VicRoads

Western Highway Project – Section 3: Ararat to Stawell

Soils and Geology Impact Assessment Report

November 2012

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2. *May only be used for the purpose of informing the Environment Effects Statement and Planning Scheme Amendment for the Western Highway Project (and must not be used for any other purpose); and*
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Executive Summary

VicRoads is progressively upgrading the Western Highway as a four-lane divided highway between Ballarat and Stawell (Western Highway Project). The Western Highway Project consists of three sections, to be constructed in stages. Section 3 (Ararat to Stawell) of the Western Highway Project (Project) is the subject of this report.

On 27 October 2010, the Victorian Minister for Planning advised that an Environmental Effects Statement (EES) would be required to identify the anticipated environmental effects of the Project. GHD has been commissioned by VicRoads to undertake a soils and geology impact assessment for part of the Project as part of the EES.

Following a multi-criteria assessment of numerous potential alignment options, VicRoads selected an alignment for the Project which was subjected to the risk and impact assessment presented in this report. The Alignment Option is outlined in Section 6.1 of this report.

This report, together with other technical reports prepared by GHD and other consultants as part of the EES, will inform VicRoads' selection of the preferred alignment for the Project. VicRoads' preferred alignment for the Project will be documented in the EES.

The EES scoping requirements for the soils and geology impact assessment of the Project are detailed in Section 2 of this report. In summary, the EES Scoping Requirements are:

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

The soils and geology impact assessment undertaken by GHD involved:

- A review of historical aerial photographs (one per decade from 1947) of the study area, 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 coastal acid sulfate soil (CASS) hazard assessment;
- A site visit;
- Identification of the soils and geology cause and effect pathways associated with the construction and operation of the Project;
- Identification of the key potential benefits or opportunities to soils and geology that the Project could provide; and
- Provision of standard environmental protection measures and additional Project specific controls recommended to be incorporated into the Environmental Management Framework for the Project.

In summary, the assessment identified the following potential impacts and risks:

- Based on the review of existing conditions review, historic and current land uses and soil conditions identified in the project area may give rise to shallow dispersed contamination during the construction phase of the project. Such contamination may be associated with agricultural uses, or isolated point source contamination associated with sheep dips, uncontrolled historic mine tailings and the railway line. The alignment northeast of the Great Western township centre intercepts the former Great Western landfill site. The risk associated with the former Great Western landfill site is considered to be medium and as such, would require appropriate planning and management ahead of the proposed construction works.

- Preliminary intrusive investigation for the purpose of early identification and confirmation of contaminated soils is recommended along project areas where excavation is proposed. This would assist with the implementation of site specific management and mitigation measures prior to construction works. Intrusive investigation works would involve an assessment in accordance with the State Environment Protection Policy (Prevention and Management of Contamination of Land), the National Environment Protection (Assessment of Site Contamination) Measure, Victorian Best Practice Guidelines for Assessing and Managing CASS and Australian Standard AS4481.1 2005.
- The former Great Western Landfill would require planning, consultation with the relevant stakeholders such as Northern Grampians Shire Council and EPA, detailed engineering design and implementation ahead of the proposed alignment. The landfill management option selected would take into consideration EPA Publication 788.1 Best Practice Environmental Management: Siting, Design, Operation, and Rehabilitation of Landfills (2010) guidelines.
- Therefore, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated soils resulting from historic uses along the alignment, including sheep shearing sheds and associated infrastructure such as sheep dips, railway corridor, areas of disturbed soils and uncontrolled historic mining works is considered to be moderate.
- There is a potential for localised land contamination associated with the Former Great Western landfill with a significant risk to human health and the environment. With implementation of appropriate controls it is considered that the risk would be unlikely to impact on sensitive receivers. Therefore, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to the former Great Western landfill is considered to be medium.
- The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to ASS is considered to be insignificant.
- The risk from chemical spills along the alignment during construction is considered to be low as the construction works would be governed by a Construction Environmental Management Plan (CEMP). This results in the overall impact from chemical spills during construction of the Project to be considered insignificant.

- There is considered to be an increased risk of transportation of contaminants offsite during operation in locations where the alignment does not follow the existing highway. As the proposed alignment would be constructed and operated in accordance with the VicRoads Integrated Water Management Guidelines (2011), the VicRoads Water Sensitive Road Design Guidelines (2007) and the Best Practice Environmental Management Guidelines (CSIRO, 1999),both the risk and overall impact of this risk is considered to be insignificant.
- Geological conditions along the alignment are expected to be variable with an assemblage of Devonian Age igneous rocks intruding the Cambrian age sedimentary and metamorphic rocks. The development of drainage lines across the undulating topography has resulted in the deposition of surficial Quaternary sediments in well-defined corridors. The propensity exists for soil erosion and local instability along sections of the alignment associated with soft compressible materials and those displaying dispersive tendencies.
- Available geotechnical information was limited to a small number of historic bores conducted near the Great Western township, together with Geotechnical report undertaken by VicRoads Technical Consulting in the assessment of Sand and Gravel Pits in the vicinity of Great Western Township. Detailed site investigations, together with appropriate design of final slope batters and adoption of appropriate control measures, should effectively control and reduce the impact of soil erosion and wasting and settlement problems due to natural soft soil deposits or historical mining activity during the Project construction and operation.

The majority of the identified risks are considered to be negligible or low provided that the identified mitigation measures (specified in Section 7 of this report) are implemented with the exception of the former Great Western Landfill. The former landfill would require the implementation of additional control measure during construction to mitigate any risk to the human health and the environment.

1. Introduction

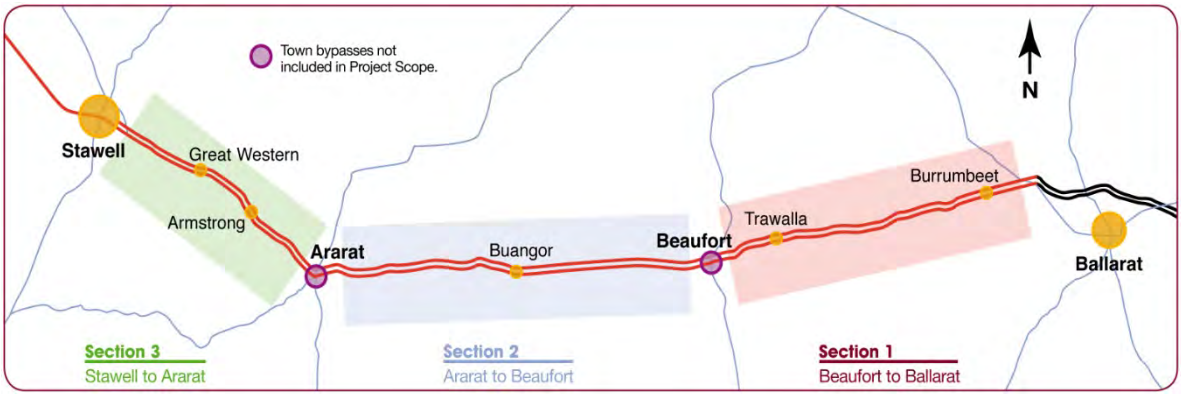
1.1 Background

The Western Highway (A8) is being progressively upgraded as a four-lane divided highway for approximately 110 kilometres (km) between Ballarat and Stawell. As the principal road link between Melbourne and Adelaide, the Western Highway serves interstate trade between Victoria and South Australia and is the key corridor through Victoria's west, supporting farming, grain production, tourism and a range of manufacturing and service activities. Currently, more than 5,500 vehicles travel on the highway west of Ballarat each day, including 1,500 trucks.

The Western Highway Project (here within described as 'the Project') consists of three stages, illustrated in Figure 1:

- Section 1: Ballarat to Beaufort
- Section 2: Beaufort to Ararat
- Section 3: Ararat to Stawell

Figure 1: The Western Highway Project



Works on an initial 8 km section between Ballarat and Burrumbeet (Section 1A) commenced in April 2010 and will be completed in 2012. Construction for Section 1B (Burrumbeet to Beaufort-Carngham Road) commenced in early 2012 and is expected to be completed by June 2014. The last 3 km section from Beaufort-Carngham Road to Smiths Lane in Beaufort (Section 1C) commenced in late 2011 and will finish in 2012. Separate Environment Effects Statements (EESs) and Planning Scheme Amendments (PSAs) must be prepared for both Sections 2 and 3. It is expected that Sections 2 and 3 will be completed and opened in stages through to 2016, subject to future funding.

Section 2 of the Project commences immediately west of the railway crossing (near Old Shirley Road) west of the Beaufort township and extends for a distance of approximately 38 km to Heath Street, Ararat.

Section 3 of the Project commences at Pollard Lane, Ararat and extends for approximately 24 km to Gilchrist Road, Stawell.

The EES will focus on assessment of the proposed ultimate upgrade of the Western Highway between Beaufort and Stawell to a duplicated highway standard complying with the road category 1 (freeway) of VicRoads Access Management Policy (AMP1). The project includes a duplicated road to allow for two lanes in each direction separated by a central median.

The EES has also considered a proposed interim upgrade of the Western Highway to a highway standard complying with the VicRoads Access Management Policy AMP3. When required, the final stage of the project is proposed to be an upgrade to freeway standard complying with AMP1.

The proposed interim stage of the Project (AMP3) would provide upgraded dual carriageways with wide median treatments at key intersections. Ultimately, the Western Highway is proposed to be a freeway (AMP1) where key intersections would be grade separated, service roads constructed and there would be no direct access to the highway.

To date $505 million has been committed for the Western Highway Project by the Victorian Government and the Australian Government as part of the Nation Building Program.

Highway improvements for the three sections between Ballarat and Stawell would involve:

- Constructing two new traffic lanes adjacent to the existing highway, separated by a central median.
- Converting the existing highway carriageway to carry two traffic lanes in each direction.
- Constructing sections of new four-lane divided highway on a new alignment.

In addition to separating the traffic lanes, highway safety would be improved with sealed road shoulders, safety barriers, protected turning lanes, intersection improvements, and service lanes for local access at some locations.

Town bypasses of Beaufort and Ararat are not included in the current proposals. Beyond Stawell to the Victorian border, ongoing Western Highway improvements will continue with shoulder sealing works, new passing lanes and road surface improvements.

The aims/objectives of this Project are to:

- Provide safer conditions for all road users by:
  – Reducing the incidence of head-on and run-off-road crashes;
  – Improving safety at intersections; and
  – Improving safety of access to adjoining properties.
- Improve efficiency of freight by designing for High Productivity Freight Vehicles.
- Provide adequate and improved rest areas.
- Locate alignment to allow for possible future bypasses of Beaufort and Ararat.

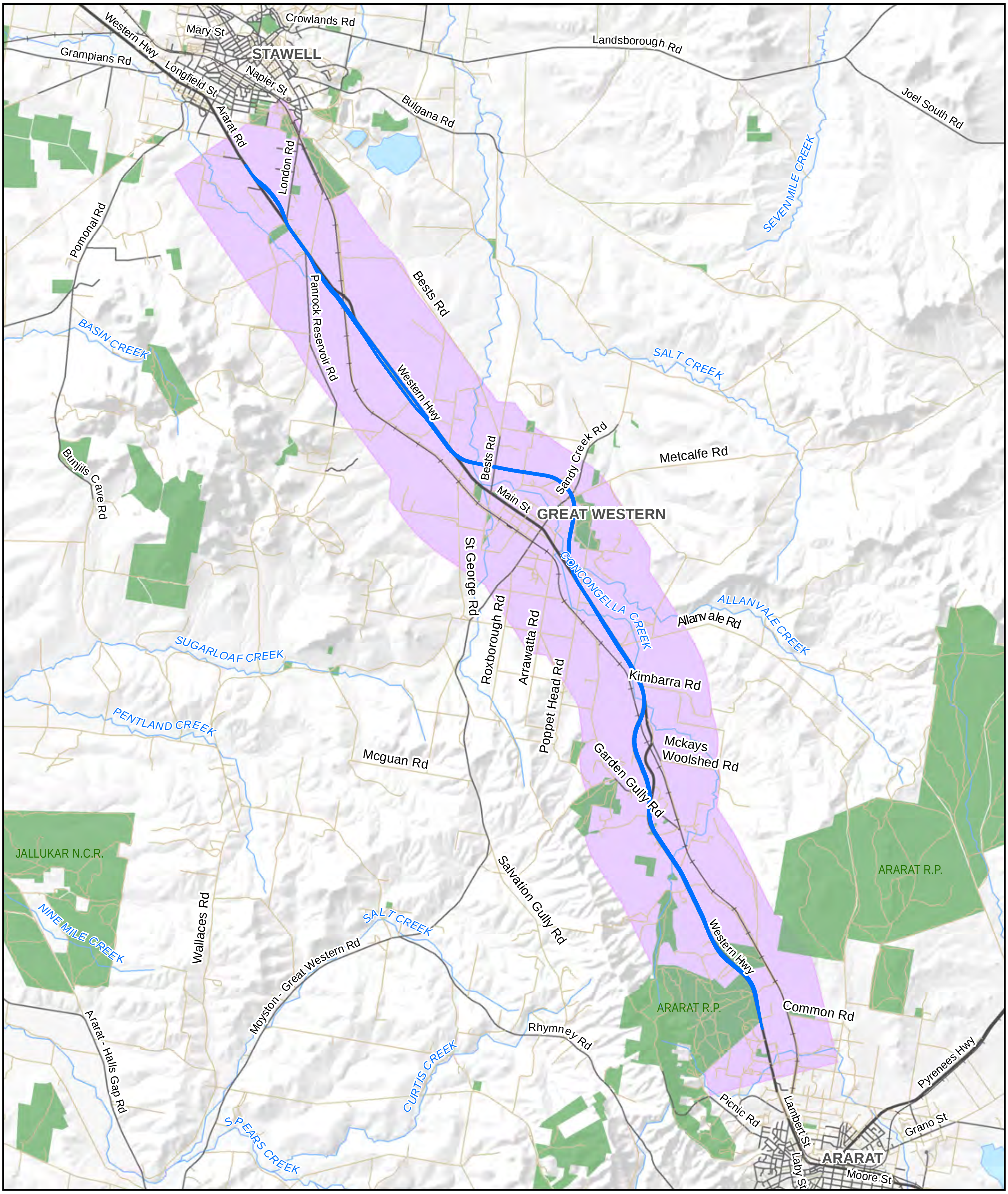
1.2 Project and Study Areas

1.2.1 Project Area

The project area was defined for the purposes of characterising the existing conditions for the Project, and to consider alignment alternatives. The project area encompasses a corridor extending generally up to 1 500 metres (m) either side (east and west) of the edge of the road reserve, except around Great Western where the project area extends up to 1 800 m (encompassing the extent of new alignment possibilities), and is illustrated in Figure 2.

1.2.2 Study Area

The study area for this soils and geology assessment is the same as the project area described above.



LEGEND

- Proposed Alignment
- Study Area
- Highway
- Sealed road (arterial & local)
- Unsealed road
- Parks

Paper Size A4

0 0.5 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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VicRoads
Western Highway Project

Ararat to Stawell
Study Area

Job Number	31-27558
Revision	C
Date	30 Oct 2012

Figure 2

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Data source: DSE, VicMap, 2012; VicRoads, 2011; GHD, Design, 2012. Created by:splaird

1.2.3 Proposed Alignment

A multi-criteria assessment of alignment options was conducted based on information from the existing conditions assessments. The outcome was the selection of a proposed alignment for further consideration in the EES for Section 3. The proposed alignment and associated construction area is the subject of the risk and impact assessment presented in this report and are described in more detail in Section 6. The assessment of alignment options and selection of the proposed alignment is documented in Chapter 5 of the EES, and in the Options Assessment Report (Technical Appendix to the EES).

2. EES Scoping Requirements

2.1 EES Objectives

For the soils and geology aspects of the Western Highway Project, the relevant draft evaluation objective outlined in the EES Scoping Requirements is:

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

2.2 EES Scoping Requirements

The EES Scoping Requirements for soils and geology aspects are as follows:

- *Identify and assess 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., highly saline or contaminated soils);*
- *Identify proposed measures to avoid, mitigate and manage any potential adverse effects, including any relevant design features of the road or techniques for construction; and*
- *Identify residual effects of road construction and operation activities on soils in the project area, including any implications for future land use activities.*

Where relevant, investigations should take account of the requirements of State Environment Protection Policy (Prevention and Management of Contaminated Land). If contaminated soils are identified, an assessment should be prepared outlining what is known about the contamination and the further steps to be implemented.

3. Legislation, Policy and Guidelines

3.1 Commonwealth

There are no Commonwealth legislation or policies that are relevant to this soils and geology assessment relevant to the Western Highway Project.

3.2 State

State legislation and policies that are relevant to soils and geology are presented in Table 1.

Table 1 Key Legislation and Policies

Legislation / Policy Title	Purpose
Environment Protection Act 1970 (EP Act)	The EP Act (1970) enables 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. All construction activities must comply with the general performance measures outlined in the legislation.
State Environmental Protection Policy (SEPP), Prevention and Management of Contamination of Land	The SEPP's set out policies of the Government to control, reduce environmental pollution and provide acceptable environmental quality standards and conditions for discharging wastes and identification of beneficial uses of the environment. The SEPP (Prevention and Management of Contamination of Land) establishes a range of general uses of land in Victoria and 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.
Catchment and Land Protection Act 1994	The 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. All construction activities must comply with the general performance measures outlined in the legislation.
Best Practise Environmental Management (BPEM), Siting, Design, Operation and Rehabilitation of Landfills	The BPEM provides guidelines for existing and future operators of landfills, planning authorities and regulatory bodies with requirements that must be taken into consideration in any works approvals or licensing of existing and new landfill sites, as well as in the design and construction of landfill cells.
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.
Industrial Waste Management Policy (Waste Acid Sulfate Soils)	Outlines a management framework and specific requirements for the management of acid sulfate soils in an environmentally responsible manner.
Best Practise 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.
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.

4. Methods

4.1 Existing Conditions

4.1.1 General

A desktop review was undertaken to assess the existing soil and geological conditions within the study area. The whole of the Project Area was assessed, including a long list of alignment options, and this existing condition assessment informed the ultimate selection of the "Alignment Option". The Alignment Option was then subject to the risk and impact assessment outlined in Section 6 of the Report.

The scope of work for the assessment of the existing conditions in relation to soils and geology included a review of available information required to address the scoping requirements. This comprised the following tasks:

- A review of historical aerial photographs (one per decade from 1947) 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 coastal acid sulfate soil (CASS) 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 option.

A review of historic title deeds was planned, however due to the lack of potential areas of concern identified in the historical aerial photograph review, this was not necessary.

