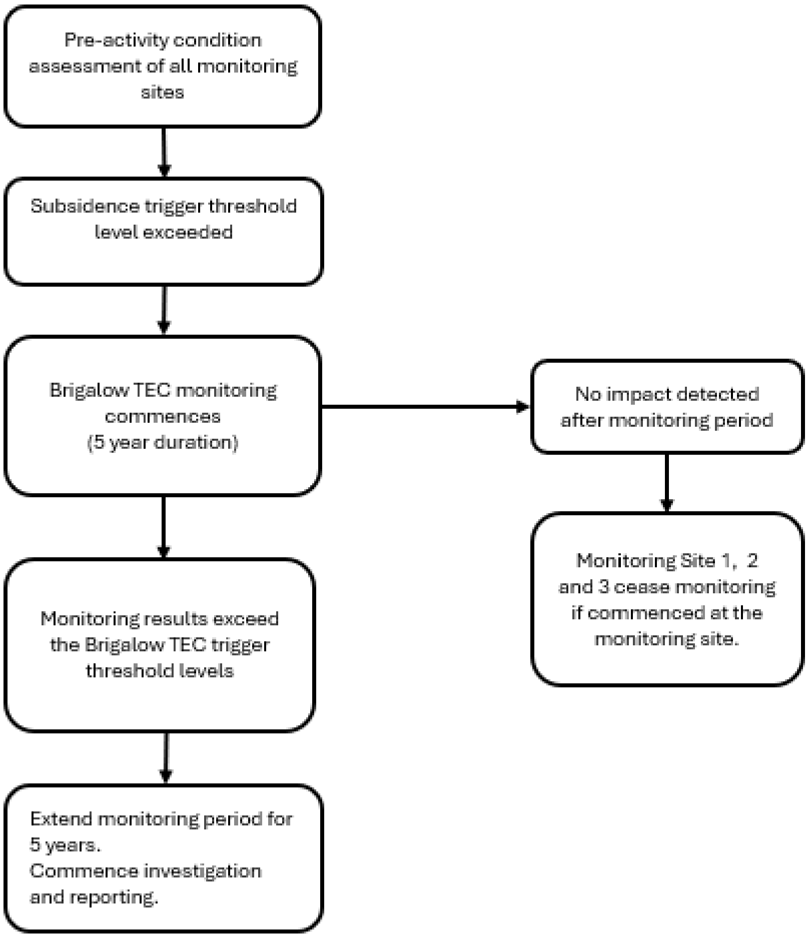

FIGURE 5-1 PROCESS TO DETERMINE MONITORING BRIGALOW TEC

5.3.1 PRE-ACTIVITY CONDITION ASSESSMENT

In the pre-activity condition assessment, three monitoring sites are proposed to be established to assess the condition of the Brigalow TEC using BioCondition and photo monitoring methods as the pre-mining/subsidence baseline (Figure 2-10). One round of measurements is proposed to be undertaken before mining commences at each monitoring site. The proposed monitoring sites are provided in Table 5-1.

5.3.2 BRIGALOW TEC SUBSIDENCE IMPACT MONITORING

The measured subsidence records may indicate a deviation, or an increased level of subsidence, from the level of subsidence predicted. Subsidence will be detected using the existing methods outlined in Section 4.1 and 4.2 of the SMMP. The existing measures in the SMMP will also be used to identify the level of subsidence that has occurred.

After underground mining activities have commenced, it is proposed that the monitoring sites, set up in the pre-activity condition assessment (Section 5.3.1) will be used for monitoring purposes if the trigger value for subsidence (Section 5.2.1) is exceeded during operations.

Brigalow TEC monitoring at the monitoring sites will only be undertaken after subsidence has been detected at a specific location.

Health of the Brigalow TEC is proposed to be verified by:

- annual photographic monitoring; and
- BioCondition monitoring conducted every two years; and
- the use Normalised Difference Vegetation Index (NDVI) assessment.

The methods are further described in Section 5.3.

With the proposed mining schedule, monitoring would be undertaken at monitoring sites 1 and 2, before monitoring site 3. Monitoring assessment methods are proposed to be undertaken, as stated in Table 5-2.

