



Application for Planning Approval

Land Use Planning and Approvals Act 1993

APPLICATION NO.

DA2025/153

LOCATION OF AFFECTED AREA

18 MILLVALE ROAD, DROMEDARY

DESCRIPTION OF DEVELOPMENT PROPOSAL

SECONDARY DWELLING & ROOFED VERANDAH

A COPY OF THE DEVELOPMENT APPLICATION MAY BE VIEWED AT www.brighton.tas.gov.au AND AT THE COUNCIL OFFICES, 1 TIVOLI ROAD, OLD BEACH, BETWEEN 8:15 A.M. AND 4:45 P.M, MONDAY TO FRIDAY OR VIA THE QR CODE BELOW. ANY PERSON MAY MAKE WRITTEN REPRESENTATIONS IN ACCORDANCE WITH S.57(5) OF THE LAND USE PLANNING AND APPROVALS ACT 1993 CONCERNING THIS APPLICATION UNTIL 4:45 P.M. ON **01/12/2025**. ADDRESSED TO THE CHIEF EXECUTIVE OFFICER AT 1 TIVOLI ROAD, OLD BEACH, 7017 OR BY EMAIL AT development@brighton.tas.gov.au. REPRESENTATIONS SHOULD INCLUDE A DAYTIME TELEPHONE NUMBER TO ALLOW COUNCIL OFFICERS TO DISCUSS, IF NECESSARY, ANY MATTERS RAISED.

JAMES DRYBURGH
Chief Executive Officer



Brighton
going places

PLANNING

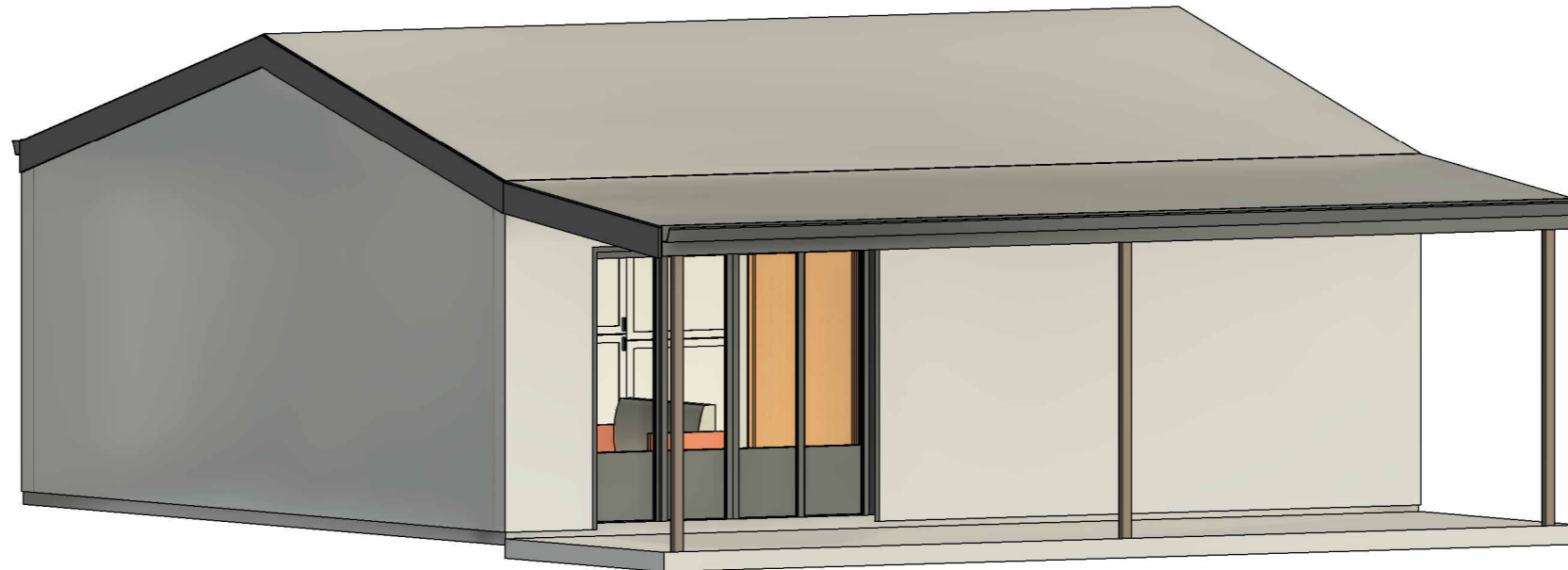
New Ancillary Dwelling and New Veranda Roof

Class 1a&10
SNH25-033

CONTENTS

| | |
|------|------------------------|
| A1.0 | COVER PAGE |
| A2.0 | SITEPLAN WHOLE SITE |
| A2.1 | SITEPLAN |
| A3.0 | FLOORPLAN |
| A3.1 | FLOORPLAN VERANDA |
| A3.2 | WINDOW/ DOOR SCHEDULES |
| A4.0 | ELEVATIONS |
| A4.1 | ELEVATIONS |
| A4.2 | ELEVATIONS VERANDA |

| | |
|--------------------------------|---|
| CLIENT | Gregory Raymond King and Julie Jones |
| PROPERTY ADDRESS | 18 Millvale Road, Dromedary |
| PROPERTY TITLE REFERENCE | 173188/1 |
| PROPERTY IDENTIFICATION NUMBER | 3515560 |
| LOCAL AUTHORITY | Brighton |
| PLANNING ZONE | Rural Living |
| OVERLAYS | Bushfire-Prone area, Low Landslip hazard band, Priority Vegetation area, Waterway and Coastal Protection area |
| BUSHFIRE ATTACK LEVEL | 29 |
| CORROSION ENVIRONMENT | NA |
| SOIL CLASSIFICATION | M Class |
| WIND CLASSIFICATION | N3 |
| PROPERTY LOT SIZE | 10440m2 |
| PROPOSED FOOTPRINT | 60m2 |



CERTIFICATES & ASSESSMENT REPORTS BY OTHERS

| | |
|--|-------------------------|
| SOIL & WIND ASSESSMENT | ENVIRO-TECH CONSULTANTS |
| ON-SITE WASTE WATER ASSESSMENT | FYSH DESIGN |
| BUSHFIRE ATTACK LEVEL ASSESSMENT (BAL) | SOUTHERN PLANNING |

DIMENSION NOTE:

Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:

This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.

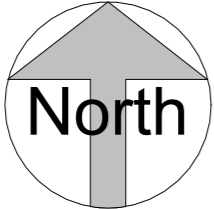
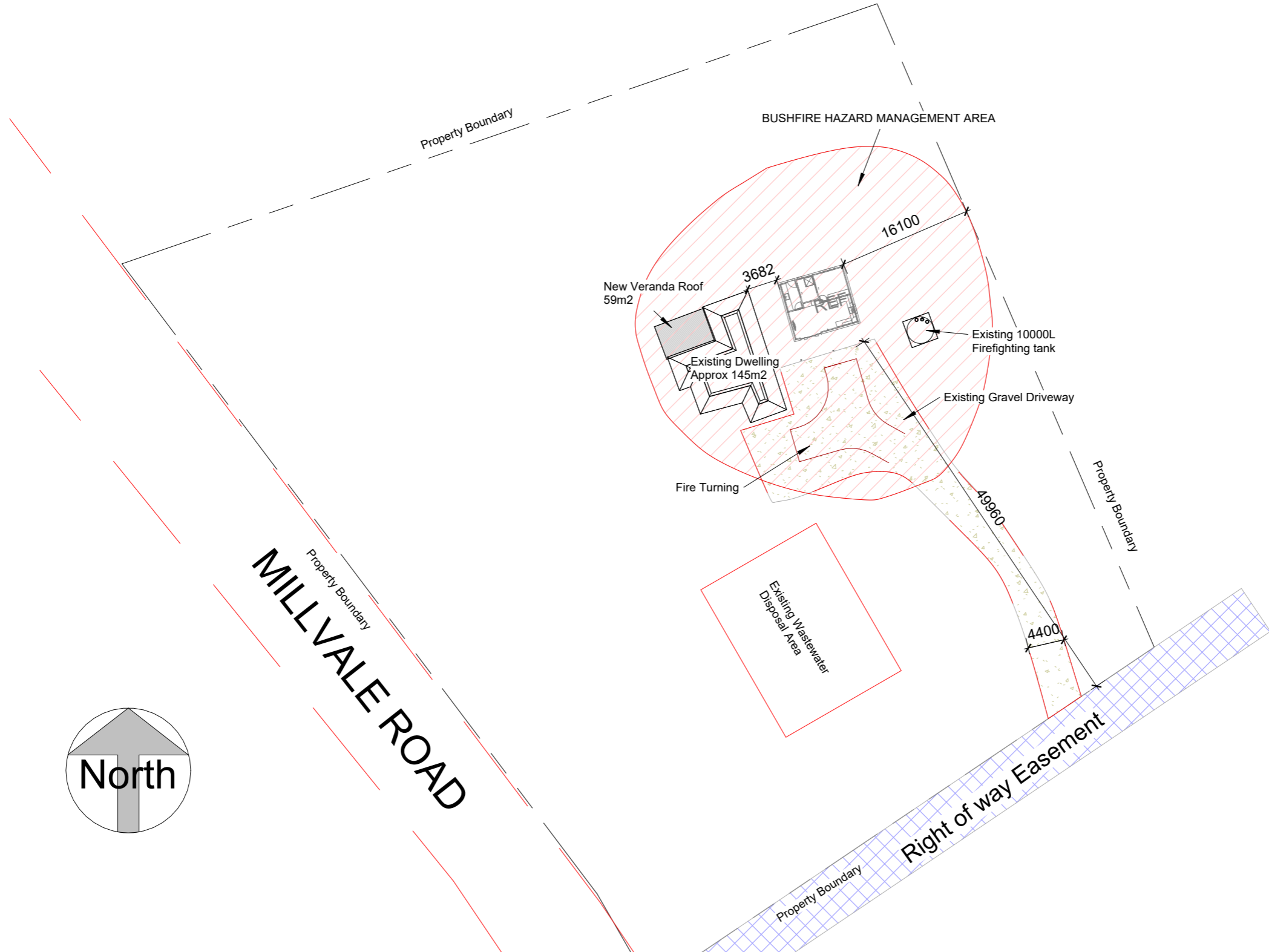


57 Cove Hill Road
Bridgewater TAS 7030
(03) 6263 6545
hobart@shedsnhomes.com.au
BLST Pty Ltd
ABN 52 660 422 159

| | | | | | | | |
|-----------------|---|--|--|---------------|------------|------------|-----------|
| CLIENT NAME | Gregory Raymond King and Julie Jones | | | DRAWING TITLE | COVER PAGE | | |
| PROJECT ADDRESS | 18 Millvale Road, Dromedary | | | DATE | 25/08/2025 | SCALE | DRAWN BY |
| PROJECT | New Ancillary Dwelling and New Veranda Roof | | | REVISION No | | SHEET SIZE | JOB No |
| | | | | | | A3 | SNH25-033 |
| | | | | | | | SHEET No |
| | | | | | | | A1.0 |

WATER

000



DIMENSION NOTE:

Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:

This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.



57 Cove Hill Road
 Bridgewater TAS 7030
 (03) 6263 6545
 hobart@shedsnhomes.com.au
 BLST Pty Ltd
 ABN 52 660 422 159

| | | | |
|---|--------------------|--------------------------------------|----------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | | DRAWING TITLE SITEPLAN Whole Site | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | DATE 25/08/2025 | SCALE 1 : 500 | DRAWN BY SH |
| PROJECT New Ancillary Dwelling | REVISION No. | SHEET SIZE A3 | JOB No. SNH25-033 |
| | | | SHEET No. C2.0 |



DIMENSION NOTE:
 Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setbacks and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:
 This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.

SHEDS HOMES
 SHEDS MADE TOUGH

57 Cove Hill Road
 Bridgewater TAS 7030
 (03) 6263 6545
 hobart@shedsnhomes.com.au

BLST Pty Ltd
 ABN 52 660 422 159

| | | | |
|---|--|---------------------------|----------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | | DRAWING TITLE SITEPLAN | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | | DATE 25/08/2025 | SCALE 1 : 200 |
| PROJECT New Ancillary Dwelling | | REVISION No. | DRAWN BY SH |
| | | SHEET SIZE A3 | JOB No. SNH25-033 |
| | | SHEET No. C2.1 | |



DIMENSION NOTE:

Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:

This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.



57 Cove Hill Road
 Bridgewater TAS 7030
 (03) 6263 6545
 hobart@shedsnhomes.com.au
 BLST Pty Ltd
 ABN 52 660 422 159

| | | | | |
|--|--|----------------------------|------------------|----------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | | DRAWING TITLE FLOORPLAN | | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | | DATE 25/08/2025 | SCALE 1 : 50 | DRAWN BY SH |
| PROJECT New Ancillary Dwelling and New Veranda Roof | | REVISION No. | SHEET SIZE A3 | JOB No. SNH25-033 |
| | | | | SHEET No. A3.0 |

| Window Schedule | | | | | | | |
|-----------------|--------|-------|-----------|------------|----------|------------------------------|------|
| Mark | Height | Width | Operation | Frame | Comments | U-Value | SHGC |
| W1 | 607 | 567 | Awning | All Ultrex | | 4.8000 W/(m ² ·K) | 0.62 |
| W2 | 1207 | 1797 | Awning | All Ultrex | | 4.8000 W/(m ² ·K) | 0.62 |
| W3 | 600 | 1200 | Awning | All Ultrex | | 4.8000 W/(m ² ·K) | 0.62 |

| Door Schedule | | | | |
|---------------|----------|----------------|--------|-------|
| Mark | Function | Frame Material | Height | Width |
| D2 | Interior | Timber | 2388 | 820 |
| D3 | Interior | Timber | 2040 | 920 |
| D1 | Interior | Aluminium | 2134 | 915 |
| D15 | Interior | Timber | 2388 | 820 |
| D5 | Interior | Timber | 2040 | 920 |
| D18 | Exterior | Aluminium | 2143 | 2500 |

DIMENSION NOTE:

Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

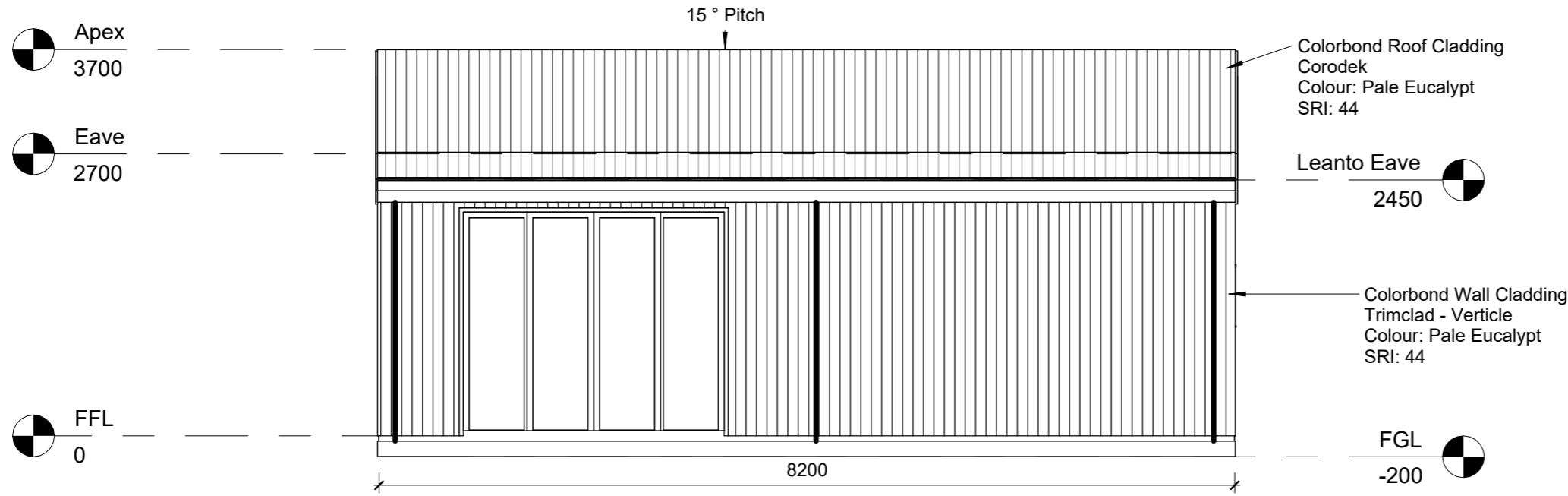
DRAWING NOTE:

This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.

