# New England Highway bypass of Muswellbrook

## Chapter 6.4 Soils and mine workings

Transport for NSW | October 2021

## 6.4 Soils and mine workings

### 6.4.1 Methodology

The desktop investigation of geology and soils included a review of publicly available information to obtain an understanding of the geological formations and soils landscapes within the proposed road corridor. Reference was made to:

- Regional geology: the Hunter Coalfield Regional Geology 1:100 000 map, the Muswellbrook 1:25,000 geological map and the Singleton 1:250,000 geological sheet SI/56-01
- The Soil Landscapes of the Singleton 1:250,000 which provides an inventory of soil and landscape properties of the study area and identifies major soil and landscape qualities and constraints
- The Soil and Land Resources of the Hunter Region which upgrades the soil landscape mapping for the Singleton area to a 1:100,000 scale and provides more land and soil information across the study area.

To address potential sources of contamination within and in proximity of the construction footprint a Contaminated Soils Phase 1 Assessment was prepared by AECOM (2021) for the proposal (refer Appendix J) which:

- Reviewed the land use history of the study area through the review of publicly available information including historic aerial photography
- Reviewed geotechnical investigations for the proposal
- Developed a conceptual site model to describe potential sources of contamination, pathways by which contaminants may be transmitted through the environment and the receivers that may be exposed to the contaminants
- Carried out a qualitative risk assessment based on the conceptual site model
- Identified environmental safeguards to manage potential contamination impacts.

Geotechnical investigations were carried out as part of a program of works during mid 2020 for the concept design. A number of these investigations targeted the former underground workings at the Muswellbrook Coal Mine in the Muswellbrook, St Heliers and Lewis Seams, including:

- Geotechnical boreholes to intercept the Muswellbrook and St Heliers Seams and the Lewis Seam workings, including four boreholes drilled along the alignment to determine the stratigraphy associated with the coal seams and where possible to identify the workings
- Down hole sonar probing where mine voids associated with the former workings in the Lewis Seam were intercepted to obtain more details of the geometry of the workings in this seam
- Review of mine tracings
- Assessment of pillar stability in the Lewis Seam.

Four soil vapour wells were installed as part of the geotechnical investigation works. These wells serve as indicators for spontaneous combustion to monitor dangerous gasses (CO, CO2, CH4 and SO2) in the former open cut immediately south of the underground workings. Interferometric Synthetic Aperture Radar (InSAR) surveys were carried out in the mid to late 2020 by Sixense Soldata SAS over the mine area, with a number of settlement points in this vicinity.

A Mining Assessment Report has also been prepared to assess the potential impacts of the former underground mine workings on the performance of the proposed road infrastructure (refer to Appendix F). The assessment has been carried out to facilitate the approval process with Subsidence Advisory NSW (SA NSW) for construction of the section of the bypass over the former underground mine workings at the Muswellbrook Coal Mine.

A pillar strength assessment was carried out for the Lewis Seam using the Power Law developed by the University of NSW and developed in *Anderson* (1999). The pillar assessment concluded that no further works would be required to stabilise workings in the Lewis Seam. Refer to Appendix F for the full methodology regarding pillar stability.

### *Study area*

The study area for the soils assessment is shown in Figure 6-7. It extends beyond the construction footprint in order to identify potential contamination sources (both historical and current) which may result in potential contamination impact within the construction footprint.

