Larry Cook Consulting Pty Ltd
(ABN 27 159 132 055)

PO Box 8146 TUMBI UMBI NSW 2261
Office: 02 4340 0193 Mobile: 0428 884645 Email: larrycookconsulting@gmail.com

CONCEPT WASTEWATER MANAGEMENT PLAN

New Lots 121 & 122
Proposed Subdivision of
Lot 12 in DP576336

14 Collingwood Drive Matcham

for

Mr. & Mrs. Ursino

Distribution

Mr. & Mrs. Ursino (1)	**Rep.No. 18116-A**
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1. INTRODUCTION

As requested by *Mr. & Mrs. Ursino* (the owners), *Larry Cook Consulting* has conducted a wastewater treatment and disposal investigation on two proposed new allotments created by the proposed subdivision of Lot 12 in DP576336 14 Collingwood Drive Matcham, Central Coast New South Wales (the Site). The location of the Site is shown on a lot plan presented in **Figure 1** and on a topographic plan shown in **Figure 2**. A plan of the subject lot showing the proposed sub-division prepared by Stephen Thorne & Associates is presented in **Figure 3**.

The results of the present investigations are incorporated in this Wastewater Management Plan (WMP) which provides a concept design for an On-Site Sewerage Management system (OSSM) for the two new allotments.

An OSSM system is designed to:

1. Dispose of treated effluent on-site using an approved and effective methodology in accordance with the Environmental Health Protection Guidelines (DLG 1998) and AS/NZS 1547:2012 (SAI & NZS 2012).
2. Meet the environmental and health *Performance Objectives* documented in the Environmental Health Protection Guidelines (DLG 1998) which ensure that on-site sewage management for single households is appropriate and will not affect public health or the environment.

These objectives are detailed in Section 7.1.

2. INVESTIGATOR

Larry Cook, an environmental scientist and geoscientist undertook the effluent disposal management investigation. Larry Cook is qualified to carry out such investigations.

3. EXISTING DEVELOPMENT

Existing conditions on the Site are shown on a copy of a *Google Earth* image in **Figure 4**. The Site is partly developed and mostly cleared and hosts a dwelling and sheds in the south-western corner.

In regard to existing OSSMs located on the Site, the following observations were made:

- Wastewater generated from the existing cottage in the south-western part of the Site is treated to primary standard in a single concrete septic tank located close to the north-eastern corner of the dwelling with disposal of treated wastewater presumably into a nearby absorption trench. The location of the existing treatment tank is annotated in **Figure 3**. The exact location and specifications of the disposal area are unknown, but the site inspection did not reveal any wet areas.

4. PROPOSED DEVELOPMENT

The owners propose to subdivide Lot 12 into two similar-sized new allotments. The proposed new lots are shown in **Figure 3**. The lots and areas are listed as follows:

New Lot	Area (ha)
121	1.012
122	1.011

It is noted that new proposed Lot 121 hosts the existing cottage which may be retained. Access to new allotment 121 will be off Collingwood Drive. Access to new allotment 122 will also be off Matcham Road via a right-of-way along the eastern boundary of the Site.

For the purposes of calculating the design hydraulic load for each new allotment, an equivalent five-bedroom dwelling is adopted which may include four bedrooms and an office/study the latter of which must be included as a potential bedroom particularly if it is similar in size (and layout) to the bedrooms, can fit a bed and has a built-in wardrobe.

The municipal seweage system is not presently available to the Site and, as such, Central Coast Council (Council) requires the development of an On-Site Seweage Management (OSSM) system for any proposed development.

5. SITE INFORMATION

The Site is a multi-sided two-hectare broadly rhomb shaped parcel of land, oriented northeast-southwest. The land is in the Parish of Kincumber, County of Northumberland and in the Central Coast Council local government area (LGA). The Site is located on the northern side of Collingwood Drive approximately 105 m west of its intersection with Matcham Road.

The Site is surrounded by partly developed rural-residential properties. There is mains power connected to the land but <u>no</u> town water or municipal seweage system.

6. SITE ASSESSMENT

The Site is located the the upper part of the Fires Creek valley system. No streams dissect the Site. The Site is observed to slope gradually from the southern Collingwood Drive boundary down to the northern boundary with elevation ranging from approximately 64.0 Australian Height Datum (AHD) in the south-eastern part down to about 40 AHD m along the northern boundary. The ground slope in the northern central part of the Site is approximately 1 in 6 (15 %). The ground slopes are considered suitable for wastewater disposal subject to satisfaction of buffer setback distances.

The Site is underlain by Triassic-age Terrigal Formation, which consists of interbedded, flat-lying, lithic to quartz-lithic sandstone, siltstone, and minor claystone and conglomerate. The Terrigal Formation is partly exposed in small road cuttings in this valley. No outcrop was observed on the Site.

The Terrigal Formation on the flanks of coastal valleys and hillsides in the district is variably deeply weathered and generally covered with a silty sandy colluvial and residual silty sandy loam to sandy-silty clay soil profile which can vary in thickness from 0.2 m to greater than two metres. The soils are predictably thicker in the lower parts of the valleys and sometimes on the flanks of the valleys where deep colluvium can be developed such as is the case on the Site. However, the soil cover atop, and close to the ridge systems can be relatively thin.

The Site, according to Council mapping, is not flood prone. The Site has been mostly historically cleared with tall open eucalypt forest along the northern boundary, parts of the southern boundary and in the south-western part.

7. ON-SITE WASTEWATER DISPOSAL MANAGEMENT PLAN

7.1 INTRODUCTION

The **objectives** of a Wastewater Disposal Management Plan are to:

1. Dispose of treated effluent on-site using an approved and effective methodology in accordance with the Environmental Health Protection Guidelines (DLG 1998) and AS/NZS 1547:2012 (SAI & NZS 2012).
2. Meet the environmental and health *Performance Objectives* documented in the Environmental Health Protection Guidelines (DLG 1998) which ensure that on-site sewage management for single households is appropriate and will not affect public health or the environment. These objectives are summarised as follows:

    - **Prevention of public health risk**. Contact with effluent should be minimised or eliminated, particularly for children. Residuals, such as composted material, should be handled carefully. Treated sewage should not be used on edible crops that are consumed raw

- **Protection of lands** - on-site sewage management systems should not cause deterioration of land and vegetation quality through soil structure degradation, salinisation, waterlogging, chemical contamination or soil erosion
- **Protection of surface waters** - on-site sewage management systems should be selected, sited, designed, constructed, operated and maintained so that surface waters are not contaminated by any flow from treatment systems and land application areas (including effluent, rainfall run-off and contaminated groundwater flow)

The following works were undertaken:

- Undertake a site inspection and site walkover of the site,
- Review recent state government colour aerial photographs and remotely sensed data acquired over the district,
- Describe the physical setting (geomorphology),
- Establish, assess and describe local and district hydrogeological conditions,
- Establish subsurface conditions including soil assessments (soil type, soil permeability) and estimate depth to bedrock (if possible) and depth to groundwater,
- Establish soil parameters including pH, Electrical Conductivity (EC), Phosphorus Sorption (PSorp), Cation Exchange Capacity (CEC), Exchangeable Sodium Capacity (ESP) and Modified Emerson Class,
- Estimate the total hydraulic load for any new development on the two new allotments,
- Acquire and utilise relevant Bureau of Meteorology (BOM) climate data and calculate a water balance,
- Assess and rank any potential impacts from the on-site disposal of treated wastewater on the groundwater system and environment, and
- Provide recommendations for the method, location and size of any disposal area/s.

7.2 CLIMATE

Sun and wind exposure over the Site are excellent. No temperature, evaporation and rainfall data are available for the Site. Based on temperature data from the official BOM station at Peats Ridge (Station No. 061351), mean daily maximum temperatures for the land are expected to be always greater than 15^{o}C (**Table 1**). Peats Ridge station was used because it is by far the closest official weather station with official pan evaporation data. Rainfall statistics for Peats Ridge are also provided in **Table 1**.

The water balance calculations utilised in the hydraulic balance (**Appendices A and B**) are based on the temperature, rainfall and mean monthly pan evaporation data acquired from Peats Ridge and is believed to be the best meteorological values available for the subject land.

Table 1
Summary Climate Statistics – Peats Ridge (Station 061351)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	27.0	26.4	24.6	22.2	19.1	16.4	15.8	17.7	20.5	22.8	24.1	25.8	21.8	31	1981 2012
Mean minimum temperature (°C)	16.3	16.4	14.6	12.0	9.5	7.2	6.1	6.6	8.7	10.9	13.0	14.8	11.3	31	1981 2012
Rainfall															
Mean rainfall (mm)	113.3	154.3	135.9	123.0	89.7	99.5	62.7	74.0	69.1	85.3	100.7	92.4	1248.6	31	1981 2015
Decile 5 (median) rainfall (mm)	102.3	121.2	126.5	112.6	79.9	68.6	44.0	44.0	54.6	58.1	95.1	87.4	1226.4	33	1981 2015
Mean number of days of rain ≥ 1 mm	10.0	10.5	10.1	8.8	8.1	7.8	6.8	6.0	6.0	7.8	9.4	9.1	100.4	33	1981 2015
Evaporation															
Mean Evaporation (mm)	142.6	114.8	105.4	78	55.8	48	52.7	74.4	102	124	129	145.7	1172.4	31	1981 2012

7.3 SOIL ASSESSMENT

The reader is referred to the *Soil Landscapes of the Gosford-Lake Macquarie 1:100,000 Sheet* Report (Murphy, 1993). The soils beneath the Site are grouped with the Erina soil landscape which is developed on undulating rises overlying the Terrigal Formation and Narrabeen Group sedimentary rocks in this area.

