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Report on Geotechnical Investigation and Groundwater Study

Yarrabend: Riverfront Area
Heidelberg Road, Alphington

Prepared for
Alphington Developments Pty Ltd

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	Signature	Date
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Reviewer		

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1. Introduction

This report prepared by Douglas Partners Pty Ltd (DP) presents the findings of a geotechnical investigation and groundwater study of the Yarrabend development site. The focus of the investigation and study is the southern portion of the site adjacent to the northern bank of the Yarra River. It is understood that an approximate 30 m wide parcel of land, adjacent to the river, is intended for ongoing public access and includes a walking track with variable tree and shrub cover. The purpose of the investigation and study was to:

- Assess likely mechanisms and contributing factors leading to localised slumping of the northern riverbank, discussed further in this report;
- In conjunction with assessment of localised slumping instances, carry out additional ground condition and groundwater investigation to assess general conditions and potential slumping risk on the northern Yarra River bank adjacent to the Yarrabend site; and
- Provide advice on further assessment, monitoring measures and options to mitigate / manage the potential for further slumping risk.

Assessment of the groundwater conditions, in the northern up-gradient site areas, was incorporated in this study in the context of considering possible influences on groundwater conditions and bank stability in the riverfront area.

The Yarrabend site is shown on drawing 1A, Appendix B and Figure 1 below. The approximate 18 ha site comprises former industrial and non-industrial areas.

Figure 1: Former AMCOR area (orange) and residential area (yellow) North to Right

The development areas comprise:

- The approximate 14-ha former AMCOR paper mill over the western majority of the site including the area west of the former Latrobe Avenue (upgraded road to be named Mills Boulevard). AMCOR Areas east of Latrobe Avenue were limited to sub-areas fronting Heidelberg Road and a zone between Lugton Road and the Yarra River front. The AMCOR site comprised numerous industrial buildings, pavements, pipelines and miscellaneous industrial units.
- An approximate 4-ha former residential area located between Parkview Road, Latrobe Avenue and Lugton Street. It is noted that most of the houses in this parcel were demolished in 1986 and the area was vacant until Yarrabend development works commenced.

DP are advised by AD that, at the time of writing, a total 4 ha area of the site is owned by third parties and not controlled by AD. A further 3.5 ha of the development have been completed and handed over to owners.

DP was engaged by Alphington Developments Pty Ltd (AD), the developer of "Yarrabend" comprising approximately 70% of the AMCOR paper mill site. DP have provided consulting geotechnical services for various phases of the Yarrabend development, including civil earthworks construction and site preparation works since 2016. It is understood that the City of Yarra (COY) and Melbourne Water (MW) are stakeholders in the management of the riverfront area adjacent to the southern boundary of the Yarrabend site. CSC Civil Constructions (CSC) are the civil earthworks contractor for the development.

2. Scope

The main tasks in the scope of work were:

Field Work

- Drilling of ten boreholes to variable depths, including selected sites on the terrace adjacent to the river, and sites set back from and upgradient of the upper edge of the embankment north of the river.
- Boreholes depths would be adjusted to straddle the expected fractured basalt aquifer and shallower aquifer conditions adjacent to the river. Drilling depths in the order of 10 m to 15 m were expected for the upgradient boreholes with depths in the order of 5 m to 7 m expected adjacent to the river.
- Use of a combination of auger and air hammer drilling methods in soil and rock as necessary. Rock conditions to be logged by examination of hammered chips, along with intermittent standard penetration tests to examine weaker rock where possible. Disturbed and undisturbed samples to be taken in soils at selected intervals.
- Installation of 50 mm UPVC standpipes in all boreholes, with lockable flush covers (i.e. custom Allan key).
- Recording of eastings and northings and levels to AHD at all borehole locations with survey equipment.
- Supervision and logging by an experienced engineering geologist.

- Obtain water well licence/s and use of a licensed water well driller for monitoring well installation.
- Excavation of five test pits in a former sediment basin area, to nominal depths of 2 m or prior refusal.
- Attendance to measure groundwater levels in the standpipes, on three occasions.

Groundwater and Background Information Study

- Collect and collate, historic groundwater records, including available borehole logs and monitoring depth data across the site.
- Collate and present rainfall and river level data relevant to the site.
- Collect and collate and summarise relevant site feature information, including key below ground pipe assets, earthworks activity summaries, development activities.

Reporting

- Prepare a report presenting the findings of the investigation and collated information from the groundwater study, with comment on likely slumping mechanisms and contributing factors, advice on further assessment and monitoring measures and options to manage potential further slumping risk.

Reference information, referred to in the preparation of this report is presented in Section 9.

3. Site Description and Background

3.1 Summarised Site History

The site was procured by Australian Paper Mills in 1918 with construction of the mill in the years thereafter for commencement of operation in 1921. Prior to APMs purchase the site formed part of the Woodlands Estate being predominately residential and farming uses. Construction activities for the mill reportedly included the importation of fill material to reshape the site along the Yarra River (GHD-2016). Historical MMBW drawings show an old tributary entering the northern bank of the Yarra, discussed later in this report. It is noted that the tributary does not form part of the current landscape. Fill was revealed along the apparent alignment of the former tributary during site remediation works, witnessed by DP in 2017-2018. It appears that the former main drain for the AMCOR facility was located along the alignment of the former tributary. Development and expansion of the mill was to the north towards Heidelberg Road with the site reaching its final form in about 1981. Plans showing the tributary location are presented in DP-2019 and are not included in this report.

3.2 Summary of Development Activity to Date

Brief descriptions of Yarrabend development works to date are presented below with sub-areas labelled on Drawing 1A, Appendix B.

- Above ground demolition of the AMCOR facility, with partial sub-structure removal over the majority of the industrial area from early 2014 to late 2015, see Figure 2. This included the area south of Lugton Avenue. Demolition of remaining industrial areas, including the buildings fronting Heidelberg Road were completed in the latter part of 2017.

Figure 2: Nearmap Image (September 2015)- North to right

- Environmental remediation of the AMCOR site including excavation of uncontrolled filling down to the underlying natural surface. Excavated materials were assessed and categorised for offsite removal or remediated and stockpiled for re-use. Where encountered, remaining sub-structures were removed. This commenced in mid-2017 and continued through to late 2017 early 2018 (see Figure 3). Suitable site-won, remediated filling was replaced over the natural surface. This was undertaken to raise levels for development purposes and to minimise offsite disposal costs. The filling was placed under the Level 1 Earthworks testing and inspection regime defined in AS3798 in the latter part of 2017 and early 2018;

Figure 3: Nearmap Image (January 2018) - North to right

- Post remediation development activities have occurred on the AMCOR site from 2018 to the present. These have included: earthworks construction of the east-west aligned portion of Mills Boulevard and bulk earthworks preparation of development parcels to its south, referred to as the Workshop North area. It is noted that the floor slabs for these developments are built and they cover most of the sites; construction of the medium rise apartment development in the north eastern corner of the site (referred to as the Parkview Apartments) commenced in mid-2019; construction of the medium rise development in the parcel north of the east-west section of Mills Boulevard, referred to as the Artisan development) commenced in early 2020 (see Figure 4);
- The former residential area between the former Latrobe Avenue and Parkview Road was remediated in 2016, including removal of filling and exposure of natural materials. Civil earthworks and townhouse construction in this area occurred from 2017 (see initial works in Figure 3) and was mainly complete 2019 (see Figure 4), this is referred to as the House and Land area shown on Drawing 1A.

Figure 4 : Nearmap Image February 2020 - North to right

Two remnant paper mill structures remain on the site, visible on Drawing 1A and Figure 3, referred to as the Wetlap building, located south of Mills Boulevard and the Boiler House, further to the south.

Works in the riverfront area have been limited to; minor pedestrian track maintenance works, infilling of cracks at one of the slump sites, fencing to manage pedestrian access, land and bathymetry survey and installation of a stormwater main drain in the river front area in 2017 / 2018. The main drain runs along Latrobe Avenue and connects to a pre-existing stormwater pit and outlet structure on the northern bank of the river. The drain currently takes run off from the house and land area and the adjacent portion of Latrobe Avenue.

Temporary stormwater sediment basins were installed at the southern end of the Latrobe Avenue in an area to the immediate west of the road reserve in accordance with the Environmental Management Plan approved by Council in June 2017. A copy of the relevant plan is included in Appendix B. Basins were formed in late 2016 and backfilled in late 2019. The basins were excavated into natural soils and periodically reconfigured to accommodate staged remediation and earthworks activities. Initial location of the basins at the southern end of Latrobe was to accommodate the site topography and original drainage along Latrobe Avenue to the south.

A temporary construction access road was installed, along the western half of the Yarrabend river front for VicRoads access during construction of the Chandler Highway bridge construction project. A new six lane bridge was constructed to the immediate west of the existing bridge between mid-2017 and late 2019. The access road was installed on the river terrace, by the bridge construction contractor. The unsealed granular access road required re-shaping of an approximate 6 m to 7 m wide, 110 m long area on the river terrace, about 10 m back from the bank.

It is noted that the North Yarra Sewer Main (NYM) was re-aligned to the north of the original sewer main in 2015. The alignment of the sewer is shown on Figures 2A, 2B and cross sections A and C in Appendix B. The eastern portion of the original brick-lined sewer ran along the river about 30 m to 40 m north of the northern river bank. From a point near the end of Latrobe Avenue, the sewer runs to the north west, passing south of the Boiler House and across the Chandler Highway. Records indicate that the sewer was tunnelled and is located 9 m to 15 m below surface. The eastern portion was reportedly relined in the early 80's. The western section was not relined. The sewer and manholes in the AMCOR site were reportedly back-grouted in 2015.

3.3 Slumping Instances

Slumping of the sub-vertical, variable height, riverbank adjacent to the Yarrabend site has occurred at the locations shown on Figure 5, referred to as Slumps A, B and C. Detailed descriptions of Slumps A and B are provided in DP Ref: 79075.12.R.003, dated July 2019. Summarised descriptions of the slumps are presented below, with approximate locations shown on the survey drawing extract in Figure 5.

Figure 5: Slump Locations and (Reeds survey drawing extract, January 2020)

Other historical slump instances are evident on the northern and southern banks on the section of river adjacent to the Yarrabend site. A number of these have well established trees growing on them and occurred well before recent demolition and development activity. This was discussed in DP-July 2019.

- Slump A: This area has exhibited intermittent drainage issues and wet ground (pre and post development, reported to DP by CSC). Historical slumping was reported at this location prior to May 2017, Ref: CDM Smith – 2019. Tension cracks at the upper edge of the riverbank have progressed to slump movement since mid-2019.

  Seepage was reported in this area in January 2019. Tension cracks were observed by DP in June 2019. Wet ground was observed in this area at this time, consistent with prolonged poor drainage and intermittent wet ground, as shown in Plate 11 Appendix B (extract from of DP-July2019).

  Surface drainage in the terrace between the embankment toe and river bank is poor due to shallow surface depressions.

  Water was observed emanating from the toe of the embankment adjacent to the terrace in January and February 2020 and further slumping has occurred where the former tension cracks were observed. Minor surface flow was seen trickling through depressions across the terrace and over the slumped bank.

  Soils in this localised part of the terrace are dark grey / black, consistent with organic matter development on the surface and apparent long-term, seasonal or intermittent, moist / wet ground.

- Slump B. This slumping instance reportedly occurred in the days prior to 1 January 2019. A single tree toppled into the river. The tree was removed by Melbourne Water on 23-25 January. From ref: CDM Smith – 2019, water was not observed emanating from the ground in the immediate slump area but was near slump A. The slump straddled the toppled tree stump and is approximately 6 m long and 2 m wide. The slump does not appear to be active (to be confirmed by monitoring, discussed in Section 8).

- Slump C: This slumping instance occurred on or near 31 May 2019, affecting adjacent trees located at the river edge. One tree toppled into the river and two others were destabilised but remained standing. One of the remaining trees was cut down on the advice of a consulting arborist/s as a safety requirement. The stumps and root zones were left in place. The third tree remains in place. DP was engaged by AD to assess this slumping instance and provide initial advice regarding tree and riverbank stability in DP-2019/July. Surface water or wet ground was not observed in the area of this slump when inspected by DP in June 2019.

4. Site Conditions

4.1 Topography

Key topographical features in the river front area comprise:

- A variable width, slightly graded to flat terrace adjacent to the river, with its surface set 2 m to 3 m above mean river level (5.1 m AHD);
- An approximate 7 m to 10 m high, vegetated slope rising above the northern edge of the terrace. Survey data indicates the slope to range from 1.6:1 (H:V) to 1.8:1 (H:V); and
- A slightly irregular, upgradient surface rising from RL18 m to 20 m at the upper edge of the riverfront slope to between 31 m and 32.5 m along Heidelberg Road. Total surface level differences across the site above the riverfront slope range from approximately 10 m to 12 m.

The river terrace is approximately 15 m to 20 m wide in the western portion adjacent to the VicRoads access track, described in Section 3.3. The eastern portion of the terrace ranges from a minimum of approximately 5 m, near the end of Latrobe avenue, at the location of Slump C shown on Figure 5 in Section 3.4 widening to around 10 m to 12 m to the east.

Regionally the surrounding areas rise to the north and north west across the surrounding basalt plane which extends over 20 km to the north and north west of the Yarrabend site. The basalt terrain extends to across Alphington Park as far as Darebin creek to the east.

It is noted that the investigation confirmed the presence of fill over basalt in the boreholes near the upper edge of the riverfront front embankment. The fill thickness ranged from 1.6 m to 4 m with the majority of the profile through the embankment comprising natural basalt discussed in Section 6.

4.2 Geological Setting

Geological Survey of Victoria information along with previous investigations on the site by GHD, DP and others indicates three surface geological units in the area with overlying variably distributed filling.

Filling

Where not obscured by vegetation filling is visible at the surface in the terrace zone, below the toe of the adjacent batter. Visual inspection of the surface soils indicated silty clay and clayey silt material with trace foreign matter (bricks) consistent with some modification of the river bank. Note Figure 6 below showing historic image 1920s view form the south.

Figure 6 : 1920's Aerial Image of Site and Northern Yarra River Bank viewed form the South

Historical information indicates the importation of fill early in the development of the AMCOR site. This included apparent infill of a former tributary entering the northern bank of the Yarra River as well as placement of fill to raise levels along the sloped embankment above the terrace. Fill over the site predominantly comprised gravelly clay.

It is noted that fill away from the riverfront has been remediated. This involved removal down to the natural surface, disposal of some fill and replacement of suitable fill, placed to a defined density regime and tested. Remediated fill typically comprised clay and gravelly clay.

Quaternary Alluvium

Sandy clay, silty clay, clayey sand alluvium was encountered above the quaternary basalt intermittently across the development. The materials were typically very stiff and dense and pale brown, to orange brown with thicknesses typically varying from 0.5 m to 3 m. Similar alluvium was encountered in the terrace area.

Quaternary Volcanics Basalt

The present topography and course of the Yarra River has been influenced by the extent of the erosion-resistant basalt flows, which have infilled an ancient valley system. The basalt flows occur as multiple events between 4.5 and 0.8 million years ago.

The basalt unit on the site extends north from the bank of the river, across the development and many kilometres north and north west of Heidelberg Road and the Chandler Highway. The northern bank of the river is defined formed by a basalt flow boundary. It is noted that reference GHD-2013, indicates a thick sub basaltic alluvium interlayer, between the underside of the basalt and the Silurian basement rock. This was not identified in Ref: GHD-2016. The basalt in the area is variably weathered, with zones of highly weathered, highly fractured rock overlying better quality, slightly weathered, high to very high strength materials

Sands silts and clayey sands intercalated with the basalt were observed in numerous places during civil site works, more in the southern part of the site than the north often towards the base of the basalt. some apparent “brecciated” vesicular basalt was encountered in occasional earthworks excavations.

Silurian Siltstone

The site is underlain by Silurian age sedimentary rock generally consisting of interbedded marine siltstone with minor sandstone (Melbourne Formation).

4.3 Surface and Drainage Conditions

4.3.1 Site Preparation and Resulting Infiltration Conditions

The main site areas are shown on Drawing 1A with sub areas labelled. In summary, site preparation works have comprised:

- Above ground demolition with partial sub-structure removal from early to early 2015;
- Removal of uncontrolled fill and replacement by CSC in 2016/2017 in the area between the Wetlap building and the Boiler House.
- The former residential area between the former Latrobe Avenue and Parkview Road was remediated in 2016, including removal of filling and exposure of natural materials.
- Environmental remediation of the majority of the area west of Latrobe Avenue including excavation of uncontrolled fill down to the underlying natural surface in accordance with EPA guidelines. Excavated materials were assessed and categorised for offsite removal or remediated and stockpiled for replacement as engineered fill. Where encountered, remaining sub-structures were removed. This was undertaken by Enviro Pacific (EP) and commenced in mid-2017 through to late 2017. DP carried out geotechnical consulting services during the environmental remediation works. This included progressive inspection to verify that uncontrolled fill was removed down to the surface of the underlying natural ground, along with ongoing advice on the suitability of site won, remediated materials for re-use as engineered fill;
- Placement of site-won remediated filling over the natural surface. This was also undertaken by Enviro Pacific to raise levels for development purposes and to minimise offsite disposal costs. The filling was placed under the under the Level 1 Earthworks testing and inspection regime defined in AS3798 and implemented by DP. This fill was placed intermittently from mid October 2017 to early 2018, discussed further in later sections of this report; and

With respect to up gradient surface and sub surface soil infiltration conditions, site preparation over the site has predominantly involved removal, remediation and replacement of uncontrolled fill with site won engineered clay and gravelly clay fill. There are some isolated exposed basalt areas, but these are limited.

Temporary exposure of fractured basalt could have temporarily increased local infiltration / recharge conditions in parts of the site. However, backfill of the remediated ground with clay fill occurred soon after exposure of the rock, providing a low permeability seal and reducing infiltration of surface water.

The remediation process involved removal of decommissioned pipes and sub structures, with the resultant excavations backfilled with compacted clayey soils. The former pipes and related trenches often comprised high permeability zones. Their removal resulted in a reduction in near surface groundwater recharge.

Post-remediation earthworks were carried out from late 2018 to present and comprised the placement and compaction of imported ripped mudstone / siltstone, and minor site won clay fill in the following areas:

- The East West section of Mills Boulevard:
- The Workshop North Area, where building construction and the installation of sealed surfaces and roofs is well underway:
- The temporary access road area, west of Workshop North and the Wetlap Building:
- The area between the Wetlap building and the boiler house:
- The area to the south of the Workshop North and west of Latrobe Avenue (bulk fill works are underway at the time of writing) including the former sediment basin area, which was backfilled in January 2020.

The compacted fill in the above areas has a very low permeability and infiltration through the profile in these areas will be negligible.

The prepared ground in the House and Land area comprised clay soils overlying basalt rock. Civil earthworks and townhouse construction over this area was complete in 2019 and has resulted in sealed roofs and pavements, with discharge to the new main drain, resulting in a significant reduction in groundwater recharge compared to pre-demolition conditions.

The zone to the south of the former Lugton Avenue, currently comprises a thin crushed rock surface and is used as depot by the project builder. The profile comprises predominant clay fill, or natural clay over basalt rock. Infiltration of any precipitation of surface run off, through the profile, to the underlying rock in this area is likely to be negligible.

The multi storey buildings adjacent to Heidelberg Road and the northern part of the Chandler Highway were demolished through the second half of 2017. Some site shaping occurred in the northern development parcels in 2018. Change in this area, since then, has been limited to construction of the Parkview Apartment Development in the north east corner of the Yarrabend site. Ground surfaces in this area typically comprise variable thickness fill over natural basalt rock. The fill composition is variable and comprises clays, gravelly clays and clayey gravels.

It is noted that the Parkview Apartment Development includes a multi-level basement. Construction dewatering was required during basement construction. Groundwater conditions during basement excavation in late 2019 were consistent with the findings in Ref: James-2015 and required temporary dewatering. With a temporary lowering of groundwater levels in the fracture basalt.

4.3.2 Surface Drainage

Surface drainage conditions across the post demolition Yarrabend site are summarised below. The summary is based on observations made by DP and information provided by CSC.

The overall site gradient is down to the south towards the Yarra River.

Initial earthworks activity commenced in 2016 and was focused on the House Land Area east of Latrobe Avenue, with some initial earthworks between the Wetlap building and Boiler House. These activities are understood to have been approved by Council and/or other relevant authorities.

CSC indicated that drainage occurred down the former council drains along Parkview Road and Latrobe Avenue to the south.

CSC stated that a number of drains on Heidelberg Road were blocked and that a significant volume of surface water was entering each of these streets as surface flow from Heidelberg Road. This reportedly continued until the affected drains were cleared.

As earthworks progressed surface flows were directed from the house and land area to a basin at the southern end of Latrobe Avenue. Surface run off in earthworks areas was limited to heavier precipitation events. Precipitation on irregular earthworks surfaces, pad foot roller indentations etc, captures a considerable volume, with trapped water moistening the soil surface. There were numerous occasions where slightly over-wet materials had to be mixed with drier soils or allowed to dry back to achieve compaction.

Surface run off from heavier precipitation events was reportedly directed from Lugton Road to temporary basins at the southern end of Latrobe Avenue. CSC stated that water impounded in the sediment basin/s was pumped out intermittently and used for dust suppression and earthworks conditioning.

In the area west of Latrobe Avenue, there is a depression north of the riverfront embankment and the topography prevents overland flow to the river.

The environmental earthworks in 2017 and 2018 included formation of numerous ad-hoc localised excavations of variable depth. A considerable proportion of rainfall in this phase was trapped in small puddles and was absorbed into the surface soils and entered temporary local depressions. The bases of the deeper localised depressions were predominantly set in natural basalt rock. Some infiltration of groundwater would have entered the fractured rock mass in the limited period between formation and backfilling with compacted site won remediated clays. Water was also pumped from these and used for dust suppression. It is noted that much of the bulk material discarded from site for environmental reasons was moist to wet, due to continuous watering as a dust suppression measure to manage asbestos. Re-used soils were often wet of optimum and required dry back or mixing with drier materials to facilitate compaction.