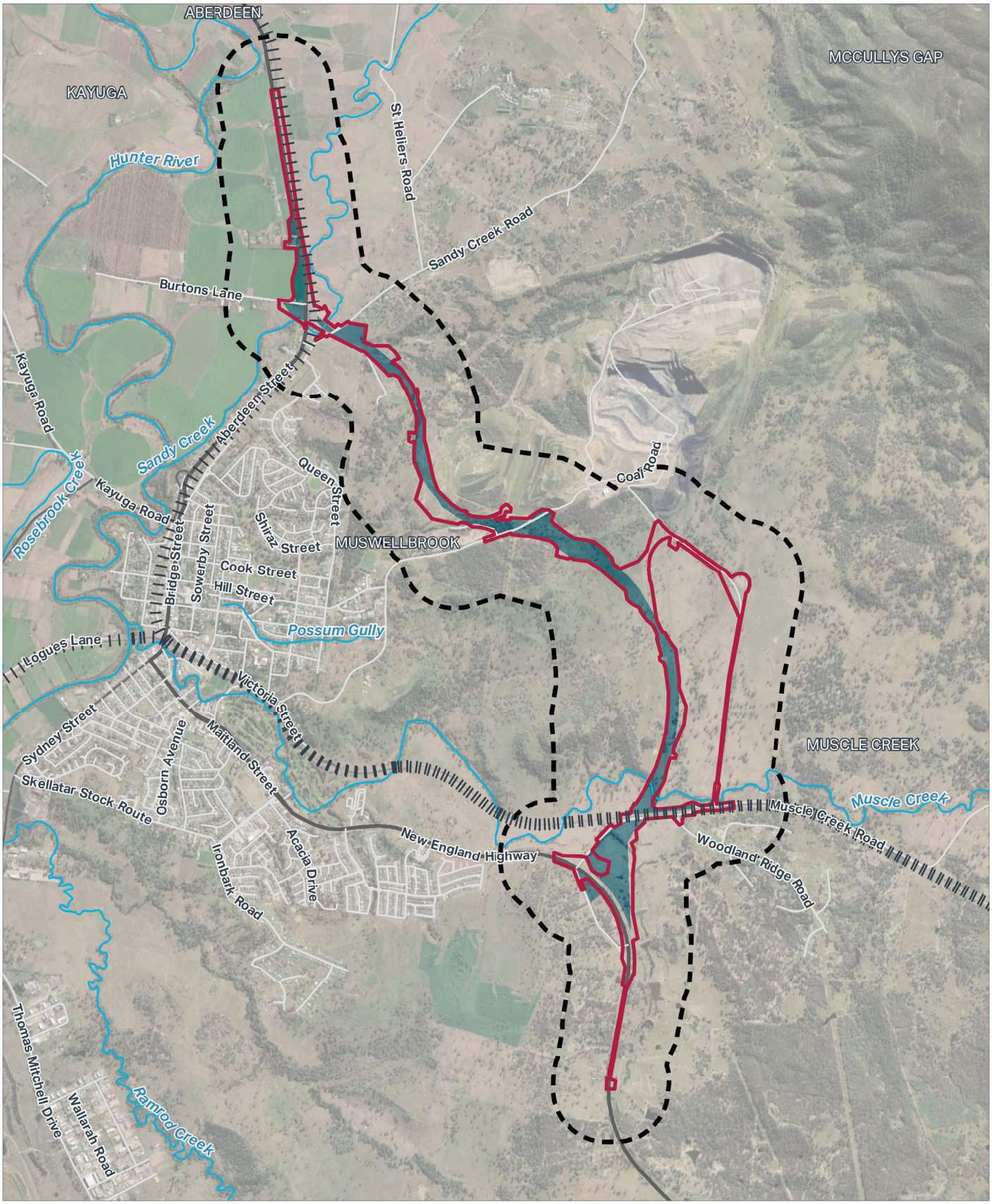


**FIGURE 6-7: STUDY AREA FOR SOILS ASSESSMENT**

N

0 0.5 1 km

AECOM

Legend

- Construction footprint
- Study area
- Proposed road corridor
- Watercourse
- State Road
- Regional Road
- Local Road
- Railway

### 6.4.2 Existing environment

#### *Regional geology*

The regional geology along the proposed road corridor is outlined in Table 6-14.

Table 6-14: Regional Geology

| Unit | Geological Group | Sub unit | Stratigraphy | Lithology description |
|---|---|---|---|---|
| 1 | Quaternary | 1.1 | Man-made fill | Mine waste |
| | | 1.2 | Alluvium (Qa) | Gravel, sand, silt, clay |
| 2 | Maitland Group | 2.1 | Mulbring Siltstone (Pmm) | Sedimentary bedrock of dark-grey shale and siltstone. Potentially bioturbated and fossiliferous |
| | | 2.2 | Branxton Formation (Pmb) | Sedimentary bedrock of sandstone, siltstone and conglomerate. Sandstone varies in thickness and may be pebbly or silty. Conglomerate appears as lens |
| 3 | Greta Coal Measures | 3.1 | Rowan Formation (Pgr) | Sedimentary bedrock of sandstone, siltstone, shale and mudstone with intercalated coal seams and subordinate conglomerate.<br>Coal seams include:<br>• Fleming Seam<br>• Hallet Seam<br>• Muswellbrook Seam<br>• St Heliers Seam<br>• Lewis Seam<br>• Loder Seam |
| | | 3.2 | Skeletar Formation (Pgk) | Rhyolite, chert and white tuffaceous shale |
| | | 4.1 | Undifferentiated including Gyarran Volcanics (Pdz) | Igneous bedrock of rhyolite, breccia and amygdaloidal basalt with minor felsite, grading to dark marine shale and mudstone |

#### *Soils*

The soil landscapes of the Singleton and Hunter Region through which the proposal traverses have been split into sections as shown in Table 6-15 and illustrated in Figure 6-8 and Figure 6-9.