Representative soil testing was carried out over the Site having regard to the location and distribution of the two new proposed allotments, landform (topography), possible building envelopes and site limitations such as dams, stream line/s and vegetation communities.

A total of two representative locations were tested across the Site. The locations of the soil test holes are shown on the site plan in **Figure 3**. Testing was undertaken in order to describe and classify the soils and determine the depth of the soil profiles developed atop the Terrigal Formation in these locations.

The soil investigations revealed a relatively well developed and consistent soil profile with a thickness of greater than approximately 1.0 m. Soil bore logs are provided in **Appendix C**.

In summary, the Site is underlain by Triassic aged Terrigal Formation. The soil profile is directly derived from the Terrigal Formation. The soil profile across the central and northern parts of the Site consists of approximately 0.20 of generally brown to yellow-brown, organic-bearing, dry and loose, silty sandy loam topsoil and colluvium overlying 0.30 m of yellow brown to yellow, organic-bearing, silty sandy loam to about 0.50 and 0.70 m. Yellow brown to orange-yellow mottled, dry and loose to semi dense silty sandy clayey loam was intersected from approximately 0.50 to 0.70 m depth. The colluvium grades down into light clay. Groundwater was not encountered in the investigations.

The soils were classified according to the textural classification in AS/NZS 1547:2012. A summary soil classification for the Site based on the results of the soil investigations is presented in **Table 2**.

Table 2 **Summary Soil Profile**	
TOPSOIL/ COLLUVIAL	0.00 - 0.20 m Silty Sandy Loam. Brown to yellow brown topsoil. Abundant amounts of organic material. Dry and loose (friable). Average thickness: 0.20 m Average interval: 0.00 - 0.20 m
COLLUVIAL	0.20 - 0.50 m Silty Sandy Loam. Yellow brown to yellow. Abundant amounts of organic material. Dry and loose. Average thickness: 0.30 m Average interval: 0.20 - 0.50 m
COLLUVIAL	0.50 - 0.90 m Silty Sandy Clayey Loam to Clay. Yellow brown to mottled orange-yellow. Grading down to light/medium clay towards base of interval. Dry and loose to semi dense. Common to rare amounts of organic material. Average thickness: > 0.50 m Average interval: 0.50 - > 0.90 m

The textural classification of the Silty Sandy LOAM encountered down to at least 0.60 m beneath the tested parts of the Site allows a determination of its expected permeability in accordance with Table 5.1 of AS/NZS 1547:2012 (SAI & NZS, 2012). The indicative permeability value (K_{sat}) is predicted to be between approximately 0.5 and 1.5 m/d with an expected Design Loading Rate (DLR) of approximately 15 mm/day (Tables L1 in Appendix L, AS/NZS 1547:2012) and a Design Irrigation Rate (DIR) of approximately 28 mm/week (Table M1 in Appendix M).

Field soil test results for the Silty Sandy LOAM soil sample collected in BH 1 at approximately 0.35 m depth are presented in **Table 3**.

Table 3
Summary Results – Field Soil Testing

Description	Silty Sandy LOAM BH 1 (0.30 m)	
	Range	Limitation
pH (pH units)	4.9	Moderate
E.C. (dS/m)	0.15	Minor
Modified Emerson Class	6	Minor

Based on recent bulk soil testing in the same soil profile in nearby Milina Road, an ESP of 0.5 %, CEC of 3.9 cmol$^+$/kg and P Sorp of 440 mg/kg are adopted.

7.4 HYDRAULIC LOAD

Any new development on the two new allotments will not be connected to any reticulated town water supply. Tank water will be used. The number of total equivalent bedrooms adopted in this concept WMP is five which allows for dedicated five bedrooms or a configuration comprising four bedrooms and a study. The design of the hydraulic load adopts standard water reduction fixtures as defined in AS/NZS 1547:2012. Based on this scenario, the design maximum wastewater production is approximately 120 L/person/day (Table H1 in Appendix H in AS/NZS 1547:2012).

Consistent with AS/NZS 1547:2012, the calculation of the hydraulic load adopts a design total of 7.5 persons for the equivalent five bedrooms (1.5 persons per bedroom). Therefore, the Design Hydraulic Load for the calculations for an equivalent **five bedrooms** is 900 L/day.

Design Hydraulic Load (5 bedrooms): 900 L/day

In comparison, the Design Hydraulic Load for an equivalent **four bedrooms** is 720 L/day.

Design Hydraulic Load (4 bedrooms): 720 L/day

7.5 SYSTEM SELECTION

In terms of the application of treated wastewater on the new proposed allotments, the potential limitations for the whole Site have been reviewed, assessed and the results summarised in **Table 5**. Positive site attributes include excellent sun and wind exposure over the two new allotments, locally good draining silty sandy loam soils on all lots and grass cover.

Table 5
Assessment of Limitations for On-site Disposal of Treated Wastewater
Lot 12 in DP576336 14 Collingwood Drive Matcham

Feature	Site	Capable level (Low Limitation)	Marginal Level (Mod. Limitation)	Unsuitable Level (High Limitation)
Proximity to any drainages or surface water bodies	> 40 m	X		
Depth to bedrock (m)	>1.00 m	X		
Depth to Water Table (m)	>1.00 m	X		
Soil Permeability	0.5 – 1.5 m/day	X		
Soil Drainage	Good	X		
Coarse Fragments (%)	<20	X		
Bulk Density (g/cm^3)	~1.5		X	
Electrical Conductivity (dS/m)	0.15	X		
Phosphorus Sorption (kg/ha)	6,600		X	
Emerson Aggregate Test	6	X		
Sun/wind Exposure	Excellent	X		
Flood Potential	Nil	X		
Slope (%)	Approx. 15 %		X	
Landform	Constant over disposal area	X		
Run-on seepage	Low	X		
Erosion Potential	Low	X		
Site Drainage	Good		X	
Site Fill	Nil	X		
Practical Available Land Area (m^2)	> 800 m^2	X		

7.6 WASTEWATER TREATMENT SYSTEM

7.6.1 Assessment of Existing Treatment System

It is understood that the sewage treatment system connected to the existing dwelling in the house block is Council approved with a current permit to operate. The surface site inspection indicated that the treatment system is operating satisfactorily with no evidence of imminent or actual failure such as wetting, odours or stains. It is considered that if the existing dwelling is retained and there is no increase in the design hydraulic load, for example additions to the dwelling, the existing treatment system can be retained subject to Council inspections and assessments.

7.6.2 New Proposed Treatment System

Wastewater treatment to minimum secondary standard using a Department of Health approved *Aerated Water Treatment System* (AWTS) is considered suitable for the new allotments and is therefore recommended for installation. Other treatment systems may be suitable subject to Council approval. The total nitrogen concentration and phosphorus levels of the treated wastewater are approximately 20 mg/L and 8 mg/L respectively.

In summary, the AWTS is a small-scale sewage treatment system that is suitable for single households. The system consists of one or two tanks of 3,000 L minimum capacity containing a series of chambers. Through a series of treatment and disinfection processes, the wastewater is transformed into non-potable water that can be applied to lawns and gardens or disposed in several approved ways. The treatment process incorporates clarification, aeration, biological treatment and disinfection (chlorination and/or UV treatment). The discharge water is treated to a secondary standard. Typical final wastewater nutrient levels for an AWTS are 25 to 50 mg/L Total N and 12 to 18 mg/L Total P.

The actual position of the AWTS (or suitable treatment system) can be selected by the installer/plumber to suit the position of any new development on the Site.

7.7 WASTEWATER DISPOSAL

7.7.1 Introduction

A review of site limitations, results of the soil investigations and review of locations of vegetation communities has resulted in the delineation of areas on each new allotment considered suitable for the disposal of minimum secondary treated wastewater. The nominated areas are effectively wastewater disposal envelopes that would also incorporate the building envelopes.

The areas considered suitable for the disposal of treated wastewater on each new allotment are shown in **Figure 5**. The position of the Land Application Area (LAA) for each new allotment takes into account the guideline buffer setback distances from the property boundaries, any surface water bodies and access driveways.

The nominated areas have excellent sun and wind exposure and suitable soil development. Disposal methods considered suitable for the Site include sub-surface drip irrigation, surface spray irrigation, Wisconsin sand mound, amended soil mound and conventional beds. **Sub-surface drip irrigation is the preferred method of disposal**.

7.7.2 Calculations

Design parameters and calculations for the design five bedrooms are provided in **Appendix A**. Design parameters and calculations for the design four-bedroom scenario are provided in **Appendix B**. The calculations of the disposal area proposed for the Site are summarised in **Table 6**. The calculations are based on an equivalent four- and five-bedroom scenario for a new dwelling.

Table 6
Summary Disposal Area Calculations

	Equivalent 4 bedrooms (6 persons)	**Equivalent 5 bedrooms (7.5 persons)**
Hydraulic Load (L/day)	**720**	**900**
Area (m^2)		
Minimum Area Method	189	236
Nominated Area Method with full wet weather storage	300	380
100 % Nitrogen Uptake	265	331
50-year Phosphorus Life	267	334
Proposed Application Area (Most Limiting)	**300 m^2**	**380 m^2**
Adopted Application Area	**320 m^2**	**400 m^2**
Parameters and Assumptions:		

1.	Total N	25 mg/L
2.	Total P	12 mg/L
3.	Indicative Permeability:	0.5 and 1.5 m/d
4.	Design Irrigation Rate (DIR):	28 mm/wk
5.	Effective Absorption Depth:	1.00m
6.	Soil Phosphorus Sorption Capacity:	6,600 kg/ha
7.	Soil Treatment:	Nil

Therefore, the proposed total primary application area required to accept the design hydraulic load of 720 and 900 L/day respectively with full wet weather storage, a satisfactory 50 year phosphorus adsorption life and the uptake of the total nitrogen is approximately 320 to 400 m^2.

