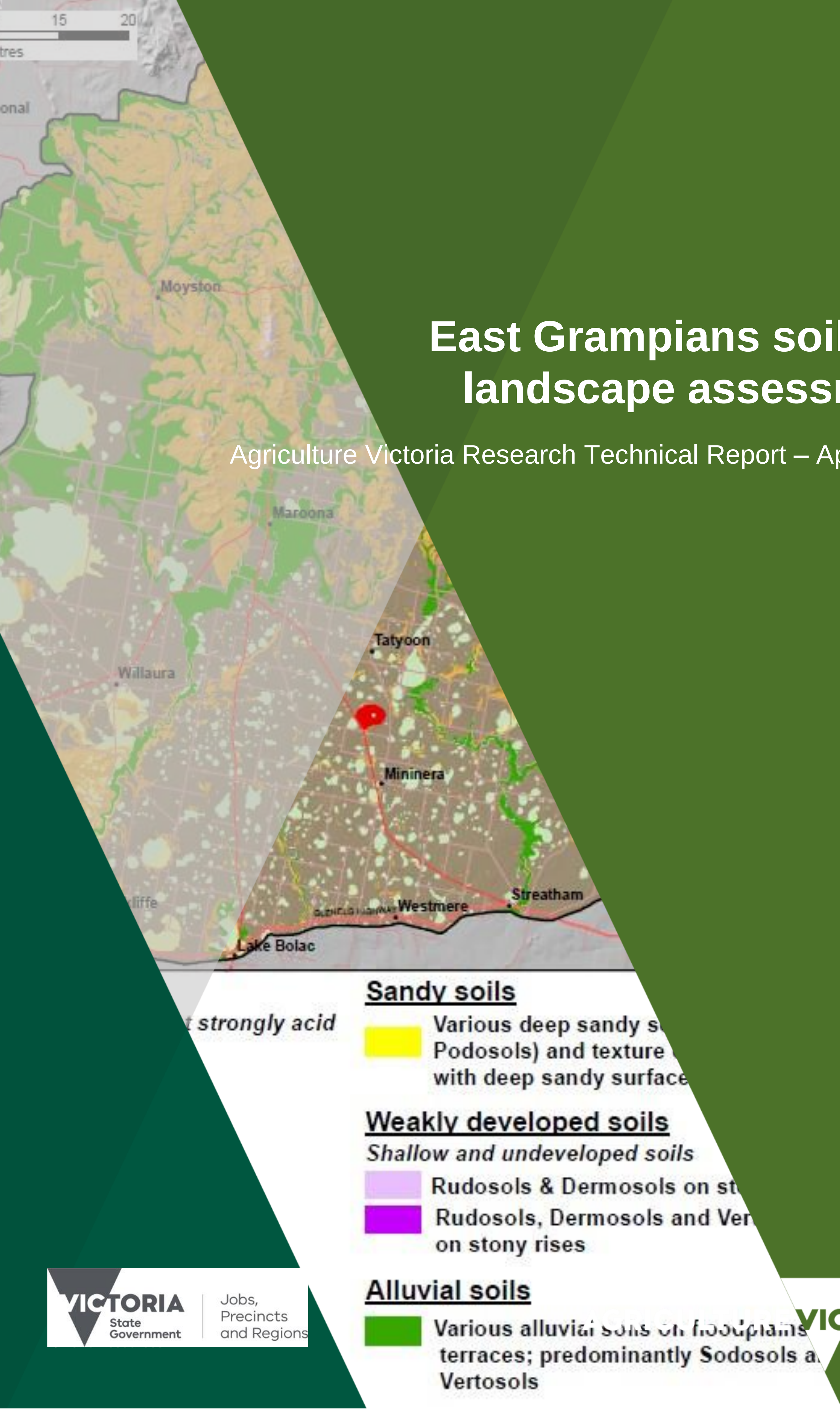



# East Grampians soil and landscape assessment

Agriculture Victoria Research Technical Report – April 2019

VICTORIA State Government
Jobs, Precincts and Regions

VICTORIA

Authors: Mark Imhof, David Rees, Don Cherry and Wayne Harvey

Project CMI Number: 106318

Department of Jobs, Precincts and Regions
1 Spring Street Melbourne Victoria 3000
Telephone (03) 9651 9999

# Contents

# INTRODUCTION

This report contains a brief summary, with maps. of the geology, soils and previously mapped landscape hazard ratings for the East Grampians Rural Pipeline (EGRP) area.

### Project background

A description of soil and landscapes (including geology) is required to support potential referrals under the Environmental Effects Act (EEA) related to the proposed East Grampians Rural Pipeline (EGRP). Dean Robertson (Environmental Officer) from GWMWater requested assistance in preparing maps and summary text associated with soils and geology of the area relevant to potential pipeline construction. AVR has experienced land resource assessment staff who can access and interpret all available soil, landscape and geology mapping and information related to the study area.

### Project objectives

- Utilise all available data held by AVR to assess soils (soil type, permeability, sodicity, drainage), landscape (i.e. slope, elevation), and geology for the EGRP study area.
- Provide a 1-2 page description of soils and geology (from a functional perspective) as well as maps showing soil types, geology and potential soil/landscape hazards.

# RESULTS

## Soils

This overview of soils in the East Grampians Rural Pipeline (EGRP) area is based on best-available soil/landscape mapping (generally at mapping scales of 1:100 000 or smaller) and associated soil site data. The soil/landscape map developed for this study area is shown in Plate 1 and is also attached as a higher resolution map in Appendix A. Soil types can vary considerably, even in a local area, due to topography, landscape position and parent material – and available mapping may not reflect this. This overview mapping and information is useful to inform broader-scale planning, but at a more localised scale, additional on-site investigation is recommended.

**Texture contrast soils** dominate the study area. These are characterised by lighter textured surface horizons (e.g. sand, sandy loam, loam) overlying heavier textured (i.e. clayey) subsoils. The texture contrast soils comprise three major Soil Orders (according to the Australian Soil Classification, Isbell 2002) – Sodosols and Chromosols and Kurosols that are distinguished based on the nature of the upper subsoil. Kurosols (with strongly acidic supper subsoils) are uncommon in this area.

Sodosols are texture contrast soils with an upper subsoil that is sodic (i.e. exchangeable sodium is 6% or greater of the total basic cations) and not strongly acidic. They are a dominant soil, particularly south of Ararat, occurring mostly on basaltic parent material (and occupy approximately 37% of the study area). Sodosols typically have bleached sub-surface (A2) horizons, often with ferruginous ('buckshot') nodules or gravels, that sharply transition to an often dense and coarsely structured clay subsoil. Soils developed on basalt often display considerable profile variability, even at a localised site level, reflecting the strong shrinking-swelling nature of basalt-derived subsoil clays. This can result in variable depths of subsurface horizons and depth to clay subsoil, and/or rock, even at a localized site level. Sodic subsoils are usually dispersive and therefore erodible when exposed. Sodic subsoils restrict water movement into the soil profile and are often associated with waterlogging in wet periods. Basaltic clayey subsoils are likely to have a high liquid limit whether sodic or not. Stonier areas occur where the landscape has been dissected (e.g. along drainage lines and depressions).

