

Croskell PSP Proposed Drainage Strategy

Geotechnical site report – additional investigation

Prepared for Melbourne Water

Prepared by Water4Good

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Appendices

APPENDIX A: Reports of Boreholes

APPENDIX B: Groundwater Well Construction Details

APPENDIX C: Reports of geotechnical laboratory testing

APPENDIX D: Groundwater Monitoring Memorandum



Revision History

Revision N°	Prepared By	Description	Date
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Document Acceptance

Action	Name	Signed	Date
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on behalf of	Water4Good		

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1 Introduction and background

The Croskell PSP concept drainage strategy has been developed by Melbourne Water as a response to urban development that is proposed by the Victorian Planning Authority's (VPA) Precinct Structure Plan (PSP). The strategy integrates a network of major and minor drainage assets to generally direct external and local catchment flows northward towards Thompsons Road, with some local catchment flows being directed eastward to Berwick-Cranbourne Road. Major assets include the Ti-Tree Creek constructed waterway, the SBRB2, WLRB3 and WLRB4 retarding basins, wetlands, the SB1, SB2 and SB3 sediment ponds, and a 1% AEP flood flow diversion pipe, supported by trunk pipes and swales.

Following an initial desktop study (W4G Ref: 3551531-268-RevB, dated 4 April 2022), Melbourne Water has commissioned Water4Good (W4G) to undertake a preliminary geotechnical investigation for the Croskell PSP Proposed Drainage Strategy Project (the Project). The project involves completing a drainage concept options assessment and functional design of major drainage assets (retarding basin, wetlands and new waterway alignment) for the Croskell PSP.

The proposed project will include:

- Horizontal realignment of existing open drain features as well as possible deepening and widening works.
- Construction of a new wetland retarding basin feature adjacent to Thompsons Road.
- Construction of the wetland and retarding basin features shown in Plate 1.

This report includes additional testing and monitoring (Aug 2025) and follows on from these two reports:

- Desk top geotechnical study (Apr 2022).
- Preliminary site investigation (Aug 2023).

The preliminary site investigation was conducted in 2023 comprising 21 boreholes, seven of which had groundwater monitoring wells installed. A site investigation report (3551531-286- O-Croskell PSP Drainage Strategy Geotechnical Site Report Rev1, dated 18 August 2023), summarising the findings of this investigation was developed and includes an assessment of the expected geotechnical and contamination conditions at the site and implications for design.

Following the preliminary investigation, the need for additional investigation at WLRB4 and the proposed DSS pipe location was identified. This report presents the results of a geotechnical investigation undertaken to supplement the preliminary site investigation conducted as part of the concept options assessment. This report should be read in conjunction with the Croskell PSP Drainage Strategy Geotechnical Site Report Rev1.

The Croskell PSP area is located within the suburbs of Cranbourne East and Clyde North and is bounded by Thompsons Rd in the north, Berwick-Cranbourne Rd in the east Narre Warren Rd in the west and Linsell Blvd and a mix of residential streets in the south.

The location of the site, and proposed drainage concept design is shown in Plate 1.

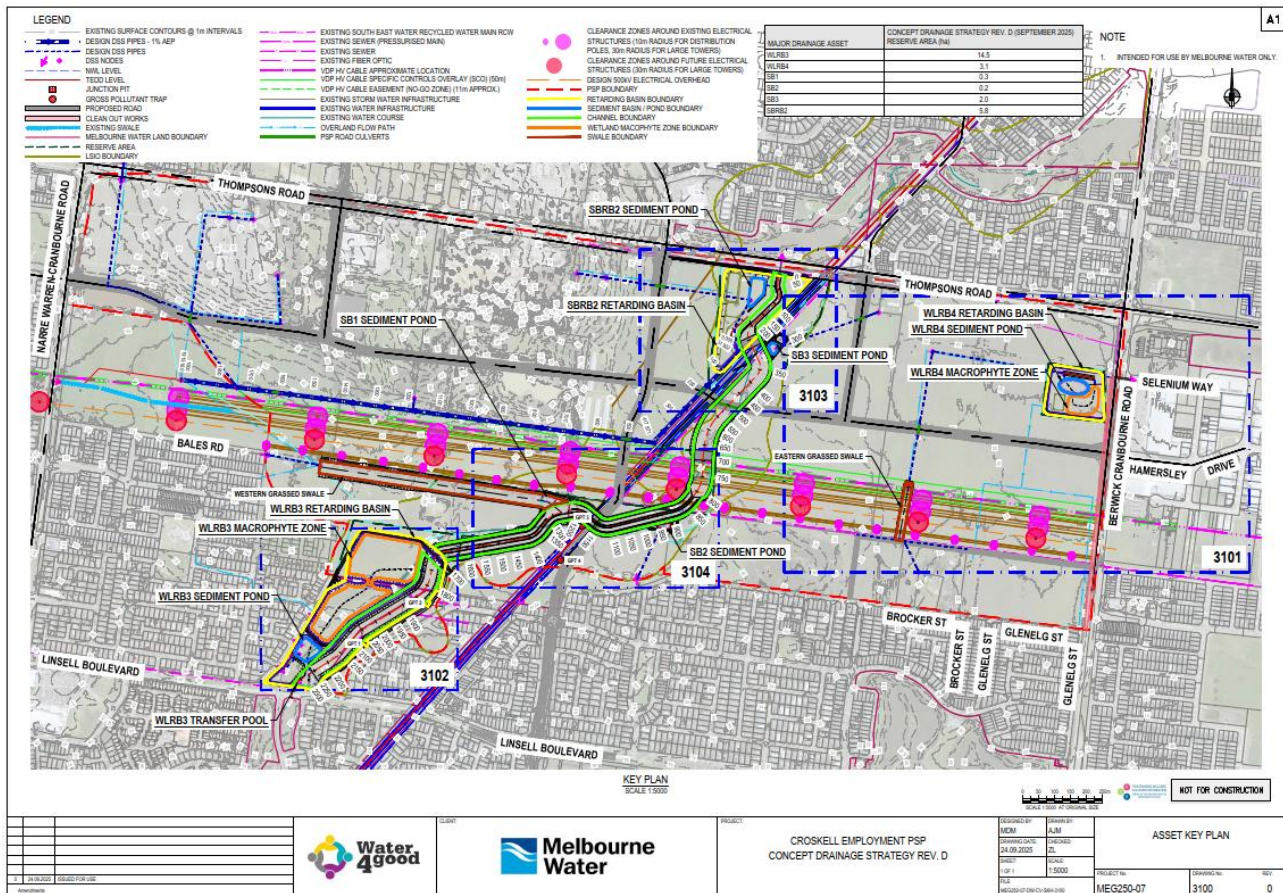


Plate 1: Croskell PSP drainage strategy, concept design.

The results of the geotechnical investigation are generally consistent with those observed in the initial investigation and indicate the site to generally be suitable for development of the proposed wetland basin(s) and ancillary open channel works. The main geotechnical hazards identified that have the potential to impact on the wetland design and construction activities and include:

- dispersive soils and increased erosion potential;
- elevated in situ soil moisture content;
- shallow groundwater.

Further discussion on these geotechnical hazards is provided in Section 6.

Groundwater wells were monitored over a twelve-month period. The factual results of the groundwater monitoring are presented in W4G memorandum “Croskell Precinct Structure Plan (PSP) Proposed Drainage Strategy – Groundwater Data Summary” provided in Appendix D. No interpretation of these results has been undertaken by W4G.

2 Aims of the investigation

Geotechnical works undertaken to date by W4G are described in the W4G Preliminary Geotechnical Site Report dated 18 August 2023. The locations of the boreholes drilled as part of the 2023 investigations are shown in Plate 2.

A total of 21 boreholes were drilled, BH01 through to BH22 (there was no BH11) to between 3.4 m and 6.45 m depth. Clayey soil types were predominantly encountered by the boreholes, with no rock encountered

by any of the boreholes. Groundwater monitoring wells were installed in BH03, BH06, BH10, BH13, BH16, BH19 and BH21. Wells were installed to 6 m depth. Geotechnical laboratory testing was undertaken on soil samples collected from all boreholes. Laboratory testing included:

- Field moisture
- Emerson crumb sodic soil dispersion
- Pinhole dispersion
- Permeability
- Atterberg limits
- Particle size distribution
- Standard compaction test

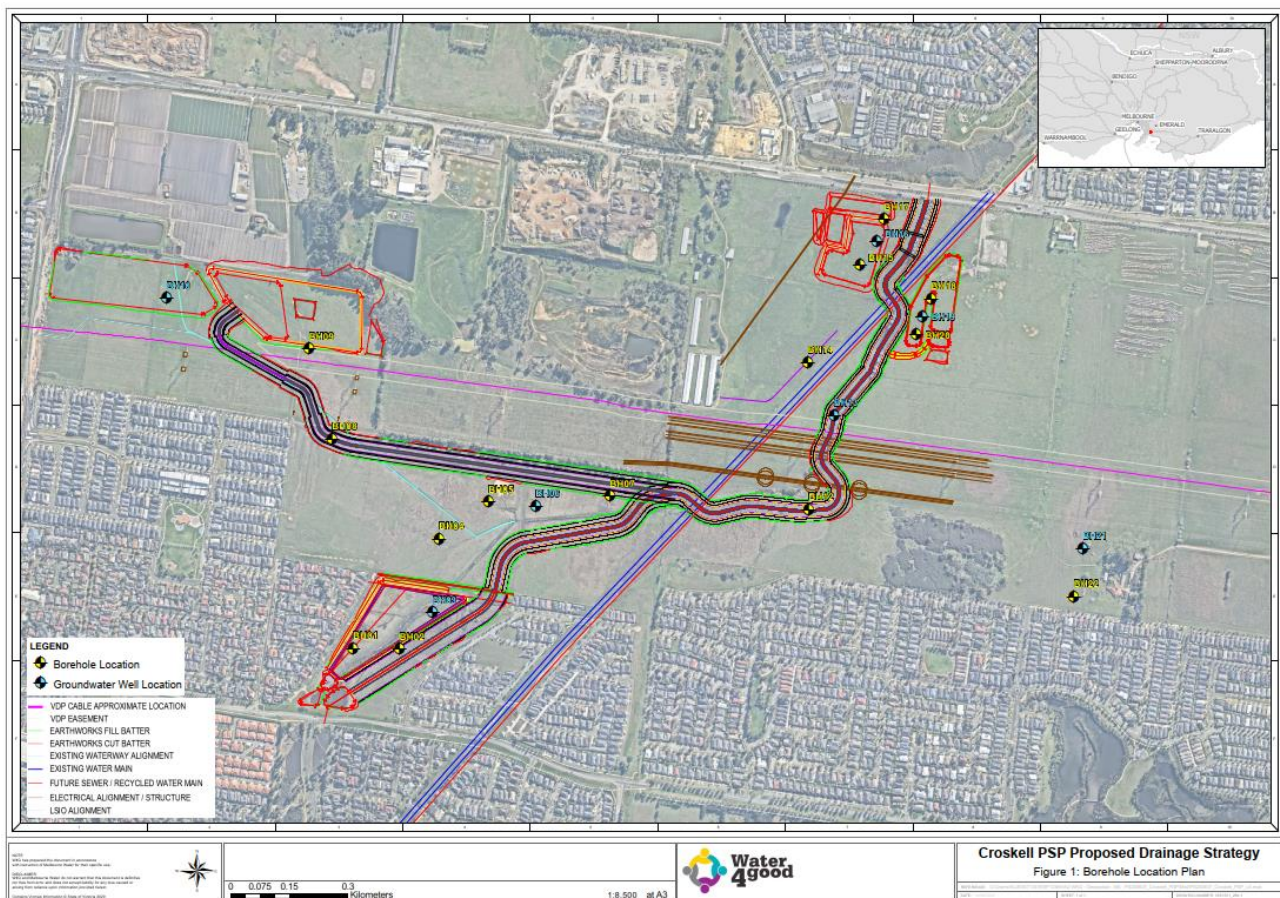


Plate 2: W4G 2023 Site Investigation Borehole Plan

Following the initial site investigation completed in 2023, W4G were commissioned to undertake an additional intrusive geotechnical soil investigation to support the next stage of the project. Additional geotechnical investigation was required within water asset footprints including the east diversion pipe and WLRB4. These assets were an addition to earlier designs.