7.7.3 Sub-Surface Drip Irrigation

The important design elements of the sub-surface irrigation system are summarised as follows:

- The recommended type of irrigation is pressurised sub-surface drip irrigation which, if designed and installed correctly, ensures even, widespread and efficient application of treated wastewater under controlled application rates within the root-zone of plants and grasses.
- The treated wastewater should be applied evenly across the designated disposal area.
- There are several suitable and available proprietary, pressure-compensating drip irrigation systems which are designed for irrigation of wastewater which contain elevated levels of nutrient and biological loads, BOD and suspended solids. Industry examples include:
    - *UniBioline* - Netafim Australia
    - *Safe-T-Flow* - BUI Ebb & Flow Technologies, Australia
    - *Wasteflow* - Triangle Filtration & Irrigation, Australia
    - *KISS Ground Irrigation system*
    - *Triangle Irrigation system*

  These proprietary irrigation systems incorporate root intrusion protection and are designed to significantly reduce the risk of any blockages.
- The irrigation lines should be installed at a depth of between approximately 100 and 150 mm below ground surface, parallel to the ground slope and parallel to each other. The recommended separation distance between lateral pipes in the irrigation panels is less than approximately 1.0 m which will minimise ‘striping’.
- Manufacturers recommend the installation of:
    - In-line 120-micron disc filter in order to minimise the amount of solids entering the pipelines and emitters
    - Air release valves (vacuum breaker valves) will be installed at the high points in individual irrigation areas to prevent soil particles being sucked into the lines at the end of pump cycles as pipelines depressurise.
    - Flushing valves are installed at points most distant to the inlet manifold, to enable periodic flushing of lines and provide for effective long term performance

It is recommended that these elements are inspected for integrity and operational status and cleaned as necessary during quarterly contractual inspections and maintenance. Repairs or replacement should be carried out as required.

A design for sub-surface drip irrigation is provided in **Figure 6** and an industry example of a sub-surface irrigation layout with principle components is presented in **Figure 7**.

7.8 NUTRIENT CALCULATIONS

The nutrient calculations and results are provided in the third spread sheet in **Appendices A and B**. The calculations are comprehensive and take into all relevant parameters and values based on the current literature. The basic formula used to calculate the area requirements based on nitrogen and phosphorus loadings are taken from the Environmental Health Protection Guidelines (DLG 1998) and are provided below in support of the model calculations in **Appendices A and B**.

The critical Total Nitrogen loading rate used in the example on Page 153 in the Environment and Health Protection Guidelines (DLG, 1998) is a 'nominal' loading rate of 25 mg/m^2/day. The calculations in this WMP adopt a rate of 68 mg/m^2/day which is consistent with the calculations used by other workers. According to our literature research, this is considered to be a conservative level and is used in the calculations below. The source publication is a landmark paper on nitrogen in wastewater written by Bob Patterson of *Lanfax Laboratories* in Armidale (Patterson, 2003). The relevant section relating to critical nitrogen uptake is reproduced below.

"The Environment and Health Protection Guidelines (DLG, 1998) suggest a nominal nitrogen loading of 25 mg/m2/day (91 kg/ha/year) be applied to land application systems. When this loading rate is compared with typical plant and microbial uptake rates, it is difficult to understand the scientific basis for the guideline value. While the value is called 'nominal' the author has had some authorities impose this as the maximum loading rate. The value is simply the mean of the range of TN for uptake values of perennial pasture referred to by EPA (1995) as 65-130 kg/ha.yr, which references a NSW Agriculture 1991 Feedlot Manual.

The revised Feedlot Manual (NSW Agriculture, 1997) indicates that for an irrigated perennial ryegrass pasture, growing actively March to December, the expected nitrogen uptake rate is 420 kg/ha.yr. Kikuyu is expected to remove 520 kg/ha.yr. Removal of the aerial portion of the grasses is required to remove the nitrogen from the application area. It would follow, although not discussed in the guidelines, that a further quantity of nitrogen would be stored in the root system as organic nitrogen, in the microbial biomass and leaching of nitrogen would be restricted to only a portion of the nitrate-N..."

The critical phosphorus loading rate used in the example on Pages 153 and 154 in the Environment and Health Protection Guidelines (DLG, 1998) is a 'nominal' loading rate of 3 mg/m^2/day However, a review of the literature on wastewater chemistry suggests that a more realistic critical loading rate is possibly closer to 7 mg/m^2/day. The source publication is a landmark paper on phosphorus in wastewater written by Robert Patterson of *Lanfax Laboratories* in Armidale (Patterson, 2001). The relevant section relating to phosphorus uptake in soils is reproduced below.

"...In all the (analytical) methods, P sorption only accounts for the addition of labile inorganic P being added and measured at specified pH for a particular period. The tests do not account for the pH of the effluent added or the other elemental

constituents of the effluent, in particular the proportion of monovalent and divalent cations.
The addition of organic P components will have no immediate impact on determination of P sorption, yet substantial masses of organic P can be stored in the soil without loss by leaching....". "The purpose of determining P sorption is to predict the capacity of the soil to bind, and reduce the potential for effluent-applied inorganic P leaching from the soil and entering surface or groundwater. The results of this testing program do not support the general discount factor of 70% from measured P sorption to that actually adsorbed. Since part of the P in effluent is in organic form, a soil's capacity to adsorb P is greater than determined for inorganic P sorption...."

The critical phosphorus loading rate adopted in this WMP is 7 mg/m^2/day. The formulae documented in the Environment and Health Protection Guidelines follows in their relevant sections with calculations for the Site. The following calculations are provided for the 900 L/day hydraulic load scenario

Determination of Minimum Area Based on Nitrogen Loading

$$A = \frac{C \times Q}{L_n}$$

$$A = 25 \times 900 / 68$$
$$= 330.9 \text{ m}^2$$

where A = land Area (m^2)
C = concentration of Total Nitrogen (TN) (17 mg/L) less 20% for lost to soil processes
Q = treated wastewater flow rate (L/day)
L_n = critical TN loading rate (mg/m^2/day) (Whitehead & Associates)

Determination of Area Based on Phosphorus Loading

The determination of the minimum area is based on a phosphorus loading of 10 mg/L. Based on the parameters gleaned from research by Patterson (2001) and used by a leading consultancy in the industry, a phosphorus soil sorption without leaching factor of 0.7, a critical phosphorus uptake rate of 7 mg/m^2/day and a recommended phosphorus sorption ability of 50 years is as follows;.

$$A = P_{\text{generated}} / (P_{\text{adsorbed}} + P_{\text{uptake}})$$

$$A = 197.1 / (0.462 + 0.128)$$
$$= 334.1 \text{ m}^2$$

$$P_{\text{generated over 50 years}} = TP \times Q \times days \times years$$
$$= 12 \times 900 \times 365 \times 50$$
$$= 197.1\ (3.94\ kg/year)$$

where $P_{\text{generated}}$ = amount of phosphorus generated (kg)
TP = Total Phosphorus concentration in treated wastewater (mg/L)
Q = treated wastewater flow rate (L/day)

$$P_{\text{adsorbed}} = P\ Sorp \times 0.7$$
$$= 6{,}600 \times 0.7$$
$$= 0.462\ kg/m^2$$

where P_{adsorbed} = amount of phosphorus that can be adsorbed without leaching
P Sorp = phosphorus sorption capacity (kg/ha)

$$P_{\text{uptake over 50 years}} = CPLR \times days \times years$$
$$= 7 \times 365\ days \times 50\ years$$
$$= 0.128\ kg/m^2$$

where P uptake = amount of phosphorus vegetation uptake
CPLR = critical P loading rate (mg/m2/day)

The results are summarised in **Table 7**.

Table 7
Summary Results of Nutrient Calculations

Parameter	Calculation
Estimated Total Nitrogen Concentration (AWTS)	25 mg/L
Estimated Total Phosphorus Concentration (AWTS)	12 mg/L
Estimated bulk soil density	1500 kg/m^3
Phosphorus sorption depth (from field soil testing)	1.00 m
Phosphorus sorption capacity (laboratory testing)	440 mg P/kg (6,600 kg/ha)

Design wastewater load (4 to 5 bedrooms/tank)	720 - 900 L/day (120 L/person/day)
Design application area	320 - 400 m^2
Total nitrogen <u>not</u> assimilated	0 kg/year
Total phosphorus <u>not</u> assimilated	2.72 – 3.36 kg/year
Site phosphorus longevity	Greater than 50 years

7.9 RESERVE APPLICATION AREA

A backup area of similar size is required by the authorities in the unlikely event that the primary area fails. Sufficient area exists within the nominated wastewater envelopes. Other methods of disposal may be suitable, subject to Council approval.

7.10 BUFFER DISTANCES

The position of the proposed irrigation areas satisfies the following buffer distances listed in **Table 8** and documented in Table 5 of the Environmental Health Protection Guidelines (DLG 1998). It is noted that Table R1 in AS/NZS 1547:2012 provides concessions on vertical and horizontal buffer distances based on a variety of sensitivities, limitations and parameters.

