

10. Soils and Geology

The Soils and Geology Assessment examined the potential for the Project to encounter adverse geological conditions, affect soil stability, cause soil erosion or expose contaminated or acid sulfate soils (ASS).

There is limited information on the soil properties and characteristics of the study area at this stage of project development and so specific areas which may be more susceptible to soil erosion cannot be accurately identified. However, there is a medium risk of encountering unstable geological units which may contribute to soil erosion, associated with softer alluvial sediments and historical mine workings. Standard construction management approaches have been recommended in this EES and site specific soil erosion management plans would be developed as part of the Project Construction Environmental Management Plan (CEMP).

Detailed geotechnical site investigations, complemented with appropriate design of temporary and final batter slopes would largely eliminate issues of gross ground instability and minimise the potential for soil erosion.

Preliminary earthwork estimates suggest a large quantity of imported fill material would be required. Fill material would be sourced from surplus materials from site and additional sources such as local quarries. Where soils are to be imported to the site, all soils would need to comply with relevant legislative requirements to prevent the importation of contaminated materials.

Exposure to contaminated soils and ASS represent a potential risk to human health and the environment. ASS have not been identified within the study area based on the preliminary assessment. Potentially pyritic and sulphidic rock both outcrop along the proposed alignment. These rock types potentially cause acid production when exposed during excavation. Therefore, targeted sampling would be required prior to construction, particularly in locations where infrastructure such as bridge supports would be installed at depth.

The proposed alignment extends across three registered sand / gravel quarries to the north-east of Great Western. The extent of cut in this location would be reduced for the Project due to quarrying activities to the depth of the proposed alignment prior to construction.

Contaminated soils are specifically a concern

around the locality of the former Great Western Landfill. Excavation of material from the former landfill and potential of fuel or chemical spills during construction present a risk of contamination. These risks would be adequately managed, firstly through the identification of contaminated soils, any ASS soils and spill risks and then by proper management via the Project CEMP.

Along the alignment is also the potential to encounter asbestos bearing rock (Ch. 2800 to 10000) which, if crushed, could release asbestiform fibres into the environment. Selected sampling would be required prior to construction, while a CEMP would provide guidance for appropriate action where required.

Based on a review of previous and current land use, the potential for localised contamination in the study area is considered to be moderate. Several features were identified that indicate potential for land contamination. These include:

- farming/shearing sheds (often associated with sheep dips);
- railway lines (historic land management practices);
- the former Great Western Landfill site;
- the presence of potentially asbestos bearing rock (the Deenicull Schist);
- areas of disturbed soils (potential sites of buried waste); and
- historic mining works.

As part of the Project, potential impacts arising from contamination sources would be managed through the CEMP. In addition, discussions have been held with the EPA associated with the proposed alignment extending through part of the former Great Western Landfill and a process identified to manage impacts.

10.1 EES Objectives

The EES evaluation objective relevant to soils and geology is:

- *To protect catchment values, surface water and groundwater quality, stream flows and floodway capacity, as well as to avoid impacts on protected beneficial uses.*

This chapter discusses the soils and geology of the study area, the potential impacts from the Project on these natural features, and the management measures recommended for implementation to minimise these impacts. More specifically, this chapter addresses the Scoping Requirements by:

- Characterising the soils in the project area (both physical and chemical aspects).
- Identifying and assessing the potential effects of road construction and operation activities on soil stability, erosion and the exposure and disposal of any waste or hazardous soils (e.g., high salinity soils).
- Identifying measures to avoid, mitigate and manage any potential effects, including any relevant design features of the road or techniques for construction.
- Identifying residual effects of road construction and operation activities on soils in the project area, including any limitations to future land use activities.

The EES Scoping Requirements also state that “*If contaminated soils are identified, an assessment should be prepared outlining what is known about the contamination and further steps to be implemented.*” This is the case with the former Great Western Landfill.

This chapter is based on the Soils and Geology Impact Assessment report completed by GHD (2012c). The assessment report is included as Technical Appendix E.

10.2 Study Area

The study area is the same as the project area, which encompasses a corridor extending up to 1500 metres (m) either side (east and west) of the edge of the exiting highway, except around Great Western where the study area extends up to 1800m encompassing the extent of alignment options.

10.3 Methodology

A desktop review was undertaken to assess the existing soil and geological conditions within the study area. This comprised of the following tasks:

- A review of historical aerial photographs of the study area, where available, to assist in establishing the physical patterns of development over time;
- A review of publicly available literature and geotechnical information relevant to the study area;
- Sourcing and collating relevant available borehole, test pit and other geotechnical data;
- Interpretation of the available information;
- Development of a preliminary geological and geotechnical model of the study area;
- A preliminary acid sulfate soil (ASS) hazard assessment; and
- A site visit including: documentation and photographing of site features; confirmation of features documented in the desktop review; inspection for potential sources of contamination; and to confirm regional geology and identify anomalies or extraneous conditions along or near the proposed alignment.

10.4 Legislation and Policy

The relevant legislation and government policies for soils and geology are shown in Table 10-1.

Table 10-1 Relevant Soils and Geology Legislation and Policies

Legislation/Policy	Description
State	
Planning and Environment Act 1987	Section 12 of the Act includes provisions to ensure that potentially contaminated land is suitable for the use allowed within the relevant planning scheme.
Environment Protection Act 1970	Enables Environment Protection Authority (EPA) Victoria to implement the State Environmental Protection Policy (SEPP) in regard to contaminated land, and the Industrial Waste Management Policy for waste acid sulfate soils (see below). All construction activities must comply with the general performance measures outlined in the legislation.
Catchment and Land Protection Act 1994	Provides a framework for the integrated and co-ordinated management of catchments in regards to long-term land productivity and maintenance of the quality of the State's land and water resources.
State Environmental Protection Policy (SEPP), Prevention and Management of Contamination of Land 2002	The SEPP is the main guidance document for the management of contaminated land in Victoria. The SEPP outlines the process for establishing land contamination and management and remediation of impacted sites.
Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999	This policy outlines a management framework and specific requirements for the management of acid sulfate soils in an environmentally responsible manner.

Legislation/Policy	Description
State	
Best Practice Environmental Management (BPEM): Siting, Design, Operation and Rehabilitation of Landfills	Guidelines for existing and future landfill operations. Provides planning authorities and regulatory bodies with considerations for works approvals or licensing of existing and new landfill sites.
Best Practice Environmental Guidelines (BPEG), Environmental Guidelines for Major Construction Sites	The BPEG provides a framework within which due diligence obligations can be met and environmental damage can be avoided during the commissioning or construction of freeways, major roads or major developments.
Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils (CASS BPG)	The CASS BPG outlines a tiered, risk-based approach to identifying, assessing and managing acid sulfate soils.