4.1.2 Assumptions and Limitations

Assumptions and limitations regarding the investigation of the soil and geological conditions within the project area include:

- GHD relied on information supplied by others, which may not have been independently verified. Intrusive investigation for the purpose of soil sampling, analytical testing and geological logging were not undertaken during the compilation of this report. It should be noted that evidence of soil contamination is not always obvious by visual inspection;
- Image resolution issues that may have led to uncertainties in interpretation are stated in the historical aerial photograph review presented in Appendix B;
- Geological understanding is based on previously completed geological mapping, and is assumed to be reasonably accurate;
- Geotechnical information is generally a site specific parameter and may only be understood through extensive intrusive investigations; and
- Previously completed boreholes, bore locations and associated logs and interpretations are assumed to be correct.

4.1.3 Information Sources

Sources of available geological and geotechnical information used as the basis for the assessment of the soils and geological environment included the following:

- Birch (eds.) (2003) Geology of Victoria, Geological Society of Australia;
- Cayley, R.A. & Taylor, D.H., 2000. Ararat 1:50,000 geological map. Geological Survey of Victoria;
- Cayley, R.A. & Taylor, D.H., 2000. Stawell and part Callawadda 1:50,000 geological map. Geological Survey of Victoria;
- Cayley, R.A., 1995. Beaufort 1:100,000 geological map. Geological Survey of Victoria;
- CSIRO Australian Soil Resource Information (ASRIS);
- Department of Primary Industries (DPI), Minerals and Petroleum Division, Explore Victoria Online – GeoVic web mapping application;
- Department of Sustainability and Environment (DSE), Aerial Photography Register;
- Department of Primary Industries (DPI) Map 1, Far South West Coast;
- Douglas, Ferguson (eds.) (1988) Geology of Victoria, Geological Society of Australia;
- Geological Exploration & Development Information System (GEDIS) database;
- Geological Survey of Victoria; Geological Map Series Ballarat, 1:250 000;
- Golder Associates Former Great Western Landfill – Management of Environmental Risks Related to Road Construction (Western Highway Duplication (2011) (report);
- King (1986) Ballarat 1:250 000 Geological Map Explanatory Notes;
- VicRoads Western Highway Project Bypass of Great Western Geotechnical Assessment of Sand/Gravel Pits (2010) (report); and
- Williams, B. & Bibby, L.M., 2003. Ararat 1:100,000 regolith-landform map. Geological Survey of Victoria.

4.2 Impact and Risk Assessment

4.2.1 Risk Assessment Methodology

The following impact assessment methodology was used to determine the soils and geology impact pathways and risk ratings for the Project:

1. Determine the impact pathway (how the Project impacts on a given soils and geology value or issue).
2. Describe the consequences of the impact pathway.
3. Determine the maximum credible ‘consequence level’ associated with the impact. Table 2 provides guidance criteria for assigning the level of consequence. The method for defining these criteria is described in Section 4.2.2.
4. Determine the likelihood of the consequence occurring to the level assigned in step 3. Likelihood descriptors are provided in Table 3 below; and
5. Using the Consequence Level and Likelihood Level in the Risk Matrix in Table 4 to determine the risk rating.

Table 2 Soils and Geology Impacts Consequence Table

Aspect	Insignificant	Minor	Moderate	Major	Catastrophic
Erosion / sediment generation potential	Negligible potential	Potential for erosion and sediment mobilisation in small isolated locations along the alignment	Potential for erosion and sediment mobilisation in multiple locations along the alignment	Potential for erosion and sediment mobilisation along the majority of the alignment	Potential significant erosion, sediment generation or land instability along the majority of the alignment
Land Contamination (historic, construction or operation)	Insignificant risk of encountering historic land contamination during construction, or contaminating land through construction or operation	Potential for minor land contamination, but minimal risk to sensitive receivers	Potential for moderate land contamination, some risk to sensitive receivers	Potential for gross land contamination, confined to a localised area. Significant risk to sensitive receivers, health	Potential for gross and widespread land contamination. Significant risk to sensitive receivers, health
Soil settlement due to poor (compressible) ground conditions	No potential	Potential for significant soil settlement in small isolated locations along the alignment	Potential for significant soil settlement in multiple locations along the alignment	Potential for significant soil settlement along many sections of the alignment	Potential significant soil settlement along the majority of the alignment

Table 3 Likelihood Guide

Descriptor	Explanation
Almost Certain	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances
Possible	The event could occur
Unlikely	The event could occur but not expected
Rare	The event may occur only in exceptional circumstances

Table 4 Risk Matrix

Likelihood	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Negligible	Low	Medium	High	High
Unlikely	Negligible	Low	Medium	Medium	High
Rare	Negligible	Negligible	Low	Medium	Medium

4.2.2 Consequence Criteria

Consequence criteria (Table 2) range on a scale of magnitude from "insignificant" to "catastrophic". Magnitude was considered a function of the size of the impact; the spatial area affected and expected recovery time of the environmental system. Consequence criteria descriptions indicating a minimal impact over a local area, and with a recovery time potential within the range of normal variability were considered to be at the insignificant end of the scale. Conversely, catastrophic consequence criteria describe scenarios involving a very high magnitude event, affecting a State-wide area, or requiring over a decade to reach functional recovery.

The soils and geology consequence criteria were derived taking into account various magnitudes of potential impacts of sediment generation and land instability, risks of the potential for exposure to contaminants in soil to sensitive receivers and the environment, and the risk of ground settlement due to soft or compressible soils.

5. Existing Conditions

5.1 Regional Geology

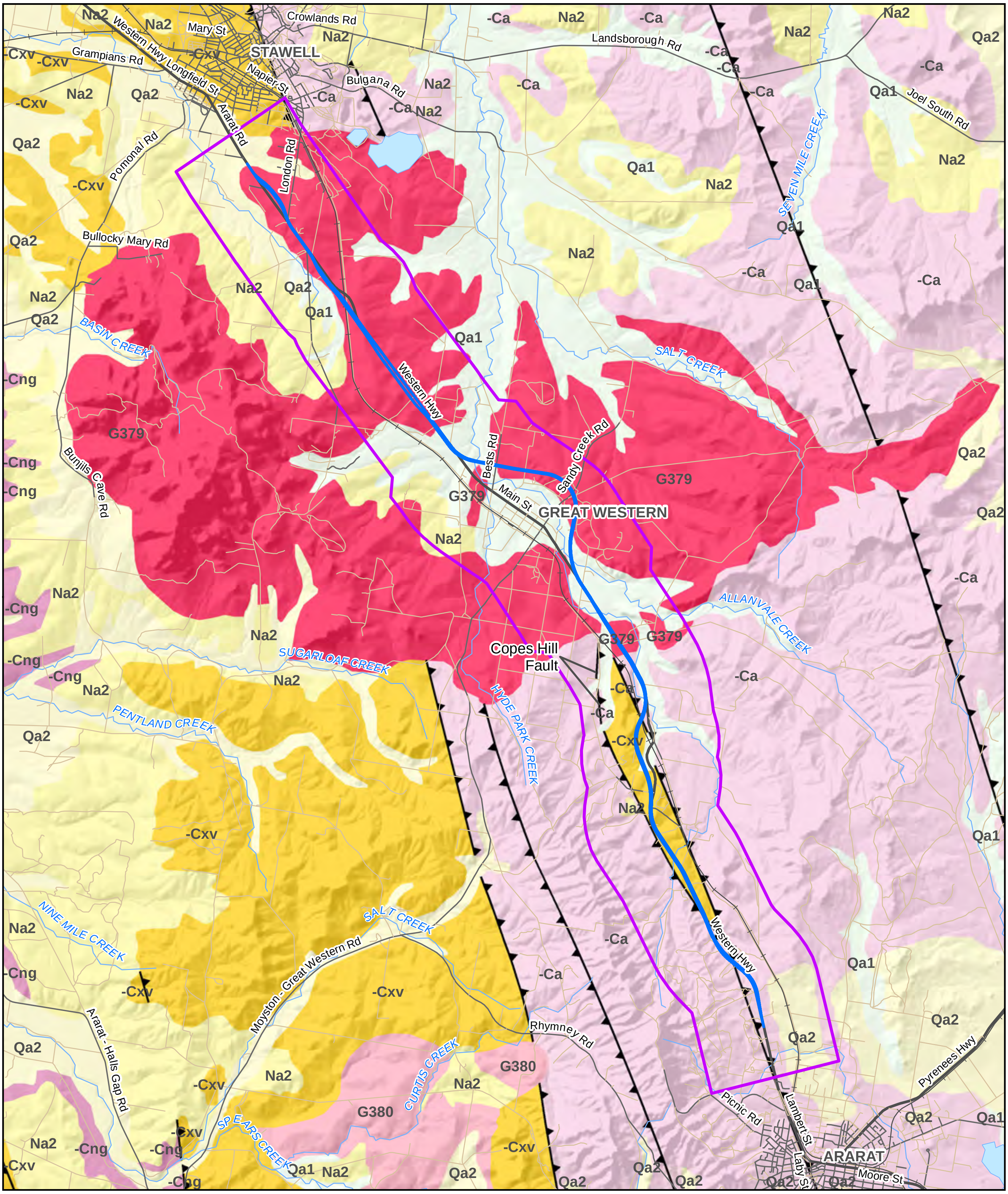
The Geological Survey of Victoria, Ballarat map sheet (1:250 000 scale) is situated in central west Victoria and depicts the surface geology of the study area. The map area in the east and south is characterised by volcanic plains and gently dissected Lower Palaeozoic sediments, which give rise to the flat to gently undulating topography. This dramatically contrasts the rugged Pyrenees in the northern area of the map sheet. The difference in terrain is attributed to the presence of granitoid bodies (large granite or granite-like masses) in the north and east which were emplaced during the Devonian period and have provided greater resistance to erosion.

An extract of the geological map is presented as Figure 3 for reference.

The western sub province of Victoria is comprised of three structural zones, namely the Stawell, Bendigo and Melbourne Zones. The study area lies completely within the Stawell Zone, which encompasses the rocks extending from the Moyston Fault eastward to the Avoca Fault. The zone is comprised of metamorphosed Cambrian oceanic volcanics, overlain by extensive Cambro-Ordovician quartz-rich turbidites, characterised by folding and northwest trending faults. Sediments of the Murray Basin cover the northern extension of the Stawell Zone, while Tertiary volcanics and Quaternary deposits cover expanses of the southern and western parts.

The geological history of the Ballarat map sheet area is characterised by periods of volcanic activity and sedimentation. During the Cambrian era volcanism and minor sedimentation was taking part in the western part of the map area, followed by the deposition of a thick pile of Cambrian Age turbidites. Widespread granitic intrusion was experienced during the Devonian period. Advancing through the Permian, the end of the early Pliocene saw the seas retreat completely from the map area. Streams rejuvenated, incising new valleys and depositing sediments (represented as Unnamed alluvium Qa1 and Qa 2 in Figure 3). Vulcanicity followed, associated with mild earth movements and an inundation of fluid lavas in the area.

The Western Highway between Ararat and Stawell falls within the Midlands Geomorphic subdivision. Parts of the Midlands, especially around the fringes, have quite subdued topography and are often deeply weathered. The Dundas surface and dissected tablelands of the southern lowlands abut sections of the study area close to Stawell. On the margins of the Midlands, the landscape of the Dundas surface and dissected tablelands contains extensive areas of horizontal or gently sloping country that is often laterite capped and in places deeply weathered.



LEGEND

Proposed Alignment	Neogene (Pliocene) (Unnamed) Na2	Cambro-Ordovician (Palaeozoic) (St Arnaud Group) -Ca
Study Area	Devonian (Middle Devonian) (Ararat Granodiorite) G380	Cambrian (Palaeozoic) (Magdala Volcanics & Deenicull Schists) -Cxv
Quaternary (Holocene) (Unnamed alluvium) Qa1	Devonian (Early Devonian) (Stawell Granite) G379	Cambrian (Palaeozoic) (Glenthompson Sandstone) -Cng
Quaternary (Pleistocene) (Unnamed alluvium) Qa2		

Anticline fine
Fault
Syncline fine
Highway
Sealed road (arterial & local)
Unsealed road

Geology Data: DPI 250K Seamless Geology

Paper Size A4
0 0.5 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Ararat to Stawell
Regional Geology

Job Number	31-27558
Revision	E
Date	31 Oct 2012

Figure 3

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Data source: DSE, VicMap, 2011; VicRoads, 2011; DPI, 2011. Created by:splaird

5.2 Geological Characteristics of Study Area

It is anticipated that the road construction activities between the areas of Ararat and just south of Great Western would traverse predominantly Cambrian sedimentary rocks, with minor zones of Quaternary fluvial deposits. Increasing complexity is expected north of Great Western toward the town of Stawell, with large zones of Devonian Granites and Cambrian Age metamorphosed volcanics indicated along and in close proximity to the study area. Areas of Tertiary and Quaternary Age deposits are expected along specific parts of the study area, particularly in the area surrounding Stawell.

The geological formations likely to be encountered within the general study area, from youngest to oldest, are summarised in Table 5 and described in more detail in subsequent sections of this report.

Table 5 Simplified Representation of Regional Stratigraphy

Period	Formation	Lithological Description	Comment
Quaternary	Undifferentiated alluvials, colluvials (Qa1, Qa2, Qc)	Fluvial, alluvium, gravel sand silt	Generally restricted to existing creeks, drainage lines and outwash fans.
Tertiary	Newer Volcanics (Qn)	Olivine and iddingsite basalt, limburgite, scoria, minor tuff	Flows mapped around Middle Creek (southeast of Buangor) and Dobie. Distribution heavily associated with ancestral valleys. Not intersected by Section 3 alignment.
	Calivil Formation ('Deep Leads')	Unconsolidated sands, gravels and clays	Not intersected by Section 3 Alignment
Unconformity			
Devonian	Stawell Granite (G379) and Ararat Granodiorite (G380)	Granite, biotite granite, associated aplite, pegmatite	Large intrusions into basement rock. Generally forming basement rock between Great Western and Stawell.
Unconformity			
Cambro-Ordovician	St Arnaud Group (Ca)	Indurated marine sandstones, siltstones and shales	Geological basement, outcropping across majority of alignment
Cambrian	Deenicull Schist (Cxv) Magdala Volcanics (Cxv)	Quartz chlorite schist with or without tremolite, actinolite and biotite. Volcanogenic sediment comprising finely layered quartz-chlorite-actinolite-graphite-pyrhhotite, occasional basalt flows, cherts and tuffs. Sulphide rich	Outcrops in a complicated arrangement along western highway between Ararat and Great Western

5.2.1 Quaternary Sediments (Qa1, Qa2)

Alluvial deposition of the Quaternary period characterise large portions of the study area between Great Western and Stawell.

Alluvial deposition has continued from the Late Tertiary through to present. The Ballarat map sheet identifies an infrequent occurrence of quaternary age fluvial deposits along the valleys and floodplains of ancestral or current watercourses. In the lower Palaeozoic areas, most streams contain recent alluvial deposits of varying thickness, often overlying, but incised into, the older alluvial sediments.

The thickness and composition of the quaternary deposits is not known, with the map sheet suggesting the alluvial material comprises silt, sand and gravel.

5.2.2 Devonian Granite (G379)

Numerous granite or granite-like masses of varying sizes intrude the Cambrian to Ordovician aged sediments within the general study area. Erosion since emplacement has caused the granitic rocks to outcrop at the surface. In particular, much of the alignment between the towns of Great Western and Stawell traverses areas characterised by Granitic rock surface exposures.

The granites are expected to be of locally high strength which may require additional effort to excavate in the form of ripping, hydraulic breaking or the use of explosives. This should be addressed during the detailed design stage as a comprehensive intrusive geotechnical investigation would be undertaken to establish appropriate excavation methods. Any adverse impacts caused by additional excavation efforts (if required) are expected to be accounted for during detailed design and mitigated by following industry guidelines and EPA regulations during construction.

5.2.3 Cambrian Saint Arnaud Group (-Ca)

Surficial outcroppings of the Saint Arnaud Group are expected over the majority of the southern portion of the alignment spanning from Ararat to the immediate south of Great Western.

The Saint Arnaud Group comprises a sequence of largely unfossiliferous, marine quartz-mica turbidites (muddy sandstones) and occasional black shales of the Stawell Zone. In some locations, some of the rocks that make up the Saint Arnaud Group are expected to be pyritic. The only location where the base of the Saint Arnaud Group is observed to outcrop is in the vicinity of Stawell, where quartz-rich turbidites appear to lie on the Magdala Volcanics.

Excavation and re-use of un-oxidised pyrite mineral bearing sedimentary rock may cause oxidation of the pyrite and the resultant production of acid. This would be addressed during the detailed design stage as a comprehensive intrusive geotechnical investigation would be undertaken to confirm the characteristics of each of the geotechnical units.

Tectonic activity has subjected the Cambro-Ordovician sedimentary rock (Saint Arnaud Group) to extensive regional deformation. The deformation has left behind a folded sequence disrupted by variably persistent faulting along a dominant NNW-SSE axis. The surface characteristics of the faults are unknown at this point in time, and could not be identified in the drive through assessment.

The sedimentary rocks have also been thermally metamorphosed adjacent to the Devonian granite intrusions. Where the sedimentary rock has been metamorphosed it is expected to have become crystalline with a corresponding increase in strength which may require additional effort to excavate in the form of ripping, hydraulic breaking or the use of explosives. Any adverse impacts caused by additional excavation efforts (if required) are expected to be accounted for during detailed design and mitigated by following industry guidelines and EPA regulations during construction.

5.2.4 Cambrian Magdala Volcanics and Deenicull Schist (-Cxv)

A narrow wedge of the Deenicull Schist interspersed with Magdala volcanics outcrops along the existing Western Highway route between Ararat and Great Western. This occurrence of this wedge at the surface is fault controlled and is surrounded on both sides by the rocks of the St Arnaud Group.

The rocks of the Magdala volcanics and Deenicull Schist are low-grade metamorphic rocks where the original rocks in the form of basalt and volcanogenic sediments such as tuff as well as sandstones, siltstones and mudstones have been recrystallised with different mineral assemblages. A significant change in the rock fabric also occurs during the metamorphism where tabular minerals in the rock become aligned with a preferred orientation that is not necessarily the same as the original depositional bedding shown in sedimentary rocks. Rocks of the Magdala volcanics can be rich in metal sulphides. The Deenicull Schist is comprised predominantly of quartz and chlorite minerals. Accessory minerals such as actinolite and tremolite may also be present. These are asbestiform minerals that can have an effect on health if inhaled. No information is available on the concentration of these minerals in the Deenicull Schist and should be assessed in the course of geotechnical investigations supported by petrology testing of selected samples.

Excavation and reuse of un-oxidised metal sulphide bearing sedimentary rock may cause oxidation of the pyrite and the resultant production of acid. This would be addressed during the detailed design stage as a comprehensive intrusive geotechnical investigation would be undertaken to confirm the characteristics of each of the geotechnical units including the presence and concentration of asbestiform minerals. It is understood that majority of alignment underlain by rock containing potential asbestiform minerals is proposed as fill construction in which case the likelihood of exposure during construction would mitigate against the risk of encountering such minerals.

Notwithstanding excavation, crushing and reuse of the Deenicull Schist may release asbestiform fibres into the environment where such rock types are being considered as fill sources.