Table 6-15: Soil Landscape

| Section[1] | Singleton 1:250,000 | Hunter Region 1:100,000 | Soil Landscape | Soils |
|---|---|---|---|---|
| 1 | Hunter (hu) | Foy Brook (fyz) – Alluvial | Level plain to gently undulating alluvial plain. Slopes 0 - 3%, local relief <5 m, elevation 160 - 165 m. Extensively cleared riparian forests | Brown Clays, Black Earths and Alluvial Soils comprising sand, silt and clay derived from the Branxton Formation |
| | Dartbrook (db) | Donalds Gully (dnz) - Transferal | Gently undulating plains. Slopes 1 - 5%, local relief <30 m, elevation 200 – 260 m. Extensively cleared woodland | Brown Clays with some Black Earths comprising alluvium and colluvium derived from moderately to strongly weathered, sandstone, conglomerate, mudstone, calcareous shale, coal and basalt |
| | | Cressfield Road (cfz) - Erosional | Undulating rises to undulating low hills. Slopes 3 - 10%, local relief 20 - 50 m, elevation 190 - 210 m. Extensively cleared open-woodland | Red Podzolic Soils, Non-calcic Brown Soils and Red-Brown Earths comprising clayey sand |
| | | Cressfield Road variant a (cfza) - Erosional | Rolling low hills to rolling hills. Slopes 10 - 33%, local relief 20 - 50 m, elevation 175 - 260 m. Extensively cleared open-woodland | Red Podzolic Soils, Non-calcic Brown Soils and Red-Brown Earths comprising clayey sand |
| | Roxburgh (rx) | Lovedale (lvv) - Transferal | Gently undulating plains. Slopes 2 - 5%, elevation 160 - 170 m. Tall woodland partially cleared for grazing | Yellow podzolic soils on upper to mid slopes and red solodic soils on more rounded hills. Brown podzolic soils on slopes with conglomerate outcrop |
| | | Dochra (dot) - Erosional | Undulating low hills on Permian siltstones and mudstones. Slopes 5 - 10% elevation 230 - 260 m. Extensively cleared open-forest | |
| 2 | Roxburgh (rx) | Disturbed Terrain variant a (xxza) - Disturbed | Areas of reshaped and revegetated land associated with mine spoil. Made land consisting of embankments, mounds, cut features and fill features. Slopes are generally simple and often traversed by contour banks and terrace features. Elevation 190 – 230 m | Derived from Permian sediments of the Greta Coal Measures |

| Section[1] | Singleton 1:250,000 | Hunter Region 1:100,000 | Soil Landscape | Soils |
|---|---|---|---|---|
| 3 | Roxburgh (rx) | Little Grasstree Hill (lgw) – Erosional | | Red and Brown Solodic soils dominate crests and hillslopes |
| | | Donalds Gully (dnz) - Transferal | Gently undulating plains. Slopes 1 - 5%, local relief <30 m, elevation 140 - 160 m. Extensively cleared woodland | |
| | | Dochra (dot) – Erosional | Undulating low hills on Permian siltstones and mudstones. Slopes 5 - 10% elevation 150 – 190 m. Extensively cleared open-forest | |
| | | Singleton (sgw) - Alluvial | Alluvial plain of variable width with both high and low terraces. Slopes 0 -3%, local relief <10 metres and elevation 140 - 150 m | Quaternary alluvium valley deposits consisting mostly of clays and silts with minor sands and gravels |