The scope of these works is described in our proposals 3551531_286-O-Groundwater Monitoring PCN14, dated 26 April 2024 and 3551531_286-O-Groundwater Monitoring PCN18, dated 19 July 2024.

The aims of the investigation are to provide a preliminary understanding of the ground conditions at the proposed WLRB4 basin and DSS pipe locations, including:

- Typical sub-surface profile and geotechnical engineering characteristics of the site soils
- Depth to groundwater

The scope of the additional investigations was:

- Monitoring of groundwater in wells installed in BH03, BH06, BH10, BH13, BH16, BH19, BH21 at monthly intervals over 12 months.
- Drilling of an additional 3 m deep borehole at the northwest diversion pipe. With assessment of soil profile and laboratory testing as per previous investigations. This included the installation of 6 m groundwater well in a borehole and monthly monitoring over 12 months.
- Drilling of an additional 3 m borehole at WLRB4. With assessment of the soil profile and laboratory testing as per previous investigations.

The scope of both PCN 14 and PCN 18 has been completed. This site investigation report provides information on the fieldworks (borehole drilling) and laboratory soil testing, but does not include groundwater monitoring results. Groundwater monitoring results are included in W4G memorandum “Croskell Precinct Structure Plan (PSP) Proposed Drainage Strategy – Groundwater Data Summary” provided in Appendix D.

3 Field investigation

The intrusive geotechnical field investigation was undertaken between 26 August and 27 August 2024. A summary of the investigation works is presented below:

- Service locating for both borehole test site locations.
- Dynamic Cone Penetrometer testing (DCP) next to each test site to a depth of 1.5 m.
- Advancement of two boreholes to 6 m, followed by the installation of groundwater monitoring wells.
- Soil sampling of the boreholes for geotechnical testing purposes.

The investigation locations are presented in Figure 1.

Reports (logs) of Boreholes are presented in Appendix A, together with the explanatory notes, relevant to the interpretation of the reports of boreholes.

3.1 Service locating

Prior to any intrusive works being undertaken, WSP Golder completed a Before You Dig Australia (BYDA) services search for the investigation area. Boreholes and DCP test locations were scanned for the presence of underground services by a specialist underground service locator. No additional services were detected at the proposed test locations.

3.2 Borehole investigation

Two boreholes (BH23 and BH24, shown in Figure 1) were advanced to a depth of 6.45 m below the ground surface level using a Comacchio Geo 205 rig supplied and operated by Rockwell Drilling Pty Ltd.

In situ testing and sampling included:

- Dynamic Cone penetrometer testing (DCP) undertaken at both borehole locations to a depth of 1.5 m. DCP test results are included on the borehole logs in Appendix A.
- Standard penetration testing (SPT) was undertaken at regular intervals to collect samples and provide an indication of the insitu consistency/density of the soil profile. SPT test results are included on the borehole logs in Appendix A.
- Open standpipe wells were installed into boreholes to allow monitoring of groundwater levels.

For groundwater wells, sand and bentonite construction materials were used to backfill the annular gap between the PVC standpipe and the surrounding ground as described on the borehole logs in Appendix B.

The locations of the boreholes were measured using handheld GPS to a horizontal accuracy of +/- 5m. The elevation of boreholes was not measured.

4 Results of the field investigation

4.1 Geology

As described in the desktop study for the project, surface geology across the project site indicated by the Geological Survey of Victoria (GSC) 1:25,000 'Berwick' map sheet consists of several geological units. Baxter Formation (Tbp) is predominately mapped across the project site, with Older Volcanics (Tvo) in the far west and Quaternary Aeolian Sands (Qrd) in the north.

Quaternary Alluvium (Qra), while not mapped is also probable locally within the vicinity of the existing drainage lines.

4.2 Subsurface profile

To provide a consistent approach to describing the subsurface profile at the site, the units identified in the 2023 investigation have been retained for the additional investigation. A summary of the subsurface conditions encountered by the boreholes is set out below and summarised in Table 1. The depth ranges presented have been rounded to the nearest 0.1 m. The subsurface units encountered are consistent with the findings of the desktop study.

A detailed description of the subsurface conditions is presented in the Reports of Boreholes and DCP plots included in Appendix A and should be referred to for further details.

4.2.1 Unit 1 – Fill (Topsoil)

Grass covered topsoil, comprising brown clayey silt to silty clay of low plasticity was observed in both boreholes. Rootlets were identified within this unit, while trace sand and gravel were also identified in boreholes. The thickness of this unit was up to 300 mm thick in the boreholes conducted as part of the additional investigation, however thicknesses of up to 600 mm has been observed in previous investigations.

4.2.2 Unit 2 – Silty Clay / Clay (Tpb)

Unit 2 was encountered by BH24 immediately underlying Unit 1.

As described in following the 2023 investigation, Unit 2 soils are generally orange-brown and grey in colour, with minor blue-grey lenses. Clay encountered by the boreholes is typically of high plasticity. Sandy clay and clayey silt lenses were commonly encountered within this unit. Clays typically displayed an elevated soil moisture content. The in situ consistency encountered in BH23 and BH24 was typically very stiff, with weaker (firm) clay soils generally associated with higher moisture content occasionally encountered by previous (earlier) investigations.

In Borehole BH24 a thin layer / lens of clayey sand was encountered within the predominantly clay soils between 3.0 m and 3.5 m depth.

4.2.3 Unit 3 – Clayey Sand (Tpb)

Unit 3 was encountered in BH23 underlying Unit 1.

Unit 3 consisted of a brown to orange, fine to medium grained clayey sand. The clay fraction in the clayey sand was generally observed to be of low plasticity. The clayey sand was generally medium dense to dense.

4.2.4 Unit 4 – Sandy Clay / Silty Clay (Tvo)

Unit 4 was not identified in the boreholes completed in this additional investigation (BH23 & BH24).

Unit 4 was previously encountered in BH10, in the westernmost part of the site by previous investigations undertaken in 2023.

4.2.5 Groundwater seepage encountered during borehole drilling

Groundwater seepage was encountered during drilling of BH24 at 4.45m depth.

Groundwater was not encountered during drilling of BH23, however wet clay soil ($w > PL$) was encountered (refer to borehole logs presented in Appendix A).

Table 1: Summary of borehole subsurface profiles (depth in m)

	BH23	BH24
Unit 1 - Topsoil	0 - 0.2	0 - 0.3
Unit 3 – Clayey SAND	0.2 -2.0	
Unit 2 – Silty CLAY / CLAY	2.0 – 6.45	0.3 – 6.45

4.3 Groundwater Monitoring Wells

A 50 mm diameter PVC open standpipe groundwater monitoring well, with a flush mounted gatic was constructed at both borehole locations. Well construction details are summarised in Table 2 with additional detail provided in Appendix B.

- A bore construction license from Southern Rural Water was obtained prior to construction of the 50 mm PVC groundwater wells.
- Groundwater levels were measured on the same day as installation of the groundwater well.
- No groundwater testing was undertaken as part of this investigation.

Table 2: Well construction details and groundwater level measurements

Borehole open standpipe groundwater well		
	BH23	BH24
Date constructed	27/08/2024	26/08/2024
Easting*	351807	353477
Northing*	5782668	5782650
Depth to base of well (mbgl)	5.7	5.7
Screen depth interval (mbgl)	2.7 - 5.7	2.7 – 5.7
Groundwater depth (mbgl)	Not encountered	4.45
Date measured	27/08/2024	26/08/2024

*Coordinates in GDA 2020

mbgl = metres below existing ground level

For further groundwater level measurements after installation, refer to W4G memorandum “Croskell Precinct Structure Plan (PSP) Proposed Drainage Strategy – Groundwater Data Summary” provided in Appendix D.

5 Geotechnical laboratory test results

To support the field descriptions of subsurface materials encountered in the borehole investigation, WSP completed a suite of geotechnical laboratory tests including:

- Field moisture
- Emerson crumb sodic soil dispersion
- Pinhole dispersion
- Permeability
- Atterberg
- Particle size distribution
- Standard compaction test

The results are summarised in Table 3 to Table 5 together with results from the W4G 2023 investigation laboratory results. Laboratory test certificates are included in Appendix C. For samples where both Atterberg limit and particle size distribution testing was completed, the associated group symbol assigned in accordance with Australian standard AS 1726:2017 Geotechnical Site Investigations is provided. The results for samples tested for Atterberg limits has also been presented graphically in Plate 3.

Table 3 Summary of Atterberg limit and particle size test results

Borehole	BH23	BH24
Sample Depth (m)	2.00	2.00
Atterberg Limits		
Liquid Limit (%)	84	77
Plastic Limit (%)	25	18
Plasticity Index (%)	59	59
Linear Shrinkage (%)	19	19
Field Moisture (%)	24.8	28.5
% Fines	69.5	58.3
Group Symbol	CH	CH

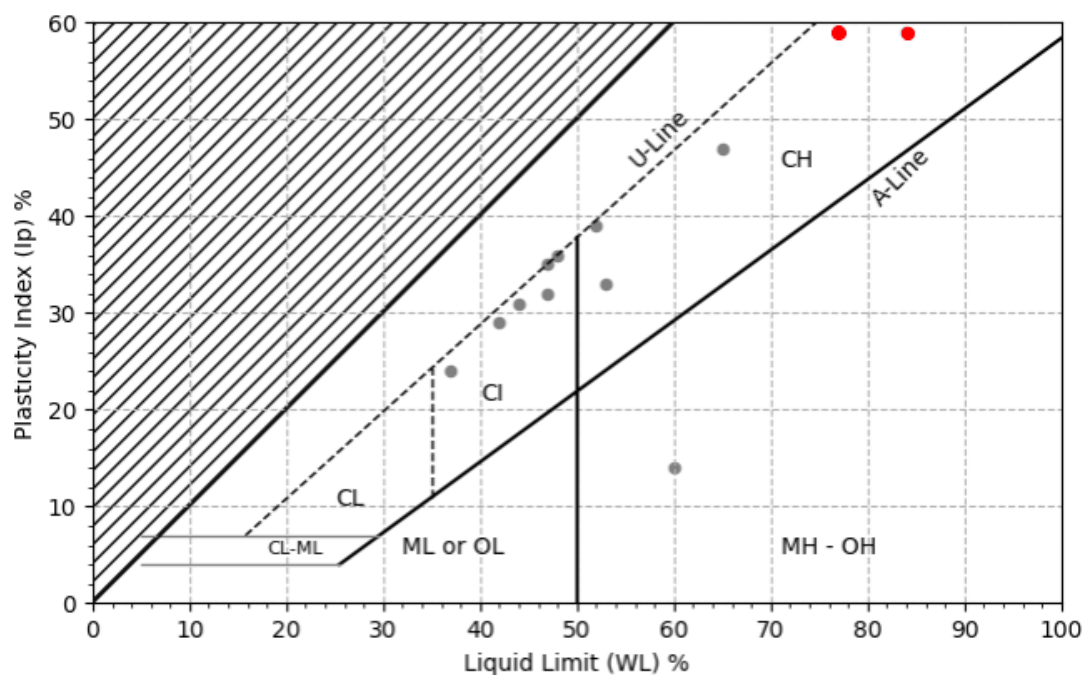


Plate 3: Plasticity chart for samples tested for Atterberg limits, red points indicate results from supplementary investigation, grey from 2023 investigation.