5.3 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 in the area on Figure 3 at the current scale of 1:250,000. These are predominantly orientated along a NNW-SSE axis. Two parallel faults, an un-named 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 present conditions which are difficult to predict. Poor rock mass conditions and advanced weathering in faulted 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. It is expected that further investigation would be undertaken to understand the significance of the geological structures identified in the regional geological information.

5.4 Historic Mining Works

A review of geological maps and information held by the Department of Primary Industries has indicated that the area between the townships of Ararat and Great Western were mined for gold. These mine workings take the form of deep shafts and drives along the "deep-leads" and also open-cut mining of shallow Tertiary and Quaternary age alluvial deposits as shallow workings. The majority of historic workings to the southwest of Stawell (approximate radius of 3 to 6 km) are expected to comprise shallow workings with a few deep leads also identified within the region. A number of shallow workings exist along the study area between Ararat and Great Western. Very little exploration or historical mining has been undertaken between Great Western and Stawell. However, another concentration of historical mining occurred at Stawell, beyond the Section 3 study area.

Whilst the nature and extent of these workings is unclear, the probability of encountering abandoned backfilled shallow workings is considered to be greater during construction. These abandoned shallow mine workings may be filled with uncompacted, soft and compressible soils and possibly rubbish and dumped items of machinery, timbers or equipment. The backfill may also be contaminated with chemicals associated with the mining process.

5.5 Erosion

Erosion is the process of weathering and transport of sediments. The rate of erosion depends on many factors, including 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 necessitate a weak failure surface.

5.6 Review of Previous Reports

5.6.1 Golder Associates (2011)

Golder Associates (Golder) was engaged by VicRoads to provide advice in relation to potential environmental risks associated with constructing a portion of the Western Highway Project through the former landfill in Great Western. The potential highway alignment at the time of Golder's assessment transected the overall footprint of the former New Great Western landfill. The former New Great Western landfill covers an area of approximately 55 by 80 m, or 4 400 m^2. The landfill was established within a former quarry site.

The assessment completed by Golder included a desktop study and ten (10) test pits across the landfill area intercepted by the proposed Western Highway Project. The assessment also focuses on:

- The nature of the landfill waste;
- The potential volume of the waste;
- Potential management of the waste; and
- Managing potential environmental risks associated with the residual wastes during and post construction phases of the Highway project.

Geological/Environmental borelogs were not included in the report; however, cross-sections indicating a soil fill layer of approximately 1 to 2.5 m thick, waste of approximately 1 to 2.5 m and natural soils generally at 3 to 4 m below existing surface at the deepest point of filling were presented in the report.

The landfill 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 4 300 m^3 of compacted mixed solid inert and putrescible municipal waste which had been overlain by approximately 7 000 m^3 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 proposed three road construction options for managing the landfill material, including:

- Construction of a bridge over the landfill site;
- Excavation and off-site disposal of the landfill material; and
- Excavation and on-site management of the landfill material, which would involve the exhumation of the existing waste profile beneath the proposed re-alignment, and its re-deposition atop the old landfill area.

It was recommended that excavation and 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.

The report does not cover aspects of geotechnical risks or concerns relating to the construction of the Western Highway across the former landfill.

5.6.2 VicRoads (2010)

VicRoads Technical Consulting undertook a brief inspection and limited assessment of several operating and disused sand/gravel quarries in the Great Western area. VicRoads Technical Consulting prepared a report titled, *Western Highway Project Bypass of Great Western Geotechnical Assessment of Sand/Gravel Pits* (Ref#: MW001364-01) dated June 2010. The report revealed the inspected areas to lie within a geological formation known as the Tertiary Age White Hills Gravel. The name White Hills Gravel has been applied to fluvial sediments that were deposited in low relief uplands.

A soil sample was collected from three of the current working sand/gravel pits located to the northeast of Great Western Township. The samples were tested for particle size distribution, liquid limit, plasticity limit, plasticity index, and standard compaction. The soils tested indicated a low plasticity, granular composition (gravelly sand), with a compacted soaked Californian Bearing Ratio (CBR) of 70% and 100%.

The report assesses and discusses the quality and quantity of materials that may be available within the pit sites. Laboratory testing suggested that the better quality materials within the indicative cut areas may be suitable as good quality granular fill material.

The Emerson Class test is used as a basis for evaluating the susceptibility of the site soils to erosion. Emerson Class values can be subdivided into three result categories as follows:

- Emerson Class Number 1 to 3 = Dispersive
- Emerson Class Number 4 to 6 = Intermediate
- Emerson Class Number 7 to 8 = Non Dispersive

The potential of the clay material to disperse in contact with water would also depend on the amount of dissolved solids contained in the water.

The report suggested that the encountered material may be susceptible to scour erosion/wash-out with soils in the cut area having an Emerson Class number of 2.

5.7 CSIRO Atlas of Australian Soils

The Atlas of Australian Soils was compiled by CSIRO in the 1960s to provide a consistent national description of Australia's soils. It comprises a series of ten maps and associated explanatory notes, compiled by K.H. Northcote and others. The Atlas of Australian Soils provides the only consistent source of spatial soil information for the entire continent.

Mapped units in the Atlas are soil landscapes, usually comprising a number of soil types. The explanatory notes accompanying the soil atlas include descriptions of soils landscapes and soil components.

The surface geology units identified within the study area approximately correspond, geographically, to mapping units of the soil atlas. Despite the similarities, the broad scale of the soil atlas dictates that the detail of the soil atlas lacks the precision conveyed by the geology mapping. The soil atlas mapping is considered regional.

The study area traverses an area characterised by the CSIRO hills and valley plains (Tb1) mapping unit. The descriptors provided in the explanatory notes specify the hills and hill slopes of these regions to comprise hard acidic yellow mottled soils in association with hard neutral red soils, shallow grey-brown sandy soils and rock outcrops.

Neighbouring the study area, on the western and eastern side, the soil atlas identifies large regions of hilly to mountain soils, described as hard acidic yellow soils in association with hard acidic red soils with rock outcrops and shallow grey-brown sandy soils. This zone roughly corresponds to areas of hilly, granitic masses.

5.8 Historic Boreholes (GEDIS)

A search of the Geological Exploration and Development Information System (GEDIS) database identified numerous historic boreholes within the study area, however it was determined that only a limited number (5) within the study area contained lithological information. The five bores identified are located in close proximity to the township of Great Western.

The GEDIS historic borehole logs are presented in Appendix A.

The description on the logs is generally brief and lacking details of engineering properties, however the logs are generally sufficient to gain a brief understanding of the local subsurface conditions.

The historic bores extend to a maximum depth of approximately 30 m below ground and were generally drilled for the purpose of groundwater investigations.

Three bores intersected a sequence of clay and gravel overlying weathered granitic rock, while the remaining two bores encountered sand, gravel and clays to approximately 6 m and 30 m respectively. The granitic formation was indicated to commence at a depth of between approximately 7 m and 15 m, where apparent.

5.9 Review of Historic Aerial Photographs

A review of aerial photography across the study area was undertaken of photographs obtained for the period 1947 to 2009. This photography was sourced from the Victorian Department of Sustainability and Environment (DSE). The historical aerial photograph review is presented in Appendix B.

The aerial photography shows a minor increase in residential development within the study area, with the area of Great Western becoming increasingly urbanised through the development of residential properties. The southern region of Stawell was steadily developed during the period observed.

The existing Western Highway and Melbourne to Adelaide rail corridor were identified in the study area from 1947. Rail corridors have the potential to lead to dispersed contamination (surface application of herbicides and other related rail uses).

A substantial number of relatively small farm dams, often within the study area, were created or altered during the period 1947 to current. The frequency of dams through the more recent photographs became less prevalent either as a result of filling in the dams, or not containing water at the time the photographs were taken and therefore were not readily visible in the photograph.

The Great Western Quarry/Landfill (located on the eastern side of the junction of Sandy Creek Road and Great Western-Bulgana Road) was observed in the 1947 photograph and shows a substantial increase in operation from 1980 to 2009. Due to the poor quality of the aerial photography prior to 1980, it cannot be ascertained when the quarry was first used as a landfill site. No other suspected landfills were observed in the study area.

Agricultural land use for pasture and grazing has the potential to lead to both point source (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 farming properties along the corridor alignment indicates the potential for their presence and the potential for dispersed contamination sources.

Vegetation density increased along limited passages of numerous watercourses traversed by the study area. A golf course was developed during the period 1947 to 1966/67 south-west of the corner of the Western Highway and Panrock Reservoir Road intersection, at Stawell.

The review of aerial photography did not identify obvious evidence of ground instability or movement. The broad scale of the aerial photography means that small-scale localised instabilities or ground movement can be difficult to confirm. Historic landslips may be disguised by subsequent revegetating and human activities.

5.10 Preliminary CASS Hazard Assessment

5.10.1 Coastal Acid Sulfate Soils (CASS)

CASS (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. CASS 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 CASS may occur directly through lowering of surface or groundwater pH, or mobilisation of metals to waterways impacting 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 CASS can be problematic for construction projects where PASS or AASS is disturbed. Ideally disturbance of CASS should be avoided, however in instances where this is not possible, CASS must be carefully managed in order to prevent potential impacts to the environment.

5.10.2 ASS Guidelines

The *Victorian Coastal Acid Sulfate Soils Strategy 2009* (CASS Strategy) was developed with the intent of protecting the environment, humans and infrastructure from impacts associated with disturbance of Coastal Acid Sulphate Soils (CASS). To implement the actions and objectives of the CASS Strategy, in October 2010 the Department of Sustainability and Environment (DSE) released the CASS Best Practice Guidelines (CASS BPG), which outline a risk-based approach to identifying, assessing and managing Acid Sulfate Soils (ASS). The CASS BPG outlines four stages to the risk identification process:

- Stage A: Preliminary CASS hazard assessment – desktop assessment and site inspection to determine whether the proposed project involves a high risk activity (e.g. excavation of soil >1 000 m^3), and is within a CASS risk area;
- Stage B: Detailed site soil sampling program and assessment – involves characterising the extent and concentrations of CASS above specific action levels so that potential impacts associated with disturbance can be evaluated, and management strategies developed;
- Stage C: Surface/groundwater sampling program and assessment – if CASS is detected in Stage B, a detailed assessment of groundwater and surface water receptors that may be impacted by disturbance of CASS is required; and
- Stage D: CASS hazard assessment – if Stage B identifies CASS above the action levels, Stage D assessment is used to determine the level of hazard (low, medium or high) associated with CASS disturbance. The hazard rating is then used to determine the planning and management strategies to be implemented during disturbance (e.g. construction) to prevent adverse effects to the environment, human health and/or infrastructure.

Detailed below are the findings of a Stage A Preliminary CASS hazard assessment.

5.10.3 Review of CASS Mapping

A review of published maps indicating the potential occurrence of ASS was undertaken, including:

- CSIRO Australian Soil Resource Information (ASRIS); and
- Department of Primary Industries (DPI) Map 1, Far South West Coast.

These maps were produced using a geomorphic approach, which identifies areas of higher sea level during the mid-Holocene period. The higher sea levels often resulted in the deposition of sediments containing significant concentrations of iron sulphide. The scale of the maps is of low resolution, and is intended as a guide only. It should be noted that the study area is not covered by the DPI Coastal Acid Sulfate Soil Hazard maps, therefore they were not considered relevant to this assessment.

The mapping information indicates the following:

- The CSIRO ASRIS indicates the site is within an area of “low probability of occurrence” of acid sulfate soils; and
- Map 1 – Central Coast indicates the site is not within an area of “prospective land” containing potential coastal acid sulfate soils.

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

5.10.4 Conclusions from Preliminary CASS Hazard Assessment

Due to the low probability of ASS occurring within the region it is concluded that the study area for Section 3 of the Project is not within a CASS risk area. It should be noted that although the published maps indicate that there is a low risk of ASS occurring along the alignment, there is uncertainty in regards to the accuracy of the published maps due to their age and resolution, and that it is considered prudent to assess and confirm the soils are not ASS.

It should also be noted that a review of the geological maps, as discussed in Section 5.2, indicate that in some locations, some of the rocks that make up the Saint Arnaud Group are expected to be pyritic. Therefore, there is a potential for oxidation of the pyrite and the resultant production of acid in locations where rocks from the Saint Arnaud Group outcrop within the study area (between Ararat and Great Western), and therefore it is considered prudent to assess and confirm the rocks are not pyritic.

5.11 Site Inspection

A site inspection of the proposed alignment was conducted by a GHD environmental engineer and geotechnical engineer on 21 December 2011.

The inspection noted that land within the Project area was predominately used for agricultural purposes (pasture and grazing). A scatter of sheeting that may potentially contain asbestos was observed over an area of approximately 130 m^2 in the vicinity of a farm shed intersected by the proposed alignment at chainage 11 500.

Potential sources of contamination observed included farm / shearing sheds and associated infrastructure, the Melbourne to Adelaide rail corridor and the former Great Western landfill. The inspection confirmed the findings of the desk study.

As part of the site inspection and drive through survey, an assessment of cut exposures and local land features was made to verify the regional geological setting and identify any extraneous conditions along or near the proposed alignment options. Instances of steeply dipping strata and discontinuities within the vast, regional Cambrian units were exposed in a number of road and railway cuttings during the site inspection. Progressive rill erosion was noted across numerous cuttings along the alignment which attest to the erodible nature of sediments likely to be encountered during construction. The exercise assisted in corroborating the conceptual geological model developed during the existing conditions assessment.

6. Risk and Impact Assessment

6.1 Overview

The detailed impact assessment documented in this report addresses the potential impacts of the construction and operation of the proposed alignment of Section 3 of the Project. The alignment assessed is a culmination of progressive refinement of the design and consideration of potential impacts. The process for assessment and rationale for selection of the proposed alignment assessed in the EES is described in the ‘Western Highway Project Section 3 Options Assessment Report’ (February 2012) (Technical Appendix B of the EES).

The Existing Conditions section of this report covers an area encompassing the long list of alignment options considered for the Project. Potential impacts of each option in the long list of alignments were considered in Phase 1 of the options assessment process, and were used to reduce the initial long list to a short list of alignment options.

The potential impacts of each option in the short list of alignment options were considered in more detail in Phase 2 of the option assessment process. A single proposed alignment was selected for further detailed assessment in the EES. The impacts of the proposed alignment, together with potential mitigation measures, were considered in detail through the environmental risk assessment process. The outcomes of the risk assessment process were used to finalise the proposed alignment assessed in the EES. The environmental risk assessment methodology and complete risk register for all specialist disciplines is presented in ‘Western Highway Project Section 3 EES Environmental Risk Assessment’ (November 2012) report.

The proposed alignment assessed in this impact assessment report is the outcome of progressive refinement through each phase of the options assessment process. The proposed alignment was also refined following the initial consideration of the environmental risk assessment.

Extracts from the environmental risk register prepared for the EES are provided in this report and the identified impacts of the proposed alignment are considered in detail in the following sections.

6.2 Project Description

The Project provides two lanes in each direction, and associated intersection upgrades to improve road safety and facilitate the efficient movement of traffic. It commences at Pollard Lane, Ararat, and extends northwest for approximately 24 km to Gilchrist Road, Stawell. The upgrade assessed in this impact assessment is a combination of freeway standard (AMP1) and duplicated highway standard (AMP3). The first length is proposed to be upgraded to duplicated highway standard (AMP3) from Pollard Lane to the Majors Road. Then the upgrade is proposed to be freeway standard (AMP1) from Pollard Lane to Gilchrist Road on the outskirts of Stawell.

From Ararat the existing carriageway is duplicated to the north-west, crossing the railway via a new bridge adjacent to the existing Armstrong Deviation bridge. A new dual carriageway highway provides for a north-eastern bypass of Great Western, commencing north-west of Delahoy Road and passing through part of the former Great Western landfill and a quarry, meeting the existing highway alignment again near Briggs Lane. The existing carriageway is then duplicated to the north-west until Harvey Lane. Oddfellows Bridge at Harvey Lane would be upgraded to accommodate one carriageway crossing of the railway, and a second bridge would be constructed for the other carriageway further west.

Overall, the proposed alignment involves two crossings of the Melbourne to Adelaide railway, eight crossings of major waterways and 26 minor waterways (tributaries, drainage lines and irrigation channels), and bypasses of both Armstrong and Great Western townships.

The topography is undulating, and the surrounding land use predominately agricultural (grazing, cropping, viticulture), apart from the forested Ararat Regional Park and other smaller remnants.

Apart from the Melbourne to Adelaide railway line which carries both freight and passenger services, no State significant infrastructure, such as major pipelines or powerlines, is located within the study area.

6.3 Key Issues

The risk assessment for the Project area was divided into nine key areas in regards to soils and geology, including:

- Exposure to contaminated soils encountered during construction;
- Exposure to contaminated materials associated with the Great Western landfill;
- Oxidation of exposed pyrite bearing rocks of the St Arnaud Group;
- 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 / altered 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.

The proposed road design is likely to have a positive outcome on the protection of the environment where the proposed alignment follows the existing alignment as it may effectively manage issues relating to containment of uncontrolled spills by incorporating improved drainage.

6.4 Impact Pathways

This section identifies and describes soils and geology cause and effect pathways associated with the construction and operation of the Project. The risk assessment is presented in Table 6 below.

6.4.1 Contaminated Soils

Excavation of soils would be required during the construction of the proposed highway. Exposure to contaminated soils 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.

Aside from these general exposure pathways, contaminated soil on a construction project poses a number of additional risks to the environment mainly in the form of sediment generation. Therefore, knowledge of these types of issues is important in planning and implementing an effective environmental management system during construction and potentially in the operational phase.

6.4.2 Unstable & Compressible Geological Units

A limited number of historic bores were identified near the township of Great Western. The bores provide limited information regarding the geotechnical properties of the encountered stratigraphy.

The Project area corridor spans multiple creek and river systems including a number of current and ancestral watercourses defined by the presence of Quaternary sediments in the vicinity of Great Western. The alluvium deposits are primarily established on the surface exposed granite intrusions and may comprise unconsolidated, low-strength soils. Ground instabilities may develop during the earthwork operations, particularly along the banks of existing creeks and tributaries, where construction equipment and embankment construction may result in additional driving forces.

Earthworks operations may also destabilise marginal slopes where cut operations remove toe support at the base of longer / large slopes or where otherwise stable slopes are surcharged by the placement of fill. Potential weaker planes within variably weathered soil and rock units may be activated by improperly designed or conceived earthworks structures.

As detailed in Section 6.5, taking into account the mitigation measures proposed, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by unstable and compressive units is considered to be minor.

6.4.3 Soil Erosion

Construction of the Project would result in the removal of some vegetation. Observations undertaken during a preliminary site walkover and drive through exercise indicates the presence of soils which exhibit dispersive characteristics. The exposed earthen batters of numerous road and rail cuttings are progressively undergoing soil wasting processes, including slumping movement and rill erosion. The soil wasting and erosion is occurring across a number of geological units. Materials with dispersive characteristics are likely to be more prone to soil erosion.