Table 8
Buffer Distances - Sub-Surface Irrigation

From Intermittent Drainages	40 m
From Permanent Drainages	100 m
Dam	40 m
Upgradient of Property Boundary	6 m
Downgradient of Property Boundary	3 m
Upgradient of swimming pools, driveways and buildings	6 m
Downgradient of swimming pools, driveways and buildings	3 m
Bore (Water Well)	250 m

8. CONCLUSIONS AND RECOMMENDATIONS

- The wastewater management plan is developed to meet the environmental and health *Performance Objectives* documented in the Environmental Health Protection Guidelines (DLG 1998), in particular the avoidance of any impacts on public health or the environment. The design disposal of secondary treated effluent on-site proposes an approved and effective methodology in accordance with the Environmental Health Protection Guidelines (DLG 1998) and AS/NZS 1547:2012 (SAI & NZS 2012).

- The geology, soil characteristics and attributes, landform, available land for on-site application and local climate allow treated wastewater to be disposed on-site via sub-surface drip irrigation.
- A Department of Health approved AWTS (or suitable treatment system) and disposal via sub-surface drip irrigation in an appropriately constructed irrigation system is considered suitable for each of the new allotments.
- The recommended area for the sub-surface irrigation system is approximately 320 to 400 m^2. This calculated disposal area is predicated on a hydraulic load of 720 to 900 L/day respectively.
- Pressure compensated drips and root invasion protection should be used in the sub-surface drip irrigation system. Lilac coloured *UniBioline, Wasteflow, Triangle*, *Safe-T-Flow* or *KISS* dripper line should be used.
- An area suitable for a reserve application system is available within each of the Land Application Areas.
- The proposed location of Land Application Areas are shown in **Figure 5**. The design specifications of the sub-surface irrigation system are shown in **Figure 6**. An industry example of a typical sub-surface drip irrigation layout is provided in **Figure 7**. Construction of any irrigation system should be in general accordance with the principles documented in Section 7.7.3.
- The approved AWTS will require quarterly (3-monthly) contractual inspections which include the examination of the operation of the aerator, pump, disinfection system and alarm system. This is an ongoing cost.
- The construction of the irrigation (disposal) system and associated plumbing and hydraulic connections should be undertaken by a licensed plumber/drainer or suitably licensed practitioner with experience in installing wastewater treatment and on-site disposal systems in accordance with AS/NZS 1547:2012 and any relevant codes of practices.
- The optimal route for the plumbing between the AWTS and the disposal system can be selected by the licensed plumber or installer to suit the development.
- As required, select an AWTS (or suitable treatment system) and complete an *Application to Install Sewage Management System including Greywater Treatment System and Greywater Diversion System* Sec 68, Chapter 7 LGA 1993. A Council fee applies.

9. REFERENCES

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For and on behalf of
Larry Cook Consulting

Larry Cook

Larry Cook
Environmental Consultant and Hydrogeologist

APPENDIX A

DESIGN PARAMETERS AND CALCULATIONS

SURFACE/SUB-SURFACE APPLICATION

Hydraulic Load: 900 L/day

Environment and Health Protection Guidelines

Minimum Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	900
Design Percolation Rate	R	mm/wk	28

Lot 12 in DP576336 14 Collingwood Drive Matcham

Parameters	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in Month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	102.3	121.2	126.5	112.6	79.9	68.6	44	44	54.6	58.1	95.1	87.4	1226.4
Evaporation	E		mm/month	142.6	114.8	105.4	78	55.8	48	52.7	74.4	102	124	129	145.7	1172.4
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Outputs																
Evapotranspiration	ET	E*C	mm/month	99.82	80.36	73.78	39	27.9	19.2	21.08	37.2	51	62	90.3	101.99	703.63
Percolation	B	(R/7)*D	mm/month	124.0	112.0	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		ET+B	mm/month	223.8	192.4	197.8	159.0	151.9	139.2	145.1	161.2	171.0	186.0	210.3	226.0	2163.6
Inputs																
Precipitation	P		mm/month	103.6	121.2	126.5	112.6	87.9	71.4	50.2	45.2	57.4	67	98.2	87.4	1226.6
Retained Precipitation		P*0.75	mm/month	77.7	90.9	94.9	84.5	65.9	53.6	37.7	33.9	43.1	50.3	73.7	65.6	771.45
Possible Effluent Irrigation	W	(ET+B)-P	mm/month	146.1	101.5	102.9	74.6	86.0	85.7	107.4	127.3	128.0	135.8	136.7	160.4	1392.2
Actual Effluent Irrigation	I	H/12	mm/month	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	1392.2
Inputs		P+I	mm/month	193.7	206.9	210.9	200.5	181.9	169.6	153.7	149.9	159.1	166.3	189.7	181.6	2163.6
Storage	S	(P+I)-(ET+B)	mm/month	-30.1	14.6	13.1	41.5	30.0	30.4	8.6	-11.3	-11.9	-19.7	-20.6	-44.4	
Cumulative Storage	M	-	mm	-30.1	14.6	27.7	69.1	99.2	129.5	138.1	126.8	114.9	95.2	74.5	30.1	
Irrigation Area	L	365*Q/H	m^2	236.0												
Storage	V	Largest M	mm	138.1												
		(V*L)/1000	m^3	32.6												

Environment and Health Protection Guidelines

Nominated Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	900
Design Percolation Rate	R	mm/wk	28
Land Area	L	m^2	380

Lot 12 in DP576336 14 Collingwood Drive Matcham

Parameters	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in Month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	102.3	121.2	126.5	112.6	79.9	68.6	44	44	54.6	58.1	95.1	87.4	1226.4
Evaporation	E		mm/month	142.6	114.8	105.4	78	55.8	48	52.7	74.4	102	124	129	145.7	1172.4
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Inputs																
Precipitation	P		mm/month	102.3	121.2	126.5	112.6	79.9	68.6	44	44	54.6	58.1	95.1	87.4	994.3
Retained Precipitation		P*0.75	mm/month	76.7	90.9	94.9	84.5	59.9	51.5	33.0	33.0	41.0	43.6	71.3	65.6	745.725
Possible Effluent Irrigation	W	(Q*D)/L	mm/month	73.4	66.3	73.4	71.1	73.4	71.1	73.4	73.4	71.1	73.4	71.1	73.4	864.5
Inputs		P+W	mm/month	150.1	157.2	168.3	155.5	133.3	122.5	106.4	106.4	112.0	117.0	142.4	139.0	1610.2
Outputs																
Evapotranspiration	ET	E*C	mm/month	99.82	80.36	73.78	39	27.9	19.2	21.08	37.2	51	62	90.3	101.99	703.63
Percolation	B	(R/7)*D	mm/month	124.0	112.0	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		ET+B	mm/month	223.8	192.4	197.8	159.0	151.9	139.2	145.1	161.2	171.0	186.0	210.3	226.0	2163.6
Storage	S	(P+W)-(ET+B)	mm/month	-73.7	-35.1	-29.5	-3.5	-18.6	-16.7	-38.7	-54.8	-59.0	-69.0	-67.9	-87.0	
Cumulative Storage	M	-	mm	-73.7	-35.1	-29.5	-3.5	-18.6	-16.7	-38.7	-54.8	-59.0	-69.0	-67.9	-87.0	
		2nd year		-73.7	-35.1	-29.5	-3.5	-18.6	-16.7	-38.7	-54.8	-59.0	-69.0	-67.9	-87.0	
Storage	V	Largest M	mm	-3.5												
		(V*L)/1000	m^3	-1.3												

Monthly Nutrient Balance Calculation

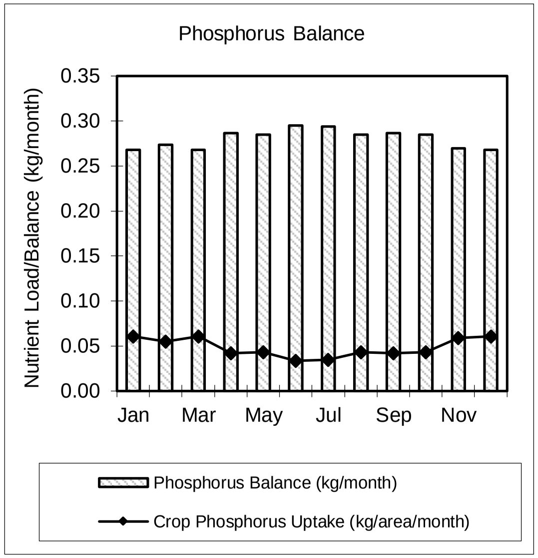
Nutrient & Soil Paramaters	
Estimated Total - N concentration (mg/L)	**25**
Effluent Total P Concentration (mg/L)	**12**
Effluent Ammonia - N concentration (mg/L) (55% total N)	13.75
Effluent Organic - N concentration (mg/L) (15% total N)	3.75
Effluent Oxidised - N concentration (mg/L) (30% total N)	7.5
Organic N conversion to ammonia (%)	90
Ammonia loss through volatilisation(%)	25
Oxidised N loss through denitrification (%)	10
Critical Total Nitrogen Loading Rate (mg/m^2/day)	68
Critical Phosphorus Loading Rate (mg/m^2/day)	7
Estimated Soil Bulk Density (kg/m^3)	1500
Assumed Phosphorus Sorption Depth (m)	1.00
Lab-determined P-Sorp capacity (mg P/kg soil)	440