Western Highway near Ararat Regional Park

10.5 Existing Conditions

10.5.1 Geology

The geology in the study area is reflective of the surface geology typically found in the central west region of Victoria (Figure 10-1). The study area lies within the Stawell Zone, which encompasses the rocks extending from the Moyston Fault eastward to the Avoca Fault.

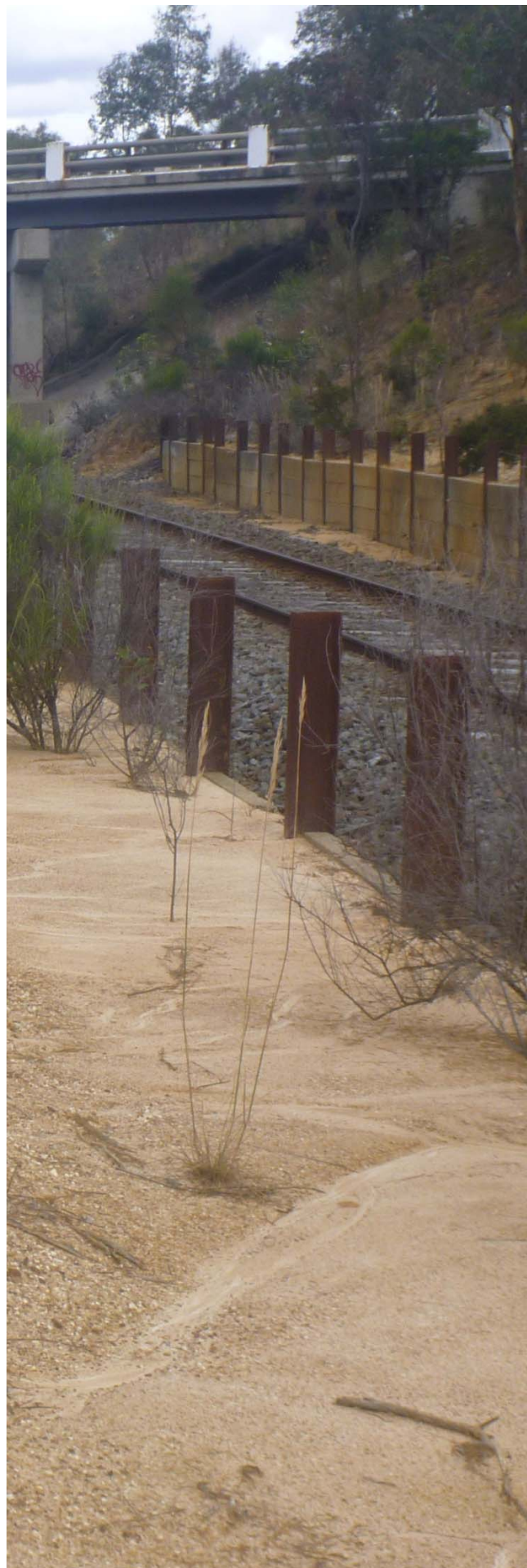
It is anticipated that the road construction activities between Ararat and just south of Great Western would traverse predominantly Cambro-Ordovician sediments, with minor zones of Quaternary fluvial deposits. Increasing complexity is expected from north of the Great Western township toward the town of Stawell, with large zones of Devonian Granites and Cambrian Age Volcanics indicated along and in close proximity to the alignment. Areas of Tertiary and Quaternary Age deposits of alluvium, gravels, sands and clays are expected along specific parts of the alignment, particularly in the area of Stawell.

Of specific geological note are the Cambro-Ordovician St Arnaud Group, and the Cambrian Magdala Volcanics and Deenicull Schist rocks.

The St Arnaud Group rocks are expected to outcrop along the majority of the alignment from Ararat to just south of Great Western, with the base also seen to outcrop in the vicinity of Stawell. The group is made up of indurated (or hardened) sandstones, shales, slates and siltstones, which are of marine origin. In some locations, some of the rocks that make up the St Arnaud Group are expected to be pyritic. The excavation and re-use of un-oxidised pyritic rock could cause the pyrite to oxidise and produce acid. This possibility and its potential impact are further investigated in Section 10.6.2.4.

There is a narrow wedge of the Deenicull Schist formation (interspersed with Magdala Volcanics) which is surrounded on both sides by the rocks of the St Arnaud Group. This wedge outcrops along the alignment between Ararat and Great Western (Ch. 2800 to 10000). Rocks of the Magdala Volcanics can be rich in metal sulphides, while the Deenicull Schist formation is comprised of quartz and chlorite minerals, but may also potentially contain asbestiform minerals. These minerals can have an effect on health if inhaled, however no information is currently available on the concentration of these minerals in the outcrop.

Similar to the St Arnaud Group, the Magdala Volcanics may cause issues during construction due to the resultant production of acid, while the excavation and crushing of the Deenicull Schist may release asbestiform fibres into the environment. Further investigation is presented in Section 10.6.2.4 and 10.6.2.5 respectively.



