Graeme Payten

Wastewater Land Capability Assessment: Lot 711, DP1128593, South Pambula, NSW



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WASTEWATER



GEOTECHNICAL



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PROJECT MANAGEMENT



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1 Overview

1.1 Background

Martens & Associates has prepared this wastewater assessment to support a rezoning application and development application to enable a future subdivision at Lot 711, DP 1128593, South Pambula, NSW. This report documents feasible onsite wastewater options for the proposed subdivision.

1.2 Development Proposal

The proposal seeks to rezone the site to allow the development of a rural subdivision.

1.3 Reference Guidelines

The assessment is prepared in accordance with the following guidelines:

- Australian/ New Zealand Standard 1547 (2012) On site Domestic Wastewater Management.
- Bega Valley Shire Council (2013) Bega Valley Development Control Plan (Revised 2019).
- Department of Local Government, NSW Environment Protection Authority, NSW Health Department, NSW Department of Land and Water Conservation and the NSW Department of Urban Affairs and Planning (1998) - Environment and Health Protection Guidelines -On-site Sewage Management for Single Households. [referred to as DLG et al. (1998)].



2 Site Description

2.1 Summary

Site description is provided in Table 1 with a site plan provided in Map 01 (Attachment A).

| Table 1: Site description summar | у. |
|----------------------------------|----|
|----------------------------------|----|

| Element | Description/Detail |
|--------------------------------|--|
| Site Area | Approximately 40.2ha |
| Lot/DP | Lot 711, DP1128593 |
| Existing site development | Single storey dwelling and associated sheds and cottage in northern portion of site. |
| Aspect | East |
| Typical slopes | Variable - 6 - 32% |
| Existing vegetation | Generally cleared, dense vegetation to the north west and south west. |
| Neighbouring environment | The site is surrounded by rural properties to the north and east and bushland to the west and south. |
| | Yowaka River borders the southern boundary. |
| Local Government Area (LGA) | Bega Valley Shire Council. |
| Easements | None based on provided survey. |
| Drainage | Drainage via sheet flow to natural intermittent drainage channel running generally west to north east between site ridge lines draining to the Yowaka River. |
| Groundwater | No groundwater was encountered in boreholes during the site investigation. |
| Geology | The Bega & Mallacoota 1:250,000 Geological Sheet Series Sheet SJ/55-4 describes the geology at the site as Boyd Volcanic Complex consisting of undifferentiated acid volcanics, basalts, quartz porphyrites and minor sediments. |



2.2 Field Investigations

A site inspection was undertaken on the September 23, 2014 and included:

- Walkover inspection to assess existing conditions, topography, geology, soil characteristics, hydrology and vegetation.
- Excavation of nine boreholes (BH) with a hydraulic auger to allow for characterisation of underlying soils.
- Collection of representative soil samples from boreholes for future reference.

Borehole testing locations are shown in Map 01 (Attachment A) and borehole logs are provided in Attachment B.

2.3 Subsurface Conditions

Borehole locations were selection to allow characterisation of existing soil landscapes. Observed subsurface conditions are summarised in Table 2 and soil characteristics for observed soil are summarised in Table 3.

| landscape | Borehole | Material and Depth (m) | | | |
|-----------|----------|------------------------|-----------|------------------|--|
| Landscape | Borenole | Sandy Clay Loam | Clay Loam | Weathered Basalt | |
| | BH101 | 0.0 - 0.1 | 0.1 – 0.8 | >1.4 | |
| Crest | BH109 | 0.0 - 0.2 | 0.2 – 1.1 | >1.1 | |
| | BH106 | 0.0 - 0.1 | 0.1 – 1.7 | >1.7 | |
| | BH103 | 0.0 - 0.1 | 0.1 – 1.5 | >1.5 | |
| Mid crest | BH107 | 0.0 - 0.1 | 0.1 – 1.2 | >1.2 | |
| | BH105 | 0.0 - 0.1 | 0.1 – 1.4 | >1.4 | |
| | BH104 | 0.0 - 0.3 | 0.3 -1.8 | >1.8 | |
| Low lying | BH108 | 0.0 - 0.1 | 0.1 – 0.8 | >0.8 | |
| | BH102 | 0.0 - 0.8 | 0.8 – 2.5 | >2.5 | |

 Table 2: Observed subsurface conditions.

<u>Notes</u>

^{1.} Material depths vary across the site.



Table 3: Summary of typical soil horizon characteristics.

| Layer | Agricultural Classification | Soil Permeability Category 1 |
|-----------------|-----------------------------|------------------------------|
| Sandy Clay Loam | SCL | 4b |
| Clay Loam | CL | 4a |

<u>Notes</u>

^{1.} In accordance with Table 8 of NSW Department of Local Government et al. (NSW DLG et al., 1998).

2.4 Climate Data

The nearest rainfall station with adequate data is the Pambula Post Office (station number 069024, 1909 - 2012) and evaporation data was taken from the Bureau of Meteorology monthly evaporation maps (based on records from 1975 - 2005). These stations are considered representative of the site. A comparison of median rainfall and evaporation is provided in Table 4.

Table 4: Comparison of monthly rainfall and evaporation data for the site.

| Month | Average Monthly Rainfall (mm) | Average Monthly Evaporation (mm) |
|-----------|-------------------------------|-------------------------------------|
| January | 81.6 | 180 |
| February | 84.1 | 150 |
| March | 88.8 | 125 |
| April | 79.2 | 70 |
| May | 66.0 | 50 |
| June | 77.3 | 40 |
| July | 53.6 | 40 |
| August | 48.6 | 60 |
| September | 53.9 | 80 |
| October | 66.2 | 120 |
| November | 78.3 | 165 |
| December | 76.0 | 170 |
| Annual | 853.6 | 1250 |

2.5 Hydrogeology

Review of WaterNSW Real-time Water Database, indicated one groundwater bore with available information within 500 m of the site, with the groundwater bore summarised in Table 5. The location of the groundwater bore is shown on Map 01 (Attachment A), and the groundwater bore log is presented in Attachment C.



 Table 5: Available hydrogeological information.

| Bore Identification | Record Date | Intended Use | Słanding Water Level (mbgl) | First Water Bearing Zone (mbgl) and Substrate | Distance and Direction from Site |
|------------------------|----------------|------------------|--------------------------------------|--|--|
| GW110974.1.1 | 2009 | Stock / Domestic | 14.9 | 19.8 – 33.5 Rhyolite | 70 m southeast |



3 Wastewater Assessment

3.1 Wastewater Treatment Options

Treatment system requirement are dictated by the selected method for effluent disposal. Primary and secondary treatment options may include (but are not limited to):

Primary options:

- Septic tank.
- Composting and Hybrid toilet system with greywater treatment systems.

Secondary options:

• Aerated wastewater treatment system (AWTS).

Typical primary and secondary treatment standards are provided in Table 6. This information is also used for the nutrient balance assessment.

| Parameter | Primary Standard | Secondary Standard |
|------------------------------|------------------|--------------------|
| BOD₅ (mg/L) | 150 | 30 |
| Suspended solids (mg/L) | 50 | 30 |
| Faecal coliforms (CFU/100mL) | 105-107 | 30 |
| Total phosphorus (mg/L) | 15 | 12 |
| Total nitrogen (mg/L) | 50 | 27 |

 Table 6: Assumed primary and secondary treatment standards.

3.2 Wastewater Disposal Options

Disposal options considered on the site include surface irrigation, subsurface irrigation and absorption systems. Secondary treatment is required for surface irrigation system and primary or secondary treatment is acceptable for subsurface irrigation or absorption based system.



3.3 Soil Chemical Capability Assessment

A summary of soil chemical properties is provided in Table 7.

 Table 7: Summary of soil assessment.

| Parameter | Value | Limitations ¹ |
|--------------------|---------------|--------------------------|
| pH (1:5) | 4.5 - 5.8 | Moderate |
| ECe (dS/m) | <0.1 | Minor |
| CEC (cmol(+)/kg) | 16.40 - 21.70 | Minor |
| P-sorption (mg/kg) | 359 - 590 | Minor |

<u>Notes</u>

^{1.}DLG et al. (1998).

Values are obtained from NSW Land and Water Conservation (1997) Soil Landscapes of Bega-Goalen Point 1:100,000 Sheet, Appendix 7.2.7 and 7.2.10 for the Bald Hills soil landscapes as found on the site (BH1 & BH3).

Site observations indicated no restriction to vegetation growth as a result of naturally acidic soil pH. The 'limitation' assessed by comparison to DLG et al. (1998) is therefore not considered to warrant any mitigation or to pose any significant limitation to onsite wastewater disposal.