Chromosols (with non-sodic upper subsoils that are also not strongly acidic) generally occur in higher rainfall zones (approximately 33% of study area), north of Ararat, and can be found on a range of parent materials such as basalt, younger sediments and older consolidated sediments (rock) where they are more common on lower slopes. As they lack a sodic upper subsoil, Chromosols are generally better drained with greater structural stability than Sodosols and with less dispersive upper subsoils. They can still be erodible, however, on sloping landscapes, particularly where cleared of native vegetation. The deeper subsoil horizons of Chromosols may also be sodic and therefore more erodible if exposed.

**Non-texture contrast soils** include cracking clay soils (Vertosols according to ASC) and a range of less well-developed soils on stony rises, steep slopes and bordering some lakes and depressions.

Vertosols are prevalent on the basalt plains (approximately 8% of the study area) occurring on alluvium and associated lake bed deposits, along creeks and rivers as well as on broad low-lying plains. Vertosols are mapped out separately but will also occur within the 'alluvial soils' mapping unit described further below. Vertosols are clay textured throughout the soil profile and demonstrate significant shrink and swell capacity, causing seasonal cracking as the soil dries out. Waterlogging as well as shrink-swell properties can be an issue for infrastructure construction in these areas. Salinity can also be an occasional issue in some lower-lying landscapes. Though not recorded in the study area, acid sulfate soils could potentially occur, associated with small ephemeral lakes/swamps/bogs and oxbow/billabongs.

Kandosols are typically weakly (or non-) structured soils that lack strong texture contrast (i.e. typically have a more gradational soil texture change down the soil profile). The limited extent is in the north west associated with Grampians outwash and associated alluvial materials where pedological development is limited. Soil textures can range from sandy loams to clays.

There are a limited number (around 1% of study area) of less well-developed sandy soils (Rudosols or Tenosols or Podosols according to the ASC) associated with windblown deposits (lunettes) derived from lakes or on colluvium (e.g. outwash fans).

Shallow, stony soils (Rudosols, Tenosols or Dermosols) are associated with stony rise landscapes on relatively younger basaltic flows to the north-east of Streatham (covering approximately 2% of study area). Vertosols may also occur in some depressions. Due to differences in age of lava flows and past climatic wind deposition, variable depth to rock may be a feature.

Various shallow, stony soils (approximately 2% of area) are also associated with the steeper upland areas of various geologies such as the metamorphic ridges west of Ararat, the sedimentary Challicum Hills to the east of Ararat as well as the granitic mountain blocks (massif) of Langi Ghiran and Mt Buangor. Soils can grade into more developed Dermosols and texture-contrast soils on lower topographic positions and slopes.

Various alluvial soils occur on floodplains and associated terraces throughout the area (approximately 17% of area). Variability in soils is likely to occur even at a localised level in these landscapes. There is a limited number of site observations in these alluvial landscapes, but soils appear to be generally Sodosols or Vertosols. Dermosols and Kandosols are also possible on some lower terraces. Though not recorded in the study area, acid sulfate soils could potentially occur, associated with small ephemeral lakes/swamps/bogs and oxbow/billabongs.

Well-structured gradational soils (Dermosols or Ferrosols) are likely on the few scoria cones in the area.

*References:*

Robinson N, Reynard K, Sheffield K, Bluml M (2004). Ararat Rural City Land Capability Pilot Project. Department of Primary Industries.

http://vro.agriculture.vic.gov.au/dpi/vro/glenregn.nsf/pages/glenelg_ararat_land_capability

Baxter N and Robinson N (2001). A Land Resource Assessment of the Glenelg Hopkins region. Agriculture Victoria.

http://vro.agriculture.vic.gov.au/dpi/vro/glenregn.nsf/pages/glenelg_soil_map

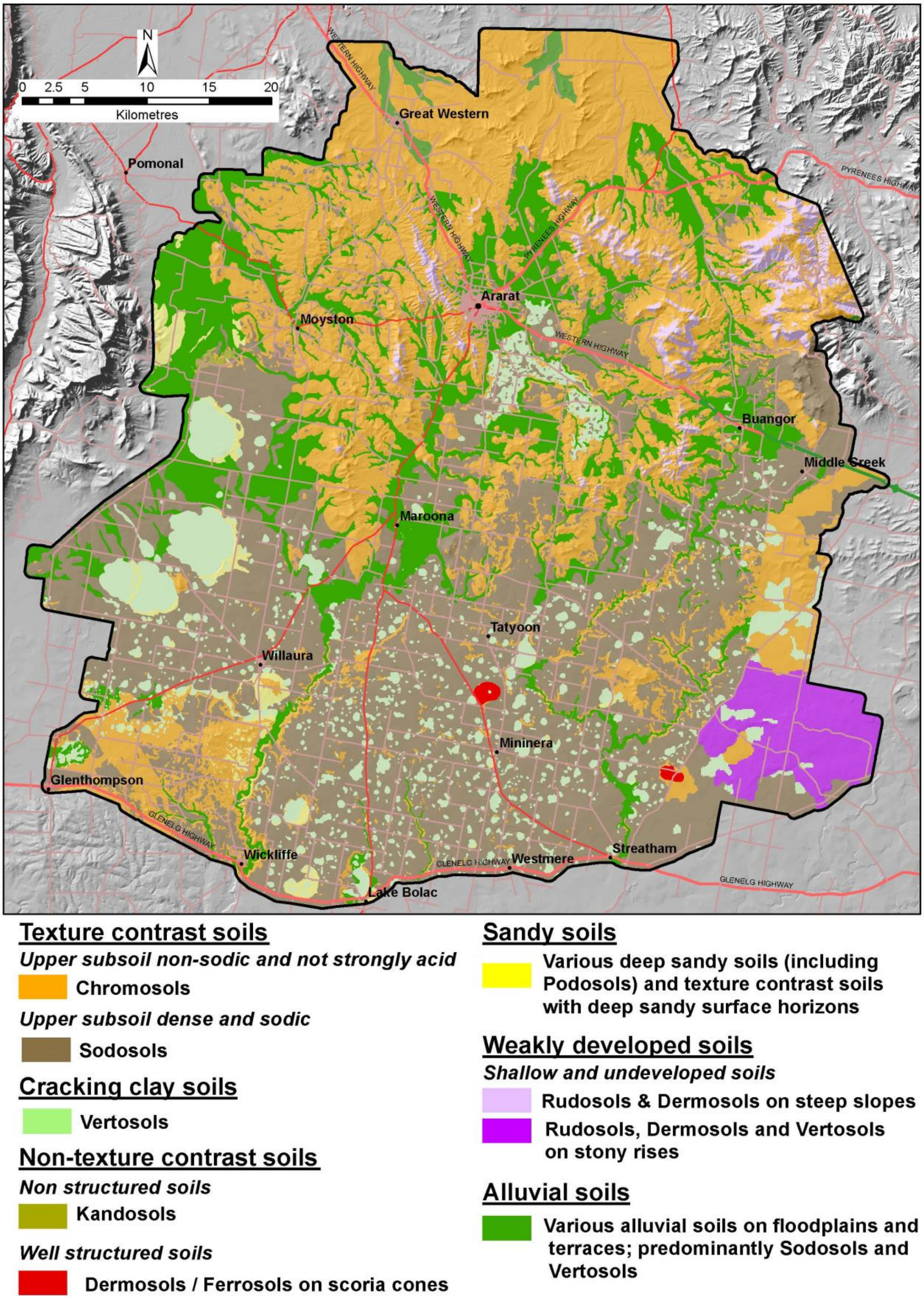



*Plate 1. Dominant soil/landscapes map for the East Grampians Rural Pipeline area.*

## Geology

This summary of the geology is based on best available 1:100 000 geological mapping by the Geological Survey of Victoria (GSV). Field mapping and air photo interpretation of geological boundaries and features (such as faults and joints) has been conducted over several years and published in a suite of detailed reports and GIS data available from the GSV. The overview geology map developed for this study area is shown in Plate 2 and is also attached as a higher resolution map in Appendix B.

