



ON-SITE SEWAGE MANAGEMENT ASSESSMENT

PROPOSED REZONING & SUBDIVISION

March 2023

WRENN PTY LTD

Lot 16 DP 856265
225 Terranora Road
Banora Point NSW

HMC2023.305.01

RE: Lot 16 DP 856265, 225 Terranora Road, Banora Point NSW

HMC Environmental Consulting Pty Ltd is pleased to present our report for an On-site Sewage Management Design Report for the abovementioned site.

We trust this report meets with your requirements. If you require further information, please contact HMC Environmental Consulting directly on the numbers provided.

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ABBREVIATIONS

AWTS	Aerated Wastewater Treatment System
BOD ₅	Biochemical oxygen demand over 5-day period
CFU	Colony forming unit.
DLR	Design loading rate
LAA	Land application area
LTAR	Long term acceptance rate (for effluent)
OSSM	On-site Sewage Management
SDI	Subsurface drip irrigation
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids

1 INTRODUCTION & SUMMARY

HMC Environmental Consulting Pty Ltd has been commissioned to prepare an on-site sewage management (OSSM) assessment for a proposed rezoning and subdivision located at Lot 16 DP 856265, 225 Terranora Road, Banora Point, NSW. It is proposed to rezone a portion of the property into R5 and subdivide to create three (3) residential lots and one (1) residual lot.

The planning proposal will result in the creation of four (4) lots with a minimum lot area of approximately 10,000m² in area, three of which are to be for future residential purposes. The fourth lot contains the residual area, primarily for conservation purposes.

The site and soil were assessed for on-site wastewater disposal limitations on each residential lot. Soil investigations were carried out comprising hand auger and/or mechanical excavations in 23 locations. Site walkovers were also carried out by experienced HMC staff on 4/10/2019, 19/11/2019 and 27/5/2021. The soil profile information and site constraints on each residential lot were used to determine the most suitable location and the area needed for disposal of treated sewage effluent.

The investigations recorded strongly structured sandy to silty clay soils with suitable drainage on gentle slopes within all of the nominated effluent land application areas. The investigations also recorded shallow rock at a depth of 400mm as a limiting layer in a few locations, and the presence of uncontrolled fill in the majority of the locations. Boulders and cobbles were encountered at depth. Areas with soil to at least 700mm depth in depth were considered suitable for effluent land application. To provide a vertical buffer of at least 1m to any limiting layer, this report recommends importing 300mm thick layer of loam/sandy loam topsoil to create raised irrigation areas of minimum 400m² within the nominated effluent land application areas on each lot.

To achieve best practice within the constraints of the uncontrolled fill, this report recommends effluent land application via shallow pressure compensating sub-surface drip irrigation installed via ripping to a depth of 100mm. The performance of the flexible dripperline is not impacted by sub-soil movement and is therefore suitable for the proposed raised irrigation beds overlying uncontrolled fill and any large boulders at depths. The pressure compensated emitters deliver the treated effluent directly to the rootzone of the nominated land application area in an efficient and uniform method.

Based on the relevant site information, this report specifies the type of sewage treatment process that is to be used and the resultant wastewater quality. Assuming a design occupancy for a household of five persons, this report specifies a 400m² area for secondary quality effluent with final disinfection. The method of land application is to be shallow sub-surface drip irrigation through pressure compensating dripperline at average 150mm depth below a turfed ground surface.

The native soil of the site may be suitable for fill material subject to compliance with texture classification. A reserve land application area of 200m² would remain unfilled and preserved for future use if the on-site sewage management system were extended or duplicated.

This report concludes that, based on the information presented, the subject site is suitable for the proposed development in relation to on-site sewage management.

2 PROJECT INFORMATION

Proposal	Proposed OSSM System Assessment – 3-Lot Subdivision & Residual Lot			
Lot numbers	Proposed Lot 1	Proposed Lot 2	Proposed Lot 4	Residual Lot
Property	Lot 16 DP 856265, 225 Terranora Road Banora Point NSW			
Proposed Lot Size	10000m ² (1 ha)	10000m ² (1 ha)	21816m ² (2.18 ha)	58709m ² (5.87 ha)
Council Area/Approvals:	Tweed Shire Council <u>DA 0152/2001</u> : The erection of a dwelling house. Submitted: 22/02/2001 <u>DA K99/0355</u> : Rural subdivision 2 lots. Submitted: 23/10/2000 <u>DA D96/0031</u> : Erection of a shed, construct a dam and plant fruit trees. Submitted: 31/01/1996			
Design Daily Hydraulic Load	750L/day 5 persons design occupancy @ 150L/p/day	750L/day 5 persons design occupancy @ 150L/p/day	750L/day 5 persons design occupancy @ 150L/p/day	No building envelope
Water Saving Devices	Expected in new building			
Water Supply	Reticulated roof water supply			

3 SUMMARY OF RECOMMENDED ONSITE SEWAGE MANAGEMENT

Proposed Sewage Treatment and Land Application method for future lots:																	
- Install an NSW Health Accredited Aerated Wastewater Treatment System or Secondary Treatment System with final disinfection - Effluent quality to achieve: <table border="1"> <tr> <td>BOD5</td><td>≤10 mg/L</td><td>20 mg/L</td></tr> <tr> <td>TSS</td><td>≤10 mg/L</td><td>20 mg/L</td></tr> <tr> <td>E.coli*</td><td>≤10 cfu/100mL</td><td>30 cfu/100mL</td></tr> <tr> <td>FAC**</td><td>Minimum 0.5mg/L ***</td><td></td></tr> <tr> <td>Turbidity****</td><td>N/A</td><td>10 NTU</td></tr> </table> * Where disinfection is required. ** Where chlorine disinfection is used. *** Minimum level, not 90% of samples. ****Where UV light is used for disinfection			BOD5	≤10 mg/L	20 mg/L	TSS	≤10 mg/L	20 mg/L	E.coli*	≤10 cfu/100mL	30 cfu/100mL	FAC**	Minimum 0.5mg/L ***		Turbidity****	N/A	10 NTU
BOD5	≤10 mg/L	20 mg/L															
TSS	≤10 mg/L	20 mg/L															
E.coli*	≤10 cfu/100mL	30 cfu/100mL															
FAC**	Minimum 0.5mg/L ***																
Turbidity****	N/A	10 NTU															
- Within nominated land application areas install 400 linear metres of pressure compensated, non-drain dripperline laterals within a raised sub-surface irrigation bed of minimum height of 300mm and minimum area of 400m² with side flanks of 1:3 batter. - Preserve additional 200m² reserve land application area for future use in the event of duplication or expansion of the on-site sewage management system.																	

4 SITE INFORMATION

Should conditions vary from those described below during any stage of installation, HMC is to be notified to ensure the recommendations of this report remain valid or alternative recommendations be made. The information relates to the general site but more specifically to the designated effluent land application areas (LAA) and available reserve effluent LAA.

4.1 SITE CONDITIONS

Inspected by	Helen Tunks, Mark Tunks & Taylah Richards
Date & Time of Inspection	Tuesday 19th November 2019. Thursday 27th May 2021 See Appendix 1 for site location
Site Location	The development site is located on vacant land on a south-facing slope of a broad ridge. The residential areas are located on a large, generally level terrace created by former earthworks. Minimal topsoil remains with the residential area, and the trees have largely been cleared.
Climate	Annual rainfall: 1555mm Tyalgum (1971 – 1984) Annual evaporation: 1000-1200mm/year Warm, temperate. High volume, seasonal rainfall typical of region.
Weather	Weather – Warm, dry during inspections. Surface water noted in depressions during inspection 27/5/2021. 8mm rainfall 72 hours previous according to BOM Station 58056 (Tweed Heads Golf Club).
Soil Investigations	Geotechnical Investigations – 14 test pits by mechanical excavation HMC – 2019: 7 boreholes via hand auger HMC – 2021: 2 boreholes via hand auger
Soil Type & Category	<u>Existing profile:</u> Sandy Clay Loam topsoil overlying Sandy or Silty Clay with rock recorded as a limiting layer ranging from 400mm to more than 1m depth across the site. Cobbles and boulders encountered but did not exceed >20% soil volume and therefore not considered an absolute constraint. Uncontrolled fill with gravels encountered reflecting the soil disturbance on site. <u>Existing profile: Residual Lot (TP8, BH8, BH9)</u> The initial test pit encountered rock at 400mm depth at TP8. An additional investigation by HMC via hand auger confirmed soil depth to 700mm in two locations within the nominated LAA. <u>Amended profile:</u> Soil amendment via placement of a 300mm deep topsoil layer is recommended on all lots to achieve minimum 1000mm vertical buffer to a receiving layer of the native silty/sandy clay soil, rather than the underlying rock. It is recommended to place 300mm of pH neutral Loam/Sandy loam fill to form a raised irrigation area of 400m ² within the nominated LAAs. Soil Category 5 (Table 5.1 AS/NZS1547:2012) See Appendix 4 for soil investigation information.