4.4 Decommissioned Former North Yarra Main

The former North Yarra Sewer Main is located north of the northern bank of the Yarra River. The sewer alignment and dimensions are shown on the Melbourne Water decommissioning plan attached in Appendix B. The proximity of the alignment to the upper edge of the embankment north of the river is shown on Drawing 2B. GHD-2016 shows the former NYM invert to be set around RL 4 m to 5 m AHD, i.e. well below the groundwater surface.
Available information regarding the former sewer indicates:

- The eastern portion of the sewer was relined in the 80s.
- The western portion of the sewer running south of the boiler house was not relined.
- Sampling and assessment of downgradient groundwater indicated sewer leakage prior to it being decommissioned (carried out by JBS&G for AD).
- The sewer was tunnelled with variable cross-sectional dimensions ranging from 0.7 m to 1.5 m.
- Back-grouting was undertaken after installation of the new sewer in 2015/2016. It is noted that any ongoing seepage of groundwater into the sewer, from the surrounding fractured basalt would have ceased at that point in time, with a potential rise in standing groundwater levels.

4.5 Rainfall and River Level Data

Rainfall, river level and wind data for Melbourne from December 2018 to February 2020 are presented in Appendix D and are summarised below:

- Cumulative rainfall records for Melbourne in 2019 show the driest January to end May period in the available record set. This was followed by a number of moderate rainfall events after 25 May.
- River level data, for a station in the immediate vicinity of the site shows fluctuating mean daily level rises and falls with amplitudes in the order of 0.2 m to 0.5 m, corresponding with rainfall events.
- Slump incidents B and C occurred immediately after high daily rainfall and river level events;
  - Slump B (immediately prior Jan-1, 2019): Daily Rainfall / Hourly River Level event immediately prior, of 42 mm and 1.4 m respectively;
  - Slump C (on or near May 31, 2019): Daily Rainfall / Hourly River Level event immediately prior, of 25 mm and 0.75 m respectively, following the six-month, driest period on record;
- There were four events where the river gauge readings were higher than 1 m in the period from Dec 2018 to end Dec 2019.
- Wind gust speeds for Melbourne are shown intermittently approaching 60 km / hr in the order of 2 to 4 times per month.
- River Level Data, at Chandler Highway, for a seven-year period from 1998 to 2005 (Sourced from the Department of Environment, Land Water and Planning), showed seven instances with river levels above 2 m with a maximum of 3.6 m in 2003. The data is attached in Appendix D.
- It is noted that the gauge datum (GHD-2016) is RL 4.8 m AHD, with level readings in excess of approximately 2.5 m resulting in parts of the river terrace being inundated.

5. Field Work

5.1 Drilling Investigation

Field work comprised ten boreholes with standpipe installations in each, between 26 November and 4 December 2019. A track mounted drill rig was used. The borehole locations are shown Drawing 1 attached, in Appendix B. It is noted that the borehole numbers are not sequential due to adjustment of the nominal spread in consultation with AD.

- 2 No boreholes (DG1 and DG2) were drilled using air hammer drilling methods to depths of 15 m. DG1 was taken through the basalt terminating in siltstone, with DG2 terminating in fractured basalt.
- 3 No boreholes (DG5, DG6, DG7) were drilled using a combination of air-blade or air-hammer and solid flight augers, to depths of between 10 m and 15 m, terminating in natural basalt or siltstone.
- 3 No boreholes (DG4, DG12, DG16) were drilled with solid flight augers to depths of between 7 m and 7.8 m, terminating in siltstone.
- 2 No boreholes (DG13, DG15) were drilled by hand auger, due to access difficulties on the river bank. These were taken to depths of 5.4 m and 2.7 m respectively, terminating in inferred natural alluvium.

Standard penetration tests (SPTs) off auger samples were taken at selected intervals in the soils. SPT's were also taken at selected intervals in the rock to supplement logging of hammered chips and debris. Selected samples were photographed.

Groundwater monitoring standpipes were installed in the boreholes. Standpipe construction details are presented on the borehole logs in Appendix C.

Water level measurements in the standpipes were made on 12 December 2019, 23 January and 21 February 2020.

Co-ordinates and ground levels at the borehole locations were established using a GPS survey unit (datum WGS84, Zone 55H). The field work was supervised by a DP engineering geologist who was responsible for field work co-ordination, logging of the strata encountered, and handling of the samples collected.

5.2 Test Pit Investigation

Five test pits were excavated on 9 December 2019 at the locations shown on Drawing 1, designated TP1 to TP5. The pits were excavated with a tracked excavator to depths of between 1 m and 2.7 m. One pit was terminated in natural alluvium at a depth of 1.5 m, with the others terminated in natural basalt. Samples were taken at selected intervals.

The pits were backfilled by bucket tamping the excavated spoil.

6. Investigation Assessment Findings

Details of the conditions encountered in the boreholes are presented on the borehole logs attached in Appendix C. These should be read in conjunction with the notes about this report attached in Appendix A, which describe the symbols and terms used. The borehole locations are presented on Drawings 1A, 1B, 2A and 2B. It is noted that the boreholes were drilled using air hammer methods and logging of rock conditions was by examination of rock chips. Detailed rock mass fracture properties are not available. The conditions encountered in the boreholes were generally consistent with those expected and comprised:

- Variable thickness fill in all of the DP boreholes, excluding (DG1, DG15 and DG16);
- Quaternary Volcanics Basalt, upgradient (north) of the crest of the riverfront embankment;
- Quaternary or possibly recent alluvium in the terrace area (DG4, DG12, DG13, DG15 and DG16); and
- Silurian Sedimentary rock, beneath the basalt in DG1 and DG6, underlying the alluvium in the terrace area in DG4, DG12 and DG16, and underlying fill in borehole DG5.

Boreholes DG2 and DG7 were terminated in basalt.

In order to visualise conditions, geological cross-sections were prepared at four locations, perpendicular to the longitudinal direction of the river as shown on Drawing 2A. Conditions in each area are summarised below.

6.1 Western Riverfront Area

Relevant boreholes in this area are DG2, DG4 and DG5. Relevant cross sections are A-1 and A-2 and B1. Borehole data from Ref: GHD-2013 (BHNY21 and BHNY22) is also presented on Cross Section A1. An extract of Section A2 is presented in Figure 7.

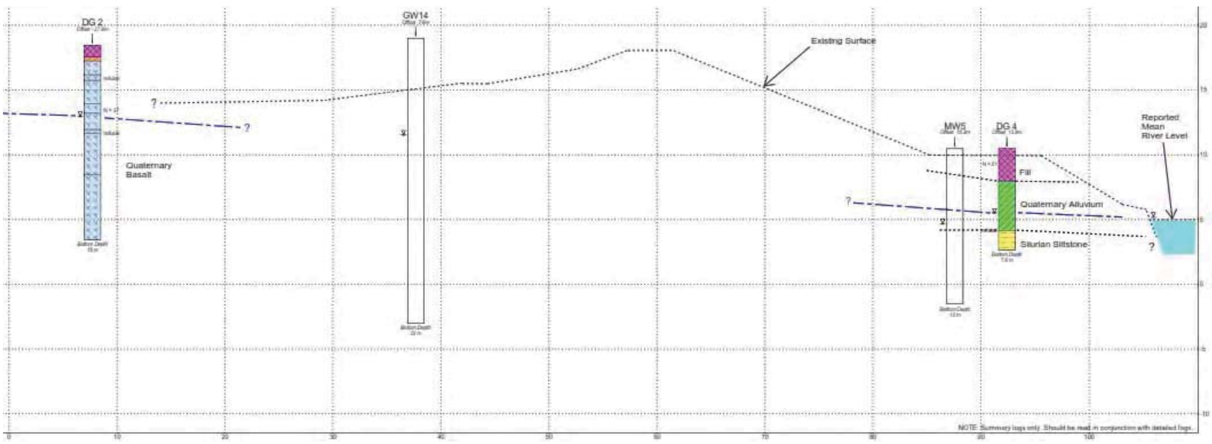

Figure 7 : Cross Section A2 Extract (see Appendix B for full cross section drawing)

Available data indicates minor engineered clay fill to a depth of 0.9 m in DG2, in the zone just south of the boiler house. It is noted that the fill at this location was removed and replaced during remediation works in 2017. The rock was typically highly to moderately weathered with occasional extremely weathered zones. Strengths ranged from low to very high. From visual inspection the basalt extends to the crest of the riverbank.

The fill in borehole DG4 was 2.5 m thick and comprised stiff gravelly clay. The fill overlay a 3.8 m thick layer of natural, very stiff clay alluvium, overlying very low strength siltstone. The surface of the siltstone appears to rise adjacent to the river and fall away to the north (see cross section A1).

Cross section B-1 indicates gravel fill overlying clay fill to a depth of 2.9 m over residual Silurian clay over siltstone. At the location of cross section B2, the terrace alluvium ceases and interfaces with the Silurian unit without interfacing with the natural basalt

6.2 Central Area River Front Area Slump C

Relevant boreholes in this area are DG1, DG6, DG12 and DG13. Relevant cross sections are C-1 and C-2. An extract of cross-section C-2 is presented in Figure 8.

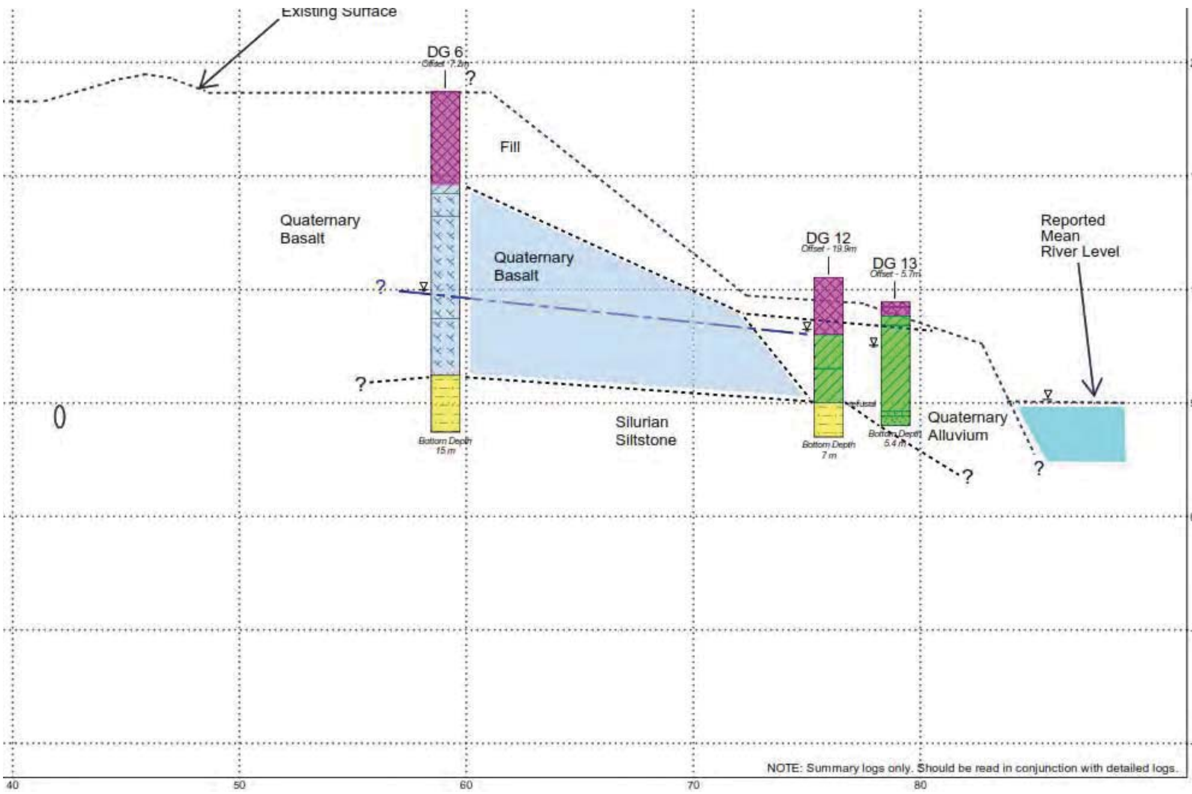

Figure 8 : Cross Section C-2 Extract (see Appendix B for full cross section drawing)

In this area the edge of the basalt flow interfaces with the fill and natural alluvium in the terrace zone. The surface of the siltstone falls away to the north (see borehole DG1 and cross-section C2-2, Appendix B). The embankment and apparent edge of the basalt flow are at their closest to the river at this location. It appears that there is a local peak in the Silurian surface around DG5 and DG6.

The fill above the basalt at the crest (DG6) was 4 m thick and comprised stiff gravelly clay.

The clay fill in DG12 was 2 m thick very stiff to hard and overlie firm natural alluvium over stiff inferred residual Silurian clay. The adjacent borehole (DG13) revealed minor fill over very stiff natural clay alluvium. A firm clay band was encountered near the water table, i.e. around 2.2 m in DG13.

6.3 Eastern Riverfront – Slump A: Area

The boreholes in this area are DG, DG15 and DG16. Relevant cross sections are D-1 and D-2. An extract of cross-section D-2 is presented in Figure 9.

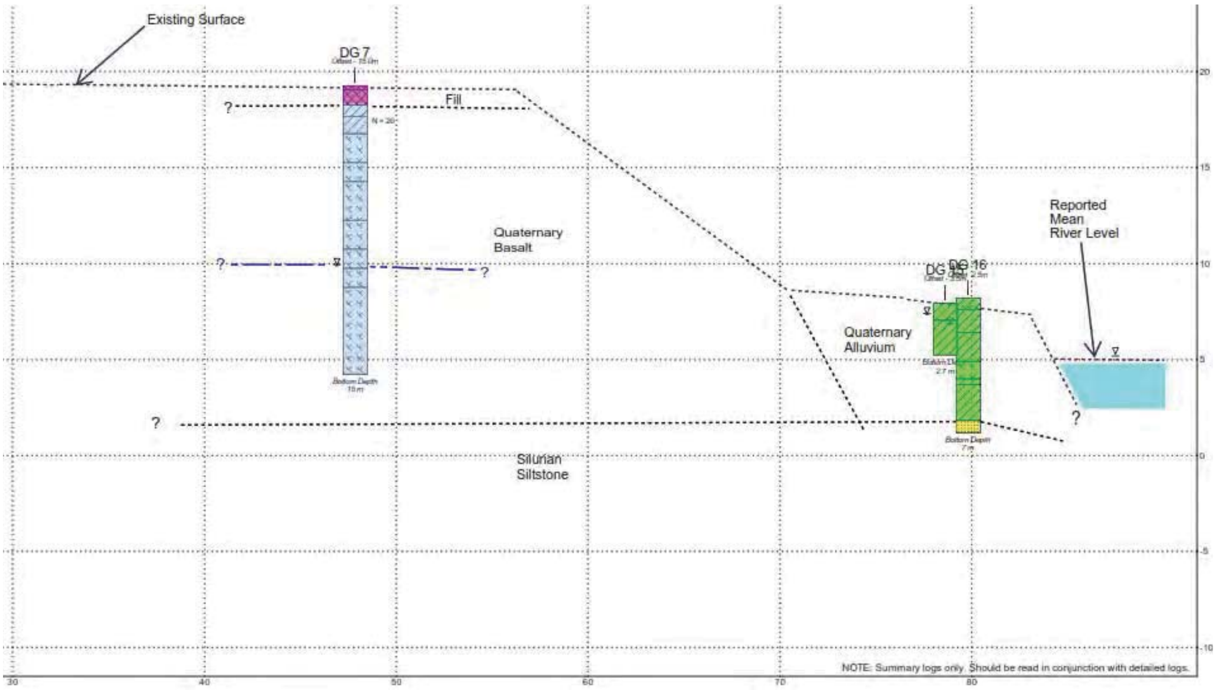

Figure 9 : Cross Section C-2 Extract (see Appendix B for full cross section drawing)

Relevant edge of the basalt flow appears to interface with the natural alluvium in the terrace zone adjacent to the river. There is minor clay fill (1 m thickness) above the natural residual volcanic clays at the embankment crest. The embankment toe and edge of the basalt flow are located about 12 m to 15 m from the river. Groundwater was observed emanating from the toe of the bank at this point, consistent with the water level in standpipe DG7.

The surface horizon in DG15 comprised low plasticity clay and was firm and wet below a depth of 0.3 m. The underlying high plasticity clays were stiff and drier than the upper horizon. The moisture profile in DG15 is consistent with the development of perched water in the upper horizon above the heavier clay sub-soils. The elevated moisture is due to surface water flowing across the terrace from the toe of the embankment.

Borehole DG16 indicated clay alluvium with a highly weathered basalt band between 3.3 m and 4.2 m. The apparent intercalated sequence of alluvium and weathered basalt is consistent with conditions encountered in construction excavations elsewhere at Yarrabend. Intercalated volcanic and alluvial materials were encountered in the lower parts of the quaternary basalt flow. The above alluvial sequence overlies the siltstone at a depth of 6.4 m. Wet soils were encountered between 1.8 m and 3.3 m in clay alluvium above the basalt band. The underlying soils did not appear to be moisture affected. The surface horizon in borehole DG16 was dry and not moisture affected at the time of the investigation.

6.4 Sediment Basin Test Pits

From visual observation the basins were excavated below original level with some of the excavated clays used to form perimeter embankments. At the time the investigation there were two basins with an embankment separating them. TP1 to TP4 were excavated through the basin floors, which were dry. TP5 was excavated through the southern embankment, which was approximately 2 m high. The pits revealed alluvial soils over quaternary basalt.

The pits excavated through the basin floors indicated alluvium above the basalt varying from 0.3 m to 1.7 m. The alluvium comprised sandy clay and fine sand with clay. Consistencies were very stiff or hard. Moisture at the surface was typically dry, becoming moist towards the base of the layer.

The embankment materials in TP5 comprised hard, dry clay fill to a depth of 1.1 m, over firm moist to wet gravelly clay fill to 1.9 m, over frim moist to wet natural clay alluvium to a depth of 2.6 m.

Basalt at the base of the pits was highly to moderately weathered and was encountered at depths of between 0.3 m and 2.6 m, typically 1 m to 1.7 m.

7. Groundwater

7.1 Historical Groundwater Data

Historical groundwater data was obtained from: DP- October 2019, DP - November 2019, GHD - August 2013, and GHD- May 2016. Reference details provided in Section 9.

Standpipe data was extracted from each of the above reports including, co-ordinates, surface RL to AHD (m), standpipe installation date, screened interval and groundwater depths for each reading. The data was collected at various times between 2008 and 2016. All of the standpipes were removed during the site demolition or remediation works.

The data was collated in a spread sheet and presented on Drawing 1C, showing borehole locations, groundwater RL and reading dates.

7.2 DP 2019 / 2020 Groundwater Data

Standpipes were installed in the DP November / December 2019 boreholes. Groundwater levels recorded in the standpipes are presented in Table 1.

Table 1: Standpipe Groundwater Levels

Borehole Number	RL Ground Surface (m) AHD	Screened Interval Depth (m)	Date of Measurement	Water Depth Below Surface (m)	RL of Water (m) AHD
DG1	16.2	5-13.5	12 December 2019	5.3	10.94
			23 January 2020	5.4	10.84
			21 February 2020	5.21	11.03
DG2	18.4	4-13.5	12 December 2019	5.52	12.93
			23 January 2020	5.4	13.05
			21 February 2020	5.39	13.06
DG4	10.5	3–5	12 December 2019	5	5.47
			23 January 2020	4.05	6.42
			21 February 2020	4.6	5.87
DG5	11.8	4–10	12 December 2019	4.44	7.33
			23 January 2020	3.25	8.52
			21 February 2020	3.86	7.91
DG6	18.7	5.5–15	12 December 2019	8.79	9.93
			23 January 2020	8.75	9.97
			21 February 2020	8.95	9.77
DG7	19.3	5.5-15	12 December 2019	9.38	9.88
			23 January 2020	9.32	9.94
			21 February 2020	9.22	10.04
DG12	10.5	2.5-4.5	12 December 2019	2.35	8.17
			23 January 2020	2.33	8.19
			21 February 2020	2.44	8.08
DG13	9.4	2-4	12 December 2019	1.42	6.79
			23 January 2020	1.26	6.95
			21 February 2020	1.11	7.1
DG8	18	-	12 December 2019	-	-
			23 January 2020	-	-
			21 February 2020	8.88	9.2

Initial water level readings are indicated on the relevant borehole logs in Appendix C and are presented on the cross-section drawings. The latter give a representation of the aquifer conditions and proximity to the riverfront embankment and Yarra River. The significance of the data is discussed in Section 8.

8. Discussion

The recent and historical (pre-demolition) slumps evident on the northern bank of the Yarra River adjacent to the Yarrabend development, are limited to approximate 1 m to 3 m wide strips back from the sub-vertical, 2 m to 3 m high, river bank. The slumps have occurred through the outer edge of the natural terrace deposit.

The slumping is restricted to the outer edge of the terrace without evidence of larger slips away from the bank.

There are no visually apparent active or recent slumps or landslip instances occurring in the embankment above the northern edge of the river terrace. The embankment ranges in height from 8 m to 10 m with slopes ranging from 1.6:1 H:V to 1.8 H:V. Boreholes DG6 and DG7 drilled at the embankment crest indicated surface fill over natural basalt rock extending well below the embankment toe and adjacent terrace soils.

Subject to visual monitoring of the embankment to confirm ongoing stability, the river edge slumping instances are the focus of this discussion and the adjacent embankment is not further discussed.

8.1 General Causes of River Bank Erosion

Rivers are dynamic systems and the factors controlling their formation are complex and interrelated. Factors include, river flows, sedimentation, geology and vegetation extent. As these factors change over time, river systems respond by changing their shape and form. In stable rivers the rate of these changes is generally slow.

River bank formation is a natural process. Even stable river systems have some eroding banks, albeit at a slower rate and on a smaller scale than unstable systems.

Fluctuations in river levels and occasional flooding can affect banks as well as land uses with bank responses.

Stream bank erosion processes generally fall into two main groups, i.e. bank scour and mass failure. In many cases of bank instability both will be evident. Often with either scour or mass failure being dominant. Bank scour is the direct removal of bank materials by the physical action of flowing water. Less common in lower reaches of stable systems.

Mass failure includes bank collapse and slumping, where masses of bank material become unstable and topple or slide into the river channel, in single events. Mass failure is often dominant in the lower reaches of large rivers, often occurs in association with scouring of lower banks.

Factors which can affect bank alteration processes comprise:

a) stream bed lowering or infill
b) rises in river levels, or inundation of bank soils followed by rapid drops in river levels
c) moisture increases or saturation of bank materials from off-stream sources
d) redirection and acceleration of flow around obstructions, debris or vegetation within the stream channel
e) removal or disturbance of vegetation from stream banks
f) bank soil characteristics such as localised higher permeability seams or zones or poor drainage in materials prone to softening within the bank profile
g) wave action generated by wind or boat wash;
h) intense rainfall/surface drainage events that affect bank materials;

The process is complex. Careful inspection can narrow down, but rarely pinpoint a single cause of instability.