Note especially the mapped linear features. The faults, joints and escarpments shown on the associated map are only those considered to be accurately mapped. Many more exist as approximate, concealed or inferred from geophysical interpretation. These have not been shown for map clarity but can be made available on request.

### *Geology*

Four main geological groups occur – bedrock, indurated sediments, *Newer Volcanics* and unconsolidated sediments with the descriptions below detailing their specific features (note 'Ma' = Million years ago).

**Bedrock** underlies all areas but outcrops in areas shown on the map, although in places it may be hidden by a thin soil cover. Bedrock comprises the following main types:

| | | |
|---|---|---|
| Cambrian metasediments<br>441-544 Ma | *St Arnaud Group*, *Nargoon Group*. Marine sedimentary rocks which have been metamorphosed to shale, mudstone and sandstone; variably weathered and sometimes resistive to weathering (often with quartz veining). Tends to occur on the prominent ridges in the north-east part of study area. | Where deeply weathered tends to be clay rich and soft; but, where resistant, it stands up as a ridge with hard outcrops. |
| *Magdala volcanic complex*<br>490-544 Ma | A small area of mafic volcanic rocks faulted into the *Moornambool complex*. These are highly metamorphosed and fractured and tend to be quite thin in outcrop. | Where deeply weathered tends to be clay rich and soft. |
| *Mt Stavely complex*<br>490-544 Ma | Ancient marine volcanics (e.g. basalt, dacite, andesite) and associated sedimentary rocks (e.g. sandstone, breccia, conglomerate). Occurs mainly in the south-western corner of study area. Strongly fractured and metamorphosed. | Tends to be deeply weathered and may not produce any outcrop or resistant ridges. |
| *Moornambool complex*<br>418-441 Ma | Strongly metamorphosed sedimentary rocks (schists mainly). Strongly faulted | Can be strongly resistant to weathering and may form ridges. |
| Grampians group<br>418-490 Ma | Marine sedimentary rocks, mostly sandstone. Distinctive outcrops along the western edge. Insignificant in area | Can be resistant to weathering and may form ridges or cliffs. |
| Granites (several in area)<br>380-418 Ma | Medium to coarse grained granites and associated intrusive rocks, forming surface boulders (tors) and sometimes high ridges or wide-open flat areas. Mostly across the northern half. Tends to have strong jointing and in some areas has a steep escarpment | Variably weathered – some areas deeply kaolinized with no outcrop, others resistant and forming distinct hard outcrops and cliffs. |
| Small igneous intrusives – dykes<br>380-418 Ma | Igneous rock associated maybe with the larger granites. Tend to be small in area, typically linear following joints or faults. | May form resistive outcrop, but more typically deeply weathered. |

The **indurated sediments** include the Cenozoic duricrust and portions of the Paleogene fluvial sediments where they have endured weathering cycles to develop cemented surfaces and laterite profiles.

| | | |
|---|---|---|
| Cenozoic duricrust<br>0-65 Ma | Represents a past weathering regime with deep development of ferricrete including silica or lateritic cement profiles. Includes underlying bleached zone and may have beds of ferruginous pisolites (‘buckshot’). May develop on any older rock type. | Tends to form erosion resistant outcrops as perched benches; may be flat topped with steep edges with a distinctive landform. |
| Paleogene fluvial sediments<br>34-97 Ma | This includes the *White Hills Gravel* and *Eastern View Formation*, both representing a period of fluvial sedimentation during the early Tertiary period (or maybe older). Vary from unconsolidated clay, sand and gravels to often partly indurated with silica or iron cements. Sometimes overlies deeply weathered kaolinitic clay. | Tends to form erosion resistant outcrops as perched benches; may be flat topped with steep edges. Historically worked for gold, so may be disturbed in places. |

The ***Newer Volcanic* group** resulted from vigorous volcanic activity in the south western districts of Victoria during the late Tertiary to Quaternary period (mostly approximately 8 million to 4500 years ago) and comprise three main landforms – plains, stony rises and scoria cones:

| | | |
|---|---|---|
| *Newer Volcanic* group<br>0-23 Ma | Suite of relatively recent basalt flows, scoria and stony rises from distinct and indistinct eruption points across a significant part of the southern section of area. Often fractured and blocky on the plain. | Generally flat, except where there are scoria cones and stony rise ridges (south-east part of study area). The plains themselves may have hard basalt at a shallow depth below a thin soil cover. Tends to have low swampy areas scattered across the plain. |

The **unconsolidated sediments** represent the most recent cycle of sedimentary systems and comprises recent and present-day stream, lake, dune and hill wash deposits:

| | | |
|---|---|---|
| Neogene sediments<br>1.8-23 Ma | Includes the *Shepparton Formation* - unconsolidated clay, sand and gravel deposits scattered across the region, derived from deposition from past streams, lakes and dunes (in previous climate regimes). May occur as perched banks or terraces along the main drainage lines or as outwash fans from ridge lines. | Mostly unconsolidated, rarely with any cementation. May overlie or hide any of the above-mentioned units. |
| Quaternary alluvium, colluvium, dunes and swamps<br><1.8 Ma | Unconsolidated clay, sand and gravel deposits scattered across the region, derived from deposition from current streams, swamps, hill wash and recent aeolian activity | Mostly unconsolidated, rarely with cementation. May overlie or obscure any of the above-mentioned units. Some areas have historically been worked for gold, so may be disturbed and undulating. |

***Glossary***

Alluvium - sedimentary deposits formed by water movement on land depositing particles of clay, silt, sand or gravel.

Cementation - process by which rock particles are cemented together during typical weathering cycles. Cement may be silica, iron or carbonate based, depending on underlying geology and groundwater chemistry. The term ‘duricrust’ is also used on some maps.

Colluvium (or hillwash) – sedimentary deposits formed on hill slopes usually from down slope movement of materials due to water, ice or gravity.

Duricrust – see cementation.

Dykes - small intrusive igneous bodies, generally as narrow linear features.

Ferricrete - specific type of cementation (see above) where the cement is iron oxide based, sometimes also called ‘laterite’.

Fluvial - relating to rivers and streams on land, as opposed to marine (meaning in the ocean).

Granite - medium to coarse grained igneous rocks formed from the intrusion of magma into other rocks, that then cool over time. Only exposed at the surface after significant prolonged erosion.