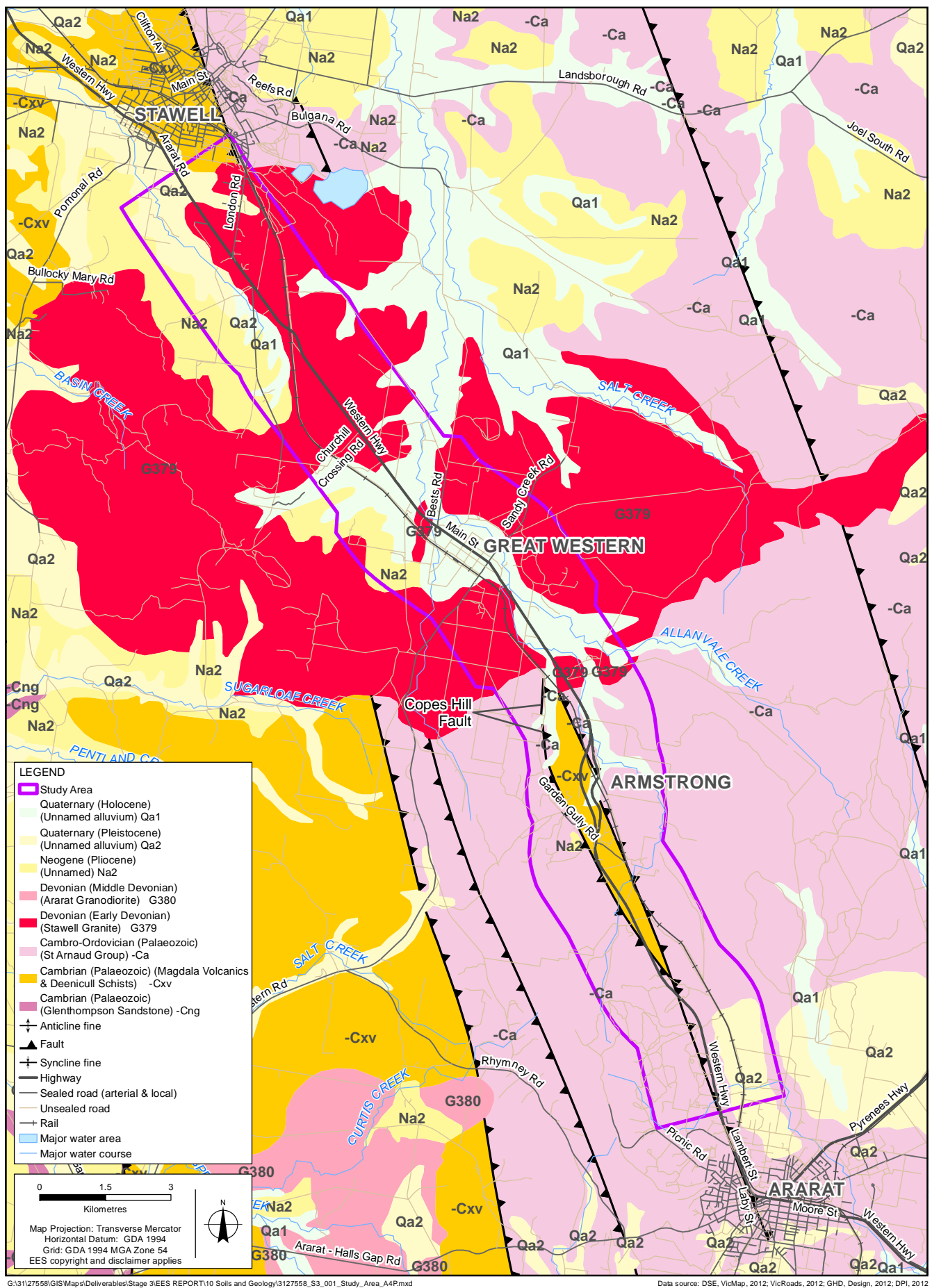


Figure 10-1 Geology of the Study Area

10.5.2 Geological Structures and Faults

A review of the Department of Primary Industries (DPI) database has identified a number of fault lines within the study area, five faults are shown on Figure 10-1. These are predominantly orientated along a NNW-SSE axis. Two parallel faults, an unnamed fault and the Copes Hill Fault, run sub-parallel to the existing highway between Ararat and Great Western. Areas directly impacted by faulted zones may be highly variable and have conditions which are difficult to predict. Fault areas are prone to instability and rapid deterioration.

The preliminary drive through assessment did not identify any significant remnant features of the mapped faults intersecting or within close proximity to the proposed alignment.

10.5.3 Historic Mining Works

The area between the townships of Ararat and Great Western was historically mined for gold. These workings take the form of deep shafts and drives along the "deep-leads", and also open cut mining of shallow alluvial deposits. The majority of historic workings to the southwest of Stawell (within 3 to 6 kilometres) are expected to comprise these shallow workings. A number of shallow and deep-leads have been explored between Great Western and Ararat in the past, with a greater concentration in the vicinity of Ararat and south west of the existing Western Highway. Very little exploration has been undertaken between Great Western and Stawell. Another concentration of historical mining occurred at Stawell, but beyond the study area.

There is a remote possibility of encountering abandoned mineshafts during construction. The potential for encountering abandoned backfilled shallow workings is greater.

10.5.4 Erosion

Erosion is the process of weathering and transport of sediments by water or wind. The rate of erosion depends on many factors, including rock type, climatic factors and the amount of and type of ground cover. Sediment with high silt and sand content and areas with steep slopes erode more easily. Ground instabilities have the potential to develop during earthwork operations, particularly along the banks of the existing creeks and steeply inclined areas where geological contacts may cause a weak failure surface.

From the photographic evidence assessed, no obvious or apparent sign of ground instability or movement was distinguished. The broad scale of the satellite photography means that small-scale localised instabilities or ground movement may be difficult to discern.

10.5.5 Review of Historic Aerial Photographs

Aerial photography over a period of time can be analysed in order to identify potentially contaminating land use activities for a particular region. Aerial photography, conducted sporadically during the period 1947 to 2009, was obtained for the study area. There has been a minor increase in residential development within the study area, with the area of Great Western and the southern region of Stawell being increasingly urbanised and developed respectively.

Based on the review of aerial photography, no obvious or apparent evidence of present or past ground instability or movement was distinguished. However, small scale localised instabilities or ground movement may exist throughout the study area. Historic landslips may be well disguised by subsequent revegetation and human activities.

The aerial photographs identified a substantial number of relatively small farm dams that were created or altered during the photographed period. There appear to be less dams in recent years, this is likely due to the dams being filled in or not containing any water.

Potential land contamination activities that were observed in the study area included the railway line, localised earthworks, agricultural practices, and the former Great Western Landfill site. Agricultural land use for pasture and grazing has the potential to lead to both point source (e.g. sheep dips) and dispersed contamination (surface application of fertilizers, herbicides and pesticides). No sheep dips (which can be a concern due to the chemicals used to dip the sheep, namely arsenic) were observed in the study area, although the frequency of pasture and grazing properties along the Western Highway corridor indicates the potential for their presence and the potential for dispersed contamination sources.

10.5.6 Sand and Gravel Quarries

Three registered sand / gravel quarries are situated to the north-east of Great Western within the study area. The largest quarry situated to the north of Sandy Creek Road is currently operating under Work Authority 1149 and as of November 2012, seeking approval for expansion. The proposed alignment extends through the existing quarry and the proposed expansion area. Discussions with the quarry owner have indicated that excavation would be undertaken to the depth of the proposed alignment ahead of the Project's construction.

10.5.7 Former Great Western Landfill

A former municipal landfill exists within the study area. The aerial photographs show a substantial increase in operation of this landfill from 1980 to 2009. In 2011, Golder Associates (Golder) was engaged by VicRoads to provide advice in relation to potential environmental risks associated with constructing a portion of the Project through a former landfill in Great Western. The landfill was

established within a former quarry site adjacent to Metcalfe Road, east of the town of Great Western.