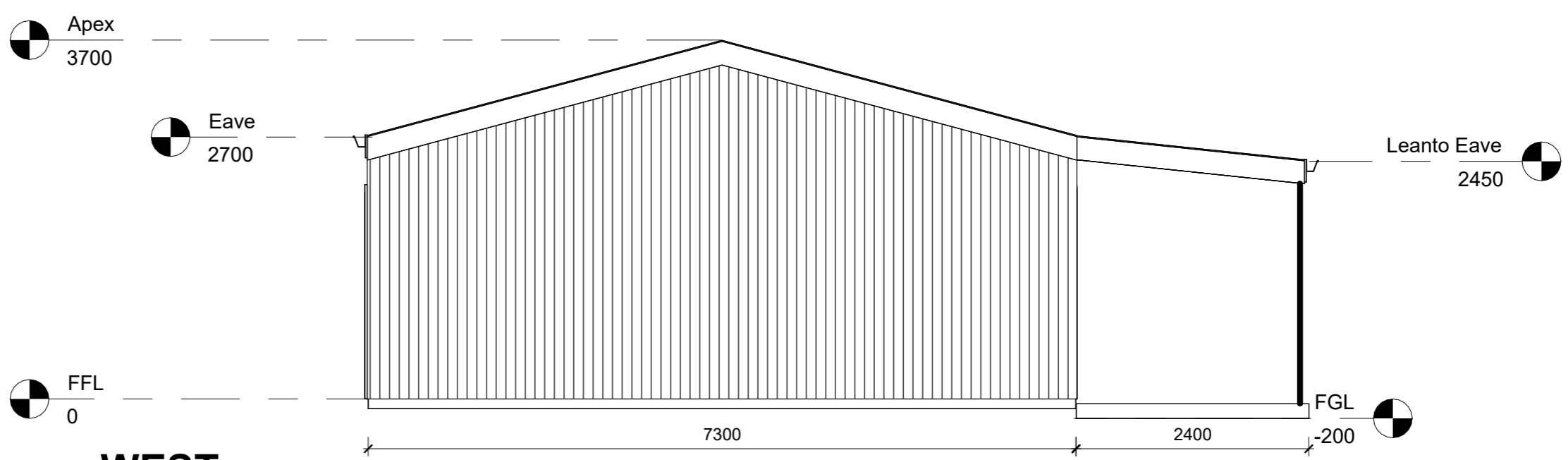


57 Cove Hill Road
 Bridgewater TAS 7030
 (03) 6263 6545
 hobart@shedsnhomes.com.au
 BLST Pty Ltd
 ABN 52 660 422 159

| | | | | | |
|--|--|---|------------------|---------------------|------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | | DRAWING TITLE WINDOW/ DOOR SCHEDULES | | | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | | DATE 25/08/2025 | SCALE | DRAWN BY BH | |
| PROJECT New Ancillary Dwelling and New Veranda Roof | | REVISION No | SHEET SIZE A3 | JOB No SNH25-033 | SHEET No A3.2 |



1 SOUTH
1 : 50



2 WEST
1 : 50

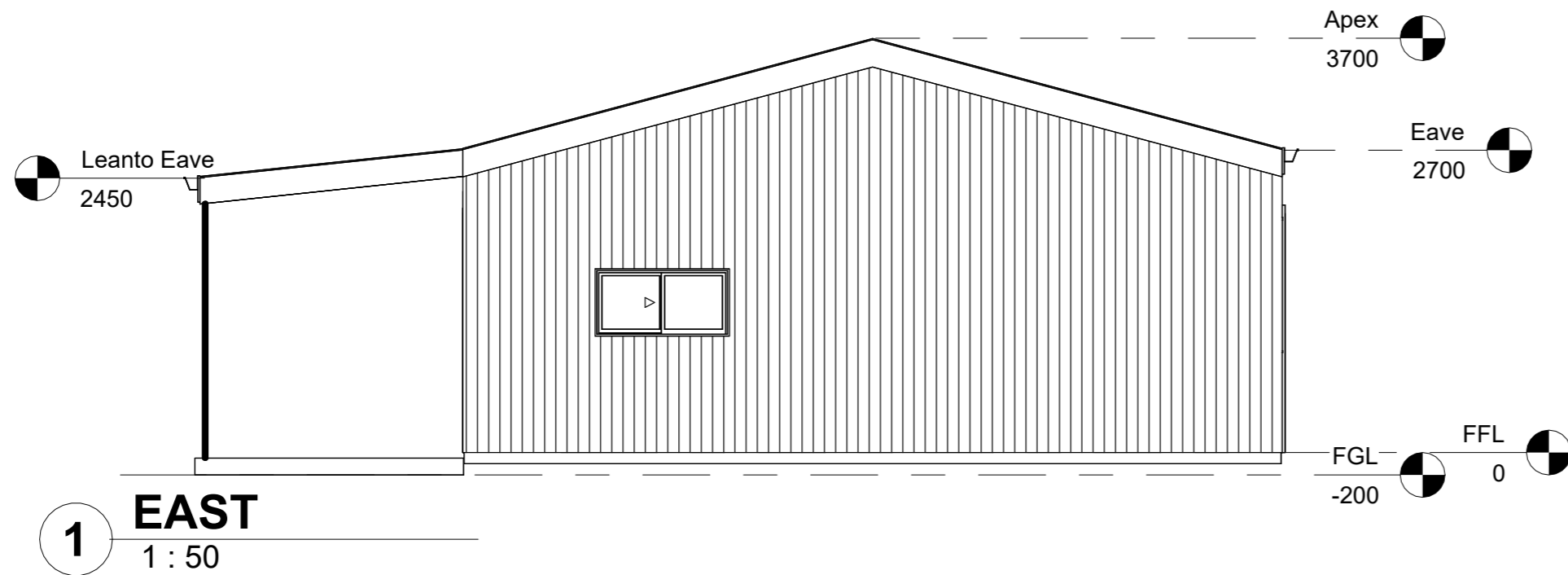
DIMENSION NOTE:
Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:
This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.

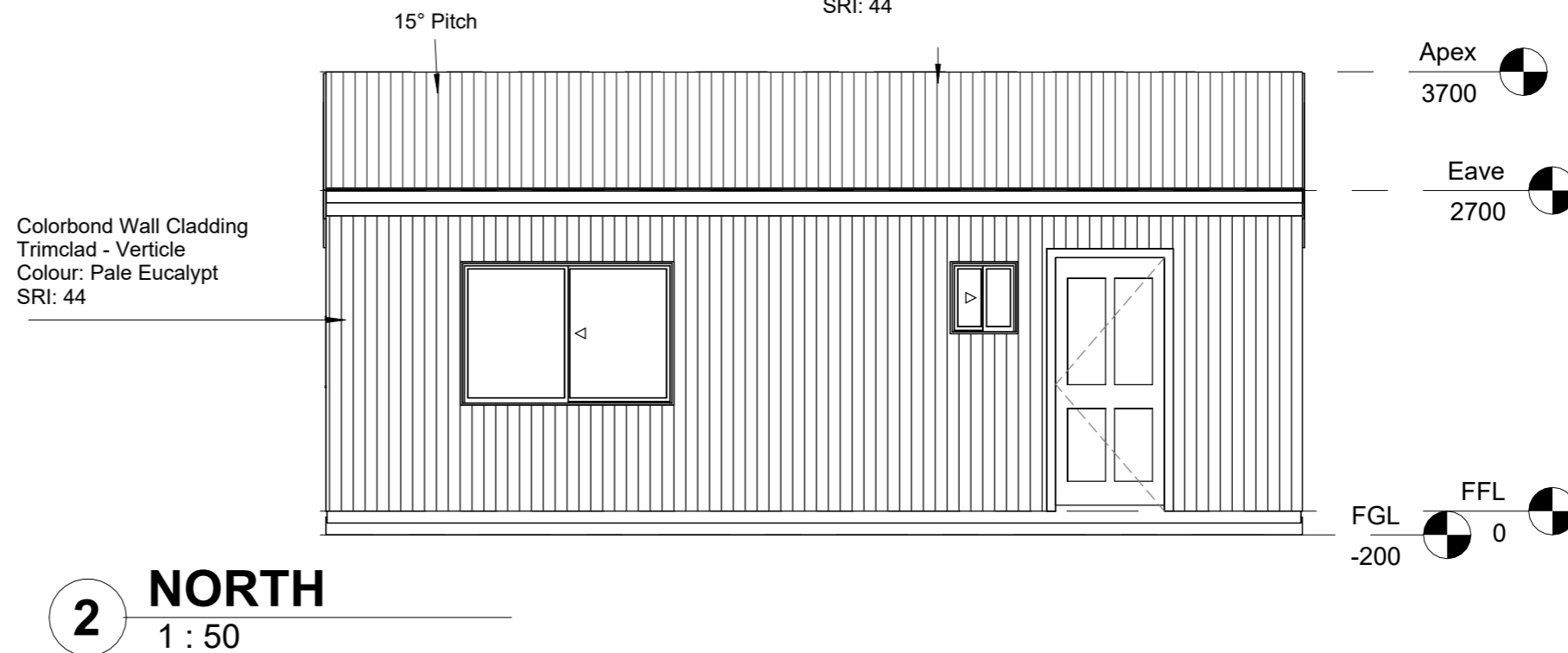


57 Cove Hill Road
Bridgewater TAS 7030
(03) 6263 6545
hobart@shedsnhomes.com.au
BLST Pty Ltd
ABN 52 660 422 159

| | | | | |
|--|--|-----------------------------|------------------|----------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | | DRAWING TITLE ELEVATIONS | | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | | DATE 25/08/2025 | SCALE 1 : 50 | DRAWN BY SH |
| PROJECT New Ancillary Dwelling and New Veranda Roof | | REVISION No. | SHEET SIZE A3 | JOB No. SNH25-033 |
| | | | | SHEET No. A4.0 |



Colorbond Roof Cladding
 Corodek
 Colour: Pale Eucalypt
 SRI: 44



Colorbond Wall Cladding
 Trimclad - Vertical
 Colour: Pale Eucalypt
 SRI: 44

DIMENSION NOTE:

Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:

This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.



57 Cove Hill Road
 Bridgewater TAS 7030
 (03) 6263 6545
 hobart@shedsnhomes.com.au
 BLST Pty Ltd
 ABN 52 660 422 159

| | | | | | | |
|-----------------|---|-----------|---------------|--------|------------|--|
| CLIENT NAME | Gregory Raymond King and Julie Jones | | DRAWING TITLE | | ELEVATIONS | |
| PROJECT ADDRESS | 18 Millvale Road, Dromedary | | DATE | SCALE | DRAWN BY | |
| PROJECT | New Ancillary Dwelling and New Veranda Roof | | 25/08/2025 | 1 : 50 | SH | |
| REVISION No | SHEET SIZE | JOB No | SHEET No | | | |
| | A3 | SNH25-033 | A4.1 | | | |

TO BE READ IN CONJUNCTION WITH:

| | | |
|-------|-------------------------|---------------------|
| A3.0 | FLOOR PLAN | BAL 29 |
| C10.0 | BAL SEALING | SECTION A |
| C11.1 | BAL NOTES | SECTION B |
| C12.0 | CONSTRUCTION NOTES | LIVABLE HOUSING |
| C12.1 | CONSTRUCTION NOTES | LIVABLE HOUSING |
| C13.0 | COMPLIANCE REQUIREMENTS | NCC 2022 Vol 2. and |
| C13.1 | COMPLIANCE REQUIREMENTS | HOUSING PROVISIONS |
| C14.0 | COMPLIANCE REQUIREMENTS | |

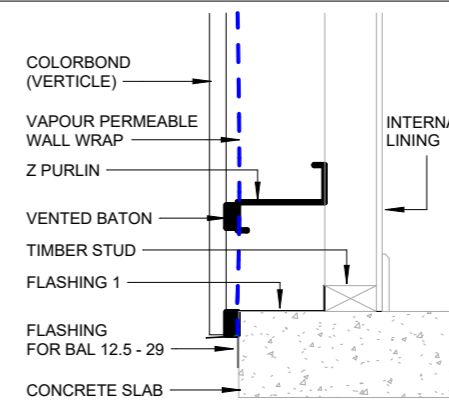
CONSTRUCTION DRAWINGS
APEX ENGINEERING GROUP

VENT-A-ROOF
BAL 12.5-40 Certified
Provide to the full length of the roof ridge in accordance with NCC Vol 2. 2022 Clause 10.8.3 for roof ventilation and condensation management compliance.

DO NOT seal ROOF BLAKENT at ridge

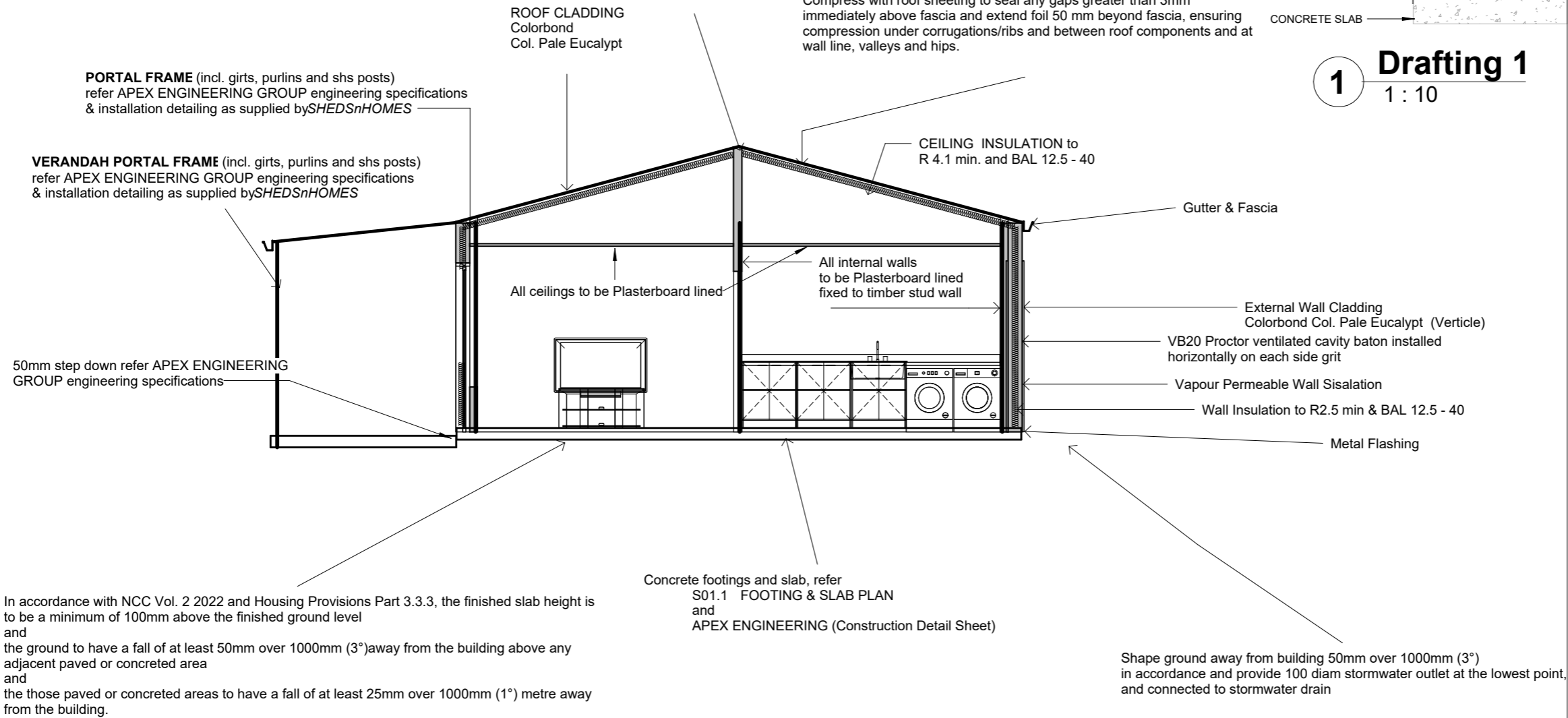
ROOF BLANKET to R0.2 min (thermal break, condensation, noise management)
BAL 12.5 - 40 (ember seal)

Install to entire roof area over the top of Z purlins. Compress with roof sheeting to seal any gaps greater than 3mm immediately above fascia and extend foil 50 mm beyond fascia, ensuring compression under corrugations/ribs and between roof components and at wall line, valleys and hips.



NOTE:
Where internal walls do not line up with mezzanine joists, provide C100 blocking at 600ctrs for top plate/bottom plate connection
Refer Detail 2 & 3

1 Drafting 1
1 : 10



In accordance with NCC Vol. 2 2022 and Housing Provisions Part 3.3.3, the finished slab height is to be a minimum of 100mm above the finished ground level and the ground to have a fall of at least 50mm over 1000mm (3°) away from the building above any adjacent paved or concreted area and the those paved or concreted areas to have a fall of at least 25mm over 1000mm (1°) metre away from the building.

Concrete footings and slab, refer S01.1 FOOTING & SLAB PLAN and APEX ENGINEERING (Construction Detail Sheet)

Shape ground away from building 50mm over 1000mm (3°) in accordance and provide 100 diam stormwater outlet at the lowest point, and connected to stormwater drain

DIMENSION NOTE:
Use written diemtnions only. Do no scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installaion; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:
This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.



57 Cove Hill Road
Bridgewater TAS 7030
(03) 6263 6545
hobart@shedsnhomes.com.au
BLST Pty Ltd
ABN 52 660 422 159

| | | | |
|--|----------------------------|-----------------------|---------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | DRAWING TITLE SECTION A | | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | DATE 25/08/2025 | SCALE As indicated | DESIGNED BY SH |
| PROJECT New Ancillary Dwelling and New Veranda Roof | REVISION No | SHEET SIZE A3 | JOB No SNH25-033 |
| | | | SHEET No A5.0 |

8630



6823

DIMENSION NOTE:

Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

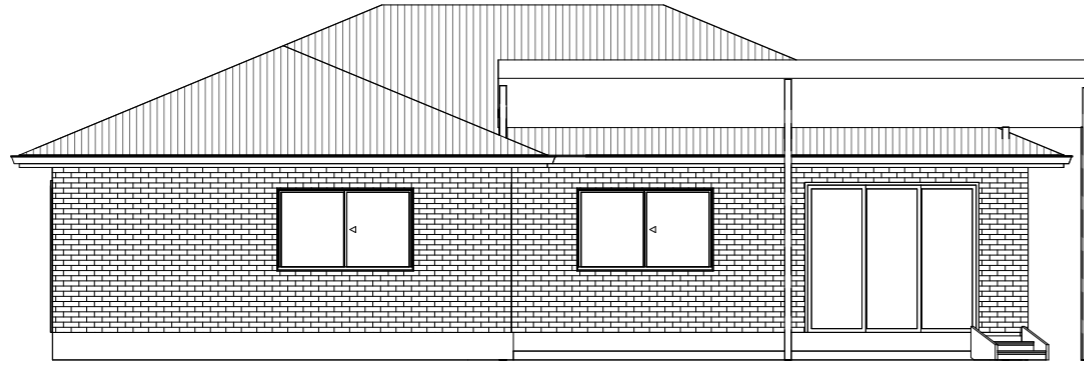
DRAWING NOTE:

This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.