Environmentally Sensitive Areas	The property is located along the Terranora broad ridgeline and extends southwards down to the Tweed River. Remnant rainforest has been identified on the site.		
Reserve LAA	50% (200m ²) nominated as minimum reserve LAA per Lot for the purposes of conservative design. Reserve LAA may remain unfilled until an extension or duplication of the effluent land application is required.		
Land Application Areas	Proposed Lot 1	Proposed Lot 2	Proposed Lot 3
Terrain	Ridge – upper slope	Ridge – upper slope	Ridge – upper slope
Slope & Drainage:	Gentle - moderate slope grade 10-15% Waxing divergent	Gentle - moderate slope grade 10-15% Linear planar	Gentle - moderate slope grade 10-15% Waxing divergent
Aspect & Shading	Southern aspect Nil shading expected	Eastern aspect Nil shading expected	Southern aspect Nil shading expected
Ground cover/vegetation	100% lawn grass cover to be established	100% lawn grass cover to be established	100% lawn grass cover to be established

4.2 SETBACK DISTANCE RISK ASSESSMENT

The setback distances adopted for this upgrade are those recommended within the following:

- Environment & Health Protection Guidelines – On-site Sewage Management for Single Households (DLG et al. 1998)
- Table R1 of AS/NZS1547: 2012
- Designing and Installing On-site Wastewater Systems (WaterNSW, 2019)

4.3 SITE COMPLIANCE

SITE CONSTRAINTS		Recommended	Complying?
Setback to Boundary	3m across slope	3m	YES
	6m downslope	6m	YES
Setback to Watercourse	>100m to watercourse	>100m	YES
Setback to Water Bore	>250m to nearest registered domestic groundwater bore	250m	YES
Setback to Buildings & Site Features	>3m to buildings	>3m	YES
Reserve LAA	100% available		YES
Slope Gradient	5-10%	<20%	YES
Flood Liability	Nil flood inundation		YES
Water Supply Catchment	Not mapped		YES

5 EFFLUENT TREATMENT & LAND APPLICATION

5.1 TREATMENT PROCESS

The proposed sewage treatment recommended for all of the residential lots is secondary treatment + final disinfection via an Aerated Wastewater Treatment System (AWTS) NSW Health accreditation.

The AWTS provides initial settling, anerobic digestion, aerobic digestion and clarification/disinfection in a one or two tank system, depending on make and model.

The effluent quality expected to be achieved upon discharge is in compliance with NSW Health criteria for Advanced Secondary Effluent in accordance with NSW Health Accreditation Criteria (AS/NZ 1546.3: 2017) as follows:

Table 1 – Effluent Quality Criteria for All Lots – Advanced Secondary Treatment System

Parameter	Advanced secondary effluent	
	90% of Samples	Maximum
BOD5	≤10 mg/L	20 mg/L
TSS	≤10 mg/L	20 mg/L
E.coli*	≤10 cfu/100mL	30 cfu/100mL
Free Available Chlorine (FAC) **	Minimum 0.5mg/L ***	
Turbidity****	N/A	10 NTU
* Where disinfection is required. ** Where chlorine disinfection is used. *** Minimum level, not 90% of samples. ****Where UV light is used for disinfection		

5.2 LAND APPLICATION METHOD

It is recommended that soil is imported to the nominated land application areas to provide a raised irrigation bed to support the installation of sub-surface dripperlines. The recommended subsurface drip line is to be pressure-compensated, non-drain and designed specifically for effluent irrigation. The drip irrigation field is to be installed with emitters and laterals at average 0.8 -1m spacing and buried 100 to 150 millimetres deep.

The finished surface of the raised irrigation area will be lawn grasses, with clumping grasses and scattered low stature shrubs also suitable subject to individual landscaping designs and care taken not to damage the dripperlines. Warning signage will be required in accordance with NSW Health accreditation criteria for the Aerated Wastewater Treatment System.

6 LAND APPLICATION AREA SIZING AND DESIGN

6.1 ASSESSED DESIGN INPUTS

Model Used: Draft Richmond Tweed On-Site Regional Strategy (Alderson, 1999). Daily Time Step	
Climate Data	Tyalgum (1971 – 1984). Mean annual rainfall 1555mm.
Structure	Proposed Lots 1-3: Assumed 3-bedroom dwelling
Design Occupancy	5 persons
Wastewater Design Flow Allowance	150L/p/day
Wastewater Design Hydraulic Load	750L/day
Nitrogen (TN)	3.8 kg/person/year (Whelan & Titammi, 1982)
TN System Nutrient Reduction	Secondary treatment ~55% reduction assumed in AWTS. See Appendix 3.
Vegetation Removal of TN	Conservative rate of 300 kg/ha/year. Note: Kikuyu up to 520kg/ha/year (NSW Agriculture 1997)
Phosphorus (TP)	0.6 kg/person/year (Geary & Gardner, 1996)
Vegetation Removal of TP	20 kg/ha/year (Myers et al 1994)
Phosphorus Adsorption	~10000 kg/ha/ based on field texture and work carried out by Morand, 1996
Maximum Design Irrigation Rate (DIR)	3mm/day for Category 5 soils (Table 5.2, AS/NZS1547:2012)
Proposed DIR	1.9mm/day

6.2 SUMMARY OF MODELLING CALCULATIONS

To provide a realistic assessment of permeability, multiple tests are required. It is considered that the conservative loading rates based on soil texture (AS/NZS 1547:2012) are adequate for design inputs in this case for a domestic situation.

Analyte	Minimum Recommended Land Application Area (LAA) Hydraulic Loading Rate (Q) = 750L/day	
	LAA Modelling Results	LAA Layout
Hydraulic Load	400m ²	400m ² subsurface drip irrigation under lawn. 200m ² reserve LAA has been nominated
Nitrogen (TN)	380m ²	
Phosphorus (TP)	58m ²	
DLR	1.9mm/day	

The nutrient management area of 380m² will be achieved within the proposed LAA, which is limited by hydraulic loading.

7 DISCUSSION/REASON FOR APPROVAL

The site is located along a broad ridge with steep southward sloping land. The proposed residential lots are located on the elevated, generally level land presenting evidence of soil disturbance and loss from prior earthworks, and largely cleared of native vegetation.

To mitigate the constraints of surface rock, uncontrolled fill and large boulders expected at varying depths, the proposed solution is to construct raised subsurface irrigation beds 300mm above ground level.

The raised irrigation bed provides a minimum 1000mm vertical buffer to the restrictive rock layer within the nominated effluent land application areas. The water balance and nutrient modelling demonstrates that the recommended 400m² of raised irrigation bed area demonstrates that this soil depth is sufficient to provide nutrient adsorption and hydraulic uptake for the wastewater generated by future households.

Based on the information presented in this report, it is considered that the recommendations listed below are sufficient to attain an acceptable level of environmental impact from the design wastewater flow generated by the future dwellings on the proposed lots.

8 RECOMMENDATIONS

DESIGN HYDRAULIC LOADING

- | | |
|---|---|
| <ul style="list-style-type: none"> Proposed Lots 1-3 Reticulated water supply | <ul style="list-style-type: none"> Assumed 3-bedroom dwelling 5 persons occupancy |
|---|---|

RECOMMENDED ON-SITE SEWAGE MANAGEMENT SYSTEM

At development approval stage:

- Provide minimum 600m² effluent land application area (LAA) to be provided per dwelling site
- Construct a raised sub-surface irrigation bed of 400m² surface area per dwelling site. The sub-surface irrigation bed is to be raised to a total height of 300mm above the natural ground surface. Perimeter flanks are to be battered at maximum 1 (vertical): 3 (horizontal)
- Fill Material: Loam to Sandy Loam with minimal clay content, and neutral pH
- Soil preparation is essential prior to placement of fill. Vegetation is to be stripped and imported fill material worked/tilled into the native soil to a depth of 200mm as a transitional layer. Compaction should be minimised when installing the bed. The fill must be Loam to Sandy Loam with minimal clay content.
- Bed Surface: Grass (turf) must be established over the raised bed immediately after completing construction.
- An earth bank diversion bund/bank must be constructed upslope of the raised irrigation bed to divert surface water run-on.

