



Western Australian Planning Commission Agenda

Notice is hereby given the next meeting of the Western Australian Planning Commission will be:

Wednesday, 28 May, 2025, 9:00 am

1. Meeting Opening and Commencement
 - 1.1 Acknowledgement of Country
 - 1.2 Apologies and leave of absence
 - 1.3 Disclosure of interests
 - 1.4 Disclosures of representation
 - 1.5 Declaration of due consideration
 - 1.5.1 Additional Information for Members
 - 1.6 Confirmation of Previous minutes - Wednesday, 30 April 2025 7 - 21
2. Deputations and presentations
 - 2.1 Proposed MRS Amendment – Lakefarm Retreat Urban Precinct – Approval to Advertise (Item 3.1) 22 - 31

Presenters: Anthony Silvestro, Tony Arias and Matthew Filov - Land Group WA
 - 2.2 Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (Item 4.1) 32 - 38

Presenter: Andrew Trosic – Shire of Serpentine Jarrahdale
 - 2.3 Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (Item 4.1) 39 - 40

Presenter: Brett Ashby - City of Rockingham
 - 2.4 Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (Item 4.1) 41 - 52

Presenters: Daniel Martinovich - CLE Town Planning + Design, Damian Shephard - Stockland and Shane McSweeney - Pentium Water
3. Non-confidential items for discussion, decision or noting
 - 3.1 Proposed MRS Amendment – Lakefarm Retreat Urban Precinct – Approval to Advertise (RLS/1165) 53 - 376

Attending Officers: Rohan Miller - Planning Director, Schemes and Strategies, Anthony Muscara - Principal Planner, Schemes and Strategies and Brent Davern - Senior Planner, Schemes and Strategies

The key considerations identified in assessing this proposal are as follows:

- The proposal seeks to rezone approximately 59ha in Ballajura from the Rural – Water Protection zone to the Urban zone in the Metropolitan Region Scheme (MRS). The amendment also reserves areas of Regional Open Space and includes these areas in the Water Catchments reserve. The proposed amendment will facilitate future residential development and areas of public open space.
- The proposal seeks to contain and protect the most significant environmental assets within the site, such as existing Black Cockatoo Habitat in the south-east corner, the Resource Enhancement Wetland (REW) in the north-west corner, and significant trees, through public open space designations in subsequent planning stages.
- Following the 2023 resolution of the former Planning Investigation Areas, the proposed amendment area has been identified under the Perth and Peel@3.5Million/North-East Sub-regional Planning Framework as an “Urban Expansion” area.
- It is recommended that the WAPC initiate a standard MRS amendment and that it be referred to the Environmental Protection Authority for a determination prior to being advertised for comment.










4. Confidential items for discussion, decision or noting

- | | | |
|------------|---|------------------|
| 4.1 | Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (RLS/1125 & RLS/1135) | 377 - 377 |
| 4.2 | Improvement Scheme - Redcliffe Station Precinct, City of Belmont - Approval to Advertise (RLS/0123) | 378 - 378 |
| 4.3 | Region Schemes Project Update and Future Directions (PLH20210051) | |
| 4.4 | Perth and Peel@3.5million Health Check – Preliminary Update (DP/15/00332/1) | |
| 4.5 | Population Forecasting Project | |

- 4.6 National Competition Policy (PLH2024P0471)
 - 4.7 Amendments to Model Subdivision Conditions - Schools (PLH2019P0056)
 - 4.8 Policy Work Program – Prioritisation Process (PLH2019P0518)
 - 4.9 Position Statement - Public Open Space (PLH2019P0241)
 - 4.10 Establishment of Additional Planning Committee - UWA QEII Planning Committee (PLH2022P1423)
 - 4.11 Approval to establish a Technical Advisory Group for West Ellenbrook (RLS/0810)
 - 4.12 WAPC Authorisation to Affix Seal and Sign Documents – Instrument Review (WAPC/11/0157 & WAPC/23/0007)
 - 4.13 WAPC Committee Minutes
- 5. Urgent or other business
 - 6. Meeting conclusion and closure

Information for WAPC members

Quorum: 5 of 9 members

	Ms Emma COLE <i>WAPC Chairperson</i>		Mr Ray Haeren <i>WAPC Deputy Chairperson</i>
	Ms Megan ADAIR <i>WAPC Board Member</i>		Ms Jane BENNETT <i>WAPC Board Member</i>
	Ms Helen BROOKES <i>WAPC Board Member</i>		Mr Ryan HALL <i>WAPC Board Member</i>
	Mr Paul LAKEY <i>WAPC Board Member</i>		Ms Bianca SANDRI <i>WAPC Board Member</i>
	Ms Amanda SHEERS <i>WAPC Board Member</i>		

The Western Australian Planning Commission (WAPC) is established under the *Planning and Development Act 2005* to provide independent advice to the Government on integrated land use planning and development, and to facilitate the preparation, implementation and delivery of state planning policies, strategies and plans through its functions and statutory decisions.

The WAPC's functions are defined under Section 14 of the *Planning and Development Act 2005* and include:

- advising the Minister for Planning on strategic land use planning and development, legislation and planning schemes.
- maintaining the State Planning Strategy to provide a vision for the future development of Western Australia.
- developing integrated land use planning strategies and policies for the coordination of transport, infrastructure and development.
- preparing and reviewing region schemes to cater for anticipated growth.
- researching and developing planning methods and models relating to land use planning, land development and associated matters (including monitoring land and housing supply).
- reserving and acquiring land for public purposes in region planning scheme areas.

- making statutory decisions on a range of planning application types including applications to subdivide land and significant development.

Membership

The composition of the Board is in accordance with Section 10 of the *Planning and Development Act 2005*:

10. Membership of board

- (1) The board is to consist of 7 to 9 members appointed by the Minister.
- (2) The Minister must appoint 1 of the members to be the chairperson.
- (3) The Minister may appoint 1 or more other members to be deputy chairpersons.
- (4) A member cannot be a public service officer.
- (5) The terms and conditions of a member's appointment are to be determined by the Minister, subject to —
 - (a) any regulations made for the purposes of section 11(1); and
 - (b) section 12.
- (6) The Minister must ensure that, taken together, the members have what the Minister considers to be a suitable level of knowledge, expertise and experience in the following fields —
 - (a) urban and regional planning;
 - (b) subdivision of land;
 - (c) property development;
 - (d) planning and management of infrastructure;
 - (e) economic, social and environmental policy;
 - (f) public sector governance and administration.
- (7) In addition to the requirement of subsection (6), the Minister must ensure the following —
 - (a) that the chairperson, and at least 1 other member, each has what the Minister considers to be —
 - (i) extensive knowledge, expertise and experience in the field of urban and regional planning; and
 - (ii) a suitable professional qualification or accreditation in that field;
 - (b) that at least 1 member has what the Minister considers to be extensive experience in local government administration as either or both of the following —
 - (i) a member of the council of a local government;
 - (ii) an employee of a local government;
 - (c) that at least 1 member has what the Minister considers to be extensive experience of living and working in regions other than the following —
 - (i) the metropolitan region;
 - (ii) the region referred to in item 6 of Schedule 4.



Western Australian Planning Commission

Minutes

Wednesday, 30 April, 2025

- Members: Commissioner Cole - Chairperson
Commissioner Haeren - Deputy Chairperson
Commissioner Adair
Commissioner Bennett
Commissioner Brookes
Commissioner Hall
Commissioner Lakey
Commissioner Sandri
Commissioner Sheers
- Apologies: Nil.
- Observers: Tenaha Culbertson - Department of Water and Environmental Regulation
Brett Dunn - Department of Water and Environmental Regulation
Damien Hills - Department of Water and Environmental Regulation
Justin McKirdy - Department of Transport
Liam O'Connell - Department of Water and Environmental Regulation
- Others present: Kathy Bonus - Chief Planning Advisor, Reform, Design and State Assessment
Sam Boucher - Manager, Commission Business
Adrian Cagnana - Planning Manager, Precincts and Projects
John Chortis - Director, Data Analysis
Michael Daymond - Strategic Advisor WAPC
Thomas Della Vedova - Principal Planner, Regional Planning Strategies
Janine Egan - Planning Director, Infrastructure Planning and Policy
Samantha Ferguson - Senior Policy and Project Officer, Infrastructure Planning and Policy
Tim Greenhill - Manager Design Projects, Design and Built Environment
Michelle King - Senior Commission Support Officer
Rohan Miller - Planning Director, Schemes and Strategies
Moe Moe Myint - Senior Planning Officer, Research and Modelling
Ben Nayton - Manager Planning Analytics, Infrastructure Planning
Irene Obales - Commission Support Officer
Melinda Payne - Director, Design and Built Environment

Lisa Powell - A/Executive Director, Infrastructure Planning and Policy
Ashley Randell - Planning Director, Regional Planning Strategies
Phillida Rodic - Director, Commission Services
David Saunders - Assistant Director General, Land Use Planning
Mathew Selby - Executive Planning Director, Land Use Planning
Jacquie Stone - Executive Director, Policy

1. Meeting Opening and Commencement

The Chairperson declared the meeting open at 9:32 am.

1.1 Acknowledgement of Country

The Chairperson acknowledged the Whadjuk people of the Noongar Nation as the custodians of the land on which the meeting is taking place and welcomed members.

1.2 Apologies and leave of absence

Commissioner Brookes has requested a leave of absence from 3 June 2025 to 2 July 2025 inclusive.

1.3 Disclosure of interests

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 3.1 - Lifting of Urban Deferment in MRS - Bullsbrook South Precinct – Determination. Commissioner Bennett advised that Mirvac is the proponent for the Amendment and Mirvac is a client of her employer, CLE, on other projects. Members agreed that Commissioner Bennett should not be present during the discussion and/or decision-making procedure on the item.

Commissioner Bennett declared a Direct Pecuniary Interest on Item 3.2 - District Structure Plan – North-East Baldivis (2025) – Final Approval. Commissioner Bennett advised that her employer, CLE, is the proponent of this item. Members agreed that Commissioner Bennett should not be present during the discussion and/or decision-making procedure on the item.

Commissioner Sheers declared a Perceived Impartiality Interest on Item 3.2 - District Structure Plan – North-East Baldivis (2025) – Final Approval. Commissioner Sheers advised that the Stockland General Manager, Col Dutton, is known to her and her family. Members agreed that Commissioner Sheers is permitted to be present during the discussion and/or decision-making procedure on the item as it is unlikely to influence Commissioner Sheers' conduct in relation to the matter.

Commissioner Sandri declared a Perceived Impartiality Interest on Item 3.2 - District Structure Plan – North-East Baldivis (2025) – Final Approval. Commissioner Sandri advised that her partner works for the Shire of Serpentine Jarrahdale and the depute is representing this local government. Commissioner Sandri also advised that Lorian Nominees Pty Ltd listed as a landowner was her former client on an unrelated matter, in her former business. Members agreed that Commissioner Sandri is permitted to be present during the discussion and/or decision-making procedure on the item as it is unlikely to influence Commissioner Sandri's conduct in relation to the matter.

Commissioner Cole declared an Actual Impartiality Interest on Item 4.1 - MRS Amendment 1344/57 – Maida Vale Urban Precinct – Recommendation to Minister. Commissioner Cole advised that a close friend of hers is an affected landowner. Members agreed that Commissioner Cole should not be present during the discussion and/or decision-making procedure on the item.

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 4.1 - MRS Amendment 1344/57 – Maida Vale Urban Precinct – Recommendation to Minister. Commissioner Bennett advised that John Wroth and MGroup are the proponents for this amendment, and they are clients of her employer, CLE, on other projects. Members agreed that Commissioner Bennett should not be present during the discussion and/or decision-making procedure on the item.

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 4.2 - MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister. Commissioner Bennett advised that her employer, CLE, is the consultant on the adjoining Brabham project, a Peel and DevelopmentWA joint venture. Members agreed that Commissioner Bennett should not be present during the discussion and/or decision-making procedure on the item.

Commissioner Lakey declared an Indirect Pecuniary Interest on Item 4.2 - MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister. Commissioner Lakey advised that he was previously an employee of Peet Ltd (ceased employment in Feb 2023) and that Peet are DevelopmentWA's development partner on this project. Commissioner Lakey further advised that he currently holds a number of Peet shares in his self-managed superfund. Members agreed that Commissioner Lakey should not be present during the discussion and/or decision-making procedure on the item.

Commissioner Hall declared a Perceived Impartiality Interest on Item 4.2 - MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister. Commissioner Hall advised that he is a Board Director of DevelopmentWA. Members agreed that Commissioner Hall is permitted to be present during the discussion and/or decision-making procedure on the item as it is

unlikely to influence Commissioner Hall's conduct in relation to the matter.

Commissioner Bennett declared a Perceived Impartiality Interest on Item 4.3 - MRS Planning Control Area No. 150 - Bullsbrook Intermodal Transport Facility - Declaration. Commissioner Bennett advised that her employer, CLE, has been previously appointed as the planners on the industrial development west of the rail and that CLE does not have a current appointment on this work. Members agreed that Commissioner Bennett is permitted to be present during the discussion and/or decision-making procedure on the item as it is unlikely to influence Commissioner Bennett's conduct in relation to the matter.

Commissioner Sandri declared an Actual Impartiality Interest on Item 4.3 - MRS Planning Control Area No. 150 - Bullsbrook Intermodal Transport Facility - Declaration. Commissioner Sandri advised that landowners within the Planning Control Area (PCA) were her former clients and that she had provided advice previously on the subject property. Members agreed that Commissioner Sandri is permitted to be present during the discussion and/or decision-making procedure on the item as it is unlikely to influence Commissioner Sandri's conduct in relation to the matter.

Commissioner Lakey declared a Perceived Impartiality Interest on Item 4.5 - Perth Convention and Exhibition Centre (PCEC) Precinct Improvement Scheme No.1 – Approval to Advertise. Commissioner Lakey advised that he provided Project Management Services for the PCEC redevelopment project joint venture partners for 3 months between May and July 2023. Commissioner Lakey further advised that his role was focused on project management protocols, processes, and overseeing consultants and that he was not involved in commercial decisions. Members agreed that Commissioner Lakey is permitted to be present during the discussion and/or decision-making procedure on the item as it is unlikely to influence Commissioner Lakey's conduct in relation to the matter.

Commissioner Hall declared a Perceived Impartiality Interest on Item 4.5 - Perth Convention and Exhibition Centre (PCEC) Precinct Improvement Scheme No.1 – Approval to Advertise. Commissioner Hall advised that he is a Board Director of DevelopmentWA. Members agreed that Commissioner Hall is permitted to be present during the discussion and/or decision-making procedure on the item as it is unlikely to influence Commissioner Hall's conduct in relation to the matter.

Commissioner Haeren declared a Direct Pecuniary Interest on Item 4.5 - Perth Convention and Exhibition Centre (PCEC) Precinct Improvement Scheme No.1 – Approval to Advertise. Commissioner Haeren advised that he had provided advice to the proponents in his role at Urbis. Members agreed that Commissioner Haeren should not

be present during the discussion and/or decision-making procedure on the item.

Commissioner Sheers declared a Perceived Impartiality Interest on Item 4.12 - WAPC Committee Minutes. Commissioner Sheers advised that the State Design Review Panel considered an item on 1 April 2025 which was in the City of Stirling where she works. Members agreed that Commissioner Sheers is permitted to be present during the discussion and/or decision-making procedure on the item as it is unlikely to influence Commissioner Sheers' conduct in relation to the matter.

The Chairperson declared that the Western Australian Planning Commission is both a landowner and a decision maker in relation to Item 4.2 - MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister and Item 4.4 - Declaration of Planning Control Area – Wilman Wadandi Highway (Bunbury Outer Ring Road). The Chairperson advised that this is an interest in common shared by members and is not considered to prejudice their ability to impartially determine the matter within the planning framework.

1.4 Disclosures of representation

Commissioner Lakey declared a Disclosure of Representation on Item 3.1 - Lifting of Urban Deferment in MRS - Bullsbrook South Precinct – Determination and Item 3.2 - District Structure Plan – North-East Baldivis (2025) – Final Approval. Commissioner Lakey advised that as the Independent Chairperson of the Department of Planning, Lands and Heritage (DPLH) Priority Corridor Working Group (PCWG), he engages with government agencies and proponents regarding the provision of infrastructure in various corridors and projects across Perth. Commissioner Lakey confirmed that he met with the proponents of these items to discuss their projects with respect to infrastructure. He also confirmed that he had not received any additional information beyond what is available to DPLH and the Western Australian Planning Commission (WAPC).

The Chairperson declared a Disclosure of Representation on Item 3.2 - District Structure Plan – North-East Baldivis (2025) – Final Approval. The Chairperson advised that she met with the proponent and their consultant in the course of her activities as Chairperson of the WAPC and that she had not been provided with any additional information that is not available to the Commission today.

1.5 Declaration of due consideration

All members indicated that they had received and considered the agenda items prior to the Western Australian Planning Commission meeting.

1.5.1 Questions from Members and Responses from DPLH Staff

1.6 Confirmation of Previous minutes - Wednesday, 19 March 2025

Moved by Commissioner Lakey
Seconded by Commissioner Haeren

That the minutes of the Western Australian Planning Commission meeting held on Wednesday, 19 March 2025, be confirmed as a true and correct record of the proceedings.

The motion was put and carried

2. Deputations and presentations

2.1 Lifting of Urban Deferment in MRS - Bullsbrook South Precinct – Determination (Item 3.1)

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 3.1 and left the meeting at 9:43 am.

Presenters: Rebecca Thompson - Rowe Group; David Parsons - Mirvac; Greg Rowe - Rowe Group and Rod Dixon - Rowe Group

Rebecca Thompson, David Parsons, Greg Rowe and Rod Dixon made a deputation to the Western Australian Planning Commission regarding the Lifting of Urban Deferment in MRS - Bullsbrook South Precinct – Determination.

2.2 District Structure Plan – North-East Baldivis (2025) – Final approval (Item 3.2)

Commissioner Bennett declared a Direct Pecuniary Interest on Item 3.2 and remained outside the meeting.

Presenter: Andrew Trosic - Shire of Serpentine Jarrahdale

Andrew Trosic made a deputation to the Western Australian Planning Commission regarding the District Structure Plan – North-East Baldivis (2025) – Final approval.

2.3 District Structure Plan – North-East Baldivis (2025) – Final approval (Item 3.2)

Presenters: Daniel Martinovich - CLE Town Planning + Design; Damian Shephard - Stockland; Col Dutton - Stockland and Shane McSweeney - Pentium Water

Daniel Martinovich, Damian Shephard, Col Dutton and Shane McSweeney made a deputation to the Western Australian Planning

Commission regarding the District Structure Plan – North-East Baldivis (2025) – Final approval.

2.4 MRS Amendment 1344/57 – Maida Vale Urban Precinct – Recommendation to Minister (Item 4.1)

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 4.1 and remained outside the meeting.

Commissioner Cole declared an Actual Impartiality Interest on Item 4.1 and left the meeting at 10:15 am.

Due to the absence of the Chairperson, and in accordance with Regulation 33 (1)(b) of the Western Australian Planning Commission Regulations 2024, the Deputy Chairperson presided over the meeting.

Presenters: Rod Dixon - Rowe Group and Mr John Wroth - MGroup

Rod Dixon and John Wroth made a deputation to the Western Australian Planning Commission regarding the MRS Amendment 1344/57 – Maida Vale Urban Precinct – Recommendation to Minister.

Commissioner Cole returned to the meeting at 10:27 am and assumed the Chair.

2.5 MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister (Item 4.2)

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 4.2 and remained outside the meeting.

Commissioner Lakey declared an Indirect Pecuniary Interest on Item 4.2 and left the meeting at 10:29 am.

Presenter: Sue Conlan - Urban Bushland Council

Sue Conlan made a deputation to the Western Australian Planning Commission regarding the MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister.

2.6 MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister (Item 4.2)

Presenter: Harry Gratte - Resident

Harry Gratte made a deputation to the Western Australian Planning Commission regarding the MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister.

2.7 MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister (Item 4.2)

Presenter: Humphrey Boogaerdt

Humphrey Boogaerdt made a deputation to the Western Australian Planning Commission regarding the MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister.

2.8 MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister (Item 4.2)

Presenter: Jan Zeck - Resident

Jan Zeck made a deputation to the Western Australian Planning Commission regarding the MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister.

2.9 MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister (Item 4.2)

Presenters: Alex Jarvis - CLE Town Planning + Design and Paul Morgan - Peet Limited

Alex Jarvis and Amy Nancarrow made a deputation to the Western Australian Planning Commission regarding the MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister.

Commissioner Lakey returned to the meeting at 11:04 am.

2.10 District Structure Plan – North-East Baldivis (2025) – Final approval (Item 3.2)

Written Deputation:

George Hajigabriel - Rowe Group

Members noted the written deputation on Item 3.2 - District Structure Plan – North-East Baldivis (2025) – Final approval.

2.11 – 2.12 MRS Amendment 1344/57 – Maida Vale Urban Precinct – Recommendation to Minister (Item 4.1)

Written Deputations:

Dana Sims - Landowner

Charles and Beverley Dornac - Ecovision

Members noted the written deputations on Item 4.1 - MRS Amendment 1344/57 – Maida Vale Urban Precinct – Recommendation to Minister.

2.13 – 2.14 MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister (Item 4.2)

Written Deputations:

**Cheryl Rogers
Anna Holt**

Members noted the written deputations on Item 4.2 - MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister.

3. Non-confidential items for discussion, decision or noting

3.1 Lifting of Urban Deferment in MRS - Bullsbrook South Precinct – Determination (RLS/1120)

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 3.1 and remained outside the meeting.

Members were informed that the area being recommended for transfer from the Urban Deferred zone to the Urban zone is based on the capacity of the existing Bullsbrook sewer system and that the Department of Planning, Lands and Heritage (the Department) has been working with the Water Corporation to look at a broader sewer system for long term solution. Members noted that subsequent structure planning and subdivision approvals would be subject to connection to a properly installed sewer system.

Members queried the potential risks of zoning the entire area as urban. Members were informed that there are no potential risks, and that the decision ultimately involves balancing whether to lift the urban deferment for the entire land area or just a portion of it, with both perspectives being valid. Members were also advised that structure planning and subdivision processes ensures that future planning stages will not proceed without appropriate infrastructure provision in place.

Members queried the view of the City of Swan on the full lifting of urban deferment and were informed that through their recommended endorsement of the structure plan, the City of Swan has identified the entire area for urban expansion.

Members queried the view of the Water Corporation on the magnitude of cost and were informed that the Water Corporation will refer to the Commission's decision on the extent of the lifting of urban deferment across the area to be. Members noted that the Water Corporation is fully aware that over time, they would need to service the entire area.

REPORT RECOMMENDATION

That the Western Australian Planning Commission, under Clause 23 of the Metropolitan Region Scheme, resolves to:

- 1. transfer the Bullsbrook South Precinct as shown on amending plan no. 4.1676/2 (Attachment 3) from the Urban Deferred zone to the Urban zone pursuant to Clause 23 of the MRS; and*
- 2. amend the City of Swan Local Planning Scheme No. 17 by transferring the Urban zoned land to the “Residential Development” zone pursuant to section 126(3) of the Planning and Development Act 2005.*

Members discussed the following alternative recommendation provided by the Department prior to the meeting.

ALTERNATIVE RECOMMENDATION

That the Western Australian Planning Commission under Clause 23 of the Metropolitan Region Scheme, resolves to:

- 1. transfer the Bullsbrook South Precinct as shown in the request for lifting of urban deferment from the Urban Deferred zone to the Urban zone pursuant to Clause 23 of the MRS; and*
- 2. amend the City of Swan Local Planning Scheme No. 17 by transferring the Urban zoned land to the “Residential Development” zone pursuant to section 126(3) of the Planning and Development Act 2005.*

Members noted that there are impacts on regional infrastructure costs and that whilst there is road reservation in place, road infrastructure has not been funded for the area.

Members noted that the proponent has acknowledged that there are unfunded regional infrastructure costs and that the Commission is not committing government to meet these costs.

Members agreed to add point 3 to the alternative recommendation as discussed and to state as follows: *“Note that elements of regional infrastructure costs have not been committed for the entirety of the MRS area”.*

Moved by Commissioner Haeren
Seconded by Commissioner Lakey

That the Western Australian Planning Commission under Clause 23 of the Metropolitan Region Scheme, resolves to:

1. *Transfer the Bullsbrook South Precinct as shown in the request for lifting of urban deferment from the Urban Deferred zone to the Urban zone pursuant to Clause 23 of the MRS;*
2. *amend the City of Swan Local Planning Scheme No. 17 by transferring the Urban zoned land to the “Residential Development” zone pursuant to section 126(3) of the Planning and Development Act 2005; and*
3. *Note that elements of regional infrastructure costs have not been committed for the entirety of the MRS area.*

The motion was put and carried

3.2 District Structure Plan – North-East Baldivis (2025) – Final approval (SPN/0873)

Commissioner Bennett declared a Direct Pecuniary Interest on Item 3.2 and remained outside the meeting.

Members queried whether there are any issues or concerns on the location of the neighbourhood centre and were advised that there had been discussions about the neighbourhood centre adjacent to Mundijong Road, as it will not only provide retail space but also incubator trade-type employment generating land. Members noted that the City of Rockingham is upgrading a portion of Mundijong Road and that it is currently closed for some repair and restoration works.

Members queried the drainage issue, the potential implications on the site and the extent of comfort that the current provision is adequate to contain it within the site. Members were advised that the subject area has had extensive modelling, is subject to a District Water Management Strategy and that the site can manage the water that flows through the area.

Members queried the status of management of the multi-use corridors (MUCs) and were advised that there is a joint briefing note being prepared for the Minister for Planning and the Minister for Water in relation to the Water Corporation becoming the interim management authority. Members noted that the Department of Water and Environmental Regulation (DWER) is not opposed to the district structure plan progressing.

Members were provided an outline of the Department of Transport (DoT) matters that were raised in relation to the district structure plan, which includes road reservation for Mundijong Road to allow for a potential Primary Regional Road corridor. Members noted that Main Roads WA has done some preliminary planning work to inform this. Other matters raised were the neighbourhood centre access arrangements, rail crossing location, freeway reserve and public transport services.

Members agreed to endorse the recommendation of the Department of Planning, Lands and Heritage for the reasons discussed and outlined in the report.

Moved by Commissioner Lakey
Seconded by Commissioner Adair

That the Western Australian Planning Commission:

1. *acting in accordance with the Planning and Development Act 2005, Section 14, approve the North-East Baldivis District Structure Plan;*
2. *note that the Department of Planning, Lands and Heritage will continue to liaise with:*
 - a. *the Department of Water and Environmental Regulation and the proponent in relation to the District Water Management Strategy; and*
 - b. *key agencies regarding the ownership and management arrangements of the Multiple Use Corridors.*

The motion was put and carried

Commissioner Bennett returned to the meeting at 11:46 am.

3.3 Local Government Design Review Manual

Members discussed the alternative recommendation provided by the Department and Planning, Lands and Heritage prior to the meeting and agreed to defer the item for a period of up to three months. Members discussed that a deferral would provide an opportunity to make the manual more concise and resolve the interface between local government and state government design review processes.

Moved by Commissioner Sandri
Seconded by Commissioner Adair

That the Western Australian Planning Commission resolves, pursuant to Section 14 of the Planning and Development Act 2005, to defer consideration of the Local Government Design Review Manual for a period of up to three months to enable further review and consideration of the documentation and resolve the interface between local government and state government design review processes.

The motion was put and carried

4. Confidential items for discussion, decision or noting

Moved by Commissioner Hall
Seconded by Commissioner Sheers

That the Western Australian Planning Commission move to the consideration of confidential items for discussion, decision or noting and resolve, pursuant to Regulation 27 of the Planning and Development (Western Australian Planning Commission) Regulations 2024, that the meeting be closed to members of the public as the remaining agenda items raise matters outlined in regulation 4(2) and require confidentiality due to the recommendations submitted to the Minister; legally and commercially sensitive material; and enable free and unfettered debate on strategic, policy and governance directions pending their confirmation and formal release.

The motion was put and carried

The Chairperson declared a break at 11:50 am.

The meeting resumed at 12:00 pm with all members present.

4.4 Declaration of Planning Control Area – Wilman Wadandi Highway (Bunbury Outer Ring Road) (RLS/1181)

THIS ITEM IS CONFIDENTIAL

4.6 Renewable Energy Planning Code and Supporting Amendments to Local Planning Scheme Regulations - Initiation (PLH2024P1071)

THIS ITEM IS CONFIDENTIAL

4.9 WAPC Instruments of Delegation – Prescribed Reporting Formats (WAPC/22/0126)

THIS ITEM IS CONFIDENTIAL

4.11 Information Report - Western Australian Planning Commission

THIS ITEM IS CONFIDENTIAL

4.12 WAPC Committee Minutes

THIS ITEM IS CONFIDENTIAL

Commissioner Bennett declared an Indirect Pecuniary Interest of Item 4.1 and left the meeting at 12:03 pm.

Commissioner Cole declared an Actual Impartiality Interest of Item 4.1 and left the meeting at 12:03 pm.

Due to the absence of the Chairperson, and in accordance with Regulation 33 (1)(b) of the Western Australian Planning Commission Regulations 2024, the Deputy Chairperson presided over the meeting.

- 4.1 MRS Amendment 1344/57 – Maida Vale Urban Precinct – Recommendation to Minister (RLS/0607)**

THIS ITEM IS CONFIDENTIAL

The Chairperson returned to the meeting at 12:16 pm and assumed the role.

- 4.2 MRS Amendment No. 1421 (standard) - Brabham and Dayton Urban Precincts - Recommendation to Minister (RLS/1094)**

Commissioner Bennett declared an Indirect Pecuniary Interest on Item 4.2 and remained outside the meeting.

THIS ITEM IS CONFIDENTIAL

Commissioner Sheers left the meeting at 12:50 pm and did not return.

Commissioners Bennett and Lakey returned to the meeting at 12:50 pm.

- 4.3 MRS Planning Control Area No. 150 - Bullsbrook Intermodal Transport Facility - Declaration (RLS/1167)**

THIS ITEM IS CONFIDENTIAL

- 4.5 Perth Convention and Exhibition Centre (PCEC) Precinct Improvement Scheme No.1 – Approval to Advertise (PLH2024P0737)**

Commissioner Haeren declared Direct Pecuniary Interest on Item 4.5 and left the meeting at 12:51 pm.

THIS ITEM IS CONFIDENTIAL

Commissioner Haeren returned to the meeting at 12:52 pm.

- 4.7 Perth and Peel Land Use and Employment Survey 2022-24 (DP/16/00112/3)**

THIS ITEM IS CONFIDENTIAL

- 4.8 Regional Planning Strategies - Intragovernmental Review (PLH2022P0460)**

THIS ITEM IS CONFIDENTIAL

- 4.10 WAPC Strategic Plan 2025-2029 - Approval (DP/10/00176)**

THIS ITEM IS CONFIDENTIAL

5. Urgent or other business

Nil.

6. Meeting conclusion and closure

The next ordinary meeting is scheduled for 9:30 am on Wednesday, 28 May 2025.

There being no further business before the Board, the Chairperson thanked members for their attendance and declared the meeting closed at 1:15 pm.

CHAIRPERSON

DATE

UNCONFIRMED



Request for Deputation / Presentation

Committee: Western Australian Planning Commission

Meeting Date: Wednesday, May 28, 2025

Deputation Information

Type of Deputation: Verbal Deputation

Agenda Item: 3.1

Agenda Title: Proposed MRS Amendment – Lakefarm Retreat Urban Precinct – Approval to Advertise (RLS/1165)

Is the presentation in support or against the report recommendation? (contained within the agenda) Support

Presenter Information

Name of Presenter Anthony Silvestro

Preferred pronouns/title Mr

Organisation: Land Group WA

Email Address:

Mobile Number:

Additional Attendees

Tony Arias - Project Advisor
Matthew Filov - Development Manager

Special Requirements: In the interest of accessibility and inclusion for people with disabilities, please identify if you have any special requirements: No

Presentation Information

Brief Outline of Deputation:

1. Context – Regional and Local Map to introduce the site
2. Proposal – Existing and Proposed Zoning.

3. State and Strategic Planning – Lakefarm is Urban Expansion under State Strategic Planning Framework, and consistent with State Planning Policy.
4. Pre-Referral Consultation – We have consulted with key agencies, with no objections to the MRS Amendment being initiated.
5. Next Steps – Land Group look forward to continuing structure planning to deliver the site.
6. Concept Plan

Will there be a PowerPoint Presentation?

Yes

Please attach any documents here



Land Group Deputation - Item 3.1 - Pro....pdf

Acknowledgements

In submitting this request, you acknowledge that your request form and presentation content will be published to the Planning Online website as part of the agenda.

Yes

I acknowledge that if my request or accompanying documents are not submitted within the required timeframe, they will not be accepted.

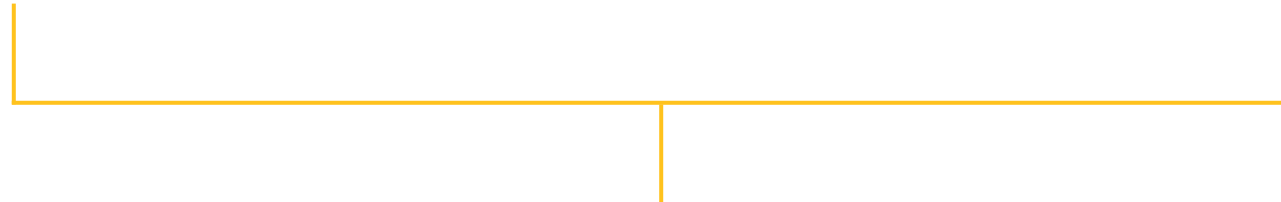
Yes

Please attach all accompanying documents to this request. Late submissions will not be accepted. Handouts or PowerPoints will not be accepted on the day of the meeting.

LAKEFARM RETREAT

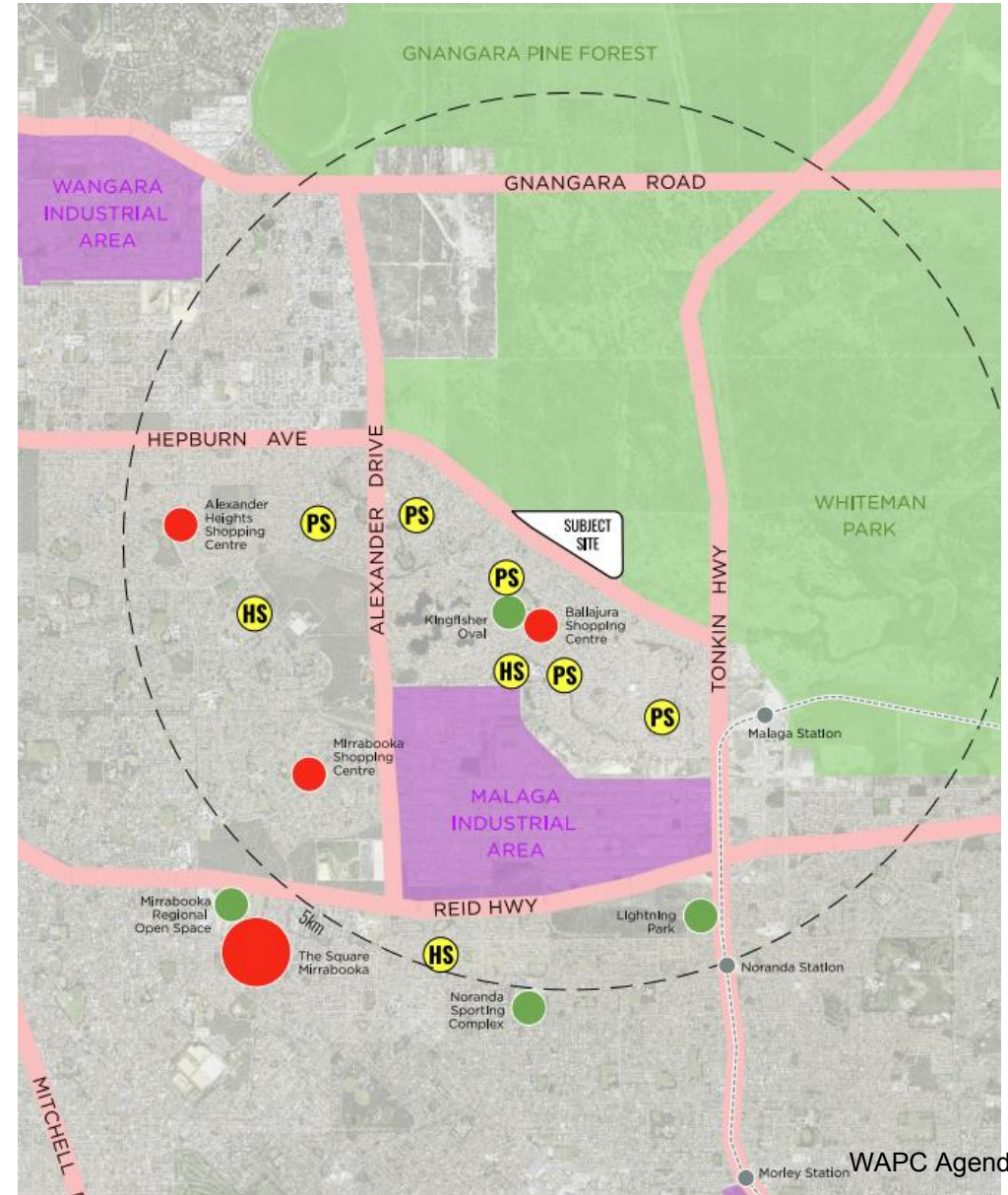
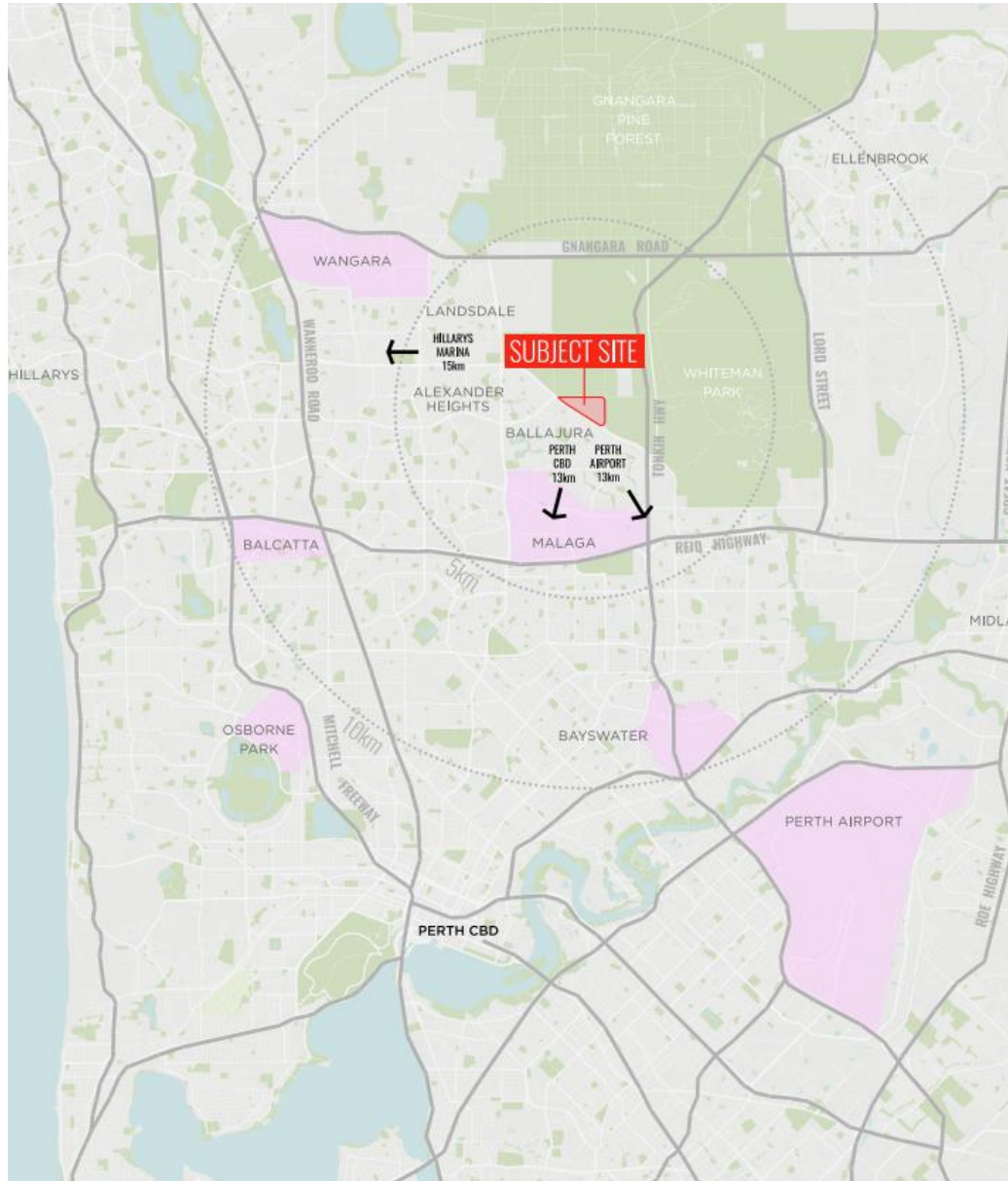
PROPOSED MRS AMENDMENT





OPERATIONS, SYNERGIES AND INNOVATIONS

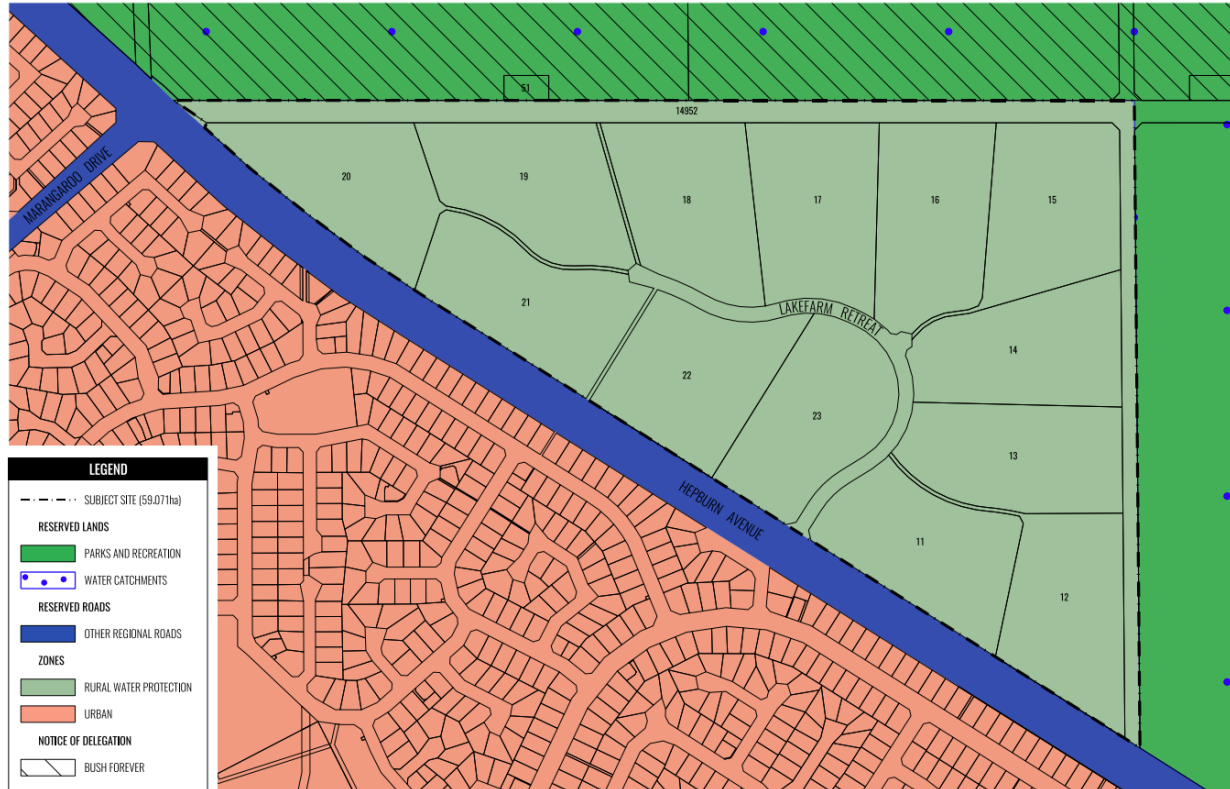
CONTEXT



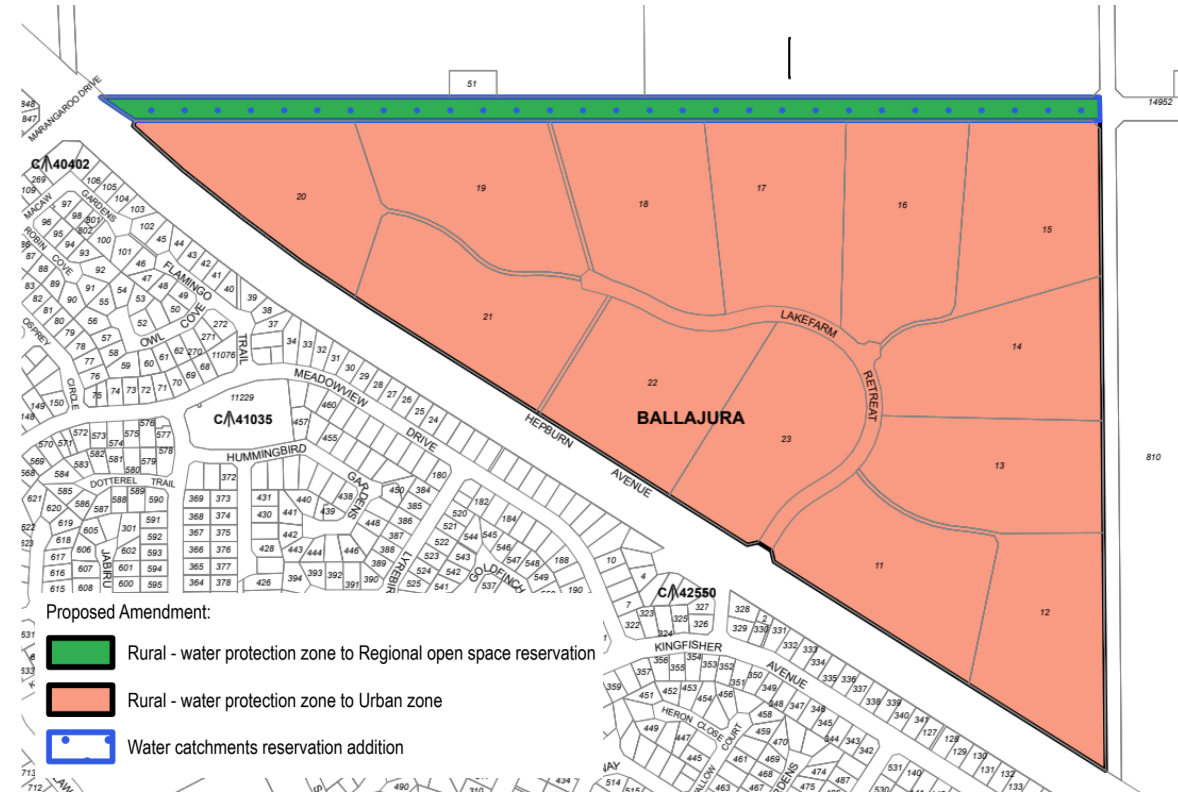
PROPOSAL

TO REZONE APPROXIMATELY 53.6HA TO URBAN AND 3.8HA TO REGIONAL OPEN SPACE, YIELDING APPROXIMATELY 776 DWELLINGS.

EXISTING ZONING



PROPOSED ZONING



STATE AND STRATEGIC PLANNING

LAKEFARM RETREAT WAS ORIGINALLY A PLANNING INVESTIGATION AREA IN THE **NORTH-EAST SUB-REGIONAL FRAMEWORK AND WAS MORE RECENTLY RECOMMENDED FOR URBAN EXPANSION** BY THE WAPC IN LATE 2023.

STATE PLANNING POLICY

DRAFT SPP2.9 - PLANNING FOR WATER

SPP3.0 – URBAN GROWTH AND SETTLEMENT

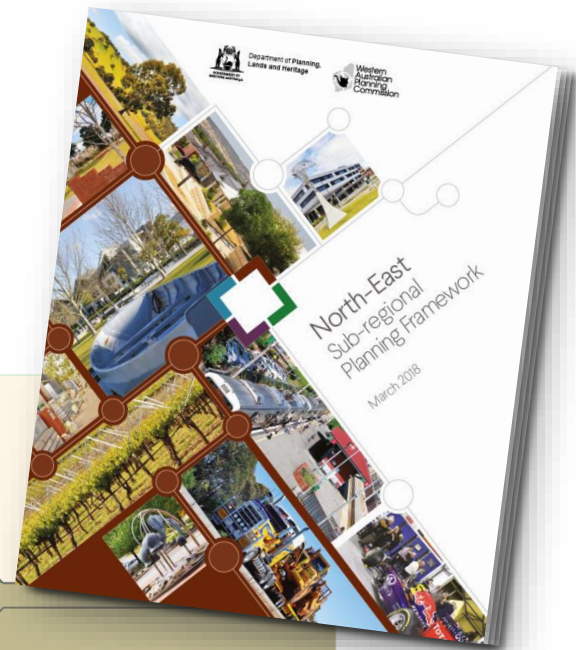
|
BROADLY CONSISTENT

SPP2.8 – BUSHLAND POLICY FOR PERTH METROPOLITAN REGION

SPP3.7 - BUSHFIRE

SPP5.4 – ROAD AND RAIL NOISE

|
FULLY CONSISTENT



PRE-REFERRAL CONSULTATION

CITY OF SWAN

DEPARTMENT OF WATER AND
ENVIRONMENTAL REGULATION

DEPARTMENT OF BIODIVERSITY,
CONSERVATION AND ATTRACTIONS

DEPARTMENT OF FIRE AND
EMERGENCY SERVICES

DEPARTMENT OF EDUCATION

WATER CORPORATION

MAIN ROADS WA

=

**NO OBJECTION
TO INITIATION**

NEXT STEPS

COMPLETE STRUCTURE PLANNING



IDENTIFY HISTORICAL WATERWAYS AND WET AREAS



IDENTIFY IMPORTANT TREES LIKE PAPERBARKS (BLUE) AND COCKATOO TREES (RED) AND LET THIS GUIDE WHERE PUBLIC OPEN SPACE AND GREEN LINKS ARE LOCATED



CREATE A COMMUNITY THAT IS GREEN, WALKABLE AND IS UNDERPINNED BY NATURE WAPC Agenda Page 30



Existing Roundabout

CCW

50m Buffer

Wellhead

50m CCW Buffer

CCW

50m CCW Buffer

Wellhead

Existing Government services vehicle track

Existing Reserve (for Parklands)

Tree Protection Zones at rear of larger lots (hatched)

Proposed road breaks creating low-speed pedestrian friendly environment

2,000m² Lot

Existing Residential

Public Open Space

Proposed LI/LO

HEPBURN AVENUE

Potential Future Roundabout

Existing Residential

Ballajura Primary School

Existing Residential

Potential bushfire egress

POS 1A (REW)

POS 1B (50m REW Buffer)

Extent of REW Buffer to be determined at detailed design stage

300m Wellhead Buffer

Homestead Lot 3,000m²

Homestead Lot 2,500m²

Community Lot 8,600m²

Homestead Lot 4,000m² (~34x115m) TBC

Green Link / Circuit (Optimising tree retention)

Proposed Existing Water Main to be enclosed

Existing Drainage Easement

Green Link / Circuit (Optimising tree retention)

POS 1D

POS 1E

POS 1F

POS 1G

POS 1H

POS 1I

POS 1J

POS 1K

POS 1L

POS 1M

POS 1N

POS 1O

POS 1P

POS 1Q

POS 1R

POS 1S

POS 1T

POS 1U

POS 1V

POS 1W

Potential future road connection linkage subject to future planning

300m Wellhead Buffer

Potential future POS linkage subject to future planning

Future Development (Lot 810) subject to future planning

Potential future road connection linkage subject to future planning

Existing Reserve (for Parklands)

Existing Powerlines



Request for Deputation / Presentation

Committee:

Western Australian Planning Commission

Meeting Date:

Wednesday, May 28, 2025

Deputation Information

Type of Deputation:

Verbal Deputation

Agenda Item:

4.1

Agenda Title:

Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (RLS/1125 & RLS/1135)

Is the presentation in support or against the report recommendation? (contained within the agenda)

Support

Presenter Information

Name of Presenter

Andrew Trosic

Preferred pronouns/title

Mr

Organisation:

Shire of Serpentine Jarrahdale

Email Address:

Mobile Number:

Special Requirements: In the interest of accessibility and inclusion for people with disabilities, please identify if you have any special requirements:

No

Presentation Information

Brief Outline of Deputation:

Mundijong Road
Regional Flood Plain
Other Relevant Key Matters

Will there be a PowerPoint Presentation?

Yes

Please attach any documents here



WAPC Deputation - North East Baldivi... .pdf

Acknowledgements

In submitting this request, you acknowledge that your request form and presentation content will be published to the Planning Online website as part of the agenda.

Yes

I acknowledge that if my request or accompanying documents are not submitted within the required timeframe, they will not be accepted.

Yes

Please attach all accompanying documents to this request. Late submissions will not be accepted. Handouts or PowerPoints will not be accepted on the day of the meeting.



Shire of
Serpentine
Jarrahdale

Proposed MRS Amendments 1427 and 1428 – NE Baldivis DSP, Precinct 1 and Precincts 2-4

28 May 2025

Mundijong Road

- **Mundijong Road** connects between the **Kwinana Freeway**, the **Tonkin Highway** extension, **South Western Highway**, and strategic regional centres and industrial areas, carrying large volumes of traffic.
- 6,000 new dwellings will place further impact on the safe operation and capacity to upgrade the road in its current reservation.
- **Mundijong Road must be designated as a Primary Regional Road**, with an urgent requirement for MRWA to take over responsibility.
- Proposed MRS Amendments should **retain a strip of 'Rural' zoned land** on the north side of Mundijong Road to enable Primary Regional Roads reservation.



Shire of
Serpentine
Jarrahdale



Regional Flood Plain

- MRS Amendment area subject to significant **inundation and flooding**.
- **Impact on the regional flood plain is a concern**, in respect of removing flood plain storage, and the potential pressure it will place upon the Birriga drainage system and Peel Harvey catchment.
- This may increase the flooding risk back towards the east, which is a concern for the Shire.
- Potential of an increased flooding risk within the region.

Other Relevant Key Matters

1. **Road infrastructure coordination** (specifically to request that Mundijong Road be recognised as a Primary Regional Road).
2. **Potable water and sewer infrastructure coordination** (specifically to request that Water Corporation provide direction on the timing and delivery of the necessary urban water and sewer infrastructure).
3. **Industrial development expansion** (specifically to recognise the capacity of West Mundijong Industrial Area to expand to anchor the future enterprise and employment needs of the southeast corridor over the next 50 years).
4. **Activity Centre classification** (specifically to request the Mundijong District Centre be considered for reclassification as a strategic regional centre so that further expansion of development is encouraged to gravitate back towards Mundijong, and the activity corridor underpinned by public transport investment).



Shire of
Serpentine
Jarrahdale

Thank you

Visit us

🏠 6 Paterson Street
Mundijong WA6123

Contact us

☎ 95261111
@ info@sjshire.wa.gov.au

Connect with us

🐦 sjshire.wa.gov.au
📘 facebook.com/shireofsj
🐦 twitter.com/shireofsj
📷 instagram.com/shireofsj



Request for Deputation / Presentation

Committee: Western Australian Planning Commission

Meeting Date: Wednesday, May 28, 2025

Deputation Information

Type of Deputation: Verbal Deputation

Agenda Item: 4.1

Agenda Title: Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (RLS/1125 & RLS/1135)

Is the presentation in support or against the report recommendation? (contained within the agenda) Against

Presenter Information

Name of Presenter Brett Ashby

Organisation: City of Rockingham

Email Address:

Mobile Number:

Special Requirements: In the interest of accessibility and inclusion for people with disabilities, please identify if you have any special requirements: No

Presentation Information

Brief Outline of Deputation:

The City will speak to matters raised in its submission and can assist with any questions WAPC Members may have.

I note item is confidential and the officer recommendation is not outlined in the Agenda so it is not possible for the City to consider or respond to it.

Will there be a PowerPoint Presentation?

No

Acknowledgements

In submitting this request, you acknowledge that your request form and presentation content will be published to the Planning Online website as part of the agenda.

Yes

I acknowledge that if my request or accompanying documents are not submitted within the required timeframe, they will not be accepted.

Yes

Please attach all accompanying documents to this request. Late submissions will not be accepted. Handouts or PowerPoints will not be accepted on the day of the meeting.



Request for Deputation / Presentation

Committee:

Western Australian Planning Commission

Meeting Date:

Wednesday, May 28, 2025

Deputation Information

Type of Deputation:

Verbal Deputation

Agenda Item:

4.1

Agenda Title:

Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (RLS/1125 & RLS/1135)

Is the presentation in support or against the report recommendation? (contained within the agenda)

Support

Presenter Information

Name of Presenter

Daniel Martinovich

Organisation:

CLE Town Planning + Design

Email Address:

Mobile Number:

Additional Attendees

Damian Shephard, Stockland
Shane McSweeney, Pentium Water

Special Requirements: In the interest of accessibility and inclusion for people with disabilities, please identify if you have any special requirements:

Yes

If yes, please detail below:

We request to attend the meeting in person please.

A separate deputation request has been lodged for Damian Shephard. Damian and myself would be pleased to combine our deputations into one 6-minute deputation, if the Chair is agreeable.

Presentation Information

Brief Outline of Deputation:

- 1) Support rezoning of the North-East Baldivis District Structure Plan (the DSP) from 'Rural' to 'Urban' and 'Urban Deferred' under the Metropolitan Region Scheme.
- 2) We request that Precinct 1 of the DSP is rezoned directly to 'Urban' as there are no outstanding matters that would otherwise need to be addressed prior to a lifting of urban deferment.
- 3) Further to item 2 above, we request a concurrent amendment to the City of Rockingham's Local Planning Scheme No.2 to rezone Precinct 1 to 'Development' zone.
- 4) Further to item 3 above, we request that the Commission require preparation of a local structure plan for Precinct 1 so that preparation and engagement can commence with certainty.

Will there be a PowerPoint Presentation?

Yes

Please attach any documents here



3097PPT238.pdf

Acknowledgements

In submitting this request, you acknowledge that your request form and presentation content will be published to the Planning Online website as part of the agenda.

Yes

I acknowledge that if my request or accompanying documents are not submitted within the required timeframe, they will not be accepted.

Yes

Please attach all accompanying documents to this request. Late submissions will not be accepted. Handouts or PowerPoints will not be accepted on the day of the meeting.



Request for Deputation / Presentation

Committee: Western Australian Planning Commission

Meeting Date: Wednesday, May 28, 2025

Deputation Information

Type of Deputation: Verbal Deputation

Agenda Item: 4.1

Agenda Title: Proposed MRS Amendments 1427 (Standard) - NE Baldivis DSP, Precinct 1; and 1428 (Standard) - NE Baldivis DSP, Precincts 2-4 - Recommendation to Minister (RLS/1125 & RLS/1135)

Is the presentation in support or against the report recommendation? (contained within the agenda) Support

Presenter Information

Name of Presenter Damian Shephard

Organisation: Stockland

Email Address:

Mobile Number:

Additional Attendees

Daniel Martinovich, CLE
Shane McSweeney, Pentium Water

Special Requirements: In the interest of accessibility and inclusion for people with disabilities, please identify if you have any special requirements: Yes

If yes, please detail below:

We request to attend the meeting in person please.

A separate deputation request has been lodged for Daniel Martinovich. Daniel and myself would be pleased to combine our deputations into one 6-minute deputation, if the Chair agrees.

Presentation Information

Brief Outline of Deputation:

- 1) Support rezoning of the North-East Baldivis District Structure Plan (the DSP) from 'Rural' to 'Urban' and 'Urban Deferred' under the Metropolitan Region Scheme.
- 2) We request that Precinct 1 of the DSP is rezoned directly to 'Urban' as there are no outstanding matters that would otherwise need to be addressed prior to a lifting of urban deferment.
- 3) Further to item 2 above, we request a concurrent amendment to the City of Rockingham's Local Planning Scheme No.2 to rezone Precinct 1 to 'Development' zone.
- 4) Further to item 3 above, we request that the Commission require preparation of a local structure plan for Precinct 1 so that preparation and engagement can commence with certainty.

Will there be a PowerPoint Presentation?

Yes

Please attach any documents here



3097PPT238.pdf

Acknowledgements

In submitting this request, you acknowledge that your request form and presentation content will be published to the Planning Online website as part of the agenda.

Yes

I acknowledge that if my request or accompanying documents are not submitted within the required timeframe, they will not be accepted.

Yes

Please attach all accompanying documents to this request. Late submissions will not be accepted. Handouts or PowerPoints will not be accepted on the day of the meeting.



CLE Town Planning + Design

Item 4.1 – Proposed MRS Amendments 1427 – NE Baldivis DSP, Precinct 1; and 1428 – NE Baldivis DSP, Precincts 2-4 – Recommendation to Minister

Presentation to WAPC on 28 May 2025 by:

- *Damian Shephard, Stockland*
- *Daniel Martinovich, CLE Town Planning + Design*

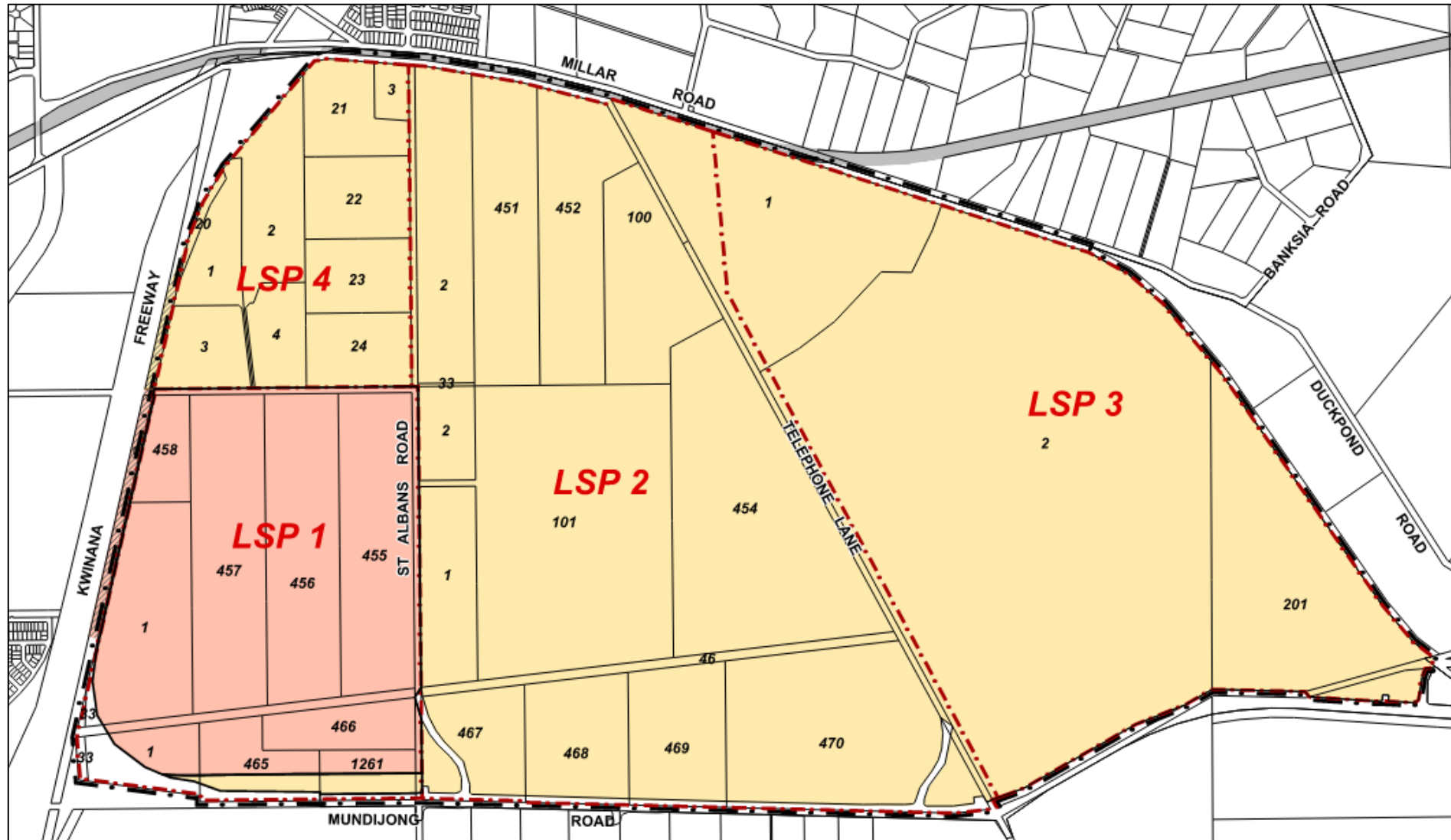


Requested Recommendation to Minister



1. Rezone Precincts 2 – 4 of the North-East Baldivis District Plan from ‘Rural’ to ‘Urban Deferred’ as initiated.
2. Rezone Precinct 1 of the North-East Baldivis District Structure Plan from ‘Rural’ to ‘Urban’ (and ‘Urban Deferred’ – Mundijong Road widening).
3. Concurrently rezone Precinct 1 to ‘Development’ zone under the City of Rockingham’s Local Planning Scheme No.2.

Rezoning Request – MRS Plan



Request Supplementary Resolution of the Commission



1. Request that the WAPC resolve that a local structure plan is required for Precinct 1, pursuant to clause 15 c) of the *Planning and Development (Local Planning Schemes) Regulations 2015*, Schedule 2 Deemed Provisions.

Rezoning Request – Precinct 1 direct to ‘Urban’



Rezoning Precinct 1 direct to the ‘Urban’ zone is warranted for the following reasons:

1. There is an approved District Structure Plan in place that establishes a clear framework to guide future planning processes and identifies key matters to be addressed.
2. Precinct 1 is not affected by land use buffers (as is the case for Precincts 2 - 4).
3. The Water Corporation has confirmed there is servicing capacity and a servicing solution for Precinct 1.
4. The District Water Management Strategy has been updated and lodged as per DWER’s request and approval is expected imminently.
5. The land that may potentially be required for the future widening of Mundijong Road has been confirmed by MRWA and will be held in the ‘Urban Deferred’ zone.

Concurrent rezoning to ‘Development’ zone under LPS 2



A concurrent amendment to LPS 2 to rezone Precinct 1 to ‘Development’ zone is warranted for the following reasons:

1. The EPA’s advice did not identify any matters or concerns that require scheme text provisions to address.
2. Local scheme text provisions are unnecessary to guide future planning as there is an approved District Structure Plan which identifies matters to be addressed at the local structure plan stage.
3. In addition to the specific DSP requirements, the information requirements for local structure plans are well established and are documented within the WAPC’s Planning Manual.
4. A concurrent rezoning is the most efficient process to progress the planning framework towards delivering housing as intended by avoiding an unnecessary process.

Resolution Item that a Local Structure Plan is required



We request the WAPC pass a separate resolution item that a local structure plan be required under the LPS Regulations.

- It is generally understood that a ‘Development’ zone under a local planning scheme triggers the requirement for a local structure plan.
- However, for the avoidance of doubt, we request the WAPC pass a supplementary resolution item that a “*structure plan for the area (Precinct 1) is required for the purposes of orderly and proper planning*” pursuant to clause 15 c) of the LPS Regulations.
- This will enable structure planning to commence with certainty and prior to the MRS Amendment and concurrent LPS2 amendment being gazetted.
- It will assist facilitate engagement with the local government and other stakeholders in the preparation of the local structure plan by providing a statutory head of power prior to gazettal of the MRS and LPS Amendment.

Conclusion



- Precinct 1 can proceed directly to 'Urban' under the MRS and 'Development' under LPS2, with preparation of a local structure plan to follow.
- This will enable Stockland to continue towards its target of titling lots in the next 18 months assisting with housing supply in the south-west corridor.

REPORT TO	Western Australian Planning Commission		
Meeting date	28 May 2025	File number	RLS/1165
Title	Proposed MRS Amendment – Lakefarm Retreat Urban Precinct – Approval to Advertise		
Purpose	For decision		
Head of power	Section 35 of the <i>Planning and Development Act 2005</i> and Regulation 5 of the <i>Planning and Development (Region Planning Schemes) Regulations 2023</i>		
Confidentiality	Non-confidential		
Name and title of responsible officer	Rohan Miller - Planning Director, Schemes and Strategies		
Processing days	180 days		
SITE DETAILS			
Region(s)	Perth		
Local government(s)	City of Swan		
Region Scheme / Zoning	Metropolitan (MRS) Rural – Water Protection		
Landowner/s	Various		
Consultant	CDP Town Planning & Urban Design on behalf of Land Group WA		
ATTACHMENTS			
A1 - Existing and Proposed MRS Plans A2 - Aerial Plan A3 - Concept Plan A4 - Draft District Water Management Strategy A5 - Supplementary Draft District Water Management Strategy Updates A6 - <i>Perth and Peel @3.5 Million / North-East Sub-regional Planning Framework</i> (Plan Extract) A7 - Draft MRS Amendment 14xx (Standard) Report – Lakefarm Retreat Urban Precinct A8 - Landowner List (Confidential Attachment)			

EXECUTIVE SUMMARY

The key considerations identified in assessing this proposal are as follows:

- The proposal seeks to rezone approximately 59ha in Ballajura from the Rural – Water Protection zone to the Urban zone in the Metropolitan Region Scheme (MRS). The amendment also reserves areas of Regional Open Space and includes these areas in the Water Catchments reserve. The proposed amendment will facilitate future residential development and areas of public open space.

- The proposal seeks to contain and protect the most significant environmental assets within the site, such as existing Black Cockatoo Habitat in the south-east corner, the Resource Enhancement Wetland (REW) in the north-west corner, and significant trees, through public open space designations in subsequent planning stages.
- Following the 2023 resolution of the former Planning Investigation Areas, the proposed amendment area has been identified under the *Perth and Peel@3.5Million/North-East Sub-regional Planning Framework* as an “Urban Expansion” area.
- It is recommended that the WAPC initiate a standard MRS amendment and that it be referred to the Environmental Protection Authority for a determination prior to being advertised for comment.

RECOMMENDATION

That the Western Australian Planning Commission, under section 35 of the Planning and Development 2005 and Regulation 5 of the Planning and Development (Region Planning Schemes) Regulations 2023, resolves to:

- 1) Initiate an amendment to the Metropolitan Region Scheme as detailed in Attachment 7 – MRS Amendment 14xx (Standard) – Lakefarm Retreat Urban Precinct, to transfer land from the Rural – Water Protection zone to the Urban zone and Regional Open Space (Water Catchments) reserve; and***
- 2) Form the opinion that the amendment constitutes a standard amendment to the Metropolitan Region Scheme as it is generally consistent with the State and Strategic Planning Framework but may have some impact or community interest.***

PROPOSAL DETAILS

The purpose of the amendment is to rezone approximately 59ha in Ballajura from the Rural – Water Protection zone to the Urban zone (53.6ha) in the MRS. The amendment also reserves approximately 3.8ha as Regional Open Space and includes this area in the Water Catchments reserve. The proposed amendment will facilitate future residential development and public open space areas. (**A1** and **A2**).

BACKGROUND

The subject land is located within the City of Swan and is approximately 13km north of the Perth CBD, and 1.2km west of Tonkin Highway and the western boundary of Whiteman Park. The land abuts Hepburn Avenue and is in close proximity to Alexander Drive, Tonkin Highway and existing local roads in the locality. The recently opened Ballajura Train Station is approximately 2.1km to the south-east, Ballajura Community College is approximately 1.2km to the south and the Malaga industrial precinct is approximately 1.6km to the south.

The subject land is a rural-living estate containing 13 lots, comprising single houses, a nursery, and a place of worship, with all properties afforded access from Lakefarm Retreat. Land abutting to the north and east contains Regional Open Space comprising extensive native vegetation. Land to the south-west, across Hepburn Avenue, contains a fully constructed low-density residential development, including single houses, public open space, schools and shopping centres.

The site is located within a Priority 2 (P2) Public Drinking Water Source Area (PDWSA) and if the amendment is approved the priority status will need to be modified to P3*. There are a number of wellhead water extraction bores located nearby, positioned along the government services vehicle access tracks within the adjacent State reserves. The 300m buffer area from two of these nearby extraction bores extend within the amendment area and compatible land uses will need to be considered for these areas.

The subject site contains a REW at the western extent of the site. Two Conservation Category Wetlands are located to the north in close proximity to, but outside of, the subject site.

The vegetation within the site is predominantly Degraded and Completely Degraded, with two small areas rated as Good. There is a high proportion of introduced species in the area, representative of the low quality of vegetation. None of the species recorded are listed as a Threatened (Declared Rare) or Priority. Bush Forever site 198 abuts the site to the north.

Land use and development within the amendment area is generally controlled by the City of Swan *Local Planning Scheme No. 17* (LPS17). The site is currently zoned General Rural in LPS17.

Concept Plan and Draft District Water Management Strategy

A concept plan has been prepared to illustrate how the land might be developed (**Attachment 3**).

The key features of the concept plan are as follows:

- Residential dwelling development ranging between R30-R60, proposing a yield of approximately 776 dwellings.
- Retained access from Lakefarm Retreat to Hepburn Avenue, upgraded to a roundabout, and new left-in-left-out access road further west.
- An internal network of roads, with potential linkages to future development at adjacent Lot 810.
- Various public open space parcels to protect existing environmental values and to generally allow the existing natural water course drainage through the site.

A draft District Water Management Strategy (DWMS) has been prepared in support of the MRS amendment proposal (**Attachment 4**). Following consultation with the Department of Water and Environmental Regulation (DWER), supplementary updates have been applied to the DWMS in the context of the Public Drinking Water Source Area (**Attachment 5**).

Framework and Policy Assessment Overview

Legislation, Policies and Framework	Consistency
<i>Perth and Peel@3.5Million / North-East Sub-regional Planning Framework</i>	Fully consistent
<i>State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region</i>	Fully consistent
<i>Draft State Planning Policy 2.9 - Planning for Water</i>	Broadly consistent, some discretion required
<i>State Planning Policy 3.0 - Urban Growth and Settlement</i>	Fully consistent
<i>State Planning Policy 3.7 - Bushfire</i>	Broadly consistent, some discretion required
<i>State Planning Policy 5.4 - Road and Rail Noise</i>	Fully consistent

DISCUSSION

Pre-referral Consultation

City of Swan

The City of Swan has advised that the proposal generally aligns with the *North-East Sub Regional Planning Framework* for urban expansion to accommodate population growth. The City has identified various considerations for addressing in future stages, including (but not limited to) the MRS amendment.

Environmental Impacts: The City has identified that implementation of mitigation strategies during the planning, construction and post-construction stages will assist in managing indirect impacts to nearby Bush Forever Site 198 and Whiteman Park, with respect to invasive species or disruption of local fauna. The City also recommends appropriate consideration of groundwater protection in accordance with draft *State Planning Policy 2.9: Planning for Water*.

Bushfire Management: The City notes that a secondary access point to Hepburn Avenue is critical to achieving bushfire planning compliance and recommended that vegetation classification and Bushfire Attack Level (BAL) ratings should be confirmed before the amendment is progressed further. The City also suggests establishment of a perimeter road within the site to increase separation distances and avoid reliance on adjoining tenure for vegetation management.

Traffic and Transport: The City has identified that Lakefarm Retreat will likely require significant road infrastructure upgrades to accommodate increased traffic volumes and suggests extending the Urban zoning into adjacent Lot 810, for more holistic consideration of the road network, and also suggested making use of the existing roundabout to the west at Hepburn Avenue and Marangaroo Drive as additional access.

Local Centres and Schools: Given the estimated 776 dwelling yield, the City anticipates a population of between 2,000–3,000 residents. The City suggests consideration of a local centre within the Lakefarm Retreat precinct, as well as broader consideration of school site land in conjunction with adjacent Lot 810.

DPLH Comment: *Comments noted. The consultant has been advised of the City's comments as some matters may require further detailed consideration in the subsequent local structure planning stage.*

The intent of the MRS amendment process is to determine whether there are any 'fatal flaws' in the zoning of a site which cannot be resolved in the subsequent more detailed planning stages. Noting the broad and non-detailed nature of Region Schemes, and that there will be a subsequent local planning scheme amendment, local structure planning, subdivision and development approval stages where further investigations occur in consultation with the City and state government agencies.

The progression of an MRS amendment is not intended to replace these more detailed investigations which typically occur as the planning of a site progresses. It is noted that no matters have been raised by State Government referral agencies which would prevent the initiation and progression of an Urban zoning at the site.

Department of Water and Environmental Regulation

District Water Management Strategy (DWMS): DWER has advised that the DWMS requires further hazard identification, improved risk assessment and contingency planning, as well as identifying a number of aspects that should be updated to be consistent with Water Quality Protection Note No. 77 and the *Australian Drinking Water Guidelines*. DWER advises that the DWMS should:

- Include specific procedures and actions for emergency response in case of groundwater or surface water contamination, with a particular focus on sewer installation at this stage, and more detail for other risks provided at later stages.
- Include information about developing and implementing specific education and awareness initiatives focused on PDWSA protection, including community workshops and informational materials.

DWER has stated that its preference is for the DWMS to be updated prior to public advertising however has no objection to the initiation of the amendment.

DPLH Comment: *Comments noted. The proponent is currently working with DWER on updates and refinements to the DWMS, as well as the parallel process of changing the PDWSA priority level to*

P3 should the amendment be finalised. Therefore, it is considered that there is adequate scope for the initiation and advertising of the amendment, as the draft DWMS can be updated and approved by DWER prior to a final decision being made on the amendment by the WAPC.*

Department of Biodiversity, Conservation and Attractions (DBCA)

Threatened Black Cockatoo habitat: DBCA has noted that the EAR outlines that the proposed development could impact on 230 potential black cockatoo breeding trees, 15.75ha of high-quality foraging habitat, and one roosting site.

DBCA recommends that future planning makes every effort to retain black cockatoo habitat. The cumulative impacts associated with the loss of black cockatoo habitat is reducing the amount of habitat and reducing the number of birds that can be supported in the region. Therefore, all remaining resources are significantly important to black cockatoos.

If trees with suitable hollows are identified they must be inspected to ensure that nesting is not occurring. If nesting is occurring, a section 40 authorisation under the *Biodiversity Conservation Act* will be required. Where nesting is occurring, trees are to be demarcated and avoided, until after the cockatoos have naturally completed nesting.

Matters of National Environmental Significance: There is potential that threatened species and communities listed under EPBC Act may be impacted. Therefore, the proponents may have notification responsibilities under the EPBC Act.

DPLH Comment: Comments noted. The consultant has been advised of the DBCA's comments as some matters may require consideration in the subsequent detailed planning stages.

Department of Fire and Emergency Services (DFES)

DFES has identified updates to the Bushfire Management Plan (BMP) to validate both the vegetation classification and the BAL ratings, as well as requiring further clarity around management of the existing adjacent government services vehicle tracks on Crown land. DFES has identified that the concept plan does not include a perimeter road to achieve separation from vegetation on external landholdings, which is consistent with advice provided by the City of Swan.

DPLH Comment: Comments noted. The proponent has been made aware of the required updates to the BMP and will attend to these during the advertising of the amendment and before a final decision is made by the WAPC. However, at this this planning stage the concept plan's purpose is to assist with understanding how the area may be developed, with further detailed "lot layout" and local road considerations to occur at local structure planning and subdivision stages.

Water Corporation

The Water Corporation advises that planning for the Lakefarm Retreat Urban Expansion area (inclusive of adjacent Lot 810) needs to examine the impacts and risks to the Gngangara groundwater resource in detail, and that any urbanisation of the area will impact upon nearby active groundwater abstraction bores.

In terms of serviceability, the Water Corporation has advised, through high-level concept planning, that mains extensions to the nearby reticulated water and wastewater network can service the precinct, and that either construction of a temporary wastewater pump station, or temporary diversion to the nearby Kingfisher Avenue wastewater pump station, would be capable of servicing approximately 500 lots. The Water Corporation has advised that it will undertake more detailed broader strategic water and wastewater planning as MRS amendments for the area (including for

adjacent Lot 810) progress, with ultimate wastewater flows for the Lakefarm Retreat urban precinct to be gravitated east towards Lot 810.

DPLH Comment: Comments noted. Refer to DWER comments above on the DWMS. The proponent is currently working with DWER on updates and refinements to the DWMS, as well as the parallel process of changing the PDWSA priority level to P3 should the amendment be finalised, including further investigation into appropriate land uses and mitigating wellhead groundwater bore impacts.*

Extension of the reticulated network and interim wastewater management options are considered adequate for development in the short-to-medium term, with capacity capable of increasing as broader service planning occurs through progression of MRS amendments in the area.

Department of Education (DoE)

DoE have advised that, in conjunction with adjacent Lot 810, two additional public primary school sites would be required across the two sites to support the increased dwelling yield and resultant student population.

DPLH Comment: Comments noted. The proponent has been made aware of the DoE's comments which will require further detailed consideration in the subsequent local structure planning stage, in conjunction with consideration of the urbanisation of adjacent Lot 810.

APA Group / ATCO Gas / Department of Communities / Department of Energy, Mines, Industry Regulation and Safety / Department of Jobs, Tourism, Science and Innovation / Department of Local Government, Sports and Cultural Industries / Department of Transport / Main Roads WA / Public Transport Authority / South-West Aboriginal Land and Sea Council / Department of Primary Industries and Regional Development / Department of Health

DPLH Comment: The above agencies/organisations either did not respond to the request for comment, raise no objections, offer no comment or provide advice applicable in the subsequent, more detailed stages of the planning and development process. Wherever applicable, this advice has been provided to the proponent.

Key Legislation, Framework and Government Considerations

Perth and Peel @ 3.5 Million / North-East Sub-regional Planning Framework

The *Perth and Peel @ 3.5 Million* document provides a snapshot of the Perth and Peel regions in the future. It makes the case for change to a more considered, connected, consolidated urban form. It links four Frameworks and encourages the consideration of new urban growth opportunities. Future areas for urban development have been determined in order to avoid and protect areas which have significant regional environmental value.

*DPLH Comment: The **North-East Sub-regional Planning Framework** identifies the subject land as "Urban Expansion", following 2023 resolution of the former Planning Investigation Areas (A6).*

Therefore, the proposal accords with the principles of urban consolidation in that it is a logical expansion of the surrounding urban area and provides for a more efficient use of the land and the long-term protection of environmental assets.

State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region (SPP 2.8)

SPP 2.8 aims to provide a policy and implementation framework that will ensure bushland protection and management issues are addressed and integrated with broader land use planning and decision-

making. In general, the policy does not prevent development where it consistent with policy measures and other planning and environmental considerations.

DPLH Comment: Vegetation within the site ranges from Degraded and Completely Degraded, with some areas classed as Good. The Good areas will be retained/protected as local public open space. As per DBCA advice, the proponent is required to consider its legislative obligations in relation to native vegetation clearing and Black Cockatoo habitat impacts. The amendment does not propose any changes to the northern adjacent Bush Forever site.

Draft State Planning Policy 2.9 – Planning for Water (SPP 2.9)

Draft SPP 2.9 intends to replace *State Planning Policy 2.2: Gnangara Groundwater Protection* and similarly states that there is a general presumption against the intensification of land uses in P1 and P2 areas, and that proposals will only be considered where land is identified for development through a strategic planning document prepared by the WAPC, such as a sub-regional planning framework.

Draft SPP 2.9 seeks to ensure that planning and development considers water resource management and includes appropriate water management measures to achieve optimal water resource outcomes at the various stages of the planning process.

DPLH Comment: The site is identified as “Urban Expansion” in Perth and Peel@3.5 Million/North-East Sub-regional Framework and therefore consistent with the requirements of Draft SPP 2.9.

The amendment has been assessed against draft SPP 2.9 which provides a range of measures which should be considered including approval of a DWMS and consideration of DWER’s Water Quality Protection Note No. 25: Land Use Compatibility Tables For Public Drinking Water Source Areas which generally restricts sensitive land uses being located within P3 areas.*

The DWER has considered the draft DWMS and in accordance with the requirements of Better Urban Water Management will require DWER’s approval prior to a final decision being made on the amendment by the WAPC.

The proponent has prepared a draft DWMS and is currently working with DWER on updates and refinements as well as the parallel process of changing the PDWSA priority level, should the amendment be finalised. The draft DWMS is to be approved by the DWER prior to final decision being made on the amendment by the WAPC.

State Planning Policy 3.0 – Urban Growth and Settlement (SPP 3.0)

SPP 3.0 sets out that the principles, considerations and key requirements for new urban growth and sustainable communities include making the most efficient use of land in urban areas through the use of vacant and underutilised land, and providing a variety and choice in the size, type and affordability of housing in response to housing demand and preference.

DPLH Comment: The proposed amendment will integrate the subject land with the broader locality, optimise the use of existing urban infrastructure, contribute to the supply of land for housing and provide housing choice in close proximity to the recently completed Ballajura Train Station. The proposed amendment is therefore consistent with SPP 3.0.

State Planning Policy 3.7 - Bushfire (SPP 3.7)

SPP 3.7 forms the foundation for land-use planning to address bushfire risk management in Western Australia. It is used to inform and guide decision-makers, referral authorities and proponents to achieve acceptable fire protection outcomes on planning proposals in bushfire-prone areas.

DPLH Comment: A BMP has been considered by DFES and changes have been requested which are to be finalised prior to a final decision being made on the amendment by the WAPC.

State Planning Policy 5.4 – Road and Rail Noise

SPP 5.4 seeks to minimise the adverse impact of road and rail noise on noise-sensitive land use and/or development within the specified trigger distance of major transport corridors. The Policy also seeks to protect the functionality of the State's transport corridors by protecting them from encroaching incompatible development.

DPLH Comment: As Hepburn Avenue abuts the precinct to the south, there is the potential for noise attenuation measures to be required. The exact detail of these matters is capable of being determined at the local structure planning stage, with implementation through conditions of subdivision approval.

Coordination of Local and Region Scheme Amendments

Under Section 126(3) of the *Planning and Development Act 2005* the WAPC has the option of concurrently rezoning land being zoned Urban under the MRS to a 'Development' zone (or equivalent) in a LPS. In accordance with standard practice, a decision on the concurrent LPS amendment will be made after the public submission period.

Substantiality

The *Planning and Development (Region Planning Schemes) Regulations 2023* allows for amendments to the MRS to be processed as either complex, standard or basic amendments depending on the alteration to the MRS. This amendment is recommended to be processed as a standard (regulation 5) amendment for the following reasons:

- The size and scale of the amendment is not regionally significant and does not reflect a significant change to the strategic planning for the Metropolitan region.
- The amendment site is identified as *Urban Expansion* in the *Perth and Peel@3.5Million/North-East Sub-regional Planning Framework*.
- Key State Government agencies have not raised any matters which would prevent the initiation and advertising of the amendment

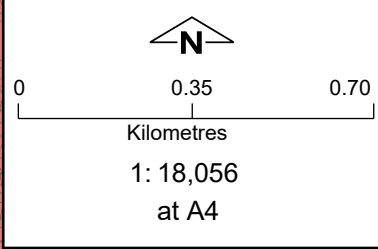
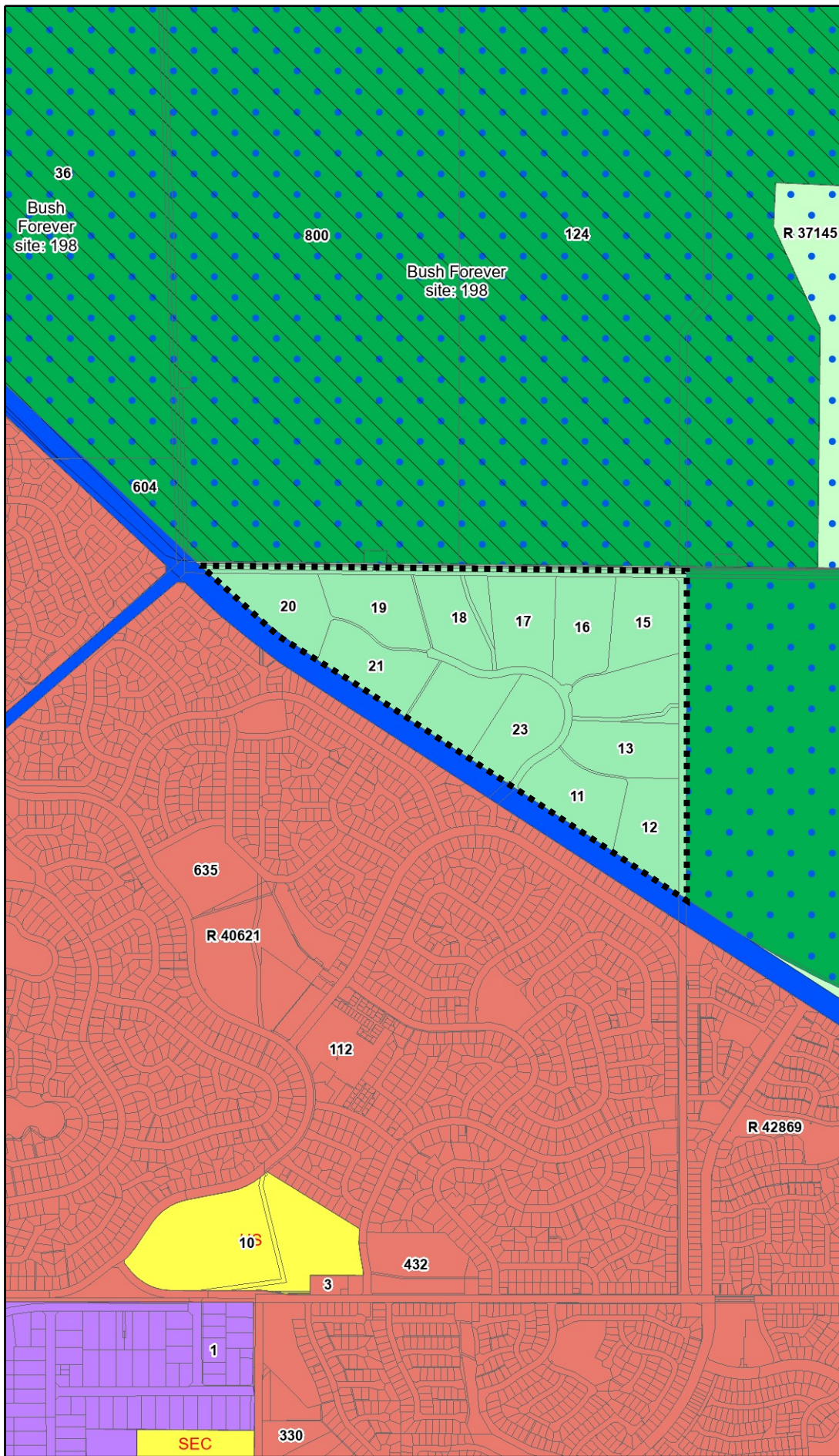
CONCLUSION

It is recommended that the WAPC initiate a standard MRS amendment as it is broadly consistent with the intent, planning, principles and recommendations of the *Perth and Peel@3.5 Million/North-East Sub-regional Planning Framework* and will provide a framework for the future planning and development of the site **(A7)**.



Legend

- Cadastre (View 1)
- Region Scheme Boundary
- Region Scheme Bush Forever Areas
- Region Scheme Water Catchments
- Region Scheme Zones and Reserves**
- Industrial
- Other regional roads
- Public purposes - State Energy Commission
- Public purposes - high school
- Regional open space
- Rural
- Rural - water protection
- Urban



Notes:

- * The data that appears on the map may be out of date, not intended to be used at the scale displayed, or subject to license agreements. The map should only be used in matters related to Department of Planning, Lands and Heritage business.
- * This map is not intended to be used for measurement purposes.

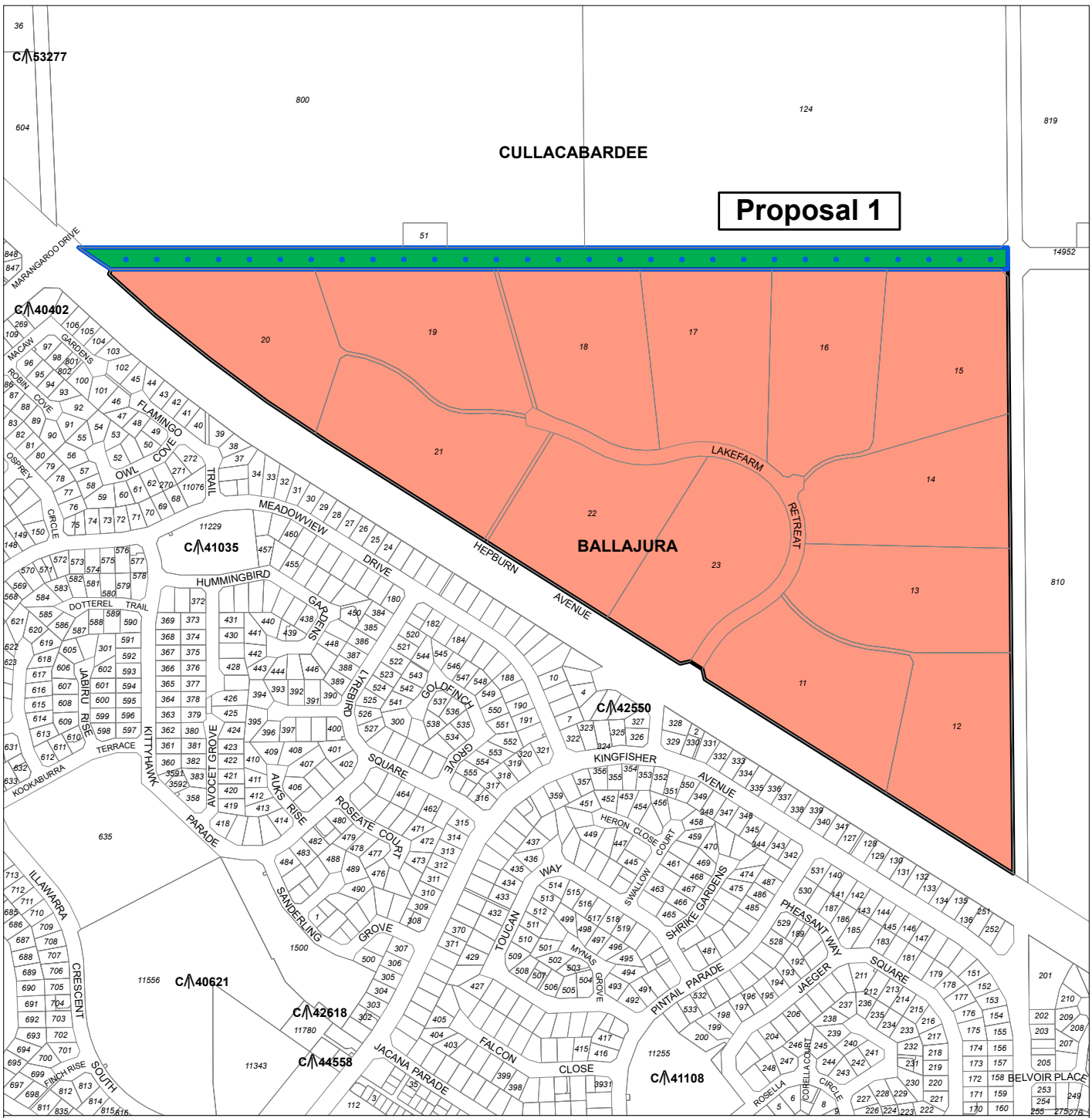
Map was produced using DPLH's InQuery.

