Geotechnical Desktop Assessment

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Melbourne Water

Silvan High Security Fence
7 February 2024

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Appendices

1. Introduction

1.1 Background

Jacobs has been engaged by Melbourne Water to undertake a geotechnical desktop assessment as part of the Functional Investigations stage for the Silvan High Security Fence replacement works. The project involves the replacement of approximately 15 km of the currently inadequate peripheral fencing surrounding the reservoir and catchment located in Silvan, approximately 40 km east of Melbourne Central Business District (CBD).

Melbourne Water's water and sewage assets are an important part of Australia's critical infrastructure under the Security of Critical Infrastructure Act 2018 (SOCI Act). Currently Silvan Reservoir has been graded as a Category 2 catchment, and is required to be a Category 1 'Protected' catchment status as Melbourne Water's most valued drinking water asset which supplies over 70% of Melbourne's drinking water. Drinking water is currently supplied from Silvan reservoir with chlorine disinfection as the only treatment.

The key objective of the Silvan High Security Fence Functional Investigations is to provide the necessary design and approvals to enable Melbourne Water to issue the project to a specialist contractor for Design and Construction (D&C) of the new fence infrastructure works.

1.2 Objectives and Scope

The purpose of this geotechnical desktop assessment is to assess the likely ground conditions across the study area and identify potential design and construction hazards and constraints. The specific scope of this assessment includes:

- Summary of available published factual data and existing reports to assess local geological setting and anticipated ground conditions in the project area, including likely soil and rock types, depth to rock, depth to groundwater (based on information available to both Jacobs, Melbourne Water and accessible within the public domain).
- Identify any significant gaps within the available information.
- A site walkover conducted by an experienced engineering geologist with a focus on visual identification of geotechnical features and hazards, topography and any other potential constrains which may influence the project.
- Provide commentary on potential geotechnical hazards and impacts of constraints to design and construction posed by likely ground and groundwater conditions within the project area.
- Provide recommendations and rationale for further geotechnical site investigations to facilitate design development.

No searches of the existing buried or overhead utilities/services infrastructure have been undertaken as part of this assessment work.

This report should also be read in conjunction with the separate Jacobs Preliminary Contaminated Land Desktop Assessment (IA5000PB-0000-EV-RPT-0001, 2023) that includes the relevant Lotsearch™ report (LS049167) for the project area, from which other applicable and site-specific publicly available data has been referenced.

1.3 Proposed Project Works

Jacobs understands the current works required for the Silvan High Security Fencing replacement comprise the works outlined below:

- Construction of a new 15 km high security fencing (Category 3) surrounding the Silvan Reservoir and catchment area; existing chainlink fence to be removed.
- Category 3 Fence minimum requirements and specification are as follows:
  - Equipped with Perimeter Intrusion Detection System (PIDS)
  - 358-wire mesh fencing (or equivalent)
  - Minimum height of 3 m with anti-climb and anti-critter functionality
  - Founded on concrete pier or pad footing with anti-dig functionality
- Potential construction of access tracks along lengths of the alignment, and access tracks to the corridor from adjacent public roads.
- Construction of foundations comprising piers socketed within soil or rock, and/or shallow pad footing foundations.

The eastern half of the fence alignment runs adjacent to Monbulk Road, a key local arterial road that provides access to numerous local residents, businesses and bicycle traffic. The western half of the alignment passes through a heavily forested and severe topographical environment.

Depending upon the constructability, permits/approvals and other relevant constraints, it is envisaged that the proposed fence is likely to be staged as follows:

- Stage 1: Eastern side of the reservoir between the northern and southern dam walls;
- Stage 2: Western side of the reservoir between the northern and southern dam walls

A project alignment plan and feature survey were supplied by Melbourne Water and are included in Appendix A (SVY210088-20303-S210-D001 to D019, by Taylors 2023).

2. Site Setting

2.1 Site Description

The Silvan Reservoir site is located approximately 40-45 km east of the Melbourne CBD in proximity to the suburbs of Silvan and Monbulk within the Yarra Ranges. It was constructed between 1926 and 1931 and is approximately 644m long, 219m wide and about 43m deep with walls at the north and south.

The existing and proposed security fence line runs adjacent to Monbulk Road along the eastern extent and is aligned predominately along a walking trail along the western extent. The two sides converge at Silvan Reservoir Park in the north. The western site extents are heavily vegetated and has fluctuating topography typical of the wider catchment area, with the existing fence line following the natural ridgelines and gullies.

Figure 2-1 below shows the approximate alignment of the existing security fencing whilst a detailed plan view is presented in Appendix A that illustrates key utilities and infrastructure both within and surrounding the project area.

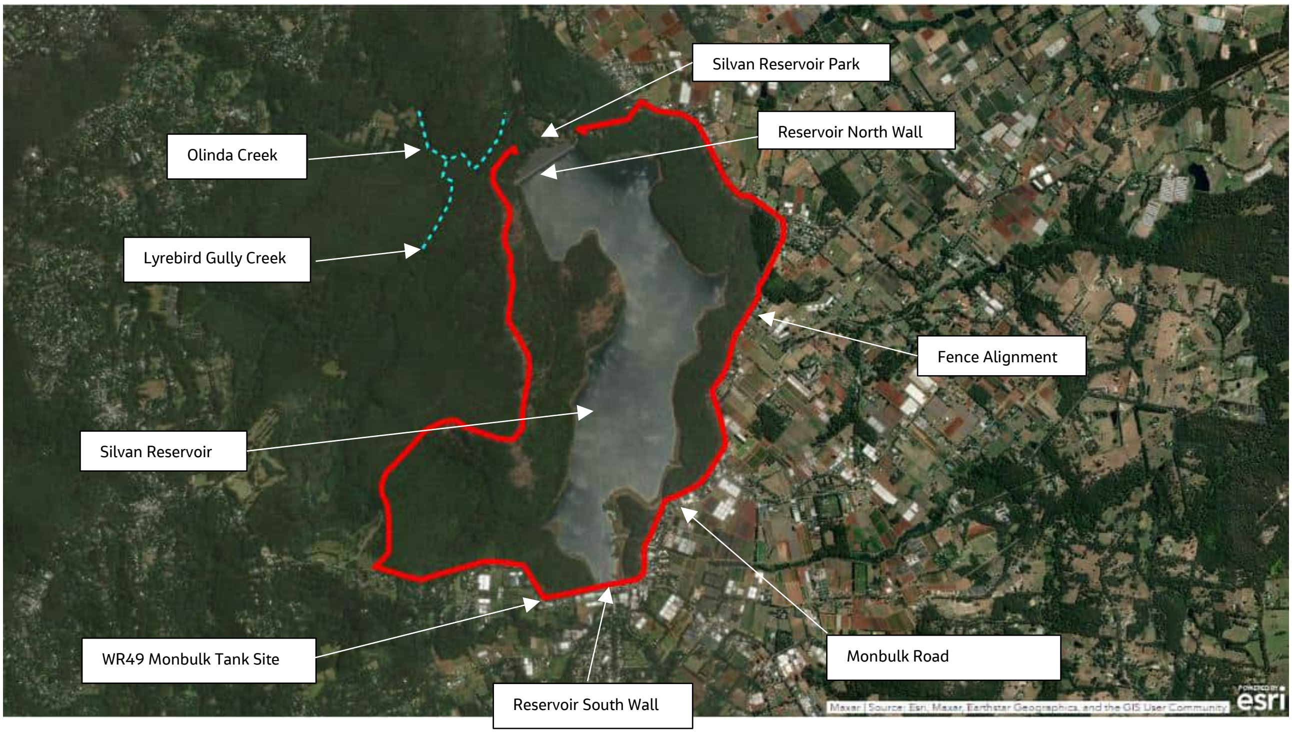


Figure 2-1 Silvan High Security Fence Project Area, VIC 3794 (Copyright © Esri, 2024)

The Dandenong Ranges National Park is located to the north and west of the project area, with low-density residential, industrial/commercial and agricultural areas to the south and east of the project area. Full details on the existing surrounding land uses are presented in the separate Jacobs Preliminary Contaminated Land Desktop Assessment (IA5000PB-0000-EV-RPT-0001, 2023).