1 Refer to Figure 6-8 and Figure 6-9

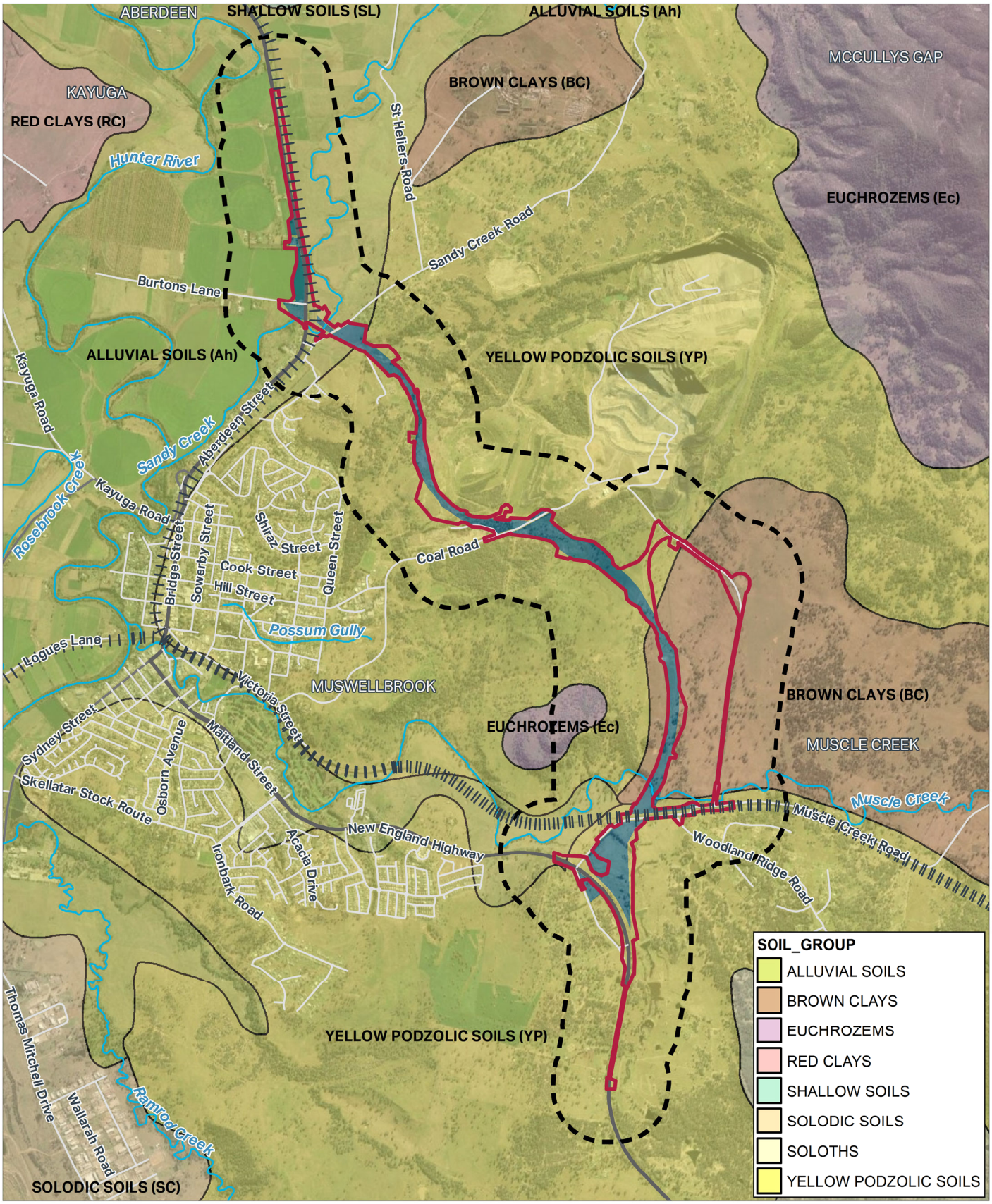


**FIGURE 6-8: SOIL LANDSCAPES OF THE SINGLETON REGION**

N

0 0.5 1 km

AECOM

Legend

- Construction footprint
- Study area
- Proposed road corridor
- Watercourse
- State Road
- Regional Road
- Local Road
- Railway