As part of the assessment, Golder undertook a site inspection and intrusive investigation of the former landfill area. It was identified that the former quarry area containing the landfill covered approximately 2.9 hectares and reportedly accepted a mixture of solid inert and putrescible wastes during its operating life, which covered the period from the 1960s to when it ceased operations in 2000. Golder estimated the landfill constituted approximately 4300 cubic metres (m³) of compacted mixed solid inert and putrescible municipal waste which had been overlain by approximately 7000m³ of compacted and loosely consolidated fill. Characterisation of the chemical properties of either the landfill or overburden materials was not performed during the assessment.

Golder's assessment of the former landfill site fulfils the scoping requirement (see Section 10.1) to outline what is known about the soil contamination, and provide further steps to be implemented. The Waste Disposal information in Section 10.6.2.2 recommends actions for future use of the site.

10.5.8 Acid Sulfate Soils (ASS)

ASS (including actual acid sulfate soil (AASS) and potential acid sulfate soils (PASS)) generally occur where soils contain high levels of metal sulphides (predominantly iron sulphide), and can occur naturally in coastal and inland settings. ASS has been found to occur in a range of soil types in Victoria, ranging from loamy sands to clays and silts.

Under natural conditions, PASS is usually located below the water table. Left undisturbed, PASS is unlikely to cause any harm to the environment, however when exposed to oxygen through excavation or lowering of the water table, the metal sulphides have the potential to oxidise and form sulphuric acid and AASS. Under acidic conditions, metals such as aluminium and iron as well as trace metal toxicants may be mobilised from the soil through infiltrating water.

Impacts to the environment resulting from disturbance of ASS may occur directly through lowering of surface or groundwater pH, or

mobilisation of metals to waterways, which impact on marine or freshwater ecosystems. Acidic conditions can also be corrosive to concrete and steel structures (pipes, bridge abutments, underground services and other infrastructure).

The presence of ASS can be problematic for construction projects where PASS or AASS is disturbed. Ideally, disturbance of ASS should be avoided, however in instances where this is not possible, ASS must be carefully managed in order to prevent potential impacts to the environment.

A review of the available mapping information indicated the following:

- The CSIRO Australian Soil Resource Information System indicated the site is within an area of "low probability of occurrence" of acid sulfate soils.
- The Department of Primary Industries (DPI) Map 1, Far South West Coast (DPI, 2006) indicated the site is not within an area of "prospective land" containing PASS.

Both sources indicated that the study area does not lie within an area of PASS, therefore, it is considered there is a low probability that ASS exist in the study area.

Due to the low probability of ASS occurring within the region, it is concluded that the study area is not within an ASS risk area.

However, due to the age and resolution of the published maps, their accuracy is uncertain. It should also be noted that a review of the geological maps indicate that in some locations, some of the Cambro-Ordovician rocks are expected to be pyritic, while there is also potential for some Magdala Volcanics to be high in metal sulphides (refer to Section 10.5.1). Therefore, where these rocks outcrop along the proposed alignment, there is a potential of the production of acid due to oxidation of the pyrite.

Due to the level of uncertainty in the maps and the possibility of pyritic outcrops along part of the alignment, it is considered prudent for the detailed design of the Project to assess and confirm the soils are not ASS and the rocks are not pyritic.



10.6 Impact Assessment

10.6.1 Key Issues

The impact assessment for the study area was divided into nine key areas, including:

- Potential exposure to contaminated soils (including ASS) encountered during construction;
- Potential exposure to contaminated materials associated with the former Great Western Landfill;
- Oxidation of exposed pyrite in St Arnaud Group;
- Potential exposure to asbestiform fibres in the Deenicull Schist;
- Encountering unstable geological units including erosion prone areas or compressible soils during construction;
- Intersecting historic mine workings which may be characterised by soft, unstable or collapsible ground;
- Encountering materials of variable performance that may be influenced/alterd by faulting;
- An imbalance in the volume of suitable cut and fill material during construction, resulting in either unplanned offsite disposal of material, or the need to source additional suitable uncontaminated material; and
- Transport of road contaminants offsite during operation.

It is worth noting that some of the impacts to soils and geology in relation to cut are also related to impacts to groundwater. Further discussion on these can be found in Chapter 11 (Groundwater).

10.6.2 Potential exposure to Contaminated Soils

Exposure to contaminated soils (including ASS) is known to be associated with a potential risk to human health and the environment. These risks are realised when the receptor (human or ecological) is exposed to the contaminants by one of the following pathways:

- Dermal contact with skin causing the contaminants to be absorbed into the underlying tissue and blood stream,
- Ingestion of contaminated soil and water due to adhesion to skin and transfer onto food; and
- Inhalation of components and contaminated dust carried by air into the lungs and respiratory systems of the organism.

The main exposure risk is to construction workers via dust or fuels and chemicals used during the construction phase.

Based on land-use activities, the potential for contaminants to be identified within the study area is moderate as there have been several different

historic uses along the Western Highway corridor that could give rise to contamination, including sheep dips and shearing sheds, a railway corridor, the former Great Western Landfill, uncontrolled historic mining works and potential asbestos bearing rock. These are discussed in the following sub-sections.

10.6.2.1 Agriculture – Pasture and Grazing

The potential risks to human health and the environment associated with contamination to soil and groundwater along the proposed alignment from agriculture would be relatively low across most of the study area. This is because contaminant concentrations due to the application of fertilisers and other pastoral improvement substances, where present, are likely to be low. The exception to this generalisation would be farm or shearing sheds with associated sheep dip sites. Though no sheep dips were found in a review of the aerial photographs of the study area, if they were to exist, then they are likely to be found near farm/shearing sheds. The following chainages identify farm/shearing sheds of potential concern due to the potential for localised high contaminant concentrations. The chainages are:

- Ch. 9400
- Ch. 11500.

During the site inspection a scatter of cement sheeting that may contain asbestos was observed covering an area approximately 130m² in close proximity to the farm / shearing shed located at Ch. 11500.

Given the small size and localised effects of farming activities, and the cement sheeting fragment scatter, it would be appropriate that the potential contamination be managed through a Construction Environmental Management Plan (CEMP). It would be beneficial to conduct intrusive investigations at the listed chainages prior to development of the CEMP to ensure that the risk to construction contractors is limited and that any potential remedial works can be performed in a timely manner.

