Whitehead & Associates
Environmental Consultants

Tim Fletcher
Shoalhaven City Council
PO Box 42
Nowra, NSW 2541

Ref: Letter_2256_002

4 December 2018

Stage 1 Report
Onsite Sewage Management - Options Analysis for Proposed Facilities at Yalwal Campground, Yalwal NSW

I am writing in regard to onsite sewage management (OSSM) for the proposed development of new facilities at the Yalwal campground, Yalwal NSW ("the Site"). The property is identified as Lot 4 DP252335 and is zoned E2 'Environmental Conservation' under the Shoalhaven Local Environmental Plan (LEP, 2014). The Site is of 'high' environmental significance, primarily utilised as a storage reservoir for Shoalhaven Water. The Site is also subject to an elevated bushfire risk. Informal 'camping' has been common at the Site; however, use has been curbed in recent years due to planning and public safety/order concerns.

It is understood that you are currently preparing a Planning Proposal to formalise camping and numerous improvements to recreational facilities for visitors of the Site such as walking tracks, internal access roads, car and boat trailer parking, picnic facilities, jetties and landscaping. As such, a significant upgrade of the public amenities is also required.

This Letter Report presents the results and recommendations from our initial investigations and outlines a range of viable OSSM system upgrade options (treatment and land application) to service the new development. Preliminary cost estimates for each upgrade option are also provided, along with an outline of the construction/operational requirements.

Once, the Client has confirmed the preferred upgrade option to service the proposed development, a detailed 'Stage 2' OSSM Report will be provided for submission with the DA. The second report will include detailed OSSM system design information describing the selected upgrade option, any relevant monitoring and maintenance requirements, and how long-term risks to health and the environment will be mitigated or managed.

1 Site and Soil Assessment

A Site investigation was undertaken by Nicholas Banbrook of Whitehead & Associates ("W&A") on the 8th November 2018. Site soils were observed by excavating three (3) test pits within the vicinity of the campground proposal (see Site Plans). Soil test pit logs are presented in Appendix B. Soil chemistry laboratory data are presented in Appendix C. Tables 1 and 2 present the results of the site and soil investigation for the property.

Table 1: Site Assessment

Parameter	Data / Observation		Reference	Classification / Outcome
Climate	Median Rainfall; 1903-1984 (81 years) Mean Evaporation; 1969-1997 (28 years) Temperate climate with median annual rainfall of 858.3mm; monthly minimum 30.8mm (August) and maximum 80mm (March). Potential evaporation exceeds rainfall for ALL months of the year.		BoM Station's 068082 and 068076	Minor limitation
Hydraulic balance (monthly) attached: Land application area (LAA) sizing attached: Wet weather storage requirement:		Yes Yes No	As per DLG (1998) and AS/NZS 1547:2012 procedures	
Flooding Land Application Area above 1:20 ARI flood level: Land Application Area above 1:100 ARI flood level: Electrical components above 1:100 ARI flood level:		Yes Yes Yes	Council LEP (2014) Flood Mapping indicates Site is not flood affected	Minor limitation
Exposure	West to northerly aspect; moderate exposure, with some minor shading from mature trees.		Minor limitation	
Slope	15-25% slope in preferred effluent management area (EMA).		Moderate limitation	
Landform	The landform in the preferred EMA location is linear to waning divergent.		Minor limitation	
Run-on and Seepage	Run-on and up-slope seepage present a significant limitation, as evidenced by the presence of Council constructed stormwater diversion berms/swales surrounding the campground. Several diversion berms are located on the southern ridge, directly upslope from the preferred EMA. Stormwater must be directed away from EMAs through the construction of an upslope stormwater diversion drain. This item will be accounted for in the project cost estimate.		Moderate limitation	
Erosion Potential	No erosion evident. Vegetation cover was approximately 50% pasture grass within the preferred EMA location. Address using erosion and sediment controls during construction of the nominated land application system and revegetate using native grass stock or seed.		Minor limitation	
Site Drainage	Moderately well drained; however, minor mottling was observed in deeper subsoil		Minor limitation	

Parameter	Data / Observation	Reference	Classification / Outcome
	horizons, indicating imperfect drainage at times during the climate cycle.		
Fill	None observed or apparent in preferred EMA.	Minor limitation	
Groundwater	No shallow groundwater encountered during soil survey. NSW Office of Water groundwater bore registry indicates no bores within 100m of the Site. Permanent GW expected to be >1.2m below existing ground surface based on local conditions and test pit excavations.	Minor limitation	

Buffers		
Permanent rivers and creeks (100m):	Yes	None present
Intermittent creeks, drainages and dams (40m):	Yes	Setback achievable
Groundwater wells and bores (100m):	Yes	None recorded
Other sensitive receptors:	N/A	
Lot boundaries (3m if EMA downslope-6m if EMA upslope):	Yes	
Buildings, driveways and swimming pools (3m if EMA downslope-6m if EMA upslope):	Yes	
Limiting horizon (GW, bedrock etc.) (0.5m):	Yes	

Surface Rock / Outcrop	Numerous large angular siltstone and mudstone boulders were observed throughout the campground and surrounding slopes.	Major limitation
Effluent Management Area (EMA)	Available EMA is restricted by slope, rock outcrop, existing vegetation cover and proposed development extent and trafficable areas. The preferred EMA location is on a moderately sloping, partially cleared area to the south-east of the proposed campground.	Major limitation

Concluding Remarks

The major Site constraints to OSSM are the limited suitable EMA location; slope and surface rocks. Surface run-on from hillslope areas to the east of the proposed campground will also need appropriate management.