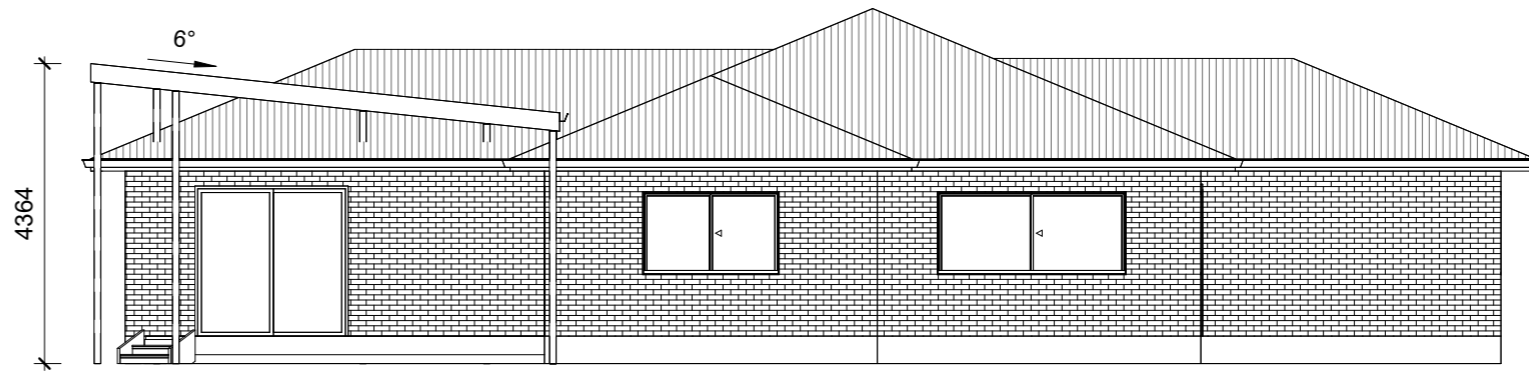


57 Cove Hill Road
 Bridgewater TAS 7030
 (03) 6263 6545
 hobart@shedsnhomes.com.au
 BLST Pty Ltd
 ABN 52 660 422 159

| | | | | |
|---|--|------------------------------------|------------------|---------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | | DRAWING TITLE FLOORPLAN VERANDA | | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | | DATE 11/09/2025 | SCALE 1 : 50 | DRAWN BY SH |
| PROJECT New veranda roof | | REVISION No | SHEET SIZE A3 | JOB No SNH25-033 |
| | | | | SHEET No A3.1 |



1 North
1 : 100



2 West
1 : 100

DIMENSION NOTE:

Use written dimensions only. Do not scale from drawings. All figured dimensions are to be used as a guide only. It is imperative that all dimensions, setouts and levels be confirmed onsite by the builder, Surveyor or Sub Contractor prior to the commencement of work, manufacture or installation; and the Builder, Sub Contractor and/or manufacturer ensures a full set of plans are on hand and reference has been made to the general notes

DRAWING NOTE:

This drawing & design shown is the property of BLST Pty Ltd and shall not be copied nor reproduced in part or in whole in any form without the written permission of BLST Pty Ltd and shall be used only by the client of BLST Pty Ltd for the project for which it was provided.



57 Cove Hill Road
Bridgewater TAS 7030
(03) 6263 6545
hobart@shedsnhomes.com.au
BLST Pty Ltd
ABN 52 660 422 159

| | | | | |
|---|--|-------------------------------------|------------------|---------------------|
| CLIENT NAME Gregory Raymond King and Julie Jones | | DRAWING TITLE ELEVATIONS VERANDA | | |
| PROJECT ADDRESS 18 Millvale Road, Dromedary | | DATE 11/09/2025 | SCALE 1 : 100 | DRAWN BY SH |
| PROJECT New veranda roof | | REVISION No | SHEET SIZE A3 | JOB No SNH25-033 |
| | | | | SHEET No A4.2 |

GEOTECHNICAL SITE INVESTIGATION



18 MILLVALE ROAD - DROMEDARY PROPOSED SHED

Client: Sheds n Homes

Certificate of Title: 173188/1

Investigation Date: 22/07/2025

Refer to this Report As

Enviro-Tech Consultants Pty. Ltd. 2025. Geotechnical Site Investigation for a Proposed Shed , 18 Millvale Road - Dromedary. Unpublished report for Sheds n Homes by Enviro-Tech Consultants Pty. Ltd., 22/07/2025.

Report Distribution

This report has been prepared by Enviro-Tech Consultants Pty. Ltd. (Envirotech) for the use by parties involved in the proposed development of the property named above.

Permission is hereby given by Envirotech and the client, for this report to be copied and distributed to interested parties, but only if it is reproduced in colour, and only distributed in full. No responsibility is otherwise taken for the contents.

Limitations of this report

In some cases, variations in actual Site conditions may exist between subsurface investigation boreholes. This report only applies to the tested parts of the Site at the Site of testing, and if not specifically stated otherwise, results should not be interpreted beyond the tested areas.

The Site investigation is based on the observed and tested soil conditions relevant to the inspection date and provided design plans (building footprints presented in Attachment A). Any site works which has been conducted which is not in line with the Site plans will not be assessed. Subsurface conditions may change laterally and vertically between test Sites, so discrepancies may occur between what is described in the reports and what is exposed by subsequent excavations. No responsibility is therefore accepted for any difference in what is reported, and actual Site and soil conditions for parts of the investigation Site which were not assessed at the time of inspection.

This report has been prepared based on provided plans detailed herein. Should there be any significant changes to these plans, then this report should not be used without further consultation which may include drilling new investigation holes to cover the revised building footprint. This report should not be applied to any project other than indicated herein.

No responsibility is accepted for subsequent works carried out which deviate from the Site plans provided or activities onsite or through climate variability including but not limited to placement of fill, uncontrolled earthworks, altered drainage conditions or changes in groundwater levels.

At the time of construction, if conditions exist which differ from those described in this report, it is recommended that the base of all footing excavations be inspected to ensure that the founding medium meets that requirement referenced herein or stipulated by an engineer before any footings are poured.

Investigation Summary

Site Classification

In accordance with AS2870 – 2011 and after thorough consideration of the known details pertaining to the proposed building and associated works (hereafter referred to as the Site), the geology, soil conditions, soil properties, and drainage characteristics of the Site have been classified as follows:

The Site has been classified as **CLASS M**, indicating that the soil profiles within the proposed building envelope are moderately reactive to soil moisture variations. This classification suggests that some or all test locations may experience surface movement within the range of 20 to 40 mm.

Foundations

Concentrated loads including but not limited to slab edge or internal beam or strip footings shall be supported directly on piers or pads which are founded on the siltstone bedrock at **0.8 to 1.0m** depth or greater (with an allowable bearing capacity of 400 kPa).

I recommend that during construction, I and/or the design engineer are notified of any major variation in the foundation conditions as predicted in this report.



Kris Taylor, BSc (hons)

Environmental & Engineering Geologist

Director

Site Investigation

The Site investigation is summarised in Table 1.

Table 1 Summary of Site Investigation

| | |
|---|---|
| Client | Sheds n Homes |
| Project Address | 18 Millvale Road - Dromedary |
| Council | Brighton |
| Planning Scheme | Tasmanian Planning Scheme |
| Inundation, Erosion or Landslip Overlays | None |
| Proposed | Shed |
| Investigation | Fieldwork was carried out by an Engineering Geologist on the 22/7/2025 |
| Site Topography | The building site has a strong slope of approximately 18% (10°) to the southwest |
| Site Drainage | The site receives overland flow runoff directly from the northeast. |
| Soil Profiling | Two investigation holes were direct push sampled from surface level around the proposed shed (Appendix A): |
| Investigation Depths | The target excavation depth was estimated at 1.5 m. Borehole BH01 was direct push sampled to 1.1 m and borehole BH02 was direct push sampled to 0.9 m (both ending in SILTSTONE). Borehole logs and photos are presented in Appendix B & C. |
| Soil moisture and groundwater | All recovered soil at the site ranged from dry to slightly moist. Groundwater was not encountered. |
| Geology | According to 1:25,000 Mineral Resources Tasmania geological mapping (accessed through The LIST), the geology comprises of: Permian - Triassic Dominantly freshwater cross-bedded quartzose sandstone, micaceous siltstone and mudstone (correlate of Ross Formation). |

Soil Profiles

The geology of the site has been documented and described according to Australian Standard AS1726 for Geotechnical Site Investigations, which includes the Unified Soil Classification System (USCS). Soil layers, and where applicable, bedrock layers, are summarized in Table 2.

Table 2 Soil Summary Table

| # | Layer | Details | USCS | BH01 | BH02 |
|---|------------|---|------|-------------------|--------------------------|
| 1 | SAND | TOPSOIL: SAND, very dark grey, well sorted, fine to medium grained sand, with silt, trace roots, trace clay, 5 % roots and leaf litter, VL-MD | SM | 0-0.1 DS@0.0 | 0-0.1 |
| 2 | Sandy SILT | SOIL & COBBLES: Sandy SILT, very dark brown, well sorted, low plasticity, medium to coarse grained sand, with gravel, trace roots, 5 % roots; angular gravel; 50% SILTSTONE cobbles, St | ML | | 0.1-0.4 DS@0.3 |
| 3 | Sandy CLAY | Sandy CLAY trace gravel, yellowish brown, high plasticity, medium to coarse grained sand; angular gravel, F | CH | | 0.4-0.7 DS@0.5 |
| 4 | Silty SAND | Silty SAND, dark brown, well sorted, fine to medium grained sand, with clay, trace roots, 5 % roots; angular gravel, MD | SM | 0.1-0.2 DS@0.1 | |
| 5 | CLAY | CLAY with sand, dark yellowish brown, high plasticity, fine grained sand, VSt | CH | 0.2-0.3 DS@0.2 | |
| 6 | Sandy CLAY | Sandy CLAY, yellowish brown, mottled reddish brown, well sorted, high plasticity, fine to medium grained sand, VSt-H | CH | 0.3-0.6 DS@0.5 | |
| 7 | Silty CLAY | Silty CLAY with sand, brownish yellow, medium plasticity, fine grained sand | CI | 0.6-1 DS@0.8 | 0.7-0.8 |
| 8 | SILTSTONE | SILTSTONE Bedrock, H (rock strenght inferred from BH02,0.8) | | 1-1.1 REF | 0.8-0.9 PL@0.8 REF |

Consistency¹ VS Very soft; S Soft; F Firm; St Stiff; Vst Very Stiff; H Hard. Consistency values are based on soil strengths AT THE TIME OF TESTING and is subject to variability based on field moisture condition

Density² VL Very loose; L Loose; MD Medium dense; D Dense; VD Very Dense

Rock Strength EL Extremely Low; VL Very Low; L Low; M Medium; H High; VH Very High; EH Extremely High

PL Point load test (lump)

DS Disturbed sample

PV Pocket vane shear test

FV Downhole field vane shear test

U50 Undisturbed 48mm diameter core sample collected for laboratory testing.

REF Borehole refusal

INF DCP has continued through this layer and the geology has been inferred.

¹ Soil consistencies are derived from a combination of field index, DCP and shear vane readings.

² Soil density descriptions presented in engineering logs are derived from the DCP testing.

Recommendations

Dispersive soils

Findings

The results presented in Appendix D indicate:

- Most of the soil layers at the Site (Layers 1 to 6) are considered either not dispersive (Class 4 or greater) or only slightly dispersive (Class 3) to depths of between 0.6 to 0.7m.
- Deeper soil Layer 7 (present in BH01 from 0.6m depth only) comprises Emerson Class 1 category soils which are considered severely dispersive

Site specific recommendations

- It is recommended that shed is either:
 - Not constructed onto dispersive soil (with the dispersive soil stripped out)
 - Constructed to prevent water from moving beneath the building entirely
 - Have the clay soil treated with gypsum as per Appendix G
- Cuts will need to be managed with either:
 - A retaining wall founded entirely onto bedrock
 - Batters treated with gypsum and topped with sand and loam.

For further guidance, general recommendations are presented in Appendix F.

Plumbing

Refer to hydraulic design drawings for detailed plumbing advice and requirements.

Refer to Table 3 to assess soil movement (Ys) around pipework for different depth ranges.

*Table 3 Millimetres soil movement (Ys) for determining plumbing requirements for various soil depths **

| Building | Profiles | P* | E Ys >75 | H2 Ys 60-75 | H1 Ys 40-60 | M Ys 20-40 | S Ys 0-20 | A Ys 0 |
|----------|-----------|----|-------------|----------------|----------------|---------------|--------------|-----------|
| Dwelling | BH01 BH02 | No | | | | 0-0.4 | 0.4-1 | 1-3 |

* Depths in this table are based on surfaces at the time of testing and do not allow for the influence of any additional fill added to the soil profile unless the Iss calculation depth has been modified based on the proposed cut and fill (see 'Footing Minimum Target Depths'). Where additional fill is proposed (and not indicated in the attached plans) Enviro-Tech are to be advised of final FFL's so the Site classification can be recalculated according to the specific fill reactivity and thickness used in the design.

Class A and S

When pipework service trench besses fall within Class A to S depth range as shown in Table 3, and all plumbing recommendations herein have been implemented, the drainage system does not require any additional protection and should be installed following the AS/NZS 3500 series standards.

Class M

When pipework service trench besses fall within Class M depth range as shown in Table 3, and all plumbing recommendations herein have been implemented, all stormwater and sanitary plumbing drains should have fittings set at their midposition during installation to allow 0.5ys movement in any direction. Pipe wrappings can be used at critical points.

AS3500.2:2021 Appendix G of AS3500.2:2021 should be referred for general advice.

Wastewater and Stormwater Management

If swale drains or absorption trenches are proposed for tank overflow or roof catchment management, the stormwater is not to be diverted within 45° downgradient of any building structure unless verified in a plan provided to Envirotech for approval. The proposed wastewater absorption area is suitably located.

Site Drainage

Surface drainage shall be considered in the design of the footing system, and necessary modifications shall be included in the design documentation. The surface drainage of the site shall be controlled from the beginning of the preparation and construction of the site. The drainage system shall be completed after the completion of the building construction.

Ideally, the areas around the footprint of the building should be graded or drained so that the water cannot pond against or near the building. As soon as footing construction has been completed, the ground immediately adjacent to the building should be graded to a uniform fall of 50mm minimum away from the building over the first metre. The final provision of paving to the edge of the building can greatly limit soil moisture variations due to seasonal wetting and drying.

Temporary Site Drainage

It is recommended that drainage protection works (cut off drains/mounds) are put in place above (upgradient of) the work area to prevent water and sediment from accumulating in and around footings and reduce the risk of erosion and instability around any proposed earth retaining structures.

Permanent Cut Batters – Soil and Rock

To ensure that cuts remain serviceable, it is recommended that unretained cuts in soil do not exceed 1V: 2H and unsupported batters in bedrock do not exceed 2V: 1H. Before cuts are approached by workers, cuts must be appropriately scaled to remove any loose soil and rock. The bedrock should not be increased beyond 2.0 m height relative to depth below natural level, without inspection by a suitably qualified person to ensure that these cuts are safe to work under.

Filling Works

- In the case where either of the following conditions occur, the Site is classified as Class P (AS2870 Clauses 2.5.2 and 2.5.3), in which case footings are to be designed in accordance with engineering specifications:
 - FILL OTHER THAN SAND exceeds 0.4 m depth.
 - SAND FILL exceeds 0.8 m depth.
- It is recommended that footing (edge beams, internal beams, and load support thickenings) concentrated loads are transferred through the fill to target founding layers.
- Subject to engineering advice, edge beams, internal beams, and load support thickenings may need to be founded on natural ground.
- SAND or FCR is always recommended rather than fill containing SILT or CLAY.
- Compacted CLAY or SAND FILL on well drained slopes should not exceed 1V:2H unless supported by an engineered retaining wall.
- Compacted stable rock fill on well drained slopes should not exceed 2V:3H unless supported by an engineered retaining wall.
- Any proposed filling works must be in accordance with AS3798 'Earthworks for Residential and Commercial Developments'.
- Before placing fill for landscaping, all topsoil should be removed from the filled area.
- Ideally, the fill should be free draining and placed to prevent water ponding. The fill should be placed in layers no greater than 150mm height and suitably compacted.