2.2 Site Topography

The site topography is highly variable with hilly terrain generally comprising convex hills and deeply-incised V-shaped valleys. Several creeks and gullies cross around and through the reservoir area.

The elevation of the reservoir is approximately RL 245 m Australian Height Datum (AHD), with the surrounding hills generally descending centrally towards this point, as indicated on the contour plan in Figure 2-2. The site perimeter descends below this level in the valleys beyond the north and south walls of the reservoir, to approximately RL 210 m AHD in the north and RL 225 m AHD in the south.

The highest elevation is located in the southwestern part of the fence perimeter at approximately 520 m AHD, which descends towards an average elevation of 350 m AHD from the west to the north. The eastern part of the fence perimeter is more gently undulating and rises from about 250 m to 280 m AHD, with the highest elevation in this area of approximately 350 m AHD.

Grades are variable across the proposed alignment, though are frequently steep and exceed 10 degrees. Some localised areas in the south western portion of the alignment exceed 15 degrees.

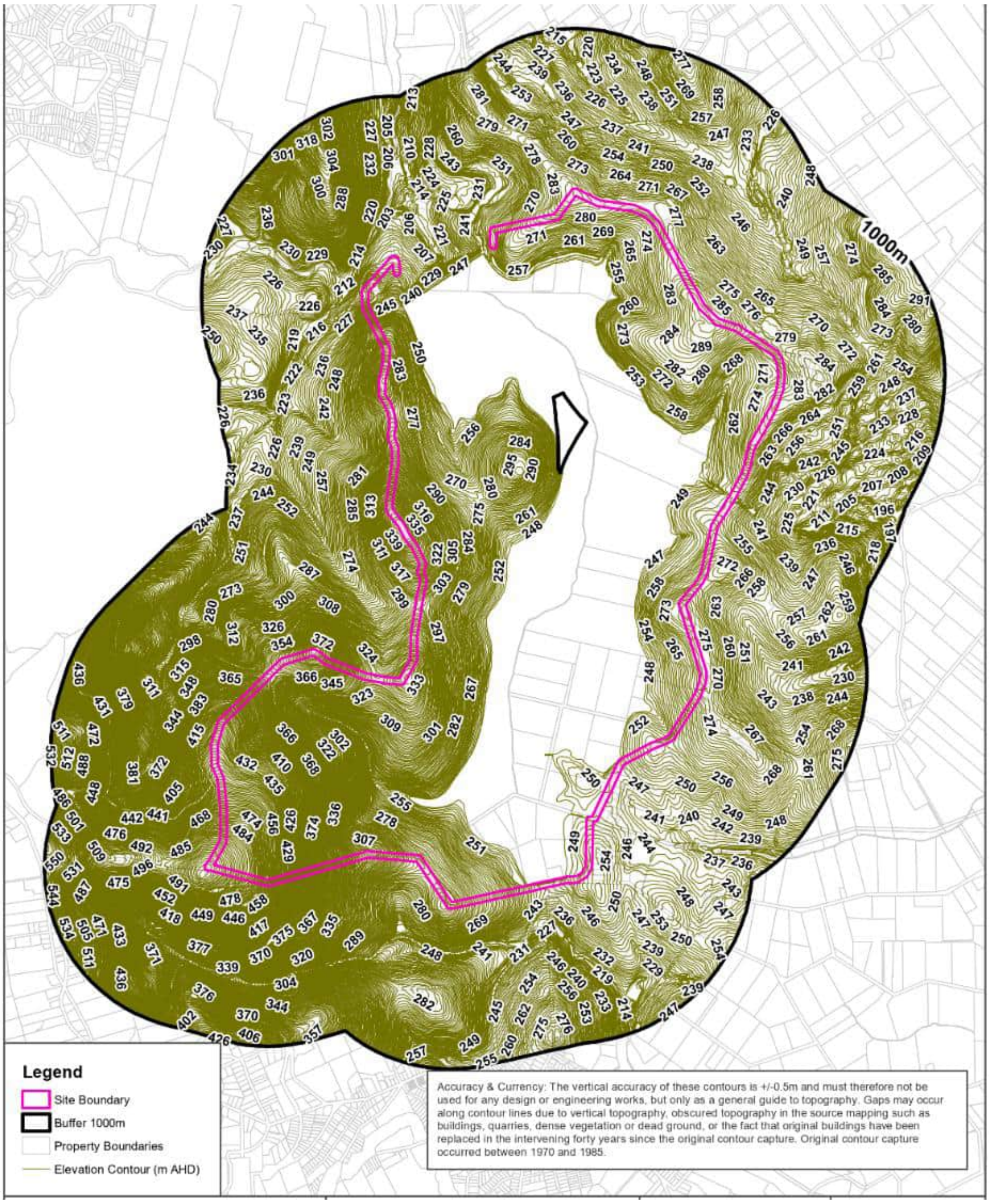


Figure 2-2 Elevation Contour Map (extracted from Lotsearch™ report LS049167)

2.3 Geological Setting

The Silvan Reservoir and project site is situated in the eastern extent of the Dandenong Ranges and comprises a complex geological setting. The surface geology is described below with reference to the Geological Survey of Victoria (GSV) 1:63,360 Ringwood Sheet (No.849, 1981), with extracts shown in Figure 2-3, Figure 2-4 and Table 2-1.

The proposed fence alignment crosses three distinct geological units, including predominantly Tertiary-aged Older Volcanics basalt flows in the east, and Upper-Devonian-aged Ferny Creek Rhyodacite and metamorphosed Hornfels of the Humevale Formation in the west. The boundary between the Rhyodacite and Hornfels is potentially the Mount Evelyn Fault line, with a Quartz Porphyrite plug in the central area to the west. A small section of Lower-Devonian Humevale Formation is encountered in the south-east, though it is noted this is covered by transported soils of basaltic origin. More recent alluvial deposits are noted in the north west associated with Lyre Bird Creek (also known as Olinda Creek).