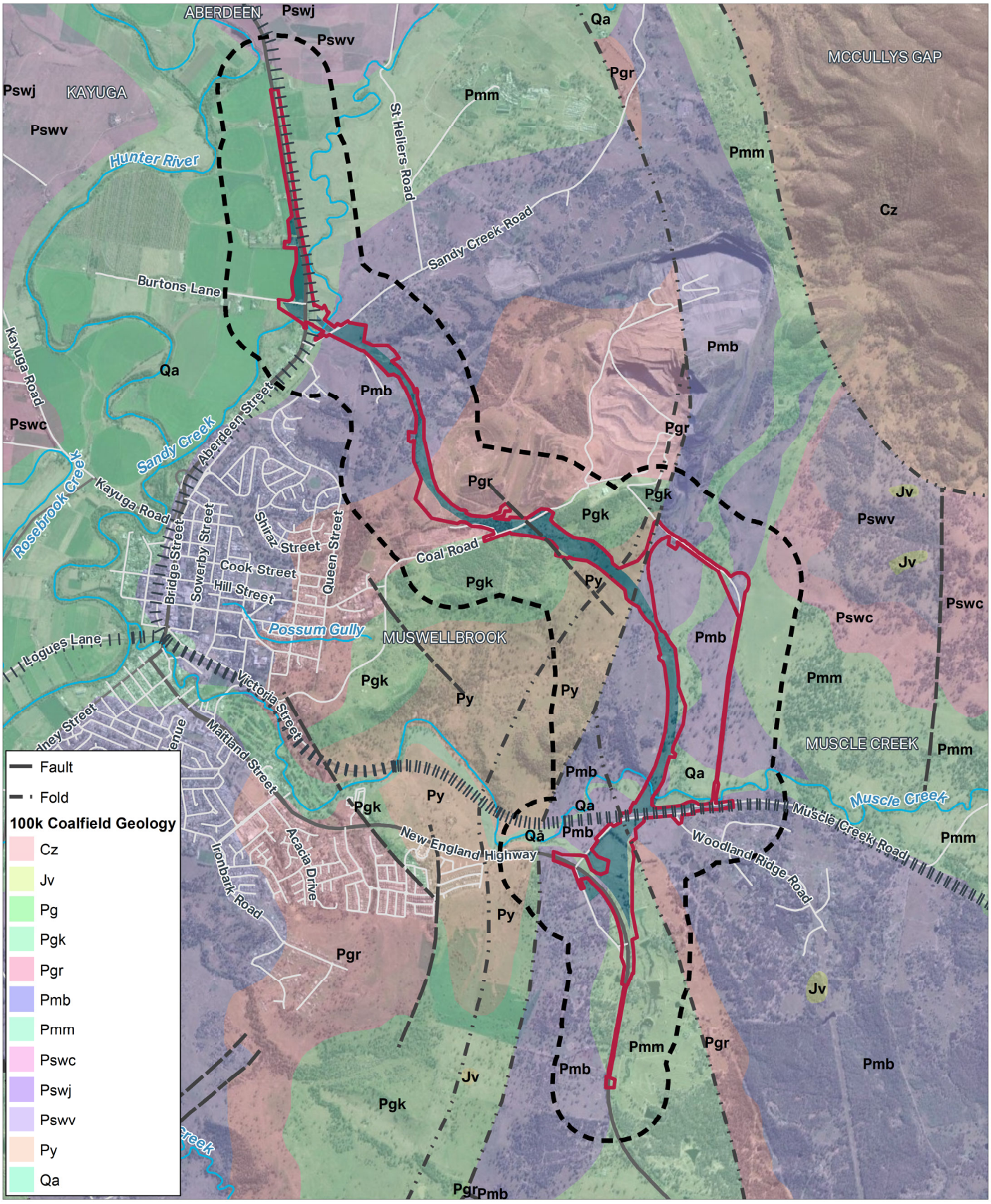


**FIGURE 6-9: SOIL AND LAND RESOURCES OF HUNTER REGION**

N 0 0.5 1 km

AECOM

Legend

- Construction footprint
- Study area
- Proposed road corridor
- Watercourse
- State Road
- Regional Road
- Local Road
- Railway

### *Acid sulfate soils*

Acid sulphate soils are not identified in the study area in publicly available acid sulphate soils mapping including the Muswellbrook LEP 2009. The results of the geotechnical investigations for the proposal (AECOM, 2020) identified no known occurrence of acid sulfate soils in the study area. Ground levels along the proposed road corridor range from 150 metres to 242 metres and it is considered unlikely that acid sulfate soils would be encountered.

The ASRIS Atlas of Australian Acid Sulfate soils indicates a low (6-70 per cent) to extremely low (1-5 per cent) probability of potential acid sulfate soil (sulfidic material) to occur within inland lakes, waterways, wetlands and riparian areas located within the study area.