10.6.2.2 Waste Disposal

Areas such as the former Great Western Landfill and uncontrolled tailings from former mining works could represent a major risk due to the potential for contaminant concentrations above the human health threshold. The proposed alignment intersects the former Great Western Landfill at the following chainage:

- Ch. 13000 to Ch. 13400.

Due to the risks associated with uncovering prescribed waste at the former Great Western Landfill, and to ensure the proposed construction works can proceed in a timely manner at this location, the following activities would be required prior to construction of the proposed alignment:

- Preliminary planning to mitigate risk appropriately;

- Liaison with appropriate authorities to gain required approvals;
- Potential relocation of the putrescible waste within the original landfill footprint or to a new location;
- Construction of a new landfill cell in accordance with the BPEM; and
- Validation and remediation (if required) of soils beneath the former landfill location.

Golder's assessment of the former landfill also concluded that if excavation works are to be undertaken at the landfill site, on-site management of the landfill material was the preferred option for the following reasons:

- It would lead to improvement in the management of the waste in the old landfill area and the integrity of the landfill cap;
- It would not consume landfill airspace at other landfills and avoid transport costs;
- It would not require the expense or resources for constructing a bridge; and
- There is a potential for recycling exhumed material.

VicRoads has met with the EPA to discuss management of the works through the old landfill. Preliminary discussions have outlined a process that would involve excavation of the material from the old landfill and relocation to an adjacent landfill on-site whereby all material would be capped. Further documentation and investigations would be required prior to final approval by the EPA.

The potential localised effects of in-filled dams, quarries or borrow pits, areas of disturbed soil and mine tailings, would be best managed through a CEMP.

As there is a significant risk to human health and a potential for gross land contamination in a localised area, the impact during construction of the former landfill is considered to be major.



Entrance to former landfill

10.6.2.3 Commercial and Industrial Activity

There are no significant industrial areas within the study area. The commercial areas within the study area include Great Western (which is bypassed by the proposed alignment and the rail corridor). Potential for contamination exists where the proposed alignment crosses the railway. This occurs at the following locations:

- Ch. 7600
- Ch. 20600.

Contamination may exist due to the potential for hydrocarbon contamination, and historic land management measures by the rail authority, such as the use of pesticides.

10.6.2.4 Acid Sulfate Soils

Discussions with both the Wimmera and Glenelg Hopkins Catchment Management Authorities indicate that no ASS has been identified within the Project area, although they have not conducted any analysis of the soils for PASS. It should be noted that the potential exists that pyritic rock is also present within the study area at locations where Cambro-Ordovician rocks outcrop. Metal sulphides are also potentially present at locations where Magdala Volcanics outcrop. The following potential areas may be affected:

- Ch. 0 to 3200
- Ch. 7600 to 8100
- Ch. 9000 to 9400.

If these rocks are allowed to oxidise due to excavation or lowering of the water table, the production of acid is likely to result. Therefore, undertaking limited selected sampling along the proposed alignment in the localities where these rocks are likely as part of the detailed design stage, in particular where infrastructure such as bridge supports are to be installed at depth, would be beneficial.

It is also considered that a CEMP would provide guidance for the appropriate method of stockpiling uncharacterised soil and provide appropriate sampling guidance to assess re-use or disposal options.

The overall impact during construction of the Project from the risk of sensitive receptors potentially being exposed to ASS is considered to be insignificant after appropriate management measures.

10.6.2.5 Asbestos Bearing Rock

There is a potential for asbestos bearing rock to be present within the study area at locations where Deenicull Schist outcrops. The area of concern where this occurs is at chainage:

- Ch. 2800 to Ch. 10000.

Though the concentration of the minerals that contain the asbestiform fibres are not known, if the Deenicull Schist rocks are excavated or crushed asbestiform fibres may be released into the

environment. Whilst the proposed alignment is to be built on fill rather than cut through most of this locality, it is considered that there would be some benefit in undertaking limited selected sampling along the proposed alignment in this region as part of the detailed design stage.

It is also considered that a CEMP would provide guidance for the appropriate method of stockpiling uncharacterised soil and provide for appropriate sampling guidance to assess re-use or disposal options.

As there is some risk to sensitive receptors and potential for moderate land contamination, the overall impact during construction of the Project due to asbestos bearing rocks is considered to be moderate.

10.6.3 Chemical Spills

The risk of impact from chemical spills during construction is considered to be low, as the construction works would be governed by a CEMP. It is considered that a CEMP would include specific procedures to minimise leakage or spillage of any fuels or chemicals and to mitigate the effects of a leak or spill. It would also be appropriate for the CEMP to specify regular inspections of any chemical storages and equipment fill points.

Through the use of a CEMP it is considered that the Project would likely have a lower environmental risk of uncontrolled spills than the existing highway, with the impact from chemical spills for the Project considered to be insignificant.

10.6.4 Ground Instability

Historic aerial photography demonstrated no obvious or apparent evidence of ground instability or movement. The broad scale of the aerial photography means that small-scale localised instabilities or ground movement may be difficult to discern. Ancient landslips may be well disguised by subsequent revegetation and human activities. The topography of the study area is generally characterised by low relief, potentially limiting the areas prone to ground instabilities. It is acknowledged that construction would occur across multiple creeks and tributaries along the proposed alignment, which may increase the potential of localised ground instabilities.

The removal of slope toe support, surcharging of slope crests, or the interception of planes of weakness may result in slope instabilities. As a result of the potentially erodible soils present on the Project, there is an additional risk to soil stability, as the movement of soils from the slope toe may initiate a destabilising effect.

The less weathered rock of the Cambrian geology is likely to afford a greater degree of stability than more weathered slopes or soil slopes. This stability however, is nonetheless still prone to instability caused by structural controls, such as joints, faults and shear zones.

Detailed geotechnical site investigations which would be required during the detailed design phase, complemented with appropriate design of temporary and final batter slopes would largely eliminate or overcome gross soil or rock instability. The overall impact during construction to the Project from unstable ground is considered to be minor.

10.6.5 Soil Erosion

The exposure of subsoils can only be minimised and not eliminated. A preliminary geological conceptual model has been developed for the study area on the basis of regional geological mapping, preliminary site walkover and drive through and limited geotechnical investigative works. The susceptibility to soil erosion would be highly dependent on the soil properties and characteristics, and local topography, which have not been accurately determined from information available at this stage of the Project.

Soil erosion is an ongoing geomorphological process and has the potential to occur anywhere and anytime along the study area, and not just during construction. The exposure of subsoils during construction activities could give rise to sheet and rill erosion conditions.

