# 3.0 SITE DESCRIPTION

## 3.1 Locality

The Rocglen Coal Mine is located in the Gunnedah Basin of northern NSW, approximately 320 km north-west of Newcastle. **Figure 2** positions the mine in its regional setting on Wean Road approximately 25 km north of Gunnedah and 23 km south-east of Boggabri.

## 3.2 Project Site

The Project Site is defined on **Figure 3** and encompasses the areas within which mining and mining-related activities are currently approved under PA 06_0198 (see **Section 4.0**) and those additional areas that are subject to the new Part 3A Project Application (see **Section 5.0**). As evident, the Project Site extends beyond the bounds of the existing mining lease identified as ML 1620.

The Project Site covers an area of approximately 460 hectares within the Parish of Tulcumba, County of Nandewar and Local Government Area (LGA) of Gunnedah. It incorporates all or part of the following land parcels:

- Lot 1 in DP 787417;
- Lots 1 and 4 in DP 1120601; and
- Public road reserves.

## 3.3 Zoning

Under the provisions of the *Gunnedah Local Environmental Plan 1998 (as amended)* (LEP), the Project Site is located within zone No. 1(a) Rural (Agricultural Protection). Mining is a permissible land use within this zone with development consent.

All land adjoining the mine site is also zoned No. 1(a), with the exception of the Vickery State Forest immediately to the west which is zoned No. 1(f) Forests.

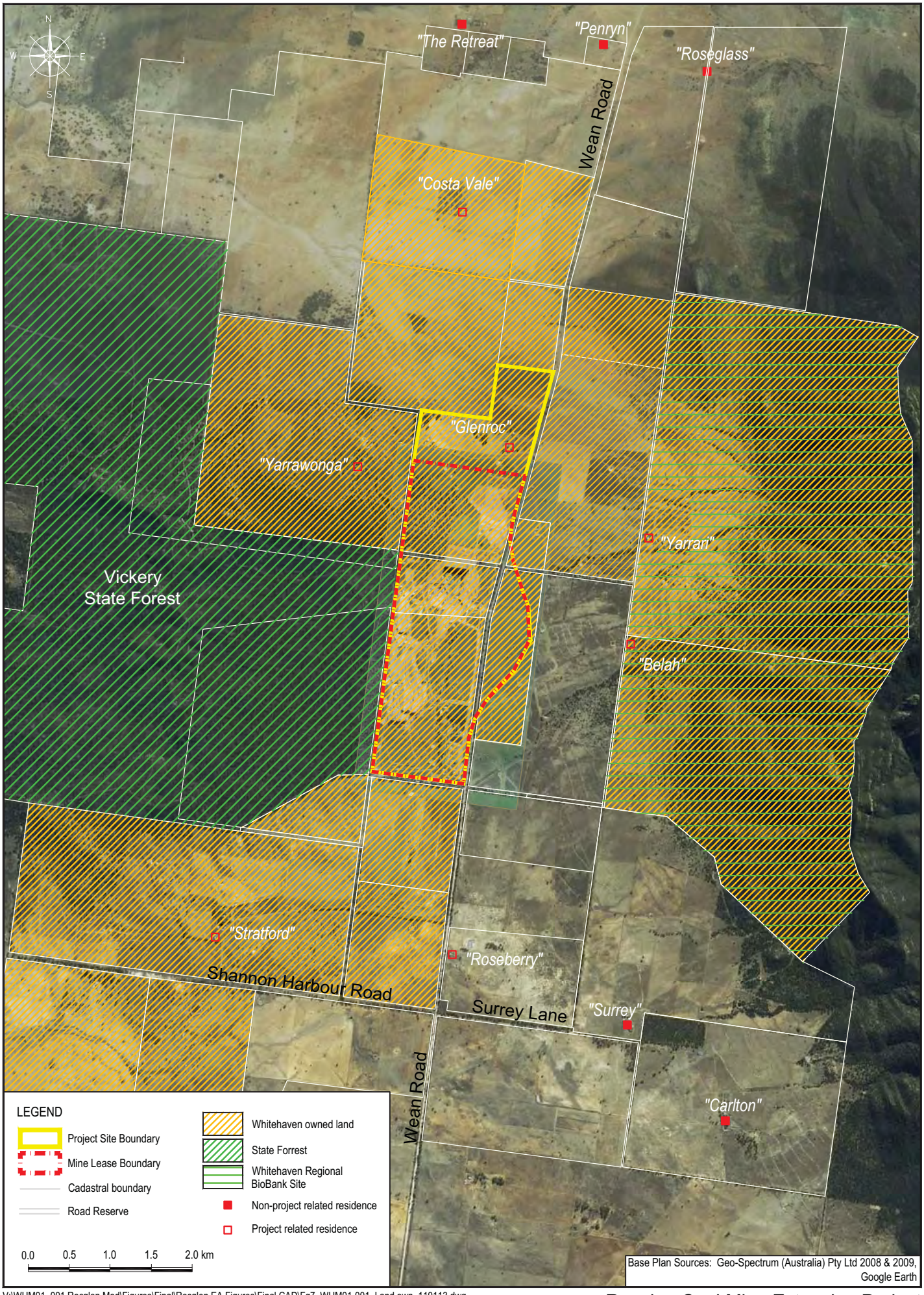
## 3.4 Land Ownership

Land ownership within the Project Site and surrounds is shown on **Figure 7**. As evident, Whitehaven currently owns all freehold land within the Project Site, being Lot 1 in DP 787417 and Lots 1 and 4 in DP 1120601, as well as the surrounding properties identified as “Glenroc”, “Costa Vale”, “Yarrawonga”, “Yarrari”, “Belah”, “Brentry”, “Stratford” and that part of the “Roseberry” property contained within the bounds of the Project Site.

The remaining properties are privately owned. As outlined in **Section 2.3.3**, Whitehaven has been undertaking consultation with these landholders in relation to the Project.

The Vickery State Forest adjoining the Project Site to the west is owned by the Crown.

The remaining land within and surrounding the Project Site occurs as public road reserves.




V:\WHM01_001 Rocglen Mod\Figures\Final\Rocglen EA Figures\Final CAD\Fg7_WHM01-001_Land own_110113.dwg
*To be printed A4*

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Land Ownership and Surrounding Residences

**FIGURE 7**

## 3.5 Existing Land Use

The majority of the Project Site, being that area within ML 1620, is utilised for the open cut coal mining and mining-related activities of the current Rocglen operation under PA 06_0198. The northern extent of the Project Site, outside of ML 1620, is utilised for traditional agricultural pursuits comprising a combination of livestock grazing and crop cultivation. As evident on **Figure 3,** the majority of the Project Site has been disturbed by historic land clearing, long-term agricultural production and/or coal mining. Successive years of such disturbance have limited the presence of remnant vegetation to relatively small scattered areas, isolated stands and individual trees.