The rate of erosion depends on factors, such as surface incline, climatic factors and the amount of and type of ground cover. Failure to reinstate exposed areas properly after construction may exacerbate soil erosion and loss of material from disturbed areas.

6.4.4 Cut & Fill Material

There is a potential for large quantities of fill material being required during the construction of the proposed highway. A risk exists that in order to meet the demands for fill material deeper cut excavations may be required exposing a greater surface area to processes of erosion and degradation. Depending on haul distances and location of local or commercial quarries to areas requiring fill, temporary stockpiles of material may be required to keep pace with construction schedules.

The location and geometry of any stockpiles would need to be carefully considered during detailed design, as local instabilities and excessive erosion may affect nearby environmental features, including waterways. Stockpiles have a propensity to suffer erosion as they are typically of high batter angles and generally exposed soil surfaces.

Deeper cuts have the propensity to become more difficult to excavate with depth, generally resulting in greater over-break in less weathered bedrock. Oversized material may be unsuitable for use unless crushed and may result in unplanned disposal off-site and higher demand for alternate sources of fill material.

Larger fill embankments impose a broader footprint and stress influence zone on founding soils. The build-up in pore pressure of moderate to high fills constructed across wet or marshy areas may take some time to dissipate (years to tens of years). Consolidation of founding soils and settlement of fill embankments may therefore continue sometime after construction.

As detailed in Section 6.5, the overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by imbalance of cut and fill material is considered to be minor.

6.4.5 Geological Faults

Areas directly impacted by faulted zones may be highly variable and present conditions which are difficult to predict. Poor rock mass conditions and advanced weathering in faulted areas are prone to instability and rapid deterioration.

Whilst no discernible remnant surface features were identified during the drive through survey exercise, it is expected that further investigation would be required in areas identified to be subjected to faulting to quantify the risk posed by past tectonic activity. Future activity along existing faults may occur, and the impacts of such movements may need to be considered in the design of batter slopes and significant structures. Potential impacts to the project include higher rates of erosion and the requirement for shallower batter angles.

The indicative location of the fault lines at 1:250,000 scale as prepared by the Geological Society of Victoria is shown on Figure 3.

6.4.6 Historic Mine Workings

A review of previous mine workings indicates that sections of the alignment may interact with historic shallow or deep lead workings. The nature and extent of the historic mining works is relatively unclear at this point in time and would need to be further explored during detailed design of the Project.

Shallow mine workings may have been reinstated to a substandard specification. Poor or uncontrolled backfilling may give rise to unpredictable and inadequate ground conditions (soft spots). The spatial distribution of shallow workings may be difficult to identify from surficial inspections as years of vegetation growth may have obscured any remnants of disturbance.

Deep lead works, including mine shafts, may instigate ground subsidence once subjected to a different stress regime (i.e. increased loading). Progressive or sudden collapse of mine works may result during or after the Project construction activities. The reinstatement works of the mines may be poorly documented.

The control measures for mine shafts and deep lead mining would depend on numerous factors such as the depths and reinstatement methods adopted after the completion of the mining works.

The mitigation measures to reduce the impact of ground subsidence or collapse associated with historic mine workings through ground replacement or reinforcement would present an overall low risk to the project. These measures would be identified as part of the detailed design and investigation stage for the Project.

6.4.7 Transport of Road Contaminants

There is a potential for transportation of road contaminates offsite during road operation. In locations where the proposed alignment follows the existing highway, it is proposed that the existing carriageway would be utilised with the existing bi-directional road converted to a single direction, and a new parallel carriageway constructed to serve traffic in the opposite direction. Where this construction method is applied, the existing waterway crossings would typically be matched for the proposed alignment. The proposed alignment would be constructed and operated in accordance with the VicRoads Integrated Water Management Guidelines (2011), the VicRoads Water Sensitive Road Design Guidelines (2007) and the Best Practice Environmental Management Guidelines (CSIRO, 1999). Therefore, it is considered that the upgrade of the existing highway through the construction of the proposed alignment would have a positive outcome on the protection of the environment from offsite contaminant transport during operation.

In locations where the proposed alignment does not follow the existing highway, the Project would involve the construction of two new carriageways in a corridor typically between 80-110 m wide. As such, there is an increased risk of exposure of sensitive receptors to potential transportation of road contaminates offsite during operation, in particular at waterway crossings. Although there is considered to be an increased risk of transportation of contaminants offsite during operation in locations where the alignment does not follow the existing highway, the overall impact of this risk is considered to be insignificant.

6.5 Risk Assessment

VicRoads has a standard set of environmental protection measures which are typically incorporated into its construction contracts for road works and bridge works. These are described in *VicRoads Contract Shell DC1: Design & Construct, April 2012*, hereafter referred to as the “VicRoads standard environmental protection measures”. These measures have been used as the starting point for the impact assessment. Those that are relevant to soils and geology are included in the “planned controls” column of the risk assessment (Table 6) and outlined in more detail in Section 7.

As a result of the initial risk assessment, in some cases additional Project specific controls have been proposed to reduce risks. These are outlined in the “additional controls” column of the risk assessment in Table 6, and are described in more detail in Section 7.

Both VicRoads standard environmental protection measures and the additional Project specific controls have been included in the Environmental Management Framework for the Project.

Key observations from the risk assessment of the proposed alignment and associated construction corridor are:

- The residual risk associated with former landfill is considered to be medium;
- The residual risk associated with encountering contaminated soils is considered to be low;
- The residual risk associated with an imbalance in the volume of suitable fill compared with excavated material is considered to be low; and
- The residual risk associated with encountering erosion prone areas, compressible soils and historic mine workings is considered to be low.

The potential for adverse impacts of contaminated soils (including ASS, asbestos bearing rocks and pyritic rocks), chemical spills, unstable geological units, historic mine workings and cut and fill material was assessed through the risk assessment process described in Section 4.2 with further mitigation proposed to manage impacts.

The risks associated with the proposed alignment option are discussed in more detail below.

6.5.1 Exposure to Potentially Contaminated Soils

Based on land-use activities, the potential for contaminants to be identified within the Project area is moderate as there have been several different historic uses along the alignment that could give rise to gross contamination, including farm / sheep shearing sheds and associated infrastructure such as sheep dips, a railway corridor, the former Great Western landfill, historical mining activity and potential asbestos bearing rock. The main risk that would need to be considered is exposure of construction workers to contaminated material, dust, fuels and chemicals used during the construction phase or stored for plant operation.

Once excavated, any contaminated materials need to be managed appropriately to mitigate risks to the environment particularly for sediment and leachate generation.

In terms of the type of land uses identified along the alignment, the main human health and environmental risks are considered below:

Agriculture – Pasture and Grazing

The potential risks to human health and the environment associated with this land use would be relatively low across most of the Project, as contaminant concentrations due to the application of fertilizers and other pastoral improvement substances, where present, are unlikely to be high (orders of magnitude greater than the National Environment Protection (Assessment of Site Contamination) Measure, NEPC 1999 criteria). The general contamination associated with this land use type is likely to have dispersed source characteristics, and would benefit from in-situ intrusive investigation along the alignment as part of future works. The exception to this generalisation would be farm / shearing sheds with associated infrastructure such as sheep dip / shower sites, which could represent localised high contaminant concentrations as they tend to be infrastructure confined to a discrete location. Farm / shearing sheds of potential concern occur along the alignment at the following chainages:

- Ch. 9 400;
- Ch. 11 500.

It should be noted that a scatter of cement sheeting that may contain asbestos was observed covering an area approximately 130 m^2 in close proximity to the farm / shearing shed located at chainage 11 500 during the site inspection. Given the magnitude and localised effects of farming activities, and the asbestos cement sheeting fragment scatter, it would be appropriate that they be managed through a Construction Environmental Management Plan (CEMP). It would be beneficial to conduct intrusive investigations at the locations listed 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.

Waste Disposal

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

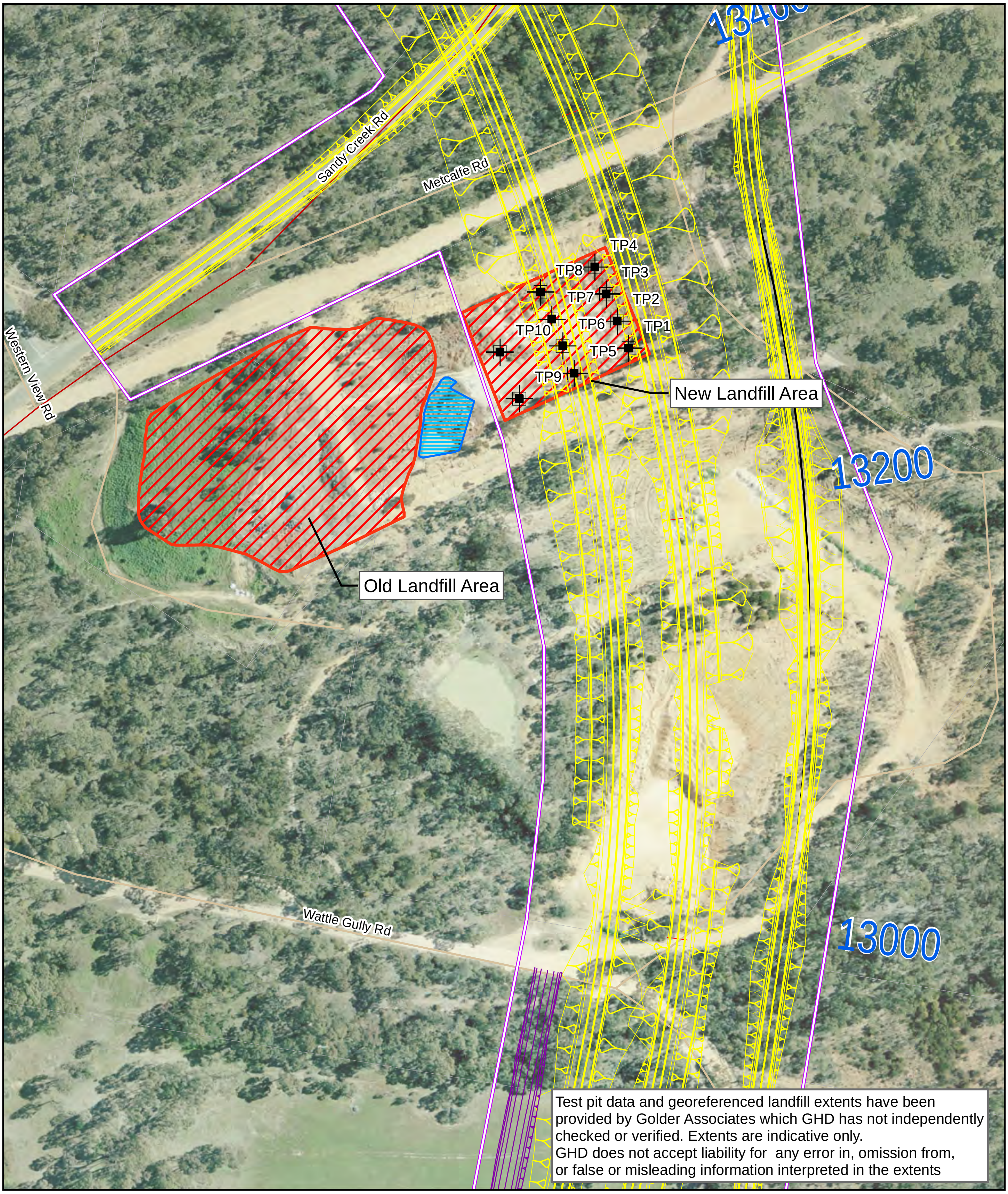
– Ch. 13 000 to 13 400.

The former Great Western landfill location and surrounds are shown in Figure 4. Figure 5 to Figure 7 show cross sections of the proposed road cut through the former landfill site.

Preliminary discussions with the Environment Protection Authority regarding removal of purtrescible waste from the former Great Western landfill have resulted in the following process to reduce risk and to ensure that the proposed alignment construction works can proceed in a timely manner at this location:

– Preliminary planning to mitigate risk appropriately;
– Liaison with appropriate authorities to gain required approvals;
– Potential relocation of the putrescible waste to the former Old Great Western landfill;
– Re-capping of the former Old Great Western landfill after the relocation of the purtrescible waste; and;
– Validation and remediation (if required) of soils beneath the former landfill location.

Given the potential localised effects of in-filled dams, quarries or borrow pits, areas of disturbed soil and mine tailings, it would be appropriate that they be managed through a Construction Environmental Management Plan (CEMP). It would be beneficial to conduct intrusive investigations at the locations listed 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.



LEGEND

Landfill Boundary (Golder 2011)

- Landfill Area
- Surface Water Pond
- Testpits (Golder 2011)
- Sealed road (arterial & local)
- Unsealed road
- Proposed Carriageway and Interchanges
- Service Road
- Maximum Construction Footprint

Paper Size A4

0 37.5 75

Meters

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

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VicRoads
Western Highway Project

Ararat to Stawell
Former Great Western Landfill

Job Number	31-27558
Revision	D
Date	31 Oct 2012

Figure 4

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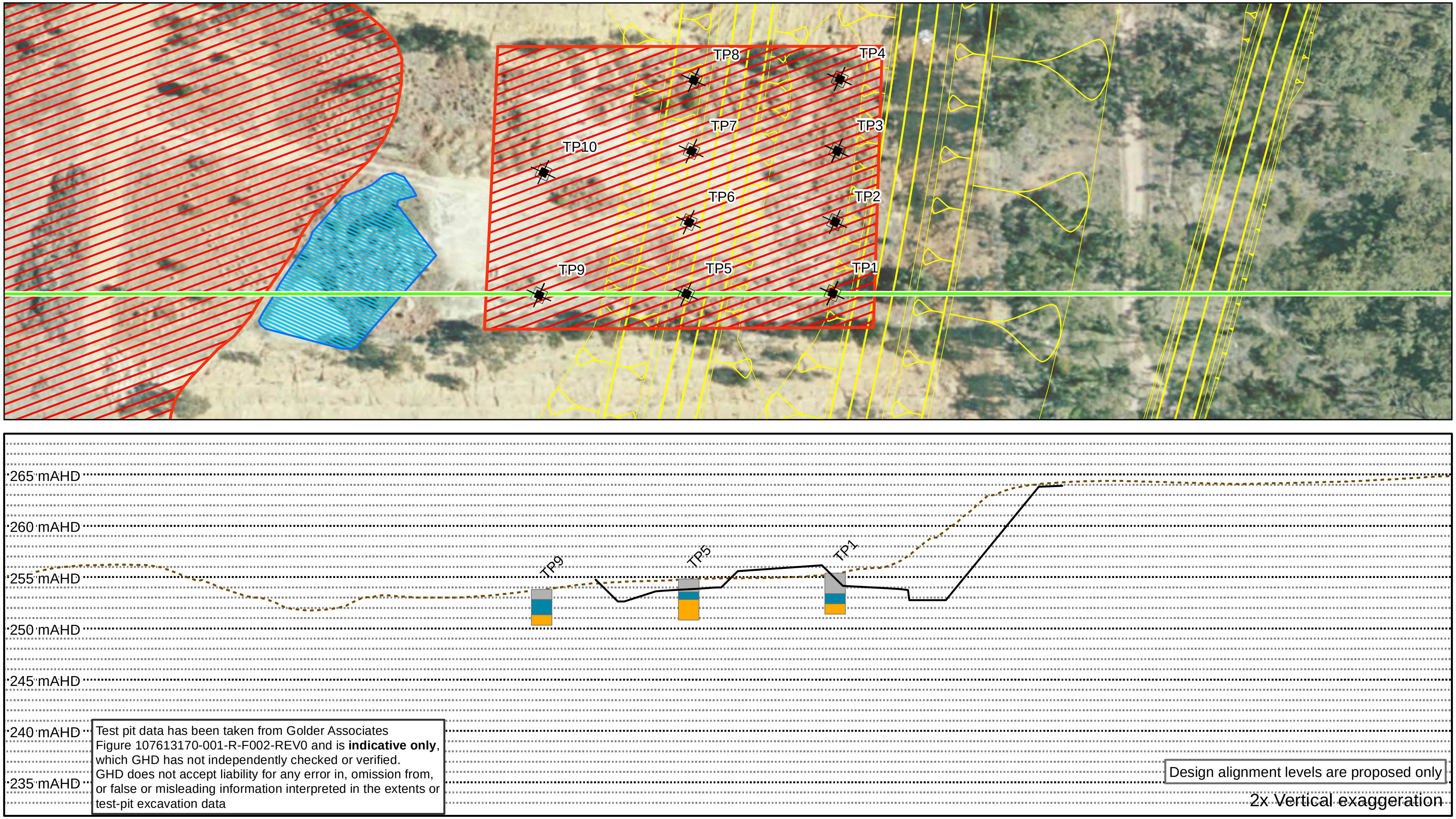
Data source: DSE, VicMap, 2012; VicRoads, 2012; GHD, Design, 2012; Golder Associates, 2011. Created by:splaird



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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LEGEND

- Testpits (Golder 2011)
- Landfill Cross-Section
- Proposed Carriageway
- Natural Surface
- Proposed Design Road Surface
- Fill
- Natural Soils
- Waste

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Western Highway Project

Job Number	31-27558
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Great Western Landfill
Cross Section 1 (CH 13310)