Igneous – rocks formed from an original molten state.

Intrusives - generic term to describe igneous rocks that have intruded into other rocks, i.e. do not make it to the surface in a molten form.

Kaolinized - generally a weathering effect of rocks initially high in K, Al, etc rich minerals that change to clay, particularly kaolin.

Mafic, basalt, andesite, dacite - igneous rocks, of variable chemistry, that have erupted to the surface from a fissure or volcano (on land or under water). The main difference between these is the increasing silica content, from mafic to dacite.

Metamorphosed -physical and chemical changes that rocks undergo due to heat and pressure.

Metasediments - sedimentary rocks that have been metamorphosed.

Schist - specific medium to coarse grained metamorphic rocks which have formed under medium to high temperature and pressure giving it a distinctive platy fracture pattern.

Sedimentary – rocks formed from the breakdown of other rocks then transported by water, wind, ice or gravity to another location as a sediment.

Unconsolidated - sedimentary material that is loose and friable, not cemented.

Quaternary, Cenozoic, Neogene, Paleogene, Tertiary, Silurian, Cambrian are all geological terms relating to past time periods. Their approximate ages are included in the tables above; however, it is recommended that users reference one of the numerous geological time scales available on the internet for more detailed explanations.

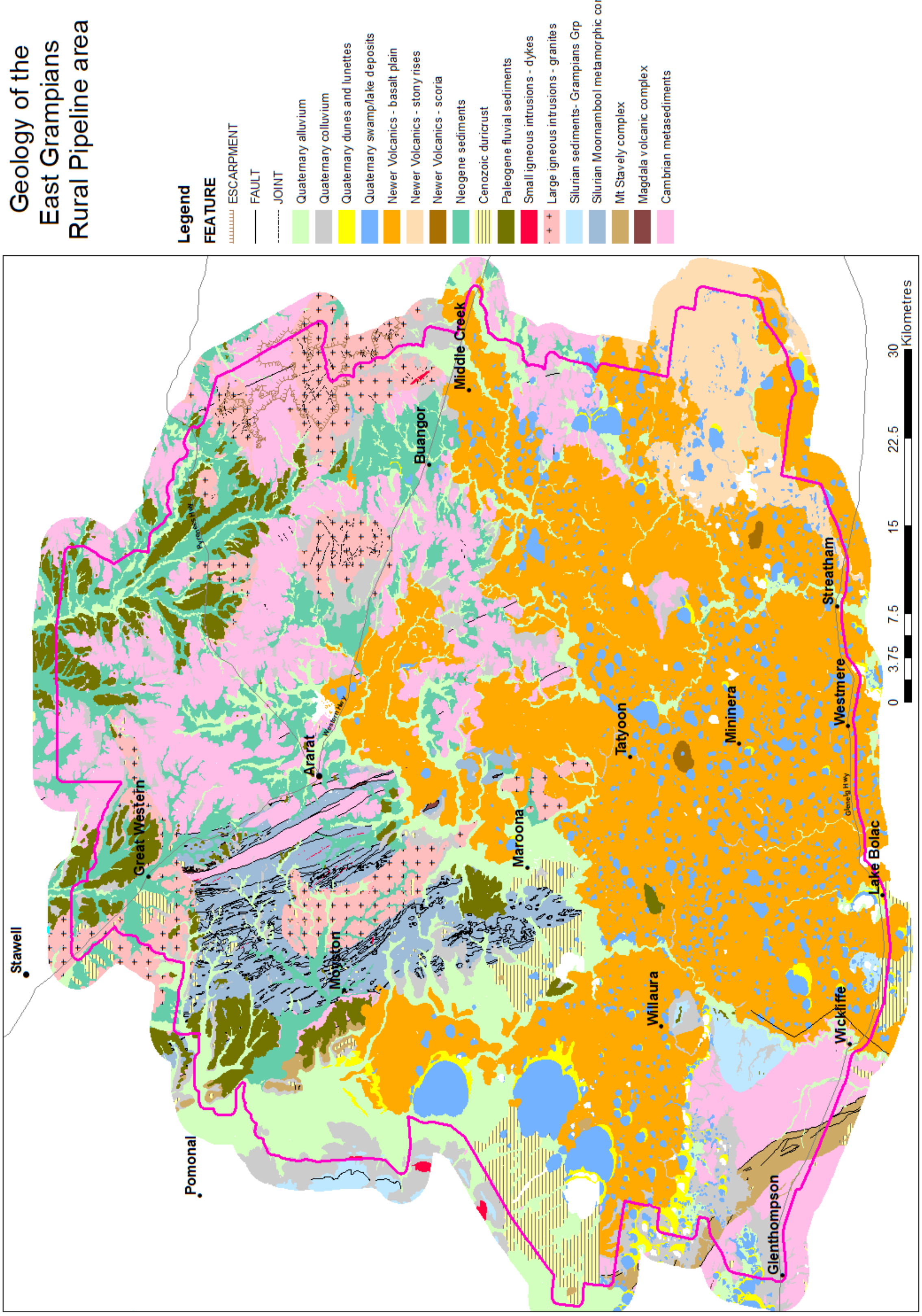



*Plate 2. Overview geology map for the East Grampians Rural Pipeline area.*

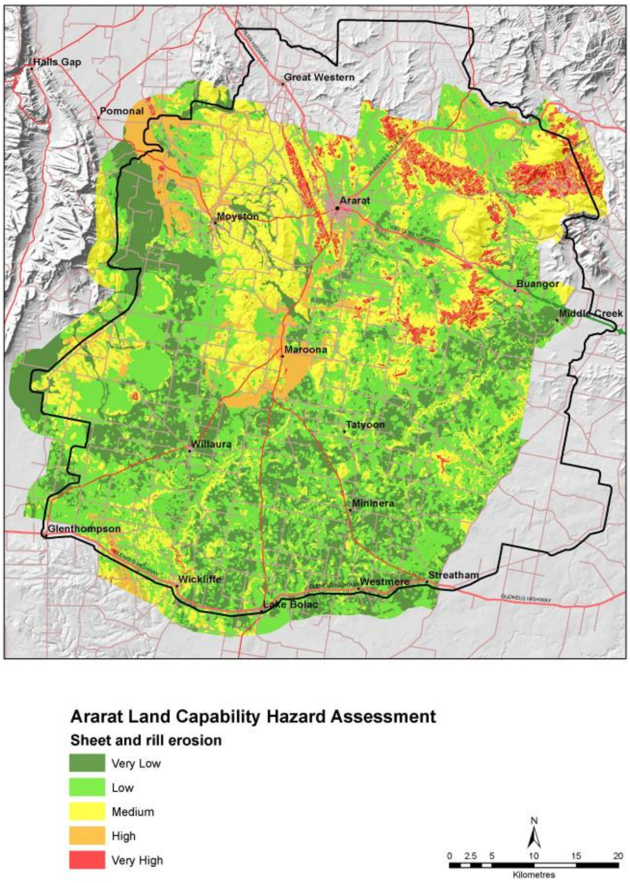
# Landscape hazards

A range of landscape hazard maps are presented in Plates 3 to 6 below and higher resolution versions is attached in Appendix C through F. These maps are derived specifically from mapping undertaken as part of the Ararat Rural City Land Capability Pilot Project (Robinson et al 2004). Some areas of the East Grampians Rural Pipeline area were not covered as part of this 2004 report.
[http://vro.agriculture.vic.gov.au/dpi/vro/glenregn.nsf/pages/glenelg_ararat_land_capability](http://vro.agriculture.vic.gov.au/dpi/vro/glenregn.nsf/pages/glenelg_ararat_land_capability)

Soil erosion can result in lost agricultural productivity, damage to infrastructure and declining water quality. The susceptibility of land to various hazards is dependent on the presence of certain soil, landform and climatic properties, and the exposure of the surface soil or subsoils. The 2004 landscape hazard assessment did not attempt to differentiate the cause of surface or subsoil exposure; rather it was designed to assess the likely frequency and magnitude of erosion events if the soil becomes exposed.