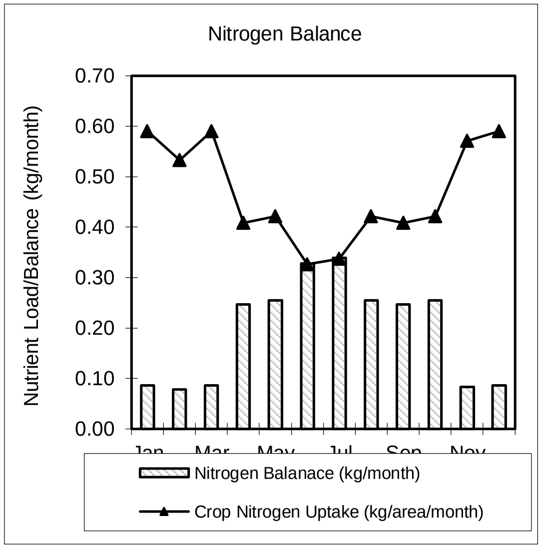
Hydraulic Load and Disposal Area Parameters	
Design wastewater load (L/day)	900
Design Application Area (m^2)	400

Computed Parameters	
Ammonia N Load (kg/year)	5.63
Organic N load (kg/year)	0.12
Oxidised N load (kg/year)	2.22
Effective total N load (kg/year)	7.97
Phosphorus load (kg/year)	3.94
Soil phosphorus sorption capacity (kg/ha)	6600

Results Summary	
Total nitrogen not assimilated (kg/year)	2.35
Percent of nitrogen not assimilated (%)	29
Total phosphorus not assimilated (kg/year)	3.36
Site phosphorus longevity (years)	78

Month	Days in Month	Growth Rate Factor (0-1)	Nitrogen Load (kg/month)	Crop Nitrogen Uptake (kg/area/month)	Nitrogen Balanace (kg/month)	Positive Nitrogen Balance (kg/month)	Phosphorus Load (kg/month)	Crop Phosphorus Uptake (kg/area/month)	Phosphorus Balance (kg/month)	Positive Phosphorus Balance (kg/month)
Jan	31	0.7	0.68	0.59	0.09	0.09	0.33	0.06	0.27	0.27
Feb	28	0.7	0.61	0.53	0.08	0.08	0.33	0.05	0.27	0.27
Mar	31	0.7	0.68	0.59	0.09	0.09	0.33	0.06	0.27	0.27
Apr	30	0.5	0.65	0.41	0.25	0.25	0.33	0.04	0.29	0.29
May	31	0.5	0.68	0.42	0.25	0.25	0.33	0.04	0.29	0.29
Jun	30	0.4	0.65	0.33	0.33	0.33	0.33	0.03	0.29	0.29
Jul	31	0.4	0.68	0.34	0.34	0.34	0.33	0.03	0.29	0.29
Aug	31	0.5	0.68	0.42	0.25	0.25	0.33	0.04	0.29	0.29
Sep	30	0.5	0.65	0.41	0.25	0.25	0.33	0.04	0.29	0.29
Oct	31	0.5	0.68	0.42	0.25	0.25	0.33	0.04	0.29	0.29
Nov	30	0.7	0.65	0.57	0.08	0.08	0.33	0.06	0.27	0.27
Dec	31	0.7	0.68	0.59	0.09	0.09	0.33	0.06	0.27	0.27
Total	365	6.8	7.97	5.62	2.35	2.35	3.94	0.58	3.36	3.36





APPENDIX B

DESIGN PARAMETERS AND CALCULATIONS

SURFACE/SUB-SURFACE APPLICATION

Hydraulic Load: 720 L/day

Environment and Health Protection Guidelines

Minimum Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	720
Design Percolation Rate	R	mm/wk	28

Lot 12 in DP576336 14 Collingwood Drive Matcham

Parameters	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in Month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	102.3	121.2	126.5	112.6	79.9	68.6	44	44	54.6	58.1	95.1	87.4	1226.4
Evaporation	E		mm/month	142.6	114.8	105.4	78	55.8	48	52.7	74.4	102	124	129	145.7	1172.4
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Outputs																
Evapotranspiration	ET	E*C	mm/month	99.82	80.36	73.78	39	27.9	19.2	21.08	37.2	51	62	90.3	101.99	703.63
Percolation	B	(R/7)*D	mm/month	124.0	112.0	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		ET+B	mm/month	223.8	192.4	197.8	159.0	151.9	139.2	145.1	161.2	171.0	186.0	210.3	226.0	2163.6
Inputs																
Precipitation	P		mm/month	103.6	121.2	126.5	112.6	87.9	71.4	50.2	45.2	57.4	67	98.2	87.4	1226.6
Retained Precipitation		P*0.75	mm/month	77.7	90.9	94.9	84.5	65.9	53.6	37.7	33.9	43.1	50.3	73.7	65.6	771.45
Possible Effluent Irrigation	W	(ET+B)-P	mm/month	146.1	101.5	102.9	74.6	86.0	85.7	107.4	127.3	128.0	135.8	136.7	160.4	1392.2
Actual Effluent Irrigation	I	H/12	mm/month	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	116.0	1392.2
Inputs		P+I	mm/month	193.7	206.9	210.9	200.5	181.9	169.6	153.7	149.9	159.1	166.3	189.7	181.6	2163.6
Storage	S	(P+I)-(ET+B)	mm/month	-30.1	14.6	13.1	41.5	30.0	30.4	8.6	-11.3	-11.9	-19.7	-20.6	-44.4	
Cumulative Storage	M	-	mm	-30.1	14.6	27.7	69.1	99.2	129.5	138.1	126.8	114.9	95.2	74.5	30.1	
Irrigation Area	L	365*Q/H	m^2	188.8												
Storage	V	Largest M	mm	138.1												
		(V*L)/1000	m^3	26.1												

Environment and Health Protection Guidelines

Nominated Area Method Water Balance and Wet Weather Storage Calculation

Design Wastewater Flow	Q	L/day	720
Design Percolation Rate	R	mm/wk	28
Land Area	L	m^2	300

Lot 12 in DP576336 14 Collingwood Drive Matcham

Parameters	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in Month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	102.3	121.2	126.5	112.6	79.9	68.6	44	44	54.6	58.1	95.1	87.4	1226.4
Evaporation	E		mm/month	142.6	114.8	105.4	78	55.8	48	52.7	74.4	102	124	129	145.7	1172.4
Crop Factor	C		-	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.7	0.7	
Inputs																
Precipitation	P		mm/month	102.3	121.2	126.5	112.6	79.9	68.6	44	44	54.6	58.1	95.1	87.4	994.3
Retained Precipitation		P*0.75	mm/month	76.7	90.9	94.9	84.5	59.9	51.5	33.0	33.0	41.0	43.6	71.3	65.6	745.725
Possible Effluent Irrigation	W	(Q*D)/L	mm/month	74.4	67.2	74.4	72.0	74.4	72.0	74.4	74.4	72.0	74.4	72.0	74.4	876.0
Inputs		P+W	mm/month	151.1	158.1	169.3	156.5	134.3	123.5	107.4	107.4	113.0	118.0	143.3	140.0	1621.7
Outputs																
Evapotranspiration	ET	E*C	mm/month	99.82	80.36	73.78	39	27.9	19.2	21.08	37.2	51	62	90.3	101.99	703.63
Percolation	B	(R/7)*D	mm/month	124.0	112.0	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460.0
Outputs		ET+B	mm/month	223.8	192.4	197.8	159.0	151.9	139.2	145.1	161.2	171.0	186.0	210.3	226.0	2163.6
Storage	S	(P+W)-(ET+B)	mm/month	-72.7	-34.3	-28.5	-2.6	-17.6	-15.8	-37.7	-53.8	-58.1	-68.0	-67.0	-86.0	
Cumulative Storage	M	-	mm	-72.7	-34.3	-28.5	-2.6	-17.6	-15.8	-37.7	-53.8	-58.1	-68.0	-67.0	-86.0	
		2nd year		-72.7	-34.3	-28.5	-2.6	-17.6	-15.8	-37.7	-53.8	-58.1	-68.0	-67.0	-86.0	
Storage	V	Largest M	mm	-2.6												
		(V*L)/1000	m^3	-0.8												

Monthly Nutrient Balance Calculation

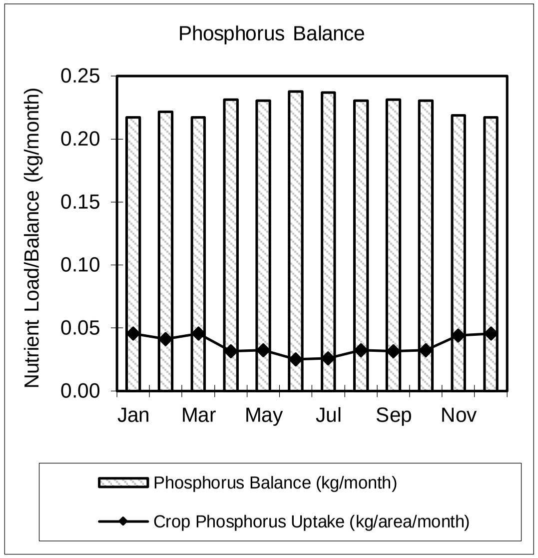
Nutrient & Soil Paramaters	
Estimated Total - N concentration (mg/L)	**25**
Effluent Total P Concentration (mg/L)	**12**
Effluent Ammonia - N concentration (mg/L) (55% total N)	13.75
Effluent Organic - N concentration (mg/L) (15% total N)	3.75
Effluent Oxidised - N concentration (mg/L) (30% total N)	7.5
Organic N conversion to ammonia (%)	90
Ammonia loss through volatilisation(%)	25
Oxidised N loss through denitrification (%)	10
Critical Total Nitrogen Loading Rate (mg/m^2/day)	68
Critical Phosphorus Loading Rate (mg/m^2/day)	7
Estimated Soil Bulk Density (kg/m^3)	1500
Assumed Phosphorus Sorption Depth (m)	1.00
Lab-determined P-Sorp capacity (mg P/kg soil)	440