3.4 Land Capability Assessment for Effluent Reuse

Site and soil suitability for effluent reuse have been determined according to Tables 4 and 6 of NSW DLG et al. (1998) and are summarised in Table 8.



| Soil Feature | Potential Irrigation Areas | Limitation Rating |
|----------------------------------|----------------------------|-------------------------------|
| Flood potential | NA | Minor |
| Sun and wind exposure | High | Minor |
| Slope (%) | 6-32% | Minor - Moderate ² |
| Landform | Convex side slopes | Minor |
| Erosion potential | Little present | Minor |
| Site drainage | Generally, well drained | Minor |
| Fill | None observed | Minor |
| Rock outcrops | < 10% | Minor |
| Geology | No major discontinuities | Minor |
| Depth to bedrock (m) | > 1 | Minor |
| Depth to water table (m) | > 1 | Minor |
| Soil permeability category | Category 4a and 4b | Minor |
| Coarse fragments (%) | 0 – 20% | Minor |
| | | |

Table 8: Site and soil suitability in accordance with NSW DLG et al. (1998).

<u>Notes</u>

^{1.} All proposed effluent management areas (EMAs) to be located above 1 in 100 year flood level.

^{2.} Slope areas within proposed EMAs will be less than 20%, therefore minor to moderate limitation depending on application system selected.

Land capability assessment indicates a moderate slope limitation. The area for major slope limitations (i.e. > 20%) for both irrigation and absorption is shown in Map 02 (Attachment A). All other soil features indicate minor limitations. A plan detailing appropriate effluent management areas (EMA)s for the proposed lots is shown in Map 03 (Attachment A).

To address variable slope the following system selection is recommended for areas of each slope 'category':

- \circ < 6 % any application system.
- 6 10% no surface irrigation; absorption or subsurface irrigation (including LPED) application only.
- 10 20% no surface irrigation; subsurface irrigation (including LPED) application rate reduced by 20%. Site specific risk assessment for absorption system.



- 20 30% no surface irrigation or absorption systems; subsurface irrigation (including LPED) application rate reduced by 50%. Site specific risk assessment for absorption system.
- \circ > 30% generally unsuitable for effluent application system.

3.5 Pathogen Modelling

A Beavers Gardner model has been completed to assess the risks posed to the existing groundwater supply bore by pathogens in applied effluent. This model determines the time taken to achieve the required magnitude of pathogen reduction in soil and the distance travelled by the effluent in that time to determine minimum buffer distances to effluent application systems. The following two equations are used:

1. Time taken to achieve pathogen reduction:

$$t = \frac{\ln{(\frac{M_t}{M_0})}}{-k}$$

Where:

t = time to achieve required pathogen reduction (days);

 $\frac{M_t}{M_0}$ = magnitude of reduction required; and,

-k = decay rate coefficient = $ln(10^{(-0.181+0.0214 x groundwater temperature)})$

2. Distance travelled by effluent:

Where:

t = time to achieve required pathogen reduction (Equation 1);

K = saturated hydraulic conductivity of soil in effluent disposal field (m/day);

i = hydraulic gradient of groundwater between effluent disposal field and observation point (m⁻¹); and,

 η_e = effective porosity of aquifer between effluent disposal field and observation point (dimensionless).

Model inputs and assumptions are provided in Table 9 with the model results provided in Attachment D.



| Table 7. Summary of modelling inputs and assumptions | s used in participen nansport modelling. |
|---|--|
| Model Parameter | Assumed value |
| Initial concentration of pathogen (CFU / 100 $\mbox{mL})^1$ | 1 x 10 ⁷ |
| Required magnitude of reduction (log ₁₀) | 7 |
| Minimum groundwater temperature (°C) | 12 |
| Maximum groundwater temperature (°C) | 22 |
| Saturated hydraulic conductivity of soil (m/day) | 1 |
| Hydraulic gradient² (m-1) | 0.16 |
| Effective aquifer porosity | 0.2 |

 Table 9:
 Summary of modelling inputs and assumptions used in pathogen transport modelling.

<u>Notes</u>

^{1.} Typical concentration of faecal coliforms following primary treatment by a septic tank (NSW DLG., 1998).

²· Assumed based on surface gradients.

Results of the modelling show that for a groundwater temperature of 12 °C and a log-7 reduction of pathogens, a buffer of approximately 74 m would be required between effluent disposal fields and the existing groundwater bore at the site. Modelling calculations are presented in Attachment D.

3.6 Buffer Setbacks for Effluent Reuse Area

EMAs are to be located with setbacks in accordance with NSW DLG et al. (1998), Bega Valley Shire Council Development Control Plan 2019 (BDCP, 2019) and site specific pathogen modelling, with recommended setbacks summarised in Table 10. Buffers are applied to the site in Map 02 and 03 (Attachment A).



| | Buffer Distance (m) | | | | | | | | | |
|-------------------------------|---|------------------|------------|--|--|--|--|--|--|--|
| Feature ¹ | Surface and Subsurface Irrigation | Spray Irrigation | Absorption | | | | | | | |
| Yowaka River ² | 150 | 150 | 150 | | | | | | | |
| Groundwater Bore ³ | 74 | 74 | 74 | | | | | | | |
| Dams and Waterways | 40 | 40 | 40 | | | | | | | |
| Dwellings | 6 / 34 | 15 | 6 / 34 | | | | | | | |
| Swimming Pools | 6 / 34 | 6 | 6 / 34 | | | | | | | |
| Driveways | 6 / 34 | 6 / 34 | 6 / 34 | | | | | | | |
| Property Boundaries | 6 / 34 | 6 / 34 | 12/ 64 | | | | | | | |

| Table 10: Adopted buffer setbacks | in accordance with | NSW DIG et al (1998) |
|-----------------------------------|--------------------|--|
| Table 10. Adopted botter serbacks | | $\prod_{i=1}^{n} D_{i} \cup D_{i} \cup \bigcup_{i=1}^{n} \bigcup_{i=1}^{n} \bigcup_{j=1}^{n} \bigcup_{i=1}^{n} \bigcup_{i=1}^{n} \bigcup_{j=1}^{n} \bigcup_{j=1}^{n} \bigcup_{j=1}^{n} \bigcup_{i=1}^{n} \bigcup_{j=1}^{n} $ |

<u>Notes</u>

 $^{\scriptscriptstyle 1}$ In accordance with NSW DLG et al. (1998) except where otherwise noted.

² BDCP (2019) required a 150m setback from the Yowaka River.

³ 74 m buffer based on pathogen modelling in section 3.5.

 4 x / y = downslope / upslope of effluent management area.

3.7 Hydraulic Load Estimations

Council's BDCP (2019) requires new onsite wastewater management systems to be designed based on an assumed future hydraulic load of 1,000 L/day.

3.8 Effluent Application Rates

3.8.1 Design Irrigation Rates

Recommended design irrigation rates (DIRs) according to AS/NZS 1547 (2012) are given in Table 11 for subsurface irrigation of secondary effluent and for subsurface LPED irrigation of primary treated effluent. For spray irrigation top soil rates are applicable, for subsurface irrigation, subsoil rates apply.



Table 11: Design irrigation rates for the site.

| Depth | Texture | Structure | Indicative | | gation Rate m/day)² |
|--------------------------------|--------------------|--------------------------|---|----------------------------------|------------------------------------|
| (m) ¹ | Texture | Silociore | Permeability (K _{sat}) (m/d) | Primary Effluent ³ | Secondary Effluent ⁴ |
| 0.0 – 0.1 (surface) | Sandy Clay Loam | Weakly Structured | 0.12 - 0.5 | 3.0 | 3.5 |
| 0.1 - >1.0 (subsurface) | Clay Loam | Moderately Structured | 0.5 – 1.5 | 3.0 | 3.5 |
| Design | | | | 3.0 | 3.5 |

<u>Notes</u>

¹ Depths of soil horizons varies across the site.

² Subject to DIR reductions in section 3.4 in response to slope.

³ Primary effluent to LPED irrigation area.

^{4.} Secondary effluent to subsurface irrigation area.

For a design hydraulic load of 1,000 L/day, secondary treated effluent irrigation fields are to be 285 m², for primary treated irrigation fields an area of 335 m² is required. In accordance with AS/NZS 1547 (2012), an area of 335 m² is to be provided as a reserve area for LPED irrigation giving a total required area of 670 m² per dwelling. Clause 5.5.3.4 of AS/NSZ 1547 (2012) notes that reserve areas are not required for secondary treated effluent applied to irrigation areas.