The Vickery State Forest adjoins the Project Site to the west and is declared under the *Brigalow and Nandewar Community Conservation Area Act 2005* to be within Community Conservation Area (CCA) Zone 4 Vickery. NSW State Forests (Gary Miller 2010, pers. comm.) advised that the Vickery State Forest has multiple uses as per responsibilities under the *NSW Forestry Act 1916,* including general management, fire protection/management, thinning for non-commercial purposes, recreation and timber harvest from time to time on a long-term cycle (i.e. 30 to 40 years). NSW State Forests further advised that there are no current plans for timber harvest in the foreseeable future.

Approximately 3.5 km to the east of the Project Site is the CCA Zone 2 Kelvin. In accordance with the *Brigalow and Nandewar Community Conservation Area Act 2005* this land, which was formally known as the Kelvin State Forest, is reserved under the *National Parks and Wildlife Act 1974* as Aboriginal area. This area, along with the Vickery State Forest, is identified on **Figures 2** and **3**.

The *Whitehaven Regional Biodiversity Offset Strategy* provides for the long-term conservation of approximately 1,500 hectares of land owned by Whitehaven to the east of the Project Site. This area of land, which is now known as the Whitehaven Regional BioBank Site (see **Figures 2** and **3**), is in the final stages of registration by the DECCW as a BioBank Site under Part 7A of the TSC Act. It will be actively managed via a BioBanking Management Plan with in-perpetuity management funding, and will have the highest level of conservation status outside of National Parks (via a BioBanking Agreement registered on the land title in-perpetuity).

The remaining land area within the vicinity of the Project Site is characterised by traditional agricultural production comprising a combination of livestock grazing and crop cultivation.

There is no land use within or surrounding the Project Site that is considered to be incompatible or sensitive to the proposed Rocglen Extension Project.

## 3.6 Surrounding Residences

The Project Site is located in an area that is removed from any urban areas and has a relatively low density of surrounding residences, with the nearest non-Project related dwelling located in excess of 2.8 km from the Project Site.

Within a distance of 4 km from the external boundaries of the Project Site there are twelve residences within the surrounding rural properties (see **Figure 7**). Six of these residences, being those on “Glenroc”, “Costa Vale”, “Yarrawonga”, “Yarrari”, “Belah” and “Stratford”, are owned by Whitehaven and hence are classified as project-related. While the “Roseberry” property is privately owned, it is considered project-related in accordance with a negotiated private agreement between the landholder and Whitehaven. This agreement includes specific conditions/limits for noise and dust, along with a commitment to formally consult with the Owner, at least once every three months, to assess whether the Owner is satisfied or otherwise with Whitehaven’s activities at the mine and to investigate and respond to any issues identified.

The approximate distances from each residence to the existing and proposed areas of activity within the Project Site are listed in **Table 3.**

**Table 3 – Proximity of Surrounding Residences**

| Residence Property Name | Landholder | Approximate Separation Distance To (metres)[1]: | | |
|---|---|---|---|---|
| | | Limit of Open Cut Mining | Coal Handling and Processing Area | Out-of-Pit Emplacement Area |
| "Retreat" | Private | 4,700 | 6,800 | 4,000 |
| "Penryn" | Private | 4,700 | 6,800 | 4,000 |
| "Roseglass" | Private | 4,900 | 6,800 | 4,200 |
| "Costa Vale" | Whitehaven (project-related) | 2,900 | 4,900 | 2,100 |
| "Glenroc" | Whitehaven (project-related) | Residence within the Project Site | | |
| "Yarrawonga" | Whitehaven (project-related) | 900 | 2,600 | 600 |
| "Yarrari" | Whitehaven (project-related) | 1,600 | 2,400 | 1,500 |
| "Belah" | Whitehaven (project-related) | 1,000 | 1,700 | 2,100 |
| "Stratford" | Whitehaven (project-related) | 2,900 | 2,900 | 2,100 |
| "Roseberry" | Private[2] (project-related) | 2,400 | 2,000 | 1,900 |
| "Surrey" | Private | 3,500 | 3,200 | 3,400 |
| "Carlton" | Private | 4,800 | 4,400 | 4,700 |

1 – All distances scaled from aerial photography and rounded down to the nearest 100 metres.

2 - "Roseberry" is subject to a negotiated private agreement between the landholder and Whitehaven

Of the non project-related residences, "Retreat" and "Penryn" appear to be the closest residences to the north at approximately 4 km from the proposed Northern Emplacement Area, and "Surrey" appears to be the closest residence to the south at approximately 3.2 km from the approved Western Emplacement Area.

## 3.7 Surrounding Mining Operations

The Project Site is located in an area that is relatively isolated from other mining or extractive industry operations. The nearest operational mine is identified as Tarrawonga at approximately 15 km from Rocglen. Other mines within the vicinity are either closed and rehabilitated (former Vickery Mine and former Gunnedah Colliery), or are currently undergoing final rehabilitation (former Canyon Coal Mine). These sites are identified on **Figure 2**.

We are unaware of any other extractive industry operations and/or proposed new mines within the surrounding neighbourhood.

## 3.8 Meteorology

The Project Site is situated in the Namoi River Valley between the tropical and temperate climatic zones, and between the belts of the subtropical highs and the zone of mid latitude westerlies (R.W. Corkery and Co. (RWC) 2007). Synoptic highs dominate the climate in summer, and low pressure systems pass at regular intervals bringing milder temperatures and winds from the southerly quadrant (RWC 2007). The climate is also influenced by the substantial mountain range within the CCA Zone 2 Kelvin to the east of the Project Site and to a lesser extent Bull Mountain within the Vickery State Forest to the west.

The meteorology data for the Project Site have been sourced from a combination of long-term data collected by the Bureau of Meteorology (BoM) in Gunnedah at Station 055023 (Gunnedah Pool) and Station 055024 (Gunnedah Resource Centre) and a weather station established within the Project Site by Whitehaven in 2002.

### 3.8.1 Temperature, Rainfall, Evaporation and Humidity

Long-term average data for temperature, rainfall, evaporation and relative humidity has been sourced from the abovementioned BoM stations and is summarised in **Table 4**.

**Table 4 – Long-Term Meteorological Conditions**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dev | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean Monthly Maximum Temperature ($^{o}$C) – BoM Station 055023 for years 1876 to 2010[1]** | | | | | | | | | | | | |
| 34.0 | 32.9 | 30.7 | 26.4 | 21.3 | 17.6 | 16.9 | 18.9 | 22.8 | 26.7 | 30.3 | 33.0 | **26.0** |
| **Mean Monthly Minimum Temperature ($^{o}$C) – BoM Station 055023 for years 1876 to 2010[1]** | | | | | | | | | | | | |
| 18.3 | 18.1 | 15.8 | 11.4 | 7.1 | 4.3 | 3.0 | 4.1 | 6.9 | 10.7 | 14.1 | 16.8 | **10.9** |
| **Mean Monthly Rainfall (mm) - BoM Station 055023 for years 1876 to 2010[1]** | | | | | | | | | | | | |
| 71.3 | 66.5 | 48.1 | 37.7 | 42.4 | 43.9 | 42.2 | 41.3 | 39.8 | 55.2 | 60.9 | 68.6 | **618.2** |
| **Mean Monthly Evaporation (mm) – BoM Station 055024 for years 1948 to 2010[1,2]** | | | | | | | | | | | | |
| 238.7 | 190.4 | 186.0 | 129.0 | 83.7 | 57.0 | 58.9 | 86.8 | 120.0 | 164.3 | 201.0 | 241.8 | 1752.0 |
| **Mean Monthly 9am Relative Humidity (%) – BoM Station 055023 for years 1876 to 2010[1]** | | | | | | | | | | | | |
| 60 | 65 | 65 | 67 | 73 | 78 | 77 | 71 | 65 | 61 | 59 | 58 | **67** |
| **Mean Monthly 3pm Relative Humidity (%) – BoM Station 055023 for years 1940 to 2010[1]** | | | | | | | | | | | | |
| 43 | 45 | 44 | 46 | 51 | 55 | 53 | 48 | 43 | 43 | 40 | 40 | **46** |