*Plate 3: Sheet and rill erosion*:

Sheet and rill erosion can greatly reduce agricultural productivity and contribute to sedimentation and turbidity in streams. Over 36% of the Ararat Shire region was assessed as having moderate to very high susceptibility to sheet and rill erosion. Landscapes most prone to sheet and rill erosion include steep to moderate sedimentary slopes along the Mt William Range, Stavely Block, Ararat and Challicum Hills; and the steep to moderate granite slopes associated with Mount Cole and Mount Langi Ghiran (see also Appendix C).



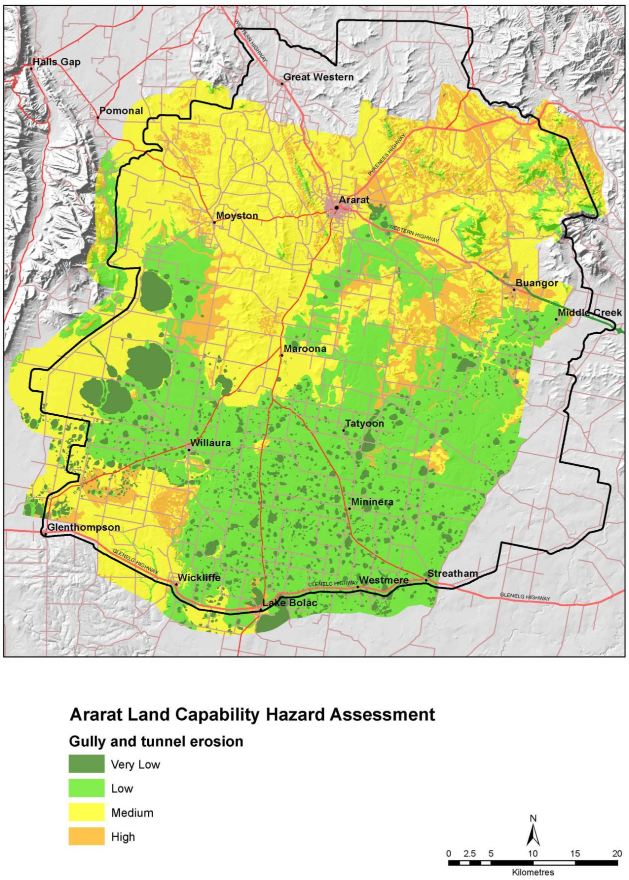
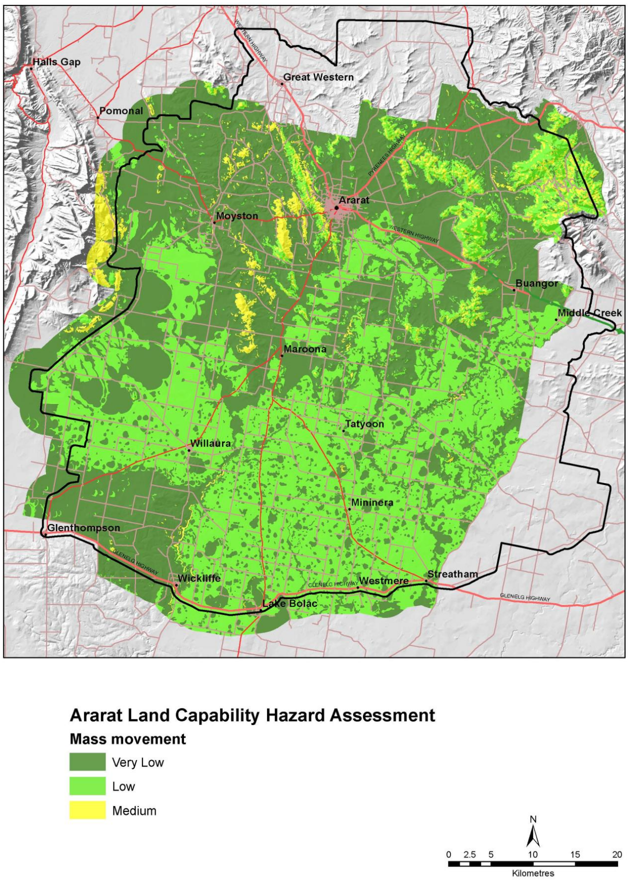



*Plate 4: Gully and tunnel erosion*:

Gully and tunnel erosion are threats to water quality within the study area. Nearly 13% of the Ararat Shire region was assessed as having a high to very high susceptibility to gully and tunnel erosion, while over 41% a moderate susceptibility. The areas of highest risk include the moderate to gentle sedimentary slopes of the Jallukar, Ararat and Challicum Hills, but also along the tributaries of Mount William Creek and the Wimmera River (see also Appendix D).

*Plate 5: Mass movement (landslips)*:

There are a numerous steeply sloping areas susceptible to landslip, particularly after significant rainfall events. Areas in the Ararat shire that are most prone include the steep to moderate sedimentary slopes of the Mt William Range and Ararat Hills, the steep to moderate metamorphic hills to the north, and steep to moderate granite hills including Rocky Point (where existing landslides have been noted). The steep slopes associated with the Hopkins River between Willaura and Wickliffe may also be susceptible in years where winter rainfall significantly exceeds the average (see also Appendix E).



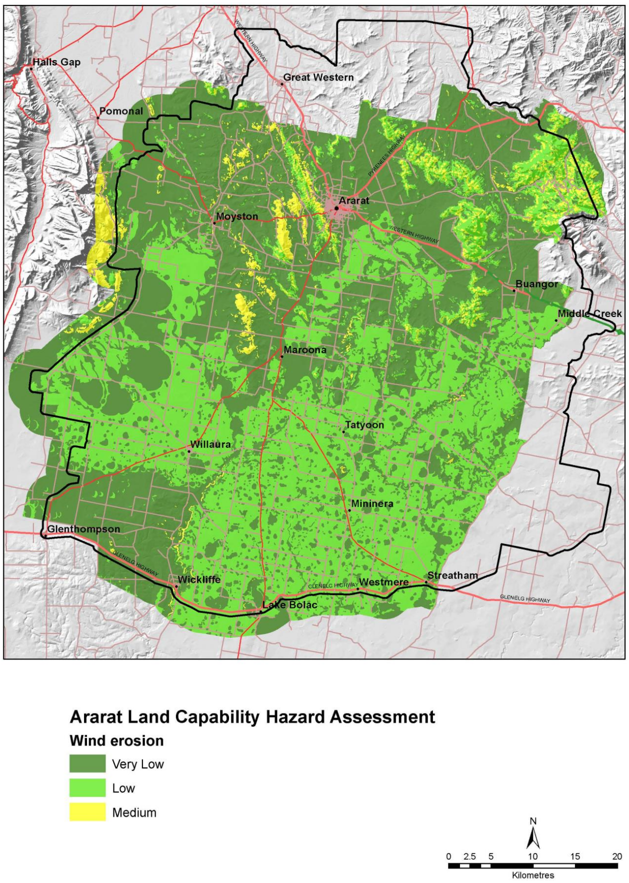



*Plate 6: Wind erosion*:

Wind erosion commonly results in the loss of topsoil and agricultural productivity. Over 16% of the Ararat shire region has a high to very high susceptibility to wind erosion, primarily due to the presence of loose sandy surface soil. These loose sandy surface soils are common to both sedimentary and granite parent materials and can also be found on the dunes and lunettes associated with floodplain and wetland complexes (see also Appendix F).

## REFERENCES


Baxter N and Robinson N (2001). A Land Resource Assessment of the Glenelg Hopkins region. Agriculture Victoria.

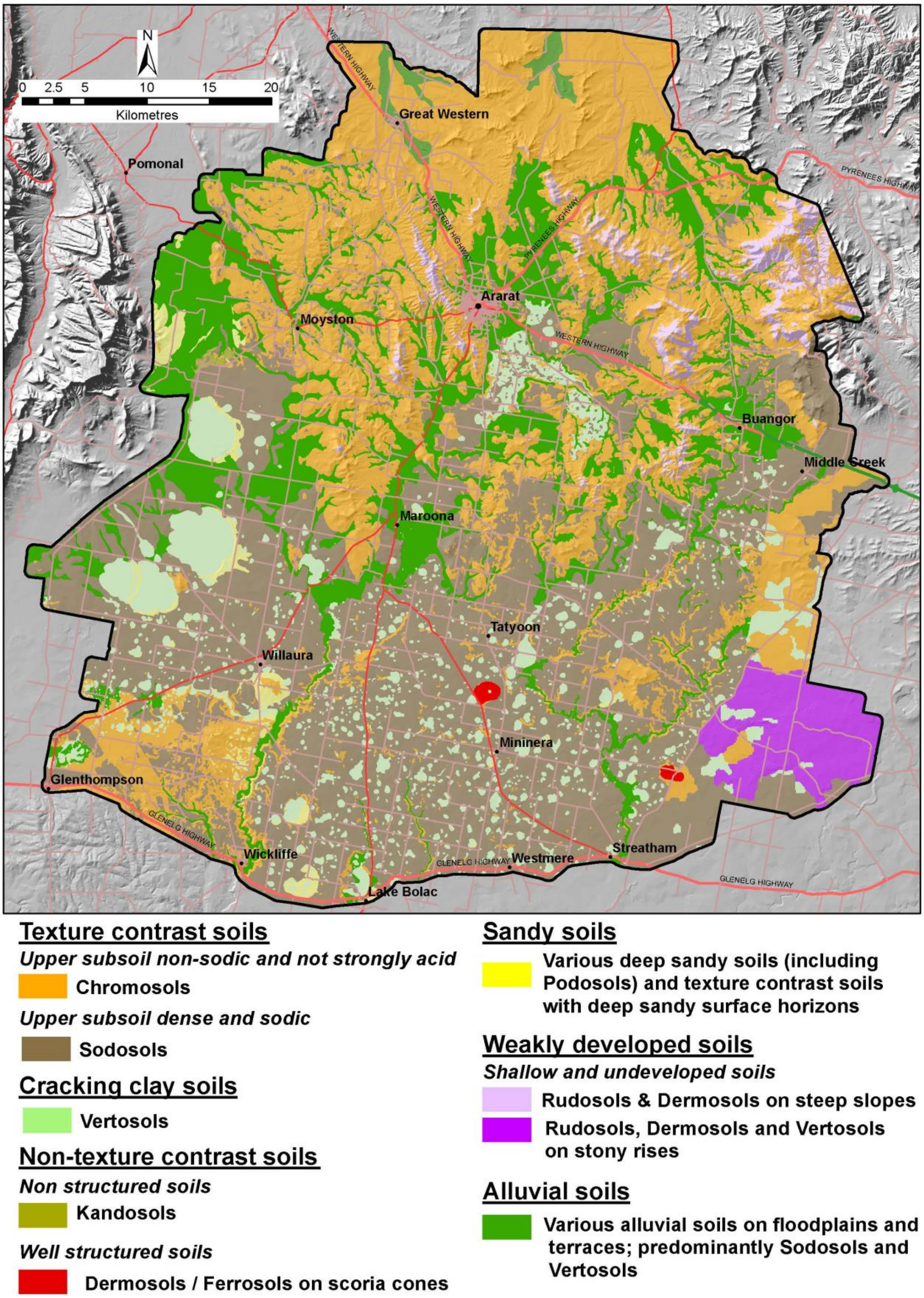
http://vro.agriculture.vic.gov.au/dpi/vro/glenregn.nsf/pages/glenelg_soil_map

Isbell RF (2002). The Australian Soil Classification. Revised edition. CSIRO Publishing, Melbourne.