3.8.2 Design Loading Rates

Recommended design loading rates (DLRs) for absorption system according to AS/NZS 1547 (2012) are given in Table 12. As absorption systems apply to subsoil, the DLR for 0.5 - 1.0 m is applicable to design.

| Dopth (m) | Texture | Structure | Indicative Permeability | | ading Rate nm/day)² |
|------------------------|--------------------|--------------------------|----------------------------|---------------------|------------------------|
| Depth (m) ¹ | Texiore | Siluciole | (K _{sat}) (m/d) | Primary Effluent | Secondary Effluent |
| 0.0 - 0.1 | Sandy Clay Loam | Weakly Structured | 0.12 – 0.5 | 6 | 10 |
| 0.1 - >1.0 | Clay Loam | Moderately Structured | 0.5 – 1.5 | 10 | 15 |
| Design | | | | 10 | 15 |

 Table 12: Design loading rates for the site.

<u>Notes</u>

^{1.} Depths of soil horizons varies across the site.

^{2.} Subject to DLR reductions in section 3.4 in response to slope.



For a design hydraulic load of 1,000 L/day an absorption area of 100 m² is required for primary effluent and 67 m² for secondary effluent. This may be provided as trench(s) or absorption bed(s).

3.9 Nutrient Modelling Summary

Assessment of nutrient balance has been undertaken in accordance with DLG et al. (1998). Modelling completed assesses the required areas for the assimilation of applied nutrient.

Detailed modelling outputs are provided in Attachment C of this report. Sustainable disposal area for primary and secondary effluent are summarised in Table 13. Primary and secondary treatment results in differing nutrient content in effluent and therefore differing areas to achieve nutrient uptake. Assessment of required areas has been completed.

950

620

| Area Rea | quired (m²) |
|-------------------|---------------------|
| Primary Treatment | Secondary Treatment |

Table 13: Area required for sustainable effluent application.

Nitrogen uptake

Phosphorus saturation



430

490

4 Recommendations

Recommendations are provided for primary or secondary treated effluent management systems. System design provided for sustainable hydraulic and nutrient loading rates.

4.1 Irrigation Requirements

The irrigation field is to be constructed in accordance with AS/NZS 1547 (2012) and the following minimum specifications.

- 4.1.1 All Irrigation Systems General Requirements
 - All effluent distribution and irrigation lines are to be fixed in place by burial to a depth of no less than 100 mm.
 - The irrigation area cannot be used for growing fruit, vegetables or other edible plants.
 - Effluent shall be pumped from the treatment system through an appropriately sized (25 mm minimum diameter) poly main line to the top of the disposal field(s). The main is to be fitted with suitable non return valves.
 - Distribution mains and irrigation laterals are to be installed by a suitably qualified individual to meet the standards of AS/NZS 1547 (2012).
 - The effluent dispersal pump and delivery mains are to be sized to provide adequate flow through the proposed irrigation system.
 - Based on nutrient and hydraulic modelling and AS/NZS 1547 (2012) a minimum irrigation field area of 490 m² (secondary treatment) and 950 m² (primary treatment) per dwelling is required based on the limiting design criteria being nutrient assimilation.
- 4.1.2 Spray Irrigation (up to 6% slopes)
 - Effluent is to be reticulated to a series of low through, coarse droplet sprinklers located across the irrigation field giving even effluent distribution.
 - Irrigation field to be fenced to prevent casual pedestrian access.



- Spray irrigation only to be used in conjunction with secondary effluent treatment.
- 4.1.3 Shallow Subsurface Irrigation (up to 30% slopes)
 - Effluent is to be distributed into a series of lateral irrigation lines parallel to site contours.
 - Effluent is to be distributed using a pressure compensating subsurface irrigation line such as "Netafim", "Amiad PC" or "Wasteflow". These products have been specifically designed for the distribution of secondary effluent and allow for the even distribution of flows along and between irrigation lines.
 - Irrigation lines are to be spaced 1.0 m apart (centres) across the irrigation field.
 - The irrigation field irrigation lines are to be installed directly into soil at a depth of 150 mm.
 - A (minimum 25 mm) manifold is to be installed along the side of the field with distribution lateral lines running from it.
 - A 25 mm reticulated flushing main with shut off valve is to be constructed for system flushing. Main is to discharge to inlet of treatment system.
 - $\circ~$ Where slopes in the irrigation field are 20 % 30 % the minimum irrigation area is to be increased to 570 m².

4.2 Absorption Trench Requirements

Trenches are to be constructed with self supporting arches with trench backfilled with 20 – 40 mm aggregate prior to placement of geotextile and 150 mm topsoil cover. Recommended typical trench dimensions are provided Table 14.

| Design Loading | Hydraulic | Required trench | Trench dimensions | | | | | | | | |
|------------------------|-----------------|-----------------|-------------------|-----------|------------|--|--|--|--|--|--|
| Rate (DLR) (mm/day) | Load (L/Day) | base (m²) | Width (m) | Depth (m) | Length (m) | | | | | | |
| 101 | 1,000 | 100 | 0.6 | 0.6 | 167 | | | | | | |
| 15 ² | 1,000 | 67 | 0.6 | 0.6 | 112 | | | | | | |

| Table 14: Approximate | absorption | trench | dimensions |
|-----------------------|------------|--------|-----------------|
| | absorption | nonch | unificitisions. |

<u>Notes</u>

^{1.} Primary treated effluent.

^{2.} Secondary treated effluent.



Absorption bed may be used where sufficient level land is available. The total required trench/absorption bed surface area may be provided as multiple trenches/beds fed by a distribution box to ensure even flow to each trench. Distribution boxes should be checked as part of performance monitoring inspection to confirm that an even flow of effluent is being directed to each distribution line.

Trench design based on soil hydraulics (Table 14) does not consider nutrient assimilation. Sustainable assimilation of nutrients requires a minimum disposal area of 490 m² (secondary effluent) to 950 m² (primary effluent) which are too large for feasible absorption trench design and even effluent application.



5 Conclusion

The completed wastewater assessment concludes that appropriate onsite effluent management system is able to be accommodated on each of new allotment in the proposed subdivision. Review of capability mapping indicates that a suitable area is available for each lot for effluent management subject to the effluent treatment standard and disposal system which as summarised in Table 15.

| Lot ID | Suitable EMA Available | Average Slope within Potential EMA | Treatme | ent Options | | Disposal Op | otions |
|-----------|------------------------------|--|--------------|-----------------|-------------------------|--------------|----------------|
| | (m²) | (%) | Primary | Secondary | In | rigation | |
| | | | | | Surface / Subsurface | Absorption | |
| 1 | > 1,000 | 13 | \checkmark | \checkmark | X1,2 | \checkmark | \checkmark |
| 2 | > 1,000 | 11 | \checkmark | \checkmark | X 2 | \checkmark | \checkmark |
| 3 | > 1,000 | 10 | \checkmark | \checkmark | X ² | \checkmark | X ³ |
| 4 | | | E | existing System | | | |
| 5 | | | E | Existing System | | | |
| 6 | > 1,000 | 14 | Х | \checkmark | X ^{1,2} | \checkmark | X3 |
| 7 | > 1,000 | 15 | \checkmark | \checkmark | X1 | \checkmark | \checkmark |
| 8 | 600 | 8 | Х | \checkmark | X2 | \checkmark | Х3 |
| 9 | > 1,000 | 14 | \checkmark | \checkmark | X ^{1,2} | \checkmark | \checkmark |
| 10 | 600 | 15 | Х | \checkmark | X1,2 | \checkmark | Х3 |
| 11 | > 1,000 | 17 | \checkmark | \checkmark | X ^{1,2} | \checkmark | \checkmark |
| 12 | > 1,000 | 17 | \checkmark | \checkmark | X1,2 | \checkmark | \checkmark |
| 13 | > 1,000 | 16 | \checkmark | \checkmark | X1 | \checkmark | \checkmark |
| 14 | > 1,000 | 13 | Х | \checkmark | X ^{1,2} | \checkmark | X ³ |
| 15 | > 1,000 | 11 | \checkmark | \checkmark | X1,2 | \checkmark | \checkmark |

Table 15: Effluent treatment and disposal options

<u>Notes</u>

 $^{\rm l.}$ Spray irrigation not likely to be an acceptable disposal option due to average slope > 6% (DLG et al., 1998). Where sufficient land < 6% is identified spray irrigation may be possible.

^{2.} Spray irrigation not a disposal option due to dwelling located within 15 m setback distance (DLG et al., 1998).