Figure 5

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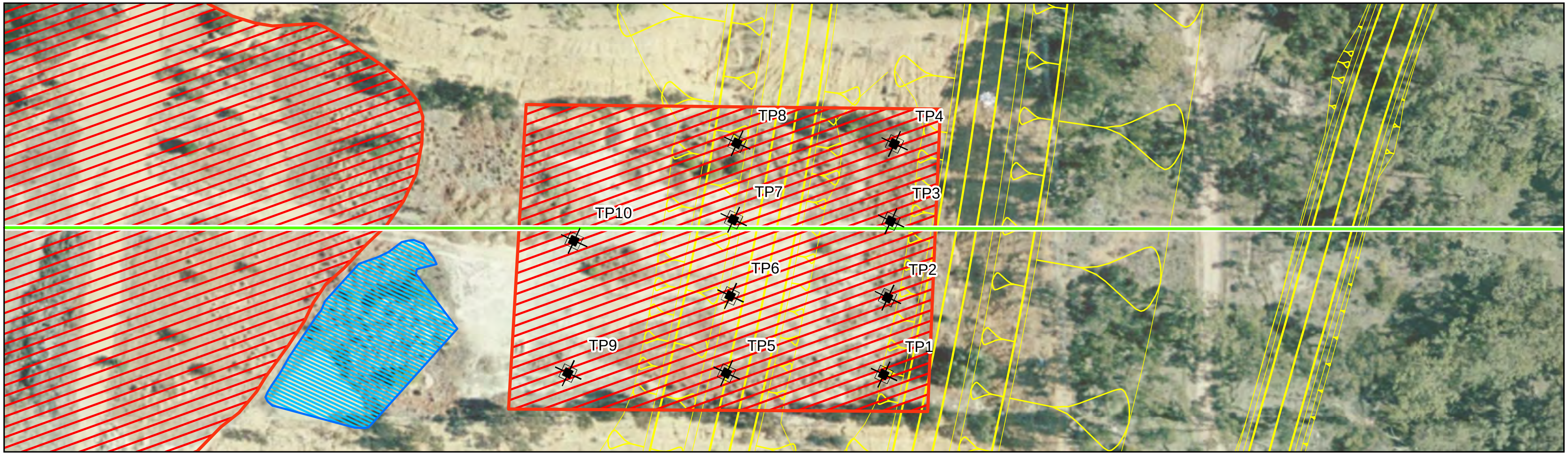
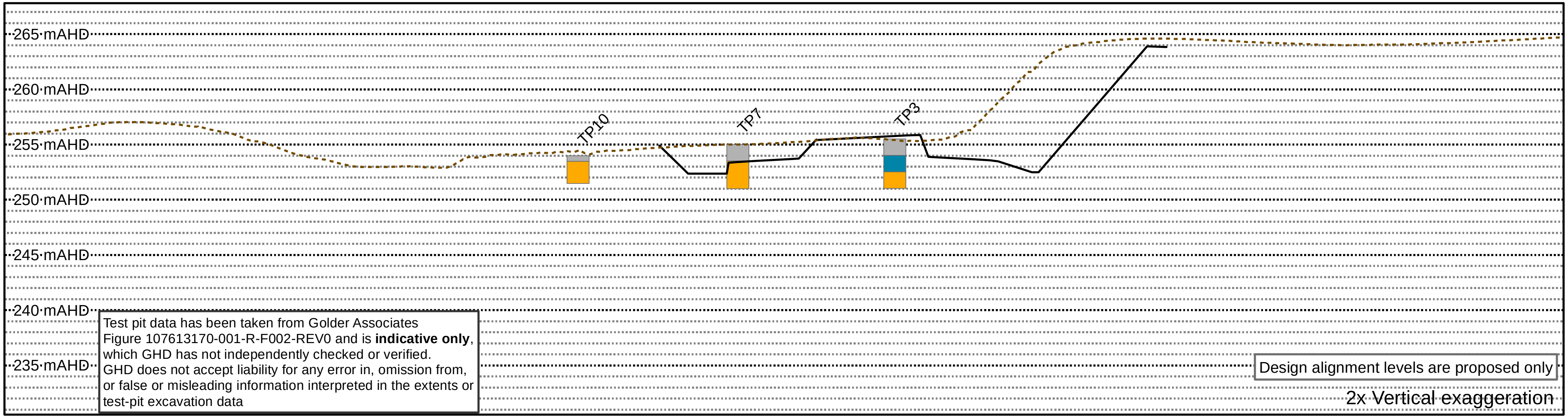
Data source: VicRoads, 2012; GHD, Design, 2012; Golder Associates, 2011. Created by:splaird





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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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LEGEND

- Testpits (Golder 2011)
- Landfill Cross-Section
- Proposed Carriageway
- Natural Surface
- Proposed Design Road Surface
- Fill
- Natural Soils
- Waste

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VicRoads
Western Highway Project

Job Number	31-27558
Revision	D
Date	31 Oct 2012

Great Western Landfill
Cross Section 2 (CH 13340)

Figure 6

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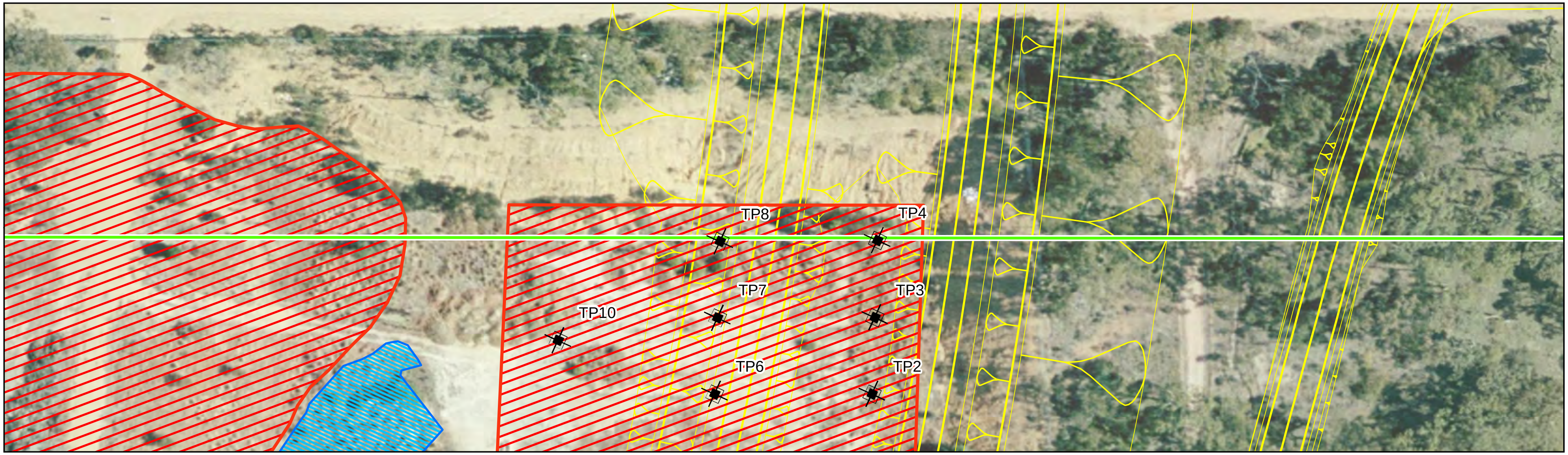

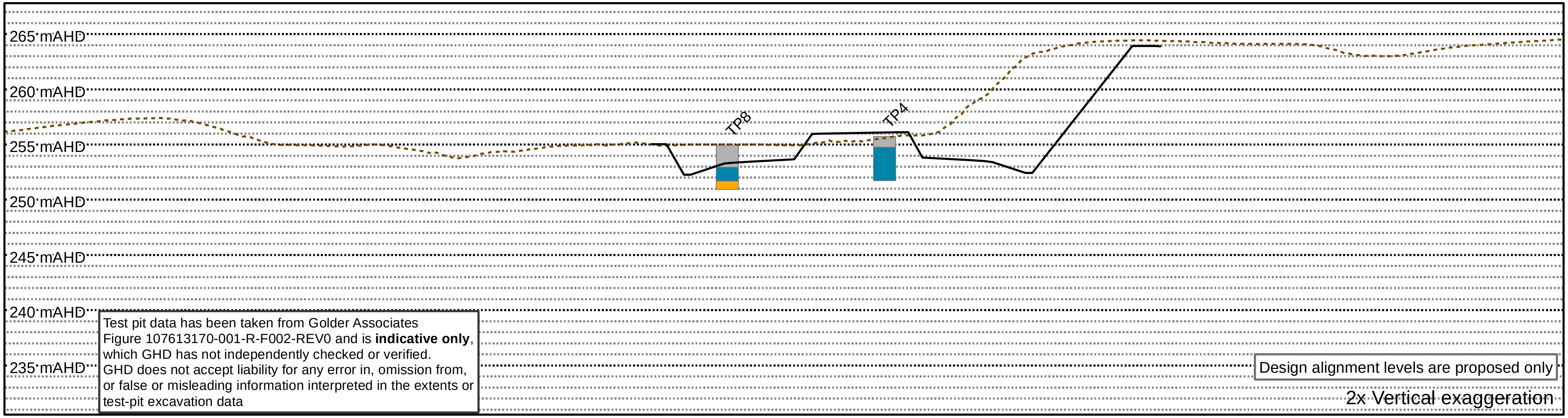

Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

LEGEND

- Testpits (Golder 2011)
- Landfill Cross-Section
- Proposed Carriageway
- Natural Surface
- Proposed Design Road Surface
- Fill
- Natural Soils
- Waste

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VicRoads
Western Highway Project

Job Number 31-27558
Revision D
Date 31 Oct 2012

Great Western Landfill
Cross Section 3 (CH 13355)

Figure 7

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Data source: VicRoads, 2012; GHD, Design, 2012; Golder Associates, 2011. Created by:splaird

Commercial and Industrial Activity

There were no significant industrial activities within the Project area. However, there were commercial activities including a rail corridor. A potential for contamination exists at locations where the highway alignment intersects the railway line. The locations where the proposed highway alignment intersects the rail corridor where at the following chainages:

- Ch. 7 600;
- Ch. 20 600.

Thus, there would be some benefit from limited selected sampling at the locations where the alignment crosses the rail line as part of future works given the potential for the historical use of pesticides containing arsenic by the rail authority for the management of weeds along the corridor.

The overall residual impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated soils resulting from historic uses along the alignment, including sheep shearing sheds and associated infrastructure such as sheep dips, the railway corridor and historical mine works is considered to be moderate.

In regards to waste disposal, the overall residual impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated soils resulting from the former Great Western landfill is considered to be major.

Acid Sulfate Soils

There is a potential for ASS to be present in the waterways within the project area. 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 project area at locations where the Saint Arnaud Group outcrop. It is considered that there would be some benefit in undertaking limited selected sampling along the alignment in this locality as part of future works. This should occur in particular where infrastructure such as bridge supports are installed at depth.

It is also considered that a CEMP should provide guidance for the appropriate method of stockpiling uncharacterised material (e.g. on plastic and covered) and provide for appropriate sampling be performed prior to material being assessed for re-use or disposal off-site. It would also detail Personal Protective Equipment (PPE) to be worn on-site and appropriate hygiene procedures to be followed.

The overall residual impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to ASS is considered to be insignificant.

Asbestos Bearing Rock

There is a potential for asbestos bearing rock to be present within the project area at locations where Deenicul Schist outcrops. The area of concern where the Deenicul Schist outcrops was at the following chainage:

- Ch. 2 800 to 10 000.

It is considered that there would be some benefit in undertaking sampling, petrological testing and geological mapping along the alignment in this locality as part of future works.

It is also considered that a CEMP should provide guidance for the appropriate method of stockpiling uncharacterised material (e.g. on plastic and covered) and provide for appropriate sampling be performed prior to material being assessed for re-use or disposal off-site. It would also detail PPE to be worn on-site and appropriate hygiene procedures to be followed.

The overall residual impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to asbestos bearing rocks is considered to be moderate.

6.5.2 Chemical Spills

The risk of impact from chemical spills along the alignment 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.

The proposed Western Highway Project is likely to have a lower environmental risk of uncontrolled spills during its operation, relative to the existing highway. The design improves road safety thus reducing the risk of spills occurring as a result of a traffic accident, and the containment of uncontrolled spills is improved by incorporating improved drainage.

Fuel and chemical spills that occur during operation are not generally VicRoads' responsibility. VicRoads' maintenance contractors are required to have emergency preparedness and response procedures, and these detail how the emergency is managed including contacting emergency services (the CFA and police are the lead agencies), and EPA. VicRoads provides support for traffic management. For these reasons, the overall residual impact of the Project from chemical spills is considered to be insignificant.

6.5.3 Unstable Ground

Historic aerial photography, spanning approximately 62 years, demonstrated no discernible 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 Project 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 alignment heightening the potential of localised ground instabilities. Creek and river banks may become unstable under the changing stress conditions anticipated with construction activities.

The removal of toe support, surcharging of slope crests or the interception of planes of weakness may result in significant slope instabilities. Erodible soils present an additional risk to soil stability, as the movement of soils from the slope toe may initiate a destabilising effect with time.

The less weathered rock of the Cambrian geology is likely to afford a greater degree of stability than more weathered slopes or soil slopes. The stability of Cambrian rock slopes is nonetheless governed by structural controls, such as joints, faults and shear zones. An understanding of the orientation and type of discontinuities is an important aspect in assessing the stability of rock slopes and cuttings.

Detailed geotechnical site investigations complemented with appropriate design of temporary and final batter slopes would largely eliminate or overcome gross soil or rock instability. The overall residual impact (consequence) during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by unstable ground is considered to be minor which translates to a low residual risk to the Project.

6.5.4 Soil Erosion

Despite efforts to avoid existing farm dams, and water crossings along the alignment which may be more prone to soil erosion and the exposure of subsoils can only be minimised and not eliminated. A preliminary geological conceptual model has been developed for the Project area on the basis of regional geological mapping, preliminary site walkover and drive through conducted by GHD and limited historic 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 Project area and not just during construction. The exposure of subsoils during construction activities would give rise to favourable sheet and rill erosion conditions.

Soil erosion is not limited to areas of high gradients but is rather a process which would occur along any section of the Project area. The likelihood is 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 (removal) 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 soils erosion, including the limitation of suspended soil transfer to water bodies. The control measures detailed are considered appropriate in the control of soil erosion, however, site specific soil erosion management plans should be developed as part of the CEMP. The provision of a site specific soil erosion management plan is recommended given the scale of the project.

Similar to the mitigation measures proposed for encountering unstable geological units by the adoption of appropriate batter slopes and surface drainage measures as described in Table 6, the overall residual impact (consequence) during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being affected by soil erosion is considered to be minor.

6.5.5 Ground Settlement (Compressible Soil)

Ground settlements are typically due to increased soil loadings and are exaggerated in weak subsoil conditions. The proposed construction of earthen fill platforms and embankments is expected to 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 significant settlements where poor ground conditions dominate. Geotechnical information is limited along the alignment and details regarding the thickness and spread of soft compressible soils are unknown and would require further geotechnical investigation to quantify.

Load induced ground settlements are unavoidable during the development of embankments and fill platforms, however these effects may be carefully controlled. A staged construction approach should be considered to aid in reducing the likelihood of significant settlements. A staged approach would allow the embankment to be constructed with multiple, smaller load increments, allowing a controlled progressive strengthening of the weak, underlying subsoils. This proposed methodology would result in mitigation of large settlement deformations and local instabilities, and should be based on the acquisition of sufficient, suitable geotechnical data.

Soil erosion and control relies heavily on the correct installation and maintenance of erosion/sediment control mechanisms. Exposed subsoils, consequent of vegetation and topsoil removal, would inevitability 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 paramount to avoiding detrimental effects to nearby creeks and water bodies. The measures detailed in the VicRoads standard environmental requirements would adequately reduce and maintain the risk. The programming and management of the Project to avoid works during or preceding wet weather and those near water courses would assist in isolating and containing erosion breaches.

Failure of erosion and sediment control mechanisms may potentially result in significant volumes of suspended soil entering existing water bodies, including groundwater systems. Post construction consideration would be required to ensure a long term solution to erosion control is in place.

Risks associated with soil erosion, instability and settlement have been assessed as a medium risk and the implementation of the environmental requirements and methods detailed in the Project description together with the additional measures as detailed in Table 6, the risk rating may be effectively reduced to a low risk. Residual risks to the project may include increased frequency of maintenance interventions.

6.5.6 Cut & Fill

Preliminary earthwork estimates suggest a large quantity of imported fill material may be required. Detailed analysis during further progression of the Project would assist in effective, proper planning of sourcing and disposing correct volumes of material and reducing the risk associated with unplanned sourcing or disposal of materials.

The estimated volume of cut and fill earthworks associated with the construction of earthwork structures as part of the Project and provision of associated service roads is as follows:

- Total Fill: 3,023,659 m^3
- Total Cut: 1,023,087 m^3

Considering the significant short-fall of suitable fill materials, sources of materials would need to be located, preferably from local quarries. It is understood that VicRoads is working with Quarry owners to identify and source suitable fill material for the project ahead of construction. The refinement of horizontal and vertical road alignment as part of detailed design together with adoption of final batter slopes on the back of geotechnical investigation and slope stability analysis may give an opportunity to achieve a closer cut and fill balance.

6.5.7 Ground Subsidence or Collapse (Anthropogenic)

The presence of historic mining works may give rise to the existence of finite areas where the ground conditions may be unstable and liable to subsidence or collapse once 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 highway at Ch. 6 200 to 7 100, together with shallow pits, mounds and partially filled tunnels along the alignment. Other historic mining activity is recorded in the vicinity of Ch. 12 600 to 13 100.

Ground subsidence can be induced by increased ground loadings and may be exaggerated in areas of large voids or cavities, such as previous mine workings. Information regarding the extent and nature of the mining works including information from the DPI is limited and would require further review and assessment, including the undertaking of a geotechnical investigation.

Areas identified as being inadequate due to previous mine workings may be rendered suitable following the implementation of ground improvement techniques. These ground improvement techniques may include the use of geotextile or geosynthetic grids to reinforce and bridge areas affected by subsidence or local collapse. Site investigation should target areas affected by past mining activity to inform detailed design of earthworks that could intersect areas of potentially instability associated with historic mining activity. Appropriate desktop studies and site investigation complimented with detailed design of earthworks structures through areas potentially impacted by historic mining activity would result in an overall low risk to the project.

6.5.8 Geological Faults

Several geological faults are expected to traverse the project area as shown on the 1:250,000 scale geological map sheet (Figure 3). Based on locations shown on referenced map-sheets no visible surface trace could be identified during the drive through survey, however, these features may be evident in cutting excavations within the project area.

Geological hazards arising 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.

In the absence of intrusive ground investigation in the area of geological faults and on the basis that no discernible remnant surface features could be identified from drive through survey, the overall impact of such features on the project is considered to be minor. Considering the influence of geological faults can be assessed under the category of encountering unstable geological unit or erosion prone areas (Risk No. 4), the overall risk to the project is considered to be low. This residual risk rating is based on the adoption of appropriate batter slopes and surface drainage measures as part of detailed design, which in turn would be supported by ground investigations to characterise potential areas affected by geological faults. Under detailed design and better characterisation of ground potentially altered or impacted by faults as part of targeted ground investigations the initial risk under the category of unstable geological units can be reduced from medium to overall low residual risk to the project.

6.6 Key Impacts

Key impacts resulting from the risk assessment of the proposed alignment and associated construction area are:

- The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated soils resulting from historic uses along the alignment, including sheep shearing sheds and associated infrastructure such as sheep dips, the railway corridor and uncontrolled tailings from historic mining works is considered to be moderate;
- The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to contaminated material from the former Great Western landfill is considered to be major;

- Although there is considered to be an increased risk of transportation of contaminants offsite during operation in locations where the alignment does not follow the existing highway, the overall impact of this risk is considered to be insignificant;
- The impact of encountering unstable or erosion prone geological units during construction is considered to be minor;
- The impact of soft and compressible soils being encountered and construction of fill embankments or drawdown of groundwater inducing ground settlement is considered to be minor
- The impact of an imbalance in earthworks cut and fill volumes during construction is assessed as being minor;
- The overall impact during construction of the Project from the risk of sensitive receptors (human or ecological) potentially being exposed to ASS is considered to be insignificant; and
- The impact associated with encountering historical gold mining works during construction is considered to be minor.