Long-term erosion management

The following measures are generally recommended for maintaining long-term erosion stability of soil slopes:

- Slopes exceeding 1V: 4H and up to 1V: 3H will need to be effectively stabilised with mulch/topsoil mixes, drill/broadcast seeding, hydroseeding or soil binders.
- Slopes up to 1V:2H can be stabilised with straw mulching.
- Slopes exceeding 1V: 2H and up to 1V:1.5H may be effectively stabilised with hydromulching
- Slopes exceeding 1V:1.5H but no greater than 1V: 1H will generally require measures such as erosion control blankets.

Earth-Retaining Structures

Any excavations higher than 1.0m and exceeding the recommended batter angle should be supported with a retaining wall engineered that allows free drainage of the retained soil and rock.

Building Pad Preparation

Any organic matter or other deleterious materials will need to be removed from the building envelope.

Topsoil containing grass roots must be removed from the area on which the footing will rest.

Unless otherwise stated in an engineering report, fill or loose, soft, low bearing capacity soil should either be removed from the building pad, or otherwise footings or piers should ideally be established to the base of this material to support the proposed structure.

Earthworks should be carried out in accordance with AS3798 'Earthworks for Residential and Commercial Developments'. Unsuitable materials in structural fill are listed in AS2870 Section 4.3.

The base of the excavation must be generally level but may slope not more than 1:40 to allow excavations to drain.

Bored Pier Impediments - Obstructions

There were no obvious impediments to auguring such as cobbles or boulders obstructions.

Bored Pier Impediments - Groundwater

Groundwater was not encountered.

Footing Preparation

Footing excavations must be free of loose earth, tree roots, mud or debris immediately before pouring concrete, ensuring the footing is appropriately seated on the target layer.

Foundation Maintenance

Details on appropriate site and foundation maintenance practises from the CSIRO BTF 18 Foundation Maintenance and Footing Performance: A Homeowner's Guide are presented in Appendix G of this report along with Australian Geoguide (LR8) Hillside Construction Practice (Appendix H).



Kris Taylor, BSc (hons)

Environmental & Engineering Geologist

Notes About Your Assessment

The Site classification provided and footing recommendations including foundation depths are assessed based on the subsurface profile conditions present at the time of fieldwork and may vary according to any subsequent *Site works* carried out. *Site works* may include changes to the existing soil profile by cutting more than 0.5 m and filling more than 0.4 to 0.8 m depending on the type of material and the design of the footing. All footings must be founded through fill *other than* sand not exceeding 0.4 m depth or sand not exceeding 0.8 m depth, or otherwise a Class P applies (AS2870 Clauses 2.5.2 and 2.5.3).

For reference, borehole investigation depths relative to natural soil surface levels are stated in borehole logs where applicable.

In some cases, variations in actual Site conditions may exist between subsurface investigation boreholes. At the time of construction, if conditions exist which differ from those described in this report, it is recommended that the base of all footing excavations be inspected to ensure that the founding medium meets the requirement referenced herein or stipulated by an engineer before any footings are poured.

The site classification assumes that the performance requirements as set out in Appendix B of AS 2870 are acceptable and that site foundation maintenance is carried out to avoid extreme wetting and drying.

It is the responsibility of the homeowner to ensure that the soil conditions are maintained and that abnormal moisture conditions do not develop around the building. The following are examples of poor practises that can result in abnormal soil conditions:

- The effect of trees being too close to a footing.
- Excessive or irregular watering of gardens adjacent to the building.
- Failure to maintain Site drainage.
- Failure to repair plumbing leaks.
- Loss of vegetation near the building.

The pages that make up the last six pages of this report are an integral part of this report. The notes contain advice and recommendations for all stakeholders in this project (i.e. the structural engineer, builder, owner, and future owners) and should be read and followed by all concerned.

References

AS 1289.6.3.2-2003 Soil strength and consolidation tests - Determination of the penetration resistance of a soil - 9 kg dynamic cone penetrometer test, Standards Australia, Sydney, Retrieved from SAI Global

AS 1289.7.1.1-2003 Methods of testing soils for engineering purposes Method 7.1.1: Soil reactivity tests—Determination of the shrinkage index of a soil—Shrink-swell index, Standards Australia, Sydney, Retrieved from SAI Global

AS 1726-2017, Geotechnical Site investigations, Standards Australia, Sydney, Retrieved from SAI Global

AS 2870-2011, Residential slabs and footings, Standards Australia, Sydney, Retrieved from SAI Global

AS4055 (2021). Australian Standard. Prepared by Committee BD-099, Wind Loads for Housing. Approved on behalf of the Council of Standards Australia on 1st June 2021 and published on 25th June 2021.

DPIPWE 2009. Dispersive Soils and their Management. Technical Reference Manual. Sustainable Land Use Department of Primary Industries Water and Environment.


Webster, S.L., Brown, R.W. and Porter, J.R. (1994) Force Projection Site Evaluation Using the Electric Cone Penetrometer (ECP) and the Dynamic Cone Penetrometer (DCP). Technical Report No. GL-94-17, Air Force Civil Engineering Support Agency, US Air Force, Tyndall Air Force Base, FL.

Appendix A Mapping



Figure 1 Site Borehole Locations

Appendix B Borehole Logs

|  | | ASSESSMENT: Geotechnical Site Investigation | | | | Borehole : BH01 | | | | | | |
|---|---------|--|---------------------------------|--------------------------|------------------------------------|-------------------------|----|----------------|----------|---------------------------|------------|------------|
| | | STRUCTURE: Shed | | | | DATE TESTED: 22/07/2025 | | | | | | |
| Positioning: GDA94 & mAHD | | EASTING: 514635 | | ACCURACY | | LOGGED BY: T. Gallagher | | | | | | |
| | | NORTHING: 5269461.5 | | HORIZ: 0.61m VERT: ~0.1m | | ELEVATION: 41.8 | | | | | | |
| LOCATION: 18 Millvale Road - Dromedary | | | | | EQUIPMENT: AMS Powerprobe 9120 RAP | | | | | | | |
| CLIENT: Sheds n Homes | | | | | ESTIMATED GROUND m (m AHD): | | | | | | | |
| DEPTH (m) | GRAPHIC | DESCRIPTION | DENSITY CONSIST. STRENGTH | LAYER | ELEVATION (mAHD) | MOISTURE | | SAMPLE TEST | Cu (kPa) | UCS (kg/cm ²) | (IS60 MPa) | |
| | | | | | | Index | % | | | | N SPT | NDCP/100mm |
| 0.0 | SM | TOPSOIL: SAND, very dark grey, well sorted, fine to medium grained sand, with silt, trace roots, trace clay, 5 % roots and leaf litter | medium dense | 1 | 41.7 | Slightly Moist | 19 | DS | | | | 3.0 |
| | SM | Silty SAND, dark brown, well sorted, fine to medium grained sand, with clay, trace roots, 5 % roots | | 4 | | | 8 | DS | | | | |
| | CH | CLAY with sand, dark yellowish brown, high plasticity, fine grained sand | very stiff | 5 | 41.5 | Dry | 23 | DS | | | | 6.0 |
| | CH | Sandy CLAY, yellowish brown, mottled reddish brown, well sorted, high plasticity, fine to medium grained sand | very stiff to hard | 6 | | | | | | | | |
| 0.5 | | | | | 41.3 | | 13 | DS | | | | 12.0 |
| | CI | Silty CLAY with sand, brownish yellow, medium plasticity, fine grained sand | | 7 | 41.1 | | | | | | | REF |
| | | | | | 40.9 | | 15 | DS | | | | |
| 1.0 | | SILTSTONE Bedrock very pale brown | | 8 | 40.7 | | | | | | | |
| | | Direct Push Sampler Refusal on SILTSTONE Bedrock | | | | | | | | | | |
| | | End of borehole at 1.1m depth. | | | | | | | | | | |

GROUNDWATER: Not Encountered

PAGE 1 of 1

TESTING: Penetrometer: AS 1289.6.3.2

DCP Blows per 100mm. For penetrometer blows per 100mm <1, distance travelled per blow is measured and converted back to blows per 100mm

DS: disturbed sample; PV: pocket vane; PP: pocket penetrometer; FV(Ømm): downhole field vane; U50: undisturbed 50mm sample; REF: DCP refusal

LOCATION: 18 Millvale Road - Dromedary
CLIENT: Sheds n Homes

EQUIPMENT: AMS Powerprobe 9120 RAP
ESTIMATED GROUND m (m AHD):

| DEPTH (m) | GRAPHIC | DESCRIPTION | DENSITY CONSIST. STRENGTH | LAYER | ELEVATION (mAHD) | MOISTURE | | SAMPLE TEST | Cu (kPa) | UCS (kg/cm ²) | (IS ₆₀ MPa) | | NDCP/100mm | |
|---|---------|--|---------------------------------|-------|---------------------|------------|----------------|----------------|----------|---------------------------|------------------------|------------------|------------|--|
| | | | | | | Index % | Well | | | | N _{SPT} | N _{DCP} | | |
| 0.0 | SM | TOPSOIL: SAND, very dark grey, well sorted, fine to medium grained sand, with silt, trace roots, trace clay, 5 % roots and leaf litter | very loose | 1 | 40.1 | | | | | | | | 1.0 | |
| | ML | SOIL & COBBLES: Sandy SILT, very dark brown, well sorted, low plasticity, medium to coarse grained sand, with gravel, trace roots, 5 % roots | stiff | 2 | 39.9 | | Slightly Moist | 5 | DS | | | | 4.0 | |
| 0.5 | CH | Sandy CLAY trace gravel, yellowish brown, high plasticity, medium to coarse grained sand | firm | 3 | 39.7 | | Moist | 23 | DS | | | | 1.8 | |
| | CI | Silty CLAY with sand, brownish yellow, medium plasticity, fine grained sand | | 7 | 39.5 | | Dry | | | | | | REF | |
| | | SILTSTONE Bedrock very pale brown | very high | 8 | 39.3 | | | PL | IS 50 | | 12 MPa | | | |
| <p>Direct Push Sampler Refusal on SILTSTONE Bedrock</p> <p>End of borehole at 0.9m depth.</p> | | | | | | | | | | | | | | |

GROUNDWATER: Not Encountered

TESTING: Penetrometer: AS 1289.6.3.2

DCP Blows per 100mm. For penetrometer blows per 100mm <1, distance travelled per blow is measured and converted back to blows per 100mm

DS: disturbed sample; PV: pocket vane; PP: pocket penetrometer; FV(Ømm): downhole field vane; U50: undisturbed 50mm sample; REF: DCP refusal

Appendix C Core Photographs

BH01



BH02



* 1 metre core tray length

Appendix D Geotechnical Testing

Dynamic Cone Penetrometer (DCP)

Dynamic cone penetrometer (DCP) testing was conducted according to AS 1289.6.3.2 with the results presented in Appendix B.

Soil Dispersion (Emerson aggregate test)

Select soil samples were tested for dispersion susceptibility using the Emerson Class number method according to AS1289.3.8.1. The results presented in Table 4 demonstrate that:

- The majority of the soil layer (Layers 1 to 6) are considered either not dispersive (Class 4 or greater) or only slightly dispersive (Class 3) to depths of between 0.6 to 0.7m.
- Deeper soil Layer 7 (present in BH01 from 0.6m depth only) comprises Emerson Class 1 category soils which are considered severely dispersive

Table 4 Summary of the Emerson class results.

| Layer | Soil | Depth | Sample ID | Emersion Class | Date Tested | Water | pH |
|-------|------------|-------|-----------|----------------|-------------|---------|-----|
| 1 | SAND | 0 | BH01 0.0 | Class >4 | 25/07/2025 | DI 13°C | |
| 4 | Silty SAND | 0.1 | BH01 0.1 | Class 3 | 25/07/2025 | DI 13°C | 6 |
| 5 | CLAY | 0.2 | BH01 0.2 | Class 3 | 25/07/2025 | DI 13°C | 6 |
| 2 | Sandy SILT | 0.3 | BH02 0.3 | Class 3 | 25/07/2025 | DI 13°C | 5.4 |
| 3 | Sandy CLAY | 0.5 | BH02 0.5 | Class 3 | 25/07/2025 | DI 13°C | 5.8 |
| 6 | Sandy CLAY | 0.5 | BH01 0.5 | Class >4 | 25/07/2025 | DI 13°C | |
| 7 | Silty CLAY | 0.8 | BH01 0.8 | Class 1 | 25/07/2025 | DI 13°C | 5.4 |

Appendix E Geotechnical Interpretation

Footing Minimum Target Depths

Footing design for the proposed structures are to consider the depths of limiting layers at the base of potentially problematic soils. Where practical/allowable, thickened beams may be deepened through problematic soil layers according to engineering specifications (Table 5). Table 6 should be referred to where only 50kPa allowable bearing capacity is required.

Table 5 also presents a summary of the estimated soil depths and associated layers where less than 5mm of vertical soil movement can be expected due to soil moisture fluctuations from normal seasonal wetting and drying cycles. Where 5mm tolerances are required, concentrated loads including but not limited to slab edge or internal beam or strip footings shall be supported directly on piers in accordance with minimum target layer depths presented in Table 5, with considerations given to required bearing capacities in accordance with Table 6.

Table 5 Soil characteristic surface movements and recommended footing minimum target depths

| Footing design parameters | BH01 | BH02 |
|---|-------------------|-------------------|
| Ys Calculation Depth | 0m [^] | 0m [^] |
| Surface movement Ys (mm) | 30 | 20 |
| Soil reactivity class | M | S |
| Base of problem soil layer (m)* | - | 0.1 |
| Layer at base of problem soil* | - | 2 |
| Pier/Footing minimum target depth (m) [#] | >1.1 [^] | >0.9 [^] |
| Pier/footing minimum target layer [#] | 8 | 8 |
| Allowable bearing capacity at min target depth (kPa) [#] | 400 | 400 |

- No problem layers encountered

[^] Calculations relative to surface of borehole at the time of investigation

[~] Calculated based on revised soil profile depth/thickness following indicative cut and fill. Inferred fill reactivity indicated (Iss value) which is typically based on more reactive soils expected to be encountered within inferred cut.

* Base of problematic soil layer depth below top of borehole surface at the time of testing to achieve 100 kPa allowable bearing capacity or greater.

[#] Target soil layer depth where Ys values from normal wetting and drying cycles are estimated at less than 5mm vertical movement. >minimum bored pier depths (see bearing capacity table for bored pier design depths).

Soil and Rock Allowable Bearing Capacity & End Bearing Capacity

Soil allowable bearing capacity was calculated from correlations with DCP blow counts. A recommended safety factor of 3 is applied in accordance with AS2870. Where high clay and silt content is observed in the soil, soil allowable bearing capacity is determined from undrained shear strengths using field vane correlated DCP values. Interpretive bearing capacity values are presented in Table 6.

Table 6 Soil allowable bearing capacities and problematic ground conditions.

| Depth below investigation surface (m) | Allowable Bearing Capacity (kPa) | |
|---------------------------------------|----------------------------------|-----------|
| | BH01 | BH02 |
| 0 | 130* | 50~ |
| 0.1 | 300 | 170* |
| 0.2 | 240 | 130 |
| 0.3 | 240 | 170 |
| 0.4 | >400 | 90~ |
| 0.5 | >400 | REF |
| 0.6 | REF | |
| 0.7 | | |
| 0.8 | | SILTSTONE |
| 0.9 | | |
| 1 | SILTSTONE | |

Correlations drawn from DCP and vane shear testing.

REF - Penetrometer Refusal

^ Footings to be founded through the FILL

~ Problematic soil layer attributed to loose, soft, or low allowable bearing capacity soil (<100 kPa)

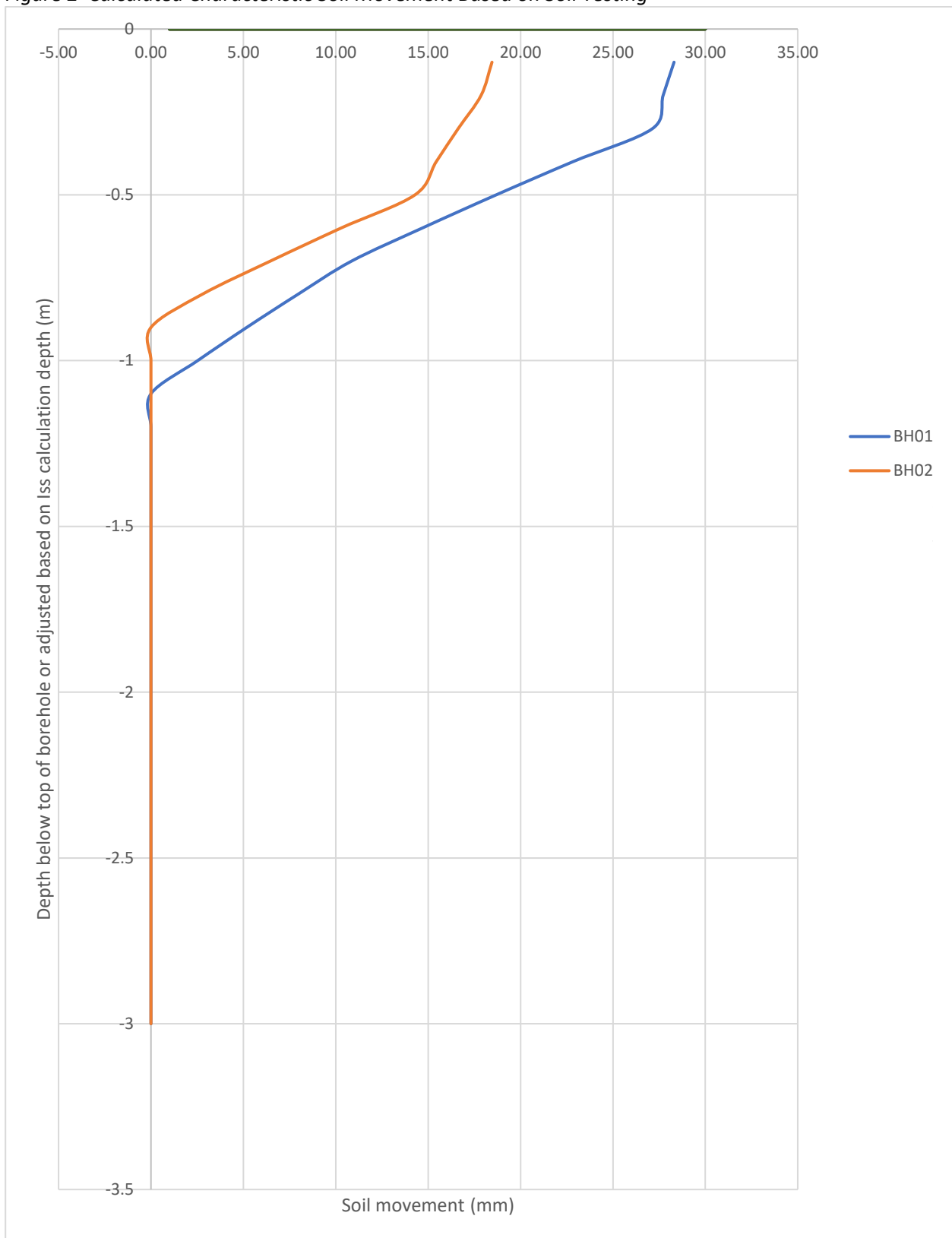
*Soil layer expected at the base of problematic soil layers at test location (or at surface where problematic soils not encountered) to achieve 100 kPa allowable bearing capacity or greater.