Existing MRS Map

DPLH BUSINESS USE ONLY

Internal Spatial Viewer
 Projection: WGS 1984 Web Mercator Auxiliary Sphere
 Graticules (if visible): GDA 1994 Latitude/Longitude

Aerial photography © Nearmap and/or © Western Australian Land Information Authority.
 Location information data licensed from Western Australian Land Information Authority (WALIA) trading as Landgate. Copyright in the location information data remains with WALIA. WALIA does not warrant the accuracy or completeness of the location information data or its suitability for any particular purpose.



**Lakefarm Retreat, Ballajura
Proposed Standard MRS amendment
as advertised**

28 May 2025

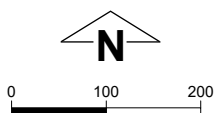
Proposal 1

- Proposed Amendment:
- Rural - water protection zone to Regional open space reservation
 - Rural - water protection zone to Urban zone
 - Water catchments reservation addition

Reference no: 5137
File no: RLS/1165
Version number: 1



Date: 29/04/2025
Produced by Data Analytics, Department of Planning, Lands and Heritage, Perth WA
Base information supplied by Western Australian Land Information Authority SLIP 1447-2023-1





Legend

- Cadastre (View 1)
- Roads**
 - State Highway
 - Main
 - Minor
 - Track
 - Not Applicable

Notes:

* The data that appears on the map may be out of date, not intended to be used at the scale displayed, or subject to license agreements. The map should only be used in matters related to Department of Planning, Lands and Heritage business.

* This map is not intended for measurement purposes.

Map was produced using DPLH's InQuery.

Aerial Map

DPLH BUSINESS USE ONLY

Internal Spatial Viewer

Aerial photography © Nearmap and/or © Western Australian Land Information Authority (Landgate). Location information data licensed from Western Australian Land Information Authority (WALIA) trading as Landgate. Copyright in the location information data remains with WALIA. WALIA does not warrant the accuracy or completeness of the location information data or its suitability for any particular purpose.



0 0.39 0.78 Kilometres

1: 18,056 at A4

Projection: WGS 1984 Web Mercator Auxiliary Sphere
Graticules (if visible): GDA 1994 Latitude/Longitude

Date produced: 29-Apr-2025



CONCEPT CELL STRUCTURE PLAN - V3
 Lakefarm Retreat, Ballajura
 A LandGroup WA Project

DRAFT

Date: 29 August 2024
 Scale: 2000:1
 Job: Lgw/L/3_Plan/2_CPI/3_240820 Concept Cell Structure Plan





Lakefarm Retreat Ballajura District Water Management Strategy

October 2024



Client: Land Group WA

Contents

Executive Summary	iii
1. Introduction	1
1.1 PLANNING CONTEXT	1
1.2 KEY DOCUMENTS	2
2. Pre-Development Environment	3
2.1 SITE CONDITIONS	3
2.2 CLIMATE	3
2.3 GEOTECHNICAL	3
2.4 ENVIRONMENTAL	4
2.5 GNANGARA UWPCA	5
2.6 SURFACE WATER	6
2.7 GROUNDWATER	6
2.8 NUTRIENT INPUT ASSESSMENT & EXISTING GROUNDWATER QUALITY	8
2.9 OPPORTUNITIES AND CONSTRAINTS	10
3. Water Management Principles and Objectives	11
4. Water Use Sustainability Initiatives	12
4.1 WATER USE EFFICIENCY	12
4.2 WATER SUPPLY	12
4.3 WASTEWATER MANAGEMENT	12
5. Stormwater Management Strategy	13
5.1 STORMWATER MANAGEMENT	13
5.2 GROUNDWATER MANAGEMENT	14
5.2.1 Fill and Subsoil Drainage	14
5.2.2 Acid Sulphate Soils	14
5.3 NUTRIENT MANAGEMENT	16
5.4 WATER BALANCE MODELLING	16
6. Implementation Framework	18
6.1 CONSIDERATIONS AND REQUIREMENTS FOR LOCAL PLANNING	18
6.2 MONITORING	18
6.2.1 Pre Development	18
6.2.2 Post Development	19
6.3 FUNDING AND ONGOING MAINTENANCE RESPONSIBILITIES	19
7. References	21

Appendices

APPENDIX A	DWMS Checklist
APPENDIX B	Geotechnical Report
APPENDIX C	Hyd2o Bore Logs & Survey
APPENDIX D	Historical & Current Surface Water Plates
APPENDIX E	DWER Bore Long Term Hydrographs
APPENDIX F	Pre-Development Groundwater Level Monitoring Data
APPENDIX G	UNDO Nutrient Modelling Pre-Development
APPENDIX H	Groundwater Quality Summary Results
APPENDIX I	Laboratory Reports
APPENDIX J	CURRV Runoff Calculator
APPENDIX K	Stormwater Modelling Outputs
APPENDIX L	Engineering Servicing Report
APPENDIX M	UNDO Nutrient Modelling Post Development

Figures

FIGURE 1	Location Plan
FIGURE 2	Concept Structure Plan
FIGURE 3	Site Conditions Plan
FIGURE 4	Geotechnical Plan
FIGURE 5	Environmental Plan
FIGURE 6a	Gnangara UWPCA Boundary
FIGURE 6b	Public Drinking Water Source Plan
FIGURE 7	Surface Water Plan
FIGURE 8	Groundwater Plan
FIGURE 9	Stormwater Management Plan

Tables

TABLE 1	Urban Water Management Planning Process
TABLE 2	Permeability Test Results (Galt Geotechnics, 2024)
TABLE 3	DWER Monitoring Bore AAMGL
TABLE 4	Site AAMGL
TABLE 5	Groundwater Physiochemical and Nutrients Summary
TABLE 6	Groundwater Metals Summary
TABLE 7	Design Principles and Objectives
TABLE 8	Existing Groundwater Licences
TABLE 9	Stormwater Management Summary
TABLE 10	Pre and Post Development Water Balance
TABLE 11	Pre Development Monitoring Program
TABLE 12	Implementation and Responsibilities

Disclaimer

This document is published in accordance with and subject to an agreement between Hyd2o and the Client for whom it has been prepared, and is restricted to those issues that have been raised by the Client in its engagement of Hyd2o. It has been prepared using the skill and care ordinarily exercised by hydrologists in the preparation of such documents.

Hyd2o recognise site conditions change and contain varying degrees of non-uniformity that cannot be fully defined by field investigation. Measurements and values obtained from sampling and testing in this document are indicative within a limited timeframe, and unless otherwise specified, should not be accepted as conditions on site beyond that timeframe.

Any person or organisation that relies on or uses the document for purposes or reasons other than those agreed by Hyd2o and the Client does so entirely at their own risk. Hyd2o denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this document for any purpose other than that agreed with the Client.

Executive Summary

This District Water Management Strategy (DWMS) has been prepared by Hyd2o on behalf of Land Group WA in support of the Metropolitan Region Scheme (MRS) rezoning of Lots 11 to 23 Lakefarm Retreat, Ballajura (herein referred to as the site).

The site is located within the City of Swan and approximately 13 km north of the Perth CBD.

The proposed rezoning of the site and its indicative concept plan have considered the opportunities and constraints of the existing environment and used this information to inform the development of this document.

The site is generally characterised as having sandy permeable soils with moderate to low Acid Sulphate Soils (ASS) risk. The maximum groundwater level according to the DWER online Perth Groundwater Map and current monitoring program is identified to be several meters below the natural surface across most of the site and suitable for stormwater infiltration. The site contains a mapped multiple use wetland crossing the site from north to east which is not a constraint to development and a resource enhancement wetland at its western boundary. This area has been appropriately used to inform the indicative site plan, and the water management strategy detailed in this document.

The site is currently classified as a Public Drinking Water Source Priority 2 area. This classification will require reclassification to P3*, which Hyd2o understands is a decision of the Department of Planning Lands & Heritage based on a government led strategic planning assessment and greater public good decision-making process.

This document provides an integrated total water cycle management approach to the rezoning application, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, nutrient and groundwater management strategy and a plan for implementation. The document provides a clear direction for future planning in terms of adopting best management practices to achieve water sensitive design based on existing site conditions and protect environmental assets.

The DWMS has been prepared in accordance with the principles, objectives, and criteria of Better Urban Water Management (BUWM) (Western Australian Planning Commission, 2008).

Implementation of the strategy will be undertaken in accordance with BUWM through the development and implementation of a local water management strategy (LWMS) to support the local structure planning process, and urban water management plan's (UWMP's) at the subdivision stage of development.

1. Introduction

This District Water Management Strategy (DWMS) has been prepared by Hyd2o on behalf of Land Group WA in support of the Metropolitan Region Scheme (MRS) rezoning of Lots 11 to 23 Lakefarm Retreat, Ballajura (herein referred to as the site).

The site is located within the City of Swan and approximately 13 km north of the Perth CBD (Figure 1). A concept structure plan for the site prepared to support the MRS Amendment is included as Figure 2.

This document provides an integrated total water cycle management approach to support the rezoning application, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, nutrient and groundwater management strategy and a plan for implementation.

The document provides a clear direction for future planning in terms of adopting best management practice, to achieve water sensitive design based on existing site conditions and protect environmental assets.

A completed copy of Department of Water and Environmental Regulation (DWER) DWMS Checklist for Developers is included as Appendix A to assist agencies in the review of this document.

1.1 Planning Context

The site is currently zoned Rural Water Protection under the Metropolitan Region Scheme, and General Rural under the City of Swan Local Planning Scheme No 17 (2024).

The site is located within the North Ballajura area identified as a planning investigation area under the Perth and Peel @ 3.5 million Sub-regional Planning Frameworks released in 2018, which noted the sites strategic location in proximity to the future METRONET Malaga Station.

This DWMS supports the proposed application for changing the zoning of the site to Urban under the MRS to facilitate future urban development.

A summary of the urban water management planning process is detailed in Table 1.

Following this DWMS, two further water management planning documents are likely to be required to facilitate future development of the site, A Local Water Management Strategy (LWMS), and an Urban Water Management Plan (UWMP).

Table 1: Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Documents
MRS Amendment	MRS Amendment	Lakefarm Retreat Ballajura District Water Management Strategy (DWMS) THIS DOCUMENT
Local Structure Plan	Local Structure Plan	Local Water Management Strategy (LWMS) FUTURE PREPARATION
Subdivision	Subdivision Application	Urban Water Management Plan (UWMP) FUTURE PREPARATION

1.2 Key Documents

Key water management planning documents used to guide the development of this DWMS include:

- Stormwater Management Manual for Western Australia (DWER,2022)
- Draft State Planning Policy 2.9 Planning for Water (WAPC, 2021a)
- Draft State Planning Policy 2.9: Planning for Water Guidelines for the implementation of Stage Planning Policy 2.9 Planning for Water (WAPC, 2021b)
- Decision Process for Stormwater Management in WA (DoW, 2017)
- Guidelines for District Water Management Strategies (Department of Water, 2013)
- Better Urban Water Management (Western Australian Planning Commission, 2008)

2. Pre-Development Environment

2.1 Site Conditions

A site conditions plan is included as Figure 3.

The total site area is estimated to be approximately 53.6 ha, and is bound by Hepburn Avenue and existing urban development to the south and west, Bush Forever to the north, and largely cleared undeveloped land to the east. The site currently is a rural residential area, and comprises scattered vegetation, houses, local driveways, gardens, firebreaks, a nursery, and the Lakefarm Retreat road reserve.

DWER 1m LiDAR data indicates the site elevation ranges from maximum elevation of approximately 38 mAHD near some of the houses to a minimum of approximately 34 mAHD at the artificial lake in Lot 23.

2.2 Climate

Climate in the region is defined as Mediterranean, experiencing warm dry summers and cool wet winters. Mean annual rainfall for the site over the period 2004-2023 is 736 mm/yr (BoM station: Whiteman Park 009263), with the majority rainfall occurring in the winter months from May to September. Evaporation predominantly exceeds rainfall, with the exception of the wettest months. Temperatures at the site range from a mean minimum of 8.1°C in July to a mean maximum of 31.7°C in February (BoM station: Perth Metro 009225).

2.3 Geotechnical

Environmental geology mapping of the 1:50,000 Perth Sheet 2034 II and Part 2034 III and 2134 III (Gozzard, 1986) is shown in Figure 4. The site is characterised as:

- S8: SAND – Bassendean Sand, very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted of eolian origin.
- S10: SAND - as S8, thin Bassendean Sand over Guilford Formation.

Galt Geotechnics conducted a geotechnical investigation in September 2024, including machine auger boreholes at 11 locations, extending to a depth of 3.0 m, Dynamic Probing Super Heavy (DPSH) tests adjacent at each borehole location, extending to a depth of 3.0 m, and infiltration tests using the 'inverse auger' technique at 7 locations, at depths between 0.55 and 1.76 m. Borehole logs shows that the subsurface conditions were generally similar across the site, consisting of:

- (TOPSOIL) SAND – fine to medium grained, sub-angular to sub-rounded, grey to dark grey, trace fines, trace organics, from surface to depths of up to 0.3 m; overlying
- (SP) SAND – fine to medium grained, sub-angular to sub-rounded, grey/brown/yellow, trace fines, interbedded with a thin lens of a weakly cemented iron indurated sand – coffee rock (typically recovered as gravel size particles) at depths between 1.0 and 2.5 m, extending to a maximum depth investigated of 3 m.

Permeability test results are shown in Table 2. Sites where permeability testing was performed at surface and at depth indicated a generally lower permeability at depth. Most testing at shallow depth recorded rates in excess of 15 m/day.

Table 2: Permeability Test Results (Galt Geotechnics, 2024)

Test Location	Test Depth (m)	Minimum Unsaturated Hydraulic Conductivity (m/day)
IT01 - Shallow	0.55	12.7
IT01 - Deep	1.69	4.9
IT02 - Shallow	0.63	7.9
IT02 - Deep	1.57	>15
IT03	0.84	>15
IT04	0.82	>15
IT05 - Shallow	0.48	14.8
IT05 - Deep	1.62	2
IT06	0.81	>15
IT07 - Shallow	0.52	>15
IT07 - Deep	1.76	3.4

Low levels for deep tests likely to reflect proximity to the water table rather than low permeability soils

Bore logs for groundwater monitoring bores installed within the site by Hyd2o in May 2024 are shown in Appendix C and similarly showed sand profiles (with traces of coffee rock in some locations), consistent with environmental geology map and Galt Geotechnics testing.

Western Australian Planning Commission mapping identifies the risk of Acid Sulphate Soils (ASS) as a moderate to low risk of occurring within 3 m of natural surface (Figure 4). Galt Geotechnics (2024) testing classified all tested materials as non-acid sulfate soils.

The Department of Environment Contaminated Sites database indicates there are no known contaminated sites within the site area. The nearest contaminated site is located approximately 350m north west of the site and is associated with the Cullacabardee Community area, where a portion of that area has been used for uncontrolled landfill.

2.4 Environmental

Wetland mapping is shown in Figure 5. There is a multiple use wetland crossing the site from north to east (which does not preclude development), and a resource enhancement wetland within the western portion of the site. Lots 124 and 800 located at the northern boundary have mapped conservation category wetlands.

A search of the Aboriginal Heritage Inquiry System indicates the site is located within the boundary of Aboriginal Cultural Heritage (ACH) Register Place 3692 Bennett Brook, a large area which extends over the developed urban areas south of the site.

2.5 Gnangara UWPCA

The site is located within the Gnangara Underground Water Pollution Control Area (UWPCA) (Figure 6a). The Gnangara UWPCA defines the central area of Gnangara groundwater system that provides public water supply as part of the Water Corporations Integrated Water Supply Scheme (IWSS). It has an area of approximately 815 km², and is located within the City's of Wanneroo, Swan, and Stirling, and Shires of Gingin and Chittering.

The Gnangara groundwater system includes four wellfields: Mirrabooka, Wanneroo, Pinjar, and Lexia. The site is located within the area of the Mirrabooka wellfield. Bores M110 and M120 are part of Mirrabooka wellfield and are located adjacent to the northern boundary of the site. Abstracted water is conveyed through collector mains to the Mirrabooka Groundwater Treatment Plant (GWTP) where it is treated prior to distribution.

Within the UWPCA, three levels of priority protection are defined, P1, P2 and P3.

- Priority 1 (P1) areas are defined to ensure there is no degradation to the water resource, and were declared over land where the provision of the highest quality public drinking water was the prime beneficial use.
- Priority 2 (P2) areas are defined to ensure there is no increased risk of pollution to the water course and where declared over land where the provision of public water supply was a high priority.
- Priority 3 (P3) areas are defined to minimise the risk of pollution to the water source and were declared over land where water supply needs co-exist with other land uses such as residential, commercial and light industrial developments. Protection of P3 areas are achieved through management guidelines rather than restrictions on land use.

A further category P3* was recently introduced to consider that government may rezone P1 or P2 areas to urban. This situation occurs when the strategic development benefit has been determined to be greater than the water quality protection benefit.

Once rezoning is complete, P1 or P2 area are amended by DWER to P3*. This P3* is a variation of the P3 management approach, to address the increased water quality risks and cumulative impact resulting from the approved land use intensification

The site is currently classified as a Rural-Water Protection zone, which correlates with the Priority 2 (P2) area (Figure 6b). This classification provides an incompatibility with future land use (Urban), and reclassification to P3* is therefore required to facilitate land use change. P3 areas are noted to already co-exist with Water Corporation superficial abstractions bores in close proximity to the site on the other side of Hepburn Avenue.

Wellhead protection zones are shown on Figure 6b. Water Corporation bores have a 300 m radius wellhead protection zone (WPZ) in Public Drinking Water Source Area (PDWSA) Priority 2 and Priority 3 areas.

Advice from DWER indicates urban development within WPZ areas is permitted consistent with the underlying Priority 3 classification, although some restrictions/exclusions may apply such as locating a sewer pump station or petrol stations in these areas.

2.6 Surface Water

A surface water plan is shown in Figure 7.

A review of historical aerial imagery and LiDAR Digital Elevation Models (DEMs) indicate the site previously received surface water from external catchments located to its north which then flowed through the site through its lower lying areas toward the east.

A drain was constructed in the late 1960s along this natural pathway. However, in the mid-1980s, with the implementation of Lakefarm Retreat rural residential area, declining groundwater levels, and following earthworks on internal lots these drains are no longer appear to be active within the site, and flow from external catchments to the north no longer occurs. While the site contains several drainage easements, none however currently appear to be functioning to convey flows through the site.

Currently all stormwater appears to be infiltrated within the site through the sandy subsurface profile, as groundwater levels have lowered over time. Appendix D contains historical aerial photos and recent site images to demonstrate the evolution of the sites surface drainage system.

It is important to note the drain constructed in the 1960 is still present downstream of the site and this will provide a potential flow path for post development flows if required.

2.7 Groundwater

In mid 2023, DWER revised the groundwater information reported on their Perth Groundwater Map (online) to report the Gnangara Jandakot maximum and minimum water table contours for 2019. Advice from DWER indicates these revised contours account for the declines and rises in water tables in recent decades and the impacts of current climate trends. These contours are understood to be based on the contouring of the actual recorded maximum and minimum groundwater levels at DWER bores in 2019.

Based on this dataset the site's 2019 maximum water table elevation ranges from approximately 33.5 to 35.8 mAHD, flowing in a southeast direction.

To refine site groundwater levels, Hyd2o installed 9 bores within the site in May 2024, and have been monitoring groundwater levels monthly since June 2024 as part of an 18-month baseline groundwater investigation. Bore locations are shown in Figure 8. Two nearby DWER bores (MM53 and M60) are also monitored. Long term hydrographs for nearby DWER bores are shown in Appendix E

Groundwater levels in the general area have been recorded by DWER since 1976 (M60), and 1977 (MM53). The average annual maximum groundwater levels (AAMGL) for DWER bores are shown in Table 3 calculated across the period from 2000 – 2023, considered representative of recent climate.

Site bore monitoring data and hydrographs are shown in Appendix F with monitoring data for site bores shown in Appendix F. In winter 2024, maximum groundwater levels occurred in September at all site bores.

Recorded levels at site bores were used with a correction factor applied based on DWER bore levels relative to their calculated AAMGL (2000-2023) to determine the sites AAMGL. Site AAMGL's are shown in Table 4 and contoured on Figure 8. These contours were marginally lower, but broadly similar to DWER regional mapping.

Based on DWER LiDAR topographic contours the natural surface clearance above AAMGL at the site ranges from approximately a minimum of 1.5 to a maximum of 3.5 m.

Table 3: DWER Monitoring Bore AAMGL

Bore	Period of Record	Period for AAMGL Calc	2000-2023 AAMGL (mAHD)	2000-2023 MGL (mAHD)	Sep 2024 Reading (mAHD)	Difference to AAMGL (m)
MM53	1977 – 2024	2000 – 2023	34.00	34.49	34.22	-0.22
M60	1976 – 2024	2000 – 2023	23.72	24.13	23.97	-0.25
Correction Factor to Apply to Site Bore for AAMGL (m)						-0.24

Table 4: Site AAMGL

Bore	Recorded Level September 2024 (mAHD)	Correction Factor (m)	AAMGL (mAHD)
GW1	34.83	-0.24	34.59
GW2	34.70	-0.24	34.46
GW3	34.78	-0.24	34.54
GW4	34.53	-0.24	34.29
GW5	34.70	-0.24	34.46
GW6	34.82	-0.24	34.58
GW7	34.33	-0.24	34.09
GW8	34.60	-0.24	34.36
GW9	34.82	-0.24	34.58

2.8 Nutrient Input Assessment & Existing Groundwater Quality

The Urban Nutrient Decision Outcomes (UNDO) model is a decision support tool developed by DWER that evaluates nutrient reduction decisions for urban developments on the Swan Coastal Plain in south-west Western Australia. It is designed for ease-of-use by urban development proponents and for assessment by local and state government authorities.

The tool was developed to assess the nutrient impact of urban development on the Swan Coastal Plain in a consistent and scientifically rigorous manner, and improve understanding relating to nutrient issues, and efficiencies in the investment to manage nutrients. The tool provides users with the ability to implement a range of structural or non-structural design options to evaluate and reduce nutrients exported from urban development.

Modelling outputs of the site's existing land use using UNDO are detailed in Appendix G. The results indicate a predevelopment nutrient export of 340.47 kg/yr of TN and 16.52 kg/yr of TP to the environment annually based on typical nutrient application rate estimates. These estimates consider soil types, groundwater gradients, and depth to groundwater in its calculation. Note the calculations do not however consider the impact of the site nursery and therefore are likely to be conservative (ie provide a low estimate).

Estimates of post development nutrient input and export are addressed in Section 5.3.

To establish a groundwater quality baseline, Hyd2o has been collecting groundwater quality samples quarterly as part of an 18 month predevelopment monitoring program. Results obtained from samples retrieved in June and September 2024 are summarised in Appendix H for physical parameters, nutrient and metals, with laboratory reports included as Appendix I covering all tested parameters.

Due to existing land uses and on-site wastewater management, Hyd2o included analysis of pathogens at all bores and pesticides and herbicides at bores GW5, GW6 and GW9 located near the Lot 16 nursery, for the sampling event in September 2024.

Tables 5 and 6 summarise the mean values of the two groundwater sampling events undertaken. The results were compared to ANZECC (2000) guideline trigger levels for wetlands in South-west Australia.

- Mean pH showed acidic values and were below the ANZECC (2000) guideline range of 6.5 – 8.0 at all bores.
- Electrical Conductivity (EC) mean falls within the ANZECC (2000) guideline range of 0.3 – 1.5 mS/cm at all bores, apart from bores GW2, GW5 and GW8 which were below the guideline range.
- Mean nutrient levels for Total Nitrogen (TN) ranged from 0.74 to 4.80 mg/L while Total Phosphorus (TP) were below the laboratory detectable limit (0.05 mg/L) at all bores apart from GW6 (0.069 mg/L). These values are within the range of expected values or nutrients on the Swan Coastal Plain given current site and surrounding land use. ANZECC (2000) guideline trigger values are 1.50 mg/L for TN and TP is 0.06 mg/L.
- Minor metals exceedances were observed for Chromium, Copper, Lead, Nickel and Zinc, based on ANZECC (2000) guidelines.
- Pesticides and herbicides analysis showed levels below laboratory detectable limit for all parameters at all bores.
- Pathogens were below laboratory detectable limit for E.coli and Thermotolerant coliforms for all bores, apart from GW3 with Thermotolerant coliform as 480 cfu/100mL.

Table 5: Groundwater Physiochemical and Nutrients Summary

Parameters	Bore								
	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9
	Mean values								
pH	3.89	5.24	4.69	4.88	4.87	4.26	4.84	5.26	5.56
EC (µS/cm)	0.37	0.19	0.44	1.28	0.22	0.97	1.24	0.25	0.61
Total Nitrogen (mg/L)	1.40	5.23	4.45	2.25	0.74	4.80	0.83	1.14	2.25
TKN (mg/L)	1.40	1.20	2.05	2.15	0.76	3.95	0.82	1.13	2.00
NOx (as N) (mg/L)	0.01	3.73	2.36	0.14	0.03	0.88	0.02	0.03	0.26
Total Phosphorus (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	0.069	<0.05	0.22	<0.05
Phosphate as P (mg/L)	0.01	0.001	0.006	0.006	0.005	0.006	0.005	0.039	0.008
Nitrate-N (mg/L)	0.008	3.73	2.36	0.13	0.03	0.88	0.02	0.03	0.25
Nitrite-N (mg/L)	<0.005	<0.005	<0.005	0.028	0.03	0.005	0.01	0.03	0.03
Ammonia as NH ₃ -N (mg/L)	0.545	0.025	0.10	0.19	0.13	0.09	0.28	0.16	0.03

Table 6: Groundwater Metals Summary

Parameters	Bore								
	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9
	Mean values (mg/L)								
Arsenic	0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001
Chromium	0.001	<0.001	0.002	0.003	0.003	0.006	0.002	0.004	0.002
Copper	0.001	<0.001	0.001	0.002	<0.001	0.004	<0.001	<0.001	0.004
Lead	<0.001	<0.001	0.001	0.002	0.001	0.005	0.002	0.001	0.004
Mercury	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Nickel	0.012	0.001	0.004	0.007	<0.001	0.003	0.006	<0.001	0.002
Zinc	0.002	0.001	0.007	0.006	0.003	0.013	0.003	0.003	0.005

2.9 Opportunities and Constraints

Based on the above assessment of the sites existing environment, the following key constraints and opportunities guide the development of this water management strategy:

- The site has a reasonable clearance to groundwater and permeable soils suitable for infiltration of stormwater post development.
- With regards to surface water, there are no currently active natural or constructed watercourses within the site, and no external catchments currently drain into the site. Downstream of the site the historical drains still exist and may provide a flow path for the site post development if required.
- Water Corporation bore wellhead protection zones (WPZ) which extend into the site will be permitted to have urban development within the WPZs consistent with their underlying Priority 3 classification although some land use restrictions/exclusions may apply.
- Opportunities exist with land use change to improve the existing stormwater management and water quality treatment outcomes for the site.

Based on this assessment the site is considered relatively unconstrained hydrologically, and it is considered the water management processes of Better Urban Water Management (WAPC, 2008) will be suitable for guiding water management during land use change.

3. Water Management Principles and Objectives

Key design principles and criteria used to formulate the water management strategy for the site are shown in Table 7 and have been established consistent with the key reference documents previously detailed in Section 1.2, and reflect the sites constraints and opportunities identified in Section 2.

Table 7: Design Principles and Objectives

Strategy Elements	DWMS Method and Approach
Water Use Sustainability	
Water Efficiency	<ul style="list-style-type: none"> Water efficiency implementation to be consistent with Building Codes of Australia requirements. Establish "Waterwise" Public Open Spaces and landscaping. Maximise infiltration and retention of stormwater within the site.
Water Supply	<ul style="list-style-type: none"> Water Corporation IWSS for lots, rainwater tanks (non-mandated) Minimise use of scheme water for non-drinking purposes. Use of groundwater for POS irrigation.
Wastewater	<ul style="list-style-type: none"> Water Corporation reticulated sewerage.
Stormwater	
Ecological Protection	<ul style="list-style-type: none"> Use of infiltration systems at lot scale to infiltrate 15mm on site. Establishment of biofiltration area for treatment and infiltration of first 15mm road runoff within POS and road reserves.
Serviceability	<ul style="list-style-type: none"> Piped drainage system sized to convey 20% annual exceedance probability (AEP) event. 20%AEP event to be infiltrated/managed within POS area.
Flood Protection	<ul style="list-style-type: none"> Overland flow paths within road reserves for safe conveyance of flows exceeding pipe drainage system capacity. 1%AEP event to be infiltrated/managed within POS area, with potential use of downstream existing drains for off-site discharge if required. Establish minimum habitable floor levels at 0.5m above the 1%AEP flood level. All stormwater to be infiltrated within a period not exceeding 96hrs to prevent mosquito and midge breeding.
Groundwater	
Fill & Subsoil	<ul style="list-style-type: none"> Cut and fill earthworks and subsoil (if required) to minimised fill importation
Acid Sulphate Soils	<ul style="list-style-type: none"> If required, any management of Acid Sulphate Soils to be handled as a separate process consistent with DoE (2004) requirements and reported in future water management documents.
Implementation	
Process	<ul style="list-style-type: none"> Future stages of planning and post development monitoring consistent with BUWM (WAPC, 2008).

4. Water Use Sustainability Initiatives

4.1 Water Use Efficiency

Development of the site will lead to an increased local demand for potable water and irrigation of POS areas. Water conservation measures will be implemented to reduce scheme water consumption within the development consistent with Water Corporation’s “Waterwise” land development criteria. Measures to be adopted will include:

- Promotion of the use of Waterwise practices including water-efficient fixtures and fittings (taps, showerheads, toilets, rainwater tanks, Waterwise landscaping).
- Buildings to be built to 6-star building standards.
- Water-efficient POS design including the use of native plants.
- Use of groundwater bores for irrigation of POS.
- Maximising on-site retention and infiltration of stormwater at source.

More specific details on measures and approaches to be adopted to achieve water use efficiency objectives will be appropriately presented in later stages of planning and landscape design.

4.2 Water Supply

Potable water supply is proposed to all lots in the site via the Water Corporation Integrated Water Supply System (IWSS).

With respect to groundwater availability for POS irrigation, the site is located within the Mirrabooka groundwater area, and the Perth-Superficial Aquifer is fully allocated. DWER’s online Water Register indicates there are three groundwater licences currently within the site comprising a total allocation of 75,960 kL/year. These licences are summarised in Table 8.

With respect to POS irrigation, based on the concept structure plan the extent of POS area within the site requiring long term irrigation is estimated to be approximately 4.08 ha. Based an irrigation estimate for POS of 6750 kL/ha/year, it is estimated approximately 30,600 kL/yr will be required to irrigate the sites POS. The current allocation of 75,960 kL is more than sufficient to meet this requirement.

Table 8: Existing Groundwater Licences

Groundwater Licence	Licence Allocation kL/year	Expiry Date
154916	15350	17/12/2029
154918	45100	23/10/2024
170283	15510	17/12/2029

4.3 Wastewater Management

Wastewater will be managed by the Water Corporation via a reticulated sewerage system.

5. Stormwater Management Strategy

Stormwater management at the site will be undertaken in accordance with Better Urban Water Management (WAPC, 2008), the City of Swan's principles for water quality management, and the Stormwater Management Manual for Western Australia (DWER, 2022), and will be conducted consistent with water sensitive design practices.

The system will broadly consist of at source lot infiltration systems, piped road drainage, distributed biofiltration areas, and stormwater storage areas and swales in POS aimed at retaining, treating, and maximising infiltration within the site.

Best management practices suited to the site to be implemented at lot, street and estate scale include:

- **Lot Scale:** infiltration systems, water-wise landscaping, rainwater tanks.
- **Street Scale:** piped stormwater conveyance system with bottomless manholes.
- **Estate Scale:** Ephemeral biofiltration and flood storage areas integrated with POS, use of amended soils and plantings in bioretention areas, monitoring and reporting.

The location of all estate scale stormwater management areas are proposed to be located outside of CCW buffer areas and retained vegetation within the proposed conservation POS areas, with due consideration of the sites existing topography and historical flow paths.

5.1 Stormwater Management

Although an MRS Amendment does not typically require a structure plan level of detail, the implementation of the above strategy on an indicative concept plan for the site (Figure 2) has been performed for this DWMS to inform the approximate location, area, and volume for stormwater management based on preliminary modelling.

This modelling has been undertaken to provide proof of concept and inform an agreed approach to stormwater management post development and will be refined as part of the LWMS and local structure planning process and UWMP.

Preliminary stormwater storage design was undertaken using the infiltration modelling program PONDS. This numerical infiltration model is specifically designed for modelling groundwater-surface water interactions for the design of stormwater infiltration areas, based on finite difference computer program MODFLOW, developed by the US Geological Survey.

The design storms modelled by PONDS were calculated internally by the model with reference to the methodology in Australian Rainfall & Runoff (AR&R) (Institution of Engineers, Australia 2016) and the Bureau of Meteorology Computerised Design IFD Rainfall System. The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 1 to 72 hours.

Key stormwater modelling runoff parameters are shown in Table 9. These rates have been based on Hyd2o's CURRV Runoff Calculator (Appendix J). Hyd2o's CURRV runoff calculator is a standardised approach used by Hyd2o across all development projects to estimate runoff rates. In estimating runoff rates CURRV considers rainfall IFD's, land use breakdown, percentages of impervious and pervious areas within land use type and likely initial and continuing loss of soil types. Importantly it also considers Book 5 Chapter 3 of Australian Rainfall and Runoff (Ball, et al 2106), which details the relationship between Effective

Impervious Area (EIA) and Total Impervious Area (TIA) and considers the different behaviour in runoff that occurs from areas which are directly connected and those impervious areas which are only indirectly connected. Research has found the Effective Impervious Area is typically in the range of 55-65% of TIA for Australian catchments.

Other key parameters used in modelling include:

- Base of superficial aquifer at -7 mAHD from the DWER Perth Groundwater Map (online).
- Biofiltration area side slopes set at 1:6 with maximum depth 0.3m.
- Side slopes for flood storage were set at 1:6 with a maximum total depth of 1.20m.
- Storage inverts set a minimum 0.4m above the sites MGL (0.85m above AAMGL).
- Saturated horizontal hydraulic conductivity for modelling purposes of 5 m/day.

Modelled storage volumes, areas, flood rise, and inverts are detailed in Table 9 and Figure 9 for managing 15mm water quality treatment requirements and 20% and 1& AEP events.

Note that these estimates are based on infiltrating all stormwater on site and smaller storages may be possible with downstream discharge along the historical flow path, which will be considered at LWMS stage.

Further details on the adopted stormwater management measures will be provided at later LWMS and UWMP stages of planning based on refined modelling and detailed site-specific investigations.

5.2 Groundwater Management

5.2.1 Fill and Subsoil Drainage

A copy of the engineering servicing report is included as Appendix L.

Based on the sites groundwater levels and existing clearances to natural surface, cut to fill earthworks will be conducted in order to minimise fill importation.

The need for subsoil drainage will be reviewed at LWMS stage based on the final earthworks strategy and with consideration of opportunities for downstream discharge and refined water balance modelling outcomes.

Note final proposed lot levels and cut/fill calculations are a detailed design issue to be addressed during the preparation of detailed engineering design drawings and preparation of the UWMP and will be ultimately submitted for council approval at that stage.

5.2.2 Acid Sulphate Soils

As previously discussed in Section 2.3, the whole site is classified as moderate to low risk of ASS at <3 m depth, and Galt Geotechnics (2024) testing classified all tested materials as non-acid sulfate soils

Notwithstanding, any required management of acid sulphate soils (ASS) will be addressed by a separate study if required depending on possible disturbance and excavation depths for engineering services. Details regarding the outcomes of any ASS studies required will be included as part of later water management planning document for the site. All assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series documentation (Department of Environmental Regulation, 2015a & b).

Table 9: Stormwater Management Summary

Land Use & Runoff Parameters	Catch 1	Catch 2	Catch 3	Catch 4	Catch 5
Residential Lots (ha)	12.57	6.93	4.29	3.58	3.88
Roads (ha)	5.11	2.41	2.11	0.99	1.51
POS (ha)	0.97	1.69	0.83	0.59	-
Equiv Imp Area (ha) (15 mm)	3.17	1.54	1.37	0.62	0.97
Equiv Imp Area (ha) (20% AEP)	5.41	2.76	2.10	1.24	1.62
Equiv Imp Area (ha) (1% AEP)	8.95	4.85	3.47	2.22	2.70
Storage Parameters					
Indicative Invert (mAHD)	35.50	35.50	35.50	35.20	35.40
Side Slopes (v:h)	1:6	1:6	1:6	1:6	1:6
Groundwater Level (mAHD)	34.50	34.40	34.35	34.35	34.20
MGL (2000-2023)	34.95	34.85	34.80	34.80	34.65
Water Quality Treatment: 15mm Event Biofiltration Storage					
Base Area (m ²)	840	1050	650	364	222
Flood Rise from Biofiltration Invert (m)	0.27	0.07	0.13	0.09	0.24
TWL (mAHD)	35.57	35.57	35.63	35.29	35.64
TWL Area (m ²)	1262	1110	751	409	452
Volume (m ³)	283	76	91	35	81
Flood Management: 20%AEP (inclusive of 15mm Event Storage)					
Flood Rise from Biofiltration Invert (m)	0.41	0.32	0.38	0.37	0.51
TWL (mAHD)	35.91	35.82	35.88	35.57	35.91
TWL Surface Area (m ²)	2502	1337	958	566	731
Volume (m ³)	806	381	304	171	240
Critical Storm (hr)	1	1	1	1	1
Flood Management: 1% AEP (inclusive of 15mm Event Storage)					
Flood Rise from Biofiltration Invert (m)	1.19	1.20	1.18	1.18	1.20
TWL (mAHD)	36.69	36.70	36.68	36.38	36.60
TWL Surface Area (m ²)	4666	2280	1743	1145	1538
Volume (m ³)	3590	1956	1372	851	1015
Critical Storm (hr)	6	6	6	6	6

5.3 Nutrient Management

Post development UNDO modelling of the site is detailed in Appendix M, showing the change with respect to nutrient application and export for the site compared to current use.

Modelling was performed on the indicative concept plan used for stormwater modelling in Figure 2. The modelling indicates land use change will result in nutrient exports of 131.56 kg/yr for TN and 9.68 kg/yr TP post development. Following water sensitive urban design implementation, exports are reduced to 123.48 kg/yr for TN and 9.08 kg/yr for TP.

These rates are far lower than pre development calculated levels, as 340.47 kg/yr for TN and 16.52 kg/yr for TP (Section 2.8).

5.4 Water Balance Modelling

Results of pre and post development water balance modelling for the site are presented in Table 10. Modelling has been based on regional estimates of key parameters at annual scale, with the balance outcomes of the site primarily influenced by rainfall inputs and evapotranspiration losses.

Key parameters used in modelling are presented as follows for the predevelopment model:

- Annual average rainfall of 736 mm/yr (BoM station: Whiteman Park 009263, 2004-2023).
- Recharge the shallow groundwater of 18% for vegetated areas and 45% for pasture based on Xu et al (2009).
- Groundwater throughflow estimated based on site groundwater mapping with water table gradient (1 in 2000), aquifer thickness (~42m) and transmissivity of 600 m/d (Davidson & Yu, 2008).
- Evapotranspiration for pasture estimated as 339 mm/yr (Scott & Sudemeyer, 1993).
- Evapotranspiration for vegetation areas estimated as 400 mm/yr (Silberstein et al, 2007).
- Evapotranspiration for urban hardstand areas (eg roads) estimated to be negligible.
- Existing superficial aquifer use of 75,960 kL/yr consistent with existing licencing.

The balance of input water is assumed to be discharged via surface runoff. On this basis, to balance the model, surface runoff was estimated as 0% of rainfall for the predevelopment (existing) condition, which is consistent with current site observations.

Parameters were then adjusted to represent a post development urban residential site condition based on the indicative concept plan as follows:

- Water supply for POS irrigation will be via groundwater abstraction. An irrigation rate of 6,750 kL/ha/yr was assumed (consistent with DWER allocation rates) over a 4 ha area.
- Scheme water used for lot irrigation post development applied over 15% of the lot area.
- Evapotranspiration for residential areas assumed to be 350 mm/yr (Silberstein et al, 2007).
- Groundwater recharge for urban residential to be 50% of rainfall (Xu et al ,2009).

Surface runoff post development was assumed to match pre-development flows based on stormwater being infiltrated on site. Groundwater throughflow was similarly considered to remain similar to the predevelopment condition.

The balance of input water in the model is assumed to be discharged from site via sub-soil drainage to maintain existing groundwater levels. To balance the model, post development subsoil drainage was estimated to represent approximately 25% of the overall post development water balance. This is largely due to the reduction in groundwater abstraction and introduction of garden scheme water. This modelling outcome will be considered in LWMS stage planning and the refinement of the proposed stormwater system.

Table 10: Pre and Post Development Water Balance

Pre-Development		Use	Area (ha)	Quantity mm/yr	Total kL/yr	%	
Inputs	Rainfall		54	736	397,440	76	
	Groundwater In				123,188	24	
					Total	520,628	100
Outputs	Evapotranspiration	Vegetation	11	400	44,000	9	
		Pasture	38	339	128,820	25	
	Recharge	Vegetation	11	132	14,573	3	
		Pasture	38	331	125,856	24	
	Groundwater Out				131,400	25	
	Water Use				75,960	15	
	Surface Water (Balance)				19	0	
					Total	520,628	100
Post Development							
Inputs	Rainfall		54	736	397,440	69	
	Scheme Water		31		54,675	10	
	Groundwater In				123,188	21	
					Total	575,303	100
Outputs	Evapotranspiration	Vegetation	11	400	44,000	8	
		Lots	31	350	108,500	19	
	Recharge	Vegetation	11	132	15,898	3	
		Lots	31	331	103,040	18	
	Groundwater Out				131,400	23	
	Water Use				27,000	5	
	Surface Water				719	0	
	Balance (subsoil export)				145,446	25	
					Total	575,303	100

6. Implementation Framework

6.1 Considerations and Requirements for Local Planning

This document supports the proposed amendment to the Metropolitan Region Scheme to rezone the site to Urban. The level of detail provided in this document is consistent with typical district water management strategy requirements and provides a proof of concept for future stormwater management within the site.

A number of additional documents will be required to progress further stages of planning and subdivision/development of the site. Local Water Management Strategy's (LWMS's) will be required for the site to support the preparation of local structure plans. Subject to approval of a relevant LWMS, an Urban Water Management Plan (UWMP) will then need to be prepared as a condition of subdivision. Depending on the staging of development, several UWMP's may be required.

The preparation of these future plans will be consistent with this DWMS, Better Urban Water Management (WAPC 2008), and other relevant DWER and City of Swan guideline documents. These documents will demonstrate that the impacts of land use change at the site from a water management view can be readily managed via the WAPC (2008) process.

Key additional information to be reported in the LWMS will include:

- Any additional site geotechnical investigations and reporting, including permeability testing in proposed stormwater management areas.
- Refinement of groundwater mapping based on the additional predevelopment monitoring data.
- Additional survey to confirm key stormwater infrastructure levels and details.
- Detailed engineering earthworks and refinement of post development catchments.
- Detailed stormwater modelling to refine volumes, areas and levels and ensure management and infiltration of stormwater within the site post development within designated areas.
- Refinement of UNDO nutrient modelling based on the final LSP.
- Landscape planning for POS and stormwater management areas, including cross sections showing the interactions of stormwater areas with POS, Reserves, and surrounding areas.
- Develop a post development monitoring program based on predevelopment outcomes, including the establishment of targets.
- Outcomes of continued liaison key agencies and stakeholders.

6.2 Monitoring

6.2.1 Pre Development

No site-specific groundwater monitoring is typically required to support a DWMS.

Pre-development monitoring for the site was however commenced by Hyd2o in June 2024 in accordance with DWER guidelines. The program will run over a period of 18 months inclusive of two winter periods.

Two winter peaks of predevelopment monitoring is typically required to be completed to support and inform development of the Local Water Management Strategy (LWMS), which is the next phase of planning for this site.

The program being undertaken is currently well advanced and is detailed in Table 9. The programme covers groundwater level and quality monitoring of nine bore locations across the site. Two nearby DWER long term groundwater bores are also measured to enable site levels to be correlated to long term DWER records.

Outcomes will appropriately be provided and analysed to support the LWMS. The current status of monitoring is detailed in Sections 2.7 and 2.8 of this DWMS and all data collected to date presented in Appendix F, H and I.

Table 11: Pre-Development Monitoring Program (In Progress)

Monitoring	Parameter	Location	Method	Frequency and Timing
Groundwater level	Water Level (mAHD)	9 bores within site area and 2 DWER bores	Electrical depth bore or similar	Monthly (18 occasions)
Groundwater quality	Physical, nutrients and heavy metals + pesticides/herbicides and pathogens	9 bores within the site area	Pumped bore sample	Quarterly (physical, nutrients & metals) (6 occasions)

6.2.2 Post Development

Department of Water (2012) indicates a minimum of 3 years post development monitoring is required, and defines post development as “from completion of first subdivision to five years after 80 per cent of the development (by land area) has been completed”.

The program will therefore be designed at LWMS stage based on pre development outcomes to operate over a three year post development period, with the timing for commencement of the program to be negotiated at UWMP stage with the City of Swan.

The program may need to be modified as data is collected to increase or decrease the monitoring effort in a particular area, or to alter the scope of the program itself.

Post-development monitoring locations, trigger values and targets will be identified in the LWMS based on pre-development (existing) monitoring outcomes and ANZECC (2000) guidelines.

All water quality testing will be conducted by a NATA approved laboratory.

6.3 Funding and Ongoing Maintenance Responsibilities

Key implementation actions and responsibilities are detailed in Table 12.

The development and implementation of this DWMS will be the responsibility of the future site developer. Ongoing funding and maintenance responsibilities will be appropriately detailed at LWMS and UWMP stages and will include a summary of responsibility for both the developer, the City of Swan, and other relevant agencies.

Table 12: Implementation and Responsibilities

Implementation Action	Developer	DWER	City of Swan
Review and approval of DWMS		✓	✓
Preparation of LWMS to support local structure planning	✓		
Review and approval of LWMS		✓	✓
Preparation of a UWMP for development stages	✓		
Review and approval of UWMP			✓
Construct stormwater system and maintenance post construction until council handover	✓		
Long term stormwater system operation & maintenance			✓
Post development monitoring program	✓		
Review of monitoring data and reporting		✓	✓

7. References

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000). National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), (2016), Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

Davidson, W.A. and Yu, X. (2006), Perth Regional Aquifer Modelling System (PRAMS) Model Development: Hydrogeology and Groundwater Modelling. Department of Water Hydrogeological Record Series. Report no. HG20, September 2008.

Department of Environmental Regulation (2015a) Acid Sulfate Soils Guideline Series: Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes

Department of Environmental Regulation (2015b) Acid Sulfate Soils Guideline Series: Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes

Department of Planning, Lands & Heritage (2018a). Perth and Peel @ 3.5 Million.

Department of Planning Lands & Heritage (2018b). North East Sub-Regional Planning Framework, March 2018

Department of Planning, Lands & Heritage (2022). Perth and Peel @ 3.5 Million Planning Investigation Areas Update, September 2022.

Department of Water (2012). Water Monitoring Guidelines for Better Urban Water Management Strategies and Plans.

Department of Water (2013). Guidelines for District Water Management Strategies.

Department of Water (2017). Decision Process for Stormwater Management in WA

Department of Water & Environmental Regulation (2022) Stormwater Management Manual for Western Australia.

Department of Water & Environmental Regulation (2024a, online). Perth Groundwater Map

Department of Water & Environmental Regulation (2024b, online). Water Information Reporting (WIR) System

Department of Water & Environmental Regulation (2024c, online). The Water Register: Licence and Water Availability Information

Department of Water & Environmental Regulation (2018). Priority 3* (P3*) Areas, Water Quality Protection Note 38, October 2018

Department of Water & Environmental Regulation (2018). Land Use Compatibility Tables for Public Drinking Water Source Areas, Water Quality Protection Note 25, August 2021

Hill, A.L, Semeniuk, C.A, Semeniuk, V and Del Marco, A. (1996). Wetlands of the Swan Coastal Plain Vol 12B: Wetland Atlas. Perth: Department of Environmental Protection; Water and Rivers Commission.

Gozzard, J. R. (1986) Perth, Sheet 2034 II and part 2034 III and 2134 III. Perth Metropolitan Region Environmental Geology Series, Geological Survey of Western Australia.

Scott P, & Sudemeyer R (1993) Evapotranspiration from Agricultural Plant Communities in the High Rainfall Zone of the South West of Western Australia, Journal of Hydrology

Silberstein R, Walker S, Hicks W, Higginson S, Dumbrell I, Canci M and Hodgson G (2007), Water Balance of the Pine Plantations on Gngangara Mound, CSIRO, Water Corporation, ENSIS and Forest Products Commission

C. Xu, M. Canci, M. Martin, M. Donnelly & R Stokes, 2009, Perth regional aquifer modelling system (PRAMS) model development: Application of the vertical flux model, Department of Water, Western Australia, Hydrogeological record series HG 27

Water Corporation (2007). Gngangara Underground Water Pollution Control Area, Drinking Water Source Protection Review, Integrated Water Supply Scheme, November 2007.

Western Australian Planning Commission (2003). Planning Bulletin No. 64: Acid Sulphate Soils. Western Australian Planning Commission, November 2003.

Western Australian Planning Commission (2008). Better Urban Water Management, October 2008.

Western Australian Planning Commission (2021a). Draft State Planning Policy 2.9 Planning for Water.

Western Australian Planning Commission (2021b). Draft State Planning Policy 2.9: Planning for Water, Guidelines for the implementation of State Planning Policy 2.9 Planning for Water.

FIGURES



Site Boundary

0 140 280 420 560 Meters
Source of Data: Landgate SLIP

hyd2o
Lakefarm Retreat Ballajura DWMS
Location Plan
Figure 1



CONCEPT CELL STRUCTURE PLAN - V5
 Lakefarm Retreat, Ballajura
 A LandGroup WA Project

DRAFT
 SUBJECT TO
 DETAILED DESIGN

Date: 25 September 2024
 Scale: 2000@A3



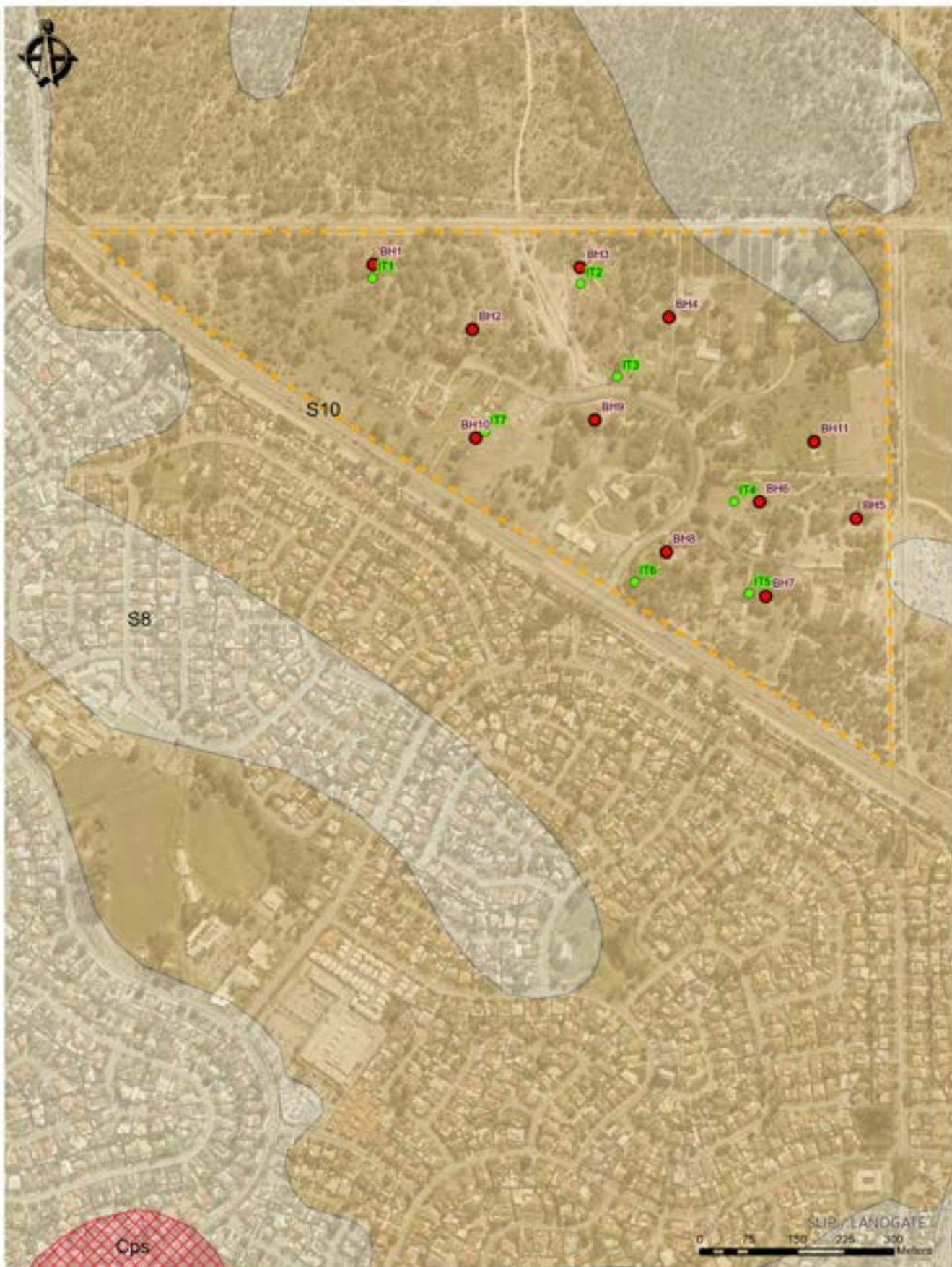
hyd2o
 Lakefarm Retreat Ballajura DWMS
 Concept Structure Plan
 Figure 2



Site
LIDAR Topography Contours (mAHD)

0 50 100 150 200 Meters
Source of Data: DWER SLIP DataWA

hyd2o
Lakefarm Retreat Ballajura DWMS
Site Conditions Plan
Figure 3



Site Boundary

Acid Sulphate Risk Classification

High to moderate risk
All other areas: Moderate to low risk

Geological Survey of WA Map

S8: SAND - very light grey at surface, yellow at depth, fine to medium grained, sub-rounded quartz, moderately well sorted of eolian origin.

S10: as S8

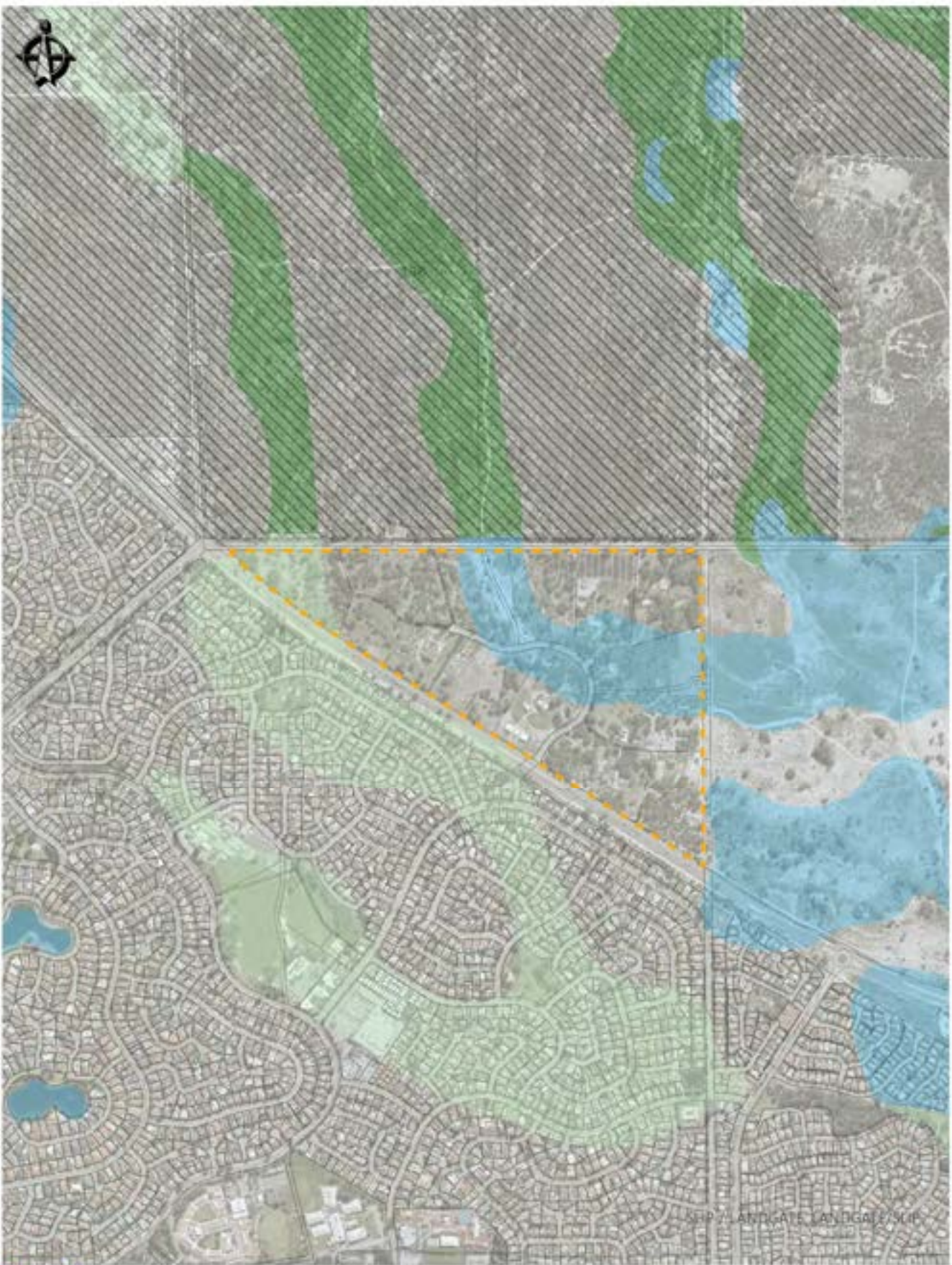
Infiltration Test (Galt Geotechnics, 2024)

Borehole (Galt Geotechnics, 2024)

SLIP / LANGGATE

0 75 150 225 300 Meters

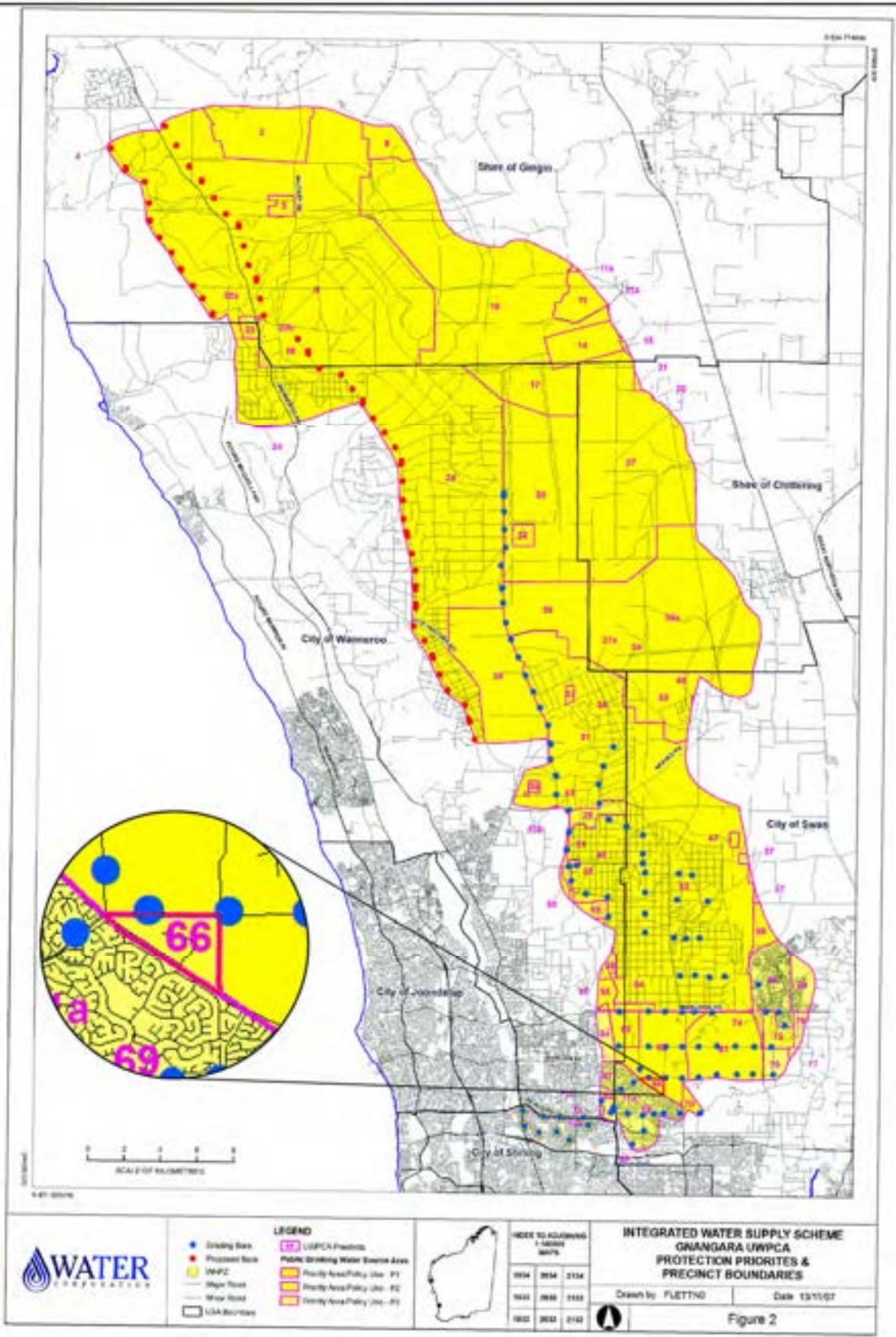
hyd2o
Lakefarm Retreat Ballajura DWMS
Geotechnical Plan
Figure 4



- Site Boundary
- Bush Forever Site No 198
Beechboro Road Bushland
Cullacabardee/Ballajura

- Geomorphic Wetlands SCP
- Conservation
 - Multiple Use
 - Resource Enhancement

0 160 320 Meters
Source of Data: Bush Forever
Areas 2000 (DPLH-019)
Geomorphic Wetlands Swan
Coastal Plain (DBCA-019)



This map was extracted from Gungahlin Underground Water Pollution Control Area - Drinking Water Source Protection Review, Integrated Water Supply Scheme, Water Corporation 2007.

hyd2o
Lakelarm Retreat Ballajura DWMS
Gungahlin UWPCA Boundary
Figure 6a



SLIP / LANDGATE / LANDGATE / SLIP



-  Site Boundary
-  DWER Wellhead Protection Zone


- Public Drinking Water Source Areas**
-  Priority 1 - Source Protection Area
 -  Priority 2 - Source Protection Area
 -  Priority 3 - Source Protection Area

0 160 320 Meters
 Source of Data: State Planning Policy
 2.2 Gwongara Groundwater
 Protection (DPLH-050)
 DWER Public Drinking Water Source
 Area Map

hyd2o
 Lakefarm Retreat Ballajura DWMS
Public Drinking Water Source Plan
Figure 6b

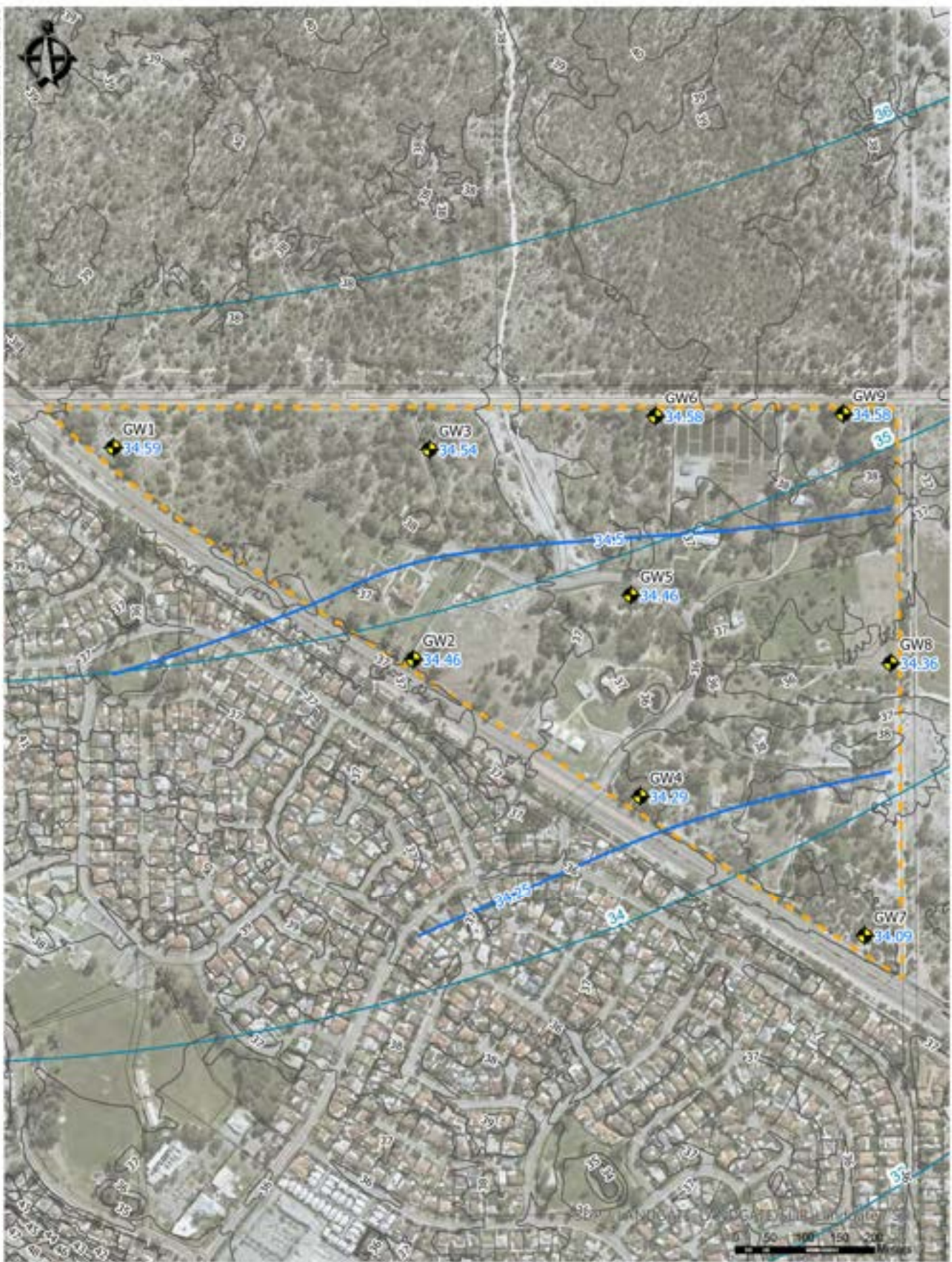


 Site Boundary
 Existing Drain - minor

Site DEM (mAHD)

 38
 35.5

0 130 260 Meters
 Source of Data: Hydrography Linear
 DWER-031
 LIDAR DEM - Perth

hyd2o
 Lakefarm Retreat Ballajura DWMS
Surface Water Plan
Figure 7



- Site
- Groundwater Monitoring Bores Hyd2o September 2024 Readings (mAHD)
- Groundwater Contours 2019 Maximum (mAHD)
- AAMGL Contour (mAHD)
- LiDAR Topography Contours (mAHD)

hyd2o
Lakefarm Retreat Ballajura LWMS
Groundwater Plan
Figure 8



Catchment 1
 15mm Event
 Invert Level (mAHD): 35.50
 Side Slopes (1:v): 6
 Flood Rise (m): 0.27
 TWL Area (m2): 1262
 Volume (m3): 283

20% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 0.41
 TWL Area (m2): 2502
 Volume (m3): 806
 Critical Storm (hr): 1

1% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 1.19
 TWL Area (m2): 4666
 Volume (m3): 3590
 Critical Storm (hr): 6

Catchment 3
 15mm Event
 Invert Level (mAHD): 35.50
 Side Slopes (1:v): 6
 Flood Rise (m): 0.13
 TWL Area (m2): 751
 Volume (m3): 91

20% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 0.38
 TWL Area (m2): 958
 Volume (m3): 304
 Critical Storm (hr): 1

1% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 1.18
 TWL Area (m2): 1743
 Volume (m3): 1372
 Critical Storm (hr): 6

Catchment 5
 15mm Event
 Invert Level (mAHD): 35.40
 Side Slopes (1:v): 6
 Flood Rise (m): 0.24
 TWL Area (m2): 452
 Volume (m3): 81

20% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 0.51
 TWL Area (m2): 731
 Volume (m3): 240
 Critical Storm (hr): 1

1% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 1.20
 TWL Area (m2): 1538
 Volume (m3): 1015
 Critical Storm (hr): 6

Catchment 2

15mm Event
 Invert Level (mAHD): 35.50
 Side Slopes (1:v): 6
 Flood Rise (m): 0.07
 TWL Area (m2): 1110
 Volume (m3): 76

20% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 0.32
 TWL Area (m2): 1337
 Volume (m3): 381
 Critical Storm (hr): 1

1% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 1.20
 TWL Area (m2): 2280
 Volume (m3): 1956
 Critical Storm (hr): 6

Catchment 4

15mm Event
 Invert Level (mAHD): 35.20
 Side Slopes (1:v): 6
 Flood Rise (m): 0.09
 TWL Area (m2): 409
 Volume (m3): 35

20% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 0.37
 TWL Area (m2): 566
 Volume (m3): 171
 Critical Storm (hr): 1

1% AEP Event
 Side Slopes (1:v): 6
 Flood Rise (m): 1.18
 TWL Area (m2): 1145
 Volume (m3): 851
 Critical Storm (hr): 6

Site Boundary	Land Use	Existing Drain
Catchment Boundary	Lots	Potential future living stream to existing drain
Biofiltration	Roads	AAMGL Contours mAHD (MGL = AAMGL + 0.45m)
1% AEP Storage	POS	Preliminary Stormwater Modelling at 5m/day

hyd2o
 Lakefarm Retreat Ballajura DWMS
Preliminary Stormwater Management Plan
Figure 9

APPENDIX A
DWMS Checklist

District water management strategy guide

Use the guide below to assist with the completion of the DWMS. Tick the box where items have been met. If the item is not applicable to the DWMS, include N/A with explanation in the notes column. Provide any other relevant comments briefly in the notes column.

District water management strategy item	<input checked="" type="checkbox"/>	Notes
Executive summary		
Describe proposed water management objectives and how the objectives will be met.	<input checked="" type="checkbox"/>	Executive Summary
Planning background and previous studies		
Map the location of the site.	<input checked="" type="checkbox"/>	Location or site context plan Figure 1
State which planning document the strategy is supporting.	<input checked="" type="checkbox"/>	District structure plan if available Section 1.1 Planning Context, Figure 2
Provide references to the key state and/or local policies, guidelines, strategies and their relevance.	<input checked="" type="checkbox"/>	Section 1.2 Key Documents Chapter 7 References
Design criteria		
Recognise water management principles, objectives and design criteria.	<input checked="" type="checkbox"/>	Chapter 1 Introduction Section 3 Water Management Principles & Objectives
Design objectives from previous water strategies and/or plans.	<input checked="" type="checkbox"/>	Chapter 1 Introduction Section 3 Water Management Principles & Objectives
Pre-development environment (identification of assets, risks and constraints)		
Describe site characteristics: provide preliminary desktop assessments and/or field investigations (if required)	<input checked="" type="checkbox"/>	Include existing data Chapter 2 and associated figures & appendices
Describe climate.	<input checked="" type="checkbox"/>	Description Section 2.2
Describe and map topography, landform and geotechnical conditions.	<input checked="" type="checkbox"/>	Aerial photo Section 2.1, Figure 3 Geotechnical plan Section 2.3 Figure 4 Appendix B & C Acid sulfate soil risk mapping Figure 4 Section 2.3

District water management strategy item	☑	Notes
Describe the existing land use.	☑	Description Section 2.1
Identify environmental assets and their significance.	☑	Environmental plan plus supporting data where available Figure 5 & 6 Section 2.4 and 2.5
Detail the social, cultural and heritage considerations.		Section 2.4
Describe the hydrology and hydrogeology of the area: <ul style="list-style-type: none"> • surface water • groundwater • water-dependent ecosystems • water resource issues. 	☑	Surface water hydrology plan Section 2.6 Figure 7 Appendix D Groundwater and topographic contours plan (or depth to groundwater) Section 2.7 Figure 8 Appendix E & F Waterways and wetlands plan Figure 5 & 7 Indicative water balance (pre- and post-development water balances can be presented together – see below) Section 5.4
Describe existing drainage infrastructure and other infrastructure likely to affect management of water resources.	☑	Arterial drainage plan (if available) including local drainage Section 2.6
Post-development water management		
Identify the proposed broad scale management strategies that will address water resource issues and meet the objectives and design criteria.	☑	Chapter 5, Figure 9
Calculate an indicative water balance.	☑	Indicative water balance. May be presented as a diagram including pre- and post-development Section 5.4
Describe the impacts to water resources and/or impacts to proposed change in land use from water issues.	☑	Chapter 5
Surface water <ul style="list-style-type: none"> – Estimate land requirements for water management. – Identify water quality issues and scope for improvement. – Describe proposed strategy for management of small, minor and major surface flows. 	☑	Include any existing data Section 5.1 Figure 9 Table 9 Appendix K Section 2.8, Section 5.3 Appendices G & M Section 5.1
Describe groundwater levels, use, management and maintenance.	☑	Include data if available Section 5.2

District water management strategy item	☑	Notes
Identify water-dependent ecosystems	☑	Section 2.4
Identify contamination issues – high risk acid sulfate soils, contaminated sites or areas with historical high nutrient and/or non-nutrient contaminants.	☑	Include data or plans if available Section 2.4 & 2.5, Figures 4 & 5
Water services and efficiency initiatives		
Describe potable water supply – options including details of technical, environmental and regulatory feasibility – regulatory approvals, technical investigations and any obtained written approvals – recommendations for water efficiency and conservation	☑	Written evidence if obtained Section 4.1 & 4.2 Appendix L
Identify wastewater servicing – options including preferred option, location, treatment process, level of treatment, disposal, buffers and infrastructure – approvals and investigations required and any obtained written approvals – recommendations for water efficiency and conservation	☑	Written evidence if obtained Section 4.3 , Appendix L
Identify non-potable (fit-for-purpose) water supply – non-potable water source options. Highlight preferred option with consideration of pre and post development water balance – approvals and investigations required and any obtained written approvals – recommendations for water efficiency and conservation	☑	Written evidence if obtained Section 4.1 & 4.2

District water management strategy item	<input checked="" type="checkbox"/>	Notes
Implementation framework		
<p>Describe commitments and obligations for the next stage of the planning process (e.g. LWMS).</p> <p>Identify issues that need specialised investigation and management for the subsequent LWMS.</p> <p>Make recommendations for implementing the DWMS.</p>	<input checked="" type="checkbox"/>	<p>Commitments and obligations may be displayed in table format</p> <p>Chapter 6, Tables 11 & 12</p>

APPENDIX B
Geotechnical Report



Report on:

**PRELIMINARY GEOTECHNICAL AND ACID
SULFATE SOIL STUDY
PROPOSED RESIDENTIAL SUBDIVISION
LAKEFARM RETREAT
BALLAJURA**

WAG240411-01 001 R Rev0

Submitted to:

Land Group (WA)
578 Murray Street
WEST PERTH WA 6005

16 October 2024

CONTENTS

1. INTRODUCTION	3
2. KEY FINDINGS	3
3. SITE DESCRIPTION	4
4. PROPOSED DEVELOPMENT	4
5. PROJECT OBJECTIVES	4
6. FIELDWORK	5
6.1. Summary	5
6.2. Infiltration Test Results	5
7. LABORATORY TESTING	5
8. SITE CONDITIONS	6
8.1. Geology	6
8.2. Groundwater	6
9. GROUND MODEL	6
10. GEOTECHNICAL ASSESSMENT	8
10.1. Summary	8
11. ACID SULFATE SOIL ASSESSMENT	9
11.1. Fieldwork	9
11.2. Results	9
12. CLOSURE	9

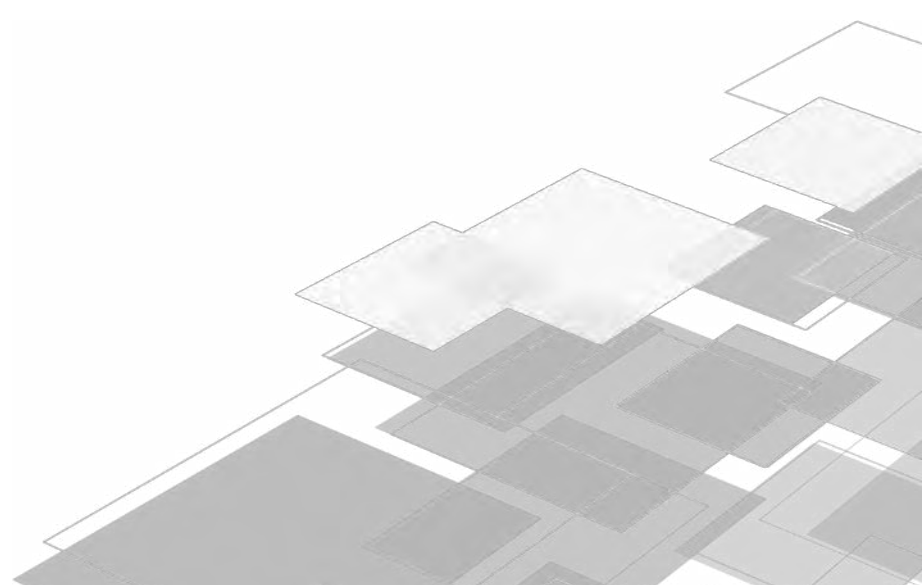


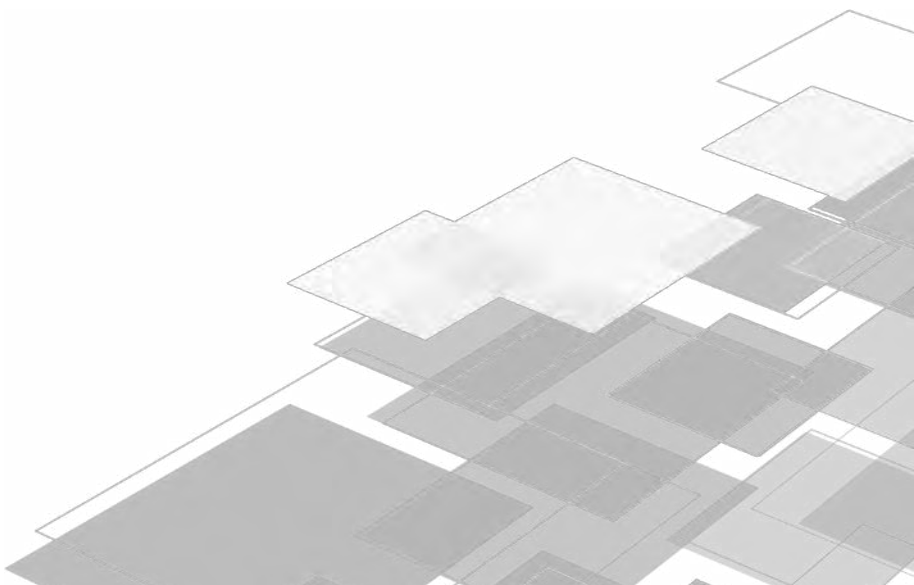
Table 1: Summary of Site.....	4
Table 2: Summary of Proposed Development.....	4
Table 3: Summary of Field Data	5
Table 4: Infiltration Test Results.....	5
Table 5: Summary of Laboratory Testing Undertaken	5
Table 6: Summary of Geology Mapping	6
Table 7: Summary of Groundwater Levels	6
Table 8: Geotechnical Model Units and Design Parameters	7
Table 9: Summary of Geotechnical Assessment	8

Attached Table 1: Summary of Geotechnical Index Test Results	10
--	----

Figure 1: Site and Location Plan

- Appendix A: Site Photographs
- Appendix B: Supplied Information
- Appendix C: Borehole Reports
- Appendix D: DPSH Test Results
- Appendix E: Infiltration Test Results
- Appendix F: Laboratory Test Results
- Appendix G: Field and Laboratory ASS Results
- Appendix H: Environmental Laboratory Certificates of Analysis

Standard Geotechnical Definitions, Recommendations, Requirements and Limitations



1. INTRODUCTION

This report presents the outcomes of Galt Geotechnics' (Galt's) preliminary geotechnical and Acid Sulphate Soil ("ASS") study for the proposed residential subdivision development, at Lake Farm Retreat, Ballajura ("the site").

This report is to be read in conjunction with the appended "Geotechnical Definitions, Recommendations, Requirements and Limitations". 'Clause GDR1', etc. refer to this Appendix, found at the back of this report.

2. KEY FINDINGS

The site is underlain by SAND to at least 3 m depth in the areas investigated. A "Class A" site class to AS2870-2011 is considered appropriate with normal site preparation measures. The site-derived soils should be suitable for structural fill and maintaining 'Class A' lots.

Stormwater disposal via soak wells is considered suitable for the site provided the base of soak wells are at least 0.5 m above the design groundwater level. A design unsaturated hydraulic conductivity of no more than 5 m/day may be used for the insitu sand. A hydrological assessment is required to inform design groundwater levels.

All soil samples tested were classified as non-acid sulfate soils (NASS). As such, no further treatment or management is required.

3. SITE DESCRIPTION

Table 1: Summary of Site

Item	Comment
Site Extent	refer Figure 1, Site and Location Plan
Site Area	About 52 ha (13 x ~ 4 ha rural residential lots)
Current Site Surface Levels ¹	About RL 36 m AHD to RL 38 m AHD
Vegetation	Mature trees, grass and native shrubs.
Current Land Use	Rural residential lots
Existing Infrastructure	Some single storey buildings, access way and associated infrastructure.
Site History ²	<p>Prior to 1985: Native bushland. Aerial photos indicate central portion of site was a Palusplain (seasonally waterlogged area).</p> <p>1985 to 1989: subdivided into residential lots.</p> <p>1989 to present: relatively unchanged. Some single storey building constructed.</p>

- NOTES:**
1. Site levels based on publicly available data (DWER 2019)
 2. Site history based on aerial imagery (Landgate)

4. PROPOSED DEVELOPMENT

Table 2: Summary of Proposed Development

Item	Comment
Proposed Development	Residential subdivision – Stage 1, 2, 3A and 3B (refer Appendix B, Supplied information).
Cut/Fill	Assumed cut and fill up to about 2 m depths.
Assumed Foundation Type	Shallow footings.
Assumed Retaining Walls	Gravit walls typically less than 1 m.
Assumed Stormwater Disposal	On site via soak wells / drainage basins.

- NOTES:**
1. FFL – finished floor level
 2. Proposed development details based on supplied information presented in Appendix B, Supplied information

5. PROJECT OBJECTIVES

The objectives of the study were to:

- assess possible presence of swamp deposits in areas where surface water has been present;
- assess possible presence of loose sandy soils which may have an impact on site classification;
- assess potential presence of sand for borrow in higher areas of the site;
- assess acid sulfate soil risk across the site; and
- assess the drainage performance of sands at the site.

6. FIELDWORK

6.1. Summary

Fieldwork was carried out in the presence of a representative from Galt on 19 and 20 September 2024 and comprised:

Table 3: Summary of Field Data

Type	Results Appendix	Summary	GDR Clause	Equipment Used	No. Tests	Depth Range (m)
Site Plan	Figure 1	-	-	Hand held GPS ¹	-	-
Photographs	A	-	-	-	-	-
Machine Auger Boreholes (BH)	C	Section 9	GDR3.3	Melville Super Rig	11	3.0
Dynamic Probing Super Heavy (DPSH)	D	Section 9	GDR3.6	GRIZZLY tracked rig	11	3.0
Infiltration Tests (I)	E	Section 6.2	GDR3.7	Inverse auger hole	11	0.55 – 1.76

NOTES: 1. Hand held GPS is accurate to ± 5 m.

6.2. Infiltration Test Results

Table 4: Infiltration Test Results

Test Location	Soil Description	Depth (m)	Minimum Unsaturated Hydraulic Conductivity, K_{unsat} (m/day)
IT01 - Shallow	SAND (SP)	0.55	12.7
IT01 – Deep		1.69	4.9
IT02 - Shallow		0.63	7.9
IT02 – Deep		1.57	>15
IT03		0.84	>15
IT04		0.82	>15
IT05 - Shallow		0.48	14.8
IT05 – Deep		1.62	2
IT06		0.81	>15
IT07 - Shallow		0.52	>15
IT07 – Deep		1.76	3.4

NOTES:

- Infiltration test method using inverse auger is explained in GDR3.7
- Conductivities greater than 15 m/day not reported due to inaccuracies of the test in highly permeable soils.
- The low values observed in tests conducted at depths greater than 1.5 m are likely due to the proximity of the groundwater table, rather than the presence of low-permeability soils.

7. LABORATORY TESTING

Table 5: Summary of Laboratory Testing Undertaken

Type	Testing Done?	Results Summary	Results Appendix
Geotechnical Index Tests	Yes	Attached Table 1	F
Acid Sulfate Soil Tests	Yes	Appendix G	H

8. SITE CONDITIONS

8.1. Geology

Table 6: Summary of Geology Mapping

Map Sheet	Map Scale	Mapped Soils	Site Findings
Perth	1:50,000	Bassendean SAND (S8 and S10) over clayey strata of Guildford Formation	SAND (SP) interbedded with weakly cemented iron indurated sand ("Coffee Rock") to maximum depth investigated of 3 m.

8.2. Groundwater

Table 7: Summary of Groundwater Levels

Item	Date	Depth Range (m)	Elevation Range (m AHD)	Comment
Perth Groundwater Atlas	1997	0.00 – 1.00	37.00	Historical maximum groundwater levels
	2004	2.00 – 5.00	33.00 – 34.00	End of summer groundwater level in May 2003
	2019	1.00 – 4.00	34.00 – 35.00	Winter groundwater elevation recorded in 2019
Site observations	July 2024	2.00 – 4.50	33.44 – 34.02	GWT readings provided by Hyd2o
	September 2024	1.90 – 3.22	-	GW2, GW4 and GW8 (monitoring well installed by others)
	September 2024	2.00 – 3.00	-	Groundwater was not observed during our investigation due to hole collapse on extraction of auger / DPSH rods. Groundwater depths are inferred based on the moisture content of soil samples recovered and collapsed depths of test holes during withdrawal of the auger rods.
Design Groundwater Level	-	-	-	Hydrological study by others

- NOTES:**
1. Depth range for Perth Groundwater Atlas observations based on mapped levels dating from 1997 – 2019.
 2. Depths for mapped levels based on an approximate mapped ground level of about RL 36 m AHD to RL 38 m AHD.
 3. Depth range for site observations based on the site surface level at the time of investigation.

9. GROUND MODEL

The encountered subsurface conditions can be summarised as comprising:

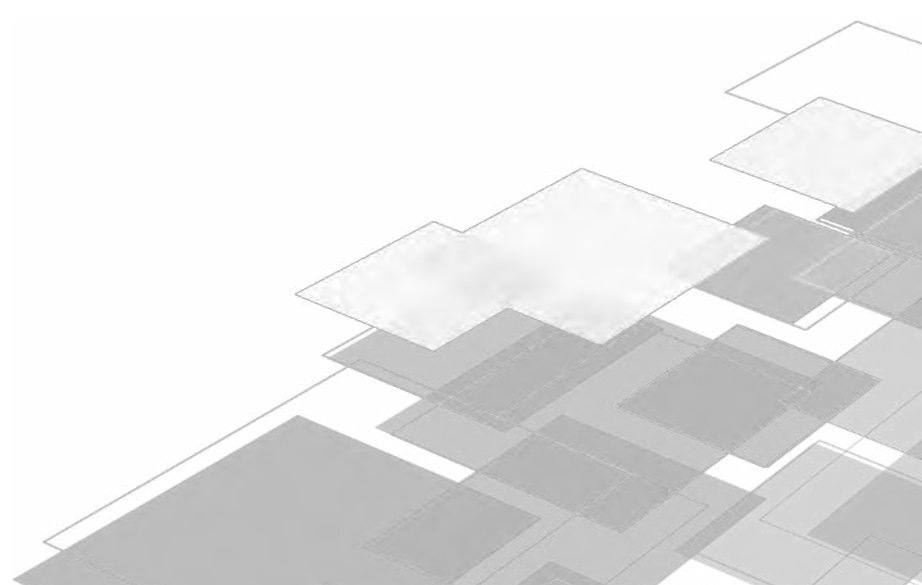
- **TOPSOIL: SAND**, fine to medium grained, sub-angular to sub-rounded, grey/dark grey, trace fines, trace organics; overlying
- **SAND (SP)**, fine to medium grained, sub-angular to sub-rounded, grey/pale grey/white/brown/yellow layers, trace fines, interbedded with weakly cemented iron cemented sand ("Coffee Rock") which is typically recovered as gravel size particles, very loose to loose within the upper 1.0 m to 1.5 m and then becomes typically loose to medium dense, extends to maximum investigated depth of 3 m.

Geotechnical design parameters for the generalised subsurface units are described in Table 8.

Table 8: Geotechnical Model Units and Design Parameters

Unit Name	γ_{bulk} (kN/m ³)	ϕ' (°)	E_v (MPa)	k_o	Wall Friction=0		Wall Friction=0.5 ϕ	
					k_a	k_p	k_a	k_p
Approved Fill Refer Table 9	18	36	50	0.41	0.26	3.85	0.22	6.54
Very Loose to Loose SAND To about 1.5 m depth	17	32	2 to 15	0.47	0.31	3.25	0.27	4.96
Loose to Medium Dense SAND Below about 1.5 m depth.	18	35	20 to 40	0.43	0.27	3.69	0.24	6.08

- NOTES:**
1. These units are a generalization of results from individual tests, which should be referred to for more information.
 2. Topsoil is not included as a discrete unit.
 3. For all earth pressure coefficients (retaining wall design) refer to clause GDR11.2 for more detail and interpretation. Unit weights for retaining structure design should be as per GDR11.2 or 1 kN/m³ greater than the values in the table above.
- γ_{bulk} – bulk unit weight
 ϕ' – effective friction angle
 E_v – vertical elastic modulus
 k_a – coefficient of active earth pressure (Coulomb – AS4678-2002, Appendix E)
 k_p – coefficient of passive earth pressure (Coulomb – AS4678-2002, Appendix E)
 k_o – coefficient of at-rest earth pressure (Jaky)



10. GEOTECHNICAL ASSESSMENT

10.1. Summary

Table 9: Summary of Geotechnical Assessment

Type	Clause	Parameter	Comment
Site Suitability	-	-	We consider the site to be geotechnically suitable for the proposed development.
Construction Methodology and Suitability	-	-	Shallow footings in accordance with AS2870-2011 will be suitable for this site. Mass retaining will be suitable for retaining above groundwater. Stormwater disposal via infiltration is suitable subject to appropriate clearance to groundwater.
Site Classification (AS2870)	GDR5	A	-
Site Preparation	GDR6	-	GDR6.2.1 Common Measures followed by GDR6.2.2 Sand Sites . Possible localised requirement for GDR6.2.3 Deep Loose Sand Sites if any deep loose sand zones are encountered. Test results to date do not indicate the requirement for treatment of deep loose sands provided the upper ~1.0 m of in situ loose sand can be effectively compacted.
Compaction Control	GDR7	Approved granular fill or in situ sand – 95% MMDD	A PSP may be used for compaction control on site-derived SAND. Deemed to comply values for 'Bassendean' sand in GDR7.4 are applicable. Note: Difficulty may be experienced achieving compaction when the groundwater is within about 1 m of the surface (local dewatering maybe required for services trenches).
Approved Fill	GDR8	-	Approved Fill for this site is to comprise Permeable Sand . In situ sand may be assumed to be Permeable Sand . If additional fill is required, imported Permeable Sand will be needed.
Shallow Footings	GDR9	$q_{all} = 100 \text{ kPa}$	In accordance with AS2870-2011 for residential buildings up to 2 storeys high
Earth Pressure Coefficients	GDR11	-	Earth pressure coefficients can be used for the generalised subsurface units presented in Table 8.
Batters	GDR12	1V:2H (temporary) 1V:3H (permanent)	Batter angles apply to units in Table 8 above the water table. Excavations below / near groundwater will require temporary retention.
Excavatability	GDR12	10 tonne excavator	Potential for obstructions (buried concrete, Soakwells etc...), cemented soils and surficial pavement layers must be considered when selecting earthmoving plant.
Unsaturated Hydraulic Conductivity	GDR13	$k_{unsat} = 5 \text{ m/day}$	k_{unsat} values apply where disposing into Approved Fill (Permeable Sand) or in situ sand, minimum 0.5 m above the design groundwater level.
Pavement Subgrade CBR	GDR16	CBR = 10%	Subgrade to comprise compacted in situ sand or Approved Fill .

NOTES: 1. q_{all} – allowable bearing pressure (maximum for all footings, refer to footing tables for further details)

11. ACID SULFATE SOIL ASSESSMENT

11.1. Fieldwork

Soil samples were collected at 0.25 m intervals at each test pit location using dedicated nitrile gloved and placed in laboratory supplied samples bags. All samples were stored with adequate packing and ice and transported to the laboratory to ensure that they arrived intact and at the appropriate temperature to ensure preservation of sample integrity.

Samples were collected from the borehole in accordance with the following guidelines:

- Department of Environmental Regulation (DER) (2015) Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes

The lateral borehole distribution and the vertical sample interval is considered appropriate for the project and in accordance with the aforementioned regulatory guidelines

Soil samples were field tested in accordance with the following guidelines:

- DER (2015a); and
- DAWR (2018).

Soil samples were tested for pH before (pH_F) and after (pH_{FOX}) rapid oxidation with hydrogen peroxide (H_2O_2). The field tests were undertaken to provide an indication of soil types likely to have the potential to generate acidity as a result of oxidation during earthworks.