Soil erosion control relies heavily on the correct installation and maintenance of erosion/sediment control mechanisms. Exposed subsoils, due to vegetation and topsoil removal, would be subjected to a degree of sheet and rill erosion upon contact with flowing water. The control and restriction of the eroded soil, through the implementation of erosion and sediment control strategies and measures, is important to avoid detrimental effects to nearby creeks and water bodies. The measures detailed in the VicRoads standard environmental requirements would reduce this risk. The programming and management of the Project to avoid works during or preceding wet weather, particularly those near water courses, would assist in isolating and containing erosion issues.

Failure of erosion and sediment control mechanisms may potentially result in significant volumes of suspended soil entering existing water bodies, including groundwater systems. To ensure a long term solution to erosion control is in place to prevent this from occurring, post-construction consideration would be required in the detailed design phase.

Soil erosion is not limited to areas of steep gradients but is a process which could occur along any section of the study area. Erosion can be dramatically reduced with the implementation of standard erosion control measures. The importance of erosion control and reduction is closely linked to mass wasting and soil stability. The mechanism of soil erosion may result in an increased instability of soil masses as the toe of slopes are reduced, or removed all together.

The VicRoads standard environmental requirements detail a series of control measures to aid in reducing

the detrimental effects of soil erosion, including the limitation of suspended soil transfer to water bodies. The control measures detailed are considered appropriate for the control of soil erosion, however, site specific soil erosion management plans should be developed as part of the CEMP.

Similar to the mitigation measures recommended for encountering unstable geological units, by adopting appropriate batter slopes and surface drainage measures, the overall impact of sensitive receptors (human or ecological) potentially being affected by the risk of soil erosion is considered to be minor.

10.6.6 Ground Settlement (Compressible Soil)

Ground settlements are typically due to increased soil loadings and are exaggerated in weak subsoil conditions. Geotechnical information is limited along the proposed alignment and details regarding the thickness and spread of soft compressible soils are unknown at this stage. This would be confirmed following the geotechnical investigation planned for the detailed engineering design phase. In general however, soft and compressible soils are likely to occur along the banks of existing creeks and tributaries, where alluvial deposits are present.

The proposed construction of embankments and fill platforms could initiate a degree of settlement, depending on the magnitude of loading and the subsoil characteristics. The proposed bridge approach embankments may result in surface loadings conducive to settlement where poor ground conditions dominate.

Mitigation of large settlement deformations and local instabilities can be achieved by using a staged construction approach. This would be utilised where the findings of the planned geotechnical investigation suggest it as necessary.

The impacts associated with settlement have been assessed as moderate, but with the implementation of the environmental requirements and methods recommended in Table 10-3, the impact may be effectively reduced to minor.

10.6.7 Cut and Fill

Preliminary earthwork estimates suggest a large quantity of imported fill material may be required. Analysis during detailed design of the Project would assist in the planning of sourcing and disposing correct volumes of material, and reducing the risk associated with unplanned sourcing or disposal of materials. Fill material would be sourced from surplus materials from site, and additional sources such as local quarries.

The estimated volume of cut and fill required for the Project is as follows:

- Total Fill: 3,024,000m³
- Total Cut: 1,023,000m³

Where soils are to be imported to the site, all soils should comply with the requirements of EPA Industrial Waste Resource Guideline (IWRG) 621 Soil Hazard Categorisation and Management (June, 2009) and meet the following minimum requirements:

- Shall be free of waste materials and be classified as fill material as defined by EPA IWRG 621.
- Have contaminant concentrations less than Table 2 of EPA IWRG 621.
- Shall meet the requirements of the Prevention and Management of Contaminated Land SEPP.

The impact associated with sensitive receptors being affected from the imbalance of cut and fill is expected to be minor.



10.6.8 Ground Subsidence or Collapse

The presence of historic mining works may give rise to localised areas of instability, which are liable to subsidence or collapse when disturbed or altered.

The GeoVic website contains information of past mining activities between Ararat and Great Western. Furthermore historic heritage study documents list registered historic mine sites alongside the Western Highway at Ch. 6200 to 7100, together with shallow pits, mounds and partially filled tunnels along the highway corridor. Other historic mining activity is recorded in the vicinity of Ch. 12600 to 13100.

Information regarding the extent and nature of the mining works including information from the DPI is limited, but could be defined prior to construction during geotechnical investigation.

Any areas identified as being problematic due to previous mine workings may be rendered suitable following the implementation of ground improvement techniques, including ground replacement (engineered fill), which may also include reinforcement with the use of geogrids.

This risk has an initial moderate impact to the Project; however, with appropriate study during detailed design and mitigation measures the impact is reduced to minor with an overall low risk.

10.6.9 Geological Faults

Several geological faults are expected to traverse the study area as shown on Figure 10-1. No visible surface trace could be identified during the drive through survey, however, these features may be evident in cutting excavations within the study area.

Geological hazards that may arise from the presence of faults include a reduction of rock mass strength caused by more pervasive fracturing in the vicinity of the fault which in turn can lead to deeper weathering of the fault zone. These fractured, weaker and more deeply weathered zones may require treatment to stabilise them in cuttings to prevent erosion and spalling into the excavation.

Large scale wedge failures of rock affecting the footprint of the cutting may also occur into the excavation along a persistent defect such as a fault. Faults and fault zones may also act as conduits for groundwater flow out of an excavation because of the increased fracturing. Conversely, the increased weathering along a fault and subsequent clay deposits in the fault may reduce the overall permeability and cause a difference in groundwater levels on either side of the fault.

Without intrusive ground investigation and on the basis that no discernible remnant surface features have been identified from the drive through survey, the overall impact of such features on the Project is considered to be minor.

10.7 Risk Assessment

An environmental risk assessment was undertaken on the proposed alignment to identify key environmental issues associated with the construction and operation of the Project. The methodology for this risk assessment has been described in Chapter 4 (EES Assessment Framework). A risk assessment report that explains the process in detail and contains the complete project risk register has also been included as Technical Appendix Q. Table 10-2 shows a summary for soils and geology of:

- The impact pathways identified; and
- A description of the impact consequences.