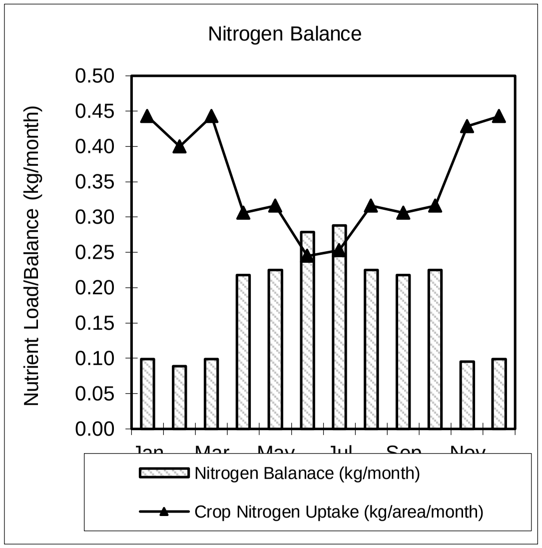
Hydraulic Load and Disposal Area Parameters	
Design wastewater load (L/day)	720
Design Application Area (m^2)	300

Computed Parameters	
Ammonia N Load (kg/year)	4.50
Organic N load (kg/year)	0.10
Oxidised N load (kg/year)	1.77
Effective total N load (kg/year)	6.37
Phosphorus load (kg/year)	3.15
Soil phosphorus sorption capacity (kg/ha)	6600

Results Summary	
Total nitrogen not assimilated (kg/year)	2.16
Percent of nitrogen not assimilated (%)	33
Total phosphorus not assimilated (kg/year)	2.72
Site phosphorus longevity (years)	73

Month	Days in Month	Growth Rate Factor (0-1)	Nitrogen Load (kg/month)	Crop Nitrogen Uptake (kg/area/month)	Nitrogen Balanace (kg/month)	Positive Nitrogen Balance (kg/month)	Phosphorus Load (kg/month)	Crop Phosphorus Uptake (kg/area/month)	Phosphorus Balance (kg/month)	Positive Phosphorus Balance (kg/month)
Jan	31	0.7	0.54	0.44	0.10	0.10	0.26	0.05	0.22	0.22
Feb	28	0.7	0.49	0.40	0.09	0.09	0.26	0.04	0.22	0.22
Mar	31	0.7	0.54	0.44	0.10	0.10	0.26	0.05	0.22	0.22
Apr	30	0.5	0.52	0.31	0.22	0.22	0.26	0.03	0.23	0.23
May	31	0.5	0.54	0.32	0.23	0.23	0.26	0.03	0.23	0.23
Jun	30	0.4	0.52	0.24	0.28	0.28	0.26	0.03	0.24	0.24
Jul	31	0.4	0.54	0.25	0.29	0.29	0.26	0.03	0.24	0.24
Aug	31	0.5	0.54	0.32	0.23	0.23	0.26	0.03	0.23	0.23
Sep	30	0.5	0.52	0.31	0.22	0.22	0.26	0.03	0.23	0.23
Oct	31	0.5	0.54	0.32	0.23	0.23	0.26	0.03	0.23	0.23
Nov	30	0.7	0.52	0.43	0.10	0.10	0.26	0.04	0.22	0.22
Dec	31	0.7	0.54	0.44	0.10	0.10	0.26	0.05	0.22	0.22
Total	365	6.8	6.37	4.21	2.16	2.16	3.15	0.43	2.72	2.72





APPENDIX C

SOIL BORE LOGS

Job No:	18116
Hole No:	BH 1
Sheet 1	of 1

Larry Cook Consulting Pty Ltd

LOG OF TEST HOLE

Client:	Mr. & Mrs. Ursino	Test Bore Location: Ref. Figure 3	
Project:	Wastewater Management Investigation	Test Method: Hand Auger	
Project Location:	Lot 12 in DP576336 14 Collingwood Drive Matcham	Coordinates (MGA Grid)	Easting: 03528909 Northing: 6301064
		Logged by: LLC	Date: Oct 2018

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T		░		**0.00 - 0.20 m Silty Sandy Loam.** Brown to yellow brown topsoil. Abundant amounts of organic material. Dry and loose (friable).	D	L	TOPSOIL	
			0.5	░		**0.20 - 0.50 m Silty Sandy Loam.** Yellow brown to yellow. Abundant amounts of organic material. Dry and loose.	D	L	COLLUVIAL	0.5
				░ ▓		**0.50 - 0.90 m Silty Sandy Clayey Loam to Clay.** Yellow brown to mottled orange-yellow. Grading down to light/medium clay towards base of interval. Dry and loose to semi dense. Common to rare amounts of organic material.	D	L/SD	COLLUVIAL	
			1.0			**BH 1 terminated at 0.90 m depth.**				1.0
			1.5							1.5
			2.0							2.0
			2.5							2.5
			3.0							3.0
			3.5							3.5

Explanatory Notes:

Consistency
- **VS** Very Soft
- **S** Soft
- **F** Firm
- **St** Stiff
- **VSt** Very Stiff
- **H** Hard

Density Index
- **VL** Very Loose
- **L** Loose
- **MD** Medium Dense
- **D** Dense
- **VD** Very Dense

Samples
- **B** Bulk Sample
- **D** Disturbed Sample
- **U50** Undisturbed Sample (50mm diam.)
- **N** S.P.T. Value

Moisture
- **D** Dry
- **M** Moist
- **W** Wet
- **Wp** Plastic Limit
- **Wl** Liquid Limit

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Job No:	18116
Hole No:	BH 2
Sheet 1	of 1

LOG OF TEST HOLE

Client:	Mr. & Mrs. Ursino	Test Bore Location: Ref. Figure 3	
Project:	Wastewater Management Investigation	Test Method: Hand Auger	
Project Location:	Lot 12 in DP576336 14 Collingwood Drive Matcham	Coordinates (MGA Grid) Easting: 0352912 Northing: 6301124	
		Logged by: LLC	Date: Oct 2018

Groundwater	Samples/	Field Tests	Depth (m)	Graphic Log	Unified	Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
N I L	B	T		▨			**0.00 - 0.20 m Silty Sandy Loam.** Brown to pale briwn to pale yellow brown topsoil. Abundant amounts of organic material. Dry and loose.	D	L	TOPSOIL	
			0.5	▨			**0.20 - 0.50 m Silty Sandy Loam.** Yellow brown to yellow. Abundant amounts of organic material. Dry and loose.	D	L	COLLUVIAL	0.5
			1.0	▨			**0.50 - 1.00 m Silty Sandy Clayey Loam to Clay.** Yellow brown to mottled orange-yellow. Grading down to light/medium clay towards base of interval. Dry and loose to semi dense. Common to rare amounts of organic material.	D	L/SD	COLLUVIAL	1.0
			1.5				**BH 2 terminated at 1.00 m depth.**				1.5
			2.0								2.0
			2.5								2.5
			3.0								3.0
			3.5								3.5

Explanatory Notes:

Consistency

VS	Very Soft
S	Soft
F	Firm
St	Stiff
VSt	Very Stiff
H	Hard

Density Index

VL	Very Loose
L	Loose
MD	Medium Dense
D	Dense
VD	Very Dense

Samples

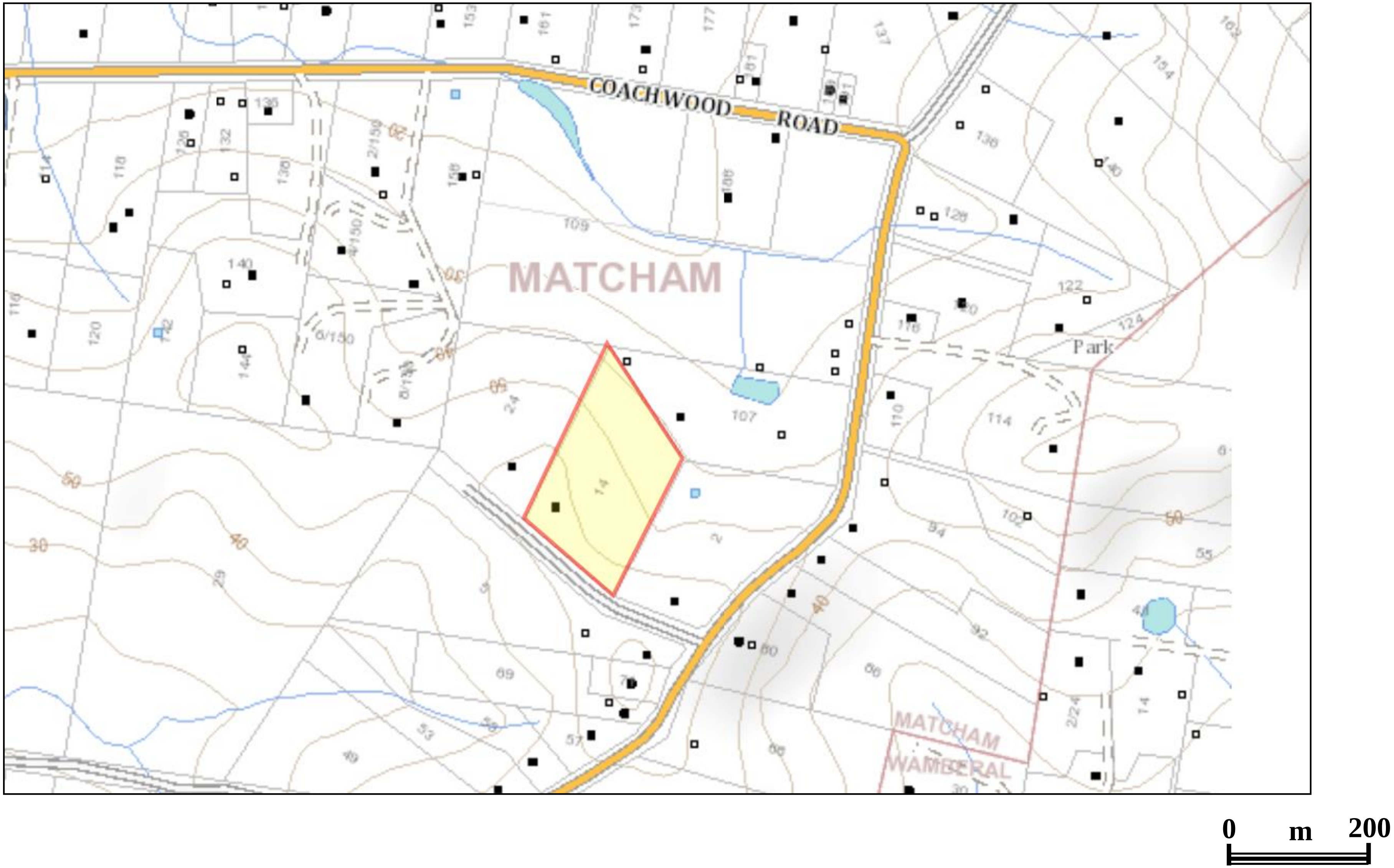
B	Bulk Sample
D	Disturbed Sample
U50	Undisturbed Sample (50mm diam.)
N	S.P.T. Value

Moisture

D	Dry
M	Moist
W	Wet
Wp	Plastic Limit
Wl	Liquid Limit

FIGURES

Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Phone 02 4340 0193**	**Wastewater Management Plan**	Scale: As shown
	Proposed Subdivision of Lot 12 in DP576336 **14 Collingwood Drive Matcham** Lot Plan	**FIGURE 1**



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Wastewater Management Plan

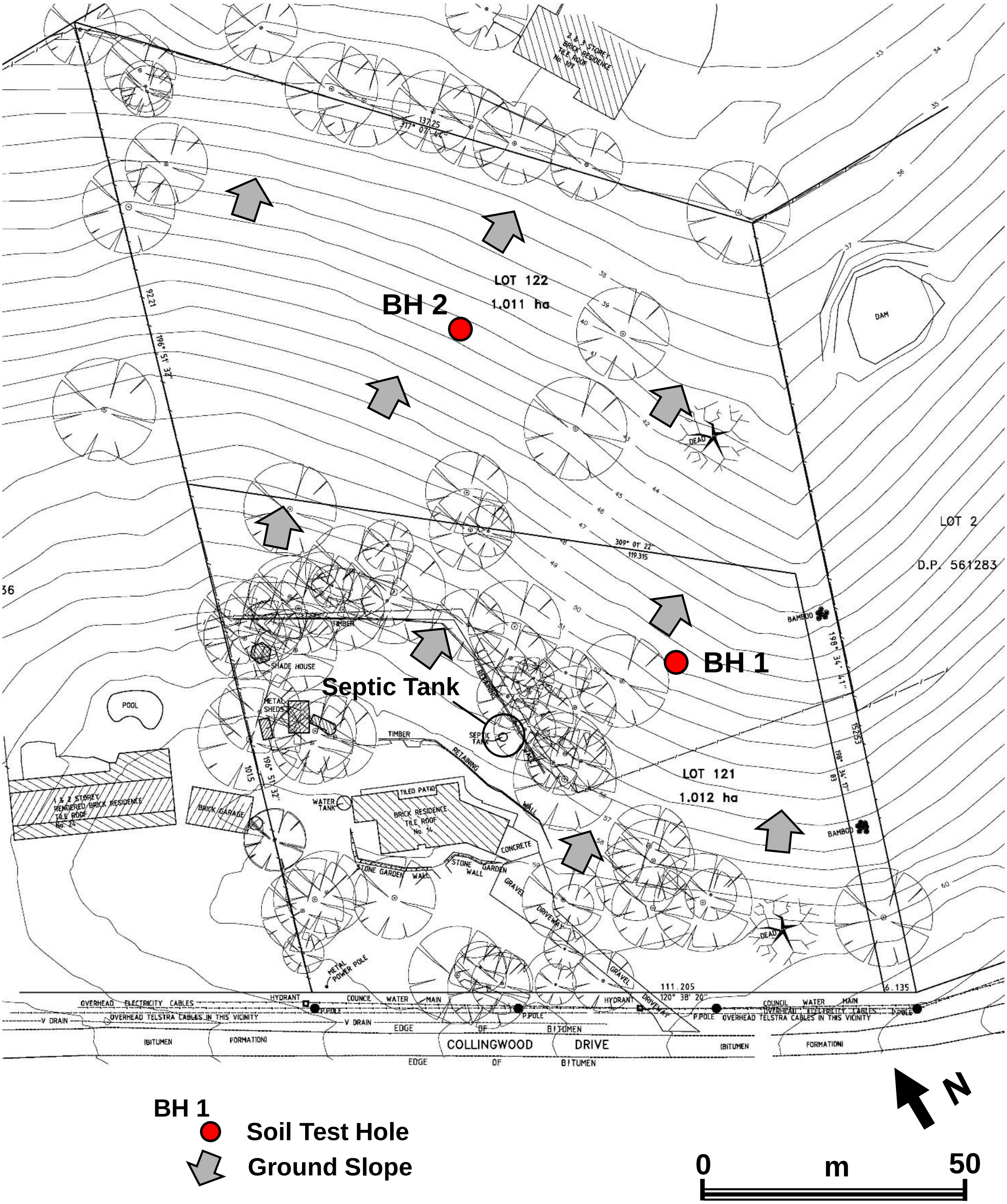
Proposed Subdivision of Lot 12 in DP576336 14 Collingwood Drive Matcham

Topographic Plan

N

Scale: As shown

FIGURE 2



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Wastewater Management Plan

Scale: As shown

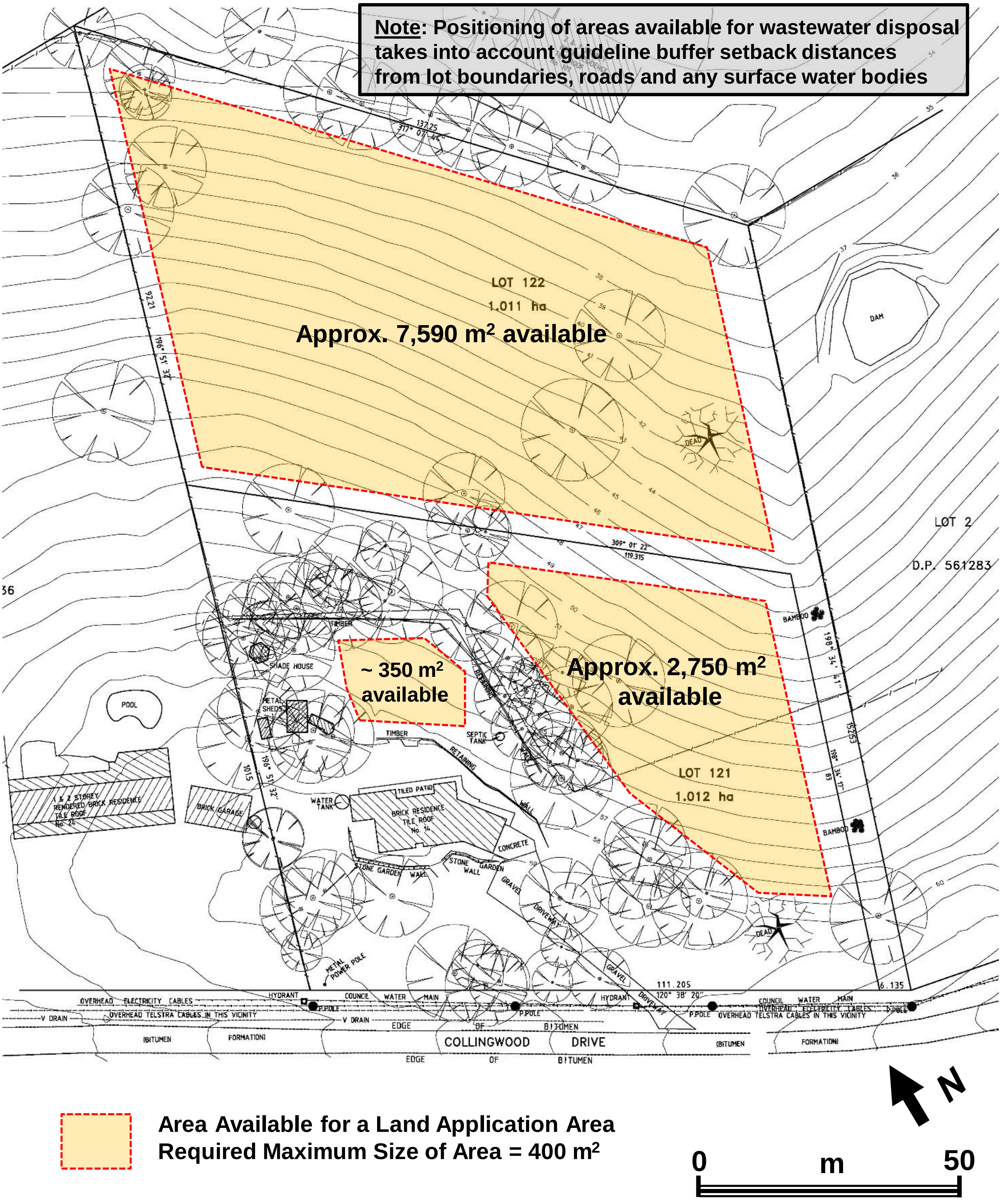
Proposed Subdivision of Lot 12 in DP576336