1 - downloaded from BoM Website June 2010 Red = Highest Value Blue = Lowest Value
2 - based on daily data

The following broad observations are made:

**Temperature**
The local climate is characterised by very warm to hot summers and cool to mild winters. Mean monthly maximum temperatures range between 34.0 and 16.9 degrees Celsius ($^{0}$C), with January being the warmest month. Mean monthly minimum temperatures range between 18.3 and 3.0 $^{0}$C, with July being the coolest month. Autumn and spring are generally mild with sporadic temperature fluctuations.

**Rainfall**
Rainfall is, on average, relatively evenly distributed throughout the year, with the warmer months (November to February, inclusive) being slightly wetter than the remainder of the year. The wetter months have a reasonably low number of mean rain days suggesting the higher volumes of rainfall are associated with higher intensity storms falling over shorter periods of time (GSSE 2010c). The area is also quite susceptible to extended periods of drought.

A statistical review of rainfall records by GSSE (2010c) within the region has identified that for a dry year (10th percentile) the annual rainfall is 392.5 mm, for a medium year (50th percentile) the annual rainfall is 578.0 mm, and for a wet year (90th percentile) the annual rainfall is 752.0 mm.

**Evaporation**
Mean monthly evaporation exceeds mean monthly rainfall throughout the year, with mean annual evaporation exceeding mean annual rainfall by a factor of nearly three. Evaporation is greatest during the warmer months of November to March, inclusive, with mean monthly rates exceeding 185 mm.

**Relative Humidity**
The area has a moderate relative humidity, with the winter months tending to be slightly more humid than other times of the year. The mean 9.00am and 3.00pm relative humidity is 67% and 46%, respectively.

### 3.8.2 Atmospheric Stability

The term atmospheric stability refers to the dispersive capacity of the atmosphere. The Pasquill-Gifford scheme classifies the atmosphere into six (sometimes seven) classes:

- Class A occurs in the day with light winds and strong solar radiation with strong convection; dispersion is rapid;
- Class D, also known as 'neutral conditions', occurs with moderate to strong winds and/or overcast skies; again dispersion is rapid;
- Class F (and G) occurs under light winds with clear skies at night. These conditions are conducive to the formation of ground-based inversions and as such; dispersion is slow; and
- Classes B and C are intermediate between A and D, and E is intermediate between D and F

(PAEHolmes 2011).

**Table 5** shows the frequency of occurrence of the stability classes expected in the area, using the 2006/2007 data from the on-site weather station, as determined by PAEHolmes (2011).

**Table 5 – Frequency of Atmospheric Stability Classes 2006/2007**

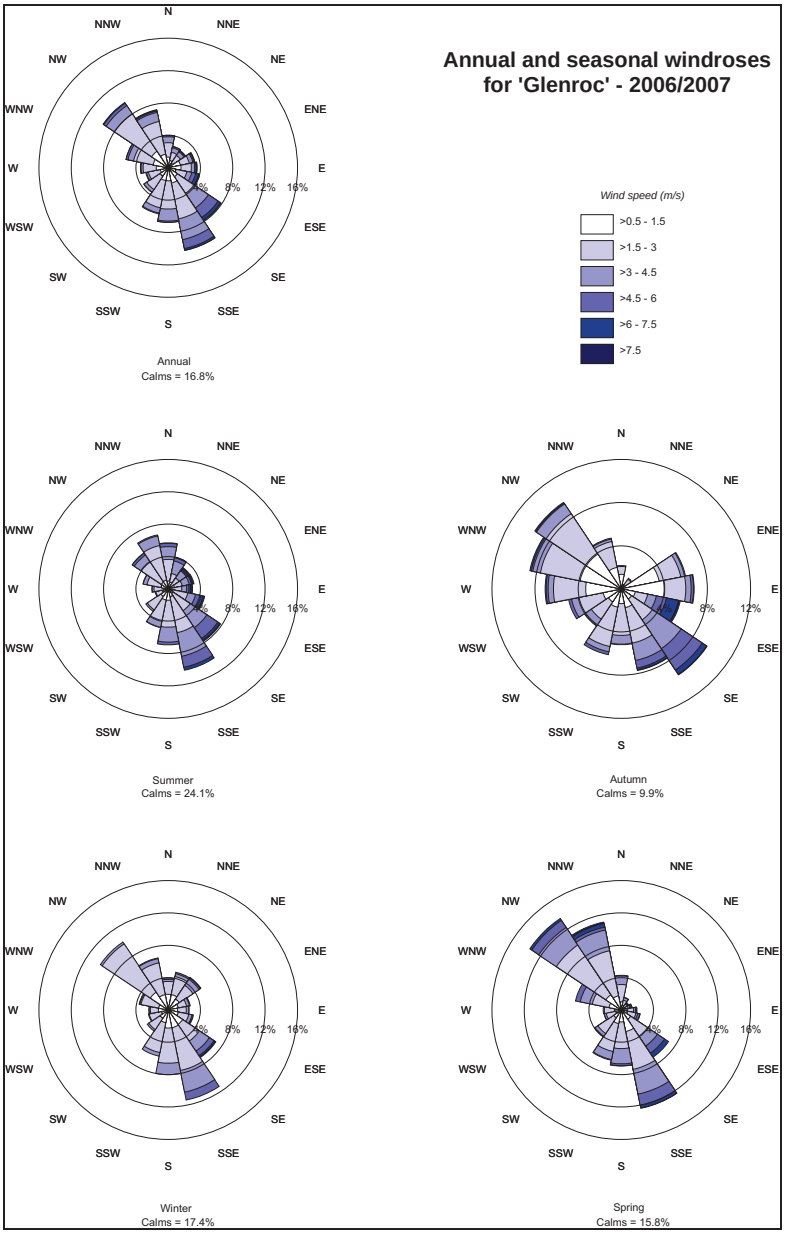
| Stability Class | Percentage Occurrence (%) |
|---|---|
| A | 22.1 |
| B | 7.7 |
| C | 7.5 |
| D | 25.9 |
| E | 12.8 |
| F | 24.0 |
| Total | 100.0 |

The most common stability class in the area was determined to be Class D at 25.9%. Under these conditions, pollutant emissions disperse rapidly. There is also a significant proportion of Class A (rapid dispersion) and Class F (slow dispersion) stabilities, indicating a wide variety of dispersion scenarios.