Bank scour is the direct removal of bank materials by the physical action of flowing water and the sediment that it carries. As flow speed increases, the erosive power of flowing water also increases and scour may occur. Increases in flow speed can be the result of natural (e.g. from d, f and h) and/or human induced processes (e.g. a and e). Undercutting of the bank toe is an obvious sign of scour processes. Effective strategies for combating scour are generally aimed at reducing flow speed through revegetation and in some cases through strategic bank or channel works. Mass failure describes the various mechanisms of bank erosion that result in sections of the bank sliding or toppling into the stream.

Mass failure is sometimes described as collapse or slumping. Bare and near-vertical banks or areas of slumped bank materials are obvious signs of these processes. The causes of these types of failures are often difficult to determine but can include natural (e.g. b or f) and/or human factors (e.g. c, e or g). Collapse following undermining of the bank toe and slumping as a result of saturation after flooding are common examples of mass failure.

It is noted that pore-water pressures within the soil are a significant factor in most cases of slope instability, particularly when rapid changes or differential pressures develop. In addition to pore pressures, soil moisture condition is also a significant factor to the stability of the bank. It is noted that moisture variation is a key factor. While dry conditions result in increased suction and increased strength in clay profiles, the clay soils are reactive and prone to shrink-swell behaviour. Dry weather leads to potential for shrinkage cracks and soil structure changes that increase infiltration rates and water pathways into the profile and form tension cracks where water pressures can drive soil movements.

8.2 Mechanisms and Factors Contributing to Slump Instances

From the available information slumping instances, A B and C are consistent with the mass failure or bank collapse described in Section 8.1. As previously mentioned the slumps are restricted to the zone just back from steep bank edges. There are a number of probable contributing factors.

Upgradient groundwater conditions, resulting from general surface infiltration and, in particular, the sediment basins, were nominated as the key factor contributing to the slumping instances by the City of Yarra's consultants (Alluvium-2019). The investigation and study indicate that upgradient groundwater conditions are a probable contributing factor in the slumping instances but one of a number. Due to the complexity of the geology, hydrogeology, variable vegetation conditions, historical slumping instances and modified site conditions it is not possible to pinpoint a single cause. While the geometry and interface shapes of the geological units vary along the river, key characteristics for the slump sites include:

- Near vertical, 2.5 m to 3 m high river edge banks, with a relatively flat terrace extending behind the bank to the toe of the adjacent embankment;
- Minor surface fill overlying natural alluvial materials extending below adjacent mean river level, over Silurian sedimentary rock;
- A basalt flow edge, forming an approximate 7 m to 10 m high, natural basalt rock embankment to the north of the terrace alluvium, with a thickening basalt unit rising and extending many km's to the north and north west of the northern river bank.
- A mean river level at 5.1 m, with occasional river level variations in the order 1 m to 2 m and less frequent but recorded instances of peak levels between 2.5 m and 3.5 m. A number of these would have inundated significant part of the terrace.
- The presence of groundwater in the fractured basalt aquifer to the north of the riverbank, interacting with the terrace alluvium, resulting in groundwater levels in the terrace ranging from RL 5.5 m to 7.8 m AHD and exhibiting some fluctuation, in recent measurements. It is noted that soil moisture conditions in the alluvium, at the borehole locations were variable. This is consistent with predominant clay alluvium, with local higher permeability seems and lenses.
- From the boreholes the terrace soils were typically stiff to very stiff with localised firm zones.
- From the investigation fill materials do not appear to be a significant factor contributing to the slump instances.

Groundwater conditions are discussed further in Section 8.3.

Comment on the significance of site-specific factors are presented below.

Table 2: Slump Instance Comment on Significance of Factors

Factor Description	Comment
a) Sub vertical bank edges with heights exceeding around 2 m to 3 m above mean river level.	This is a key factor. No active slumping is evident in river edge areas that have been made flatter through previous historical slumping.
a) stream bed lowering or infill	No information confirming this. Would require historical bathymetry data.
b) Rises in river levels, or inundation of bank soils followed by rapid drops in river levels	Probable contributing factor. Note that slumps B and C occurred after river level peaks, in December 2018 and May 2019. Consistent with fluctuating GW levels in standpipes near the river edge, historical and recent (MW5, MW4, DG4). Note that historical slumps are evident near these boreholes. See Plate 1 Appendix B, extracted from DP report -July 2019.
c) moisture increases or saturation of bank materials from off-stream sources	Probable contributing factor. Up-gradient standing water levels are influencing soil moisture conditions in the areas of the slumps. The investigation has demonstrated likely hydraulic influence between groundwater in the fractured basalt unit and the soil in the terrace areas near Slumps A and C. The historical data is variable, but there is evidence historical occurrence of groundwater in the terrace soils before. Historical data in MW4, MW5 JBS&G21 is consistent with previous elevated water in the terrace. It noted that organic soil development and absence of shrub vegetation under the Oak trees, near slump A is consistent with long term seasonal or intermittent wet ground. Upgradient groundwater conditions are inconclusive in demonstrating that recent upgradient conditions have caused the recent groundwater level increases, discussed in Section 8.3.
d) redirection and acceleration of flow around obstructions, debris or vegetation within the stream channel	No information demonstrating this.
e) removal or disturbance of vegetation from stream banks	Not aware of significant removal other than toppled trees, where root systems were left in place as far as practicable.
f) bank soil characteristics such as localised higher permeability seams or zones or poor drainage in materials prone to softening within the bank profile	The terrace soils exhibit permeability variation consistent with alluvial deposits. Soil strengths are not an apparent factor with soils in the near slump boreholes typically exhibiting stiff to very stiff consistency. This points to bank height, sub vertical inclination and variation in groundwater levels through river fluctuation and upgradient conditions.

8.3 Upgradient Groundwater Influences

Groundwater level data is presented on Drawing 1C Appendix B.

The key upgradient groundwater feature is the fractured basalt rock and the interface between the southern edge of the basalt flow boundary / embankment and the river terrace alluvial deposit.

It is evident from recent groundwater levels measured in the boreholes located in the embankment crest areas, in conjunction with the levels recorded in the river terrace that there is hydraulic connection between the fractured basalt aquifer and the alluvium in the terrace. This is illustrated on the cross-section drawings in Appendix B.

At the time of writing water is emanating from the toe of the embankment, adjacent to and just above the adjacent terrace. The water is trickling down to the river over slump A. This has developed since December 2019 and January 2020.

Key conclusions from the data are:

River front area West of Latrobe Avenue:

- Recent groundwater level readings and comparison with historic upgradient levels indicates consistency between recent and historical data;
- The levels in standpipes in the river front area (DG4, DG5) indicate levels well below the terrace surface and well below the upper bank zone.
- Upgradient groundwater levels do not appear to be a contributing factor to bank stability in this area at the time of writing.

River front area East of Latrobe Avenue:

- Groundwater levels in the crest area (DG6 and DG7) and adjacent terrace (DG12, DG13, DG15 and DG16) indicated groundwater levels in the terrace about 2 m to 2.5 m higher than adjacent mean river level, representing a likely contributing factor to adjacent slump activity.
- Historical groundwater data is not available in the crest area and it cannot be determined if these recent levels are unprecedented.
- There is evidence that the conditions have occurred before
    - The level in JBSG21 from 2016 is consistent with the recent readings in DG15 and DG15 without significant change between then and now.
    - As previously stated the organic soil under the Oak trees is consistent with localised intermittent wet / swampy ground.
- The present groundwater levels in the eastern part of the terrace are a probable contributing factor to slump activity.

Upgradient site factors contributing to the groundwater conditions in the current eastern terrace area include:

- The presence of compacted site won and imported clay fill over a significant proportion of the upgradient site, minimising surface infiltration pathways;
- Sealed surfaces across the House and Land Area, since 2019, reducing infiltration in this zone in comparison to historical conditions;
- Removal of most of the former below ground services and associated drainage pathways from the site during the remediation phase in 2017/2018.
- Potential infiltration of water through the sediment basins located at the southern end of Latrobe Avenue. It is noted that City of Yarra's consultant (Alluvium-2019) nominate this as the key contributing factor influencing groundwater conditions in the river front area. The available data is not considered conclusive on this aspect. The profile underlying the basins comprise low permeability natural clay. The soils were generally dry and were not consistent with long term water infiltration. Seepage losses through an intermittently filled basin with a low permeability clay subgrade are unlikely to significantly contribute to the conditions in the underlying fractured basalt aquifer. It is further noted that the basins were managed in a way that minimised stored volumes, by using the water for moisture conditioning and dust suppression. Inflows were mitigated due the irregular surfaces during remediation. A proportion of water falling on the ground is absorbed into the surface soils, as discussed in Section 4.3.2.
- Significant contribution from the basins would require significant high permeability zones in the basin floors and these were not identified.
- It is noted that downgradient borehole DG1 did not indicate elevated water, with level approximately consistent with historical levels.

Backfilling the basins has eliminated any potential groundwater recharge pathways.

As mentioned in Section 4.4, the invert depth and location of the unlined western portion of the former North Yarra Sewer Main is a potential contributing factor to altered conditions in the eastern crest and terrace zone. With a reported invert level around 4 m to 5 m AHD, any infiltration into the old brick lined sewer would have reduced groundwater levels in the fractured basalt for decades. The suspected dewatering affect would have ceased when the sewer was back grouted as a decommissioning measure in 2015/2016.

It is noted that there are numerous possible unidentified natural or former industrial features that could be contributing to groundwater conditions. This includes the possibility of localised high-level perched water features in the natural basalt encountered elsewhere on the site (the Parkview apartment site) or natural fluctuation.

Further planned groundwater monitoring could assist in identifying possible influences.

8.4 Further Action

Considering the ground profiles, groundwater conditions, recent and historical (pre-demolition) slumping instances, different approaches are recommended for three different the three terrace zones defined below. Further groundwater monitoring is required to define conditions and AD have instructed DP to install automated water level loggers for six targeted boreholes, with ongoing manual measurements required in the other four standpipes.

It is noted that bathymetry data (river floor levels) were recently collected for the relevant stretch of river. The data will be used to revise the cross-section drawings and as input for stability analysis.

8.4.1 Area West of Latrobe Avenue

From visual observation, geotechnical and groundwater condition information, there does not appear to be a bank stability issue in this area at present.

It is suggested that ongoing measures include periodic groundwater level checks in the relevant borehole standpipes and periodic visual inspection of the riverbank and adjacent embankment.

8.4.2 Central Area Slump C End of Latrobe

Relevant Cross-sections are C1 and C2, Appendix B, adjacent to Slump C. The available information indicates potential for further movement of the existing slump and there is some uncertainty around ongoing groundwater levels. It is also noted that the terrace is at its thinnest point at this location with the distance between the groundwater source and river bank, the closest for the site. This is a natural condition that increases the sensitivity of the location to upgradient groundwater variation.

It is recommended that monitoring be undertaken at this location, including groundwater levels, survey and visual inspection, with possible consideration of temporary or long-term sub-surface drainage depending on the outcome of the monitoring.

8.4.3 Area East of Latrobe Avenue

Relevant Cross-sections are D1 and D2, Appendix B, adjacent to Slumps A and B. The available information indicates potential for further movement of the existing slump and the need for temporary drainage to mitigate the effect of the water emanating from the toe of the adjacent embankment and flowing across the surface to the current Slump A. It is understood that installation of the temporary sub-soil drain is occurring at the time of writing.

It is recommended that monitoring be undertaken at this location, including groundwater levels, survey and visual inspection, with possible consideration of long-term sub surface drain installation depending on the outcome of the monitoring.

9. References

- Alluvium (august 2019) Tree collapse and bank slump investigation on Yarra River adjacent to former Amcor site at Alphington.
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- Australian Government Bureau of Meteorology. Website (bom.gov.au) rainfall and wind data for Melbourne.
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- GHD (May 2016). Former Alphington Paper Mill, Alphington. Groundwater Beneficial Use Impact Assessment.
- Melbourne Water website. (melbournewater.com.au) stream gauge data for Yarra River at Alphington.
- Nearmap.com (various historical aerial images).
- Reeds (January 2018) Yarrabend Main Drain Stage 1 – South Section Layout Plan and Longitudinal Cross Section, 22185G/MD1 Version G Sheets 2 and 4 of 8.
- Reeds (January 2020) Plan of Features and Levels. 626 Heidelberg Road, Alphington. Ref: 22185/G Version C, Sheets 1 to 4.
- Reeds (February 2020) Yarrabend SEMP Drawings Strategy Plans 22185G/SEMP. Sheets 1 to 4.
- Reeds (August 2013) Plan of Features and Levels. 626 Heidelberg Road, Alphington. Ref: 22185/FL Version C, 12/8/2013.

10. Limitations

Douglas Partners (DP) has prepared this report for the Yarrabend River Frontage as instructed by Alphington Developments Pty Ltd. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Cone Penetration Tests

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

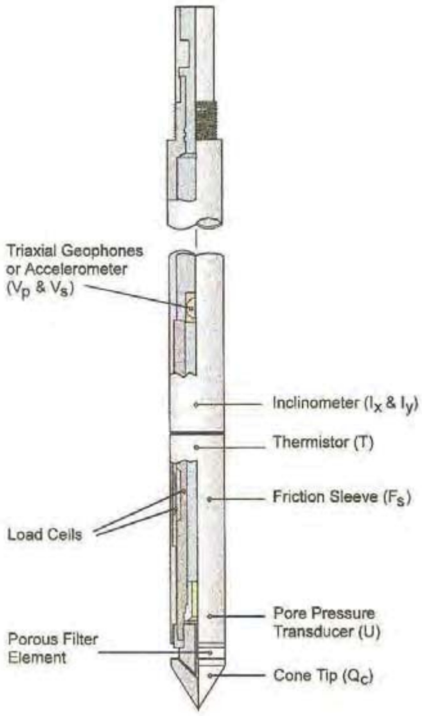


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

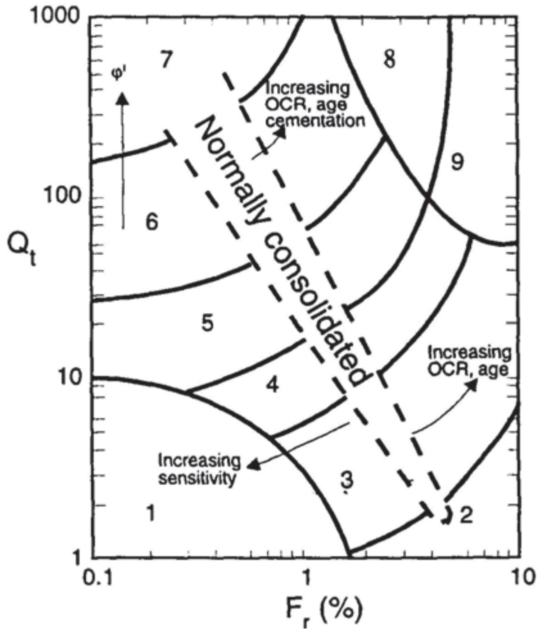


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

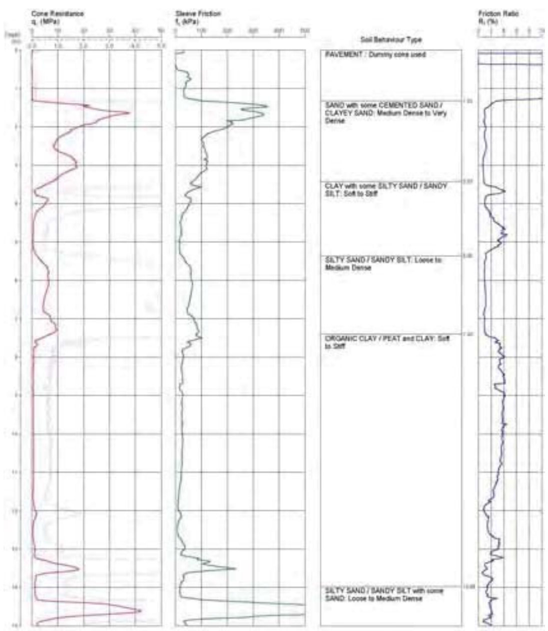


Figure 4: Sample Cone Plot

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * $Is_{(50)}$ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	M	6 - 20	0.3 - 1.0
High	H	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100\text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w <PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w >PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈LL' (i.e. near the liquid limit).
- 'Wet' or 'w >LL' (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

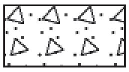
Symbols & Abbreviations

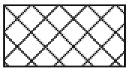
Graphic Symbols for Soil and Rock

General

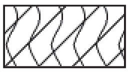
 Asphalt

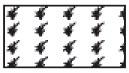
 Road base

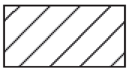
 Concrete

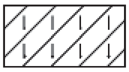
 Filling

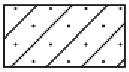
Soils

 Topsoil

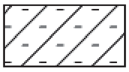
 Peat

 Clay

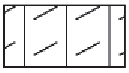
 Silty clay

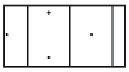
 Sandy clay

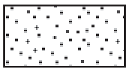
 Gravelly clay

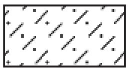
 Shaly clay

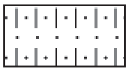
 Silt

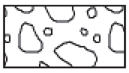
 Clayey silt

 Sandy silt

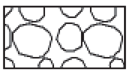
 Sand

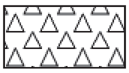
 Clayey sand

 Silty sand

 Gravel

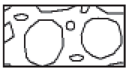
 Sandy gravel

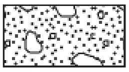
 Cobbles, boulders

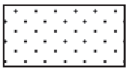
 Talus

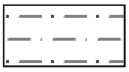
Sedimentary Rocks

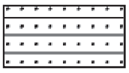
 Boulder conglomerate

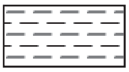
 Conglomerate

 Conglomeratic sandstone

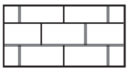
 Sandstone

 Siltstone

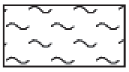
 Laminite

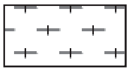
 Mudstone, claystone, shale

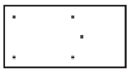
 Coal

 Limestone

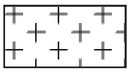
Metamorphic Rocks

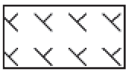
 Slate, phyllite, schist

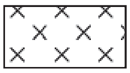
 Gneiss

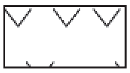
 Quartzite

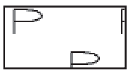
Igneous Rocks

 Granite

 Dolerite, basalt, andesite

 Dacite, epidote

 Tuff, breccia

 Porphyry

Appendix B

Drawing 1A Yarrabend: Groundwater / Geotechnical Borehole / Test Pit Plan (2020 Nearmap Image Overlay)

Drawing 1B Yarrabend: Groundwater / Geotechnical Borehole / Test Pit Plan (Pre-demolition Survey Overlay)

Drawing 1C Yarrabend: Groundwater / Geotechnical Borehole / Test Pit Plan – Groundwater Level Data. (2020 Nearmap Image Overlay)

Drawing 2A Yarrabend: Northern River Bank Area: Groundwater / Geotechnical Borehole / Test Pit Plan (Nearmap and Contour 2020 Survey Overlay)

Drawing 2B Yarrabend: Northern River Bank Area Groundwater / Geotechnical Borehole / Test Pit Plan (Pre-Demolition Survey Overlay)

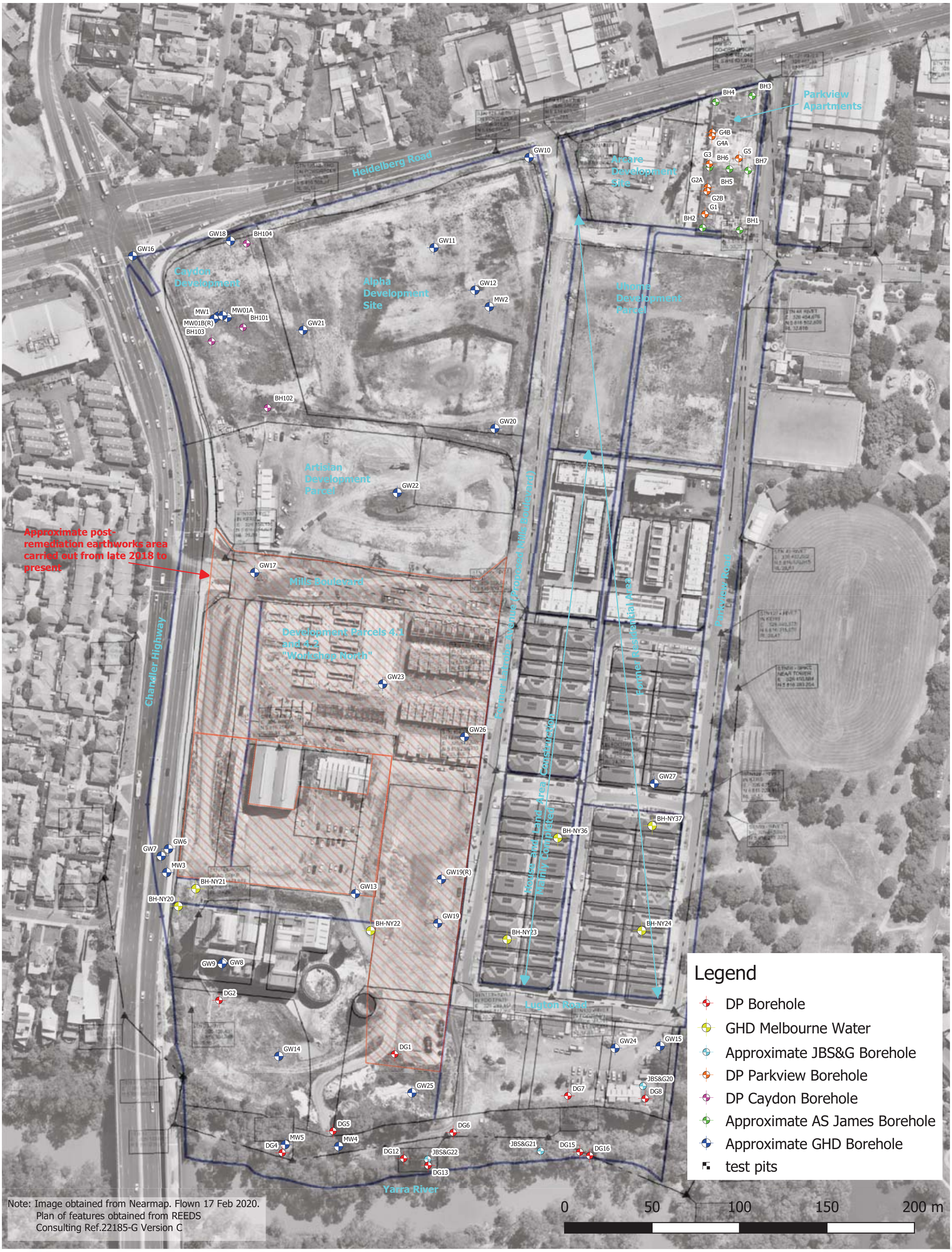
Cross Sections A1-A1 / A2-A2 / B-B / C1-C1 / C2-C2 / D1-D1 / D2-D2 (8 sheets)