Selected soil samples were couriered to the laboratory with adequate packing and ice to ensure that they arrived intact and at the appropriate temperature to ensure sample preservation. Laboratory analysis was undertaken on selected soil samples using the chromium reducible sulfur (CRS) method which provides acid base accounting and quantification of potential acid generation. The selection of samples for laboratory analysis was based on soil type and the results of field testing. All laboratory analysis was undertaken using NATA-accredited methods of analysis.

11.2. Results

A total of 101 samples were field tested. During field testing all samples displayed a low reaction rate. pH_F results ranged from 4.9 to 7.3 with pH_{FOX} results ranging from 4.0 to 5.6. The largest pH change noted was 2.0 units.

Soil samples were then selected based on pH change, reaction rate and soil type for laboratory analysis using the chromium reducible sulfur method (CRS). It was noted that all samples contained net acidity were either below the laboratory LOR conforming to the adopted assessment criterion of 0.03 %S. Therefore, all material is classified as non-acid sulfate soils (NASS).

Acid sulfate soil laboratory results along with field testing results are presented in Appendix G. Laboratory certificates of analysis are presented in Appendix H.

12. CLOSURE

GALT GEOTECHNICS



Owen Woodland CPEng
Geotechnical Engineer



William Yukun Feng
Geotechnical Engineer

Figures



Legend

- Site Boundary
- ◆ Borehole
- ◆ Borehole / Dynamic Probing Super Heavy Test
- Infiltration Test

NOTES
Aerial Imagery and Cadastre sourced from Landgate/SLIP

	SCALE	1:4,500	(A3)
	DRAWN	CED	
	DATE DRAWN	27/9/2024	
	CHECKED	-	
	DATE CHECKED	-	
PROJECTION	GDA 1994 MGA Zone 50		

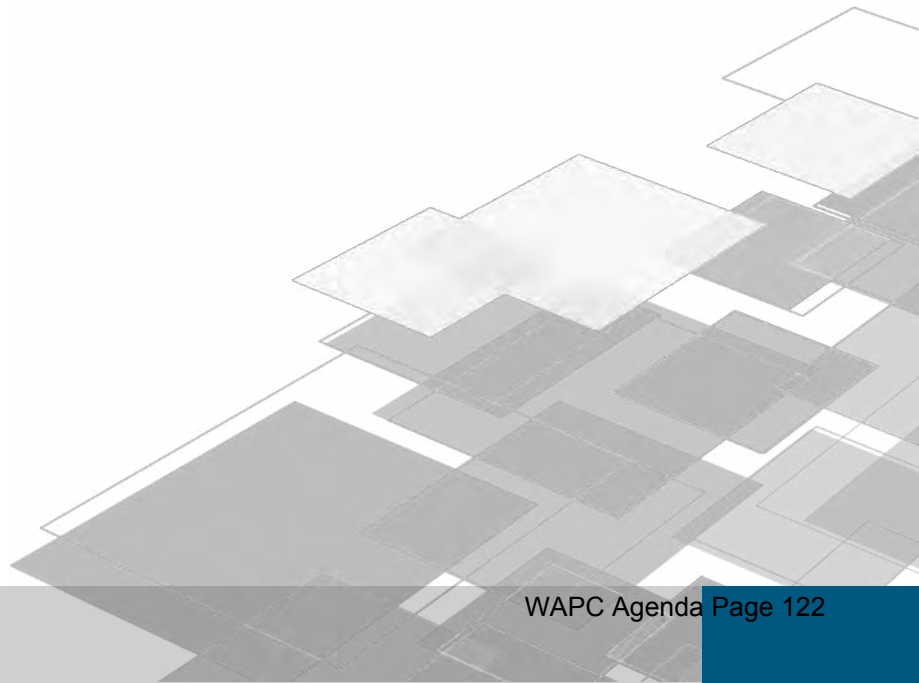
Galt Geotechnics Pty Ltd
 ACN : 138 490 865
 Tel : +61 (0)8 6272-0200
 Address : 50 Edward Street
 Osborne Park WA 6017

COPYRIGHT © 2024 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT GEOTECHNICS PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	LAND GROUP (9WA) - GROVES ST PTY LTD
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	LAKEFARM RETREAT BALLAJURA
TITLE	SITE & LOCATION PLAN
Job No	WAG240411-01
Fig No	FIGURE 2
Rev	A

Appendices

Appendix A: Site Photographs



Photograph 1: Typical soil profile (BH05)



Photograph 2: Aerial view of the site



Photograph 3: Aerial view of the site



Photograph 4: Aerial view of the site



Photograph 5: Aerial view of the site



Photograph 6: Aerial view of the site



Photograph 7: Aerial view of the site



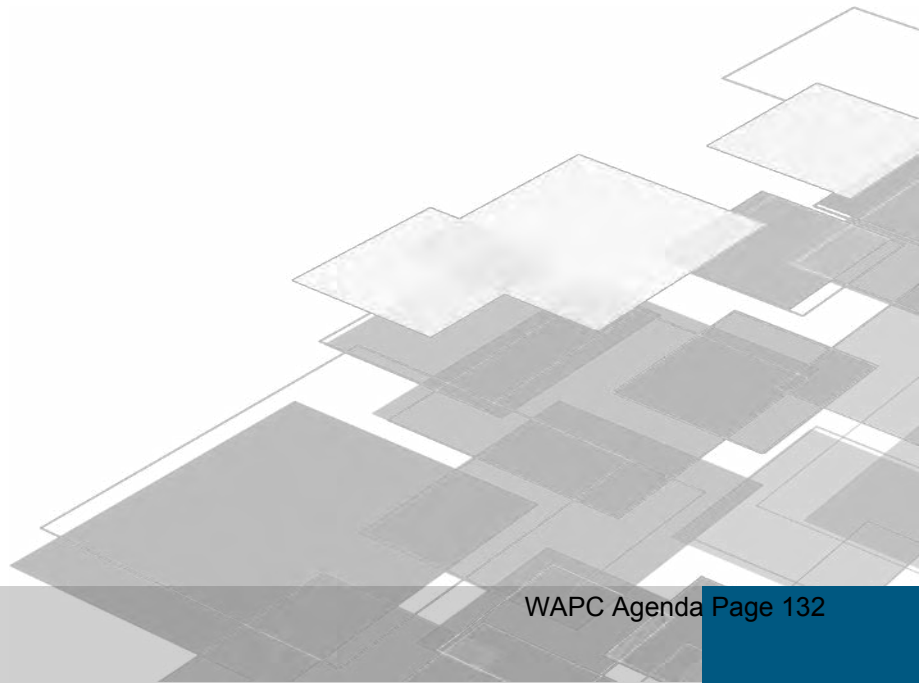
Photograph 8: Aerial view of the site

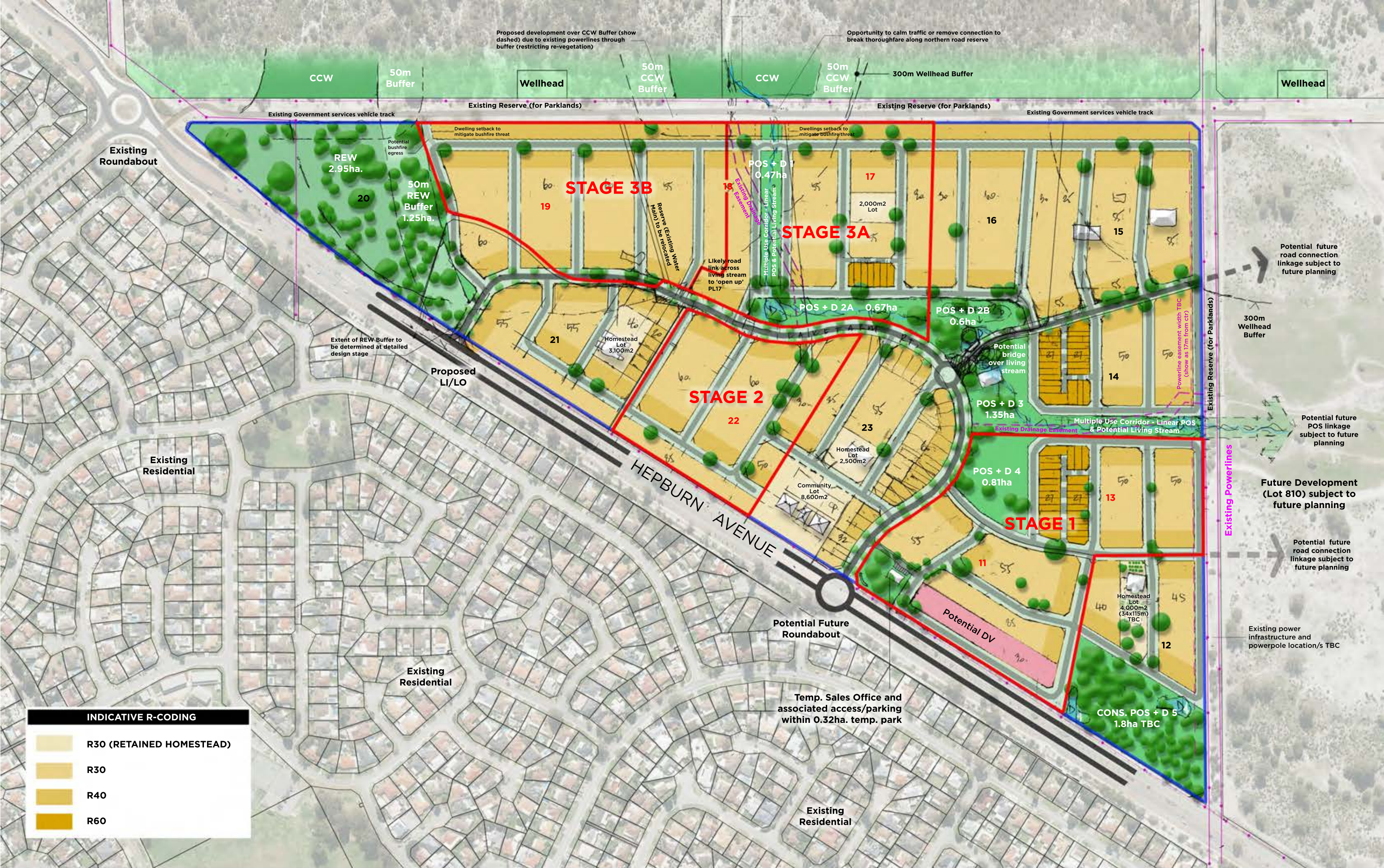


Photograph 9: Aerial view of the site

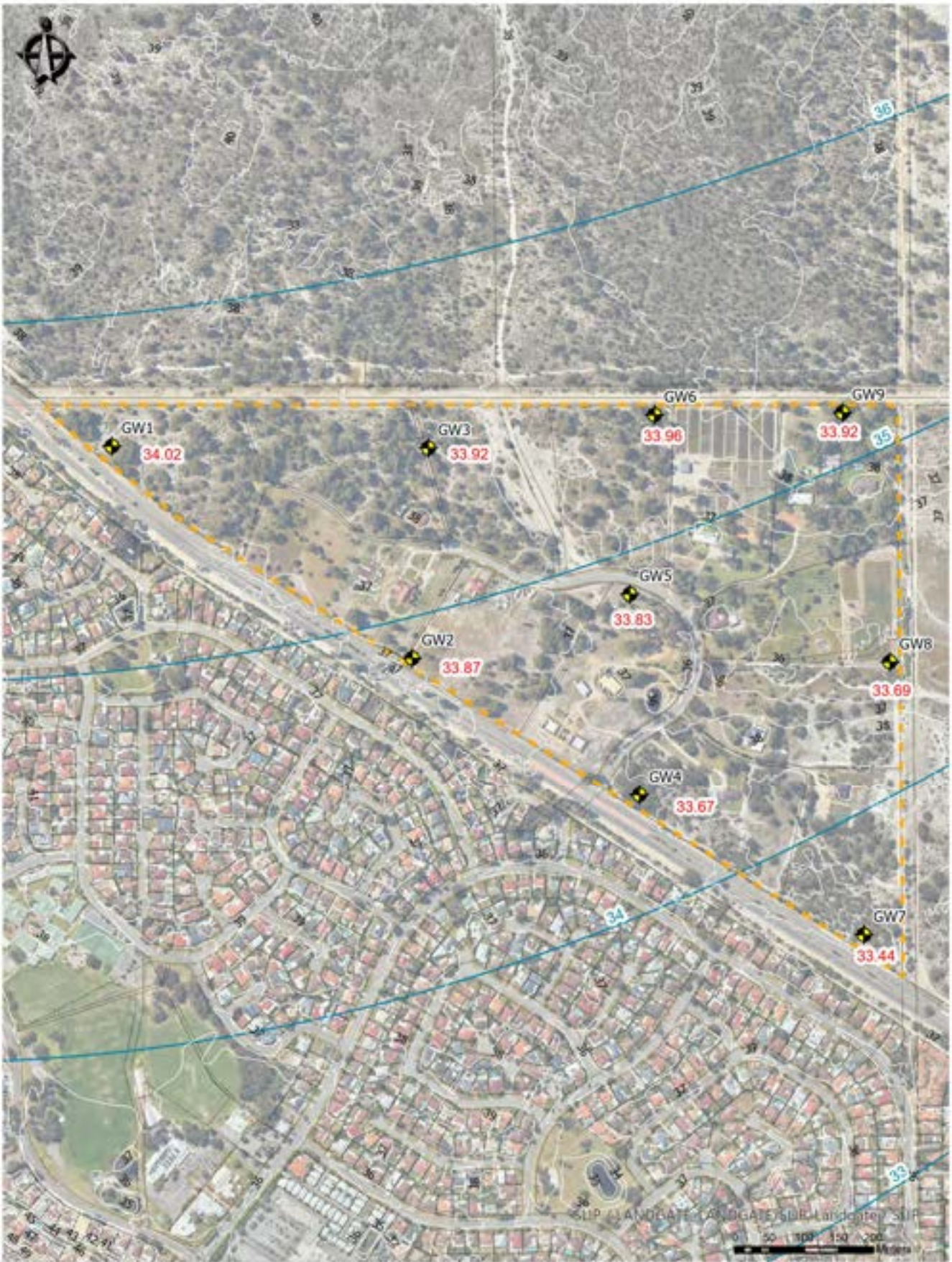


Appendix B: Supplied Information





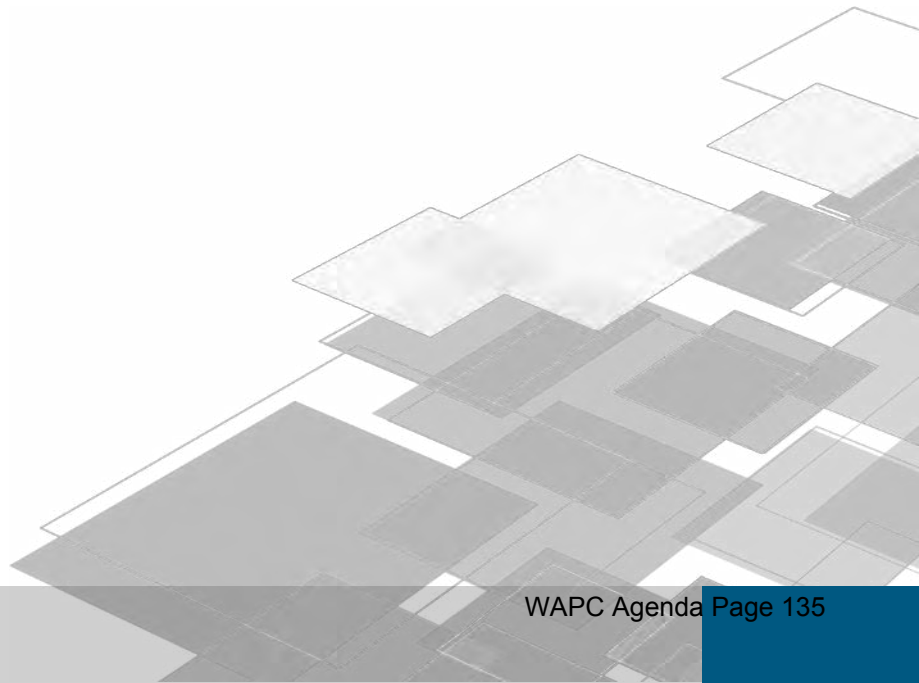
INDICATIVE R-CODING	
	R30 (RETAINED HOMESTEAD)
	R30
	R40
	R60



- Site
- Hyd2o July 2024 Readings (mAHD)
- DWER 2019 Groundwater Maximum (mAHD)
- DWER Topography Contours (m)

hyd2o
Lakefarm Retreat Ballajura LWMS
Groundwater Plan
Figure 1

Appendix C: Borehole Reports



METHOD OF SOIL DESCRIPTION BOREHOLE AND TEST PIT REPORTS



GRAPHIC LOG & SOIL CLASSIFICATION SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES / BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	GM	Silty GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

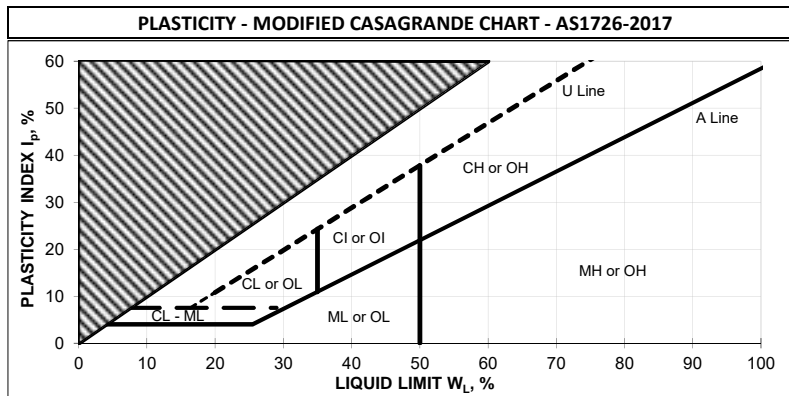
NOTE: Dual classification given for soils with a fines content between 5% and 12%.

SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-2017. Material properties are assessed in the field by visual/tactile methods in combination with field and laboratory testing techniques (where used).

NOTE: AS 1726-2017 defines a fine grained soil where the total dry mass of fine fractions (<0.075 mm particle size) exceeds 35%.

PARTICLE SIZE		
Soil Name	Particle Size (mm)	
BOULDERS	>200	
COBBLES	63 to 200	
GRAVEL	Coarse	19 to 63
	Medium	6.7 to 19
	Fine	2.3 to 6.7
SAND	Coarse	0.6 to 2.36
	Medium	0.21 to 0.6
	Fine	0.075 to 0.21
FINES	SILT	0.002 to 0.075
	CLAY	<0.002



RESISTANCE TO EXCAVATION		
Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

MOISTURE CONDITION	
Symbol	Term
D	Dry
M	Moist
W	Wet

CEMENTATION	
Cementation	Description
Weakly cemented	Soil may be easily disaggregated by hand in air or water
Moderately cemented	Effort is required to disaggregate the soil by hand in air or water

CONSISTENCY		
Symbol	Term	Undrained Shear Strength (kPa)
VS	Very Soft	0 to 12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very Stiff	100 to 200
H	Hard	>200

ORGANIC SOILS	
Material	Organic Content % of dry mass
Inorganic soil	<2%
Organic soil	2% to 25%
Peat	>25%

DENSITY		
Symbol	Term	Density Index (%)
VL	Very Loose	<15
L	Loose	15 to 35
MD	Medium Dense	35 to 65
D	Dense	65 to 85
VD	Very Dense	>85

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS



METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

▶	Water Inflow	▼	Water Level
◀	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

$$TCR = \text{Total Core Recovery (\%)} = \frac{CRL}{TCL} \times 100$$

$$RQD = \text{Rock Quality Designation (\%)} = \frac{ALC > 100}{TCL} \times 100$$

TCL Length of Core Run

CRL Length of Core Recovered

ALC>100 Total Length of Axial Lengths of Core Greater than 100 mm Long

Job Number: WAG240411-01	Contractor: GBI	Drill Rig: Melville	Date: 19/09/2024
Client: Landgroup WA	Location: Lakefarm Retreat, Ballajura	Inclination: -90°	Logged: PF
Project: Proposed Residential Subdivision			Checked Date: 02/10/2024
			Checked By: TM

Drilling			Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0				SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, grey, trace fines and roots			BH02/0.00	
			0.5					SAND: fine to medium grained, sub-angular to sub-rounded, pale grey, trace fines			BH02/0.50	
			1.0					Weakly cemented, brown Brown yellow/pale grey	D		BH02/1.00	
			1.5				SP				BH02/1.50	
			2.0								BH02/2.00	
			2.5								BH02/2.50	
			3.0						M - W		BH02/3.00	
			3.5					Hole terminated at 3.00 m Target depth Groundwater not encountered				

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions








GALT IUB 1.01.GLB Log GH EXCAVATION WAG240411-01.GPJ <<DrawingFile>> 08/10/2024 13:52 10.02.00.04 D:\galt\08_04_Drill\08_04_CPT_Photo_Monitoring_Tools | Lib: GALT 1.01 2019-02-21 Proj: GALT 1.01 2019-02-21

Job Number: WAG240411-01
Client: Landgroup WA
Project: Proposed Residential Subdivision

Contractor: GBI
Location: Lakefarm Retreat, Ballajura

Drill Rig: Melville
Inclination: -90°

Date: 19/09/2024
Logged: PF
Checked Date: 02/10/2024
Checked By: TM

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0				SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, grey/dark grey, trace fines, trace organics	D		BH03/0.00	0.00 : Small patches of grass and mature trees in surrounds
			0.5					SAND: fine to medium grained, sub-angular to sub-rounded, grey, trace fines			BH03/0.50	
			1.0					----- Becomes white	D - M		BH03/1.00	
			1.5								BH03/1.50	
			2.0				SP				BH03/2.00	
			2.5					----- Becomes pale grey/brown	M		BH03/2.50	
			3.0						M - W		BH03/3.00	
			3.5					Hole terminated at 3.00 m Target depth Groundwater not encountered				

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT IUB 1.01.GLB Log GH EXCAVATION WAG240411-01.GPJ <<DrawingFile>> 08/10/2024 13:52 10.02.00.04 D:\galt\08_04_Dragnet\08_04_CPT_Photo_Monitoring_Tools | Lib: GALT 1.01 2019-02-21 Proj: GALT 1.01 2019-02-21

Job Number: WAG240411-01	Contractor: GBI	Drill Rig: Melville	Date: 19/09/2024
Client: Landgroup WA	Location: Lakefarm Retreat, Ballajura	Inclination: -90°	Logged: PF
Project: Proposed Residential Subdivision			Checked Date: 02/10/2024
			Checked By: TM

Drilling			Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0				SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, grey/dark grey, trace fines, trace organics	D		BH04/0.00	0.00 : Surrounded by grass patches and mature trees
			0.5					SAND: fine to medium grained, sub-angular to sub-rounded, grey, trace fines Becomes white			BH04/0.50	
			1.0						D - M		BH04/1.00	
			1.5				SP	Becomes white/pale brown			BH04/1.50	
			2.0					Becomes brown, with gravel size weakly to moderately cemented sand			BH04/2.00	
			2.5						M		BH04/2.50	
			3.0					Becomes pale brown/grey	M - W		BH04/3.00	
			3.5					Hole terminated at 3.00 m Target depth Groundwater not encountered				

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT IUB 1.01.GLB Log GH EXCAVATION WAG240411-01.GPJ <<DrawingFile>> 08/10/2024 13:52 10.02.00.04 Dageel DGD CPT Photo Monitoring Tools | Lib: GALT 1.01 2019-02-21 Proj: GALT 1.01 2019-02-21

Job Number: WAG240411-01	Contractor: GBI	Drill Rig: Melville	Date: 19/09/2024
Client: Landgroup WA	Location: Lakefarm Retreat, Ballajura	Inclination: -90°	Logged: PF
Project: Proposed Residential Subdivision			Checked Date: 02/10/2024
			Checked By: TM

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0			SP	SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, pale grey, trace fines and roots			BH06/0.00	
			0.5			D	D	SAND: fine to medium grained, sub-angular to sub-rounded, pale grey, trace fines			BH06/0.50	
			1.0			D	D				BH06/1.00	
			1.5			SP	SP	----- Becoming grey at depths			BH06/1.50	
			2.0			M-W	M-W				BH06/2.00	
			2.5			M-W	M-W				BH06/2.50	
			3.0					Hole terminated at 3.00 m Target depth Groundwater not encountered			BH06/3.00	
			3.5									

Sketch & Other Observations









Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT IUB 1.01.GLB Log GH EXCAVATION WAG240411-01.GPJ <<DrawingFile>> 08/10/2024 13:52 10.02.00.04 D:\galt\08_04_Drill\08_04_CPT_Photo_Monitoring_Tools | Lib: GALT 1.01 2019-02-21 Proj: GALT 1.01 2019-02-21

Job Number: WAG240411-01	Contractor: GBI	Drill Rig: Melvelle	Date: 19/09/2024
Client: Landgroup WA	Location: Lakefarm Retreat, Ballajura	Inclination: -90°	Logged: PF
Project: Proposed Residential Subdivision			Checked Date: 02/10/2024
			Checked By: TM

Drilling				Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0				SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, dark grey, trace fines, trace organics	D		BH07/0.00	0.00 : Patches of grass on surface, surrounded by large mature trees
			0.5					SAND: fine to medium grained, sub-angular to sub-rounded, grey, trace fines Becomes white			BH07/0.50	
			1.0					Becomes grey Becomes dark brown, with gravel size weakly to moderately cemented sands (COFFEE ROCK)	D - M		BH07/1.00	
			1.5					Becomes brown mottled yellow			BH07/1.50	
			2.0				SP	Becomes white			BH07/2.00	
			2.5					Becomes pale grey/brown	M		BH07/2.50	
			3.0					Hole terminated at 3.00 m Target depth Groundwater not encountered	M - W		BH07/3.00	
			3.5									

Sketch & Other Observations

Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT IUS 1.01.GLB Log GH EXCAVATION WAG240411-01.GPJ <<DrawingFile>> 08/10/2024 13:52 10:02:00.04 D:\galt\08_04_Drill\08_04_CPT_Photo_Monitoring_Tools | Lib: GALT 1.01 2019-02-21 Proj: GALT 1.01 2019-02-21

Job Number: WAG240411-01	Contractor: GBI	Drill Rig: Melvelle	Date: 19/09/2024
Client: Landgroup WA	Location: Lakefarm Retreat, Ballajura	Inclination: -90°	Logged: PF
Project: Proposed Residential Subdivision			Checked Date: 02/10/2024
			Checked By: TM

Drilling			Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0				SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, pale grey-brown, trace fines and roots	D		BH08/0.00	0.00 : Grass patches on surace, surrounded by large mature trees
			0.5					SAND: fine to medium grained, sub-angular to sub-rounded, yellow, trace fines			BH08/0.50	
			1.0								BH08/1.00	
			1.5				SP		D - M		BH08/1.50	
			2.0					Becomes pale yellow/white			BH08/2.00	
			2.5					Becomes pale grey/brown			BH08/2.50	
			3.0					Becomes grey/brown	M		BH08/2.50	
								Becomes pale grey/brown				
								Becomes pale brown/yellow	M - W		BH08/3.00	
			3.5					Hole terminated at 3.00 m Target depth Groundwater not encountered				

Sketch & Other Observations



--	--

Comments: See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT IUB 1.01.GLB Log GH EXCAVATION WAG240411-01.GPJ <<DrawingFile>> 08/10/2024 13:52 10.02.00.04 D:\galt\08_04_Drill\08_04_CPT_Photo_Monitoring_Tools | Lib: GALT 1.01 2019-02-21 Proj: GALT 1.01 2019-02-21

Job Number: WAG240411-01	Contractor: GBI	Drill Rig: Melville	Date: 19/09/2024
Client: Landgroup WA	Location: Lakefarm Retreat, Ballajura	Inclination: -90°	Logged: PF
Project: Proposed Residential Subdivision			Checked Date: 02/10/2024
			Checked By: TM

Drilling			Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	SAMPLE	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0				SP	TOPSOIL: SAND, fine to medium grained, sub-angular to sub-rounded, pale brown, trace fines, trace organics	D		BH11/0.00	0.00 : Grass on surface
			0.5					SAND: fine to medium grained, sub-angular to sub-rounded, pale brown, trace fines			BH11/0.50	
			1.0						D - M		BH11/1.00	
			1.5				SP	Gravel size weakly to moderately cemented sand (COFFEE ROCK)			BH11/1.50	
			2.0								BH11/2.00	
			2.5						M		BH11/2.50	
			3.0						M - W		BH11/3.00	
			3.5					Hole terminated at 3.00 m Target depth Groundwater not encountered				

Sketch & Other Observations

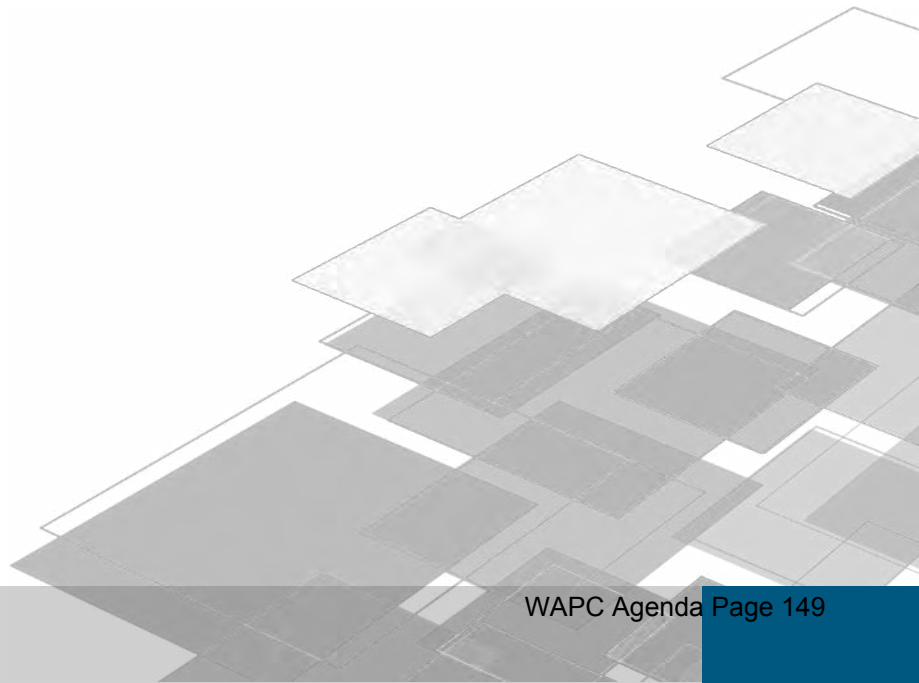


Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT IUB 1.01.GLB Log GH EXCAVATION WAG240411-01.GPJ <<DrawingFile>> 08/10/2024 13:53 10:02:00.04 D:\galt\08_04_Dragnet\08_04_CPT_Photo_Monitoring_Tools\IUB_GALT 1.01 2019-02-21.Pjt GALT 1.01 2019-02-21

Appendix D: DPSH Test Results



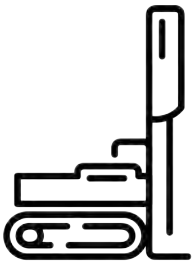
Sounding : DPSH01
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 395623 | 6477959
 Altitude : 33.8 m
 Tracking :

Test

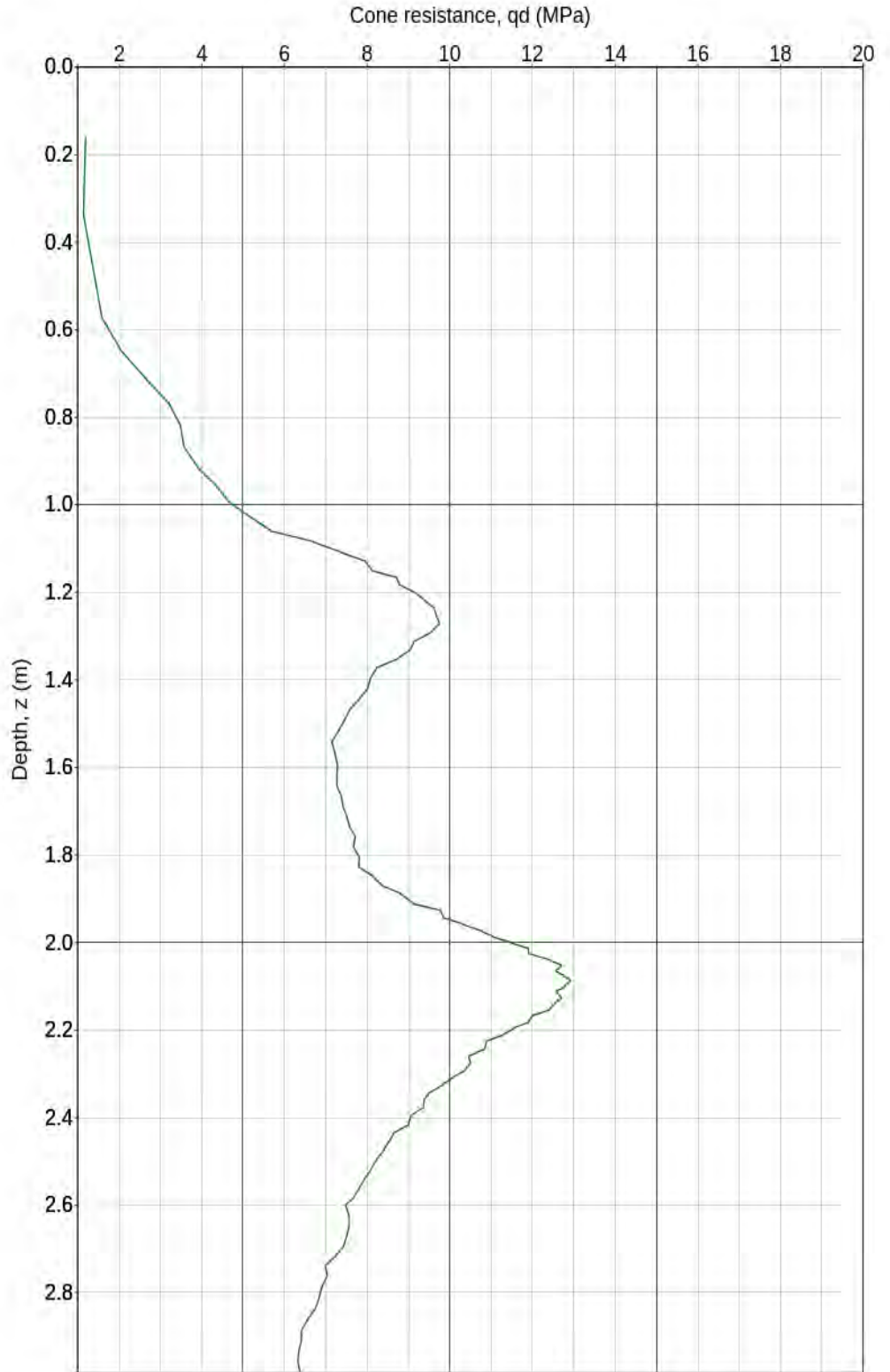
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.01 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 2.4m

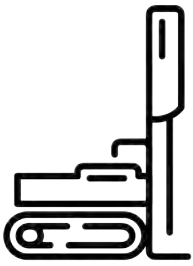
Sounding : DPSH02
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 395768 | 6477850
 Altitude : 36.7 m
 Tracking :

Test

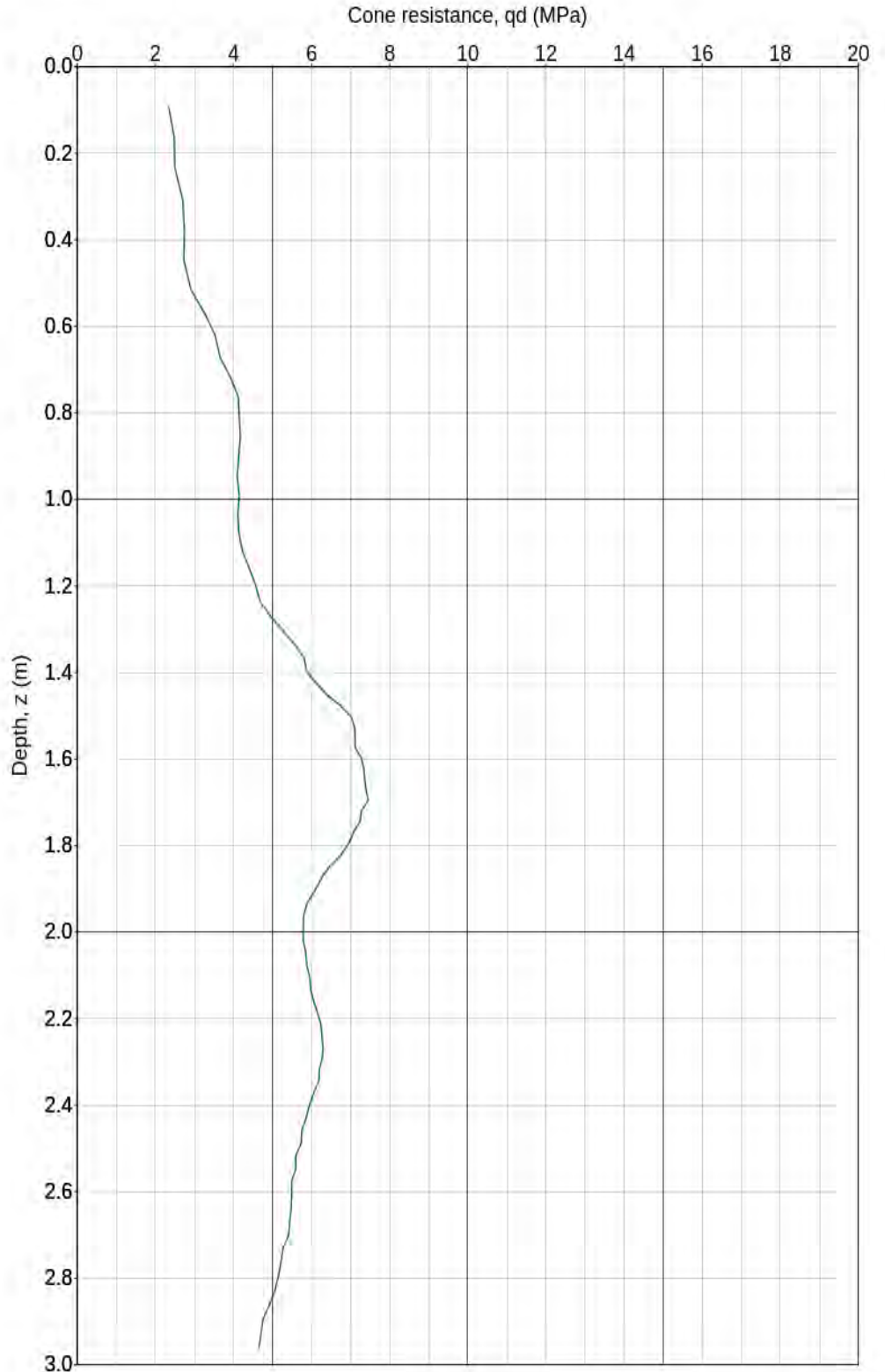
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.02 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 2.5m

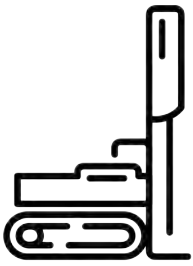
Sounding : DPSH03
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 395941 | 6477941
 Altitude : 36.3 m
 Tracking :

Test

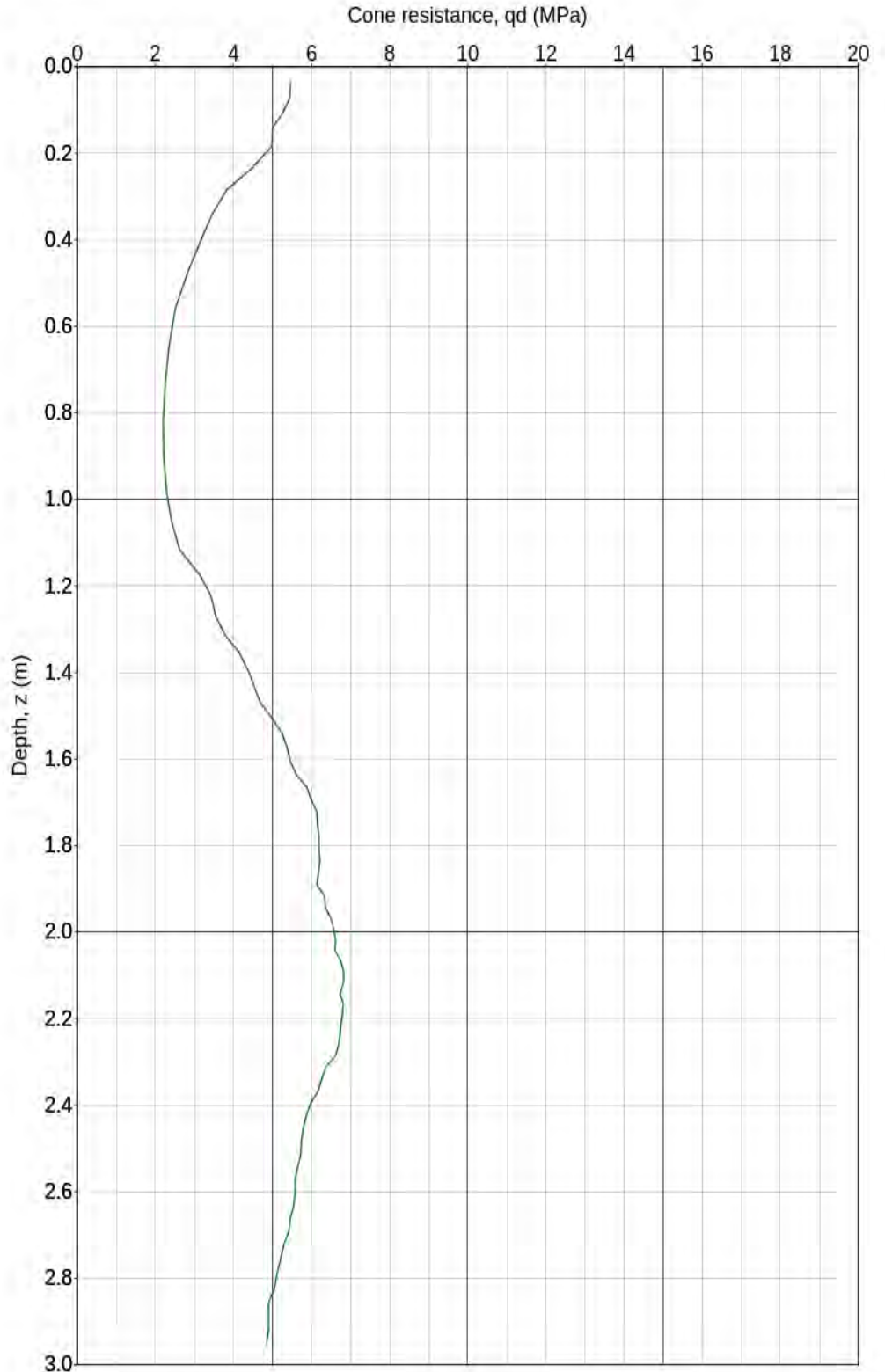
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.02 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 2.5m

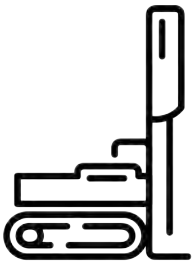
Sounding : DPSH04
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 396083 | 6477863
 Altitude : 37.5 m
 Tracking :

Test

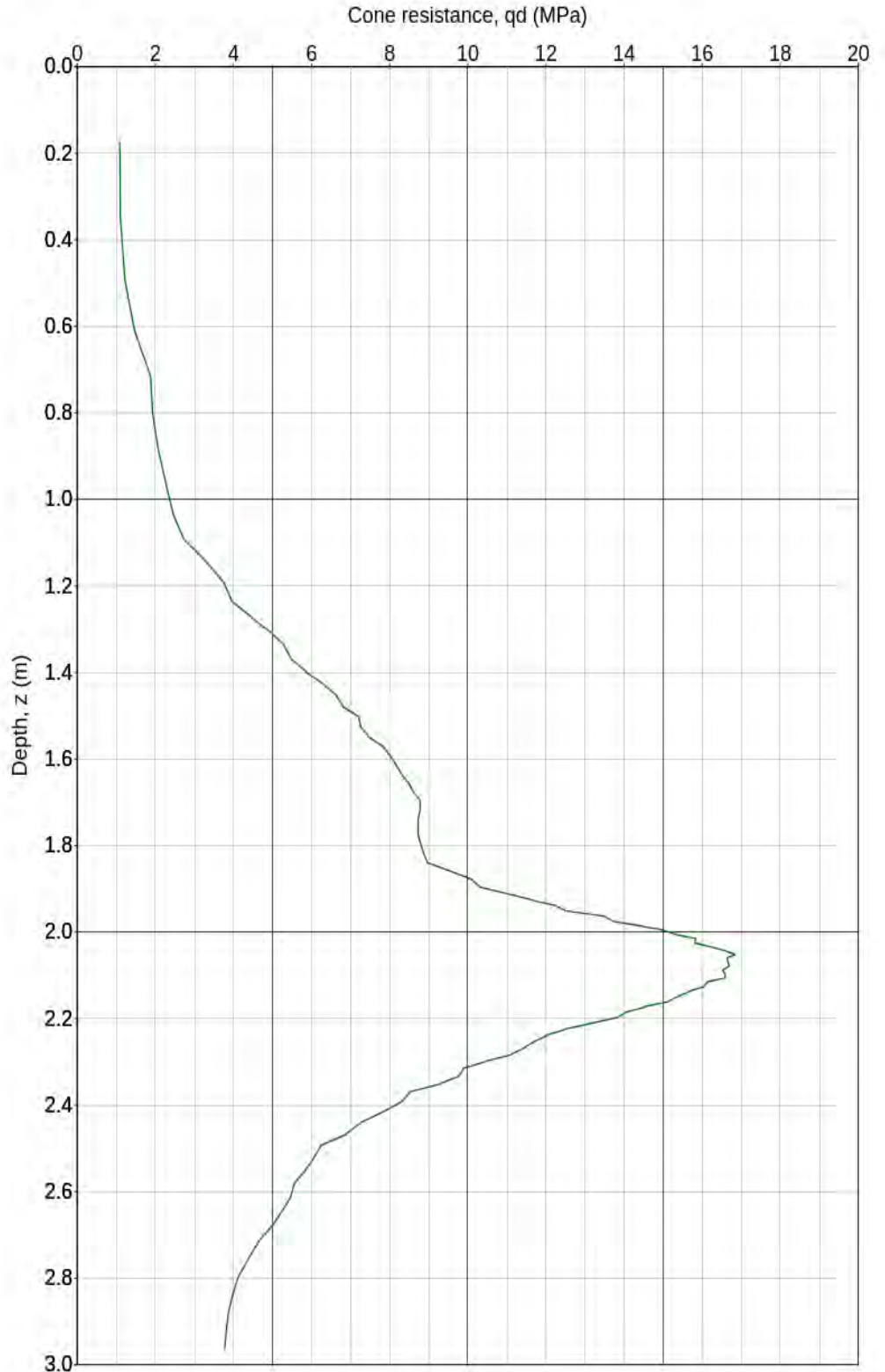
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.0 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 2.3m

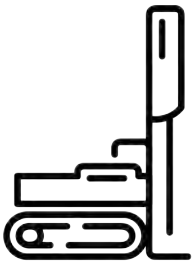
Sounding : DPSH05
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 396368 | 6477553
 Altitude : 35.3 m
 Tracking :

Test

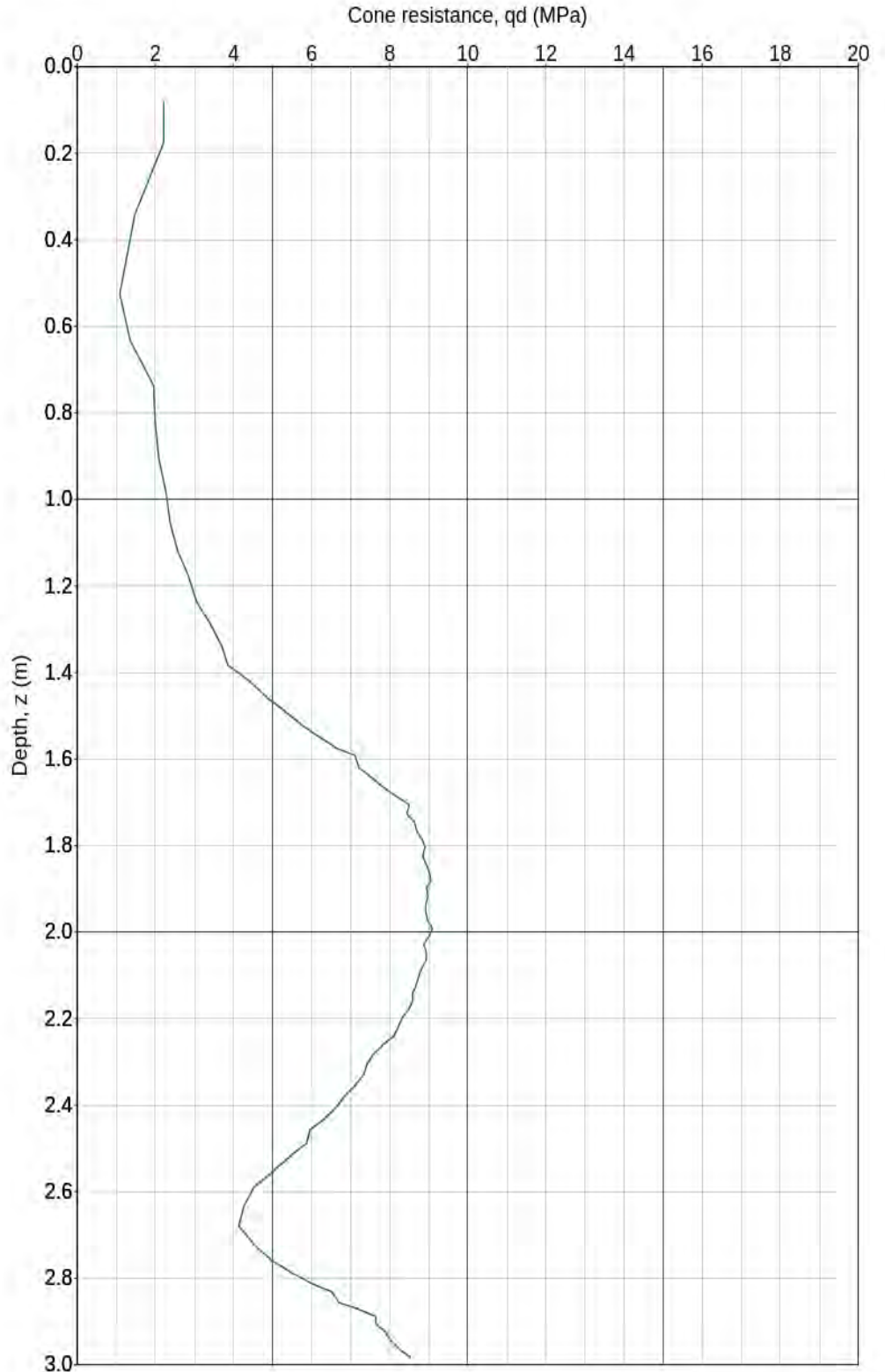
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.01 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 1.6m

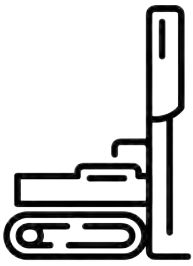
Sounding : DPSH06
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 396226 | 6477576
 Altitude : 41.1 m
 Tracking :

Test

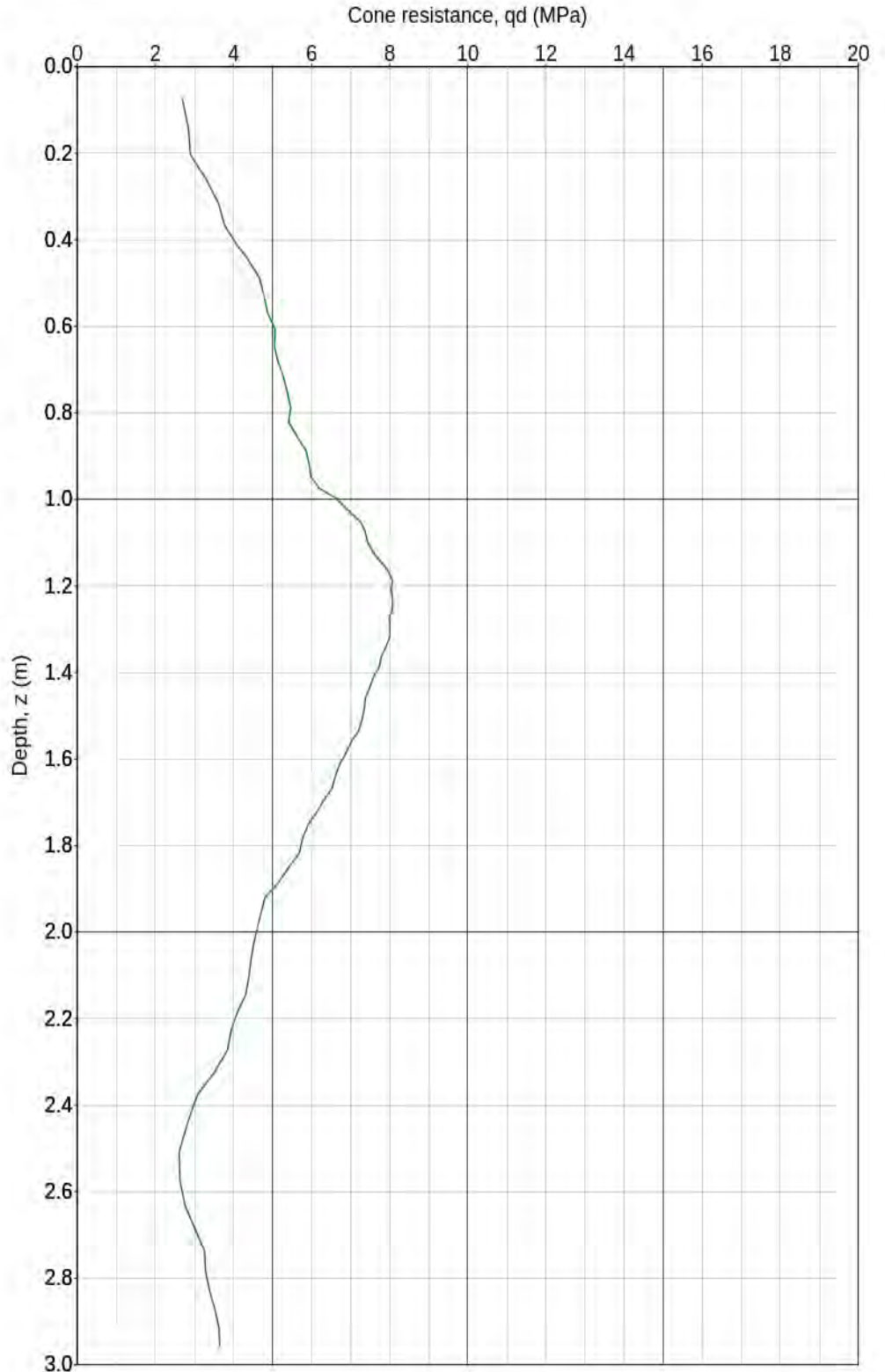
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.03 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 1.4m

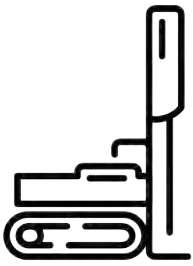
Sounding : DPSH07
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 396248 | 6477416
 Altitude : 34.4 m
 Tracking :

Test

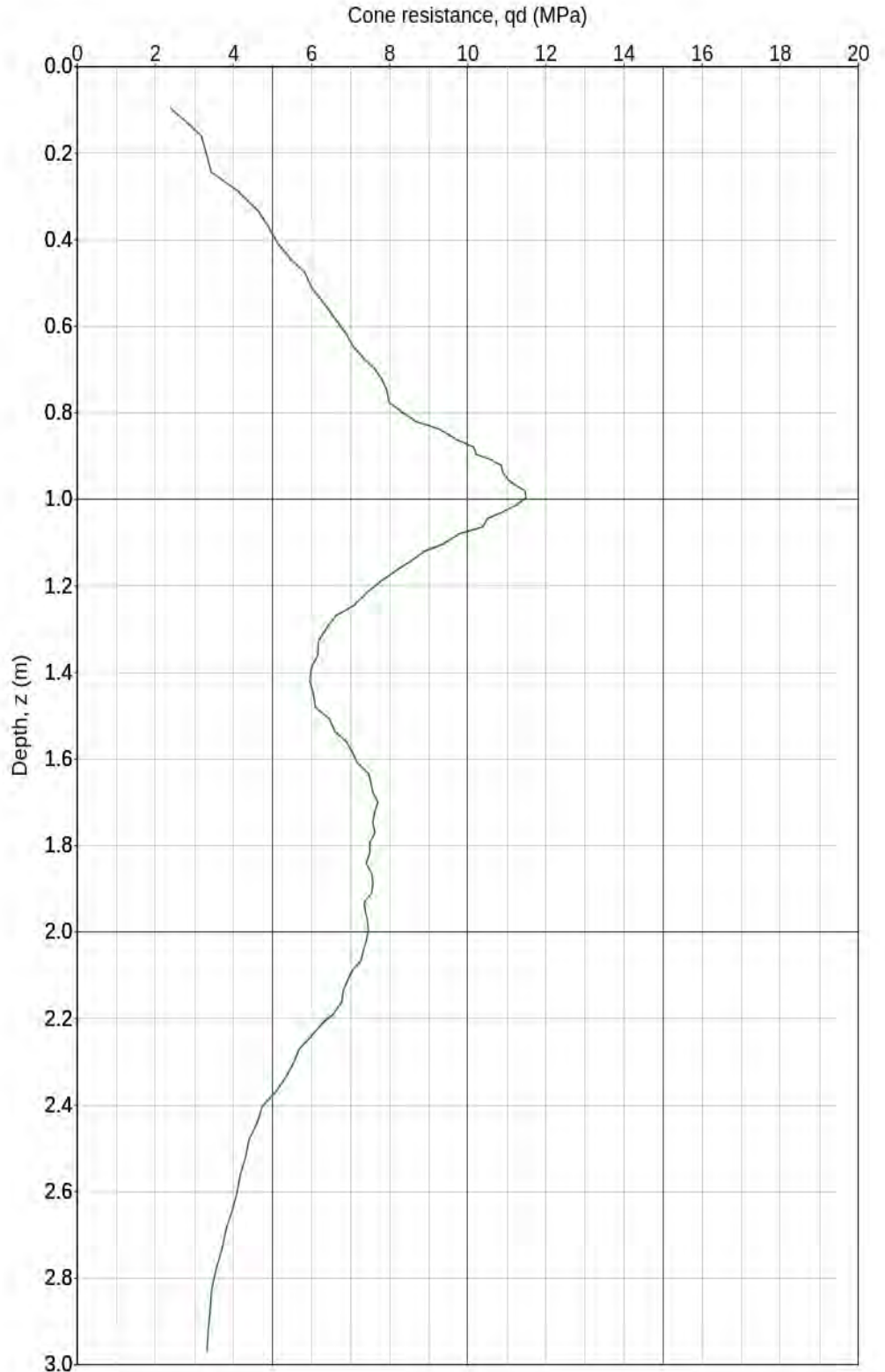
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.01 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 1.6m

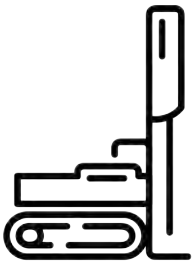
Sounding : DPSH08
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 396075 | 6477501
 Altitude : 39.4 m
 Tracking :

Test

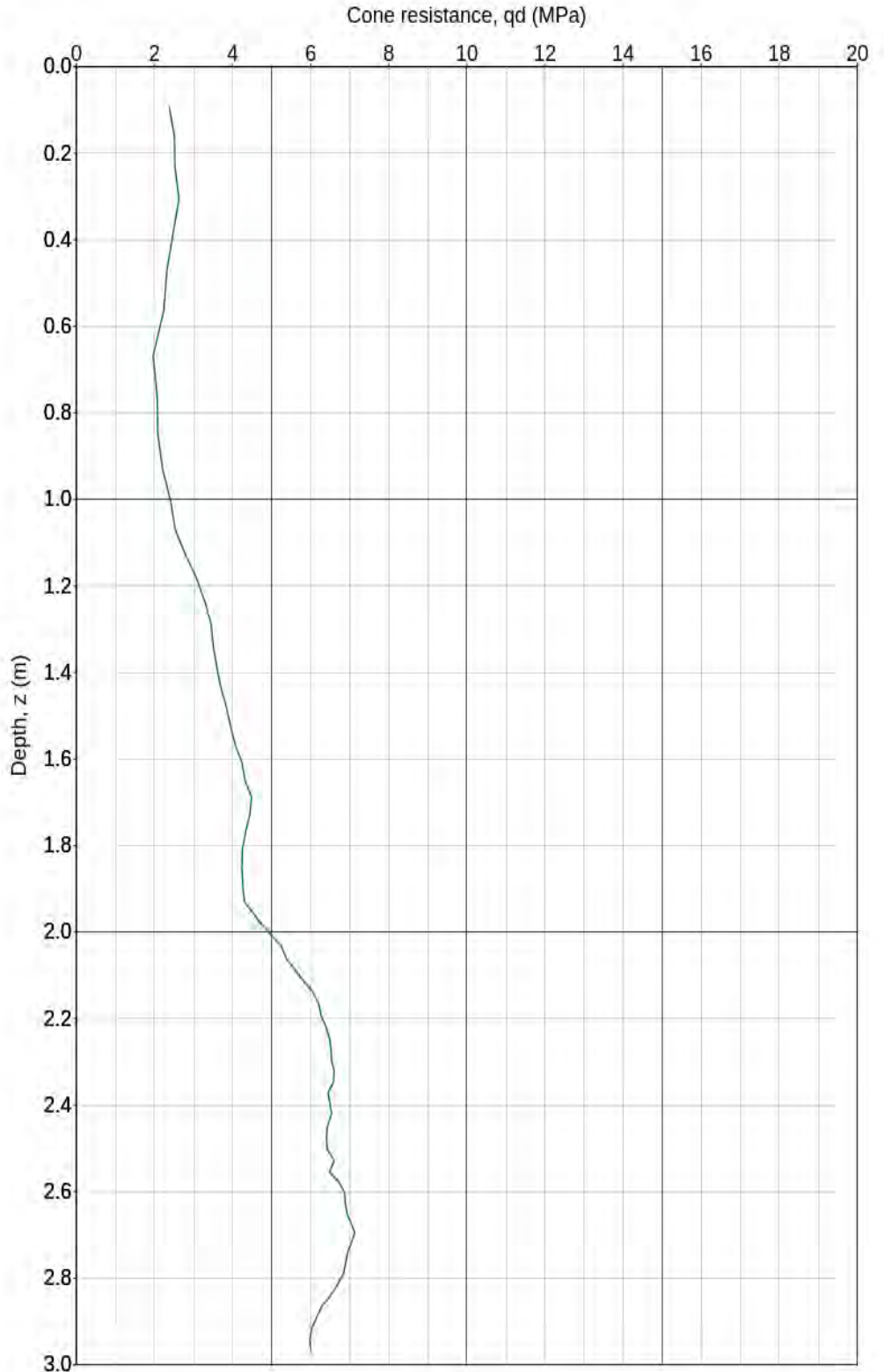
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.02 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 2.0m

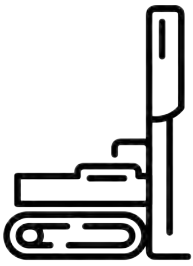
Sounding : DPSH09
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 395960 | 6477718
 Altitude : 36.3 m
 Tracking :

Test

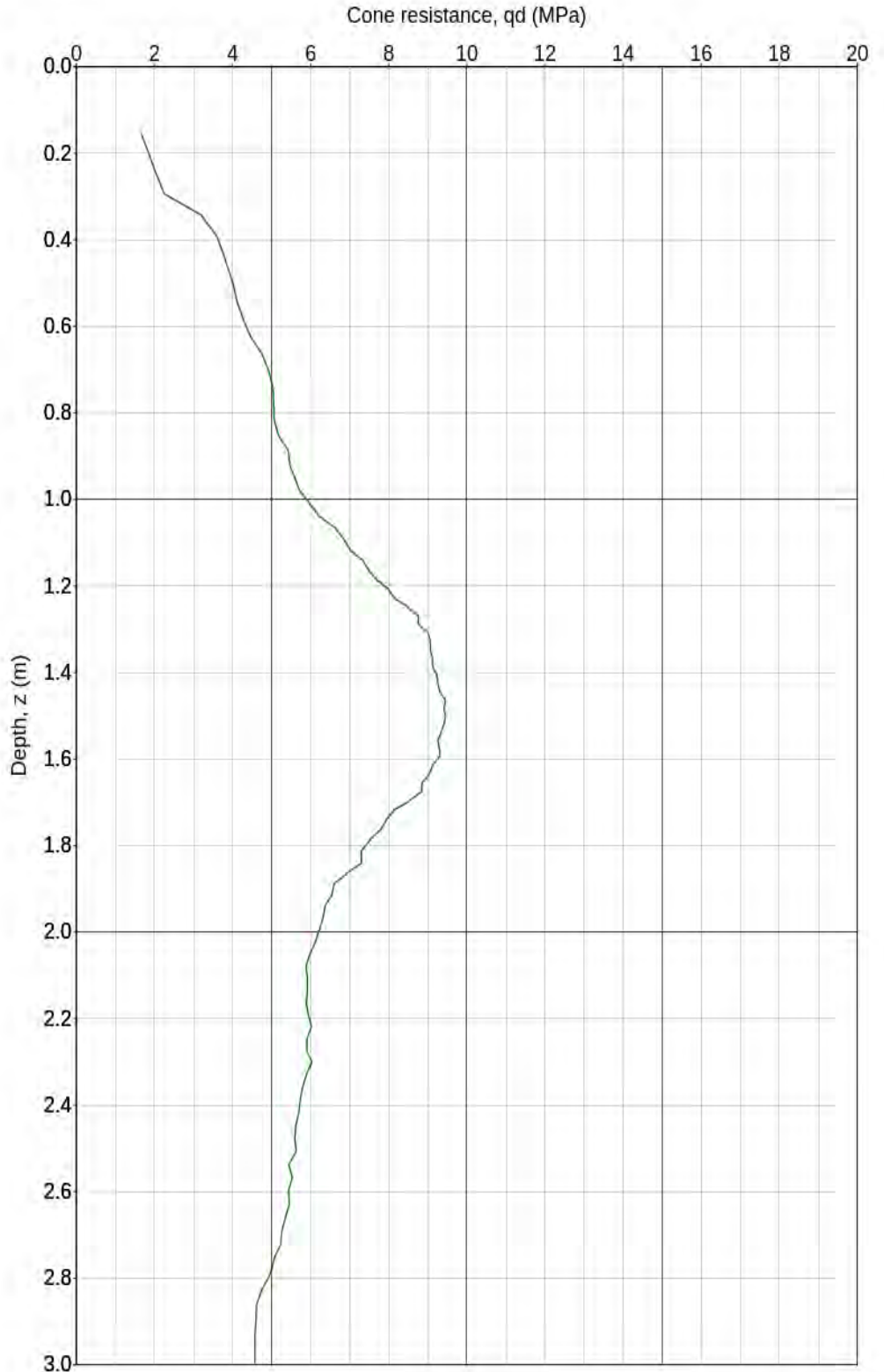
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.03 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 1.9m

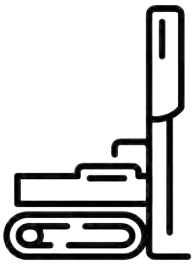
Sounding : DPSH10
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 395773 | 6477669
 Altitude : 37.4 m
 Tracking :

Test

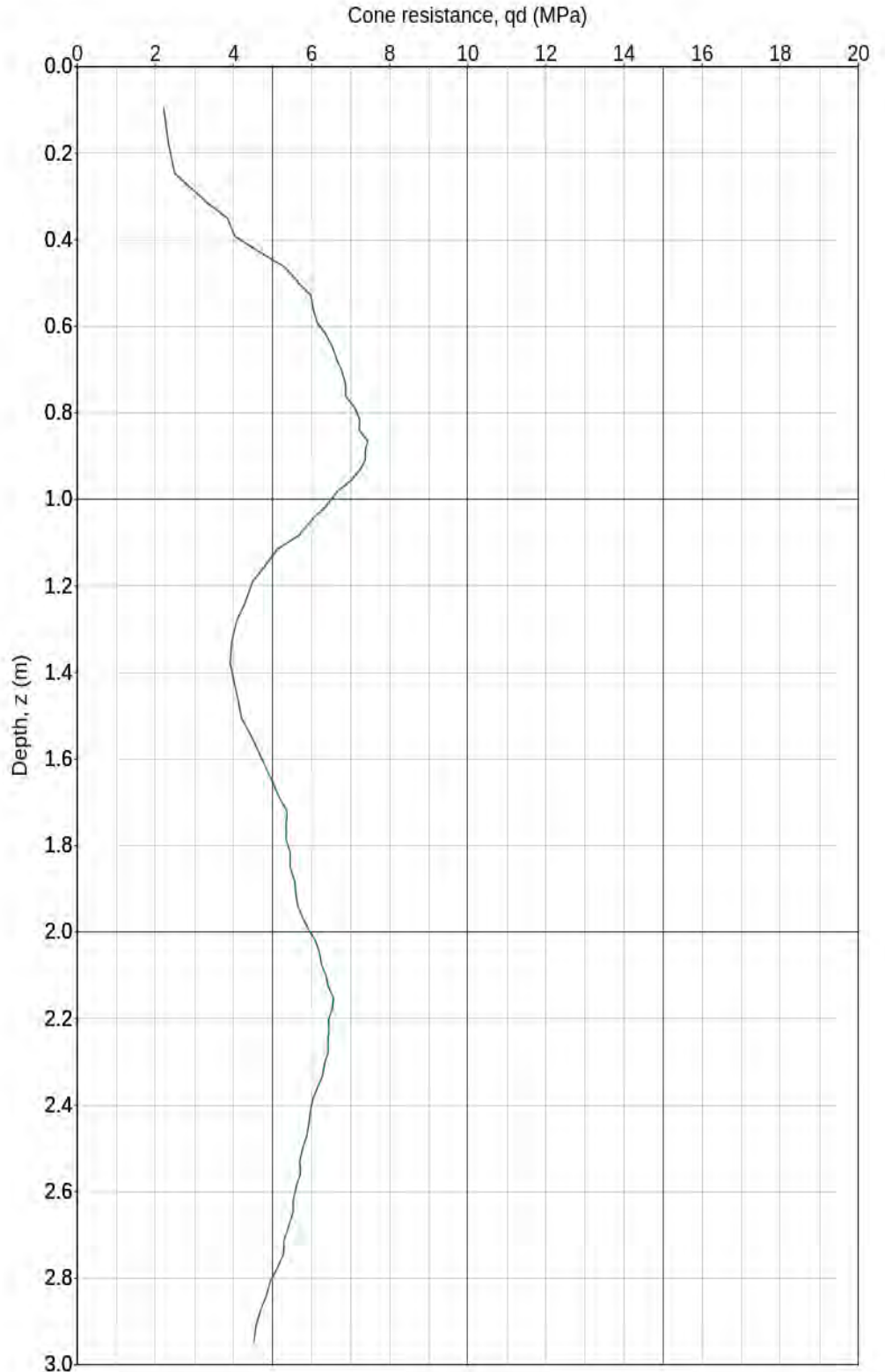
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.02 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 2.1m

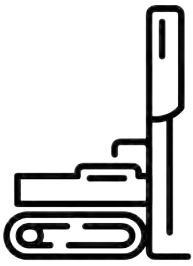
Sounding : DPSH11
 Site : WAG240411-01 BALLAJU
 Date : 20/09/2024 00:00
 Company : Groundbreaking Inves
 User : Chris Harkin
 Supervisor : MS
 UTM area : 50J
 UTM E,N : 396296 | 6477650
 Altitude : 35.0 m
 Tracking :

Test

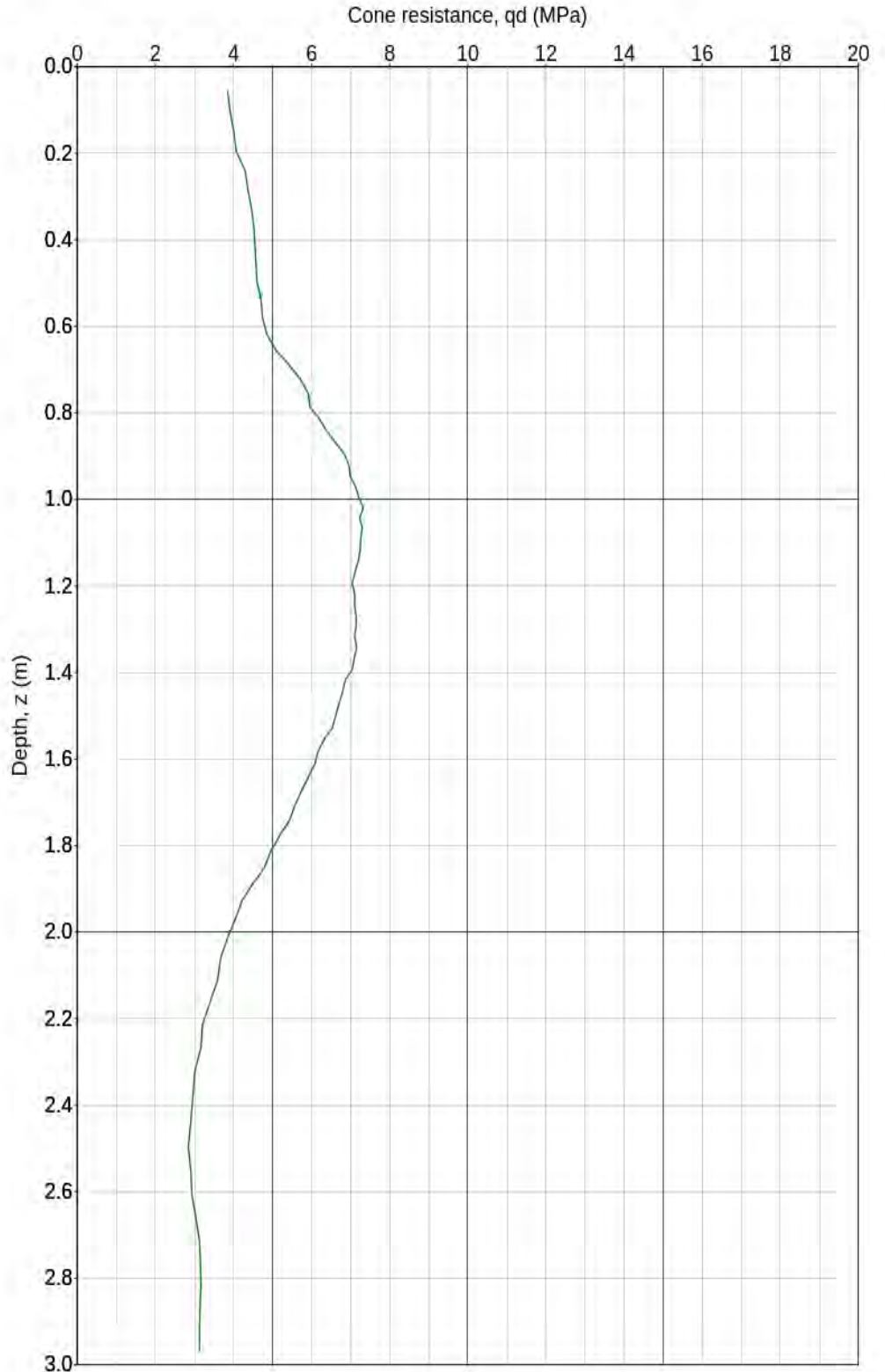
Target depth : 3.0 m
 Pre-drilling depth :
 Stop condition : Temporary
 Reached depth : 3.02 m
 Water table : Not found
 Stable level :
 Unstable level :

Characteristics

Device type : Grizzly
 Hammering mode : 63.5 kg
 Cone section : 20 cm²



GRIZZLY®



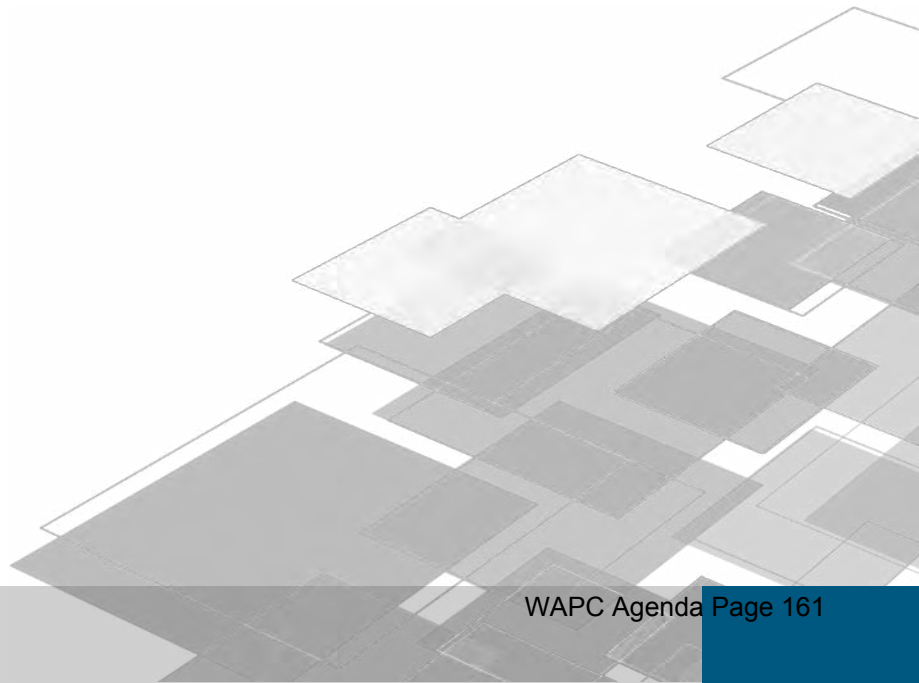
Processing

Smoothing step : 100 mm
 Regularization step : 1 mm
 Clipping : No

Observation

Target Depth 3m. Dry @ 1.6m

Appendix E: Infiltration Test Results



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

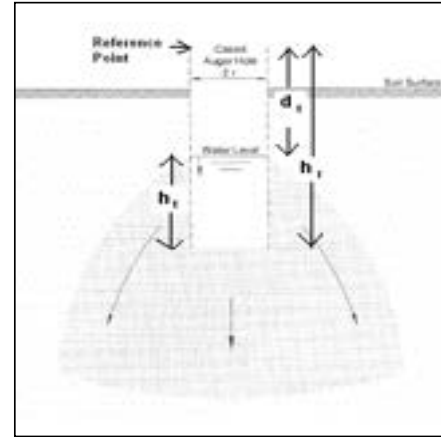
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT01	Parameter	Description	Value	Units
Test Depth:	0.550	K	Hydraulic Conductivity		m/s
		r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	0.67	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.49	0.18		
20	0.555	0.115	4.4E-04	37.6
40	0.595	0.075	4.1E-04	35.5
60	0.63	0.04	4.4E-04	38.0
AVERAGE			4.3E-04	37.0

Test 2

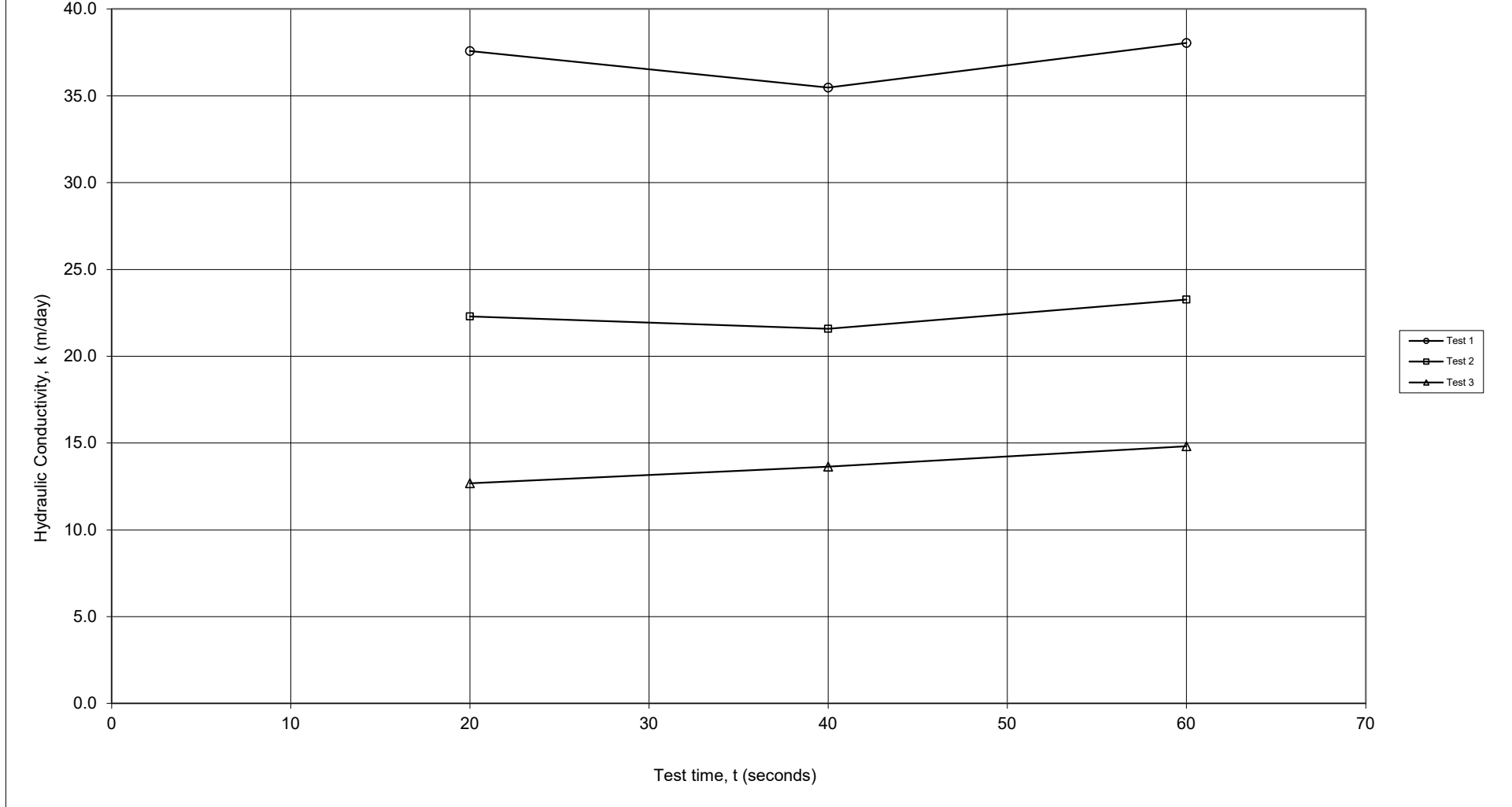
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.595	0.075		
20	0.615	0.055	2.6E-04	22.3
40	0.63	0.04	2.5E-04	21.6
60	0.645	0.025	2.7E-04	23.3
AVERAGE			2.6E-04	22.4

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.57	0.1		
20	0.585	0.085	1.5E-04	12.7
40	0.6	0.07	1.6E-04	13.6
60	0.615	0.055	1.7E-04	14.8
AVERAGE			1.6E-04	13.7

Hydraulic Conductivity by Inverse Auger Hole Method

IT01



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

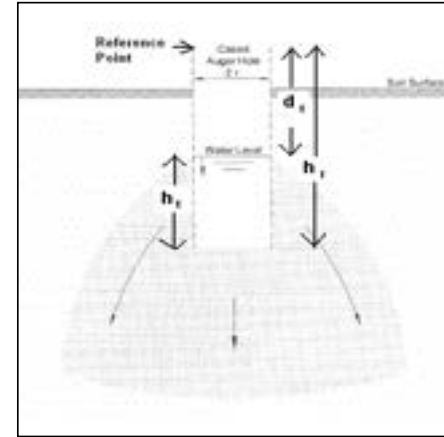
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT01	Parameter	Description	Value	Units
Test Depth:	1.685	K	Hydraulic Conductivity		m/s
		r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	1.745	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.708	0.037		
20	1.712	0.033	7.8E-05	6.8
40	1.718	0.027	1.0E-04	8.9
60	1.722	0.023	1.0E-04	8.7
80	1.727	0.018	1.1E-04	9.3
AVERAGE			9.8E-05	8.4

Test 2

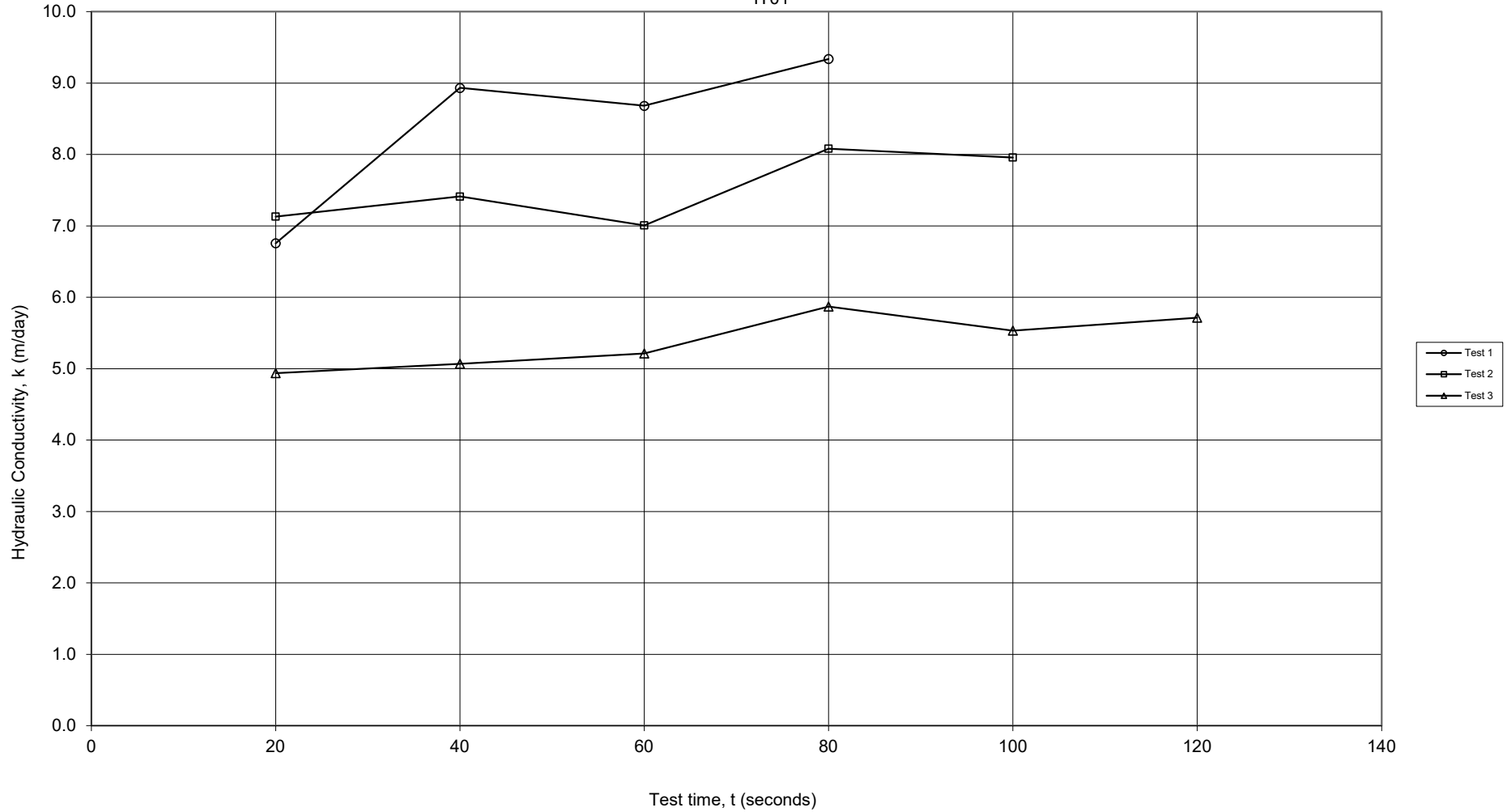
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.711	0.034		
20	1.715	0.03	8.3E-05	7.1
40	1.719	0.026	8.6E-05	7.4
60	1.722	0.023	8.1E-05	7.0
80	1.727	0.018	9.4E-05	8.1
100	1.73	0.015	9.2E-05	8.0
AVERAGE			8.7E-05	7.5

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.707	0.038		
20	1.71	0.035	5.7E-05	4.9
40	1.713	0.032	5.9E-05	5.1
60	1.716	0.029	6.0E-05	5.2
80	1.72	0.025	6.8E-05	5.9
100	1.722	0.023	6.4E-05	5.5
120	1.725	0.02	6.6E-05	5.7
AVERAGE			6.2E-05	5.4

Hydraulic Conductivity by Inverse Auger Hole Method

IT01



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

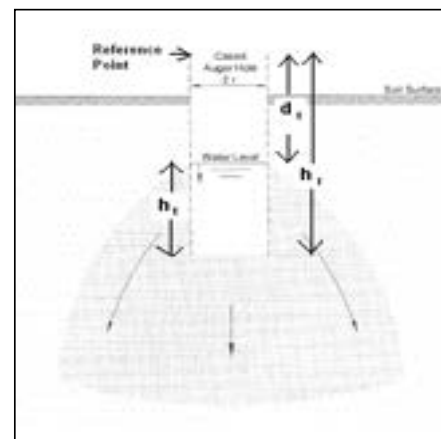
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT02	Parameter	Description	Value	Units
Test Depth:	0.630	K	Hydraulic Conductivity		m/s
Spreadsheet Legend		r	radius of test hole	0.045	m
	Required input	t	time since start of measurement		s
	Calculated field	h _r	reference point height above base	0.66	m
	Comment field	d _t	depth from reference point to water at time t		m
	Field not used	h _t	Water column height at time t		m
	Fixed field	h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.49	0.17		
20	0.56	0.1	5.1E-04	43.9
40	0.61	0.05	5.5E-04	47.4
60	0.635	0.025	5.2E-04	45.3
AVERAGE			5.3E-04	45.5

Test 2

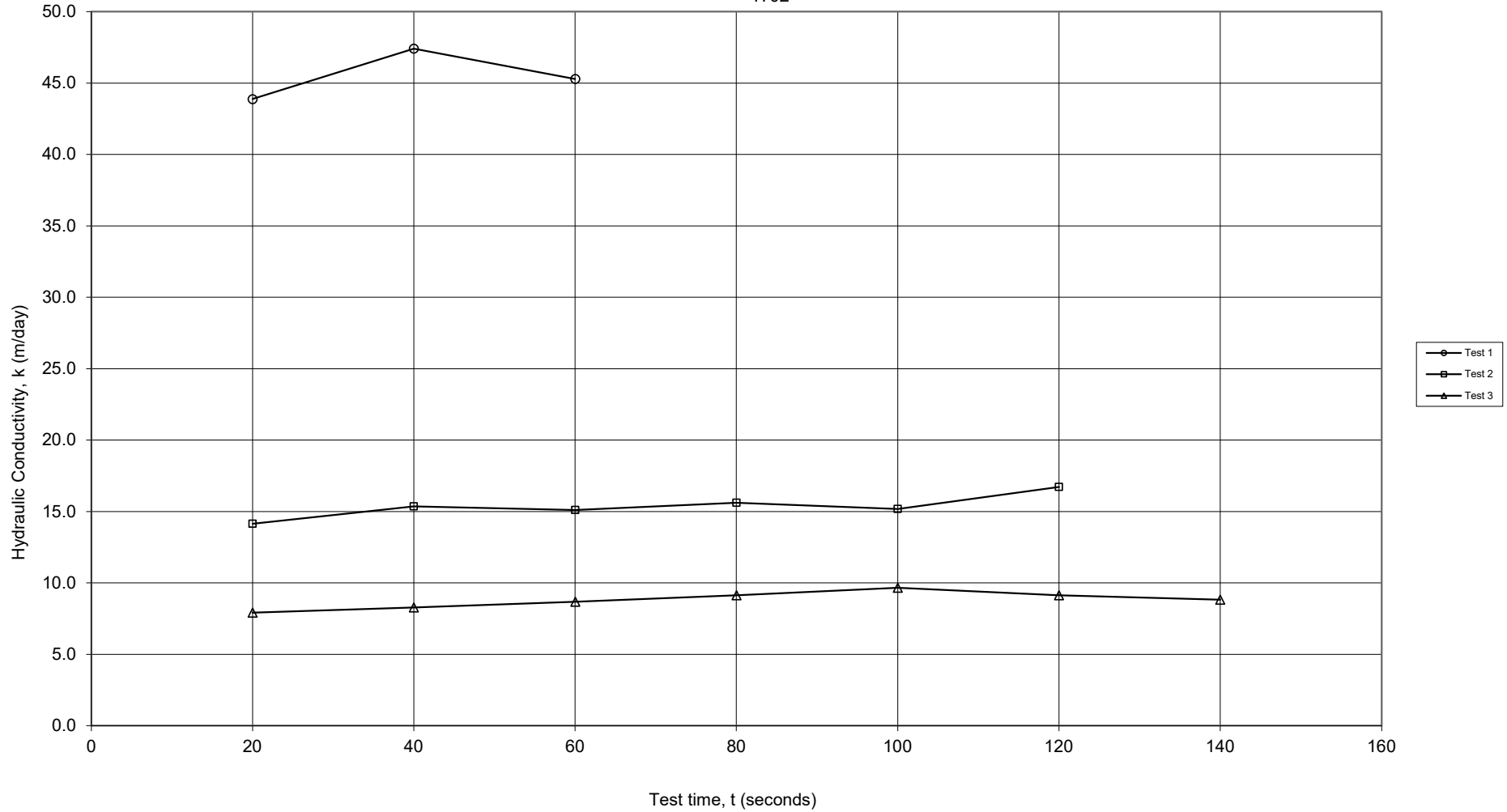
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.535	0.125		
20	0.555	0.105	1.6E-04	14.1
40	0.575	0.085	1.8E-04	15.4
60	0.59	0.07	1.7E-04	15.1
80	0.605	0.055	1.8E-04	15.6
100	0.615	0.045	1.8E-04	15.2
120	0.63	0.03	1.9E-04	16.7
AVERAGE			1.8E-04	15.4

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.555	0.105		
20	0.565	0.095	9.2E-05	7.9
40	0.575	0.085	9.6E-05	8.3
60	0.585	0.075	1.0E-04	8.7
80	0.595	0.065	1.1E-04	9.1
100	0.605	0.055	1.1E-04	9.7
120	0.61	0.05	1.1E-04	9.1
140	0.615	0.045	1.0E-04	8.8
AVERAGE			1.0E-04	8.8