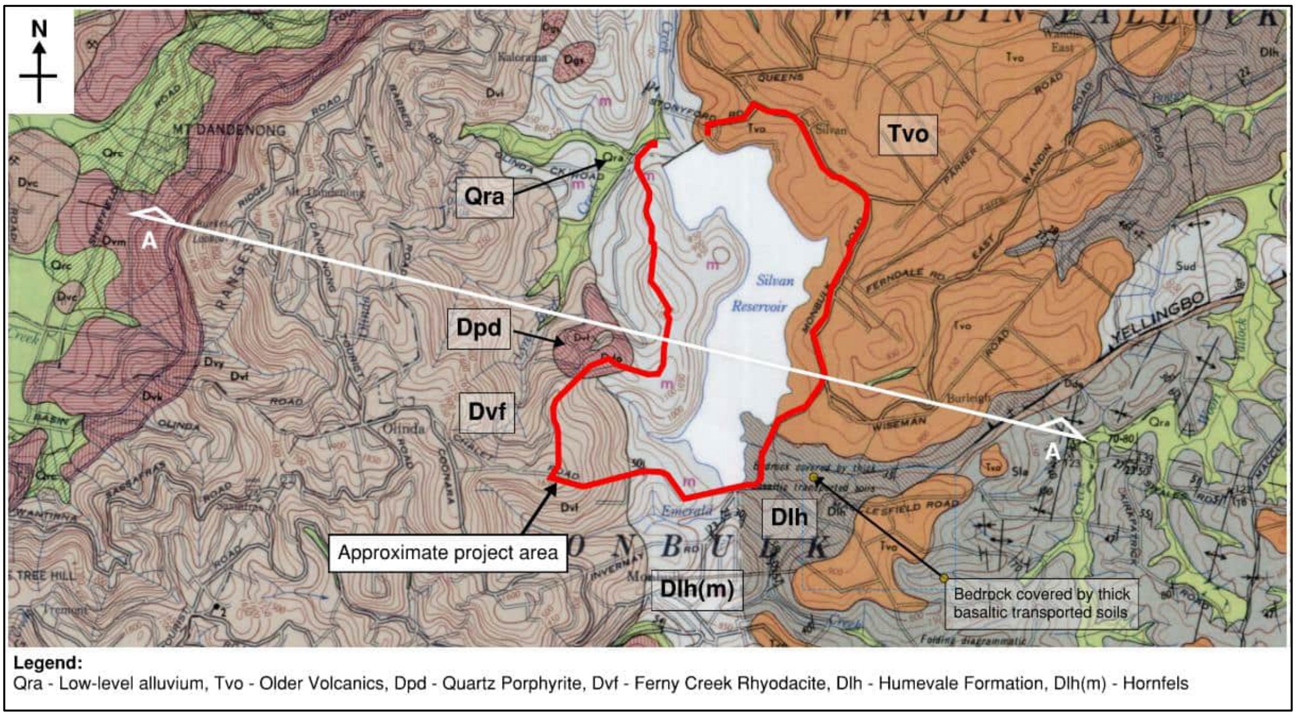


Figure 2-3 Extract from GSV 1:63,360 Ringwood Sheet (No.849, 1981) (not to scale)

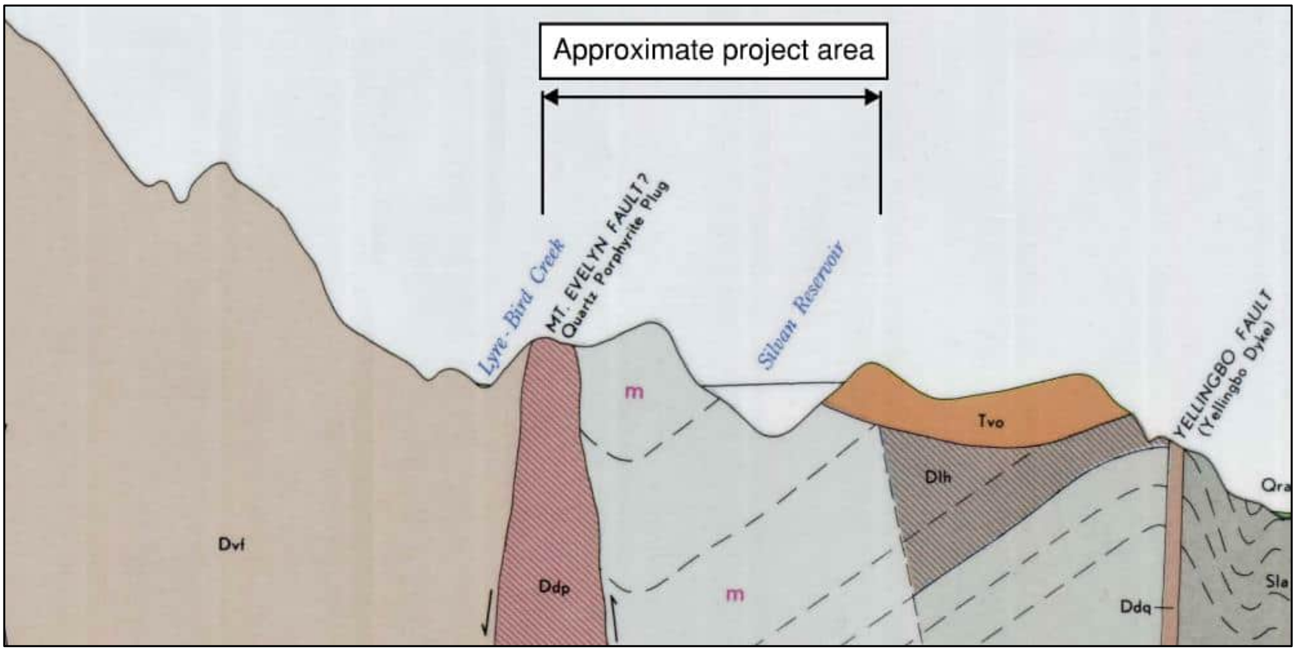


Figure 2-4 Extract from GSV 1:63,360 Ringwood Sheet, Section A-A (No.849, 1981) (not to scale)

Table 2-1 Relevant geological unit description as per GSV 1:63,360 Ringwood Sheet (No.849, 1981).

Unit Symbol	Geological Unit	Material Description
Qra	Low-level Alluvium	Low-level alluvium
Tvo	Older Volcanic Basalts	Olivine basalts and titanaugite basalts, dense, glassy, non-vesicular; Alkaline dykes, deeply weathered
Ddp	Quartz porphyrite	Quartz porphyrite
Dvf	Ferny Creek Rhyodacite	Single(?) flow of biotite-hypersthene rhyodacites. Chilled glassy base; Schistose phase: highly schistose biotite-hypersthene rhyodacites
Dlh	Humevale Formation	Massive to thin bedded siltstones, with sandstones interbedded near base *Noted as covered by thick basaltic transported soils in project area*
m	Hornfels	Metamorphic phase: Hornfels *Derived from Humevale Formation*

The 1981 GSV surface geology map generally aligns with the more recent GSV 1:50,000 scale Seamless Geology mapping. Aside from minor variations in unit names and boundaries, the principle difference was the more recent Alluvium has been reclassified as Colluvial deposits, and that the Mount Evelyn Fault is shown along the same interface with more certainty.

Further discussion of the geological units is included below.

Recent Alluvium/Colluvium: Recent alluvial and colluvial deposits are transported soils from the surrounding units, typically comprising gravel, sand, silt, clay, along with larger clasts of the parent material. Typically they are unconsolidated and poorly sorted. Likely to be encountered more broadly along the alignment, particularly towards the base of slopes, gullies and local watercourses. Whilst not shown on the mapping, it is expected that alluvial material may be encountered in the valley floors to the immediate north and south of the reservoir and walls.

Older Volcanics: Basalt flows of the Older Volcanics are expected to consist of predominately dark blue-grey to black, dense, moderately weathered to fresh basalt of and very high strength.

This unit is typically overlain by residual soils of variable thickness consisting of red-brown, high plasticity clays, which can sharply transition to competent rock. Cobbles and boulders (‘floaters’) are commonly encountered within the residual material and colluvium deriving from the Older Volcanics.

Quartz Porphyrite: Porphyrite is expected to comprise a lightly coloured or glassy rock with a fine crystalline matrix and strength characteristics similar to granite.

Ferny Creek Rhyodacite: The Ferny Creek Rhyodacite is a light grey, fine grained volcanic rock, typically encountered as moderately weathered to fresh and of very high strength.

Overlying residual soils are expected to be red-brown, medium to high plasticity, stiff clays and silts, often with very high strength floaters. Similar to the Older Volcanics basalt, rhyodacite often exhibits a similar strong volcanic differential weathering pattern, which is often results in rapid variations in weathering over short distances. The depth of residual soils of the Ferny Creek Rhyodacite are variable, but can be very deep, and are susceptible to instability and landslides following heavy rainfall events.