### 3.8.3 Wind

The weather station located within the Project Site records 15-minute values of temperature, wind speed, wind direction and sigma-theta (a measure of the fluctuation of the horizontal wind direction). Data from March 2006 to February 2007 (inclusive) were used for this assessment as this was the most recent and complete data set available that contained all necessary parameters. Annual and seasonal windroses have been prepared by PAEHolmes (2011) from these data and are shown on **Figure 8**.

According to PAEHolmes (2011), the most common winds are from the north-west and south-eastern quadrants. This pattern of wind is evident in all seasons to various degrees, with a little more variation in the autumn months. Very few winds blow from the southwest or northeast, likely due to the channelling effects of the surrounding terrain. The percentage of calms (winds less than or equal to 0.5 m/s) throughout the year is relatively high, at almost 17% annually. The mean wind speed for 2006/2007 data was 2.3 metres per second (m/s).




Source: PAEHolmes (2011)

**Figure 8 – Annual and Seasonal Windroses 2006/2007**

## 3.9 Topography

### 3.9.1 Regional Topography

The Project Site lies within the Namoi River Basin in an area representative of the transition from the higher broken country to the northeast and south associated with the Nandewar, Great Dividing and Liverpool Ranges and the open plains to the west (RWC 2007). The predominate topographical features are level floodplains of the Namoi River, Mooki River and Cox's Creek, which are generally long corridors up to 40 km across that become slightly undulating as they expand across the landform, and residual hill ridge systems.

While the majority of the area is characterised by floodplains and slope of less than 15 degrees, areas within the adjoining Vickery State Forest and nearby CCA Zone 2 Kelvin comprise slopes over 25 degrees and 45 degrees, respectively. Elevations in the region vary from 1,094 metres Australian Height Datum (AHD) approximately 35 km east of the Project Site, to 250 metres AHD within the Namoi River Valley approximately 12 km southwest of the Project Site, with isolated peaks elsewhere (RWC 2007).

### 3.9.2 Local Topography

The Project Site is situated within a small north-south tending valley between the isolated elevated areas of Vickery State Forest to the west and the CCA Zone 2 Kelvin to the east, with elevations in these areas extending to approximately 490 metres AHD and 885 metres AHD, respectively. The valley widens to the north and south ultimately forming part of the Namoi River floodplain.

The Project Site lies within the valley floor with gentle slopes generally between 1 and 5 degrees, and elevations generally ranging between approximately 280 and 300 metes AHD. The rises to the east and west direct runoff into the valley floor with a central crest within the Project Site separating flows to the north and south.

## 3.10 Surface Hydrology

The Project Site is located within the Namoi River catchment area and lies within a central crest of the valley floor between the hills of the Vickery State Forest and the CCC Zone 2 Kelvin.

Prior to mining operations, there were several drainage lines that would have entered the site from the east and drained into the two ephemeral drainage lines that lie within the Project Site. These drainage lines originate from the ridgeline within the CCC Zone 2 Kelvin and run down into the valley floor. Agricultural activities on the neighbouring land to the east of the current alignment of Wean Road have heavily modified the drainage paths, which now flow into the Project Site via a series of contour drains and dams. The runoff from the eastern catchment is split in two, with Jaeger Lane being the approximate catchment divide. The runoff from the northern section is directed around the northern end of the current mine boundary, and the runoff from the southern section reports to the approved water management system within the mine site.

The catchment lying to the west of the Project Site within the Vickery State Forest, which previously entered a central drainage line within the Project Site, has been temporarily diverted around the existing mining operations. A second order ephemeral drainage line has been diverted to the north and into the head waters of Driggle Draggle Creek with a commitment made to re-instate after the completion of mining. To the south, a clean water diversion diverts runoff from the Vickery State Forest around the existing mine operations and back into the central drainage line to the south of the mining area.

Within the existing approved mining area there are currently two major catchments that generally drain north or south. Water is discharged from the site through two licensed discharge points (LDP 11 in the south and LDP 12 in the north) held under the site's current Environmental Protection Licence (EPL 12870). As runoff exits from the south of the Project Site, it reports to the Namoi River via an un-named depression that flows generally in a southerly direction before turning west into the Namoi River approximately 10 km from the Project Site. To the north, runoff from the Project Site reports to Driggle Draggle Creek, which subsequently flows to the Namoi River via Barbers Lagoon drainage line approximately 14 km from the Project Site.

Overall the surface hydrology within and immediately surrounding the Project Site (with the exception of the State Forest areas) has been heavily disturbed by past agricultural activities and altered as a result of the present mining operations. No drainage lines within the Project Site were found to contain significant riparian vegetation with the majority of the drainage lines having poorly defined bed and banks.

## 3.11 Land Management Units

In accordance with the publication *Land Management Units in the Namoi Catchment* (Namoi CMA 2009), as cited in GSSE (2010a), the Project Site comprises the following two primary Land Management Units (LMUs):

**Central Mixed Soil Floodplains (0 to 2% Slope)**
This LMU is dominated by a mixture of alluvial soils and very extensive meander plains, with a land capability classification range of 2 to 7. The soils are highly variable with Black Earths, Brown and Grey Clays, Red-Brown Earths and with minor Chernozems and hardsetting duplex soils, depending on the parent material contributing to the alluvium.

Localised extensive shallow saline groundwater is generally not a feature of this LMU, however deep fresh irrigation aquifers are found beneath where the alluvium sits on a coarse gravel fill over basement material. Recharge is generally thought to be from surface streams with gravel beds that are well connected to the underlying aquifers.

Land use is generally a mosaic of cropping and grazing on native or improved pastures, which is largely determined by the fertility and tilth of the soil. Timber generally occurs as isolated or scattered trees, with occasional open woodland. Native vegetation is mainly Bimble Box, White Box, Rough-Barked Apple, River Red Gum and Myall, with localised treeless plains dominated by Plains Grass.

**Central Black Earth Floodplains (0 to 1% Slope)**
This LMU is characterised by the Black Earth floodplains existing in association with the major rivers and creeks in the central part of the catchment. It generally has a land capability classification of 2, 7 or 8. Floodways generally have a slope of less then 2% and are dominated by very extensive black plains, with minor swamp and outwash areas.

Soils include deep Black Earths, Brown or Grey clays and some Earthy Sands. Some floodways are farmed, others are managed as pasture and some retain native vegetation of grasses, understory, River Red Gum, Myall and Grey, Yellow or Bimble Box. The floodplain is intensively farmed and largely cleared of vegetation.

This LMU is a dynamic environment and subject to inundation and severe erosion. Shallow saline groundwaters can be locally extensive, and deep fresh irrigation aquifers are found beneath where the alluvium sits on a coarse gravel fill over basement material. Most of this LMU is used for cropping (with significant irrigation areas), with a minor portion used for grazing on native and improved pastures.

Refer to **Section 7.1** for further details and assessment of land capabilities and agricultural suitabilities within the Project Site.