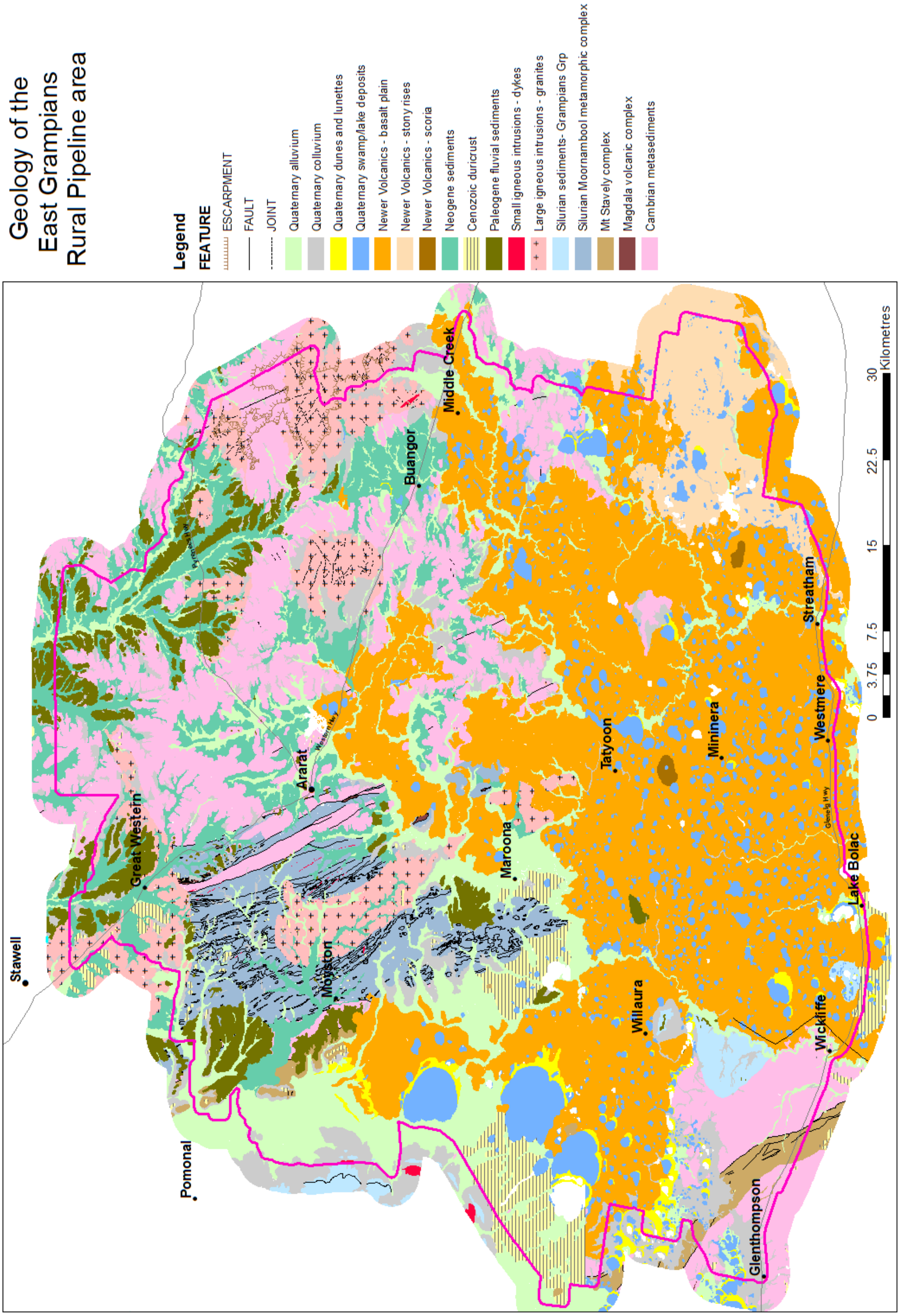
Robinson N, Reynard K, Sheffield K, Bluml M (2004). Ararat Rural City Land Capability Pilot Project. Department of Primary Industries.

http://vro.agriculture.vic.gov.au/dpi/vro/glenregn.nsf/pages/glenelg_ararat_land_capability