At dwelling construction approval stage:

- Install an Advanced Secondary Treatment System (STS) including Aerated Wastewater Treatment System (AWTS) with NSW Health Accreditation to achieve the following effluent quality:

Parameter	Advanced secondary effluent	
	90% of Samples	Maximum
BOD5	≤10 mg/L	20 mg/L
TSS	≤10 mg/L	20 mg/L
E.coli*	≤10 cfu/100mL	30 cfu/100mL
Free Available Chlorine (FAC) **	Minimum 0.5mg/L ***	
Turbidity****	N/A	10 NTU
* Where disinfection is required. ** Where chlorine disinfection is used. *** Minimum level, not 90% of samples. ****Where UV light is used for disinfection		

- Install minimum 400m² shallow subsurface drip irrigation (SDI) with pressure compensated, non-drain, non-siphoning emitters. Dripperline laterals must be buried 100-150mm below the surface of the raised bed. Irrigation design to include hydraulic analysis, pump performance, and specifications for all components including dripperline, filters, air relief and check valves. A full hydraulic design is to be carried out as part of the installation approval at construction stage.
- Retain 200m² for reserve effluent land application area. Reserve LAA may be unfilled provided access remains available for future filling works and the design loading exceeds 750L/day

OPERATION & MAINTENANCE

- DO NOT ALLOW VEHICLES OR STOCK TO ENTER THE LAA.
- DO NOT DISPOSE OF DOWN THE DRAINS: Bleach, bleach-based products, whiteners, nappy soakers and spot removers. Dispose of in the garden in an unused location.
- DO NOT FLUSH DOWN THE SEPTIC SYSTEM: Hygiene products, condoms, tampons, sanitary napkins, disposable nappies and cotton buds.
- DO PRACTICE WATER CONSERVATION.
- DO USE only the recommended amounts of disinfectants and cleaners. Biodegradable products for septic systems are recommended.
- DO MOW & TOPDRESS the LAA regularly to ensure that rainfall is shed from the surface.
- Every 6-12 months: Remove biological effluent filter from within septic tank outlet and dislodge solids back into the main chamber of the septic tank or bury on site at a depth of <300mm. Wear gloves to avoid contact with effluent.
- Every 3-5 years: Engage a licensed liquid waste contractor to pump out septic tank to remove sludge and scum build up.

8.1 SITE PLAN & DETAIL

SEE FOLLOWING PAGES

ONSITE SEWAGE MANAGEMENT FEASIBILITY

LEGEND

- Site Boundary
- Proposed R5 Zone
- Available Effluent Land Application Area (600m²)
- Nominated Development Envelope
- Contour lines - 1m intervals

GEOTECHNICAL/SOIL INVESTIGATIONS

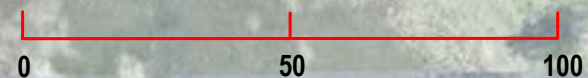
- HMC - 19.11.19 (Constrained by shallow limiting layer)
- Geotech Investigations 21.12.18 (Constrained by shallow limiting layer)
- Geotech Investigations 21.12.18 (Silty Clay - Suitable for LAA)
- HMC 27.05.2021 (Limiting layer >700 deep - Suitable for LAA)



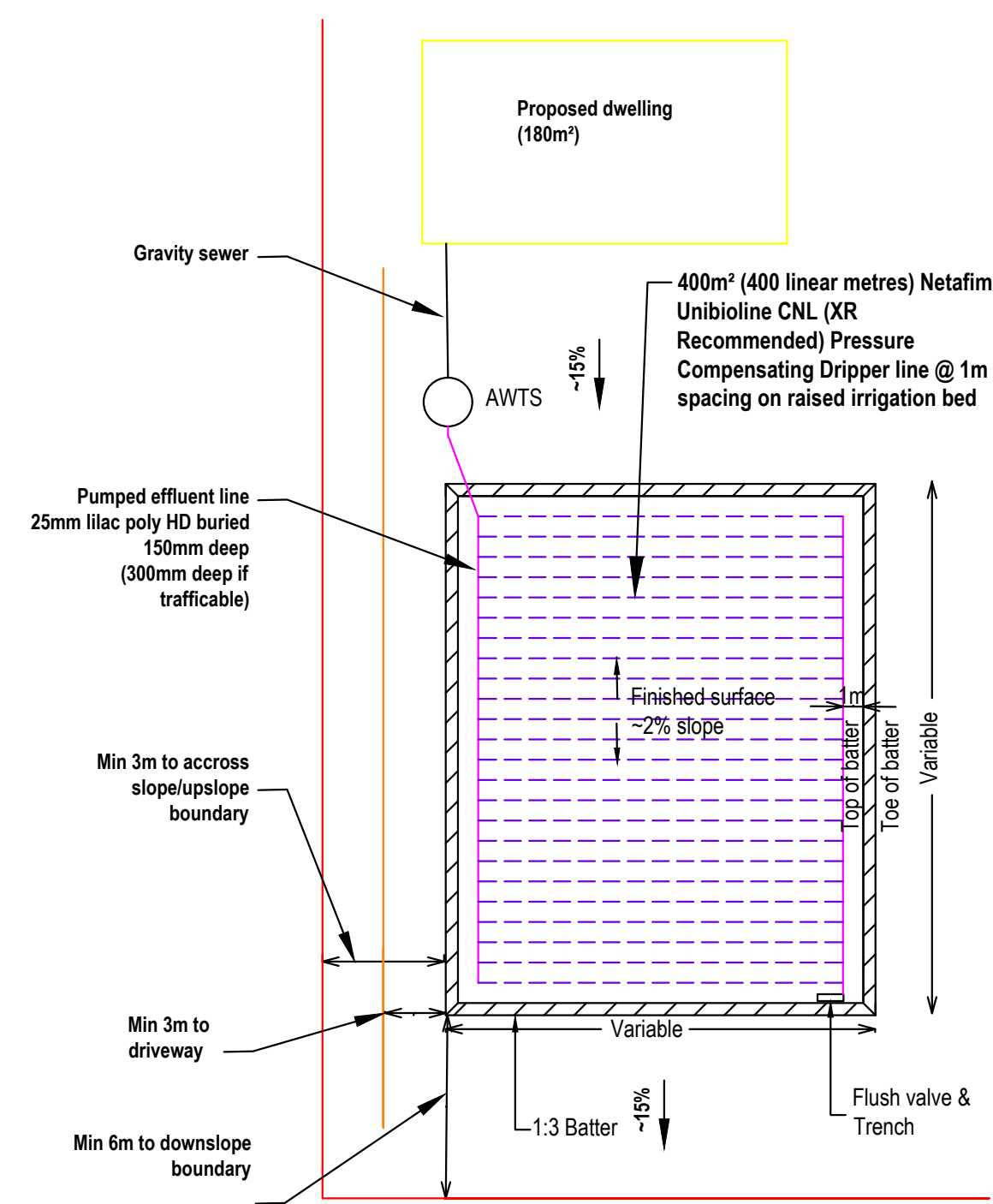
Job: HMC2023.305.01
DWG: HMCDWG2023.305
Date: March 2023
Revised: 31/03/2023
Drawn: KH
Base: Concept Plan Rev04
(Planit Consulting)