Humevale Formation: Surface exposures of the Humevale Formation generally comprise clayey residual soils derived from the underlying interbedded siltstone, sandstone and shale. The weathering profile from residual soil to rock is generally gradual. In fresh to slightly weathered condition, the siltstone is generally dark grey to grey and the sandstone white to light grey, which transitions to yellow, brown, pink and red as the weathering increases. Outcrops of bedrock can be visible in cuttings and slopes and are generally low to medium strength.

Mount Evelyn Fault: Running along the unit interface between the Ferny Creek Rhyodacite and the Humevale Formation, this major structural geological feature is reported to form a sharp faulted contact, which an intrusive Porphyrite plug outcropping intermittently at the ground surface.

Whilst not shown on the geological mapping, anthropogenic fill materials may also be encountered throughout the project area. Fill is most likely to be encountered around altered areas such as roadways and cuttings across the whole project area, though may be most prevalent at the north and south extents of the reservoir where there is a concentration of facilities, pipelines, other infrastructure and altered/landscaped areas.

Based on the available surface geological mapping and the fence alignment within Appendix B, the anticipated geological conditions underlying the project area are summarised below in Table 2-2.

Table 2-2 Summary of Anticipated Surface Geology.

Geological Zones	Approximate Fence Extent by Gate		General location	Approximate Length	Anticipated Surface Geological Unit
	From	To			
01	Gate 21	Gate 07 + 0.3 km	North and east Stonyford Rd and Monbulk Rd (northern section)	5.6 km	Older Volcanics basalt and residual soil
02	Gate 07 + 0.3 km	Gate 08	East Monbulk Rd (southern section)	0.7 km	Older Volcanics colluvial soils and floaters overlying Humevale Formation rock and residual soil
03	Gate 08	Gate 09	Adjacent south reservoir wall	0.3 km	Fill, Alluvial and Colluvial soils and potential floaters
04	Gate 09	Gate 10 + 0.3 km	South McCarthy Rd	1.3 km	Humevale Formation (Hornfels) rock and residual soil
05	Gate 10 + 0.6 km	Gate 12	West Dandenong Ranges National Park (southern section)	2.1 km	Ferny Creek Rhyodacite rock and residual soil
06	Gate 12	Gate 12 + 0.5 km		0.5 km	Quartz Porphyrite rock and residual soil
07	Gate 12 + 0.5 km	Gate 18	West Dandenong Ranges National Park (northern section)	3.5 km	Humevale Formation (Hornfels) rock and residual soil
08	Gate 18	Gate 21	North Silvan Reservoir Park adjacent to north reservoir wall	0.5 km	Fill material or Humevale Formation (Hornfels) rock and residual soil

2.4 Surface Water and Hydrogeology

The two primary waterways near to the project area are Lyrebird Gully Creek and Olinda Creek, located to the northwest (refer Figure 2-1). Whilst both creeks are close, neither intersects the existing fence alignment, though it is noted they may influence decisions around temporary access during construction. Throughout the remainder of the project area are numerous drainage paths and gullies which typically drain centrally to the reservoir itself.

Visualising Victoria's Groundwater is a federated web-GIS portal that collates groundwater data for Victoria. Visualising Victoria's Groundwater (VVG) database indicates that the approximate depth to groundwater for the majority of the fence alignment is generally in excess of 50-100 m below ground level (bgl). There are a number of locations where shallower groundwater within 5 m of the ground surface is expected:

- Gate 07 + 200 to 300 m in the south eastern portion of the alignment
- Gate 08 to Gate 09 adjacent the south wall
- Gate 16 to Gate 19 adjacent to north wall

Due to the generally cohesive nature of the residual soil within the project area it is possible perched groundwater may be encountered across the project alignment, particularly within localised gullies, drainage lines and low points.

The VVG database contains a large number of borehole records, mostly to the north, east and south of the project area, although most do not contain groundwater monitoring data. One of these boreholes, deep state observation well 79928, has been actively monitored since 1975 and is located immediately south of the reservoir south wall. This bore indicates groundwater in this location has typically fluctuated between 0.5 to 1.0 m bgl, with the latest reading on 02 August 2022 indicating a groundwater level of 0.99 m bgl. Many of the other VVG borehole records contain useful stratigraphic information which is discussed further in Section 3.2.1 and summarised in Appendix C (including well 79928).

VVG indicates groundwater salinity across the project area is less than 500 mg/l.

3. Existing Information

3.1 Historical Landslides

In the Dandenong Ranges landslips have previously been identified as historically occurring within the Ferny Creek Rhyodacite geological unit, typically where thick weathering profiles are present (refer Chapter 2, Neilsen et al, 1992). The Older Volcanics Formation within the area is similarly susceptible to instability.

The project area was reviewed against the "ThinkHazard Yarra Ranges Landslide Risk Assessment Map", an extract of which is shown below in Figure 3-1. The Silvan Reservoir is site is classified as a Low hazard level for landslide susceptibility, as per the broader region. This classification is based on the information that is currently available and means that "this area has rainfall patterns, terrain slope, geology, soil, land cover and (potentially) earthquakes that make localised landslides an uncommon hazard phenomenon".

A "Landslip Zoning of the Shire of Yarra Ranges" report produced by Coffey in 1999 describes a study undertaken to prepare landslip zone plans for various districts within the Yarra Range Shire. The report was used as the basis for developing the Erosion Management Overlay (EMO) for the Yarra Ranges Council and has been used in the planning of any future development to understand what impact, if any, the development may have on areas subject to significant erosion or landslips. This study indicates that:

- Landslips and debris flows are known in the Ferny Creek Rhyodacite geological unit which occur in the Dandenong Ranges;
- Landslips are known in the Tertiary Older Volcanic Basalt geological unit that occur over a large area of Silvan, as these materials typically underlie rolling hills with a thick red brown soil cover;
- In the Quaternary Colluvium/Alluvium deposits, riverbank collapse and reactivation of known landslide debris may also potentially occur.

It was noted that the Erosion Management Overlay (EMO) is listed to apply within the Dandenong Ranges National Park immediately to the west of the site, and at locations to the south and east of the site, but not within the Silvan Reservoir parcel of land itself. Given the Melbourne Water ownership of the Silvan Reservoir site it is possible the EMO survey has not extended to within the site itself. It is noted that the landforms are similar both inside and outside the site boundary.

As noted above and previously identified in Section 3.1, the Ferny Creek Rhyodacite has been known to be vulnerable to landslides along fault lines and given the right conditions. Significant construction problems occurred when tunnelling through old Ferny Creek Rhyodacite landslide debris at the nearby Silvan Portal of the Emerald Tunnel (Peck et al, 1992). As this bedrock unit is predominately vulnerable to slump/flow type landslides, appropriate measures should be taken during all construction phase activities to mitigate the effects of heavy rainfall.