Characteristic Soil Movement (Ys)

The characteristic soil movement (soil reactivity) from wetting and drying cycles is calculated according to AS 2870 Section 2.3. The calculations are based on Iss % testing results or correlations with linear shrink data and are based on complete soil profiles for boreholes drilled within the building Site. In the case of where cut and fill are proposed and building finished floor levels (FFL) are made available, the Iss value is recalculated based on the FFL and estimated cut and fill as per Table 5.

According to AS 2870 Section 2.3, calculations consider the depth of groundwater and bedrock. Soil characteristic movements based on lab testing are presented in Figure 2.

Figure 2 Calculated Characteristic Soil Movement Based on Soil Testing



Appendix F General Advice - Dispersive Soil Management

The Site may be susceptible to tunnel erosion if subsurface drainage is not adequately managed. Tunnel erosion typically initiates in excavated cuts; however, it can also develop where dispersive soils are exposed through excavation, leading to the release of pore water and concentrated groundwater discharge. Additional contributing factors may include broken pipes, ineffective stormwater infrastructure, or unmanaged surface flows. If left unaddressed, these conditions can result in progressive subsoil loss, potentially undermining footings or causing settlement-related damage to the structure.

Tunnel erosion typically progresses upslope, initiated by the dissolution and removal of highly dispersive Class 1 and Class 2 soil layers. As tunnels enlarge, they can undermine surrounding soils that may not be dispersive but are still susceptible to collapse due to loss of subsoil support. If unmanaged, tunnel erosion can extend beyond property boundaries, posing a risk to nearby infrastructure including buildings, roads, and underground services. For further background on the management of Emerson Class 1 soils, refer to the Department of Primary Industries, Parks, Water and Environment (DPIPWE, 2009) guidance document.

Dispersive soils should be managed through a combination of drainage control and ground treatment measures. These may include overland flow management, controlled cut and fill practices, and, in more severe cases, the installation of sand barriers to interrupt subsurface flow paths. Where dispersive soils are exposed—particularly on batters or in excavation faces—chemical treatment using gypsum or lime may be employed to improve soil cohesion and reduce erosion potential. Application rates should be guided by Emerson Class test results, as outlined in Table 7.

Gypsum and hydrated lime are proven effective in mitigating erosion in dispersive soils by displacing sodium ions on clay particles and replacing them with calcium. This cation exchange improves soil structure, increases shear strength, and enhances resistance to tunnel and surface erosion. The effectiveness of treatment is influenced by the soil's properties; higher application rates of gypsum are typically required for soils with greater cation exchange capacity, elevated pH, and lower Emerson Class numbers. Application guidelines should be based on laboratory test results, including Emerson Class assessment, to ensure appropriate treatment dosages.

Table 7 Prescribed gypsum and hydrated lime application rates – see Emerson soil testing results

| Dispersive soil Emerson class | Gypsum/Hydrated Lime Application Rate pH < 7.5 | Gypsum Application Rate pH > 7.5 |
|-------------------------------|--|----------------------------------|
| Class 3 | 0 to 0.3 kg/m ² | 0.2 – 0.5 kg/m ² |
| Class 2 | 0.5 kg/m ² | 1.0 kg/m ² |
| Class 1 | 1.0 kg/m ² | 1.5 kg/m ² |

Where practicable, vehicle driveways and parking areas should be located on level or gently sloping terrain to minimise the need for deep excavation and reduce disturbance to dispersive soils identified on Site.

General Recommendations

To minimise disturbance and erosion in areas where Class 1 dispersive soils have been identified, the following measures are recommended:

- **Drainage Control:** Construct soil cut-off mounds or shallow interceptor trenches in non-dispersive soils, no deeper than 0.2 m above the interface with Class 1 dispersive soils. These should be positioned upslope of any proposed cuts to divert surface water before it reaches vulnerable areas.
- **Chemical Treatment:** Apply gypsum or hydrated lime to exposed dispersive soils where surface water movement is expected—particularly on freshly cut embankments, filled areas, service trenches, and zones where topsoil has been removed.
- **Surface Protection:** Cover all severely dispersive soils with either impermeable surfacing (e.g. paving) or a layer of non-dispersive topsoil to reduce erosion and limit moisture ingress.
- **Batter Stabilisation:** Place non-dispersive topsoil over freshly cut batters to protect against surface erosion and reduce the likelihood of tunnel initiation.
- **Remediation of Existing Tunnels:** Where tunnel erosion has already occurred, additional stabilisation of natural or constructed drainage gullies may be required. This may include the use of sand barriers and, in more severe cases, geotextile-wrapped drainage rock structures. When correctly designed, such barriers can intercept subsurface flow, promote controlled surface discharge, and direct water away from at-risk areas.

Key Management Measures for Dispersive Soils in Cut Embankments:

Surface water drainage can erode dispersive soils in embankment cuts. Groundwater discharge may worsen tunnel erosion by accelerating the development of secondary porosity—where subsurface flow progressively enlarges voids within the soil mass, leading to tunnel formation and internal instability. Management considerations:

- **Topsoil Removal Risks:** Earthworks commonly begin with the removal of non-dispersive topsoil, which often acts as a natural protective layer. Once removed, the underlying dispersive soils become highly vulnerable to erosion.
- **Barrier Construction in Cut Slopes:** Where excavation is necessary, erosion can be mitigated through immediate installation of physical barriers:
 - Place a sand layer (sand barrier) over exposed dispersive soil within the cut to interrupt flow paths.
 - Construct an earth retaining wall in front of the cut to contain soil and stabilise the slope face.
- **Timely Implementation:** All erosion control measures must be implemented immediately following excavation to prevent the initiation of tunnel erosion.
- **Use of Retaining Structures:** Low-height retaining walls (e.g., timber sleeper walls) constructed at the base of cut faces can assist in retaining eroding soils and maintaining the effectiveness of sand barriers.

Sand Barriers

To manage dispersive soils exposed in cut slopes, the following layered treatment is recommended:

- **Chemical Stabilisation:** Apply gypsum or hydrated lime at application rates specified in Table 7, based on Emerson Class testing.
- **Sand Layer:** Install a minimum 100 mm thick layer of clean, free-draining sand to act as a barrier and interrupt preferential flow paths.
- **Topsoil Cover:** Place a layer of non-dispersive, free-draining topsoil (such as loam) over the sand barrier to retain the sand in place and facilitate effective revegetation or application of surface treatments.
- **Erosion Control:** Implement surface erosion protection measures as outlined in the Erosion Control section to prevent wash-off and maintain system effectiveness.

Retaining Walls

The following measures are recommended when constructing retaining walls in areas with dispersive soils:

- Retaining walls should be founded on bedrock or non-dispersive soils to reduce the risk of tunnel erosion and structural instability.
- Where walls are constructed in Class 1 dispersive soils, freshly cut surfaces may be treated with gypsum or hydrated lime at application rates specified in Table 7 to reduce erosion potential.

Drainage

Effective drainage is critical in dispersive soil environments to prevent erosion, tunnel formation, and structural damage. The following measures are recommended:

- Divert surface water away from cut and fill slopes to reduce infiltration into dispersive soils.
- A sealed toe drain is essential to prevent water from soaking into freshly cut dispersive soils and migrating through dispersive fill layers beneath paved surfaces.
- For optimal surface drainage over Class 1 soils, install concrete spoon drains in preference to earthen swales to minimise erosion risk.
- Where earthen swale drains are used, stabilise Class 1 soils with gypsum or hydrated lime at a rate adjusted to soil pH. A liner (e.g. 20 mm bentonite layer) beneath topsoil and turf may be used to limit vertical water infiltration.
- Subsurface drains installed in Class 1 soils should be backfilled with a sand mix containing 2% gypsum or hydrated lime to inhibit dispersion and maintain flow pathways.
- Non-perforated drainage pipes should be used to divert water away from identified groundwater discharge points, limiting further erosion.

Filling

The use of dispersive soils as fill presents a significant risk for tunnel erosion, especially where water movement is poorly controlled. The following measures are recommended to reduce risk and ensure long-term stability:

- Dispersive soil used as fill is highly susceptible to tunnel erosion, particularly when exposed to concentrated surface or groundwater flow.
- Groundwater can migrate along the base of and within fill layers, initiating erosion of dispersive materials and undermining overlying structures.
- All proposed filling, especially within or near building footprints, should be carefully managed. This may involve either:
 - Removal of Class 1 dispersive soil from beneath the structure, or
 - Chemical treatment of dispersive fill using gypsum or hydrated lime, applied to the surface of each compacted lift.
 - Preventing water from intercepting dispersive soil by liming the fill or with careful drainage management
- When chemically treating fill:
 - Use 300 mm thick lifts with full application rates as specified in Table 7.
 - For 150 mm thick lifts, halve the application rate accordingly.
- Ensure compaction is achieved close to optimum moisture content, particularly in areas adjacent to footings and structures.
- Paved surfaces over filled areas significantly reduce the risk of tunnel erosion, if cut-off drains are installed to prevent water ingress at the fill base.
- Where feasible, spoon drains and pavement edges at the toe of cut batters should be founded on non-dispersive soil or bedrock to intercept all surface water and eliminate seepage pathways.
- If topsoil is removed prior to filling, and it is classified as slightly dispersive (Class 3) or non-dispersive (Class 4 or higher), it may be replaced with a liner or imported non-dispersive material to protect the dispersive fill beneath.

Roofed and Paved Area Stormwater Management

All captured water on-site, including roof runoff, must be managed to remain at the surface and be evenly dispersed downslope across the Site. Roof runoff must be directed to detention tanks, with overflow discharged via surface irrigation—not into soakage pits. Due to the absence of non-dispersive topsoil, imported loam is required in irrigation areas. Irrigation must either:

1. Be delivered just below the surface, draining directly into the imported loam without contact with dispersive soils; or
2. Be applied via above-ground sprinklers onto imported loam to prevent erosion and maintain surface stability.

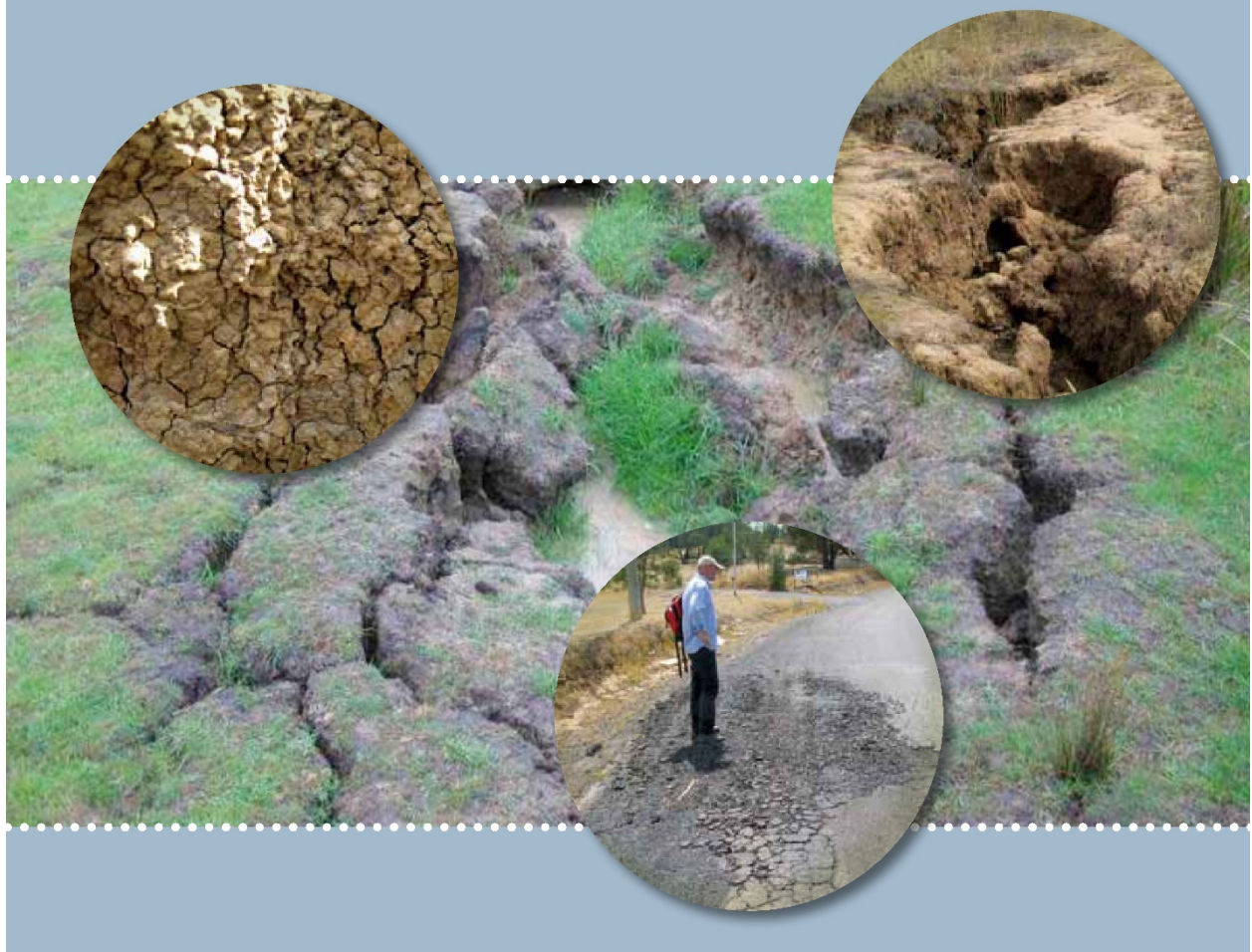
Runoff from pavements and other impervious surfaces must either be captured and redirected into detention tanks for controlled redistribution.

For driveways, runoff should be directed via cross-slope or in-slope alignment into lined side drains or swales. These must convey collected water to designated redistribution areas —such as detention tanks with surface irrigation or into distribution swales. Overflow must be dispersed across imported loam soils which is not located upgradient or downgradient of existing structures and ensuring water is not concentrated near foundations or fill. If distribution swales are used, they must be lined, constructed with low gradients, and designed to promote sheet flow rather than concentrated runoff. Distribution swale overflow must discharge onto non-dispersive imported loam soils.

Service Trenches

An effective measure to prevent stormwater ingress into backfilled service trenches is to ensure the trench surface is well sealed with non-dispersive soils or stable topsoil. As an additional site-specific recommendation, service trenches should be backfilled with compacted sand, which will help prevent water channelisation and reduce the risk of tunnel erosion along trench alignments.

DISPERSIVE SOILS *and* *their* MANAGEMENT



Technical Reference Manual

Sustainable Land Use
Department of Primary Industries and Water



4.1 MANAGEMENT OPTIONS FOR TUNNEL EROSION

Past efforts to repair tunnel erosion in agricultural landscapes have relied on mechanical destruction of the tunnel system by deep ripping, contour furrowing, and contour ripping. Unfortunately many of these techniques either failed or resulted in tunnel re-emergence in an adjacent areas (Floyd 1974, Boucher 1995). The use of these 'agricultural' techniques is inappropriate in peri-urban areas where tunnel repair requires a low incidence of re-failure due to the potential for damage to infrastructure. Experience with the construction of earth dams using dispersive clays, demonstrates that repair and prevention of tunnel erosion in urban and peri-urban environments is best achieved using a combination of,

- » Identification and avoidance of dispersive soils.
- » Precise re-compaction.
- » Chemical amelioration.
- » Sand blocks and barriers.
- » Topsoil, burial and revegetation.