^{3.} Absorption disposal not suitable due to setback distance less than 12 m from property boundary.

General requirements for onsite effluent disposal have been developed and are detailed in this report. Identified soil and land capability constraints have been assessed in accordance with relevant guidelines. Design of typical wastewater management solution have considered



nutrient and soil assessments. This assessment is considered preliminary and a more detailed wastewater management assessment would be required at the development application stage for residential dwellings and then again at the Local Government Act section 68 application stage for individual systems.



6 References

- Australian/ New Zealand Standard 1547 (2012) On site Domestic Wastewater Management
- Bega Valley Shire Council (2013) Bega Valley Development Control Plan (Revised 2019). [referred to as BDCP (2019)]
- Department of Local Government, NSW Environment Protection Authority, NSW Health Department, NSW Department of Land and Water Conservation and the NSW Department of Urban Affairs and Planning (1998) - Environment and Health Protection Guidelines - On-site Sewage Management for Single Households.
- Lewis P.C. and Glen R.A. (1995) Bega & Mallacoota 1:250,000 Geological Sheet Series Sheet SJ/55-4, SJ/55-8. (New South Wales Department of Mineral Resources).
- OCRE (2021) General Arrangement: Lot 711, DP1128593, 3810 Princes Highway Griegs Flat.
- Southeast (2021) Planning Proposal Lot 711 DP 1128593: Flood Risk Assessment and Surface Water Assessment.



7 Attachment A – Figures





50 150 200 250 m 0 100

1:5000 @ A3

Sources: Aerial Image Source: Nearmap (2021); Flooding information from Southeast (2021) Planning Proposal Lot 711 DP1128593: Flood Risk Assessment and Surface Water Assessment; Lot layout and building pads provided by OCRE (2021); Waterways from SixMaps; Contours from ELVIS Lidar.



Map Title / Figure: Site Testing Plan

Мар Site Project Sub-Project Client Date

Map 01 Lot 711, DP 1128593 South Pambula, NSW Wastewater land capability assessment

> Mr. Graeme Payten 24/02/2022





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Sources: Aerial Image Source: Nearmap (2021); Flooding information from: Southeast (2021) Planning Proposal Lot 711 DP1128593: Flood Risk Assessment and Surface Water Assessment; Lot layout and building pads provided by OCRE (2021); Waterways from SIxMaps; Contours from ELVIS Lidar.



Map Title / Figure: Onsite Sewage Constraints

Map Site Project Sub-Project Client Date

Map 02 Lot 711, DP 1128593 South Pambula, NSW Wastewater land capability assessment

> Mr. Graeme Payten 24/02/2022





1:5000 @ A3

Sources: Aerial Image Source: Nearmap (2021); Flooding information from: Southeast (2021) Planning Proposal Lot 711 DP1128593: Flood Risk Assessment and Surface Water Assessment; Lot layout provided by OCRE; Waterways from SixMaps; Contours from ELVIS lidar.



Map Title / Figure: Potential Individual Lot Effluent Management Areas

Map 03

Lot 711, DP 1128593 South Pambula, NSW Wastewater land capability assessment

Мар Site Project Sub-Project Client Date

Mr. Graeme Payten 24/02/2022

8 Attachment B – Borehole Logs



Wastewater Land Capability Assessment: Lot 711, DP1128593, South Pambula, NSW P1404330JR02V02 – February 2022 Page 28

| CL | IEN | Т | C | addey S | Searl & | Jarman | Pty | Ltd | COMMENCED | 23.09.14 | COMPLETER | 23.09 | .14 | | | REF | BH1 | 01 |
|---------------------------------|---|---|---|--|--|---|---|--|---|---|--|--|---------------------------------------|---|---|---------------------|-------------------|-------------------|
| PR | OJE | СТ | W | astewa | ter Ass | sessmen | t | | LOGGED | AB | CHECKED | AN | | | | Sheet 1 o | of 1 | - |
| SI | | | Lo | ot 711, I | OP 112 | 8593 Sou | ith F | Pambula NSW | GEOLOGY | Basalt | VEGETATIO | _ | 6 | | | PROJECT NO | P1404330 | |
| | | | | 0,010 | Hydraulic | | | | EASTING | - | RL SURFACI | | | | | | 40.450 | |
| EXC | | | | | | X 3.0m depth | | МАТ | ERIAL DAT | - Δ | ASPECT | North | East | SAM | | LOPE | 10-15° | |
| METHOD | SUPPORT | WATER | MOISTURE | DEPTH (M) | | (D) | CLASSIFICATION | MATERIA SOIL NAME, plastic colour, secondar moisture condition, ROCK NAME, grai | L DESCRIPTIO sity or particle char y and minor comp consistency/relation | N acteristics, onents, re density, | CONSISTENCY | DENSITY INDEX | түре | DEPTH (M) | | RESU | TS AND | ONS |
| v | Nil | N | М | 0.1 | | | SCL | , , , | | akly structured, | | | | | | | | |
| v | Nil | N | м | - - - - 0.8 | | | - CL | Clay Loam - Brown | organic. n, moderately | structured. | | | В | 0.5- 0.75 | 4330/101/ | | Bit refusal at 0. | 8m. |
| тс | Nil | N | D | - 1.0 - - 1.4 | | | **** | BASALT - Pale gre strength, distinct | | | | | | | | | | <u>1.(</u> |
| тс | Nil | N | D | - - 2.0 - - - - - - - - - - - - - - - - - - - | | | | BASALT - Pale grey/ slightly Borehole terminated | y weathered. | | | | | | | | | 2.(|
| | | | | - - - - - - - - - - - - - - - - - - - | | | | inferred lov | w strength ba | salt. | | | | | | | | <u>4.</u> |
| N E F S C V T | H Ba A Ha C Co V-I C Tur | atural e xisting ackhoe and au oade ncrete | exposi excave bucke ger Core Carbi | ure SH vation SC et RE Ni r | JPPORT H Shoring C Shotcre 3 Rock B(1 No supp | ete X Not olts <u>▼</u> Wa ← Wa ┣ Wa | ne obs meas ter lev ter ou ter infl | ured M Moist L Low el W Wet M Mode Wp Plastic limit H High flow WI Liquid limit R Refus ow | NCE VS Ve S Sc erate F Fir St Sti sal VSt Ve H Ha F Fria | m MD Medium [ff D Dense rry Stiff VD Very Den: rd able | ISE A Aug B Bul Dense U Un D Dis Se M Mo Ux Tub | ING & TE ler sample sample disturbed sa turbed sa sture con e sample | e sample mple tent (x mm) | pp Po S S VS V DCP FD F WS V | tandard p /ane shea Dynamic penetron ield dens Vater san | cone leter ty | N USO | S AND CRIPTION |
| ╻ | EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS | | | | | | | | | | | | | | | | | |
| Quality Sheet No. 4 | | | | rte Martens & Ass | | | | 20 G Phor | George St,Horns ne: (02) 9476 99 | SOCIATES PTY LTD sby, NSW 2077 Austra 999 Fax: (02) 9476 876 EB: http://www.marten | 67 | | E | - | | ering reho | Log le | - |