When the measured subsidence exceeds the trigger value without the Brigalow threshold triggers being exceeded, the process described in Section 5.5.1.1*,* will be undertaken.

If a decline in Brigalow vegetation condition is detected, the notification process and investigation process will be triggered. The process is described in Section 5.4.1 and 5.4.2. Monitoring under this scenario is proposed to be undertaken for a duration of a further five years if a significant impact on Brigalow TEC from subsidence is confirmed by ecologists. The confirmation would require evidence and an evaluation report.

5.3.3 MONITORING SITE LOCATIONS

The Brigalow TEC occurs in two distinct linear shaped areas above the proposed underground mining; monitoring area A is approximately 19.8 ha; and monitoring area B is a smaller area of 3.7 ha. Three monitoring sites have been selected to ensure adequate monitoring in the two areas (Table 5-1). Proposed locations may be adjusted based on local conditions such as accessibility.

TABLE 5-1 LOCATION OF MONITORING SITES

Monitoring Site	Latitude (GDA 94)	Longitude (GDA 94)	Pre-activity indicative year to be undertaken, or prior to nominated date	Brigalow TEC subsidence impact monitoring
Monitoring Site 1 (Area A)	-23.4622	148.4266	2030	TBD, if subsidence monitoring during operations exceeds trigger level.
Monitoring Site 2 (Area B)	-23.4367	148.4377	2030	TBD, if subsidence monitoring during operations exceeds trigger level.
Monitoring Site 3 (Area A)	-23.4610	148.4168	2030	TBD, if subsidence monitoring during operations exceeds trigger level.

Monitoring site 1 in monitoring area A was selected because it is the location of the site used in previous Brigalow assessment studies; existing data can be used for background information and there will be similar data parameters used to continue monitoring the site; and it appears to be within the polygon avoiding edge effects.

Two new monitoring sites are to be established. Site 2 in monitoring area B, and site 3 in monitoring area A (Table 5-1). These two sites have been selected because of the occurrence of Brigalow TEC within the area of potential subsidence; to be less exposed to edge effects; and the proposed scheduled mining in that area. Monitoring may be undertaken at the four separate patches (four monitoring sites) in Area C, if the mine plan is revised and potential subsidence may result in that area.

5.3.4 BRIGALOW TEC MONITORING ASSESSMENT METHODS

Brigalow monitoring at Ensham mine will use Queensland industry established qualitative and quantitative vegetation methods:

- Photographic monitoring at monitoring sites;
- BioCondition at monitoring sites; and
- Remote sensing using the Normalised Difference Vegetation Index (NDVI).

The proposed indicative monitoring schedule is provided in Table 5-2. Each method is described in the sections following. A review of the methods and the schedule for monitoring will occur as the monitoring results are analysed. Monitoring results and data records will be stored in electronic format by the mine. They will be used for annual reporting as required.

The frequency, purpose, accountable role, and benchmarks to be measured are provided in Table 5-3.

TABLE 5-2 MONITORING PURPOSE AND SCHEDULE FOR BRIGALOW TEC

Monitoring/ Assessment method	Monitoring stage	Role responsible for monitoring	Frequency	Benchmarks being monitored for
Photographic Monitoring	Pre-activity condition assessment Brigalow TEC subsidence impact monitoring	Environmental Advisor	Pre-activity condition assessment, then annually.	Mortality of multiple tree and shrub individuals at monitoring site.
BioCondition Assessment	Pre-activity condition assessment Brigalow TEC subsidence impact monitoring	Consultant Ecologist	Pre-activity condition assessment, then every 2 years.	Biocondition Score decline by 10; and 'Tree Canopy Cover' aspect declined by 5 from initial assessment.
NDVI	Exceeded trigger value monitoring.	Spatial specialist	As required based on trigger value of photographic or BioCondition monitoring, or if	Median NDVI value fails to maintain a value greater than the first quartile of the reference site for at least 85% for any sample event.

	May be used to validate site monitoring results.		trigger threshold value exceeded.	