Table 4 Summary of Emerson crumb sodic soil dispersion test results

Borehole	Sample Depth (m)	Emerson Class Number		
		Distilled Water	Tap Water	Behavior
BH23	2.0	Class 5	Class 5	Non-Dispersive
BH24	2.0	Class 2	Class 2	Dispersive

Table 5 Summary of standard compaction, pinhole dispersion and permeability test results

Borehole	Sample Depth (m)	FMC (%)	OMC (%)	Max Dry Density (t/m3)	Pinhole Classification		Permeability (m/s)
BH24	1.0 - 1.4	26.7	26.5	1.49	ND2	Completely erosion resistant	1.00E-10

FMC= Field Moisture Content

OMC= Optimum Moisture Content

6 Geotechnical Assessment

6.1 Previous geotechnical assessment

Following the 2023 geotechnical investigation, a geotechnical assessment was provided within the Geotechnical Site Investigation Report (3551531-286- O-Croskell PSP Drainage Strategy Geotechnical Site Report Rev1, dated 18 August 2023). The discussion provided in this section does not supersede the previous report. Rather, should it be used to supplement the previous assessment.

6.2 Summary of geotechnical conditions

The results of the preliminary geotechnical investigation are generally consistent with those observed in the initial investigation and indicate the site to generally be suitable for development of the proposed wetland basin(s) and ancillary open channel works.

The additional geotechnical investigation supports the interpreted subsurface ground profile as described following the 2023 investigation. Along the proposed drainage alignment, the subsurface profile is expected to consist of a shallow cover of topsoil (Unit 1) overlying clay rich soils (Unit 2) of moderate to high plasticity to a depth of at least 2.8 m. Where present, clayey sands (Unit 3) are medium dense to dense. Local interbedding of Unit 2 and Unit 3 clay and sandy materials may be present across the site as indicated in BH23. A sandy clay / silty clay (Unit 4) was observed in BH10, indicative of residual soil of Older Volcanics. As this unit was not identified in other boreholes, the extents of this unit along the proposed drainage alignment are uncertain.

The soils encountered in boreholes were generally described as being wet ($w > PL$).

Groundwater was measured at 4.45 m below ground level in BH24, within the installed open standpipe groundwater wells. No groundwater was observed within Borehole BH23 following installation of an open standpipe. This is generally consistent with the 2023 investigation supporting the inference that the groundwater depth generally increases from southwest to northeast across the site.

Upon review of the geotechnical laboratory testing results, the following commentary can be made of the supplementary investigation:

- Tested soils are classified as high plasticity clays.
- Emerson crumb testing undertaken on soil samples in distilled and tap water indicate both dispersive behaviour (Emerson Class 2) in BH24 and non-dispersive behaviour (Emerson Class 5) in BH23. When compared with the results of the previous investigation, this indicates some variability in dispersive behaviour. However overall, a significant proportion of the soils tested across the site to date indicate potentially dispersive behaviour.
- Pinhole dispersion testing indicates a completely erosion resistant (ND2) behaviour for sample BH24 (1.0 m to 1.4 m). This result provides further evidence of some variability in dispersive behaviour and erosion susceptibility within the tested soils.
- Laboratory pinhole testing of recompacted soil at BH23 (1.0 m to 1.4 m) indicates the field moisture content was approximately (within $\pm 0.2\%$) of optimum moisture condition (OMC). Previous investigation identified soils up to 8% greater than the OMC. It is noted that the soils tested as part of this investigation possess high plasticity and high liquid limit properties, which is reflective of moisture sensitive soils.
- Permeameter testing of a recompacted clay sample collected from Borehole BH24 indicates very low permeability (1×10^{-10} m/sec), and potential suitability for use as a natural liner material.

6.3 Geotechnical commentary on potential construction hazards

The additional investigation did not identify geotechnical hazards that would differ substantially from those previously identified by earlier investigations.

Potential construction hazards that present a risk to earthworks identified through the 2023 investigation remain relevant. These are summarised as follows:

- The elevated in situ soil moisture content may lead to the following issues:
 - Additional effort in moisture conditioning of the material (i.e. difficulties in achieving a uniform moisture content within the material required for compaction).
 - Poor workability (i.e. difficult to place and compact), especially during periods of wet weather.
 - Inability to meet stringent proof-roll criteria (i.e. 'deflecting', 'spongy' or 'springing' subgrade).

In such instances, the use of imported fill material or drying back of existing soils may be required to achieve compaction targets. Where drying back is considered as an option this is likely to require additional effort to re-scarify and rework the clay material, which may be unsuccessful if wet weather conditions are prevalent or in situ soil moisture content is very high. Consideration under such circumstances could be given to lime treatment to assist in drying back the soils if required.
- Exposed clay soils may be subject to potential loss of strength after placement if subjected to moisture ingress.
- Exposed clay soils may be subject to desiccation cracking if left exposed to drying.
- Erosion potential of batters will need to be managed, particularly given the generally dispersive soil properties. Utilizing gentle batter angles and providing erosion protection (geosynthetics/vegetation) to reduce surface water run-off will assist in reducing erosion impacts.
- Erosion potential and the dispersive nature of soils at the site suggest measures such as filter zones within embankments or around proposed pipes/culverts may be required to reduce the risk of piping failure. Requirements for and details of such measures should be reviewed during detailed design. It is noted that the single pinhole dispersion test undertaken from BH24 (1.0-1.4m) indicates that soil from this area may have a lower risk of internal erosion (piping failure) where used as embankment fill in water retention structures.
- Shallow groundwater conditions were observed at several locations across the proposed alignment (from 0.45 m below existing ground level). Groundwater will require active management during construction via sumps and pumping, particularly at the basin locations. Further discussion on this can be found in section 6.6.
- The site is mostly located in an area of low-lying land, which is subject to periodic saturation and flooding. Based on the site position and observed geotechnical conditions, trafficability during construction may be significantly impeded (i.e. become soft / boggy), particularly if undertaken during the wetter months of the year. For this reason, it is recommended that earthworks are scheduled to occur during the drier months of the year.
- Clay soils obtained from excavation of the proposed basins have the potential to be reused as compacted embankment fill. Reuse suitability would be subject to appropriate moisture control and conditioning during placement and compaction. Soils that are significantly wet of optimum may be difficult to place and may require reworking / scarifying, or the addition of lime to facilitate drying back. Design consideration should be given to selectively excluding potentially dispersive materials in proposed embankment works or providing other protective measures. For example, engineering controls such as lime or gypsum additives could be used to reduce dispersion potential, or by including a filter layer in the embankment design to reduce the risk of piping.

6.4 Permanent Batter Slopes (basins and embankments)

The supplementary investigation supports the previous advice given on the recommended batter slopes for basins and embankments. Refer to the Preliminary Geotechnical Site Investigation Report 3551531-286- O-Croskell PSP Drainage Strategy Geotechnical Site Report Rev1, dated 18 August 2023.

Where permanent batters are constructed below the identified groundwater level, then these should be further flattened to reduce issues associated with possible groundwater seepages and localised increased potential for erosion. Further advice on this is given in the following sub-sections.

6.5 Clay Liners

The supplementary investigation supports the previous advice given on the requirement for clay liners to be implemented within the design and the potential options available for consideration. Refer to the Preliminary Geotechnical Site Investigation Report 3551531-286- O-Croskell PSP Drainage Strategy, Geotechnical Site Report Rev1, dated 18 August 2023.

6.6 Groundwater Considerations Surrounding Basin Design

The risks and engineering solutions associated with the presence of groundwater in retarding basins and wetlands have been further assessed and expanded upon from previous reports. The groundwater interaction related risks to the basin are summarised as follows:

- The development of slow groundwater seeps through the basin cut face may occur, where the groundwater table remains elevated, relative to the design basin levels. This may lead to wet spots developing in the basin as well as some inflow (leakage) into the basin.
- If the accumulated groundwater can drain through to the surface outlet works, then it is possible that service issues relating to dead storage (due to accumulation of groundwater in the basin over time) can be managed.
- Consideration of downstream impacts to wetlands (i.e. hydrology / flow and groundwater chemistry), if any, arising from groundwater interaction, should be considered in the design.
- Although unlikely, there is potential for erosion of the basin walls and the transportation of sediments into the wetlands and downstream assets, where groundwater leakage permeates through the basin internal batter. This issue is likely to be manageable where internal batter angles are modest (flatter than about 1V:6H) and topsoil cover with appropriate binding surface vegetation is maintained.

Adopting a design geometry, as far as practical, that limits the depth of the proposed basin is recommended. This will reduce interaction with the groundwater table and consequent issues as described above. An example of this control would be to design for basins that are wider and shallower, rather than narrow and deep to meet the required storage requirement.

Where the wetland normal water level is below the groundwater level, seepage through the cut face is anticipated to be manageable provided that soil conditions are stable. The risk of significant heave of the wetland floor due to upward groundwater seepage pressures is generally considered to be low, given the predominant clay soil geology.

7 Summary of Conclusions

The additional investigation generally supports the interpretation and assessment developed as part of the preliminary investigation. However, further investigations will be required as due diligence at future design stages. In total, the 23 boreholes generally indicate a subsurface profile comprising moderate to highly plastic clay rich soils, overlying sandy clays.

Geotechnically, the site is generally considered suitable for the development of the proposed wetland basin(s) and ancillary channel works, however some risks have been identified which could require management.

Key geotechnical hazards identified that have the potential to impact on the wetland design and construction activities include:

- **Dispersive soils and increased erosion potential.** Erosion potential and dispersive nature of the soils mean batter erosion and stability will need to be managed. Utilizing gentle batter angles and providing erosion protection (geosynthetics/vegetation) to reduce surface run-off will assist in reducing erosion impacts.
In addition, measures such as filter zones within embankments or around proposed pipes and culverts may be required to reduce the risk of piping. Requirements for and details of such measures should be reviewed during detailed design.
- **Elevated in situ soil moisture content.** The elevated in situ soil moisture content may lead to a requirement for additional effort in moisture conditioning of the material for compaction. Poor workability of the material especially during periods of wet weather and inability to meet stringent proof-roll criteria (i.e. 'deflecting', 'spongy' or 'springing' subgrade). This may lead to the use of imported fill material or drying back of existing soils to achieve compaction targets for earthworks.
- **Shallow groundwater.** Shallow groundwater conditions were observed at several locations across the proposed alignment (from 0.45 m below existing ground level). Groundwater is expected to require active management during construction via sumps and pumping, particularly at the basin locations (refer to Section 6.6 for commentary on risks to basin design).