Reeds Main Drain Plan and Longitudinal Cross Section

GHD North Yarra Sewer Main Plan

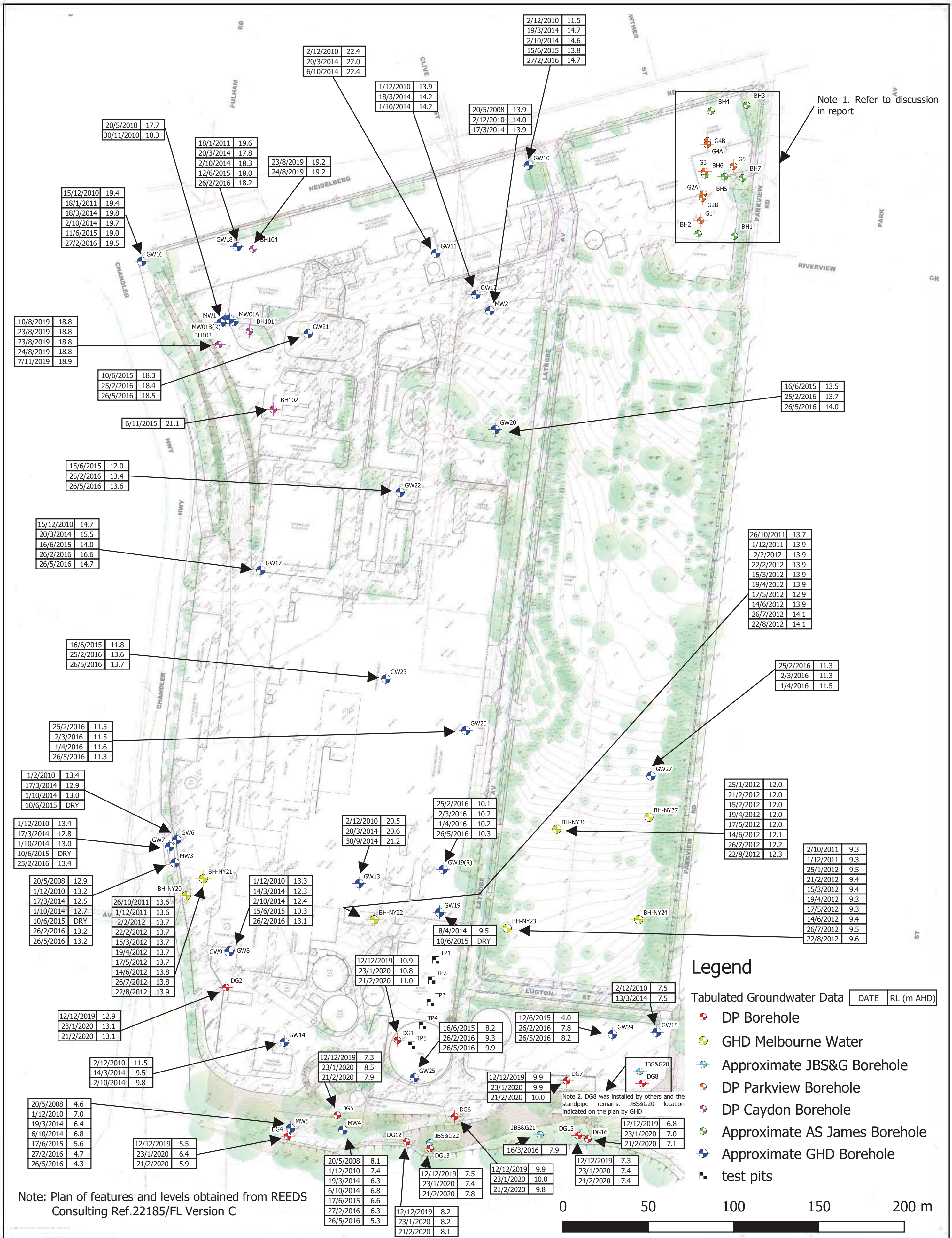
Plate 1 and Plate 11 (extracts of DP July 2019 Report)

CSC Environmnetal Management Plan (EMP



Douglas Partners Geotechnics / Environment / Groundwater	TITLE: **Yarrabend: Yarra River Frontage Geotechnical/ Groundwater study Groundwater / Geotechnical Borehole / Test Pit Plan**			OFFICE: Melbourne DRAWN BY: ML DATE: Feb 2020
CLIENT: Alphington Developments Pty Ltd	PROJECT No: 79075.12	DRAWING No: 1A	REVISION: A	SCALE: As Shown

Douglas Partners *Geotechnics / Environment / Groundwater*	TITLE: **Yarrabend: Yarra River Frontage Geotechnical/ Groundwater study** **Groundwater / Geotechnical Borehole / Test Pit Plan** **Pre-Demolition Survey Overlay**
OFFICE: Melbourne	DRAWN BY: ML
DATE: Feb 2020	SCALE: As Shown
CLIENT: Alphington Developments Pty Ltd	PROJECT No: 79075.12
DRAWING No: 1B	REVISION: A



Douglas Partners
Geotechnics | Environment | Groundwater

TITLE: **Yarrabend: Yarra River Frontage Geotechnical / Groundwater study Groundwater / Geotechnical Borehole / Test Pit Plan with groundwater level data to AHD Pre-Demolition Survey Overlay**

N

OFFICE: Melbourne

DRAWN BY: ML

DATE: Feb 2020

CLIENT: Alphington Developments Pty Ltd

PROJECT No: 79075.12

DRAWING No: 1C

REVISION: A

SCALE: As Shown

Note: Image obtained from Nearmaps. Flown 17 Feb 2020.
Plan of features and levels obtained from REEDS Consulting Ref.22185/G Version C

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: AP oVG Me GDbubPJr bGn 2e0 Lep	
OFFICE: h bPI gtGb	DRAWN BY: h L
SCALE: An nol wG	DATE: Fbi ydyd

TITLE: **Yarrabend Northern River Bank Area**
Groundwater / Geotechnical Borehole / Test Pit Plan
Contours From Early 2020 Survey

N

2ROvECT NI : 79d75.1y
DRAWINs NI : yA
REmISION: A

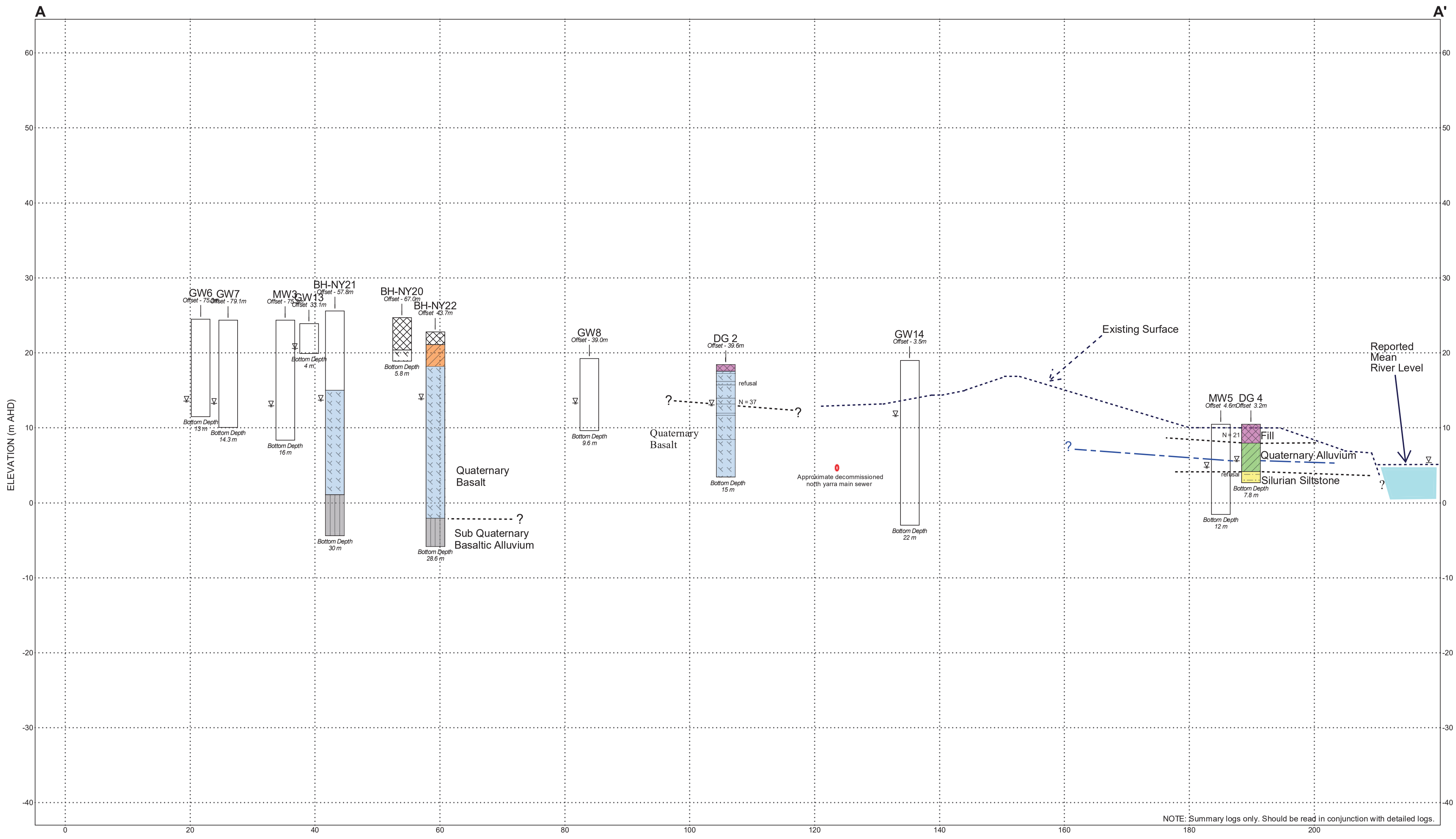
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: AЗoVGMe GDbubPJr bGen 2e0 Lep		
OFFICE: h bPl gtGb	DRAWN BY: h L	
SCALE: An nol wG	DATE: Fbi ydyd	

TITLE: **Yarrabend Northern River Bank Area**
Groundwater / Geotechnical Borehole / Test Pit Plan
Contours From Pre-Demolition Survey

N

2ROmECT NI : 79d75.1y
DRAWINs NI : yB
REv ISION: A



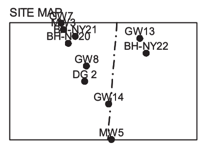
LEGEND

- Filling
- Basalt
- Silt
- Clay
- Siltstone

TESTS / OTHER

N - Standard penetration test value
Water level
PP - Pocket penetrometer test value

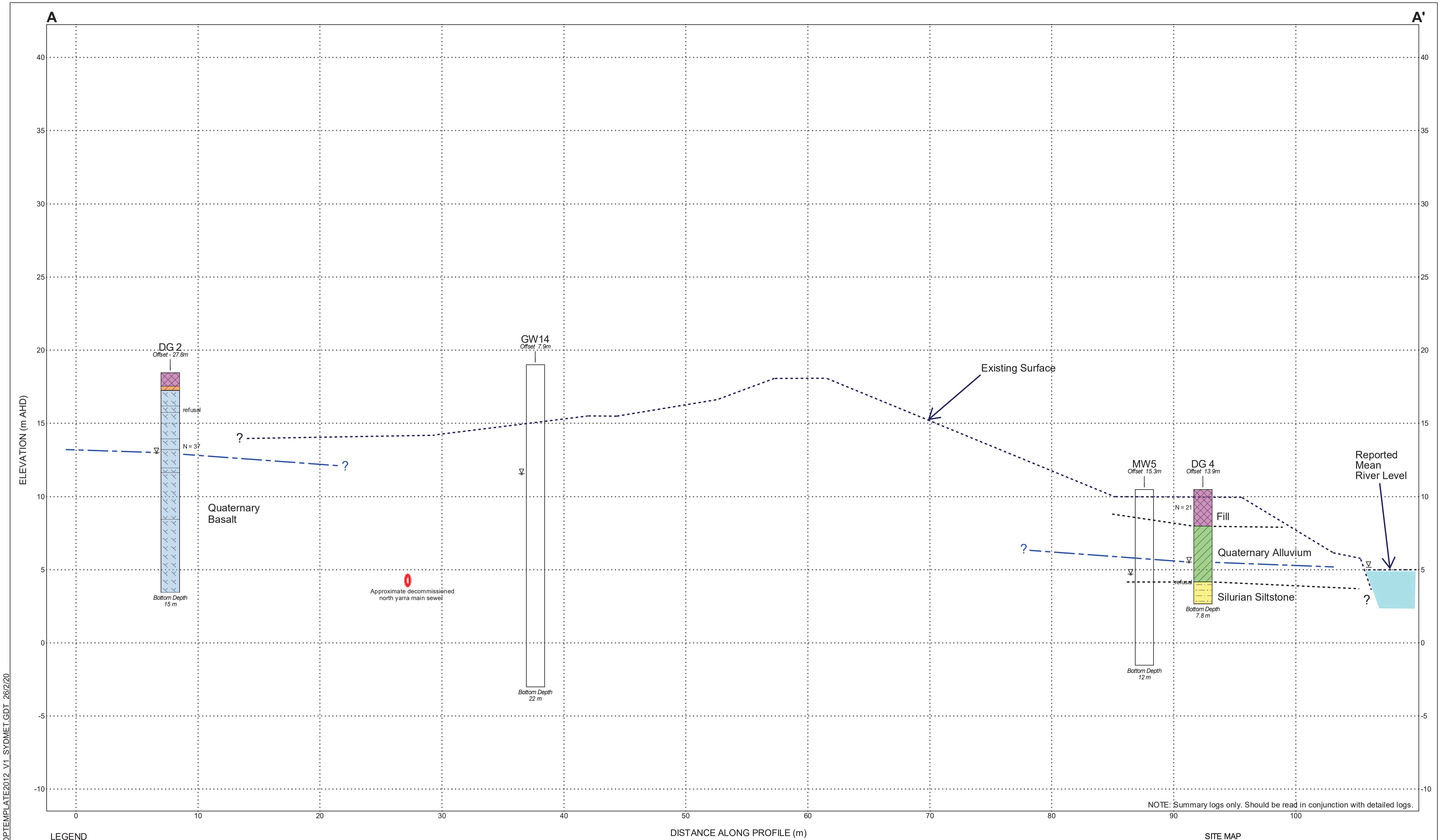
SITE MAP



0 12
Horizontal Scale (metres)
Vertical Exaggeration = 1.2

Douglas Partners
Geotechnics / Environment / Groundwater

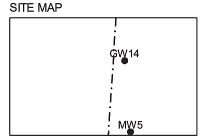
CLIENT: Alphington Developments Pty Ltd		TITLE: **Cross-section A1-A1** **Yarra Bend** **Northern Yarra River Bank Area**	PROJECT No: 79075.12
OFFICE: Melbourne	DRAWN BY:		DRAWING No: A-1
SCALE: 1:600 (H) 1:500 (V) @ A3	DATE: 26.02.2020		REVISION:



LEGEND
- Filling
- Clay
- Basalt
- Siltstone

TESTS / OTHER
N - Standard penetration test value
Water level
PP - Pocket penetrometer test value

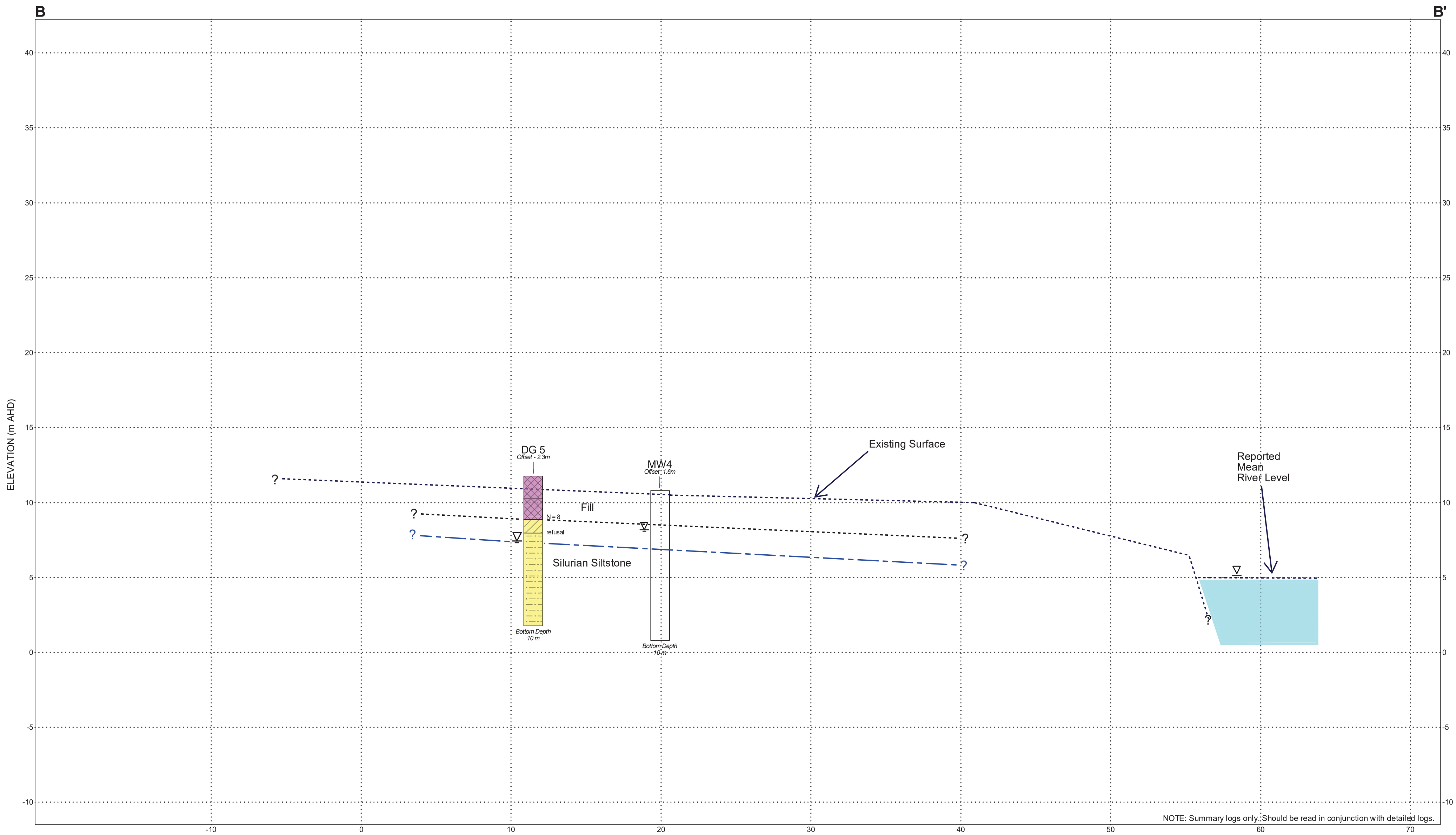
SITE MAP



0 6
Horizontal Scale (metres)
Vertical Exaggeration = 1.2

Douglas Partners
Geotechnics / Environment / Groundwater

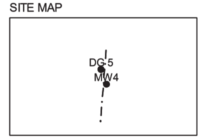
CLIENT: Alphington Developments Pty Ltd		TITLE: **Cross-section A2-A2**	PROJECT No: 79075.12
OFFICE: Melbourne	DRAWN BY:	**Yarra Bend**	DRAWING No: A-2
SCALE: 1:300 (H) 1:250 (V) @ A3	DATE: 26.02.2020	**Northern Yarra River Bank Area**	REVISION:



LEGEND
- Filling
- Clay
- Siltstone

TESTS / OTHER
N - Standard penetration test value
Water level
PP - Pocket penetrometer test value

SITE MAP

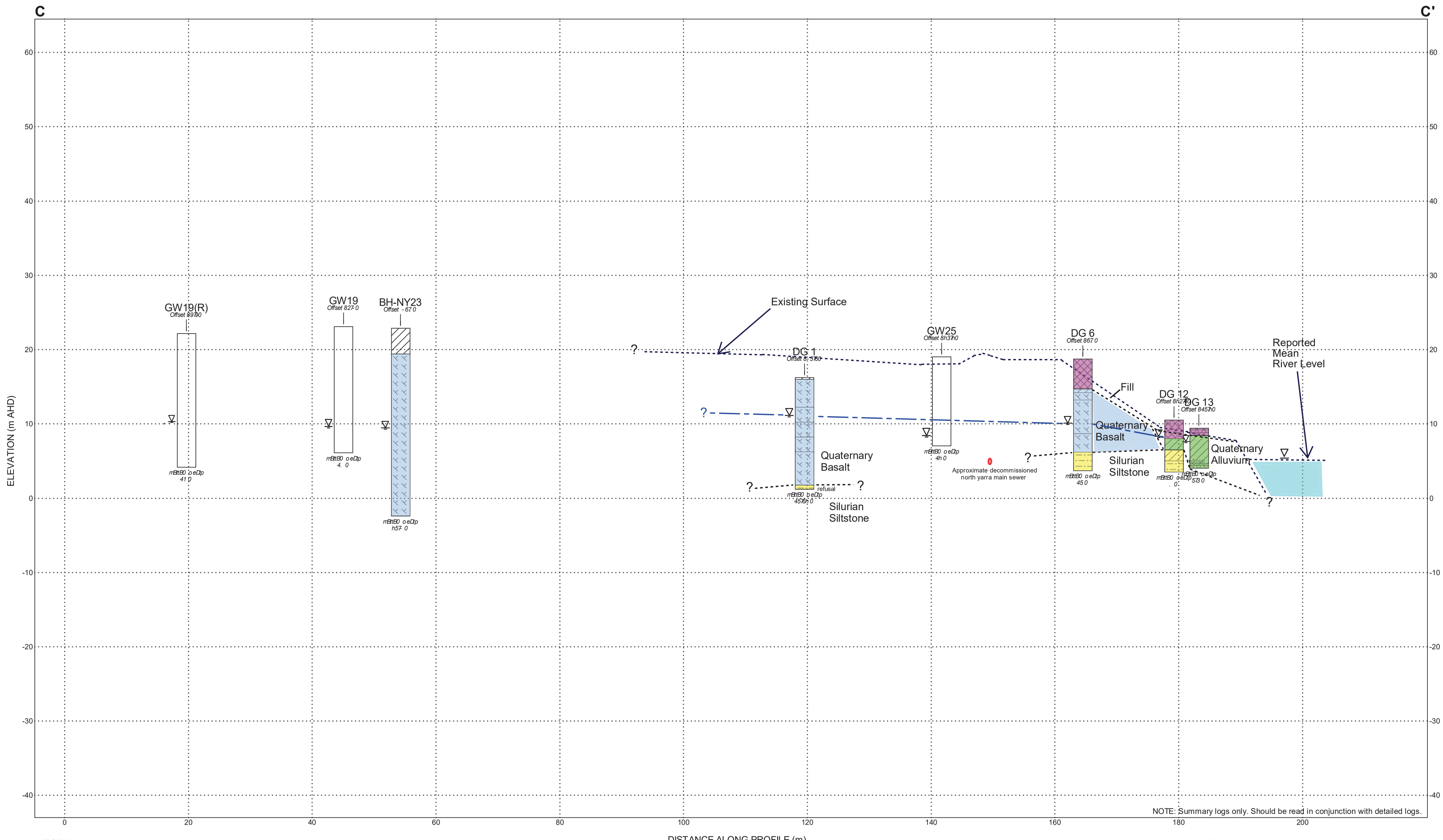


0 5
Horizontal Scale (metres)
Natural Scale

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Alphington Developments Pty Ltd		TITLE: **Cross-section B-B**	PROJECT No: 79075.12
OFFICE: Melbourne	DRAWN BY:	**Yarra Bend**	DRAWING No: B-1
SCALE: 1:250 (H) 1:250 (V) @ A3	DATE: 26.02.2020	**Northern Yarra River Bank Area**	REVISION:

CPT CROSS-SECTION CROSS SECTION.GPJ DPTEMPLATE2012_V1 SYDMET.GDT 26/2/20



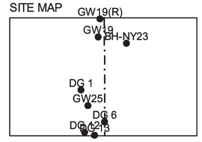
LEGEND

- Clay
- Basalt
- Siltstone
- Filling
- Silt
- Sand

TESTS / OTHER

N - Standard penetration test value
- Water level
PP - Pocket penetrometer test value

SITE MAP

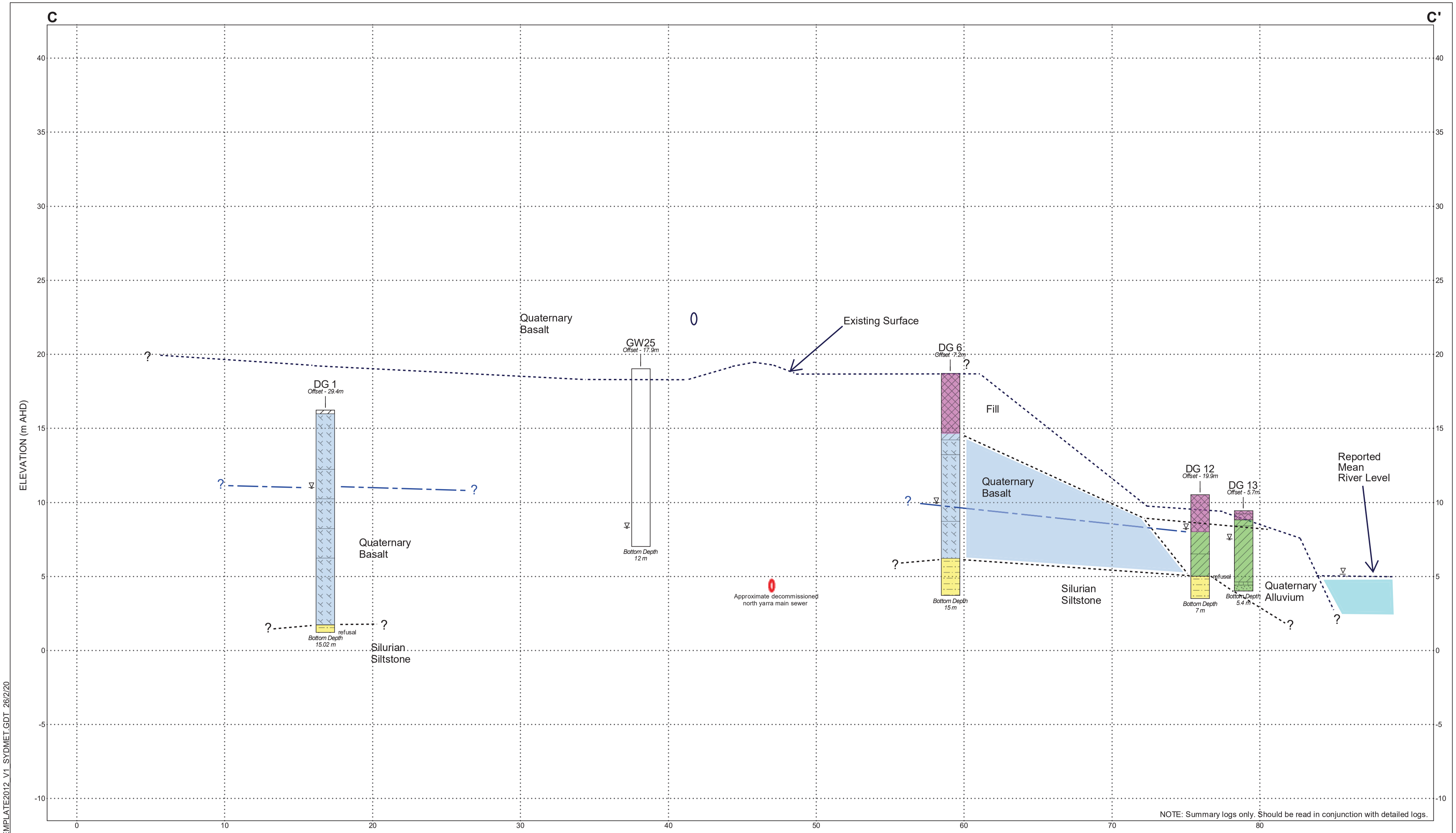


0 12
Horizontal Scale (metres)
Vertical Exaggeration = 1.2

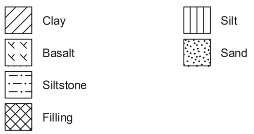
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Alphington Developments Pty Ltd		TITLE: **Cross-section C1-C1**	PROJECT No: 79075.12
OFFICE: Melbourne	DRAWN BY:	**Yarra Bend**	DRAWING No: C-1
SCALE: 1:600 (H) 1:500 (V) @ A3	DATE: 26.02.2020	**Northern Yarra River Bank Area**	REVISION:

CPT CROSS-SECTION CROSS SECTION.GPJ DPTEMPLATE2012_V1 SYDMET.GDT 26/2/20

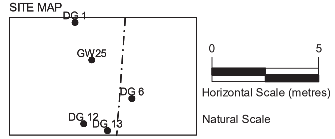


LEGEND



TESTS / OTHER
N - Standard penetration test value
Water level
PP - Pocket penetrometer test value

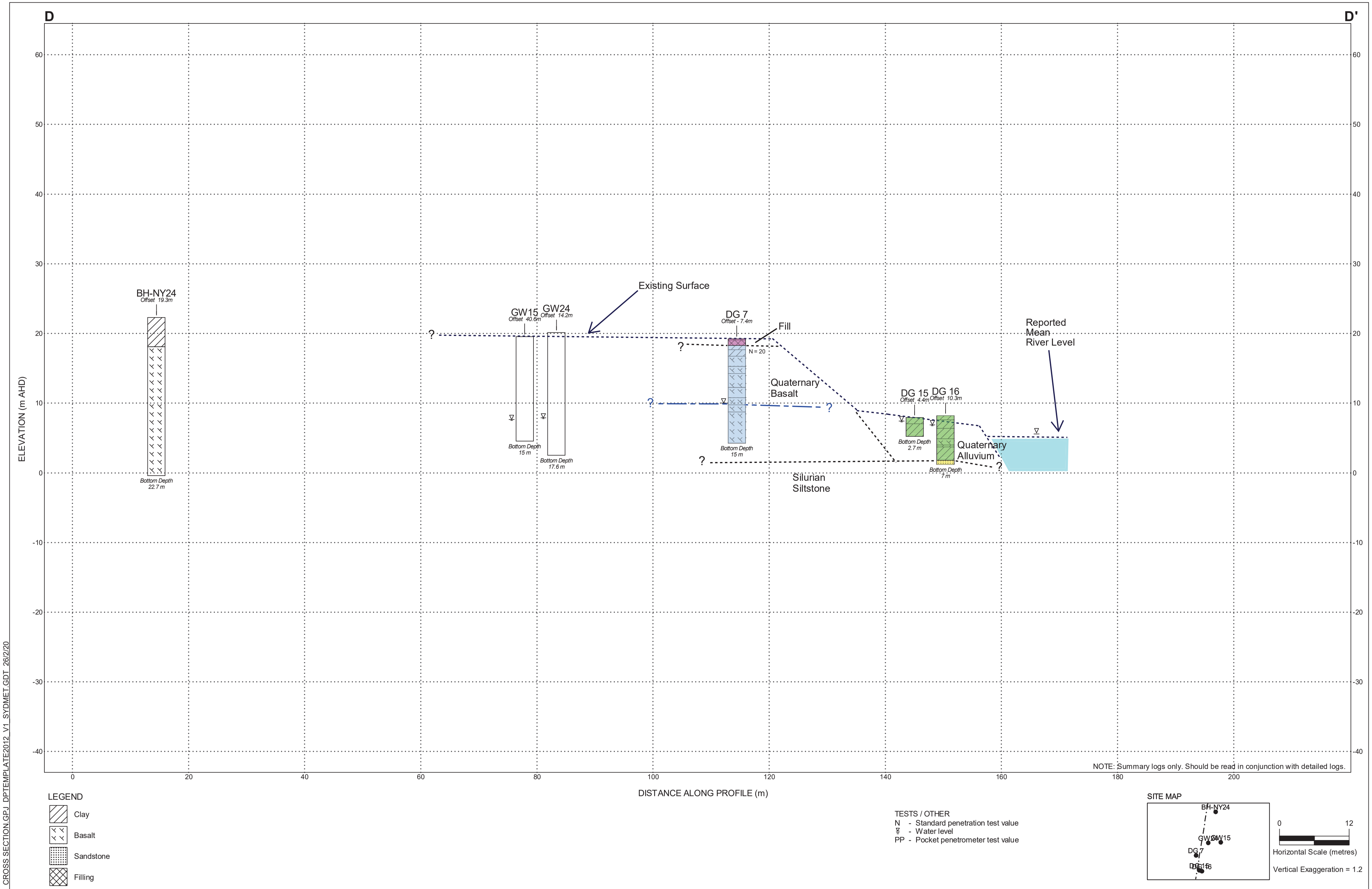
SITE MAP



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Alphington Developments Pty Ltd		TITLE: **Cross-section C2-C2** **Yarra Bend** **Northern Yarra River Bank Area**	PROJECT No: 79075.12
OFFICE: Melbourne	DRAWN BY:		DRAWING No: C-2
SCALE: 1:250 (H) 1:250 (V) @ A3	DATE: 26.02.2020		REVISION:

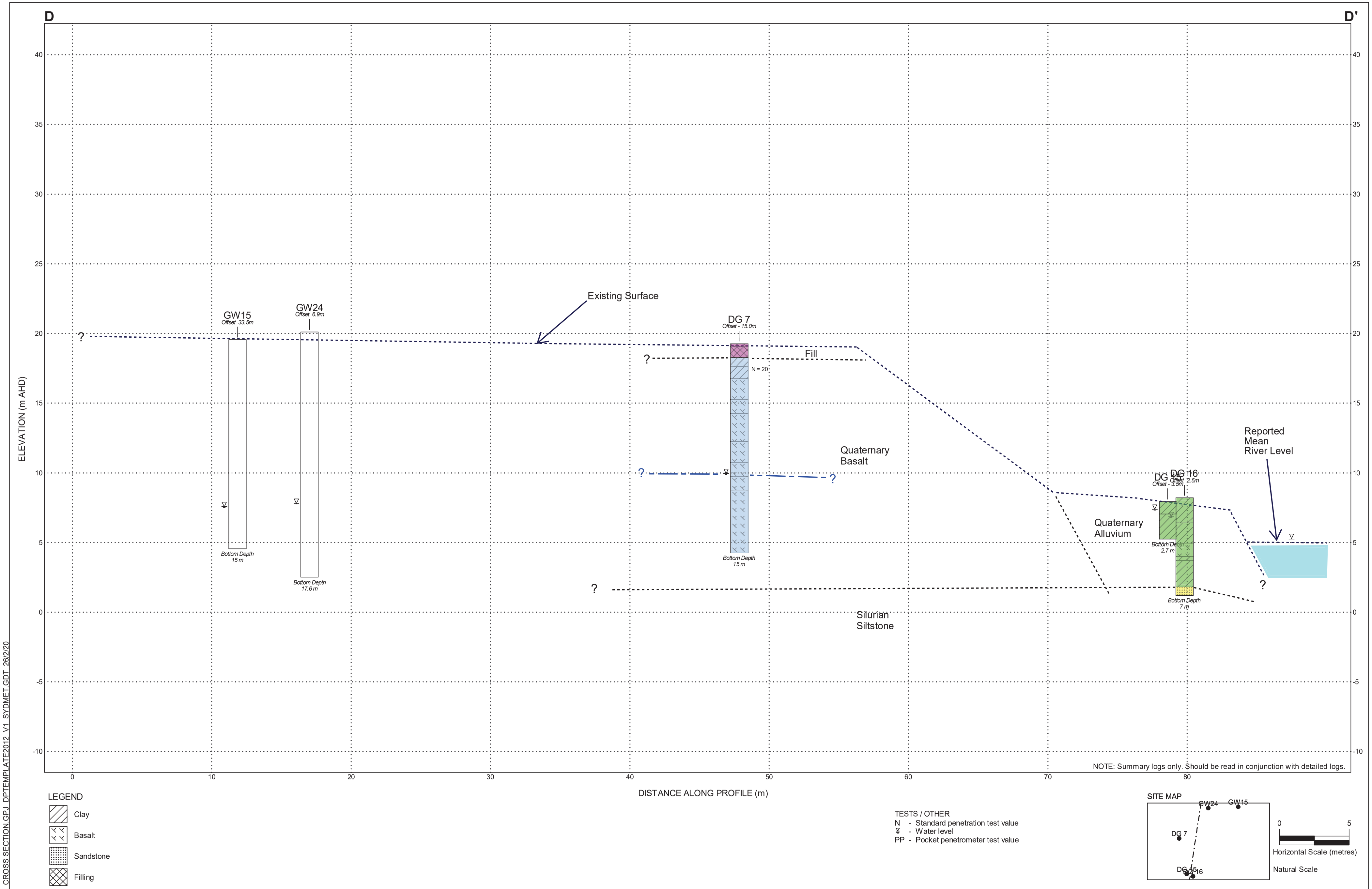
CPT CROSS-SECTION CROSS SECTION.GPJ DPTEMPLATE2012_V1 SYDMET.GDT 26/2/20



Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Alphington Developments Pty Ltd		TITLE: **Cross-section D1-D1**	PROJECT No: 79075.12
OFFICE: Melbourne	DRAWN BY:	**Yarra Bend**	DRAWING No: D-1
SCALE: 1:600 (H) 1:500 (V) @ A3	DATE: 26.02.2020	**Northern Yarra River Bank Area**	REVISION:

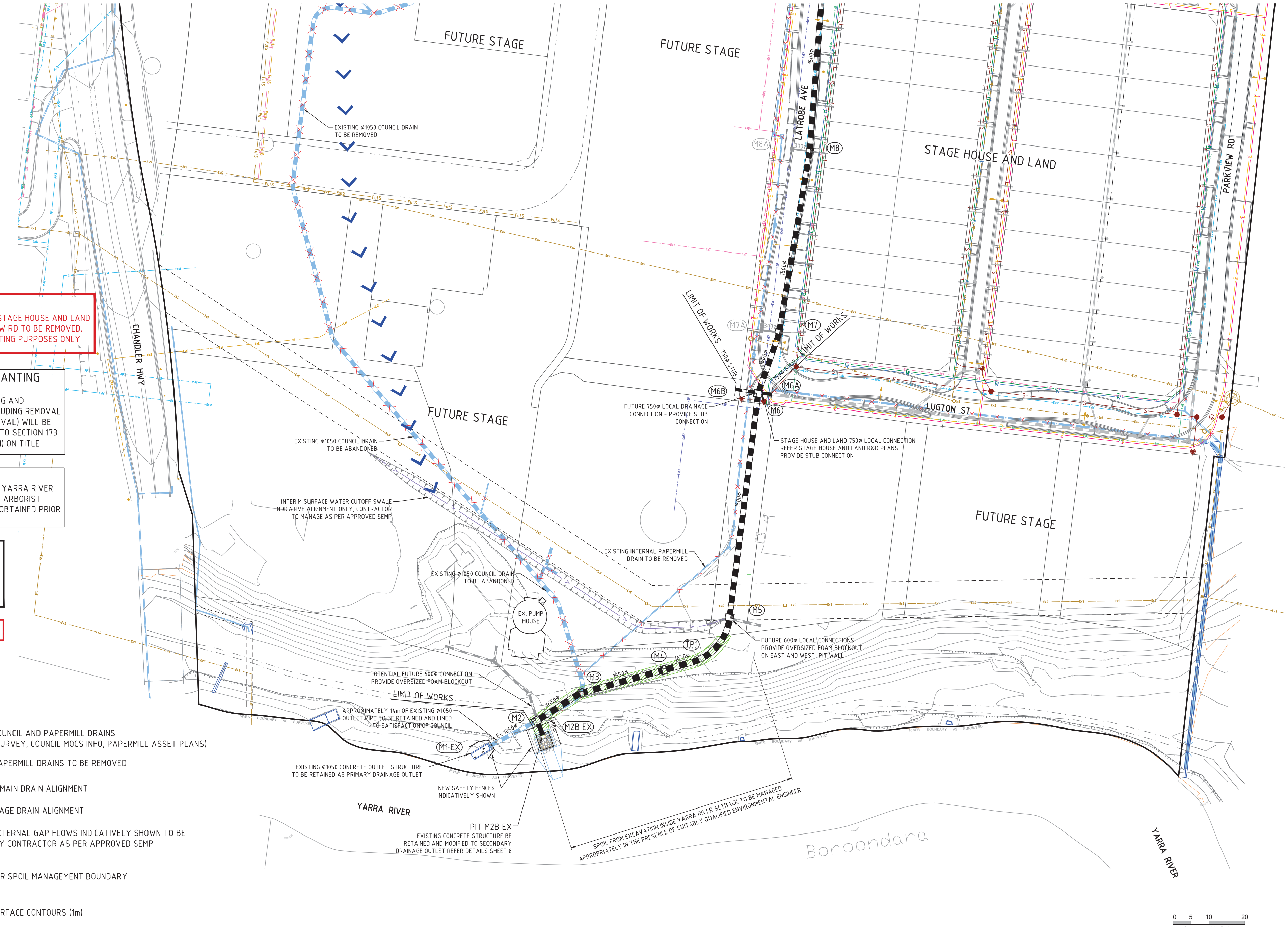
CPT CROSS-SECTION CROSS SECTION.GPJ DPTEMPLATE2012 V1 SYDMET.GDT 26/2/20



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Alphington Developments Pty Ltd		TITLE: **Cross-section D2-D2** **Yarra Bend** **Northern Yarra River Bank Area**	PROJECT No: 79075.12
OFFICE: Melbourne	DRAWN BY:		DRAWING No: D-1
SCALE: 1:250 (H) 1:250 (V) @ A3	DATE: 26.02.2020		REVISION:

CPT CROSS-SECTION CROSS SECTION.GPJ DPTEMPLATE2012_V1 SYDMET.GDT 26/2/20



NOTE

ALL EXISTING SERVICES SHOWN WITHIN STAGE HOUSE AND LAND LATROBE AVE, LUGTON ST & PARKVIEW RD TO BE REMOVED. EXISTING SERVICES SHOWN FOR LOCATING PURPOSES ONLY

NOTE REPLACEMENT TREE PLANTING

DETAILS OF REPLACEMENT TREE PLANTING AND LANDSCAPING OF THE EMBANKMENT, INCLUDING REMOVAL OF TREE STUMPS (FOLLOWING TREE REMOVAL) WILL BE PROVIDED AT A LATER DATE PURSUANT TO SECTION 173 AGREEMENT (INSTRUMENT NO. AN278889H) ON TITLE

NOTE

MAIN DRAINAGE OUTFALL WORKS INSIDE YARRA RIVER SETBACK REQUIRE TREE REMOVAL REFER ARBORIST REPORT. TREE REMOVAL PERMITS TO BE OBTAINED PRIOR TO COMMENCEMENT OF OUTFALL WORKS

WARNING

BEWARE OF UNDERGROUND SERVICES

THE LOCATIONS OF UNDERGROUND SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

CONSTRUCTION PLAN

LEGEND

- EXISTING COUNCIL AND PAPERMILL DRAINS (FEATURE SURVEY, COUNCIL MOCS INFO, PAPERMILL ASSET PLANS)
- EXISTING PAPERMILL DRAINS TO BE REMOVED
- PROPOSED MAIN DRAIN ALIGNMENT
- FUTURE STAGE DRAIN ALIGNMENT
- EXISTING EXTERNAL GAP FLOWS INDICATIVELY SHOWN TO BE MANAGED BY CONTRACTOR AS PER APPROVED SEMP
- YARRA RIVER SPOIL MANAGEMENT BOUNDARY
- EXISTING SURFACE CONTOURS (1m)

THIS DRAWING IS NOT TO BE COPIED OR SCALED

VERSION	REMARKS	DATE	BY
G	SHEET 8 ADDED TO DRAWING SET, PIT M2B EX AMENDED	15.01.18	SJ
F	EXISTING SERVICES SHOWN FOR CLARITY	22.11.17	SJ
E	REPLACMENT TREE PLANTING NOTATION ADDED	24.10.17	SJ
D	PIT M2 REVISED PROVED EX DRAIN PICKUP	26.07.17	SJ
C	REVISED COUNCIL COMMENTS, CONSTRUCTION ISSUE	23.06.17	SJ