| С | LIEN | т | С | addey S | Sear | & J | arman | Pty | Ltd | COMMENCED | 23.09.14 | | COMPLETE | 23.09 | .14 | | | REF | BH102 |
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| Ρ | ROJE | ЕСТ | W | astewa | ter A | Asse | ssment | | | LOGGED | AB | | CHECKED | AN | | | | Sheet 1 c | |
| s | TE | | Lo | ot 711, I | DP 1 | 1285 | 93 Sou | th P | ambula NSW | GEOLOGY | Basalt | | VEGETATIO | Grass | 5 | | | PROJECT NO | P1404330 |
| | | | | 010 | - | aulic Au | | | | | - | | RL SURFAC | | | | | | |
| P | | | | ISIONS | | nm X 2 | .5m depth | | МАТ | NORTHING | - - | | ASPECT | North | East | 64 | | SLOPE | 5-10° |
| METHOD | | WATER | MOISTURE | DEPTH (M) | DRILLING | | GRAPHIC LOG | CLASSIFICATION | MATERIA SOIL NAME, plastic colour, secondar moisture condition, ROCK NAME, grai | L DESCRIPTIO ity or particle char and minor comp consistency/relativ | n racteristics, ionents, ve density, | | CONSISTENCY | DENSITY INDEX | ТҮРЕ | DEPTH (M) | | RESUL | TS AND DBSERVATIONS |
| v | Nil | N | м | - - - - 0.8 - 1.0 | | | | SCL | Sandy Clay Loam - Da c | rk brown, we rganic. | akly structure | ed, | | | в | 0.1- 0.3 0.5- 0.75 | 4330/10 | 2/ 0.1-0.3 2/ 0.5-0.75 2/ 1.0-1.2 | - - - - - - 1 <u>.0</u> |
| v | v Ni N M - | | | | | | | | | n, moderately | structured. | | | | в | 2.0- 2.25 | 4330/10 | 2/ 2.0-2.25 | - - - - - - - - - - - - - - - - - - - |
| | | | | 2.5 | | | | | | | | | | | | | | | |
| | | | | - | | | | | V bit refusal at 2.5 | m on weathe | ered basalt. | | | | | | | | - |
| | | | | - | | | | | | | | | | | | | | | - |
| | | | | - | | | | | | | | | | | | | | | - |
| | | | | 3.0 | | | | | | | | | | | | | | | - 3.0 |
| | | | | | | | | | | | | | | | | | | | <u> </u> |
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| | | | | 4.0 | | | | | | | | | | | | | | | 4.0 |
| | | | | | | | | | | | | | | | | | | | - |
| | | | | F | | | | | | | | | | | | | | | - |
| | | | | | | | | | | | | | | | | 1 | | | - |
| 4.5 | | | | | | | | | | | | | | | | | | | - 4.5 |
| | EQUIPMENT / METHOD SUPPORT WATER MOISTURE DRILLII N Natural exposure SH Shoring N None observed D Dry RESIST X Existing excavation SC Shotcrete X Not measured M Moist L Low BH Backhoe bucket RB Rock Bolts Water level W Wet M M HA Hand auger Nii No support Plastic limit H Hig S Spade | | | | | | | | | | oft L L mm MD M ff D D eryStiff VD V | ITY Very Loos ∟oose Medium De Dense /ery Dense | se A Aug B Bul lense U Uno D Dis e M Mo | ING & TE er sample isturbed urbed sa sture con | e sample mple tent | pp S VS D0 | Standard S Vane she CP Dynam penetro | ic cone meter | CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION |
| | CC Cc V V- TC Tu | Bit | | | | | → Wat | er inflo | w | H Ha F Fri | ade | | Ux Tub | e sample | (x mm) | | D Field der S Water sa | | Y Agricultural |
| \vdash | PT PL | ish tub | e | | | | VO 11 / | | | | 00014011 | | | | | // • | | | |
| + | EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS | | | | | | | | | | | | | | | | | | |
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| lity Sh | | Ш | d | rte | 113 | 5 | | | Phor | e: (02) 9476 99 | 999 Fax: (02) 9 EB: http://www. | 476 876 | 7 | | | | | oreho | - |
| Qua | - | (C) Cop | oyright I | Martens & As | sociates | s Pty. Ltd | 1.2014 | | man@man | au vv | mp.//www. | | | | | | D | <i>יו בווט</i> | 1C |

| | LIEN | | - | addey \$ | Sea | rl & . | Jarman | Pty | Ltd | COMMENCED | 23.09.14 | COMPLETED | 23.09 | .14 | | | REF | BH103 | 3 |
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| | | NT | | ot 711, I | - | raulic A | | ith P | Pambula NSW | GEOLOGY | Basalt | VEGETATION RL SURFACE | _ | 3 | | | PROJECT N | O. P1404330 | |
| | | | DIMEN | SIONS | | | 1.4m depth | | | NORTHING | - | ASPECT | North | East | | | SLOPE | 10-15° | |
| | E) | | /AT | ON DA | _ | | | | MAT | ERIAL DAT | A | | | | SA | MPLIN | G & TES | TING | |
| METHOD | SUPPORT | WATER | MOISTURE | DEPTH (M) | | | GRAPHIC LOG | CLASSIFICATION | SOIL NAME, plasti colour, seconda moisture condition, ROCK NAME, gra | AL DESCRIPTION city or particle characteristics, ry and minor components, consistency/relative density, ain size, texture/fabric, colour th, weathering. | | CONSISTENCY | DENSITY INDEX | ТҮРЕ | DEPTH (M) | | DDITIONAL | JLTS AND . OBSERVATIONS | 5 |
| V | Nil | N | М | 0.1 | | | | SCL | Sandy Clay Loam - Da | ark brown, we organic. | eakly structured, | | | В | 0.1- 0.3 | 4330/10 | 3/ 0.1-0.3 | | |
| v | Nil | Ν | м | - | | | | CL | Clay Loam - Brow | | v structured. | | | В | 0.5- 0.75 | 4330/10 | 8/0.5-0.75 | | - |
| | | | | _ 1.0 | | | [| | | | | | | в | 1.0- 1.2 | 4330/10 | 8/ 1.0-1.2 | | - 1.0 |
| v | Nil | N | м | - - 1.4 | | | | CL | Clay Loam - Whit wi | te, pale grey, eathered. | moderately | | | | | | | | - |
| F | | | | - | | | | | V bit refusal at 1.4 | 4m on weathe | ered basalt. | | | | | | | | - |
| | | | | | | | | | | | | | | | | | | | |
| | X E BH B HA H S S CC C | atural Existing ackhoe and au pade pade Dister Bit ingster | exposi excave bucke ger e Corei carbi | ure SI vation So et Ri Ni | B Ro | oring otcrete ock Bolt o suppo | s ⊻ Wat rt ∢ Wat → Wat | e obse measu ter leve ter out ter infle | ured M Moist L Low el W Wet M Mod Wp Plastic limit H High flow WI Liquid limit R Refu ow | ANCE VS Vo S S erate F Fi St St sal VSt Vo H Ha F Fri | ery Stiff VD Very Dens ard able | B Bulk Dense U Und D Dist se M Mois Ux Tub | er sample sample isturbed urbed sa sture con e sample | e sample mple ttent (x mm) | pp S VS DC FE W | Standard S Vane she CP Dynam penetro D Field den S Water sa | c cone meter sity | CLASSIFICATI SYMBOLS AND SOIL DESCRIP N USCS Y Agricultur | D PTION |
| 0.4 | EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS | | | | | | | | | | | | | | | | | | |
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| | | | - | | | | larman ssment | | Ltd | | | | | | 23.09.14 AB | | _ | MPLETED | 23.09. AN | .14 | | | REF | | H104 | ł |
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| SI | | | - | | | | 593 Sou | | Pamb | ula NS | w | | GEOLO | | Basalt | | VEG | ETATION | | | | | PROJECT N | | 404330 | |
| | JIPME | | | | · · | aulic A | - | | | | | | EASTIN | | - | | _ | SURFACE | - | _ | | | | | | |
| EXC | | | | ISIONS | | mm X 1 | 1.8m depth | | | | | МАТ | NORTH | ING | - Δ | | ASP | ECT | North | East | SA | | SLOPE | 5-10° | | |
| METHOD | SUPPORT | WATER | MOISTURE | DEPTH (M) | DRILLING | | GRAPHIC LOG | CLASSIFICATION | | n | OIL NAN colour, noisture | IATERIA ME, plastic , secondar condition, IAME, gra | L DESC ity or part y and min consisten | ERIPTION ticle chara nor compo ncy/relative xture/fabri | N acteristics, onents, e density, | | CONSIGNATION | CONSISTENCE | DENSITY INDEX | ТҮРЕ | DEPTH (M) | | | JLTS AI | | 3 |
| v | Nil | N | М | - - 0.3 | | | | SCL | s | Sandy C | lay Lo | | ark brov organic | | akly stru | ctured, | | | | В | 0.1- 0.3 | 4330/10 | 4/ 0.1-0.3 | | | - |
| v | Nil | Ν | М | - - - 1.0 - - 1.4 | | | | CL | | Clay | Loam | - Brow | n, mod | erately | structur | ed. | | | | В | 0.5-0.75 | 4330/10 | 4/0.5-0.75 | | | |
| v | Nil | Ν | м | - - 1.8 | | | | CL | | Clay | Loam | n - Whit weath | e, pale lered b | grey, r asalt. | noderat | ely | | | | В | 1.5- 1.7 | 4330/10 | 4/ 1.5-1.7 | | | - |
| N X E | i E IH Ba IA Ha | MENT tutural e kisting ade | / ME exposi excas | ure SI vation Si et Ri | B Ro | | s 👽 Wat | e obs measi er lev | erved ured el | MOISTUR D Dry M Mois W Wet W Liquit | E t ic limit | DRILLING RESISTA L LOW M Mode H High | S INCE erate | CONSIS VS Ver S Soi F Firr S Stiff | ry Soft ft n f | DENSITY VL Very L L Loose | n Dense | U Undi | er sample sample sturbed s urbed sau | e sample mple | pr S V: | Pocket pr Standard S Vane she CP Dynam penetrc | ic cone | SY | ASSIFICATI MBOLS AND IL DESCRIF | D |
| T N | C Co V-E C Tur T Pu | Bit Igsten | Carbi | | | E | → Wat | er infl | DW | | | | | H Har F Fria | rd ble | NYING RE | | Ux Tube | | | W | D Field der S Water sa | sity | Y | Agricultur | al |
| Quality Sheet No. 4 | | | | rte Martens & As | | | d.2014 | | | | ma | 20 G Phor | George S ne: (02) | St,Horns 9476 99 | by, NSW 99 Fax: (| S PTY LTI 2077 Aust (02) 9476 8 www.marte | ralia 3767 | .au | | E | ng | | ering oreho | - | og - | |