4.2 IDENTIFICATION AND AVOIDANCE OF DISPERSIVE SOILS

The risk of tunnel erosion resulting from construction activities on dispersive soils can often be reduced or eliminated by identifying and avoiding areas containing dispersive soils. The presence and severity of dispersive soils can vary enormously over short distances (Figure 13). In many instances, large scale (ie 10 x 10 or 20 x 20 meter grid) soil survey and screening of soils for dispersion, (using the Emerson crumb test - section 3, Appendix I) can be used to site dwellings and infrastructure away from dispersive soils. Advice should be sought from a suitably qualified and experienced engineer or soil professional.



Figure 13. The severity (or sodium content) and depth of dispersive subsoils can vary considerably over short distances. (a). At this site highly dispersive subsoils exist meters away from (b) non-dispersive soils.

4.3 COMPACTION

Ritchie (1965) demonstrated that the degree of compaction within the dam wall was the single most important factor in reducing dam failure from piping (tunnel erosion). A high degree of compaction reduces soil permeability, restricting the movement of water and dispersed clay through the soil matrix, which decreases the severity of dispersion and restricts tunnel development (Vacher *et al.* 2004). However, dispersive soils can be difficult to compact as they lose strength rapidly at or above optimum moisture content, and thus may require greater compactive force than other soils (McDonald *et al.* 1981). Bell & Bryun (1997) and Bell and Maud (1994) suggest that dispersive clays must be compacted at a moisture content 1.5 -2% above the optimum moisture content in order to achieve sufficient density to prevent piping (Elges 1985).

Construction of structures such as earth dams and footings for buildings with dispersive soils require geotechnical assessment and advice from a qualified and experienced engineer, in order to determine compaction measures such as the optimal moisture content, number of passes, and maximum thickness of compacted layers.

Normal earth moving machinery including bull-dozers, excavators and graders do not provide sufficient compactive force to reduce void spaces or achieve adequate compaction in dispersive soils. A sheepsfoot roller of appropriate weight is usually required to compact dispersive soils. By comparison a D6 dozer applies only 0.6 kg/cm² pressure compared to 9.3 kg/cm² for a sheepsfoot roller (Sorensen 1995).

4.4 CHEMICAL AMELIORATION

Initiation of tunnel erosion is predominantly a chemical process, so it makes sense to use chemical amelioration strategies when attempting to prevent or repair tunnel erosion in dispersive soils. Despite the widespread use of gypsum and lime to treat sodic soils in agriculture, the use of gypsum and lime to treat tunnel affected areas has been relatively rare (Boucher 1990).

Hydrated lime (calcium hydroxide) has been widely used to prevent piping in earth dams. Rates of application have varied depending on soils and degree of compaction used in construction. Laboratory testing usually indicates that only around 0.5 – 1.0% hydrated lime is required to prevent dispersion, however difficulties with application and mixing necessitate higher rates of application (Moore *et al.* 1985). Moore *et al.* (1985) cite examples of the use of hydrated lime to control piping in earth dams at rates between 0.35% (N.S.W. Australia) and 4% (New Mexico). Elgers (1985), and McElroy (1987) recommend no less than 2% hydrated lime (by weight of the total soil material) to prevent dispersion within dam embankments, while Bell and Maud (1994) suggest that 3% - 4% by mass of hydrated lime should be added to a depth of 0.3m on the upper face of embankments. In alkaline (pH >7.0) soils (most sodic subsoils in Tasmania are neutral or alkaline) the effectiveness of hydrated lime is reduced by the formation of insoluble calcium carbonate (Moore *et al.* 1985), such that gypsum is preferred to hydrated lime. It is important to note that agricultural lime (calcium carbonate) is not a suitable substitute for hydrated lime due to its low solubility (McElroy 1987). Also note that excessive applications of lime may raise soil pH above levels required to sustain vigorous plant growth.

Gypsum (calcium sulphate) is more effective than lime for the treatment of dispersive soils as it increases the electrolyte concentration in the soil solution as well as displacing sodium with calcium within the clay structure (Raine and Loch 2003). Gypsum is less commonly used than hydrated lime in dam construction and other works due to its lower solubility, and higher cost. Elges (1985) recommends that in construction, a minimum of 2% by mass of gypsum be used. Bell and Maud (1994) present a means of calculating the amount of gypsum required to displace excess sodium and bring ESP values within desired limits (normally < 5). Be aware that application of excessive amounts of gypsum may cause soil salinity to temporarily rise beyond the desired level for plant growth.

NOTE:

- » Use of gypsum in Tasmania is covered under the Fertiliser Act 1993, which has established the allowable limit for cadmium and lead at 10 mg/kg and 5 mg/kg for mercury.
- » Gypsum is usually imported into Tasmania from Victoria or South Australia, which have different standards for allowable heavy metal content.
- » Purchasers of gypsum should check with suppliers to ensure that gypsum imported into Tasmania is compliant with current regulations.

Alum (aluminium sulphate) has been effectively used to prevent dam failure and protect embankments from erosion. Application rates are not well established. Limited data suggests mixtures of 0.6 – 1.0% (25% solution of aluminium sulphate) (Bell and Bruyn 1997, McElroy 1987) to 1.5% (Ouhadi, and Goodarzi 2006) of the total dry weight of soil may be appropriate. Alum is however highly acidic (pH 4-5), and thus alum treated soils will need to be capped with topsoil in order to establish vegetation (Ryker 1987). Soil testing is required to establish appropriate application rates for Tasmanian soils.

Long chain polyacrylamides have been shown to increase aggregate stability, reduce dispersion and maintain infiltration rates in dispersive soils (Levy *et al.* 1992, Raine and Loch 2003). However the effect is highly variable between various polyacrylamide products and the chemical and physical properties of the soil. The benefit of polyacrylamides is generally short due to their rapid degradation (Raine and Loch 2003). Further advice and laboratory testing should be conducted before using polyacrylamides to protect earth dams from piping failure.

Note that appropriate application rates for gypsum, hydrated lime, alum and polyacrylamides have not been established for dispersive soils in Tasmania. Extensive laboratory assessment of materials used for the construction of dams or embankments is required before locally relevant 'rules of thumb' can be established for the use of these products.

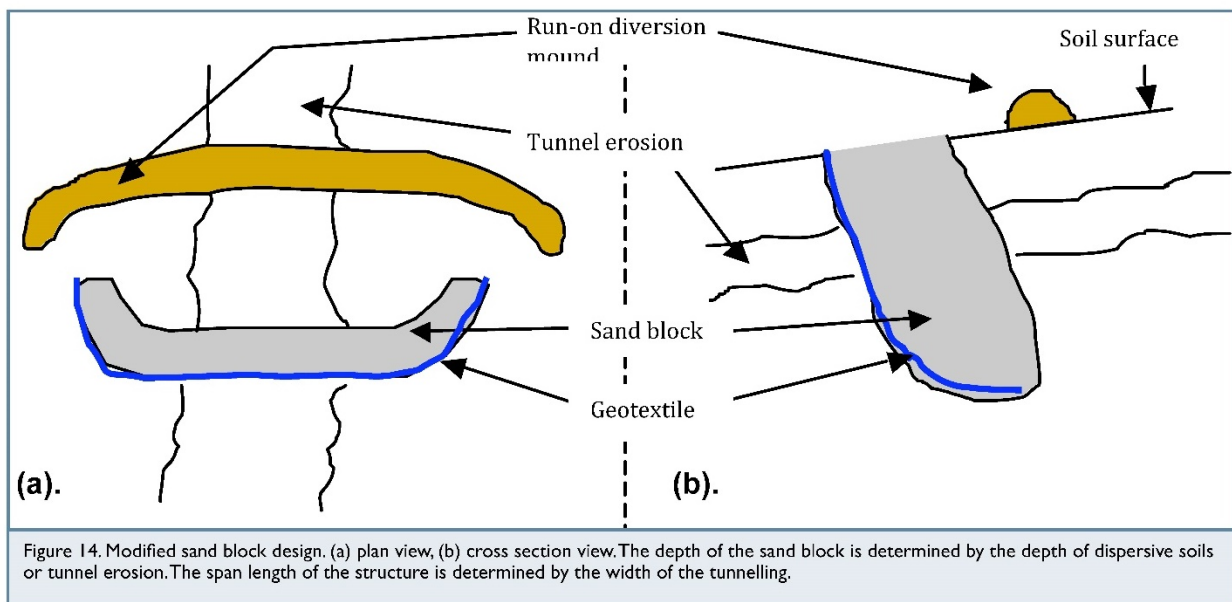
4.5 SAND BLOCKS AND SAND BARRIERS

Sand filters were first developed to prevent piping in earth dams. Sand filters prevent dam failure by trapping entrained sand and silt, blocking the exit of the tunnel and preventing further tunnel development (Sherard *et al.* 1977). Following the work of Sherard *et al.* (1977), Richley (1992 and 2000) developed the use of sand blocks to prevent tunnel erosion during installation of an optical fibre cable in highly dispersive soils near Campania, Tasmania. The sand blocks work slightly differently to the sand filters in that they allow the free water to rise to the surface through the sand. The use of sand blocks has recently been modified by Hardie *et al.*, (2007) to prevent re-initiation of tunnel erosion along an optical fibre cable near Dunalley. Modifications to the original technique developed by Richley (1992 and 2000) include (Figure 14 & 15);

- » Upslope curved extremities to prevent the structure from being by-passed.
- » Geotextile on the downslope wall to prevent collapse or removal of sand following settlement or erosion.
- » Application of gypsum (around 5% by weight) to ensure infiltrating water contains sufficiently electrolyte to prevent further dispersion.
- » Earth mound upslope of the structure to prevent run-on entering the sand blocks.



Figure 15. (a) Installation of sandblock perpendicular to a service trench. Note securing of geotextile to the optical fibre cable to prevent water flowing past the sand block. (b) Sandblock before final topsoiling.



4.6 USE OF TOPSOIL / BURIAL AND REVEGETATION

Topsoil or burial of exposed dispersive soils reduces the likelihood of subsoil dispersion and initiation of tunnel erosion by;

- » Providing a source of salt to increase the electrolyte content of infiltration water:
- » Preventing desiccation and subsoil cracking.
- » Promoting even infiltration.
- » Providing a protective cover from raindrop impact.
- » Providing a suitable medium for revegetation.

Topsoil minimises the interaction between water and dispersive clays by providing both a physical and chemical barrier. Topsoil also reduces soil desiccation and development of surface cracks (Sorensen 1995). It is suggested that exposed dispersive subsoils be covered with at least 150mm of non dispersive topsoil and sown with an appropriate mix of grass species. In some cases it will be necessary to protect the topsoil from erosion with 'jute' cloth or similar product.

The suitability of planting trees in tunnel affected areas is influenced by the amount of annual rainfall and frequency of soil cracking resulting from desiccation. Boucher (1995) recommends the preferred option for revegetation of reclaimed tunnel erosion is a widely spaced tree cover in association with a combination of perennial and annual pastures, rather than a dense stand of trees or pasture alone. Experience in Tasmania suggests that in low rainfall areas, or areas in which existing trees or shrubs cause soil drying and cracking, the preferred option for revegetating tunnel affected land is a dense healthy pasture. In high rainfall areas, dense plantings of trees have been successfully used to repair or stabilise tunnel erosion for example Colclough (1973) successfully used *Pinus radiata* to stabilise tunnel-gully affected land in a moderate rainfall area near Tea Tree, Tasmania.

5.0 ACTIVITIES THAT INCREASE THE RISK OF EROSION ON DISPERSIVE SOILS

ACTIVITIES THAT INCREASE RISK OF INITIATING TUNNEL EROSION, INCLUDE;

- » Removal of topsoil.
- » Soil excavation or expose of subsoils to rainfall.
- » Supply of services via trenches.
- » Construction of roads and culverts in dispersive subsoils.
- » Installation of sewage and grey water disposal systems in dispersive subsoils.
- » Dam construction from dispersive soils.

OPTIONS FOR REDUCING THE RISK OF TUNNEL EROSION DURING CONSTRUCTION AND DEVELOPMENT WORKS ON DISPERSIVE SOILS INCLUDE,

- » Where possible do not remove or disturb topsoil or vegetation.
- » Ensure that dispersive subsoils are covered with an adequate layer of topsoil.
- » Avoid construction techniques that result in exposure of dispersive subsoils.
- » Use alternatives to 'cut and fill' construction such as pier and post foundations.
- » Where possible avoid the use of trenches for the supply of services ie water & power:
- » If trenches must be used, ensure that repacked spoil is properly compacted, treated with gypsum and topsoiled.
- » Consider alternative trenching techniques that do not expose dispersive subsoils.
- » Ensure runoff from hard areas is not discharged into areas with dispersive soils.
- » If necessary create safe areas for discharge of runoff.
- » If possible do not excavate culverts and drains in dispersive soils.
- » Consider carting non-sodic soil to create appropriate road surfaces and drains without the need for excavation.
- » Ensure that culverts and drains excavated into dispersive subsoils are capped with non-dispersive clays mixed with gypsum, topsoiled and vegetated.
- » Avoid use of septic trench waste disposal systems; consult your local council about the use of alternative above ground treatment systems.
- » Where possible do not construct dams with dispersive soils, or in areas containing dispersive soils.
- » If dams are to be constructed from dispersive clays, ensure you consult an experienced, qualified civil engineer to conduct soil tests before commencing construction.
- » Construction of dams from dispersive soils is usually possible, using one or a combination of: precise compaction, chemical amelioration, capping with non-dispersive clays, sand filters and adequate topsoiling.

With all forms of construction on dispersive soils, ensure you obtain advice and support from a suitably experienced and qualified engineer or soil professional before commencing work.

Foundation Maintenance and Footing Performance: A Homeowner's Guide



CSIRO

BTF 18
replaces
Information
Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

| Class | Foundation |
|--------|---|
| A | Most sand and rock sites with little or no ground movement from moisture changes |
| S | Slightly reactive clay sites with only slight ground movement from moisture changes |
| M | Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes |
| H | Highly reactive clay sites, which can experience high ground movement from moisture changes |
| E | Extremely reactive sites, which can experience extreme ground movement from moisture changes |
| A to P | Filled sites |
| 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 |

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpend).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/ Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

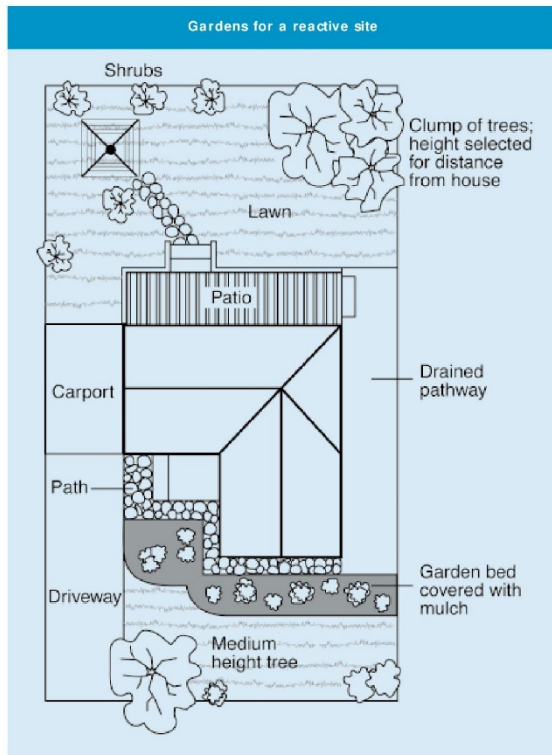
It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

| CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS | | |
|---|---|-----------------|
| Description of typical damage and required repair | Approximate crack width limit (see Note 3) | Damage category |
| Hairline cracks | <0.1 mm | 0 |
| Fine cracks which do not need repair | <1 mm | 1 |
| Cracks noticeable but easily filled. Doors and windows stick slightly | <5 mm | 2 |
| Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired | 5–15 mm (or a number of cracks 3 mm or more in one group) | 3 |
| Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted | 15–25 mm but also depend on number of cracks | 4 |



- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

Distributed by

CSIRO PUBLISHING PO Box 1139, Collingwood 3066, Australia

Freecall 1800 645 051 Tel (03) 9662 7666 Fax (03) 9662 7555 www.publish.csiro.au

Email: publishing.sales@csiro.au

© CSIRO 2003. Unauthorised copying of this Building Technology file is prohibited

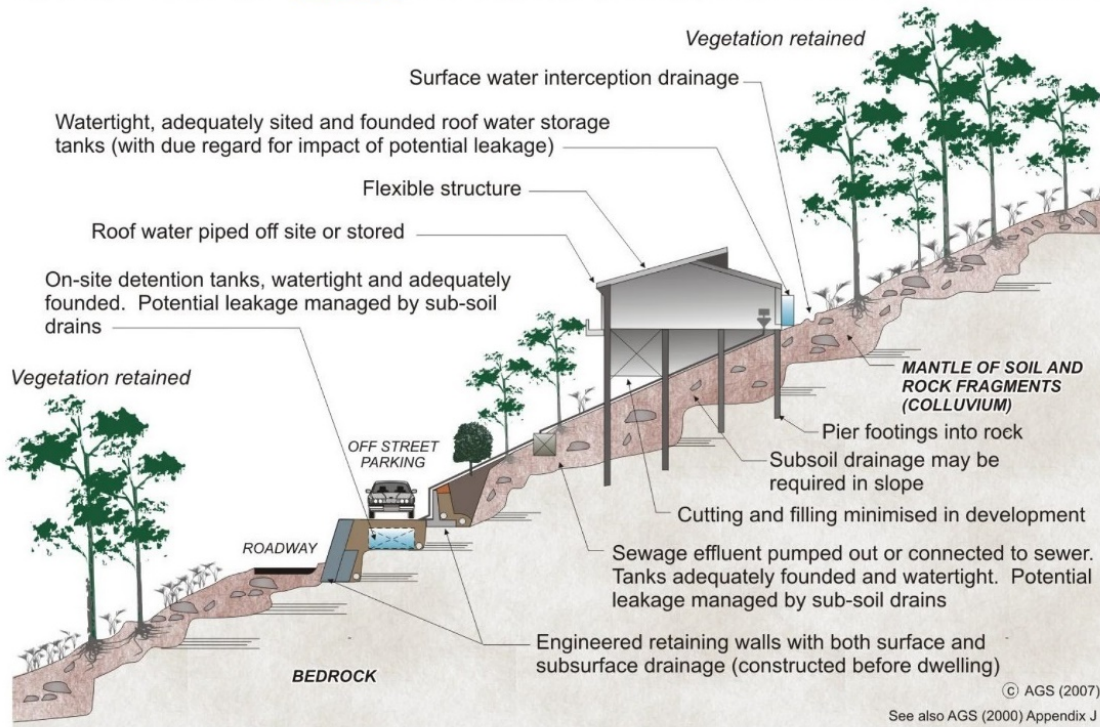
Appendix H Examples of Good Hillside Construction (AGS LRM LR8)

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.