Hydraulic Conductivity by Inverse Auger Hole Method

IT02



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

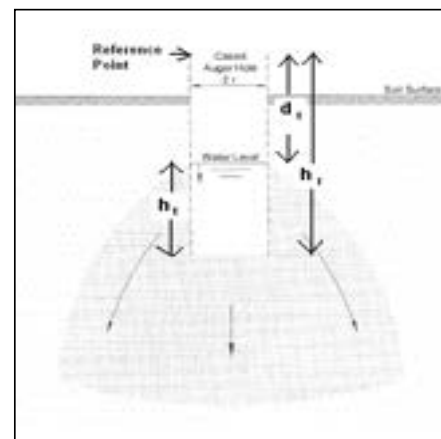
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT02	Parameter	Description	Value	Units
Test Depth:	1.565	K	Hydraulic Conductivity		m/s
		r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	1.645	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.55	0.095		
20	1.58	0.065	3.3E-04	28.6
40	1.605	0.04	3.5E-04	30.6
60	1.62	0.025	3.4E-04	29.3
80	1.635	0.01	3.6E-04	31.2
AVERAGE			3.5E-04	29.9

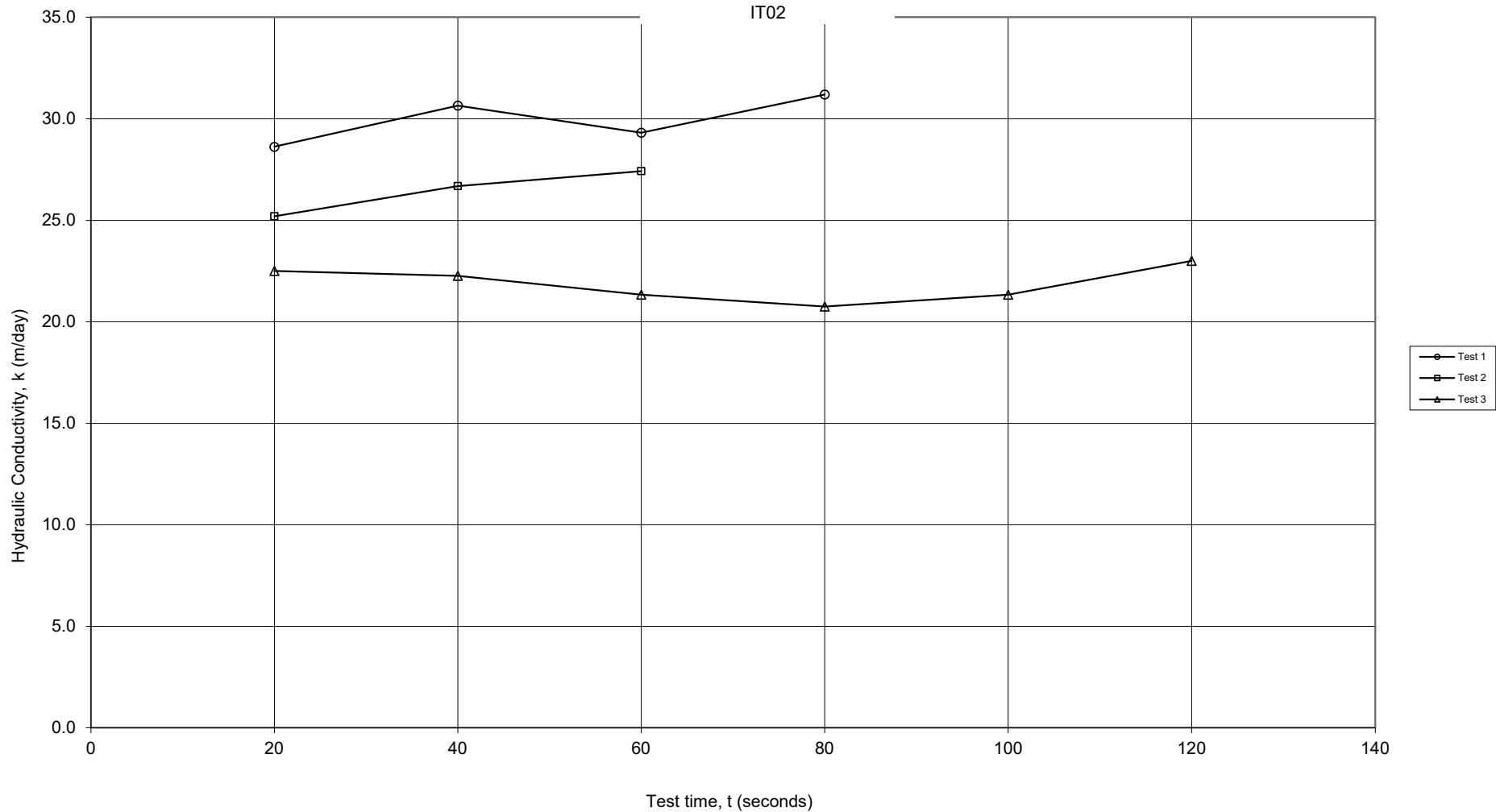
Test 2

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.58	0.065		
20	1.6	0.045	2.9E-04	25.2
40	1.617	0.028	3.1E-04	26.7
60	1.63	0.015	3.2E-04	27.4
AVERAGE			3.1E-04	26.4

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.45	0.195		
20	1.495	0.15	2.6E-04	22.5
40	1.53	0.115	2.6E-04	22.3
60	1.555	0.09	2.5E-04	21.3
80	1.575	0.07	2.4E-04	20.8
100	1.595	0.05	2.5E-04	21.3
120	1.615	0.03	2.7E-04	23.0
AVERAGE			2.5E-04	21.9

Hydraulic Conductivity by Inverse Auger Hole Method



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

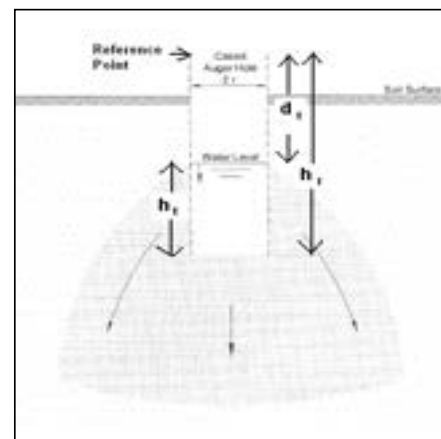
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT03	Parameter	Description	Value	Units
Test Depth:	0.84	K	Hydraulic Conductivity		m/s
	m	r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	0.87	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.675	0.195		
20	0.745	0.125	4.4E-04	37.7
40	0.795	0.075	4.5E-04	39.0
60	0.83	0.04	4.7E-04	40.4
AVERAGE			4.5E-04	39.0

Test 2

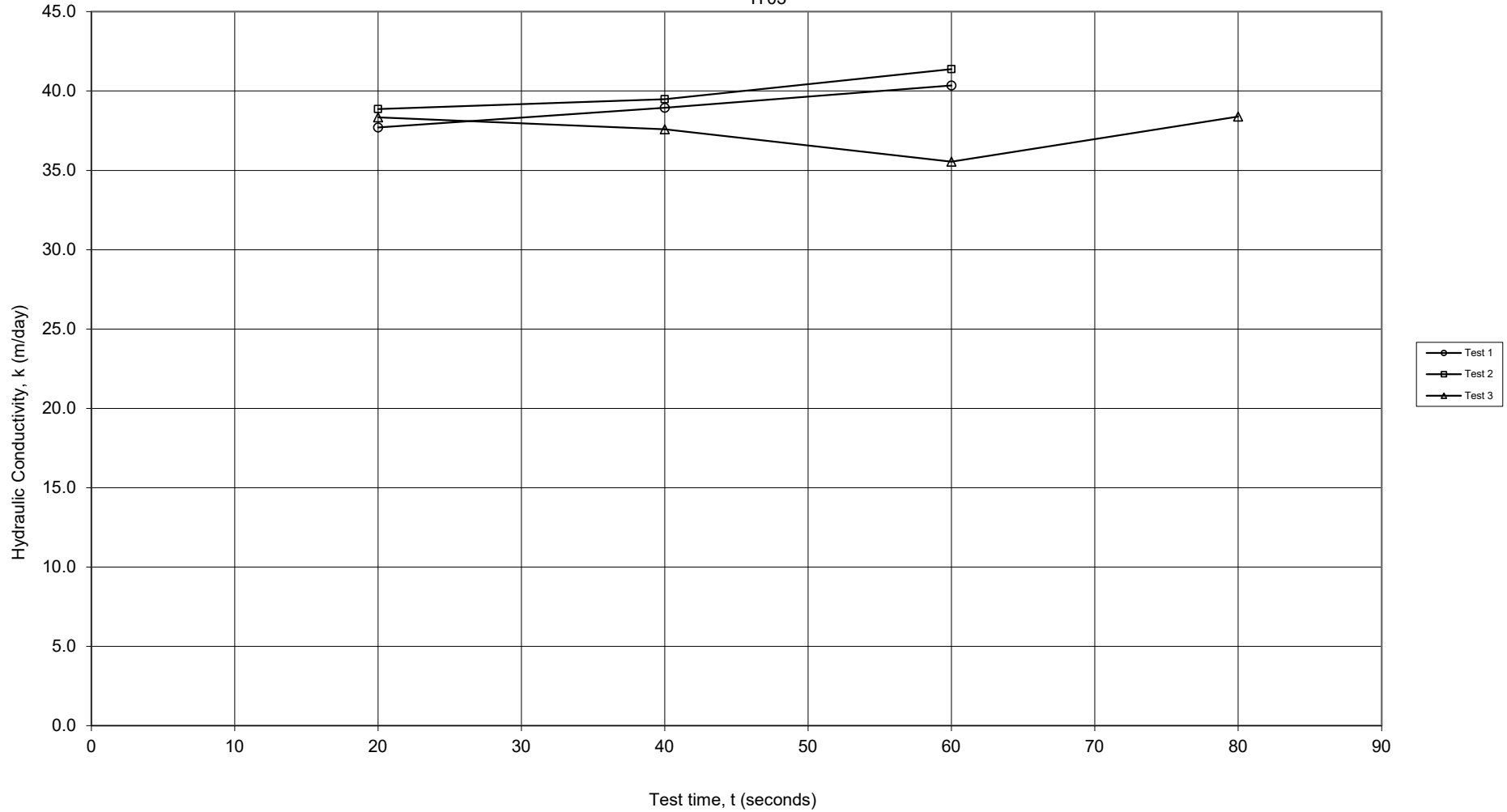
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.65	0.22		
20	0.73	0.14	4.5E-04	38.9
40	0.785	0.085	4.6E-04	39.5
60	0.825	0.045	4.8E-04	41.4
AVERAGE			4.6E-04	39.9

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.54	0.33		
20	0.655	0.215	4.4E-04	38.3
40	0.73	0.14	4.4E-04	37.6
60	0.775	0.095	4.1E-04	35.6
80	0.82	0.05	4.4E-04	38.4
AVERAGE			4.3E-04	37.5

Hydraulic Conductivity by Inverse Auger Hole Method

IT03



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

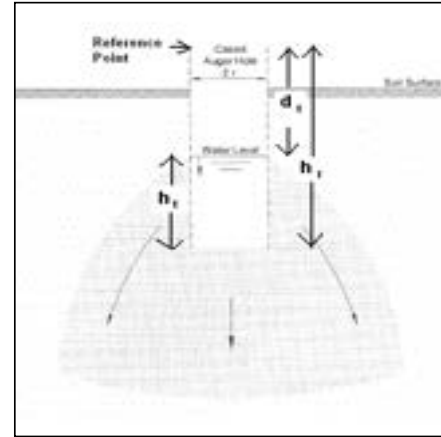
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT04	Parameter	Description	Value	Units
Test Depth:	0.82	K	Hydraulic Conductivity		m/s
	m	r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	0.87	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.71	0.16		
20	0.77	0.1	4.5E-04	38.7
40	0.815	0.055	4.8E-04	41.6
60	0.84	0.03	4.7E-04	40.3
AVERAGE			4.7E-04	40.2

Test 2

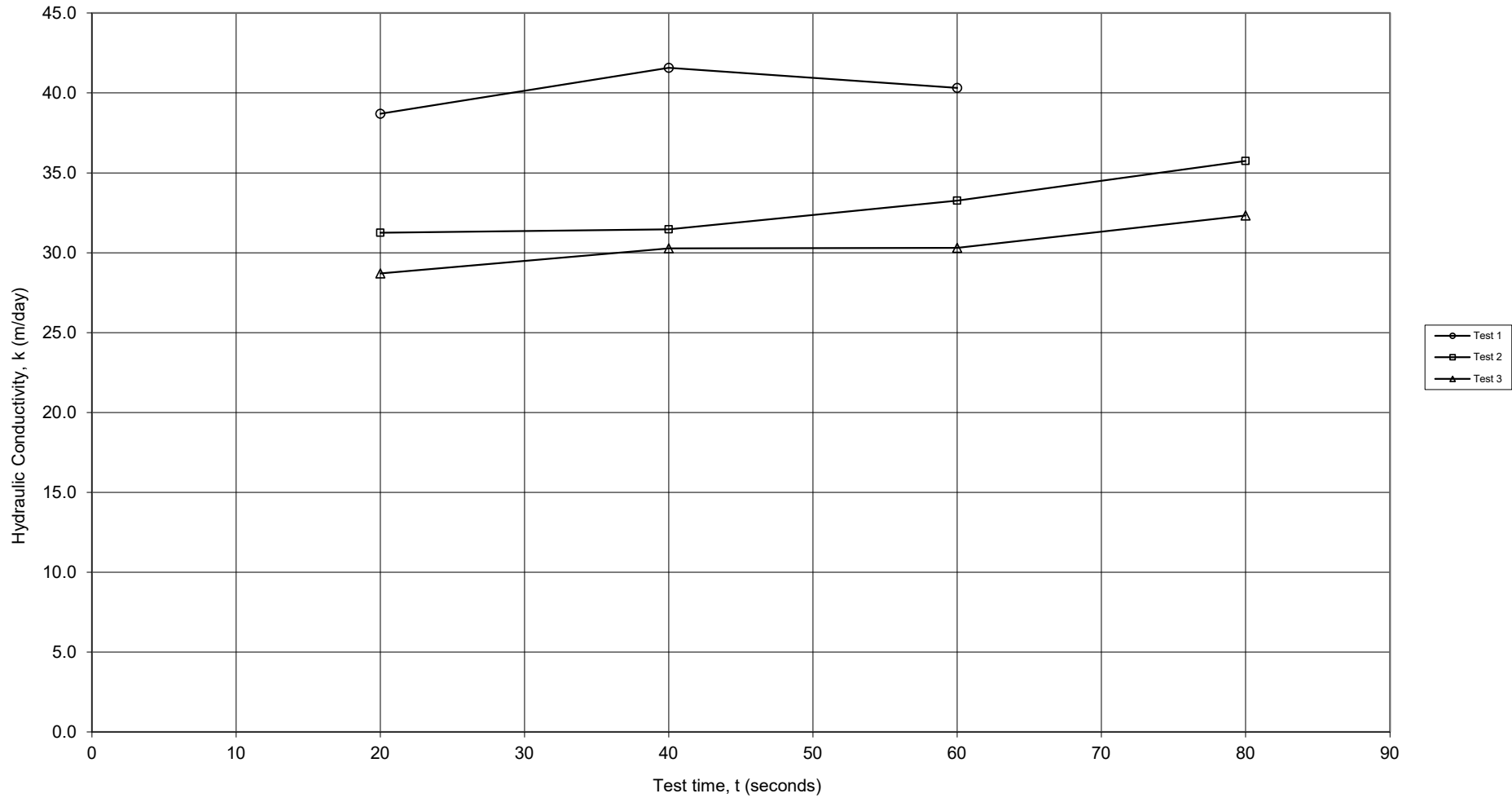
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.62	0.25		
20	0.695	0.175	3.6E-04	31.3
40	0.75	0.12	3.6E-04	31.5
60	0.795	0.075	3.8E-04	33.3
80	0.83	0.04	4.1E-04	35.7
AVERAGE			3.8E-04	32.9

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.58	0.29		
20	0.66	0.21	3.3E-04	28.7
40	0.725	0.145	3.5E-04	30.3
60	0.77	0.1	3.5E-04	30.3
80	0.81	0.06	3.7E-04	32.3
AVERAGE			3.5E-04	30.4

Hydraulic Conductivity by Inverse Auger Hole Method

IT04



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

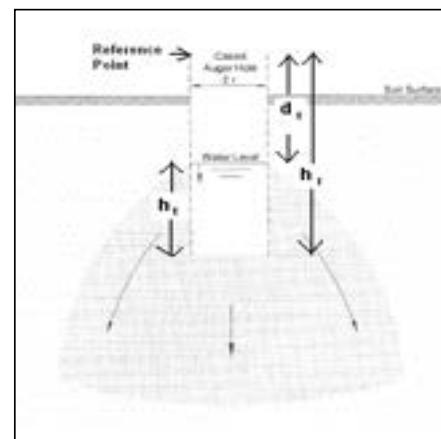
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT05	Parameter	Description	Value	Units
Test Depth:	0.48	K	Hydraulic Conductivity		m/s
	m	r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h_r	reference point height above base	0.6	m
		d_t	depth from reference point to water at time t		m
		h_t	Water column height at time t		m
		h_0	h_t at t=0		m

Test 1

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.39	0.21		
20	0.44	0.16	2.7E-04	23.5
40	0.48	0.12	2.8E-04	23.8
60	0.51	0.09	2.7E-04	23.5
80	0.535	0.065	2.7E-04	23.7
AVERAGE			2.7E-04	23.6

Test 2

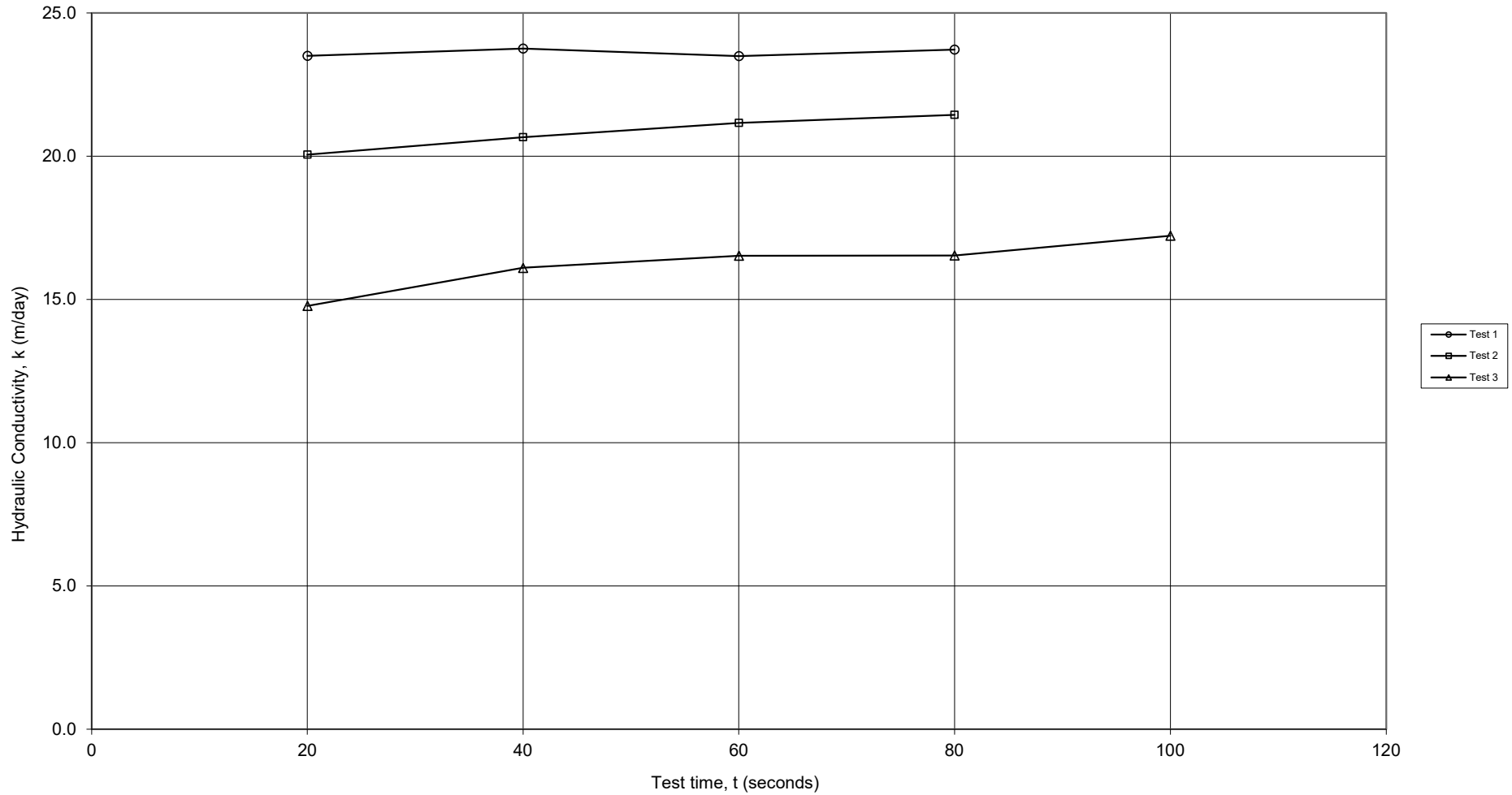
t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.435	0.165		
20	0.47	0.13	2.3E-04	20.1
40	0.5	0.1	2.4E-04	20.7
60	0.525	0.075	2.4E-04	21.2
80	0.545	0.055	2.5E-04	21.4
AVERAGE			2.4E-04	20.8

Test 3

t (s)	d_w (m)	h_t (m)	K (m/s)	K (m/day)
0	0.41	0.19		
20	0.44	0.16	1.7E-04	14.8
40	0.47	0.13	1.9E-04	16.1
60	0.495	0.105	1.9E-04	16.5
80	0.515	0.085	1.9E-04	16.5
100	0.535	0.065	2.0E-04	17.2
AVERAGE			1.9E-04	16.2

Hydraulic Conductivity by Inverse Auger Hole Method

IT05



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

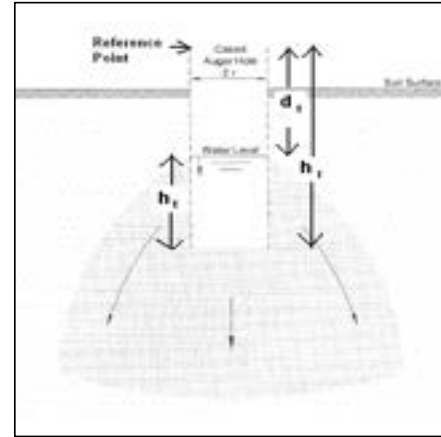
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT05	Parameter	Description	Value	Units
Test Depth:	1.62	K	Hydraulic Conductivity		m/s
	m	r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	1.695	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.603	0.092		
20	1.608	0.087	5.0E-05	4.3
40	1.614	0.081	5.7E-05	4.9
60	1.619	0.076	5.6E-05	4.9
80	1.621	0.074	4.8E-05	4.2
100	1.627	0.068	5.3E-05	4.6
AVERAGE			5.3E-05	4.6

Test 2

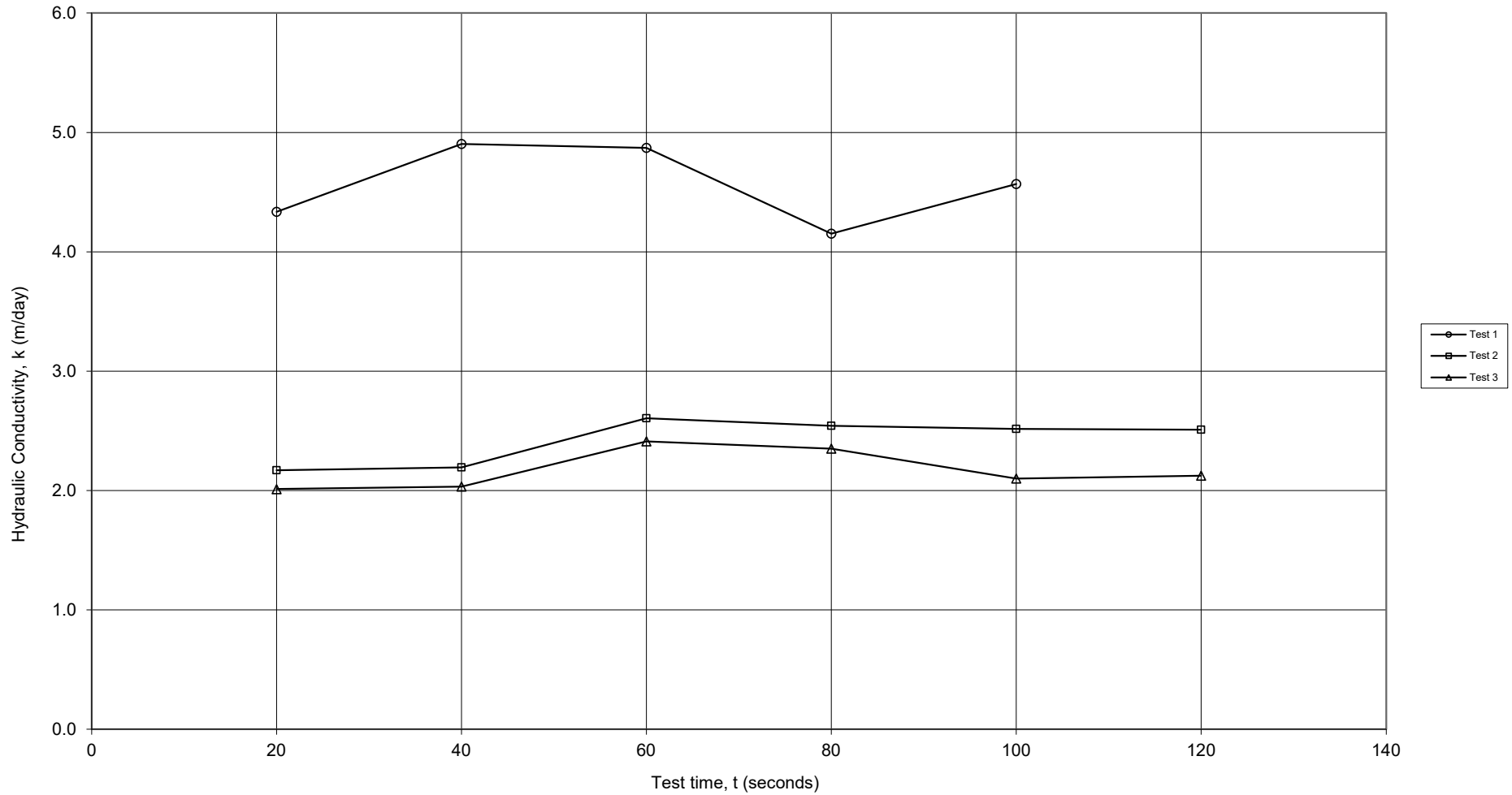
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.627	0.068		
20	1.629	0.066	2.5E-05	2.2
40	1.631	0.064	2.5E-05	2.2
60	1.634	0.061	3.0E-05	2.6
80	1.636	0.059	2.9E-05	2.5
100	1.638	0.057	2.9E-05	2.5
120	1.64	0.055	2.9E-05	2.5
AVERAGE			2.8E-05	2.4

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.62	0.075		
20	1.622	0.073	2.3E-05	2.0
40	1.624	0.071	2.4E-05	2.0
60	1.627	0.068	2.8E-05	2.4
80	1.629	0.066	2.7E-05	2.4
100	1.63	0.065	2.4E-05	2.1
120	1.632	0.063	2.5E-05	2.1
AVERAGE			2.5E-05	2.2

Hydraulic Conductivity by Inverse Auger Hole Method

IT05



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

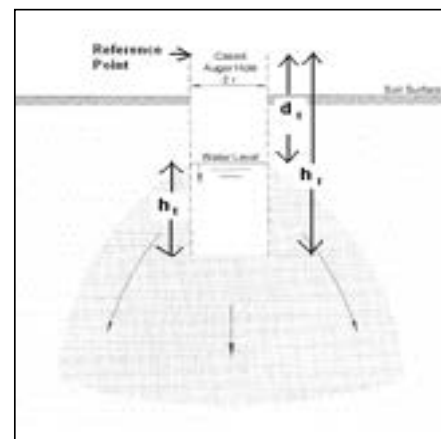
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	Parameter	Description	Value	Units
IT06	K	Hydraulic Conductivity		m/s
Test Depth: 0.81 m	r	radius of test hole	0.045	m
	t	time since start of measurement		s
	h _r	reference point height above base	0.86	m
	d _t	depth from reference point to water at time t		m
	h _t	Water column height at time t		m
	h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.55	0.31		
20	0.63	0.23	3.1E-04	26.7
40	0.685	0.175	2.9E-04	25.3
60	0.73	0.13	2.9E-04	25.2
80	0.77	0.09	3.0E-04	26.3
100	0.795	0.065	3.0E-04	25.9
AVERAGE			3.0E-04	25.9

Test 2

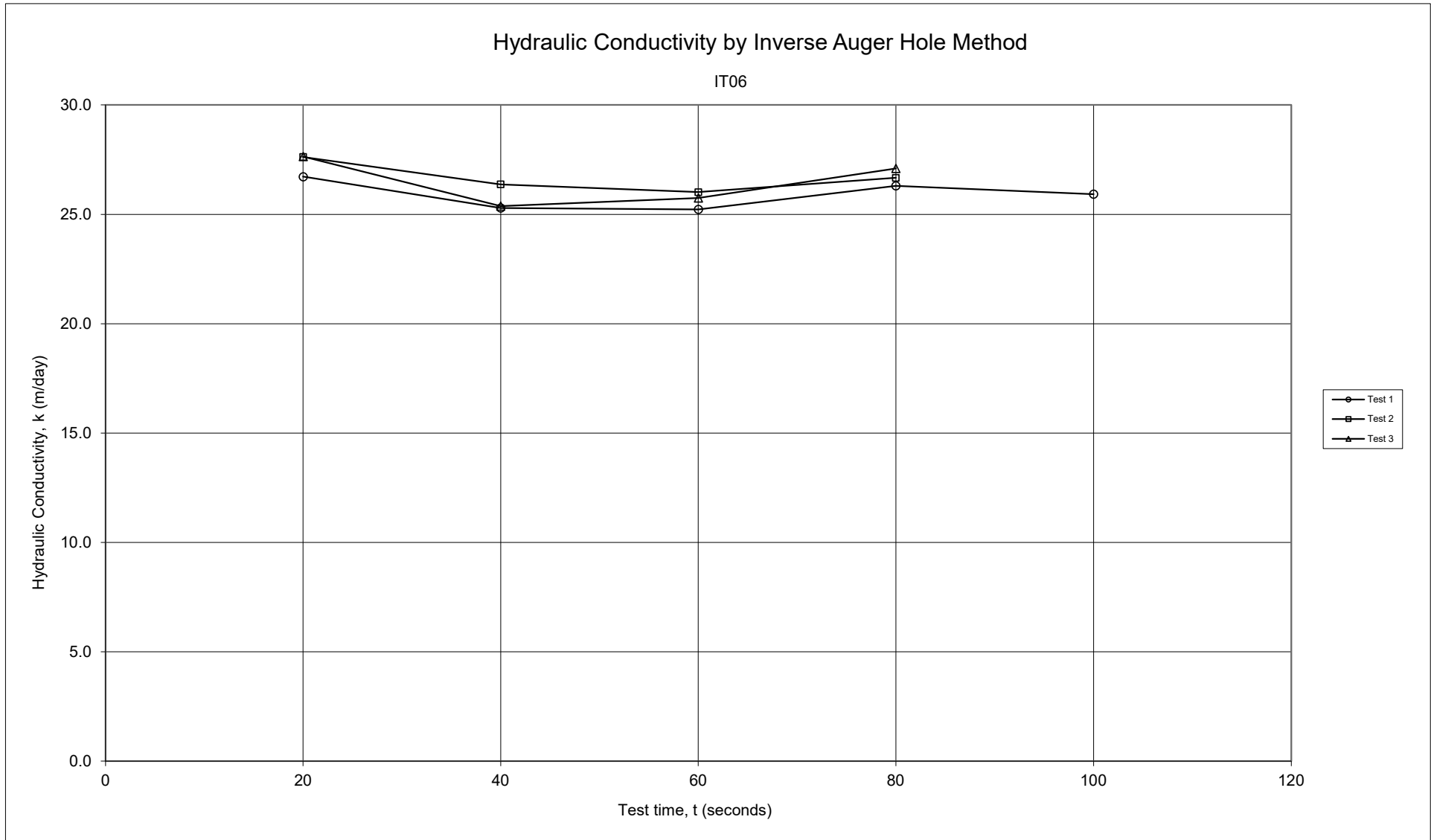
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.62	0.24		
20	0.685	0.175	3.2E-04	27.6
40	0.73	0.13	3.1E-04	26.4
60	0.765	0.095	3.0E-04	26.0
80	0.795	0.065	3.1E-04	26.7
AVERAGE			3.1E-04	26.7

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.6	0.26		
20	0.67	0.19	3.2E-04	27.6
40	0.715	0.145	2.9E-04	25.4
60	0.755	0.105	3.0E-04	25.7
80	0.79	0.07	3.1E-04	27.1
AVERAGE			3.1E-04	26.5

Hydraulic Conductivity by Inverse Auger Hole Method

IT06



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

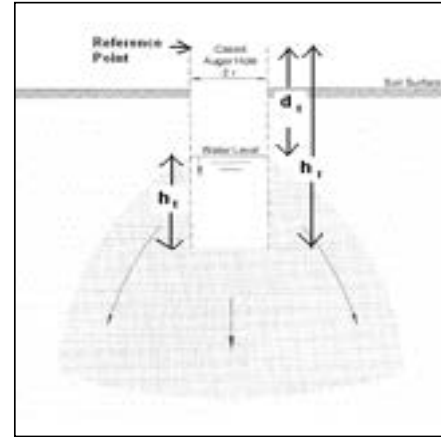
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT07	Parameter	Description	Value	Units
Test Depth:	0.52	K	Hydraulic Conductivity		m/s
	m	r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	0.62	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.34	0.28		
20	0.43	0.19	4.0E-04	34.3
40	0.5	0.12	4.2E-04	36.5
60	0.555	0.065	4.6E-04	40.1
AVERAGE			4.3E-04	37.0

Test 2

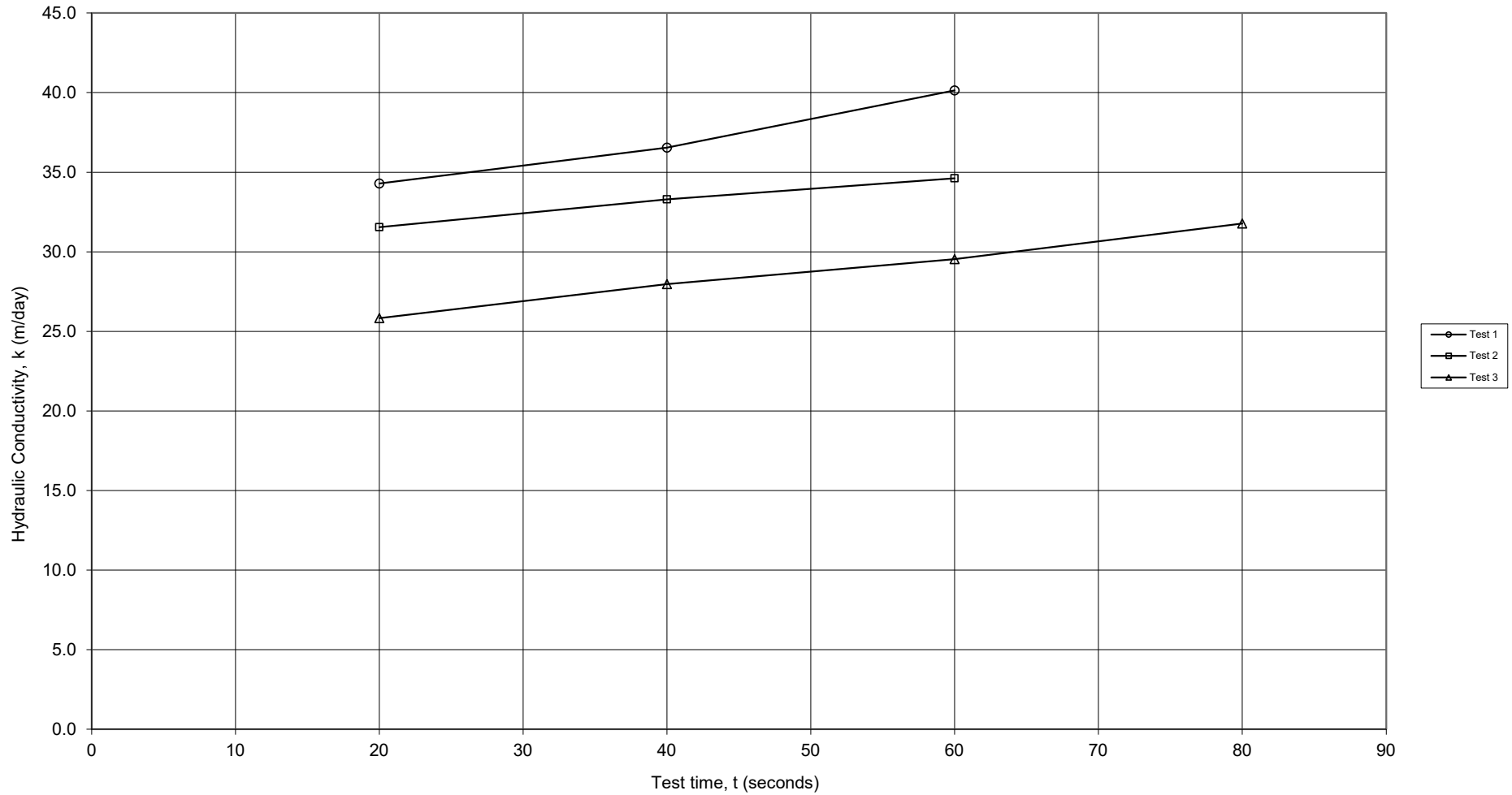
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.3	0.32		
20	0.395	0.225	3.7E-04	31.5
40	0.47	0.15	3.9E-04	33.3
60	0.525	0.095	4.0E-04	34.6
AVERAGE			3.8E-04	33.2

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.3	0.32		
20	0.38	0.24	3.0E-04	25.8
40	0.45	0.17	3.2E-04	28.0
60	0.505	0.115	3.4E-04	29.5
80	0.55	0.07	3.7E-04	31.8
AVERAGE			3.3E-04	28.8

Hydraulic Conductivity by Inverse Auger Hole Method

IT07



Hydraulic Conductivity Calculation - Inverse Auger Hole Method

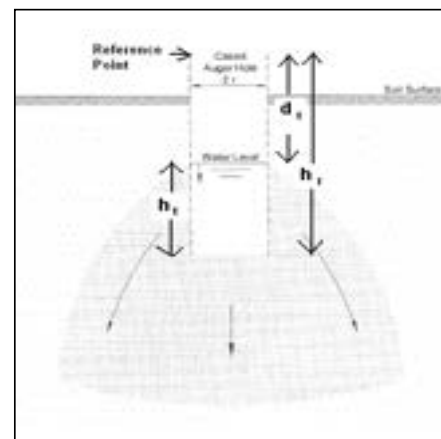
Galt Geotechnics

Spreadsheet author: ORW 17-Oct-09

REFERENCE: Cocks, G. *Disposal of Stormwater Runoff by Soakage in Perth Western Australia*, Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114

Job No: WAG240411-01
 Client: Land Group (WA)
 Project: Residential Subdivision
 Location: Lakefarm Retreat
 Calc by: WF

$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$



Test No	IT07	Parameter	Description	Value	Units
Test Depth:	1.76	K	Hydraulic Conductivity		m/s
	m	r	radius of test hole	0.045	m
		t	time since start of measurement		s
		h _r	reference point height above base	1.78	m
		d _t	depth from reference point to water at time t		m
		h _t	Water column height at time t		m
		h ₀	h _t at t=0		m

Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.716	0.064		
20	1.722	0.058	8.1E-05	7.0
40	1.727	0.053	7.6E-05	6.6
60	1.73	0.05	6.6E-05	5.7
80	1.735	0.045	7.0E-05	6.0
AVERAGE			7.3E-05	6.3

Test 2

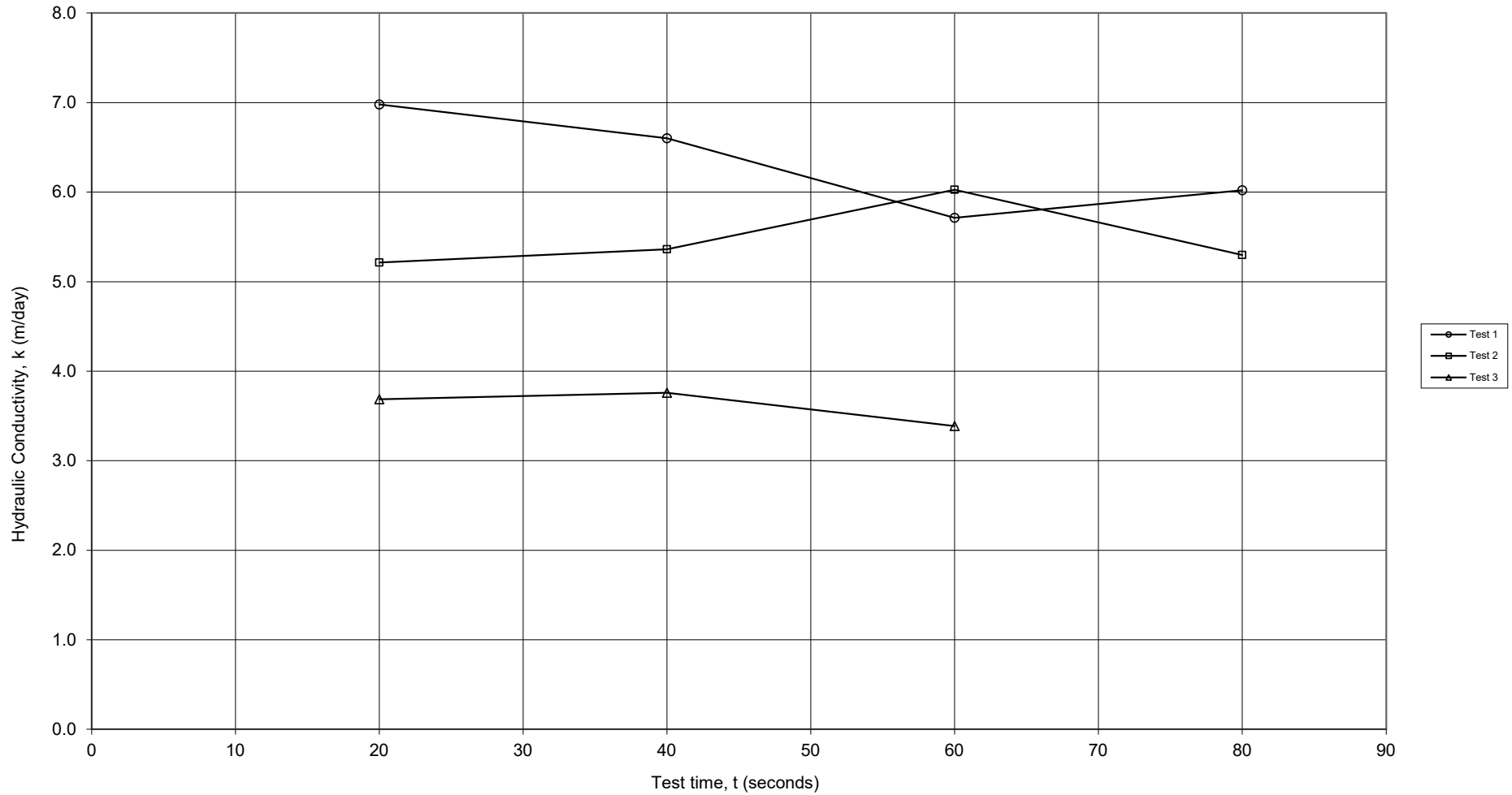
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.726	0.054		
20	1.73	0.05	6.0E-05	5.2
40	1.734	0.046	6.2E-05	5.4
60	1.739	0.041	7.0E-05	6.0
80	1.741	0.039	6.1E-05	5.3
AVERAGE			6.3E-05	5.5

Test 3

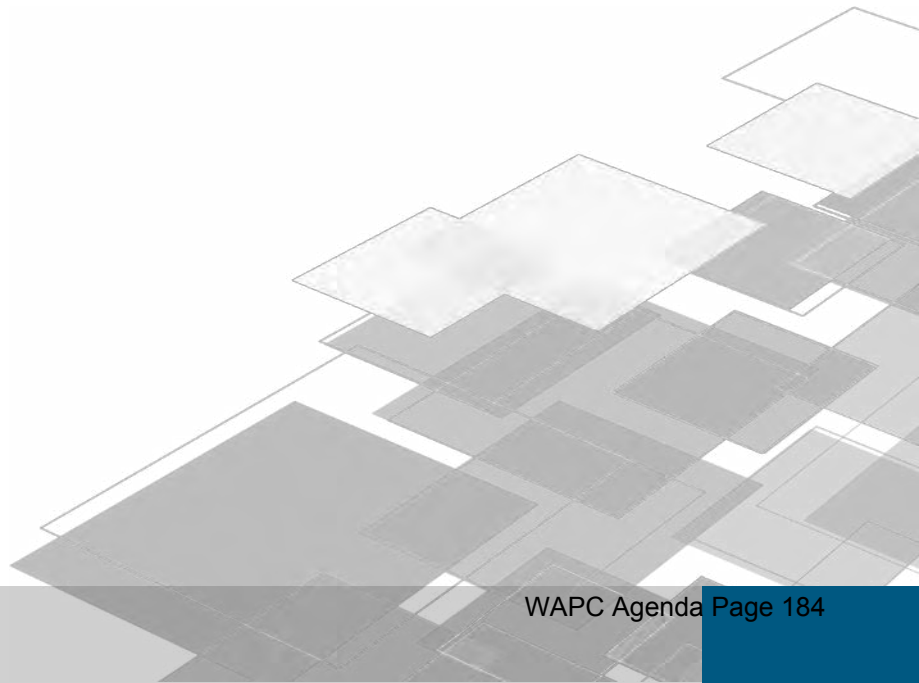
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	1.722	0.058		
20	1.725	0.055	4.3E-05	3.7
40	1.728	0.052	4.4E-05	3.8
60	1.73	0.05	3.9E-05	3.4
AVERAGE			4.2E-05	3.6

Hydraulic Conductivity by Inverse Auger Hole Method

IT07



Appendix F: Laboratory Test Results





SOIL | AGGREGATE | CONCRETE | CRUSHING

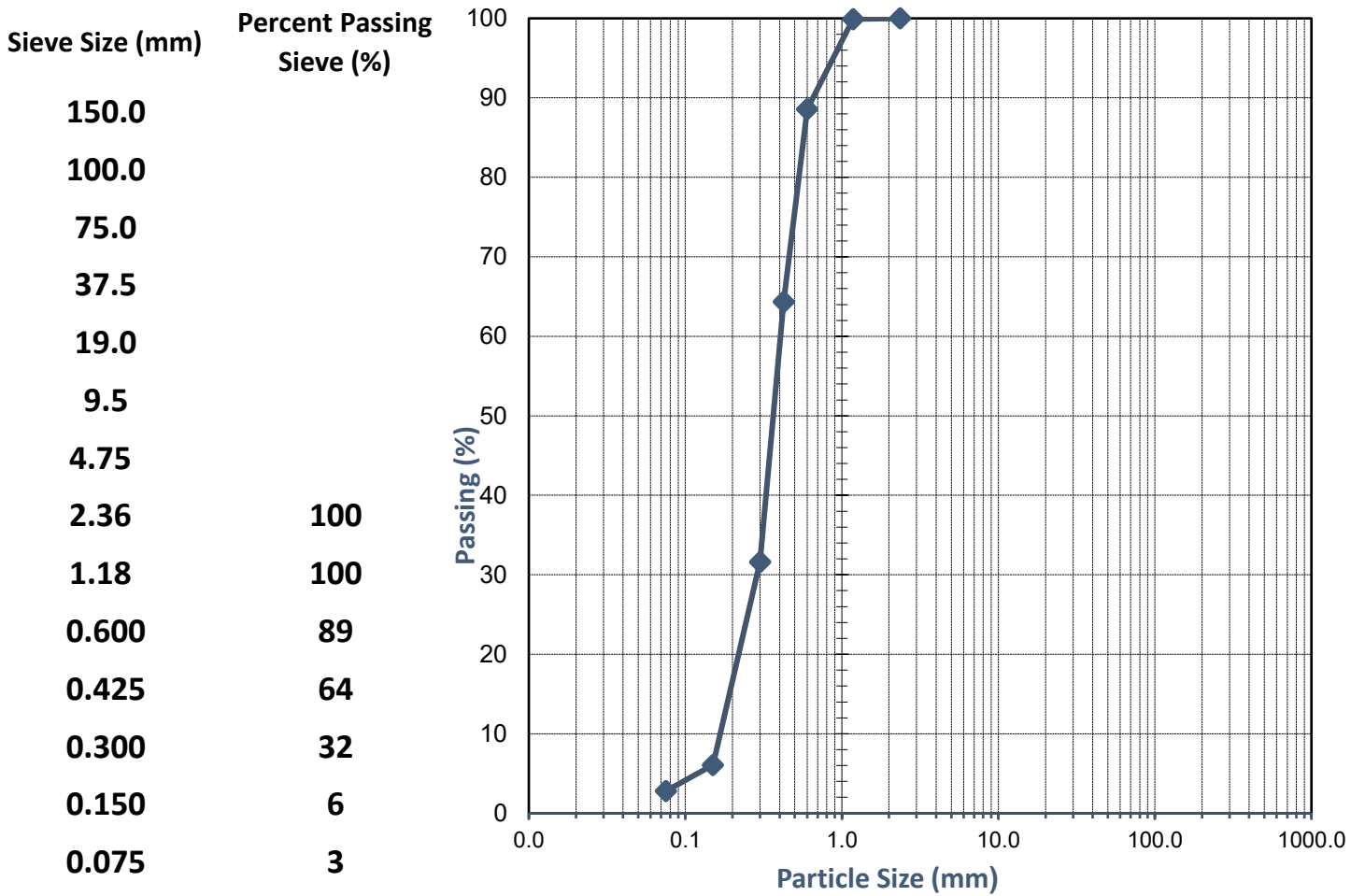
TEST REPORT - AS 1289.3.6.1

Client:	Land Group (WA) - Groves St Pty Ltd	Ticket No.	S14514
Client Address:	-	Report No.	WG24.14393_1_PSD
Project:	Propoed Residential Subdivision	Sample No.	WG24.14393
Location:	Lake Farm Retreat	Date Sampled:	Not Specified
Sample Identification:	BH02 (0.1-1.0m)	Date Tested:	25/09 - 26/09/2024

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 26/September/2024



Accreditation No. 20599

Accredited for compliance

with ISO/IEC 17025 - Testing

This document shall not be reproduced except in full



SOIL | AGGREGATE | CONCRETE | CRUSHING

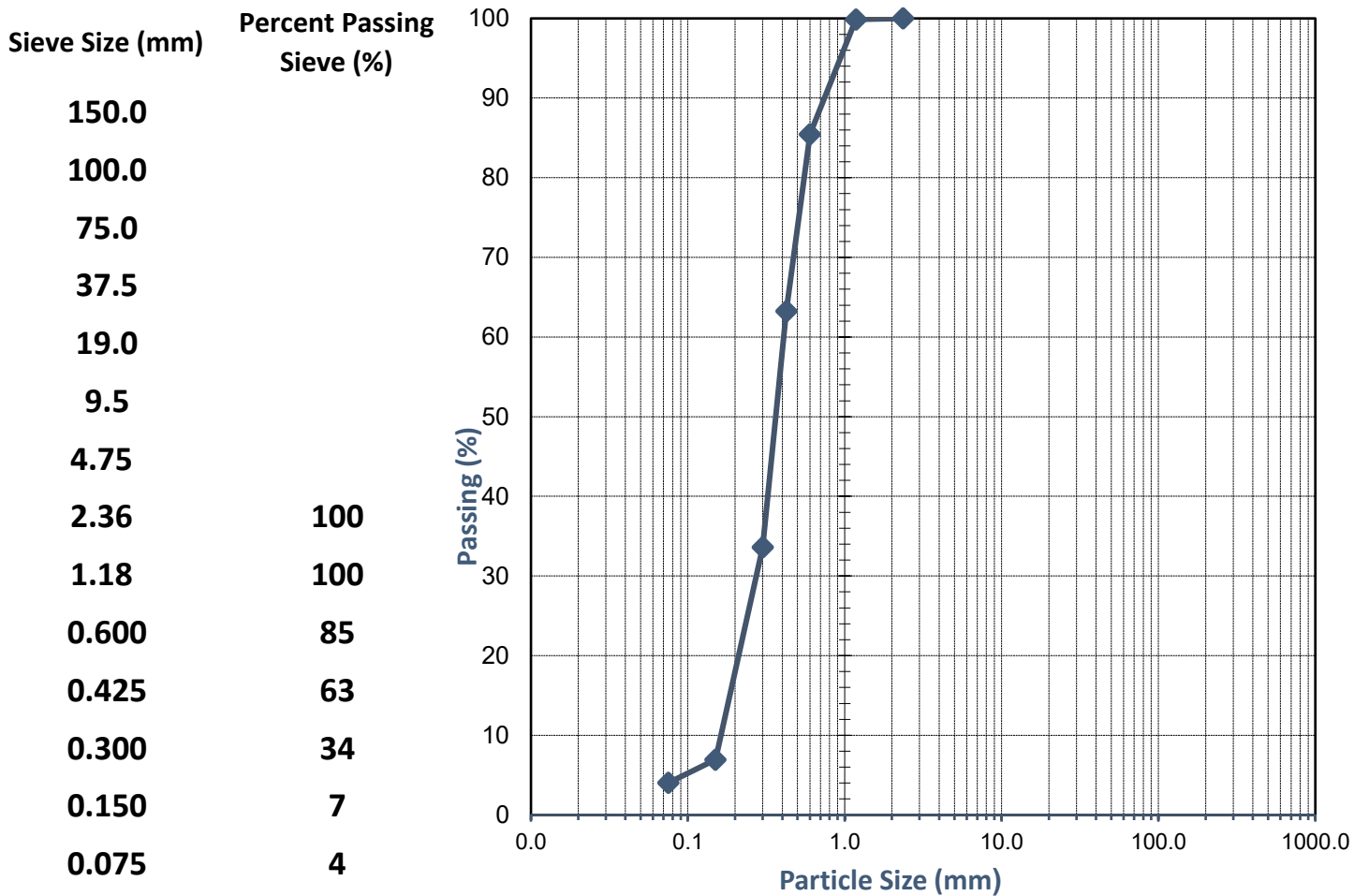
TEST REPORT - AS 1289.3.6.1

Client:	Land Group (WA) - Groves St Pty Ltd	Ticket No.	S14514
Client Address:	-	Report No.	WG24.14394_1_PSD
Project:	Propoed Residential Subdivision	Sample No.	WG24.14394
Location:	Lake Farm Retreat	Date Sampled:	Not Specified
Sample Identification:	BH02 (1.0-2.0m)	Date Tested:	25/09 - 26/09/2024

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 26/September/2024



Accreditation No. 20599

Accredited for compliance

with ISO/IEC 17025 - Testing

This document shall not be reproduced except in full



SOIL | AGGREGATE | CONCRETE | CRUSHING

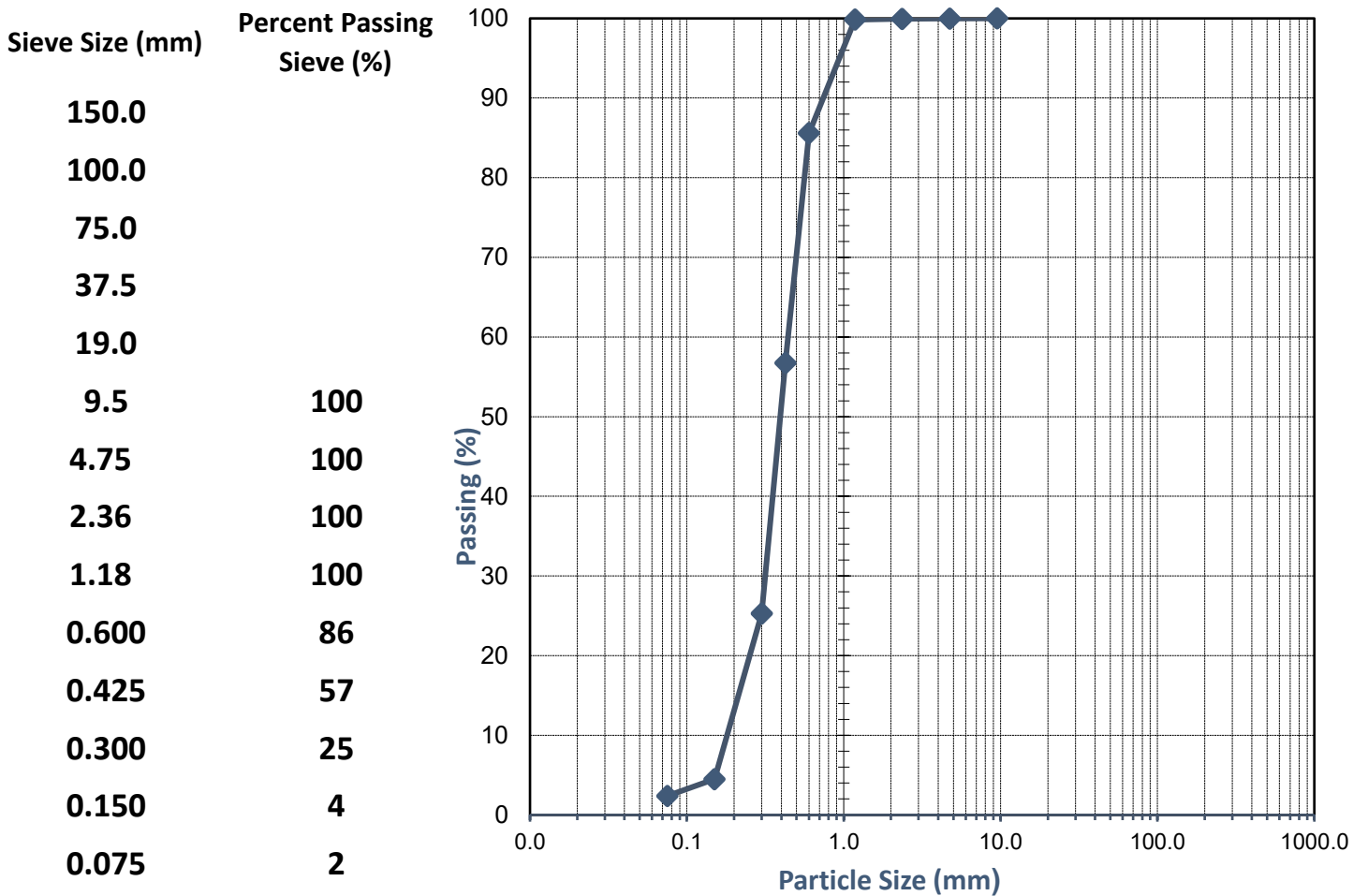
TEST REPORT - AS 1289.3.6.1

Client:	Land Group (WA) - Groves St Pty Ltd	Ticket No.	S14514
Client Address:	-	Report No.	WG24.14395_1_PSD
Project:	Propoed Residential Subdivision	Sample No.	WG24.14395
Location:	Lake Farm Retreat	Date Sampled:	Not Specified
Sample Identification:	BH06 (0.1-1.0m)	Date Tested:	25/09 - 26/09/2024

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 26/September/2024



Accreditation No. 20599

Accredited for compliance

with ISO/IEC 17025 - Testing

This document shall not be reproduced except in full



SOIL | AGGREGATE | CONCRETE | CRUSHING

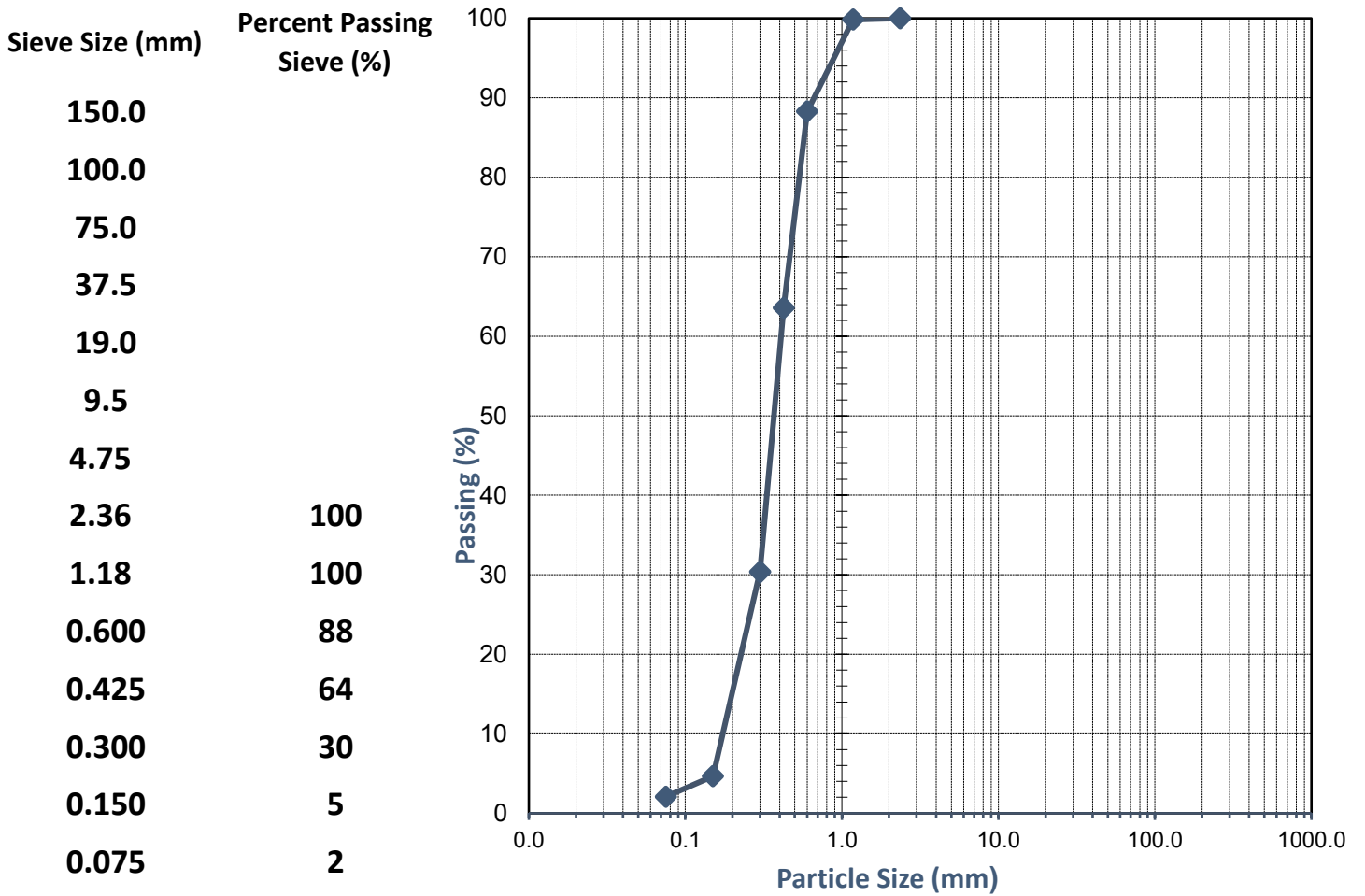
TEST REPORT - AS 1289.3.6.1

Client:	Land Group (WA) - Groves St Pty Ltd	Ticket No.	S14514
Client Address:	-	Report No.	WG24.14396_1_PSD
Project:	Propoed Residential Subdivision	Sample No.	WG24.14396
Location:	Lake Farm Retreat	Date Sampled:	Not Specified
Sample Identification:	BH06 (1.0-2.0m)	Date Tested:	25/09 - 26/09/2024

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 26/September/2024



Accreditation No. 20599
Accredited for compliance
with ISO/IEC 17025 - Testing

This document shall not be reproduced except in full



SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.4.1.1

Client:	Land Group (WA) - Groves St Pty Ltd	Ticket No.	C165
Client Address:	-	Report No.	WC24.407-408_1_OMC
Project:	Propoed Residential Subdivision	Sample No.	WC24.407-408
Location:	Lake Farm Retreat	Date Sampled:	Not Specified
Sample Identification:	Various - See Below	Date Tested:	30/09 - 01/10/2024

TEST RESULTS - Organic Matter Content of Soil - Normal Method

Sampling Method:

Sampled by Client, Tested as Received

Sample Number	Sample Identification	Material Description	Organic Matter (%)
WC24.407	BH02 (0.1-1.0m)	Sand	0.2
WC24.408	BH06 (0.1-1.0m)	Sand	0.3

Comments:

Approved Signatory:

Name: Natasha Bielawski

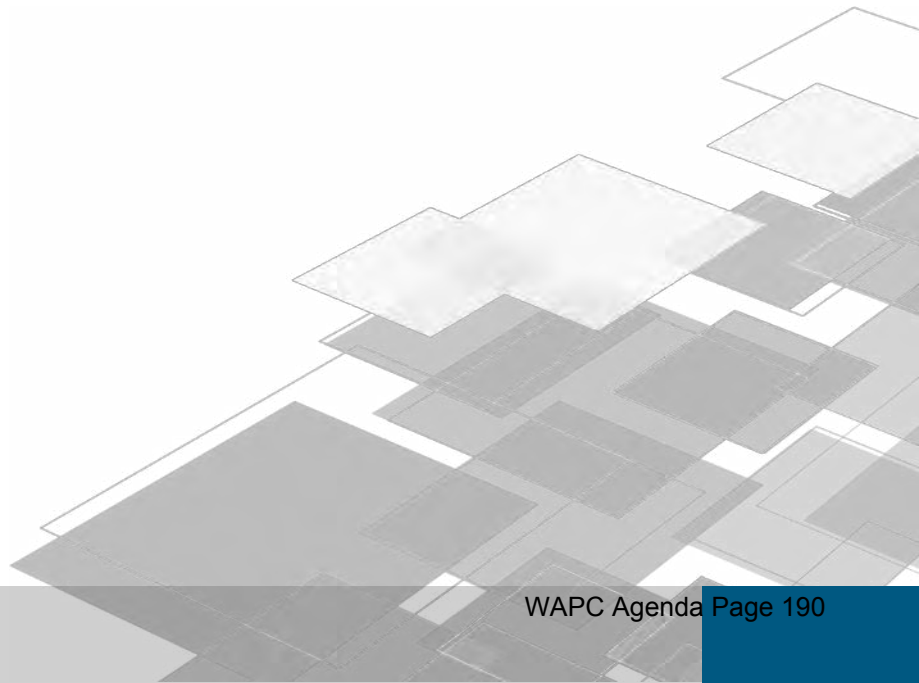
Date: 02/October/2024



Accreditation No. 20599
Accredited for compliance
with ISO/IEC 17025 - Testing

This document shall not be reproduced except in full

Appendix G: Field and Laboratory ASS Results



Acid Sulfate Soil Testing Results

Field Observations							Laboratory Results
Sample ID			pH _f	pH _{f,ox}	pH _f - pH _{f,ox}	Reaction Rate	Net Acidity
Location	Depth (m)	Elevation (m AHD)	pH units	pH units	pH units	LMHXV	%S
			4	4	1	NV	0.03
BH01	0.00		...	...	...	...	...
	0.25		5.4	4.5	0.9	L	...
	0.50		5.5	4.6	0.9	L	...
	0.75		5.5	4.6	0.9	L	...
	1.00		5.5	4.5	1.0	L	...
	1.25		5.4	4.6	0.8	L	...
	1.50		5.5	4.5	1.0	L	0.02
	1.75		5.3	4.5	0.8	L	...
	2.00		5.2	4.4	0.8	L	...
	2.25		5.3	4.4	0.9	L	...
	2.50		5.4	4.5	0.9	L	...
BH02	0.00		...	...	...	...	...
	0.25		6.6	5.4	1.2	L	...
	0.50		6.5	5.1	1.4	L	...
	0.75		6.5	5.0	1.5	L	...
	1.00		6.6	4.9	1.7	L	...
	1.25		6.5	5.1	1.4	L	...
	1.50		6.7	5.0	1.7	L	...
	1.75		6.7	5.2	1.5	L	...
	2.00		6.7	5.2	1.5	L	<0.02
	2.25		6.3	5.0	1.3	L	...
	2.50		6.0	4.7	1.3	L	...
BH03	0.00		...	...	...	...	...
	0.25		5.0	4.0	1.0	L	...
	0.50		5.1	4.1	1.0	L	...
	0.75		5.0	4.3	0.7	L	...
	1.00		4.9	4.3	0.6	L	...
	1.25		5.1	4.1	1.0	L	...
	1.50		5.2	4.2	1.0	L	...
	1.75		5.3	4.4	0.9	L	...
	2.00		5.5	4.5	1.0	L	...
	2.25		5.4	4.6	0.8	L	...
	2.50		5.5	4.5	1.0	L	<0.02
BH04	0.00		...	...	...	...	...
	0.25		5.3	4.1	1.2	L	...
	0.50		5.4	4.5	0.9	L	...
	0.75		5.5	4.4	1.1	L	...
	1.00		5.4	4.5	0.9	L	...
	1.25		5.5	4.5	1.0	L	...
	1.50		5.5	4.4	1.1	L	...
	1.75		5.4	4.4	1.0	L	...
	2.00		5.3	4.3	1.0	L	...
	2.25		5.3	4.4	0.9	L	...
	2.50		5.2	4.3	0.9	L	...
2.75		5.3	4.4	0.9	L	...	
3.00		5.4	4.5	0.9	L	<0.02	

Acid Sulfate Soil Testing Results

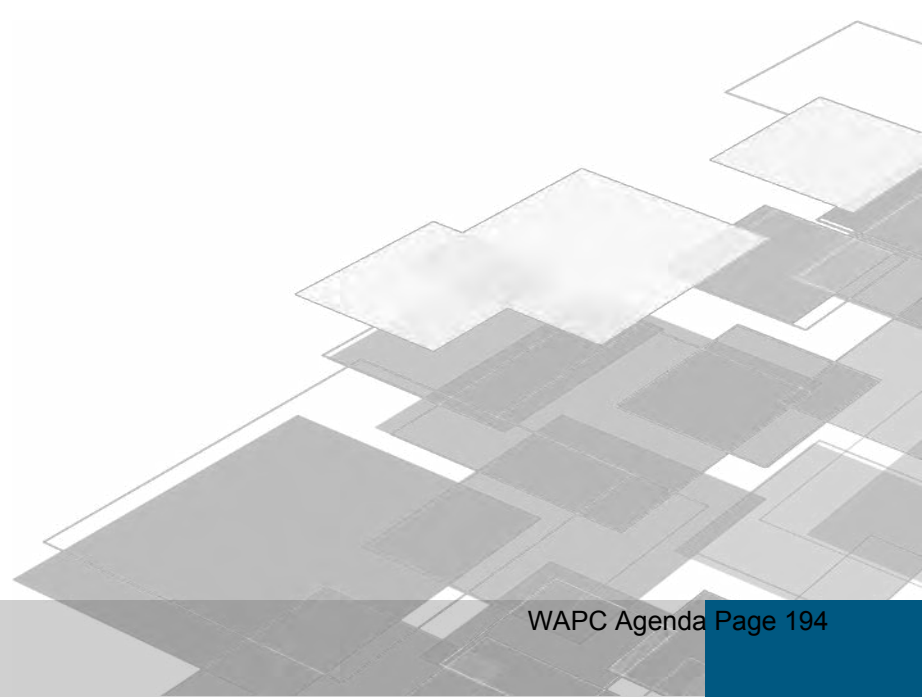
Field Observations							Laboratory Results
Sample ID			pH _f	pH _{f,ox}	pH _f - pH _{f,ox}	Reaction Rate	Net Acidity
Location	Depth (m)	Elevation (m AHD)	pH units	pH units	pH units	LMHXV	%S
			4	4	1	NV	0.03
BH05	0.00		...	...	...	...	...
	0.25		5.5	4.6	0.9	L	...
	0.50		5.6	4.6	1.0	L	...
	0.75		5.5	4.7	0.8	L	...
	1.00		5.4	4.8	0.6	L	<0.02
	1.25		5.4	4.8	0.6	L	...
	1.50		5.5	5.0	0.5	L	...
	1.75		5.4	5.0	0.4	L	...
	2.00		5.9	5.0	0.9	L	...
	2.25		5.8	5.1	0.7	L	...
	2.50		5.9	5.1	0.8	L	...
	2.75		5.7	4.9	0.8	L	...
3.00		5.8	4.7	1.1	L	...	
BH06	0.00		...	...	...	...	...
	0.25		5.5	4.5	1.0	L	...
	0.50		5.5	4.6	0.9	L	...
	0.75		5.7	4.7	1.0	L	...
	1.00		5.8	4.8	1.0	L	...
	1.25		5.9	5.0	0.9	L	...
	1.50		6.0	5.1	0.9	L	<0.02
	1.75		6.2	5.3	0.9	L	...
	2.00		6.3	5.2	1.1	L	...
	2.25		6.2	5.2	1.0	L	...
	2.50		6.3	5.2	1.1	L	...
	2.75		6.2	5.0	1.2	L	...
3.00		6.1	4.9	1.2	L	...	
BH07	0.00		...	...	...	...	...
	0.25		6.1	5.1	1.0	L	...
	0.50		6.0	5.0	1.0	L	...
	0.75		6.0	5.1	0.9	L	...
	1.00		6.0	5.0	1.0	L	...
	1.25		6.1	5.0	1.1	L	...
	1.50		6.2	5.0	1.2	L	...
	1.75		6.2	5.1	1.1	L	...
	2.00		6.1	5.2	0.9	L	<0.02
	2.25		6.2	5.2	1.0	L	...
	2.50		6.3	5.0	1.3	L	...
	2.75		6.3	5.1	1.2	L	...
3.00		6.0	5.1	0.9	L	...	
BH08	0.00		...	...	...	...	...
	0.25		7.0	5.4	1.6	L	...
	0.50		6.9	5.5	1.4	L	...
	0.75		7.0	5.4	1.6	L	...
	1.00		7.3	5.3	2.0	L	...
	1.25		7.2	5.2	2.0	L	...
	1.50		7.0	5.3	1.7	L	...
	1.75		6.9	5.2	1.7	L	...
	2.00		6.9	5.1	1.8	L	...
	2.25		6.4	4.9	1.5	L	...
	2.50		6.2	4.9	1.3	L	<0.02
	2.75		6.3	5.1	1.2	L	...
3.00		6.4	5.4	1.0	L	...	

Acid Sulfate Soil Testing Results

Field Observations							Laboratory Results
Sample ID			pH _f	pH _{f,ox}	pH _f - pH _{f,ox}	Reaction Rate	Net Acidity
Location	Depth (m)	Elevation (m AHD)	pH units	pH units	pH units	LMHXV	%S
			4	4	1	NV	0.03
BH09	0.00		...	...	...	...	...
	0.25		6.5	5.2	1.3	L	...
	0.50		6.4	5.1	1.3	L	...
	0.75		6.3	5.2	1.1	L	...
	1.00		6.4	5.4	1.0	L	...
	1.25		6.5	5.5	1.0	L	...
	1.50		6.7	5.4	1.3	L	...
	1.75		6.6	5.3	1.3	L	...
	2.00		6.6	5.1	1.5	L	...
	2.25		6.3	5.0	1.3	L	...
	2.50		5.9	4.7	1.2	L	...
2.75		5.7	4.6	1.1	L	...	
3.00		5.4	4.6	0.8	L	<0.02	
BH10	0.00		...	...	...	...	...
	0.25		6.6	5.6	1.0	L	...
	0.50		6.7	5.5	1.2	L	...
	0.75		6.6	5.3	1.3	L	...
	1.00		6.6	5.2	1.4	L	...
	1.25		6.3	5.1	1.2	L	...
	1.50		6.1	5.0	1.1	L	...
	1.75		6.2	5.2	1.0	L	...
	2.00		6.3	5.3	1.0	L	...
	2.25		6.0	5.0	1.0	L	...
	2.50		5.4	4.9	0.5	L	<0.02
2.75		5.2	4.7	0.5	L	...	
3.00		5.3	4.5	0.8	L	...	
BH11	0.00		...	...	...	...	...
	0.25		6.1	5.1	1.0	L	...
	0.50		6.0	5.0	1.0	L	...
	0.75		6.1	5.2	0.9	L	...
	1.00		6.2	5.5	0.7	L	...
	1.25		6.0	5.2	0.8	L	...
	1.50		6.0	5.1	0.9	L	...
	1.75		5.9	5.0	0.9	L	...
	2.00		5.8	4.9	0.9	L	...
	2.25		5.7	4.9	0.8	L	...
	2.50		5.7	4.8	0.9	L	...
2.75		5.8	4.7	1.1	L	...	
3.00		5.7	4.7	1.0	L	<0.02	

Appendix H: Environmental Certificates of Analysis

Laboratory



Galt Environment P/L
50 Edward Street
Osborne Park
WA 6017



NATA Accredited
Accreditation Number 1261
Site Number 20794 & 2780

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition
Arrangement for the mutual recognition of the
equivalence of testing, medical testing, calibration,
inspection, proficiency testing scheme providers and
reference materials producers reports and certificates.

Attention: - ALL SRA/Results

Report 1142779-S
Project name LAKEFARM RTT BALLAJURA
Project ID WAG240411
Received Date Sep 24, 2024

Client Sample ID			BH01/1.5	BH02/2.0	BH03/2.5	BH04/3.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L24-Se0064012	L24-Se0064013	L24-Se0064014	L24-Se0064015
Date Sampled			Sep 19, 2024	Sep 19, 2024	Sep 19, 2024	Sep 19, 2024
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	50	82	54	71
>2mm Fraction	0.005	g	< 0.005	< 0.005	< 0.005	< 0.005
Analysed Material	0.1	%	100	100	100	100
Extraneous Material	0.1	%	< 0.1	< 0.1	< 0.1	< 0.1
Net Acidity (Excluding ANC)						
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	13	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Actual Acidity (NLM-3.2)						
pH-KCL (NLM-3.1)	0.1	pH Units	5.1	6.7	5.3	5.7
Titrateable Actual Acidity (NLM-3.2)	2	mol H+/t	13	< 2	4.0	3.0
Titrateable Actual Acidity (NLM-3.2)	0.003	% pyrite S	0.020	< 0.003	0.010	< 0.003
Potential Acidity - Chromium Reducible Sulfur						
Chromium Reducible Sulfur (s-SCr) (NLM-2.1) ^{S04}	0.005	% S	< 0.005	< 0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	3	mol H+/t	< 3	< 3	< 3	< 3
Extractable Sulfur						
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Retained Acidity (S-NAS)						
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1 ^{S02}	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
Acid Neutralising Capacity (ANCbt)						
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A	0.28	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2) ^{S03}	0.02	% S	N/A	0.09	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	55	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
Net Acidity (Including ANC)						
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	13	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Including ANC) ^{S01}	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Sample Properties						
% Moisture	1	%	4.1	1.0	7.8	15

Client Sample ID			BH05/1.0	BH06/1.5	BH07/2.0	BH08/2.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L24-Se0064016	L24-Se0064017	L24-Se0064018	L24-Se0064019
Date Sampled			Sep 19, 2024	Sep 19, 2024	Sep 19, 2024	Sep 19, 2024
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	75	69	66	70
>2mm Fraction	0.005	g	< 0.005	< 0.005	< 0.005	< 0.005
Analysed Material	0.1	%	100	100	100	100
Extraneous Material	0.1	%	< 0.1	< 0.1	< 0.1	< 0.1
Net Acidity (Excluding ANC)						
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Actual Acidity (NLM-3.2)						
pH-KCL (NLM-3.1)	0.1	pH Units	5.5	5.3	5.3	5.3
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	3.0	3.0	7.0	6.0
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	< 0.003	0.010	0.010	0.010
Potential Acidity - Chromium Reducible Sulfur						
Chromium Reducible Sulfur (s-SCr) (NLM-2.1) ^{S04}	0.005	% S	< 0.005	< 0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	3	mol H+/t	< 3	< 3	< 3	< 3
Extractable Sulfur						
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Retained Acidity (S-NAS)						
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1 ^{S02}	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
Acid Neutralising Capacity (ANCbt)						
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2) ^{S03}	0.02	% S	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	N/A	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
Net Acidity (Including ANC)						
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Including ANC) ^{S01}	1	kg CaCO3/t	< 1	< 1	< 1	< 1
Sample Properties						
% Moisture	1	%	2.6	6.3	4.3	3.8

Client Sample ID			BH09/3.0	BH10/2.5	BH11/3.5
Sample Matrix			Soil	Soil	Soil
Eurofins Sample No.			L24-Se0064020	L24-Se0064021	L24-Se0064022
Date Sampled			Sep 19, 2024	Sep 19, 2024	Sep 19, 2024
Test/Reference	LOR	Unit			
Extraneous Material					
<2mm Fraction	0.005	g	72	50	140
>2mm Fraction	0.005	g	< 0.005	< 0.005	< 0.005
Analysed Material	0.1	%	100	100	100
Extraneous Material	0.1	%	< 0.1	< 0.1	< 0.1

Client Sample ID			BH09/3.0	BH10/2.5	BH11/3.5
Sample Matrix			Soil	Soil	Soil
Eurofins Sample No.			L24-Se0064020	L24-Se0064021	L24-Se0064022
Date Sampled			Sep 19, 2024	Sep 19, 2024	Sep 19, 2024
Test/Reference	LOR	Unit			
Net Acidity (Excluding ANC)					
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO ₃ /t	< 1	< 1	< 1
Actual Acidity (NLM-3.2)					
pH-KCL (NLM-3.1)	0.1	pH Units	5.6	5.4	5.6
Titrateable Actual Acidity (NLM-3.2)	2	mol H+/t	3.0	5.0	5.0
Titrateable Actual Acidity (NLM-3.2)	0.003	% pyrite S	< 0.003	0.010	0.010
Potential Acidity - Chromium Reducible Sulfur					
Chromium Reducible Sulfur (s-SCr) (NLM-2.1) ^{S04}	0.005	% S	< 0.005	< 0.005	0.006
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	3	mol H+/t	< 3	< 3	4.0
Extractable Sulfur					
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A
Retained Acidity (S-NAS)					
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1 ^{S02}	0.005	% S	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0
Acid Neutralising Capacity (ANCbt)					
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO ₃	N/A	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2) ^{S03}	0.02	% S	N/A	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5
Net Acidity (Including ANC)					
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	< 0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	< 10	< 10
CRS Suite - Liming Rate - NASSG (Including ANC) ^{S01}	1	kg CaCO ₃ /t	< 1	< 1	< 1
Sample Properties					
% Moisture	1	%	15	10	14

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Extraneous Material - Method: LTM-GEN-7050/7070	Brisbane	Sep 27, 2024	6 Week
Chromium Suite - NASSG (Excluding ANC) - Method: LTM-GEN-7070 Chromium Reducible Sulfur Suite	Brisbane	Sep 27, 2024	6 Week
% Moisture - Method: LTM-GEN-7080 Moisture	Brisbane	Sep 25, 2024	14 Days



Perth
46-48 Banksia Road
Welshpool
WA 6106
+61 8 6253 4444
NATA# 2377
Site# 2370

Melbourne
6 Monterey Road
Dandenong South
VIC 3175
+61 3 8564 5000
NATA# 1261
Site# 1254

Geelong
19/8 Lewalan Street
Grovedale
VIC 3216
+61 3 8564 5000
NATA# 1261
Site# 25403

Sydney
179 Magowar Road
Girraween
NSW 2145
+61 2 9900 8400
NATA# 1261
Site# 18217

Canberra
Unit 1,2 Dacre Street
Mitchell
ACT 2911
+61 2 6113 8091
NATA# 1261
Site# 25466

Brisbane
1/21 Smallwood Place
Murarrie
QLD 4172
T: +61 7 3902 4600
NATA# 1261
Site# 20794 & 2780

Newcastle
1/2 Frost Drive
Mayfield West
NSW 2304
+61 2 4968 8448
NATA# 1261
Site# 25079

Perth ProMicro
46-48 Banksia Road
Welshpool
WA 6106
+61 8 6253 4444
NATA# 2561
Site# 2554

Auckland
35 O'Rorke Road
Penrose,
Auckland 1061
+64 9 526 4551
IANZ# 1327

Auckland (Focus)
Unit C1/4 Pacific Rise,
Mount Wellington,
Auckland 1061
+64 9 525 0568
IANZ# 1308

Christchurch
43 Detroit Drive
Rolleston,
Christchurch 7675
+64 3 343 5201
IANZ# 1290

Tauranga
1277 Cameron Road,
Gate Pa,
Tauranga 3112
+64 9 525 0568
IANZ# 1402

web: www.eurofins.com.au
email: EnviroSales@eurofins.com

Company Name: Galt Environment P/L
Address: 50 Edward Street
Osborne Park
WA 6017

Project Name: LAKEFARM RTT BALLAJURA
Project ID: WAG240411

Order No.: WAG240411
Report #: 1142779
Phone: 08 6272 0200
Fax: 08 9285 8444

Received: Sep 24, 2024 4:15 PM
Due: Oct 1, 2024
Priority: 5 Day
Contact Name: - ALL SRA/Results

Eurofins Analytical Services Manager : Natalie Hill

Sample Detail						Moisture Set	Chromium Suite - NASSG (Excluding ANC)
Brisbane Laboratory - NATA # 1261 Site # 20794 & 2780						X	X
External Laboratory							
No	Sample ID	Sample Date	Sampling Time	Matrix	LAB ID		
1	BH01/1.5	Sep 19, 2024		Soil	L24-Se0064012	X	X
2	BH02/2.0	Sep 19, 2024		Soil	L24-Se0064013	X	X
3	BH03/2.5	Sep 19, 2024		Soil	L24-Se0064014	X	X
4	BH04/3.0	Sep 19, 2024		Soil	L24-Se0064015	X	X
5	BH05/1.0	Sep 19, 2024		Soil	L24-Se0064016	X	X
6	BH06/1.5	Sep 19, 2024		Soil	L24-Se0064017	X	X
7	BH07/2.0	Sep 19, 2024		Soil	L24-Se0064018	X	X
8	BH08/2.5	Sep 19, 2024		Soil	L24-Se0064019	X	X
9	BH09/3.0	Sep 19, 2024		Soil	L24-Se0064020	X	X
10	BH10/2.5	Sep 19, 2024		Soil	L24-Se0064021	X	X
11	BH11/3.5	Sep 19, 2024		Soil	L24-Se0064022	X	X
Test Counts						11	11

Internal Quality Control Review and Glossary

General

- Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follow guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013. They are included in this QC report where applicable. Additional QC data may be available on request.
- Unless otherwise stated, all soil/sediment/solid results are reported on a dry weight basis.
- Unless otherwise stated, all biota/food results are reported on a wet weight basis on the edible portion.
- For CEC results where the sample's origin is unknown or environmentally contaminated, the results should be used advisedly.
- Actual LORs are matrix dependent. Quoted LORs may be raised where sample extracts are diluted due to interferences.
- Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds where annotated.
- SVOC analysis on waters is performed on homogenised, unfiltered samples unless noted otherwise.
- Samples were analysed on an 'as received' basis.
- Information identified in this report with **blue** colour indicates data provided by customers that may have an impact on the results.
- This report replaces any interim results previously issued.

Holding Times

Please refer to the 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours before sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and despite any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the sampling date; therefore, compliance with these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether, the holding time is seven days; however, for all other VOCs, such as BTEX or C6-10 TRH, the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	mg/L: milligrams per litre	ppm: parts per million
µg/L: micrograms per litre	ppb: parts per billion	%: Percentage
org/100 mL: Organisms per 100 millilitres	NTU: Nephelometric Turbidity Units	MPN/100 mL: Most Probable Number of organisms per 100 millilitres
CFU: Colony Forming Unit	Colour: Pt-Co Units (CU)	

Terms

APHA	American Public Health Association
CEC	Cation Exchange Capacity
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where moisture has been determined on a solid sample, the result is expressed on a dry weight basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples, these are performed on laboratory-certified clean sands and in the case of water samples, these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC represents the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a similar compound to the analyte target is reported as percentage recovery. See below for acceptance criteria.
TBTO	Tributyltin oxide (<i>bis</i> -tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment; however, free tributyltin was measured, and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 6.0
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should only be used as a guide and may be different when site-specific Sampling Analysis and Quality Plan (SAQP) have been implemented.

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is ≤30%; however, the following acceptance guidelines are equally applicable:

Results <10 times the LOR:	No Limit
Results between 10-20 times the LOR:	RPD must lie between 0-50%
Results >20 times the LOR:	RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range, not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%, VOC recoveries 50 – 150%

PFAS field samples containing surrogate recoveries above the QC limit designated in QSM 6.0, where no positive PFAS results have been reported or reviewed, and no data was affected.

QC Data General Comments

- Where a result is reported as less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
- Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown are not data from your samples.
- pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
- Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery, the term "INT" appears against that analyte.
- For Matrix Spikes and LCS results, a dash "-" in the report means that the specific analyte was not added to the QC sample.
- Duplicate RPDs are calculated from raw analytical data; thus, it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code	
LCS - % Recovery								
Actual Acidity (NLM-3.2)								
pH-KCL (NLM-3.1)	%	99			80-120	Pass		
Titrateable Actual Acidity (NLM-3.2)	%	104			80-120	Pass		
LCS - % Recovery								
Potential Acidity - Chromium Reducible Sulfur								
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)	%	89			80-120	Pass		
CRM - % Recovery								
Actual Acidity (NLM-3.2)								
pH-KCL (NLM-3.1)	%	101			80-120	Pass		
CRM - % Recovery								
Acid Neutralising Capacity (ANCbt)								
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	%	100			80-120	Pass		
Test	Lab Sample ID	QA Source	Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code
Duplicate								
Net Acidity (Excluding ANC)				Result 1	Result 2	RPD		
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	L24-Se0064012	CP	% S	0.02	N/A	N/A	30%	Pass
CRS Suite - Net Acidity - NASSG (Excluding ANC)	L24-Se0064012	CP	mol H+/t	13	N/A	N/A	20%	Pass
CRS Suite - Liming Rate - NASSG (Excluding ANC)	L24-Se0064012	CP	kg CaCO3/t	< 1	N/A	N/A	30%	Pass
Duplicate								
Actual Acidity (NLM-3.2)				Result 1	Result 2	RPD		
pH-KCL (NLM-3.1)	L24-Se0064012	CP	pH Units	5.1	5.0	2.0	20%	Pass
Titrateable Actual Acidity (NLM-3.2)	L24-Se0064012	CP	mol H+/t	13	14	8.0	20%	Pass
Titrateable Actual Acidity (NLM-3.2)	L24-Se0064012	CP	% pyrite S	0.020	0.020	8.0	30%	Pass
Duplicate								
Potential Acidity - Chromium Reducible Sulfur				Result 1	Result 2	RPD		
Chromium Reducible Sulfur (s-SCr) (NLM-2.1)	L24-Se0064012	CP	% S	< 0.005	< 0.005	<1	20%	Pass
Chromium Reducible Sulfur (a-SCr) (NLM-2.1)	L24-Se0064012	CP	mol H+/t	< 3	< 3	<1	30%	Pass
Duplicate								
Extractable Sulfur				Result 1	Result 2	RPD		
Sulfur - KCl Extractable	L24-Se0064012	CP	% S	N/A	N/A	N/A	30%	Pass
HCl Extractable Sulfur	L24-Se0064012	CP	% S	N/A	N/A	N/A	20%	Pass
Duplicate								
Retained Acidity (S-NAS)				Result 1	Result 2	RPD		
Net Acid soluble sulfur (SNAS) NLM-4.1	L24-Se0064012	CP	% S	N/A	N/A	N/A	30%	Pass
Net Acid soluble sulfur (s-SNAS) NLM-4.1	L24-Se0064012	CP	% S	N/A	N/A	N/A	30%	Pass
Net Acid soluble sulfur (a-SNAS) NLM-4.1	L24-Se0064012	CP	mol H+/t	N/A	N/A	N/A	30%	Pass
Duplicate								
Acid Neutralising Capacity (ANCbt)				Result 1	Result 2	RPD		
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	L24-Se0064012	CP	% CaCO3	N/A	N/A	N/A	20%	Pass
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)	L24-Se0064012	CP	% S	N/A	N/A	N/A	30%	Pass
ANC Fineness Factor	L24-Se0064012	CP	factor	1.5	1.5	<1	30%	Pass

Duplicate								
Net Acidity (Including ANC)				Result 1	Result 2	RPD		
s-CRS Suite - Net Acidity - NASSG (including ANC)	L24-Se0064012	CP	% S	0.02	0.02	8.0	30%	Pass
CRS Suite - Net Acidity - NASSG (Including ANC)	L24-Se0064012	CP	mol H+/t	13	14	8.0	30%	Pass
CRS Suite - Liming Rate - NASSG (Including ANC)	L24-Se0064012	CP	kg CaCO3/t	< 1	1.0	8.0	30%	Pass
Duplicate								
Sample Properties				Result 1	Result 2	RPD		
% Moisture	L24-Se0064017	CP	%	6.3	6.4	1.0	30%	Pass

Comments
Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	N/A
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
S01	Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil' multiply 'reported results' x 'wet bulk density of soil in t/m3'
S02	Retained Acidity is Reported when the pHKCl is less than pH 4.5
S03	Acid Neutralising Capacity is only required if the pHKCl is greater than or equal to pH 6.5
S04	Acid Sulfate Soil Samples have a 24 hour holding time unless frozen or dried within that period

Authorised by:

Natalie Hill	Analytical Services Manager
Jonathon Angell	Senior Analyst-Sample Properties
Jonathon Angell	Senior Analyst-SPOCAS



Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please [click here](#).

Eurofins shall not be liable for loss, cost, damages or expenses incurred by the client, or any other person or company, resulting from the use of any information or interpretation given in this report. In no case shall Eurofins be liable for consequential damages including, but not limited to, lost profits, damages for failure to meet deadlines and lost production arising from this report. This document shall not be reproduced except in full and relates only to the items tested. Unless indicated otherwise, the tests were performed on the samples as received.

Standard Geotechnical Definitions, Recommendations, Requirements and Limitations

GDR1 ABOUT THIS APPENDIX

These technical notes are to be read with the attached report. These notes contain important information regarding the study in the attached report, and the report cannot be considered in isolation without full reading of these notes.

Where there are conflicts between this appendix and the report text, the report text takes precedence.

Unless noted otherwise, geotechnical investigations are conducted in accordance with AS1726-2017, "Geotechnical site investigations".

Unless noted otherwise, the report does not include any assessment (or implied assessment) of karst risk.