5.3.4.1 PHOTOGRAPHIC MONITORING

Photographic monitoring will adopt the method described in the Guide to photo monitoring of ecological restoration projects (NSW Office of Environment and Heritage 2018) and be undertaken annually. Photographic monitoring is recommended as it is a rapid method and provides a relatively direct way to measure changes in vegetation and provides on ground evidence of vegetation condition (NSW Office of Environment and Heritage 2018).

An annual monitoring frequency for five years is proposed for photographic monitoring if the subsidence trigger level is exceeded, as subsidence impacts on Brigalow condition are not expected to be immediately noticeable.

5.3.4.2 BIOCONDITION ASSESSMENT

Biocondition assessment is recommended as it can quantitatively measure vegetation composition, structure and function (Eyre et al. 2015). Combined with photographic monitoring, the methods provide detailed information on vegetation condition that are complementary when used at different frequencies, and they diversify the data collected. Both photographic and Biocondition field-based methods are proposed to be used to measure and monitor vegetation. They are considered suitable to provide reliable records for vegetation condition and evaluate vegetation changes through time.

Biocondition assessment is proposed to be the primary assessment method to quantitatively measure vegetation condition. It will be undertaken according to the BioCondition Assessment Manual (Eyre et al. 2015). The assessment will be conducted twice within the five-year period if the subsidence trigger threshold is exceeded.

5.3.4.3 NORMALISED DIFFERENCE VEGETATION INDEX (NDVI)

Normalised Difference Vegetation Index (NDVI) is recommended as a method to measure change throughout the entire TEC area. Based on vegetation colour, it is a commonly used vegetation imaging system to provide insights into vegetation condition for a broader vegetation area (Eco Logical Australia 2015).

Non-impacted Brigalow TEC in area C can be used as a reference area to provide a comparative baseline for the other areas above the mining area (Brigalow TEC in area A and B). By comparing the NDVI collected from each monitoring area with reference area C, Brigalow TEC with a median NDVI value 15% less than the first quartile of the reference site at any sample event throughout the year will trigger a field verification assessment.

5.3.5 BRIGALOW TRIGGER THRESHOLD LEVELS TO TRIGGER AN INVESTIGATION

If the subsidence trigger level is reached (>500mm), and monitored thresholds for photographic monitoring, NDVI and BioCondition assessments have been exceeded (Table 5-3), an investigation will be required (Section 5.4.1). Further justification for each threshold is also provided.

TABLE 5-3 TRIGGER THRESHOLD LEVELS FOR EACH MONITORING ASSESSMENT METHOD TO TRIGGER AN INVESTIGATION

Assessment method	Threshold to trigger additional requirements
BioCondition assessment	Total score declines by 10, and 'Tree Canopy Cover' score declines by 5.
Photographic monitoring	Photographic monitoring detects mortality of multiple trees and shrubs.
NDVI	Median NDVI value fails to maintain a value greater than the first quartile of the reference site for at least 85% for any sample event.

The total BioCondition score provides an overview of the vegetation, including grasses and shrubs. A decline by 10 indicates an overall condition decline in the vegetation. The 'Tree Canopy Cover' is one of the aspects in BioCondition that characterises stand productivity, distribution and abundance of biomass of the tree component (McElhinny 2002). A change in both total score and tree canopy cover will identify a decline in the Brigalow TEC condition.

At any particular location, it is acknowledged that individual plants will naturally senesce over time. The trigger for photographic monitoring at the site will be when mortality of multiple individual trees and shrubs are observed at the monitoring site.

Brigalow TEC productivity can be measured using NDVI, and if there is a significant decrease in the median NDVI value, it can indicate a change in TEC condition.

5.4 Complying with EPBC Approval

This section outlines the requirements for notifying investigating and reporting, to address the EPBC approval. The diagram (Figure 5-2) identifies when each will be required, and the following sections provide further detail.