EXAMPLES OF GOOD HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

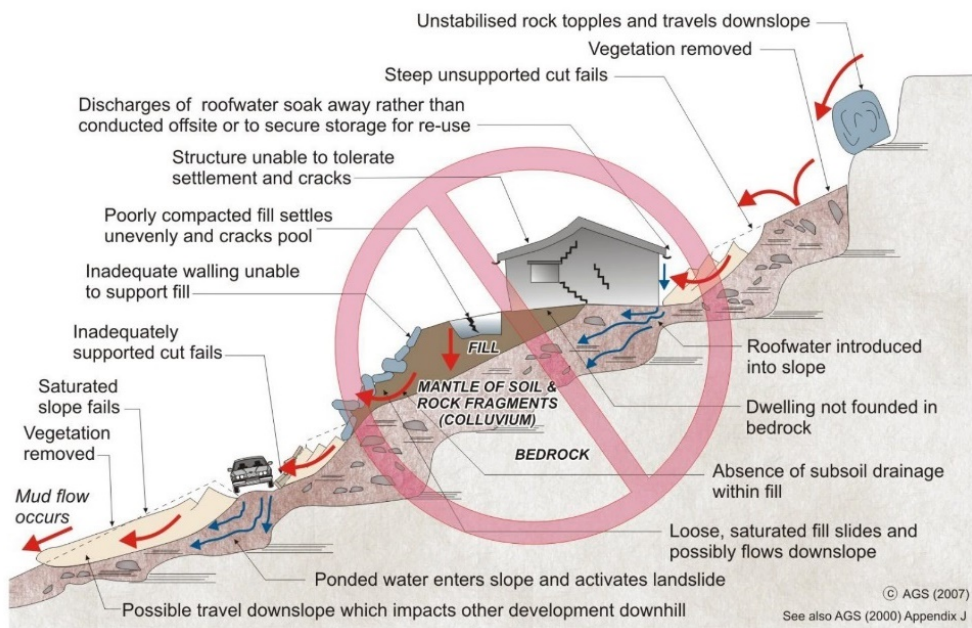
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF **POOR** HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the [Australian Geomechanics Society](#), a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

CERTIFICATE OF QUALIFIED PERSON – ASSESSABLE ITEM

Section 321

To: Owner /Agent
 Address
 Suburb/postcode

Form **55**

Qualified person details:

Qualified person:
Address: Phone No:
 Fax No:
Licence No: Email address:

Qualifications and Insurance details: (description from Column 3 of the Director's Determination - Certificates by Qualified Persons for Assessable Items)

Speciality area of expertise: (description from Column 4 of the Director's Determination - Certificates by Qualified Persons for Assessable Items)

Details of work: Geotechnical Site Investigation

Address: Lot No:
 Certificate of title No:

The assessable item related to this certificate: (description of the assessable item being certified)
Assessable item includes –
- a material;
- a design
- a form of construction
- a document
- testing of a component, building system or plumbing system
- an inspection, or assessment, performed

Certificate details:

Certificate type: (description from Column 1 of Schedule 1 of the Director's Determination - Certificates by Qualified Persons for Assessable Items n)

This certificate is in relation to the above assessable items, at any stage, as part of – (tick one)

building work, plumbing work or plumbing installation or demolition work

OR

a building, temporary structure or plumbing installation

In issuing this certificate the following matters are relevant –

| | |
|------------------------|--|
| Documents: | Enviro-Tech Consultants Pty. Ltd. 2025. Geotechnical Site Investigation for a Proposed Shed , 18 Millvale Road - Dromedary. Unpublished report for Sheds n Homes by Enviro-Tech Consultants Pty. Ltd., 22/07/2025. |
| Relevant calculations: | |
| References: | - AS1726-2017 Geotechnical Site Investigations |

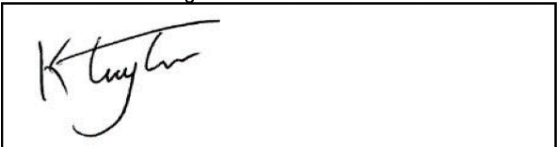

Substance of Certificate: (what it is that is being certified)

| |
|---|
| - An assessment of: - Foundations for proposed building structures.* |
|---|

Scope and/or Limitations

| |
|---|
| The Geotechnical Site Investigation applies to the Site and Project Area as inspected and does not account for future alteration to foundation conditions as a result of earth works, drainage condition changes or variations in site maintenance which are not included within the provided plans. *This report contains soil classification information prepared in accordance with AS2870 as well as AS2870 extracts which may be used as general guidance for plumbing design. The hydraulic designer is to use their own judgment in the application of this information and this report must be read in conjunction with hydraulic plans for the proposed development. |
|---|

I certify the matters described in this certificate.

| | | | |
|-------------------|---|---|----------------------------|
| Qualified person: | <i>Signed:</i>  | <i>Certificate No.:</i>  | <i>Date:</i> 22/07/2025 |
|-------------------|---|---|----------------------------|

ON-SITE WASTEWATER REPORT

Julie Jones & Gregory Hacka

Sheds n Homes

18 Millvale Road – Dromedary

*CKDesign Reference: **CKD-HYD-316***

Date:04/09/2025

For Approval – Rev 0

TABLE OF CONTENTS

1. INTRODUCTION AND SCOPE OF ENGAGEMENT
2. WASTEWATER DESIGN
3. Trench 3 Design
4. INSTALLED IRRIGATION DETAILS
5. CONCLUSION

1. INTRODUCTION AND SCOPE OF ENGAGEMENT

Fysh Design has been engaged to provide an assessment of an existing on-site wastewater secondary AWTS system to service the existing dwelling and the proposed 1 bedroom ancillary dwelling at 18 Millvale Road, Dromedary

The following report outlines the methodology and assumptions used for the existing secondary wastewater treatment system

2. WASTEWATER DESIGN

Site Conditions

Client: Sheds n Homes (Julie Jones and Gregory Jacka

Address: 18 Millvale Road, Dromedary

Site Area – Approx 1 ha

Building Type –existing dwelling and proposed ancillary dwelling

Drainage lines & Water Courses – Good drainage with overland flow run off directly from the northwest

Vegetation – Mixed native grass species, bushland trees

Rainfall in the previous 7 days – 26.5mm

Average slope approx. Moderate slope of 18% (10 deg) to the Southwest

Domestic water supply – TasWater Supply

Background Information

Mapped Geology – Mineral Resources Tasmania 1:25,000

Rock Type – Sandstone

Soil Depth – 1.5 to siltstone refusal

Local Authority – Brighton City Council

Landslide Zoning – None

Local Services – Onsite wastewater disposal, TasWater Water supply

FYSH DESIGN
CIVIL HYDRAULIC

Wastewater Classification and Recommendations

According to AS1547.2012 for on- site wastewater management the soil in the property is classified as **Clay Loams (Category 4)**.

A site inspection was performed to inspect the existing concrete Econocycle 7000L ENC10-1 AWTS currently being used by the existing dwelling located at the property



Figure 3: Existing 7000L Econocycle ENC10-1 system



Figure 4: Existing 7000L Econocycle ENC10-1 system

FYSH DESIGN
CIVIL HYDRAULIC

Wastewater Loading Certificate for system design (As per Clause 7.4.2(d) of AS1547/2012) (Proposed)

Proposed System DEMAND – 7 people @ 150 L/Person/Day (As per Table 1 of Tasmanian directors' determination for wastewater, for a 3-bedroom dwelling (5) plus single bedroom ancillary dwelling (2))

Summary of Design Criteria (Proposed) –DIR 3.5/m²/day (Secondary Treatment DIR Rating)

Q = Design Flow = 1050L/Day

Q/ (DIRxLine) separation (1m)

1050 / (3.5x1.0) = 300m sqm area (Minimum rounded required)

(Category 4)

Water Supply – TasWater Supply

Reserve area use - (unused backyard area)

Consequences of changes in loading capacity – The existing concrete Econocycle 7000L ENC10-1 AWTS Secondary treatment system has an additional peak load capacity of 5950L per day with demands only requiring 1050L per day, with an overall capacity of 7000L per day. Irrigation area has some redundancy and has been sized conservatively with slope etc.

Consequences of overloading the system – The existing concrete Econocycle 7000L ENC10-1 AWTS Secondary treatment system has an additional peak load capacity of 5950L per day with demands only requiring 1050L per day, with an overall capacity of 7000L per day. Irrigation area has some redundancy and has been sized conservatively with slope etc.

Consequences of underloading the system – No odour should occur due to 2 stage solid break down of the proposed system utilizing secondary treatment, so long as the proposed system is maintained by qualified contractor on a quarterly basis.

As per site inspection and existing wastewater as constructed drawings by the previous designer and the existing design, it is determined the existing 300sqm of sub surface area is still adequately sized to handle the additional load for the additional ancillary dwelling and bedrooms as per loading calculations above

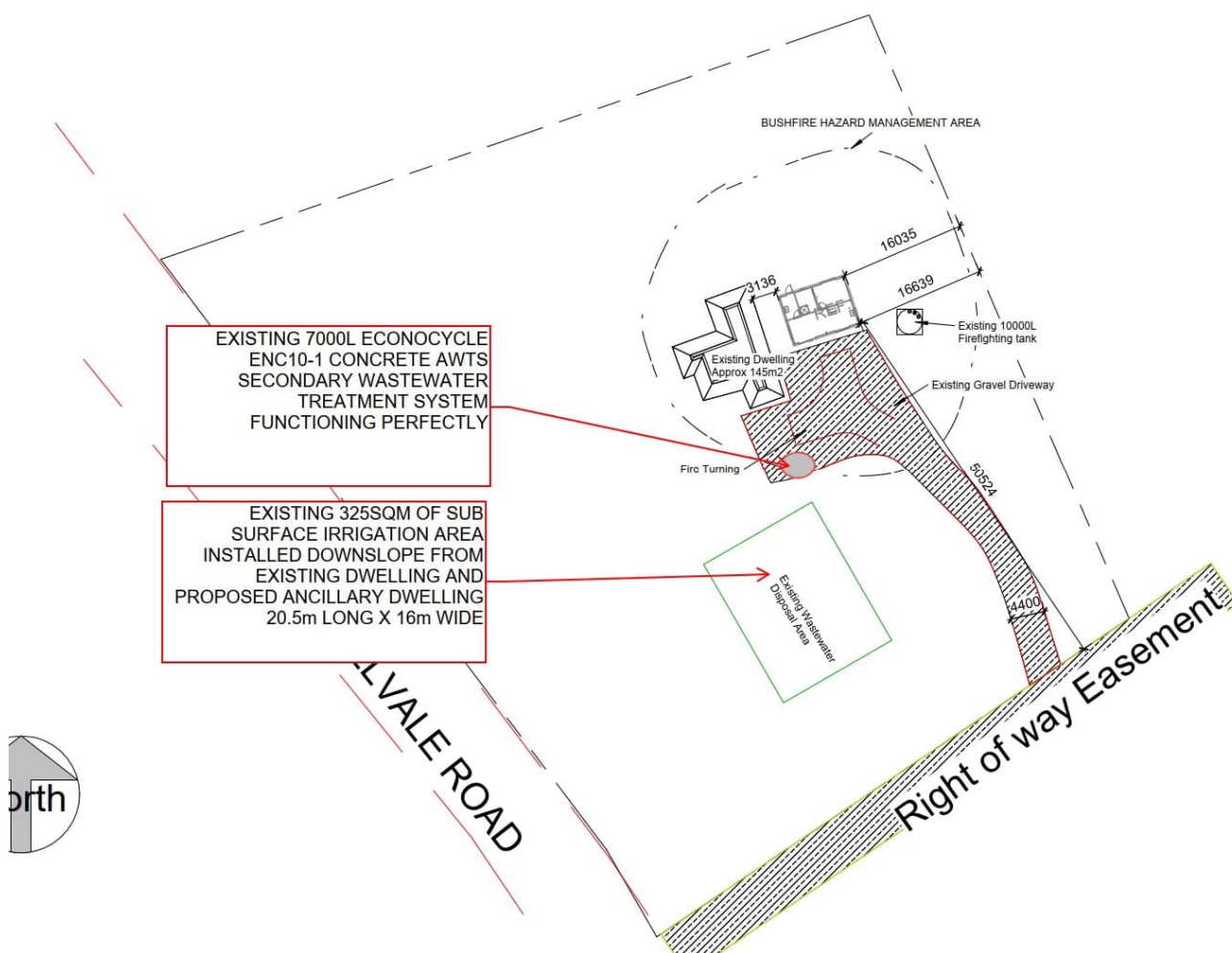


Figure 5: Existing wastewater system layout

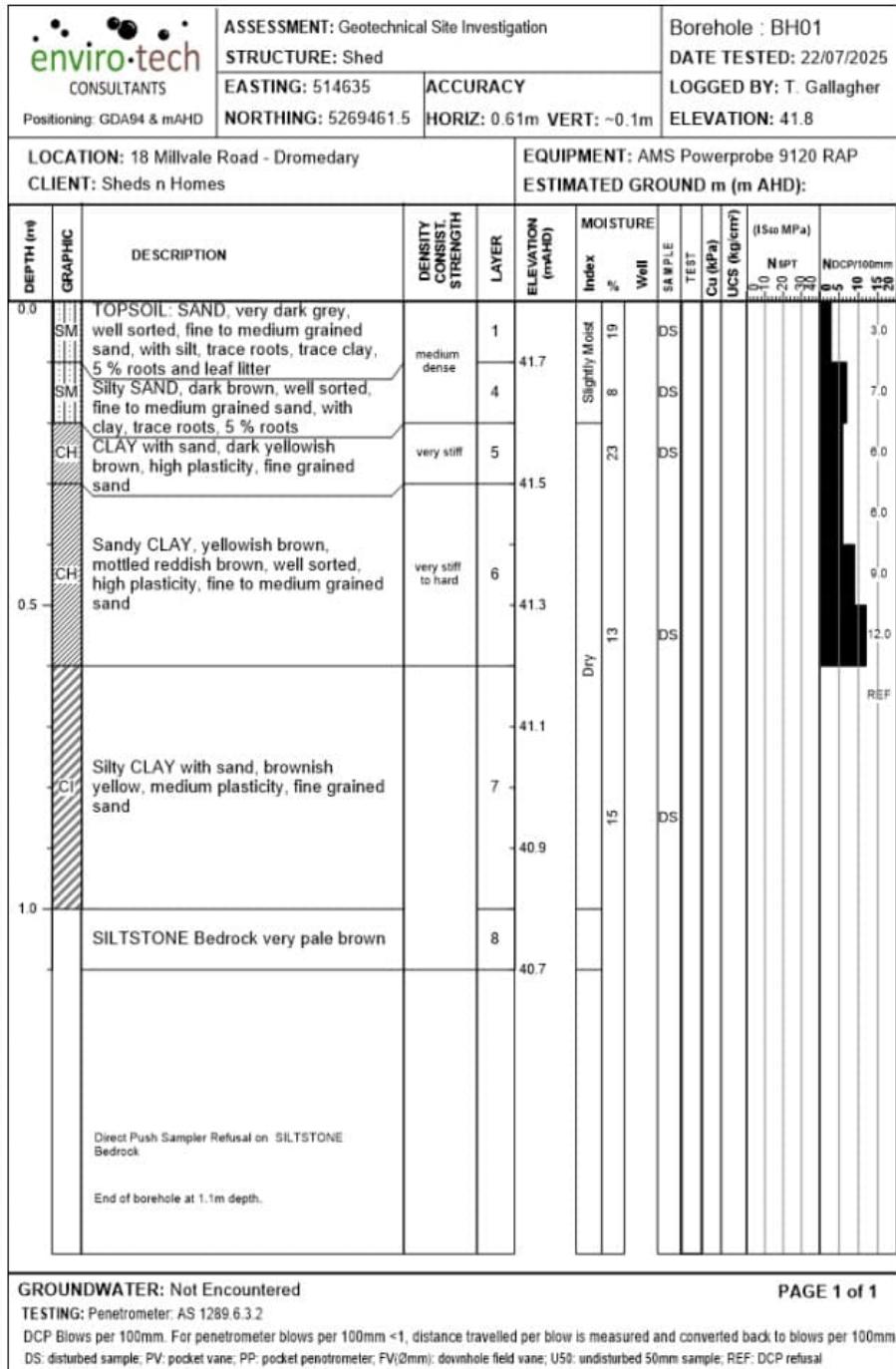


Figure 6: Test Hole BH01 by Enviro-Tech



Figure 7: Test Hole Locations

FYSH DESIGN
CIVIL HYDRAULIC

3. TRENCH 3

Fysh Design

Land suitability and system sizing for on-site wastewater management
Trench 3.0 (Australian Institute of Environmental Health)

Assessment Report Wastewater Design

| | | | |
|------------------|----------------------------|-------------------|-------------|
| Assessment for | Sheds N Homes | Assess. Date | 27-Aug-25 |
| | 18 Millvale Road Dromedary | Ref. No. | CKD-HYD-316 |
| Assessed site(s) | 18 Millvale Road Dromedary | Site(s) inspected | 27-Aug-25 |
| Local authority | Brighton Council | Assessed by | Chris Fysh |

This report summarises wastewater volumes, climatic inputs for the site, soil characteristics and system sizing and design issues. Site Capability and Environmental sensitivity issues are reported separately, where 'Alert' columns flag factors with high (A) or very high (AA) limitations which probably require special consideration for system design(s). Blank spaces on this page indicate data have not been entered into TRENCH.