GDR2 DEFINITIONS

The following definitions apply:

- **Approved Fill** – fill that has been assessed and approved by the geotechnical engineer or civil designer for a particular purpose.
- **Bulk Fill** – Controlled fill intended to support future infrastructure, but potentially lacking some engineering properties required for upper fill layers or adjacent to structures, where fill with specific properties may be required. Contrast with Select Fill.
- **Civil Design** – the engineering design of the earthworks including surface water and erosion control and subsurface drainage control (where required) to achieve an earthworked, drained site which is capable of supporting the proposed development (including target site classification to AS2870, where relevant). This design is separate to this geotechnical investigation and is a required element of a site development.
- **Clay** – A component of a soil with particles smaller than 0.002 mm in size.
- **Cohesionless (Non-cohesive) Soil** – A soil mass that has does not hold together at low applied stress levels. The strength of the soil depends solely on friction between particles.
- **Cohesive Soil** – A soil mass that has holds together and can adhere to itself.
- **Collapsible Soil** – a soil with high void ratio that is typically strong when dry but loses strength and consolidates under constant stress when wetted, usually due to loss of soil matric suction or dissolving of a chemical cementing agent.
- **Compaction** – The process of increasing the soil density, typically be mechanical means.
- **Competent Person** – A person who has, through a combination of training, education and experience, acquired knowledge and skills enabling that person to correctly perform a specified task.
- **Consistency** – The stiffness of a cohesive soil, at specific moisture contents, to resist mechanical stress or manipulation (remoulding).
- **Controlled (or engineered) Fill** – Any fill for which engineering properties are controlled during placement. Also referred to as structural fill.
- **Dense** – with respect to sandy soils, at a relatively high density index or dry density ratio, exhibiting better engineering parameters with respect to strength and stiffness than the same material at a lower density index.
- **Density** – A measure of the mass of material per unit volume.
- **Eccentric Load** – a load incorporating either a varying vertical load and/or a horizontal load such that the peak vertical stress exceeds the average vertical stress.
- **Fill** – Any material that has been placed by anthropogenic processes.
- **Fines** – A component of a soil with particles smaller than 0.075 mm in size.
- **Groundwater** – Water located beneath the earth's surface in pore spaces, fractures and voids in soil or rock.
- **Gravel** – A component of a soil with particles between 2.36 mm and 63 mm in size.

- **Heavily Loaded** – in reference to mobile plant, particularly intended for equipment where ground bearing pressures exceed 50 kPa and/or equipment has a high centre of gravity and could be prone to toppling. In reference to buildings/structures, where footing pressures exceed 100 kPa and/or footing dimensions exceed 1 m wide.
- **Hydraulic Conductivity** – ratio of volume flux to hydraulic gradient – a quantitative measure of soil's ability to transmit water when subjected to a hydraulic gradient. k_{sat} – saturated hydraulic conductivity, intended for dewatering assessment, subsoil drainage design and other engineering assessments where saturated soils are relevant. k_{unsat} – unsaturated hydraulic conductivity, intended for design of stormwater disposal elements such as soakwells and infiltration basins, where the base of disposal elements is above the groundwater level.
- **In situ** – In the place and condition in which it exists naturally. May also refer to fill that is present at any site prior to an investigation taking place.
- **Limestone** – A sedimentary carbonate rock. The use of the term does not infer a specific strength, carbonate content or grain size. Refer to GDR4.1 for further detail.
- **Loose** – with respect to sand soils, at a relatively low density index or dry density ratio, typically indicating poorer engineering parameters with respect to strength and stiffness than the same material at a higher density index.
- **Material** – Matter that meets the definitions of 'soil', 'rock', other engineered matter (i.e., concrete, bricks etc.) or non-engineered matter (organics, contaminated refuse, deleterious material).
- **May** – Indicates that the statement is an option.
- **Must** – Indicates that the statement is mandatory.
- **Natural** – In the context of soil or rock, material which is present as a result of natural geological processes and has not been subject to anthropogenic engineering processes (such as filling, excavation, replacement, etc).
- **Organic** – In the context of soil, material derived from living matter, primarily plants.
- **Overconsolidated** – a soil that has been subjected to a greater vertical stress than its current state.
- **Permeable Soil** – soil that meets the civil design permeability requirements to allow relatively rapid flow of water through the soil matrix.
- **Rock** – Any aggregate of minerals and/or materials that cannot be disaggregated by hand in air or water without prior soaking.
- **Sand** – a component of soil with particle size between 0.075 mm and 2.36 mm.
- **Select Fill** – a controlled fill which has been chosen for particular engineering characteristics (such as strength, CBR, grading, permeability, etc), commonly for use as a higher-grade capping layer or adjacent to structures. Contrast with Bulk Fill.
- **Shall** – Indicates that the statement is mandatory.
- **Should** – Indicates that the statement is a recommendation.
- **Silt** – A component of a soil with particles between 0.075 mm and 0.002 mm in size.
- **Soil** – Particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking.
- **Sand** – A component of a soil with particle between 0.075 mm and 2.36 mm in size.
- **Uncontrolled Fill** – Any material that has been deposited by anthropogenic process, which does not meet the definition of 'controlled fill'.

GDR3 GEOTECHNICAL TEST METHODS AND INTERPRETATION

GDR3.1 Test Pit Excavation

Test pit excavations are formed using mechanical excavation equipment (typically an excavator) or hand dug, with the objective of inspecting (or profiling) the soil exposed in the excavation.

Typical limitations on test pit excavations are:

- Limited depth of excavation – typically governed by reach of the excavator arm.
- Cannot be excavated below groundwater in cohesionless soils, due to collapse and water ingress.
- Cannot be excavated through very stiff / very dense soils (i.e., desiccated clays or cemented soils) or most rock.
- Cannot typically obtain rock samples that are suitable for strength testing.

Test pits are usually mechanically excavated with a toothed bucket (intended for excavation in clay or weak rock) or a flat-edged bucket (typically for sands).

When hand-dug test pits are excavated, it is usually for recovery of near-surface soils or inspection of shallow in-ground elements.

We note that where test pits are excavated on a site, they are only ever loosely backfilled during our studies. They must always be located during site preparation works, over-excavated to their full depth and plan extents and re-filled with approved fill in compacted layers.

GDR3.2 Cone Penetration Tests (CPTs)

Cone penetration testing (CPT) is done by Galt or specialist contractors and typically to AS1289.6.5.1. The test involves pushing an instrumented cone into the soil with a hydraulically operated pushing frame. The test measures tip resistance and sleeve friction on the cone, which are then plotted with depth.

We interpret soil types and associated geotechnical soil parameters from CPT data using the following:

Technical Interpretations and International Guides

- Robertson P.K., Campanella R.G., Gillespie D. and Grieg J. (1986). "Use of piezometer cone data". Proceedings of the ASCE Speciality Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, pp 1263-80, American Society of Civil Engineers (ASCE).
- Robertson, P.K., Cabal K.L. (2016) "Guide to Cone Penetration Testing for Geotechnical Engineering 6th Edition 2015". Gregg Drilling & Testing, Inc., California.
- Baldi G., Bellotti R., Ghionna V.H., Jamiolkowski M., Lo Presti D. C. (1989) "Modulus of sands from CPTs and DMTs". Proc. 12th Int. Conf. on SMFE, Rio de Janeiro, Vol 1, p165-170, Balkema, Rotterdam.

Local (Perth and Western Australia) Research, Interpretation and Guides

- Fahey, M., Lehane, B., Stewart, D. (2003) "Soil stiffness for shallow foundation design in the Perth CBD". Australian Geomechanics Vol. 8 No. 3.
- Main Roads Western Australia (MRWA) (2009) "Structures Engineering Design Manual". Document 3912/03, Perth.
- Lehane B. (2017). "CPT-Based Design of Foundations", E.H. Davis Memorial Lecture, Australian Geomechanics, Vol 54. No. 4' and
- Galt's in-house correlations between CPT data and other geotechnical testing.

GDR3.3 Borehole Drilling

Boreholes are drilled for sampling of the soil and rock, with a small disturbance footprint. Typical techniques are:

- Auger drilling (hand auger or machine auger) – for recovery of soil at relatively shallow depths only. Cannot penetrate cemented soils or rock.
- Push probe drilling – for recovery of soil at relatively shallow depths and below groundwater. Cannot penetrate cemented soils or rock.
- Air core drilling – for recovery of soil, cemented soil and rock (typically up to high strength rock). Not suited to drilling of very high strength rock.
- Diamond coring (or rotary coring) – for recovery of cemented soil, rock and some soil types (typically not sand). Suited to all strengths of rock.

If used, standard penetration tests (SPTs) are done in accordance with AS1289.6.3.1. Correlations for consistency and density are based on:

- Standards Australia (2016), “HB160-2006, Soils Testing”.

GDR3.4 Dynamic Cone Penetrometer (DCP)

The DCP is a hand-held tool for assessing penetration resistance of a soil. This comprises a 16 mm rod equipped with a 20 mm cone, hammered into the ground using a falling 9 kg weight on a 510 mm slide hammer on the top of the rod. This is done in accordance with AS1289.6.3.2 and the blow counts to hammer in the rod are measured in 100 mm penetration increments. Where provided, correlations for consistency and density are based on:

- Standards Australia (2016), “HB160-2006, Soils Testing”.

GDR3.5 Perth Sand Penetrometer (PSP)

The PSP is a variation on a DCP and uses a 9 kg weight on a 600 mm slide hammer to hammer in a 16 mm rod with a blunt (square-faced) end. Testing is done in accordance with AS1289.6.3.3, with the following typical variations:

- Testing is often done to a greater depth than the 450 mm covered in the standard.
- Blow counts are sometimes recorded in 150 mm intervals (compared to 300 mm intervals used in the standard) to provide better resolution on the tests.

Where provided, correlations for density are based on:

- Standards Australia (2016), “HB160-2006, Soils Testing”.

GDR3.6 Dynamic Probing Super Heavy (DPSH)

The DPSH test involves driving a solid cone (20 cm²) into the ground using a 63.5 kg hammer falling 760 mm. Testing is done in accordance with EN ISO 22476-2 – Geotechnical engineering – Field testing – Part 2: Dynamic probing – DPSH-B.

Results may be presented as either:

- N10 (No. of blows required for every 100 mm penetration);
- N30 (No. of blows required for every 300 mm penetration); or
- q_d (dynamic tip resistance, analogous to CPT q_c).

GDR3.7 Inverse Auger Hole Infiltration Test (Falling Head, Unsaturated Soil)

Infiltration tests are carried out using the ‘inverse auger hole’ method described by:

- Cocks, G (2007), “Disposal of Stormwater Runoff by Soakage in Perth Western Australia”, Journal and News of the Australian Geomechanics Society, Volume 42 No. 3, pp 101-114

This test is an unsaturated falling head test, in that it is carried out above the groundwater table and is intended to mimic the behaviour of soak wells and similar drainage elements (i.e. soakage basins), which discharge stormwater into an unsaturated medium.

The hole is wetted only for a short period prior to the testing.

The test is usually repeated three times, with the intention that the second and third tests provide similar results (within about 10%-20%). Tests are done over a short duration, typically 2 minutes to 10 minutes. The focus of the testing is generally when the head is low (200 mm or lower), such that the relevant lateral zone is as saturated as the zone directly below the borehole.

The hydraulic conductivity derived from this test is not to be used for applications where saturated hydraulic conductivity is relevant, e.g.:

- Subsoil drainage design; and
- Dewatering estimations.

Based on Galt's in-house research, this method does not completely saturate the soil in any reasonable test length, and thus may not be suitable for assessment of soils at sites where the critical drainage condition is a fully saturated soil (i.e., in areas with high groundwater tables). Our research on sand sites indicates that the test does correlate well with actual soak well performance, in unsaturated sand zones without impermeable zones.

GDR3.8 Guelph Permeameter Test (Constant Head, Quasi-Saturated Soil)

The Guelph permeameter test, conducted in accordance with the constant head test method outlined in Appendix G of AS1547, is a constant-head test in nominally "saturated" soil (in that the test is conducted until a "steady state" is reached). However, we note that this test can only be done above the groundwater table and as such, is in an unsaturated zone. Therefore, the hydraulic conductivity derived from this test should be used with caution and evaluated against other test methods (such as saturated, constant-head permeability testing from laboratory samples, or in situ saturated hydraulic conductivity testing below the groundwater table).

GDR4 GEOLOGICAL UNITS

GDR4.1 Limestone

The term 'Limestone' is used to describe a carbonate rock. Tamala Limestone is the common limestone in Western Australia, and typically comprises cemented quartz and shell fragments cemented together by calcium carbonate.

Limestone can vary significantly across short distances in composition, strength and cementation. Tamala limestones in Western Australia also have known possible geological features including:

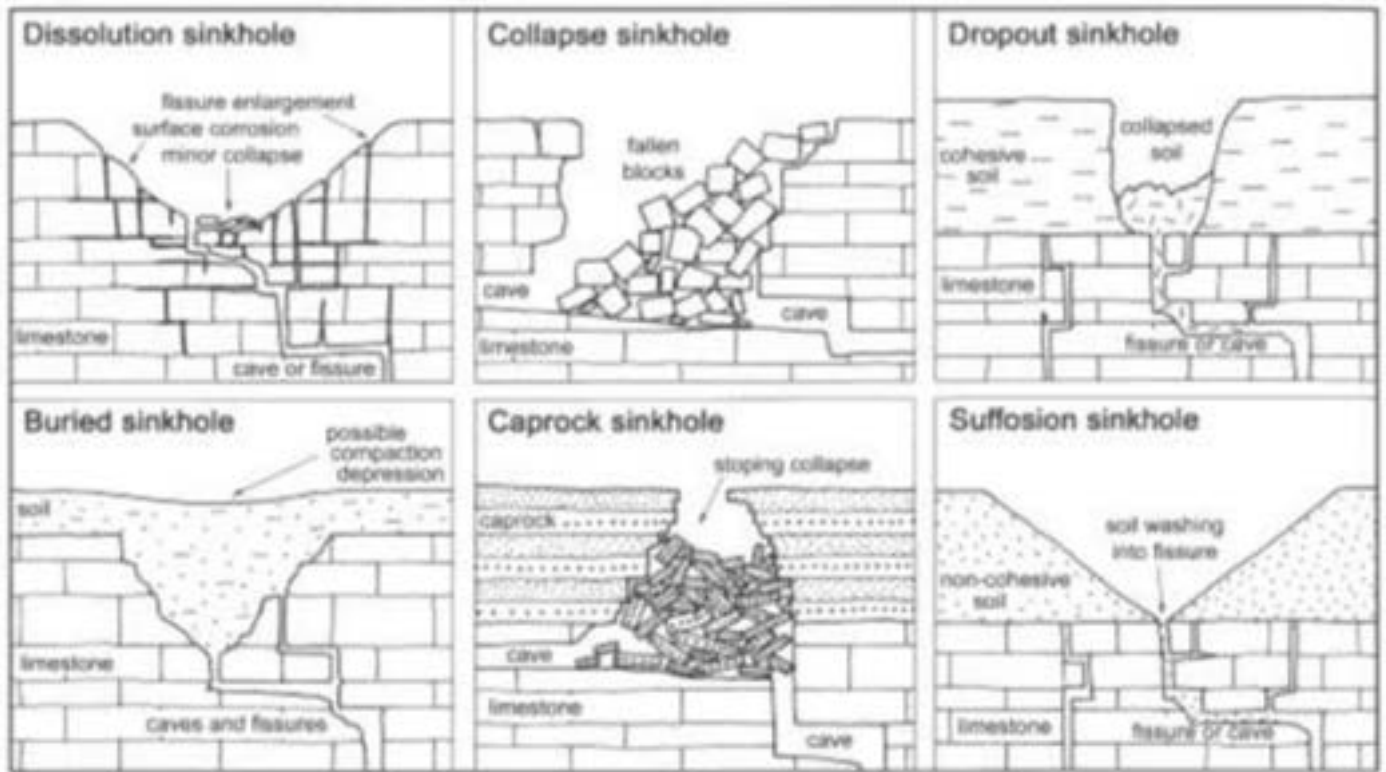
- Caprock/calcrete – The formation of a very hard duricrust, usually due to sun exposure. Caprock may be up to 3 m thick, but typically around 1.5 m thick. Caprock is very difficult to excavate and may require the use of hydraulic rock breakers or rock saws to excavate.
- Solution features/tubes – Often initially formed due to the presence of Eucalypt and Jarrah roots during limestone formation, and often increasing in depth and size due to ongoing weathering. May be up to 500 mm in diameter. These are typically filled with very loose, unconsolidated sand.
- Pinnacles – Pinnacles are usually the limestone that is left around surrounding solution features. Often can comprise very hard limestone/caprock that can be substantially higher than surrounding areas. Pinnacles may have also been formed by surrounding erosion (i.e., wind/water).
- Karst/caves – Karst is caused by the dissolution of limestone, typically where there is interaction in low-lying areas with water and limestone. Karst manifests itself as loose near-surface sand with cavities (caves) in the underlying limestone. This can lead to sinkholes and collapse of overlying structures.

Inline images showing typical pinnacle/solution features and Karstic features follow. These are taken from:

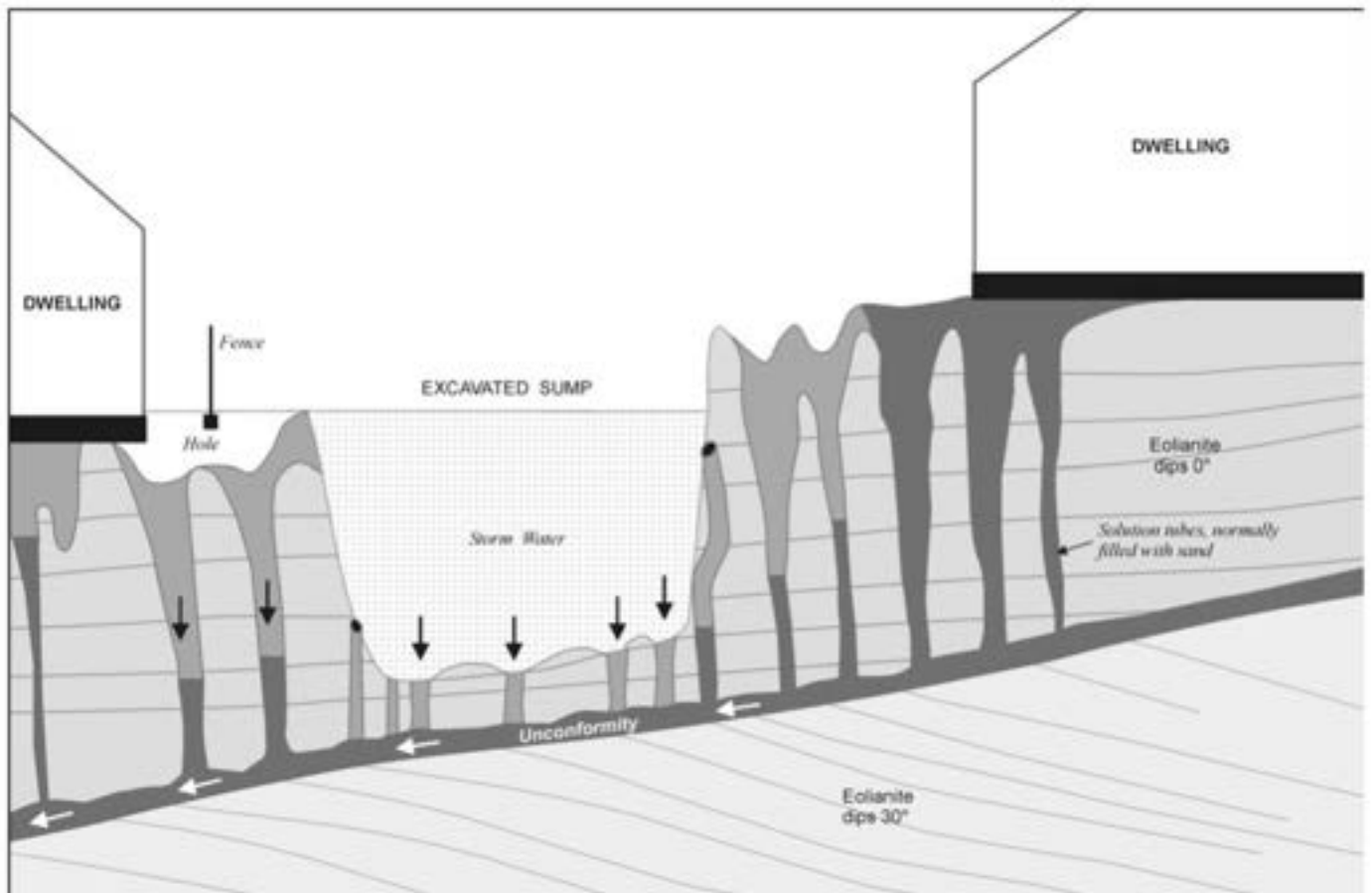
- Gordon, R. (2003). "Coastal Limestones". Australian Geomechanics Vol.38 No. 4, The Engineering Geology of Perth.

- Waltham, A. & Fookes, P. (2003). "Engineering Classification of Karst Ground Conditions: Quarterly Journal of Engineering Geology and Hydrogeology, Vol 36.

Inline Image GDR 1 - Karstic Sinkhole Features from Waltham and Fookes (2003)



Inline Image GDR 2: Pinnacle/Solution Features from Gordon (2003)



GDR4.2 Pindan Sands and Collapsible Soils

In the Western Australian context, Pindan sands are sandy soils present predominantly across the Pilbara and Kimberley regions. Pindan sands are typically:

- Red brown in colour.
- Between 10% and 40% fines.
- Of aeolian origin, usually resulting in unconsolidated in situ conditions (nuclear density gauge testing often indicates these soils have in situ density ratios of 80%-85% of modified maximum dry density).
- Very strong when dry due to high soil suctions in the fine fraction, which create strong bonds between the sand particles.

As the grains are usually held in place by the dry fine fraction, this can lead to:

- very high settlements (i.e., “collapse”) as the grain-to-grain bonds are weakened as matric suction decreases on soaking; and
- loss of vertical and horizontal strength/stiffness as the grain-to-grain bonds weaken.

The risks associate with Pindan sands are usually quantified in terms of the collapse potential/magnitude of possible collapse events.

Other similar soils are present in Western Australia that may exhibit similar collapse potential and may not strictly be Pindan sands (i.e., have other grain-to-grain bonding mechanisms).

GDR5 SITE CLASSIFICATION

Site classification refers to the assessment of a site in reference to AS2870-2011, “Residential slabs and footings”. The method for assessing the site class is outlined in Section 2 of AS2870-2011, which indicates that this may be done by:

- assessing the characteristic surface movement, due to seasonal moisture changes in the soil profile;
- assessing the performance of existing foundations; or
- assessment of the soil profile (where there are deleterious inclusions, landfill, putrescible waste etc.).

The site classifications based on the expected characteristic surface movement are summarised in Table GDR 1.

Table GDR 1: Summary of Site Classifications (AS2870-2011)

Class	Description	Characteristic Surface Movement (y_s)
A	Most sand and rock site with little or no ground movement from moisture change	Not Defined (typically <5 mm)
S	Slightly reactive clay sites with only slight ground movement from moisture changes	0 – 20 mm
M	Moderately reactive clay sites, which may experience moderate ground movements from moisture change	20 – 40 mm
H1	Highly reactive sites, which may experience high ground movements from moisture change	40 – 60 mm
H2	Highly reactive sites, which may experience very high ground movements from moisture change	60 – 75 mm
E	Extremely reactive sites, which may experience extreme ground movements from moisture change	>75 mm
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise	Not Defined

The calculated characteristic surface movement is predominantly based on:

- the reactivity (i.e., the shrink-swell potential) of the soil (and any proposed fill);

- the design depth of soil suction change, which is the maximum expected depth of soil suction change due to seasonal soil moisture changes; and
- the depth to any bedrock and groundwater table.

The design depth of soil suction change for Western Australia has been refined using the Thornthwaite Moisture Index (TMI). We have carried out assessment using the depths as detailed in:

- Hu Y, Saraceni P, Cocks G, Zhou M (2016). "TMI assessment and climate zones in Western Australia". Australian Geomechanics Journal, Vol.51 No.3.
- Hu Y, Raj A, Cocks G, Verheyde F (2019). "Re-assessment of TMI based climate zones in metropolitan Perth, WA". ANZ Geomechanics Conference 2019, Perth Australia.

The design depth of soil suction change for Northern Territory is based on the research presented in:

- Jackson, S (2022), "Thornthwaite moisture index and climate zones in the Northern Territory", Australian Geomechanics Journal, Vol. 57 No. 3.

We highlight that AS2870-2011 does not make any reference to the fines content of a soil when assessing the site classification.

Where a site classification is provided in our reports, it is always predicated on the requirement that the recommended site preparation procedures are carried out.

We also highlight that the footing performance and shrink-swell movements of a site can be impacted by the planting or removal of trees. This should be considered where appropriate, and we refer to the CSIRO BTF 18-2011 "Foundation Maintenance and Footing Performance: A Homeowner's Guide" for further information.

AS 2870 is limited to single and double storey residential buildings with normal shallow footings with a maximum bearing pressure of 100 kPa and is not applicable where development types other than this are proposed.

GDR6 SITE PREPARATION

GDR6.1 General

The intent of the site preparation guidelines provided in the above report are to ensure that the earthworks can be constructed to meet specific requirements, i.e., minimum compaction, fill requirements, removal of unsuitable material etc. The site preparation guidelines are not exhaustive, and on-site conditions may dictate that other preparation measures may be required to meet geotechnical requirements.

GDR6.2 Site Preparation

Site preparation measures outlined in this section relate to bulk earthworks at the site in preparation for the construction of buildings, pavements and other structures.

The preparation of a site in accordance with outlined measures below or those presented in the report text does not imply that the site is suitable for heavily loaded plant or eccentric loads. This is especially applicable for working platforms for mobile plant including cranes, crawlers or the like. The site surface may still not be trafficable for mobile plant. Individual working platform assessments must be done if heavily loaded mobile plant are proposed.

GDR6.2.1 Common Measures

The common measures outlined below are to prepare standard sites in advance of proof compaction, bulk excavation and filling. These measures are applicable to most sites, however the applicability of these measures is stated in the main report.

Table GDR 2: Common Measures

Measure	Commentary
Demolish and remove structures and pavements	Demolish existing structures and pavements, including removal of all buried services and footings and dispose off-site.
Remove demolition debris and other deleterious material	Remove any demolition debris and other deleterious material from site including old footings, slabs, soak wells, buried services, paving and building rubble.
Strip uncontrolled fill (where present)	Strip any uncontrolled fill from the site (where encountered) and, if suitable, stockpile it for potential re-use as non-structural fill. If contaminated, dispose off-site. Refer to the report text for discussions on the presence of detected uncontrolled fill and its composition. It is important to realise that undetected uncontrolled fill may be present between test locations and the absence of its identification in our report does not preclude its presence. If uncontrolled fill is detected during site works, please contact us for inspection and to provide recommendations.
Remove trees	All tree roots must be removed, this may result in significant excavation in places. Where tree roots and stumps are removed, the disturbed soil must be over-excavated and replaced with controlled, compacted fill. Backfilling of over-excavations is discussed in the following sections .
Strip and stockpile topsoil.	Strip and stockpile topsoil from unpaved areas of the site for potential re-use in non-structural applications. The topsoil strip is only necessary to remove roots and we recommend a topsoil strip as necessary to remove all roots from the soil.
Carry out bulk excavation	Excavate to the required level. Stockpile suitable excavated material for potential re-use as fill (the re-use of spoil as fill , if appropriate, is discussed in the report text) and remove unsuitable or excess material off-site.
Batter edges of excavation	Excavations should be battered to a temporary slope as given in the report text where applicable and not in close proximity to adjacent structures etc. If required, construct temporary/permanent retaining walls where batters cannot be accommodated.

By following these measures, the site should have been prepared to a point where topsoil and vegetation has been removed to expose either natural soil or controlled fill. Over-excavation to the required levels may then be required for some projects. Once complete, the site is now ready for proof compaction and filling.

GDR6.2.2 Sand Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by sand.
- No collapsible soils present.
- No deep loose sand.
- Compaction of a loose upper horizon to maximum 1 m depth.
- No shallow groundwater (<1 m deep).
- No limestone or other rock present at shallow depth.
- “Common Measures” outlined in Section GDR6.2.1 have been completed (as required).

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings, pavements and any other settlement-sensitive infrastructure is proposed.

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 3: Sand Site Measures

Measure	Commentary
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must not assume that the use of the PSP is appropriate.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with Approved Fill as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where fill is required to build up levels, use Approved Fill , placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction to achieve the density specified in Section GDR7.1.

In following this method, shallow/surficial loose sand will be compacted, and the site will be filled (where required) in preparation for supporting footings, ground slabs, pavements and the like.

GDR6.2.3 Deep Loose Sand Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by sand.
- Collapsible soils or deep loose sand present (if applicable, this is discussed in the report).
- Over-excavation, compaction and replacement of loose sand required.
- No shallow groundwater (<1 m deep).
- No limestone or other rock present at shallow depth.
- "Common Measures" outlined in Section GDR6.2.1 have been completed.

The greatest depth of compaction that can be achieved with standard compaction equipment (vibrating roller, etc) is around 1 m (for sands). As such, it is necessary to cut down the site level to a point where this compaction can be done to the lowest level needed to be improved.

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings and any other settlement-sensitive infrastructure are proposed. Not typically required for pavement subgrades, however, this is discussed in the report if required.

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 4: Deep Loose Sand Site Measures

Measure	Commentary
Over-excavate to the required depth.	Over-excavate sand soil to the depth stated in the report and, if appropriate (discussed in report) retain it for re-use as fill. Over-excavation is likely to be done in stages depending on the site area available for earthworks. Excavations must be battered to a temporary slope as given in the report text where applicable and not in close proximity to adjacent structures etc. If required, construct temporary/permanent retaining walls where batters cannot be accommodated.
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must not assume that the use of the PSP is appropriate.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted Approved Fill as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.

Measure	Commentary
Carry out bulk filling	Where fill is required to build up levels (including restoration of the site surface level to the original level), use Approved Fill , placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction as specified in Section GDR7.1.

In following this method, deep, loose sand will be compacted to a sufficient depth to reduce settlement impacts and the site will be filled (where required) in preparation for supporting footings, ground slabs, pavements and the like.

GDR6.2.4 Clayey Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by cohesive soils (typically >12% fines, i.e., clayey enough for the fines proportion of the soil to dominate behaviour).
- No collapsible soils present.
- No deep soft soils or organic soils.
- Over consolidated clayey soils present which will not be subject to significant primary or secondary consolidation (settlements expected to be within the limit of typical seasonal movements occasioned by moisture content changes, which would be captured in assignment of an AS2870 site classification).
- No shallow groundwater (<1 m deep)
- No rock present at shallow depth.
- “Common Measures” outlined in Section GDR6.2.1 have been completed.

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings, pavement subgrades and any other settlement-sensitive infrastructure is proposed.

Unless specified otherwise in the report, the **Approved Fill** to be used is **Clay** as outlined in Section GDR8.

Table GDR 5: Clay Site Measures

Measure	Commentary
Moisture condition and proof compact.	Moisture condition and compact the exposed clayey ground to achieve the density specified in Section GDR7.1 (“fine grained soils”) to a depth of at least 300 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 (“fine grained soils”) has been achieved to a depth of at least 300 mm. The use of a penetrometer for compaction control of cohesive soils is not an appropriate substitute for in situ NDG testing.
Treat areas of loose or unsuitable material	Any areas of soft clayey soils or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted Approved Fill . The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where excavations are done into clayey soils (e.g. to treat soft zones, remove root balls and the like), they must not be backfilled filled with sand fill (even where a sand topping layer is proposed). Where fill is required (including backfilling of excavations to remove trees), only use Approved Fill , moisture conditioned, placed and compacted in layers of no greater than 300 mm loose thickness. Test moisture and compaction as specified in Section GDR7.1.
Grade completed clayey surface	Surface water control is essential for clayey sites. This also applies to control of infiltrated water into sand topping layers or the like. The surface of clayey ground must be graded at a minimum of 1% crossfall to drain. This is a general recommendation and an appropriate civil design must be done to account for surface and subsoil drainage.
Install sand topping layer	Where a sand topping layer is proposed, this should be done as outlined in Section GDR6.2.5.

These measures do not take into account the objectives of the civil design for the site, particularly with regard to surface water drainage and groundwater control (including clay grading, subsoil drainage, thickness and composition of a sand topping layer and the like). This must be taken into account by the civil designer. General commentary on drainage control measures is presented in Section GDR14.

GDR6.2.5 Sand Topping Layer

Where a sand topping layer is required:

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 6: Sand Topping Layer Measures

Measure	Commentary
Prepare Substrate	Prepare the clayey or other substrate as separately outlined prior to installing the topping layer.
Build up sand topping layer	Build up level to the required level with Approved Fill , placed and compacted in layers of no greater than 300 mm loose thickness to achieve the density specified in Section GDR7.1.

For the purposes of achieving the allowable bearing pressures and site classification discussed in the report, it is not necessary to have the bases of slabs and footings in the sand topping layer, i.e. if required, they may extend through the sand topping layer into clayey soil below.

GDR6.2.6 Limestone Sites

The preparation measures outlined below are provided for sites underlain by limestone (refer to Section GDR4.1), meeting the following criteria:

- Site underlain by sand overlying limestone.
- Compaction of a loose upper horizon to maximum 1 m depth, with localised deeper treatments between pinnacles if required.
- No shallow groundwater (<1 m deep)
- “Common Measures” outlined in Section GDR6.2.1 have been completed.

The site preparation measures outlined below are aimed at improvement of the site in preparation for construction of the structures including on-ground slabs, shallow footings, retaining walls and pavements.

Unless specified otherwise in the report, the **Approved Fill** may comprise one of the following as specified in Section GDR8 (the specific selection is subject to the requirements of the civil designer):

- **Permeable Sand** where permeable fill is required
- **General Sand** where permeable fill is not required
- **Mixed Sand/Limestone Fill** where permeable fill is not required

The re-use of any limestone for fill is subject to the requirements of the civil design and discussions in the report text. The use of **Mixed Sand/Limestone Fill** is discussed in Section GDR6.2.7. The preparation measures outlined in Table GDR 7 assume sand fill.

Table GDR 7: Standard Limestone Site Measures (Bulk Earthworks)

Measure	Commentary
Treat zones of loose sand	Where deep loose sand is present (particularly, but not exclusively, between limestone pinnacles), over-excavate to the depth as noted in the report. Sand should be retained for re-use as fill if recommended in the report. Limestone debris and pinnacles should be separated and only re-used if recommended in the report.
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm. Proof compaction of intact limestone is not required.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must not assume that the use of the PSP is appropriate. If refusal to the test method is encountered within the target test depth on limestone and the results to the refusal depth are acceptable, it is not necessary to repeat compaction testing at that location. Compaction control of intact limestone is not required.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted Approved Fill as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where fill is required to build up levels, use Approved Fill , placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction to achieve the density specified in Section GDR7.1.

These measures do not take into account the specifics of the civil design, including the requirement (if any) for excavatable and/or free draining layers to achieve construction and drainage objectives. The civil design must take precedence and is not specifically considered in this advice.

Soakwells can perform poorly in limestone and specific advice may apply to the installation of soakwells in limestone areas. If not discussed in our report, please contact us for further advice.

Without further consultation with the structural designer, footings for any one structure must not be founded on a mixture of sand and intact limestone. This is due to potential differential settlements between limestone zones (relatively stiff) and soil zones (relatively soft). Where this is the case, the measures outlined in Table GDR 8 must be followed, only with guidance from the structural designer and Galt.

Table GDR 8: Standard Limestone Site Measures (Footing and Slab Preparation)

Measure	Commentary
Excavate and compact for slabs, subgrades, pad or strip footings	Excavate for pad and strip footings. Where a mix of soil and limestone is present below any one structure, one of the following must be done (to be agreed with structural designer and us): <ul style="list-style-type: none"> ▪ Over-excavate limestone and replace with compacted soil: Typically where the foundation largely comprises soil and a relatively small amount of limestone is present. Where footings and slabs are founded partly on soil and partly on limestone, over-excavate the limestone by at least 300 mm below the base of footing or slab and replace the excavated material with compacted Approved Fill. ▪ Remove soil from over limestone and replace with concrete: Typically where the foundation largely comprises limestone and a relatively small amount of soil is present. Localised zones of sand and mixed sand/limestone rubble must be removed and replaced with lean-mix concrete, e.g. 10 MPa blinding concrete. ▪ Design the structure to accommodate differential foundation movements: For example, include construction joints or use a more heavily reinforced footing (subject to the structural designer's requirements).
Test compaction of footing bases, slabs or subgrades.	Compact the exposed bases to achieve the density specified in Section GDR7.1 ("sand"), to a depth of at least 900 mm, or to the depth where limestone is intersected. If refusal to the test method is encountered within the target test depth on limestone and the results to the refusal depth are acceptable, it is not necessary to repeat compaction testing at that location. Compaction control of intact limestone is not required. Remove, replace and compact as required with approved fill any zone not achieving the density specified in Section GDR7.1 ("sand")

GDR6.2.7 Mixed Sand/Limestone Filling

On sites where deemed appropriate by the Civil Design, **Approved Fill** may comprise limestone rubble fill (**Mixed Sand/Limestone**, as specified in Section GDR8).

The preparation measures outlined below are provided for sites meeting the following criteria:

- No shallow groundwater (<1 m deep)
- “Common Measures” outlined in Section GDR GDR6.2.1 have been completed.
- Substrate preparation for the relevant site type has been done in preparation for further filling (as relevant for sand, limestone or clayey sites discussed in the preceding sections).

The site preparation measures outlined below are required prior to construction of structures including on-ground slabs, shallow footings, retaining walls and pavements.

Table GDR 9: Mixed Sand/Limestone Fill Measures

Measure	Commentary
Develop a method specification for the filling	A performance specification is not appropriate for compaction control in Mixed Sand/Limestone fill, due to oversized limestone particles and the limitations of test methods. Therefore, a method specification is required. Development of a method specification is discussed in Section GDR7.5. A tentative method specification for Mixed Sand/Limestone Fill preparation is also provided.
Carry out bulk filling	Where fill is required to build up levels, use Approved Fill , placed and compacted in accordance with the developed method specification.
Maintain Construction Records	As performance testing cannot be done, quality assurance records are limited. Therefore, the parameters mentioned in Section GDR7.5.1 must be kept in a comprehensive record of the earthworks done to the developed method specification. The use of the PSP is possible <u>only to check for loose sand zones between limestone particles</u> . High PSP blow counts, where limestone particles are intersected, are meaningless in terms of assessing density of the prepared fill. The primary means of validation of the earthworks is conformance with the developed method specification.
Install sand topping layer	Where a sand topping layer is proposed, this should be done as outlined in Section GDR6.2.5.

These measures do not take into account the specifics of the civil design, including the requirement (if any) for excavatable and/or free draining layers to achieve construction and drainage objectives. The civil design must take precedence and is not specifically considered in this advice.

Soakwells can perform poorly in limestone fill and specific advice may apply to the installation of soakwells in limestone fill areas. If not discussed in our report, please contact us for further advice.

GDR6.3 Guidance on Sites with Cohesive Soils

Cohesive soils (most commonly, “clayey” soils) require careful moisture conditioning to facilitate compaction. We recommend that the moisture content of the material is between optimum moisture content (OMC) and 2% wet of OMC at the time of placement and compaction. We note that compaction to the densities specified in Section GDR7.1 can be difficult to achieve for clayey material when not appropriately moisture conditioned.

Vibratory padfoot rollers are preferred for compacting cohesive fill to promote proper kneading and interlocking of subsequent layers.

Clayey soils will drain poorly when inundated following rain events and result in saturated conditions that may inhibit compaction of the soil. In general, it is preferable to avoid trying to re-work clayey sites within several days of any substantial rainfall.

We recommend that the surfaces of clayey sites are sealed by compaction (i.e., final compaction should be with a smooth drum roller) and graded to drain (to avoid low spots where water can pond and cause softening) prior to any

rain events. Stripping back of softened materials to expose competent natural or compacted clayey soil is required before continuing earthworks.

If difficulties are experienced during compaction due to water, further advice should be sought from a geotechnical engineer.

GDR6.4 Preparation and Testing of Shallow Footings

It is preferable to dig all footing excavations carefully with a flat-edged bucket to minimise the disturbance of underlying foundation soil.

Where the footing base is disturbed, or compaction is required, this must be done using appropriate compaction equipment particular to the task (as evaluated by the contractor) – typically a ‘jumping jack’, self-propelled plate compactor or an excavator-mounted plate compactor.

All footing bases must be tested to achieve the density requirements of Section GDR7.1. PSP testing of sand foundations is only applicable where the use of the PSP is specifically approved in the report, otherwise all testing is to be done using the NDG.

Sand Topping Layer - Where a sand topping layer is present over a different soil (i.e., clay, limestone etc.), testing of the density of the sand topping layer is only necessary within the thickness of the sand topping layer. Testing does not need to extend into the underlying compacted substrate, which is separately subjected to compaction control.

Mixed Sand/Limestone Fill – Where mixed sand/limestone fill has been installed to a method specification, no compaction control testing is required, however re-compaction of the base must be done as noted above.

In situ limestone – where in situ limestone (weakly or more cemented limestone, with no sand zones or voids) is present at a footing base and no over-excavation has been done (refer to Section GDR6.2.6 regarding over-excavation of footing bases in limestone), then no compaction control testing is required.

Where loose or soft material is encountered, one of the following actions must be taken:

- Over-excavate the loose / soft layer to expose a suitable layer that does meet the required density (Section GDR7.1) and either:
 - Place and compact Approved Fill (relevant to the appropriate preparation measures outlined in Section GDR6.2) to achieve the required density (Section GDR7.1); or
 - Pouring blinding concrete ($f'_c > 15$ MPa at 28 days) from the competent layer up to the underside of the footing.

All foundations must be assessed by a competent person prior to blinding.

Measures must be taken to minimise moisture changes in clayey foundation soils at the base of footing excavations. Concrete footings are to be poured soon after excavation to minimise the potential for excessive moisture change. The use of a concrete blinding layer following foundation preparation should be considered.

GDR7 COMPACTION AND MOISTURE CONDITIONING

GDR7.1 Requirements

Any soil within the significant founding zone of structures (buildings, slabs, pavements, etc.) must be suitably moisture conditioned and compacted. These soils must be compacted to the requirements as outlined below.

Table GDR 10: Compaction and Moisture Requirements

Soil Description	Soil Particle Limits	Moisture Requirement	Density Requirement (DDR)	Possible QA/QC Test Methods
Sand	<5% fines <5% gravel <i>Maximum particle size 9.5 mm</i>	MOMC $\pm 2\%$	95% MMDD	PSP NDG
Gravel	<5% fines >50% gravel <i>Maximum particle size 19.0 mm</i>	MOMC $\pm 2\%$	95% MMDD	NDG
Clayey/Silty Gravel	5-35% fines >50% gravel <i>Maximum particle size 19.0 mm</i>	MOMC $\pm 2\%$	95% MMDD	NDG
Sand with fines or gravel	5-35% fines; and/or 5-50% gravel <i>Maximum particle size 19.0 mm</i>	MOMC $\pm 2\%$	95% MMDD	NDG Method Specification
Fine grained soils (Clayey or Silty)	>35% fines <i>Maximum particle size 19.0 mm</i>	MOMC $\pm 2\%$; or SOMC $\pm 2\%^2$	92% MMDD; or 95% SMDD	NDG Method Specification
Oversize/rubblly soil	Any soils with particles >19.0 mm	MOMC $\pm 2\%$	95% MMDD (Or equivalent to)	Method Specification Detailed Assessment Based on Specific Material

- NOTES:**
1. *DDR – Dry Density Ratio*
MMDD – Modified maximum dry density (AS1289.5.2.1)
MOMC – Modified optimum moisture content (AS1289.5.2.1)
SMDD – Standard maximum dry density (AS1289.5.1.1)
SOMC – Standard optimum moisture content (AS1289.5.1.1)
PSP – Perth Sand Penetrometer
NDG – Nuclear Density Gauge
 2. *Preferably OMC to OMC +2%, for ease of compaction and producing a homogenous fill*
 3. *Test frequencies are specified in Section GDR7.6.*

The soil groups and definitions outlined above are generally based on AS1726-2017. Test methods are discussed in subsequent sections.

GDR7.2 Construction Recommendations

Over-excavation and replacement of loose material must be done where the minimum DDR cannot be achieved.

Fill must be placed in horizontal layers of not greater than 300 mm loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken if compacting in the vicinity of existing structures, such as the adjacent properties. This is particularly important if vibratory compaction is being carried out.

- Tynan (1973), "Ground Vibration and Damage Effects on Buildings", Australia Road Research Board, Special Report No. 11.

Tynan (1973) provides guidance on the selection of compaction equipment for use adjacent to structures. The distance of influence (i.e., the definition of "vicinity") will vary depending on the size of compaction plant proposed for use. Where there is concern regarding the impact on nearby structures, a dilapidation study should be done.

Care must be taken when compaction is undertaken when the site surface is within 1 m of the groundwater level, as compaction (particularly with vibration) can draw the water up to the surface. In this instance, consideration should be given to:

- Static rolling only;
- Using a pioneering layer (if possible); or
- Dewatering to keep the water at least 1 m below the surface being compacted.

GDR7.3 Nuclear Density Gauge

Where applicable, a nuclear density gauge (NDG) must be used in accordance with AS1289.5.8.1. NDG tests must be done to a depth of 300 mm or as otherwise indicated in the text of the attached report.

GDR7.4 Perth Sand Penetrometer

Where clean sand is used (<5% fines and <5% gravel), a Perth sand penetrometer (PSP) may be used for compaction control in accordance with AS1289.6.3.3. Refer to the report for recommended blow counts correlating to the specified density.

Where the fines or gravel contents of a sand soil exceed the maximum contents noted above, a PSP must not be used exclusively for compaction control. As a minimum, ongoing confirmation testing with an NDG is required. If not specified in our report, please contact us for further advice regarding test frequencies.

If difficulties are experienced recording the required blow counts, a site-specific PSP correlation should be carried out to determine the PSP blow count correlating to a DDR of 95% MMDD. In addition, a particle size distribution (PSD) test should be carried out to verify that the use of a PSP is suitable for the sands being tested. A site-specific PSP correlation must:

- be done on site;
- use the nuclear density gauge (NDG) to determine density at a minimum of 5 points with varying density to a depth of 300 mm below surface;
- include at least 1 point where the dry density ratio is in excess of 95% MMDD;
- use a calibrated PSP to determine the PSP blow count from 150 mm to 450 mm at each NDG test point; and
- be plotted on a chart of PSP blow count vs DDR.

Only where specifically stated as applicable in the report and where the use of the PSP is relevant as noted above, the following values may be taken as deemed to conform to a dry density ratio of 95% MMDD for the relevant sand type.

Table GDR 11: Deemed-to-comply Values for PSP Results in Perth Sands

Depth Interval (mm)	Bassendean	Tamala	Calcareous
0-150	SET	SET	SET
150-450	7	8	12
450-750	9	10	14
750-1050	11	12	16

- NOTES:**
1. Blows per 300 mm interval
 2. Bassendean Sand is typically a white - grey, low-fines quartz sand found on the eastern part of the Perth coastal plain
 3. Tamala /Spearwood sand is typically yellow or orange, low-fines quartz sand found on the western part of the Perth coastal plain
 4. Calcareous sands are typically white or yellow, calcareous sand found in low-lying areas on the western fringe of the Perth coastal plain

5. Values derived from Galt experience on PSP correlations done on sites across Perth for the 150-450 mm interval.

GDR7.5 Method Specifications

GDR7.5.1 General

Where proposed, a method specification should be developed by a geotechnical engineer or similarly qualified person and ratified by us (including a site visit by us). The method specification should be confirmed by the construction of a trial pad or trial area and the compaction methodology should be checked against either:

- density, as assessed using a nuclear density gauge; or
- settlement, as assessed using a dGPS.

Specific advice should be requested for the development of a method specification, taking into consideration the material being compacted.

Method specification compliance should be maintained for all areas on a minimum 20 m grid, with the compliance to include:

- Roller used (weight, style, vibration);
- Water application rate (per lift);
- Layer thickness placed; and
- Number of passes with roller.

GDR7.5.2 Indicative Method Specification – Sand/Limestone Rubble Mix

Where mixed sand/limestone is used as structural fill, a performance specification is not appropriate due to the inaccuracies of standard test methods (NDG/PSP etc.) in this type of material. A method specification can be used instead. The following indicative method specification is provided for evaluation and trial but must be trialled and ratified by us prior to widespread employment on site. The following would be typically adopted:

- Maximum particle size: 250 mm
- Maximum loose layer thickness: 350 mm
- Minimum watering rate: 10 L/m²/100 mm thickness of loose material (e.g. 35 L/m² for a 350 mm thick layer)
- Minimum 8 passes with a vibrating padfoot roller, minimum static weight 10 tonnes.
- The compacted fill must comprise closely packed particles without any significant voids between the larger particles.

GDR7.6 Testing Frequency

After compaction, verify that the required density has been achieved by testing at the base of excavation and through the full depth of any fill, and to a minimum depth of:

- 900 mm where a PSP is used; or
- 300 mm where a NDG is used.

The frequency of testing (when a method specification is not used) should be as follows:

Table GDR 12: Compaction Testing Frequency Requirements

Area	Minimum Testing Frequency	Minimum Tests Per Lot
Proof Compacted Area	1 test per 1,000 m ² (30 m grid)	2
Structural Fill Outside of Building and Pavement Footprints	1 test per 500 m ³ 2 tests per layer <i>Whichever is greater</i>	2
Structural Fill Within Building and Pavement Footprints	1 test per 500 m ³ 4 tests per layer <i>Whichever is greater</i>	4
Spread/Pad Footings	1 test per 9 m ² per footing	1
Strip Footings/Retaining Wall Foundations	Minimum 2 tests At 5 m centres <i>Whichever is greater</i>	2
On-ground slabs, pavements and rafts	Minimum 2 tests At 10 m centres 1 test per 100 m ² <i>Whichever is greater</i>	2

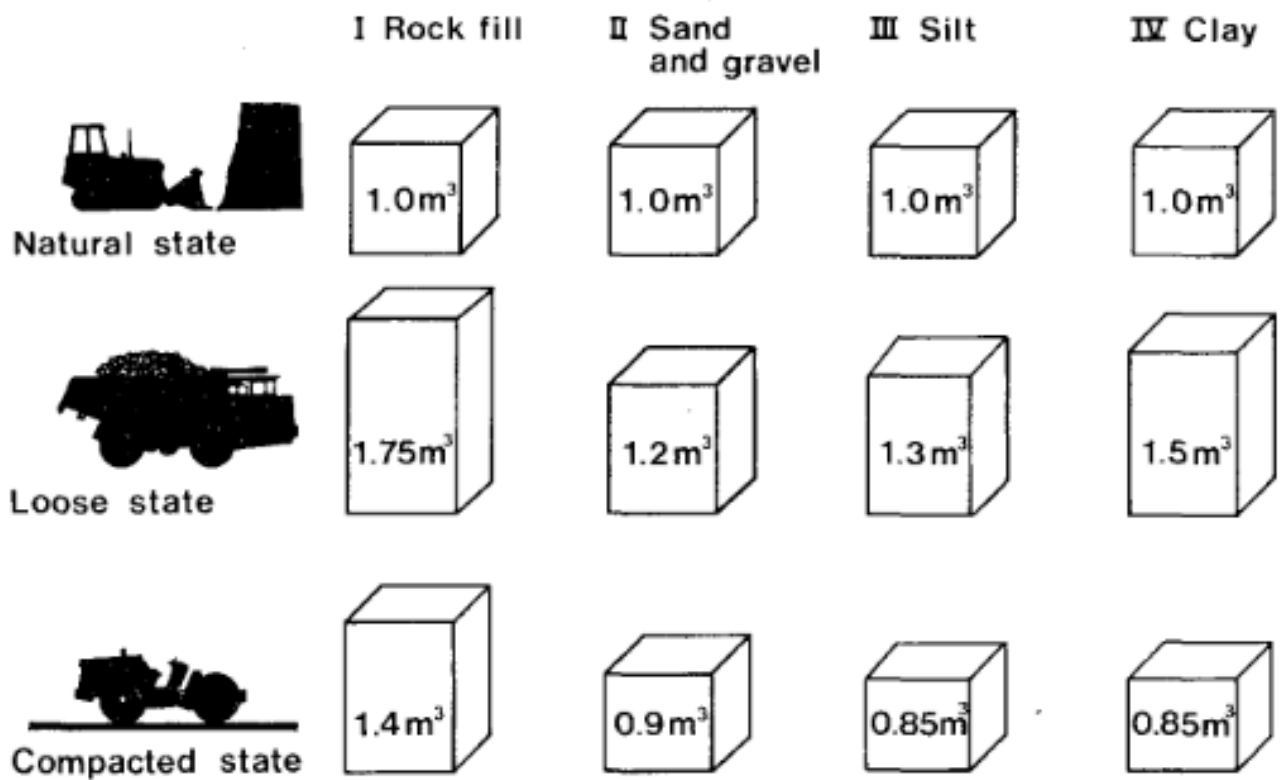
- NOTES:**
1. A 'lot' is defined in the context of this section as a section of earthworks that is undertaken in one operation where the equipment, personnel, materials and methodology are consistent throughout the entire process. This would typically be limited to operations done in one day, but this is not mandatory.
 2. There will frequently be multiple 'lots' in an earthworks process, therefore the number of tests must be adjusted according to the minimum number per lot in this table (where this is more than the frequency specified in 'testing requirements').

GDR7.7 Bulking and Compaction Factors

All soils will "bulk" when excavated to stockpile, and "compact" when placed from stockpile to earthworks layers. Published bulk and compaction factors are presented below for conventional materials, taken from:

- Forssblad, L (1981), "Vibratory Soil and Rock Fill Compaction", Dynapac Maskin AB

Inline Image GDR 3: Volumes of Different Types of Fill Materials in Natural, Loose and Compacted State



These values are indicative only and will vary according to site specific conditions. The values provided here must not be used for commercial volume estimates or settling disputes regarding volumes.

GDR8 APPROVED FILL AND CONFORMANCE TESTING

Imported fill must comply with the material requirements as stated in AS 3798-2007, "Guidelines on Earthworks for Commercial and Residential Developments".

Where doubt exists, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

The following table presents recommended material parameters for standard fill types. This does not take account of availability of materials either on site or in the local area. Refer to the report text for specific advice on fill at the subject site.

Table GDR 13: Standard Fill Recommendations

Soil Description	Application	Soil Particle Limits (%) ³				k_{min} ¹ (m/d)	OC ² (%)	Atterberg Limits		CBR ⁶ (%)	Test Method ⁴
		Fines	Sand	Gravel	Max.			LL (%)	PI (%)		
Permeable Sand	Permeable bulk fill Retaining wall backfill Permeable select fill	≤5	≥90	≤5	9.5	5	≤2	NP	NP	≥12	PSP NDG
General Sand	Bulk fill Select fill (permeability not required)	≤5	≥90	≤5	9.5	N/A	≤2	NP	NP	≥12	PSP NDG
Silty Sand	Bulk fill Select fill	≤35	≥55	≤10	9.5	N/A	≤2	<35	<11	≥12	NDG
Clayey Sand	Bulk fill Select fill	≤35	≥55	≤10	9.5	N/A	≤2	<40	N/A	≥12	NDG
Mixed Sand/Limestone	Bulk fill (permeability not required)	≤5	≥20	≤80	250	N/A	≤2	NP	NP	N/A	NDG Method
Blue Metal Gravel ⁸	Retaining wall backfill Drainage trench backfill	≤3	≤5	≥90	37.5	5	≤1	NP	NP	N/A	NDG
Clay ⁷	Reinstatement of localised excavations in clay Bulk fill	≥12	Varies	≤30	19	N/A	≤2	Varies			NDG

- NOTES:**
- k_{min} – minimum saturated hydraulic conductivity (AS1289.6.7.1, remoulded to minimum DDR 100% MMDD).
 - OC – organic content (Walkley-Black method recommended, AS1289.4.1.1 – not loss on ignition methods)
 - % by mass.
 - Test method indicates possible compaction control methods for this material.
 PSP – Perth sand penetrometer (AS1289.6.3.3). Where a PSP is used, a site-specific correlation must be done unless otherwise noted in the report.
 NDG – Nuclear density gauge (AS1289.5.8.1)
 Method – method specification
 - Atterberg Limits: LL – liquid limit PI – plasticity index NP – non-plastic
 - CBR: California bearing ratio (for sand - remoulded to DDR 95% MMDD @ OMC, 4.5 kg surcharge). CBR values may be changed depending on the design pavement requirements.
 - “Clay” fill type is included for broad reference only and to illustrate preferred applications, particle size limits and recommended test method. Specific discussion on the use of clayey fills is included in the report text if applicable. Atterberg limit and CBR testing of clayey fills may be required and advice must be sought from us if not stated in the report.
 - “Blue metal” gravel refers to single sized, crushed, washed igneous rock gravel used for drainage purposes.
 - In the absence of specific test frequencies by the civil designer, the testing shown in Table GDR 14 must be done (highlights in Table GDR 13 show where the test is required).

Table GDR 14: Conformance Testing Frequency Requirements

Parameter	Frequency (m ³)	Minimum Tests per Source	AS1289 Reference
Particle size distribution	5,000	1	3.6.1
Hydraulic conductivity (permeability)	10,000	2	6.7.1
Organic content	5,000	1	4.1.1
Atterberg limits	5,000	1	3.1.1, 3.2.1, 3.3.1
CBR	10,000	2	6.1.1

- NOTES:**
1. Frequency is for the nominal number of cubic metres of compacted fill.
 2. Unless stated otherwise in the report text, the conformance testing must also be carried out on site-derived materials to confirm suitability.

GDR9 SHALLOW FOUNDATIONS

GDR9.1 Design

Footings and slabs may be designed in accordance with the assigned site classification in accordance with AS2870-2011. We note that AS2870-2011 is limited to single and double storey residential and commercial developments and may not be strictly applicable.

Where the report provides tables for shallow footing design, custom footings may be designed by the structural engineer using the data provided therein.

GDR9.2 Interpretation of Provided Values

BEARING PRESSURES

All settlement and bearing pressures estimates are provided on the assumption that the site preparation requirements outlined in the report are completed below all structures plus a minimum distance of 1 m beyond the outside edge of any footing or slab. It is essential that the soil below all foundations is appropriately prepared as outlined and meets the relevant compaction requirements.

Allowable bearing pressures for footings of intermediate plan dimensions (to any tabulated) can be interpolated. Footings that have a plan dimension either smaller or larger than those presented in the report will need to be considered individually along with other embedment depths.

Allowable bearing pressures, where provided, are considered to be the upper limit for shallow footings to limit total and differential settlements. Footings carrying eccentric loading, such as below retaining walls, must be assessed separately.

SETTLEMENTS

The reporting of settlements to any precision level is not intended to imply a high accuracy of settlement prediction. Settlements as reported should be considered 'order of magnitude'.

Estimated settlements represent vertical downwards movement due to loading and do not take into account potential additional movement associated with the characteristic surface movement of the soil (which must be taken in addition to these settlements from loading, refer Section GDR5). The site classification is discussed in the report.

The actual settlement of any proposed structure will depend upon a number of factors including the applied pressures, footing size and base preparation. The estimated settlement(s) provided in this report are for the working bearing pressures as indicated. Differential settlements are likely between footings of similar sizes, loads and elevations (as

stated in the report text). A proportion of the settlement is expected to occur during construction (i.e., during initial loading).

The provided settlement estimates (unless otherwise stated) do not include interaction effects from footings founded near other footings (i.e., groups of footings). Interaction effects will need to be considered if the spacing between adjacent footings is smaller than the dimension of the footings (i.e., the centre-to-centre spacing between footings is less than twice the width of the footing). This could act to double provided settlements, dependent on the footing configuration. Where an assessment of footing groups is required, a more detailed numerical or finite-element modelling analysis would need to be undertaken.

CREEP AND CONSOLIDATION

Creep settlement is an irreversible component of long-term soil settlement caused by sustained vertical stress. Consolidation is a time-dependent irreversible compression in a soil layer caused by a reduction in pore pressure between soil particles. Both creep and consolidation can occur in natural materials as a result of earthworks or the placement of loads on to soil layers. The settlements as presented for short-term loading do not include consideration for creep and consolidation settlements unless specifically stated.

GDR9.3 Raft Foundations

Where moduli of subgrade reactions are provided for the design of raft foundations, we highlight that these are an estimate of the elastic reaction of the soil. The values are provided based on an expected load and loaded area size. Soils are typically non-linear in their response and will have different stiffnesses at different levels of strain and load repetitions. This is due to the physical interaction of soil particles under different levels of stress.

The possibility of a non-linear response must be considered by the designer of any raft foundation.

GDR10 PILED FOUNDATIONS

Piles must be designed and tested in accordance with AS2159-2009, "Piling – Design and Installation". We use the following interpretation/design methods to provide pile design parameters:

- Franki Africa Pty Ltd (2008) "A Guide to Practical Geotechnical Engineering in South Africa". 4th ed.
- AFNOR (2012) "NF P 94-262 – Justification des ouvrages géo-techniques, Normes d'application nationale de l'Eurocode 7", Afnor, Paris, July 2012.
- Lehane, B. (2017) "CPT-Based Design of Foundations". E.H Davis Memorial Lecture, Australian Geomechanics Vol 54. No. 4.
- Lehane, B. et al. (2020) "A New 'Unified' CPT-Based Axial Pile Capacity Design for Drivel Piles in Sand". Proceedings of the Fourth International Symposium on Frontiers of Offshore Geotechnics.
- Doan., Lehane, B. (2021) "CPT-Based Design Method for Axial Capacities of Drilled Shafts and Cast-in-place Piles." American Society of Civil Engineers (ASCE), Journal of Geotechnical and Geoenvironmental Engineering.

The pile designer must:

- consider the possible variation in subsurface conditions at each pile location;
- consider any pile group effects based on the final piling configuration;
- assume that the unit shaft resistance in tension is less than 80% of the unit shaft resistance in compression to account for Poisson's effect in sand;
- ignore pile resistance in the surficial 0.5 m or 1 x pile diameter (whichever is greater), if relevant;

- consider the impact of weak layers underlying stiffer layers (or vice versa) on end bearing capacity; and
- reduce the pile capacity in tension to no greater than 0.8 of the pile capacity in compression.

The piling contractor must:

- make their own assessment on the suitability of their equipment to install any piles at the subject site; and
- carry out or appoint a suitably experienced contractor to test the piles in accordance with AS2159.

Where dynamic or static testing of the piles does not occur, we consider that a design geotechnical reduction factor (ϕ_g) of 0.4 is applicable for the pile design. If testing of the piles is proposed by the piling contractor, a higher ϕ_g could be adopted.

Unless otherwise stated, providing pile design parameters does not specifically indicate the driveability of any piles into soil units.

A separate driveability study may be required and must be considered by the pile designer and installer. The given pile design parameters must not be used for driveability assessments as these parameters are likely to be un-conservative.

GDR11 EARTH RETAINING STRUCTURES

GDR11.1 General

Retaining structures may be designed in accordance with AS4678 (2002) "Earth Retaining Structures". Unless otherwise specifically stated, we recommend that all retaining walls are backfilled with free-draining soil (Permeable Sand or Blue Metal Gravel as defined in Section GDR8).

Where the cohesive soil is used as retaining wall backfill, a suitable, permanent drainage system must be placed behind the wall such that a build-up of pore pressure is prevented. A separator geotextile (Bidim A24, or similar, or heavier) must be used between the interface of any granular backfill and the cohesive soil.

Where drainage is not provided, the retaining wall must be designed to accommodate water pressure behind the wall (10 kPa per metre height).

GDR11.2 Earth Pressure Coefficients and Strength Parameters

Where earth pressure coefficients are provided for retaining walls, the wall designer must make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction. Unless otherwise stated, we have assumed a horizontal ground surface behind and in front of the retaining wall for provided parameters.

GDR11.2.1 Cohesionless Soils

Where cross-referenced for suitability in the report, the following parameters may be adopted for design of earth retaining structures in cohesionless soils (sand and gravel).

Table GDR 15: Retaining Wall Geotechnical Parameters (Cohesionless Soils)

Density	γ (kN/m ³)	ϕ' (°)	K_0	Wall Friction=0		Wall Friction=0.5 ϕ		Wall Friction=0.67 ϕ	
				K_a	K_p	K_a	K_p	K_a	K_p
Very Loose	17	30	0.44	0.33	3.00	0.29	4.81	0.28	5.74
Loose	17	32	0.42	0.31	3.25	0.27	5.55	0.26	6.83
Medium Dense	18	34	0.39	0.28	3.54	0.25	6.47	0.23	8.26
Dense	19	36	0.36	0.26	3.85	0.22	7.63	0.21	10.18
Very Dense (1)	19	38	0.34	0.24	4.20	0.21	9.11	0.20	12.85
Very Dense (2)	19	40	0.31	0.22	4.60	0.19	11.06	0.18	16.73

- NOTES:**
1. Earth pressure coefficients are provided in this table for conditions of zero friction between the wall and the soil and with wall friction of 0.5 ϕ' or 0.67 ϕ' .
 2. A horizontal ground surface behind and in front of the wall has been assumed.
 3. The retaining wall designer should make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction.
 4. γ – bulk unit weight
 ϕ' – effective friction angle
 K_a – coefficient of active earth pressure (Coulomb – AS4678-2002, Appendix E)
 K_p – coefficient of passive earth pressure (Coulomb – AS4678-2002, Appendix E)
 K_0 – coefficient of at-rest earth pressure (Jaky)
 5. Maximum fines content 12% for applicability of this table for design purposes.
 6. Unit weights based on Table D1 of AS4678-2002, for moist bulk weight.
 7. Friction angle based on Equation D1 and Table D2 of AS4678-2002, based on rounded, moderately graded siliceous sand.

GDR11.2.2 Cohesive Soils

Where cohesive soils (i.e. clayey or silty soils) are proposed for backfill, geotechnical design parameters may be provided in the form of effective strength and undrained strength parameters. We note that:

- Undrained strength parameters should be used for analysis of short-term stability, or stability under sudden loading of cohesive soils.
- The effective strength parameters should be used for analysis of free-draining soils and the long-term stability of cohesive soils.

Table GDR 16: Retaining Wall Geotechnical Design Parameters (Cohesive Soils – Undrained)

Consistency	γ_b (kN/m ³)	c_u (kPa)
Soft	17	12
Firm	18	25
Stiff	19	50
Very Stiff	20	100
Hard	20	200

- NOTES:**
1. γ_b – bulk unit weight
 c_u – undrained cohesion
 $\phi_u = 0^\circ$ (undrained friction angle)
 2. Unit weights based on Table D1 of AS4678-2002
 3. Undrained cohesion based on lower end of shear strengths as define in AS1726-2017, Table 11

Table GDR 17: Retaining Wall Geotechnical Design Parameters (Cohesive Soils – Drained)

Fines Content	PI (%)	γ_b (kN/m ³)	ϕ' (°)	c' (kPa) ⁵
12-35%	All	19	32	0
>35%	10	20	30	0 – 5
>35%	20	20	26	0 – 5
>35%	30	20	23	0 – 5
>35%	40	20	21	0 – 5

- NOTES:**
- γ_b – bulk unit weight
 c' – drained cohesion
 ϕ' – effective friction angle
PI – plasticity index
 - Unit weights based on Table D1 of AS4678-2002, assuming generally stiff to hard overconsolidated soils.
 - For fines contents <35% (silty sand and clayey sand), strength parameters based on:
 - Lehane, B. et al (2007) "A Laboratory Investigation of the Upper Horizons of the Perth/Guildford Formation in Perth CBD", Australian Geomechanics Vol 42. No. 3.
 - For fines content >35% (sandy clay), strength parameters based on:
 - CIVL5503 course notes (2004), "Underground Construction", University of Western Australia
 - $c' = 0$ recommended for long-term design. Table D4 of AS4678 suggests c' up to 5 kPa for 'poor' fine grained soils and 10 kPa for 'average' fine-grained soils. The use of c' for design is subject to the designer's judgement but recommended by us only for temporary works.

Per AS4678-2002 Appendix E, horizontal earth pressures for frictional-cohesive soils may be calculated in accordance with the Rankine-Bell design model (illustrated in Figure E2 of AS4678). The earth pressures are as follows (Z = depth, all other terms have the meanings given in the above tables):

- Active: $p_a = \gamma Z \tan^2 \left(45 - \frac{\phi}{2} \right) - 2c \tan \left(45 - \frac{\phi}{2} \right)$
- Passive: $p_p = \gamma Z \tan^2 \left(45 + \frac{\phi}{2} \right) + 2c \tan \left(45 + \frac{\phi}{2} \right)$

GDR11.3 Design and Construction Considerations

Compaction plant can augment the lateral earth pressure acting on retaining walls. Hand operated compaction equipment is recommended within 2 m of any retaining walls to minimise compaction pressures.

Retaining walls can move and rotate under imposed soil loading resulting in settlement behind the wall. This must be considered in the design and during construction of the retaining walls in order that adjacent infrastructure is not adversely affected.

It is important to note that some ground movement will occur behind any soil retaining system, including gravity retaining walls.

GDR12 EXCAVATIONS, BATTERS AND SLOPES

GDR12.1 Excavatability

Our assessment of the excavatability of rock is based on a combination of:

- Our experience on earthworks and construction projects across Australia; and
- Figure 10 of the revised graphical method of assessing excavatability of rock by:
- Pettifer, G.S. & Fookes, P.G., "A revision of the graphical method for assessing the excavatability of rock", Quarterly Journal of Engineering Geology, 27, pp145-164, 1994.

GDR12.2 Safety

All excavations must be carried out in accordance with:

- Commission for Occupational Safety and Health (2022). "Excavation: Code of Practice", Department of Mines, Industry Regulation and Safety, 89pp, Perth.

Excavations in cohesionless soils are particularly prone to instability unless support is provided. Care must be exercised in such excavations and appropriate safety measures adopted where necessary, particularly in the vicinity of existing buildings, structures and infrastructure.

The toe of any batter must be at least 500 mm above groundwater (including perched groundwater).

Unless a specific slope stability assessment or retention design has been done, the toe of any excavation should not encroach within a line of 1V:3H to any nearby footings, pavements or other settlement-sensitive structures.

Surcharges (such as structures, plant and soil stockpiles) must not be placed at or close to the crest of unsupported excavations, without a specific slope stability assessment.

A geotechnical engineer must be consulted where there is any doubt regarding the stability or safety of unsupported excavations.

GDR12.3 Batters

Temporary batter slopes provided in the report are subject to the following conditions, unless otherwise stated:

- The maximum slope height is 2 m without specific advice and slope stability analysis.
- The groundwater level for the duration of the excavation must be at least 500 mm below the toe of the slope.
- No surcharges are present in the vicinity of the slope (i.e. must be outside a line of 1V:3H from the toe of the slope).

Unless noted specifically in the report, the following batters may be adopted (maximum height: 2 m):

Table GDR 18: Default Batter Angles

Situation	Material	Batter
Temporary	Cohesionless Soils (Sand/Gravel)	1V:2H
Temporary	Cohesive Soils – Soft	1V:2H
Temporary	Cohesive Soils – Firm, Stiff, Very Stiff or Hard	1V:1H
Temporary	Limestone – Variably Cemented	1V:1H
Temporary	Limestone – Well Cemented	1V:0.5H
Permanent	All Soils	1V:3H
Permanent	Limestone – Variably Cemented	1V:2H
Permanent	Limestone – Well Cemented	1V:1H

Where specified batters cannot be accommodated in the vicinity of existing footings, roads and services, temporary or permanent lateral support will be required.

Specific advice is required for batters higher than 2 m.

Erosion control must be considered for permanent slopes.

Rock slopes must be inspected, and all loose cobbles / boulders removed. Permanent rock slopes may require dentition works or possibly rock catch drains.

GDR12.4 Grouting

Permeation or jet grouting involves injecting a microfine cement into soil to form a grouted soil block (soilcrete) to support excavation and structures. Grouting is typically only effective where the soil has the capacity to “take” the grout and form a uniformly cemented soil mass. Permeation grouting is generally limited to relatively permeable, coarse-grained cohesionless soils (sands and gravels with <5% fines).

If grouting is proposed, we recommend the following:

- Grouting must be carried out by a suitably experienced contractor.
- Only microfine cement grout should be used (not GP or coarse cement blends) to ensure adequate penetration into the soil matrix.
- Grouting should be done on a grid of not greater than 300 m.
- Application rates must be discussed with the contractor.
- The grouted soil mass must have intimate contact with any structures it is intended to support.
- The contractor must satisfy themselves that the proposed grouting can be installed with their equipment and into the subsurface conditions encountered at the site, considering possible obstructions, groundwater, cemented layers, loose sands etc.
- Testing of the grouted soil mass must be done to ensure that the grout has adequately permeated through the soil matrix. This can be done by drilling into the soil mass to ensure the cementation is continuous.

Grouting is most effective on permeable, relatively loose natural sand. Where historical filling or other ground disturbances have occurred, the grouting process can be less effective due to the tendency of grout (or other liquids) to follow more permeable paths / zones through the disturbed soil.

GDR13 STORMWATER DISPOSAL AND DRAINAGE DESIGN

GDR13.1 Groundwater Separation – Controlled Groundwater

These recommendations ONLY apply to where regional controls on groundwater (primarily: subsoil drainage, but also surficial ‘main drains’) exist, i.e. only to areas where groundwater is actively controlled.

The following reference:

- IPWEA (2016), “Specification: Separation Distances for Groundwater Controlled Urban Development”, Institute of Public Works Engineering Australasia

recommends the following separation distances from drainage infrastructure to groundwater:

- Underground infiltration systems: 0 mm from the 50% AEP (annual exceedance probability) phreatic surface.
- Surface infiltration systems (vegetated): 300 mm from the 50% AEP phreatic surface.

The above IPWEA reference also states that performance measures for underground infiltration systems are to have a *demonstration of acceptable volumetric capacity when groundwater is elevated above base of system and that the groundwater recedes below the invert of the system during mosquito breeding seasons (grated or partially open systems)*.

GDR13.2 Groundwater Separation – Uncontrolled Groundwater

These recommendations apply where regional controls on groundwater levels are not present. For infiltration into soakwells and soakage basins to be the full theoretical value, an adequate separation to groundwater must be achieved, because otherwise performance is hindered by inadequate separation to groundwater or partial submergence of the infiltrative element.

We recommend a minimum separation of 500 mm from the underside of infiltrative elements to maximum groundwater level.

- To average annual maximum groundwater level (AAMGL), where this has been defined for the site; or
- To historical maximum groundwater level, where this has been defined to the site.

GDR13.3 Design Hydraulic Conductivity Values

Where provided, the values of hydraulic conductivity (k) should be considered the maximum/upper limit design values. As discussed in Section GDR3.7, the inverse auger hole test is an unsaturated field test carried out above the groundwater table and, as such, presents the best-case conditions for drainage.

For soak wells in sand, we provide the design value taking into consideration the variability in materials and reduced permeability as a result of:

- Densification of sand during site preparation works; and
- Natural variation in sands.

Design k_{unsat} values provided for soak wells are only appropriate for the design of unsaturated soils where the base of disposal area is at least 500 mm above groundwater and 500 mm above any impermeable layer.

Where design values of k_{unsat} have been provided, clogging of the base of the soakwell / drainage basin has not been considered. Clogging will need to be controlled with maintenance over the life of the soakwell / drainage basin.

For the design of subsoil drains or modelling of saturated soil performance, a k_{sat} value must be given (in the report text) or assessed by laboratory testing (or a combination of field and laboratory testing). Unless specifically stated, k_{unsat} values presented in our report are for unsaturated conditions and intended for design of stormwater disposal elements above groundwater. If no k_{sat} value has been provided, do not use the provided k_{unsat} value for saturated drainage design. Please contact us for further advice.

For saturated or semi-saturated sands, the hydraulic conductivity must be assessed by testing of representative soil samples at a NATA accredited laboratory to determine:

- The modified maximum dry density (MMDD); and
- The constant-head permeability (AS1289.6.7.1) on a sample remoulded to at least 5% greater than the proposed specification density (i.e., sample should be remoulded to 100% MMDD if the earthworks specification requires a density ratio of 95% MMDD).

For saturated or semi-saturated clayey or silty soils, the hydraulic conductivity must be assessed by testing of representative soil samples at a NATA accredited laboratory to determine:

- The standard maximum dry density (SMDD); and
- The falling-head permeability (AS1289.6.7.2) on a sample remoulded to at least 3% greater than the proposed specification density (i.e., sample should be remoulded to 101% SMDD if the earthworks specification requires a density ratio of 98% SMDD).

GDR13.4 Soakwells

In uncontrolled groundwater environments, the base of any soakwell must be the higher of:

- At least 500 mm above the average annual maximum groundwater level (AAMGL).
- At least 500 mm above any low permeability/impermeable layers (clay, rock or otherwise).

In controlled groundwater environments (refer to Section GDR13.1), the base of any soakwell may be 0 mm above the controlled groundwater level at the location of the soakwell (as determined by the civil engineer).

Soak wells must be placed outside a line of 1V:2H extending below the edge of the nearest footing, subject to local council regulations. Discharge from soak wells has been known to promote densification of loose sandy soils, leading to settlements of footings and slabs. Soak wells should be carefully wrapped with geotextile to prevent migration of sand and fines into the soak well.

Where soak wells are proposed to dispose of water within a line of 1V:2H from any basement walls or similar, the walls must be waterproofed to prevent seepage or damp within the basement wall.

In potentially karstic terrain or areas of potentially collapsible soils, soakwells should typically be located 10 m from the nearest footing, slab or pavement.

GDR13.5 Design Groundwater Elevation

Where applicable, a recommended design groundwater elevation will be provided in the report and will be identified as such.

In the absence of a specific statement on design groundwater elevation, **do not assume** that:

- Absence of comments about groundwater indicates an absence of groundwater (in particular, sites that are dry in the dry season to the investigated depth may well become waterlogged in the rainy season).
- Where groundwater depths/levels are noted, that these are fixed (groundwater fluctuations occur over the course of the year and between wetter and drier years).

Where groundwater elevations are likely to be critical for a development (particularly where large-scale subdivision or large developments are proposed with substantial channelling of stormwater into on-site disposal by infiltration), a site-specific hydrology study is likely to be required to confirm design groundwater elevations.

GDR14 DRAINAGE CONTROL

In addition to the site preparation measures outlined for cohesive soils (refer Section GDR6.2.4), careful control of surface water and stormwater is essential to minimise the likelihood of cohesive soils decreasing in strength and affecting the installed infrastructure. These measures include:

- The ground surface of clayey soils should be graded to drain any seepage away from structures and prevent standing water over the cohesive soils. A grade of at least 1% is recommended.
- Pavements should be sealed to minimise water ingress.
- Stormwater disposal swales should be located at least 10 m away from buildings, retaining walls and pavements.
- Runoff from hardstandings and pavements must either be collected and discharged via pipes into discrete locations (via swales or soakage basins) at least 10 m away from structures and pavements or, alternatively, discharged over a wide area, but not allowed to collect and discharge into concentrated areas, particularly near structures and pavements.

- Spoon drains should be used to collect water at the crest of slopes to capture surface runoff and direct it away from running directly down slopes or seeping into the ground behind slopes.

These measures are general in nature only and do not take into account the civil design objectives, which must be addressed separately by the civil designer.

GDR15 DEWATERING

Dewatering may be required for excavations and construction below groundwater or perched groundwater tables. Common dewatering methods are summarised below:

Table GDR 19: Dewatering Recommendations

Material	Recommended Methods
Sandy Soils	Spears Deep Well Point
Impermeable Clay	Sump Pumping

Dewatering spears are typically suitable for small scale excavations below groundwater, with a typical recommendation for spears to be installed at 1 m below the base of any excavation. Dewatering spears may not be suitable where there are impermeable/cemented/strong transition layers, i.e., it may not be possible to extract water near an impermeable layer (rock/clay), or the spear may not be readily driven through a hard clay/cemented layer (i.e., coffee rock).

Sump pumping can be done by grading a clayey excavation to drain (i.e., by using spoon drains), and excavating a sump in the excavation. A sump can typically be backfilled with a blue metal gravel, with a pump wrapped in a geofabric (i.e., Bidim A14 or similar), with disposal of water away from the excavation.

Deep well point dewatering is typically suitable for larger excavations, where there are transitional layers or where the aquifer is confined. It may not be suitable where there are impermeable layers within the profile. It involves the installation of a deep filtered well to a depth required to draw down the groundwater level at the entire site. A deep well dewatering system must be designed by a suitable designer to provide design flow rates, draw down depths etc.

GDR16 PAVEMENT SUBGRADES

Unless otherwise specified, the provided subgrade California bearing ratio (CBR) is not a pavement design, but an assessment of the subgrade as an input into any required pavement designs.

Provided design values are based on the assumption that the relevant site preparation measures are completed for all pavement subgrades, including the use of appropriate approved fill and adequate compaction. We highlight that specific requirements such as those outlined by Main Roads WA (MRWA) or the local council in their construction specifications may have different requirements.

The provided design value is based on laboratory testing (where done), local experience, and the advice as outlined in:

- Main Roads Western Australia (2013). "Engineering Road Note 9 – Procedure for the Design of Road Pavements". Western Australia Supplement to the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design, East Perth.

Where the subgrade differs from that described in the text, the subgrade CBR must be confirmed.

The performance of any pavement is highly dependent on the surface and subsurface drainage provided (also considering factors like capillary rise from seasonally high groundwater tables). Adequate drainage must be provided to any pavements, and capillary rise must be considered by the designer.

GDR17 SOIL CORROSIVITY AND AGGRESSIVITY

The relevant exposure classifications for concrete and steel piles in soils based on the exposure conditions are presented in Table GDR 20 and Table GDR 21 respectively.

The relevant exposure classifications for concrete in sulfate soils based on the exposure conditions are presented in Table GDR 22.

Table GDR 20: Exposure Classification for Concrete Piles in Soil

Exposure Conditions				Exposure Classification	
Sulfates (expressed as SO ₄) ¹		pH	Chlorides in Groundwater (ppm)	Soil Conditions A ²	Soil Conditions B ³
In Soil (ppm)	In Groundwater (ppm)				
< 5,000	< 1,000	> 5.5	<6000	Mild	Non-aggressive
5,000 – 10,000	1,000 – 3,000	4.5 – 5.5	6,000-12,000	Moderate	Mild
10,000 – 20,000	3,000 – 10,000	4 – 4.5	12,000-30,000	Severe	Moderate
> 20,000	> 10,000	< 4	>30,000	Very Severe	Severe

- NOTES:**
1. Approximately 100 ppm SO₄ = 80 ppm SO₃
 2. Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater
 3. Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater
 4. Table reproduced from Table 6.4.2(C) of AS2159-2009

Table GDR 21: Exposure Classification for Steel Piles in Soil

pH	Chlorides		Resistivity (ohm.cm)	Exposure Classification	
	In Soil (ppm)	In Water (ppm)		Soil Conditions A ²	Soil Conditions B ³
> 5	< 5,000	< 1,000	> 5,000	Non-aggressive	Non-aggressive
4–5	5,000-20,000	1,000–10,000	2,000 – 5,000	Mildly aggressive	Non-aggressive
3–4	20,000-50,000	10,000–20,000	1,000 – 2,000	Moderately aggressive	Mildly aggressive
< 3	> 50,000	> 20,000	< 1,000	Severely aggressive	Moderately aggressive

- NOTES:**
1. 1 ppm (parts per million) is equivalent to 1 mg/kg
 2. Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater
 3. Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater
 4. Table reproduced from Table 6.5.2(C) of AS2159-2009

Table GDR 22: Exposure Classification for Concrete in Sulfate Soils

Exposure Conditions			Exposure Classification	
Sulfates (expressed as SO ₄) ¹		pH	Soil Conditions A ²	Soil Conditions B ³
In Soil (ppm)	In Groundwater (ppm)			
< 5,000	< 1,000	> 5.5	Mild	Non-aggressive
5,000 – 10,000	1,000 – 3,000	4.5 – 5.5	Moderate	Mild
10,000 – 20,000	3,000 – 10,000	4 – 4.5	Severe	Moderate
> 20,000	> 10,000	< 4	Very Severe	Severe

- NOTES:**
1. Approximately 100 ppm SO₄ = 80 ppm SO₃
 2. Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater
 3. Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater
 4. For disturbed soils, the assumption of soil A conditions where accelerated corrosion is possible should be considered.
 5. Table reproduced from Table 4.8.1 of AS3600-2018

GDR18 LIQUEFACTION

Soil liquefaction can occur when loose, granular, Holocene age material below the groundwater table is subjected to a seismic event (typically within 15 m of the ground surface). This can cause a loss of strength and result in vertical and lateral movements of the site surface.

Where a liquefaction analysis is carried out and outlined in the report, this has been done in accordance with consideration to the design earthquake details as presented in AS1170.4-2007:

- The hazard factor is taken from Figure 3.2 (C) and Table 3.2. The Hazard Factor (Z) for Western Australia represents the 1 in 500-year annual probability of exceedance of ground motions measured in gravity (g).
- The probability factor (k_p) is taken from Table 3.1.

Unless otherwise stated, an earthquake magnitude of 7.5 for the south-west of WA is based on research by:

- Dhu T., Sinadinovski C., Edwards M., Robinson D., Jones T., Jones A. (2004) "Earthquake Risk Assessment for Perth, Western Australia". 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada. Paper No. 2748.

GDR19 EXPECTATIONS OF THE REPORT

The following sections have been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

GDR20 THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

GDR21 DATA PROVIDED BY THIRD PARTIES

Where data is provided by third parties, it will be identified as such in our reports. We necessarily rely on the completeness and accuracy of data provided by third parties in order to draw conclusions presented in our reports. We are not responsible for omissions, incomplete or inaccurate data associated with third party data, including where we have been requested to provide advice in relation to field investigation data provided by third parties.

GDR22 SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques prepared by Galt. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

GDR23 THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

GDR24 CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

GDR25 SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

GDR26 ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Geotechnical advice presented in a Galt Environmental report has been provided by Galt Geotechnics under a sub-contract agreement. Similarly, environmental advice presented in a Galt Geotechnics report has been provided by Galt Environmental under a sub-contract agreement.

Unless specifically noted otherwise, no parties shall draw any inferences about the applicability of the Western Australian state government landfill levy from the contents of this document.