LEGEND

DRAIN, PROPERTY INLET & PIT; EX DRAIN & PIT; HOUSE DRAIN; SEWER AND MAINTENANCE HOLE; EX SEWER AND MAINTENANCE HOLE; WATER MAIN; EX WATER MAIN, VALVE & HYDRANT; GAS MAIN; EX GAS MAIN, VALVE; TELSTRA SERVICES & PITS; EX TELSTRA SERVICES & PITS

RECYCLED WATER; EX RECYCLED WATER; ELECTRICAL U.G. SERVICES; EX ELECTRICAL U.G. SERVICES; ELECTRICAL SERVICE & PIT; LIGHT POLE PIT EX ELECTRICAL ASSETS; EX ELECTRICAL OVERHEADS; GAS & WATER CONDUITS; TOP OF BATTER; TOE OF BATTER

F FINISHED SURFACE AFTER CUTTING OR FILLING; Fb TOP OF PROPOSED BATTER; P PROPOSED PAVEMENT OR FOOTPATH SURFACE; IL EXISTING OR PROPOSED INVERT LEVEL OF PIPE OR OPEN DRAIN; TP TANGENT POINT; CH CHAINAGE; PSM; STREET SIGN; DRAINAGE PIT No.; TBM; EX FENCE; EX WALL OR BUILDING

DRAWN BY	S. JELICIC	DESIGNED BY	S. JELICIC
MELWAY	31, B11	CHECKED BY	D. DAMEN S. RAVIDA
DATUM	AHD	AUTHORISED BY	S. RAVIDA

REEDS CONSULTING

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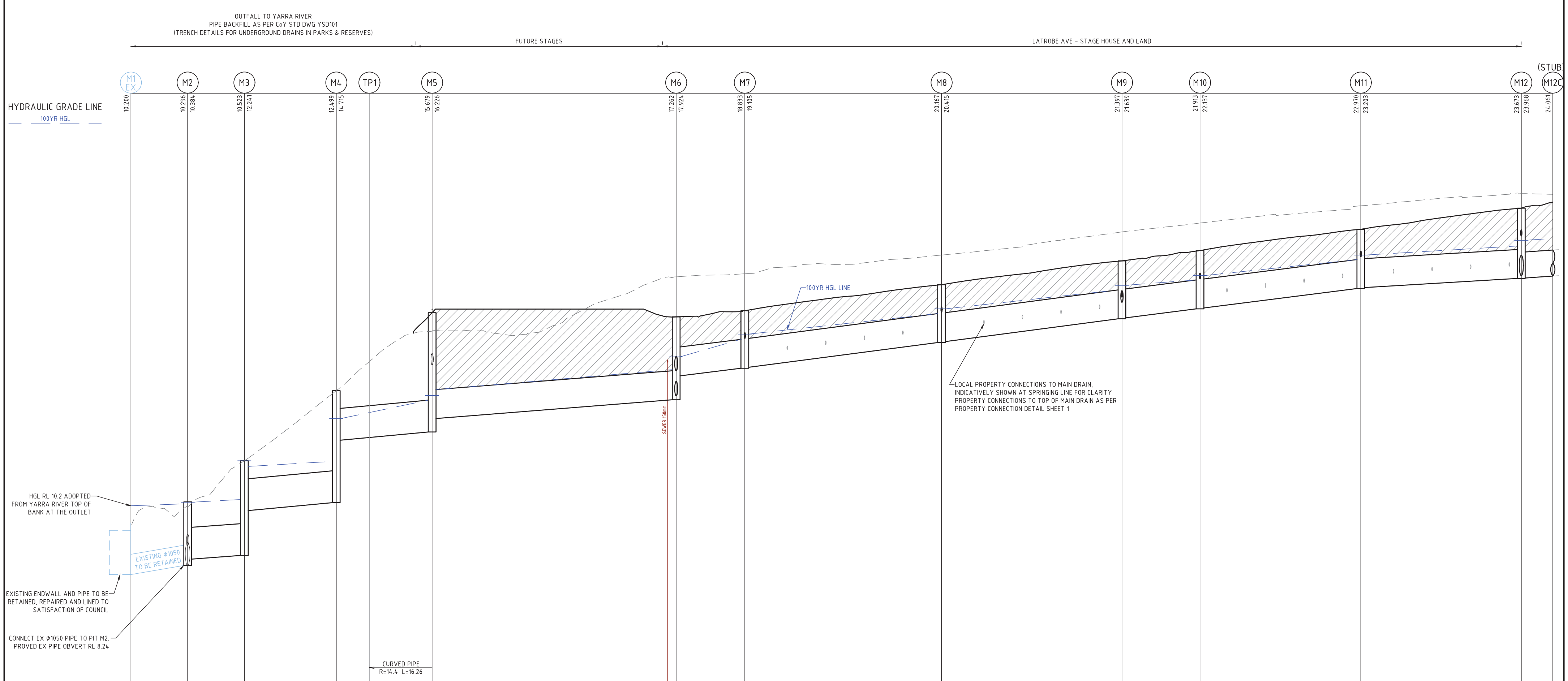
p (03) 8660 3000

CITY OF YARRA
YARRABEND - PARK PRECINCT
MAIN DRAIN STAGE 1 - SOUTH SECTION
MAIN DRAIN LAYOUT PLAN

DRAWING No.	MD2
VERSION	G
REFERENCE	22185G/MD1
SHEET	2 OF 8

H:\22185G\STAGE MAIN DRAIN 1 - SOUTH\CAD\DWG SET\MAIN DRAIN\22185G_MD2G-3F.DWG



Segment	DESIGN FLOW (m3/s)	CAPACITY (m3/s)	AT GRADE VELOCITY (m/s)	PIPE SIZE (mm)	GRADE	Reach Length
M1 EX – M2	4.685	5.340	6.17	1050ϕ	1 in 31.3	(14.714)
M2 – M3	10.100	10.961	5.13	1650ϕ	1 in 78.7	(14.694)
M3 – M4	10.100	12.770	5.97	1650ϕ	1 in 58	(23.836)
M4 – M5 (via TP1)	10.100	12.770	5.97	1650ϕ	1 in 58	(24.865)
M5 – M6	9.700	9.404	5.32	1500ϕ	1 in 65	(63.288)
M6 – M7	8.394	11.308	6.4	1500ϕ	1 in 45	(17.804)
M7 – M8	8.372	12.037	6.81	1500ϕ	1 in 39.7	(51.014)
M8 – M9	8.350	12.046	6.82	1500ϕ	1 in 39.7	(46.787)
M9 – M10	8.079	11.512	6.51	1500ϕ	1 in 43.4	(20.243)
M10 – M11	8.064	11.789	6.67	1500ϕ	1 in 41.4	(41.695)
M11 – M12	8.050	8.079	4.57	1500ϕ	1 in 88	(41.632)
M12 – M12C	6.637	6.647	4.64	1350ϕ	1 in 75	STUB (8.160)

DATUM -3.0

Pit	DEPTH TO INVERT	INVERT LEVEL	FINISHED SURFACE LEVELS (DEFERRED WORKS)	EXISTING SURFACE LEVEL	CHAINAGE
M1 EX	2.670 / 2.670	6.630 / 6.630	9.300	9.300	0.000
M2	3.300 / 2.966	7.100 / 7.434	10.400	10.163	14.714
M3	4.910 / 2.581	7.621 / 9.950	12.531	12.531	29.408
M4	5.806 / 2.567	10.361 / 13.600	16.167	16.167	53.243
M5	6.186 / 5.488	14.029 / 14.726	20.215	19.269	78.109
M6	4.299 / 3.062	15.68 / 15.700 / 16.937	19.999	22.075	139.197 / 141.397
M7	2.986 / 2.936	17.333 / 17.383	20.319	22.233	159.201
M8	3.000 / 2.950	18.667 / 18.717	21.667	23.204	210.214
M9	3.006 / 2.956	19.897 / 19.947	22.903	24.407	257.001
M10	3.024 / 2.974	20.413 / 20.463	23.437	24.865	277.244
M11	3.069 / 3.019	21.470 / 21.520	24.539	25.761	318.939
M12	3.646 / 3.626	21.993 / 22.013	25.639	26.393	360.571
M12C	3.885	22.115	26.000	26.393	368.720

FCR BACKFILL AS PER CoY STD DWG YSD102
(TRENCH DETAILS FOR UNDERGROUND DRAINS IN ROAD RESERVES)

0 5 10 20
0 1 2 4
Scale H 1:500 V 1:100 @ A1

THIS DRAWING IS NOT TO BE COPIED OR SCALED

VERSION	REMARKS	DATE	BY
G	SHEET 8 ADDED TO DRAWING SET	15.01.18	SJ
F	STUB M12C AMENDED	22.11.17	SJ
E	PIT M2 REVISED PROVED EX DRAIN, PIT M10 ADJUSTED	27.07.17	SJ
D	AMENDED COUNCIL COMMENTS, CONSTRUCTION ISSUE	23.06.17	SJ
C	AMEND GRADE M5-M6 (COUNCIL COMMENT), SEWER SHOWN	14.03.17	SJ

WARNING

BEWARE OF UNDERGROUND SERVICES

THE LOCATIONS OF UNDERGROUND SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

CONSTRUCTION PLAN

DRAWN BY	S. JELICIC	DESIGNED BY	S. JELICIC
MELWAY	31, B11	CHECKED BY	D. DAMEN S. RAVIDA
DATUM	AHD	AUTHORISED BY	S. RAVIDA

REEDS CONSULTING
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www.reedsconsulting.com.au
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p (03) 8660 3000

CITY OF YARRA
YARRABEND - PARK PRECINCT
MAIN DRAIN STAGE 1 - SOUTH SECTION
LONGITUDINAL DRAINAGE SECTION 1

DRAWING No. MD4 — VERSION G
REFERENCE 22185G/MD1
SHEET 4 OF 8

H:\22185G\STAGE MAIN DRAIN 1 - SOUTH\CAD\DWG SET\MAIN DRAIN\22185G_MD4G-6H.DWG

PLAN

SCALE 1:2500

IMAGERY COPYRIGHT
DSE, MELBOURNE AERIAL 30cm, 2009
WITH PERMISSION.

NOTES:

1. FOR RETICULATION SEWER OVERALL PLAN REFER TO DRG C3056/39/101.
2. MANHOLES MARKED WITH PREFIX 'X' ARE EXISTING MANHOLES.
3. FOR DETAILS ON THE KWNU PROJECT REFER TO DRG PACKAGE C3120/04.
4. EXISTING SEWER AND MANHOLES DECOMMISSIONED REFER TO DRG C3056/39/094.

LEGEND:

- NORTH YARRA MAIN SEWER REPLACEMENT (TUNNEL)
- NORTH YARRA MAIN SEWER REPLACEMENT (TRENCH)
- BRANCH AND RETICULATION SEWERS
- EXISTING SEWER & MANHOLE
- DECOMMISSIONED MANHOLE

0 25 50 75 100 125m
SCALE 1:2500 AT ORIGINAL SIZE

AS BUILT

REV	DESCRIPTION	COMPANY	PROJECT OR WO NUMBER	DRAWN	ENG. CHECK	PR. MAN. APP'D	DATE
2	AS BUILT	GHD		AFI	AN*	AS*	25.02.16
1	CONFIGURATION UPDATED	GHD		TJ	CP*	AS*	29.10.14
0	ISSUED FOR CONSTRUCTION	GHD		RFN	UME *	AS*	04.04.14

GHD
Level 8, 180 Lonsdale Street, Melbourne VIC 3000 Australia
T 61 3 8687 8000 F 61 3 8687 8111
E melmail@ghd.com.au W www.ghd.com

GHD DRAWING NUMBER
31-29450-C010

Melbourne Water
NORTH YARRA MAIN SEWER REPLACEMENT

DRAFTER	DESIGNER	DESIGN MANAGER APPROVAL	PROJECT MANAGER APPROVAL
C. EDGE	M. VOGT	M. WEEKS *	U. McELVANEY *
DRAFTING CHECK: T. SWANN *	ENGINEERING REVIEW: J. REID *		

TITLE NYMR SEWER
OVERALL PLAN

PROJECT DATUM
SCALE AS SHOWN
Original Size A1

MELBOURNE WATER CORPORATION

CODE	MWC DRAWING NUMBER	REV
C	C3056/39/010	2

Plot Date: 26 February 2016 - 1:27 PM
Plotted by: Andrew Ivicevic, Melbourne
Cad File No: G:\31\31316\CADD\Drawings\Melbourne Water DWG Number Rename\C3056_39_010.dwg

1 Old slump area, west of recent slump.

This map incorporates data which is © State of Victoria. The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information. Aerial image used under licence from Nearmap.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **River Bank Erosion Assessment** **Yarrabend Development,** **Alphington**	PROJECT: 79075.12
		DWG No: Plate 1
		REV: 0
	CLIENT: Alphington Developments Pty Ltd	DATE: June 2019

11 Terrace area.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **River Bank Erosion Assessment** **Yarrabend Development,** **Alphington**	PROJECT: 79075.12 DWG No: Plate 11 REV: 0
	CLIENT: Alphington Developments Pty Ltd	DATE: June 2019

THE FOLLOWING HAS BEEN IDENTIFIED AS SIGNIFICANT ENVIRONMENTAL ASPECTS FOR THE SITE
These aspects will be managed with the control measures outlined in this plan

MANAGEMENT
1. RESPONSIBILITIES
The CONTRACTOR is responsible for implementing & maintaining control measures detailed in the EMP for the duration of the works

COMPANY	CSC CIVIL CONSTRUCTIONS (AUST) PTY LTD	
EMERGENCY (24Hr) CONTACT	(03) 9872 7100	
CONSTRUCTION MANAGER	BRENT SCOBLE	0413 019 [illegible]
SITE SUPERVISOR	TRAVIS O'NEILL	0413 019 [illegible]

2. COMMUNICATION OF EMP REQUIREMENTS
-All Site Personnel, including sub-contractors, must be inducted on the requirements of this EMP
-The EMP is to be displayed in the Site Shed at all times
-Toolbox Meetings are to be held at regular intervals to reinforce the requirements of the EMP

3. INSPECTION OF EMP REQUIREMENTS
-CSC Site Supervisor is to inspect the EMP measures at the start & end of each working day
-CSC Site Supervisor is to inspect the EMP measures prior to & after any storm event
-Any EMP measures that identified for rectification must be addressed on the same day as identified

4. STAGING OF WORKS
-Where possible, works are to be staged to minimise the exposure to sensitive areas identified in this EMP

5. INFORMING RESIDENTS
-Residents are to notified, by way of a letter drop, prior to commencing works onsite and every 4 months onwards
-Residents are to notified, by way of a letter drop, 2 days prior to commencing schedule noisy works

6. ASSOCIATED DOCUMENTS
-Construction Management Plan
-Day Report, Daily Pre-start, Toolbox Meeting, Monthly Audit & Site Inspections
-Incident Report & Non-Conformance Report

NOISE
REQUIREMENT: EPA Victoria & Council requirements must be adhered to in relation to the level of NOISE & WORKING HOURS to ensure that the residents and other applicable Neighbours to the site are not disturbed unreasonably.
The generation of NOISE must be minimised in accordance with the following

7. WORKING HOURS

-MON - FRI	7:00AM - 6:00PM	*Excludes Public Holidays, ANZAC Day, Christmas Day and Good Friday
-SAT	9:00AM - 3:00PM	
-SUN	NO WORK	

8. NOISE MINIMISATION METHODS
-All Plant & Equipment to have mufflers attached, maintained and tested in accordance with Manufacturers Specifications

9. OTHER
-All activities shall comply with the EPA Noise Control Guideline 12 for Construction (Pub 1254 Oct 2008)

WASTE
REQUIREMENT: LITTER & WASTE must be contained on site before disposal in a responsible manner
WASTE generation must be minimised in accordance with the following

10. MOVEMENT OF SOIL
-CLEAN FILL will be removed from site via Lipshe Ave
-CONTAMINATION is present and has been remediated onsite as part of the designated Remediation works

11. WASTE MINIMISATION METHODS
-Asphalt, Bricks, Concrete & Steel to be stockpiled separately & disposed of to a licensed recycling facility
-Star Pickets & Wooden Pegs are to be collected & stored for re-used at a later date

12. WASTE STORAGE & DISPOSAL
-Garbage Bins are provided at the Site Facilities for all litter generated at meal breaks
-Skip Bins are provided for all Waste Disposal that is not recyclable. The Skip must be emptied once full

13. OTHER
-N/A

CHEMICALS
REQUIREMENT: STORAGE & SPILL Management practices must be implemented to ensure that no environmental damage can result from the escape or spillage of chemicals or fuel

14. STORAGE
-No Fuels of Chemicals are to be stored onsite

15. SPILL MANAGEMENT
-Spill kit is to be stored in the Site Container within the Site Compound
-In the event a Spill the area is to be contained and cleaned up immediately to avoid contamination of surrounding area
-Any Soil that becomes contaminated as a result of a spill must be removed and disposed to an EPA licensed facility

16. RE-FUELLING PROCEDURE
-Re-fuelling is to be carried out away from areas of environmental sensitivity, such as Waterways, Stormwater Drainage, etc
-Re-fuelling with Mini-Tankers must be conducted in the designated re-fuelling area within the Site Compound

17. OTHER
-N/A

FLORA / FAUNA
REQUIREMENT: All significant Flora & Fauna on and adjacent to site must be protected

18. TREE PROTECTION
-Trees East of Parkview Rd within Alphington Park are to be protected in accordance with the Tree Management Plan
-Trees South of Lugton St are subject to a Planning Permit application and are to be protected
-Trees along the Main Drain Outfall to the Yarra River are subject to a Planning Permit application and are to be protected
-All other Trees have been designated to be removed along Latrobe Ave, Lugton St and Parkview Rd

19. FAUNA
-Zoologist is to be present before and during any Tree Removal works

19. ARCHEOLOGICAL / HERITAGE
-N/A to House & Land Stages 1-4

LEGEND

Symbol	Meaning
Blue dashed line	STAGE BOUNDARY
Green dashed line	TREE PROTECTION FENCING
Red grid	SITE COMPOUND
Yellow square	SPILL KIT
Dark square	RE-FUELLING AREA

I / We hereby acknowledge I have read & understood all conditions of the Environmental Management Plan.
I / We agree to undertake the works & ensure that all sub-contractors undertake the works in accordance with this Environmental Management Plan.

DEVELOPER		SUPERINTENDENT		CONTRACTOR	
COMPANY	Alphington Developments Pty Ltd	COMPANY	REEDS Consulting Pty Ltd	COMPANY	CSC Civil Constructions (AUST) Pty Ltd
NAME	Adam Matthew	NAME	John McKenna	NAME	Brent Scoble
SIGNATURE		SIGNATURE		SIGNATURE	[signature]

REV	DATE	DESCRIPTION	DRAWN	APP.
A	8/6/2017	FOR COUNCIL APPROVAL	B.S.	B.S.

CSC CIVIL CONSTRUCTIONS

CSC CIVIL CONSTRUCTIONS (AUST) PTY LTD
ABN 28 611 000 625
13 Trade Place, Vermont, VIC, 3133
Tel: (03) 9872 7100 Email: admin@csccivil.com.au Web: csccivil.com.au

DRAWN	B.SCOBLE
DATE	8/6/2017
CHECKED	B.SCOBLE
DATE	8/6/2017
APPROVED	B.SCOBLE
SIGNATURE	[signature]

TITLE
ENVIRONMENTAL MANAGEMENT PLAN

PROJECT ADDRESS				SHEET
LATROBE AVE & PARKVIEW RD, ALPHINGTON				1 of 2
PROJECT No. C5258	MELWAYS 31 C12	SCALE NTS	SIZE A3	REVISION
STATUS: FOR COUNCIL APPROVAL				A

THE FOLLOWING HAS BEEN IDENTIFIED AS SIGNIFICANT ENVIRONMENTAL ASPECTS FOR THE SITE.
These aspects will be managed with the control measures outlined in this plan.