Wastewater Characteristics

Wastewater volume (L/day) used for this assessment = 1,040 (using the 'No. of bedrooms in a dwelling' method)
 Septic tank wastewater volume (L/day) = 340
 Sullage volume (L/day) = 700
 Total nitrogen (kg/year) generated by wastewater = 8.2
 Total phosphorus (kg/year) generated by wastewater = 5.1

Climatic assumptions for site

(Evapotranspiration calculated using the crop factor method)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Mean rainfall (mm) | 43 | 38 | 42 | 45 | 43 | 49 | 47 | 48 | 48 | 55 | 54 | 51 |
| Adopted rainfall (R, mm) | 43 | 38 | 42 | 45 | 43 | 49 | 47 | 48 | 48 | 55 | 54 | 51 |
| Retained rain (Rr, mm) | 34 | 30 | 34 | 36 | 34 | 39 | 38 | 38 | 38 | 44 | 43 | 41 |
| Max. daily temp. (deg. C) | 14 | 14 | 11 | 9 | 6 | 4 | 3 | 12 | 13 | 15 | 16 | 17 |
| Evapotrans (ET, mm) | 153 | 135 | 124 | 66 | 32 | 16 | 23 | 36 | 55 | 91 | 99 | 133 |
| Evapotr. less rain (mm) | 119 | 105 | 91 | 30 | -2 | -23 | -14 | -2 | 17 | 47 | 56 | 92 |
| Annual evapotranspiration less retained rain (mm) = | | | | | | | | | | | 514 | |

Soil characteristics

Texture = Clay Loams Category = 4 Thick (m) = 1.5
 Adopted permeability (m/day) = 1.5 Adopted LTAR (L/sq m/day) = 15 Min depth (m) to water = 20

Proposed disposal and treatment methods

Proportion of wastewater to be retained on site: All wastewater will be disposed of on the site
 The preferred method of on-site primary treatment: In a package treatment plant
 The preferred method of on-site secondary treatment: In-ground
 The preferred type of in-ground secondary treatment: None
 The preferred type of above-ground secondary treatment: Trickle irrigation
 Site modifications or specific designs: Not needed

Suggested dimensions for on-site secondary treatment system

Total length (m) = 21
 Width (m) = 16
 Depth (m) = 0.3
 Total disposal area (sq m) required = 300
 comprising a Primary Area (sq m) of: 300
 and a Secondary (backup) Area (sq m) of:

Sufficient area is available on site

To enter comments, click on the line below 'Comments'. (This yellow-shaded box and the buttons on this page will not be printed.)

Figure 8: WASTEWATER ASSESSMENT REPORT

Fysh Design

Land suitability and system sizing for on-site wastewater management
Trench 3.0 (Australian Institute of Environmental Health)

Site Capability Report Wastewater Design

Assessment for Sheds N Homes
18 Millvale Road Dromedary
Assessed site(s) 18 Millvale Road Dromedary
Local authority Brighton Council

Assess. Date 27-Aug-25
Ref. No. CKD-HYD-316
Site(s) inspected 27-Aug-25
Assessed by Chris Fysh

This report summarises data relating to the physical capability of the assessed site(s) to accept wastewater. Environmental sensitivity and system design issues are reported separately. The 'Alert' column flags factors with high (A) or very high (AA) site limitations which probably require special consideration in site acceptability or for system design(s). Blank spaces indicate data have not been entered into TRENCH.

| Alert | Factor | Units | Value | Confid level | Limitation | | Remarks |
|-------|-----------------------------|------------------------|-------|--------------|------------|---------|---------|
| | | | | | Trench | Amended | |
| A | Expected design area | sq m | 300 | | High | | |
| | Density of disposal systems | /sq km | 1 | | Very low | | |
| | Slope angle | degrees | 10 | | Moderate | | |
| | Slope form | Convex spreading | | | Very low | | |
| | Surface drainage | Mod. good | | | Low | | |
| | Flood potential | Site floods <1:100 yrs | | | Very low | | |
| | Heavy rain events | Infrequent | | | Moderate | | |
| | Aspect (Southern hemi.) | Faces NE or NW | | | Low | | |
| | Frequency of strong winds | Infrequent | | | Moderate | | |
| A | Wastewater volume | L/day | 1,040 | | High | | |
| | SAR of septic tank effluent | | 1.9 | | Low | | |
| A | SAR of sullage | | 3.1 | | High | | |
| | Soil thickness | m | 1.5 | | Very low | | |
| | Depth to bedrock | m | 1.5 | | Moderate | | |
| A | Surface rock outcrop | % | 5 | | High | | |
| | Cobbles in soil | % | 5 | | Low | | |
| | Soil pH | | 4.5 | | Moderate | | |
| | Soil bulk density | gm/cub. cm | 1.2 | | Very low | | |
| | Soil dispersion | Emerson No. | 5 | | Moderate | | |
| | Adopted permeability | m/day | 1.5 | | Very low | | |
| | Long Term Accept. Rate | L/day/sq m | 15 | | | | |

Figure 9: SITE CAPABILITY REPORT HYDRAULIC

Fysh Design
 Land suitability and system sizing for on-site wastewater management
 Trench 3.0 (Australian Institute of Environmental Health)

Environmental Sensitivity Report
Wastewater Design

Assessment for Sheds N Homes
 18 Millvale Road Dromedary
 Assessed site(s) 18 Millvale Road Dromedary
 Local authority Brighton Council

Assess. Date 27-Aug-25
 Ref. No. CKD-HYD-316
 Site(s) inspected 27-Aug-25
 Assessed by Chris Fysh

This report summarises data relating to the environmental sensitivity of the assessed site(s) in relation to applied wastewater. Physical capability and system design issues are reported separately. The 'Alert' column flags factors with high (A) or very high (AA) limitations which probably require special consideration in site acceptability or for system design(s). Blank spaces indicate data have not been entered into TRENCH.

| Alert | Factor | Units | Value | Confid level | Limitation | | Remarks |
|-------|--------------------------------|-------------------|----------|--------------|------------|---------|---------------------|
| | | | | | Trench | Amended | |
| A | Cation exchange capacity | mmol/100g | 30 | | High | | Factor not assessed |
| | Phos. adsorp. capacity | kg/cub m | 1 | | Moderate | | |
| | Annual rainfall excess | mm | -514 | | Very low | | |
| | Min. depth to water table | m | 20 | | Very low | | |
| | Annual nutrient load | kg | 13.2 | | Moderate | | |
| | G'water environ. value | Indust non-sensit | | | Very low | | |
| A | Min. separation dist. required | m | 40 | | High | | |
| | Risk to adjacent bores | | | | | | |
| | Surf. water env. value | Indust non-sensit | | | Very low | | |
| | Dist. to nearest surface water | m | 700 | | Very low | | |
| | Dist. to nearest other feature | m | 50 | | Moderate | | |
| | Risk of slope instability | | Very low | | Very low | | |
| | Distance to landslip | m | 1000 | | Very low | | |

Figure 10: ENVIROMENTAL ASSESSMENT REPORT



4. INSTALLED IRRIGATION DETAILS

SOLUTIONS

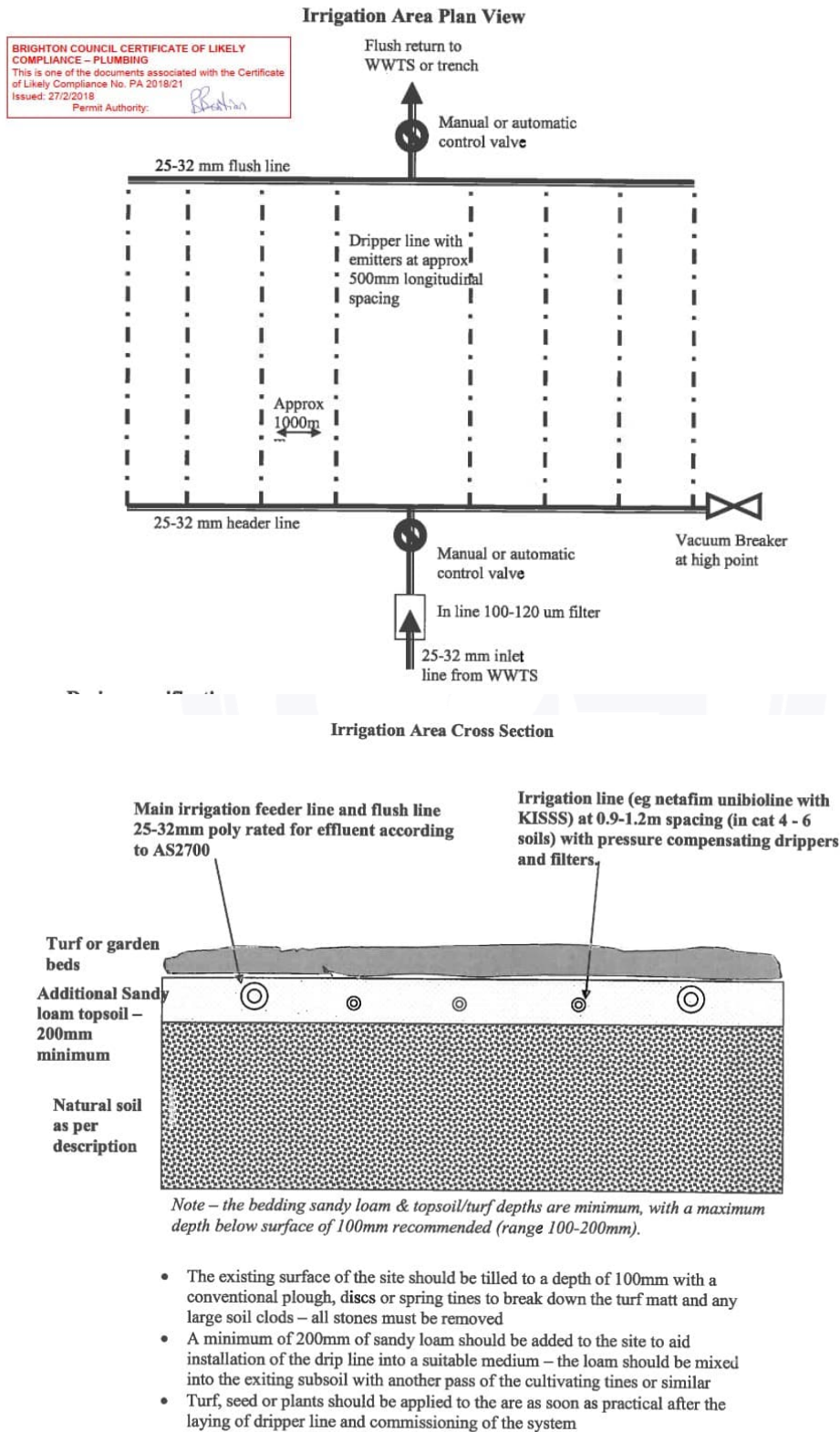


Figure 11: INSTALLED IRRIGATION DETAILS

5. CONCLUSION

Based on the demands on the existing dwelling and the proposed ancillary dwelling (extra bedroom) and the existing system is functioning fine with minimum capacity of AWTS size and irrigation area size, I have no issues with supporting the existing system for continual use.

Please contact cfysh@fyshdesign.com.au if you require any additional information.

Yours sincerely

Chris Fysh



Director

Fysh Design

Building Services Designer Licence: 479819732

Mob: 0414 149 394

Email: cfysh@fyshdesign.com.au



FYSH DESIGN
CIVIL HYDRAULIC

CERTIFICATE OF THE RESPONSIBLE DESIGNER



Section 94
Section 106
Section 129
Section 155

Form **35**

To: *Owner name*
 Address
 Suburb/postcode

Designer details:

Name: Category:
 Business name: Phone No:
 Business address:
 Fax No:
 Licence No: Email address:

Details of the proposed work:

Owner/Applicant *Owner name*
 Address:

Type of work: Building work Plumbing work (X all applicable)

Description of work:

(new building / alteration / addition / repair / removal / re-erection / water / sewerage / stormwater / on-site wastewater management system / backflow prevention / other)

Description of the Design Work (Scope, limitations or exclusions): (X all applicable certificates)

| Certificate Type: | Certificate | Responsible Practitioner |
|-------------------|--|---|
| | <input type="checkbox"/> Building design | Architect or Building Designer |
| | <input type="checkbox"/> Structural design | Engineer or Civil Designer |
| | <input type="checkbox"/> Fire Safety design | Fire Engineer |
| | <input type="checkbox"/> Civil design | Civil Engineer or Civil Designer |
| | <input checked="" type="checkbox"/> Hydraulic design | Building Services Designer |
| | <input type="checkbox"/> Fire service design | Building Services Designer |
| | <input type="checkbox"/> Electrical design | Building Services Designer |
| | <input type="checkbox"/> Mechanical design | Building Service Designer |
| | <input type="checkbox"/> Plumbing design | Plumber-Certifier; Architect, Building Designer or Engineer |
| | <input type="checkbox"/> Other (specify) | |

Deemed-to-Satisfy: Performance Solution: (X the appropriate box)

Other details:

Design documents provided:

The following documents are provided with this Certificate –

Document description:

| | | |
|--|--------------------------|-----------------|
| Drawing-numbers: Wastewater Design Report Rev 0 | Prepared by: Fysh Design | Date:04/09/2025 |
| Schedules: | Prepared by: | Date: |
| Specifications: | Prepared by: | Date: |
| Computations: | Prepared by: | Date: |
| Performance solution proposals: | Prepared by: | Date: |
| Test reports: | Prepared by: | Date: |

Standards, codes or guidelines relied on in design process:

AS1547.2012, NCC 2022, Council EHO regulations and requirements

Any other relevant documentation:


Insurance details:
CGU Civil / Hydraulic Liability Professional Indemnity CGU PI 05-21 \$5,000,000
CGU General and Product Public Liability \$20,000,000

Attribution as designer:

I Christopher Fysh am responsible for the design of that part of the work as described in this certificate;

The documentation relating to the design includes sufficient information for the assessment of the work in accordance with the *Building Act 2016* and sufficient detail for the builder or plumber to carry out the work in accordance with the documents and the Act;

This certificate confirms compliance and is evidence of suitability of this design with the requirements of the National Construction Code.

| | <i>Name: (print)</i> | <i>Signed</i> | <i>Date</i> |
|-------------|----------------------|--|-------------|
| Designer: | Christopher Fysh |  | 04/09/2025 |
| Licence No: | 479819732 | | |

Assessment of Certifiable Works: (TasWater)

Note: single residential dwellings and outbuildings on a lot with an existing sewer connection are not considered to increase demand and are not certifiable.

If you cannot check ALL of these boxes, LEAVE THIS SECTION BLANK.

TasWater must then be contacted to determine if the proposed works are Certifiable Works.


I confirm that the proposed works are not Certifiable Works, in accordance with the Guidelines for TasWater CCW Assessments, by virtue that all of the following are satisfied:

- The works will not increase the demand for water supplied by TasWater
- The works will not increase or decrease the amount of sewage or toxins that is to be removed by, or discharged into, TasWater's sewerage infrastructure
- The works will not require a new connection, or a modification to an existing connection, to be made to TasWater's infrastructure
- The works will not damage or interfere with TasWater's works
- The works will not adversely affect TasWater's operations
- The work are not within 2m of TasWater's infrastructure and are outside any TasWater easement
- I have checked the LISTMap to confirm the location of TasWater infrastructure
- If the property is connected to TasWater's water system, a water meter is in place, or has been applied for to TasWater.

Certification:

I ..Christopher Fysh..... being responsible for the proposed work, am satisfied that the works described above are not Certifiable Works, as defined within the *Water and Sewerage Industry Act 2008*, that I have answered the above questions with all due diligence and have read and understood the Guidelines for TasWater CCW Assessments.

Note: the Guidelines for TasWater Certification of Certifiable Works Assessments are available at: www.taswater.com.au

| | <i>Name: (print)</i> | <i>Signed</i> | <i>Date</i> |
|-----------|----------------------|--|-------------|
| Designer: | Christopher Fysh |  | 04/09/2025 |