Galt Geotechnics Pty Ltd

ABN: 64 625 054 729

www.galtgeo.com.au

50 Edward Street

OSBORNE PARK WA 6017

T: +61 (8) 6272-0200

APPENDIX C
Hyd2o Bore Logs & Survey



Lithological Log

Hyd20
Suite 1 387 Hay St
Subiaco, WA 6008

PO Box 1055
Subiaco WA 6904

Date : 17/05/2024
Client : Burgess Design Group
Project : Lakefarm Retreat Ballajura GW Monit
Easting : 395285.235
Northing : 6477934.219
Datum : GDA94
Drill type : Drill Rig Auger
Hole diameter : 2.5 inches

Job Number : H24009
Start Hole : 7:45
End Hole : 9:00
Logged by : AFR
Total Depth : 6
RL Top of Casing : 38.239
RL Nat Surface : 37.639

Bore Name
GW1

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics						
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment	
PVC (Class 9)	CEMENT			0.5m	Dark Grey		Sand	Low	Dry	Well-sorted Rounded Subangular	
				1.0m	Grey			None			
	1.5m			Grey Light Brown	Fine to Medium						
	2.0m									Brown	Well-sorted Subrounded Subangular
	2.5m											Dark Brown
	3.0m			Moist						Traces of Coffee Rock	
	3.5m							Saturated			Well-sorted Subrounded Subangular
4.0m											
4.5m											
5.0m											

COLOUR : Black, White, Beige
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level


Date	17/05/2024
Stickup above NS (m)	38.24
Water Level bTOC (m)	37.64
Water Level bNS (m)	

Date : 17/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 395285.235
 Northing : 6477934.219
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 7:45
 End Hole : 9:00
 Logged by : AFR
 Total Depth : 6
 RL Top of Casing : 38.239
 RL Nat Surface : 37.639

Bore Name

GW1

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	GRAVEL		[Screen]	5.5m	Brown Dark Brown	Fine to Medium	Sand	None	Saturated	Well-sorted Subrounded Subangular
				6.0m	end of hole at 6.0m					
				6.5m						
				7.0m						
				7.5m						
				8.0m						
				8.5m						
				9.0m						
				9.5m						
				10.0m						

COLOUR : Black, White, Biege
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level


Date	17/05/2024
Stickup above NS (m)	38.24
Water Level bTOC (m)	37.64
Water Level bNS (m)	

Date : 16/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 395719.848
 Northing : 6477627.556
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 9:00
 End Hole : 10:00
 Logged by : AFR
 Total Depth : 5
 RL Top of Casing : 37.884
 RL Nat Surface : 37.284

Bore Name

GW2

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment
					Colour	Particle Size	Texture	Organic Content	Moisture	
PVC (Class 9)	CEMENT			0.5m	Grey			Low	Dry	Moderately Well-sorted Subrounded Subangular 
	BENTONITE SEAL			1.0m	Light Grey					
	GRAVEL			1.5m	Light Brown				Moist	
				2.0m	Light Beige					
				2.5m	Light Brown	Fine to Medium	Sand			
				3.0m				None		
				3.5m	Brown				Saturated	
				4.0m	Beige					
				4.5m	Light Brown					
		5.0m								

COLOUR : Black, White, Beige
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle
 PARTICLE SIZE : Fine, Medium, Course
 TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay
 ORGANICS : High, Medium, Low
 MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level


Date : 17/05/2024
 Stickup above NS (m) : 37.88
 Water Level bTOC (m) : 37.28
 Water Level bNS (m) :

Date : 16/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 395743.036
 Northing : 6477931.444
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 15:30
 End Hole : 16:40
 Logged by : AFR
 Total Depth : 5
 RL Top of Casing : 37.937
 RL Nat Surface : 37.337

Bore Name

GW3

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment
					Colour	Particle Size	Texture	Organic Content	Moisture	
PVC (Class 9)	CEMENT			0.5m	Dark Grey			Low		Moderately Well-sorted Subrounded Subangular
	BENTONITE SEAL			1.0m	Grey					
	GRAVEL			1.5m	Light Brown					
				2.0m	Brown				Dry	
				2.5m		Fine to Medium	Sand			
				3.0m	Dark Brown			None		Traces of Coffee Rock
		4.0m					Moist	Moderately Well-sorted Subrounded Subangular		
		4.5m						Saturated		
				5.0m						

COLOUR : Black, White, Beige
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level


Date	17/05/2024
Stickup above NS (m)	37.94
Water Level bTOC (m)	37.34
Water Level bNS (m)	

Date : 17/05/2024
Client : Burgess Design Group
Project : Lakefarm Retreat Ballajura GW Monit
Easting : 396048.35
Northing : 6477429.188
Datum : GDA94
Drill type : Drill Rig Auger
Hole diameter : 2.5 inches

Job Number : H24009
Start Hole : 9:20
End Hole : 10:30
Logged by : AFR
Total Depth : 5
RL Top of Casing : 37.418
RL Nat Surface : 36.818

Bore Name

GW4

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	CEMENT			0.5m	Dark Grey Black	Fine to Medium	Sand	Medium	Dry	Moderately Well-sorted Subrounded Subangular
				1.0m	Dark Grey			Low		
	1.5m			Grey	None					
	2.0m			Light Brown						
	2.5m			Dark Brown						
	3.0m			Dark Brown						
	3.5m			Dark Brown						
	4.0m			Brown						
	4.5m			Light Brown Beige						
5.0m	Light Brown Beige									

COLOUR : Black, White, Beige
Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clayey Loam
Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	17/05/2024
Stickup above NS (m)	37.42
Water Level bTOC (m)	36.82
Water Level bNS (m)	

Date : 16/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 396034.504
 Northing : 6477720.219
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 7:45
 End Hole : 9:00
 Logged by : AFR
 Total Depth : 5
 RL Top of Casing : 37.419
 RL Nat Surface : 36.819

Bore Name

GW5

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment			
					Colour	Particle Size	Texture	Organic Content	Moisture				
PVC (Class 9)	CEMENT			0.5m	Dark Grey Black			Medium	Dry	Moderately Well-sorted Rounded Subangular			
				1.0m	Dark Grey			Low					
	1.5m			Grey Light Brown	None			Dry			Moderately Well-sorted Subrounded Subangular		
	2.0m			Light Brown								Fine to Medium	Sand
	2.5m			Light Brown Beige									
	3.0m			Beige								Moist	
	3.5m			Beige									
	4.0m			Light Beige										Saturated
4.5m	Light Beige												
5.0m	Light Beige	Saturated	Moderately Well-sorted Subrounded Subangular										

COLOUR : Black, White, Beige
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	17/05/2024
Stickup above NS (m)	37.42
Water Level bTOC (m)	36.82
Water Level bNS (m)	

Date : 16/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 396070.304
 Northing : 6477979.457
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 14:00
 End Hole : 15:15
 Logged by : AFR
 Total Depth : 5
 RL Top of Casing : 38.224
 RL Nat Surface : 37.624

Bore Name

GW6

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					Comment	
					Colour	Particle Size	Texture	Organic Content	Moisture		
PVC (Class 9)	CEMENT			0.5m	Dark Grey			Medium		Moderately Well-sorted Rounded Subangular	
	BENTONITE SEAL			1.0m	Grey						
	GRAVEL			1.5m				Dry			
				2.0m	Brown						
				2.5m		Fine to Medium	Sand				Traces of Coffee Rock
				3.0m	Beige			None	Slightly Moist		
			3.5m								
				4.0m	Light Brown				Moist		
				4.5m							
				5.0m	Beige				Saturated	Moderately Well-sorted Subrounded Subangular	

COLOUR : Black, White, Beige
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	17/05/2024
Stickup above NS (m)	38.22
Water Level bTOC (m)	37.62
Water Level bNS (m)	

Date : 17/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 396373.045
 Northing : 6477226.652
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 11:15
 End Hole : 12:35
 Logged by : AFR
 Total Depth : 6
 RL Top of Casing : 38.537
 RL Nat Surface : 37.937

Bore Name

GW7

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	CEMENT			0.5m	Dark Grey			Low		
	BENTONITE SEAL			1.0m	Grey					
	GRAVEL			2.5m	Light Grey	Fine to Medium	Sand	None	Dry	Well-sorted Subrounded Subangular
				3.0m						
				4.5m	Light Brown				Moist	
				5.0m						

COLOUR : Black, White, Beige
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle
 PARTICLE SIZE : Fine, Medium, Course
 TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay
 ORGANICS : High, Medium, Low
 MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level


Date	17/05/2024
Stickup above NS (m)	38.54
Water Level bTOC (m)	37.94
Water Level bNS (m)	

Date : 17/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 396373.045
 Northing : 6477226.652
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 11:15
 End Hole : 12:35
 Logged by : AFR
 Total Depth : 6
 RL Top of Casing : 38.537
 RL Nat Surface : 37.937

Bore Name

GW7

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	GRAVEL		[Screen Icon]	5.5m	Brown	Fine to Medium	Sand	None	Saturated	Well-sorted Subrounded Subangular
				6.0m						end of hole at 6.0m
				6.5m						
				7.0m						
				7.5m						
				8.0m						
				8.5m						
				9.0m						
				9.5m						
				10.0m						

COLOUR : Black, White, Biege
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date : 17/05/2024


Stickup above NS (m) : 38.54
 Water Level bTOC (m) : 37.94
 Water Level bNS (m) :

Date : 16/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 396410.757
 Northing : 6477622.165
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 10:15
 End Hole : 11:20
 Logged by : AFR
 Total Depth : 5
 RL Top of Casing : 36.475
 RL Nat Surface : 35.875

Bore Name

GW8

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics					
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment
PVC (Class 9)	CEMENT			0.5m	Grey			Low		Moderately Well-sorted Subrounded Subangular
	BENTONITE SEAL			1.0m	Light Grey				Dry	
	GRAVEL			1.5m	Light Brown					
				2.0m					Slightly Moist	
				2.5m		Fine to Medium	Sand			
			3.0m				None	Moist		
				3.5m	Beige					
				4.0m					Saturated	
				4.5m						
				5.0m						

COLOUR : Black, White, Beige
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level




Date	17/05/2024
Stickup above NS (m)	36.48
Water Level bTOC (m)	35.88
Water Level bNS (m)	

Date : 16/05/2024
 Client : Burgess Design Group
 Project : Lakefarm Retreat Ballajura GW Monit
 Easting : 396342.263
 Northing : 6477982.753
 Datum : GDA94
 Drill type : Drill Rig Auger
 Hole diameter : 2.5 inches

Job Number : H24009
 Start Hole : 12:45
 End Hole : 13:45
 Logged by : AFR
 Total Depth : 5
 RL Top of Casing : 37.903
 RL Nat Surface : 37.303

Bore Name

GW9

support	backfill	water	Slot / Screen Depth	Depth (metres)	Soil Characteristics						
					Colour	Particle Size	Texture	Organic Content	Moisture	Comment	
PVC (Class 9)	CEMENT			0.5m	Dark Grey	Fine to Medium	Sand	None	Dry	Moderately Well-sorted Rounded Subangular	
				1.0m	Light Grey						
	1.5m			Dark Brown	Slightly Moist						Traces of Coffee Rock
	2.0m			Light Beige	Dry						
	2.5m			Beige							
	3.0m			Dark Beige	Moist						
	3.5m			Light Brown	Saturated						
	4.0m			Beige							
	4.5m			Beige	Moderately Well-sorted Rounded Subangular						
5.0m	Beige										

COLOUR : Black, White, Beige
 Dark/Medium/Light : Brown, Red, Orange, Yellow, Grey, Blue
 Composition : Solid, Blemish, Mottle

PARTICLE SIZE : Fine, Medium, Course

TEXTURE : Sand, Loamy Sand, Clayey Sand
 Silt, Loam, Sandy Loam, Clayey Loam
 Clay, Sandy Clay

ORGANICS : High, Medium, Low

MOISTURE : Dry, Slightly Moist, Moist, Saturated

Static Water Level

Date	17/05/2024
Stickup above NS (m)	37.90
Water Level bTOC (m)	37.60
Water Level bNS (m)	

Location	ID	Description	GDA94			AHD71			n Value (m)	AHD (m) T.O.C.	Height Pipe A.G.L. (m)	Surface Elevation (m)	RWL (m)	Notes
			Horizontal Accuracy (m)	Horizontal Accuracy (m)	Horizontal Accuracy (m)	Horizontal Accuracy (m)	Vertical Accuracy (m)	Vertical Accuracy (m)						
Ballajura	MW01	Piezometer	395285.235	0.020	6477934.219	0.020	5.965	0.020	-32.274	38.239	0.60	37.639	38.239	DGPS Control
Ballajura	MW02	Piezometer	395719.848	0.020	6477627.556	0.020	5.646	0.020	-32.238	37.884	0.60	37.284	37.884	DGPS Control
Ballajura	MW03	Piezometer	395743.036	0.020	6477931.444	0.020	5.700	0.020	-32.237	37.937	0.60	37.337	37.937	DGPS Control
Ballajura	MW04	Piezometer	396048.350	0.020	6477429.188	0.020	5.202	0.020	-32.216	37.418	0.60	36.818	37.418	DGPS Control
Ballajura	MW05	Piezometer	396034.504	0.020	6477720.219	0.020	5.204	0.020	-32.215	37.419	0.60	36.819	37.419	DGPS Control
Ballajura	MW06	Piezometer	396070.304	0.020	6477979.457	0.020	6.017	0.020	-32.207	38.224	0.60	37.624	38.224	DGPS Control
Ballajura	MW07	Piezometer	396373.045	0.020	6477226.652	0.020	6.352	0.020	-32.185	38.537	0.60	37.937	38.537	DGPS Control
Ballajura	MW08	Piezometer	396410.757	0.020	6477622.165	0.020	4.291	0.020	-32.184	36.475	0.60	35.875	36.475	DGPS Control
Ballajura	MW09	Piezometer	396342.263	0.020	6477982.753	0.020	5.719	0.020	-32.184	37.903	0.60	37.303	37.903	DGPS Control

APPENDIX D
Historical & Current
Surface Water Plates

1953

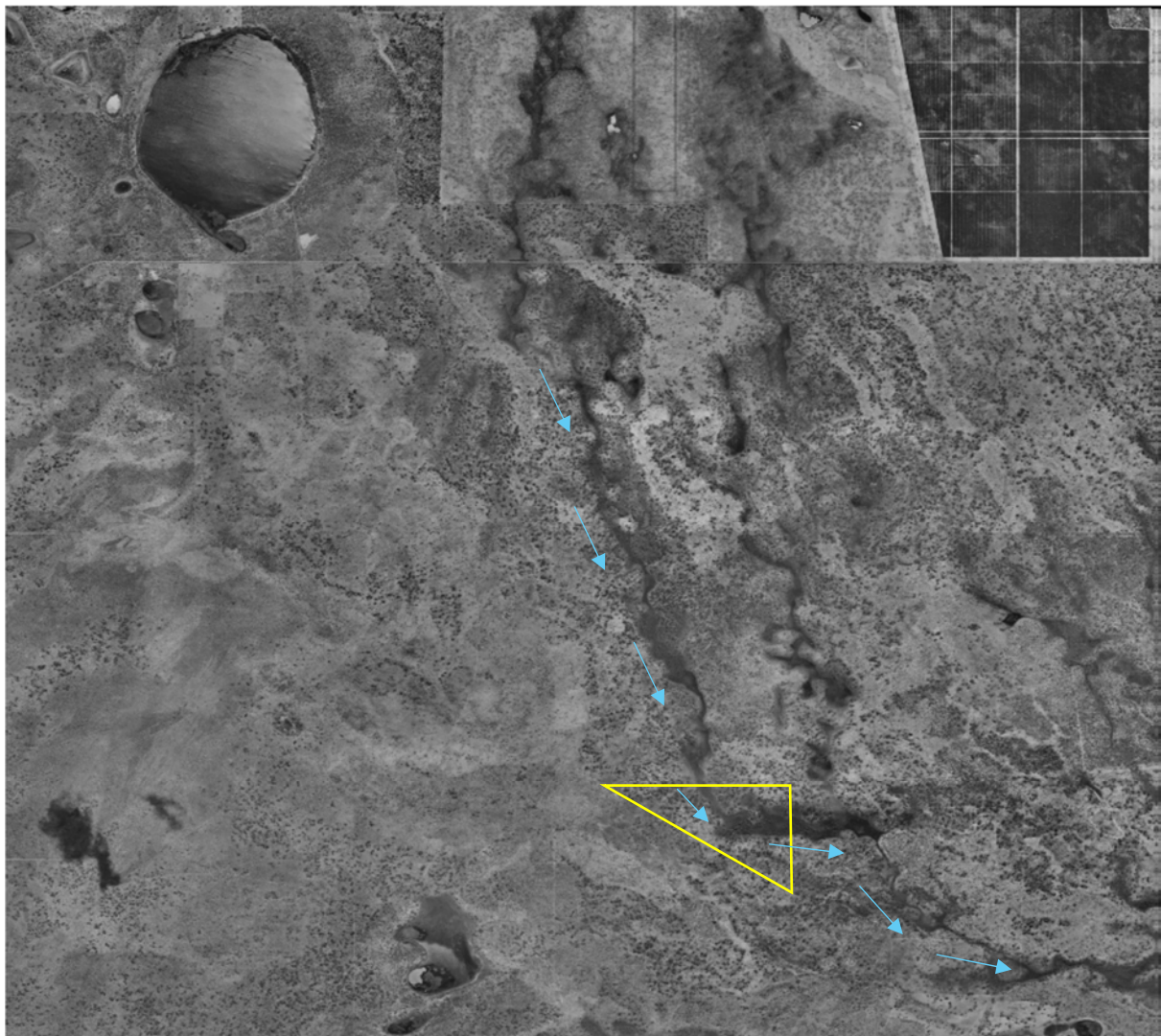


Plate 1: Historical aerial image (Landgate: Perth Metropolitan Area 30/10 – 27/11/1953) showing external catchment draining through the site mid last century.

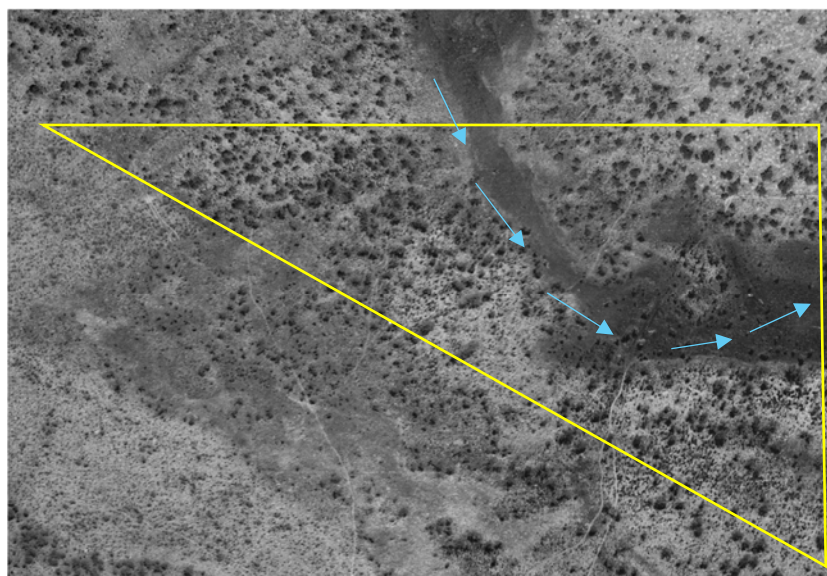


Plate 2: Historical natural surface water pathway from north to east (same image as Plate 1).

1970



Plate 3: Historical aerial image (Landgate: Perth Metro 20/07/1970).

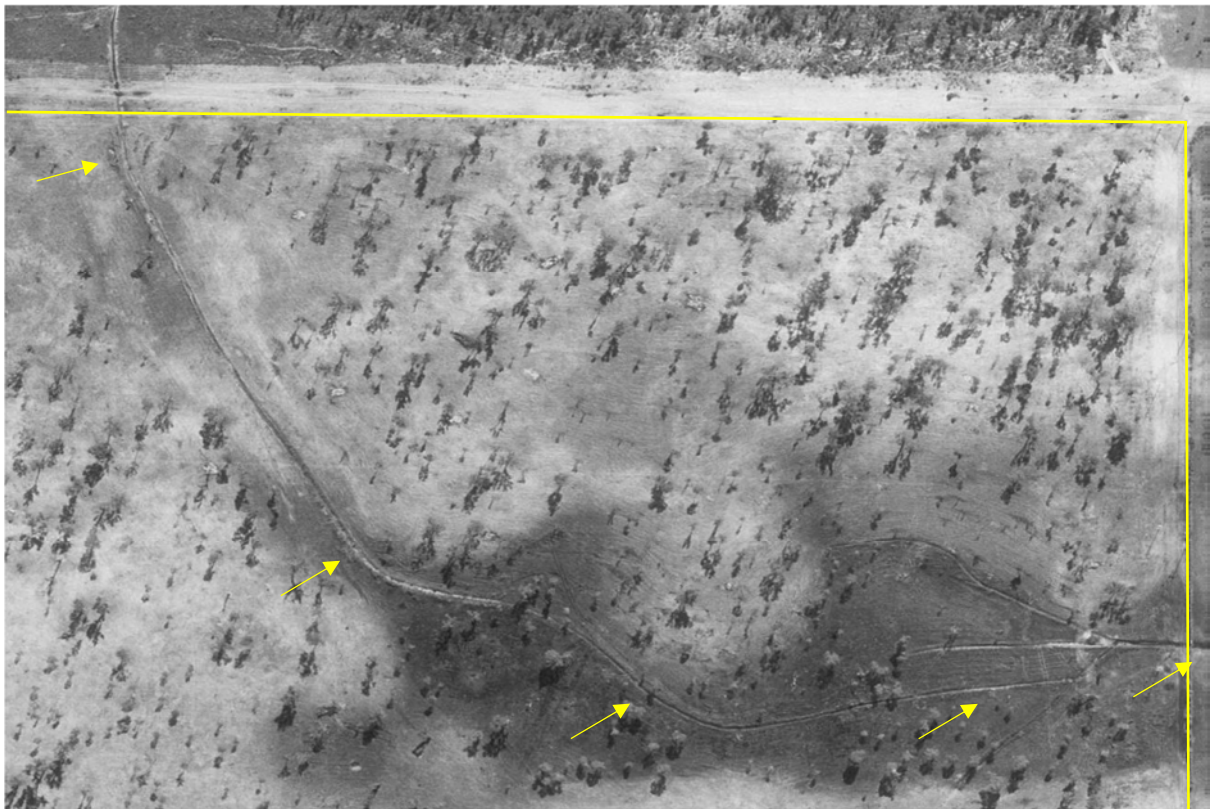


Plate 4: Same image as Plate 3. Formal drainage constructed within site to assist flows/reduce waterlogging. Formal drain at eastern boundary of site evident.

1989



Plate 5: Historical aerial image (Landgate: Perth Metropolitan Area 19-31/12/1989).



Plate 6: Same image as Plate 5, showing the construction of Lakefarm Retreat internal road modifying the drain's configuration.

2024



Plate 7: Historical aerial image (Landgate: Perth Metropolitan Area North 27/01-10/02/2024).



Plate 8: Same image as Plate 7. Drain at northern boundary no longer appears to exist – 4WD use evident in area. Drain within site at east boundary not present due to previous site earthworks and lower groundwater levels which allows infiltration to sandy soils. Formal drain to east of site still present. No water observed in drain during monitoring.



Plate 9: Aerial view. Drain at northern boundary (blue arrow) no longer present. 4WD vehicles activity present. Source of Image: Galt Geotechnics WAG240411-01 001 R Rev0.



Plate 10: Aerial view. Drain within site near eastern boundary no longer exist following earthworks in early 2000s. Yellow arrows show culvert under road, blue arrow shows the previous drain pathway, and orange arrow shows the still existing drain located downstream of the site. Source of Image: Galt Geotechnics WAG240411-01 001 R Rev0.



Plate 11: View from adjacent property toward the northern boundary of the site, N-S direction. Drain from north not evident and no indication of surface water flow. Yellow arrow shows the historical drain pathway. Date of image: 09/10/2024



Plate 12: Access track along northern boundary, W-E direction. Yellow arrow shows historical drain pathway, no longer existing. Date of image: 09/10/2024

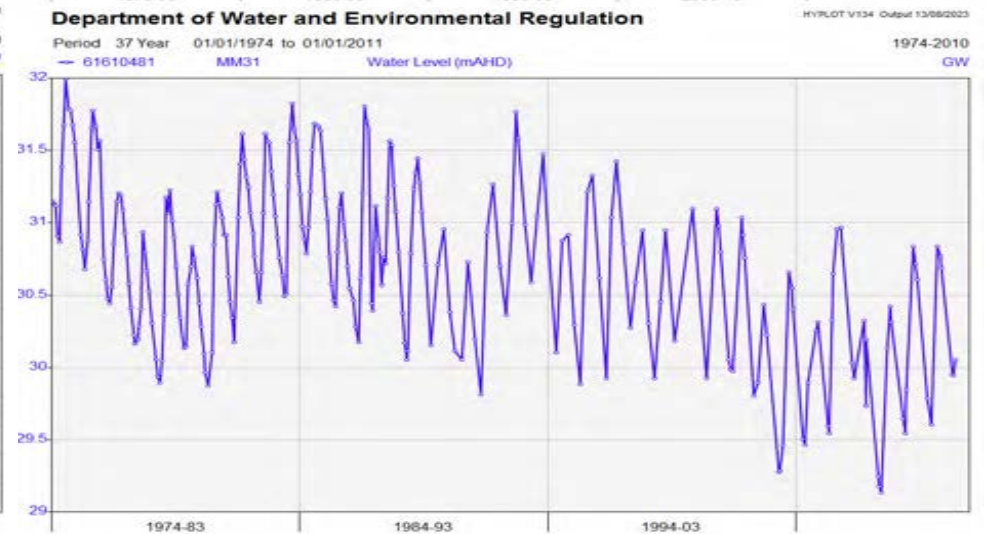
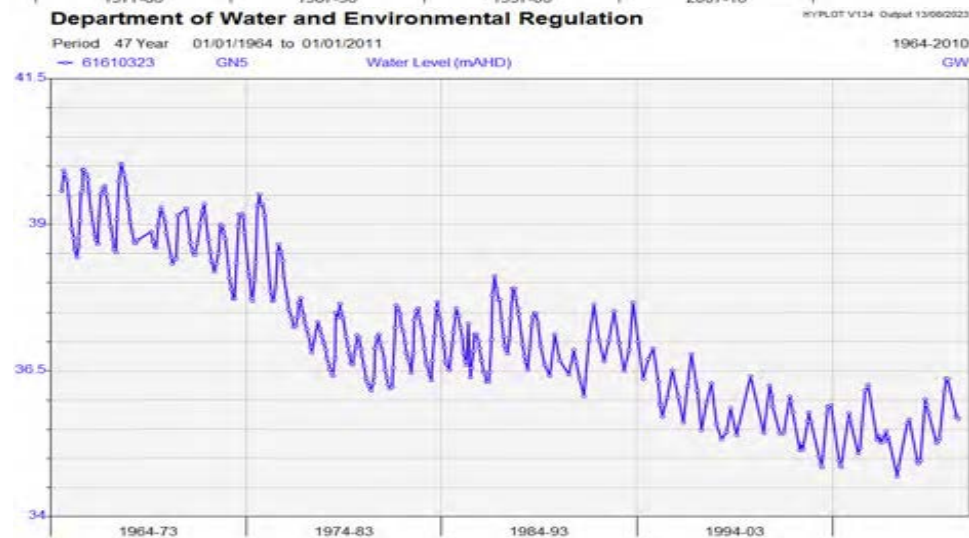
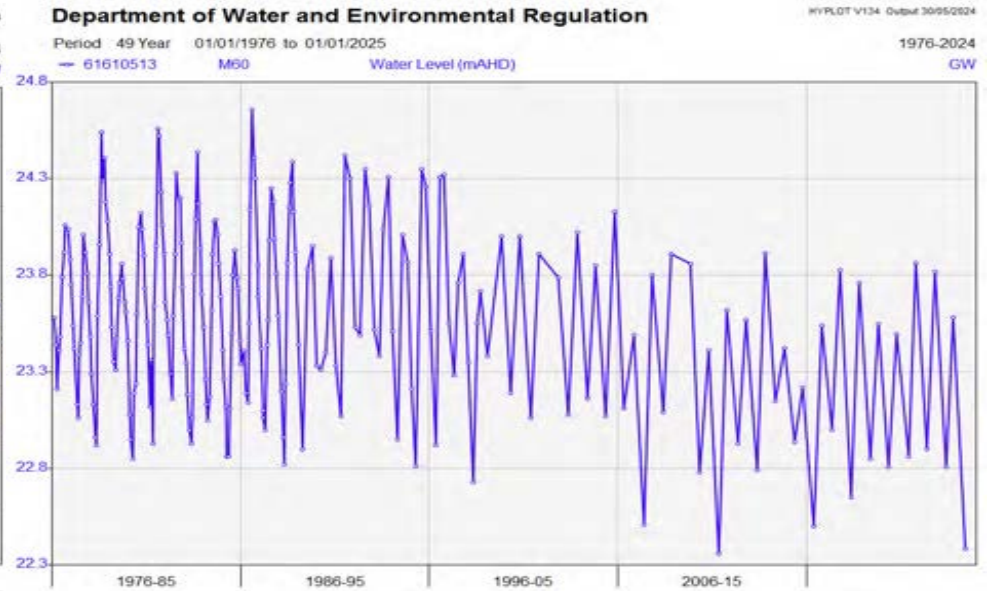
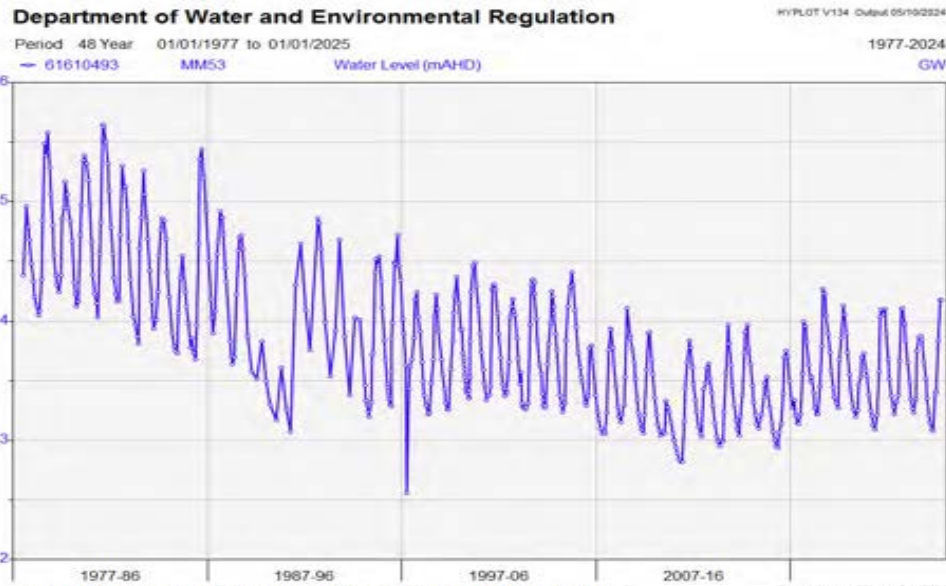


Plate 13: Western boundary of the site, at Lot 14, NE-SW direction. Previous drain filled and no surface water flow path through the site currently exists. Yellow arrow indicatively shows previous surface water pathway. Date of image: 09/10/2024



Plate 14: View from site boundary towards adjacent property at east, W-E direction. Drain downstream still exists however no water present. Access track crosses drain without culvert. Flow towards southeast. Date of image: 09/10/2024

APPENDIX E
DWER Bore Long Term Hydrographs



Source : DWER Water Information Reporting (online)

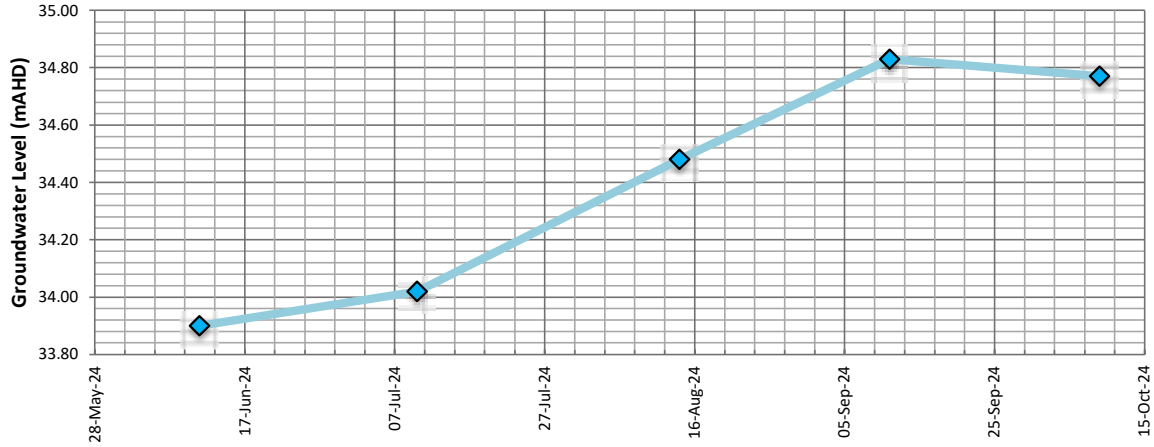
APPENDIX F
Pre-Development Groundwater
Level Monitoring Data

GW1 Site Bore GW1



Data Analysis Period Start Date	11/06/2024	Easting	395285.235	Natural Surface (mAHD)	37.64
Data Analysis Period End Date	9/10/2024	Northing	6477934.219	Top of Casing (m AHD)	38.24
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	4.34	33.90	3.74
10/07/2024	4.22	34.02	3.62
14/08/2024	3.76	34.48	3.16
11/09/2024	3.41	34.83	2.81
9/10/2024	3.47	34.77	2.87

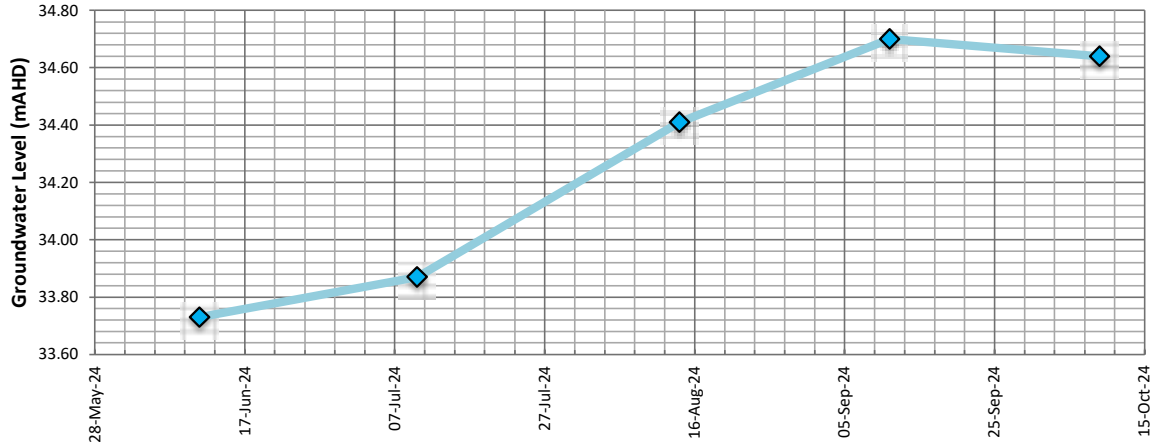
Minimum Recorded Level (mAHD)	33.90
Maximum Recorded Level (mAHD)	34.83

GW2 Site Bore GW2



Data Analysis Period Start Date	11/06/2024	Easting	395719.848	Natural Surface (mAHD)	37.28
Data Analysis Period End Date	9/10/2024	Northing	6477627.556	Top of Casing (m AHD)	37.88
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	4.15	33.73	3.55
10/07/2024	4.01	33.87	3.41
14/08/2024	3.47	34.41	2.87
11/09/2024	3.18	34.70	2.58
9/10/2024	3.24	34.64	2.64

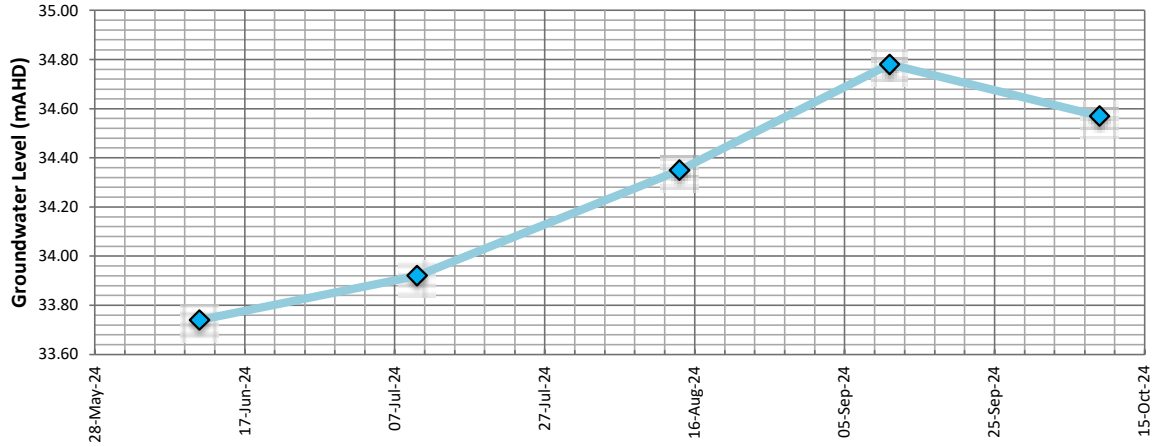
Minimum Recorded Level (mAHD)	33.73
Maximum Recorded Level (mAHD)	34.70

GW3 Site Bore GW3



Data Analysis Period Start Date	11/06/2024	Easting	395743.036	Natural Surface (mAHD)	37.34
Data Analysis Period End Date	9/10/2024	Northing	6477931.444	Top of Casing (m AHD)	37.94
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	4.20	33.74	3.60
10/07/2024	4.02	33.92	3.42
14/08/2024	3.59	34.35	2.99
11/09/2024	3.16	34.78	2.56
9/10/2024	3.37	34.57	2.77

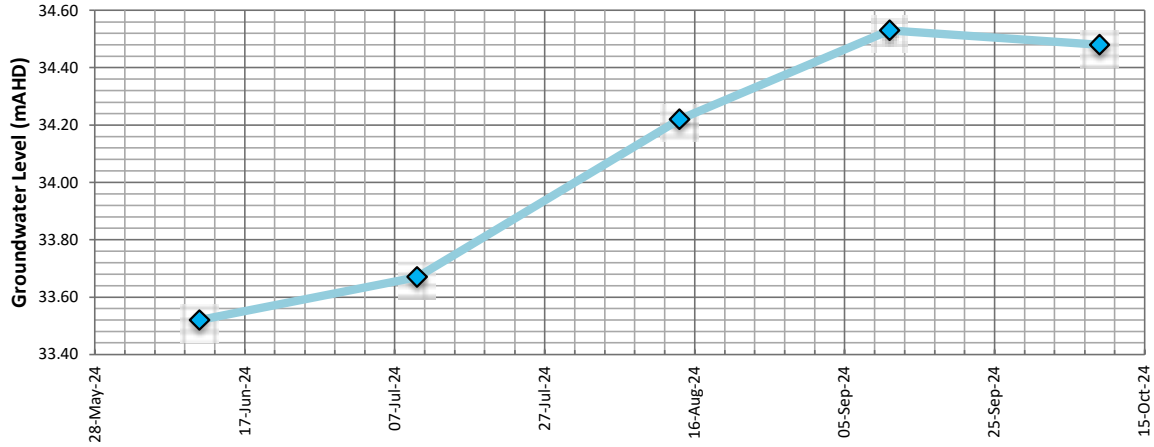
Minimum Recorded Level (mAHD)	33.74
Maximum Recorded Level (mAHD)	34.78

GW4 Site Bore GW4



Data Analysis Period Start Date	11/06/2024	Easting	396048.35	Natural Surface (mAHD)	36.82
Data Analysis Period End Date	9/10/2024	Northing	6477429.188	Top of Casing (m AHD)	37.42
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	3.90	33.52	3.30
10/07/2024	3.75	33.67	3.15
14/08/2024	3.20	34.22	2.60
11/09/2024	2.89	34.53	2.29
9/10/2024	2.94	34.48	2.34

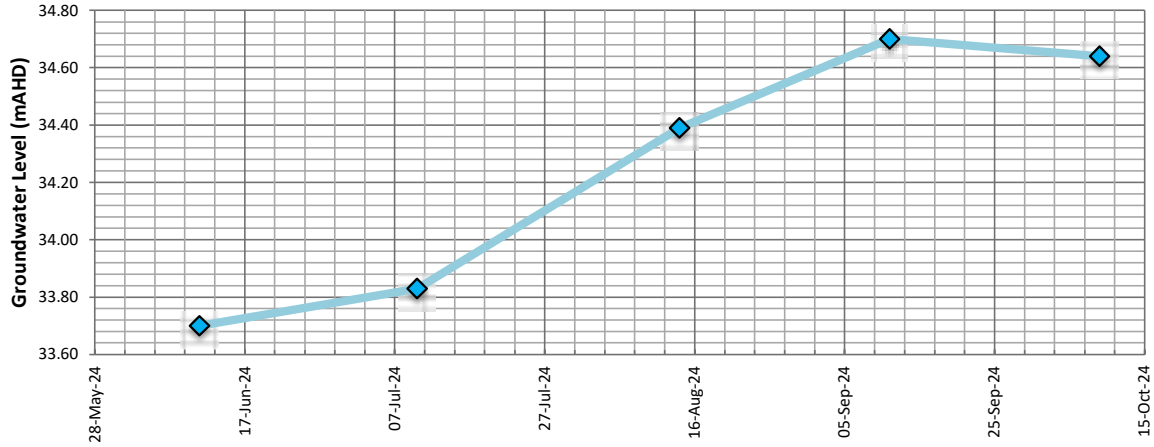
Minimum Recorded Level (mAHD)	33.52
Maximum Recorded Level (mAHD)	34.53

GW5 Site Bore GW5



Data Analysis Period Start Date	11/06/2024	Easting	396034.504	Natural Surface (mAHD)	36.82
Data Analysis Period End Date	9/10/2024	Northing	6477720.219	Top of Casing (m AHD)	37.42
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	3.72	33.70	3.12
10/07/2024	3.59	33.83	2.99
14/08/2024	3.03	34.39	2.43
11/09/2024	2.72	34.70	2.12
9/10/2024	2.78	34.64	2.18

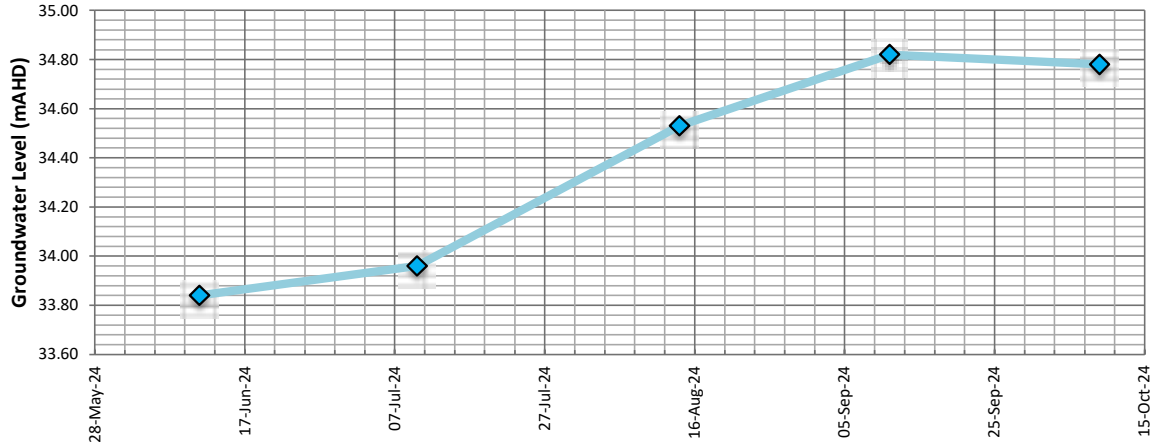
Minimum Recorded Level (mAHD)	33.70
Maximum Recorded Level (mAHD)	34.70

GW6 Site Bore GW6



Data Analysis Period Start Date	11/06/2024	Easting	396070.304	Natural Surface (mAHD)	37.62
Data Analysis Period End Date	9/10/2024	Northing	6477979.457	Top of Casing (m AHD)	38.22
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	4.38	33.84	3.78
10/07/2024	4.26	33.96	3.66
14/08/2024	3.69	34.53	3.09
11/09/2024	3.40	34.82	2.80
9/10/2024	3.44	34.78	2.84

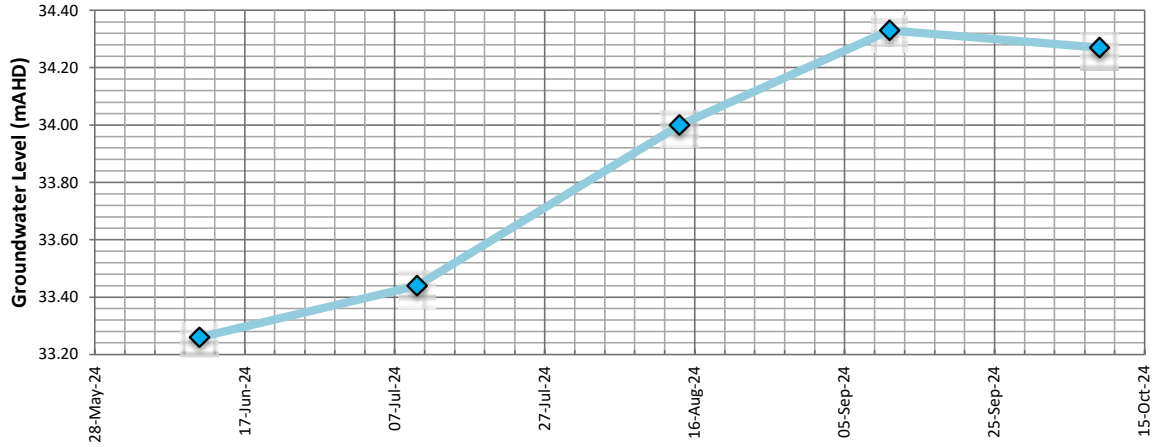
Minimum Recorded Level (mAHD)	33.84
Maximum Recorded Level (mAHD)	34.82

GW7 Site Bore GW7



Data Analysis Period Start Date	11/06/2024	Easting	396373.045	Natural Surface (mAHD)	37.94
Data Analysis Period End Date	9/10/2024	Northing	6477226.652	Top of Casing (m AHD)	38.54
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	5.28	33.26	4.68
10/07/2024	5.10	33.44	4.50
14/08/2024	4.54	34.00	3.94
11/09/2024	4.21	34.33	3.61
9/10/2024	4.27	34.27	3.67

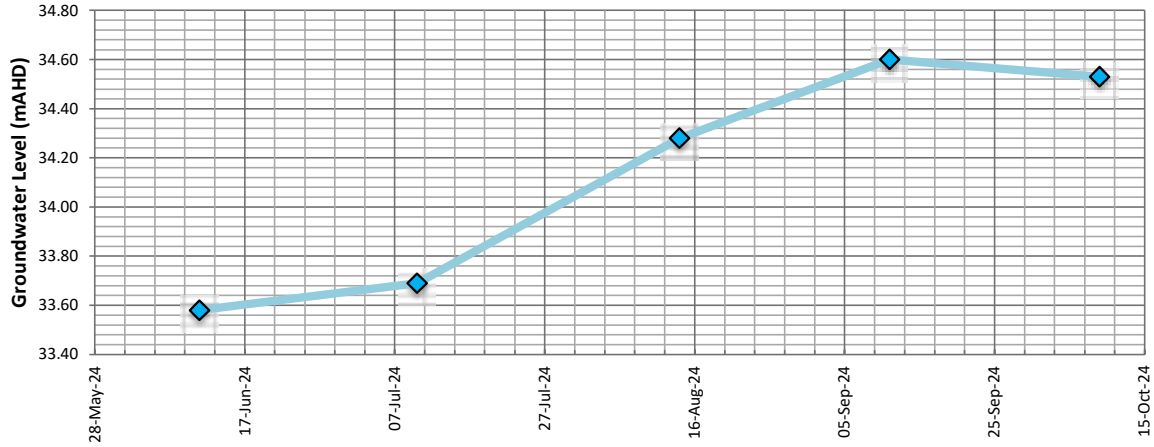
Minimum Recorded Level (mAHD)	33.26
Maximum Recorded Level (mAHD)	34.33

GW8 Site Bore GW8



Data Analysis Period Start Date	11/06/2024	Easting	396410.757	Natural Surface (mAHD)	35.88
Data Analysis Period End Date	9/10/2024	Northing	6477622.165	Top of Casing (m AHD)	36.48
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	2.90	33.58	2.30
10/07/2024	2.79	33.69	2.19
14/08/2024	2.20	34.28	1.60
11/09/2024	1.88	34.60	1.28
9/10/2024	1.95	34.53	1.35

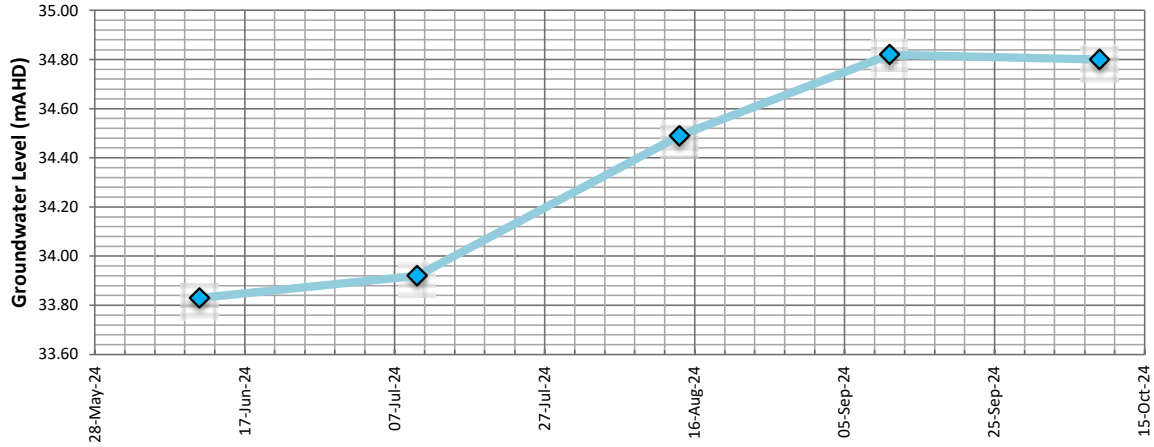
Minimum Recorded Level (mAHD)	33.58
Maximum Recorded Level (mAHD)	34.60

GW9 Site Bore GW9



Data Analysis Period Start Date	11/06/2024	Easting	396342.263	Natural Surface (mAHD)	37.30
Data Analysis Period End Date	9/10/2024	Northing	6477982.753	Top of Casing (m AHD)	37.90
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/06/2024	4.07	33.83	3.47
10/07/2024	3.98	33.92	3.38
14/08/2024	3.41	34.49	2.81
11/09/2024	3.08	34.82	2.48
9/10/2024	3.10	34.80	2.50

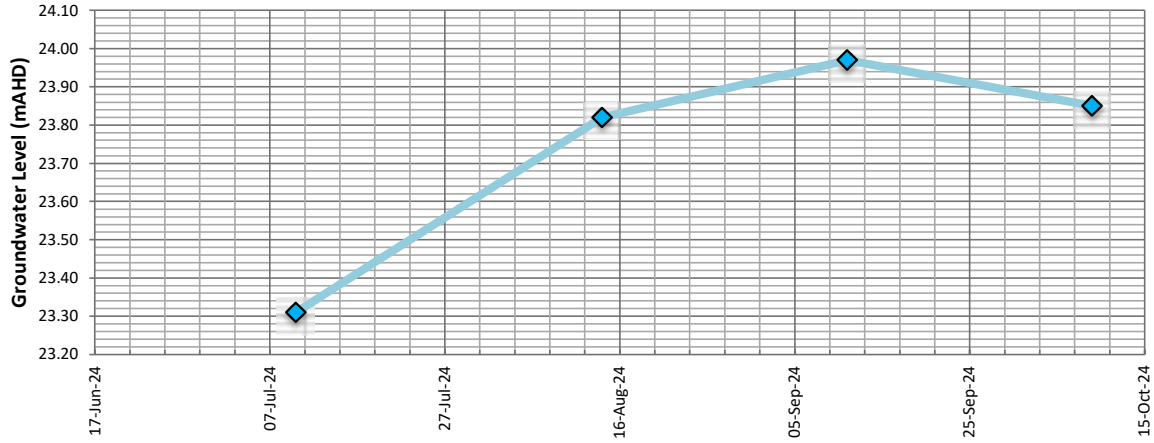
Minimum Recorded Level (mAHD)	33.83
Maximum Recorded Level (mAHD)	34.82

M60 DWER Mirrabooka Observation M60



Data Analysis Period Start Date	11/06/2024	Easting	399380.99	Natural Surface (mAHD)	
Data Analysis Period End Date	9/10/2024	Northing	6476121.51	Top of Casing (m AHD)	25.79
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
10/07/2024	2.48	23.31	
14/08/2024	1.97	23.82	
11/09/2024	1.82	23.97	
9/10/2024	1.94	23.85	

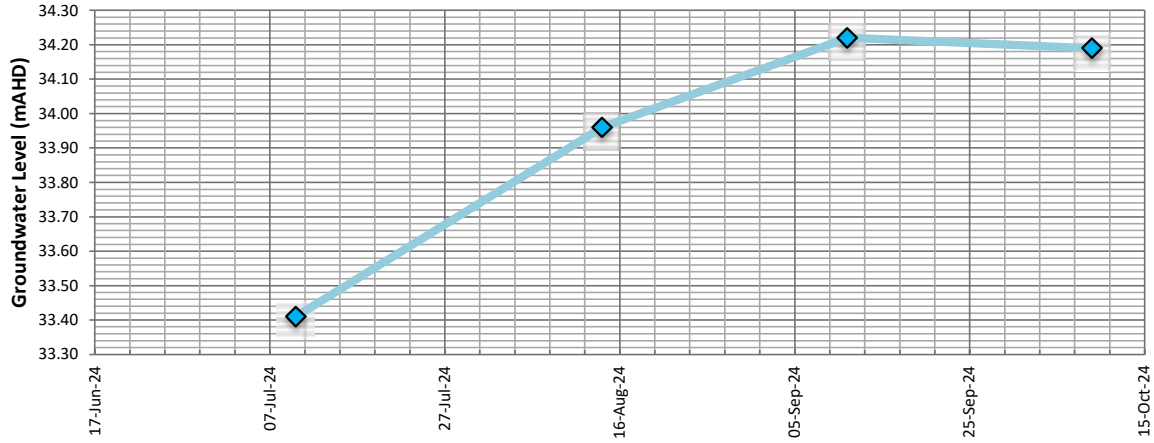
Minimum Recorded Level (mAHD)	23.31
Maximum Recorded Level (mAHD)	23.97

MM53 DWER Mirrabooka Monitoring MM53



Data Analysis Period Start Date	11/06/2024	Easting	398944	Natural Surface (mAHD)	
Data Analysis Period End Date	9/10/2024	Northing	6479048.5	Top of Casing (m AHD)	37.27
				End of Hole (mAHD)	

Report Date : 11/10/2024



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
10/07/2024	3.86	33.41	
14/08/2024	3.31	33.96	
11/09/2024	3.05	34.22	
9/10/2024	3.08	34.19	

Minimum Recorded Level (mAHD)	33.41
Maximum Recorded Level (mAHD)	34.22

APPENDIX G
UNDO Nutrient Modelling
Pre-Development



Project: Lakefarm Ballajura DWMS Pre Development Date: 7/10/2024
Version: Version 1.2.0.19289

Subregion name: Lots 11 to 23 Lakefarm Retreat Ballajura

Landuse	Percent (%)	Area (ha)	Input load		Total area (ha)	Total percent (%)
			Nitrogen (kg)	Phosphorus (kg)		
Residential	0	0.00	0.00	0.00	53.55	100
Industrial, commercial & schools	0	0.00	0.00	0.00		
Rural living	100	53.55	3194.26	444.47	3474.32	452.50
Public open space	0	0.00	0.00	0.00		
Road reserve	0	0.00	0.00	0.00	340.47	16.52
					Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
					Nitrogen export (kg/yr)	Phosphorus (kg/yr)

Rural living

Landuse	Percent (%)	Area (ha)	Total area (ha)	Total percent (%)
No livestock	50	26.78		
No clearing apart from the housing pad	0	0.00	3194.26	444.47
			Nitrogen input (kg)	Phosphorus input (kg)

Note: Commercial horticulture is not permitted in the rural living zone, due to spray drift buffers.

Soil and drainage information

Type of drainage	Infiltration	Does it contain imported fill?	No
Soil type	Bassendean	Does subregion contain onsite sewage disposal system?	Yes
Depth to groundwater (m)	2	Type of system installed	Septic tank
Groundwater slope (%)	0.5	No. of units installed	9
Soil PRI	5.0		

Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices

Treatment	Name	Size (m ²)	Treated area (ha)	Treating	N removed (kg/yr)	P removed (kg/yr)
Load removed					0.00	0.00
Net export					340.47	16.52

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/yr)	N export (kg/yr)
Lots 11 to 23 Lakefarm Retreat Ballajura	53.55	16.52	340.47

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
340.47	16.52	0.00	0.00	340.47	16.52

APPENDIX H
Groundwater Quality Summary Results

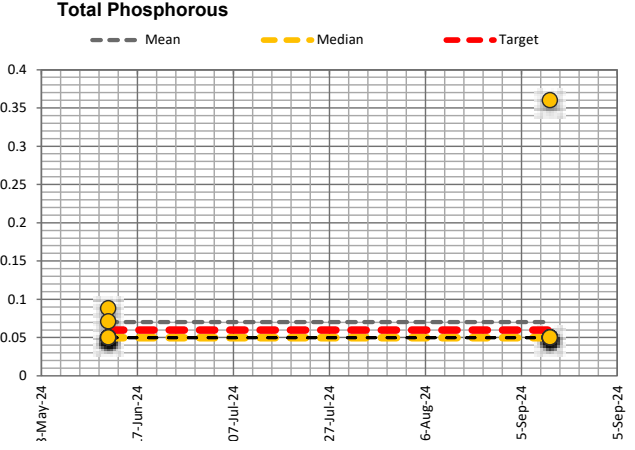
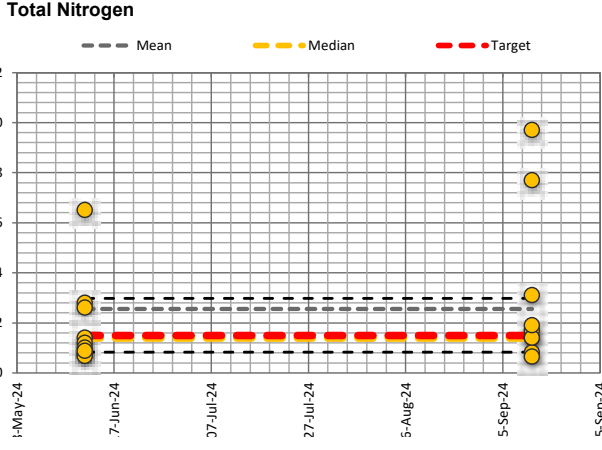
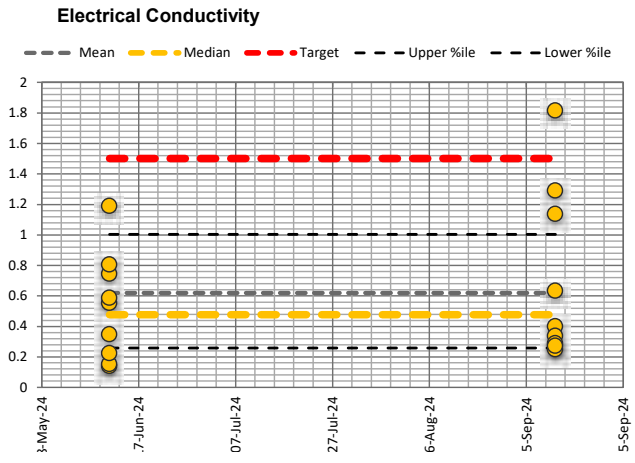
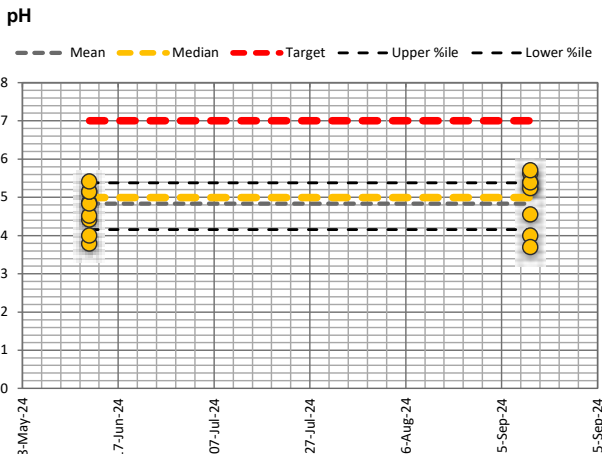
H24009 Lakefarm Retreat Ballajura
Aggregated Data for All Sites
Groundwater

Data Analysis Period Start Date **1/01/2024**
 Data Analysis Period End Date **31/12/2025**



Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target	ANZECC - SWA Wetlands	Times Exceeded
					20	80			80	90				
GWL bToC	Groundwater Level	mBToC	53	1.82	2.89	3.43	3.41	4.12	5.28			✓	0	
GWL mAHD	Groundwater Level	mAHD	53	23.31	33.69	33.41	34.22	34.62	34.83			✓	0	
T	Temperature	°C	18	19.00	19.74	20.611	20.800	21.560	22.100			✓	0	
EC	Electrical Conductivity	mS/cm	18	0.14	0.26	0.620	0.476	1.004	1.815	1.500		✗	1	
pH	pH	pH	18	3.69	4.16	4.83	5.00	5.38	5.70	7.00		✓	0	
DO	Dissolved Oxygen	%	18	9.10	12.22	22.37	18.75	28.14	53.70	120.00		✓	0	
TN	Total Nitrogen	mg/L	18	0.65	0.84	2.56	1.40	2.98	9.70	1.50		✗	8	
TKN	Total Kejdhal Nitrogen	mg/L	18	0.49	0.85	1.75	1.40	2.46	5.90			✓	0	
NO3	Nitrate	mg/L	18	0.01	0.01	0.83	0.05	0.52	7.20			✓	0	
NO2	Nitrite	mg/L	18	0.01	0.01	0.02	0.01	0.03	0.05			✓	0	
Nox	Nox	mg/L	18	0.01	0.01	0.83	0.05	0.53	7.20	0.10		✗	8	
NH3	Ammonia	mg/L	18	0.01	0.05	0.17	0.13	0.27	0.55			✓	0	
TP	Total Phosphorous	mg/L	18	0.05	0.05	0.07	0.05	0.05	0.36	0.06		✗	3	
FRP	Filterable Reactive Phosphorous	mg/L	18	0.01	0.01	0.01	0.01	0.01	0.05	0.03		✗	2	
As	Arsenic	mg/L	18	0.00100	0.00100	0.00104	0.00100	0.00100	0.00130			✓	0	
Cd	Cadmium	mg/L	18	0.00010	0.00010	0.00011	0.00010	0.00010	0.00019			✓	0	
Cr	Chromium	mg/L	18	0.00100	0.00128	0.00274	0.00240	0.00382	0.00630			✓	0	
Cu	Copper	mg/L	18	0.00100	0.00100	0.00186	0.00100	0.00234	0.00610			✓	0	
Pb	Lead	mg/L	18	0.00100	0.00100	0.00199	0.00100	0.00228	0.00710			✓	0	
Hg	Mercury	mg/L	18	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005			✓	0	
Ni	Nickel	mg/L	18	0.00100	0.00100	0.00409	0.00270	0.00674	0.01300			✓	0	
Zn	Zinc	mg/L	18	0.00100	0.00228	0.00477	0.00300	0.00672	0.01500			✓	0	



H24009 Lakefarm Retreat Ballajura
GW1 Site Bore GW1

Easting 395285.24
 Northing 6477934.2

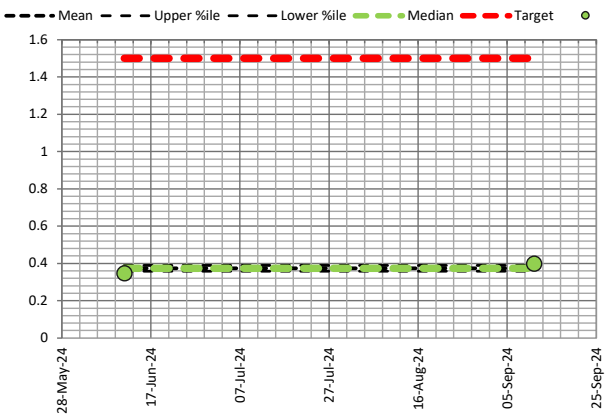
Data Analysis Period Start Date 1/01/2024
 Data Analysis Period End Date 31/12/2024



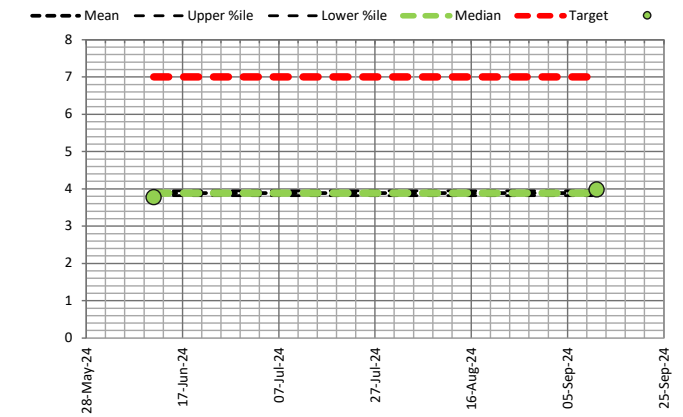
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80			80	80			
GWL bToC	Groundwater Level	mBToC	5	3.41	3.46	3.84	3.76	4.24	4.34			0	
GWL mAHD	Groundwater Level	mAHD	5	33.90	34.00	34.40	34.48	34.78	34.83			0	
T	Temperature	°C	2	20.00	20.160	20.400	20.40	20.640	20.800			0	
EC	Electrical Conductivity	mS/cm	2	0.35	0.36	0.37	0.37	0.39	0.40	1.500		0	
pH	pH	pH	2	3.78	3.82	3.89	3.89	3.95	3.99	7.00		0	
DO	Dissolved Oxygen	%	2	10.90	14.12	18.95	18.95	23.78	27.00	120.00		0	
TN	Total Nitrogen	mg/L	2	1.40	1.40	1.40	1.40	1.40	1.40	1.50		0	
TKN	Total Kejdhal Nitrogen	mg/L	2	1.40	1.40	1.40	1.40	1.40	1.40			0	
NO3	Nitrate	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01			0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01			0	
Nox	Nox	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01	0.10		0	
NH3	Ammonia	mg/L	2	0.54	0.54	0.55	0.55	0.55	0.55			0	
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05	0.05	0.05	0.06		0	
FRP	Filterable Reactive Phosphorous	mg/L	2	0.01	0.01		0.01	0.01	0.01	0.03		0	
As	Arsenic	mg/L	2	0.00100	0.00102	0.00105	0.00105	0.00108	0.00110			0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010			0	
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Cu	Copper	mg/L	2	0.00100	0.00110	0.00125	0.00125	0.00140	0.00150			0	
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005			0	
Ni	Nickel	mg/L	2	0.01100	0.01140	0.01200	0.01200	0.01260	0.01300			0	
Zn	Zinc	mg/L	2	0.00120	0.00140	0.00170	0.00170	0.00200	0.00220			0	

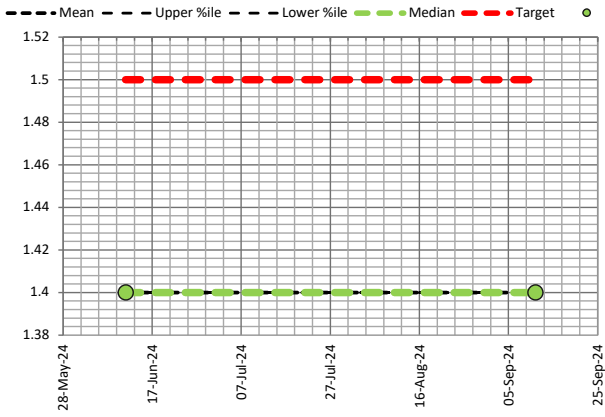
Electrical Conductivity



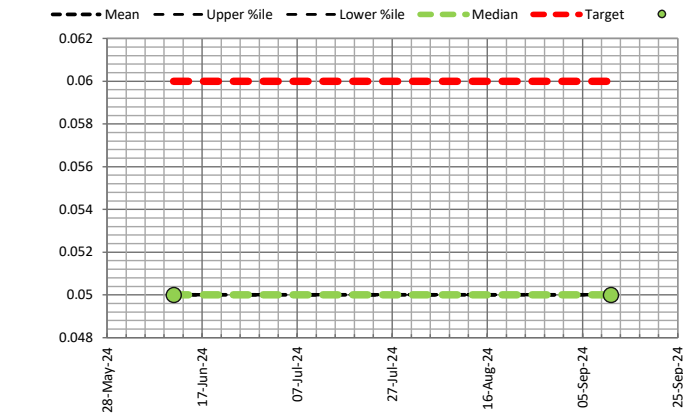
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW2 Site Bore GW2

Easting 395719.85
 Northing 6477627.6

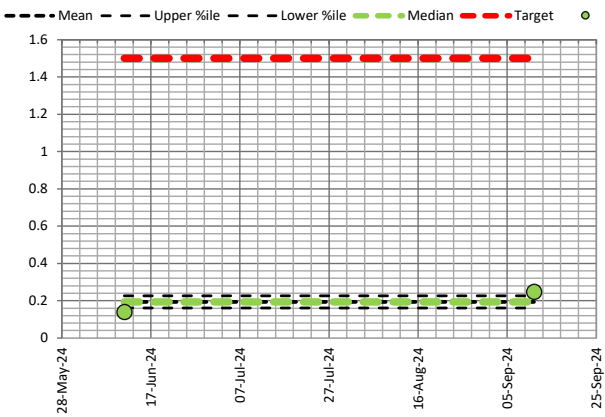
Data Analysis Period Start Date 1/01/2024
 Data Analysis Period End Date 31/12/2024



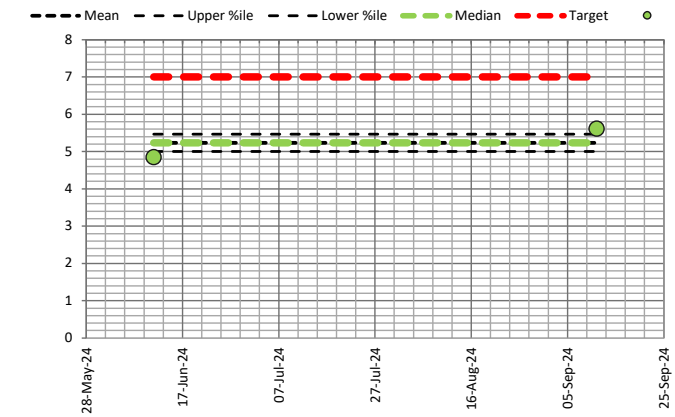
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80						
GWL bToC	Groundwater Level	mBToC	5	3.18	3.23	3.61	3.47	4.04	4.15		0	
GWL mAHD	Groundwater Level	mAHD	5	33.73	33.84	34.27	34.41	34.65	34.70		0	
T	Temperature	°C	2	21.50	21.560	21.650	21.65	21.740	21.800		0	
EC	Electrical Conductivity	mS/cm	2	0.14	0.16	0.19	0.19	0.23	0.25	1.500	0	
pH	pH	pH	2	4.85	5.00	5.24	5.24	5.47	5.62	7.00	0	
DO	Dissolved Oxygen	%	2	26.20	31.70	39.95	39.95	48.20	53.70	120.00	0	
TN	Total Nitrogen	mg/L	2	0.75	2.54	5.23	5.23	7.91	9.70	1.50	1	
TKN	Total Kejdhal Nitrogen	mg/L	2	0.49	0.89	1.50	1.50	2.10	2.50		0	
NO3	Nitrate	mg/L	2	0.26	1.65	3.73	3.73	5.81	7.20		0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01		0	
Nox	Nox	mg/L	2	0.26	1.65	3.73	3.73	5.81	7.20	0.10	2	
NH3	Ammonia	mg/L	2	0.02	0.02	0.03	0.03	0.03	0.03		0	
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0	
FRP	Filterable Reactive Phosphorous	mg/L	2	0.01	0.01		0.01	0.01	0.01	0.03	0	
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010		0	
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0	
Cu	Copper	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0	
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005		0	
Ni	Nickel	mg/L	2	0.00100	0.00102	0.00105	0.00105	0.00108	0.00110		0	
Zn	Zinc	mg/L	2	0.00100	0.00138	0.00195	0.00195	0.00252	0.00290		0	

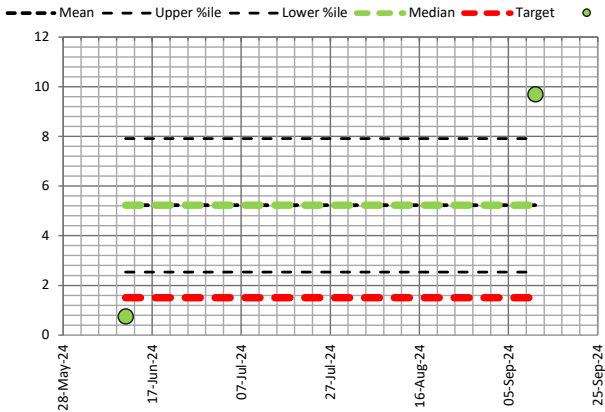
Electrical Conductivity



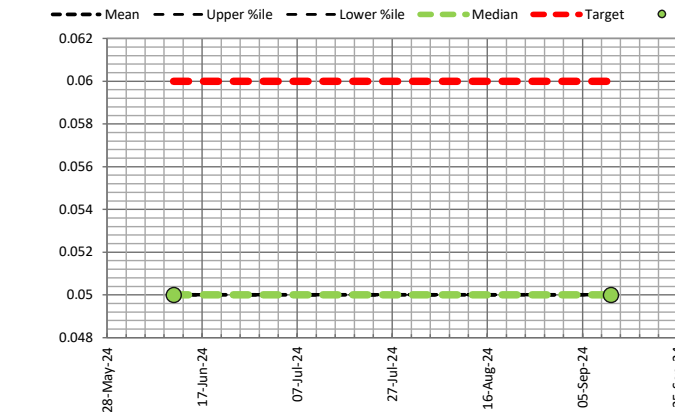
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW3 Site Bore GW3

Easting 395743.04
 Northing 6477931.4

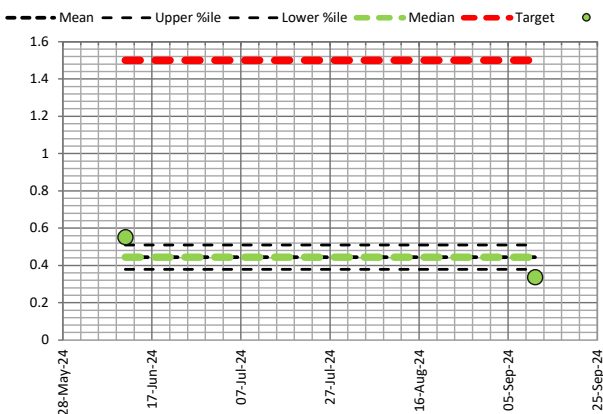
Data Analysis Period Start Date **1/01/2024**
 Data Analysis Period End Date **31/12/2024**



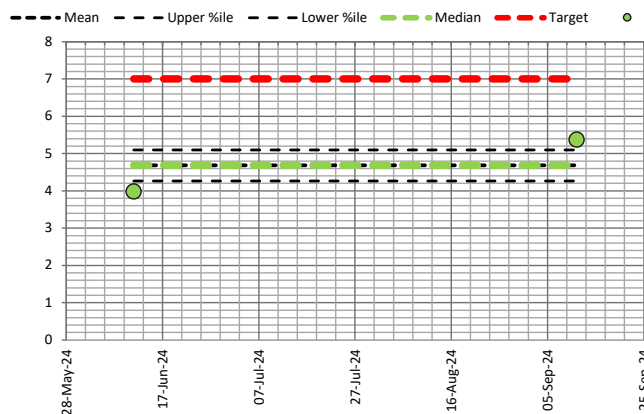
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80							
GWL bToC	Groundwater Level	mBToC	5	3.16	3.33	3.67	3.59		4.06	4.20		0	
GWL mAHD	Groundwater Level	mAHD	5	33.74	33.88	34.27	34.35		34.61	34.78		0	
T	Temperature	°C	2	20.80	20.880	21.000	21.00		21.120	21.200		0	
EC	Electrical Conductivity	mS/cm	2	0.34	0.38	0.44	0.44		0.51	0.55	1.500	0	
pH	pH		2	3.99	4.27	4.69	4.69		5.10	5.38	7.00	0	
DO	Dissolved Oxygen	%	2	20.50	23.86	28.90	28.90		33.94	37.30	120.00	0	
TN	Total Nitrogen	mg/L	2	1.20	2.50	4.45	4.45		6.40	7.70	1.50	1	
TKN	Total Kejdhal Nitrogen	mg/L	2	1.10	1.48	2.05	2.05		2.62	3.00		0	
NO3	Nitrate	mg/L	2	0.02	0.96	2.36	2.36		3.76	4.70		0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	0.01		0.01	0.01		0	
Nox	Nox	mg/L	2	0.02	0.96	2.36	2.36		3.76	4.70	0.10	1	
NH3	Ammonia	mg/L	2	0.05	0.07	0.10	0.10		0.14	0.16		0	
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05		0.05	0.05	0.06	0	
FRP	Filterable Reactive Phosphorous	mg/L	2	0.01	0.01		0.01		0.01	0.01	0.03	0	
As	Arsenic	mg/L	2	0.00100	0.00106	0.00115	0.00115		0.00124	0.00130		0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010		0.00010	0.00010		0	
Cr	Chromium	mg/L	2	0.00170	0.00180	0.00195	0.00195		0.00210	0.00220		0	
Cu	Copper	mg/L	2	0.00100	0.00116	0.00140	0.00140		0.00164	0.00180		0	
Pb	Lead	mg/L	2	0.00100	0.00114	0.00135	0.00135		0.00156	0.00170		0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005		0.00005	0.00005		0	
Ni	Nickel	mg/L	2	0.00210	0.00286	0.00400	0.00400		0.00514	0.00590		0	
Zn	Zinc	mg/L	2	0.00370	0.00484	0.00655	0.00655		0.00826	0.00940		0	

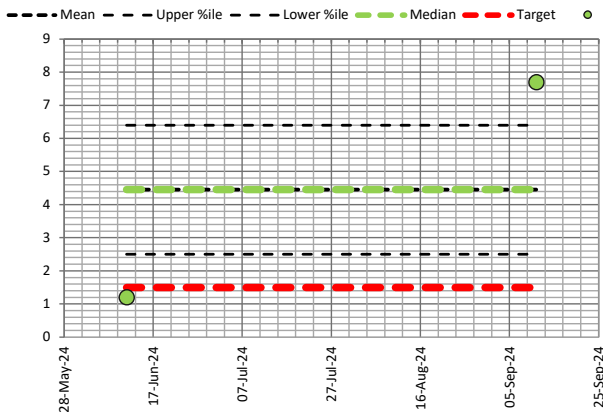
Electrical Conductivity



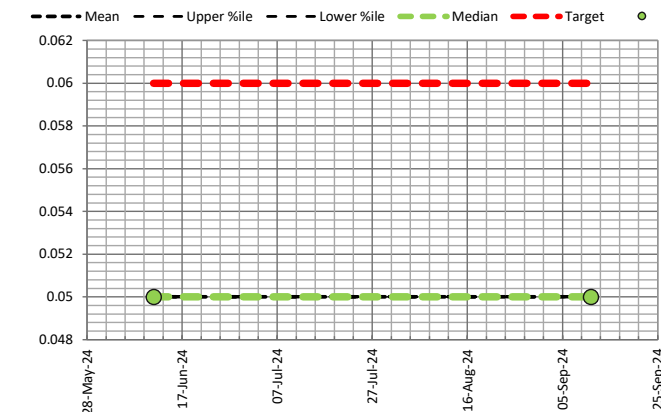
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW4 Site Bore GW4

Easting 396048.35
 Northing 6477429.2

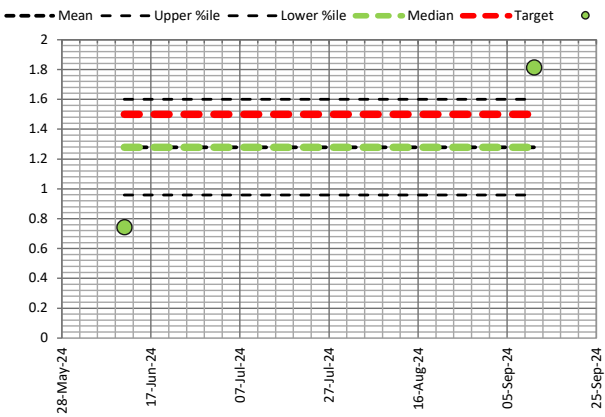
Data Analysis Period Start Date 1/01/2024
 Data Analysis Period End Date 31/12/2024



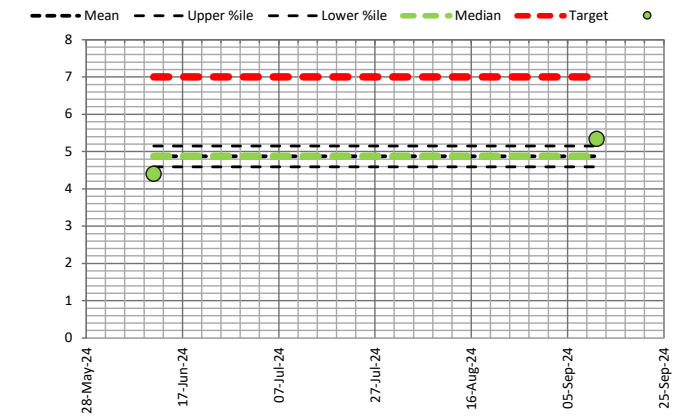
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80			80	90			
GWL bToC	Groundwater Level	mBToC	5	2.89	2.93	3.34	3.20	3.78	3.90			0	
GWL mAHD	Groundwater Level	mAHD	5	33.52	33.64	34.08	34.22	34.49	34.53			0	
T	Temperature	°C	2	19.20	19.340	19.550	19.55	19.760	19.900			0	
EC	Electrical Conductivity	mS/cm	2	0.74	0.96	1.28	1.28	1.60	1.82	1.500		1	
pH	pH	pH	2	4.41	4.60	4.88	4.88	5.15	5.34	7.00		0	
DO	Dissolved Oxygen	%	2	14.70	16.00	17.95	17.95	19.90	21.20	120.00		0	
TN	Total Nitrogen	mg/L	2	1.70	1.92	2.25	2.25	2.58	2.80	1.50		2	
TKN	Total Kejdhal Nitrogen	mg/L	2	1.70	1.88	2.15	2.15	2.42	2.60			0	
NO3	Nitrate	mg/L	2	0.05	0.08	0.13	0.13	0.18	0.21			0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.03	0.03	0.04	0.05			0	
Nox	Nox	mg/L	2	0.05	0.08	0.14	0.14	0.19	0.22	0.10		1	
NH3	Ammonia	mg/L	2	0.11	0.14	0.19	0.19	0.23	0.26			0	
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05	0.05	0.05	0.06		0	
FRP	Filterable Reactive Phosphorous	mg/L	2	0.01	0.01		0.01	0.01	0.01	0.03		0	
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010			0	
Cr	Chromium	mg/L	2	0.00260	0.00282	0.00315	0.00315	0.00348	0.00370			0	
Cu	Copper	mg/L	2	0.00150	0.00152	0.00155	0.00155	0.00158	0.00160			0	
Pb	Lead	mg/L	2	0.00100	0.00128	0.00170	0.00170	0.00212	0.00240			0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005			0	
Ni	Nickel	mg/L	2	0.00440	0.00552	0.00720	0.00720	0.00888	0.01000			0	
Zn	Zinc	mg/L	2	0.00600	0.00612	0.00630	0.00630	0.00648	0.00660			0	

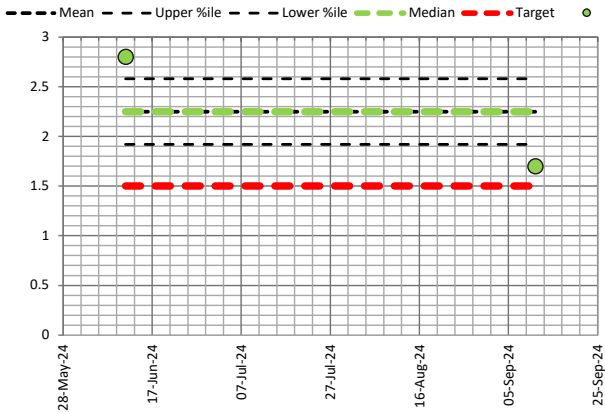
Electrical Conductivity



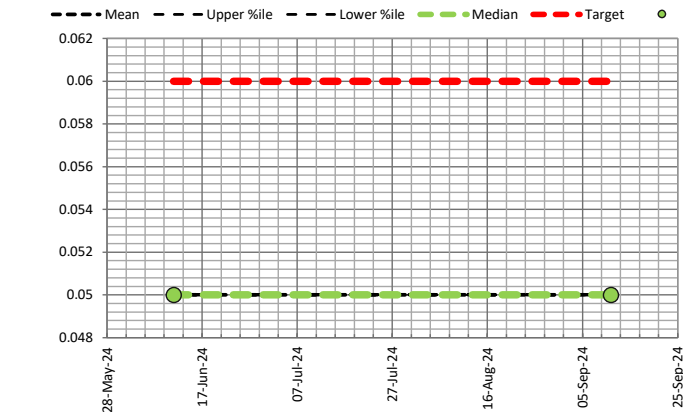
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW5 Site Bore GW5

Easting 396034.5
 Northing 6477720.2

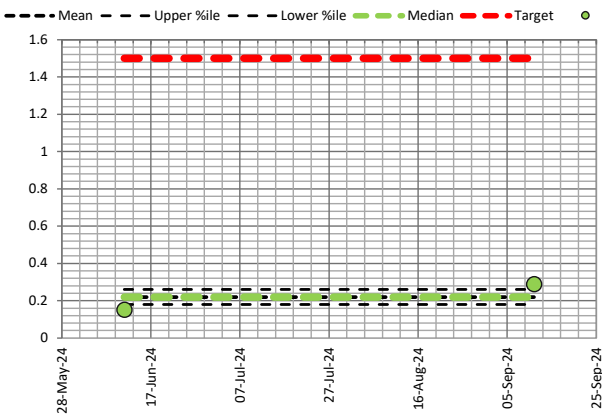
Data Analysis Period Start Date 1/01/2024
 Data Analysis Period End Date 31/12/2024



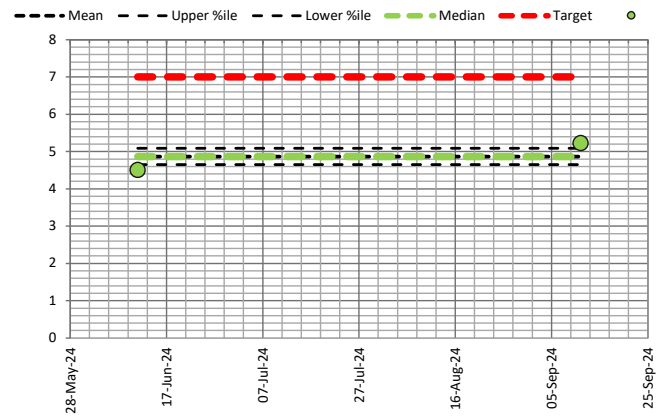
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80							
GWL bToC	Groundwater Level	mBToC	5	2.72	2.77	3.17	3.03	3.62	3.72			0	
GWL mAHD	Groundwater Level	mAHD	5	33.70	33.80	34.25	34.39	34.65	34.70			0	
T	Temperature	°C	2	21.60	21.640	21.700	21.70	21.760	21.800			0	
EC	Electrical Conductivity	mS/cm	2	0.15	0.18	0.22	0.22	0.26	0.29	1.500		0	
pH	pH	pH	2	4.51	4.65	4.87	4.87	5.09	5.23	7.00		0	
DO	Dissolved Oxygen	%	2	9.10	10.14	11.70	11.70	13.26	14.30	120.00		0	
TN	Total Nitrogen	mg/L	2	0.67	0.70	0.74	0.74	0.78	0.81	1.50		0	
TKN	Total Kejdhal Nitrogen	mg/L	2	0.67	0.70	0.76	0.76	0.81	0.84			0	
NO3	Nitrate	mg/L	2	0.01	0.01	0.03	0.03	0.04	0.05			0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.03	0.03	0.04	0.05			0	
Nox	Nox	mg/L	2	0.01	0.01	0.03	0.03	0.04	0.05	0.10		0	
NH3	Ammonia	mg/L	2	0.12	0.12	0.13	0.13	0.14	0.14			0	
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05	0.05	0.05	0.06		0	
FRP	Filterable Reactive Phosphorous	mg/L	2	0.01	0.01		0.01	0.01	0.01	0.03		0	
As	Arsenic	mg/L	2	0.00100	0.00106	0.00115	0.00115	0.00124	0.00130			0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010			0	
Cr	Chromium	mg/L	2	0.00240	0.00264	0.00300	0.00300	0.00336	0.00360			0	
Cu	Copper	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Pb	Lead	mg/L	2	0.00100	0.00108	0.00120	0.00120	0.00132	0.00140			0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005			0	
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Zn	Zinc	mg/L	2	0.00280	0.00280	0.00280	0.00280	0.00280	0.00280			0	

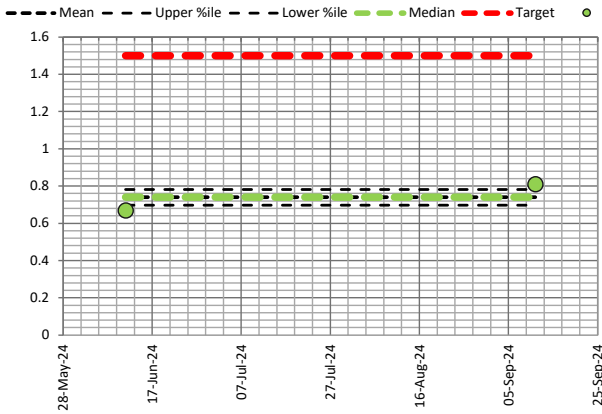
Electrical Conductivity



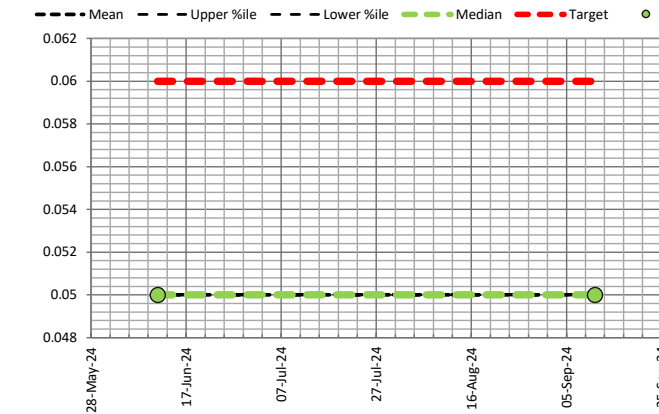
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW6 Site Bore GW6

Easting 396070.3
 Northing 6477979.5

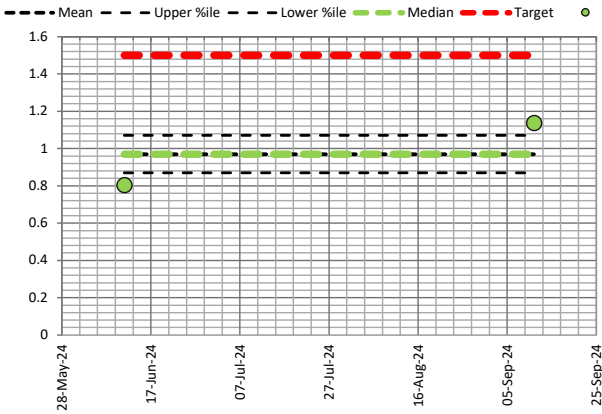
Data Analysis Period Start Date 1/01/2024
 Data Analysis Period End Date 31/12/2024



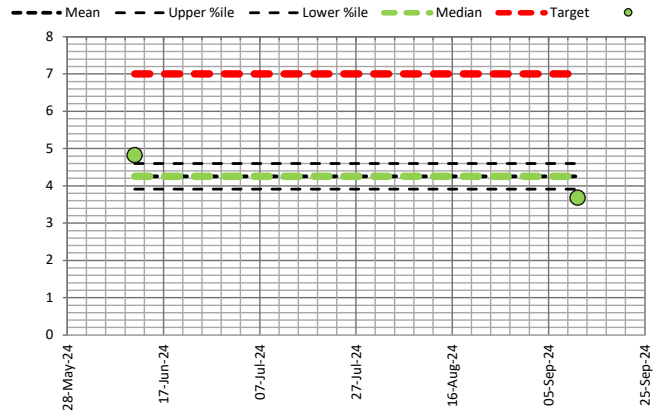
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80						
GWL bToC	Groundwater Level	mBToC	5	3.40	3.43	3.83	3.69	4.28	4.38		0	
GWL mAHD	Groundwater Level	mAHD	5	33.84	33.94	34.39	34.53	34.79	34.82		0	
T	Temperature	°C	2	20.30	20.420	20.600	20.60	20.780	20.900		0	
EC	Electrical Conductivity	mS/cm	2	0.80	0.87	0.97	0.97	1.07	1.14	1.500	0	
pH	pH	pH	2	3.69	3.92	4.26	4.26	4.60	4.83	7.00	0	
DO	Dissolved Oxygen	%	2	17.00	19.38	22.95	22.95	26.52	28.90	120.00	0	
TN	Total Nitrogen	mg/L	2	3.10	3.78	4.80	4.80	5.82	6.50	1.50	2	
TKN	Total Kejdhal Nitrogen	mg/L	2	2.00	2.78	3.95	3.95	5.12	5.90		0	
NO3	Nitrate	mg/L	2	0.66	0.75	0.88	0.88	1.01	1.10		0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01		0	
Nox	Nox	mg/L	2	0.66	0.75	0.88	0.88	1.01	1.10	0.10	2	
NH3	Ammonia	mg/L	2	0.08	0.08	0.09	0.09	0.10	0.10		0	
TP	Total Phosphorous	mg/L	2	0.05	0.06	0.07	0.07	0.08	0.09	0.06	1	
FRP	Filterable Reactive Phosphrous	mg/L	2	0.01	0.01		0.01	0.01	0.01	0.03	0	
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0	
Cd	Cadmium	mg/L	2	0.00010	0.00012	0.00015	0.00015	0.00017	0.00019		0	
Cr	Chromium	mg/L	2	0.00600	0.00606	0.00615	0.00615	0.00624	0.00630		0	
Cu	Copper	mg/L	2	0.00380	0.00394	0.00415	0.00415	0.00436	0.00450		0	
Pb	Lead	mg/L	2	0.00380	0.00414	0.00465	0.00465	0.00516	0.00550		0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005		0	
Ni	Nickel	mg/L	2	0.00320	0.00326	0.00335	0.00335	0.00344	0.00350		0	
Zn	Zinc	mg/L	2	0.01100	0.01180	0.01300	0.01300	0.01420	0.01500		0	

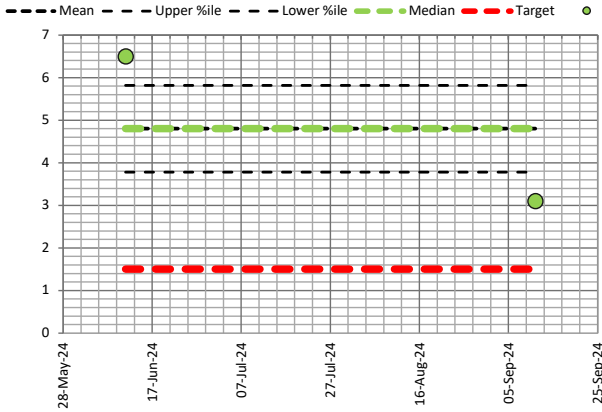
Electrical Conductivity



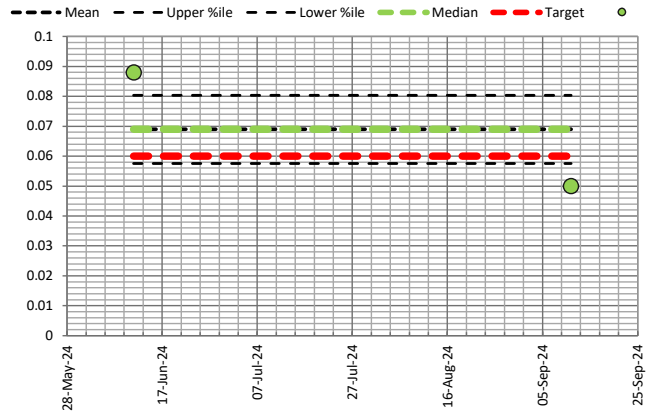
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW7 Site Bore GW7

Easting 396373.05
 Northing 6477226.7

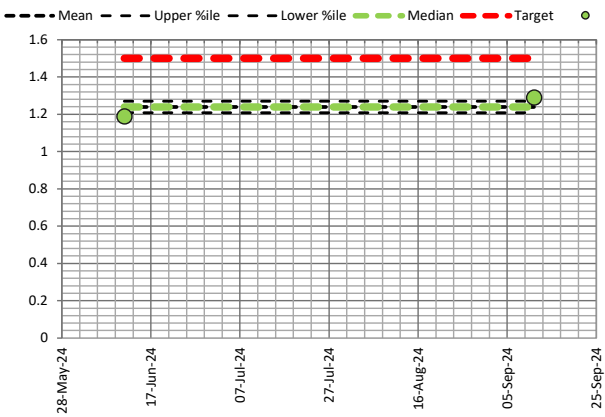
Data Analysis Period Start Date 1/01/2024
 Data Analysis Period End Date 31/12/2024



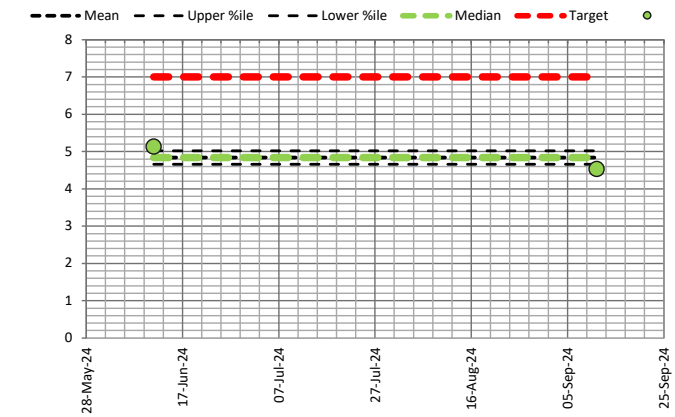
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80							
GWL bToC	Groundwater Level	mBToC	5	4.21	4.26	4.68	4.54	5.14	5.28			0	
GWL mAHD	Groundwater Level	mAHD	5	33.26	33.40	33.86	34.00	34.28	34.33			0	
T	Temperature	°C	2	19.60	19.640	19.700	19.70	19.760	19.800			0	
EC	Electrical Conductivity	mS/cm	2	1.19	1.21	1.24	1.24	1.27	1.29	1.500		0	
pH	pH	pH	2	4.54	4.66	4.84	4.84	5.02	5.14	7.00		0	
DO	Dissolved Oxygen	%	2	11.90	12.06	12.30	12.30	12.54	12.70	120.00		0	
TN	Total Nitrogen	mg/L	2	0.65	0.72	0.83	0.83	0.93	1.00	1.50		0	
TKN	Total Kejdhal Nitrogen	mg/L	2	0.65	0.72	0.82	0.82	0.92	0.99			0	
NO3	Nitrate	mg/L	2	0.01	0.01	0.02	0.02	0.02	0.03			0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01			0	
Nox	Nox	mg/L	2	0.01	0.01	0.02	0.02	0.02	0.03	0.10		0	
NH3	Ammonia	mg/L	2	0.27	0.27	0.28	0.28	0.29	0.29			0	
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05	0.05	0.05	0.06		0	
FRP	Filterable Reactive Phosphrous	mg/L	2	0.01	0.01		0.01	0.01	0.01	0.03		0	
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010			0	
Cr	Chromium	mg/L	2	0.00230	0.00232	0.00235	0.00235	0.00238	0.00240			0	
Cu	Copper	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Pb	Lead	mg/L	2	0.00100	0.00122	0.00155	0.00155	0.00188	0.00210			0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005			0	
Ni	Nickel	mg/L	2	0.00390	0.00458	0.00560	0.00560	0.00662	0.00730			0	
Zn	Zinc	mg/L	2	0.00270	0.00296	0.00335	0.00335	0.00374	0.00400			0	

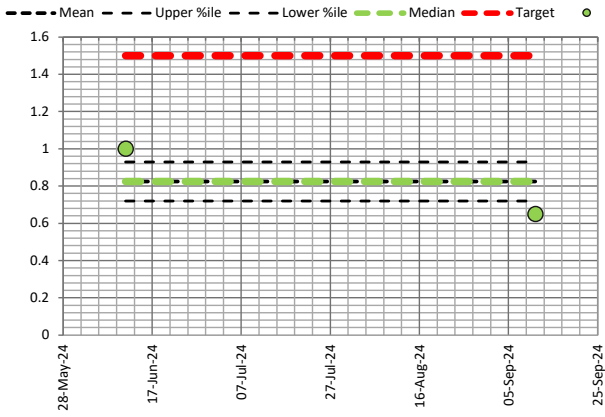
Electrical Conductivity



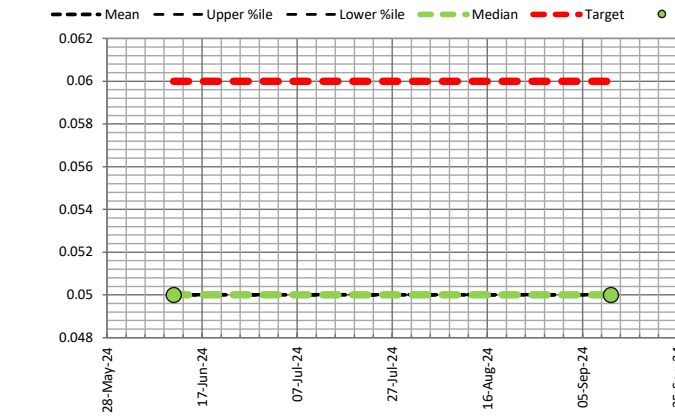
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW8 Site Bore GW8