## 3.12 Soil Survey

GSSE (2010a) undertook a soil survey and land resource assessment for the Rocglen Extension Project in order to assist Whitehaven plan and implement appropriate post-mining rehabilitation. A copy of the *Soil Survey and Land Resource Assessment* in contained within **Appendix G**.

Survey methodology comprised the use of aerial photography and topographic mapping, previous soil survey results, stratified observations, field sampling and laboratory analysis. Five soil profile sites were assessed across the Project Site, with subsurface exposure generally undertaken by backhoe excavation of test pits to a depth of approximately 1.2 metres. The test pit locations were selected to provide representative profiles of the soil types encountered during the survey. The soil layers were generally distinguished on the basis of changes in texture, structure and colour, and soil colours were assessed according to the Munsell Soil Colour Charts (Macbeth, 1994). Soil profiles were also observed through the use of surface exposures located in existing erosion gullies, creek banks, roadway cuttings and dams.

Soil profiles within the Project Site were assessed generally in accordance with the *Australian Soil and Land Survey Field Handbook Soil Classification Procedures* (McDonald et al. 1998, as cited in GSSE 2010a). Soil layers at each profile site were also assessed according to a procedure devised by Elliot and Veness (1981, as cited in GSSE 2010a) for the recognition of suitable topdressing material, which assesses soils based on grading, texture, structure, consistence, mottling and root presence. This procedure remains the benchmark for land resource assessment in the Australian coal mining industry.

Collected soil samples were analysed by the NSW Department of Lands' Soil and Water Testing Laboratory (Scone NSW). The soil laboratory results are appended to the report within **Appendix G**. Samples were analysed for a range of parameters to establish the suitability of surface and near-surface soil horizons as potential growth media in rehabilitation and to identify high value soils, and, conversely, soils that may have properties that are deleterious to vegetation establishment.

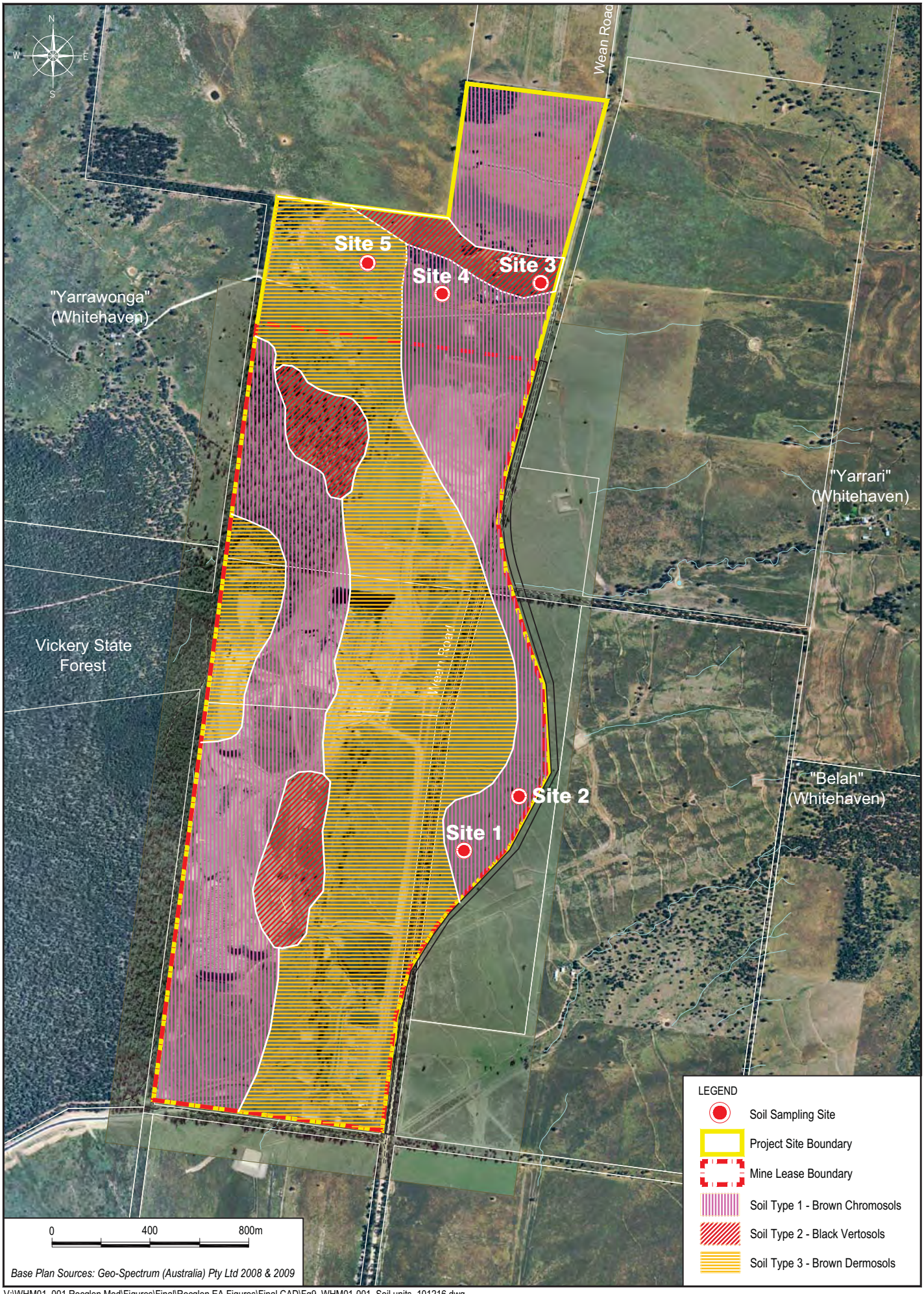
The location of soil profiles and the distribution of soil units within the Project Site are shown on **Figure 9**. Sites 1 and 2 were from lower to mid slope sites east of the current Wean Road alignment, and Sites 3, 4 and 5 were located on lower lying valley floor sites west of Wean Road in the general area of the "Glenroc" residence. The following three soil units were identified and mapped within the Project Site:

**Soil Unit 1 - Brown Duplex Sandy Loams (Eutrophic Brown Chromosol)**

**Description –** The Project Site encompasses approximately 204 hectares of this soil unit on the midslope. The Brown Duplex Sandy Loam soils generally consist of dark brown fine sandy loams with a clear wavy change to strong brown clays. These well-drained soils are moderately strongly alkaline at depth, and are generally non saline with moderate fertility characteristics. The topsoil and subsoil are non-sodic.

**Land Use -** The land overlying these soils is currently grazed, but has been cropped for many years. Due to severe erosion in the past, graded banks and waterways have been constructed. There are scattered silver ironbark, grey box with wire grass and spear grass native pastures.

**Management -** The top 0.25 metres of this soil unit is suitable for stripping and can be reused as a topdressing material in rehabilitation. The subsoil, down to a depth of 1.05 metres, is suitable as an intermediate layer between overburden and topdressing in rehabilitation. The subsoil below this depth is not recommended for rehabilitation purposes due to the limiting factors of weathered rock. This soil requires standard erosion and sediment control measures if disturbed.