DUST
REQUIREMENTS: DUST generation must be minimised to ensure there is no health risk or loss of amenity

20. MINIMISING DUST GENERATION
-Limit Stripping of Grass & Vegetation to the area that are planned to be worked
-Limit Construction Traffic to designated haul routes to enable control measures to be effectively implemented
-Consolidate & Seal Stockpiles once formed
-Limit / Cease Construction Traffic on days of high WIND

21. DUST SUPPRESSION
-Water Truck to be available to water down haul routes and stockpiles, as required

22. CONTINGENCIES
-If high WIND days are expected utilise a Water Truck to spray down any Haul Road(s) & Stockpile(s) to form a thick crust
-Mulch or Matting can also be utilised where the Water Truck is unable to control the dust

23. OTHER
-Cover Temporary Fencing with Shade Cloth to control any Dust that may be generated from leaving site

EROSION & SEDIMENT
REQUIREMENT: Erosion & Sediment must be managed in accordance with current best practice environmental management practices to prevent sediment laden water from entering any drainage system or natural waterway

24. DRAINAGE MANAGEMENT
-Catch Drain along the West side of Latrobe Ave will direct and collect all water flow from Latrobe Ave (North)
-Catch Drain along the South Side of Lugton St will direct and collect all water flow from Site 2 Beckwith Ave (North)
-All Catch Drains are directed into the Sediment Pond
-Control Measures such as Silt Fencing & Silt Sausages as per the EMP will be implemented & maintained to aid in capturing any sediment

25. SOIL STABILISATION
-Vegetation to be required on exposed areas, where possible
-Monitor catch drains and batters for erosion and rectify where applicable on the same day

26. STOCKPILE PROTECTION
-Stockpiles to be placed away from drainage inlets, open drains, water courses & pavements
-Cut-off drain to be established on the high side of the stockpile to divert water away from the stockpile
-Silt fencing to be installed on the low side of the stockpile to catch any sediment run-off
-Encourage re-vegetation of stockpiles that will be located in the same position more than 28 days

27. SEDIMENT TRAPS
-Sediment Pond will store the majority of the water from site. The Water will be allowed to soak into the natural ground and/or be re-used for filling works or dust suppression

28. DE-WATERING
-N/A

29. VEHICLE & ROAD MANAGEMENT
-All vehicles leaving the site must be checked & washed to remove any excess sediment collected on the vehicles whilst onsite
-Wash down bay has been established as per the EMP
-All Vehicles must travel over the Rumble Grid prior to exiting the Site
-On Haulage Days all Trucks must exit via Latrobe Ave. A Water Truck is to be utilised to wash down Latrobe Ave to ensure that no truck carries sediment onto Heidelberg Rd. A Person will be stationed at the Heidelberg Rd interface to monitor trucks prior to exiting site
-In the event sediment leaves site a Street Sweeper will be made available within 4 hours to clean any excess spill

30. OTHER STORMWATER DRAINAGE & OUTFALL
-Temporary Sediment Traps in all new Stormwater Pits and Pipes is to be installed as the drainage system progresses

LEGEND

- SILT FENCE
- CATCH DRAIN / CUT-OFF DRAIN
- RUMBLE GRID
- WASH DOWN AREA
- SEDIMENT POND
- ACCESS TRACK

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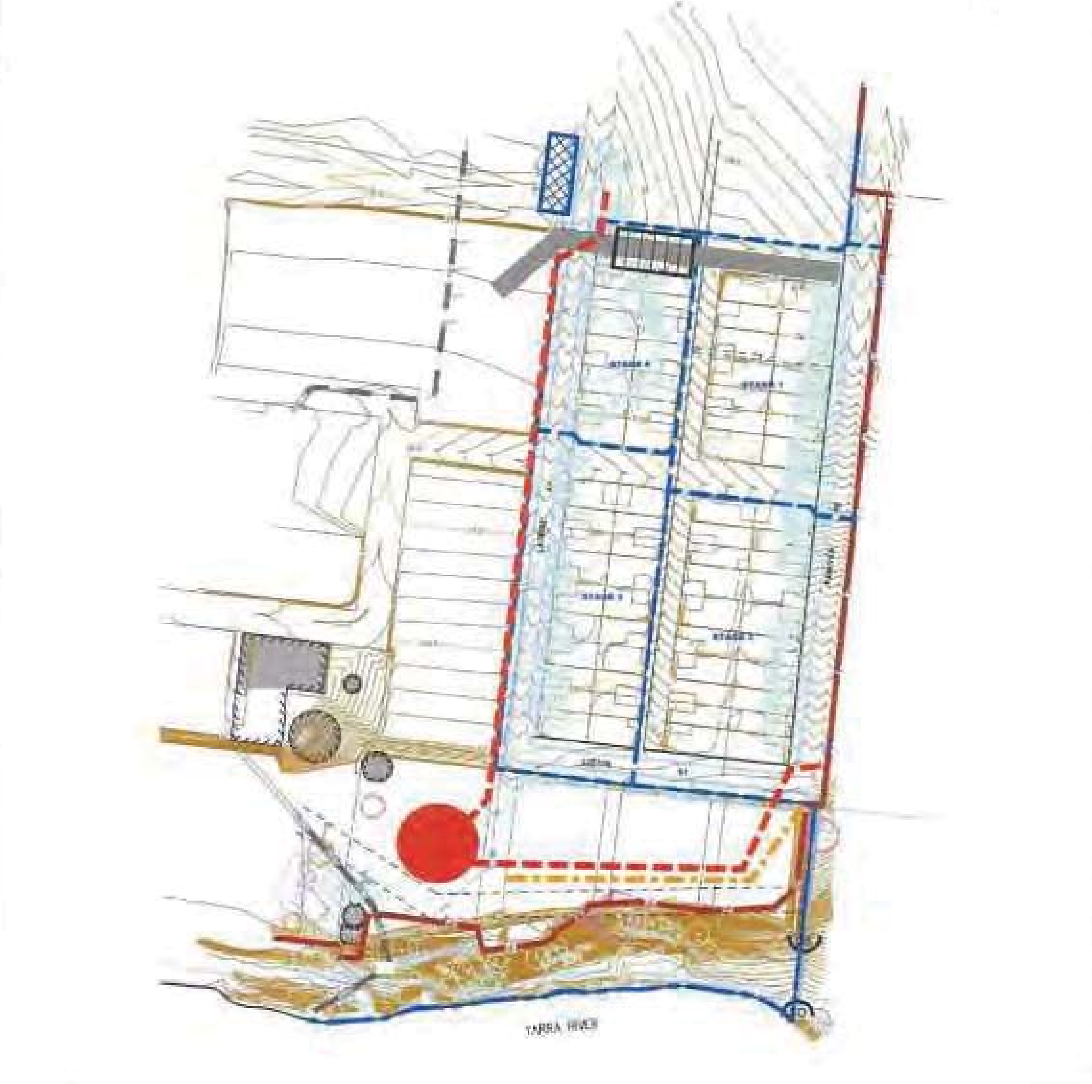

I / We hereby acknowledge I have read & understood all conditions of the Environmental Management Plan.
I / We agree to undertake the works & ensure that all sub-contractors undertake the works in accordance with this Environmental Management Plan.

DEVELOPER COMPANY	Alphington Developments Pty Ltd	SUPERINTENDENT COMPANY	REEDS Consulting Pty Ltd	CONTRACTOR COMPANY	CSC Civil Constructions (AUST) Pty Ltd
NAME	Adam Matthews	NAME	John McKernan	NAME	Brett Scoble
SIGNATURE		SIGNATURE		SIGNATURE	

REV	DATE	DESCRIPTION	DRAWN	APP.
A	8/6/2017	FOR COUNCIL APPROVAL	B.S	B.S

CSC CIVIL CONSTRUCTIONS

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Tel: (03) 8872 7100 Email: admin@csccivil.com.au Web: csccivil.com.au

DRAWN	B.SCOBLE
DATE	8/6/2017
CHECKED	B.SCOBLE
DATE	8/6/2017
APPROVED	B.SCOBLE
SIGNATURE	

TITLE
ENVIRONMENTAL MANAGEMENT PLAN

PROJECT ADDRESS
LATROBE AVE & PARKVIEW RD, ALPHINGTON

PROJECT No.	MELWAYS	SCALE	SIZE	SHEET
C5258	31 C12	NTS	A3	2 of 2

STATUS
FOR COUNCIL APPROVAL

REVISION
A

Appendix C

DP Borehole Logs Novemer – December (2019)
SPT Sample Photoraphs
DP Test Pit Logs (December 2019)
Test Pit Photographs

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 16.24 m AHD
EASTING: 326254.71
NORTHING: 5816077.4
DIP/AZIMUTH: 90°/--

BORE No: DG 1
PROJECT No: 79075.18
DATE: 26/11/2019
SHEET 1 OF 2

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Water	Well Construction Details
0.25	CLAY (CL): orange brown, with fine to medium grained sand, w>PL, stiff (Alluvial).	D	0.1–0.2		Flush gatic cover
4.0	BASALT (MW-SW): very high strength, dark grey.				Bentonite to 4 m; Unslotted PVC to 5.5 m
6.0	(HW): low to high strength, orange brown, with clay.			12-12-19 (5.3 m)	
8.0	(HW-MW): low to very high strength, grey brown.				
10.0	(SW): very high strength, dark grey.				Sand filter pack to 13.5 m; Slotted PVC 5.5 - 13.5 m

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 0.25 m; hammer drill to 15 m.
WATER OBSERVATIONS: Groundwater measured at 5.3 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 16.24 m AHD
EASTING: 326254.71
NORTHING: 5816077.4
DIP/AZIMUTH: 90°/--

BORE No: DG 1
PROJECT No: 79075.18
DATE: 26/11/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		BASALT (SW): very high strength, dark grey.							
	14.5	SILTSTONE (MW): low strength, grey brown.							End cap (13.4); Sand and bentonite fill
	15.02	Bore discontinued at 15.02m		S	15.0 15.02		3/20 mm double bouncing		

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA

TYPE OF BORING: Solid flight auger to 0.25 m; hammer drill to 15 m.

WATER OBSERVATIONS: Groundwater measured at 5.3 m

REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 18.45 m AHD
EASTING: 326154.27
NORTHING: 5816108.19
DIP/AZIMUTH: 90°/--

BORE No: DG 2
PROJECT No: 79075.18
DATE: 27/11/2019
SHEET 1 OF 2

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Results & Comments	Water	Well Construction Details
0.0	FILL / CLAY (CH): grey brown, trace fine to coarse angular gravel, w>PL, firm to stiff.	D	0.8–0.9			flush gatic cover
0.9	CLAY (CH): brown, w=PL, stiff, residual quaternary volcanics.	D	1.1–1.2			
1.2	BASALT (MW): very high strength, brown.					Bentonite to 4 m; Unslotted PVC to 4.4 m
2.25	(EW): orange brown, with basalt gravel, hard.	S	2.35–2.71	13, 18, 15/60 mm double bouncing		
2.71	(MW): high strength, grey brown.					
4.5	(EW): orange brown, with angular basalt gravel.	S	4.8–5.25	4,12,25 N = 37		
5.25	(MW): very high strength, grey brown.				12-12-19 (water level ~5.52)	
6.5	(EW): orange brown.	S	6.67–6.8	17/125 mm double bouncing		
6.8	(HW-MW): low to very high strength, grey brown.					Sand filter pack 4 to 13.4 m; Slotted PVC to 13.4 m
10.0						

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 1.2 m; hammer drilling to 15 m.
WATER OBSERVATIONS: Groundwater measured at 5.52 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Strong hydrocarbon odour on top of water table; standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 18.45 m AHD
EASTING: 326154.27
NORTHING: 5816108.19
DIP/AZIMUTH: 90°/--

BORE No: DG 2
PROJECT No: 79075.18
DATE: 27/11/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
8, 7, 6, 5, 4	11, 12, 13, 14	BASALT (HW-MW): low to very high strength, grey brown.							End cap (approx. 13.3 m); Borehole collapse 13.4 - 15 m
3, 2, 1, 0, -1	15 15.0, 16, 17, 18, 19	Bore discontinued at 15.0m							

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 1.2 m; hammer drilling to 15 m.
WATER OBSERVATIONS: Groundwater measured at 5.52 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Strong hydrocarbon odour on top of water table; standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 10.47 m AHD
EASTING: 326190.38
NORTHING: 5816021.01
DIP/AZIMUTH: 90°/--

BORE No: DG 4
PROJECT No: 79075.18
DATE: 4/12/2019
SHEET 1 OF 1

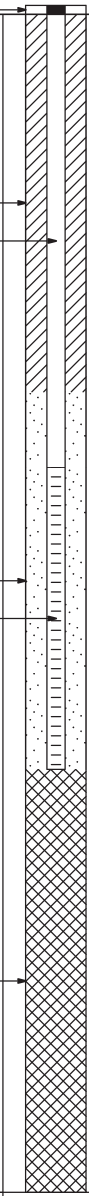
Depth (m)	Description of Strata
	FILL / GRAVELLY CLAY (CL): brown, with mottled orange, fine to coarse subangular gravel, w<PL, very stiff.
2.5	SILTY CLAY (CL): brown, w<PL, very stiff, alluvial.
	3.5 m: w=PL.
	4 m: w>PL, stiff.
6.3	SILTSTONE (HW): very low strength, pale brown, Fe stained.
7.8	Bore discontinued at 7.8m

Sampling & In Situ Testing

Type	Depth	Sample	Results & Comments
U_{63}	0.5–0.6		PP NA due to gravel at base of tube
S	1.0–1.45		10,12,9 N = 21
U_{63}	2.0–2.26		PP NA due to gravel at base of tube
U_{63}	2.5–2.95		
U_{63}	4.4–4.55		pp = 110-120
S	6.3–6.34		30/40 mm double bouncing

Water: 12-12-19 (water level at 5.0 m)

Well Construction Details



- Flush gatic cover
- Bentonite to 2.5 m
- Unslotted PVC to 3 m
- Sand filter pack 2.5 to 5 m
- Slotted PVC 3 to 5 m
- Backfill 5 to 7.8 m

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to end.
WATER OBSERVATIONS: Groundwater measured at 5.00 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 11.77 m AHD
EASTING: 326219.45
NORTHING: 5816033.41
DIP/AZIMUTH: 90°/--

BORE No: DG 5
PROJECT No: 79075.18
DATE: 27/11/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Results & Comments	Water	Well Construction Details
0.0	FILL / SANDY GRAVEL (GP): grey, fine to medium gravel, fine to coarse grained sand, trace clay, moist, inferred dense.					flush gatic cover
1.5	FILL / CLAY (CH): brown, trace sand, trace fine to coarse subrounded gravel, w>PL, firm to stiff.					Bentonite to 4 m
		S	2.5 – 2.95	2,4,4 N = 8		
2.9	SILTY CLAY (CI): pale brown, w=PL, very stiff; (Residual Silurian Siltstone).					Unslotted PVC to 4.5 m
3.8	SILTSTONE (HW): very low strength, brown.	S	3.7 – 3.81	15/110 mm double bouncing	12-12-19 (approx. 4.44 m)	Sand filter pack 4 - 10 m; Slotted PVC 4.5 - 10 m
10.0	Bore discontinued at 10.0m					End cap

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 3.7 m; PCD blade bit to 10 m.
WATER OBSERVATIONS: Groundwater measured at 4.44 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 18.72 m AHD
EASTING: 326288.17
NORTHING: 5816032.61
DIP/AZIMUTH: 90°/--

BORE No: DG 6
PROJECT No: 79075.18
DATE: 28/11/2019
SHEET 1 OF 2

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Results & Comments	Water	Well Construction Details
0.0	FILL / GRAVELLY CLAY (CI): brown, fine to coarse subangular gravel, with fine grained sand, w<PL, very stiff.					flush gatic cover
		U_{63}	1.0 – 1.14	PP NA due to gravel at base of tube		
		D	2.0 – 2.1			Bentonite to 5 m
		U_{63}	2.1 – 2.35	PP NA due to gravel at base of tube		Unslotted PVC to 5.5 m
		D	3.0 – 3.1			
		U_{63}	3.92 – 4.14	pp = 350-380		
4.0	CLAY (CH): brown, with fine to coarse basalt gravel, w=PL, very stiff, residual quaternary volcanics.					
4.5	BASALT (MW): very high strength, grey.					
5.5	(HW-MW): low to very high strength, grey brown.					Slotted PVC 5.5 to 15 m
8.79					12-12-19	
10.0						

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 4.5 m; hammer drilling to 15 m.
WATER OBSERVATIONS: Groundwater measured at 8.79 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 18.72 m AHD
EASTING: 326288.17
NORTHING: 5816032.61
DIP/AZIMUTH: 90°/--

BORE No: DG 6
PROJECT No: 79075.18
DATE: 28/11/2019
SHEET 2 OF 2

Depth (m)	Description of Strata
	BASALT (HW-MW): low to very high strength, grey brown.
12.5	SILTSTONE (HW): very low strength, brown.
15.0	Bore discontinued at 15.0m

Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments

Water

Well Construction Details: Sand filter pack 5 to 15 m

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 4.5 m; hammer drilling to 15 m.
WATER OBSERVATIONS: Groundwater measured at 8.79 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

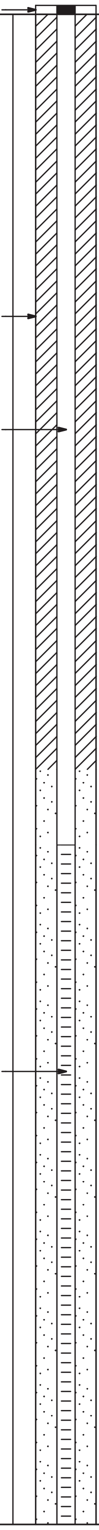
BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 19.26 m AHD
EASTING: 326353.77
NORTHING: 5816053.55
DIP/AZIMUTH: 90°/--

BORE No: DG 7
PROJECT No: 79075.18
DATE: 28/11/2019
SHEET 1 OF 2

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Results & Comments	Water	Well Construction Details
0.0	FILL/ SANDY GRAVEL (SP): fine to medium gravel, fine to coarse grained sand, dry, inferred medium dense.					flush gatic cover
0.2	FILL / CLAY (CI): brown and dark grey, trace gravel, w=PL, stiff to very stiff.					
1.0	CLAY (CH): brown, trace rounded quartz gravel, w<PL, hard, alluvial.	U_{63}	1.0 – 1.3	pp >600		
1.6	CLAY (CH): brown, w=PL, very stiff, residual quaternary volcanics.	S	1.6 – 2.05	4,6,14 N = 20		Bentonite to 5 m
2.5	BASALT (MW): very high strength, grey brown.					Unslotted PVC to 5.5 m
4.0	(SW): very high strength, grey.					
5.0	(MW): very high strength, grey brown.					
7.0	(HW): low to high strength, brown.					Slotted PVC 5.5 to 13.5 m
8.5	(MW): very high strength, grey brown.					
9.5	(SW): very high strength, grey brown.				12-12-19 (water level ~9.38 m)	



RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 2.5 m; hammer drilling to 15 m.
WATER OBSERVATIONS: Groundwater measured at 9.38 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 19.26 m AHD
EASTING: 326353.77
NORTHING: 5816053.55
DIP/AZIMUTH: 90°/--

BORE No: DG 7
PROJECT No: 79075.18
DATE: 28/11/2019
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		(SW): very high strength, grey brown. *(continued)*							
	10.5	BASALT (MW-HW): low to very high strength, grey brown.							Sand filter pack 5 to 13.5 m; hole collapse 13.5 - 15 m
	15.0	Bore discontinued at 15.0m							

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 2.5 m; hammer drilling to 15 m.
WATER OBSERVATIONS: Groundwater measured at 9.38 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

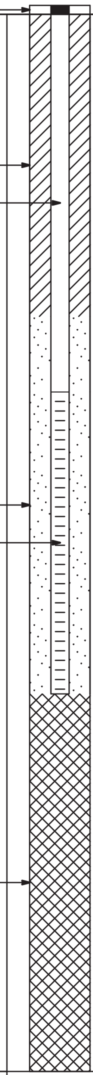
BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 10.52 m AHD
EASTING: 326259.85
NORTHING: 5816017.74
DIP/AZIMUTH: 90°/--

BORE No: DG 12
PROJECT No: 79075.18
DATE: 3/12/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water	Well Construction Details
	FILL / CLAY (CI): brown and grey, trace subangular gravel, w=PL, very stiff to hard.						Flush gatic cover
		U_{63}	0.75 0.95		pp >600		Bentonite to 2 m Unslotted PVC to 2.5 m
	1.5 m: w>PL, firm.						
	2 m: becoming yellow brown.	U_{63}	2.0 2.1		pp = 80-100	12-12-19	
2.5	CLAY (CL): brown, grey, with fine grained sand, trace rootlets, w>PL, firm (Alluvial).	U_{63}	2.5 2.95		pp = 70		Sand filter pack 2 to 4.5 m Slotted PVC 2.5 to 4.5 m
4.0	CLAY (CI): pale brown, orange, fissured, w=PL, very stiff; (Residual).	U_{63}	4.0 4.37		pp = 260-290		
5.5	SILTSTONE (HW): very low strength, brown.	S	5.5 5.53		20/30 mm double bouncing		Backfill 4.5 to 7 m
7.0	Bore discontinued at 7.0m						



RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to end.
WATER OBSERVATIONS: Groundwater measured at 2.35 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 9.43 m AHD
EASTING: 326273.84
NORTHING: 5816013.78
DIP/AZIMUTH: 90°/--

BORE No: DG 13
PROJECT No: 79075.18
DATE: 3/12/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Water	Well Construction Details
0.2	SILTY SAND (SP): fine grained, brown, moist.		Flush gatic cover
0.6	FILL / CLAY (CL): brown, trace subangular gravel, w<PL, very stiff.		
1.0	CLAY (CI): pale grey brown, w=PL, very stiff; (Residual basalt).		
4.8	SILTY CLAY (CI): brown, w=PL, very stiff (Alluvial). 2.1 m: trace fine to coarse basalt gravel. 2.2 m: becoming w>PL, firm. 2.5 m: fissured, mottled orange grey brown. 3.5 m: becoming very stiff.	12-12-19 (approx. 1.95 m)	Unslotted PVC to 2 m Slotted PVC to 5.4 m Slotted PVC 2 to 4 m Backfill 4 to 5.4 m
5.0	SILT (ML): pale grey, w>PL, very stiff.		
5.4	SAND (SP): pale grey, firm to medium grained, very dense.		
	Bore discontinued at 5.4m		

RIG: Hand Auger **DRILLER:** DP **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: Groundwater measured at 1.95 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

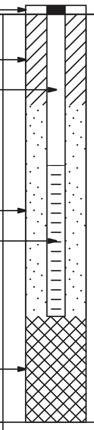
CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 7.94 m AHD
EASTING: 326360.6
NORTHING: 5816021.43
DIP/AZIMUTH: 90°/--

BORE No: DG 15
PROJECT No: 79075.18
DATE: 2/12/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
		CLAY (CL): grey brown, with fine sand, w>PL, firm; (Alluvial). 0.3 m: becoming w>>PL.						▼ 12-12-19
7	0.9	CLAY (CH): grey, trace basalt gravel, w>PL, stiff; (Alluvial). 1.5 m: with minor orange brown mottling.		D	1.1 2.7			
5	2.7	Bore discontinued at 2.7m due to auger refusal, inferred to be top of basalt unit.						