Lot 16 DP856265
225 Terranora Road
Banora Point NSW

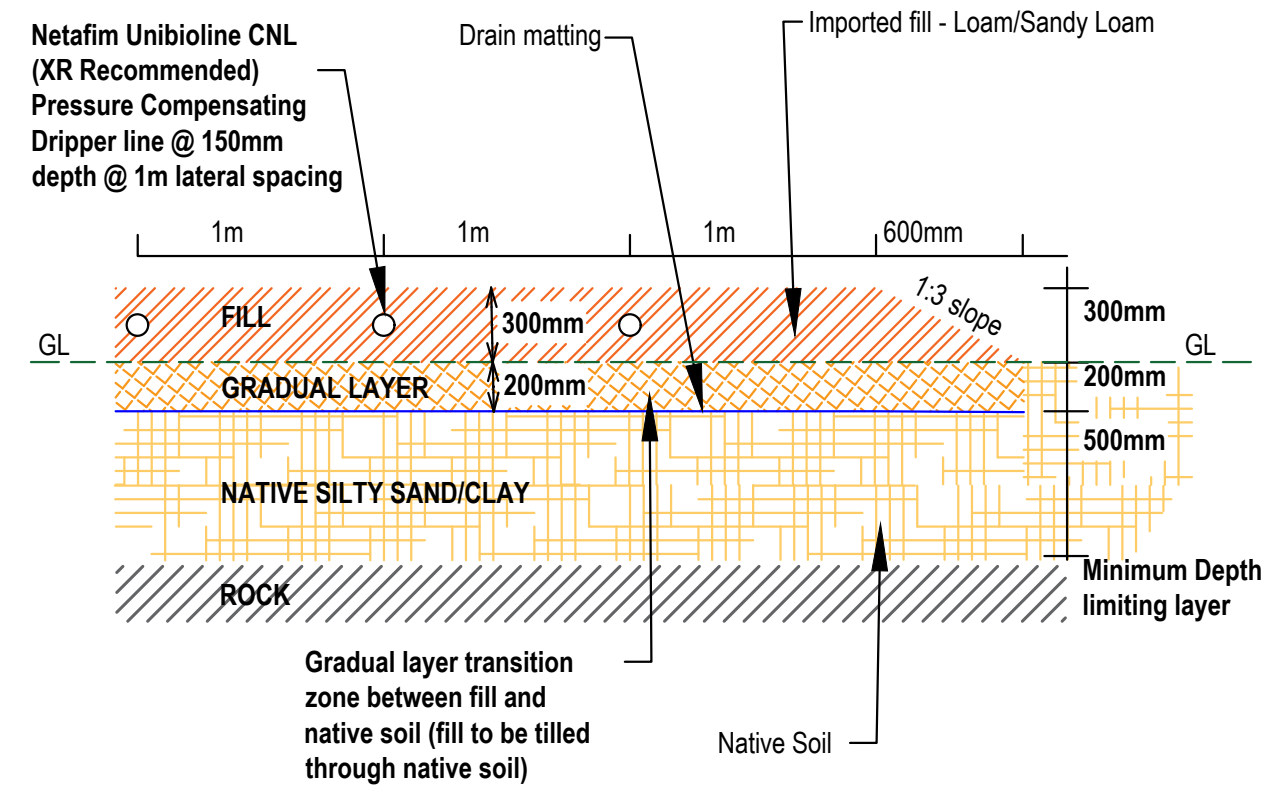
Scale :



TYPICAL SUB-SURFACE DRIP LAYOUT DETAIL



TYPICAL SUB-SURFACE DRIP ON RAISED IRRIGATION BED - SECTION DETAIL



TYPICAL SUB-SURFACE DRIP IRRIGATION ON RAISED BED

LAYOUT AND SECTION DRAINING

COMPONENTS

- Aerated Wastewater Treatment System (AWTS)
- 400m² sub-surface drip irrigation

All drainage work is to be undertaken by a licensed Plumber/Drainer
Plumber to check all levels on site and adjust layout where necessary

COUNCIL REQUIREMENTS:

- A Notice of Work for Plumbing and Drainage work is required to be submitted to council prior to any works beginning.
- Installation must comply with Council's OSSM approval document and conditions.
- The corresponding numbered Certificate of Compliance is to be submitted to council within 2 business days of the final inspection of works.

Q = 750L/day
DIR = 1.8mm/day
LAA = 400m²
Deep Drainage Rate = 3mm/day

Job: HMC2023.305.01
DWG: HMCDDWG2023.305
Date: March 2023
Revised: 31/03/2023
Drawn: KH
Base:

Lot 16 DP856265
225 Terranora Road
Banora Point NSW

9 LIMITATIONS

The information within this document is and shall remain the property of HMC Environmental Consulting Pty Ltd. This document was prepared for the sole use of client and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of HMC Environmental Pty Ltd and client. The report and conclusions are based on the information obtained at the time of the assessment. Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary.

Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time, natural processes and the activities of man. Changes to the subsurface, site or adjacent site conditions may occur subsequent to the investigation described herein, through natural processes or through the intentional or accidental addition of imported material, and these conditions may change with space and time.

The findings of this report are based on the objectives and scope of work outlined within. HMC performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environment assessment profession. No warranties or guarantees, expressed or implied, are made. Subject to the scope of work, HMC's assessment is limited strictly to identifying typical environmental conditions associated with the subject property and does not include evaluation of any other issues. This report does not comment on any regulatory obligations based on the findings, for which a legal opinion should be sought. This report relates only to the objectives and scope of the work stated and does not relate to any other works undertaken for the Client. All conclusions regarding the property area are the professional opinions of the HMC personnel involved with the project, subject to the qualifications made above.

While normal assessments of data reliability have been made by HMC, HMC assume no responsibility or liability for errors in any data obtained from regulatory agencies, or information from sources outside HMC's control, or developments resulting from situations outside the scope of this project.

10 REFERENCES

- Alderson, G. & Associates Pty Ltd, Draft Richmond Tweed On-site Regional Wastewater and Sewage Management Strategy, 1999 (OSSM Design Model)
- Australian/New Zealand Standard AS 1547: 2012 - *On-site domestic wastewater management*, February 2012
- eSPADE V2.0 NSW Office of Environment and Heritage
<https://www.environment.nsw.gov.au/eSpade2WebApp>
- Geary, P. and Gardner, T. *On-site disposal of effluent*. Innovative Approaches to the On-Site Management of Waste and Water: A one day conference, Southern Cross University, Lismore NSW, 1996.
- Lismore City Council, (2013) "Revised On-site Sewage and Wastewater Management Strategy," Lismore.
- Morand, D.T., *Soil Landscapes of the Lismore-Ballina 1:100 000 Sheet*, 1994
- NSW Department of Local Government, EPA (NSW), NSW Health, Land and Water Conservation and Department of Urban Affairs and Planning, *Environment & Health Protection Guidelines – On-site Sewage Management for Single Household*, February 1998
- Sydney Catchment Authority, "Designing and Installing On-site Wastewater Systems. A Sydney Catchment Authority Current Recommended Practice", SCA, May 2012
- NSW Office of Water, "Commenced Water Sharing Plan for the Tweed River Area unregulated and alluvial water sources", October 2010
- Whelan, B.R. and Titamnis, Z.V. Daily chemical variability of domestic septic tank effluent. *Water, Air and Soil Pollution* **17**, 131-139