Groundwater wells were monitored over a twelve-month period. The factual results of the groundwater monitoring are presented in W4G memorandum "Croskell Precinct Structure Plan (PSP) Proposed Drainage Strategy – Groundwater Data Summary" provided in Appendix D. No interpretation of these results has been undertaken by W4G.

8 Further Investigations

The information presented in the report is intended to provide a preliminary indication of the ground conditions at the site, sufficient to support early design stages of the project.

Further geotechnical, hydrogeological and contamination investigations are expected to be required to support future functional design and detailed design stages of the project.

These future investigations should preferably be scoped once the design matures and should be based on the final channel alignment and basin configuration, including any structural components such as weirs or culverts.

9 Limitations

9.1 Scope of services

This geotechnical site assessment report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and W4G (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

9.2 Reliance on data

In preparing the report, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

9.3 Geotechnical Investigation

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared to meet the specific needs of individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting civil engineer. This report was prepared expressly for the client and expressly for purposes indicated by the client or his representative. Use by any other persons for any purpose, or by the client for a different purpose, might result in problems. The client should not use this report for other than its intended purpose without seeking additional geotechnical advice.

9.4 This geotechnical report is based on project-specific factors

This geotechnical engineering report is based on a subsurface investigation which was designed for project-specification factors, including the nature of any development, its size and configuration, the location of any development on the site and its orientation, and the location of access roads and parking areas. Unless further geotechnical advice is obtained this geotechnical engineering report cannot be used:

- when the nature of any proposed development is changed
- when the size, configuration location or orientation of any proposed development is modified.

This geotechnical engineering report cannot be applied to an adjacent site.

9.5 Limitations of the site investigation

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by increasing the frequency of test locations; however this often does not result in any overall cost savings for the project. The investigation program undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation program and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

The borehole logs are the subjective interpretation of subsurface conditions at a particular location, made by trained personnel. The interpretation may be limited by the method of investigation, and can not always be definitive. For example, inspection of an excavation or test pit allows a greater area of the subsurface profile to be inspected than borehole investigation, however, such methods are limited by depth and site disturbance restrictions. In borehole investigation, the actual interface between materials may be more gradual or abrupt than a report indicates.

9.6 Subsurface conditions are time dependent

Subsurface conditions may be modified by changing natural forces or man-made influences. A geotechnical engineering report is based on conditions which existed at the time of subsurface exploration.

Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

9.7 Avoid misinterpretation

A geotechnical engineer should be retained to work with other appropriate design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

9.8 Bore profile logs should not be separated from the engineering report

Final bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the likelihood of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this matter reference should be made to 'Guidelines for the Provision of Geotechnical Information in Construction Contracts' published by the Institution of Engineers Australia, National Headquarters, Canberra 1987.

9.9 Geotechnical involvement during construction

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed and to conduct additional tests which may be required and to deal quickly with geotechnical problems if they arise.

9.10 Report for benefit of the client

The report has been prepared for the benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

9.11 Other Limitations

WSP will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

FIGURES – Test Location Plan (Figure 1)



NOTE
W4G has prepared this document in accordance with instruction of Melbourne Water for their specific use.

DISCLAIMER
W4G and Melbourne Water do not warrant that this document is definitive nor free from error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

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0 125 250 500 Meters

1:8,500 at A3



Croskell PSP Proposed Drainage Strategy

Figure 1: Borehole Location Plan

REFERENCE: C:\Users\AUJE507134\WSP\0365AU-WKG - Geospatial - AIS - Project\PS200634_Croskell_PSPMxd\PS200634_Croskell_PSP_2024_v1_no_design.mxd

DATE: 30/02/2025 SHEET 1 of 1 DRAWING NUMBER: 3551531_286-1

APPENDIX A - Reports of Boreholes

- Explanatory notes – Engineering Logs

Explanatory Notes – Engineering Logs

Engineering logs have been prepared in general accordance with AS1726:2017 “Geotechnical Site Investigations”, AGS 4.1AU data format and as defined below.

DRILLING/EXCAVATION METHODS

Symbol	Term
AD/T	Auger drilling with TC-bit
AD/V	Auger drilling with V-bit
AS	Auger screwing
AT	Air track / rotary air blast
DP	Direct push
DT	Diatube
E	Excavator
HA	Hand auger
HAND	Hand excavation
HSA	Hollow stem auger
NMLC/HMLC	Diamond core – triple tube
NQ3/HQ3/PQ3	Diamond core – wireline
RC	Reverse circulation
RR	Rock roller
S	Sonic drill
VB	Vibrocoring
VE	Vacuum extraction
WB	Washbore with blade or drag bit

WATER

	Complete water loss		Outflow
	Partial water loss		Inflow
	Water level at date shown		

NOT OBSERVED – not possible to assess groundwater conditions e.g. due to drilling water, surface seepage or cave-in
 NOT ENCOUNTERED – the hole was dry soon after excavation, however, groundwater could be present in less permeable strata.
 Inflow may have been observed had the hole been left open for a longer period

FIELD TEST (Soil borehole and test pit logs)

DCP	Dynamic Cone Penetrometer
HB	Hammer bounce
HW/RW	SPT penetration under rod/hammer weight only
OT	Other test (e.g., plate load test)
PID	Photoionisation detector
PKT	Permeability test (various methods)
PRM	Pressuremeter test
PP	Pocket penetrometer
PSP	Perth sand penetrometer
SPT	Standard penetration test, with ‘N’ value
VST	Shear vane test

SAMPLE

B	Bulk disturbed sample
C	Core sample
CBR	CBR mould sample
D	Small disturbed sample
ES	Soil sample for environmental testing
EW	Water sample for environmental testing
G	Gas sample
P	Piston sample
U63	Push tube sample (with diameter in mm)
W	Water sample

TOTAL CORE RECOVERY (Rock logs only)

$$\text{TCR (\%)} = \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

ROCK QUALITY DESIGNATION (Rock logs only)

$$\text{RQD (\%)} = \frac{\sum \text{Length of sound core pieces} > 100\text{mm}}{\text{Length of core run}} \times 100$$

GROUP SYMBOL (Soil borehole and test pit logs)

Soils are classified to reflect their primary and significant secondary component/characteristic using the classification symbols described in AS1726-2017, summarised as follows.

Symbol	Major division	Typical names
GW, GP	GRAVEL	Gravel & gravel-sand mixtures, little/no fines
GM		Gravel-silt & gravel-sand-silt mixtures
GC		Gravel-clay & gravel-sand-clay mixtures
SW, SP	SAND	Sand & gravel-sand mixtures, little/no fines
SM		Sand-silt mixtures
SC		Sand-clay mixtures
ML	SILT & CLAY (low & medium plasticity)	Inorganic silt/clayey fine sand or silt
CL, CI		Inorganic clay, gravelly clay, sandy clay
OL		Organic silt
MH	SILT & CLAY (high plasticity)	Inorganic silt
CH		Inorganic clay, high plasticity
OH		Organic clay, med-high plasticity, organic silt
Pt	Highly organic soil	Peat, highly organic soil

FIELD DESCRIPTION

Soil and rock materials described in general accordance with AS1726-2017. The description of percentage of cobbles and boulders in a soil may be limited by sample size.

MOISTURE CONDITION

Coarse grained soils and rocks

Dry (D), Moist (M) or Wet (W).

Estimated based on appearance and feel.

Cohesive soils (estimated based on judgement)

Symbol	Term
MC<PL	Moist, dry of plastic limit
MC≈PL	Moist, near plastic limit
MC>PL	Moist, wet of plastic limit
MC≈LL	Wet, near liquid limit
MC>LL	Wet, wet of liquid limit

COHESIVE SOILS – CONSISTENCY

The consistency of a cohesive soil is assessed by tactile means or field measurement of undrained shear strength. A Hand Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils (kPa) as follows:

Strength	Symbol	Indicative undrained shear strength (kPa)	Hand Penetrometer Reading (kPa)
Very Soft	VS	≤ 12	< 25
Soft	S	>12 and ≤ 25	25 to 50
Firm	F	> 25 and ≤ 50	50 to 100
Stiff	St	>50 and ≤ 100	100 to 200
Very Stiff	VSt	> 100 and ≤ 200	200 to 400
Hard	H	>200	> 400
Friable	Fr	-	-

COHESIONLESS SOILS – RELATIVE DENSITY

Relative density terms are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) ‘N’ values.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm is recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating

depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows /0.3 m)	DCP (blows/100 mm)
Very Loose	VL	0 to 15	0 to 4	0 to 1
Loose	L	15 to 35	4 to 10	1 to 2
Medium Dense	MD	35 to 65	10 to 30	2 to 3
Dense	D	65 to 85	30 to 50	4 to 8
Very Dense	VD	>85	>50	>8

SOIL STRUCTURE

Soil structure is described to AS 1726-2017 if visible and present.

SOIL / ROCK ORIGIN

The geological origin of the soil or rock is presented as an interpretation of the geological and geomorphological setting. Origin cannot be deduced on the basis of material appearance and properties alone and is therefore limited by the availability of supporting geological information

ROCK MATERIAL WEATHERING

Rock weathering is described mainly using the following abbreviations and definitions used in AS1726.

Term	Symbol	Definition
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.
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	Rock shows no sign of decomposition of individual minerals or colour changes.

If differentiation between highly and moderately weathered rock is not practicable, then Distinctly Weathered (DW) is used as defined in AS1726:2017.

INFERRED ROCK STRENGTH

Rock strength is inferred based on field assessment, Point Load Index (AS4133.4.1) or Uniaxial Compressive Strength (AS 4133.4.2.1) as follows:

Term	Symbol	UCS (MPa)	Point Load Index $I_{s(50)}$ (MPa)*
Very Low	VL	0.6 to 2	0.03 to 0.1
Low	L	2 to 6	0.1 to 0.3
Medium	M	6 to 20	0.3 to 1
High	H	20 to 60	1 to 3
Very High	VH	60 to 200	3 to 10
Extremely High	EH	>200	>10

*example based on $UCS = 20 \times I_{s(50)}$, actual correlation factor varies across rock types and weathering grades

-   Axial/Diametral Point Load Index test
 Uniaxial Compressive Strength test

DEFECT SPACING/BEDDING SPACING (Rock)

Measured at right angles to defects of same set or bedding.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm 6 to 20 mm	Thinly Laminated Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT TYPE (Rock)

Symbol	Term	Symbol	Term
CS	crushed seam	J	joint
DB	drilling break	MB	mechanical break
DL	drill lift	P	parting
EW	extremely weathered seam	S	sheared surface
HB	handling break	SS	shear seam
IS	infilled seam	SZ	shear zone

DEFECT ORIENTATION (Rock)

Dip measured relative to the horizontal plane in vertical boreholes and relative to core axis in inclined boreholes.

DEFECT ROUGHNESS AND SHAPE (Rock)

Roughness	Description	Roughness	Description
SM	Smooth	PO	Polished
RF	Rough	SL	Slickensided
VR	Very Rough		

Shape	Description	Shape	Description
PR	Planar	CU	Curved
UN	Undulating	ST	Stepped
IR	Irregular		

DEFECT APERTURE OBSERVATION (Rock)

Symbol	Term
CN	Clean
CT	Coating (<=1 mm)
SN	Stained
VN	Veneer

Aperture infill is denoted through presence of a value in the aperture thickness measurement and an infill material code or name in the infill material cell.