V:\WHM01_001 Rocglen Mod\Figures\Final\Rocglen EA Figures\Final CAD\Fg9_WHM01-001_Soil units_101216.dwg
*To be printed A4*

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Soil Units and Sampling Sites

**FIGURE 9**

**Soil Unit 2 - Self Mulching Black Earths (Self Mulching Black Vertosol)**

**Description –** The Project Site encompasses approximately 38 hectares of this soil unit on lower slopes in drainage lines predominately within grazing land. Black Earths of very dark brown clayey topsoil and sub-surface soil overlies dark brown clayey subsoils. These moderately-drained soils are strongly alkaline and are generally slightly saline to saline at depth, however have excellent fertility characteristics. The topsoil is non-sodic whilst the subsoil is sodic.

**Land Use -** The land overlying these soils includes open grazing farmland. The vegetation consist of isolated poplar box with warrego summer grass and various Stipa spp and Panicum spp native pastures.

**Management -** The top 0.6 metres of this soil unit is suitable for stripping and can be reused as a topdressing material in rehabilitation. The lower layers are generally unsuitable for reuse as topdressing or an intermediate layer due to the limiting factors of salinity, high sodicity and high alkalinity. This soil requires standard erosion and sediment control measures if disturbed, however given the sodicity at depth, if the topsoil is removed, it may lead to dispersion and erosion in wet conditions.

**Soil Unit 3 - Sodic Brown Alluvial Clays (Calcic Brown Dermosol)**

**Description –** The Project Site encompasses approximately 218 hectares of this soil unit on the lower slopes, flats and floodplain of the higher quality grazing and cropping soil. The Brown Alluvial Clays also exhibit crusty surfaces and scattered gravel. These moderately well drained soils are strongly alkaline in the upper layers and moderately alkaline at depth. The soils are slightly saline in the subsurface but have good fertility characteristics throughout. The topsoil is marginally sodic tending to be highly sodic in the subsoil.

**Land Use -** The land overlying these soils is used for high quality grazing and cropping activities. Therefore, the vegetation ranges from various crops to improved and native pastures. The occasional poplar box and yarran trees are present.

**Management -** The top 0.25 metres of this soil unit is suitable for stripping and can be reused as a topdressing material in rehabilitation. However any sections with clay topsoil and all subsoil is texturally unsuitable for use as a topdressing and therefore not recommended for rehabilitation purposes. The high sodicity levels in the subsoil indicate this soil is not recommended for use as an intermediate layer between overburden and topdressing, as the risks associated with erosion are high. This soil requires standard erosion and sediment control measures if disturbed, however given the sodicity at depth, if the topsoil is removed, it may lead to dispersion and erosion if exposed to wet conditions over time.

## 3.13 Geology

The information contained within the below sections has been sourced from the I&I NSW's website and from RWC (2007).

### 3.13.1 Regional Geology

The Project Site is located in the Gunnedah Basin, which forms the central part of the Sydney-Gunnedah-Bowen Basin system extending along the eastern margin of Australia. The Gunnedah Basin covers an area of just over 15,000 square kilometres and comprises rocks of Permian and Triassic age. The basin is in part unconformably overlain by the Jurassic-Cretaceous strata of the Surat Basin.

The Gunnedah Basin is a foreland basin with sediments unconformably overlying deformed and metamorphosed Ordivician to Devonian Lachlan Fold Belt strata in the west and abutting Devonian to Carboniferous New England Fold Belt strata to the east, along the east dipping Hunter-Mooki Thrust. As shown on **Figure 10**, the Boggabri Ridge is a major structural feature dividing the basin into sub-basins, with the Project Site located within the south-eastern extent of the Maules Creek Sub-basin.

Adjacent to the Project Site is the Hunter-Mooki Fault System, which forms a prominent ridge of carboniferous rocks that have been overthrust onto the younger coal measures strata.

### 3.13.2 Local Geology

The principal local structure in the area of the Project Site, which is an important control on coal distribution, is a north-northwest oriented asymmetrical anticline that plunges and flattens to the south. Dips in the south range from four to six degrees to the west and 20 degrees to the east. In the north of the deposit, a syncline is developed to the east of the anticline, and appears to be bounded by steeply dipping and faulted strata.

The overburden within the Project Site comprises a deeply weathered section of interbedded claystone, siltstone, sandstone, conglomerate and tuffaceous claystone (see **Figure 11**). The depth of weathering is generally between 30 and 40 metres on the crest and western limb of the anticline, however increases to between 45 and 68 metres on the eastern limb of the anticline. A thin soil layer is underlain by between 4 and 14 metres of light olive brown clay that is variably stained yellow and orange by secondary iron oxides. On the eastern side of the deposit, this clay layer often grades into a weathered cream to greenish grey claystone unit that varies from 2 metres to almost 20 metres thick, with the thicker intersections being on the crest and eastern flank of the anticline. Interbedded conglomerate, sandstone, siltstone and coal lie below the clay and claystone layers.