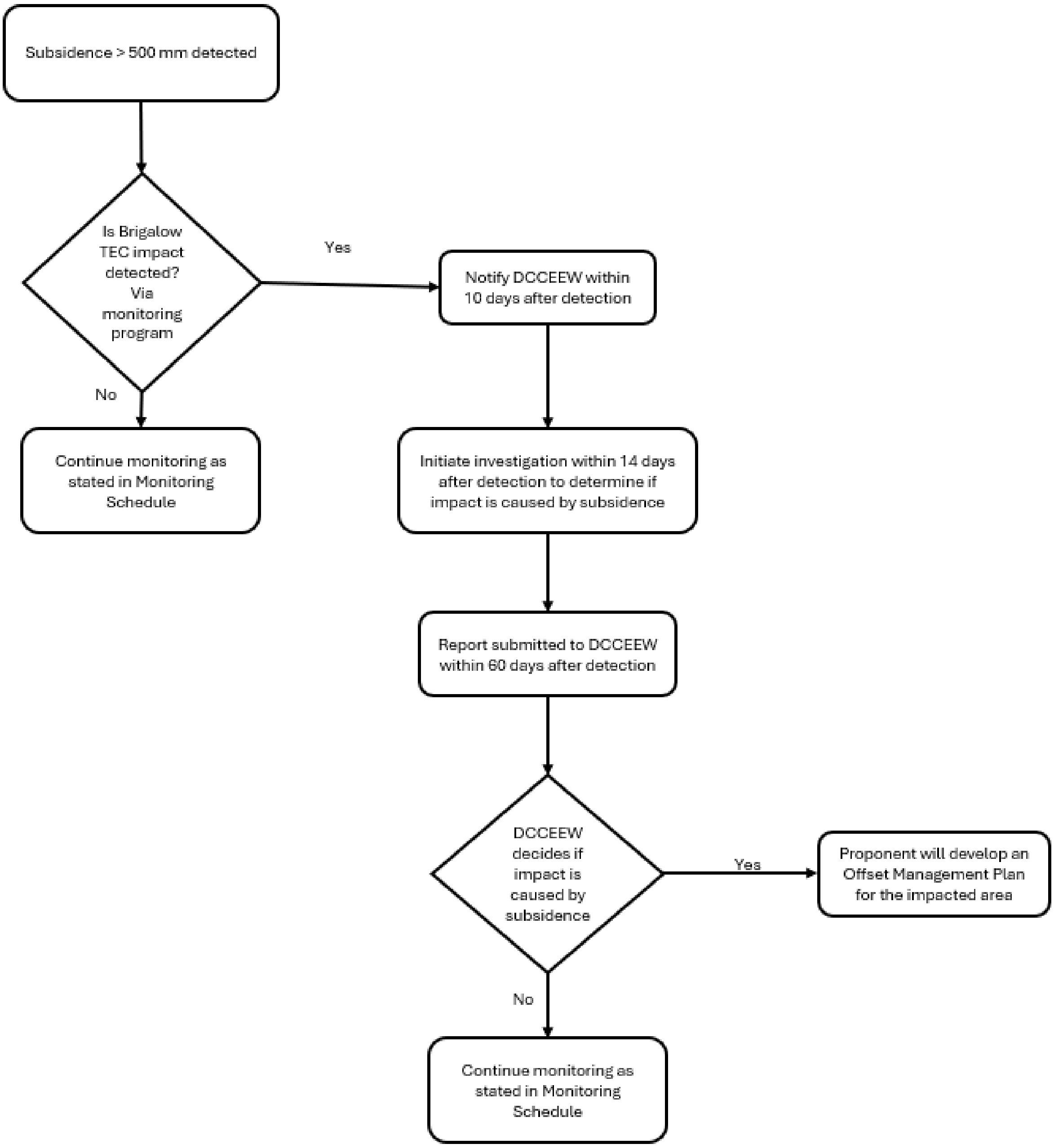

Figure 5-2 Conceptualized Flowchart of the Notification Process

5.4.1 NOTIFYING THE DEPARTMENT OF CLIMATE CHANGE, ENERGY, THE ENVIRONMENT AND WATER

If the subsidence threshold is exceeded, and an impact to Brigalow TEC is detected, a process to notify the relevant Australian Government Department is required. The detection may be approximately 6-12 months after the subsidence occurs, and within the five-year monitoring period.

When the trigger values for photographic monitoring, BioCondition or NDVI are also exceeded (Table 5-3), the process to notify the Department according to the EPBC approval is to be implemented.