DEFECT INFILLING (Rock)

Where defects are infilled, the infilling material is either coded with a soil/mineral name (e.g. CLAY), a group symbol code (e.g. SC), or one of the material codes in the table below.

Term	Description	Term	Description
Ca	Calcite	Mn	Manganese
Ch	Chlorite	Py	Pyrite
Co	Coal/carbonaceous	Gp	Gypsum
CR	Crushed rock	Qz	Quartz
Fe	Limonite/ironstone	Ud	Unidentified
Fs	Feldspar		

OTHER OBSERVATIONS

Ranking of visually observable contamination and odour (applies on specific soil contamination projects only)

Symbol	Term
R = 0	No visible evidence of contamination
R = 1	Slight evidence of contamination
R = 2	Visible evidence of contamination
R = 3	Significant visible evidence of contamination
R = A	No non-natural odours identified
R = B	Slight non-natural odours identified
R = C	Moderate non-natural odours identified
R = D	Strong non-natural odours identified

Graphic Log Colour Scheme – Soils and Rocks

The soil and rock colour schemes presented on the logs and fences have been derived from those below. The rock colour scheme is taken from Geoscience Australia's predecessor, the Bureau of Mineral Resources (BMR).

	Clay dominated soils	Soils
	Silt dominated soils, topsoil, undifferentiated fine grained soil	
	Sand dominated soils	
	Gravel or cobble dominated soils	
	Peat soils	
	Lithic sedimentary breccia and conglomerate	Sedimentary rocks
	Sandstone, arenite	
	Arkose	
	Pelitic rocks, shale, mudstone	
	Greywacke, siltstone, siltstone-sandstone mixtures	
	Coal, lignite, undifferentiated carbonaceous rock	Metamorphic rocks
	Limestone, chert, undifferentiated calcareous soils, and rocks	
	Undifferentiated metamorphic rocks of any grade	
	Schist, gneiss, and other high grade metamorphic rocks	
	Greenschist, phyllite, hornfels and lower grade metamorphic rocks	
	Undifferentiated igneous rock, tuff, volcanics	Igneous rocks
	Extrusive acid igneous rock, rhyolite	
	Extrusive basic igneous rock, basalt, spilite	
	Extrusive intermediate igneous rock, dacite	
	Extrusive ultrabasic igneous	
	Intrusive acid igneous rock, all granitoid rock	
	Intrusive basic igneous rock, gabbro, dolerite	
	Intrusive intermediate igneous rock, andesite, diorite	
	Intrusive ultrabasic igneous rock, peridotite	
	Fill, concrete, pavement	Secondary rock, man-made and other materials
	Water	
	Undifferentiated evaporite unit	
	Calcrete	
	Ironstone, ferricrete, ferruginous rock	

Graphic Symbols – Soils and Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicate mixed materials such as clayey sand.

SOIL SYMBOLS

Main components



CLAY



SILT



SAND



GRAVEL



BOULDERS / COBBLES



TOPSOIL



PEAT

Minor components



CLAYEY



SILTY



SANDY



GRAVELLY

OTHER MATERIAL SYMBOLS



FILL



BITUMEN



CONCRETE

ROCK SYMBOLS

Sedimentary Rocks



SANDSTONE



SILTSTONE



CLAYSTONE, MUDSTONE



SHALE



COAL



LIMESTONE



CONGLOMERATE

Igneous rocks



GRANITE



BASALT



UNDIFFERENTIATED IGNEOUS

Metamorphic rocks



SLATE, PHYLLITE, SCHIST



GNEISS



QUARTZITE



BOREHOLE: BH23

Sheet 1 of 1

Project: Croskell PSP Drainage Strategy

Location: Cranbourne VIC

Client: Melbourne Water

Job No.: PS200634

Coords: 351836.0 m E 5782689.0 m N MGA2020-55

Contractor: Rockwell Drilling Drill Rig: Comacchio

Inclination: -90°

Date Started: 27/8/2024

Date Completed: 27/8/2024

Logged: ML

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DCP TEST
												Blows per 100 mm
												0510152025
ADV	F	Not Encountered	0	0.20				ML	TOPSOIL Sandy SILT: dark brown, sand is fine to medium grained; with rootlets.	w<PL	St	
								SC	Clayey SAND: fine to medium grained, orange brown, clay is low plasticity.			
			1		U 1.00-1.40 m WSP24-BH23-001 PP 1.00 m >600 kPa				Pale grey, orange brown.	M	D	HB
			2	2.00	SPT 2.00-2.45 m 8,11,14 N=25 D 2.00-2.45 m WSP24-BH23-002			CH	CLAY: high plasticity, red brown, pale grey.			
			3		SPT 3.00-3.45 m 8,12,18 N=30 D 3.00-3.45 m WSP24-BH23-003							
			4	4.00	SPT 4.00-4.45 m 5,10,13 N=23 D 4.00-4.45 m WSP24-BH23-004			CH	CLAY: high plasticity, red-orange brown, pale grey, trace fine to medium grained sand.	w>PL	VSt - H	
			5	5.00	SPT 5.00-5.45 m 6,9,10 N=19 D 5.00-5.45 m WSP24-BH23-005			CH	Sandy CLAY: high plasticity, pale grey, orange brown, sand is fine to medium grained.			
			6	6.45	SPT 6.00-6.45 m 9,15,14 N=29 D 6.00-6.45 m WSP24-BH23-006				Hole Terminated at 6.45 m Target depth			
			7									
			8									
			9									
			10									
Comments										Checked	AJD	
										Date	2/9/2024	

WSP-AU 6.00.0 LIB.GLB Log IS AU BOREHOLE 3 PS200634 BECA_AUGUST24.GPJ <<DrawingFile>> 4/10/2024 14:21 10.03.00.09 D:\git\Lab and In Situ Tool - DGD [Lib: WSP 6.00.0 2024-06-03 Proj: WSP 5.03.3 2023-01-19



BOREHOLE: BH24

Sheet 1 of 1

Project: Croskell PSP Drainage Strategy

Location: Cranbourne VIC

Client: Melbourne Water

Job No.: PS200634

Coords: 353477.0 m E 5782650.0 m N MGA2020-55

Contractor: Rockwell Drilling Drill Rig: Comacchio

Inclination: -90°

Date Started: 26/8/2024

Date Completed: 26/8/2024

Logged: ML

Drilling				Sampling		Field Material Description												
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	DCP TEST					
													Blows per 100 mm					
													0	5	10	15	20	25
AD/V	F	Encountered	0					SM	TOPSOIL Silty SAND: fine to medium grained, low plasticity, dark brown, with rootlets.	w<PL	St							
			0.30					CH	CLAY: high plasticity, dark brown, red-orange brown, trace sand.		F							
									Orange brown, red brown, pale grey.		St							
			1		U 1.00-1.40 m WSP24-BH24-002 PP 1.00 m =250-300 kPa					w=PL								
			1.45						Orange brown, pale grey, red.									
			2		SPT 2.00-2.45 m 3,3,3 N=6 D 2.00-2.45 m WSP24-BH24-003			CH	CLAY: high plasticity, pale grey, orange brown.	w>PL								
			2.00							w=PL								
			3		SPT 3.00-3.45 m 5,9,10 N=19 D 3.00-3.45 m WSP24-BH24-004			SC	Clayey SAND: fine to medium grained, pale grey, red brown.	M	D							
			3.50					CH	CLAY: high plasticity, pale grey, orange brown.									
			4		SPT 4.00-4.45 m 2,4,3 N=7 D 4.00-4.45 m WSP24-BH24-005													
			5		SPT 5.00-5.45 m 4,4,8 N=12 D 5.00-5.45 m WSP24-BH24-006				Orange brown, pale grey.	w>PL	VSt - H							
			5.00															
			6		SPT 6.00-6.45 m 10,11,12 N=23 D 6.00-6.45 m WSP24-BH24-007				Red brown, orange brown, pale grey.									
			6.00															
			6.45															
									Hole Terminated at 6.45 m Target depth									
			7															
			8															
			9															
			10															
Comments													Checked AJD Date 2/9/2024					

WSP-AU 6.00.0 LIB.GLB Log IS AU BOREHOLE 3 PS200634 BECA_AUGUST24.GPJ <<DrawingFile>> 4/10/2024 14:21 10.03.00.09 Ddgel Lab and In Situ Tool - DGD [Lib: WSP 6.00.0 2024-06-03 Proj: WSP 5.03.3 2023-01-19

APPENDIX B – Groundwater Well Construction Details



REPORT OF BOREHOLE: BH23

SHEET: 1 OF 1
DRILL RIG: Comacchio
CONTRACTOR: Rockwell Drilling
LOGGED: ML DATE: 27/8/24
CHECKED: AJD DATE: 2/9/24

CLIENT: Melbourne Water
PROJECT: Croskell PSP Drainage Strategy
LOCATION: Cranbourne VIC
JOB NO: PS200634
COORDS: 351836.0 m 5782689.0 m MGA2020-55
INCLINATION: -90°
HOLE DEPTH: 6.45 m

Drilling					Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	CAVITY/FRACTURE	AIRLIFT YIELD (L/s)	CONSTRUCTION ID Static Water Level BH23 Reference Point
ADV	Not Encountered	0	0.20		TOPSOIL Sandy SILT ML: dark brown, sand is fine to medium grained; with rootlets. stiff to very stiff; Moist, dry of plastic limit.			← Gatic Cover ← Grout ← Bentonite ← 2.7 m - 5.7 m: 50mm PVC, well screen, 0.5mm ← Sand
		0.80			Clayey SAND SC: fine to medium grained, orange brown, clay is low plasticity. very stiff to hard; Moist, dry of plastic limit to Moist, wet of plastic limit.			
		1			Pale grey, orange brown.			
		2	2.00		CLAY CH: high plasticity, red brown, pale grey. very stiff to hard; Moist, wet of plastic limit.			
		3						
		4	4.00		CLAY CH: high plasticity, red-orange brown, pale grey, trace fine to medium grained sand. very stiff to hard; Moist, wet of plastic limit.			
		5	5.00		Sandy CLAY CH: high plasticity, pale grey, orange brown, sand is fine to medium grained. very stiff to hard; Moist, wet of plastic limit.			
		6						
		6.45			END OF BOREHOLE @ 6.45 m TARGET DEPTH GATIC COVER			
		7						
		8						
		9						
		10						

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F06
RL3

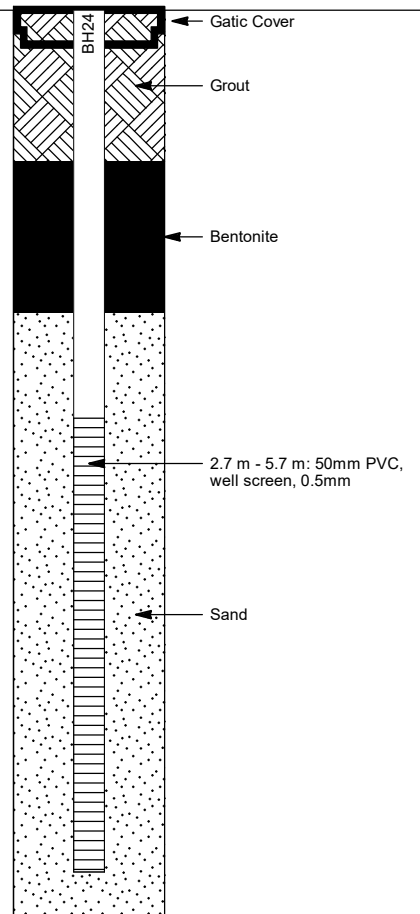


REPORT OF BOREHOLE: BH24

SHEET: 1 OF 1
DRILL RIG: Comacchio
CONTRACTOR: Rockwell Drilling
LOGGED: ML DATE: 26/8/24
CHECKED: AJD DATE: 2/9/24