Table 6 Soils and Geology Risk Assessment

Risk No.	Impact Pathway Description	Description of consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads *Contract Shell DC1: Design & Construct* (April 2012)).	Initial Risks			Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G1	Presence of contaminated soil and rock along alignment.	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: - Railway line intersections (Ch. 7600 and 20600) - Farm shed (Ch. 11500) - Quarry (Ch. 13600 to 14000) - Deenicull Schist (Ch. 2800 to 10000) Generation of surplus soils and rock during construction may require treatment and appropriate handling or disposal.	1) The discovery of contaminated material on the site during construction works shall be managed in accordance with VicRoads and EPA Guidelines. 2) Where putrescible waste material is encountered, the Superintendent and EPA shall be notified. Construction works along the affected area shall stop until a mitigation plan is established and agreed between the relevant project stakeholders. 3) The Contractor shall undertake a visual assessment of the Site for contaminated soils and uncontrolled waste during construction works.	Moderate	Possible	Medium	The Construction Environmental Management Plan (CEMP) is to provide details on appropriate methods for managing contaminated soils and rock. An in-situ investigation in accordance 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 or rocks are present, the results of the investigation would assist to provide appropriate soil and rock management advice including disposal recommendations.	Moderate	Rare	Low

Risk No.	Impact Pathway Description	Description of consequences	**Planned Controls to Manage Risk** (as per Project Description, and VicRoads *Contract Shell DC1: Design & Construct* (April 2012)).	Initial Risks			Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G2	Uncontained spill or leak during construction.	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: - Concongella Creek (Ch. 1600, 8350, 9100, 12300 & 15950) - Allanvale Creek (Ch. 12125) - Donald Creek (Ch. 15700) - Robinsons Creek (Ch. 16200).	Contaminated Soils and Waste Materials 1) The discovery of contaminated soils along the alignment during construction works shall be managed in accordance with VicRoads and EPA Guidelines. 2) Where putrescible waste material is encountered the Superintendent and EPA shall be notified and a management strategy established to mitigate any potential risks to immediate. 3) The Contractor shall undertake a visual assessment of the construction areas for contaminated soils and waste materials. Fuels and Chemicals 1) Environmental Management Plan (EMP) shall include specific procedures to minimise spillage of any fuels or chemicals and mitigate the effect in the event that leakages and spillages occur. 2) Fuel, chemical and equipment storage areas shall be visually monitored at intervals of not more than 7 days to mitigate contamination in a timely manner.	Moderate	Rare	Low	Additional measures would be required depending on the CEMP which would include: - Appropriate procedures for containing spills and leaks should be contained - Appropriate methods for cleaning up spills and leaks where safe to do so. If an uncontained spill or leak occurs during construction resulting in soil contamination, refer to management controls detailed in G1.	Insignificant	Rare	Negligible
G3	Runoff transports road contaminants offsite during operation.	Contamination of waterways with hydrocarbons or heavy metals. Impacts on water resources, flora, fauna, and human health, including: - Maintenance workers - General Public - Local Flora and Fauna The following potential areas may be affected: - Ch. 12050 - Ch. 12850 - Ch. 15950 - Ch. 16200.	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).	Insignificant	Possible	Negligible	Road construction should include design features to mitigate runoff of spills into waterways.	Insignificant	Unlikely	Negligible

Risk No.	Impact Pathway Description	Description of consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads *Contract Shell DC1: Design & Construct* (April 2012)).	Initial Risks			Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G4	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 potential areas may be affected: - 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).	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. 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.	Geotechnical investigations would be conducted prior to construction to assess nature of soils encountered along the alignment. Implement Erosion and Sediment Control Measures through a 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.	Moderate	Possible	Medium	Detailed design cuts and final batter slopes to appropriately reflect the local geological and geotechnical conditions. Improved surface drainage measures in the management of Erosion and Sediment Control. Ensure Erosion and Sediment Control Measures as part of CEMP makes allowance for the control of wind borne dust that may be produced as consequence of excavation of materials of sedimentary origin.	Minor	Possible	Low

Risk No.	Impact Pathway Description	Description of consequences	**Planned Controls to Manage Risk** (as per Project Description, and VicRoads *Contract Shell DC1: Design & Construct* (April 2012)).	Initial Risks: Consequence	Initial Risks: Likelihood	Initial Risks: Risk Rating	Controls Recommended to Reduce Risk	Residual Risks: Consequence	Residual Risks: Likelihood	Residual Risks: Risk Rating
G5	Soft or compressible soils are present along proposed alignment. The following locations predominantly associated with alluvial sediments are highlighted: - Ch. 7800 to 9000 - Ch. 10200 to 12600 - Ch. 14600 to 17000 - Ch. 20200 to 21000.	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: - Concongella Creek (Ch. 4400, 4500, 8250, 10550, 12150, 15400, 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.	Geotechnical investigations would be conducted prior to construction to identify and assess the nature of soft or compressible, together with recommendations for construction, which may include a staged construction approach or treatment of existing subgrade soils.	Moderate	Possible	Medium	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. 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.	Minor	Possible	Low

Risk No.	Impact Pathway Description	Description of consequences	**Planned Controls to Manage Risk** (as per Project Description, and VicRoads *Contract Shell DC1: Design & Construct* (April 2012)).	Initial Risks: Consequence	Initial Risks: Likelihood	Initial Risks: Risk Rating	Controls Recommended to Reduce Risk	Residual Risks: Consequence	Residual Risks: Likelihood	Residual Risks: Risk Rating
G6	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: - Ch. 20200 to 21000.	Imbalance of suitable cut-to-fill material during construction results in unplanned disposal of cut material off site, or sourcing of suitable additional material.	Earthworks are expected to be dominated by the need for fill above the natural surface to achieve drainage and greater 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 or disposed of in the following order of priority: 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 disposal facility.	Minor	Possible	Low	Assess likely earthworks volumes during design to optimise design solution (balance cut and fill where possible). Ground investigations and slope stability assessments should assist in assigning final earthworks batters to achieve a closer cut to fill balance. Surplus material that cannot be used on site would be re-used or disposed of in the following order of priority: 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 disposal facility.	Minor	Possible	Low

Risk No.	Impact Pathway Description	Description of consequences	**Planned Controls to Manage Risk** (as per Project Description, and VicRoads *Contract Shell DC1: Design & Construct* (April 2012)).	Initial Risks			Controls Recommended to Reduce Risk	Residual Risks		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
G7	Construction intersects Acid Sulfate Soils or pyritic rocks, potential disturbance and exposure to air.	The Project alignment option is not considered to be in a Potential Acid Sulfate Soil risk area. There is a potential the in some rocks that make up the Saint Arnaud Group are pyritic. The following potential areas may be affected: - Ch. 0 to 3 200 - Ch. 7 600 to 8 100 - Ch. 9 000 to 9 400 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).		Moderate	Rare	Low	Soils suspected of being acid sulfate soils (ASS) are to be sampled and analysed to assess the ASS potential. In the event ASS are discovered an ASS Management Plan would be prepared. 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 would be prepared.	Insignificant	Rare	Negligible

Risk No.	Impact Pathway Description	Description of consequences	Planned Controls to Manage Risk (as per Project Description, and VicRoads *Contract Shell DC1: Design & Construct* (April 2012)).	Initial Risks: Consequence	Initial Risks: Likelihood	Initial Risks: Risk Rating	Controls Recommended to Reduce Risk	Residual Risks: Consequence	Residual Risks: Likelihood	Residual Risks: Risk Rating
G8	Presence of an operational or former transfer station/landfill along the 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: - Former Great Western landfill (Ch. 1 3000 to 13 400).		Major	Almost Certain	Extreme	The uncovering of municipal rubbish and potentially prescribed waste along this particular alignment location during the construction phase would require: 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.	Major	Unlikely	Medium
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.	Geotechnical investigations and Desktop Studies would be conducted prior to design and construction to identify the extent and nature of the historic mine workings.	Moderate	Possible	Medium	Project to implement a ground improvement programme for areas identified as having shallow workings. The control measures for mine shafts and deep lead mining would depend on numerous factors such as the depths and reinstatement methods adopted after the completion of the mining works.	Minor	Possible	Low

6.7 Benefits and Opportunities

This section identifies key potential benefits or opportunities to soils and geology that the Project could provide, rates the significance of these, and outlines measures to enhance and capture these benefits.

Benefit ratings are described in Table 7.

Table 7 Benefit Ratings

Rating	Potential Project benefits
Very well	Significant benefit to the State Superior benefit to the region Policy consistency with superior positive impact
Well	Moderate benefit to the State Significant benefit to the region Superior benefit to the locality Policy consistency with significant positive impact
Moderately well	Moderate benefits to the region Significant benefit to the locality Policy consistency with moderate positive impact
Partial	Minor benefits as a local level or significant benefits for a small number of individuals
Negligible	Minimal benefit at any level

A potential benefit from the construction of the proposed alignment would be:

- A positive outcome on the protection of the environment where the proposed alignment follows the existing alignment as it may effectively manage issues relating to containment of uncontrolled spills by incorporating improved drainage, particularly at waterway crossings.

It is proposed that the waterway crossing treatments for the existing highway would typically be matched for the duplication. It is also proposed that the alignment be designed to meet the objectives for water quality described in the *Best Practise Environmental Management Guidelines (CSIRO)* and would be constructed and operated in accordance with the *VicRoads Water Sensitive Water Management Guidelines (2011)* and *VicRoads Water Sensitive Road Design Guidelines (2007.* As such, the construction of the alignment would likely lead to in an improvement in the management of surface water runoff, in particular at water way treatments, which would be considered both a 'Superior Benefit to the locality' and a 'Significant benefit to the region' from the protection of waterway from potential environmental degradation with a benefit rating of 'Well'.

Where the alignment deviates from the existing highway and comprises fill embankment constructed across generally less elevated terrain, such construction may offer the potential benefit of flood water control. The benefit of such construction is found in retarding flood waters, building up against fill embankments, and via outlet control (culverts designed for a particular storm event) offsetting the time of concentration that may be realised had the embankment not been in place. The benefit offered is in reducing overland flow energies downstream of the fill embankment and confining downstream floodwaters to pre-existing drainage lines.

7. Mitigation Measures

7.1 Construction

VicRoads would require the construction contractor to develop and implement a Construction Environmental Management Plan (CEMP) for the Project. VicRoads standard environmental protection measures and some additional Project specific controls identified below have been incorporated into the Environmental Management Framework for the Project, which is documented in the Project Environment Protection Strategy (PEPS). The PEPS is a VicRoads Document that details the environmental management arrangements for the design, construction and operation of the Project. VicRoads would require the construction contractor to incorporate all of these measures into the CEMP. Refer to Chapter 21 of the EES for further explanation of the environmental management framework and documentation proposed for the project.

VicRoads standard environmental protection measures for soils and geology that would be adopted for this Project include:

1200.08 EROSION AND SEDIMENT CONTROL

(a) *General*

All exposed surfaces shall be free of erosion.

Soil conservation measures shall include but are not limited to:

- *minimising the amount of exposed erodible surfaces during construction - this may include staging of works;*
- *installation and maintenance of erosion and sedimentation controls, established in accordance with EPA best practice guidelines for the treatment of sediment laden run-off resulting from construction activities;*
- *prompt temporary and/or permanent progressive revegetation of the Site as work proceeds;*
- *installation and maintenance of catch drains to divert and segregate water runoff from catchments outside the construction site from water exposed to the construction site and to adequately control and route runoff within the construction site to the appropriate sedimentation control installation;*
- *treatment of open drains to prevent erosion before adjacent ground is disturbed and excavation is commenced;*
- *prompt covering of exposed surfaces (including batters and stockpiles) that would otherwise remain bare for more than 28 days - cover may include mulch, erosion control mat or seeding with sterile grass;*
- *minimising the timing between clearing and stripping of the Site and covering of erodible surfaces; and*
- *where trees are required to be removed more than two months in advance of any construction works, remove only that part of the tree that is above ground level and where possible allow the roots to remain intact beneath the ground surface to assist with erosion control.*

(b) Work in/near Waters

Works shall be programmed and managed so as to avoid work in waters. Where work in waters is unavoidable, procedures shall be developed and implemented to satisfy the requirements of this Clause 1200 and as required by any permits from the responsible authority(s).

Where construction activities are undertaken in, near or over waters, Environmental Management Plan(s) shall be prepared to protect beneficial uses in accordance with any permit, the State Environment Protection Policy (Waters of Victoria), its schedules and best practice guidelines.

(c) Sedimentation Basins

Where sedimentation basins are proposed as control measures, basins shall be designed to contain flows from a rainfall event having an Average Recurrence Interval of not less than 2 years and 6 hours duration when allowing for a 30% reduction in capacity as a result of sediment accumulation.

Sedimentation basins shall be modelled and sized to manage rainfall intensities and soil characteristics specific to the region shall be used. The sizing and modelling of sedimentation basin(s) shall consider the expected works and associated area of disturbance within catchment areas(s) within the site.

The sizing and modelling of temporary sedimentation basins shall be undertaken utilising recognised 'best practice' modelling techniques or by utilising 'VicRoads Temporary Sedimentation Basin Design Tool'.

Spillways or bypass systems (installations that divert all clean surface flows around a works site) shall be designed for an event having an Average Recurrence Interval of 5 years.

An independent hydraulic consultant who has demonstrated competence and suitable experience in the design of temporary sedimentation basins, shall complete and sign a declaration in accordance with the proforma included in Appendix E2 of this specification. The declaration shall accompany submission of the sedimentation basin designs to the Superintendent.

HP[1] The Contractor shall submit to the Superintendent the temporary sedimentation designs and the associated independent verification declarations not less than 2 weeks prior to the commencement of construction of the temporary sedimentation basin.

Sedimentation basins shall be cleaned out whenever the accumulated sediment has reduced the capacity of the basin by 30 % or more, or whenever the sediment has built up to a point where it is less than 500 mm below the spillway crest, whichever occurs earlier.

The Contractor shall maintain the capacity of the sedimentation basin and shall ensure compliance with Clause 1200.04(b)(ii) if dewatering to a waterway.

(d) Stockpiles

Where soil is stockpiled on Site, such stockpiles shall be located, where possible, to provide a clearance of not less than 10 m from waters. Where it is not possible to provide a clearance of 10 m, the stockpile shall be above the normal high water level of the waters and additional protection shall be provided to prevent the stockpiled material entering the waters.

[1] Hold Point

(e) *Monitoring*

The Contractor shall monitor the whole Site for instances of soil erosion or scour and the effectiveness of erosion and sedimentation controls in accordance with the following:

- *at intervals not more than 7 days;*
- *within one hour of the commencement of any runoff resulting from rain events during working hours;*
- *every 4 hours during periods of continuous rain during working hours; and*
- *within 12 hours of a rain event outside working hours.*

Any defects and/or deficiencies in control measures identified by monitoring undertaken shall be rectified immediately and these control measures shall be cleaned, repaired and augmented as required to ensure effective control thereafter.

Additional, Project specific controls are also proposed to reduce risks to soils and geology include:

- Where the former Great Western Landfill is intersected by the proposed alignment, preliminary planning is to be performed to review opportunities and constrains associated with the relocation of the landfill. Liaison with the relevant authorities, including but not limited to, EPA, Northern Grampians Shire Council and the Wimmera Catchment Management Authority is to occur to gain appropriate approvals for relocating the landfill. Relocation of part or all of the landfill to a new cell would then be performed. The new landfill cell would be constructed in accordance with the EPA publication 788.1, Best Practice Environmental Management: siting, design, operation and rehabilitation of landfills (BPEM, 2010). Validation of soils beneath the former landfill location with any potential identified soil contamination to be managed as detailed below.
- If soils are to be reused on site, liaise with EPA to determine soil reuse options in accordance with the "State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95", (4-June-2002).
- Where contaminated soils are identified, or occur as a result of chemical spills on site, an assessment is to be undertaken in accordance with the "State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95", (4-June-2002), the "National Environment Protection (Assessment of Site Contamination) Measure", (NEPC, 1999) and the Australian Standard AS4482.1 – 2005, "Guide to the sampling and investigation of potentially contaminated soil" and the nominated beneficial uses of land as defined by the SEPP.
- Where concentrations of contaminants impact the beneficial uses identified in the SEPP as a result of contamination caused by construction or operation activities, soil remediation and groundwater contamination investigations may be required. Where remediation works are required, remediation of soil and groundwater (if required), should be completed to the extent practicable.
- Where soils exhibit indicators of AASS or PASS, a "Stage B: Detailed site soil sampling program and assessment" should be undertaken in accordance with the CASS Best Practice Guidelines (CASS BPG) (October, 2010).
- Soils to be stockpiled onsite are to be placed on plastic and covered to prevent spread of the material via transport vectors such as wind and rain. Prior to re-use or off-site disposal, stockpiled soil is to be classified in accordance with EPA Industrial Waste Resource Guideline (IWRG) 621 Soil Hazard

Categorisation and Management with frequency of sampling to be performed in accordance with EPA IWRG 702 Soil Sampling.

- Where soils are to be imported to the site (for example, for the purpose of site levelling and/or temporary construction requirements), all soils shall comply with the requirements of EPA IWRG 621 Soil Hazard Categorisation and Management (June, 2009) and meet the following minimum requirements:
  - 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; and
  - Meet the requirements of the State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95, 4-June-2002 (Land SEPP).
- Where soils exhibit susceptibility to erosion, measures required during the construction to manage short and long term soil erosion to include, but not limited to:
  - EPA Publication 480 Best Practice Environmental Management: Environmental Guidelines for Major Construction Sites; and
  - EPA Publication 275 Construction Techniques for Sediment Pollution Control.
- The design and construction should limit or prevent surface water channelization.
- Earthworks are expected to be dominated by the need for fill above the natural surface to achieve drainage and greater flood control. Fill material would be sourced from surplus materials from site, and additional sources including local quarries, and possible borrow pits under arrangement between Contractors and local land owners and with required approvals.
- Road pavement materials would be sourced from appropriately licenced facilities to meet quality requirements as per VicRoads specifications.
- Surplus material that cannot be used on site would be re-used or disposed of in the following order of priority:
  - Transfer to nearby VicRoads projects for immediate use or to an approved VicRoads stockpile site for future use;
  - Transfer to an alternative VicRoads approved site for re-use on concurrent private/local government project; or
  - Disposal at an accredited materials recycling or waste disposal facility.

7.2 Operation

Project specific controls proposed that would reduce risks to soils and geology during operation include:

- Where contaminated soils occur as a result of chemical spills on site, an assessment is to be undertaken in accordance with the Land SEPP, the National Environment Protection (Assessment of Site Contamination) Measure, NEPC 1999 and the Australian Standard, Guide to the sampling and investigation of potentially contaminated soil AS4482.1 – 2005 and the nominated beneficial uses of land as defined by the SEPP.
- Where concentrations of contaminants exceed the beneficial uses identified in the SEPP as a result of contamination caused by construction or operation activities, soil remediation and groundwater

contamination investigations may be required. Where remediation works are required, remediation of soil and groundwater (if required), should be completed to the extent practicable.