### *Unexploded ordnance*

A review of the Department of Defence (DoD) unexploded ordnance (UXO) map was completed on 31 March 2020. This review indicates that the township of Muswellbrook was once used as an advanced ordnance depot during WWII. The closest known location of an UXO is located within the study area to the west of the northern connection.

### *Per and Poly Fluoro Alkyl Substances*

The Australian potential per- and poly-fluoroalkyl substances (PFAS) Chemicals Map was viewed on 31 March 2020. There were no sites identified as impacted by PFAS contamination within the study area.

The Contaminated Soils Phase 1 Assessment (AECOM, 2021) found Aqueous Film Forming Foams containing PFAS could historically have been used during fire fighting and/or fire training exercises.

### *Salinity*

Dryland salinity has been observed in the Upper Hunter area; however no salinity hazard maps are listed in the Muswellbrook LEP 2009. The Salinity hazard report for Catchment Action Plan upgrade – Hunter-Central Rivers CMA (Nicholson et al., 2012) identified a very high hazard risk of salinity around Muswellbrook. The area encompasses the major coal extraction areas of the Hunter area, including the Muswellbrook Coal Mine.

### *Contamination*

The Contaminated Soils Phase 1 Assessment in Appendix J identified potential contamination sources within or in proximity to the study area.

Locations or structures identified as potentially containing contamination include market gardens; agricultural land (including dairy farms and pastoral land); the existing New England Highway and associated connecting roads; the Main North railway line and a former rail line; a former timber mill, former Muswellbrook Brick Works, Muswellbrook substation and Muswellbrook Waste Management Facility; Muswellbrook Coal Mine; a former power station as well as existing buildings and historical structures which may contain potential asbestos containing material.

The potential contamination sources are mapped in the Contaminated Soils Phase 1 Assessment in Appendix J.

### *Mine workings*

#### Areas of backfill

The proposal passes over the old backfilled Open Cut No.1 at Muswellbrook Coal Mine including the highwall and low wall where potential for differential compaction is high, and where the old single seam underground workings in the Lewis seam are located. The Open Cut No. 1 has been backfilled with various types of uncompacted mine waste from former open cut operations up to a depth of 70 metres.

#### Underground mine workings

Three underground mine workings are located north of Coal Road, in the Lewis, St Heliers and Muswellbrook Seams.

Geotechnical investigations carried out as part of a program of works during mid 2020 for the concept design indicated that the proposal would pass directly over the Lewis Seam workings (see Section 6.4.3).

The geotechnical investigations encountered solid coal in the boreholes in the Muswellbrook and St Heliers Seams. The mine tracings indicate that the workings in these seams are 100 metres or more from the alignment and therefore are unlikely to pose a risk to the proposal. In addition, the open cut high wall was constructed with a 25 metre to 30 metre barrier between the open cut and the high wall. This barrier of solid coal would also inhibit the spread of fire between the open cut and the underground workings.

#### *Spontaneous combustion and gas venting (underground fires)*

The InSAR surveys carried out in mid to late 2020 over Muswellbrook Coal Mine, surveyed a number of settlement points in the vicinity of the underground workings. These points are stable and show no signs of ongoing settlement that could be attributed to underground fires.

With the water table being about eight metres above the roof level of the workings of the Lewis Seam, underground fires are not considered to be a potential issue in this seam.

The potential for underground fires to extend to coal seams from either the existing workings or from the former open cut is unlikely and has not been considered further.

### 6.4.3 Potential impacts

#### *Construction*

#### Erosion and sedimentation

The proposal would involve removal of topsoil, earthworks associated with filling for the new road and stockpiling of spoil for construction. If not adequately managed, earthworks, stockpiling and transportation of spoil could potentially have the following impacts:

- Erosion of exposed soil and stockpiled materials
- An increase in sediment loads entering nearby watercourses.

With the implementation of erosion and sedimentation control outlined in Section 6.4.4, potential construction related erosion and sedimentation impacts would be appropriately managed and would be minor.

#### Acid sulphate soils

Acid sulphate soils are unlikely to be encountered during construction.

#### Salinity

The construction of the proposal has the potential to exacerbate dryland salinity in the proposed road corridor where the groundwater table is impacted by construction works. Given that impacts to the groundwater table are anticipated to be minor, the proposal is unlikely to contribute to dryland salinity.

#### Contamination

The Contaminated Soils Phase 1 Assessment in Appendix J found there is a moderate risk of contamination from a range of potential contaminants and sources within and adjacent to the proposed road corridor that may present an unacceptable risk to human health and/or the environment. Contamination risks would be managed in accordance with the environmental safeguards provided in Section 6.4.4.