| | | | | 1 | | | | Jarman | | Ltd | | 23.09.14 AB | COMPLETE | D 23 | .09.14 | | | REF | BH105 | |
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| | PRO SITE | | CI | - | | | | essmen 593 Sou | | Pambula NSW | GEOLOGY | AB Basalt | VEGETATIO | - | ass | | | Sheet 1 PROJECT NO | | |
| - | QUIP | | IT | | , | - | draulic / | | | | EASTING | - | RL SURFAC | _ | | | | | 1 | |
| F | | | | | SIONS | | 5mm X | 1.4m depth | | | NORTHING | - | ASPECT | No | orth East | | | | 5-10° | |
| | | SUPPORT | WATER | MOISTURE | DEPTH (M) | | | GRAPHIC LOG | CLASSIFICATION | MATER SOIL NAME, plat colour, secont moisture conditio ROCK NAME, c | IAL DESCRIPTIC sticity or particle cha dary and minor com n, consistency/relati rrain size, texture/fati ngth, weathering. | DN racteristics, oonents, ve density, | CONSISTENCY | DENSITY INDEX | ТҮРЕ | DEPTH(M) | | | ING LTS AND OBSERVATIONS | |
| F | v | Nil | Ν | м | 0.1 | | | | SCL | Sandy Clay Loam - I | , | eakly structured, | | | В | 0.1- 0.3 | 4330/10 | 5/ 0.1-0.3 | | |
| | v | Nil | Ν | М | - - - - - - - - - - - - - - - - - - - | | | | | Clay Loam - Bro | organic. wn, moderately | y structured. | | | В | 0.5-0.75 | 4330/10 | 5/ 0.5-0.75 | | |
| | | | | | | | | | | V bit refusal at 1 | .4m on weath | ered basalt. | | | | | | | | |
| | N BH HA S CC V TC | Na Ex Bao Hai Sp Cor V-B Tun | tural e isting ckhoe nd au ade ncrete sit | exposi excave bucke ger Core Carbi | ure Si vation Si et R N | C SH B Ro | horing hotcrete ock Bol o suppo | ts ⊻ Wa ort √ Wa ⊳ Wa | ne obs meas ter lev ter out ter infl | sured M Moist L Lo vel W Wet M M Wp Plastic limit H Hig fflow WI Liquid limit R Re | TANCE VS V w S S oderate F F fusal St St fusal VSt V H H F Fr | ery Stiff VD Very De ard iable | nose A Au B Bu I Dense U U D Di nse M Ma Ux Tu | iger san ilk sam idisturb sturbed bisture be sam | ple led sample I sample content nple (x mm) | pr S V: D FI W | Standard S Vane she CP Dynam penetro D Field den /S Water sa | ic cone meter sity | CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION N USCS Y Agricultural | |
| ł | | | _ | ~ | | | | XCAVAT | UN L | LOG TO BE READ IN CONJU | | | | | | | | | _ | |
| Quality Sheet No. | (| | | | rte Martens & As | | | td . 2014 | | Ph | George St,Horn one: (02) 9476 9 | SSOCIATES PTY LTE sby, NSW 2077 Austr 999 Fax: (02) 9476 8 EB: http://www.marte | alia 767 | | E | ng | | ering oreho | l Log - Je | |

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| P | RO. | EC | гν | /astewa | ter As | sessment | t | | LOGGED | AB | CHECKED | AN | | | | Sheet 1 | | Ū |
| s | ITE | | L | ot 711, I | DP 112 | 28593 Sou | ith F | ambula NSW | GEOLOGY | Basalt | VEGETATIO | N Gras | s | | | PROJECT NO | . P1404330 | |
| | QUIPN | | | | | lic Auger | | | EASTING | - | RL SURFAC | E - | | | | | 1 | |
| E | | | | ISIONS | | n X 1.7m depth | | | NORTHING | - | ASPECT | Nort | h East | | | | 15-20° | |
| ┢ | E | | | ION DA | _ | | 7 | MAT | ERIAL DAT | Α | | | | SAI | MPLIN | G & TEST | ING | |
| | | WATER | MOISTURE | DEPTH (M) | | (1) | CLASSIFICATION | SOIL NAME, plastic colour, secondar moisture condition, ROCK NAME, grai | y and minor comp consistency/relativ | racteristics, onents, ve density, | CONSISTENCY | DENSITY INDEX | TYPE | DEPTH (M) | | | LTS AND OBSERVATION | NS |
| | / N | I N | М | 0.1 | | | SCL | Sandy Clay Loam - Da | ark brown, we organic. | akly structured, | | | В | 0.1- 0.3 | 4330/10 | 6/ 0.1-0.3 | | |
| | / N | IN | М | - - - - - - - - - - - - - - - - - - - | | | CL | Clay Loam - Brown | - | y structured. | | | В | 0.5-0.75 | 4330/10 | \$/0.5-0.75 | | - - - - - - - - - - - - - - - - - - - |
| | | | | 1.7 | | | | V bit refusal at 1.7 | 'm on weathe | ered basalt. | | | | | | | | - 2.0 - - - - - - - - - - - - - - - - - - - |
| | | | IT / ME | | UPPORT | | | MOISTURE DRILLING | | STENCY DENSITY | | | resting | | | | CLASSIFICA | |
| | N BH HA S CC (V TC T | Natura Existii Backho Hand a Spade Concre /-Bit | I exposing exca be buck luger te Core | ure Si vation Si et R N | H Shorir C Shotci B Rock I II No su | ng N Nor rete X Not Bolts ⊻ Wa ⊖ Wa → Wa | e obs measi ter levi ter out ter infl | arved D Dry RESISTA ured M Moist L Low el W Wet M Mode Wp Plastic limit H High flow WI Liquid limit R Refus Dw | NCE VS Ve S Si State F Fi St Sti al VSt Ve H Ha F Fri | ary Soft VL Very Loos oft L Loose mm MD Medium I ff D Dense ary Stiff VD Very Dens ard able | ose A Au B Bu Dense U Un D Dis se M Mo Ux Tul | ger sample k sample disturbed sturbed s isture co be sampl | ble d sample ample ntent e (x mm) | pp S VS DC FD WS | Standard Vane she P Dynami penetro Field den S Water sa | c cone meter sity | SYMBOLS A | ND RIPTION |
| L | | | | | | EXCAVATI | ON L | OG TO BE READ IN CONJUN | CTION WITH A | ACCOMPANYING REP | ORT NOTES | AND A | BBRE | VIATIO | NS | | | |
| Quality Sheet No. 4 | (| | | rte Martens & As | | | | 20 G Phor | eorge St,Horn ne: (02) 9476 9 | SOCIATES PTY LTD sby, NSW 2077 Austra 999 Fax: (02) 9476 876 EB: http://www.marten: | 67 | | E | ng | | ering oreho | Log - le | |