The approval holder must notify the Department of Climate Change, Energy, the Environment and Water (DCCEEW) of any potential non-compliance or actual non-compliance. The approval holder must notify electronically within two business days of a potential non-compliance (Condition 30). They must also notify in writing within 12 business days of the detection (Condition 32 of the approval), of an exceedance of the trigger values in Table 5-3.

5.4.2 INVESTIGATING AND REPORTING

The Environmental section will notify the Area Supervisor to ensure they are made aware of the impacted area. The impacted Brigalow vegetation will be demarcated, by fencing as required, or by using GPS coordinates for the impacted area collected in the field.

An investigation, aligned with the Ensham Resources SOP for incident notification, investigation and reporting (IMS.SOP.14.00.01), is to be commenced by ecologist(s) within 14 business days of detection, to determine if the reaching of the trigger value or exceedance of the limit is a result of the approved activity. The investigation and reporting process in the SOP will facilitate data collection and analysis to identify the cause of the trigger exceedance. All supporting documentation, including past data collected from photographic monitoring, NDVI and Biocondition assessments (including the photos), and reports will be attached to the investigation report. An NDVI assessment, combined with Biocondition and photographic assessments will be used to determine the extent and severity of the actual harm to the Brigalow TEC. All primary information shall be recorded by the Supervisor responsible for the incident. The Investigation Report will be completed by ecologist(s) and reviewed by a Supervisor.

The investigation report, highlighting the magnitude of impact, area of impact and potential cause of impact, must be submitted to the DCCEEW within 60 business days of the detection.

If the trigger value is reached by virtue of subsidence from the underground mining activities, the corrective actions stated in the Section 5.5 will be undertaken to halt and prevent further harm to protected matters.

5.4.3 WHEN AN OFFSET MANAGEMENT PLAN WILL BE REQUIRED

After an exceedance of the trigger thresholds has been detected, and it can be confirmed by an Ecologist working with relevant specialists, that the exceedance has been caused by subsidence; an Offset Management Plan will be required. The Offset Management Plan will be required to be developed within 12 months. It must be consistent with the Environmental Management Plan Guidelines and the Environmental Offsets Policy to address residual harm to protected matters. Once developed, it must be submitted to DCCEEW for the Minister's written approval.

5.5 BRIGALOW TEC CORRECTIVE ACTION AND MANAGEMENT MEASURES

5.5.1 CORRECTIVE ACTIONS FOR ROUTINE OPERATIONS

Due to the low-level subsidence effects measured and expected as a result of the bord and pillar mining operation at Ensham, remedial management measures are presently not required unless there is a significant deviation in the level of subsidence that would be detected during the monitoring program. It is also unlikely that any corrective action could be implemented to minimise an impact to Brigalow, once subsidence has occurred.

To avoid harm to the Brigalow TEC, the following will be integrated into the mining operation:

- vehicle tracks through the TEC area will be avoided;
- as per EPBC 2020/8669 condition 2, environmental officers will ensure no other mine related development is located in the Brigalow TEC; and
- weed management will be implemented on the mine site throughout the active mining operation period.

There are no identified remedial actions that are practical or feasible, in the short term, to improve the condition of Brigalow, should mortality or an impact be detected as a result of subsidence.

Any significant detection of subsidence change will trigger a review of underground mining activities, and this is described in section 4.8.

5.5.1.1 SUBSIDENCE LEVEL IS EXCEEDED WITH NO IMPACT TO BRIGALOW TEC DETECTED

If the subsidence level has exceeded the predicted expectations, but the assessments for Brigalow TEC in Section 5.3.2 do not indicate the community has been impacted (Table 5-3); monitoring requirements will cease after the 5 year period.

5.5.1.2 BRIGALOW SPECIFIC TRIGGER VALUE EXCEEDED

The corrective actions when trigger value(s) are exceeded, as stated in Table 5-3 is detected includes:

- demarcating or mapping, as appropriate, the impacted Brigalow vegetation area so that the location of the area can be communicated to mine staff;
- preparing and implementing a site-specific weed management plan;
- continuing monitoring as stated in Table 5-2, for TEC regrowth improvement during restoration process; and
- increasing Biocondition assessments to an annual frequency.