Soil contamination could occur as a result of any accidental spills or leaks of fuels, oils and other chemicals from equipment and vehicles during construction. To avoid this potential impact, fuels and chemicals would be managed in accordance with the management measures provided in Section 6.4.4.

### Mine subsidence risk

**Areas of backfill**

Due to the uncompacted and variable nature of the mine waste below the proposed road alignment, differential settlement of the pavement is anticipated over relatively short distances. This can lead to the formation of small-scale settlement bowls in the pavement that exceed differential settlement (ride comfort) criteria. This would be managed through geotechnical treatments included in the Concept Design.

**Underground mine workings**

Underground mine workings may cause ground subsidence due to the following mechanisms:

- Failure of the roof, delamination of overlying strata.
- Failure of board and pillar workings due to spontaneous combustion fires removing the pillar support.

The geotechnical investigations determined that the angle of draw from the workings in the Lewis Seam would have the potential to affect the proposal, as shown in Figure 6-10. However, the workings in the Lewis Seam are considered to have a low risk of pillar collapse and a low risk of caving failure reaching the surface.

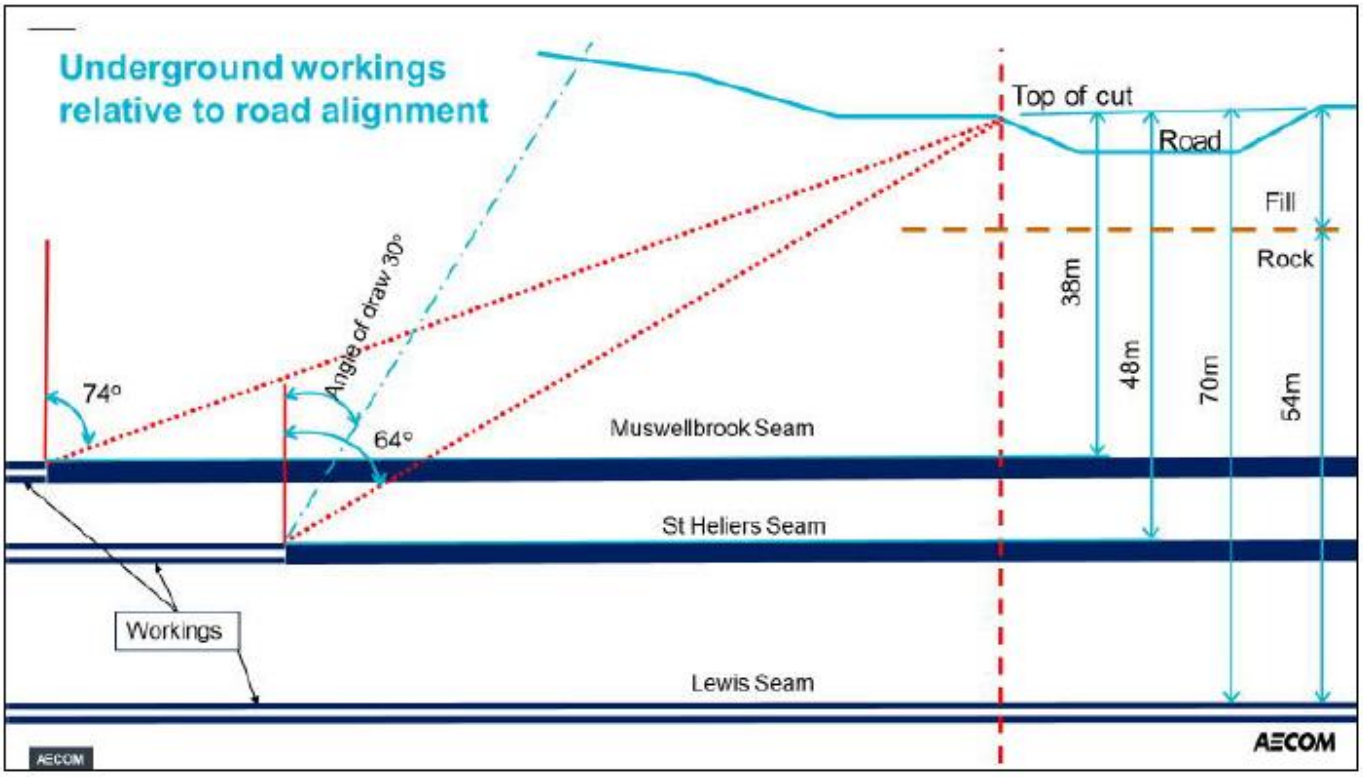


Figure 6-10: Former underground workings relative to the proposed road corridor/alignment