Easting 396410.76
 Northing 6477622.2

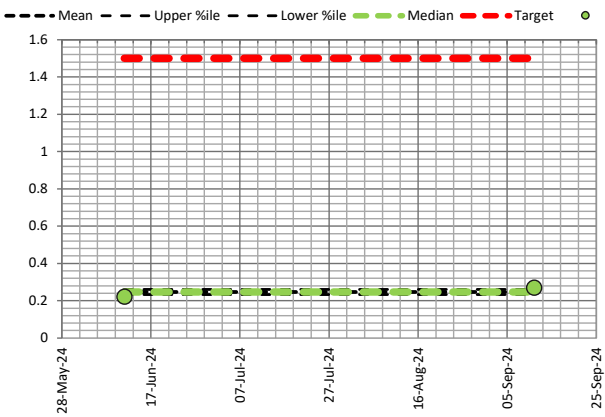
Data Analysis Period Start Date **1/01/2024**
 Data Analysis Period End Date **31/12/2024**



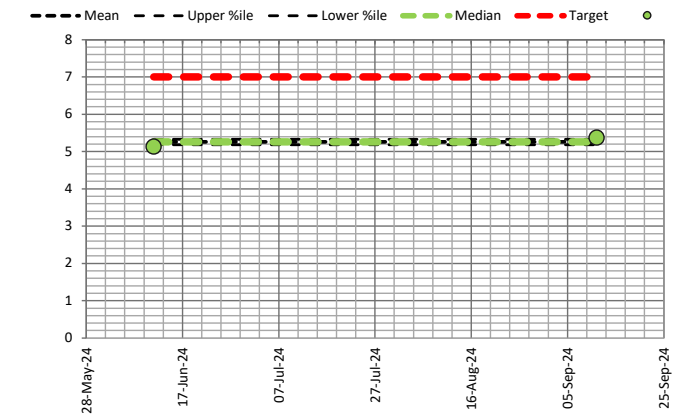
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80							
GWL bToC	Groundwater Level	mBToC	5	1.88	1.94	2.34	2.20	2.81	2.90			0	
GWL mAHD	Groundwater Level	mAHD	5	33.58	33.67	34.14	34.28	34.54	34.60			0	
T	Temperature	°C	2	21.00	21.220	21.550	21.55	21.880	22.100			0	
EC	Electrical Conductivity	mS/cm	2	0.22	0.23	0.25	0.25	0.26	0.27	1.500		0	
pH	pH	pH	2	5.14	5.19	5.26	5.26	5.33	5.38	7.00		0	
DO	Dissolved Oxygen	%	2	9.80	10.78	12.25	12.25	13.72	14.70	120.00		0	
TN	Total Nitrogen	mg/L	2	0.88	0.98	1.14	1.14	1.30	1.40	1.50		0	
TKN	Total Kejdhal Nitrogen	mg/L	2	0.86	0.97	1.13	1.13	1.29	1.40			0	
NO3	Nitrate	mg/L	2	0.02	0.02	0.03	0.03	0.04	0.05			0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.03	0.03	0.04	0.05			0	
Nox	Nox	mg/L	2	0.02	0.02	0.03	0.03	0.04	0.05	0.10		0	
NH3	Ammonia	mg/L	2	0.13	0.14	0.16	0.16	0.18	0.19			0	
TP	Total Phosphorous	mg/L	2	0.07	0.13	0.22	0.22	0.30	0.36	0.06		2	
FRP	Filterable Reactive Phosphorous	mg/L	2	0.03	0.04		0.04	0.04	0.05	0.03		2	
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010			0	
Cr	Chromium	mg/L	2	0.00390	0.00392	0.00395	0.00395	0.00398	0.00400			0	
Cu	Copper	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Pb	Lead	mg/L	2	0.00100	0.00116	0.00140	0.00140	0.00164	0.00180			0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005			0	
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Zn	Zinc	mg/L	2	0.00240	0.00254	0.00275	0.00275	0.00296	0.00310			0	

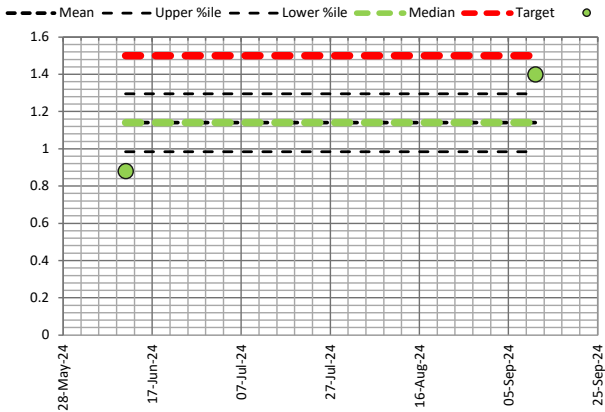
Electrical Conductivity



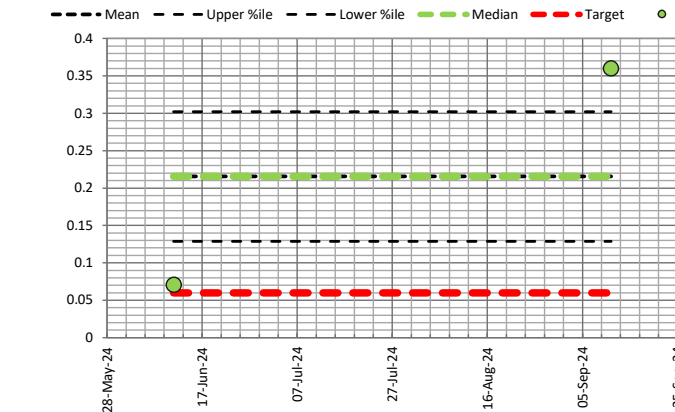
pH



Total Nitrogen



Total Phosphorous



H24009 Lakefarm Retreat Ballajura
GW9 Site Bore GW9

Easting 396342.26
 Northing 6477982.8

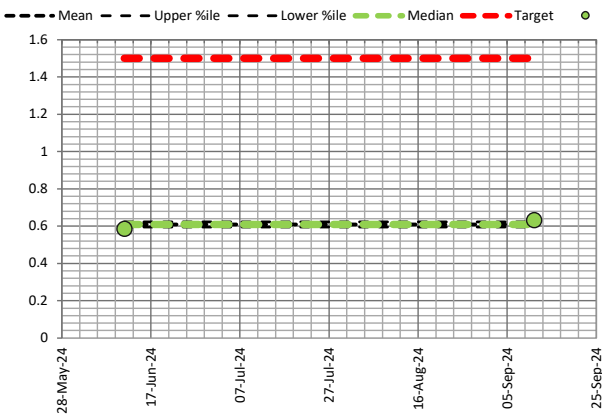
Data Analysis Period Start Date **1/01/2024**
 Data Analysis Period End Date **31/12/2024**



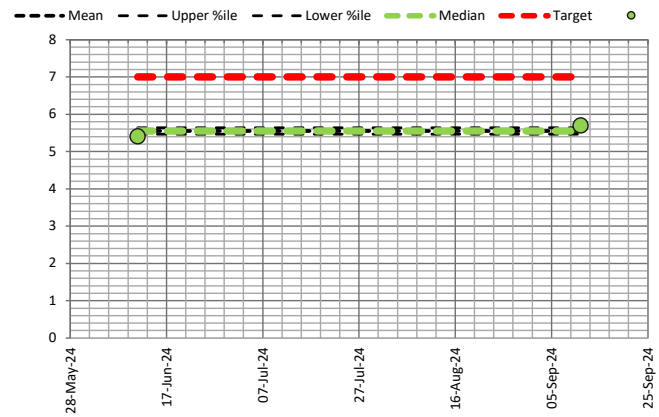
Report Date : 23/10/2024

Parameter	Description	Units	Samples	Minimum	Low %ile		Mean	Median	High %ile		Maximum	Target ANZECC - SWA Wetlands	Times Exceeded
					20	80							
GWL bToC	Groundwater Level	mBToC	5	3.08	3.10	3.53	3.41	4.00	4.07			0	
GWL mAHD	Groundwater Level	mAHD	5	33.83	33.90	34.37	34.49	34.80	34.82			0	
T	Temperature	°C	2	19.00	19.140	19.350	19.35	19.560	19.700			0	
EC	Electrical Conductivity	mS/cm	2	0.59	0.60	0.61	0.61	0.62	0.63	1.500		0	
pH	pH	pH	2	5.41	5.47	5.56	5.56	5.64	5.70	7.00		0	
DO	Dissolved Oxygen	%	2	26.50	30.44	36.35	36.35	42.26	46.20	120.00		0	
TN	Total Nitrogen	mg/L	2	1.90	2.04	2.25	2.25	2.46	2.60	1.50		2	
TKN	Total Kejdhal Nitrogen	mg/L	2	1.60	1.76	2.00	2.00	2.24	2.40			0	
NO3	Nitrate	mg/L	2	0.18	0.21	0.25	0.25	0.28	0.31			0	
NO2	Nitrite	mg/L	2	0.01	0.01	0.03	0.03	0.04	0.05			0	
Nox	Nox	mg/L	2	0.19	0.22	0.26	0.26	0.30	0.33	0.10		2	
NH3	Ammonia	mg/L	2	0.01	0.02	0.03	0.03	0.04	0.05			0	
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05	0.05	0.05	0.06		0	
FRP	Filterable Reactive Phosphrous	mg/L	2	0.01	0.01		0.01	0.01	0.01	0.03		0	
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100			0	
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010			0	
Cr	Chromium	mg/L	2	0.00190	0.00200	0.00215	0.00215	0.00230	0.00240			0	
Cu	Copper	mg/L	2	0.00270	0.00338	0.00440	0.00440	0.00542	0.00610			0	
Pb	Lead	mg/L	2	0.00100	0.00222	0.00405	0.00405	0.00588	0.00710			0	
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005			0	
Ni	Nickel	mg/L	2	0.00100	0.00124	0.00160	0.00160	0.00196	0.00220			0	
Zn	Zinc	mg/L	2	0.00220	0.00312	0.00450	0.00450	0.00588	0.00680			0	

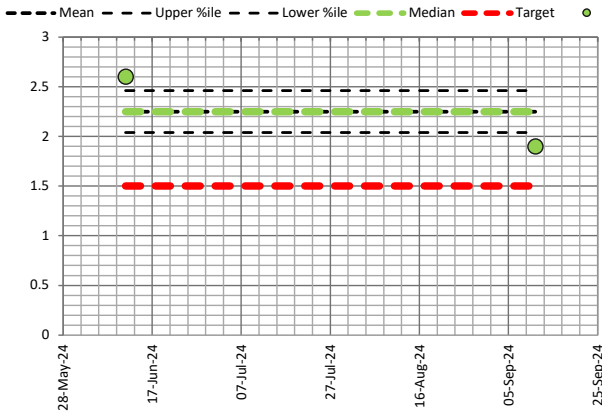
Electrical Conductivity



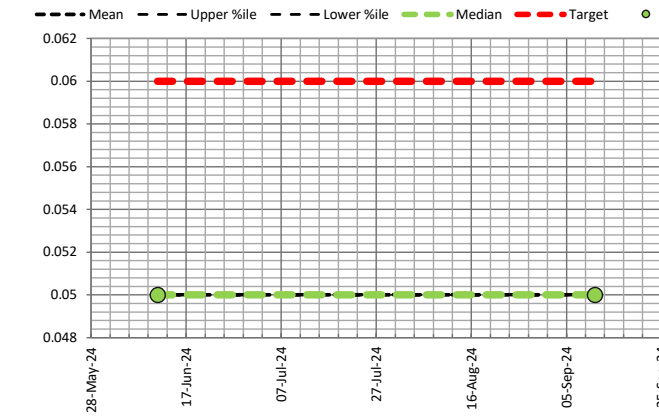
pH



Total Nitrogen



Total Phosphorous



APPENDIX I
Laboratory Reports



Certificate of Analysis PFF0711

Client Details

Client	Hyd20
Contact	Ted Dann
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H24009 - Ballajura Monitoring
Number of Samples	9 Groundwater
Date Samples Received	12/06/2024
Date Instructions Received	12/06/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date Results Requested by	19/06/2024
Date of Issue	19/06/2024

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Ben Carpenter, Metals Technician Heram Halim, Operations Manager Michael Mowle, Inorganics Supervisor Varsha Ho Wing, Inorganics and Metals Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PFF0711

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PFF0711-01	GW1	Groundwater	11/06/2024	12/06/2024
PFF0711-02	GW2	Groundwater	11/06/2024	12/06/2024
PFF0711-03	GW3	Groundwater	11/06/2024	12/06/2024
PFF0711-04	GW4	Groundwater	11/06/2024	12/06/2024
PFF0711-05	GW5	Groundwater	11/06/2024	12/06/2024
PFF0711-06	GW6	Groundwater	11/06/2024	12/06/2024
PFF0711-07	GW7	Groundwater	11/06/2024	12/06/2024
PFF0711-08	GW8	Groundwater	11/06/2024	12/06/2024
PFF0711-09	GW9	Groundwater	11/06/2024	12/06/2024

Certificate of Analysis PFF0711

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PFF0711-01	PFF0711-02	PFF0711-03	PFF0711-04	PFF0711-05
Your Reference			GW1	GW2	GW3	GW4	GW5
Date Sampled			11/06/2024	11/06/2024	11/06/2024	11/06/2024	11/06/2024
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Envirolab ID	Units	PQL	PFF0711-06	PFF0711-07	PFF0711-08	PFF0711-09
Your Reference			GW6	GW7	GW8	GW9
Date Sampled			11/06/2024	11/06/2024	11/06/2024	11/06/2024
Phosphorus	mg/L	0.050	0.088	<0.050	0.071	<0.050

Certificate of Analysis PFF0711

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PFF0711-01	PFF0711-02	PFF0711-03	PFF0711-04	PFF0711-05
Your Reference			GW1	GW2	GW3	GW4	GW5
Date Sampled			11/06/2024	11/06/2024	11/06/2024	11/06/2024	11/06/2024
Arsenic	µg/L	1.0	1.1	<1.0	1.3	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	1.0	<1.0	2.2	2.6	2.4
Copper	µg/L	1.0	<1.0	<1.0	<1.0	1.6	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	13	1.1	5.9	4.4	<1.0
Lead	µg/L	1.0	<1.0	<1.0	1.7	2.4	1.4
Zinc	µg/L	1.0	2.2	2.9	9.4	6.6	2.8

Envirolab ID	Units	PQL	PFF0711-06	PFF0711-07	PFF0711-08	PFF0711-09
Your Reference			GW6	GW7	GW8	GW9
Date Sampled			11/06/2024	11/06/2024	11/06/2024	11/06/2024
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	µg/L	0.10	0.19	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	6.0	2.4	4.0	2.4
Copper	µg/L	1.0	4.5	<1.0	<1.0	6.1
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	3.5	3.9	<1.0	2.2
Lead	µg/L	1.0	3.8	2.1	1.8	7.1
Zinc	µg/L	1.0	11	2.7	3.1	6.8

Certificate of Analysis PFF0711

Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PFF0711-01	PFF0711-02	PFF0711-03	PFF0711-04	PFF0711-05
Your Reference			GW1	GW2	GW3	GW4	GW5
Date Sampled			11/06/2024	11/06/2024	11/06/2024	11/06/2024	11/06/2024
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	10	<5.0	<5.0	<5.0
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	10	<5.0	<5.0	<5.0

Envirolab ID	Units	PQL	PFF0711-06	PFF0711-07	PFF0711-08	PFF0711-09
Your Reference			GW6	GW7	GW8	GW9
Date Sampled			11/06/2024	11/06/2024	11/06/2024	11/06/2024
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	9.8	14	15	21
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	9.8	14	15	21

Certificate of Analysis PFF0711

Inorganics - Nutrients (Groundwater)

Envirolab ID Your Reference Date Sampled	Units	PQL	PFF0711-01 GW1 11/06/2024	PFF0711-02 GW2 11/06/2024	PFF0711-03 GW3 11/06/2024	PFF0711-04 GW4 11/06/2024	PFF0711-05 GW5 11/06/2024
Ammonia as N	mg/L	0.0050	0.55	0.024	0.16	0.26	0.12
Nitrate as N	mg/L	0.0050	<0.0050	0.26	0.020	0.21	<0.0050
Nitrate as NO3 by calculation	mg/L	0.020	<0.020	1.2	0.087	0.94	<0.020
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	<0.0050	0.26	0.020	0.22	<0.0050
TKN as N by calculation	mg/L	0.10	1.4	0.49	1.1	2.6	0.67
Organic Nitrogen by calc.	mg/L	0.10	0.82	0.47	0.97	2.3	0.55
Total Nitrogen	mg/L	0.10	1.4	0.75	1.2	2.8	0.67
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Envirolab ID Your Reference Date Sampled	Units	PQL	PFF0711-06 GW6 11/06/2024	PFF0711-07 GW7 11/06/2024	PFF0711-08 GW8 11/06/2024	PFF0711-09 GW9 11/06/2024
Ammonia as N	mg/L	0.0050	0.10	0.27	0.13	0.0095
Nitrate as N	mg/L	0.0050	0.66	0.025	0.016	0.18
Nitrate as NO3 by calculation	mg/L	0.020	2.9	0.11	0.072	0.81
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.020
NOx as N	mg/L	0.0050	0.66	0.025	0.016	0.19
TKN as N by calculation	mg/L	0.10	5.9	0.99	0.86	2.4
Organic Nitrogen by calc.	mg/L	0.10	5.8	0.72	0.73	2.4
Total Nitrogen	mg/L	0.10	6.5	1.0	0.88	2.6
Phosphate as P	mg/L	0.0050	0.0070	<0.0050	0.045	0.0056

Certificate of Analysis PFF0711

Method Summary

Method ID	Methodology Summary
Calc	Calculation
Calc - TKN	TKN determined by calculation (Total Nitrogen - NOx).
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition 2320-B. Solids reported from a 1:5 water extract unless otherwise specified. Total Carbon Dioxide - determined by calculation in accordance with APHA latest edition, 4500-CO2 D.
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS. Please note for Bromine and Iodine, any forms of these elements that are present are included together in the one result reported for each of these two elements. Salt forms and/or anion/cation forms (e.g. FeO, PbO, ZnO, BO3) are determined stoichiometrically from the base metal concentration.

Certificate of Analysis PFF0711

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Certificate of Analysis PFF0711

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PFF0711

Client Details

Client Hyd20
Your Reference H24009 - Ballajura Monitoring
Date Issued 19/06/2024

Recommended Holding Time Compliance

Recommended holding time exceedances exist - See detailed list below

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	No	Duplicate Outliers Exist - See detailed list below
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PFF0711

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
Total Phosphorus | Water	1-9	11/06/2024	13/06/2024	14/06/2024	Yes
Dissolved Metals (LL) | Water	1-8	11/06/2024	13/06/2024	14/06/2024	Yes
	9	11/06/2024	13/06/2024	17/06/2024	Yes
Dissolved Metals (LL)-Hg | Water	1-9	11/06/2024	13/06/2024	13/06/2024	Yes
Alkalinity Suite | Water	1-9	11/06/2024	13/06/2024	13/06/2024	Yes
Nitrogen - Ammonia | Water	1-9	11/06/2024	14/06/2024	14/06/2024	Yes
Nitrogen - Nitrate | Water	1-9	11/06/2024	14/06/2024	14/06/2024	Yes
Nitrogen - Nitrite | Water	1-9	11/06/2024	14/06/2024	14/06/2024	No
Nitrogen - NOx | Water	1-9	11/06/2024	14/06/2024	14/06/2024	Yes
Nitrogen - Total N | Water	1-8	11/06/2024	14/06/2024	14/06/2024	Yes
	9	11/06/2024	14/06/2024	15/06/2024	Yes
Phosphate as P | Water	1-9	11/06/2024	14/06/2024	14/06/2024	No
TKN as N calc | Water	1-9	11/06/2024	13/06/2024	18/06/2024	Yes

Outliers: Duplicates

METALS-022 | Dissolved Low Level Metals (Water) | Batch BFF1889

Sample ID	Duplicate ID	Analyte	% Limits	RPD
BFF1889-DUP1#	DUP1	Copper	20.00	200[1]
BFF1889-DUP1#	DUP1	Nickel	20.00	200[1]

Quality Control PFF0711

METALS-020 | Acid Extractable Metals (Water) | Batch BFF1891

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BFF1891-DUP1# Samp | QC | RPD %	BFF1891-DUP2# Samp | QC | RPD %		
Phosphorus	mg/L	0.050	<0.050	<0.050 | <0.050 | [NA]	0.773 | 0.781 | 1.11	96.7	94.9

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-021 | Dissolved Low Level Metals (Water) | Batch BFF1811

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BFF1811-DUP1# Samp | QC | RPD %	PFF0711-01 Samp | QC | RPD %		
Mercury	µg/L	0.050	<0.050	<0.050 | <0.050 | [NA]	<0.050 | <0.050 | [NA]	106	105

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-022 | Dissolved Low Level Metals (Water) | Batch BFF1830

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BFF1830-DUP1# Samp | QC | RPD %	BFF1830-DUP2# Samp | QC | RPD %		
Arsenic	µg/L	1.0	<1.0	11.1 | 10.9 | 2.13	<1.0 | <1.0 | [NA]	113	110
Cadmium	µg/L	0.10	<0.10	0.510 | 0.515 | 0.976	<0.10 | <0.10 | [NA]	116	114
Chromium	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	<1.0 | <1.0 | [NA]	114	110
Copper	µg/L	1.0	<1.0	4.86 | 4.96 | 2.04	<1.0 | <1.0 | [NA]	118	113
Lead	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	<1.0 | <1.0 | [NA]	105	103
Nickel	µg/L	1.0	<1.0	5.00 | 5.26 | 4.87	<1.0 | <1.0 | [NA]	115	112
Zinc	µg/L	1.0	<1.0	36.8 | 34.9 | 5.38	2.87 | 2.67 | 7.08	110	92.6

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-022 | Dissolved Low Level Metals (Water) | Batch BFF1889

Analyte	Units	PQL	Blank	DUP1	LCS %	Spike %
				BFF1889-DUP1# Samp | QC | RPD %		
Arsenic	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	108	108
Cadmium	µg/L	0.10	<0.10	<0.20 | <0.20 | [NA]	108	110
Chromium	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	107	105
Copper	µg/L	1.0	<1.0	2.78 | <2.0 | 200 [1]	108	105
Lead	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	102	102
Nickel	µg/L	1.0	<1.0	2.10 | <2.0 | 200 [1]	108	105
Zinc	µg/L	1.0	<1.0	<2.0 | <2.0 | [NA]	108	101

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-006 | Inorganics - Ionic Balance and Indexes (Water) | Batch BFF1751

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BFF1751-DUP1# Samp | QC | RPD %	PFF0711-03 Samp | QC | RPD %	
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	25.0 | 24.3 | 2.84	<5.0 | <5.0 | [NA]	[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	25.0 | 24.3 | 2.84	<5.0 | <5.0 | [NA]	96.4

Analyte	Units	PQL	Blank	LCS %

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PFF0711

INORG-006 | Inorganics - Ionic Balance and Indexes (Water) | Batch BFF1752

Analyte	Units	PQL	Blank	DUP1		LCS %
				PFF0711-05		
				Samp | QC | RPD %		
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]		[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]		[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]		[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]		101

Analyte	Units	PQL	Blank			LCS %
Total Alkalinity as CaCO3	mg/L as CaCO3	5				105

INORG-127 | Inorganics - Nutrients (Water) | Batch BFF2081

Analyte	Units	PQL	Blank	DUP1		DUP2	LCS %	Spike %
				BFF2081-DUP1#		PFF0711-02		
				Samp | QC | RPD %		Samp | QC | RPD %		
Total Nitrogen	mg/L	0.10	<0.10	2.05 | 2.10 | 1.97		0.752 | 0.795 | 5.57	109	108

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-057 | Inorganics - Nutrients (Water) | Batch BFF2121

Analyte	Units	PQL	Blank	DUP1		DUP2	LCS %	Spike %
				PFF0711-01		BFF2121-DUP2#		
				Samp | QC | RPD %		Samp | QC | RPD %		
Ammonia as N	mg/L	0.0050	<0.0050	0.552 | 0.624 | 12.2		53.3 | 52.8 | 0.885	88.5	110
Nitrate as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]		<0.0050 | <0.0050 | [NA]	101	129
Nitrate as NO3 by calculation	mg/L	0.020	<0.020				[NA]	[NA]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]		<0.0050 | <0.0050 | [NA]	91.6	106
Nitrite as NO2 by calculation	mg/L	0.020	<0.020				[NA]	[NA]
NOx as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]		<0.0050 | <0.0050 | [NA]	101	129
Phosphate as P	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]		7.80 | 7.85 | 0.611	113	118

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

QC Comments

Identifier	Description
[1]	Duplicate %RPD may be flagged as an outlier to routine laboratory acceptance, however, where one or both results are <10*PQL, the RPD acceptance criteria increases exponentially.



Certificate of Analysis PFI0937

Client Details

Client	Hyd20
Contact	Sean O'Sullivan
Address	Suite 6B, 103 Rokeby Rd, SUBIACO, WA, 6008

Sample Details

Your Reference	H24009 - Ballajura Monitoring
Number of Samples	9 Groundwater
Date Samples Received	12/09/2024
Date Instructions Received	12/09/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for soils and on an as received basis for other matrices.

Report Details

Date Results Requested by	19/09/2024
Date of Issue	19/09/2024

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Authorisation Details

Results Approved By	Jessica Miller, Microbiological Supervisor Lien Tang, Assistant Operations Manager Lucas Yij, Inorganics Team Leader Sally Rogers, Senior Microbiological Analyst Travis Carey, Organics Supervisor Varsha Ho Wing, Inorganics and Metals Supervisor
Laboratory Manager	Michael Kubiak

Certificate of Analysis PFI0937

Samples in this Report

Envirolab ID	Sample ID	Matrix	Date Sampled	Date Received
PFI0937-01	GW1	Groundwater	11/09/2024	12/09/2024
PFI0937-02	GW2	Groundwater	11/09/2024	12/09/2024
PFI0937-03	GW3	Groundwater	11/09/2024	12/09/2024
PFI0937-04	GW4	Groundwater	11/09/2024	12/09/2024
PFI0937-05	GW5	Groundwater	11/09/2024	12/09/2024
PFI0937-06	GW6	Groundwater	11/09/2024	12/09/2024
PFI0937-07	GW7	Groundwater	11/09/2024	12/09/2024
PFI0937-08	GW8	Groundwater	11/09/2024	12/09/2024
PFI0937-09	GW9	Groundwater	11/09/2024	12/09/2024

Certificate of Analysis PFI0937

Organochlorine Pesticides (Groundwater)

Envirolab ID Your Reference Date Sampled	Units	PQL	PFI0937-05 GW5 11/09/2024	PFI0937-06 GW6 11/09/2024	PFI0937-09 GW9 11/09/2024
alpha-BHC	µg/L	0.20	<0.20	<0.20	<0.20
Hexachlorobenzene	µg/L	0.20	<0.20	<0.20	<0.20
beta-BHC	µg/L	0.20	<0.20	<0.20	<0.20
gamma-BHC	µg/L	0.20	<0.20	<0.20	<0.20
delta-BHC	µg/L	0.20	<0.20	<0.20	<0.20
Heptachlor	µg/L	0.20	<0.20	<0.20	<0.20
Aldrin	µg/L	0.20	<0.20	<0.20	<0.20
Heptachlor epoxide	µg/L	0.20	<0.20	<0.20	<0.20
trans-Chlordane	µg/L	0.20	<0.20	<0.20	<0.20
cis-Chlordane	µg/L	0.20	<0.20	<0.20	<0.20
Endosulfan I	µg/L	0.20	<0.20	<0.20	<0.20
4,4'-DDE	µg/L	0.20	<0.20	<0.20	<0.20
Dieldrin	µg/L	0.20	<0.20	<0.20	<0.20
Endrin	µg/L	0.20	<0.20	<0.20	<0.20
4,4'-DDD	µg/L	0.20	<0.20	<0.20	<0.20
Endosulfan II	µg/L	0.20	<0.20	<0.20	<0.20
Endrin aldehyde	µg/L	0.20	<0.20	<0.20	<0.20
4,4'-DDT	µg/L	0.20	<0.20	<0.20	<0.20
Endosulfan sulfate	µg/L	0.20	<0.20	<0.20	<0.20
Endrin ketone	µg/L	0.20	<0.20	<0.20	<0.20
Methoxychlor	µg/L	0.20	<0.20	<0.20	<0.20
Mirex	µg/L	0.20	<0.20	<0.20	<0.20
Total +ve OCP	µg/L	0.20	<0.20	<0.20	<0.20
<i>Surrogate 4-chloro-3-nitrobenzotrifluoride</i>	%		75.1	84.2	70.0

Certificate of Analysis PFI0937

Organophosphorus Pesticides (Groundwater)

Envirolab ID Your Reference Date Sampled	Units	PQL	PFI0937-05 GW5 11/09/2024	PFI0937-06 GW6 11/09/2024	PFI0937-09 GW9 11/09/2024
Dichlorvos	µg/L	0.20	<0.20	<0.20	<0.20
Dimethoate	µg/L	0.20	<0.20	<0.20	<0.20
Diazinon	µg/L	0.20	<0.20	<0.20	<0.20
Chlorpyrifos-methyl	µg/L	0.20	<0.20	<0.20	<0.20
Ronnel	µg/L	0.20	<0.20	<0.20	<0.20
Fenitrothion	µg/L	0.20	<0.20	<0.20	<0.20
Malathion	µg/L	0.20	<0.20	<0.20	<0.20
Chlorpyrifos	µg/L	0.20	<0.20	<0.20	<0.20
Parathion	µg/L	0.20	<0.20	<0.20	<0.20
Bromophos-ethyl	µg/L	0.20	<0.20	<0.20	<0.20
Ethion	µg/L	0.20	<0.20	<0.20	<0.20
Coumaphos	µg/L	0.20	<0.20	<0.20	<0.20
Disulfoton	µg/L	0.20	<0.20	<0.20	<0.20
Fenamiphos	µg/L	0.20	<0.20	<0.20	<0.20
Fenthion	µg/L	0.20	<0.20	<0.20	<0.20
Methidathion	µg/L	0.20	<0.20	<0.20	<0.20
Mevinphos	µg/L	0.20	<0.20	<0.20	<0.20
Parathion-methyl	µg/L	0.20	<0.20	<0.20	<0.20
Phorate	µg/L	0.20	<0.20	<0.20	<0.20
Phosalone	µg/L	0.20	<0.20	<0.20	<0.20
Azinphos-methyl	µg/L	0.20	<0.20	<0.20	<0.20
<i>Surrogate 4-chloro-3-nitrobenzotrifluoride</i>	%		75.1	84.2	70.0

Certificate of Analysis PFI0937

Glyphosate (Groundwater)

Envirolab ID	Units	PQL	PFI0937-05	PFI0937-06	PFI0937-09
Your Reference			GW5	GW6	GW9
Date Sampled			11/09/2024	11/09/2024	11/09/2024
Glyphosate	mg/L	0.010	<0.010	<0.010	<0.010

Certificate of Analysis PFI0937

Acid Extractable Metals (Groundwater)

Envirolab ID	Units	PQL	PFI0937-01	PFI0937-02	PFI0937-03	PFI0937-04	PFI0937-05
Your Reference			GW1	GW2	GW3	GW4	GW5
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024	11/09/2024
Phosphorus	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Envirolab ID	Units	PQL	PFI0937-06	PFI0937-07	PFI0937-08	PFI0937-09
Your Reference			GW6	GW7	GW8	GW9
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024
Phosphorus	mg/L	0.050	<0.050	<0.050	0.36	<0.050

Certificate of Analysis PFI0937

Dissolved Low Level Metals (Groundwater)

Envirolab ID	Units	PQL	PFI0937-01	PFI0937-02	PFI0937-03	PFI0937-04	PFI0937-05
Your Reference			GW1	GW2	GW3	GW4	GW5
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024	11/09/2024
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	1.3
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	<1.0	<1.0	1.7	3.7	3.6
Copper	µg/L	1.0	1.5	<1.0	1.8	1.5	<1.0
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	11	<1.0	2.1	10	<1.0
Lead	µg/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	1.2	<1.0	3.7	6.0	2.8

Envirolab ID	Units	PQL	PFI0937-06	PFI0937-07	PFI0937-08	PFI0937-09
Your Reference			GW6	GW7	GW8	GW9
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024
Arsenic	µg/L	1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	µg/L	0.10	<0.10	<0.10	<0.10	<0.10
Chromium	µg/L	1.0	6.3	2.3	3.9	1.9
Copper	µg/L	1.0	3.8	<1.0	<1.0	2.7
Mercury	µg/L	0.050	<0.050	<0.050	<0.050	<0.050
Nickel	µg/L	1.0	3.2	7.3	<1.0	<1.0
Lead	µg/L	1.0	5.5	<1.0	<1.0	<1.0
Zinc	µg/L	1.0	15	4.0	2.4	2.2

Certificate of Analysis PFI0937

Inorganics - Ionic Balance and Indexes (Groundwater)

Envirolab ID	Units	PQL	PFI0937-01	PFI0937-02	PFI0937-03	PFI0937-04	PFI0937-05
Your Reference			GW1	GW2	GW3	GW4	GW5
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024	11/09/2024
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	7.9	14	13	11
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	7.9	14	13	11

Envirolab ID	Units	PQL	PFI0937-06	PFI0937-07	PFI0937-08	PFI0937-09
Your Reference			GW6	GW7	GW8	GW9
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	9.8	29
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0	9.8	29

Certificate of Analysis PFI0937

Inorganics - Nutrients (Groundwater)

Envirolab ID Your Reference Date Sampled	Units	PQL	PFI0937-01 GW1 11/09/2024	PFI0937-02 GW2 11/09/2024	PFI0937-03 GW3 11/09/2024	PFI0937-04 GW4 11/09/2024	PFI0937-05 GW5 11/09/2024
Ammonia as N	mg/L	0.0050	0.54	0.026	0.045	0.11	0.14
Nitrate as N	mg/L	0.0050	0.011	7.2	4.7	<0.050 [2]	<0.050 [2]
Nitrate as NO3 by calculation	mg/L	0.020	0.049	32	21	<0.20 [2]	<0.20 [2]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.050 [2]	<0.050 [2]
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.020	<0.20 [2]	<0.20 [2]
NOx as N	mg/L	0.0050	0.012	7.2	4.7	<0.050 [2]	<0.050 [2]
TKN as N by calculation	mg/L	0.10	1.4	2.5	3.0	1.7	0.84
Organic Nitrogen by calc.	mg/L	0.10	0.85	2.5	3.0	1.6	0.69
Total Nitrogen	mg/L	0.10	1.4	9.7	7.7	1.7	0.81
Phosphate as P	mg/L	0.0050	0.011	0.0082	0.0062	0.0070	<0.0050

Envirolab ID Your Reference Date Sampled	Units	PQL	PFI0937-06 GW6 11/09/2024	PFI0937-07 GW7 11/09/2024	PFI0937-08 GW8 11/09/2024	PFI0937-09 GW9 11/09/2024
Ammonia as N	mg/L	0.0050	0.081	0.29	0.19	0.051
Nitrate as N	mg/L	0.0050	1.1	<0.0050	<0.050 [2]	0.31 [2]
Nitrate as NO3 by calculation	mg/L	0.020	4.7	<0.020	<0.20 [2]	1.4 [2]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050	<0.050 [2]	<0.050 [2]
Nitrite as NO2 by calculation	mg/L	0.020	<0.020	<0.020	<0.20 [2]	<0.20 [2]
NOx as N	mg/L	0.0050	1.1	<0.0050	<0.050 [2]	0.33
TKN as N by calculation	mg/L	0.10	2.0	0.65	1.4	1.6
Organic Nitrogen by calc.	mg/L	0.10	2.0	0.35	1.3	1.5
Total Nitrogen	mg/L	0.10	3.1	0.65	1.4	1.9
Phosphate as P	mg/L	0.0050	0.0054	<0.0050	0.033	0.011

Certificate of Analysis PFI0937

Microbiological Suite (Groundwater)

Envirolab ID	Units	PQL	PFI0937-01	PFI0937-02	PFI0937-03	PFI0937-04	PFI0937-05
Your Reference			GW1	GW2	GW3	GW4	GW5
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024	11/09/2024
Thermotolerant Coliforms	cfu/100mL	1	<10 [1]	<10 [1]	480 [1]	<10 [1]	<10 [1]
E.coli	cfu/100mL	1	<10 [1]	<10 [1]	<10 [1]	<10 [1]	<10 [1]

Envirolab ID	Units	PQL	PFI0937-06	PFI0937-07	PFI0937-08	PFI0937-09
Your Reference			GW6	GW7	GW8	GW9
Date Sampled			11/09/2024	11/09/2024	11/09/2024	11/09/2024
Thermotolerant Coliforms	cfu/100mL	1	<10 [1]	<10 [1]	<10 [1]	<10 [1]
E.coli	cfu/100mL	1	<10 [1]	<10 [1]	<10 [1]	<10 [1]

Certificate of Analysis PFI0937

Result Comments

Identifier	Description
[1]	Microbiological testing PQL raised due to high sample turbidity and/or matrix interference.
[2]	PQL(s) has/have been raised due to matrix interference.

Certificate of Analysis PFI0937

Method Summary

Method ID	Methodology Summary
Calc	Calculation
Calc - TKN	TKN determined by calculation (Total Nitrogen - NOx).
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition 2320-B. Solids reported from a 1:5 water extract unless otherwise specified. Total Carbon Dioxide - determined by calculation in accordance with APHA latest edition, 4500-CO2 D.
INORG-055	Nitrate/Nitrite/NOx/TKN - determined colourimetrically. Waters samples are filtered on receipt prior to analysis. Soils/solids are analysed following a water extraction.
INORG-057	Ammonia - determined colourimetrically. Water samples are filtered on receipt prior to analysis. Soils and OHS media are analysed following a water extraction. Alternatively, Ammonia can be extracted from soil using 1M KCl.
INORG-060	Phosphate - determined colourimetrically using APHA latest edition 4500 P E. Water samples are filtered on receipt prior to analysis. Soils are analysed from a water extract.
INORG-127	Total Nitrogen by high temperature catalytic combustion with chemiluminescence detection. Organic Carbon forms (inorganic, organic, total) determined using a TOC/NDIR analyser via combustion. Dissolved forms require filtering prior to determination.
METALS-020	Determination of various metals by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS.
METALS-022	Determination of various metals by ICP-MS. Please note for Bromine and Iodine, any forms of these elements that are present are included together in the one result reported for each of these two elements. Salt forms and/or anion/cation forms (e.g. FeO, PbO, ZnO, BO3) are determined stoichiometrically from the base metal concentration.
MICRO-001B	E. coli/Thermotolerant coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.5-latest edition). Recommended maximums based on NHMRC Australian Drinking Water Guidelines. Please note that results for this test derived from counts outside of the range 10-100 are considered approximate as per AS4276.1.
ORG-022	Determination of semi-volatile organic compounds (SVOCs) by GC-MS. Water samples are extracted by LLE and soils using DCM/Acetone/Methanol.
ORG-022_OC	Determination of semi-volatile organic compounds (SVOCs) by GC-MS. Water samples are extracted by LLE and soils using DCM/Acetone/Methanol.
ORG-029_SVOC_VO C_LCMSMS	Water samples are run directly, soils are extracted using an aqueous buffer and plant material using solvent extraction/cleanup. Further cleanup maybe necessary. Analysis using LC-MSMS.

Certificate of Analysis PFI0937

Result Definitions

Identifier	Description
NR	Not reported
NEPM	National Environment Protection Measure
NS	Not specified
LCS	Laboratory Control Sample
RPD	Relative Percent Difference
>	Greater than
<	Less than
PQL	Practical Quantitation Limit
INS	Insufficient sample for this test
NA	Test not required
NT	Not tested
DOL	Samples rejected due to particulate overload (air filters only)
RFD	Samples rejected due to filter damage (air filters only)
RUD	Samples rejected due to uneven deposition (air filters only)
##	Indicates a laboratory acceptance criteria outlier, for further details, see Result Comments and/or QC Comments

Quality Control Definitions

Blank

This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, and is determined by processing solvents and reagents in exactly the same manner as for samples.

Surrogate Spike

Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

LCS (Laboratory Control Sample)

This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Matrix Spike

A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

Duplicate

This is the complete duplicate analysis of a sample from the process batch. The sample selected should be one where the analyte concentration is easily measurable.

Certificate of Analysis PFI0937

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria. Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction. Spikes for Physical and Aggregate Tests are not applicable. For VOCs in water samples, three vials are required for duplicate or spike analysis.

General Acceptance Criteria (GAC) - Analyte specific criteria applies for some analytes and is reflected in QC recovery tables.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% - see ELN-P05 QAQC tables for details (available on request); <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase. Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was typically insufficient in order to satisfy laboratory QA/QC protocols.

Miscellaneous Information

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached. We have taken the sampling date as being the date received at the laboratory.

Two significant figures are reported for the majority of tests and with a high degree of confidence, for results <10*PQL, the second significant figure may be in doubt i.e. has a relatively high degree of uncertainty and is provided for information only.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS where sediment/solids are included by default.

Urine Analysis - The BEI values listed are taken from the 2022 edition of *TLVs and BEIs Threshold Limits by ACGIH*.

Air volume measurements are not covered by Envirolab's NATA accreditation.

Data Quality Assessment Summary PFI0937

Client Details

Client Hyd20
Your Reference H24009 - Ballajura Monitoring
Date Issued 19/09/2024

Recommended Holding Time Compliance

No recommended holding time exceedances

Quality Control and QC Frequency

QC Type	Compliant	Details
Blank	Yes	No Outliers
LCS	Yes	No Outliers
Duplicates	Yes	No Outliers
Matrix Spike	Yes	No Outliers
Surrogates / Extracted Internal Standards	Yes	No Outliers
QC Frequency	Yes	No Outliers

Surrogates/Extracted Internal Standards, Duplicates and/or Matrix Spikes are not always relevant/applicable to certain analyses and matrices. Therefore, said QC measures are deemed compliant in these situations by default. See Laboratory Acceptance Criteria for more information

Data Quality Assessment Summary PFI0937

Recommended Holding Time Compliance

Analysis	Sample Number(s)	Date Sampled	Date Extracted	Date Analysed	Compliant
OCP | Water	5-6, 9	11/09/2024	13/09/2024	13/09/2024	Yes
OPP (21 list) | Water	5-6, 9	11/09/2024	13/09/2024	13/09/2024	Yes
Glyphosate | Water	5-6, 9	11/09/2024	17/09/2024	17/09/2024	Yes
Total Phosphorus | Water	1-9	11/09/2024	18/09/2024	18/09/2024	Yes
Dissolved Metals (LL) | Water	1-9	11/09/2024	18/09/2024	18/09/2024	Yes
Dissolved Metals (LL)-Hg | Water	1-9	11/09/2024	18/09/2024	18/09/2024	Yes
Alkalinity Suite | Water	1-9	11/09/2024	13/09/2024	13/09/2024	Yes
Nitrogen - Ammonia | Water	1-9	11/09/2024	13/09/2024	13/09/2024	Yes
Nitrogen - Nitrate | Water	1-3, 6-7	11/09/2024	13/09/2024	13/09/2024	Yes
	4-5, 8-9	11/09/2024	13/09/2024	16/09/2024	Yes
Nitrogen - Nitrite | Water	1-3, 6-7	11/09/2024	13/09/2024	13/09/2024	Yes
	4-5, 8-9	11/09/2024	13/09/2024	16/09/2024	Yes
Nitrogen - NOx | Water	1-3, 6-7	11/09/2024	13/09/2024	13/09/2024	Yes
	4-5, 8-9	11/09/2024	13/09/2024	16/09/2024	Yes
Nitrogen - Total N | Water	1-9	11/09/2024	17/09/2024	18/09/2024	Yes
Phosphate as P | Water	1-9	11/09/2024	13/09/2024	13/09/2024	Yes
TKN as N calc | Water	1-9	11/09/2024	16/09/2024	19/09/2024	Yes
E. coli & T.T.coli | Water	1-9	11/09/2024	12/09/2024	12/09/2024	Yes

Quality Control PFI0937

ORG-022_OC | Organochlorine Pesticides (Water) | Batch BFI2420

Analyte	Units	PQL	Blank	DUP1		DUP2		LCS %	Spike %
				BFI2420-DUP1#		BFI2420-DUP2#			
				Samp	QC | RPD %	Samp	QC | RPD %		
alpha-BHC	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	84.1	96.1
Hexachlorobenzene	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
beta-BHC	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	80.9	93.2
gamma-BHC	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
delta-BHC	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Heptachlor	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	87.6	90.8
Aldrin	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	72.9	61.5
Heptachlor epoxide	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	86.2	92.3
trans-Chlordane	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
cis-Chlordane	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Endosulfan I	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
4,4'-DDE	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	60.5	62.2
Dieldrin	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	86.7	89.8
Endrin	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	88.9	99.6
4,4'-DDD	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	78.5	79.3
Endosulfan II	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Endrin aldehyde	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
4,4'-DDT	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Endosulfan sulfate	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	81.4	94.3
Endrin ketone	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Methoxychlor	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Mirex	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Surrogate 4-chloro-3-nitrobenzotrifluoride	%		77.6		77.8 | 92.1		89.1 | 87.3	84.4	97.2

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

ORG-022 | Organophosphorus Pesticides (Water) | Batch BFI2420

Analyte	Units	PQL	Blank	DUP1		DUP2		LCS %	Spike %
				BFI2420-DUP1#		BFI2420-DUP2#			
				Samp	QC | RPD %	Samp	QC | RPD %		
Dichlorvos	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	78.5	92.5
Dimethoate	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Diazinon	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Chlorpyrifos-methyl	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	83.9	93.0
Ronnel	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	77.6	84.0
Fenitrothion	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	90.6	107
Malathion	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	90.4	103
Chlorpyrifos	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	82.0	86.5
Parathion	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	90.5	111
Bromophos-ethyl	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Ethion	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	75.7	80.4
Coumaphos	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Disulfoton	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Fenamiphos	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Fenthion	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Methidathion	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Mevinphos	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Parathion-methyl	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Phorate	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Phosalone	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Azinphos-methyl	µg/L	0.20	<0.20	<0.20	<0.20 | [NA]	<0.20	<0.20 | [NA]	[NA]	[NA]
Surrogate 4-chloro-3-nitrobenzotrifluoride	%		77.6		77.8 | 92.1		89.1 | 87.3	84.4	97.2

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PFI0937

ORG-029_SVOC_VOC_LCMSMS | Glyphosate (Water) | Batch BFI2968

Analyte	Units	PQL	Blank	DUP1 PFI0937-05 Samp | QC | RPD %	LCS %	Spike % PFI0937-06
Glyphosate	mg/L	0.010	<0.010	<0.010 | <0.010 | [NA]	105	93.1

METALS-020 | Acid Extractable Metals (Water) | Batch BFI3176

Analyte	Units	PQL	Blank	DUP1 BFI3176-DUP1# Samp | QC | RPD %	DUP2 BFI3176-DUP2# Samp | QC | RPD %	LCS %	Spike % BFI3176-MS1#
Phosphorus	mg/L	0.050	<0.050	<0.050 | <0.050 | [NA]	<0.050 | <0.050 | [NA]	103	103

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-020 | Acid Extractable Metals (Water) | Batch BFI3177

Analyte	Units	PQL	Blank	DUP1 PFI0937-04 Samp | QC | RPD %	DUP2 BFI3177-DUP2# Samp | QC | RPD %	LCS %	Spike % PFI0937-05
Phosphorus	mg/L	0.050	<0.050	<0.050 | <0.050 | [NA]	0.649 | 0.632 | 2.63	98.9	99.5

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-021 | Dissolved Low Level Metals (Water) | Batch BFI3194

Analyte	Units	PQL	Blank	DUP1 PFI0937-01 Samp | QC | RPD %	DUP2 BFI3194-DUP2# Samp | QC | RPD %	LCS %	Spike % PFI0937-02
Mercury	µg/L	0.050	<0.050	<0.050 | <0.050 | [NA]	<0.050 | <0.050 | [NA]	105	107

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

METALS-022 | Dissolved Low Level Metals (Water) | Batch BFI3198

Analyte	Units	PQL	Blank	DUP1 PFI0937-01 Samp | QC | RPD %	DUP2 PFI0937-09 Samp | QC | RPD %	LCS %	Spike % PFI0937-02
Arsenic	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	<1.0 | <1.0 | [NA]	101	102
Cadmium	µg/L	0.10	<0.10	<0.10 | <0.10 | [NA]	<0.10 | <0.10 | [NA]	102	105
Chromium	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	1.93 | 1.97 | [NA]	101	104
Copper	µg/L	1.0	<1.0	1.50 | 1.58 | [NA]	2.68 | 2.70 | [NA]	95.6	97.0
Lead	µg/L	1.0	<1.0	<1.0 | <1.0 | [NA]	<1.0 | <1.0 | [NA]	91.3	92.5
Nickel	µg/L	1.0	<1.0	11.4 | 11.6 | 1.83	<1.0 | <1.0 | [NA]	97.6	98.4
Zinc	µg/L	1.0	<1.0	1.20 | 1.22 | [NA]	2.24 | 2.56 | [NA]	98.7	104

INORG-006 | Inorganics - Ionic Balance and Indexes (Water) | Batch BFI2475

Analyte	Units	PQL	Blank	DUP1 BFI2475-DUP1# Samp | QC | RPD %	DUP2 BFI2475-DUP2# Samp | QC | RPD %	LCS %
Bicarbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	274 | 268 | 2.31	329 | 336 | 2.07	[NA]
Carbonate Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Hydroxide OH- as CaCO3	mg/L as CaCO3	5.0	<5.0	<5.0 | <5.0 | [NA]	<5.0 | <5.0 | [NA]	[NA]
Total Alkalinity as CaCO3	mg/L as CaCO3	5.0	<5.0	274 | 268 | 2.31	329 | 336 | 2.07	91.9

Analyte	Units	PQL	Blank	LCS %
Total Alkalinity as CaCO3	mg/L as CaCO3	5		101

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

Quality Control PFI0937

INORG-057 | Inorganics - Nutrients (Water) | Batch BFI2496

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BFI2496-DUP1# Samp | QC | RPD %	PFI0937-09 Samp | QC | RPD %		
Ammonia as N	mg/L	0.0050	<0.0050	0.0334 | 0.0301 | 10.5	0.0510 | 0.0477 | 6.67	104	99.9
Nitrate as N	mg/L	0.0050	<0.0050	0.945 | 0.928 | 1.78	0.312 | 0.318 | 1.73	93.5	92.7
Nitrate as NO3 by calculation	mg/L	0.020	<0.020			[NA]	[NA]
Nitrite as N	mg/L	0.0050	<0.0050	<0.0050 | <0.0050 | [NA]	<0.050 | <0.050 | [NA] [2]	102	91.5
Nitrite as NO2 by calculation	mg/L	0.020	<0.020			[NA]	[NA]
NOx as N	mg/L	0.0050	<0.0050	0.947 | 0.930 | 1.79	0.331 | 0.336 | 1.59	93.5	92.5
Phosphate as P	mg/L	0.0050	<0.0050	0.0116 | 0.0107 | [NA]	0.0105 | 0.0120 | [NA]	99.4	71.7

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

INORG-127 | Inorganics - Nutrients (Water) | Batch BFI3117

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %	Spike %
				BFI3117-DUP1# Samp | QC | RPD %	PFI0937-01 Samp | QC | RPD %		
Total Nitrogen	mg/L	0.10	<0.10	22.3 | 22.6 | 1.15	1.38 | 1.43 | 3.58	118	128

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

MICRO-001B | Microbiological Suite (Water) | Batch BFI2422

Analyte	Units	PQL	Blank	DUP1	DUP2	LCS %
				BFI2422-DUP1# Samp | QC | RPD %	BFI2422-DUP2# Samp | QC | RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]

Analyte	Units	PQL	Blank	DUP3	DUP4	LCS %
				BFI2422-DUP3# Samp | QC | RPD %	BFI2422-DUP4# Samp | QC | RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]

Analyte	Units	PQL	Blank	DUP5	DUP6	LCS %
				BFI2422-DUP5# Samp | QC | RPD %	BFI2422-DUP6# Samp | QC | RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]

Analyte	Units	PQL	Blank	DUP7	DUP8	LCS %
				BFI2422-DUP7# Samp | QC | RPD %	BFI2422-DUP8# Samp | QC | RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 | <1 | [NA]	<1 | <1 | [NA]	[NA]

Analyte	Units	PQL	Blank	DUP9	LCS %
				BFI2422-DUP9# Samp | QC | RPD %	
Thermotolerant Coliforms	cfu/100mL	1	<1	<1 | <1 | [NA]	[NA]
E.coli	cfu/100mL	1	<1	<1 | <1 | [NA]	[NA]

The QC reported was not specifically part of this workorder but formed part of the QC process batch.

QC Comments

Identifier	Description
[2]	PQL(s) has/have been raised due to matrix interference.

APPENDIX J
CURRV Runoff Calculator

CURRV

Calculator for Urban Runoff Rates & Volumes
11/10/2024



Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R				Comment
								EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	
1 Residential 300-600m2	6.93	Yes	1.5	20.0	4.0	15.0	0.25	60%	60	20	20	soakwells
2 Local Roads	2.41	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	70	30	no soakwells assumed
3 Active POS	1.69	Yes	1.5	20.0	4.0	0.0	1.00	30%	0	5	95	assume similar EIA/TIA to rural residential
4			1.5	20.0	4.0		1.00					
5			1.5	20.0	4.0		1.00					
6			1.5	20.0	4.0		1.00					
7			1.5	20.0	4.0		1.00					
8			1.5	20.0	4.0		1.00					
9			1.5	20.0	4.0		1.00					
10			0.0	20.0	4.0		1.00					

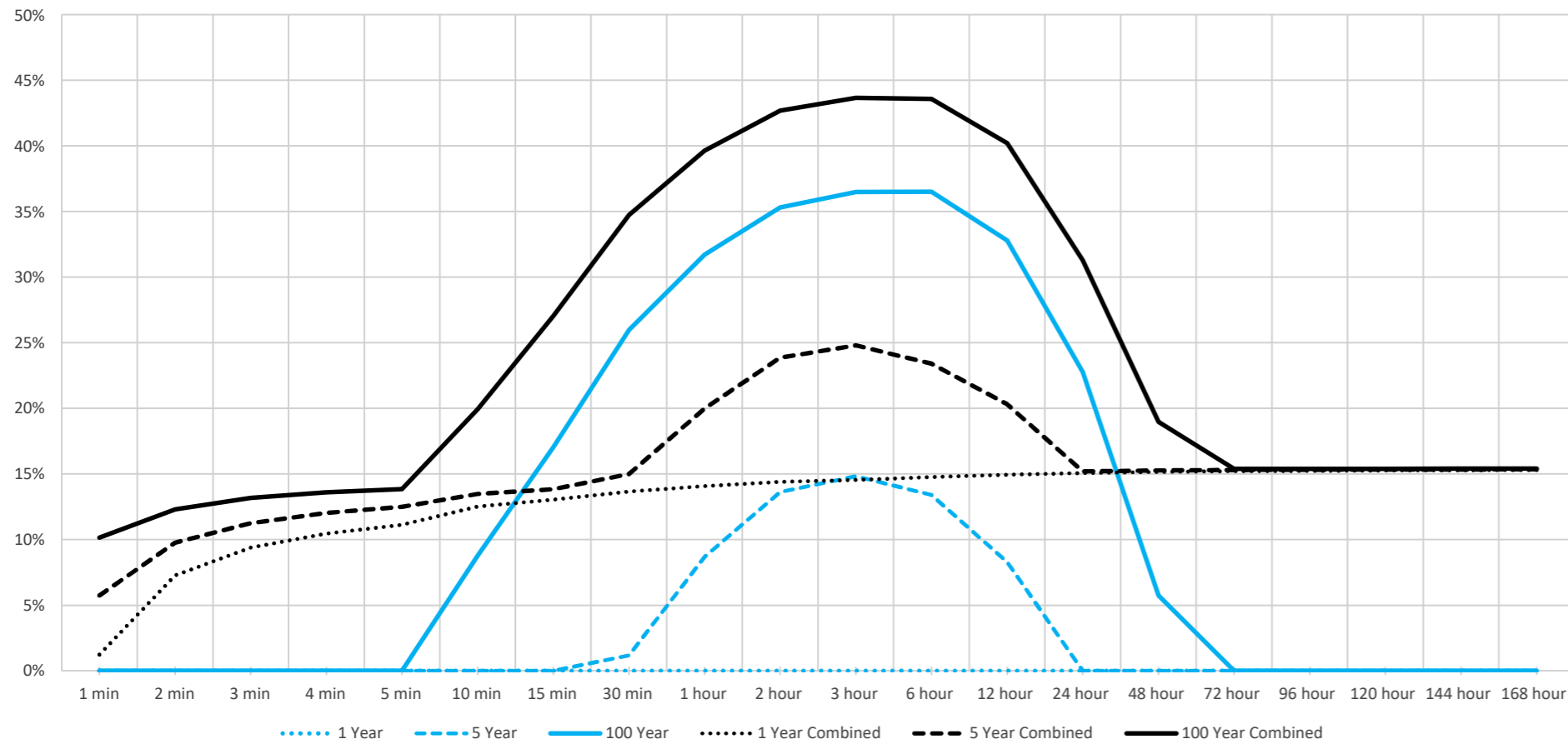
EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector

(11 - combined total)

Residential 300-600m2

Estimated Runoff Rates for Various Land Use and ARI



Project Lakefarm Ballajura DWMS - Catchment 2

Rainfall IFD Data

Annual Exceedence Probability

Duration	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
1 1 min	1.63	1.8	2.38	2.8	3.23	3.84	4.33
2 2 min	2.82	3.11	4.04	4.71	5.4	6.4	7.22
3 3 min	3.8	4.18	5.46	6.38	7.34	8.71	9.85
4 4 min	4.6	5.08	6.66	7.81	9	10.7	12.1
5 5 min	5.29	5.85	7.7	9.04	10.4	12.4	14
6 10 min	7.75	8.59	11.4	13.4	15.5	18.4	20.7
7 15 min	9.37	10.4	13.8	16.2	18.7	22.2	25
8 30 min	12.5	13.8	18.2	21.3	24.6	29.2	32.8
9 1 hour	16.1	17.8	23.2	27.3	31.5	37.5	42.4
10 2 hour	20.6	22.6	29.5	34.7	40.3	48.5	55.4
11 3 hour	23.8	26.1	34	40.2	46.8	56.8	65.3
12 6 hour	30.6	33.5	43.7	51.9	60.9	74.7	86.8
13 12 hour	39.4	43.1	56.2	66.8	78.5	96.4	112
14 24 hour	50.3	55.1	71.6	84.1	97.6	119	136
15 48 hour	63.5	69.6	89.3	103	117	138	155
16 72 hour	72.7	79.7	101	115	129	150	166
17 96 hour	80.3	88	111	126	140	160	176
18 120 hour	87.2	95.5	120	136	151	172	189
19 144 hour	93.8	103	129	147	163	186	203
20 168 hour	100	109	138	157	176	202	221

Estimated Runoff Rates

Annual Exceedence Probability

Maximum of All Events	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
Residential 300-600m2	0%	4%	15%	22%	27%	33%	36%
Local Roads	69%	69%	69%	74%	77%	81%	84%
Active POS	1%	1%	3%	7%	10%	14%	16%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	15%	17%	25%	31%	36%	41%	44%

Event Selector	9	1 hour					
Residential 300-600m2	0%	0%	9%	16%	22%	28%	32%
Local Roads	63%	64%	65%	70%	74%	78%	81%
Active POS	1%	1%	1%	5%	8%	12%	14%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	14%	14%	20%	26%	31%	36%	40%

CURRV

Calculator for Urban Runoff Rates & Volumes
11/10/2024



Project **Lakefarm Ballajura DWMS - Catchment 3**

Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R			Comment	
								EIA/TIA System Connect Ratio	Roof %	Ext Imp %		Ext Perv %
1 Residential 300-600m2	4.29	Yes	1.5	20.0	4.0	15.0	0.25	60%	60	20	20	soakwells
2 Local Roads	2.11	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	70	30	no soakwells assumed
3 Active POS	0.83	Yes	1.5	20.0	4.0	0.0	1.00	30%	0	5	95	assume similar EIA/TIA to rural residential
4			1.5	20.0	4.0		1.00					
5			1.5	20.0	4.0		1.00					
6			1.5	20.0	4.0		1.00					
7			1.5	20.0	4.0		1.00					
8			1.5	20.0	4.0		1.00					
9			1.5	20.0	4.0		1.00					
10			0.0	20.0	4.0		1.00					

EIA : Effective Impervious Area, TIA : Total Impervious Area

Rainfall IFD Data

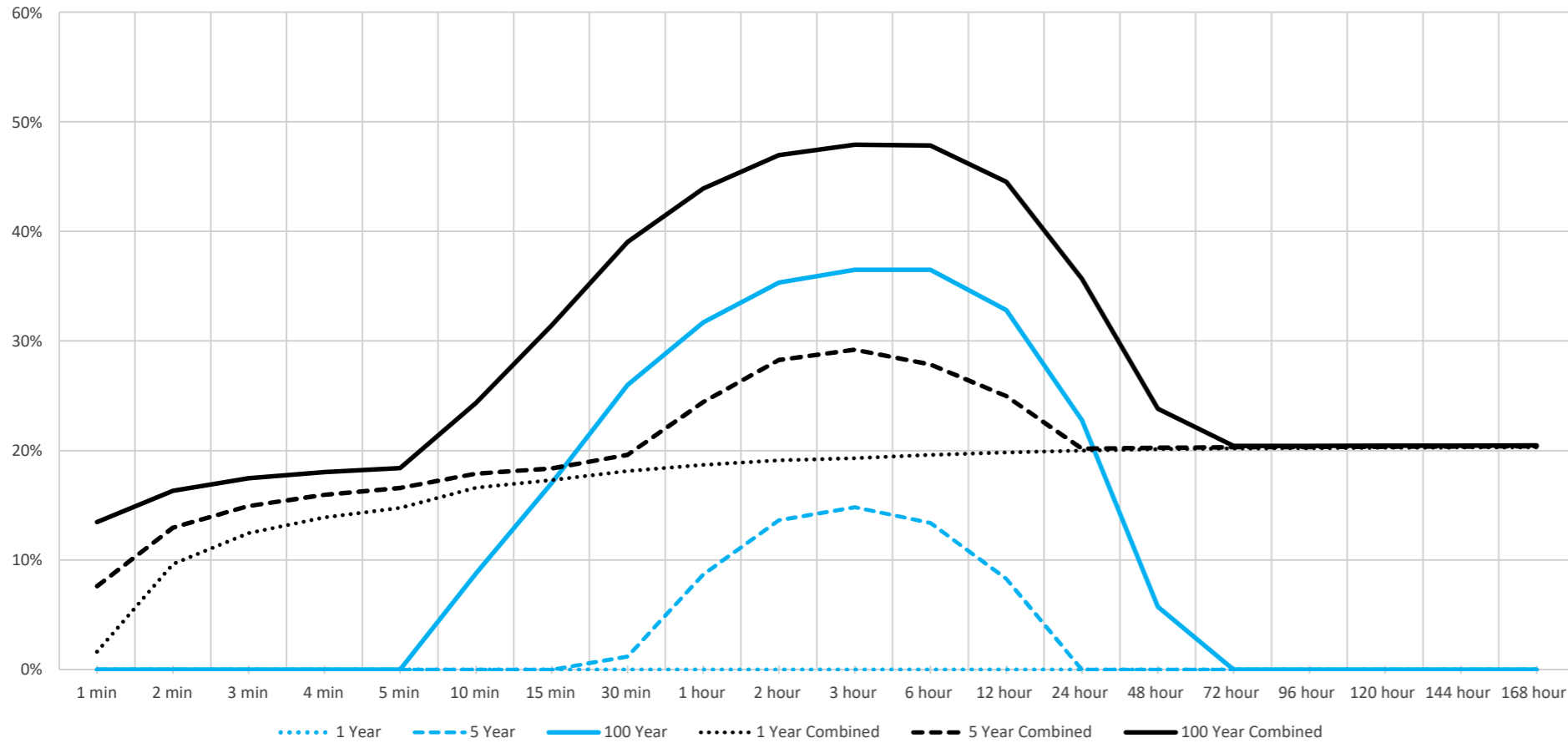
Duration	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
1 1 min	1.63	1.8	2.38	2.8	3.23	3.84	4.33
2 2 min	2.82	3.11	4.04	4.71	5.4	6.4	7.22
3 3 min	3.8	4.18	5.46	6.38	7.34	8.71	9.85
4 4 min	4.6	5.08	6.66	7.81	9	10.7	12.1
5 5 min	5.29	5.85	7.7	9.04	10.4	12.4	14
6 10 min	7.75	8.59	11.4	13.4	15.5	18.4	20.7
7 15 min	9.37	10.4	13.8	16.2	18.7	22.2	25
8 30 min	12.5	13.8	18.2	21.3	24.6	29.2	32.8
9 1 hour	16.1	17.8	23.2	27.3	31.5	37.5	42.4
10 2 hour	20.6	22.6	29.5	34.7	40.3	48.5	55.4
11 3 hour	23.8	26.1	34	40.2	46.8	56.8	65.3
12 6 hour	30.6	33.5	43.7	51.9	60.9	74.7	86.8
13 12 hour	39.4	43.1	56.2	66.8	78.5	96.4	112
14 24 hour	50.3	55.1	71.6	84.1	97.6	119	136
15 48 hour	63.5	69.6	89.3	103	117	138	155
16 72 hour	72.7	79.7	101	115	129	150	166
17 96 hour	80.3	88	111	126	140	160	176
18 120 hour	87.2	95.5	120	136	151	172	189
19 144 hour	93.8	103	129	147	163	186	203
20 168 hour	100	109	138	157	176	202	221

Land Use Graph Selector **1**

(11 - combined total)

Residential 300-600m2

Estimated Runoff Rates for Various Land Use and ARI



Estimated Runoff Rates

	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
Maximum of All Events	1.00	1.44	4.48	10	20	50	100
Residential 300-600m2	0%	4%	15%	22%	27%	33%	36%
Local Roads	69%	69%	69%	74%	77%	81%	84%
Active POS	1%	1%	3%	7%	10%	14%	16%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	20%	22%	29%	35%	40%	45%	48%

Event Selector	1 hour						
	Residential 300-600m2	0%	0%	9%	16%	22%	28%	32%
Local Roads	63%	64%	65%	70%	74%	78%	81%
Active POS	1%	1%	1%	5%	8%	12%	14%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	19%	19%	24%	30%	35%	41%	44%

CURRV

Calculator for Urban Runoff Rates & Volumes
11/10/2024



Project **Lakefarm Ballajura DWMS - Catchment 4**

Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R				Comment
								EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	
1 Residential 300-600m2	3.58	Yes	1.5	20.0	4.0	15.0	0.25	60%	60	20	20	soakwells
2 Local Roads	0.99	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	70	30	no soakwells assumed
3 Active POS	0.59	Yes	1.5	20.0	4.0	0.0	1.00	30%	0	5	95	assume similar EIA/TIA to rural residential
4			1.5	20.0	4.0		1.00					
5			1.5	20.0	4.0		1.00					
6			1.5	20.0	4.0		1.00					
7			1.5	20.0	4.0		1.00					
8			1.5	20.0	4.0		1.00					
9			1.5	20.0	4.0		1.00					
10			0.0	20.0	4.0		1.00					

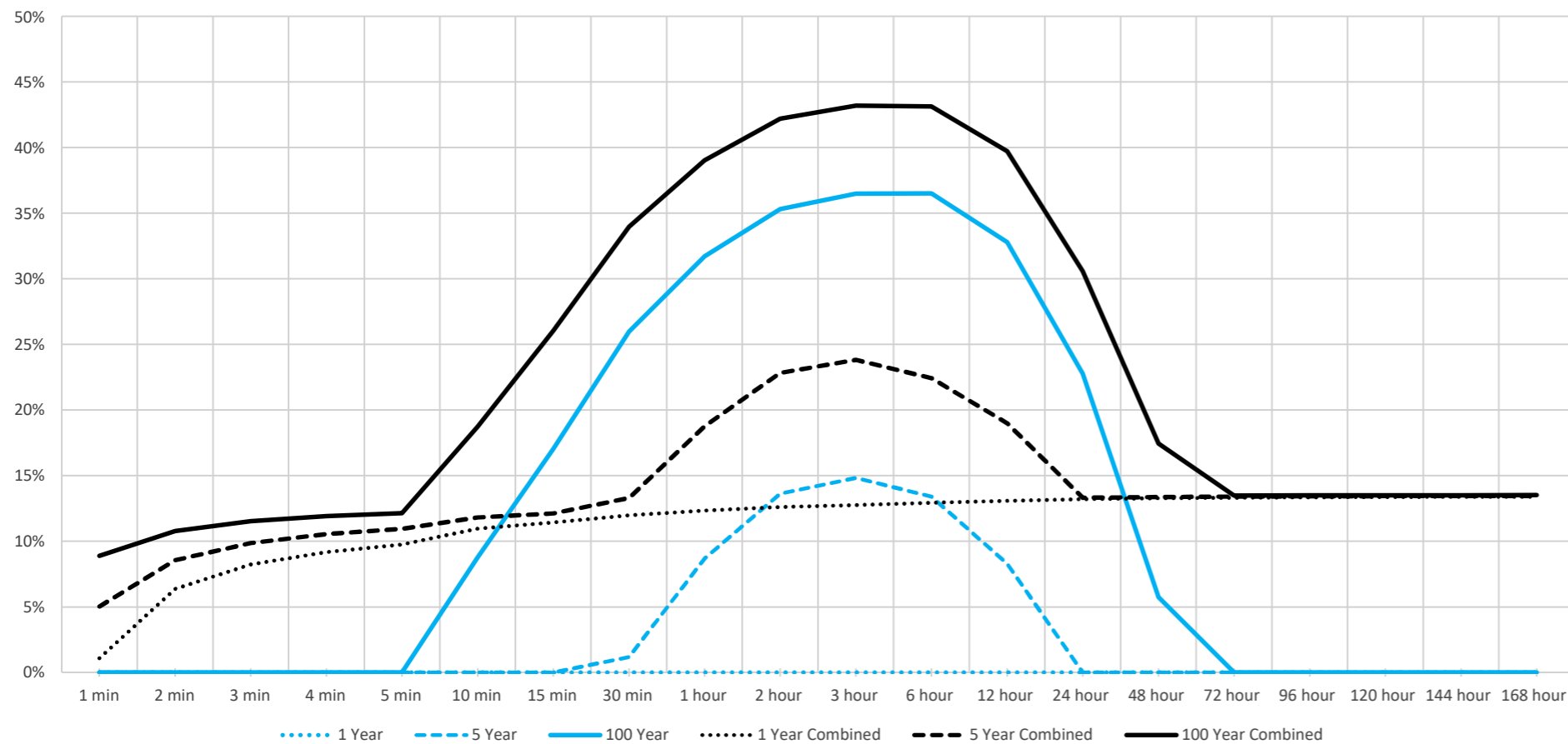
EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector **1**

(11 - combined total)

Residential 300-600m2

Estimated Runoff Rates for Various Land Use and ARI



Rainfall IFD Data

Duration	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
1 1 min	1.63	1.8	2.38	2.8	3.23	3.84	4.33
2 2 min	2.82	3.11	4.04	4.71	5.4	6.4	7.22
3 3 min	3.8	4.18	5.46	6.38	7.34	8.71	9.85
4 4 min	4.6	5.08	6.66	7.81	9	10.7	12.1
5 5 min	5.29	5.85	7.7	9.04	10.4	12.4	14
6 10 min	7.75	8.59	11.4	13.4	15.5	18.4	20.7
7 15 min	9.37	10.4	13.8	16.2	18.7	22.2	25
8 30 min	12.5	13.8	18.2	21.3	24.6	29.2	32.8
9 1 hour	16.1	17.8	23.2	27.3	31.5	37.5	42.4
10 2 hour	20.6	22.6	29.5	34.7	40.3	48.5	55.4
11 3 hour	23.8	26.1	34	40.2	46.8	56.8	65.3
12 6 hour	30.6	33.5	43.7	51.9	60.9	74.7	86.8
13 12 hour	39.4	43.1	56.2	66.8	78.5	96.4	112
14 24 hour	50.3	55.1	71.6	84.1	97.6	119	136
15 48 hour	63.5	69.6	89.3	103	117	138	155
16 72 hour	72.7	79.7	101	115	129	150	166
17 96 hour	80.3	88	111	126	140	160	176
18 120 hour	87.2	95.5	120	136	151	172	189
19 144 hour	93.8	103	129	147	163	186	203
20 168 hour	100	109	138	157	176	202	221

Estimated Runoff Rates

Maximum of All Events	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
Residential 300-600m2	0%	4%	15%	22%	27%	33%	36%
Local Roads	69%	69%	69%	74%	77%	81%	84%
Active POS	1%	1%	3%	7%	10%	14%	16%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	13%	15%	24%	30%	35%	40%	43%

Event Selector	9	1 hour					
Residential 300-600m2	0%	0%	9%	16%	22%	28%	32%
Local Roads	63%	64%	65%	70%	74%	78%	81%
Active POS	1%	1%	1%	5%	8%	12%	14%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	12%	12%	19%	25%	30%	36%	39%

CURRV

Calculator for Urban Runoff Rates & Volumes
11/10/2024



Project **Lakefarm Ballajura DWMS - Catchment 5**

Land Use Description	Area (ha)	Use in Calc	Imperv Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R				Comment
								EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	
1 Residential 300-600m2	3.88	Yes	1.5	20.0	4.0	15.0	0.25	60%	60	20	20	soakwells
2 Local Roads	1.51	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	70	30	no soakwells assumed
3 Active POS	0.00	Yes	1.5	20.0	4.0	0.0	1.00	30%	0	5	95	assume similar EIA/TIA to rural residential
4			1.5	20.0	4.0		1.00					
5			1.5	20.0	4.0		1.00					
6			1.5	20.0	4.0		1.00					
7			1.5	20.0	4.0		1.00					
8			1.5	20.0	4.0		1.00					
9			1.5	20.0	4.0		1.00					
10			0.0	20.0	4.0		1.00					

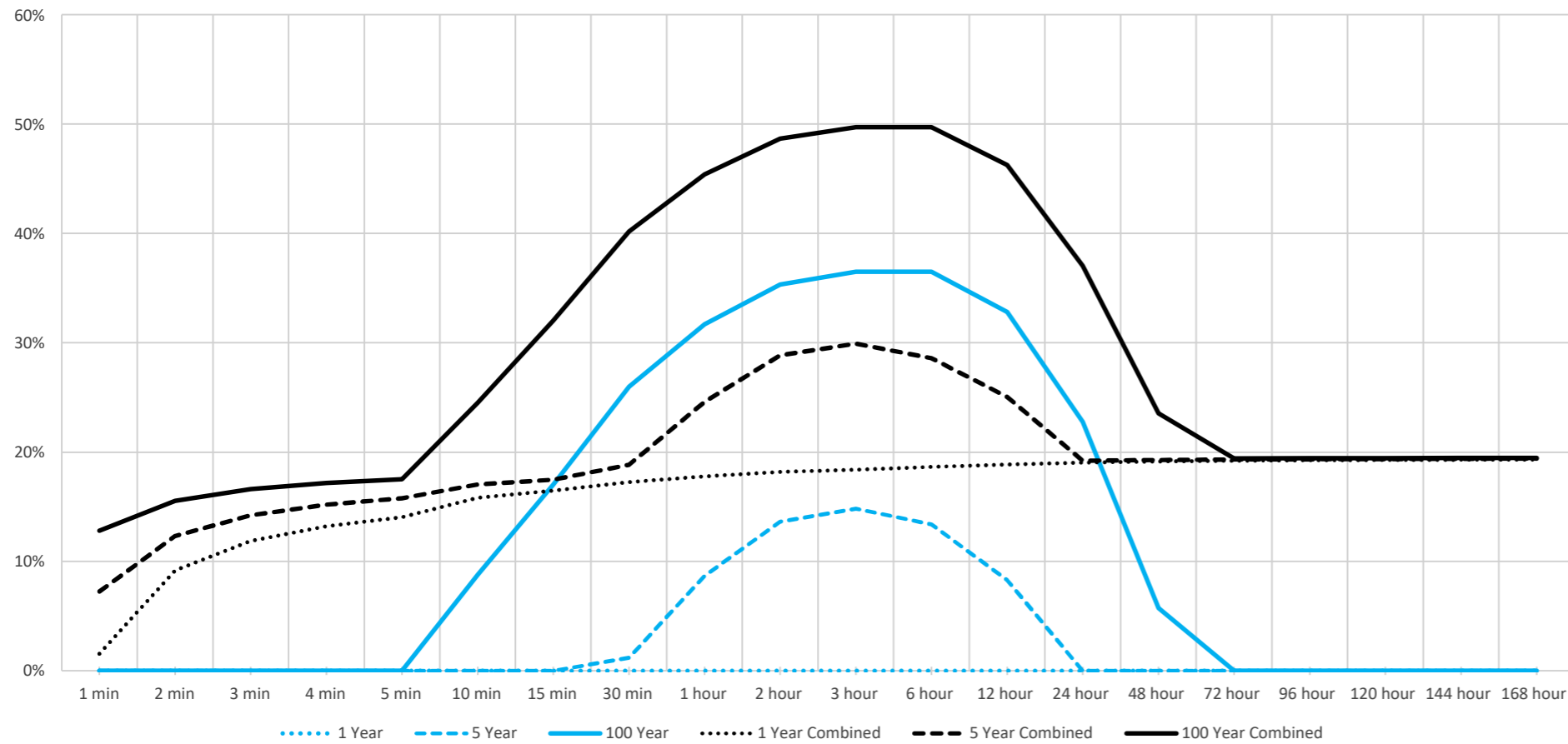
EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector **1**

(11 - combined total)

Residential 300-600m2

Estimated Runoff Rates for Various Land Use and ARI



Rainfall IFD Data

Duration	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
1 1 min	1.63	1.8	2.38	2.8	3.23	3.84	4.33
2 2 min	2.82	3.11	4.04	4.71	5.4	6.4	7.22
3 3 min	3.8	4.18	5.46	6.38	7.34	8.71	9.85
4 4 min	4.6	5.08	6.66	7.81	9	10.7	12.1
5 5 min	5.29	5.85	7.7	9.04	10.4	12.4	14
6 10 min	7.75	8.59	11.4	13.4	15.5	18.4	20.7
7 15 min	9.37	10.4	13.8	16.2	18.7	22.2	25
8 30 min	12.5	13.8	18.2	21.3	24.6	29.2	32.8
9 1 hour	16.1	17.8	23.2	27.3	31.5	37.5	42.4
10 2 hour	20.6	22.6	29.5	34.7	40.3	48.5	55.4
11 3 hour	23.8	26.1	34	40.2	46.8	56.8	65.3
12 6 hour	30.6	33.5	43.7	51.9	60.9	74.7	86.8
13 12 hour	39.4	43.1	56.2	66.8	78.5	96.4	112
14 24 hour	50.3	55.1	71.6	84.1	97.6	119	136
15 48 hour	63.5	69.6	89.3	103	117	138	155
16 72 hour	72.7	79.7	101	115	129	150	166
17 96 hour	80.3	88	111	126	140	160	176
18 120 hour	87.2	95.5	120	136	151	172	189
19 144 hour	93.8	103	129	147	163	186	203
20 168 hour	100	109	138	157	176	202	221

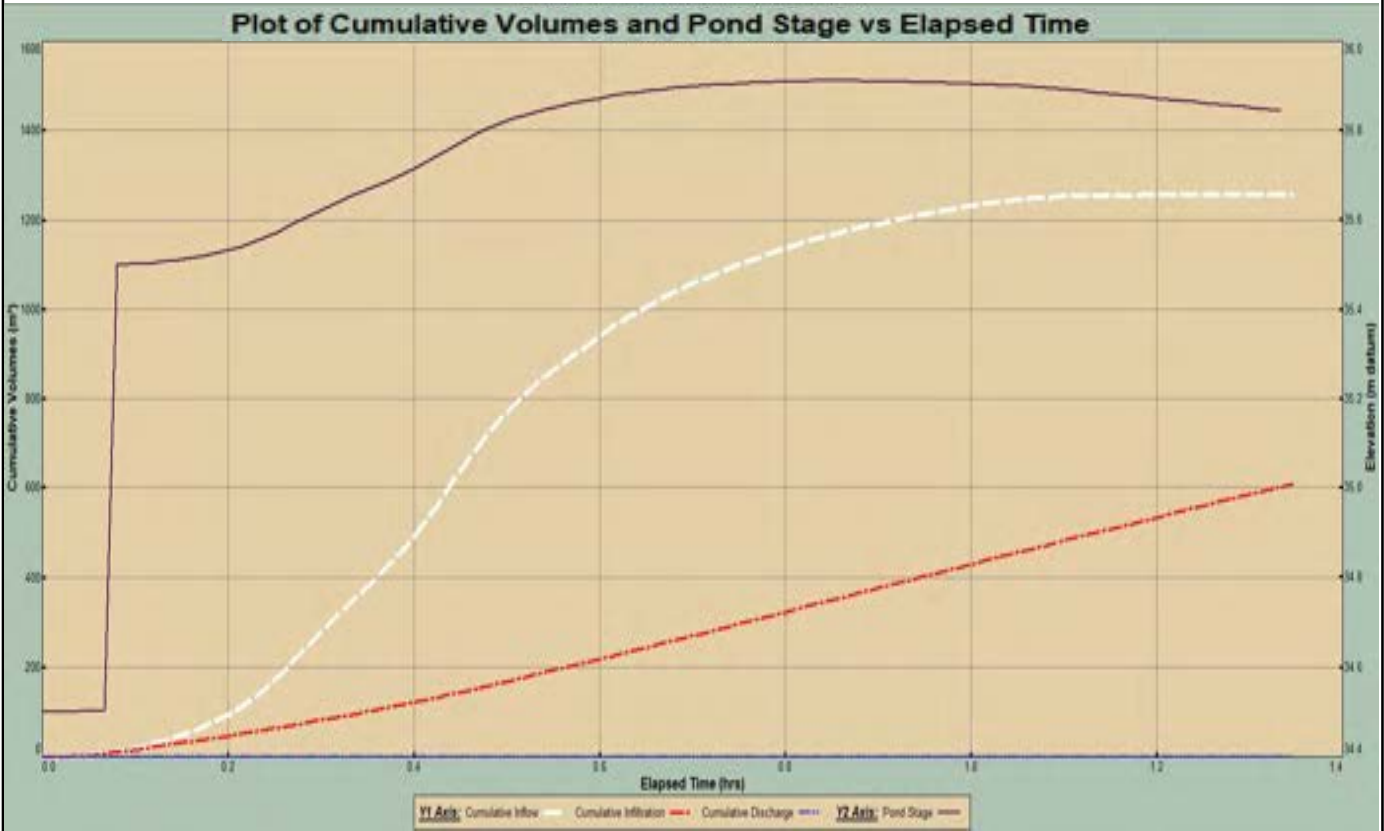
Estimated Runoff Rates

Maximum of All Events	Annual Exceedence Probability						
	63.2%	50%	20%	10%	5%	2%	1%
Residential 300-600m2	0%	4%	15%	22%	27%	33%	36%
Local Roads	69%	69%	69%	74%	77%	81%	84%
Active POS	1%	1%	3%	7%	10%	14%	16%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	19%	21%	30%	36%	41%	46%	50%

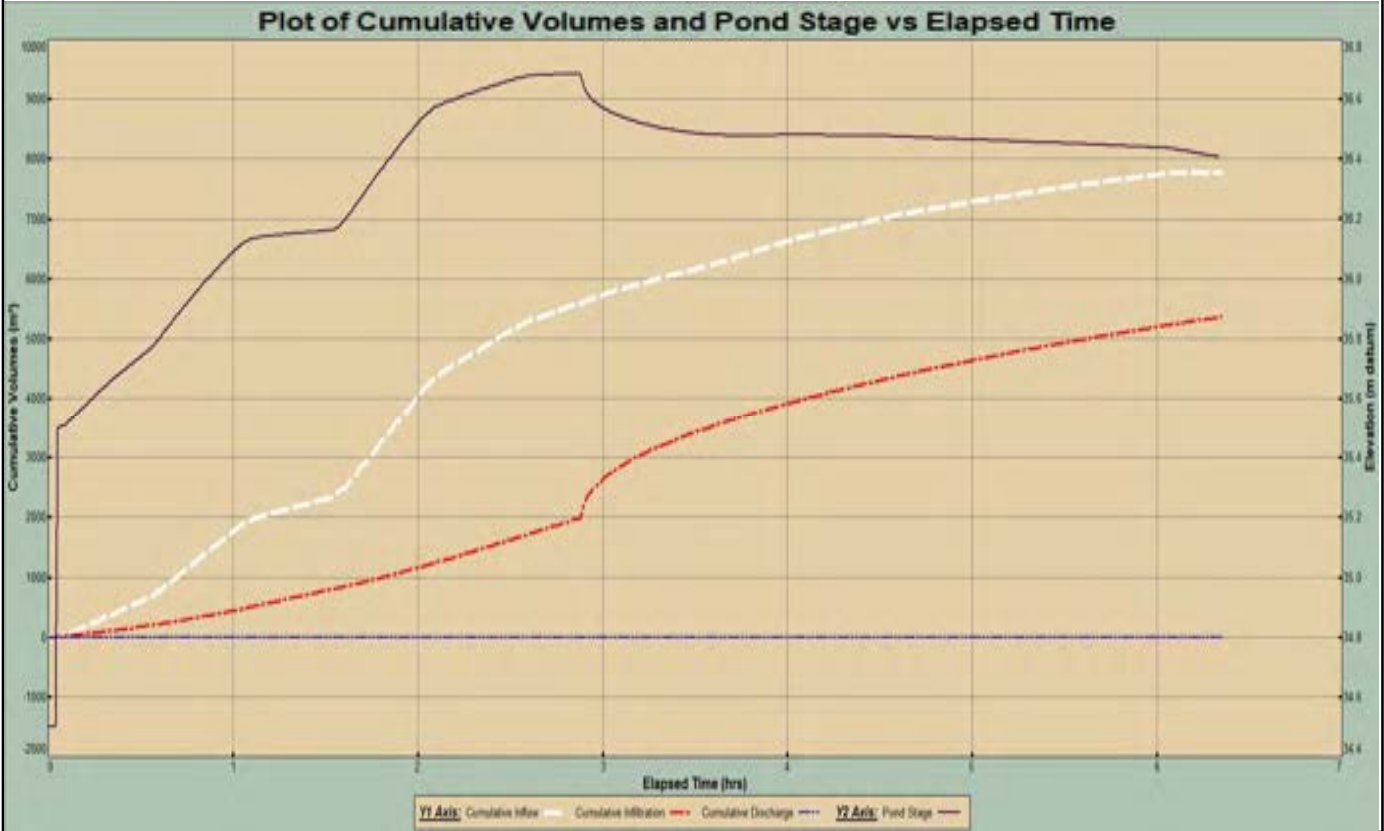
Event Selector	9 1 hour						
Residential 300-600m2	0%	0%	9%	16%	22%	28%	32%
Local Roads	63%	64%	65%	70%	74%	78%	81%
Active POS	1%	1%	1%	5%	8%	12%	14%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	18%	18%	25%	31%	36%	42%	45%