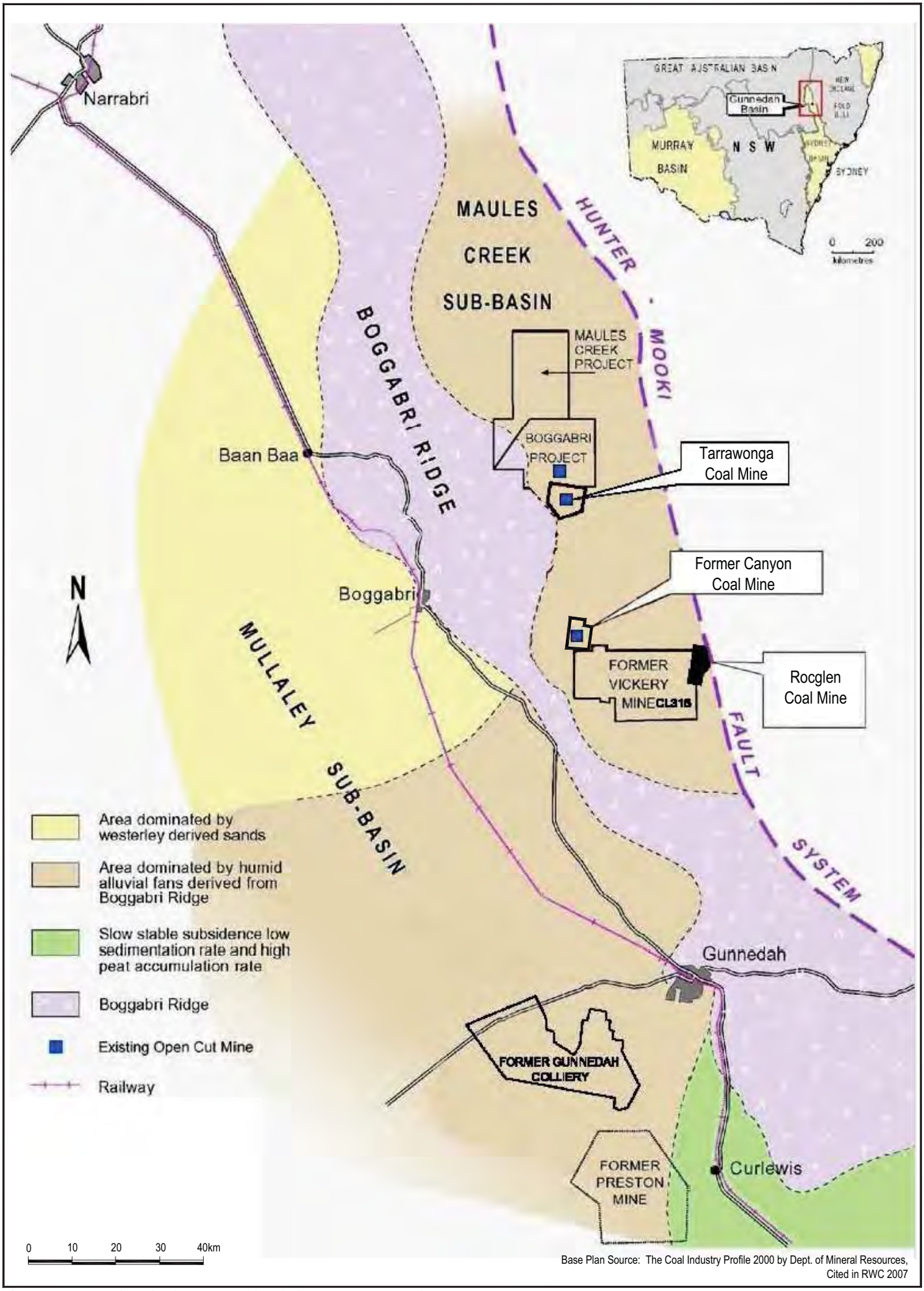
## 3.14 Coal Resources

Whitehaven was granted an Exploration Licence (EL 5831) over the area incorporating the Project Site in April 2001 and, since that time, has undertaken several exploration drilling campaigns. Within the area, and as shown on **Figures 11** and **12**, there are three mineable coal seams, which are identified as, in descending order, the Upper Glenroc, Lower Glenroc and Belmont Seams. All three seams appear to thicken on the eastern limb of the anticline, although many of the thicker intersections are artificially inflated by steeper dips. These three seams have an average combined thickness of up to 17 metres. **Table 6** lists the average thicknesses of the three seams (where present) within the Project Site, as advised by Whitehaven.

**Table 6 – Coal Seam Thicknesses**

| Coal Seam | Minimum Thickness (metres) | Maximum Thickness (metres) | Average Thickness (metres) |
|---|---|---|---|
| Upper Glenroc | 0.80 | 5.95 | 2.65 |
| Lower Glenroc | 0.85 | 5.30 | 2.00 |
| Belmont | 4.22 | 12.00 | 7.00 |

As the thicker coal sequences are often associated with thinner interburden, some quite thick coalesced sequences (up to 17 metres) have developed in some areas. However, along the crest of the anticline the coal has been uplifted and now lies within the oxidation zone with the Upper and Lower Glenroc Seams, and, in places, the Belmont Seam, having been removed completely by the weathering process.

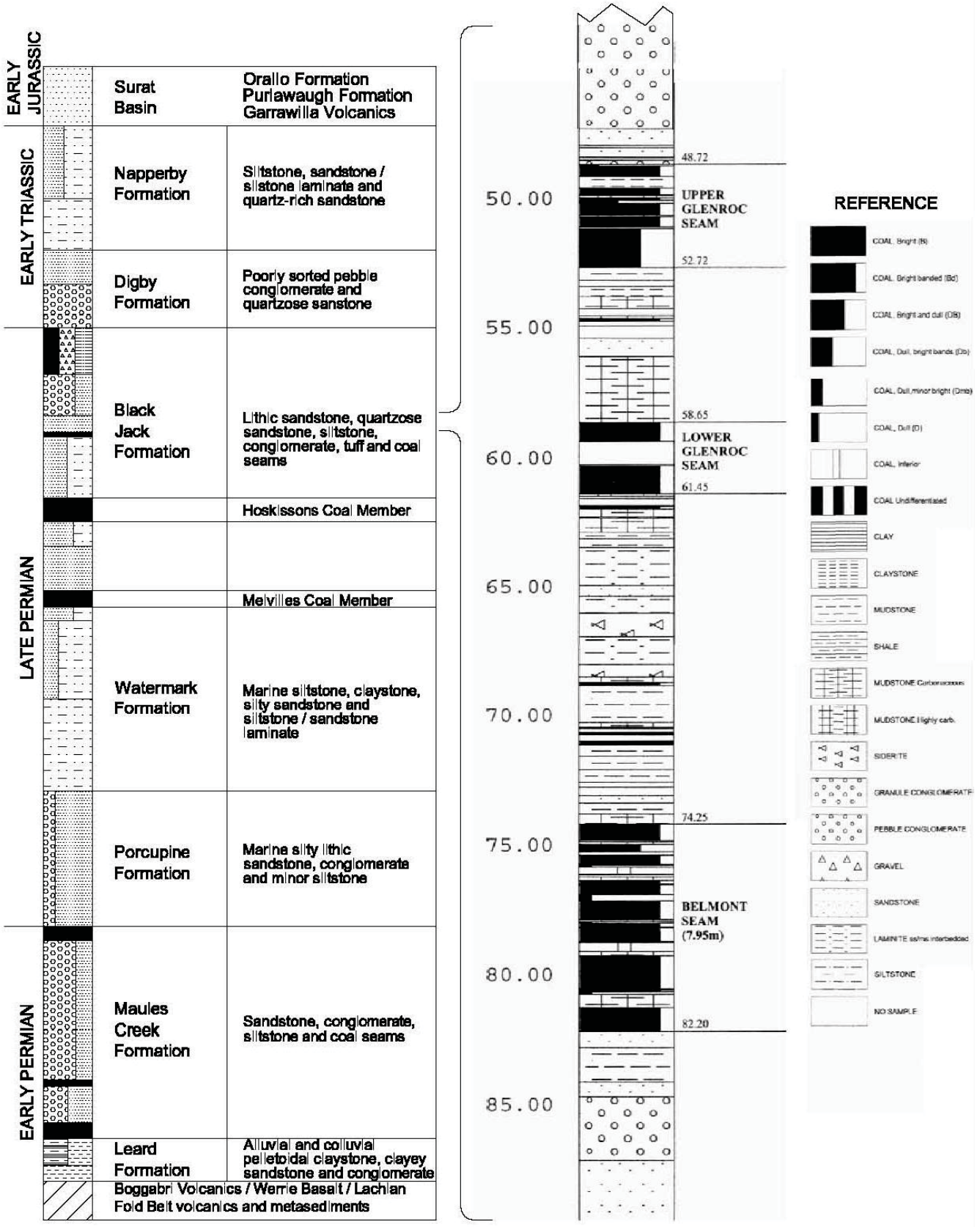



Base Plan Source: The Coal Industry Profile 2000 by Dept. of Mineral Resources, Cited in RWC 2007

V:\WHM01_001 Rocglen Mod\Figures\Final\Rocglen EA Figures\Final CAD\Fg10_WHM01-001_Regional Geology_101216.dwg
*To be printed A4*