CLIENT: Melbourne Water
PROJECT: Croskell PSP Drainage Strategy
LOCATION: Cranbourne VIC
JOB NO: PS200634
COORDS: 353477.0 m 5782650.0 m MGA2020-55
INCLINATION: -90°
HOLE DEPTH: 6.45 m

Drilling				Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	CAVITY/FRACTURE	AIRLIFT YIELD (L/s)
ADV	Encountered	0			TOPSOIL Silty SAND SM: fine to medium grained, low plasticity, dark brown, with rootlets. stiff; Moist, dry of plastic limit.		
		0.30					
		0.50			CLAY CH: high plasticity, dark brown, red-orange brown, trace sand. firm to stiff; moist.		
		1			Orange brown, red brown, pale grey.		
		1.45			Orange brown, pale grey, red.		
		2			CLAY CH: high plasticity, pale grey, orange brown. stiff; moist to Moist, wet of plastic limit.		
		3			Clayey SAND SC: fine to medium grained, pale grey, red brown. very stiff; Moist, wet of plastic limit.		
		3.50			CLAY CH: high plasticity, pale grey, orange brown. very stiff to hard; Moist, wet of plastic limit.		
		4					
		5			Orange brown, pale grey.		
		6			Red brown, orange brown, pale grey.		
		6.45			END OF BOREHOLE @ 6.45 m TARGET DEPTH GATIC COVER		
		7					
		8					
		9					
		10					



This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

APPENDIX C - Reports of geotechnical laboratory testing

Soils testing - Report of Emerson class number

Soil classification

AS 1289.3.8.1-2017



Test request ID:	TRM24-0331	Specimen ID:	LMEL202409030	WSP Australia Pty Ltd
Client:	Melbourne Water	MELBOURNE GEOTECHNICAL LABORATORY		
Client address:	990 La Trobe Street, Docklands VIC 3008	Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Project ID:	PS200634	Exploratory Hole	Sample depth (m): 2.00 - 2.45	
Project name:	Croskell PSP Drainage Strategy Cranbourne VIC	WSP24-BH23	Client sample ref: WSP24-BH24-002	
Project reference:		Loc. ref.:	-	

Specimen description: (CH), CLAY, high plasticity, brown, with fine to coarse grained sand, trace gravel

Sampling co-ordinates
Easting (m) **Northing (m)** **Reduced Level**

TEST REPORT - SUMMARY OF ANALYSIS

Visual reference	Date sampled: Unknown - tested as rcvd. Date tested: 09/09/24 Temperature (°C): 20.0° Type of water used: Distilled
	Observations / Notes
	Emerson class number Class 5

Emerson Class	Definition / Notes
Class 1	Air-dried crumbs of soil show a strong dispersing reaction, i.e., a colloidal cloud covers nearly the whole of the bottom of the beaker, usually in a very thin layer. The reaction should be evident within 10 minutes. In extreme cases all the water in the beaker becomes cloudy, leaving only a coarse residue in a cloud of clay.
Class 2	Air-dried crumbs of soil show a moderate to slight reaction. A moderate reaction consists of an easily recognizable cloud of colloids in suspension, usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs.
Class 3	The soil remoulded at the plastic limit disperses in water.
Class 4	The remoulded soil does not disperse in water. Calcium carbonate (calcite) or calcium sulfate (gypsum) is present.
Class 5	The remoulded soil does not disperse in water and the 1:5 soil/water suspension remains dispersed after 10 minutes.
Class 6	The remoulded soil does not disperse in water and the 1:5 soil/water suspension begins to flocculate within 10 minutes.
Class 7	The air-dried crumbs of soil remain coherent in water and swell.
Class 8	The air-dried crumbs of soil remain coherent in water and do not swell.

Definitions:

ND = Not determined

Result reviewed by: AStevenson

Test performed by: NMD

Date reported: 24/09/2024

Cert. ref.: PS200634_TRM24-0331_Emerson_LMEL202409030_R115575	Approved signatory:
 NATA accreditation number: 1961 - Site:1250 - Melbourne Accredited for compliance with ISO/IEC 17025 - Testing	 Aaron Stevenson - Senior Geotechnical Laboratory Technician
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Soils testing - Report of Emerson class number

Soil classification

AS 1289.3.8.1-2017

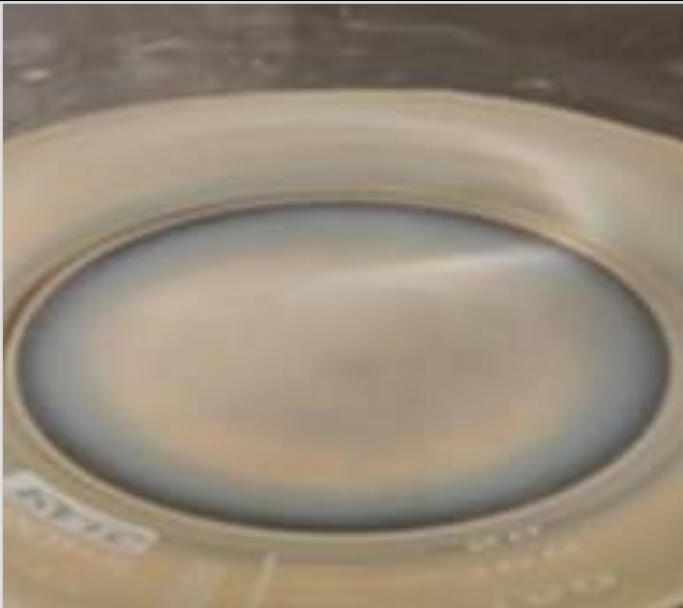


Test request ID:	TRM24-0331	Specimen ID:	LMEL202409033	WSP Australia Pty Ltd
Client:	Melbourne Water	MELBOURNE GEOTECHNICAL LABORATORY		
Client address:	990 La Trobe Street, Docklands VIC 3008	Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Project ID:	PS200634	Exploratory Hole	Sample depth (m): 2.00 - 2.45	
Project name:	Croskell PSP Drainage Strategy Cranbourne VIC	WSP24-BH24	Client sample ref: WSP24-BH24-003	
Project reference:		Loc. ref.:	-	

Specimen description: (CH), Sandy CLAY, high plasticity, grey, fine to coarse grained sand, trace fine to medium gravel

Sampling co-ordinates
Easting (m) **Northing (m)** **Reduced Level**

TEST REPORT - SUMMARY OF ANALYSIS

Visual reference	Date sampled: Unknown - tested as rcvd. Date tested: 09/09/24 Temperature (°C): 20.0° Type of water used:
	Observations / Notes
	Emerson class number Class 2

Emerson Class	Definition / Notes
Class 1	Air-dried crumbs of soil show a strong dispersing reaction, i.e., a colloidal cloud covers nearly the whole of the bottom of the beaker, usually in a very thin layer. The reaction should be evident within 10 minutes. In extreme cases all the water in the beaker becomes cloudy, leaving only a coarse residue in a cloud of clay.
Class 2	Air-dried crumbs of soil show a moderate to slight reaction. A moderate reaction consists of an easily recognizable cloud of colloids in suspension, usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs.
Class 3	The soil remoulded at the plastic limit disperses in water.
Class 4	The remoulded soil does not disperse in water. Calcium carbonate (calcite) or calcium sulfate (gypsum) is present.
Class 5	The remoulded soil does not disperse in water and the 1:5 soil/water suspension remains dispersed after 10 minutes.
Class 6	The remoulded soil does not disperse in water and the 1:5 soil/water suspension begins to flocculate within 10 minutes.
Class 7	The air-dried crumbs of soil remain coherent in water and swell.
Class 8	The air-dried crumbs of soil remain coherent in water and do not swell.

Definitions:

ND = Not determined

Result reviewed by: AStevenson

Test performed by: NMD

Date reported: 24/09/2024

Cert. ref.: PS200634_TRM24-0331_Emerson_LMEL202409033_R115577	Approved signatory:
 NATA accreditation number: 1961 - Site:1250 - Melbourne Accredited for compliance with ISO/IEC 17025 - Testing	 Aaron Stevenson - Senior Geotechnical Laboratory Technician
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Soils testing - Report of Emerson class number

Soil classification

AS 1289.3.8.1-2017

Test request ID:	TRM24-0331	Specimen ID:	LMEL202409035	WSP Australia Pty Ltd
Client:	Melbourne Water	MELBOURNE GEOTECHNICAL LABORATORY		
Client address:	990 La Trobe Street, Docklands VIC 3008	Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Project ID:	PS200634	Exploratory Hole	Sample depth (m):	2.00 - 2.45
Project name:	Croskell PSP Drainage Strategy Cranbourne VIC	WSP24-BH24	Client sample ref:	Tap water
Project reference:		Loc. ref.:		-

Specimen description: (CH), Sandy CLAY, high plasticity, grey, fine to coarse grained sand, trace fine to medium gravel

Sampling co-ordinates
Easting (m) Northing (m) Reduced Level

TEST REPORT - SUMMARY OF ANALYSIS

Visual reference	Date sampled:	Unknown - tested as rcvd.
	Date tested:	09/09/24
	Temperature (°C):	20.0°
	Type of water used:	Tap
	Observations / Notes	
Emerson class number		
Class 2		

Emerson Class	Definition / Notes
Class 1	Air-dried crumbs of soil show a strong dispersing reaction, i.e., a colloidal cloud covers nearly the whole of the bottom of the beaker, usually in a very thin layer. The reaction should be evident within 10 minutes. In extreme cases all the water in the beaker becomes cloudy, leaving only a coarse residue in a cloud of clay.
Class 2	Air-dried crumbs of soil show a moderate to slight reaction. A moderate reaction consists of an easily recognizable cloud of colloids in suspension, usually spreading in thin streaks on the bottom of the beaker. A slight reaction consists of the bare hint of cloud in water at the surface of the crumbs.
Class 3	The soil remoulded at the plastic limit disperses in water.
Class 4	The remoulded soil does not disperse in water. Calcium carbonate (calcite) or calcium sulfate (gypsum) is present.
Class 5	The remoulded soil does not disperse in water and the 1:5 soil/water suspension remains dispersed after 10 minutes.
Class 6	The remoulded soil does not disperse in water and the 1:5 soil/water suspension begins to flocculate within 10 minutes.
Class 7	The air-dried crumbs of soil remain coherent in water and swell.
Class 8	The air-dried crumbs of soil remain coherent in water and do not swell.