14 Collingwood Drive Matcham

Site Plan

FIGURE 3

Larry Cook Consulting **PO Box 8146** **Tumbi Umbi NSW 2261** **Phone 02 4340 0193**	**Wastewater Management Plan**	Scale: As shown
	Proposed Subdivision of Lot 12 in DP576336 **14 Collingwood Drive Matcham** Aerial Photo Showing Exiting Conditions	**FIGURE 4**



Note: Positioning of areas available for wastewater disposal takes into account guideline buffer setback distances from lot boundaries, roads and any surface water bodies

Area Available for a Land Application Area
Required Maximum Size of Area = 400 m²

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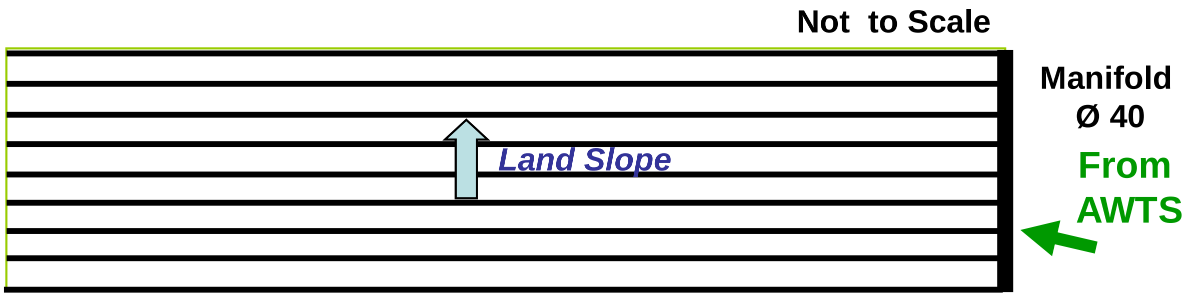
Wastewater Management Plan

Scale: As shown

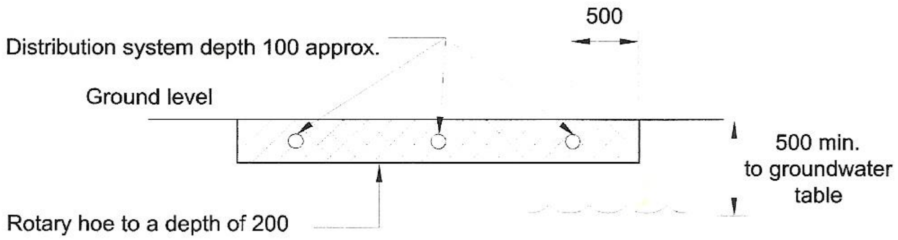
Proposed Subdivision of Lot 12 in DP576336
14 Collingwood Drive Matcham
Locations Available Areas for Application

FIGURE 5



Recommended Dripper Line Separation = approx. 0.6 – 1.0m
Recommended Emitter separation = 0.4 m
Proposed Application Area = 320 – 400 m^2

Sub-Surface Drip Irrigation Concept Plan



Sub-Surface Drip Irrigation Bed Cross Section

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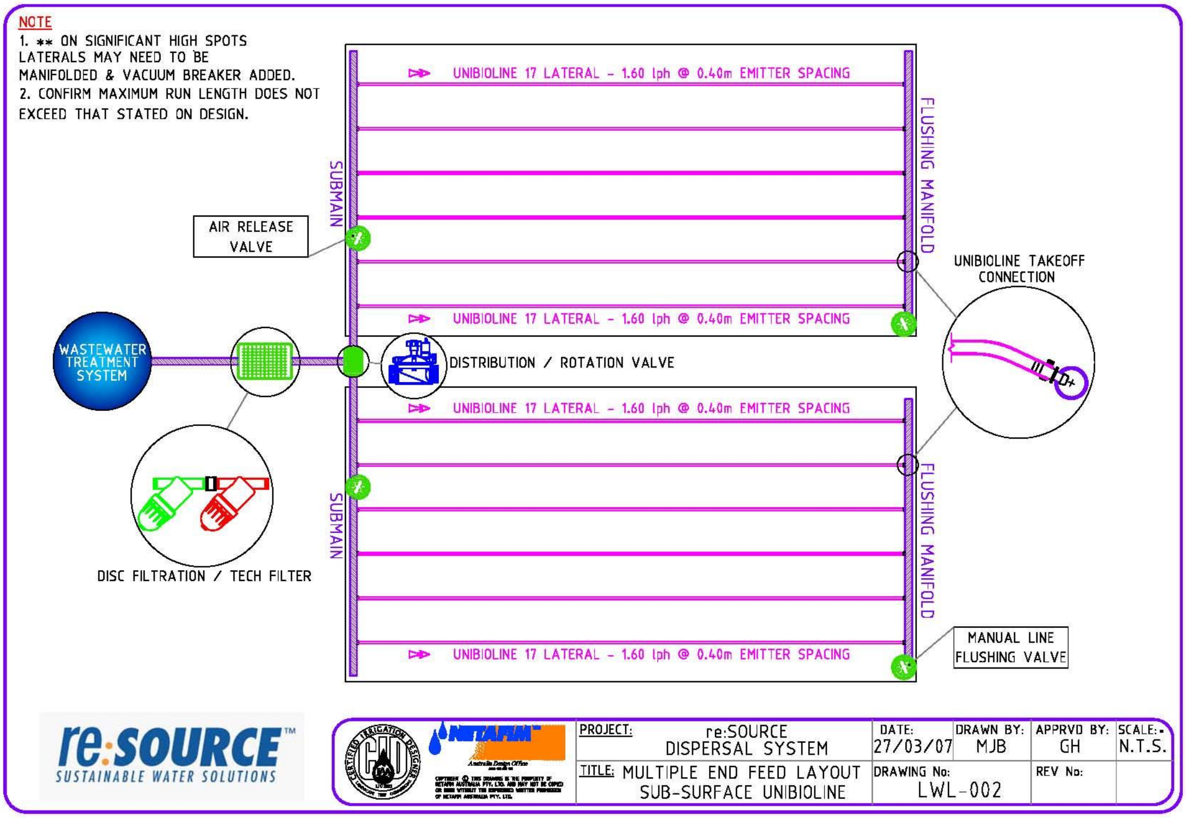
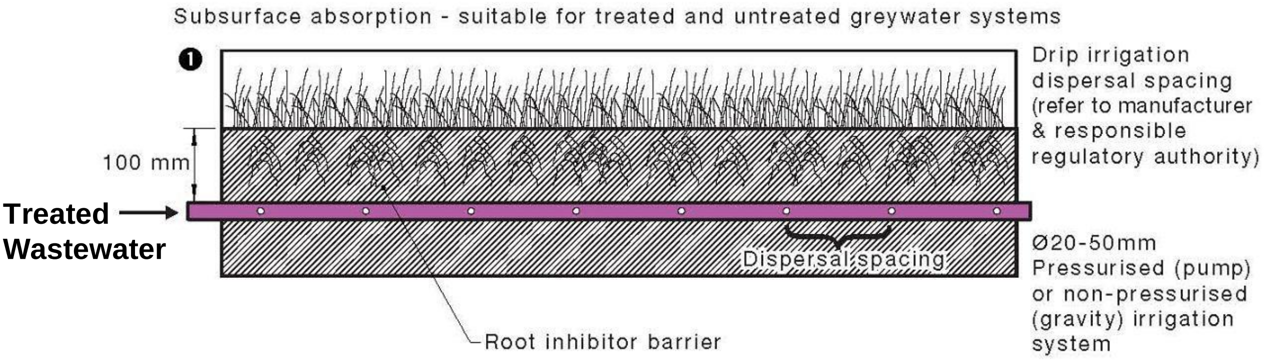
	Proposed Subdivision of Lot 12 in DP576336 **14 Collingwood Drive Matcham** Design Sub-Surface Irrigation	**FIGURE 6**



Industry Example Sub-Surface Drip Irrigation System



Typical Cross Section

Modified after *Urban Greywater Design and Installation Handbook*
(National Water Commission, 2008)

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Wastewater Management Plan

Scale: As shown

Proposed Subdivision of Lot 12 in DP576336
14 Collingwood Drive Matcham
Industry Example Sub-Surface Drip Irrigation System

FIGURE 7