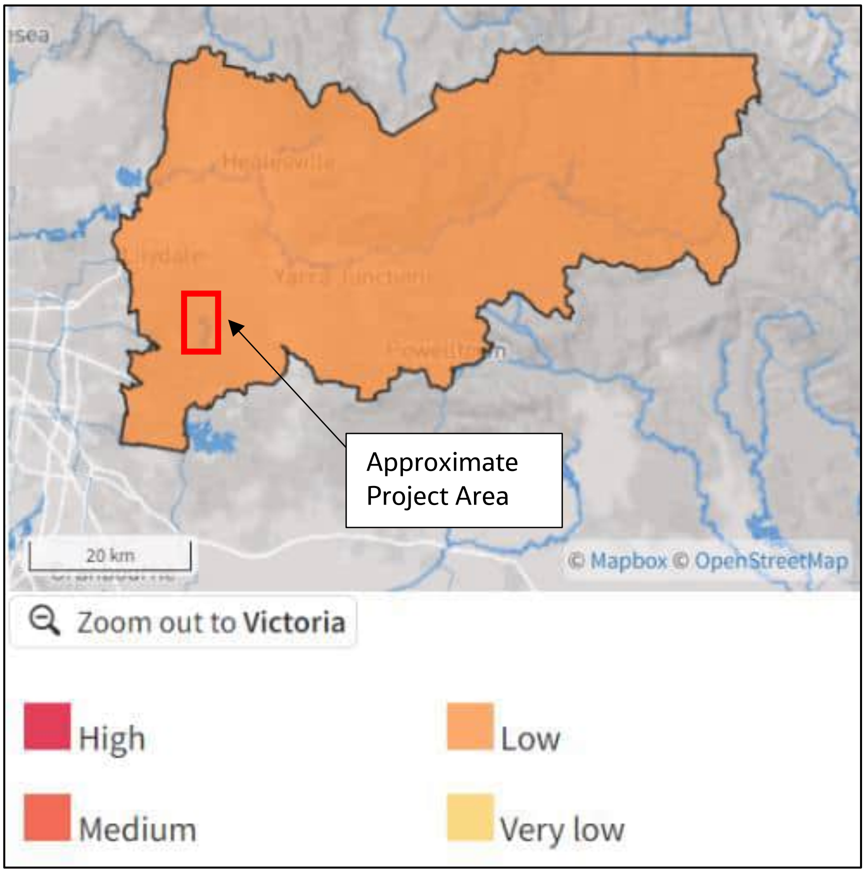


Figure 3-1 Landslide Risk assessment Map (extracted from ThinkHazard Yarra Ranges Shire, 2020)

3.2 Historical Geotechnical Information

Historical geotechnical investigation data was obtained from Jacobs' past project records and publicly available sources, and their locations relative to the Silvan Reservoir site. This information is discussed in the following sections.

3.2.1 Visualising Victoria's Groundwater (VVG) Boreholes

As noted in Section 0, a large number of borehole records are available from the VVG database. The majority of the historical borehole logs within close proximity to the Silvan Reservoir were obtained from VVG (summarised in LotsearchTM report LS049167) and originate from the last five decades. This data set represents a significant amount of data on the north, east and south boundaries of the proposed site. Whilst it is noted that the general quality of the data is low, it still provides indicative information regarding the local stratigraphy. A representative selection of logs within 400 m of the proposed fence line are presented in Appendix C, including location and a summary of the borehole stratigraphy.

The borehole data to the east and north of the alignment generally indicates that the subsurface conditions consist of a thin layer of topsoil (0 m to 1 m bgl) followed by 10 m to 20 m of high plasticity residual basaltic clay, or red, brown or grey colour. Where noted the underlying basalt comprises hard, fresh rock. These conditions generally line up with the surface geology indicated in Section 2.3.

The borehole data to the south suggests some variation from the geology indicated by the GSV 1:63,360 geological map presented in Section 2.3. This map suggests the are south of the fence is underlain by transported Older Volcanics soils, overlying the Humevale Formation at depth. However, some of the boreholes encountered thick deposits of basaltic rock at depth, suggesting that the Older Volcanics flows extended further south. The shallow material encountered within these boreholes generally presented similar deep, high plasticity residual soils, similar to the north and east.

Only two VVG boreholes were available to the west of the project alignment, however neither had available stratigraphic information.

3.2.2 Jacobs Archive Boreholes

Five shallow borehole logs were obtained from Jacobs' archives for a nearby sewerage project adjacent to the proposed fence alignment to the southeast. The borehole locations and summary of the encountered geology is included in Appendix C. The boreholes generally encountered a thin, low plasticity topsoil layer, followed by dark orange-brown, high plasticity clay ranging from 0.2 m to 3.5 m bgl.

3.2.3 Melbourne Water Archive Boreholes

Melbourne Water provided archival boreholes from the 1960s to 1980s from around the Silvan Reservoir area, which have been grouped into a north and south set. These are summarised below and included in Appendix C.

> **North Boreholes:** 21 borehole logs were extracted from investigations LD-007, LD-014, LD-080 and LD-101 at and around the northern reservoir wall and within Silvan Park. These are mostly shallow boreholes from 1.5 m to 4.0 m bgl associated with pipelines, or in the case of LD-101 a number of boreholes drilled to 5.0 m and one to 41.6 m bgl in the reservoir wall . The boreholes predominantly show stiff clays within 2-4 m bgl, and indicate 'medium' and 'hard' siltstone and sandstone was encountered within 1-2 m of the ground surface at some locations within the area.
>
> **South Boreholes:** 23 borehole logs from investigation LD-015 are included at the WR49 Monbulk Tank site along McCarthy Road at the south extent of the reservoir site. Boreholes 01 to 18 were drilled in 1970 to depths of 4.0 m bgl and generally indicate 1-2 m of stiff red-brown clay overlying 'medium to hard' mudstone. Boreholes 19 to 23 were drilled in 1980 up to 7.4 m bgl and indicate a

1-2 m of similar residual soil overly variably ‘weak’, ‘medium’ and ‘hard’ hornfels. It is reasonable to suppose the mudstone rock from the earlier boreholes is likely hornfels rock.

These boreholes align with the geological mapping in Section 2.3 which indicates Humevale Formation at both of these areas, including the potential for metamorphosed hornfels.

3.2.4 Melbourne Water WR49 Monbulk Tank Cutting Photos

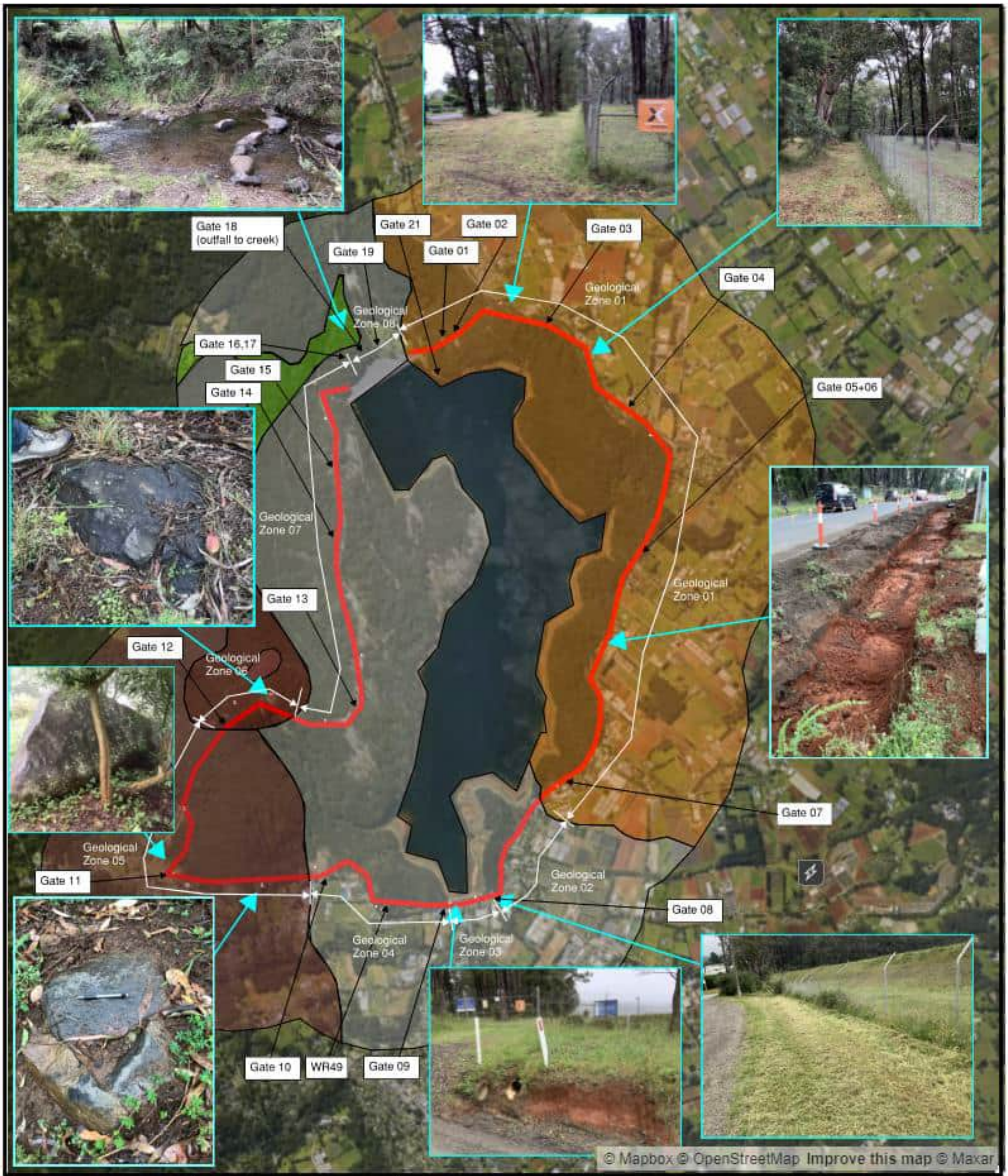
Melbourne Water provided four photos (November 2023) showing the rock cutting at the WR49 Monbulk Tank site discussed in Section 3.2.3. These photos illustrate the battered rock slope where the tanks are cut into the natural ground surface, showing what appears to be shallow Humevale Formation, and are included in Appendix C.3.