11 APPENDICES

See following pages

APPENDIX 1 - SITE LOCATION

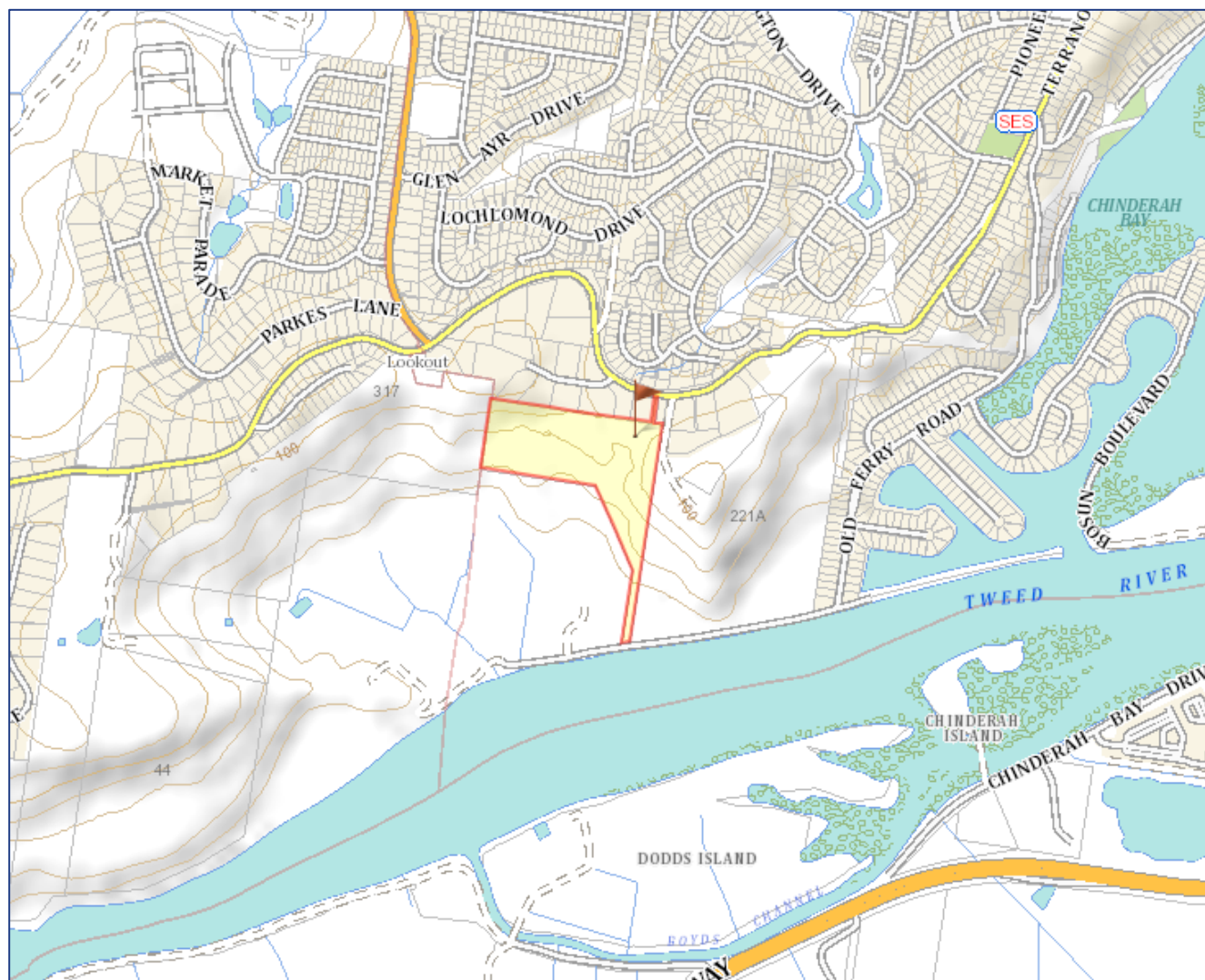


Figure 1: Site Location and Property Boundary as shown in Yellow (NSW SIX Maps)

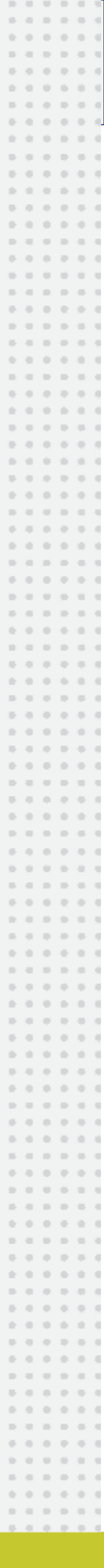


Figure 2: Property Boundary (TSC GIS 2022).

APPENDIX 2 - LAA DESIGN MODEL

Daily Effluent Disposal Model using Boughton Water Balance Model - Tyalgum Greg Alderson & Associates Pty Ltd (LCC, Part C, 2007) Period of Rainfall & Evaporation Record: 01/01/1971 - 31/12/1984		
Client:	Wrenn Pty Ltd	
Site:	225 Terranora Road, Banora Point	
Number of Persons	5 equivalent persons	
Daily Flow =	750 L/day	
Nitrogen Volume per year	19.0 kg/year	3.80 kg N /p/year - See Table 7 & table 8
Denitrification reduce to	11.40 kg/year	40.00 % reduction rate
Plant Uptake rate (N) =	300 kg/ha/year - See Table 6	
Phosphorus in Effluent (Ip) =	3 kg/year	0.6 kg P /person/year - see Table 11
P Uptake by plants (Hp) =	20 kg/ha/year - P which is taken up by vegetation, Table 9	
P sorption (Ps) =	10000 kg/ha/m depth - soil sorption capacity, Table 10	
Water Table Depth (Wtd) =	3 m - measured depth to the water table at the disposal site	
Buffer to W table (Bwt) =	0.5 m - adopted buffer to be set above water table	
Time for accumulation of P =	50.00 years	
Min. planted disposal area =	380 m ² (based on N loading)	
Min. planted disposal area =	58 m ² (based on P loading)	
Hydraulic Area	400 m ² (ignored if less than Min. planted disposal area)	
Crop factor =	1 See Table 3 and Section - B2.8	
% Effective Rainfall =	75% See Table 2	
Drainage below root zone/ Percolation =	13 mm/day - LTAR	
% of storage depth at which percolation occurs =	50% See Section –B2.3	
Depth of topsoil/ of trench =	De	0.45 m
Available water/	0.179 Available water from Table 1 (m/m)	
Soil Moisture Holding Capacity/ Trench storage =	80.55 mm	
Permissible days overflow =	20 days/year	
Minimum effluent application =	1.88 mm/day/m ²	
Max cum stor =	7.50 mm	
Required permissible storage =	0.00 m ³	
Max cum stor =	3.00 m ³	

APPENDIX 3 - NUTRIENT LOADING



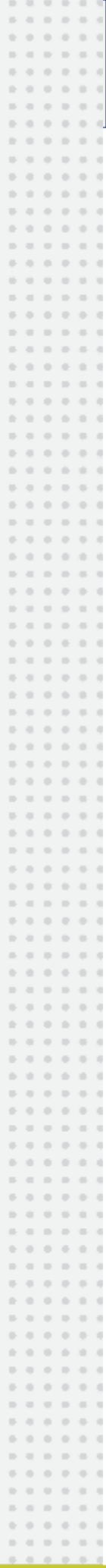
In consideration of nutrients such as nitrogen and phosphorus, a mass balance was used to estimate the application rate and long-term management of the on-site sewage management system based on effluent quality, wastewater volume and land application system, plant uptake, site and soil characteristics. In determination of LAA sizing regarding TN the following data was used.

Table 2: Nitrogen Production Data

Study	Mean Annual Loading
Witt et al. 1974	2.2 kg/person/year
Whelan & Titammis 1982	3.8kg/person/year
Sarac, K et al 2001	4.0kg/person/year (based on 6 dwellings within tank)
Davison et al., 2002	4.2 kg/person/year (based on two dwellings within tank)
Patterson, R.A 2004	4.38 kg/person/year (using mean of 85.8mg/L ⁻¹ at 140L/person/day)
Mean of listed studies	3.73kg/person/year
Realistic annual loading rate based on above listed studies	3.8 kg/person /year (as per Whelan & Titammis 1982)

The mean of the above studies provides a TN of approximately 3.7kg/person/year therefore the previously quoted figure of 3.8kg/person/year by Whelan & Titammis, 1982, is considered realistic for this domestic installation.

APPENDIX 4 - SOIL INVESTIGATION



**NSW DLWC 1:100,000 Soil
Landscape Map (Morand, 1996)**

Disputed Plains (dp) landscape:

Basalt derived valley in-fills and alluvial fans forming gently inclined slopes.

Soils:

Deep poorly drained Black Earths.

Geology:

Generally fine-grained sediments of the Lismore Basalts. Eluvial or outwash deposits at the toes of steep slopes or in the heads of gullies.