| | | | . | | addey S | | | | | | y Li | td | | 23.09.14 | | COMPLET | | 23.09.1 | 4 | | | REF | | BH107 | , |
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| | RO. ITE | EC | ان | | astewa ot 711. I | | | | | | Pa | mbula NSW | GEOLOGY | AB Basalt | | VEGETATI | | AN Grass | | | | Sheet 1 PROJECT | | 1 P1404330 | |
| | QUIPN | IENT | Г | | ,- | _ | draulic | | | | | | EASTING | - | | RL SURFA | - | - | | | | | | | |
| E | | | | | | | | K 1.2 | m depth | ı | | | NORTHING | - | | ASPECT | | North E | ast | | | | | 10° | |
| | | | | | DEPTH(M) | | | - | GRAPHIC LOG | | CLASSIFICATION | MATERIA SOIL NAME, plasti colour, seconda moisture condition, ROCK NAME. gra | consistency/relati | PN racteristics, ionents, ve density, | | CONSISTENCY | | | ТҮРЕ | DEPTH (M) | | | SULTS | | 3 |
| | / N | il | Ν | М | 0.1 | | | | | s | CL | Sandy Clay Loam - D | | akly structure | ed, | | | | В | 0.1- 0.3 | 4330/107 | / 0.1-0.3 | | | |
| , | / N | 11 | N | Μ | - - - - - - 1.0 | | | | | | CL | Clay Loam - Brow | organic. n, moderately | v structured. | | | | | В | 0.5- 4 | 4330/107 | /0.5-0.7 | | | - - - - - - - - - - - - - - - - - - - |
| ┢ | | | | | 1.2 | | | - | | | | | D | | | | | | | | | | | | |
| | N X | Natu Exis | ural ex sting e | / MET | re SI ation S(| | ORT | | WATE N NG | one c | | | G CONSI INCE VS V | STENCY DENS Py Soft VL | SITY Very Loo: Loose | se A A | | 3 & TESS sample | STING | pp P | | petrometer | | CLASSIFICATI SYMBOLS AND SOLL DESCRIF | D |
| | HA I S CC C | Hand Spac Conci /-Bit ungs | d aug de crete (t sten (| Corer Carbio | Ni | i N | ock Bo o supp | port | ÷ ∢ w ⊳ w | ater ater | inflow | Wp Plastic limit H High w Wl Liquid limit R Refu | St St sal VSt V H Ha F Fri | ff D ery Stiff VD N urd able | Medium D Dense /ery Dens | D D Se M N Ux T |)isturb loistu ube s | urbed sam red sam re conte ample (x | ple ent x mm) | DCP FD F WS V | √ane shea Dynamia penetror Field dens Water sar | cone neter ity | | N USCS Y Agricultur | al |
| ₽ | | | _ | 7 | | | | EX | CAVAT | NOI | I LOO | G TO BE READ IN CONJUN | CTION WITH A | CCOMPANYIN | IG REP | ORT NOTE | S AN | ID ABI | | | | | | | |
| Quality Sheet No. | (| | | | rte Martens & Ass | | | Ltd. | 2014 | | | 20 (Pho | /ARTENS & As George St,Horn ne: (02) 9476 9 tens.com.au W | sby, NSW 2077 999 Fax: (02) 9 | ' Austral 476 876 | 67 | | | E | - | | erin reh | - | _og - | |

| | | | - | addey S | | | | | Ltd | | | 23.09.14 | | COMPLET | | 09.14 | | | REF | BH108 |
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| | ROJE TE | :C1 | - | astewa ot 711, E | | | | | ambula NSW | | GEOLOGY | AB Basalt | | VEGETATI | AN ON Gra | | | | Sheet 1 PROJECT NO | |
| | UIPME | NT | | , | Hydrau | | | | | | EASTING | - | | RL SURFA | _ | | | | | |
| EX | | | | SIONS | | n X 0.8 | 8m depth | | | | | - | | ASPECT | Noi | th East | | | | 2-5° |
| | EX | | | ION DA | - | u | | z | | MAT | ERIAL DA | Α | | | | | SA | MPLIN | G & TEST | ING |
| METHOD | SUPPORT | WATER | MOISTURE | DEPTH (M) | M DRILLING | | GRAPHIC LOG | CLASSIFICATION | SOIL NAME colour, s moisture cc ROCK NA | E, plastici econdary ondition, o ME, grain strengt | DESCRIPTIC ity or particle cha y and minor com consistency/relat n size, texture/fal h, weathering. | racteristics, ponents, ve density, pric, colour | | CONSISTENCY | DENSITY INDEX | ТҮРЕ | DEPTH (M) | | DDITIONAL | LTS AND OBSERVATIONS |
| V | Nil | N | м | 0.1 | | | | SCL | Sandy Clay Loa | | rk brown, we rganic. | eakly structu | ured, | | | В | 0.1- 0.3 | 4330/10 | 3/ 0.1-0.3 | |
| v | Nil | N | м | - - - 0.8 | | | | CL | Clay Loam - | Browr | n, moderatel | y structured | | | | В | 0.5- 0.75 | 4330/10 | 3/ 0.5-0.75 | |
| | | | | - 1.0 | | | | | V bit refusa | at 0.8 | m on weath | ered basalt. | | | | | | | | 1. |
| | | | | - | | | | | | | | | | | | | | | | ι <u>τ</u> |
| | | | | - | | | | | | | | | | | | | | | | |
| | | | | - | | | | | | | | | | | | | | | | |
| | | | | 2.0 | | | | | | | | | | | | | | | | 2 |
| | | | | _ | | | | | | | | | | | | | | | | |
| | | | | _ | | | | | | | | | | | | | | | | |
| | | | | _ | | | | | | | | | | | | | | | | |
| | | | | 3.0 | | | | | | | | | | | | | | | | 3. |
| | | | | - | | | | | | | | | | | | | | | | |
| | | | | - | | | | | | | | | | | | | | | | |
| | | | | - | | | | | | | | | | | | | | | | |
| | | | | 4.0 | | | | | | | | | | | | | | | | 4_ |
| | | | | - | | | | | | | | | | | | | | | | |
| | X E BH Ba HA Ha | atural e xisting ackhoe and au oade ncrete Bit ngsten | exposi excav bucke ger corei Corei | ure SH vation SC et RE Nil | JPPORT Shorin Shotc Rock No su | ng srete Bolts ipport | ⊥ - Wat | e obse measu er leve er out | erved D Dry R ured M Moist L el W Wet M Wp Plastic limit H flow WI Liquid limit R ow | High Refus | NCE VS V srate F F St S' al VSt V H H F Fr | ery Soft VL oft L rm MD iff D ery Stiff VD ard iable | Loose Medium E Dense Very Dens | se A A B B Dense U U D D Se M M Ux T | uger sam ulk samp indisturbed isturbed oisture c ube samp | e d sample sample ontent ble (x mm) | pr S V: D FI W | Standard S Vane she CP Dynam penetro D Field den /S Water sa | c cone meter sity | 4 CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION NUSCS Y Agricultural |
| 4 | | _ | _ | | | EX | CAVATI | ON L | OG TO BE READ IN CO | | | | | ORT NOTE | S AND | | | | | |
| Quality Sheet No. | | | | rte Martens & Ass | | | . 2014 | | mail | 20 G Phon | ARTENS & A eorge St,Horn le: (02) 9476 9 ens.com.au W | sby, NSW 20 999 Fax: (02 | 77 Austral) 9476 876 | 67 | | Ε | ng | | ering oreho | ı Log - de |