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Regional Geology
**FIGURE 10**




(a) General Stratigraphic Sequence - Gunnedah Basin

(b) Stratigraphic Section - Proposed Belmont Coal Mine

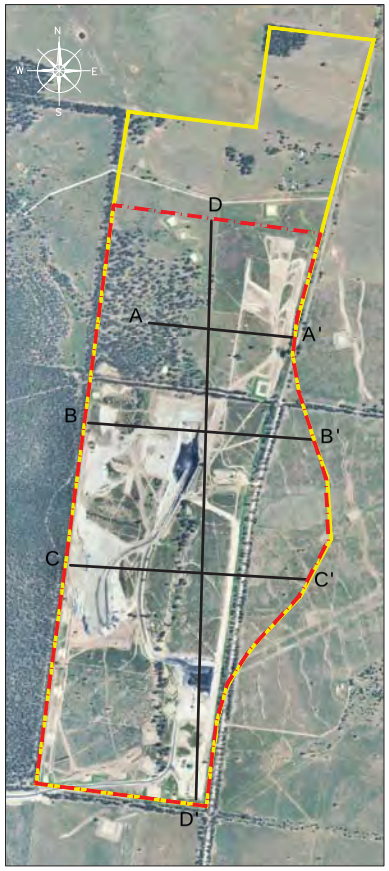
Base Plan Source: Belford Dome Resource Consultants, Cited in RWC 2007

V:\WHM01_001 Rocglen Mod\Figures\Final\Rocglen EA Figures\Final CAD\Fg11_WHM01-001_LocalStrat_110106.dwg
*To be printed A4*

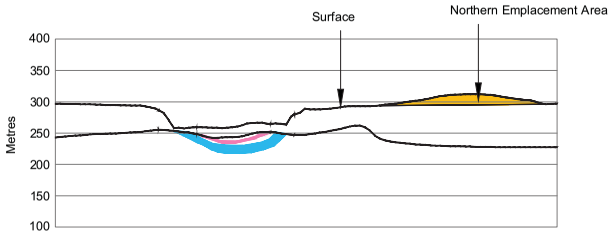
GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Local Stratigraphy

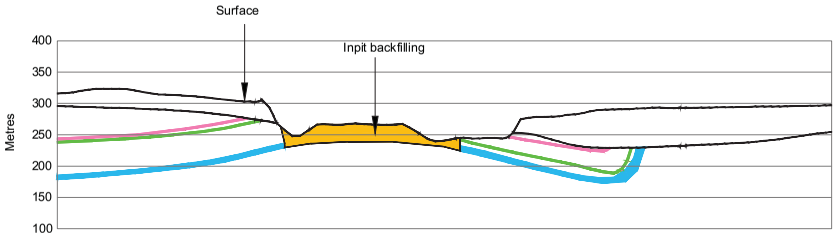
**FIGURE 11**



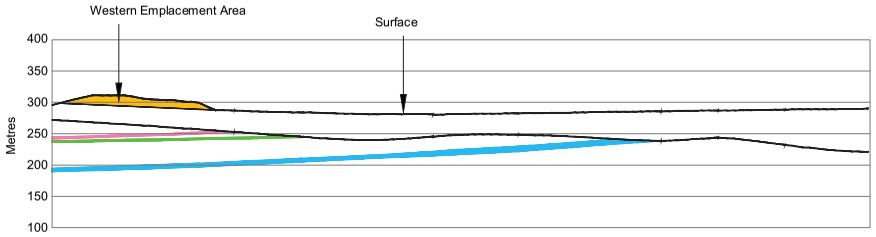

PLAN showing SECTION LOCATIONS



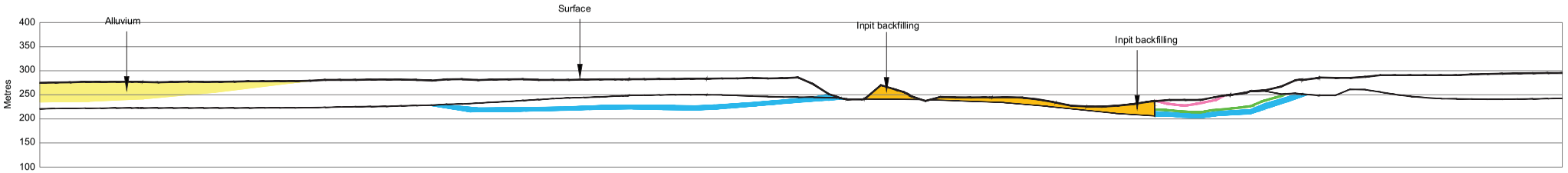

SECTION A - A'




SECTION B - B'




SECTION C - C'




SECTION D - D'

LEGEND:

- Upper Glenroc Seam
- Lower Glenroc Seam
- Belmont Seam

V:\WHM01_001 Rocglen Mod\Figures\Final\Rocglen EA Figures\Final CAD\Fg12_WHM01-001_Geological Cross Sect_110106.dwg
*To be printed A3*

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Rocglen Coal Mine Extension Project
Geological Cross Section

**FIGURE 12**

As outlined above in **Section 3.13.2**, the overburden within the Project Site comprises a deeply weathered section of interbedded claystone, siltstone, sandstone, conglomerate and tuffaceous claystone (see **Figure 11**). The interburden strata compromises interbedded conglomerate, sandstone and siltstone.

Coal resources within the Project Site have been estimated by seam for an average vertical ratio of around 5.5 bcm of overburden per in-situ tonne of coal, as calculated at the base of the Belmont Seam.

Cumulatively, between the three economical seams, it is estimated that an in-situ resource of up to approximately 18.5 Mt is currently available within the Project Site. This comprises up to 13.5 Mt remaining for recovery under the original Project Approval PA 06_0198 (the original EA prepared by R.W. Corkery & Co. in 2007 states an identified in-situ resource of 14.18 Mt, with a further 0.48 Mt available should auger mining proceed) and up to an additional 5 Mt not previously considered in the life of mine plan and proposed to now be extracted as part of the Rocglen Extension Project.

Core quality sampling and analysis has also been undertaken as part of previous exploration activities. **Table 7** presents a summary of the coal quality results.

**Table 7 – Recoverable Coal Quality**

| Coal Seam | Density | Moisture (%) | Ash (% adb[1]) | Volatile Matter (% adb[1]) | Specific Energy (kcal/kg[2]) | Total Sulfur (% adb[1,2]) |
|---|---|---|---|---|---|---|
| Upper Glenroc | 1.4 | 3.2 | 9.3 | 35.9 | 7105 | 0.40 |
| Lower Glenroc | 1.4 | 3.7 | 9.2 | 34.7 | 7010 | 0.38 |
| Belmont | 1.4 | 3.1 | 9.4 | 36.0 | 7105 | 0.41 |

Source: Belford Dome Resources Consultants, as cited in R.W. Corkey & Co. (2007)
1 – air dried basis, 2 – average values

The quality information indicates that the coal, including the coal reject material, has a low sulphur content and therefore a low potential propensity for spontaneous combustion.