Soil Profile - HMC bore logs 19th November 2019 – Soil profile exposed by hand auger excavation

Bore hole No.	Depth (mm)	Field Texture Determination	Structure	Colour - Moist MUNSELL	pH	Coarse Fragments	Modified Emerson Aggregate Test
1	0-400	Sandy Clay Loam	Strong	Dark Yellowish Brown 10YR 3/4 Moist	4.5	Yes, fine gravels <20%	Class 3/6 Not limiting
2	0-400	Silty Loam	Strong	Dark Yellowish Brown 10YR 3/4 Moist	4.5	Yes, fine gravels <20%	Class 3/6 Not limiting
3	0-350	Clay Loam	Moderate	Dark Brown 7.5YR 3/4 Dry	5.0	Yes, fine gravels <20%	Class 8 No slaking Not limiting
4	0-750	Sandy Clay	Moderate	Dark Brown 7.5YR 3/4 Dry	5.5	Yes, fine gravels <20%	Class 3/6 Not limiting
	750-850	Sandy Clay Loam	Strong	Strong Brown 7.5YR 4/6 Dry	5.0	Yes, fine gravels <20%	Class 3/6 Not limiting
	850-1000	Sandy Clay	Single grained	Yellowish Brown 10YR 5/4 Dry	6.5	Yes, fine gravels >20%	–
5	0-450	Sandy Clay	Weak	Dark Yellowish Brown 10YR 3/4 Dry	4.5	Nil	Class 3/6 Not limiting
	450-850	Sandy Clay Loam	Moderate	Dark Yellowish Brown 10YR 3/4 Moist	4.5	Yes, fine gravels <20%	Class 3/6 Not limiting
6	0-200	Fine Sandy Clay Loam	Single grained	Dark Yellowish Brown 10YR 3/4 Dry	6.5	Yes, fine gravels <20%	Class 3/6 Not limiting
	200-350	Sandy Clay	Single grained	Black 2.5YR 2.5/1 Dry	9.0	Yes, fine gravels <20%	–
7	0-200	Sandy Clay	Strong	Dark Yellowish Brown 10YR 3/4 Dry	7.0	Yes, fine gravels <20%	Class 3/6 Not limiting

Soil Profile - HMC bore logs 27 th May 2021 – Soil profile exposed by hand auger excavation							
Bore hole no.	Depth (mm)	Field Texture Determination	Structure	Colour - Moist MUNSELL	pH	Coarse Fragments	Modified Emerson Aggregate Test
8	0-700	Sandy Clay	Moderate	Dark Brown 7.5YR 3/4 Dry	5.0	Yes, fine gravels <20%	Class 8 No slaking Not limiting
9	0-700	Sandy Clay	Moderate	Dark Brown 7.5YR 3/4 Dry	5.0	Yes, fine gravels <20%	Class 8 No slaking Not limiting

Modified Emerson Aggregate Test

As described by Robert Patterson Lanfax Labs Technical Note T14-1 (November 2014)

"The modified Emerson test can be reported and interpreted, with respect to domestic wastewater application as:

Class 1 - Severe dispersion, maybe related to high sodicity which forces the clay particles apart in water. Amelioration with lime or gypsum may improve structural stability by increasing EC. Class 1 soils have a major limitation to wastewater application because of reduced permeability and potential to compact as the pores block.

Class 2 - Moderate dispersion, may be related to high sodicity. Amelioration may be effective by increasing EC. Without amelioration, this class has a major limitation to wastewater application as for class 1.

Classes 3-6 -Remoulding, and 1:5 soil:water suspension tests are irrelevant to wastewater assessment, but one can report the test results with degree of slaking as:

Slake 1 (slight), slake 2 (moderate) or slake 3 (completely slumped). Slake 1, 2, or 3 – no limitation to wastewater application, but may benefit from additional organic matter for surface irrigated soils.

Classes 7 and 8 - these soils are water stable but may swell (Class 7) or retain original size and shape (Class 8). Neither of these classes is a limitation to wastewater application."

APPENDIX 5 - GEOTECHNICAL INVESTIGATIONS

Geotechnical Investigation – Geotechnical Investigations Pty Ltd
Report No. GI 3953-B 31 January 2019

Table 1: Summary of Subsurface Materials

Test Pit No.	Uncontrolled Fill (m)	Residual Soils (m)	Rock (m)	T.D. (m)
TP 1	0 – 1.8	1.8 – 2.3	NE	2.3
TP 2	0 – 1.3	NE	1.3 – 1.8	1.8 ⁽¹⁾
TP 3	0 – 3.2	NE	3.2 – 3.4	3.4
TP 4	0 – 0.6	0.6 – 2.1	NE	2.1
TP 5	0 – 3.5	NE	NE	3.5
TP 6	0 – 2.1	NE	NE	2.1 ⁽¹⁾
TP 7	0 – 0.4	NE	0.4 – 0.6	0.6 ⁽¹⁾
TP 8	NE	0 – 0.4	0.4 – 1.7	0.7 ⁽¹⁾
TP 9	0 – 1.6	NE	1.6 – 1.7	1.7 ⁽¹⁾
TP 10	0 – 0.7	0.7 – 0.9	0.9 – 1.1	1.1 ⁽¹⁾
TP 11	NE	0 – 2.8	NE	2.8
TP 12	0 – 2.9	NE	NE	2.9
TP 13	0 – 2.1	2.1 – 2.8	NE	2.8
TP 14	NE	0 – 2.4	NE	2.4

Notes: ⁽¹⁾ Slow penetration to practical refusal
NE - Not Encountered

Figure 3 Summary of Borelogs (Source: Geotechnical Investigations Report No. GI 953-b, January 2019, p3)

SEE FOLLOWING PAGES FOR BORELOGS

APPENDIX B

ENGINEERING LOGS – TEST PITS PROFILES TP 1 TO TP 14

DRILLING

ENVIRONMENTAL

GEOTECHNICAL



GEOTECH INVESTIGATIONS PTY LTD

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Ph: 0755 233 979

Fax: 0755 233 981

ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	-28.235641	E:	153.532198
CLIENT: WRENN PTY LTD							TEST PIT I.D.: TP 1	
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT							JOB No.: GI 3953-a	
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm			PAGE: 1 of 1	

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation	
TB		0.5	▶	(CH) Silty CLAY: High plasticity, With gravel, With cobbles and boulders throughout, Moist ($w > w_p$), Dark red/brown and grey	F - St	PP = 110 - 130		FILL *PP's difficult to complete due to coarse materials and friable nature of clay *Boulders up to 0.6m dia.	
		1.0							
		1.5							
		2.0		(CH) Silty CLAY: High plasticity, With gravel and boulders, With cobbles throughout, Moist ($w > w_p$), Red/brown	St			RESIDUAL	
		2.5							
		3.0							
		3.5							
		4.0							
		4.5							

TP 1 TERMINATED AT 2.3m – LIMIT OF INVESTIGATION DUE TO DIFFICULT PENETRATION THROUGH COBBLES

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High

WATER ▼ Water Level ▶ Water Seepage	Logged By: JDW	Date: 13/03/18	Checked By:	Date:
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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	-28.235315	E:	153.531518
CLIENT: WRENN PTY LTD							TEST PIT I.D.: TP 2	
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT							JOB No.: GI 3953-a	
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm			PAGE: 1 of 1	

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CH) Silty CLAY: High plasticity, With gravel, With cobbles and Weathered basalt boulders throughout, Wet to very moist ($w > w_p$), Dark red/brown and grey	F - St			FILL ? *PP's difficult to complete due to coarse materials
		1.5		(HW) BASALT and layers of (XW) BASALT mixed with medium to high plasticity silty clay: Red, dark orange/brown and grey	VLw			RESIDUAL
				(HW-MW) BASALT: Fine grained, Grey, dark grey and red/brown	Lw			
		2.0						
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						

TP 2 TERMINATED AT 1.8m – LIMIT OF INVESTIGATION DUE TO VERY SLOW PENETRATION

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	U () Undisturbed (size in mm)
C Casing	HW Highly	S Soft	D Disturbed
MS Mud Support	DW Distinctly	F Firm	BS Bulk Sample
NMLC Rock Coring	MW Moderately	St Stiff	DCP Dynamic Cone Penetrometer
RR Rock Roller	SW Slightly	VSt Very Stiff	SPT Standard Penetrometer Test
TB Toothed Bucket	F Fresh	Hd Hard	N Number of blows for SPT / 300mm
TC Tri Cone		VL Very Loose	VS Vane Shear
WB Wash Bore		L Loose	A Acid Sulfate Sample
		MD Medium Dense	PP Pocket Penetrometer (kPa)
▼ Water Level ▶ Water Seepage	Logged By: JDW Date: 13/03/18 Checked By: Date:		

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ENGINEERING LOG – TEST PIT PROFILE