- Suspected or known contaminated soils including topsoils should be stockpiled on plastic and covered to prevent spread of the material via transport vectors such as wind and rain. Prior to re-use or off-site disposal, stockpiled soil is to be classified in accordance with EPA Industrial Waste Resource Guideline (IWRG) 621 "Soil Hazard Categorisation and Management" with frequency of sampling to be performed in accordance with EPA IWRG 702 "Soil Sampling".
- Where soils are to be imported to the site (for example, for the purpose of site levelling and/or temporary construction requirements), all soils shall comply with the requirements of EPA IWRG 621 "Soil Hazard Categorisation and Management" (June, 2009), and meet the following minimum requirements:
  - Be free of waste materials;
  - Have contaminant concentrations that will not be detrimental to the receiving environment and human health; and
  - Meet the requirements of the Land SEPP.
- All VicRoads maintenance contractors are required to develop an Environmental Management Plan (EMP) that includes specific procedures to mitigate the effect on the environment from fuels and chemicals including herbicides and pesticides. In the event of a fuel or chemical spill during operation of the Project the procedures in this EMP would be implemented. These procedures include, but are not limited to:
  - Providing readily accessible and maintained hydrocarbon spill kits to the purpose of cleaning up oil and fuel spillages on the site; and
  - Ensuring that personnel trained in the efficient deployment of the spill kits are readily available in the event of spillages.

7.3 Summary

Table 8 presents a summary of the mitigation measures that have been identified to avoid, reduce or minimise impact risk. The measures comprise both relevant requirements of the VicRoads standard environmental protection measures as well as the additional measures identified by this impact assessment. The aim to achieve the relevant EES Objectives described in Section 2.1.

Table 8 Environmental Management Measures

Risk No.	Risk Description	Management Measures	Responsibility
G1	There is a potential that contaminated soils could be encountered during construction of the Project resulting in exposure of construction works to contaminated soils.	The discovery of contaminated material on the site during construction works shall be managed in accordance with VicRoads and EPA Guidelines. Where putrescible waste material is encountered, the Superintendent and EPA shall be notified. Construction works along the affected area shall stop until a mitigation plan is established and agreed between the relevant project stakeholders. The Contractor shall undertake a visual assessment of the Site for contaminated soil and uncontrolled waste during construction works. A Construction Environmental Management Plan (CEMP) developed to provide details on appropriate methods for managing contaminated soils. 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 management advice including disposal recommendations.	VicRoads
G2	An uncontained spill or leak of chemicals occurs during construction of the Project.	Refer to management details detailed in G1 for soils that are contaminated by an uncontrolled spill or leak. 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 shall be visually monitored at intervals of not more than 7 days to mitigate contamination in a timely manner. Additional management measures may be required depending on the CEMP which would include: - Appropriate procedures for containing spills and leaks should be contained. Appropriate methods for cleaning up spills and leaks where safe to do so.	VicRoads
G3	Runoff transports road contaminants offsite during operation.	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) Road construction should include design features to mitigate runoff of spills into waterways.	VicRoads

Risk No.	Risk Description	Management Measures	Responsibility
G4	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.	Geotechnical investigations would be conducted prior to construction to assess nature of soils encountered along the alignment. 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, and control of wind-borne dust arising from excavation in materials of sedimentary origin. Detailed design cuts and final batter slopes to appropriately reflect the local geological and geotechnical conditions. Improved surface drainage measures in the management of erosion and sediment control.	VicRoads
G5	Soft or compressible soils are present along the alignment.	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. 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. Consider the identification of soft or compressible soils by using the proof 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.	VicRoads

Risk No.	Risk Description	Management Measures	Responsibility
G6	Imbalance in the volume of suitable fill and the volume of excavated material.	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: 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. Assess likely earthworks volumes during detailed design to optimise final solution in assigning safe earthworks batters (balance cut and fill where possible).	VicRoads
G7	Construction intersects Acid Sulfate Soils, potential disturbance and exposure to air	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.	VicRoads
G8	Presence of an operational or former transfer station/landfill along the alignment	The uncovering of municipal rubbish and potentially prescribed waste along this particular alignment location during the construction phase would require: 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.	VicRoads

Risk No.	Risk Description	Management Measures	Responsibility
G9	Construction intersects historic mining works, including deep lead and shallow workings.	Desktop assessment complemented 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 poorly reinstated or susceptible historical mining areas.	VicRoads

8. Conclusion

The draft EES evaluation objective relevant to the soils and geology assessment outlined in the Scoping Requirements was as follows:

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

The assessment was undertaken in accordance with the EES Scoping Requirements.

Based on the soils and geology existing conditions review and identified impacts, the potential for significant widespread contamination was considered low, however, some localised contamination may exist as a result of general farming and industrial activities.

Existing Conditions

In accordance with the land SEPP, the quality of the land environment must be maintained to maximise to the extent practicable the beneficial uses of the land environment. Therefore, the effective identification of potential sources of impact is considered important to protect human health and the environment. The potential for contamination in the Project area is generally associated with farming practices such as:

- Sheep dip sites used to treat livestock for pests,
- Application of fertilisers or other pastoral improvement substances across individual fields sub regions; and
- Filling of dams, quarries or borrow pits with contaminated soils or other wastes.

Further to the above, the following potential land uses may give rise to soil contamination;

- Railway lines;
- Uncontrolled historical mine tailings; and
- Former landfill sites such as the former Great Western Landfill.

Aerial photography shows that the majority of the project area between Ararat and Stawell has been used for farming (typically grazing and agriculture).

A scatter of bonded fragments of asbestos cement sheeting covering an area approximately 130 m^2 was observed in close proximity to the farm / shearing shed located at Ch. 11 500 during an inspection of the project area. No other evidence of contamination was observed although potential sources of contamination were identified including farm / shearing sheds and associated infrastructure and the Ballarat to Ararat rail corridor. Progressive rill erosion was noted across the numerous cuttings along the existing highway alignment.

In terms of a geological setting:

- A review of published maps providing information about the potential occurrence of ASS indicated that the project area is not within a CASS risk area;
- Published geological and soil mapsheets indicate the geology of the study area consists of Cambrian metamorphosed sediments (Deenicull Schist) and volcanic rocks (Magdala Volcanics), Cambro-

Ordovician marine sedimentary rocks, Devonian intrusive igneous rocks and unconsolidated Quaternary sediments;

- The areas between Ararat and Great Western was historically mined for gold and as such, there is a likelihood of encountering of old mine workings in the project area;
- Cambrian age metamorphic rocks may be acid sulfate and asbestiform mineral bearing; and
- Cambro-Ordovician and contacting intrusive Devonian igneous rocks were noted during site inspection to appear prone to erosion, with exposures exhibiting riling.

Positive Impacts

The positive impacts of the Project during construction as they relate to soil and geology are the protection of the environment where the proposed alignment follows the existing highway as it may effectively manage issues relating to containment of uncontrolled spills by incorporating improved drainage, particularly at waterway crossings.

Negative Impacts

The negative impacts of the Project during construction as they relate to soil and geology are:

- Taking into account land use type and the location of these in relation to the proposed construction, it is considered that there may be potential risks to human health and the environment at locations where the proposed alignment encounters likely sources of contamination, such as sheep dips, in-filled dams, quarries and borrow pits, uncontrolled historic mine tailings, former landfill operations and at locations in close proximity or intersection with the railway line;
- The proposed alignment intersects the former Great Western landfill site. Appropriate planning and stakeholder liaison would be required to relocate part of the landfill to a new landfill cell constructed in accordance with the relevant guidelines; and
- Considering the variable geological units likely to be encountered along the alignment, environmental risks associated with unstable and compressible geological units, soil erosion, and imbalance in cut and fill volumes are likely to be encountered, however, with detailed site investigation, appropriate design and control measures these risks would be effectively managed to acceptable levels of impact.

Notwithstanding, all of the adverse impacts identified in the course of this assessment can be efficiently managed and mitigated through the implementing of the measures outlined in Section 7 of this report.

9. References

Birch, W.D. (eds.) 2003, *Geology of Victoria*, Geological Society of Australia Special Publication 23, Geological Society of Australia

Department of Sustainability and Environment*, Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils*, October 2010.

Douglas, J.G.& Ferguson, J.A. 1988, *Geology of Victoria*, Victorian Division Geological Survey of Australia Incorporated, Melbourne

Environment Protection Authority, 1970: Environmental Protection Act. Act No. 8056/1970.

Environment Protection Authority, 2002: State Environmental Protection Policy (Prevention and Management of Contamination of Land). Victorian Government Gazette No. S 95.

EPA Victoria 2010. Best Practise Environmental Management, Siting, Design, Operation and Rehabilitation of Landfills. Publication 778.1 September 2010

EPA Victoria 1996. *Best Practice Environmental Management: Environmental Guidelines for Major Construction Sites.* Publication 480 February 1996

EPA Victoria 1991. Construction Techniques for Sediment Pollution Control. Publication 275 May 1991.

EPA Victoria 2009. Soil Hazard Categorisation and Management. Publication IWRG 621 June 2009.

EPA Victoria 2009. Soil Sampling. Publication IWRG 702 June 2009.

Geological Survey of Victoria 1997, Ballarat 1:250 000 Geological Series, SJ 54-8; Geological Survey of Victoria, Victoria

Geological Survey of Victoria 2000, Stawell 1:50 000 Geological Series, 7423-1 Zone 54 and part of Callawadda 7424-2 Zone 54; Geological Survey of Victoria, Victoria

Golder Associates 2011*, Former Great Western Landfill – Management of Environmental Risks Related to Road Construction*, Great Western, VIC.

King, R.L. 1986, *Explanatory Notes on the Ballarat 1: 250 000 Geological Map*, Department of Minerals and Energy, Geological Survey of Victoria

McKenzie, N.J.; Jacquier, D.W.; Ashton, L.J.; Cresswell, H.P. 2000, *Estimation of Soil Properties Using the Atlas of Australian Soils (Technical Report 11/00)*, CSIRO Land and Water, Canberra

NEPC, 1999. National Environment Protection (Assessment of Site Contamination) Measure (NEPM). National Environment Protection Council.

Northcote, K. H.; with Beckmann, G. G.; Bettenay, E.; Churchward, H. M.; Van Dijk, D. C.; Dimmock, G. M.; Hubble, G. D.; Isbell, R. F.; McArthur, W. M.; Murtha, G. G.; Nicolls, K. D.; Paton, T. R.; Thompson, C. H.; Webb, A. A.; Wright, M. J. 1960-1968, *Atlas of Australian Soils*, Sheets 1 to 10 (with explanatory data); CSIRO Aust. and Melbourne University Press, Melbourne

Standards Australia, 2005. Australian Standard, Guide to the investigation and sampling of sites with potentially contaminated soil. AS4482.1 - 2005.

VicRoads 2010, *Western Highway Project Bypass of Great Western Geotechnical Assessment of Sand/Gravel Pits*.

VicRoads August 2011, *VicRoads Integrated Water Management Guidelines*, Melbourne: VicRoads

VicRoads April 2012, *Contract Shell DC1: Design & Construct, Section 1200 Environment Protection,* Melbourne.

Victorian Catchment Management Council 1994, *Catchment and Land Protection Act. Act No. 52/1994*

Appendix A

Historic Boreholes

GEDIS

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	56268
Parish Name:	CONCONGELLA 1
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	Drought
Status:	
Other Names:	Location of bore: DIAHLO RD GT WESTERN
	Drilling Rig Borehole Name: 28/67/000
	Rural Water Comm Borehole Name: 056268

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	665791	5885537	54	37.16188	142.86719	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Great Western(7423.1.3) 1:25000
Orientation/Depth:	Measured Depth: 17.374 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Dept. Manufacturing & Industry
Regulation:	Regulation Unknown
Operator:	Department of Manufacturing & Industry Development, Victoria
Contractor:	Unknown (or Not Specified)
Completed On:	06/11/1967
Child Borehole Details:	None Recorded

Contact : Selected core is available for inspection at Werribee, Contact

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Available Data

Attributes		Links		External Data	
Core Samples:	1	Tenements:		Aquifer:	1967
Lithology Log:	2	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	3	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				

Attributes	Links	External Data
Downhole Survey: 0		

Borehole Project Details

Project Code	Project Description
CORE	Core record
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

Core Samples

From	To	Orig	Type	Recovery	Location	Trays	Bay	From Row	To Row
0.0 m	17.374 m	F	Cuttings	Unknown	CORE	2	040	E	E

Lithological Logs

Drillers Log created by UNKNOWN on November 6, 1967

From	To	Comments
0.0	5.8	SOIL CLAY
5.8	14.0	CLAY GRAVEL
14.0	17.37	GRANITE DECOMPOSED

Geologists Log created by UNKNOWN on December 31, 1967

From	To	Comments
0.0	0.31	SURFACE LOAM
0.31	1.22	DARK BROWN CLAY
1.22	1.83	LIGHT BROWN CLAY
1.83	2.74	BROWN AND GREY CLAY
2.74	5.79	BROWN CLAY STONE AND MARL
5.79	7.01	BROWN AND GREY CLAY AND QUARTZ STONE, A LITTLE WATER
7.01	8.84	BROWN GRANITE AND CLAY
8.84	9.75	BROWN AND GREY CLAY WITH GRAVEL
9.75	14.02	GREENISH GREY CLAY
14.02	17.37	DECOMPOSED GRANITE WATER STRUCK AT 19 FEET, STANDING AT 9 FEET

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	56269
Parish Name:	CONCONGELLA 2
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	Drought
Status:	
Other Names:	Location of bore: DIAHLO RD GT WESTERN
	Drilling Rig Borehole Name: 28/67/000
	Rural Water Comm Borehole Name: 056269

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	665791	5885168	54	37.1652	142.86726	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Great Western(7423.1.3) 1:25000
Orientation/Depth:	Measured Depth: 15.24 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Dept. Manufacturing & Industry
Regulation:	Regulation Unknown
Operator:	Department of Manufacturing & Industry Development, Victoria
Contractor:	Unknown (or Not Specified)
Completed On:	09/11/1967
Child Borehole Details:	None Recorded

Contact : Selected core is available for inspection at Werribee, Contact
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Available Data

Attributes		Links		External Data	
Core Samples:	1	Tenements:		Aquifer:	1967
Lithology Log:	2	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	3	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				

Attributes	Links	External Data
Downhole Survey: 0		

Borehole Project Details

Project Code	Project Description
CORE	Core record
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

Core Samples

From	To	Orig	Type	Recovery	Location	Trays	Bay	From Row	To Row
0.0 m	15.24 m	F	Cuttings	Unknown	CORE	1	040	E	E

Lithological Logs

Drillers Log created by UNKNOWN on November 9, 1967

From	To	Comments
0.0	8.8	CLAY
8.8	11.0	GRAVEL
11.0	15.24	GRANITE DECOMPOSED

Geologists Log created by UNKNOWN on December 31, 1967

From	To	Comments
0.0	0.61	DARK BROWN CLAY
0.61	1.52	BROWN AND GREY CLAY
1.52	2.44	DARK BROWN CLAY
2.44	3.66	LIGHT BROWN CLAY
3.66	4.57	BROWN AND GREY CLAY
4.57	6.71	BROWN AND GREY CLAY AND STONE
6.71	8.84	GREY AND YELLOW CLAY
8.84	10.97	BROWN GRAVEL
10.97	15.24	DECOMPOSED GRANITE WATER STRUCK AT 15 FEET,STANDING AT 12 FEET

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	56275							
Parish Name:	CONCONGELLA 10001							
Purpose:	Groundwater							
Sub Purpose:								
Method:								
Usage:	Domestic & Stock water supply							
Status:	Abandoned							
Other Names:	Rural Water Comm Borehole Name: 056275							
Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	662418	5888918	54	37.13201	142.82848	300.0 m	Digitised metric
Location Check:								
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown							
Maps	Great Western(7423.1.3) 1:25000							
Orientation/Depth:	Measured Depth: 6.09 m Collar Inclination: Unknown Collar Azimuth: Unknown							
Authority:	Rural Water Commission							
Regulation:	Groundwater Act							
Operator:	Private Individual/Corporation							
Contractor:	Unknown (or Not Specified)							
Completed On:	28/08/1971							
Child Borehole Details:	None Recorded							

Contact : Selected core is available for inspection at Werribee, Contact

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Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	0
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	2	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				
Downhole Survey:	0				

Borehole Project Details

Project Code	Project Description
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

No Borehole Core Samples Recorded

Lithological Logs

Drillers Log created by UNKNOWN on January 28, 1971

From	To	Comments
0.0	0.91	SURFACE SOIL
0.91	3.04	WHITE SANDY CLAY
3.04	6.09	WHITE CLAY (ABANDONED)

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	56276
Parish Name:	CONCONGELLA 10002
Purpose:	Groundwater
Sub Purpose:	
Method:	
Usage:	Stock/Poultry water supply
Status:	Abandoned
Other Names:	Rural Water Comm Borehole Name: 056276

Location:

Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
GDA94	666338	5886222	54	37.15561	142.87318	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Great Western(7423.1.3) 1:25000
Orientation/Depth:	Measured Depth: 30.48 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Rural Water Commission
Regulation:	Groundwater Act
Operator:	Private Individual/Corporation
Contractor:	Unknown (or Not Specified)
Completed On:	15/10/1976
Child Borehole Details:	None Recorded

Contact : Selected core is available for inspection at Werribee, Contact

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Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	0
Lithology Log:	1	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	2	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				
Downhole Survey:	0				

Borehole Project Details

Project Code	Project Description
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

No Borehole Core Samples Recorded

Lithological Logs

Drillers Log created by UNKNOWN on October 11, 1976

From	To	Comments
0.0	0.61	TOPSOIL
0.61	7.62	CEMENTED SAND
7.62	22.84	CLAY GRAVEL (DRY)
22.84	30.48	GREY CLAY (ABANDONED)

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

GEDIS Borehole System

Borehole Details

Borehole Summary Information

Site ID:	56280
Parish Name:	CONCONGELLA SOUTH 1
Purpose:	Groundwater
Sub Purpose:	
Method:	Percussion (cable)
Usage:	Drought
Status:	
Other Names:	Location of bore: DIAHLO RD GT WESTERN
	Drilling Rig Borehole Name: 28/67/000
	Rural Water Comm Borehole Name: 056280

Location:	Datum	MGAEm	MGANm	MGA Zone	Latitude	Longitude	+/-	Method
	GDA94	665765	5884648	54	37.16989	142.86708	300.0 m	Digitised metric

Location Check:	
Elevation:	-999.0 m Kelly Bush: Unknown Elevation Acc: Unknown
Maps	Great Western(7423.1.3) 1:25000
Orientation/Depth:	Measured Depth: 18.29 m Collar Inclination: Unknown Collar Azimuth: Unknown
Authority:	Dept. Manufacturing & Industry
Regulation:	Regulation Unknown
Operator:	Department of Manufacturing & Industry Development, Victoria
Contractor:	Unknown (or Not Specified)
Completed On:	14/11/1967
Child Borehole Details:	None Recorded