| СГ | IEN | Т | Ca | addey S | Searl | & J | arman | Pty | Ltd | | | cc | MMENCED | 23.09.14 | | COMPLET | ED 2 | 23.09.14 | | | REF | BH109 |
|-----------------------|-----------------------|--|--|-------------------------------|----------------|------------------------------|---------------------------------------|----------------------------|--------------------------|--|--|---|---|--|---|----------------------------------|--|--|-----------------------|---|---------------------------|---|
| PF | ROJE | СТ | W | astewa | ter A | Asse | ssment | | | | | LO | GGED | AB | | CHECKEI | , כ | AN | | | Sheet 1 | |
| Sľ | TE | | Lo | ot 711, I | DP 1 | 128 | 593 Sou | th P | Pamb | oula NSW | 1 | GE | OLOGY | Basalt | | VEGETAT | | Grass | | | PROJECT N | D. P1404330 |
| | | | | SIGNO | - | aulic A | | | | | | | | - | | RL SURF | - | | | | SLOPE | 15.00° |
| | | | | | | um X 1 | 1.6m depth | | | | N | | | - A | | ASPECT | | North East | S/ | | G & TES | 15-20° |
| METHOD | SUPPORT | WATER | MOISTURE | DEPTH (M) | DRILLING | | GRAPHIC LOG | CLASSIFICATION | | o mo | MATI IL NAME, I colour, sec isture cond DCK NAME | ERIAL DI plasticity o condary and lition, cons | ESCRIPTIC r particle cha d minor comp sistency/relati ze, texture/fat | PN racteristics, ionents, ve density, | | CONSISTENCY | DENSITY INDEX | ТҮРЕ | DEPTH (M) | | RESU | LTS AND OBSERVATIONS |
| V | Nil | N | М | 0.1 | | | | SCL | | Sandy Cla | iy Loam | - Dark I orga | | akly stru | ictured, | | | | | | | |
| v | Nil | N | м | - - - - - 1.0 | | | | CL | | Clay L | .oam - B | | noderately | r structur | red. | | | В | 0.5- 0.75 | 4330/10 | 9/ 0.5-0.75 | |
| v | Nil | N | м | - - - 1.6 | | | | CL | | Clay L | .oam - B | Brown, n | noderately | structur | ed. | | | В | 1.2- 1.4 | 4330/10 | 9/ 1.2-1.4 | |
| | | | | _ | | | | | | V bit r | efusal a | at 1.6m | on weathe | ered basa | alt. | | | | | | | |
| | | MENT | / ME | | UPPOF 1 Sha | | WATER N Non | | | MOISTURE | | LLING | | | DENSITY VL Very Lo | | IPLING Augers | & TESTIN | | | | 2.1 2.1 3.1 3.1 3.1 4.1 4.1 4.1 4.1 4.1 4.1 4.1 4.1 4.1 4 |
| E F S O N | K E BH Ba HA Ha | xisting ackhoe and au bade ncrete Bit ngsten | excav bucke ger Core Carbi | vation S(et RI Ni r | C Sho B Roc | tcrete :k Bolt: suppor | s ⊻ Not t ⊻ Wat - Wat → Wat | measu er leve er out | ured el flow ow | M Moist W Wet Wp Plastic WI Liquid li | L M limit H imit R | Low Moderate High Refusal | S S F F St St VSt V H H F Fr | oft rm ff ery Stiff adle | L Loose MD Medium D Dense VD Very Der | B Dense U D nse M Ux | Bulk sar Undistu Disturbe Moisture Tube sa | nple rbed sample ed sample e content imple (x mn | S V D 1) F W | Standard S Vane she CP Dynam penetro D Field der /S Water sa | ic cone meter isity | |
| + | | | | | | E | XCAVATI | ON L | OG T | O BE READ | IN CON | JUNCTI | ON WITH / | CCOMPA | ANYING REF | PORT NOT | ES AN | | | | | |
| Quality Sheet No. | | | | rte Martens & Ass | | | d.2014 | | | | | 20 Geor Phone: (| ge St,Horn 02) 9476 9 | sby, NSW 999 Fax: | ES PTY LTD 2077 Austra (02) 9476 87 www.marter | alia '67 | | E | ng | - | ering oreho | y Log - ole |

9 Attachment C – Groundwater Bore Log



WaterNSW Work Summary

3W110974

Licence:

Licence Status:

Authorised Purpose(s): Intended Purpose(s): STOCK, DOMESTIC

Final Depth: 55.80 m Drilled Depth: 55.80 m

Work Type: Bore Work Status: Supply Obtained Construct.Method: Rotary Air Owner Type: Private

Commenced Date: Completion Date: 20/03/2009

Contractor Name: Gordon Noel BRIGGS Driller: Gordon Noel Briggs Assistant Driller:

Property: GWMA: GW Zone:

Standing Water Level (m): 14.900 Salinity Description: Yield (L/s): 0.120

Site Details

Site Chosen By:

County Form A: AUCKLAND Licensed:

Northing: 5905879.000 Easting: 755260.000

Parish YOWAKA Cadastre 5//262002

Region: 10 - Sydney South Coast River Basin: - Unknown Area/District:

CMA Map: Grid Zone:

Scale:

Coordinate Source: Unknown

Latitude: 38°57'30.9'S Longitude: 149°52'01.1'E

MGA Zone: 55

Construction

Elevation: 0.00 m (A.H.D.) Elevation Source: Unknown

GS Map: -

legative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure remented; S-Sump; CE-Centralisers

| Glued | | |
|----------------|-----------------|------------------------------------|
| otted, PVC, SL | : 80.0mm, A: 2. | .00mm |
| | | ued ted, PVC, SL: 80.0mm, A: 2. |

onstruction

egative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure emented; S-Sump; CE-Centralisers

| lole | Pipe | Component | Туре | From (m) | To (m) | Outside Diameter (mm) | Interval | Details |
|------|------|-----------|------------------|-------------|-----------|-----------------------------|----------|--|
| 1 | | Hole | Hole | 0.00 | 2.70 | 185 | S 11 | Rotary Air |
| 1 | | Hole | Hole | 2.70 | 55.80 | 182 | 0 | Down Hole Hammer |
| 1 | 1 | Casing | Pvc Class 9 | -0.30 | 55.80 | 140 | 3 N | Seated on Bottom, Glued |
| 1 | 1 | Opening | Slots - Vertical | 18.00 | 55.00 | 140 | 0 | Casing - Machine Slotted, PVC, SL: 80.0mm, A: 2.00mm |

Vater Bearing Zones

| m) | To (m) | Thickness (m) | WBZ Type | S.W.L. (m) | D.D.L. (m) | | Hole Depth (m) | Duration (hr) | Salinity (mg/L) |
|-------|-----------|------------------|----------|---------------|---------------|------|----------------------|------------------|--------------------|
| 19.80 | 33.50 | 13.70 | Unknown | 14.90 | | 0.12 | | 02:00:00 | 1.0 |

rillers Log

| rom m) | To (m) | Thickness (m) | Drillers Description | Geological Material | Comments |
|-----------|-----------|------------------|-----------------------------|---------------------|----------|
| 0.00 | 0.60 | 0.60 | TOPSOIL | Topsoil | |
| 0.60 | 2.70 | 2.10 | CLAY RED | Clay | |
| 2.70 | 19.80 | 17.10 | RHYOLITE RED | Rhyolite | |
| 19.80 | 23.70 | 3.90 | RHYOLITE RED, FOULTED ZONES | Rhyolite | - A 2 |
| 23.70 | 55.80 | 32.10 | RHYOLITE BLUE | Rhyolite | |

*** End of GW110974 ***

Varning To Clients: This raw data has been supplied to the WaterNBW by drillers, licencees and other sources. WaterNBW does not verify the accuracy of this data. The data is presented for use by you at you own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

10 Attachment D – Pathogen Transport Modelling



| | Vers Ga | raner - | | ansport As: | marten |
|-----|---|--------------------------------|------------|----------------------------|--|
| | | | Sun | te 201, Level 2, 20 George | e, Hornsby, NSW 2077, Ph: (02) 9476 9999, mail@martens.com.au, www.martens.c |
| JEC | CT DETAILS | | | | |
| ect | Prop | Developn | | 28593, South Pambula, | I, NSW Ref. No. P1404330JS05V01 |
| hor | MI | - | Reviewed | | |
| Ĺ | | | 1 | | |
| 1:0 | CONTAMINANT | BOUNDARY C | ONDITIONS | | |
| | Initial Concentrat | tion of Viruses ([,] | viruses/L) | 1.00E+07 | (<i>M</i> ₀) |
| | Magnitude of Rec | duction | | 1.00E-07 | $\left(\frac{M_t}{M_0}\right)$ |
| | | | | | (v / |
| | Aquifer Boundary | | | · | |
| | Minimum Ground | | | 12 | (T_l) |
| | Maximum Ground | | | 22 | (T_h) |
| | Saturated Hydraulic Hydraulic Gradient (| | lay) | 0.16 | (K) (i) |
| | Effective Porosity | | | 0.16 | (l) (η_e) |
| | | | | | Cie? |
| 2:1 | ASSESSMENT | | | | |
| | | | | | |
| | Modelled Predict | tors Decay rate | | | |
| | Temperature (°C) | coefficient (k) | | Travel Distance (m) | |
| | 12.0 | 0.17 | 92 | 73.9 | Virus Transport & Setback Distances |
| | 13.0 14.0 | 0.22 | 72 59 | 57.6 47.2 | |
| | 14.0 | 0.27 | 59 | 47.2 | (E) 90 |
| | 16.0 | 0.32 | 43 | 34.7 | (Lu 90 10 10 10 10 10 10 10 10 10 1 |
| | 17.0 | 0.42 | 38 | 30.6 | - 00 - C |
| | 18.0 | 0.47 | 34 | 27.4 | S(S 40 |
| | 19.0 | 0.52 | 31 | 24.8 | U Travel Time (days) |
| | 17.0 | | | 22.7 | P 10 - Travel Distance (m) |
| | 20.0 | 0.57 | 28 | | |
| | | 0.57 0.62 | 28 26 | 20.9 | 0.0 5.0 10.0 15.0 20.0 25 Groundwater Temperature (oC) |

11 Attachment E – Nutrient Modelling Calculations