GPS:				S: -28.235063		E: 153.530866	
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 3	
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-a	
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm		PAGE: 1 of 1	
Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm Structure and additional observation
TB		0.5		(CH) Silty CLAY: High plasticity, With gravel, With cobbles and boulders throughout, Wet to very moist ($w > w_p$), Dark red/brown and grey	F - St		FILL *PP's not possible with Cobbles throughout
		1.0					
		1.5					
		2.0					
		2.5					Trace of building Material and grease cartridge
		3.0					
		3.5		(HW) BASALT and layers of (XW) BASALT mixed with medium to high plasticity silty clay: Red, dark orange/brown and grey	VLw		RESIDUAL
		4.0					
		4.5					
TP 3 TERMINATED AT 3.4m – LIMIT OF REACH							
METHOD		WEATHERING		CONSISTENCY / DENSITY / ROCK STRENGTH		SAMPLES / TESTS	
AD	Auger Drilling	EW	Extremely	VS	Very Soft	D	Dense
C	Casing	HW	Highly	S	Soft	VD	Very Dense
MS	Mud Support	DW	Distinctly	F	Firm	Fb	Friable
NMLC	Rock Coring	MW	Moderately	St	Stiff	ELw	Extremely Low
RR	Rock Roller	SW	Slightly	VSt	Very Stiff	VLw	Very Low
TB	Toothed Bucket	F	Fresh	Hd	Hard	Lw	Low
TC	Tri Cone			VL	Very Loose	M	Medium
WB	Wash Bore			L	Loose	H	High
				MD	Medium Dense	VH	Very High
WATER							
▼	Water Level						
►	Water Seepage						
Logged By: JDW		Date: 13/03/18		Checked By:		Date:	

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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	-28.234886	E:	153.530287
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 4		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-a		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm		PAGE: 1 of 1		

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CH) Silty CLAY: High plasticity, With gravel, With cobbles and boulders, Moist ($w > w_p$), Dark red/brown	F			FILL *Boulders up to 0.6m dia.
				(GP) GRAVEL: With clay and cobbles,	L			
			1.0		(CH) Silty CLAY: High plasticity, With gravel, With cobbles and boulders, Moist ($w > w_p$), Dark red/brown			
		1.5						
		2.0						
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						

TP 4 TERMINATED AT 2.1m – ???

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	U () Undisturbed (size in mm)
C Casing	HW Highly	S Soft	D Disturbed
MS Mud Support	DW Distinctly	F Firm	BS Bulk Sample
NMLC Rock Coring	MW Moderately	St Stiff	DCP Dynamic Cone Penetrometer
RR Rock Roller	SW Slightly	VSt Very Stiff	SPT Standard Penetrometer Test
TB Toothed Bucket	F Fresh	Hd Hard	N Number of blows for SPT / 300mm
TC Tri Cone		VL Very Loose	VS Vane Shear
WB Wash Bore		L Loose	A Acid Sulfate Sample
		MD Medium Dense	PP Pocket Penetrometer (kPa)
▼ Water Level ▶ Water Seepage	Logged By: JDW	Date: 13/03/18	Checked By: Date:

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ENGINEERING LOG – TEST PIT PROFILE

GPS:				S:		-28.234981		E:		153.531520	
CLIENT: WRENN PTY LTD								TEST PIT I.D.: TP 5			
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT								JOB No.: GI 3953-a			
EQUIPMENT TYPE: 5.5 TONNE KUBOTA						BUCKET SIZE: 450mm		PAGE: 1 of 1			

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CH) Silty CLAY: High plasticity, With gravel, With cobbles and boulders, Very moist ($w > w_p$), Red/brown	F - St	PP = 80 - 120		FILL
		2.0		(MH/CH) Clayey SILT/Silty CLAY: High plasticity, Trace of cobbles, Wet ($w > w_p$), Dark grey	F	PP < 80		*PP's difficult as Material was crumbling
		3.5		(MH/CH) Clayey SILT/Silty CLAY: High plasticity, With gravel, Tree roots and rubbish, Wet ($w > w_p$), Dark grey				
		4.0						
		4.5						

TP 5 TERMINATED AT 3.5m – LIMIT OF REACH

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High

WATER ▼ Water Level ► Water Seepage	Logged By: JDW	Date: 13/03/18	Checked By:	Date:
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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	-28.235479	E:	153.530789
CLIENT: WRENN PTY LTD							TEST PIT I.D.: TP 6	
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT							JOB No.: GI 3953-a	
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm			PAGE: 1 of 1	

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(GP) GRAVEL: Fine to coarse gravel, Moist, Dark grey	L			FILL
		1.0		(GP) GRAVEL: Fine to coarse gravel, With sand and clay throughout, With cobbles and boulders, Moist, Dark grey				
		1.5						
		2.0						
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						

TP 6 TERMINATED AT 2.1m – TERMINATED DUE TO LIMIT OF INVESTIGATION AND SLOW EXCAVATION

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High

WATER ▼ Water Level ► Water Seepage	Logged By: JDW	Date: 13/03/18	Checked By:	Date:
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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	-28.235950	E:	153.531665
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 7		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-a		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm		PAGE: 1 of 1		

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB				(CH) Silty CLAY: High plasticity, Trace of gravel, Moist ($w > w_p$), Dark red/brown	F - St			FILL
				(GP) Sandy GRAVEL: Fine to coarse gravel, Moist, Grey				
		0.5		(HW) BASALT: Fine grained, Dark grey				RESIDUAL
		1.0						
		1.5						
		2.0						
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						

TP 7 TERMINATED AT 0.6m – EXCAVATOR REFUSAL

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High

WATER ▼ Water Level ► Water Seepage	Logged By: JDW	Date: 13/03/18	Checked By:	Date:
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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	28.235130	E:	153.533190
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 8		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-b		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm x 2.1m		PAGE: 1 of 1		

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CI) Gravelly CLAY: Medium plasticity, Dry, Red/brown	VSt - Hd	PP = 300 - 450		RESIDUAL Organic material throughout
				(CI) Sandy CLAY: Medium plasticity, With silt, Trace of gravel, Dry (w<w _p), Red/brown				
					(HW) BASALT: Fine grained, Very fractured, Dry, Dark red/brown, orange/brown and grey			
		1.0						
		1.5						
		2.0						
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						

TP 8 TERMINATED AT 0.7m – EXCAVATOR REFUSAL ON ROCK

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High

WATER ▼ Water Level ► Water Seepage	Logged By: JDW	Date: 21/12/18	Checked By: JW	Date: 31/01/19
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ENGINEERING LOG – TEST PIT PROFILE

					GPS:	S:	28.235015°		E:	153.532526°	
CLIENT: WRENN PTY LTD								TEST PIT I.D. : TP 9			
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT								JOB No.: GI 3953-b			
EQUIPMENT TYPE: 5.5 TONNE KUBOTA					BUCKET SIZE: 450mm X 2.8m			PAGE: 1 of 1			
Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation			
TB		0.5		(SC) Clayey SAND: Fine to coarse sand, With gravel and boulders, Wet, Dark red/brown and grey				FILL	Large >1.0m boulders		
		1.0		(CI-CH) Sandy CLAY: Medium to high plasticity, With gravel, Wet, Dark orange/brown	F						
		1.5		(HW) BASALT: Fine grained, Very fractured, Dry, Dark red/brown, orange/brown and grey	Lw - M				RESIDUAL		
		2.0									
		2.5									
		3.0									
		3.5									
		4.0									
TP 9 TERMINATED AT 1.7m – EXCAVATOR REFUSAL ON ROCK											
METHOD			WEATHERING		CONSISTENCY / DENSITY / ROCK STRENGTH				SAMPLES / TESTS		
AD	Auger Drilling	EW	Extremely	VS	Very Soft	D	Dense	U()	Undisturbed (size in mm)		
C	Casing	HW	Highly	S	Soft	VD	Very Dense	D	Disturbed		
MS	Mud Support	DW	Distinctly	F	Firm	Fb	Friable	BS	Bulk Sample		
NMLC	Rock Coring	MW	Moderately	St	Stiff	ELw	Extremely Low	DCP	Dynamic Cone Penetrometer		
RR	Rock Roller	SW	Slightly	VSt	Very Stiff	VLw	Very Low	SPT	Standard Penetrometer Test		
TB	Toothed Bucket	F	Fresh	Hd	Hard	Lw	Low	N	Number of blows for SPT / 300mm		
TC	Tri Cone			VL	Very Loose	M	Medium	VS	Vane Shear		
WB	Wash Bore			L	Loose	H	High	A	Acid Sulfate Sample		
	WATER			MD	Medium Dense	VH	Very High	PP	Pocket Penetrometer (kPa)		
▼	Water Level			Logged By: JDW		Date: 21/12/18		Checked By: JW		Date: 31/01/19	
►	Water Seepage										