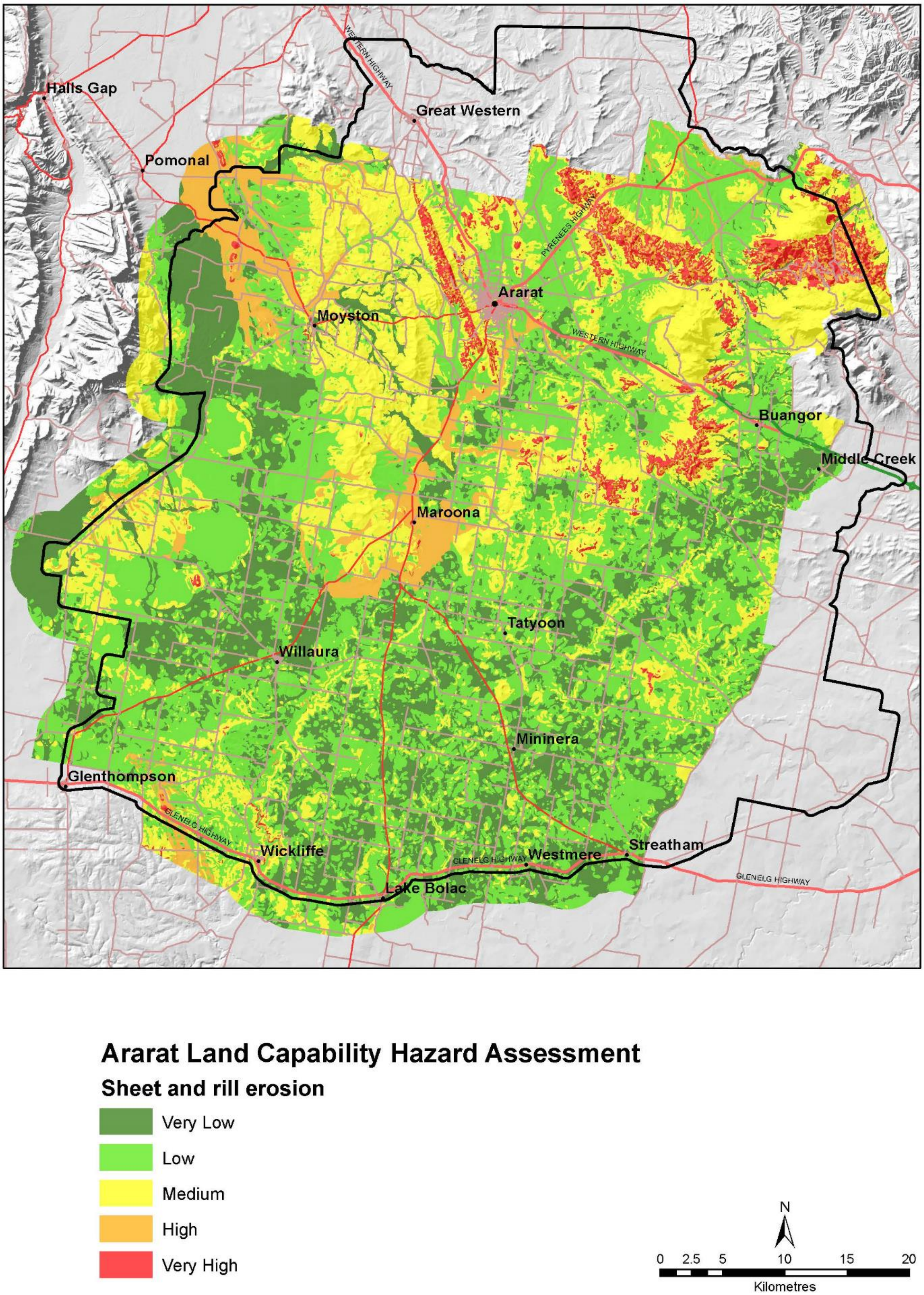
## Appendix A: Soil/landscape map



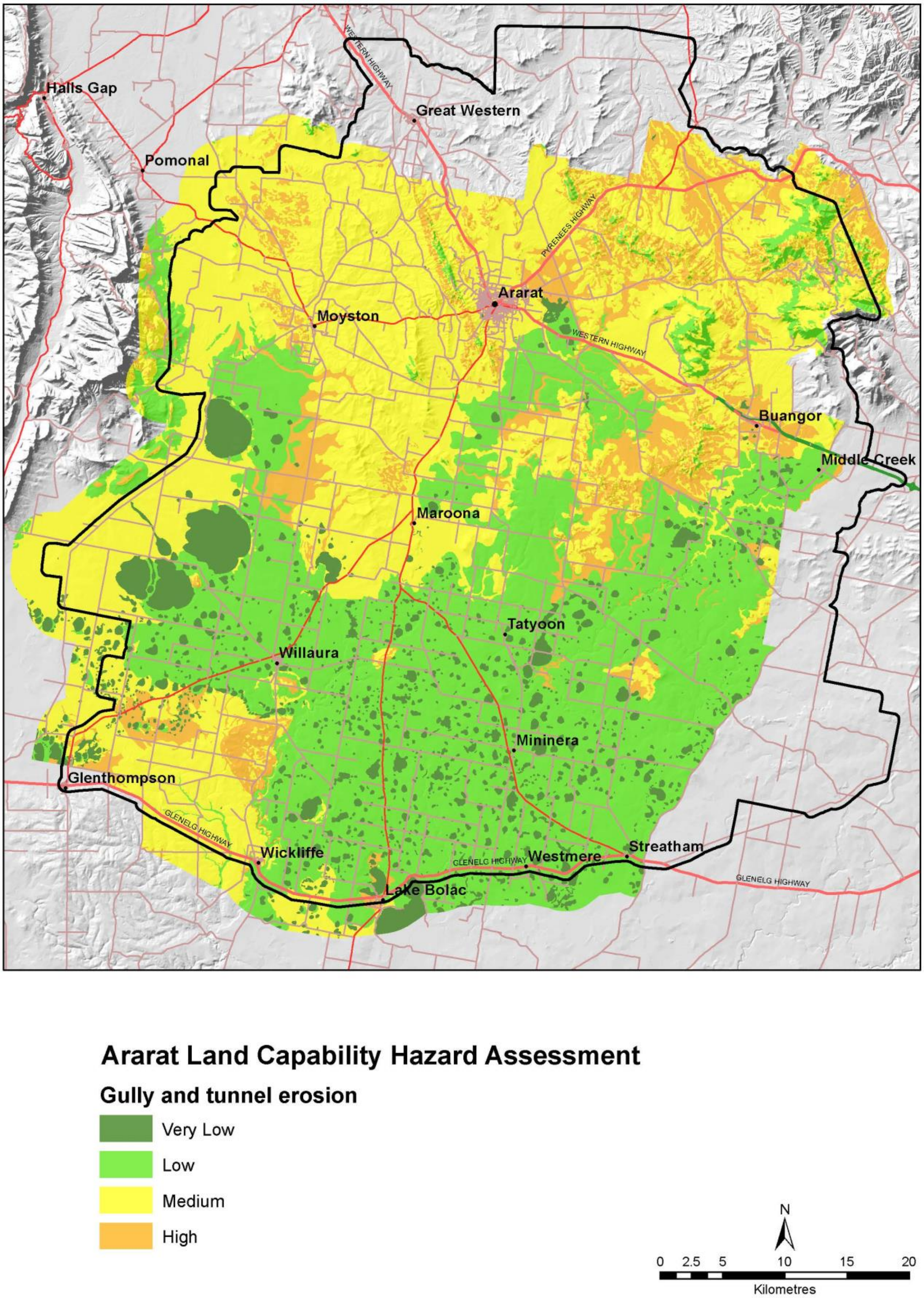
## Appendix B: Geology map



## Appendix C: Landscape hazard map – sheet and rill erosion



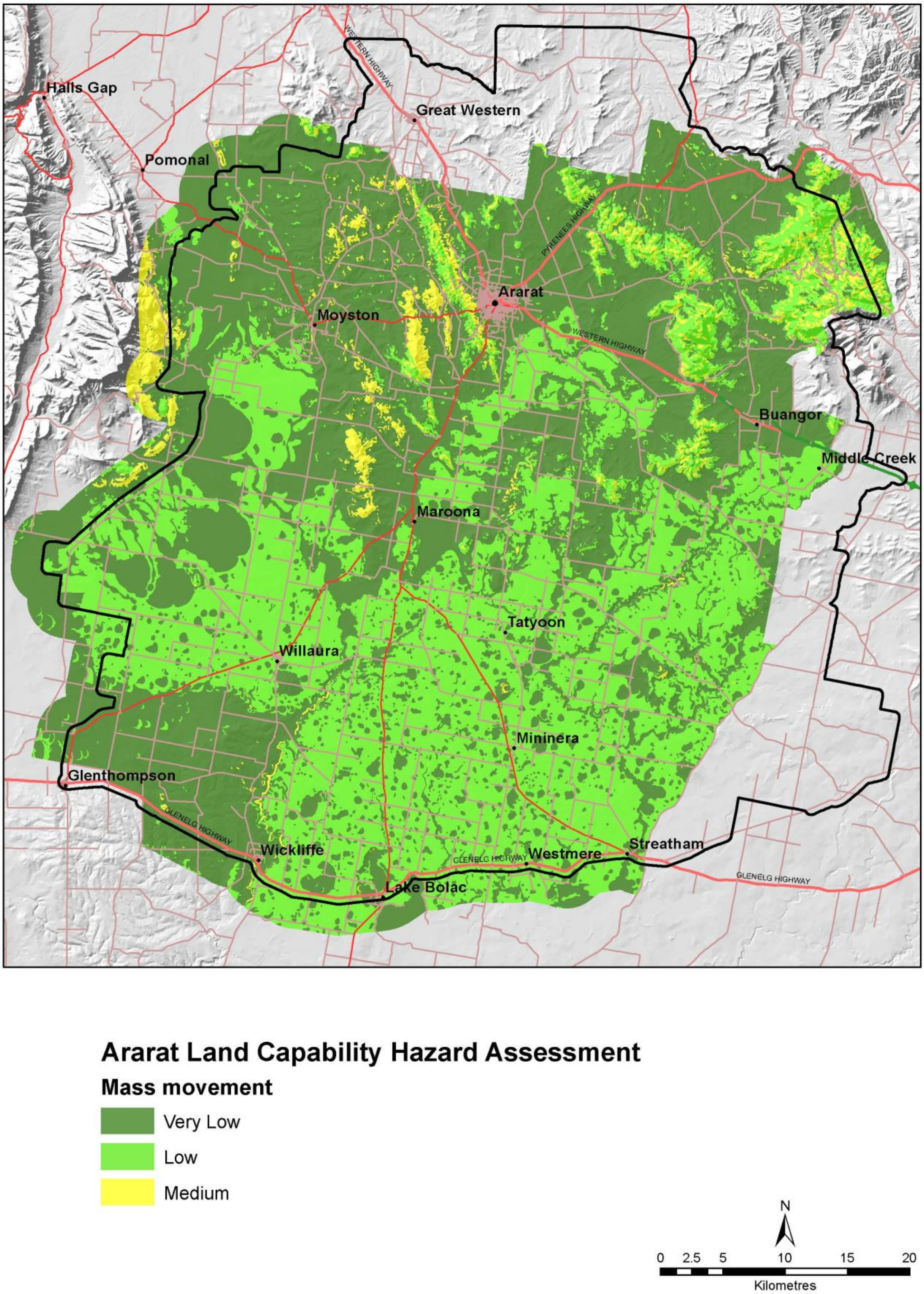
## Appendix D: Landscape hazard map – gully and tunnel erosion






AGRICULTURE VICTORIA

## Appendix E: Landscape hazard map – mass movement erosion



## Appendix F: Landscape hazard map – wind erosion