Definitions:

ND = Not determined

Result reviewed by: AStevenson

Test performed by: NMD

Date reported: 24/09/2024

Cert. ref.:	PS200634_TRM24-0331_Emerson_LMEL202409035_R115576	Approved signatory:
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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS 1289.3.6.1, 2.1.1, 3.1.1, 3.2.1, 3.3.1, 3.4.1 & (AS 1726:2017 Section 6.1)

Test request #:

TRM24-0331

Specimen ID:

LMEL202409030

WSP Australia Pty Ltd

Client:

Melbourne Water

MELBOURNE GEOTECHNICAL LABORATORY

Client address:

990 La Trobe Street, Docklands VIC 3008

Building 7, Botanica Corporate Park

570 - 588 Swan Street

Richmond, Victoria 3121

Project ID:

PS200634

Location ID

Project name:

Croskell PSP Drainage Strategy Cranbourne VIC

WSP24-BH23

Sample depth (m): 2.00 - 2.45

Client sample ref: WSP24-BH24-002

Project reference:

Loc. ref.:

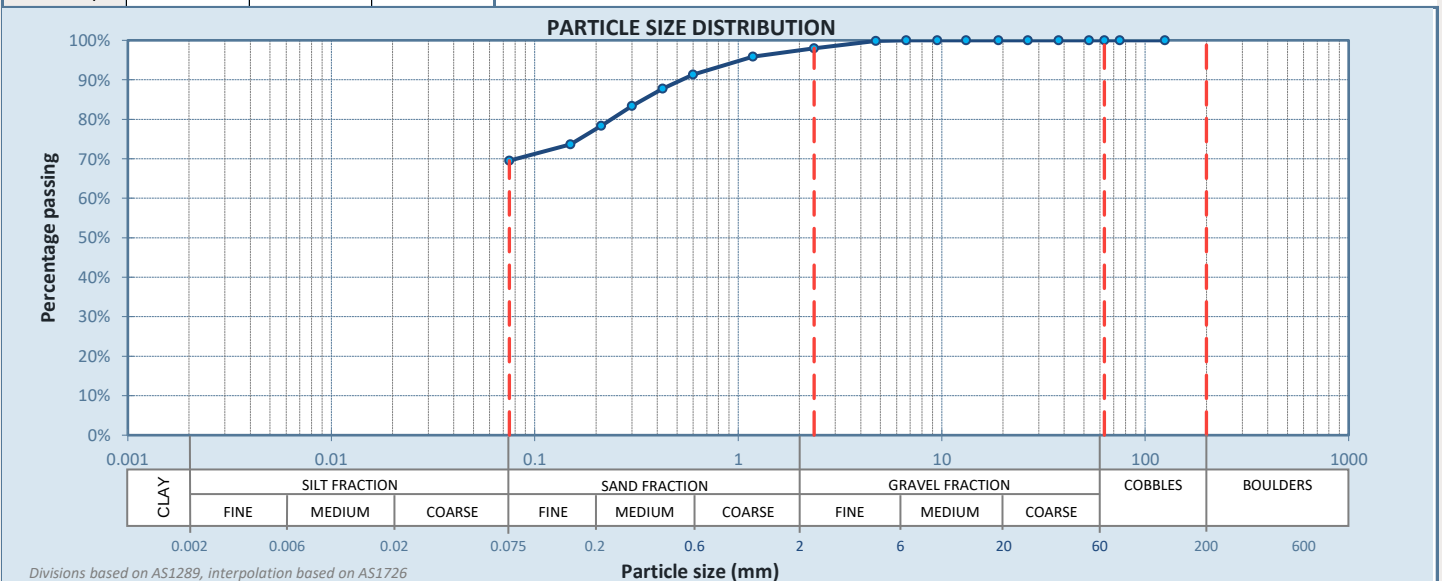
-

Specimen description: (AS 1726:2017 Section 6.1)

Sampling:

Supplied by client

PARTICLE SIZE DISTRIBUTION				AS 1289.3.6.1				(CH), CLAY, high plasticity, brown, with fine to coarse grained sand, trace gravel		Easting (m)		Northing (m)		Level (m)		
Sieve Size	Passing	LB S	UB S	Method:		AS 1289.2.1.1		AS 1289.3.1.1		AS 1289.3.2.1		AS 1289.3.3.1		AS 1289.3.4.1		
125 mm	100%															
75 mm	100%															
63 mm	100%															
53 mm	100%															
37.5 mm	100%															
26.5 mm	100%															
19 mm	100%															
13.2 mm	100%															
9.5 mm	100%															
6.7 mm	100%															
4.75 mm	100%															
2.36 mm	98%															
1.18 mm	96%															
600 µm	91%															
425 µm	88%															
300 µm	83%															
212 µm	78%															
150 µm	74%															
75 µm	70%															
										</						



Testing by:

PL

Dates:

11/09/24 - 17/09/24

Results reviewed by:

AStevenson

Date reported:

24/09/2024

Cert. ref.: PS200634_WSP24-BH23_TRM24-0331_PSD_2409030_Rep24115572

Approved signatory:



NATA accreditation number: 1961 - Site:1250 - Melbourne
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These tests were carried out in accordance with the Australian standards identified in this certificate.
Test results relate only to the specimens tested.

Rep AS1289.3.6.1 - RL49

For issue

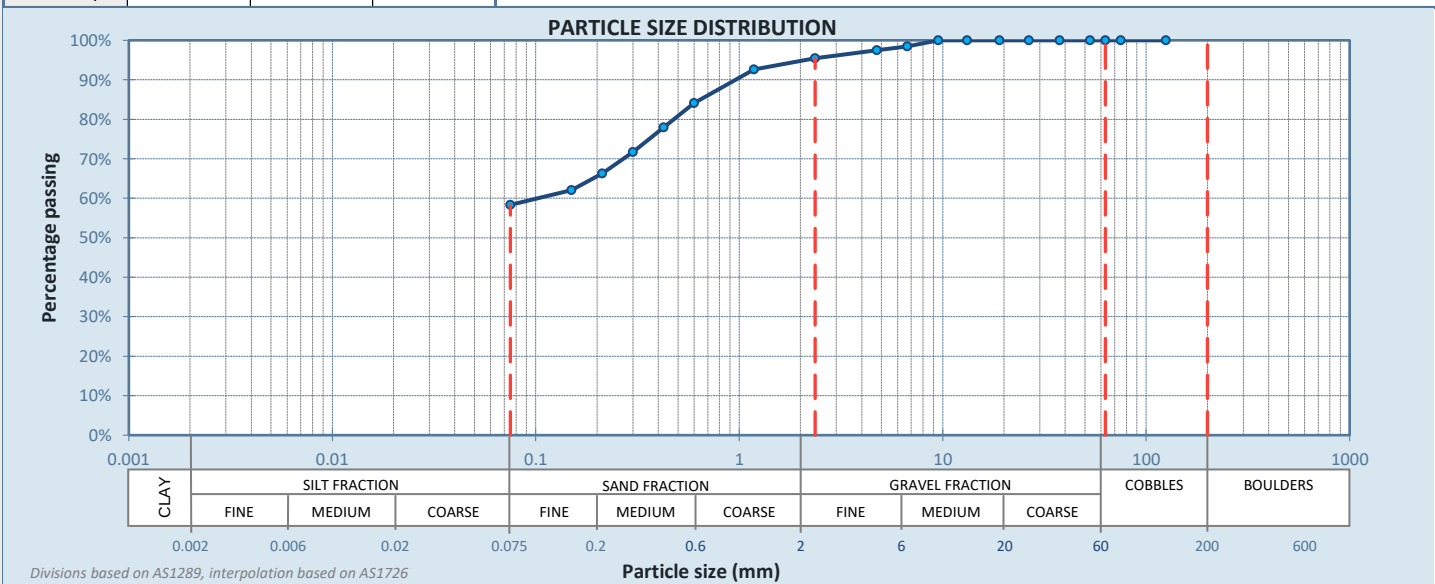
Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving)

AS 1289.3.6.1, 2.1.1, 3.1.1, 3.2.1, 3.3.1, 3.4.1 & (AS 1726:2017 Section 6.1)

Test request #:	TRM24-0331	Specimen ID:	LMEL202409033	WSP Australia Pty Ltd
Client:	Melbourne Water	MELBOURNE GEOTECHNICAL LABORATORY		
Client address:	990 La Trobe Street, Docklands VIC 3008	Building 7, Botanica Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121		
Project ID:	PS200634	Location ID:	WSP24-BH24	Sample depth (m): 2.00 - 2.45
Project name:	Croskell PSP Drainage Strategy Cranbourne VIC	Client sample ref:	WSP24-BH24-003	
Project reference:		Loc. ref.:	-	

Specimen description: (AS 1726:2017 Section 6.1)				Sampling:				Supplied by client			
PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1				(CH), Sandy CLAY, high plasticity, grey, fine to coarse grained sand, trace fine to medium gravel				Easting (m)	Northing (m)	Level (m)	
Sieve Size	Passing	LB S	UB S	Method:		AS 1289.2.1.1	AS 1289.3.1.1	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1	
125 mm	100%				Moisture content		4 point Liquid limit	Plastic limit	Plasticity index	Linear shrinkage	Curling/ Crumbling/ Cracking
75 mm	100%				Result:	28.5% As Rcvd.	77%	18%	59%	19.0%	Curling
63 mm	100%				LB S:						-
53 mm	100%				UB S:						-
37.5 mm	100%			Att. preparation method:		Dry sieved		LSM length (mm):		125	
26.5 mm	100%			Specimen history/notes:	Compliance check AS 1289.1.1 - Clause 5.7 - Table 1 - OK						
19 mm	100%				Definitions:	LB S = Lower bound specification LSM = Linear shrinkage mould UB S = Upper bound specification		N/A = Not applicable ND = Not determined; SIB = Slip in bowl NO = Not obtainable; NP = Non plastic			
13.2 mm	100%			GRADING SUMMARY							
9.5 mm	100%			Fines	Sand*		Gravel*		Cobbles*		
6.7 mm	98%			(<75 µm)	(>75 µm - <2.36 mm)		(>2.36 mm - <63 mm)		(>63mm - <200 mm)		
4.75 mm	98%			58.3%	37.1%		4.6%		0.0%		
2.36 mm	95%			*Proportions based on guidance in AS1726-2017 Section 6.1.4.2							
1.18 mm	93%										
600 µm	84%										
425 µm	78%										
300 µm	72%										
212 µm	66%										
150 µm	62%										
75 µm	58%										



Testing by:	PL	Dates:	11/09/24 - 17/09/24	Results reviewed by:	ASTevenson	Date reported:	24/09/2024
Cert. ref.:	PS200634_WSP24-BH24_TRM24-0331_PSD_2409033_Rep24115573					Approved signatory:	
		NATA accreditation number: 1961 - Site:1250 - Melbourne Accredited for compliance with ISO/IEC 17025 - Testing					
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL (Sheet 1 of 1)					Aaron Stevenson - Senior Geotechnical Laboratory Technician		
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Soil testing - Determination of permeability of a saturated specimen

Constant head method using a flexible wall permeameter

AS 1289.6.7.3-2016



Test request #:	TRM24-0331	Specimen ID:	LMEL202409031	WSP Australia Pty Ltd
Client:	Melbourne Water			MELBOURNE GEOTECHNICAL LABORATORY
Client address:	990 La Trobe Street, Docklands VIC 3008			Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Project ID:	PS200634	Location ID		
Project name:	Croskell PSP Drainage Strategy Cranbourne VIC	WSP24-BH24		Sample depth (m): 1.00 - 1.50 Client sample ref: WSP24-BH24-001
Project reference:		Loc. ref.:	-	

Specimen description: (CH) CLAY, high plasticity, brown, trace, with fine to coarse grained sand