GEOTECH INVESTIGATIONS PTY LTD

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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	28.235214°	E:	153.531991°
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 10		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-b		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm x 2.5m		PAGE: 1 of 1		

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CI-CH) Sandy CLAY: Medium to high plasticity, With gravel, Wet, Dark orange/brown	F - St			FILL
		1.0		(CI-CH) Sandy CLAY: Medium to high plasticity, Trace of gravel, Wet, Dark orange/brown				RESIDUAL
		1.0		(HW) BASALT: Fine grained, Very fractured, Dry, Dark grey	Lw - M			
		1.5						
		2.0						
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						

TP 10 TERMINATED AT 1.1m – EXCAVATOR REFUSAL ON ROCK

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High
WATER ▼ Water Level ▶ Water Seepage			U() Undisturbed (size in mm) D Disturbed BS Bulk Sample DCP Dynamic Cone Penetrometer SPT Standard Penetrometer Test N Number of blows for SPT / 300mm VS Vane Shear A Acid Sulfate Sample PP Pocket Penetrometer (kPa)

Logged By: JDW	Date: 21/12/18	Checked By: JW	Date: 31/01/19
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ENGINEERING LOG – TEST PIT PROFILE

GPS:				S: 28.235635°		E: 153.531748°		
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 11		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-b		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm x 3.0m		PAGE: 1 of 1		
Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CH) Silty CLAY: High plasticity, With sand, Trace of boulders, Moist ($w > w_p$), Dark red/brown	VSt	PP = 300		RESIDUAL Grass roots at surface Trace of organic material.
		1.0				PP = 350		
		1.5						
		2.0						
		2.5		(CH) Silty CLAY: High plasticity, With sand, Trace of boulders, Moist ($w > w_p$), Dark grey and red/brown	St - VSt			
		3.0						
		3.5						
		4.0						
		4.5						
TP 11 TERMINATED AT 2.8m – HIT A BOULDER AND REFUSED								
METHOD		WEATHERING		CONSISTENCY / DENSITY / ROCK STRENGTH				SAMPLES / TESTS
AD	Auger Drilling	EW	Extremely	VS	Very Soft	D	Dense	U() Undisturbed (size in mm)
C	Casing	HW	Highly	S	Soft	VD	Very Dense	D Disturbed
MS	Mud Support	DW	Distinctly	F	Firm	Fb	Friable	BS Bulk Sample
NMLC	Rock Coring	MW	Moderately	St	Stiff	ELw	Extremely Low	DCP Dynamic Cone Penetrometer
RR	Rock Roller	SW	Slightly	VSt	Very Stiff	VLw	Very Low	SPT Standard Penetrometer Test
TB	Toothed Bucket	F	Fresh	Hd	Hard	Lw	Low	N Number of blows for SPT / 300mm
TC	Tri Cone			VL	Very Loose	M	Medium	VS Vane Shear
WB	Wash Bore			L	Loose	H	High	A Acid Sulfate Sample
	WATER			MD	Medium Dense	VH	Very High	PP Pocket Penetrometer (kPa)
▼	Water Level							
►	Water Seepage							
		Logged By: JDW		Date: 21/12/18		Checked By: JW		Date: 31/01/19

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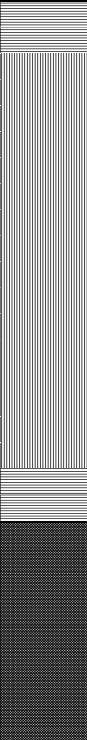
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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	28.235240°	E:	153.531027°
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 12		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-b		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 400mm x 1.0m		PAGE: 1 of 1		

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CI-CH) Sandy Silty CLAY: Medium to high plasticity, Dry (w<wp), Red/brown				FILL
		2.0		Boulders and cobbles (crushed and angular)				
		3.0						
		3.5						
		4.0						
		4.5						

TP 12 TERMINATED AT 2.9m – LIMIT OF EXCAVATION DUE TO CONTINUAL CAVE IN

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High

WATER ▼ Water Level ► Water Seepage	Logged By: JDW	Date: 21/12/18	Checked By: JW	Date: 31/01/19
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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	28.235237°	E:	153.530449°
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 13		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-b		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm x 3.5m		PAGE: 1 of 1		

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(GC) Clayey GRAVEL: Fine to coarse gravel, With sand, Cobbles throughout, Moist, Grey/brown	L - MD			FILL
		1.0		(GP) Sandy GRAVEL: Fine to coarse gravel, With cobbles throughout, Dry, Grey				
		2.0		(CI) Sandy CLAY: Medium plasticity, Fine to coarse sand, With gravel, Moist, Dark red/brown and orange/brown	St - VSt			
		2.5		(CI) Silty CLAY: Medium plasticity, With sand, Moist (w=w _p), Dark red/brown and dark orange/brown				RESIDUAL
		3.0						
		3.5						
		4.0						
		4.5						

TP 13 TERMINATED AT 2.8m – LIMIT OF INVESTIGATION

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	U () Undisturbed (size in mm)
C Casing	HW Highly	S Soft	D Disturbed
MS Mud Support	DW Distinctly	F Firm	BS Bulk Sample
NMLC Rock Coring	MW Moderately	St Stiff	DCP Dynamic Cone Penetrometer
RR Rock Roller	SW Slightly	VSt Very Stiff	SPT Standard Penetrometer Test
TB Toothed Bucket	F Fresh	Hd Hard	N Number of blows for SPT / 300mm
TC Tri Cone		VL Very Loose	VS Vane Shear
WB Wash Bore		L Loose	A Acid Sulfate Sample
		MD Medium Dense	PP Pocket Penetrometer (kPa)
▼ Water Level			
► Water Seepage			

Logged By: JDW	Date: 21/12/18	Checked By: JW	Date: 31/01/19
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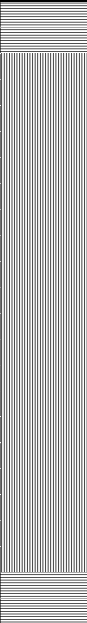
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ENGINEERING LOG – TEST PIT PROFILE

				GPS:	S:	28.235516°	E:	153.529928°
CLIENT: WRENN PTY LTD						TEST PIT I.D.: TP 14		
PROJECT: LOT 16 (No.225) TERRANORA ROAD, BANORA POINT						JOB No.: GI 3953-b		
EQUIPMENT TYPE: 5.5 TONNE KUBOTA				BUCKET SIZE: 450mm		PAGE: 1 of 1		

Method	Water	Depth (m)	Graphic Log	Material Description	Consistency / Rel. Density	Sample / Test	DCP Blows / 100mm	Structure and additional observation
TB		0.5		(CI) Silty CLAY: Medium plasticity, Trace of sand and cobbles and boulders, Moist (w<w _p), Dark orange/brown and red/brown				RESIDUAL
		1.0						
		1.5						
		2.0						
		2.5						
		3.0						
		3.5						
		4.0						
		4.5						

TP 14 TERMINATED AT 2.4m – LIMIT OF INVESTIGATION

METHOD	WEATHERING	CONSISTENCY / DENSITY / ROCK STRENGTH	SAMPLES / TESTS
AD Auger Drilling	EW Extremely	VS Very Soft	D Dense
C Casing	HW Highly	S Soft	VD Very Dense
MS Mud Support	DW Distinctly	F Firm	Fb Friable
NMLC Rock Coring	MW Moderately	St Stiff	ELw Extremely Low
RR Rock Roller	SW Slightly	VSt Very Stiff	VLw Very Low
TB Toothed Bucket	F Fresh	Hd Hard	Lw Low
TC Tri Cone		VL Very Loose	M Medium
WB Wash Bore		L Loose	H High
		MD Medium Dense	VH Very High

WATER ▼ Water Level ► Water Seepage	Logged By: JDW	Date: 21/12/18	Checked By: JW	Date: 31/01/19
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APPENDIX 6

PHOTOGRAPHIC LOG