Former quarry site

Table 10-2 Soils and Geology Risks

Risk No.	Impact Pathway	Description of Consequences
G1	Presence of contaminated soil and rock along alignment	<p>Construction workers exposure through dermal, ingestion and inhalation of potential contaminants of concern in soil or rock. This risk could occur at any location along the alignment but the more likely locations are within the vicinity of agriculture land, waste disposal (controlled and uncontrolled), commercial and industrial activity and rail corridors due to the use of herbicides and other related rail uses, and where asbestos bearing rocks exist. The following areas may be of concern including:</p> <ul style="list-style-type: none">▪ Railway line intersections (Ch. 7600 & 20600)▪ Farm shed (Ch. 11500)▪ Quarry (Ch. 13600 to 14000)▪ Deenicull Schist – potentially asbestos bearing (Ch. 2800 to 10000). <p>Generation of surplus soils and rock during construction may require treatment and appropriate handling or disposal.</p>
G2	Uncontained spill or leak during construction	<p>Groundwater, soil and/or surface water contamination. Impacts on water resources, flora, fauna, and human health. This risk could occur at any location along the alignment but the more sensitive locations are within the vicinity of waterways, including:</p> <ul style="list-style-type: none">▪ Concongella Creek (Ch. 1600, 8350, 9100, 12300 & 15950)▪ Allanvale Creek (Ch. 12125)▪ Donald Creek (Ch. 15700)▪ Robinsons Creek (Ch. 16200).

Risk No.	Impact Pathway	Description of Consequences
G3	Runoff transports road contaminants offsite during operation	<p>Contamination of waterways with hydrocarbons or heavy metals. Impacts on water resources, flora, fauna, and human health, including:</p> <ul style="list-style-type: none"> ▪ Maintenance workers ▪ General Public ▪ Local Flora and Fauna. <p>The following potential areas may be affected:</p> <ul style="list-style-type: none"> ▪ Ch. 12050 ▪ Ch. 12850 ▪ Ch. 15950 ▪ Ch. 16200.
G4	<p>Excavation encounters unstable geological units (which may include units altered by faults or tectonic activity) or erosion prone areas. Geological units of Cambrian origin may be more prone to erosional processes on exposure. The following areas may be affected:</p> <ul style="list-style-type: none"> ▪ Ch. 800 (rill erosion noted) ▪ Ch. 2800 to 3600 (minor slumping noted) ▪ Ch. 4200 (minor slumping in Cambrian exposed cutting) ▪ Ch. 4600 to 5200 (Weathered Cambrian bedrock, residual product displaying dispersive tendencies). 	<p>Instability exacerbates erosion or mass wasting impacts on safety, land and water resources. This risk may occur within areas subject to cuts, or steepening / excessive loading of existing slopes. Areas near watercourse may also be of concern.</p> <p>Materials demonstrating dispersive behaviour were observed along the alignment. Changes in prevailing topography / site geometry or exposure may result in accelerated soil loss due to loss of fines.</p>
G5	<p>Soft or compressible soils are present along proposed alignment. The following locations predominantly associated with alluvial sediments are highlighted:</p> <ul style="list-style-type: none"> ▪ Ch. 7800 to 9000 ▪ Ch. 10200 to 12600 ▪ Ch. 14600 to 17000 ▪ Ch. 20200 to 21000. 	<p>Construction of fill embankments or drawdown of groundwater induces ground settlement. This risk could occur at locations along the alignment characterised by soft fluvial sediments, being areas dominated by Quaternary age sediments. The more sensitive locations are within the vicinity of waterways, including:</p> <ul style="list-style-type: none"> ▪ Congongella Creek (Ch. 4400, Ch. 4500, Ch. 4400, Ch. 8250, Ch. 10550, Ch. 12150, Ch. 15400, Ch. 15950) ▪ Allanvale Creek (Ch. 12050) ▪ Robinsons Creek (Ch. 16200) ▪ Donald Creek (Ch. 16500) ▪ Pleasant Creek (Ch. 21700) ▪ Any of the more significant unnamed tributaries along the alignment.
G6	<p>Imbalance in the volume of suitable fill and the volume of excavated material. Areas requiring more significant volumes of cut and fill are identified in the following locations:</p> <p>Ch. 20200 to 21000.</p>	<p>Imbalance of suitable cut-to-fill material during construction results in unplanned disposal of cut material off site, or sourcing of suitable additional material.</p>
G7	<p>Construction intersects Acid Sulfate Soils or pyritic rocks, potential disturbance and exposure to air.</p>	<p>The proposed alignment is not considered to be in a Potential Acid Sulfate Soil risk area.</p> <p>There is a potential in some rocks that make up the St Arnaud Group are pyritic. The following potential areas may be affected:</p> <ul style="list-style-type: none"> ▪ Ch. 0 to 3200 ▪ Ch. 7600 to 8100 ▪ Ch. 9000 to 9400. <p>Sulphuric acid, iron, aluminium and heavy metal contamination. Potential impacts to ecology, human health, crops, infrastructure and property (through corrosion, iron precipitates, and/or subsidence).</p>

Risk No.	Impact Pathway	Description of Consequences
G8	Presence of an operational or former transfer station/landfill along the proposed alignment.	Exposure of construction workers to uncontrolled municipal and potentially prescribed waste, leachate and contaminated soils and groundwater. This risk occurs along the alignment at the following location: <ul style="list-style-type: none"> Former Great Western Landfill (Ch. 13000 to 13400).
G9	Construction intersects historic gold mining works, including deep lead and shallow workings.	Construction on areas of shallow working may result in soil instability and ground subsidence. Construction near historic deep lead workings and shafts may result in ground subsidence or instability.

In assessing the impacts, the majority of risks associated with the Project have been assigned as medium to low. There is potential for impacts from localised contamination potentially as the result of activities associated with farming, rail operation, where pyritic and sulphidic rocks and potentially asbestos bearing rocks are present and due to the presence of the former Great Western Landfill. There is also some medium potential risk of encountering unstable geological units, associated with softer alluvial sediments and any historical mine workings.

10.8 Environmental Management Measures

VicRoads has a standard set of environmental management measures which are typically incorporated into the construction contracts for road works and bridge works. These measures have been used as the starting point for the assessment of construction related risks, and are described in detail in Chapter 21 (Environmental Management Framework). In some instances, additional Project specific environmental management measures have been recommended to reduce risks.

Management measures specific to each identified impact pathway, and the residual risk rating after environmental management measures have been applied, are outlined in Table 10-3.