4. Jacobs Geological Site Walkover (Dec 2023)

Jacobs undertook a geological site walkover on 11 December 2023 to visually assess the fence alignment for geological features, hazards, topography and any other potential constraints which may influence the project. The walkover covered the full western half of the alignment on foot, whilst the eastern half of the alignment was reviewed by vehicle with stops at key points. Some key notes from the walkover include:

- The existing fence (and foundations) has generally performed as intended, with minimal signs of degradation such as leaning, movement or collapse;
- The topography is can be steep and difficult to traverse along the western half of the alignment;
- Some sections of fence in the north west area are heavily vegetated and were not accessible;
- Rock outcrops and floater material were frequently visible within the Ferny Creek Rhyodacite and Porphyrite areas (Geological Zones 5 and 6)

A summary map plan is shown in Figure below, with field notes, observations and photos of the walkover included within Appendix D.



Legend	Indicative Alignment	Geological Zones	Gate X Approximate Gate Locations	
Dvf: Ferny Creek Rhyodacite	Tvo: Older Volcanics Basalt	Ddp: Quartz Porphyrite	Dlh/m: Humevale Formation/Hornfels	Qra: Alluvium/Colluvium

Figure 4-1 Landslide Risk assessment Map (extracted from ThinkHazard Yarra Ranges Shire, 2020)

5. Geotechnical Hazards and Recommendations

5.1 Geotechnical Hazards

A summary of the main geotechnical hazards associated with the project are outlined in Table 5-1 below. The key risks are listed below:

Table 5-1 Summary of geotechnical hazards and recommendations.

Potential Hazard	Section	Description	Recommendations
Variable soil conditions	All	Variable soil conditions are expected within the thick residual soils (and limited alluvial/ colluvial) areas, including: ▪ Soft zones ▪ Gravel layers ▪ High permeability zones ▪ Potential highly reactive clays or dispersive soils (discussed below)	Geotechnical investigations along the proposed fence alignment are recommended to assess the extent and properties of soil and rock. Selection of appropriate footing design, construction plant and methodology based on presence of very high strength rock and floaters. A contingency allowance as part of the construction cost estimate and project cost is also recommended for variation in ground conditions.
Shallow rock and floaters	Geological Zones 5+6	The depth to rock across the project alignment is expected to be highly variable and shallow rockhead may be encountered. This is particularly the case within the Ferny Creek Rhyodacite and Quartz Porphyrite areas on the west of the alignment. Floaters may be encountered within these areas, along with the Older Volcanics areas to the east and within colluvial/alluvial material. Shallow rock or floaters of very high strength material are likely to be encountered and the current extents are unknown. Conventional excavator mounted augers will be unable to penetrate very high strength rock and floaters.	
Reactive soils	All	The residual soil across the alignment mostly comprises high plasticity clays which may be highly reactive to changes in moisture conditions. Shrink or swell behaviour is likely, which may lead to excessive movement or damage to the footings and fence.	Geotechnical investigations with appropriate laboratory testing are recommended to confirm the soil properties and potential reactivity and dispersivity. Adequate drainage of the finished ground surface and surrounding areas to manage water runoff is the most effective way to minimise reactive or dispersive behaviours.
Dispersive soils	Geological Zone 1	Dispersive soils may erode and quickly deteriorate when disturbed or exposed, and may lead to long term instability.	
Fill material	All	The specification, composition and construction quality of embankment fill and general fill within the project area is presently unknown. Excavations within embankment fill and general fill may result in instability or impacts to underground services and utilities. Fill materials are most likely to be encountered in the more heavily altered north, east and south areas, particularly around existing infrastructure and utilities.	Geotechnical investigations along the proposed fence alignment are recommended to assess the extent of areas of known embankment fill and general fill. It will not be possible to identify all locations of fill material along the alignment, it is recommended that additional contingency is allowed during construction to account for difficulties arising from fill materials.

Potential Hazard	Section	Description	Recommendations
			If alterations are made to existing embankments, slope stability assessment will be required.
Settlement	All	Residual soil, alluvium and colluvium may be susceptible to settlement resulting from mechanical excavation or consolidation due to dewatering. This is particularly the case in low-lying areas where soft or water-logged soils may be present. Differential settlement may cause damage to the fence or result in misalignment of gates.	The adopted methodology and design of the temporary works needs to consider the likely ground movements which may occur due to design loading, mechanical excavation and groundwater drawdown.
Impact to adjacent infrastructure	All	Adjacent utilities, infrastructure and properties can be damaged by the works due to ground movements, excessive vibration, physical clash or loading from construction plant.	Detailed survey should be undertaken of all known assets within the proposed works area, including AS 5488 (Classification of Subsurface Utility Information) Class A detection where appropriate. Pre-construction condition surveys may also be appropriate. The construction methodology should be selected to minimise the risk of damage occurring to adjacent assets.
Landslide behaviour and instability	Geological Zones 5+6	Potential landslide behaviour within Ferny Creek Rhyodacite residual soils to slightly weathered rock. The steep terrain across the majority of the western portion of the alignment may be susceptible to instability during construction, particularly if excavation and fill is required for temporary access roads.	Design of temporary works should retain natural contours wherever possible, and slope stability assessments may be required for excavations and temporary works platforms. As noted above, slope stability assessments may also be required for amendments to existing embankments. Construction works should minimise excessive clearing, establish and maintain appropriate surface water drainage, store equipment and materials away from steep slopes, cuttings and gullies, and monitor areas of potential landslide risk. Excessive rainfall should be included as a construction risk. Good hillside construction practices should be employed, as outlined in Appendix E.
Perched or shallow groundwater	All Notable Geological Zones 3+8	Perched or shallow groundwater may be encountered across much of the alignment, particularly in low-lying areas or gullies. This may elevate the potential for settlement, landslide behaviour and instability as noted above. Trafficability may also be reduced in such areas.	The construction methodology should allow for the presence or management of groundwater.