In addition, an Offset Management Plan will be developed, to comply with the information and commitments specified in Attachment 4 of the EPBC approval.

5.5.2 CORRECTIVE ACTIONS FOR NON-ROUTINE SITUATION

A non-routine situation for Brigalow vegetation is considered to be an incident or natural disasters that has caused decline in Brigalow TEC condition and caused the trigger values to be exceeded.

In case of an incident, the SOP for Incident Notification, Investigation and Reporting and actions will be implemented.

In the case of natural disasters, such as flood, the actions stated in Section 5.4.1 will be implemented. A report with details of the related natural disaster and its impacts to Brigalow TEC will be included in the annual compliance reporting submission to the DCCEEW.

6. LEGAL COMPLIANCE AND REFERENCES

TABLE 6-1 REFERENCES.

Legislation/Recognized Standards	• Regional Interests Development Approval (RIDA) RPI22/002 • Environmental Authority EPML00732813. • Environmental Protection Biodiversity Conservation Act 1999. • Water Act 2000.
Reports	Commonwealth of Australia (2014). Subsidence from coal mining activities, background review, prepared by Sinclair Knight Merz Pty Ltd for the Department of the Environment, Commonwealth of Australia, Canberra. Commonwealth of Australia (2015). Management and monitoring of subsidence induced by longwall coal mining activity, prepared by Jacobs Group (Australia) for the Department of the Environment, Commonwealth of Australia, Canberra.

7. TERMS AND ABBREVIATIONS

7.1 ABBREVIATION AND DESCRIPTION

TABLE 7-1 TERMS

Abbreviation	Description
EA	Environmental Authority
EPBC Act	*Environment Protection and Biodiversity Protection Act 1999* (Commonwealth).
GM	General Manager
GPS	Global Positioning System
HSE	Health, Safety and Environment
LIDAR	Light Detection And Ranging
NDVI	Normalised Difference Vegetation Index
PHMP	Principal Hazard Management Plan

Abbreviation	Description
RTK	Real Time Kinematic
SSE	Site Senior Executive
TARP	Trigger Action Response Plan
TEC	Threatened Ecological Community

8. DOCUMENT PREPARATION

This SMP has been prepared by Gordon Geotechniques Pty Ltd (GGPL), in conjunction with Ensham technical and environmental personnel. The SMP has been updated based on the Subsidence Report prepared for Zone 1 by Gordon Geotechniques in June 2022. The SMP has been updated based on Flora Technical Report (AECOM 2020) by AARC Environmental Solutions in April 2024.

9. REVIEW HISTORY

This Subsidence Monitoring Plan will be subject to review every 2 years or under the following conditions due to:

- Change to licence conditions and/or reporting requirements.
- Significant change to current mine plan/operations.
- An investigation report recommendation.

Table 9-1 Review History.

Date of review	Revision Number	Trigger for review	New revision Number
8/2/2022	1	Requirement of EIS assessment report and EA Amendment – Zones 2 and 3 subsidence technical report	2
17/6/22	2	Addition of Zone 1	3
20/9/2022	3	Update as result of requirements from PRCP and RIDA	4
2/6/2023	4	RIDA application for Zone 1, Updated monitoring	5

		Update monitoring results	
25/06/2024	5	Inclusion of EPBC Brigalow Triggers and Monitoring Trigger Levels & Monitoring Section restructured to identify applicability to various approvals	6
28/08/2024	6	General document review. Update monitoring charts.	7

10. ROLES AND RESPONSIBILITIES

Survey Section

- Carry out monitoring – fixed monitor and LIDAR.
- Prepare monitoring data.
- Ensure compliance of the dimensions of the underground pillars and roadways.

Environmental Section

- Surface inspections.
- Monitor creeks/rivers/groundwater.
- Prepare subsidence monitoring report.
- Monitor Brigalow population.
- Prepare Brigalow monitoring report.
- Review LIDAR and NDVI data.
- Liaise with landowners.

Technical Services Section

- Underground inspections.
- Plan subsidence monitoring requirements.
- Review and reconcile subsidence monitoring data.
- Facilitate review if trigger levels are exceeded.
- Liaise with landowners.

11. REFERENCES

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