Phase / Locale: -
Sample type: Disturbed

Specimen before testing

Compaction Details

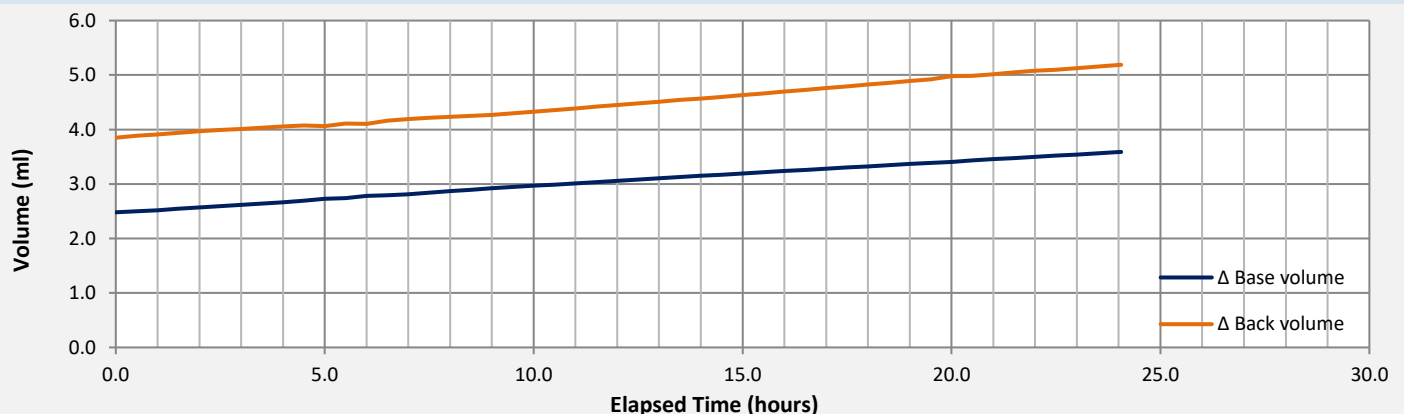
Height [H] (mm)	75.8	Method:	Standard
Diameter [D] (mm)	75.0	Material retained on 19mm sieve (g):	-
[D]:[H]	1:1.01	Optimum Moisture Content:	26.0%
Mass (g)	628.5	Maximum Dry Density (t/m ³):	1.57
Moisture Content:	26.0%	Target moisture content to OMC:	0.26
Dry Density (t/m ³):	1.49	Target dry density relative to MDD:	1.49
Assumed Porosity (%)	43.7%	Laboratory Moisture Ratio:	100.1%
Assumed Pore Volume (mL)	146.3	Laboratory Density Ratio:	95.0%

Pre-test photo

Post-test photo

Permeability test details

		Permeant used:	Distilled water
		Method of saturation:	Back pressure saturation
		Estimate of initial saturation:	88.7%
		Saturation B value:	98.0%
		Confining Pressure (kPa):	1050
		Inlet Pressure (kPa):	1010
		Outlet Pressure (kPa):	990
		Mean effective stress (kPa):	50
		Hydraulic Head (kPa):	20
		Moisture content after test:	31.5%
		Permeability: (m/s)	1E-10



Notes: Specimen remoulded to a target of 95% SMDD @ OMC. SMDD & OMC obtained by Std compaction to AS 1289 5.1.1

Definitions: Specimen Prepared by: LM Test Performed by: LM
ND = Not Determined Results Reviewed by: NLObb Date Reported: 24/09/24

Cert. Ref.: PS200634_WSP24-BH24_2409031_TRM24-0331_PERM_R24115596	Approved signatory
  NATA accreditation number: 1961 - Site:1250 - Melbourne Accredited for compliance with ISO/IEC 17025 - Testing THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL [PAGE 1 OF 1]	 Nick Lobb - Senior Geotechnical Laboratory Technician

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Soils test - Determination of pinhole dispersion classification of a soil

Standard laboratory method

AS 1289.3.8.3-2014



Test request #:	TRM24-0331	LMEL202409032	WSP Australia Pty Ltd
Client:	Melbourne Water		MELBOURNE GEOTECHNICAL LABORATORY
Client address:	990 La Trobe Street, Docklands VIC 3008		Building 7, Botanicca Corporate Park 570 - 588 Swan Street Richmond, Victoria 3121
Project ID:	PS200634	Exploratory Hole	Sample depth (m): 1.00 - 1.40
Project name:	Croskell PSP Drainage Strategy Cranbourne VIC	WSP24-BH24	Client sample ref: WSP24-BH24-002
Project reference:		Loc. ref.:	-

Specimen description: (CH), CLAY, high plasticity, grey, with fine to coarse grained sand

Sampling: WSP Engineer

Preparation of specimen and testing performed on samples supplied to the laboratory

Sample type: Remoulded Curing time: >48 hours Date prepared: 16/09/2024 Date Tested: 20/09/2024 Target dry density (t/m³): 1.49 Initial moisture content: 26.7% Remoulded moisture content: As received Remoulded moisture content: 26.5% Remoulded density (t/m³): 1.88 Remoulded dry density (t/m³): 1.49 Moisture content calculation is performed in accordance with AS AS 1289.2.1.1 - 2005	Photo post test - Final cylinder 
Specimen history /Notes: Sample remoulded to target of 95% of SMDD at 100% OMC. Compaction data; SMDD = 1.57 t/m3, OMC = 26 %.	

TEST RESULTS SUMMARY

Pinhole classification	Designation: ND2	Description: Completely erosion resistant
Final flow through specimen (ml/s):	1.85	Source of water: Potable water
Hole reformed at 50mm head:	-	
Other observations: 1:1 hole diameter ratio at completion of test		

PINHOLE DISPERSION CLASSIFICATION [Ref: TABLE 2: AS 1289.3.8.3;2014]

Designation	Description	Head at termination of test (mm)	Test time of head (min)	Visibility of colour of flow at end of test	Final flow through specimen (ml/s)
D1	Highly dispersive	50	10	Very distinct	-
D2	Dispersive	50	10	Distinct to slight	-
PD1	Potentially dispersive	175	5	Slight to easily visible	-
PD2	Potentially dispersive (intermediate)	350	5	Slight	> 3.5
ND1	Non-dispersive	1000	5	Slight to barely visible	< 5.0
ND2	Completely erosion resistant	1000	5	Clear	< 5.0

Definitions:	Specimen prepared by: AHS	Tests performed by: AHS
ND = Not determined	Result reviewed by: AStevenson	Date reported: 24/09/24

Cert. ref.:	PS200634_WSP24-BH24_2409032_TRM24-0331_PDC_R24115584	Approved signatory:
 NATA accreditation number: 1961 - Site:1250 - Melbourne Accredited for compliance with ISO/IEC 17025 - Testing	THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL [PAGE 1 OF 1]	Nick Lobb - Senior Geotechnical Laboratory Technician

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APPENDIX D – Groundwater Monitoring Memorandum

Memorandum

Memorandum

To: Melbourne Water

Date: 13 August 2025

From: Water4Good

Our Ref: 3551531_286 -
Memorandum

Copy:

Subject: Croskell Precinct Structure Plan (PSP) Proposed Drainage Strategy – Groundwater Data Summary

Doc # 3551531_286-Croskell PSP Proposed Drainage Strategy – Groundwater Data Summary

Melbourne Water (MW) has commissioned Water4Good (W4G) to undertake a geotechnical investigation as part of the Croskell Precinct Structure Plan (PSP) Proposed Drainage Strategy Project (the Project). This memo provides a summary of the groundwater levels recorded during this investigation.

The Croskell PSP area is located within the suburbs of Cranbourne East and Clyde North and is bounded by Thompsons Road in the north, Berwick-Cranbourne Road in the east, Narre Warren Road in the west and Linsell Boulevard in addition to a number of residential streets in the south.

As part of the preliminary investigations for the project a total of 23 boreholes were drilled at the project site, during two site investigation programs. Drilling undertaken as part the initial site investigation program occurred across two periods, the first between 28 February and 2 March 2023, the second between 3 April and 6 April 2023. An additional investigation occurred between 26 August and 27 August 2024 with a total of 2 additional boreholes (boreholes BH23 and BH24) drilled at the project site.

In total the investigation included:

- 14 boreholes drilled to a depth of 3m.
- 9 boreholes drilled to a depth of 6m, including the installation of a groundwater monitoring well with a flush mounted gatic cover.

Results of the geotechnical site investigations have been provided in the following reports:

- W4G Report: '3551531_286-Croskell PSP Proposed Drainage Strategy Geotechnical Site Report'.
- W4G Report: '3551531_286-Croskell PSP Proposed Drainage Strategy Geotechnical Site Report Additional Investigation'.

These reports should be read in conjunction with this memorandum.

Memorandum

Figure 1, attached, shows the location of the completed boreholes. Borehole locations were recorded using a handheld GPS to an approximate horizontal accuracy of +/- 5 m. Borehole elevations were not recorded.

Prior to installing groundwater monitoring wells, a bore construction license was obtained from Southern Rural Water. After installation, groundwater levels at the installed monitoring wells were measured using a handheld dip meter on 6 April 2023. Further measurements were then taken on a monthly basis between August 2024 and July 2025 as part of a twelve-month groundwater monitoring program. These measurements are summarised in Table 1. The highest groundwater level recorded at each location has been highlighted. Note that as the relative level of the boreholes were not surveyed, they have been estimated based on a projection to a topographic surface.

During the twelve-month groundwater monitoring program, access limitations and changing site conditions impacted the ability to collect measurements at all well locations. Where a reading in Table 1 is listed as not measured, this is indicative of the well not being accessed for groundwater monitoring for that month.

Memorandum

Table 1 Groundwater levels measured in wells.

Borehole / Well ID		BH03	BH06	BH10	BH16	BH13	BH19	BH21	BH23	BH24
	Estimated Collar RL*	36.50	36.70	40.80	31.10	33.10	32.20	31.80	43.10	29.60
Groundwater Depth (mRL AHD)	6th April 2023	36.05	35.17	40.20	29.06	31.12	29.64	29.50	Not yet drilled	Not yet drilled
	27th August 2024	Well location flooded	Not measured	Not measured	Not measured	29.13	29.14	30.23	GNE^	25.15
	9th September 2024	Well location flooded	Not measured	40.67	Not measured	31.14	29.04	30.26	Not measured	27.43
	14th October 2024	Not measured	35.78	40.56	Not measured	Not measured	Not measured	Not measured	GNE	Not measured
	11th November 2024	Not measured	35.74	39.74	Not measured	Not measured	Not measured	Not measured	GNE	27.47
	9th December 2024	Not measured	35.76	40.36	29.20	Not measured	29.24	Not measured	GNE	27.65
	20th January 2025	Not measured	35.41	39.91	29.04	Not measured	29.27	Not measured	GNE	27.52
	10th February 2025	Not measured	35.08	39.52	28.92	Not measured	29.19	Not measured	GNE	27.34
	20th March 2025	Not measured	34.86	39.41	28.74	Not measured	29.14	Not measured	GNE	27.1
	17th April 2025	Not measured	34.72	39.48	28.61	Not measured	29.07	Not measured	GNE	27.05
	15th May 2025	Not measured	34.88	39.58	28.61	Not measured	28.98	Not measured	GNE	26.97
	12th June 2025	Not measured	34.93	39.63	28.54	Not measured	28.89	Not measured	38.44	26.94
	9th July 2025	Not measured	35.07	39.82	28.49	Not measured	28.82	Not measured	38.28	26.91

*RLs for boreholes were not surveyed and are estimated based on projection onto topographic surface.

^Groundwater not encountered





NOTE
W4G has prepared this document in accordance
with instruction of Melbourne Water for their specific use.

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