It is important to highlight there is currently very little reliable information available along the project alignment, particularly concerning the western region of the project area. This is of particular interest as it lies in a differing geological unit, the Ferny Creek Rhyodacite, within which the key risks coincide. The depth of the residual layer overlying depth to competent bedrock is unknown alongside the weathering condition of the underlying rhyodacite. In the authors experience, the Ferny Creek Rhyodacite often follows a similar trend of medium to high plasticity clays derived from weathering of the parent rock, followed by moderately weathered or better rock. As noted in the site walkover observations (Appendix D), shallow bedrock is likely in some areas, especially within the Porphyrite zone as signs of rock outcropping were common.

5.2 Recommendations

Based on the available geological and historical information the proposed Silvan Reservoir fence alignment is primarily underlain by residual soils or variable thickness from a variety of geological units, with the potential for shallow rock and floater material.

The key geotechnical risks include:

- Lack of geological information
- Variable soil and rock conditions
- Potential shallow, high strength rock or floater material
- Landslide behaviour and instability during construction

It is expected that the majority of the fence alignment can be constructed using conventional pier footings embedded within residual soil or extremely weathered rock. However, it is noted that alternative footing design or construction methods may be required where shallow high strength rock or floater material is encountered, as conventional excavator-mounted augers will be unable to penetrate such material.

It is recommended that a ground investigation is undertaken across the project alignment to confirm the in-situ ground conditions and supply sufficient information for the prospective contractor to undertake detailed design and construction planning. This could be undertaken during the function or detailed design stages or the project.

Ground investigations could involve:

- Intrusive geotechnical investigation comprising auger and rock core drilling, in-situ testing and sample collection of soil and rock
- Laboratory and in-situ testing of soil and rock
- Geophysical survey

Many of the ground condition risks need to be managed during the detailed design and construction phase of the project. The following are recommended key activities to be considered by Melbourne Water and their prospective contractor:

- Allowance of a contingency budget within the construction cost estimate and project cost for variability in ground conditions.
- Design and construction methodology:
  - Construction method should be selected to minimise the risk of damage to adjacent assets
  - Ground movements should be assessed resulting from both mechanical excavation and due to groundwater drawdown
  - Extensive rainfall should be recorded as a construction risk

6. References

1) Australian Geomechanics Society (2007). Guidelines for Landslide Risk Management, 2007c.

2) Coffey Geotechnics Pty Ltd (1999). Landslip Zoning of the Shire of Yarra Ranges.

3) FedUni (2015). Visualising Victoria's Groundwater (VVG) database, Federation University Australia, accessed December 2023. Available online: https://www.vvg.org.au

4) Geological Survey of Victoria (1981). Ringwood 1:63:360 Mapsheet (No. 849 – Zone 7)

5) Geoscience Victoria (2014). Victoria Seamless Geology 1:50,000 scale map.

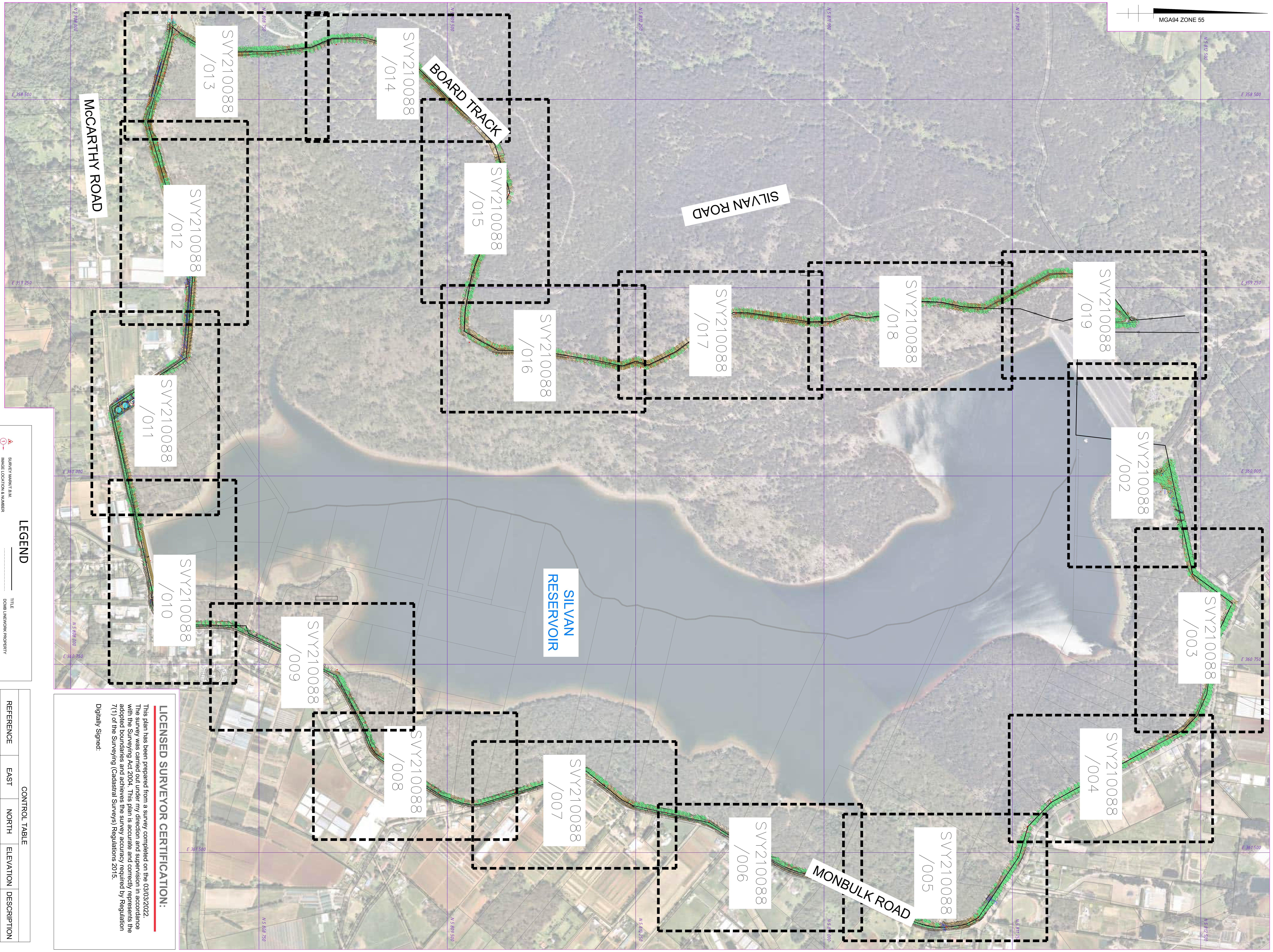
6) Lotsearch™ (2023). Report LS049167 EL, Silvan Reservoir, Monbulk Rd, Monbulk, VIC 3793, issued 16 October 2023.

7) Peck, W.A., Neilson, J.L., Olds, R.J., Seddon, K.D. (1992). Engineering Geology of Melbourne, Taylor & Francis, Brookefield

8) Taylors (2022). Feature and Level Survey Plan, Silvan Reservoir VIC 3795, Sheets 001 to 019, File Ref: SVY210088

9) Yarra Ranges Council (n.d.). Landslide Risk and Management – ThinkHazard, accessed December 2023. Available online: https://thinkhazard.org/en/report/5431-australia-victoria-yarra-ranges-s/LS

Appendix A. Alignment Plan and Feature Survey (Taylors 2023)



RELATIVE ACCURACY
FEATURE LOCATION ± 0.05m
FEATURE LEVEL ± 0.03m.