Well Construction Details



RIG: Hand Auger **DRILLER:** DP **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: Groundwater measured at 0.62 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: 8.21 m AHD
EASTING: 326366.28
NORTHING: 5816019.38
DIP/AZIMUTH: 90°/--

BORE No: DG 16
PROJECT No: 79075.18
DATE: 2/12/2019
SHEET 1 OF 1

Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	CLAY (CL): brown, w<PL, stiff; (Alluvial).							Flush gatic cover
0.6	0.5 m: becoming w=PL.		U63	0.5 – 0.68				
	CLAY (CH): dark grey, trace subangular basalt gravel, w>PL, stiff; (Residual Quaternary Volcanics).		U63	1.3 – 1.95		pp = 100-150	12-12-19	
1.8	CLAY (CI): yellow brown, with fine sand, w>>PL, stiff; (Alluvial).		U63	2.5 – 2.95		pp = 110-130		Bentonite to 5.5 m; Unslotted PVC to 6.0 m
3.3	BASALT (HW): low to high strength, dark grey and orange brown.							
4.2	CLAY (CH): grey, w>PL, stiff, possibly residual quaternary volcanics.							
4.5	CLAY (CI): grey, trace carbonaceous fragments, w=PL, very stiff (possibly alluvial).		U63	4.5 – 4.95		pp = 320-350		Sand filter pack 5.5 to 7.0 m; Slotted PVC 6.0 to 7.0 m
6.4	SANDSTONE (HW): very low strength, fine grained, grey.							
7.0	Bore discontinued at 7.0m							

RIG: Fraste Multi-drill ML **DRILLER:** Apex Drilling **LOGGED:** APM **CASING:** NA
TYPE OF BORING: Solid flight auger to 7 m.
WATER OBSERVATIONS: Groundwater measured at 1.42 m
REMARKS: Location coordinates are in WGS 84 Zone 55 H. Standpipe installed on completion.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Photo 1 : DG-7 1.6 – 2.05 m

Douglas Partners Geotechnics / Environment / Groundwater	SPT PHOTOGRAPHS	Project No. : 79075.18
	Yarrabend Riverfront Area	Plate No: 5
	Client: Alphington Developments Pty Ltd	Date: 2019

Photo 2 : DG-16 6.95 m

Douglas Partners Geotechnics / Environment / Groundwater	**SAMPLE PHOTOGRAPHS**	Project No. :	79075.18
	Yarrabend Riverfront Area	Plate No:	6
	Client: Alphington Developments Pty Ltd	Date:	20209

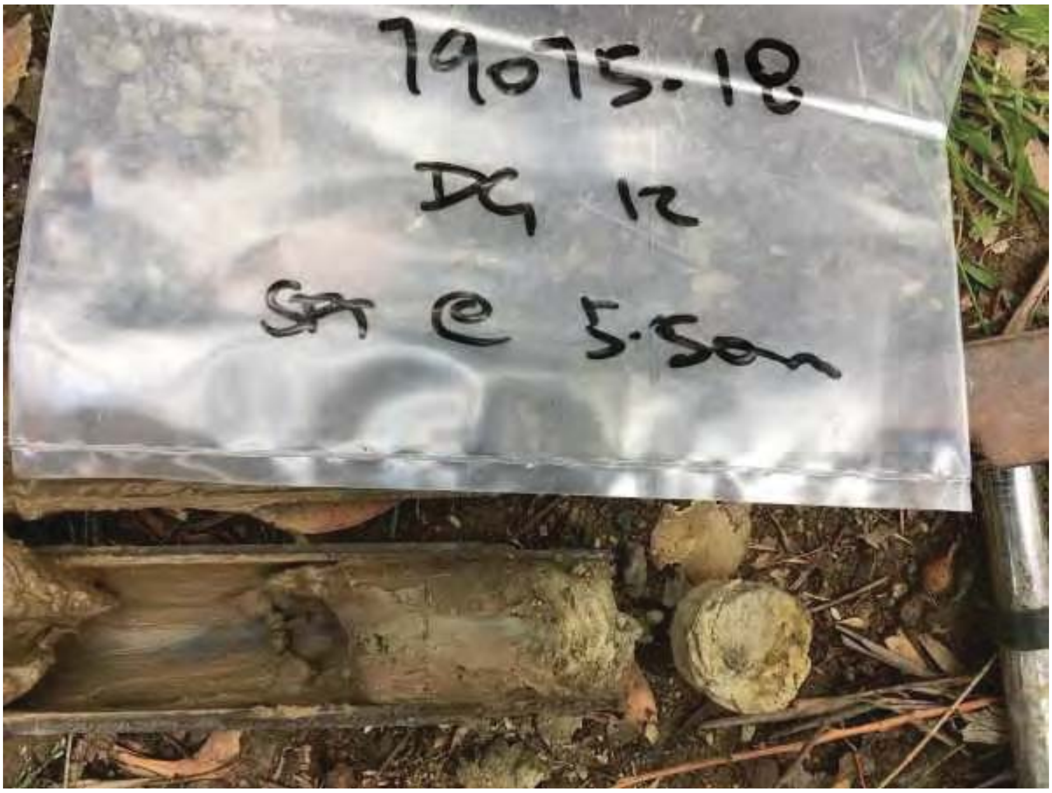


Photo 2 : DG-12   5.5 m

Douglas Partners Geotechnics / Environment / Groundwater	**SPT PHOTOGRAPHS**	Project No. :	79075.18
	Yarrabend Riverfront Area	Plate No:	7
	Client: Alphington Developments Pty Ltd	Date:	2020

Photo 3 : DG-4 1.0 m - 1.45 m

Photo 4 : DG 4 6.3 - 6.34 m

Douglas Partners Geotechnics / Environment / Groundwater	**SPT PHOTOGRAPHS**	Project No. :	79075.18
	Yarrabend Riverfront Area	Plate No:	8
	Client: Alphington Developments Pty Ltd	Date:	2020

TEST PIT LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: --
EASTING:
NORTHING:

PIT No: TP 1
PROJECT No: 79075.18
DATE: 9/12/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.05	CLAYEY SILT (ML): grey, w<<PL, stiff.						
		SANDY CLAY (ci): brown, w<PL, fine to coarse subrounded sand, very stiff.						
		0.4 m: becoming w=PL.	U63	0.4 – 0.9		pp >600		
	0.7	SAND (Sm): brown, fine to medium, subrounded, moist, inferred medium dense, with iron cemented nodules throughout, with clay.	B	1.0 – 1.2				
	1.7 / 1.75	BASALT (HW-MW): very high strength, grey.						
		Pit discontinued at 1.75m						

RIG: 5T Backhoe
LOGGED: APM
SURVEY DATUM: WGS 84 Zone 55 H

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: --
EASTING:
NORTHING:

PIT No: TP 2
PROJECT No: 79075.18
DATE: 9/12/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		CLAYEY SILT (ML): grey, w<<PL, stiff.							
	0.05	SANDY CLAY (CI): fine to coarse, subrounded sand, brown, iron stained. 0.3 m: becoming moist. irregular lenses of clay and sand).		U64	0.05 0.25				
	1.0	BASALT (HW-MW): very high strength, grey.							
	1.1	Pit discontinued at 1.1m							

RIG: 5T Backhoe **LOGGED:** APM **SURVEY DATUM:** WGS 84 Zone 55 H

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: --
EASTING:
NORTHING:

PIT No: TP 3
PROJECT No: 79075.18
DATE: 9/12/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
	0.0	SAND (SM): fine to medium grained, brown, with clay, dry, inferred dense.							
	0.5	SANDY CLAY (CI): brown, moist, w=PL, very stiff to dense, fine to coarse sand (irregular mixture of sand and clay, with iron cemented lenses throughout.		B	0.7 0.9				
	1.5	BASALT (HW-MW): very high strength, grey.							
	1.6	Pit discontinued at 1.6m							

RIG: 5T Backhoe **LOGGED:** APM **SURVEY DATUM:** WGS 84 Zone 55 H

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: --
EASTING:
NORTHING:

PIT No: TP 4
PROJECT No: 79075.18
DATE: 9/12/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		CLAYEY SILT (ML): grey, w<<PL, stiff.							
	0.05	SANDY CLAY (CI): fine to coarse, subrounded sand, brown, iron stained.		U63 B	0.05 0.1 0.25				
	0.3	BASALT (HW-MW): very high strength, grey. 0.3 m - 0.6 m: undulating basalt.			0.3				
	0.6	Pit discontinued at 0.6mAddl pit approx 10 to SE; basalt encountered approx 0.2 m.							
	1								
	2								

RIG: 5T Backhoe **LOGGED:** APM **SURVEY DATUM:** WGS 84 Zone 55 H

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Alphington Developments Pty Ltd
PROJECT: Groundwater Monitoring
LOCATION: Heidelberg Road, Alphington

SURFACE LEVEL: --
EASTING:
NORTHING:

PIT No: TP 5
PROJECT No: 79075.18
DATE: 9/12/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		FILL / CLAY (CI): brown, trace fine to medium sand,trace gravel, w<PL, hard.			0.2		pp = 320-510		
		0.3 m: becoming w=PL, very stiff to stiff.			0.3		pp = 210-220		
					0.5				
		0.7 m: w>PL, firm.		U		63			
					0.8		pp = 50-60		
					0.95				
	1								1
	1.1	FILL / GRAVELLY CLAY (CI): dark brown, fine to coarse subangular gravel, w>>PL, soft to firm.							
	1.9	CLAY (CI): brown, with orange, iron stained, with fine grained sand, w>>PL, soft to firm.							
	2								2
	2.6	BASALT (HW-MW): very high strength, grey.							
	2.7	Pit discontinued at 2.7m							

RIG: 5T Backhoe **LOGGED:** APM **SURVEY DATUM:** WGS 84 Zone 55 H

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Test Pit - TP 1

Douglas Partners Geotechnics / Environment / Groundwater	TEST PIT PHOTOGRAPHS	Project No. : 79075.18
	Yarrabend Riverfront Area	Plate No: 1
	Client: Alphington Developments Pty Ltd	Date: 2019

Photo 2 : Test Pit TP2

Douglas Partners Geotechnics / Environment / Groundwater	**SAMPLE PHOTOGRAPHS**	Project No. :	79075.18
	Yarrabend Riverfront Area	Plate No:	2
	Client: Alphington Developments Pty Ltd	Date:	20209

Photo 3 : Test Pit TP3

Photo 4 - Test Pit TP4

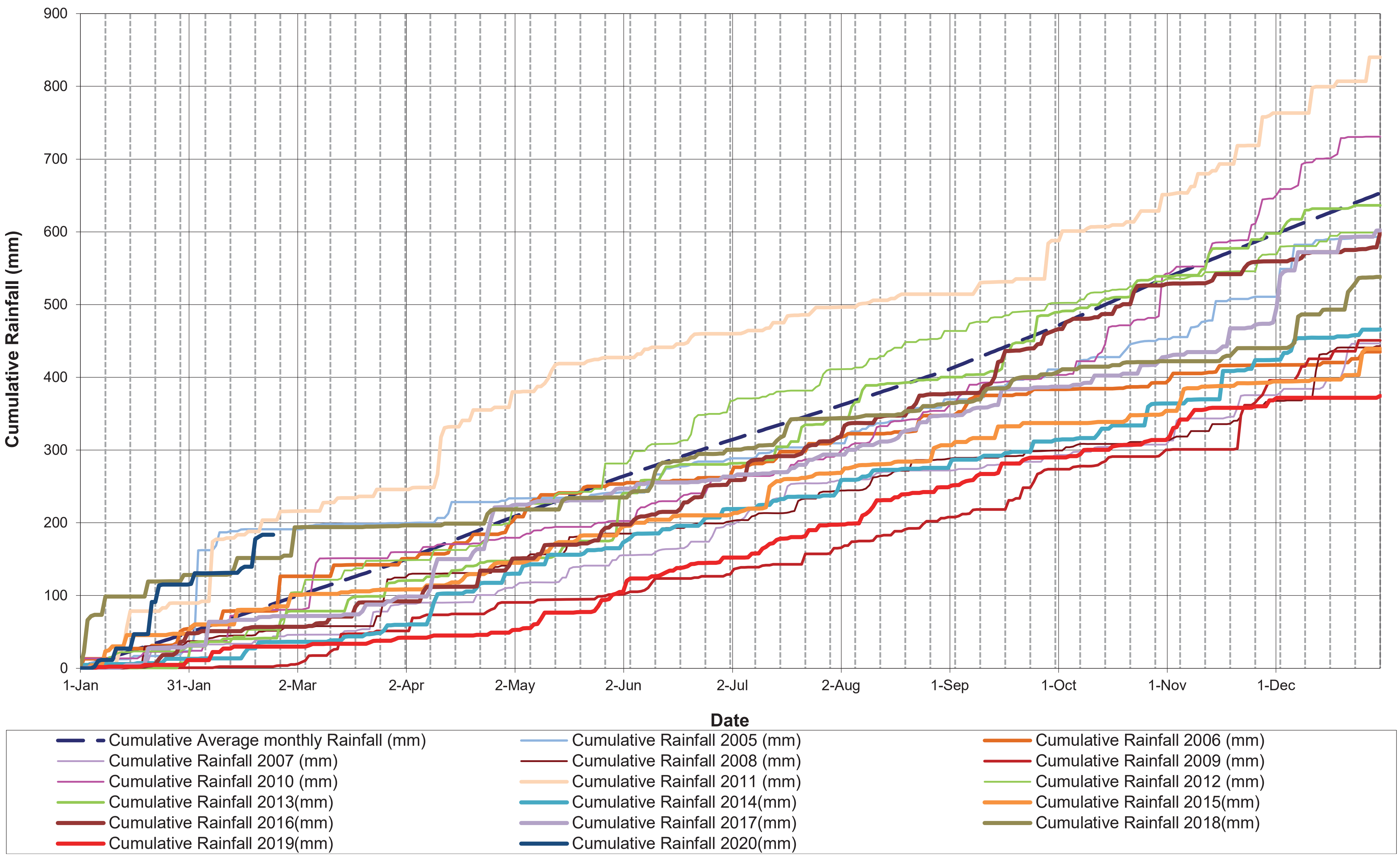
Douglas Partners Geotechnics / Environment / Groundwater	**TEST PIT PHOTOGRAPHS**	Project No. :	79075.18
	Yarrabend Riverfront Area	Plate No:	3
	Client: Alphington Developments Pty Ltd	Date:	2020

Photo 5 : Test Pit TP5

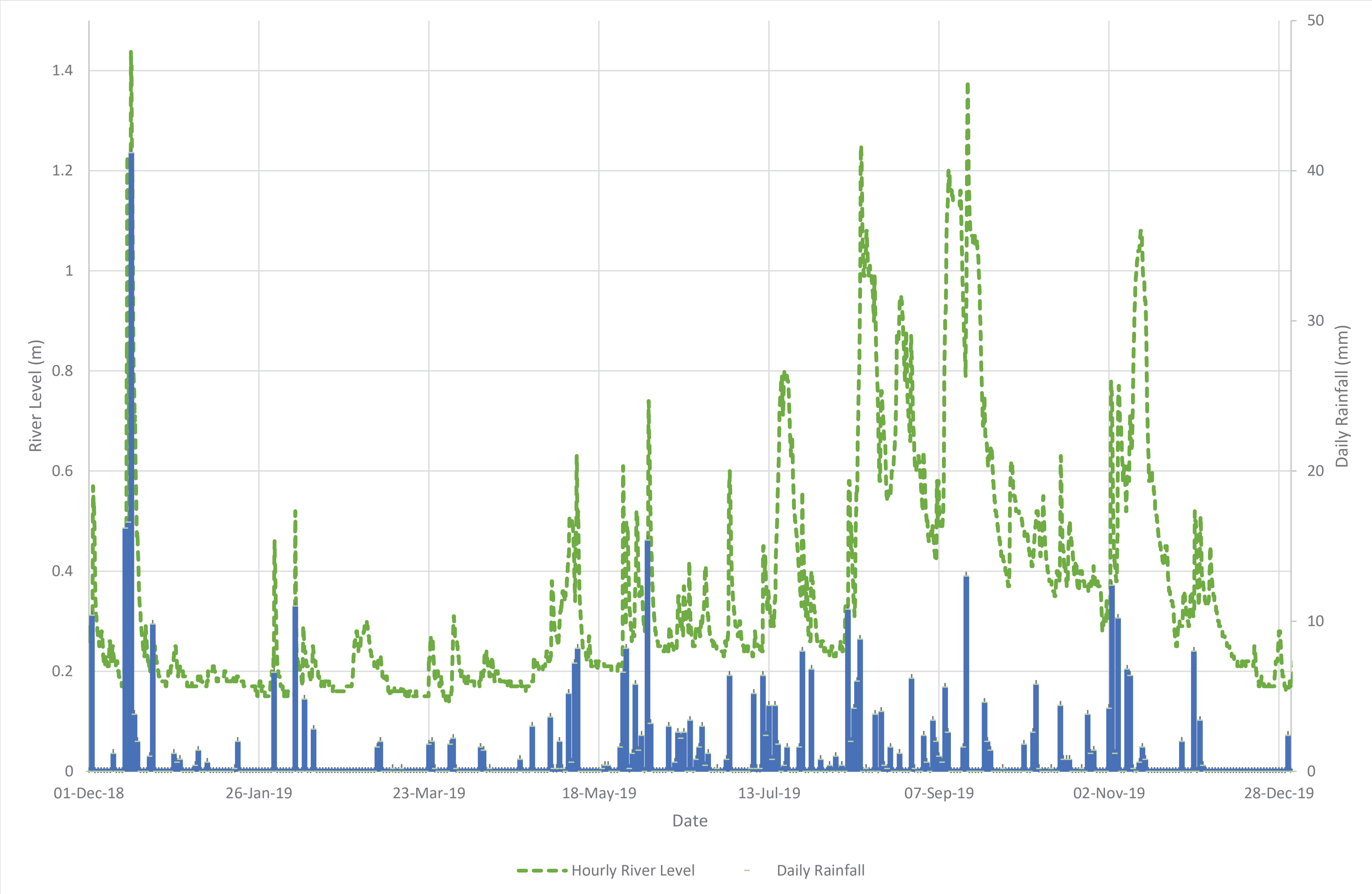
Douglas Partners Geotechnics / Environment / Groundwater	TEST PIT PHOTOGRAPHS	Project No. : 79075.18
	Yarrabend Riverfront Area	Plate No: 4
	Client: Alphington Developments Pty Ltd	Date: February 2020

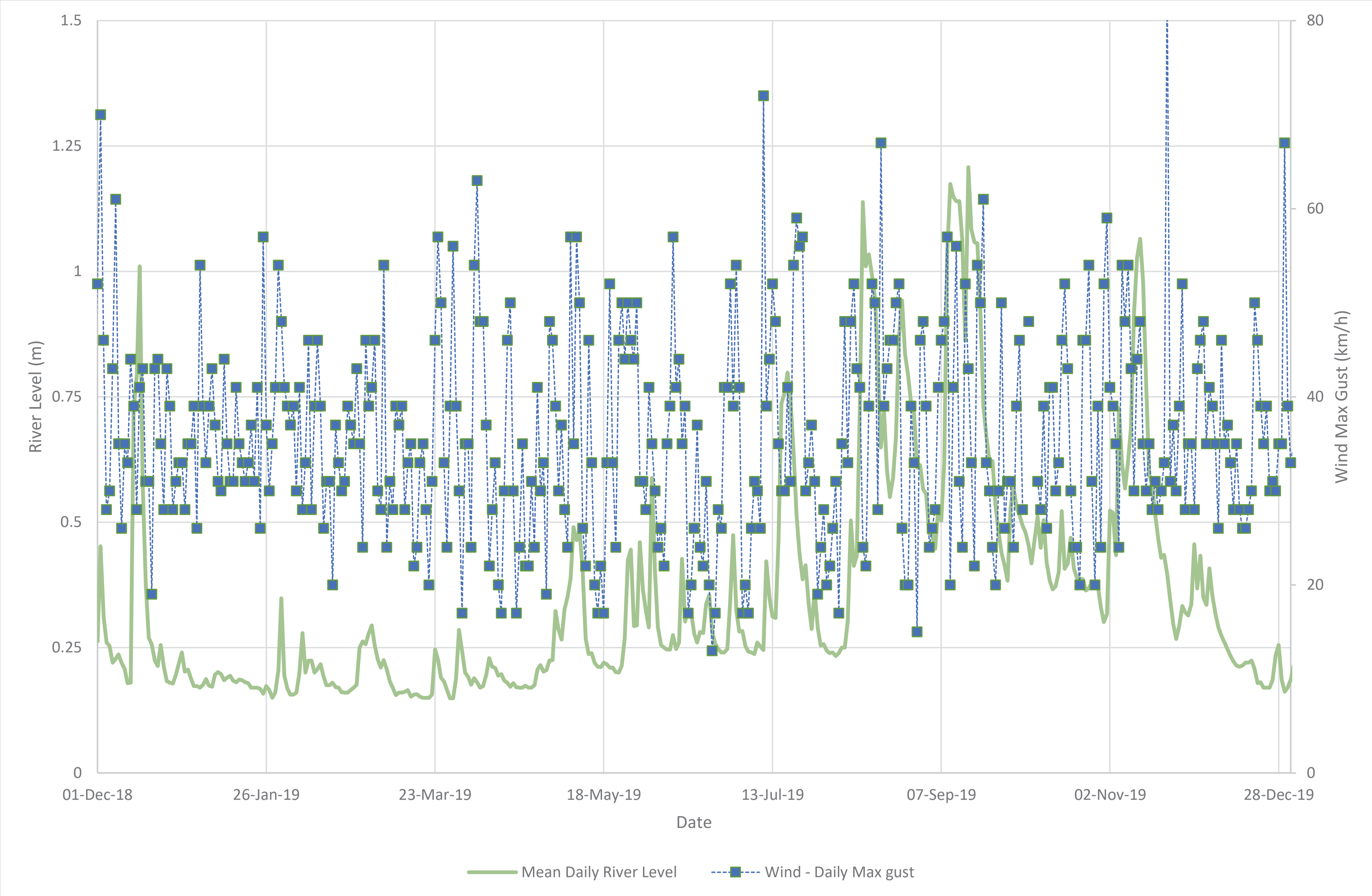
Appendix D

Rainfall, River Level and Wind Data



Cumulative Rainfall (mm)
900
800
700
600
500
400
300
200
100
0
1-Jan
31-Jan
2-Mar
2-Apr
2-May
2-Jun
2-Jul
2-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Date
Cumulative Average monthly Rainfall (mm)
Cumulative Rainfall 2005 (mm)
Cumulative Rainfall 2006 (mm)
Cumulative Rainfall 2007 (mm)
Cumulative Rainfall 2008 (mm)
Cumulative Rainfall 2009 (mm)
Cumulative Rainfall 2010 (mm)
Cumulative Rainfall 2011 (mm)
Cumulative Rainfall 2012 (mm)
Cumulative Rainfall 2013(mm)
Cumulative Rainfall 2014(mm)
Cumulative Rainfall 2015(mm)
Cumulative Rainfall 2016(mm)
Cumulative Rainfall 2017(mm)
Cumulative Rainfall 2018(mm)
Cumulative Rainfall 2019(mm)
Cumulative Rainfall 2020(mm)


River Level (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Daily Rainfall (mm)
0
10
20
30
40
50
01-Dec-18
26-Jan-19
23-Mar-19
18-May-19
13-Jul-19
07-Sep-19
02-Nov-19
28-Dec-19
Date
Hourly River Level
Daily Rainfall



River Level (m)
1.5
1.25
1
0.75
0.5
0.25
0
Wind Max Gust (km/h)
80
60
40
20
0
01-Dec-18
26-Jan-19
23-Mar-19
18-May-19
13-Jul-19
07-Sep-19
02-Nov-19
28-Dec-19
Date
Mean Daily River Level
Wind - Daily Max gust

Department of Environment, Land, Water & Planning

HYPLOT V133 Output 24/02/2020

Period 7 Year 01/01/1998 to 01/01/2005 1998-2004

Site 229143 YARRA RIVER @ CHANDLER HIGHWAY KEW