Table 10-3 Soils and Geology Environmental Management Measures and Residual Risk

Risk No.	Environmental Management Measures	Residual Risk Rating
G1	<p>The discovery of contaminated material on the site during construction works would be managed in accordance with VicRoads and EPA Guidelines.</p> <p>Where putrescible waste material is encountered, the Superintendent and EPA would be notified. Construction works along the affected area would stop until a mitigation plan is established and agreed between the relevant project stakeholders.</p> <p>The Contractor would undertake a visual assessment of the Site for contaminated soil and uncontrolled waste during construction works.</p> <p>A Construction Environmental Management Plan (CEMP) developed to provide details on appropriate methods for managing contaminated soils and rock.</p> <p>An in-situ investigation in with EPA Industrial Waste Resource Guideline (IWRG) 702 would be completed along the proposed alignment to establish if contaminated soils are present. If contaminated soils are present, the result of the investigation would assist to provide appropriate soil and rock management advice including disposal recommendations.</p>	Low
G2	<p>Refer to management details detailed in G1 for soils that are contaminated by an uncontrolled spill or leak.</p> <p>For Fuel and Chemicals stored onsite, the CEMP would include specific procedures to minimise spillage of any fuels or chemicals and mitigate the effect in the event that leakages and spillages occur. Fuel, chemical and equipment storage areas would be visually monitored at intervals of not more than 7 days to mitigate contamination in a timely manner.</p> <p>Additional management measures may be required depending on the CEMP which would include:</p> <ul style="list-style-type: none"> Appropriate procedures for containing spills and leaks. Appropriate methods for cleaning up spills and leaks where safe to do so. 	Negligible
G3	<p>Water Sensitive Road Design measures would be evaluated for inclusion in the detailed design phase, as described in VicRoads Integrated Water Management Guidelines (August 2011)</p> <p>Road construction would include design features to mitigate runoff of spills into waterways.</p>	Negligible

Risk No.	Environmental Management Measures	Residual Risk Rating
G4	<p>Geotechnical investigations would be conducted prior to construction to assess nature of soils encountered along the alignment.</p> <p>Implementation of erosion and sediment Control Measures though CEMP, including but not limited to: minimising the amount of exposed erodible surfaces, installation of erosion and sedimentation control, prompt covering of exposed surfaces, progressive revegetation of the site, management of stockpiles and co-ordination to avoid works near watercourses.</p> <p>Detailed design cuts and final batter slopes to appropriately reflect the local geological and geotechnical conditions.</p> <p>Improved surface drainage measures in the management of erosion and sediment control.</p>	Low
G5	<p>Geotechnical investigations would be conducted prior to construction to identify and assess the nature of soft or compressible soils, together with recommendations for construction. Such recommendations may include adopting a staged construction approach (allowing for dissipation of pore pressure and / or temporary surcharge loading) or treatment of existing subgrade soils.</p> <p>Project to implement a staged construction approach in the construction of fill embankments, allowing for dissipation of excess pore water pressures where soft soils are expected or known to exist. Subgrade treatment or improvement may be required in instances to control settlement of fills.</p> <p>Consider the identification of soft or compressible soils by using the proof roll of prepared subgrades to receive fill, together with in-situ density and bearing capacity tests, at an appropriate interval for the section of road being constructed.</p>	Low
G6	<p>Earthworks are expected to be dominated by the need for fill above the natural surface to achieve drainage and great flood control or grade separation. Fill material would be sourced from surplus materials from site, and additional sources including local quarries, borrow pits under arrangement between Contractors and local land owners. Road pavement materials would be sourced from appropriately licenced facilities. Surplus material that cannot be used on site would be re-used disposed of in the following order of priority:</p> <ol style="list-style-type: none"> 1) Transfer to nearby VicRoads projects for immediate use or to an approved VicRoads stockpile site for future use; 2) Transfer to an alternative VicRoads approved site for re-use on concurrent private / local government project; or 3) Disposal at an accredited materials recycling or waste facility. 4) Disposal at an approved borrow pits for fill material <p>Assess likely earthworks volumes during detailed design to optimise solution (balance cut and fill where possible).</p>	Low
G7	<p>Soils suspected of being Acid Sulfate Soils are to be sampled and analysed to assess the Acid Sulfate Soil potential. In the event that Acid Sulfate Soils are discovered an Acid Sulfate Soil Management Plan would be prepared.</p> <p>Rocks suspected of being pyritic are to be sampled and analysed to assess the potential to produce acid when oxidised. In the event pyritic rocks are discovered a management plan will be prepared.</p>	Negligible
G8	<p>The uncovering of municipal rubbish and potentially prescribed waste along this particular alignment location during the construction phase will require:</p> <ol style="list-style-type: none"> 1. Preliminary planning ahead of the construction phase to mitigate this risk appropriately 2. Seek agreement with the relevant Authorities with regards to works approvals and other approvals required to address this risk appropriately. 3. Potential relocation of part or all of the landfill 4. Construction of a new cell in accordance with EPA publication 788.1, Best Practice environment management: siting, design, operation and rehabilitation of landfills (BPEM, 2010) 5. Analytical validation of soils from beneath original landfill location. If soil contamination is identified, refer to management controls detailed in G1. 	Medium
G9	<p>Desktop assessment complimented with Geotechnical investigations would be conducted prior to detailed design and construction to identify and assess the nature and extent of the shallow and deep mine workings. Construction may include ground improvement techniques to bridge identified poorly reinstated or susceptible historical mining areas.</p>	Low

10.8.1 Residual Risks

Following implementation of the recommended mitigation measures, only one risk (presence of a former municipal landfill along the alignment) still

presents as a medium risk. There are not expected to be any significant risks.

10.9 Conclusion

Several features were identified that indicate potential for land contamination. These include: farming/shearing sheds (often associated with sheep dips), railway lines (historic land management practices), the former Great Western Landfill, the presence of pyritic/sulphidic rock (St Arnaud Group) and potentially asbestos bearing rock (Deenicull Schist), areas of disturbed soils (potential sites of buried waste) and historic mining works mine tailings. Exposure to contaminated soils represents a potential risk to human health and the environment. Based on the review of previous and current land use, the potential impact of localised contamination in the study area is considered moderate.

The potential impact of encountering unstable geological units including erosion prone areas or compressible soils during construction is also considered moderate as it affects many sections of the alignment.

The areas of greatest concern for soils and geology along the proposed alignment are the locations of the former Great Western Landfill and the potentially asbestos bearing rocks of the Deenicull Schist outcrop. These areas present the greatest potential for impact on both the environment and humans. However, discussions with the EPA have identified a process for disposal of material from the former landfill. Other potential impacts can be mitigated through the implementation of the recommended management measures.

Appropriate management responses have been outlined to protect catchment values and avoid impacts associated with potential adverse geological conditions, contaminated soils, acid sulfate soils, asbestos bearing rocks, soil erosion and instability risks. Following implementation of the recommended mitigation measures, most identified risks are considered to be negligible to low, with the only exception being the potential contamination risk to soil and humans caused by the former Great Western Landfill, remaining a medium risk after mitigation measures.