AUSTRALIAN HEIGHT DATUM

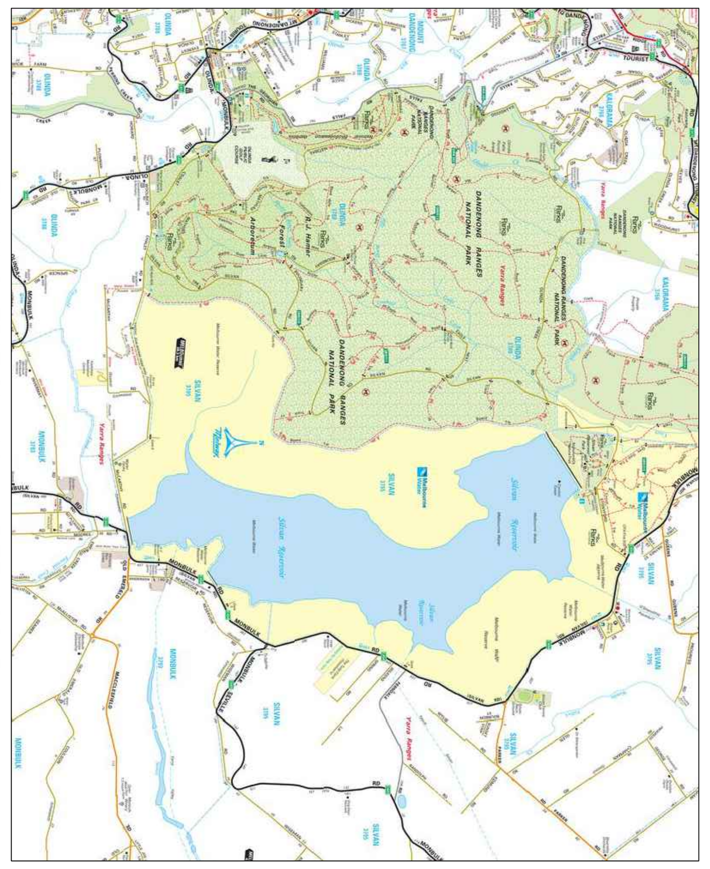
MAP GRID AUSTRALIA MGA94 ZONE 55

THE MAPBASE SHOWN HAS NOT BEEN VERIFIED BY FIELD SURVEY

LEVELS MAY EXIST THAT HAVE BEEN TURNED OFF FOR PLOTTING CLARITY

LOCALITY PLAN

SITE LOCATION



MELWAYS EDITION 46 – REF:122J5
NOT TO SCALE

LEGEND

SURVEY MARK/T.B.M.
IMAGE LOCATION & NUMBER
COMMUNICATIONS JUNCTION BOX/PIT
COMMUNICATIONS MARKER POST
ELECTRICITY POLE
ELECTRICITY BOX
EARTH POINT
ELECTRICITY MARKER POST
ELECTRICITY PIT
STAY FOR POLE
LIGHT POLE
PIPE INVERT
GAS CATHODE PROTECTION
GAS METER
GAS VALVE
WATER MARKER POST
FIRE HYDRANT PLUG
FIRE HYDRANT PILLAR
WATER METER
WATER TAP
WATER STOP VALVE
IRRIGATION SPRINKLER VALVE
ELECTROLYSIS PIT/BOX
FIRE EXTINGUISHER
FIRE HOSE REEL
FIRE BOOSTER VALVE
UNKNOWN POLE
UNKNOWN VALVE
TRAFFIC SIGNAL PIT
AIR CONDITIONER
SIGN
MAIL BOX
BARBECUE
BOLLARD
ROAD GUIDE POST
POST
TREE
STUMP/ DEAD TREE

TITLE
DCMB LINEWORK PROPERTY
CONTOUR MINOR & LABEL
CONTOUR MAJOR & LABEL
CHANGE OF GRADE
TOP OF BANK
TOE OF BANK
FENCE
RAILING
RETAINING WALL
CONCRETE EDGE
CONCRETE KERB & CHANNEL
CENTRELINE OF BITUMEN
ROAD FORMATION
ROAD TRACK
BITUMEN EDGE
VEGETATION EDGE/ SCRUB
DRAINAGE INVERT
DRAINAGE PIPE INVERT (SURVEY)
UNKNOWN CABLE/PIPE A/G (SURVEY)
ELECTRICITY OVERHEAD (SURVEY)
WATER PIPE U/G (QUALITY A)
GAS PIPE U/G (QUALITY A)

DRAINAGE
Ø300 PIPE DIAMETER
IL64.65 PIPE INVERT & INVERT LEVEL

CMP COMMUNICATIONS PIT
ELP ELECTRICITY PIT
GAP GAS PIT
WSP WATER PIT
JP JUNCTION PIT
SEP SIDE ENTRY PIT
GP GRATED PIT
MH SEWER MAINTENANCE HOLE
UNP UNKNOWN PIT

BUILDINGS
GRAVEL
WATER TANK
WATER (QL-A)
GAS (QL-A)
UNKNOWN A/G

LICENSED SURVEYOR CERTIFICATION:

This plan has been prepared from a survey completed on the 03/03/2022. The survey was carried out under my direction and supervision in accordance with the Surveying Act 2004. This plan is accurate and correctly represents the adopted boundaries and achieves the survey accuracy required by Regulation 7(1) of the Surveying (Cadastral Surveys) Regulations 2015.

Digitally Signed:

CONTROL TABLE

REFERENCE	EAST	NORTH	ELEVATION	DESCRIPTION
SVY210088 TDS 01	360467.61	5808344.30	248.27	STAR PICKET
SVY210088 TDS 12	361156.29	5810040.75	277.83	STAR PICKET
SVY210088 TDS 16	361497.56	5810736.06	261.54	STAR PICKET
SVY210088 TDS 20	361795.57	5811487.44	275.14	STAR PICKET
SVY210088 TDS 32	360209.77	5812428.88	275.55	STAR PICKET
SVY210088 TDS 35	359924.49	5812240.21	248.69	RIVET
SVY210088 TDS 40	359344.57	5812177.61	219.24	STAR PICKET
SVY210088 TDS 52	359569.56	5810269.05	326.78	STAR PICKET
SVY210088 TDS 60	358664.56	5809666.92	368.44	STAR PICKET
SVY210088 TDS 67	358240.65	5808411.42	508.73	STAR PICKET
SVY210088 TDS 77	359667.72	5808256.99	291.39	STAR PICKET

Rev	Date	Details	By	Ckd	App

	Signed	Date
Drawn SSM		10/11/2022
Surveyed SRH		04/11/2022
Checked PNK		22/11/2022
Approved PNK		22/11/2022

Notations
Date of survey - 04/11/2022
Co-ordinate datum is MGA94 Zone 55 vide MelbPOS GNSS observations
Level datum is Vide Best Fit To MONBULK PM68 (RL248.733 and WANDIN YALLOCK PM160 (RL286.063)
Grid interval is 750m
Contour Interval : 0.2m
Melway reference - 122J5

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Project
SILVAN RESERVOIR
VIC 3795
File Ref: SVY210088

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FEATURE AND LEVEL SURVEY PLAN
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Taylors reference S20303-S210-D001
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MWC plan number SVY210088/001
Rev A

SVY210088/001

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SVY210088/002

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Date of survey - 04/11/2022
Co-ordinate datum is MGA94 Zone 55 vide MelbPOS GNSS observations
Level datum is Vide Best Fit To MONBULK PM68 (RL248.733 and WANDIN YALLOCK PM160 (RL286.063)
Grid interval is 100m
Contour Interval : 0.2m
Melway reference - 120H11

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Contour Interval : 0.2m
Melway reference - 120K11

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Approved PNK	Signed	Date 22/11/2022

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Grid interval is 100m
Contour Interval : 0.2m
Melway reference - 122K8

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Approved	PNK		22/11/2022

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Melway reference - 122J9

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File Ref: SVY210088

Plan title
FEATURE AND LEVEL SURVEY PLAN
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Taylors reference S20303-S210-D010
Scale 1:1000
Sheet size A1
MWC plan number SVY210088/010
Rev A