APPENDIX K
Stormwater Modelling Outputs

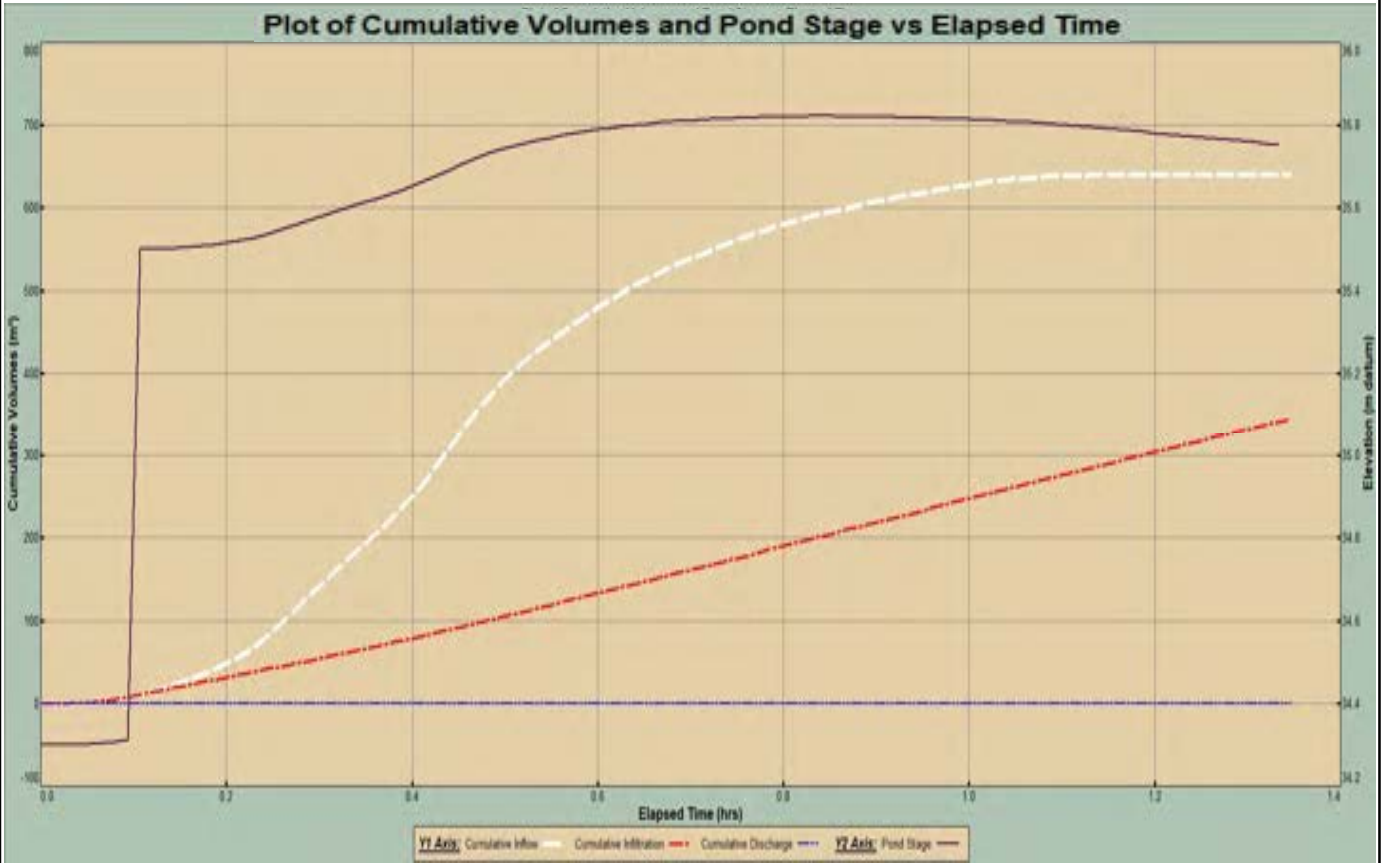
PONDS 20% AEP Results



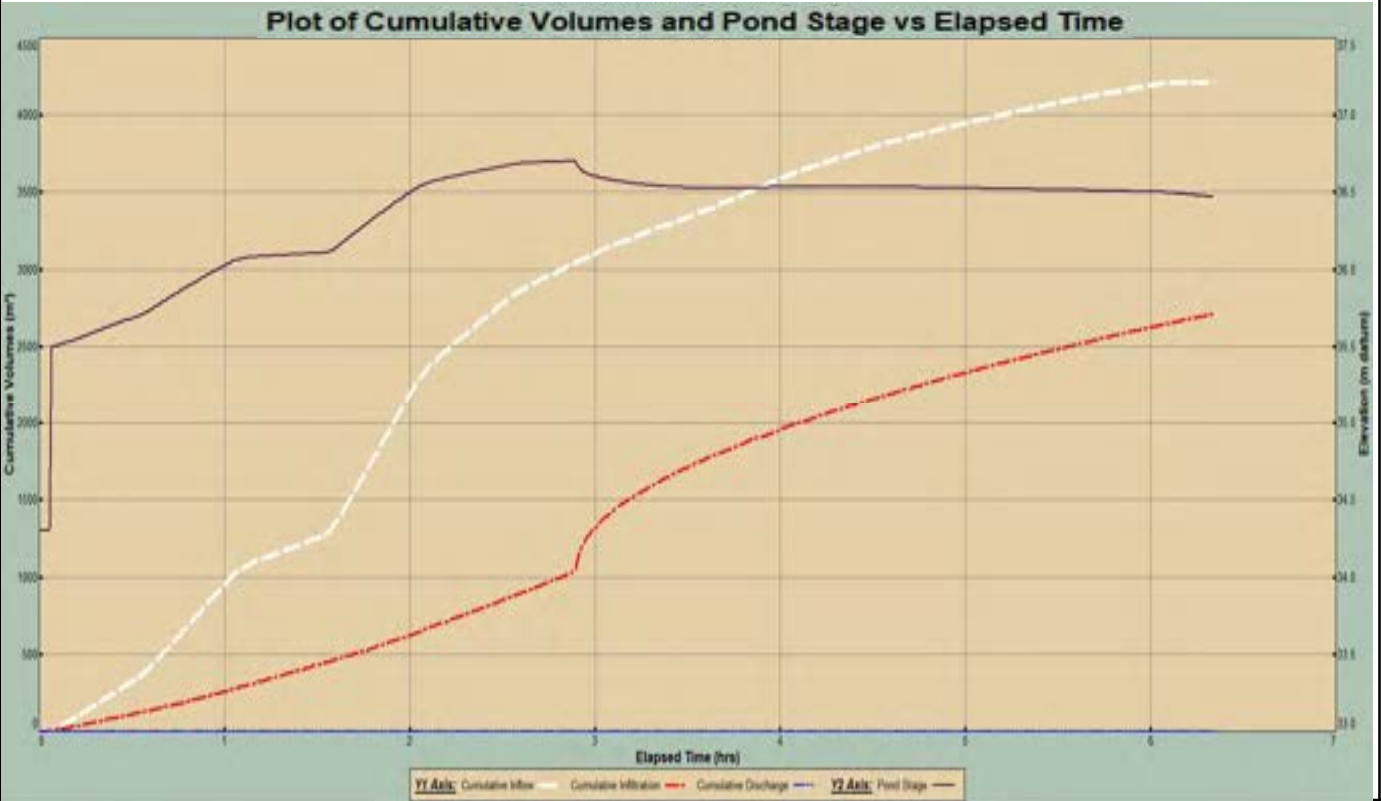
PONDS 1% AEP Results



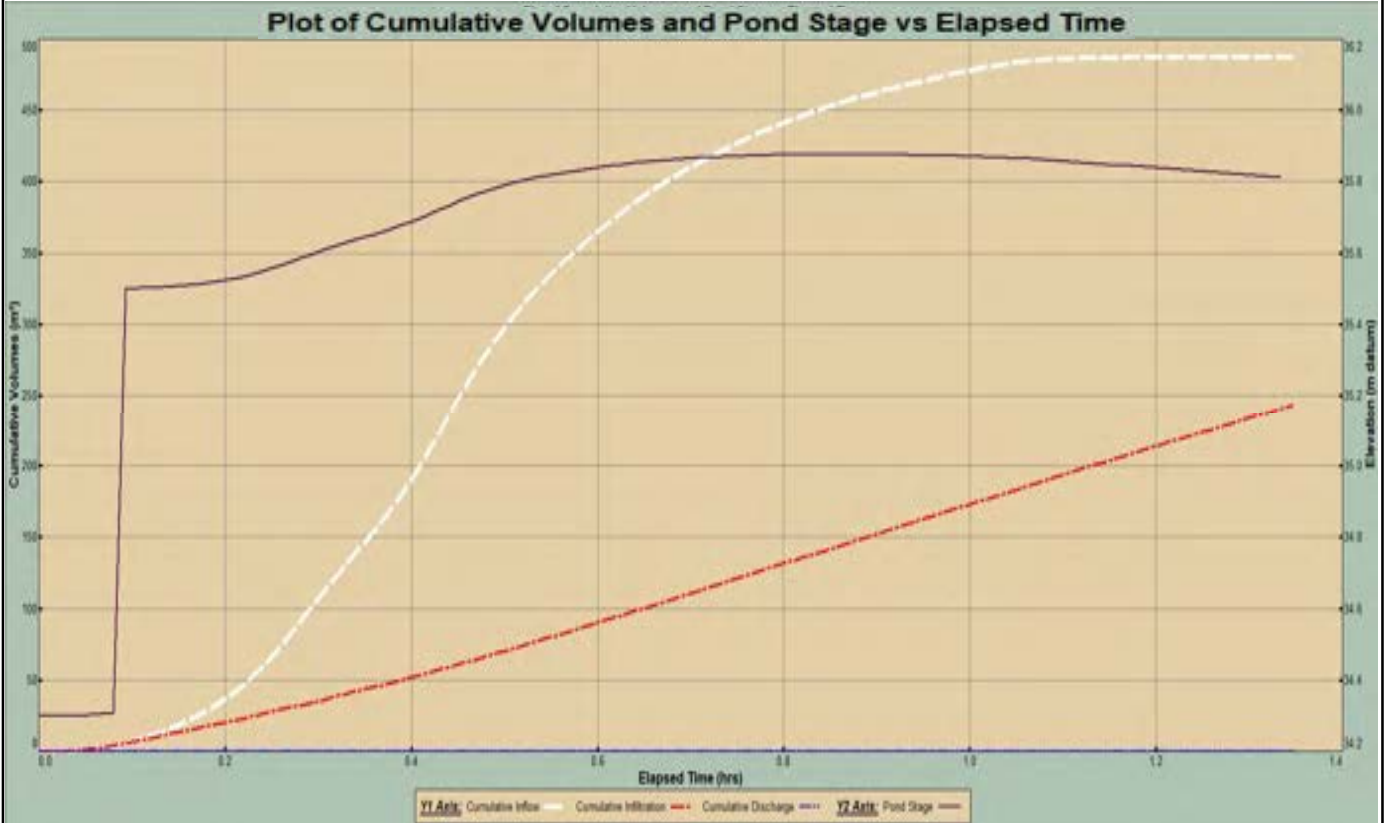
PONDS 20% AEP Results



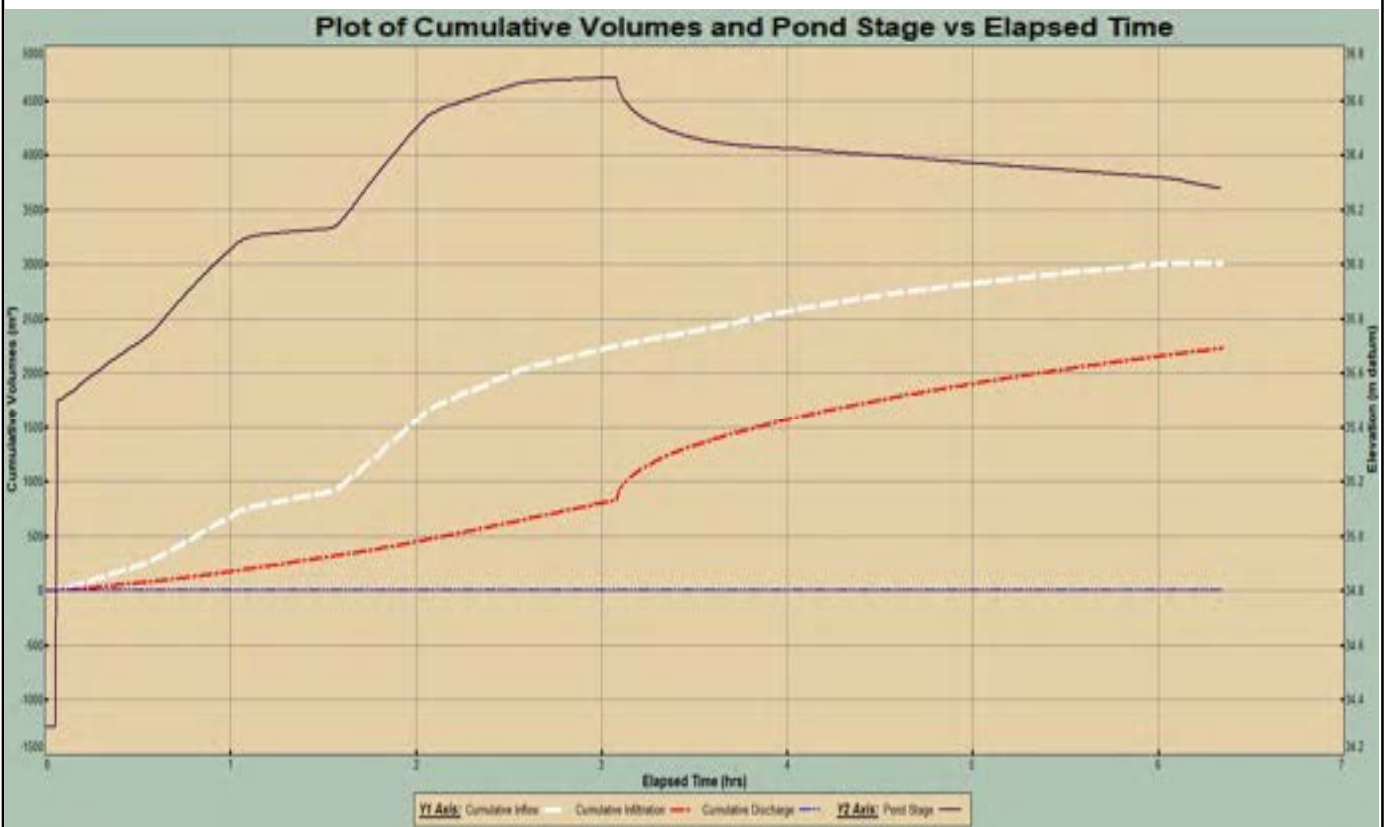
PONDS 1% AEP Results



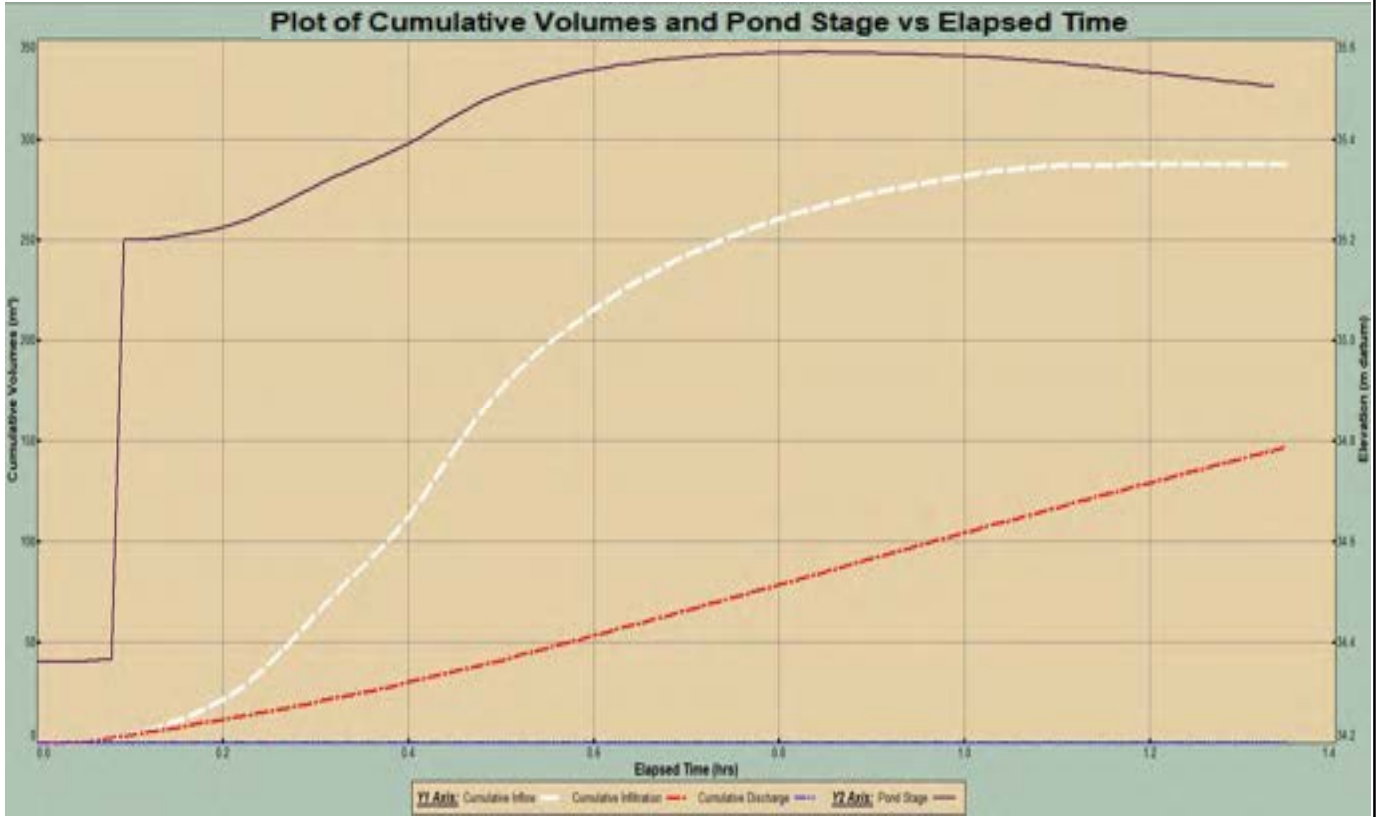
PONDS 20% AEP Results



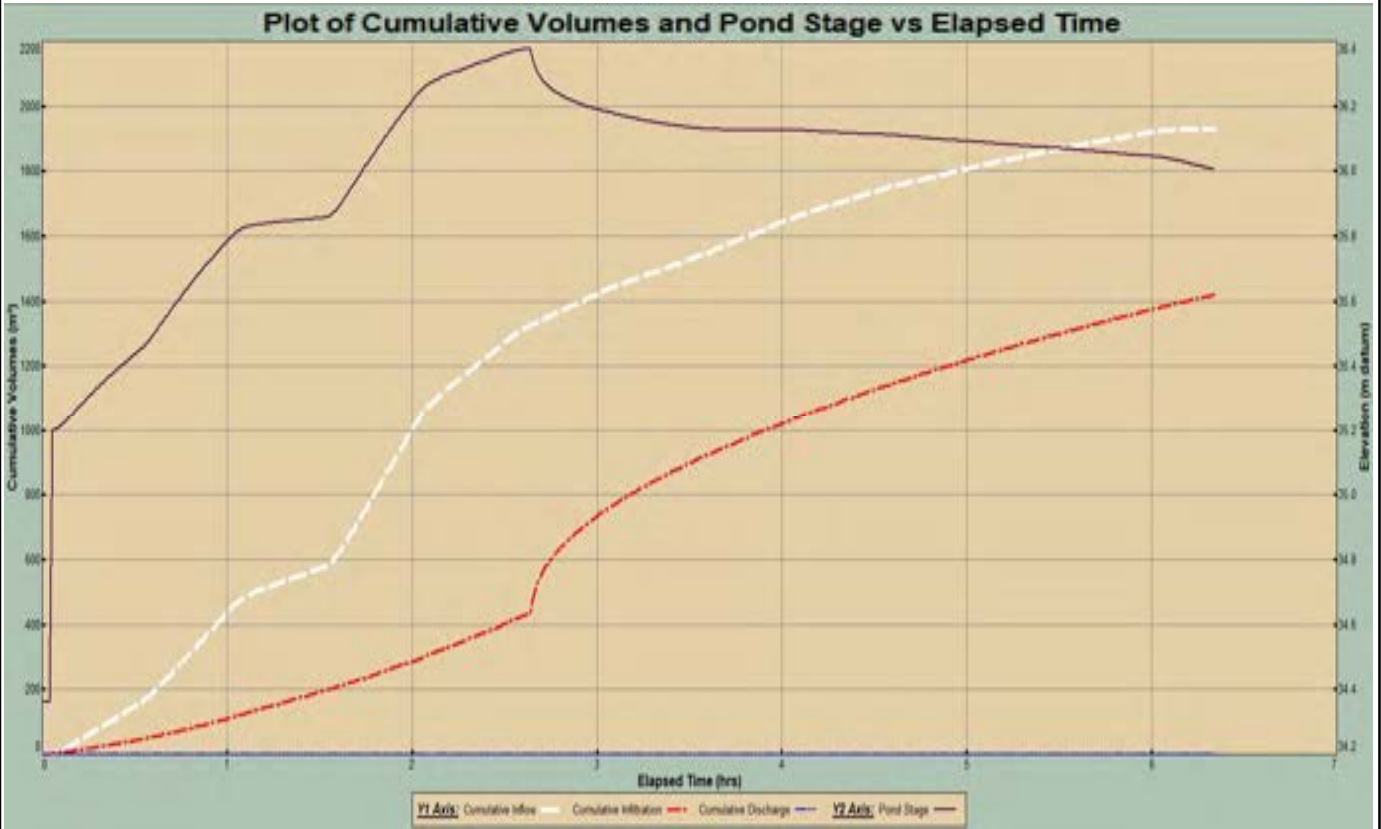
PONDS 1% AEP Results



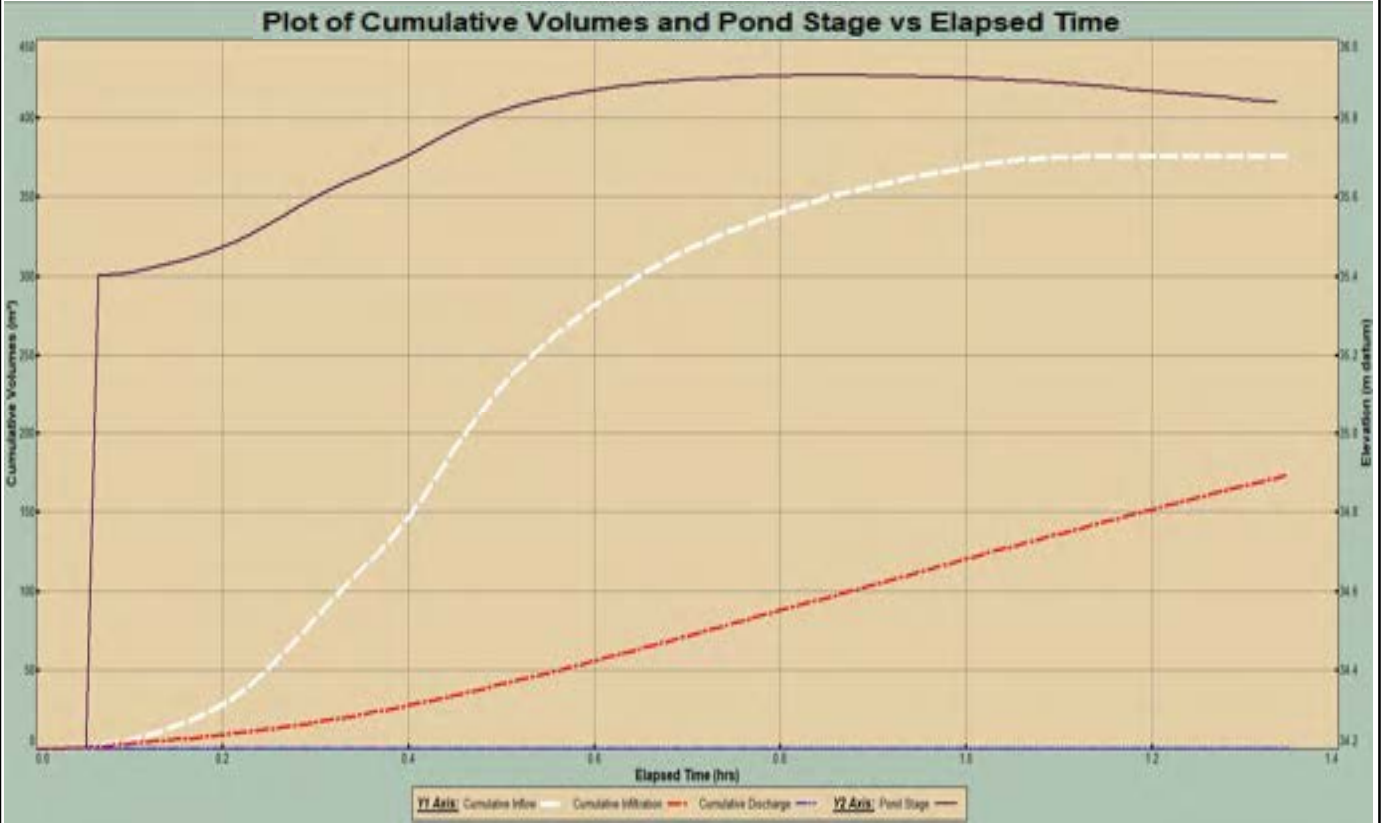
PONDS 20% AEP Results



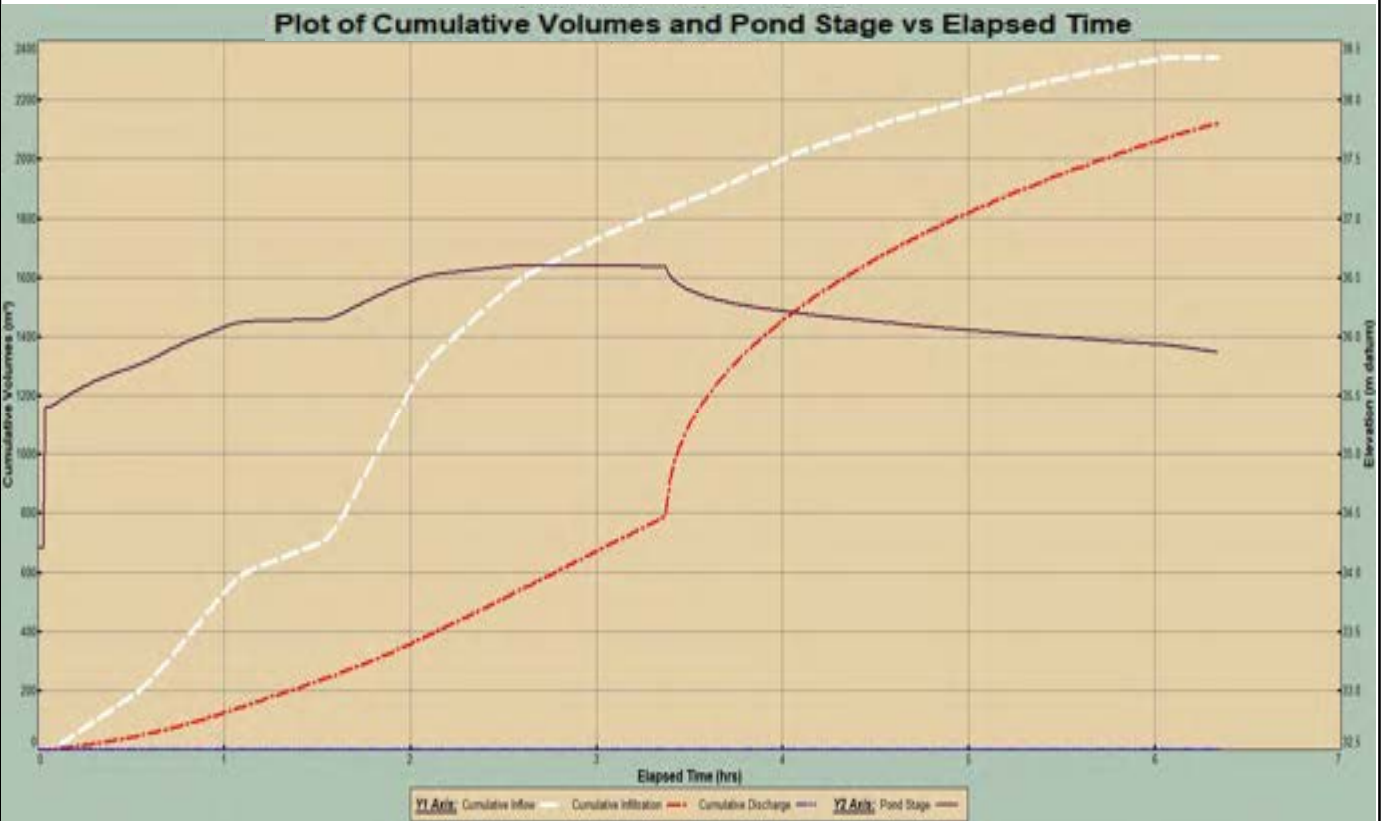
PONDS 1% AEP Results



PONDS 20% AEP Results



PONDS 1% AEP Results



APPENDIX L
Engineering Servicing Report

24-213

27 September 2024

Mr Tim Bycroft
Land Group WA
578 Murray St
West Perth WA 6005

Dear Tim

LAKEFARM RETREAT Desktop Engineering Servicing Assessment

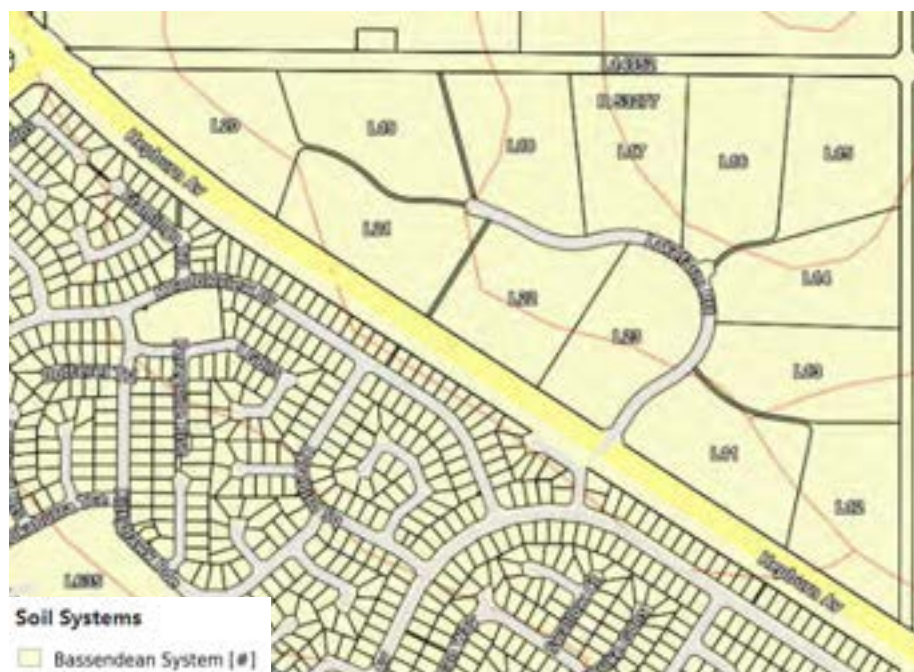
Desktop review of online mapping and consultation with service authorities has determined that urban development of lots 11 – 23 Lakefarm Retreat, Ballajura is technically feasible. Existing site conditions and nearby services provide for swift development with minimal engineering headworks required. Please refer below for a breakdown of the different site components and services which considered approximately 750 lots:

1 Local Government – City of Swans

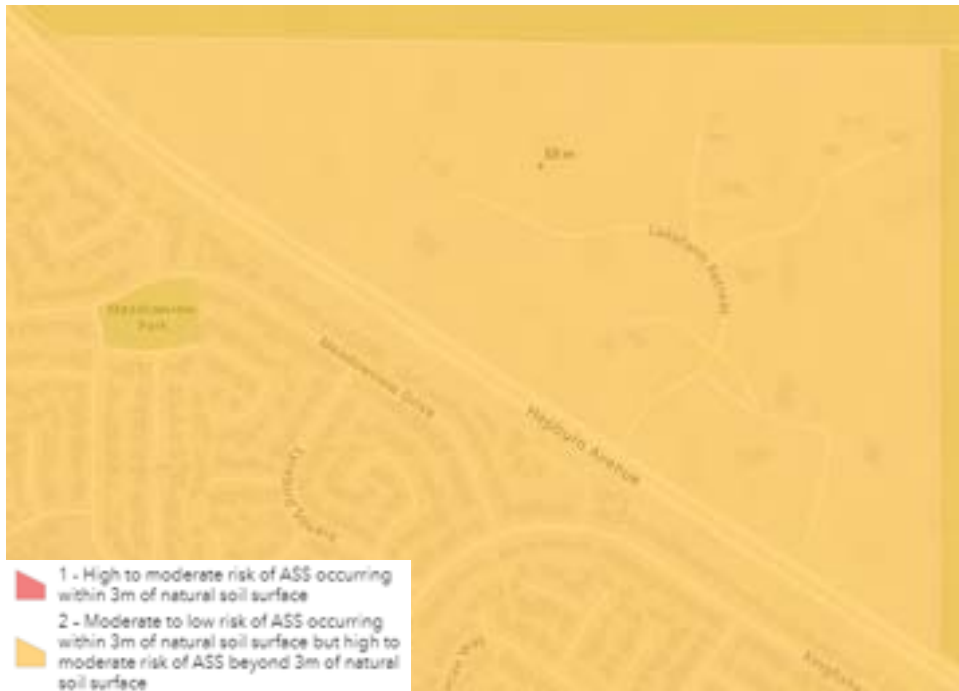
- Lots 12 - 23 Lakefarm Retreat are zoned General Rural under Town Planning Scheme 17.
- MRS Zoning Rural – Water Protection.
- Design of earthworks, roadworks and drainage shall adhere to the City of Swan's specifications and standards.

2 Geotechnical / Environmental

- The Perth 1:50 000 Environmental Geology sheet indicates that the site is part of the Bassendean Sand system meaning free draining and well graded soils.
- Galt Geotechnics have conducted site works and confirmed the site consists of sand to a maximum investigation depth of 3m with a thin lens of coffee rock found at depths between 1-2.5m. Based on these findings, a preliminary site classification as "Class A" has been confirmed.
- No site remediation or significant earthworks are required and therefore the site is immediately ready for development from a geotechnical perspective.



- Acid Sulphate Soils (ASS) mapping categorises the site as Moderate to Low Risk. ASS testing should be conducted on site to aid management through construction.



- Multiple Use category wetland bisects the site representing a former waterway however, no surface water is present when reviewing current aerial imagery. This category of wetland can be developed to an urban standard.
- Conservation and Resource Enhancement wetlands are present and cannot be developed. Wetland management advice is to be sought from an environmental consultant.



- Bushfire Prone Areas are found throughout the site and along the northern boundary. Bushfire management plan is to be prepared to assess clearing of vegetation, Bushfire Attack Levels (BAL) to future urban lots and emergency access/egress.



3 Earthworks

- The site areas total to approximately 53ha and comprise of a homesteads, grass cover and trees.



- The site mostly undulates between 38m AHD to 37m AHD with a low trough through the middle of the site that follows the overland drainage path to 36m AHD.



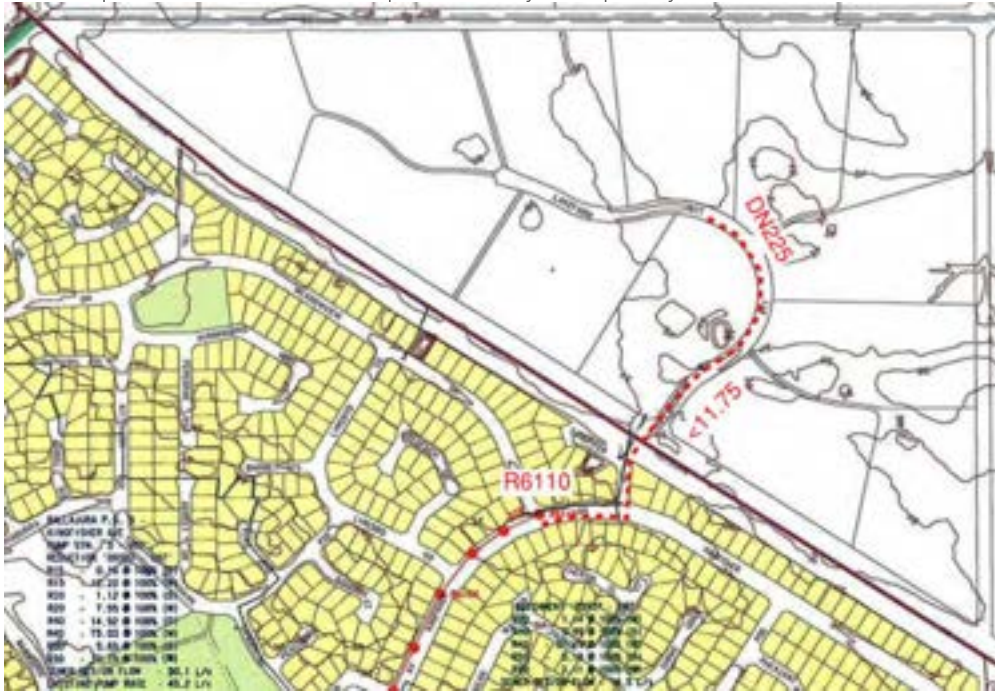
- Maximum groundwater levels range from 36m AHD to 34m AHD (2 – 2.5m below surface level) according to DWER mapping. However, groundwater monitoring bores installed by Hyd2o depicts greater separation from surface to groundwater of greater than 3m.
- Water Corporation have two groundwater bores north of the site, each with 300m wellhead buffer zones. Proximity to these bores results in the site being classified P2 in accordance with DWER.



- Minor earthworks (cut to fill balance) expected for the purposes of overland drainage flow.

4 Sewer

- The proposed development results in an overall wastewater flow rate of approximately 11 L/s suitable for a DN225 pipe.
- Water Corporation initial planning advice confirmed the nearby Ballajura wastewater network had spare capacity. Existing access chamber R6110, approximately 200m from Lakefarm Retreat, is deemed the connection point.
- Mechanical and electrical upgrades may be required for Kingfisher Avenue Pump Station as flow rates increase through the development timeline. Water Corporation are yet to quantify this information.



5 Water

- Probable Simultaneous Demand for the proposed development equals a flow rate of approximately 51 L/s
- Water Corporation initial planning advice shows the existing DN200 reticulation mains can be extended from Marangaroo Drive and Kingfisher Avenue to create a loop to service the site.



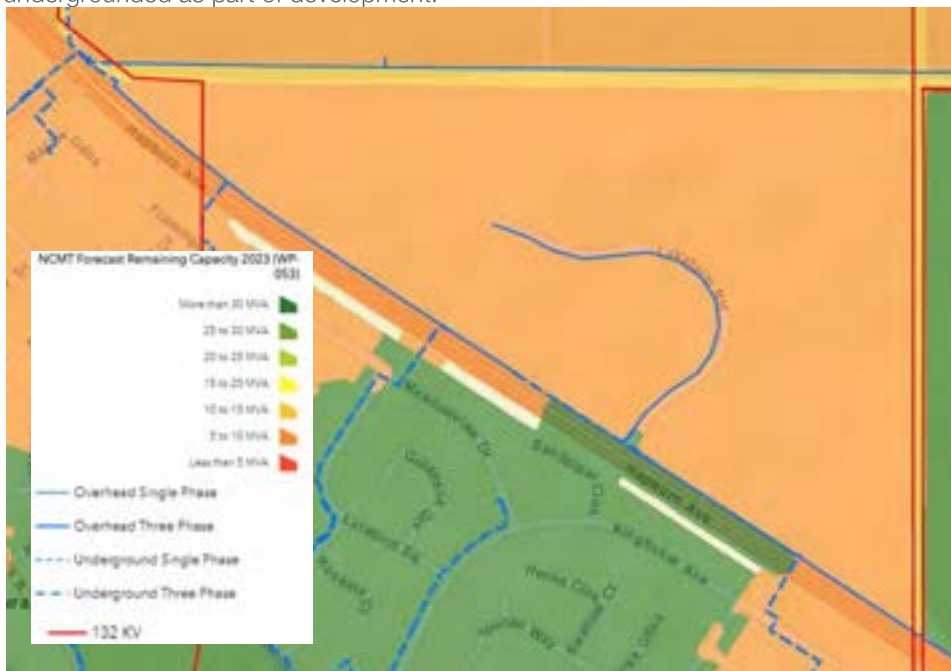
6 Drainage

- An open drain extends flows in from the north and out to the east via two drainage easements. There is no standing water in this drain due to the groundwater levels and sandy soils.
- The first flush and minor storm (5% AEP) event shall navigate to drainage basins within POS via a pit and pipe system. The roads shall be graded such that the major storm event (1% AEP) is conveyed the POS via overland flow. Basin sizing shall occur at the LWMS stage.
- Initial conversations with DWER indicate that given the dry nature of the existing water course, the area could be used to fully detain 100year ARI event and that Water Sensitive Urban Design should apply.



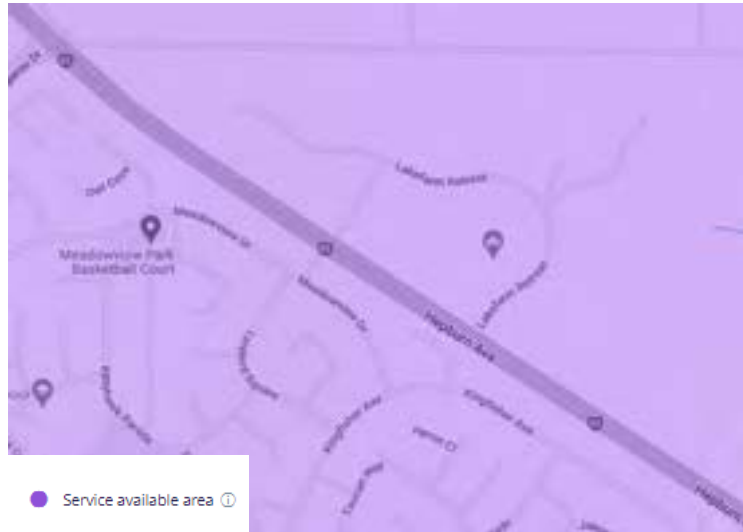
7 Power

- The development is expected to draw approximately 4MVA from Western Power.
- Although the Western Power Network Capacity Tool 2023 pictured below indicates there is between 5 - 10 MVA available, its more than likely network reinforcement is required.
- A Design Information Package has been lodged with Western Power to commence master planning.
- 132kV overhead line traverse the eastern and western sides of the site and will constrain the site development layout if relocation is to be avoided due to time and cost.
- HV power is present to the west, north and south and offer possible connection points. Overhead powerline will need to be undergrounded as part of development.



8 Communications

- NBN Co mapping depicts Fixed Line service is available to Lakefarm Retreat.
- The nearest NBN FTTP estate is approximately 2km northwest (Darling Rise, Lansdale)



9 Gas

- DN80 PVC medium pressure gas main services the existing Lakefarm Retreat dwellings and a DN80 PVC medium low pressure main spans the northern boundary.
- ATCO Gas Asset Planning have confirmed the existing network is sufficient for the proposed development.



10 Traffic & Acoustic

- Vehicle noise generate by Hepburn Avenue exceeds allowable residential noise limits therefore an acoustic noise wall plus quiet homes are required to abate sound.
- Traffic Impact Assessment has been completed by Transcore. The traffic modelling suggests the ultimate development will operate efficiently with a roundabout at the intersection of Lake Farm Retreat and Hepburn Ave and a secondary access/egress point will suffice as Left In/Left Out.

The information contained in this letter is compiled using the following sources:

- Before You Dig Australia
- 1:50 000 Environmental Geology
- City of Swan Intramaps
- Perth Groundwater Atlas
- Water Corporation ESInet
- Western Power Network Capacity Tool
- NBN Co Rollout Map

Yours sincerely

A handwritten signature in black ink, appearing to read 'Chris Clay'.

Chris Clay
Associate - Civil
Perth

APPENDIX M
UNDO Nutrient Modelling
Post Development



Project: Lakefarm Ballajura DWMS Post Development Date: 7/10/2024
Version: Version 1.2.0.19289

Subregion name: Lots & POS

Landuse	Percent (%)	Area (ha)	Input load		Total area (ha)	Total percent (%)
			Nitrogen (kg)	Phosphorus (kg)		
Residential	72	31.23	733.70	214.94	43.38	81
Industrial, commercial & schools	0	0.00	0.00	0.00		
Rural living	0	0.00	0.00	0.00	1189.49	230.13
Public open space	28	12.15	228.94	8.68		
Road reserve	0	0.00	0.00	0.00	112.70	8.00
					Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
					1189.49	230.13
					Nitrogen export (kg/yr)	Phosphorus (kg/yr)
					112.70	8.00

Residential

Size (m ²)	Percent (%)	Area (ha)	Input load		Total area (ha)	Total percent (%)
			Nitrogen (kg)	Phosphorus (kg)		
<400	100	31.23	733.70	214.94	31.23036	72
400-500 m ²	0	0.00	0.00	0.00		
501-600 m ²	0	0.00	0.00	0.00	733.70	214.94
601-730 m ²	0	0.00	0.00	0.00		
>730 m ²	0	0.00	0.00	0.00	733.70	214.94
Multiple dwellings	0	0.00	0.00	0.00		
					Nitrogen input (kg)	Phosphorus input (kg)
					733.70	214.94

Public Open Space (POS)		
Landuse	Percent (%)	Area (ha)
Native gardens	35	4.25
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	50	6.07
Sport	5	0.61
Recreation	5	0.61
Golf course	0	0.00
Bowling green	0	0.00
Impervious	5	0.61
Water body	0	0.00

Total area (ha)	Total percent (%)
12.15	28

Nitrogen input (kg)	Phosphorus input (kg)
228.94	8.68

Soil and drainage information

Type of drainage	Infiltration	Does it contain imported fill? No
Soil type	Bassendean	Does subregion contain onsite sewage disposal system? No
Depth to groundwater (m)	2	
Groundwater slope (%)	0.5	
Soil PRI	5.0	

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Roads**

Landuse	Percent (%)	Area (ha)	Input load		Total area (ha)	Total percent (%)
			Nitrogen (kg)	Phosphorus (kg)		
Residential	0	0.00	0.00	0.00	10.17	19
Industrial, commercial & schools	0	0.00	0.00	0.00		
Rural living	0	0.00	0.00	0.00	295.37	32.51
Public open space	0	0.00	0.00	0.00		
Road reserve	100	10.17	242.15	30.98	18.86	1.68

Road reserve

Landuse	Percent (%)	Area (ha)	Total area (ha)	Total percent (%)
Road reserve - impervious	30	3.05		
Road reserve - native garden	5	0.51	242.15	242.15
Road reserve - non-native garden	0	0.00		
Road reserve - turf	20	2.03		
Road reserve - not fertilised	5	0.51		

Soil and drainage information

Type of drainage	Piped drainage	Does it contain imported fill? No
Soil type	Bassendean	Does subregion contain onsite sewage disposal system? No
Depth to groundwater (m)	2	
Groundwater slope (%)	0.5	
Soil PRI	5.0	

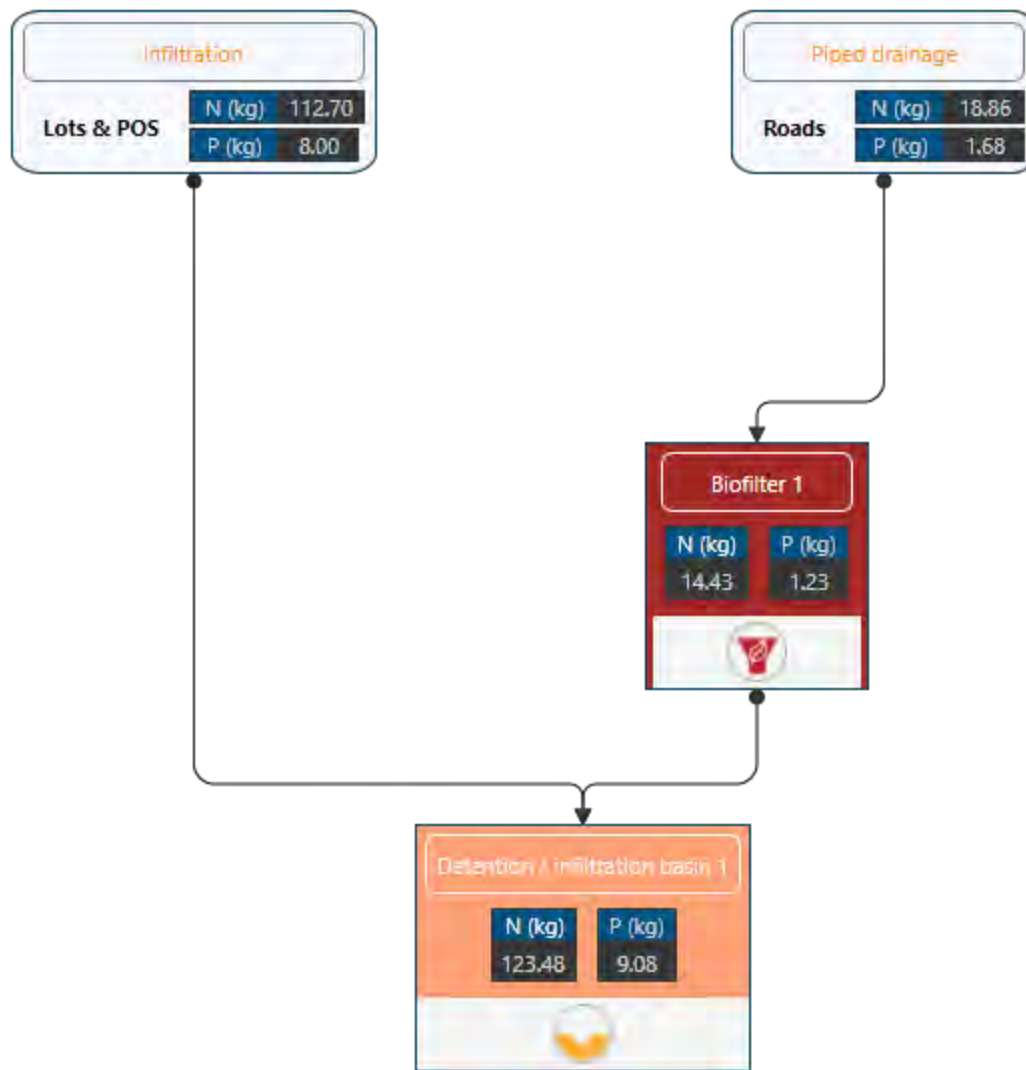
Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices						
Treatment	Name	Size (m²)	Treated area (ha)	Treating	N removed (kg/yr)	P removed (kg/yr)
Biofilter	Biofilter 1	3984.00	10.17	Sandy soils – Runoff only (infiltration on lots)	4.43	0.45
Detention / infiltration basin	Detention / infiltration basin 1	11372.00	53.55	Sandy soils – Runoff only (infiltration on lots)	3.65	0.15
Load removed					8.08	0.60
Net export					123.48	9.08

Summary: Nutrient load exports			
Region	Area (ha)	P export (kg/yr)	N export (kg/yr)
Lots & POS	43.38	8.00	112.70
Roads	10.17	1.68	18.86

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
131.56	9.68	8.08	0.60	123.48	9.08

Treatment diagram





Lakefarm Retreat Ballajura
District Water Management Strategy

January 2025



Client: Land Group WA

8. References

23

Appendices

APPENDIX A	DWMS Checklist
APPENDIX B	Geotechnical Report
APPENDIX C	Hyd2o Bore Logs & Survey
APPENDIX D	Historical & Current Surface Water Plates
APPENDIX E	DWER Bore Long Term Hydrographs
APPENDIX F	Pre-Development Groundwater Level Monitoring Data
APPENDIX G	UNDO Nutrient Modelling Pre-Development
APPENDIX H	Groundwater Quality Summary Results
APPENDIX I	Laboratory Reports
APPENDIX J	CURRV Runoff Calculator
APPENDIX K	Stormwater Modelling Outputs
APPENDIX L	Engineering Servicing Report
APPENDIX M	UNDO Nutrient Modelling Post Development
APPENDIX N	Risk Assessment

Figures

FIGURE 1	Location Plan
FIGURE 2	Concept Structure Plan
FIGURE 3	Site Conditions Plan
FIGURE 4	Geotechnical Plan
FIGURE 5	Environmental Plan
FIGURE 6a	Gnangara UWPCA Boundary
FIGURE 6b	Public Drinking Water Source Plan
FIGURE 7	Surface Water Plan
FIGURE 8	Groundwater Plan
FIGURE 9	Stormwater Management Plan

Tables

TABLE 1	Urban Water Management Planning Process
TABLE 2	Permeability Test Results (Galt Geotechnics, 2024)
TABLE 3	DWER Monitoring Bore AAMGL
TABLE 4	Site AAMGL
TABLE 5	Groundwater Physiochemical and Nutrients Summary
TABLE 6	Groundwater Metals Summary
TABLE 7	Design Principles and Objectives
TABLE 8	Existing Groundwater Licences
TABLE 9	Stormwater Management Summary
TABLE 10	Pre and Post Development Water Balance
TABLE 11	Pre Development Monitoring Program
TABLE 12	Implementation and Responsibilities

Disclaimer

This document is published in accordance with and subject to an agreement between Hyd2o and the Client for whom it has been prepared, and is restricted to those issues that have been raised by the Client in its engagement of Hyd2o. It has been prepared using the skill and care ordinarily exercised by hydrologists in the preparation of such documents. Hyd2o recognise site conditions change and contain varying degrees of non-uniformity that cannot be fully defined by field investigation. Measurements and values obtained from sampling and testing in this document are indicative within a limited timeframe, and unless otherwise specified, should not be accepted as conditions on site beyond that timeframe. Any person or organisation that relies on or uses the document for purposes or reasons other than those agreed by Hyd2o and the Client does so entirely at their own risk. Hyd2o denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this document for any purpose other than that agreed with the Client.

Executive Summary

This District Water Management Strategy (DWMS) has been prepared by Hyd2o on behalf of Land Group WA in support of the Metropolitan Region Scheme (MRS) rezoning of Lots 11 to 23 Lakefarm Retreat, Ballajura (herein referred to as the site).

The site is located within the City of Swan and approximately 13 km north of the Perth CBD.

The proposed rezoning of the site and its indicative concept plan have considered the opportunities and constraints of the existing environment and used this information to inform the development of this document.

The site is generally characterised as having sandy permeable soils with moderate to low Acid Sulphate Soils (ASS) risk. The maximum groundwater level according to the DWER online Perth Groundwater Map and current monitoring program is identified to be several meters below the natural surface across most of the site and suitable for stormwater infiltration. The site contains a mapped multiple use wetland crossing the site from north to east which is not a constraint to development and a resource enhancement wetland at its western boundary. This area has been appropriately used to inform the indicative site plan, and the water management strategy detailed in this document.

The site is currently classified as a Public Drinking Water Source Priority 2 area. This classification will require reclassification to P3*, which Hyd2o understands is a decision of the Department of Planning Lands & Heritage based on a government led strategic planning assessment and greater public good decision-making process.

This document provides an integrated total water cycle management approach to the rezoning application, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, nutrient and groundwater management strategy and a plan for implementation. The document provides a clear direction for future planning in terms of adopting best management practices to achieve water sensitive design based on existing site conditions and protect environmental assets.

The DWMS has been prepared in accordance with the principles, objectives, and criteria of Better Urban Water Management (BUWM) (Western Australian Planning Commission, 2008), and also addresses additional requirements of the Department of Water and Environmental Regulation's Priority 3* (P3*) Areas, Water Quality Protection Note 38 (DWER, 2018)

Implementation of the strategy will be undertaken in accordance with BUWM through the development and implementation of a local water management strategy (LWMS) to support the local structure planning process, and urban water management plan's (UWMP's) at the subdivision stage of development.

1.2 Key Documents

Key water management planning documents used to guide the development of this DWMS include:

- Stormwater Management Manual for Western Australia (DWER,2022a)
- Draft State Planning Policy 2.9 Planning for Water (WAPC, 2021a)
- Draft State Planning Policy 2.9: Planning for Water Guidelines for the implementation of Stage Planning Policy 2.9 Planning for Water (WAPC, 2021b)
- Priority 3* (P3*) Areas, Water Quality Protection Note 38 (DWER, 2018)
- Decision Process for Stormwater Management in WA (DoW, 2017)
- Guidelines for District Water Management Strategies (Department of Water, 2013)
- Better Urban Water Management (Western Australian Planning Commission, 2008)

3. Water Management Principles and Objectives

Key design principles and criteria used to formulate the water management strategy for the site are shown in Table 7 and have been established consistent with the key reference documents previously detailed in Section 1.2, and reflect the sites constraints and opportunities identified in Section 2.

Table 7: Design Principles and Objectives

Strategy Elements	DWMS Method and Approach
Water Use Sustainability	
Water Efficiency	<ul style="list-style-type: none"> Water efficiency implementation to be consistent with Building Codes of Australia requirements. Establish "Waterwise" Public Open Spaces and landscaping. Maximise infiltration and retention of stormwater within the site.
Water Supply	<ul style="list-style-type: none"> Water Corporation IWSS for lots, rainwater tanks (non-mandated) Minimise use of scheme water for non-drinking purposes. Use of groundwater for POS irrigation.
Wastewater	<ul style="list-style-type: none"> Water Corporation reticulated sewerage.
Stormwater	
Ecological Protection	<ul style="list-style-type: none"> Application of best management practices Avoidance of land uses in compliance with DWER (2017) for P3* areas Use of infiltration systems at lot scale to infiltrate 15mm on site. Establishment of biofiltration area for treatment and infiltration of first 15mm road runoff within POS and road reserves.
Serviceability	<ul style="list-style-type: none"> Piped drainage system sized to convey 20% annual exceedance probability (AEP) event. 20%AEP event to be infiltrated/managed within POS area.
Flood Protection	<ul style="list-style-type: none"> Overland flow paths within road reserves for safe conveyance of flows exceeding pipe drainage system capacity. 1%AEP event to be infiltrated/managed within POS area, with potential use of downstream existing drains for off-site discharge if required. Establish minimum habitable floor levels at 0.5m above the 1%AEP flood level. All stormwater to be infiltrated within a period not exceeding 96hrs to prevent mosquito and midge breeding.
Groundwater	
Fill & Subsoil	<ul style="list-style-type: none"> Cut and fill earthworks and subsoil (if required) to minimised fill importation
Acid Sulphate Soils	<ul style="list-style-type: none"> If required, any management of Acid Sulphate Soils to be handled as a separate process consistent with DoE (2004) requirements and reported in future water management documents.
Implementation	
Process	<ul style="list-style-type: none"> Future stages of planning and post development monitoring consistent with BUWM (WAPC, 2008).

5. Stormwater Management Strategy

Stormwater management at the site will be undertaken in accordance with Better Urban Water Management (WAPC, 2008), DWER's **Priority 3* (P3*) Areas, Water Quality Protection Note 38 (2018)**, the City of Swan's principles for water quality management, and the Stormwater Management Manual for Western Australia (DWER, 2022), and will be conducted consistent with water sensitive design practices.

The system will broadly consist of at source lot infiltration systems, piped road drainage, distributed biofiltration areas, and stormwater storage areas and swales in POS aimed at retaining, treating, and maximising infiltration within the site.

Best management practices suited to the site to be implemented at lot, street and estate scale include:

- **Lot Scale:** infiltration systems, water-wise landscaping, rainwater tanks.
- **Street Scale:** piped stormwater conveyance system with bottomless manholes.
- **Estate Scale:** Ephemeral biofiltration and flood storage areas integrated with POS, use of amended soils and plantings in bioretention areas, monitoring and reporting.

The location of all estate scale stormwater management areas are proposed to be located outside of CCW buffer areas and retained vegetation within the proposed conservation POS areas, with due consideration of the sites existing topography and historical flow paths.

5.1 Stormwater Management

Although an MRS Amendment does not typically require a structure plan level of detail, the implementation of the above strategy on an indicative concept plan for the site (Figure 2) has been performed for this DWMS to inform the approximate location, area, and volume for stormwater management based on preliminary modelling.

This modelling has been undertaken to provide proof of concept and inform an agreed approach to stormwater management post development and will be refined as part of the LWMS and local structure planning process and UWMP.

Preliminary stormwater storage design was undertaken using the infiltration modelling program PONDS. This numerical infiltration model is specifically designed for modelling groundwater-surface water interactions for the design of stormwater infiltration areas, based on finite difference computer program MODFLOW, developed by the US Geological Survey.

The design storms modelled by PONDS were calculated internally by the model with reference to the methodology in Australian Rainfall & Runoff (AR&R) (Institution of Engineers, Australia 2016) and the Bureau of Meteorology Computerised Design IFD Rainfall System. The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 1 to 72 hours.

Key stormwater modelling runoff parameters are shown in Table 9. These rates have been based on Hyd2o's CURRV Runoff Calculator (Appendix J). Hyd2o's CURRV runoff calculator is a standardised approach used by Hyd2o across all development projects to estimate runoff rates. In estimating runoff rates CURRV considers rainfall IFD's, land use breakdown, percentages of impervious and pervious areas within land use type and likely initial and continuing loss of soil types. Importantly it also considers Book 5 Chapter 3 of Australian

6. Risk Assessment

DWER (2018) provides additional recommendations above WAPC (2008) requirements to be considered in the development of water management strategies and plans for P3* areas. These recommendations as specified in DWER (2018) as follows:

- Early DWER involvement in the planning process to maximise the potential to protect drinking water quality and public health
- Exclusion of the following land uses within P3* Areas : airport, amusement park, aquatic centre (unless backwash disposed to reticulated sewerage), caravan and park home park, campground (unless connected to reticulated sewerage), cemetery, hospital , education – tertiary and scientific research, golf course, landfill, waste transfer station, recycling depot, light, heavy and rural industry (including dry cleaner), motor vehicle repair, wash, sales and racing, service station, fuel depot, works depot, underground fuel and chemical storage, bulk chemical storage/handling (e.g. warehouse), wastewater treatment plant, ponds, irrigation and managed aquifer recharge (if not treated to drinking water standards).
- Application of best management practices to appropriate land uses.

The recommendations have been considered and implemented within the site to the current stage of planning, with compatible land uses adopted within the indicative concept plan (Figure 2).

A risk assessment evaluating the impacts of the proposed development on the surrounding environment, specifically focusing on water quality, groundwater resources, and the overall integrity of the PDWSA is provided in Appendix N. This risk assessment has been prepared in accordance with the Australian Drinking Water Guidelines (Australian Government ,2022) and DWER's Water Quality Protection Note 77 (DWER,2022).

In this assessment, potential risks related to various development activities, such as land use changes, stormwater management, wastewater disposal, and contamination, are identified and analysed. The aim of the assessment is to ensure that the development does not compromise the ability to protect the drinking water supply and that any risks are adequately mitigated through appropriate management measures and strategies.

The outcome of the risk assessment is to identify key actions to inform the sustainable development of the site in later stages of planning, ensuring alignment with environmental protection guidelines and regulatory frameworks. By evaluating and managing these risks effectively, the development will contribute to the ongoing protection of water quality and availability, while supporting reclassification to a P3* area.

The risk assessment detailed in Appendix N was based on the implementation of the indicative concept plan for the site. This plan is likely to change during the local structure planning phase and refined further in consultation with agencies.

The sites existing risks under current land use are detailed in the Gngangara Underground Drinking Water Source Protection Review (Water Corporation, 2007). This document contains a comprehensive assessment of risks to water quality in the Gngangara Underground Water Pollution Control Area, detailing land uses, hazards, and management strategies to protect the public drinking water source.

The site is identified in Water Corporation (2007) as Precinct 66 (Lakefarm area) and a number of existing hazards to groundwater quality are identified.

These hazards include wastewater management in the area currently relying on septic tanks, which pose a risk of pathogen contamination to the groundwater if not properly maintained. Additionally, the area includes one lot with intensive holding of sheep and another lot with mixed livestock, where animal excreta pose a hazard of pathogen and nutrient contamination of groundwater. Other risks arise from two lots that having citrus orchards, and one lot has large scale plant nursery. The application of fertilisers and pesticides associated with these orchards and nursery pose existing risks of nutrient and chemical contamination to groundwater.

Existing risks for the site under current land use were deemed Medium to High Priority in Water Corporation (2007).

7. Implementation Framework

7.1 Considerations and Requirements for Local Planning

This document supports the proposed amendment to the Metropolitan Region Scheme to rezone the site to Urban. The level of detail provided in this document is consistent with typical district water management strategy requirements and provides a proof of concept for future stormwater management within the site.

A number of additional documents will be required to progress further stages of planning and subdivision/development of the site. Local Water Management Strategy's (LWMS's) will be required for the site to support the preparation of local structure plans. Subject to approval of a relevant LWMS, an Urban Water Management Plan (UWMP) will then need to be prepared as a condition of subdivision. Depending on the staging of development, several UWMP's may be required.

The preparation of these future plans will be consistent with this DWMS, Better Urban Water Management (WAPC 2008), DWER water quality protection notes, and other relevant DWER and City of Swan guideline documents. These documents will demonstrate that the impacts of land use change at the site from a water management view can be readily managed via the WAPC (2008) process.

Key additional information to be reported in the LWMS will include:

- Any additional site geotechnical investigations and reporting, including permeability testing in proposed stormwater management areas.
- Refinement of groundwater mapping based on the additional predevelopment monitoring data.
- Additional survey to confirm key stormwater infrastructure levels and details.
- Detailed engineering earthworks and refinement of post development catchments.
- Detailed stormwater modelling to refine volumes, areas and levels and ensure management and infiltration of stormwater within the site post development within designated areas.
- Refinement of UNDO nutrient modelling based on the final LSP.
- Landscape planning for POS and stormwater management areas, including cross sections showing the interactions of stormwater areas with POS, Reserves, and surrounding areas.
- Develop a post development monitoring program based on predevelopment outcomes, including the establishment of targets.
- Outcomes of continued liaison key agencies and stakeholders.

7.2 Monitoring

7.2.1 Pre Development

No site-specific groundwater monitoring is typically required to support a DWMS.

8. References

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000). National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

Australian Government National Health and Medical Research Council (2022), National Water Quality Management Strategy, Australian Drinking Water Guidelines 6 2011 Version 3.8, Updated September 2022

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), (2016), Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

Davidson, W.A. and Yu, X. (2006), Perth Regional Aquifer Modelling System (PRAMS) Model Development: Hydrogeology and Groundwater Modelling. Department of Water Hydrogeological Record Series. Report no. HG20, September 2008.

Department of Environmental Regulation (2015a) Acid Sulfate Soils Guideline Series: Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes

Department of Environmental Regulation (2015b) Acid Sulfate Soils Guideline Series: Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes

Department of Planning, Lands & Heritage (2018a). Perth and Peel @ 3.5 Million.

Department of Planning Lands & Heritage (2018b). North East Sub-Regional Planning Framework, March 2018

Department of Planning, Lands & Heritage (2022). Perth and Peel @ 3.5 Million Planning Investigation Areas Update, September 2022.

Department of Water (2012). Water Monitoring Guidelines for Better Urban Water Management Strategies and Plans.

Department of Water (2013). Guidelines for District Water Management Strategies.

Department of Water (2017). Decision Process for Stormwater Management in WA

Department of Water & Environmental Regulation (2022a) Stormwater Management Manual for Western Australia.

Department of Water & Environmental Regulation (2022b), Risk Assessment Process for Public Drinking Water Source Areas , Water Quality Protection Note 77, April 2022

Department of Water & Environmental Regulation (2024a, online). Perth Groundwater Map

Department of Water & Environmental Regulation (2024b, online). Water Information Reporting (WIR) System

Department of Water & Environmental Regulation (2024c, online). The Water Register: Licence and Water Availability Information

Department of Water & Environmental Regulation (2018). Priority 3* (P3*) Areas, Water Quality Protection Note 38, October 2018

Department of Water & Environmental Regulation (2018). Land Use Compatibility Tables for Public Drinking Water Source Areas, Water Quality Protection Note 25, August 2021

APPENDIX N
Risk Assessment

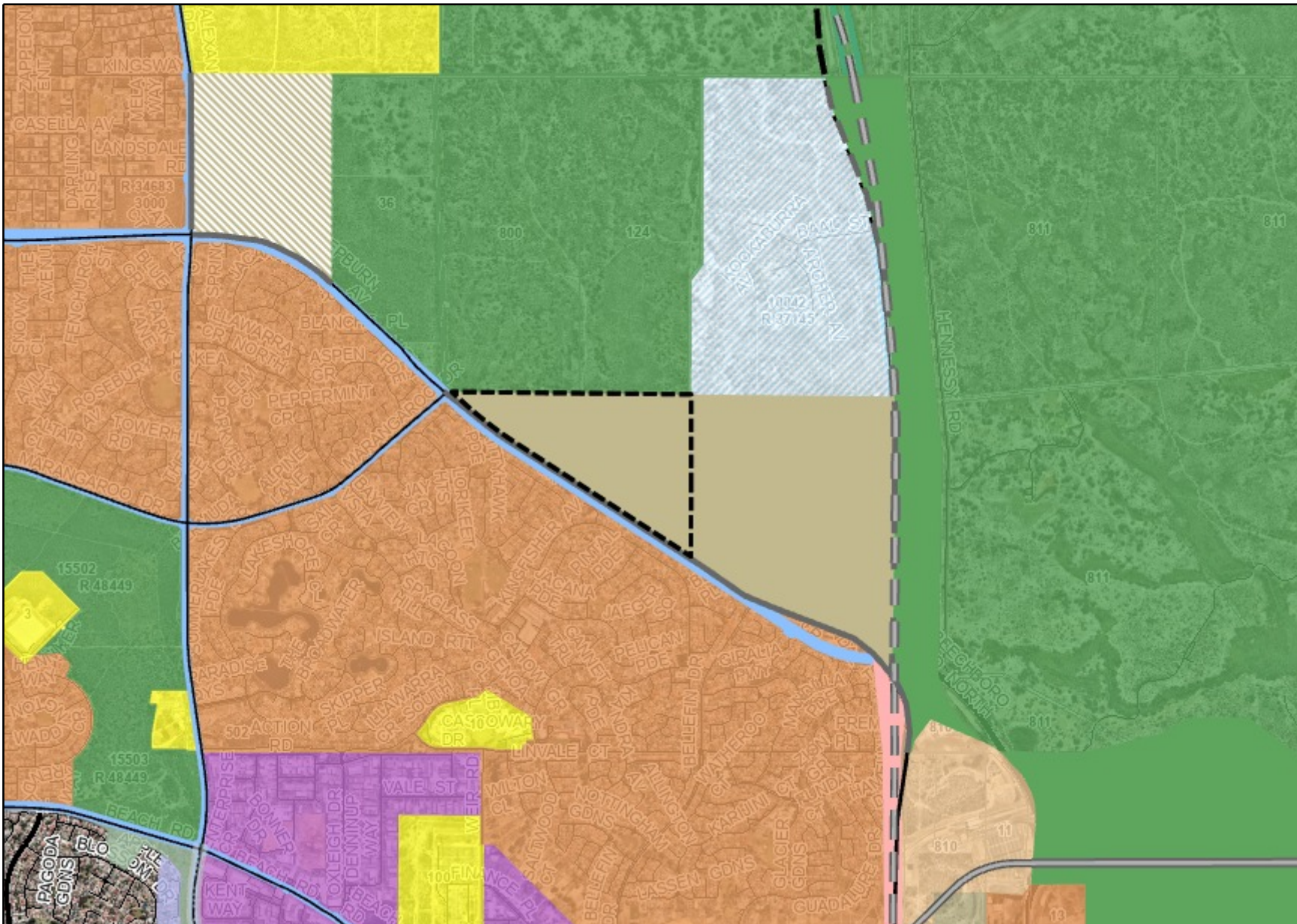
Appendix N : Risk Assessment

	Hazards	Potential Risks to Water Source Quality	Likelihood	Impact	Risk Rating	Mitigation Actions	Residual Risks
Stormwater Management (Planning)	<p>Stormwater runoff and infiltration.</p> <ul style="list-style-type: none"> -Hydrocarbons -Chemicals -Nutrients 	<p>Stormwater with high nutrients and hydrocarbon entering the shallow groundwater system through infiltration.</p>	Likely	Minor	High	<p>Land Use compliant with WQPN 38 (DWER,2018)</p> <p>Adopt best management practice in accordance with Stormwater Management Manual for WA (DWER, 2022a)</p> <p>Implement stormwater treatment measures such as biofiltration swales, and infiltration/detention basins.</p> <p>Ensure use of high performance bio media in biofiltration systems.</p> <p>Locate water quality treatment areas for stormwater (and subsoil if required) outside of WHPZ's where possible.</p> <p>Design of stormwater system to be based on site specific investigations.</p> <p>Kerbs and piped systems to direct and control stormwater flow to biofiltration treatment areas.</p> <p>Ongoing regular maintenance and monitoring to maintain performance.</p> <p>Contingency planning to be established at later stages of planning (LSP stage).</p>	<p>Moderate</p> <p>(note : assessment based on site already exhibiting high nutrient levels under existing land use).</p>
Groundwater Management (Planning)	<p>Lot scale & direct rainfall POS area infiltration.</p> <ul style="list-style-type: none"> -Nutrients 	<p>Diffuse infiltration of nutrients via fertiliser application at lot scale and POS areas increasing nutrients to groundwater system.</p>	Unlikely	Minor	Low	<p>Use of higher density land use to reduce nutrient input.</p> <p>POS locations to be predominately outside of WHPZ's.</p> <p>Retention of existing vegetation in conservation reserves to minimise POS nutrient application.</p>	<p>Low</p> <p>(note : assessment based on site already exhibiting high nutrient levels)</p>

	Hazards	Potential Risks to Water Source Quality	Likelihood	Impact	Risk Rating	Mitigation Actions	Residual Risks
						<p>Extraction bores for POS irrigation to be located considering existing Water Corporation bore locations and outside WHPZ's.</p> <p>Ongoing groundwater level and quality monitoring program to define local conditions.</p> <p>Consideration of groundwater flow direction in the design/location of stormwater management areas.</p>	<p>under existing land use and the mapped groundwater flow direction being away from the existing Water Corp bores).</p>
Wastewater Management (Planning)	<p>Existing & future wastewater system design</p> <p>-Pathogens</p>	Groundwater contamination	Likely (under current land use)	Minor	High	<p>Ongoing groundwater level and quality monitoring program to define local conditions including pathogens.</p> <p>Decommission existing site septic tanks</p> <p>Implementation of reticulated sewerage system connected to existing Water Corporation system south of the site in Ballajura.</p> <p>Location of sewer flow away from WHPZ's (refer engineering servicing report, Appendix L for further details)</p>	Low
Earthworks & Infrastructure Construction	<p>Soil disturbance, clearing & excavation, machinery use.</p> <p>-Hydrocarbons</p> <p>-Chemicals</p>	<p>Contamination from construction materials (e.g., oils, chemicals) infiltrating to groundwater.</p> <p>Disturbance of soil leading to compaction, reduced groundwater infiltration, and increased runoff.</p>	Possible	Minor	High	<p>Ensure that earthworks are carried out in accordance with AS 3798-2007 Earthworks Residential and Commercial Developments.</p> <p>Establish site compound at distance from WHPZ's.</p> <p>Implement erosion control measures such as temporary sediment ponds, and soil stabilisation (where necessary) to control any stormwater runoff during the construction process.</p> <p>Use bunding and spill management systems within site compounds if necessary for storage of any required materials.</p>	Low

	Hazards	Potential Risks to Water Source Quality	Likelihood	Impact	Risk Rating	Mitigation Actions	Residual Risks
						Minimise shallow groundwater exposure. Construction timing near WHPZ's to consider Water Corporation bore operation schedule. Ensure (via testing) permeability of soils maintained consistent with design intent. Contingency plan to be established at later stages of planning for construction management.	
Operation & Maintenance	Fertiliser and pesticide use. Biofilter and stormwater system maintenance -Hydrocarbons -Chemicals -Nutrients	Diffuse infiltration of nutrients via fertiliser application at lot scale and and POS areas increasing nutrients to groundwater system. Performance of biofiltration water quality treatment areas declining with time.	Likely	Minor	High	Provide public awareness information regarding fertiliser use and WHPZ's. Reduce fertiliser use in POS areas via retention of existing vegetation, adopted plantings, and POS landscape design. Post development groundwater monitoring program to be assessed against predevelopment monitoring data to identify trends and triggers for any contingency actions if required. Regular checks on system performance during monitoring to ensure proper maintenance of stormwater treatment and infiltration systems and initiate maintenance actions if required.	Low

- **Phase of Development:** Describes different stages of the development process, from site preparation to ongoing operations.
- **Hazards:** Includes the specific activities or conditions that could potentially cause harm to water quality. It serves as the cause that leads to the Potential Risks in the next column.
- **Potential Risks to Water Quality:** Outlines the primary risks and issues that could arise at each phase of development based on the site conditions (e.g., groundwater levels, nutrients).
- **Likelihood:** Assesses the probability of each risk occurring (Possible, Likely, or Unlikely).
- **Impact:** Describes the severity of the consequences of each risk (Moderate, High, etc.).
- **Risk Rating:** Combines both Likelihood and Impact to assess the overall level of risk posed by a particular issue or hazard. This provides a more comprehensive evaluation of the risk and helps prioritize mitigation measures. It is calculated by considering both the likelihood and the severity of the impact, typically resulting in one of the following ratings: High, Moderate or Low.
- **Mitigation Actions:** Suggests strategies to reduce or manage the identified risks and minimize their impact on the public drinking water source area.
- **Residual Risk** refers to the level of risk that remains after the identified mitigation actions are implemented. Even with the best mitigation strategies, some residual risks might still be present, and these should be addressed through monitoring or contingency measures.



Legend

- Rail - Public Transport (Outcomes)**
 - Passenger Rail - Proposed
 - Passenger Rail - Further investigation
- Existing road (Outcomes)**
- Proposed road (Outcomes)**
- Framework Land Uses (Outcomes)**
 - Urban Expansion
 - Urban Investigation
 - Open Space
- Rail - Public Transport (Plan 1)**
 - Passenger Rail - Proposed
 - Passenger Rail - Further investigation
- High-frequency public transit (Plan 1)**
- Existing Regional Roads (Plan 1)**
 - Primary Distributor
 - Integrator Arterial
- Proposed Regional Roads (Plan 1)**
 - Proposed Primary Distributor
- Existing Region Scheme Road Reserves (Plan 1)**
 - Integrator Arterial - Existing

Notes:

* The data that appears on the map may be out of date, not intended to be used at the scale displayed, or subject to license agreements. The map should only be used in matters related to Department of Planning, Lands and Heritage business.

* This map is not intended for measurement purposes.

Map was produced using DPLH's InQuery.

Sub-regional Framework

DPLH BUSINESS USE ONLY

Aerial photography © Nearmap and/or © Western Australian Land Information Authority (Landgate).
Location information data licensed from Western Australian Land Information Authority (WALIA) trading as Landgate. Copyright in the location information data remains with WALIA. WALIA does not warrant the accuracy or completeness of the location information data or its suitability for any particular purpose.

Internal Spatial Viewer



0 0.78 1.56 Kilometres

1: 36,112 at A4

Projection: WGS 1984 Web Mercator Auxiliary Sphere
Graticules (if visible): GDA 1994 Latitude/Longitude

Date produced: 29-Apr-2025

DRAFT
AMENDMENT REPORT

METROPOLITAN REGION SCHEME
AMENDMENT NO. 14xx
(Standard Amendment)

LAKEFARM RETREAT URBAN PRECINCT

City of Swan

CONTENTS

	The Metropolitan Region Scheme.	.	.	.	.
	Abbreviations	.	.	.	.
1.	Planning Objective	.	.	.	.
2.	Background	.	.	.	.
3.	Discussion	.	.	.	.
4.	Aboriginal Cultural Heritage	.	.	.	.
5.	Coordination of Region and Local Scheme Amendments	.	.	.	.
6.	Substantiality	.	.	.	.
7.	Environmental Protection Authority Advice	.	.	.	.
8.	The Amendment Process	.	.	.	.
9.	Submissions on the Amendment	.	.	.	.
10.	Modifications to the Amendment	.	.	.	.
11.	Final Outcome.	.	.	.	.

Amendment Figure 1

Appendix A	Environmental Protection Authority Advice
Appendix B	List of Detailed Plans Supporting the Amendment
Appendix C	Preparing a submission
Appendix D	Submission Form for this Amendment

**AMENDMENT NO. 14xx TO THE METROPOLITAN REGION SCHEME
(Standard Amendment)**

LAKEFARM RETREAT URBAN PRECINCT

City of Swan

1. PLANNING OBJECTIVE

The purpose of the amendment is to rezone approximately 59ha in Ballajura from the Rural – Water Protection zone to the Urban zone (53.6ha) in the Metropolitan Region Scheme (MRS). The amendment also reserves approximately 3.8ha as Regional Open Space and includes this area in the Water Catchments reserve. The proposed amendment will facilitate future residential development and public open space areas.

2. BACKGROUND

The subject land is located within the City of Swan and is approximately 13km north of the Perth CBD, and 1.2km west of Tonkin Highway and the western boundary of Whiteman Park. The land abuts Hepburn Avenue and is in close proximity to Alexander Drive, Tonkin Highway and existing local roads in the locality. The recently opened Ballajura Train Station is approximately 2.1km to the south-east, Ballajura Community College is approximately 1.2km to the south and the Malaga industrial precinct is approximately 1.6km to the south.

The subject land is a rural-living estate containing 13 lots, comprising single houses, a nursery, and a place of worship, with all properties afforded access from Lakefarm Retreat. Land abutting to the north and east contains Regional Open Space comprising extensive native vegetation. Land to the south-west, across Hepburn Avenue, contains a fully constructed low-density residential development, including single houses, public open space, schools and shopping centres.

The site is located within a Priority 2 (P2) Public Drinking Water Source Area (PDWSA) and if the amendment is approved the priority status will need to be modified to P3*. There are a number of wellhead water extraction bores located nearby, positioned along the government services vehicle access tracks within the adjacent State reserves. The 300m buffer area from two of these nearby extraction bores extend within the amendment area and compatible land uses will need to be considered for these areas.

The subject site contains a REW at the western extent of the site. Two Conservation Category Wetlands are located to the north in close proximity to, but outside of, the subject site.

The vegetation within the site is predominantly Degraded and Completely Degraded, with two small areas rated as Good. There is a high proportion of

introduced species in the area, representative of the low quality of vegetation. None of the species recorded are listed as a Threatened (Declared Rare) or Priority. Bush Forever site 198 abuts the site to the north.

Land use and development within the amendment area is generally controlled by the City of Swan *Local Planning Scheme No. 17* (LPS17). The site is currently zoned General Rural in LPS17.

Concept Plan and Draft District Water Management Strategy

A concept design has been prepared to illustrate how the land might be developed. The key features of the concept plan are as follows:

- Residential dwelling development ranging between R30-R60, proposing a yield of approximately 776 dwellings.
- Retained access from Lakefarm Retreat to Hepburn Avenue, upgraded to a roundabout, and new left-in-left-out access road further west.
- An internal network of roads, with potential linkages to future development at adjacent Lot 810.

Various public open space parcels to protect existing environmental values and to generally allow the existing natural water course drainage through the site.

A draft District Water Management Strategy (DWMS) has been prepared in support of the MRS amendment proposal. Following consultation with the Department of Water and Environmental Regulation (DWER), supplementary updates have been applied to the DWMS in the context of the Public Drinking Water Source Area.

3. DISCUSSION

STRATEGIC CONTEXT

Perth and Peel @ 3.5 Million / North-East Sub-regional Planning Framework

The *Perth and Peel @ 3.5 Million* document provides a snapshot of the Perth and Peel regions in the future. It makes the case for change to a more considered, connected, consolidated urban form. It links four Frameworks and encourages the consideration of new urban growth opportunities. Future areas for urban development have been determined in order to avoid and protect areas which have significant regional environmental value.

The *North-East Sub-regional Planning Framework* identifies the subject land as “Urban Expansion”, following 2023 resolution of the former Planning Investigation Areas.

Therefore, the proposal accords with the principles of urban consolidation in that it is a logical expansion of the surrounding urban area and provides for a more efficient use of the land and the long-term protection of environmental assets.

State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region (SPP 2.8)

SPP 2.8 aims to provide a policy and implementation framework that will ensure bushland protection and management issues are addressed and integrated with broader land use planning and decision-making. In general, the policy does not prevent development where it consistent with policy measures and other planning and environmental considerations.

Vegetation within the site ranges from Degraded and Completely Degraded, with some areas classed as Good. The Good areas will be retained/protected as local public open space. As per DBCA advice, the proponent is required to consider its legislative obligations in relation to native vegetation clearing and Black Cockatoo habitat impacts. The amendment does not propose any changes to the northern adjacent Bush Forever site.

Draft State Planning Policy 2.9 – Planning for Water (Draft SPP 2.9)

Draft SPP 2.9 intends to replace *State Planning Policy 2.2: Gnangara Groundwater Protection* and similarly states that there is a general presumption against the intensification of land uses in P1 and P2 areas, and that proposals will only be considered where land is identified for development through a strategic planning document prepared by the WAPC, such as a sub-regional planning framework.

Draft SPP 2.9 seeks to ensure that planning and development considers water resource management and includes appropriate water management measures to achieve optimal water resource outcomes at the various stages of the planning process.

The site is identified as “Urban Expansion” in *Perth and Peel@3.5 Million/North-East Sub-regional Framework* and therefore consistent with the requirements of Draft SPP 2.9.

The amendment has been assessed against draft SPP 2.9 which provides a range of measures which should be considered including approval of a DWMS and consideration of DWER’s Water Quality Protection Note No. 25: Land Use Compatibility Tables For Public Drinking Water Source Areas which generally restricts sensitive land uses being located within P3* areas.

The DWER has considered the draft DWMS and in accordance with the requirements of Better Urban Water Management will require DWER’s approval prior to a final decision being made on the amendment by the WAPC.

The proponent has prepared a draft DWMS and is currently working with DWER on updates and refinements as well as the parallel process of changing the PDWSA priority level, should the amendment be finalised. The draft DWMS is to be approved by the DWER prior to final decision being made on the amendment by the WAPC.

State Planning Policy 3.0 – Urban Growth and Settlement (SPP 3.0)

SPP 3.0 sets out that the principles, considerations and key requirements for new urban growth and sustainable communities include making the most efficient use of land in urban areas through the use of vacant and underutilised land, and providing a variety and choice in the size, type and affordability of housing in response to housing demand and preference.

The proposed amendment will integrate the subject land with the broader locality, optimise the use of existing urban infrastructure, contribute to the supply of land for housing and provide housing choice in close proximity to the recently completed Ballajura Train Station. The proposed amendment is therefore consistent with SPP 3.0.

State Planning Policy 3.7 - Bushfire (SPP 3.7)

SPP 3.7 forms the foundation for land-use planning to address bushfire risk management in Western Australia. It is used to inform and guide decision-makers, referral authorities and proponents to achieve acceptable fire protection outcomes on planning proposals in bushfire-prone areas.

A BMP has been considered by DFES and changes have been requested which are to be finalised prior to a final decision being made on the amendment by the WAPC.

State Planning Policy 5.4 – Road and Rail Noise (SPP 5.4)

SPP 5.4 seeks to minimise the adverse impact of road and rail noise on noise-sensitive land use and/or development within the specified trigger distance of major transport corridors. The Policy also seeks to protect the functionality of the State's transport corridors by protecting them from encroaching incompatible development.

As Hepburn Avenue abuts the precinct to the south, there is the potential for noise attenuation measures to be required. The exact detail of these matters is capable of being determined at the local structure planning stage, with implementation through conditions of subdivision approval.

STATUTORY CONTEXT

Environment

District Water Management Strategy

DWER has advised that the DWMS requires further hazard identification, improved risk assessment and contingency planning, as well as identifying a number of aspects that should be updated to be consistent with Water Quality Protection Note No. 77 and the *Australian Drinking Water Guidelines*. DWER advises that the DWMS should:

- Include specific procedures and actions for emergency response in case of groundwater or surface water contamination, with a particular focus on sewer installation at this stage, and more detail for other risks provided at later stages.
- Include information about developing and implementing specific education and awareness initiatives focused on PDWSA protection, including community workshops and informational materials.

Threatened Black Cockatoo habitat

DBCA has noted that the EAR outlines that the proposed development could impact on 230 potential black cockatoo breeding trees, 15.75ha of high-quality foraging habitat, and one roosting site.

DBCA recommends that future planning makes every effort to retain black cockatoo habitat. The cumulative impacts associated with the loss of black cockatoo habitat is reducing the amount of habitat and reducing the number of birds that can be supported in the region. Therefore, all remaining resources are significantly important to black cockatoos.

If trees with suitable hollows are identified they must be inspected to ensure that nesting is not occurring. If nesting is occurring, a section 40 authorisation under the *Biodiversity Conservation Act* will be required. Where nesting is occurring, trees are to be demarcated and avoided, until after the cockatoos have naturally completed nesting.

Matters of National Environmental Significance:

There is potential that threatened species and communities listed under EPBC Act may be impacted. Therefore, the proponents may have notification responsibilities under the EPBC Act.

Infrastructure

Water and Wastewater

The Water Corporation has advised, through high-level concept planning, that mains extensions to the nearby reticulated water and wastewater network can service the precinct, and that either construction of a temporary wastewater pump station, or temporary diversion to the nearby Kingfisher Avenue wastewater pump station, would be capable of servicing approximately 500 lots. The Water Corporation has advised that it will undertake more detailed broader strategic water and wastewater planning as MRS amendments for the area (including for adjacent Lot 810) progress, with ultimate wastewater flows for the Lakefarm Retreat urban precinct to be gravitated east towards Lot 810.

Transportation

Comments provided by MRWA, Department of Transport and the Public Transport Authority are more applicable to subsequent planning processes and do not require addressing at this stage.

4. ABORIGINAL CULTURAL HERITAGE

The process of rezoning or reservation of land in a region scheme is broad by nature and does not physically interfere with the land. Consideration of Aboriginal Cultural Heritage is addressed more specifically at later stages of the planning process, typically when preparing a local structure plan or at the subdivision and development approval stages. All Aboriginal Cultural Heritage is protected whether or not it has been previously recorded or reported.

Nevertheless, in recognising the importance of having reliable Aboriginal cultural heritage information, the WAPC and the Department of Planning, Lands and Heritage have entered into a Memorandum of Understanding with the South West Aboriginal Land and Sea Council (SWALSC) for the provision of Aboriginal consultative services. All amendment proposals likely to be of interest to Aboriginal persons are pre-referred to SWALSC for comment. SWALSC is the recognised Native Title Representative Body for Western Australia's southwest region and as such is well placed to provide advice on Aboriginal heritage. The amendment was pre-referred to SWALSC and no response was received. However, the amendment will be formally referred to SWALSC during the public advertising period.

5. COORDINATION OF LOCAL AND REGION SCHEME AMENDMENTS

Under Section 126(3) of the *Planning and Development Act 2005* the WAPC has the option of concurrently rezoning land being zoned Urban under the MRS to a 'Development' zone (or equivalent) in a LPS. In accordance with standard practice a decision on the concurrent LPS amendment will be made after the public submission period.

6. SUBSTANTIALITY

The *Planning and Development (Region Planning Schemes) Regulations 2023* allows for amendments to the MRS to be processed as either complex, standard or basic amendment depending on the alteration to the MRS. This amendment is recommended to be processed as a standard amendment for the following reasons:

- The size and scale of the amendment is not regionally significant and does not reflect a significant change to the strategic planning for the Metropolitan region.
- The amendment site is identified as Urban Expansion in the *Perth and Peel@3.5Million/North-East Sub-regional Planning Framework*.

- Key State Government agencies have not raised any matters which would prevent the initiation and advertising of the amendment

7. ENVIRONMENTAL PROTECTION AUTHORITY ADVICE

{to be inserted after advice received from the EPA}

8. THE AMENDMENT PROCESS

The procedures for amending the MRS are set out in the *Planning and Development Act 2005* (the PD Act) and the *Planning and Development (Region Planning Schemes) Regulations 2023* (the PD Regulations). The amendment proposed in this report is being made under the provisions of sections 35 and 43 of the PD Act and regulation 5 of the PD Regulations.

In essence, the procedure for a standard region scheme amendment involves:

- formulation and initiation of the amendment by the WAPC;
- referral to the EPA for environmental assessment;
- completion of an Environmental Review to EPA instructions (if required);
- public submissions being sought on the proposed amendment (including environmental review if required);
- consideration of submissions;
- approval, with or without any modifications in response to submissions, or refusal to approve, by the Minister; and
- the amendment takes legal effect with Gazettal of the Minister's approval.

An explanation of this process entitled *The Metropolitan Region Scheme, what it is and how it is amended*, can be found in the front of this report.

9. SUBMISSIONS ON THE AMENDMENT

The amendment will be advertised for public submissions for a period of 42 days from the date of gazettal, being Friday, XX XXXX 2025.

You can lodge a submission during the advertising period:

- online at <https://consultation.dplh.wa.gov.au>.
- in writing to Western Australian Planning Commission, Level 2, 140 William Street, Perth 6000.

and must be received by Friday XX XXXXXXXX 2025.

All submissions received by the WAPC will be acknowledged.

For your convenience a submission form for this amendment No. 14XX is attached to this report (Appendix D). Additional copies of the form are available from the Department of Planning, Lands and Heritage website <https://www.dplh.wa.gov.au/mrs-amendments>.

You should be aware that calling for submissions is a public process and all submissions lodged will together become a public document. The document will be published and made available when the Minister for Planning has made a determination on the amendment. Advice of disclosure and access requirements is shown on side two of the submission form.

Before making your submission, it is recommended that you read the information in Appendix C of this report regarding preparing a submission.

10. MODIFICATIONS TO THE AMENDMENT

After considering any submissions received from Government agencies and the public, the WAPC may recommend that the Minister modify the amendment. The Minister may approve the amendment, with or without any modifications in response to submissions, or decline to approve.

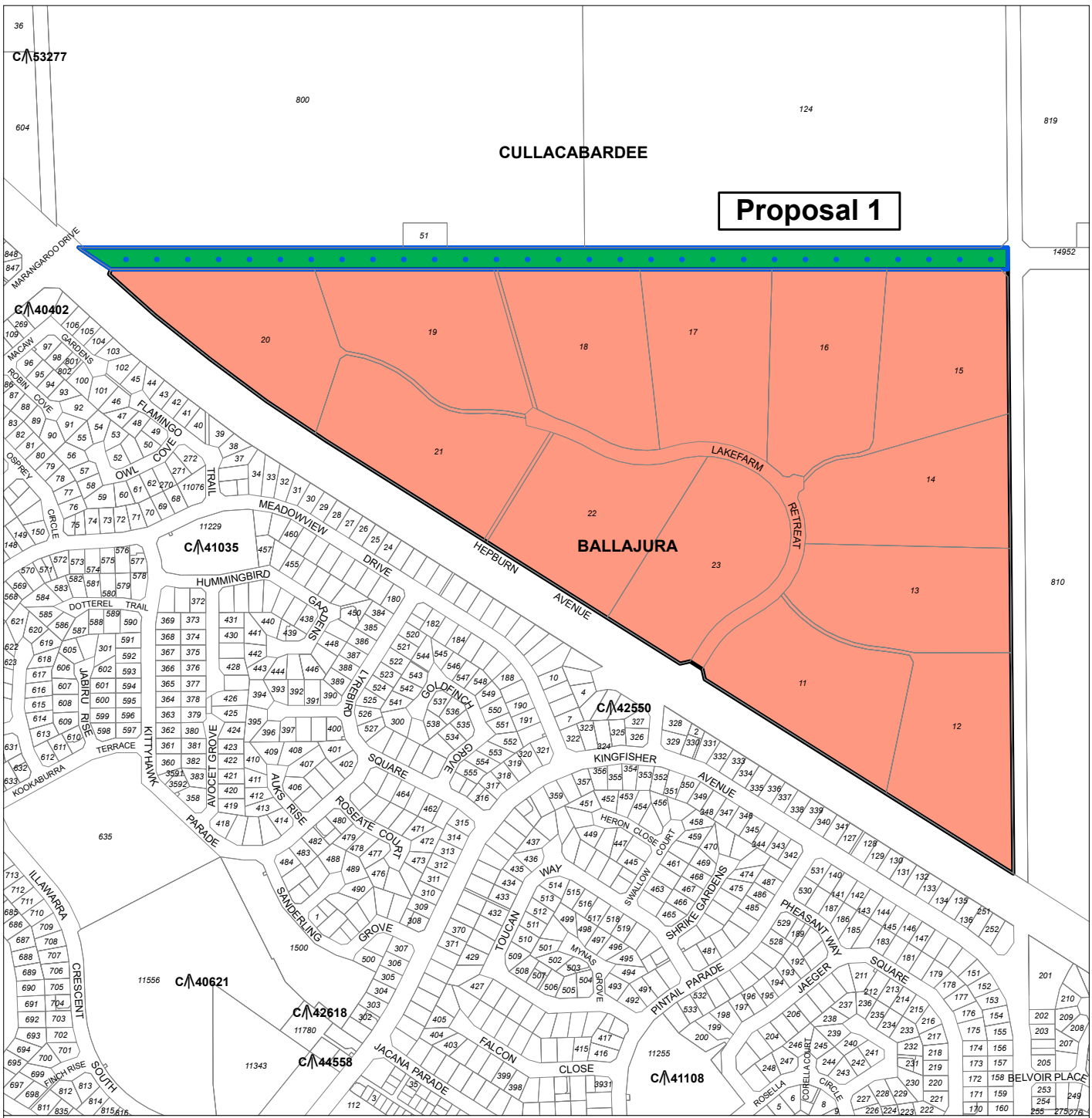
11. FINAL OUTCOME

The recommendations of the WAPC, including any modifications, along with the determination of the Minister, are published in the *Report on Submissions*. Anyone who has made a submission, will be notified of the outcome when the amendment is gazetted to give it legal effect.

LAKEFARM RETREAT URBAN PRECINCT

**AMENDMENT NO. 14XX
(STANDARD AMENDMENT)**

FIGURE 1






Proposal 1

**Lakefarm Retreat, Ballajura
Proposed Standard MRS amendment
as advertised**

28 May 2025

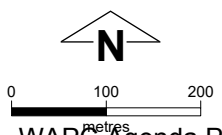
Proposal 1

- Proposed Amendment:
-  Rural - water protection zone to Regional open space reservation
 -  Rural - water protection zone to Urban zone
 -  Water catchments reservation addition

Reference no: 5137
File no: RLS/1165
Version number: 1



Date: 29/04/2025
Produced by Data Analytics, Department of Planning, Lands and Heritage, Perth WA
Base information supplied by Western Australian Land Information Authority SLIP 1447-2023-1





KEY MATTERS COVERSHEET			
REPORT TO	Western Australian Planning Commission		
Meeting date	28 May 2025	File number	RLS/1125 & RLS/1135
Title	MRS Amendments 1427 (Standard) - NE Baldivis DSP - Precinct 1 and 1428 (Standard) - NE Baldivis DSP - Precincts 2 – 4, Recommendation to Minister		
Purpose	For recommendation to Minister		
Head of power	Section 57 of the <i>Planning and Development Act 2005</i>		
Name and title of responsible officer	Rohan Miller – Planning Director, Schemes and Strategies		
KEY MATTERS IDENTIFIED BY THE DEPARTMENT OF PLANNING, LANDS AND HERITAGE			
<p>MRS Amendment 1427 (Standard) – North-East Baldivis District Structure Plan, Precinct 1 (129.04ha) and MRS Amendment 1428 (Standard) - North-East Baldivis District Structure Plan, Precincts 2 - 4 (632.59ha) seek to collectively rezone 760.63ha from the Rural zone to the Urban Deferred zone under the Metropolitan Region Scheme. The purpose of these amendments is to facilitate future residential development and areas for public open space.</p> <p>The amendments were initiated to an Urban Deferred zone as the <i>NE Baldivis District Structure</i> and the District Water Management Strategy required approval. In addition, the resolution of regional road widening, water and wastewater confirmation and buffers around the fish/marron farm and livestock feed lot were required or termination of these uses.</p> <p>The following key matters have been identified by the Department of Planning, Lands and Heritage:</p> <ul style="list-style-type: none"> • whether the amendments are consistent with <i>Perth and Peel @3.5 Million</i> and the <i>North-East Sub-regional Planning Framework</i>; and • whether the WAPC should support the finalisation of these amendments (as advertised) and progress them to the Minister for Planning for final approval. <p>This does not fetter consideration of the proposal by the Western Australian Planning Commission, its Committees or the decision-maker which / who may identify others.</p>			

KEY MATTERS COVERSHEET			
REPORT TO	Western Australian Planning Commission		
Meeting date	28 May 2025	File number	RLS/0123
Title	Improvement Scheme - Redcliffe Station Precinct, City of Belmont - Approval to Advertise		
Purpose	For decision		
Head of Power	Sections 122B and 81 to 84 of the <i>Planning and Development Act 2005</i>		
Name and title of responsible officer	Dale Sanderson – Planning Director, Metro Central		
KEY MATTERS IDENTIFIED BY THE DEPARTMENT OF PLANNING, LANDS AND HERITAGE			
<p>The following key matters have been identified by the Department of Planning, Lands and Heritage:</p> <ul style="list-style-type: none"> • The proposed Redcliffe Station Precinct Improvement Scheme covers 49 hectares and is generally bound by Tonkin Highway, Great Eastern Highway, Coolgardie Avenue and the western boundary of the Perth Airport. • The subject area is predominantly zoned Urban under the Metropolitan Region Scheme with portions of the south-west and north-west boundary reserved Primary Regional Road associated with Tonkin and Great Eastern Highways. • The precinct includes the Redcliffe train station on the METRONET Forrestfield-Airport Link, which opened in October 2022. • <i>Improvement Plan No. 45 – Redcliffe Station Precinct (IP45) was gazetted in December 2022. IP45 provides for the making of an Improvement Scheme to facilitate development of the Scheme Area for a mix of housing, employment and community uses.</i> • <i>The draft Redcliffe Station Precinct No. 1 (draft Improvement Scheme) has now been prepared for consideration by the WAPC.</i> • <i>Following WAPC approval to advertise the draft Improvement Scheme and supporting documentation will be referred to the Environmental Protection Authority, pursuant to section 81 of the Planning and Development Act 2005.</i> • <i>Subject to complying with sections 81 and 82 (if applicable) of the Planning and Development Act 2005, the draft Improvement Scheme and supporting documentation will be submitted to the Minister for approval to advertise pursuant to section 83A of the Planning and Development Act 2005 and in accordance with clause 22 of the Planning and Development (Local Planning Schemes) Regulations 2015.</i> <p><i>This does not fetter consideration of the proposal by the Western Australian Planning Commission, its Committees or the decision-maker which / who may identify others.</i></p>			