### *Operation*

During the operation of the proposal, the risk of soil erosion would be minor as all areas impacted during construction would be sealed or rehabilitated and landscaped to prevent soil erosion from occurring. There are minor contamination risks associated with the operation of the proposal which would be limited to:

- Spills from industrial heavy vehicles such as oil tankers

- Accidents causing oil and petrol spills.

Spills and other contamination sources during operation would be appropriately managed by implementing standard emergency spill environmental safeguards.

### 6.4.4 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing | Reference |
|---|---|---|---|---|
| Excess spoil | Excess spoil not required or able to be used for backfilling will be stockpiled in a suitable location before being reused or removed from the site, and disposed of appropriately in accordance with the NSW EPA Waste Classification Guidelines (2014) | Construction contractor | Construction | Additional safeguard |
| Erosion and sedimentation | Erosion and sediment controls will be implemented before any construction starts and inspected regularly, particularly after a rainfall event. Maintenance work will be carried out as needed | Construction contractor | Construction | Additional safeguard |
| Erosion and sedimentation | Site stabilisation of disturbed areas will be carried out progressively as stages are completed | Construction contractor | Construction | Additional safeguard |
| Erosion and sedimentation | All stockpiles will be designed, established, operated and decommissioned in accordance with Roads and Maritime Stockpile Management Guideline (RTA, 2011) | Construction contractor | Construction | Additional safeguard |
| Erosion and sedimentation | The rehabilitation of disturbed areas will be undertaken progressively as construction stages are completed, in accordance with:<br>• The NSW Soils and Construction – Managing Urban Stormwater Volume 1 “the Blue Book” (Landcom, 2004) and Volume 2 (DECC, 2008)<br>• Landscape Guideline (RTA 2018)<br>• Guideline for Batter Stabilisation using Vegetation (Roads and Maritime 2015) | Construction contractor | Construction | Additional safeguard |
| Erosion and sedimentation | Batters will be designed and constructed to minimise risk of exposure, instability and erosion, and to support long-term, on-going best practice management, in accordance with *Guideline for Batter Surface Stabilisation using Vegetation* (Roads and Maritime 2015) | Transport and Construction contractor | Detailed design and construction | Additional safeguard |

| Impact | Environmental safeguards | Responsibility | Timing | Reference |
|---|---|---|---|---|
| Tracking of soil off site | Controls will be implemented at exit points to minimise the tracking of soil and particulates onto pavement surfaces | Construction contractor | Construction | Additional safeguard |
| Contamination | A Phase II Environmental Site Assessment (ESA) will be prepared to quantify potential areas of contamination and to better inform the CEMP | Transport | Pre-construction | Additional safeguard |
| Contamination | The CEMP will include an unexpected finds protocol for potentially contaminated material encountered during construction work | Construction contractor | Construction | Additional safeguard |
| Contamination | Should contamination which may pose potential risk to human health and the environment be encountered during construction, further assessment may be required following consultation with Transport environmental staff | Construction contractor | Construction | Additional safeguard |
| Contamination | If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. This may include but not be limited to:<br>• Diversion of surface runoff<br>• Capture of any contaminated runoff<br>• Temporary capping<br>All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls (for the proposed road corridor) or further actions identified in consultation with the Transport Environment Manager and/or the EPA are implemented | Construction contractor | Construction | Additional safeguard |
| Contamination | An Asbestos Management Plan (AMP) will be developed and implemented to manage asbestos and asbestos containing material if encountered during the construction. The AMP will include:<br>• Identification of potential asbestos on site<br>• Procedures to manage and handle any asbestos<br>• Mitigation measures if asbestos is encountered during construction<br>• Procedures for disposal of asbestos in accordance with the NSW EPA | Construction contractor | Construction | Additional safeguard |

| Impact | Environmental safeguards | Responsibility | Timing | Reference |
|---|---|---|---|---|
| | guidelines, Australian Standards and relevant industry codes of practice | | | |

Other safeguards and management measures that would address potential impacts to soil and contamination are identified in Section 6.2 and 6.3.