Contact : Selected core is available for inspection at Werribee, Contact

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Available Data

Attributes		Links		External Data	
Core Samples:	0	Tenements:		Aquifer:	0
Lithology Log:	2	References:		Construction:	0
Qualitative Log:	0	Surveys:		Water Chem:	0
Quantitative Log:	0	Projects:	2	Water Level:	0
Strat Log:	0	Notes:		Pump Test:	0
Biostratigraphy:	0	Petroleum Well:	0		
Geophys Logs:	0	Petroleum Casing:	0		
Temp Samples:	0				
Collar Data:	0				

Attributes	Links	External Data
Downhole Survey: 0		

Borehole Project Details

Project Code	Project Description
LITHO	Lithological Logs
TEMP	Temporary marker

No Borehole Notes Recorded

No Borehole References Recorded

No Borehole Core Samples Recorded

Lithological Logs

Drillers Log created by UNKNOWN on November 14, 1967

From	To	Comments
0.0	4.9	CLAY
4.9	15.2	CLAY GRAVEL
15.2	18.29	GRANITE DECOMPOSED

Geologists Log created by UNKNOWN on December 31, 1967

From	To	Comments
0.0	0.31	DARK LOAM
0.31	1.22	DARK BROWN CLAY
1.22	1.52	LIGHT BROWN CLAY
1.52	2.74	BROWN AND GREY CLAY
2.74	3.96	BROWN CLAY
3.96	4.88	GREY CLAY
4.88	7.62	GREY CLAY AND GRAVEL (WATER)
7.62	10.36	COARSE YELLOW GRAVEL
10.36	14.02	COARSE BROWN GRAVEL
14.02	15.24	YELLOW CLAY
15.24	18.29	DECOMPOSED GRANITE WATER STRUCK AT 16 FEET,STANDING AT 11 FEET

No Borehole Quantitative Logs Recorded

No Borehole Qualitative Logs Recorded

No Borehole Stratigraphic logs Recorded

No Borehole Biostratigraphy Recorded

No Borehole Geophysical Header Logs Recorded

No Borehole Geophysical Data Logs Recorded

No Geothermal Information Recorded

No Down Hole Survey Information Recorded

No Collar Information Recorded

Appendix B

Historic Aerial Photographs

Review

Western Highway Duplication- Stage 3 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo*	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1947	P: 897/6 F: 669 R: 12 Ph: 150	4723	High density vegetation	Present along road reserve	Predominantly vacant fields. Isolated areas of low medium and high density vegetation. Large areas of dense vegetation to the south west of the study area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Farming /Agriculture / Rail Corridor
	P: 897/6 F: 669 R 12 Ph: 150	4748	Medium density vegetation	Directly on the buffer		
	P: 897/6 F: 669 R 12 Ph: 149	47127	Dam	Next to 1A, on the 1B side		
	P: 897/6 F: 673 R 7 Ph: 75	4700	Dam	In between 1A and buffer		
	P: 897/6 F: 670 R 10 Ph: 103	47129	Dam	Next to buffer		
	P: 897/6 F: 669 R: 12 Ph: 151	4745	Dam	In between 1B and 1A		
	P: 897/6 F: 670 R 10 Ph: 103	4755	Medium density vegetation	Intersecting 1E and buffer		
	P: 897/6 F: 669 R: 12 Ph: 151	4744	Medium density vegetation	Intersecting 1D		
	P: 897/6 F: 670 R 10 Ph: 103	4789	Dam	In between 1A and buffer		
	P: 897/6 F: 669 R: 12 Ph: 150	4735	Medium density vegetation	Present along road reserve		
	P: 897/6 F: 670 R: 11 Ph: 14	4739	High density vegetation	Between alignments 1A and 1B		
	P: 897/6 F: 669 R: 12 Ph: 149,150,151	4719	High density vegetation	High density vegetation present along alignments at time of earliest photo (1947) and at time of most recent photo (base map)		
	P: 897/6 F: 669 R 12 Ph: 151	4765	Dam	In between 1B and 1D		
	P: 897/6 F: 669 R: 12 Ph: 150	4726	High density vegetation	Present along rail reserve		
	P: 897/6 F: 669 R: 12 Ph: 151	474754	Medium density vegetation	Running along 1D and 1B. Extending out past the buffer		
	P: 897/6 F: 670 R 11 Ph: 14	4753	Medium density vegetation	Running along 1D		
	P: 897/6 F: 670 R 10 Ph: 101	4766	Dam	In between 1A and buffer		
	P: 897/6 F: 669 R 12 Ph: 151	4738	Dam	northwest of the junction of 1B and 1D		
	P: 897/6 F: 670 R: 11 Ph: 14	4738	High density vegetation	Present along rail reserve		
	P: 897/6 F: 669 R: 12 Ph: 150	4732	Medium density vegetation	present along rail reserve		
	P: 897/6 F: 669 R 12 Ph: 149	47126	Dam	Next to 1A, on the 1B side		
	P: 897/6 F: 672 R 9 Ph: 112	4769	Medium density vegetation	In between 1A and 1B		
	P: 897/6 F: 669 R: 12 Ph: 150	4728	Medium density vegetation	Present along rail reserve		
	P: 897/6 F: 669 R 12 Ph: 151	4739	Dam	On buffer perimeter, west of alignment 1A		
	P: 897/6 F: 669 R: 12 Ph: 150	4731	Medium density vegetation	Present along rail reserve		
	P: 897/6 F: 669 R 12 Ph: 150	4747	Dam	In between 1A and 200 m buffer		

Western Highway Duplication- Stage 3 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	**Associated Photo**	**Arcmap GHD ID:**	**Category**	**Study Area**	**Surrounding Area**	**Description/Justification**
1947 continued	P: 897/6 F: 669 R: 12 Ph: 149,150,151	4715	High density vegetation	High density vegetation present along alignments at time of earliest photo (1947) and at time of most recent photo (base map)	Predominantly vacant fields. Isolated areas of low medium and high density vegetation. Large areas of dense vegetation to the south west of the study area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Farming /Agriculture / Rail Corridor
	P: 897/6 F: 670 R 11 Ph: 14	4764	Dam	In between 1D and buffer		
	P: 897/6 F: 670 R: 10 Ph: 101	4743	Medium density vegetation	Along western perimeter of buffer		
	P: 897/6 F: 670 R 10 Ph: 103	4761	Grazing land	Intersecting western buffer and 1A/1E		
	P: 897/6 F: 670 R: 10 Ph: 101	4742	Medium density vegetation	Along alignment 1B		
	P: 897/6 F: 669 R 12 Ph: 151	4746	Medium density vegetation	Running north through 1D and buffer		
	P: 897/6 F: 669 R: 12 Ph: 149,150,151	4721	Medium density vegetation	Medium density vegetation present along alignments at time of earliest photo (1947)		
	P: 897/6 F: 670 R 10 Ph: 103	4758	Grazing land	Intersecting the western buffer zone		
	P: 897/6 F: 669 R 12 Ph: 151	4741	Low density vegetation	Intersecting the alignment 1D and the buffer		
	P: 897/6 F: 669 R 12 Ph: 151	4742	Low density vegetation	Adjacent to alignment 1A		
	P: 897/6 F: 670 R 11 Ph: 14	4763	Dam	In between 1A and buffer		
	P: 897/6 F: 670 R 10 Ph: 103	4760	Grazing land	In between 1A and 1B		
	P: 897/6 F: 669 R 12 Ph: 149	47128	Dam	Intersecting 1D		
	P: 897/6 F: 670 R 11 Ph: 14	4785	Dam	In between 1A and buffer. Next to Garden Gully		
	P: 897/6 F: 670 R 11 Ph: 12	4750	Dam	500 m east of buffer		
	P: 897/6 F: 669 R: 12 Ph: 150	4724	High density vegetation	Present along rail reserve		
	P: 897/6 F: 670 R 11 Ph: 14	4787	Dam	In between 1A and buffer. South of Garden Gully		
	P: 897/6 F: 669 R: 12 Ph: 149,150,151	4718	High density vegetation	High density vegetation present along alignments at time of earliest photo (1947) and at time of most recent photo (base map)		
	P: 897/6 F: 670 R 11 Ph: 14	4762	Dam	In between 1E and 1B		
	P: 897/6 F: 670 R 11 Ph: 14	4754	Medium density vegetation	Running east from 1D through the buffer		
	P: 897/6 F: 670 R 11 Ph: 12	4751	Dam	In between buffer and 1D		
	P: 897/6 F: 670 R 10 Ph: 103	4759	Grazing land	Intersecting 1A and 1E		
	P: 897/6 F: 670 R 11 Ph: 14	4786	Dam	In between 1A and buffer. Next to Garden Gully		
	P: 897/6 F: 669 R: 12 Ph: 151	4743	Crops	In between 1B and 1D		
	P: 897/6 R: 12 Ph: 149,150,151	12	Dam	Located between alignment option 1B and 1D		
	P: 897/6 R: 12 Ph: 149,150,151	13	Building	Located between alignments 1A and 1B. May not be a building- difficult to tell due to image quality		
	P: 897/6 R: 12 Ph: 149,150,151	14	Dam	Located between alignments 1A and 1B		
	P: 897/6 R: 12 Ph: 149,150,151	15	Dam	Located directly on alignment 1D		

Western Highway Duplication- Stage 3 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	Associated Photo	Arcmap GHD ID:	Category	Study Area	Surrounding Area	Description/Justification
1947 continued	P: 897/6 F: 670 R:11 Ph: 14	16	Dam	Between alignments 1A and 1B	Predominantly vacant fields. Isolated areas of low medium and high density vegetation. Large areas of dense vegetation to the south west of the study area. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Farming /Agriculture / Rail Corridor
	P: 897/6 F: 670 R:11 Ph: 14	17	Dam	Within buffer to the east of alignment 1D		
	P: 897/6 Film: 670 :11 Ph: 14	18	Dam	Outside buffer to the east of alignment option 1D		
	P: 897/6 F: 670 R:11 Ph: 14	19	Dam	Adjacent to alignment 1A		
	P: 897/6 F: 670 R:11 Ph: 14	20	Dam	Adjacent to alignment 1D (to the east)		
	P: 897/6 F: 670 R:11 Ph: 14	21	Dam	Inside buffer west of alignment 1A		
	P: 897/6 F: 670 R:11 Ph: 14	22	Dam	Inside buffer west of alignment 1A		
	P: 897/6 F: 670 R:11 Ph: 14	23	Dam	Inside buffer, just east of west buffer perimeter		
	P: 897/6 F: 670 R:11 Ph: 14	24	Dam	West of buffer perimeter(outside buffer)		
	P: 897/6 F: 670 R:11 Ph: 14	25	Building	West of buffer perimeter(outside buffer)		
	P: 897/6 F: 670 R:11 Ph: 14	26	Building	West of buffer perimeter(outside buffer)		
	P: 897/6 F: 670 R:11 Ph: 14	27	Building	West of buffer perimeter(outside buffer)		
	P: 897/6 F: 670 R:11 Ph: 14	28	Building	West of buffer perimeter(outside buffer)		
	P: 897/6 F: 670 R:11 Ph: 14	29	Building	On buffer perimeter west of alignment 1A		
	P: 897/6 F: 670 R:11 Ph: 14	30	Building	Between alignment 1A and 1B		
	P: 897/6 F: 670 R:11 Ph: 14	31	Building	Adjacent to the east side of alignment 1A		
	P: 897/6 F: 670 R: 10 Ph: 101	32	Dam	Adjacent to alignment 1A		
	P: 897/6 F: 669 R 12 Ph: 151	45	Dam	~ east of investigation area		
	P: 897/6 F: 669 R 12 Ph: 151	46	Dam	~ east of the 200 m buffer		
	P: 897/6 F: 670 R 11 Ph: 12	Z147	General farming prop	Adjacent to eastern line		
	P: 897/6 F: 670 R 11 Ph: 103	Z248	Dam	25 outside of buffer		
1966	P: 550 F: 1911 R: 41 Ph: 8	6621	Dam	In between 1B and 1D	Additional dams and properties around military bypass road. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Farming /Agriculture / Rail Corridor
	P: 550 F: 1911 R: 41 Ph: 7	6622	Dam	Intersecting 1D		
1967	P: 602 F: 1571 R: 44 Ph: 33	6730	Building	In between 1D and buffer		
	P: 602 F: 1571 R: 44 Ph: 38	6742	Dam	Intersecting 1A		
	P: 602 F: 1571 R: 44 Ph: 35	6739	Dam	In between 1D and buffer		
	P: 602 F: 1571 R: 44 Ph: 35	6736	Building	In between 1E and buffer		
	P: 602 F: 1571 R: 46 Ph: 58	6759	Dam	Near Bowtells Rd		
	P: 602 F: 1571 R: 44 Ph: 33	6732	Building	Intersecting 1B		
	P: 602 F: 1571 R: 44 Ph: 33	6729	Building	In between 1D and buffer		
	P: 602 F: 1571 R: 44 Ph: 32	6723	Building	In between 1E and buffer		
	P: 602 F: 1571 R: 44 Ph: 33	6728	Building	In between 1D and buffer		

Western Highway Duplication- Stage 3 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	*Associated Photo*	*Arcmap GHD ID:*	*Category*	*Study Area*	*Surrounding Area*	*Description/Justification*
1967 continued	P: 602 F: 1571 R: 46 Ph: 58	6781	Dam	Next to 1A and 1E	Additional dams and properties around military bypass road. The study area follows the alignment of the Melbourne to Adelaide rail corridor.	Farming /Agriculture / Rail Corridor
	P: 602 F: 1571 R: 46 Ph: 58	6781	Building	Near Main St and Tomlinson St		
	P: 602 F: 1571 R: 44 Ph: 35	6737	Dam	In between 1B and the Western Hwy		
	P: 602 F: 1571 R: 44 Ph: 37	6740	Dam	In between 1A and buffer		
	P: 602 F: 1571 R: 44 Ph: 33	6731	Dam	Intersecting 1B		
	P: 602 F: 1571 R: 44 Ph: 33	6726	Building	In between 1E and buffer		
	P: 602 F: 1571 R: 44 Ph: 35	6735	Dam	In between 1E and buffer		
	P: 602 F: 1571 R: 44 Ph: 33	6733	Dam	In between 1E and 1B, near Thomas Rd		
	P: 602 F: 1571 R: 44 Ph: 33	6725	Earthworks	In between 1D and the buffer		
	P: 602 F: 1571 R: 45 Ph: 45	6782	Building	Between 1A and 1B		
	P: 602 F: 1571 R: 44 Ph: 38	6743	Building	In between 1B and 1A		
	P: 602 F: 1571 R: 44 Ph: 38	6741	Dam	In between 1A and buffer, near Kimbarra Rd		
	P: 602 F: 1571 R: 44 Ph: 33	6734	Building	In between 1E and buffer		
	P: 602 F: 1571 R: 44 Ph: 35	6738	Crops	In between 1D and buffer		
	P: 602 F: 1571 R: 44 Ph: 33	6724	Dam	In between 1D and the buffer		
	P: 602 F: 1571 R: 44 Ph: 33	6727	Building	In between 1B and 1D		
	P: 602 F: 1571 R: 44 Ph: 35	21	Dam	Dam no longer present- Potential for fill 1947 ID: 87		
	P: 602 F: 1571 R: 44 Ph: 37	22	Dam	Dam no longer present- Potential for fill 1947 ID: 89		
1972	P: 7423N F: 2666 R: 07 Ph: 104	7203	Dam	Intersecting 1A and 1E	No major changes observed * No photograph available for military bypass Road area	Farming /Agriculture / Rail Corridor
	P: 907 F: 2478 R: 03 Ph: 152	7202	Crops	Between 1B and 1D		
	P: 907 F: 2478 R: 02 Ph: 161	7201	Dam	Intersecting the buffer		
1980	P: 7423 F: 3463 R: 06 Ph: 210	8001	Crops	Running alongside 1A, next to 1B. Previous crops and house appear to be gone.	No major changes observed	Farming /Agriculture / Rail Corridor
	P: 7423 F: 3463 R: 07 Ph: 153	8003	Dam	~160 m east of new west alignment just south of Garden Gully Rd		
	P: 7423 F: 3463 R: 06 Ph: 210	8004	Dam	Adjacent to rail line between 1B and 1A (~100 m from each) south Kimbarra Rd		
	P: 7423 F: 3463 R: 07 Ph: 151	8002	Crops	On alignment 1A north of Ararat		
1986	P: 1862 F: R: 4041 03 Ph: 157	8600	General farming property	On new eastern alignment southeast of Great Western (adjacent crops (poly ID:: 1947 71, 73)	No major changes observed	Farming /Agriculture / Rail Corridor
	P:7423 F: 4063 R: 07 Ph:138	8602	Dam	On western alignment		
	P: 1861 F: R: 4041 03 Ph: 84	8614	Other	Dry creek bed on western alignment north of Ararat		

Western Highway Duplication- Stage 3 Zone 1

Photo Details		Site Description				Potential Areas of Concern
Year	**Associated Photo**	**Arcmap GHD ID:**	**Category**	**Study Area**	**Surrounding Area**	**Description/Justification**
1986 continued	P:7423 F: 4063 R: 07 Ph:138	8604	Dam	ON eastern alignment	No major changes observed	Farming /Agriculture / Rail Corridor
	P:7423 F: 4063 R: 07 Ph:138	8605	Dam	ON 1B		
	P: 1861 F: R: 4041 03 Ph: 80	8613	Dam	Adjacent to western alignment north of Ararat		
	P: 1861 F: R: 4041 03 Ph: 78	8612	Dam	Adjacent to western alignment north of Ararat		
	P: 7423 F: 4063 R: 08 Ph: 104	8618	Dam	On alignment 1B just south of The Majors Rd		
	P:7423 F: 4063 R: 07 Ph:138	8601	Crops	Southwest of now western alignment		
	P:7423 F: 4063 R: 07 Ph:138	8603	Dam	~30 m SW of western new alignment North Ararat		
	P:7423 F: 4063 R: 07 Ph:138	2	Dam	~70 m west of western alignment		
	P:7423 F: 4063 R: 07 Ph:138	1	Dam	East eastern alignment north of Ararat		
2009	Arcmap Base map- VIC Roads		Rural Residential	2 new residential properties at start of zone 1- 1 East of 1C and 1 between 1AB and 1C	Increased clearing of vegetation between 1AB and Rail line. Increase in residential properties, buildings and crops	Farming /Agriculture / Rail Corridor
	Arcmap Base map- VIC Roads		Crops	Small area- possible grape vines- E of highway at Petticoat Gully Road		
	Arcmap Base map- VIC Roads		Rural Residential	House west of 1AB south of Thomas Road		
	Arcmap Base map- VIC Roads		Dam	~ E of 1AB at highway/rail crossing		
	Arcmap Base map- VIC Roads		Dam	~ west of 1C		
	Arcmap Base map- VIC Roads		Dam	On 1C north of Mckays Woodshed Road		

*Note: P = Project, F = Film, R = Run, Ph = Photo

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