These constraints can be mitigated and avoided by conservative sizing; flexible OSSM system design and management.

Table 2: Soil Assessment

Soil Physical Properties			
Parameter	**Data / Observation**	**Reference**	**Classification / Outcome**
Soil Depth	950mm-1,200mm. Refusal on rock floaters at 350mm in TP2.	Minor limitation	
Soil Profile	**TP1:** Weak to moderately structured loam (Cat 3) to 100mm depth; overlying Moderately structured clay loam (Cat 4) to 1,200mm depth. **TP2:** Moderately structured silty clay loam (Cat 4) to 350mm depth. Refusal on angular siltstone/mudstone floaters. **TP3:** Moderately structured light clay (Cat 5) to 200mm depth; overlying Moderately structured medium clay (Cat 6) to 950mm depth.	Minor to Moderate limitation	
Depth to Water Table	Shallow (episodic) water table not encountered.	Minor limitation	
Coarse Fragments (%)	2-40% (gravel and cobbles)	Moderate limitation	
Soil Permeability	0.5-1.5m/day (indicative) within preferred EMA location (TP1)	Based on moderately structured clay loam (Cat 4).	Minor limitation
Modified Emerson Aggregate Class (EAT)	Topsoil: 7 and 8 Subsoil: 2(1) and 2(2)	Minor to Moderate limitation Subsoil dispersion noted in observed soil pits. Will be managed though soil amendment and conservative LAA design	
Soil Landscape	Soil landscape data is not available for the Yalwal local area. The nearest SALIS soil profile survey was undertaken in the Yalwal picnic area. The soil profile is described as a Brown Dermosol, comprising clay loam to 900mm depth. This is consistent with the observed soil properties during the Site investigation.	eSPADE (SALIS)	

Concluding Remarks

No major limitations to onsite effluent management are identified from soil physical properties. Table L1 in AS/NZS 1547:2012 presents recommended design loading rates (DLRs) for absorption trenches/beds receiving either primary or secondary quality effluent. Based on the limiting moderately structured Category 4 subsoil (TP1), a DLR of 15mm/day for primary quality effluent and a DLR of 30mm/day for secondary quality effluent is recommended.

Soil Chemistry				
Parameter	**Data / Observation**		**Reference**	**Classification / Outcome**
pH	5.1-5.7 (topsoil) 5.4-5.7 (subsoil)	Moderately to strongly acidic	Moderate limitation	
EC (EC_e)	0.21-0.87	Non-saline	Minor limitation	
ESP (%)	2.7	Non-sodic	From soil laboratory analysis	Minor limitation
CEC (me/100g)	12.7	Moderate		Minor limitation
P-sorption (mg/kg)	800 (11,200 kg/ha)	Very high		Minor limitation

Concluding Remarks

Laboratory analyses of the composite soil sample (TP1) revealed a slight calcium and potassium deficiency, with a calcium/magnesium ratio of 0.4. It is broadly accepted that a Ca:Mg ratio of >2.0 is required for healthy soils to avoid reduced crop yields. Whilst the soil pH is acidic, it is typical of eastern Australian soils and pH adjustment is likely to provide little benefit to native plant species.

The identified calcium deficiency can be mitigated through application of gypsum within the LAA footprint during construction.

2 Buffers

Buffer distances from LAAs are recommended to minimise risk to public health, maintain public amenity and protect sensitive environments. Buffer (or setback) distances are recommended to provide a form of mitigation against unidentified hazards and reduce potential pathways of human and environmental exposure.

The following buffers are required, based on Table 1 in Chapter G8 of the Shoalhaven Development Control Plan (2015):

- 100m from any groundwater bores;
- 100m from permanent surface waters (e.g. river, streams, lakes etc.);
- 40m from other waters (e.g. farm dams, intermittent waterways; street drainage including gutters, swales and table drains and drainage channels etc.);
- 6m if area up-gradient and 3m if area down-gradient of driveways and property boundaries;
- 6m from swimming pools and buildings;

- a minimum 0.5m vertical separation from hardpan or bedrock for application of secondary treated effluent; and
- a minimum 1.2m depth of soil for application of primary treated effluent.

All of the recommended buffer distances are achievable on Site, as shown on the Site Plan (Figure 2, Appendix A).

3 Wastewater Generation

3.1 Wastewater Quantity

All existing and proposed facilities are located on the eastern shore of Danjera Dam. Potable water supply is currently delivered by truck to 2 x ~15kL storage tanks, located upslope to the north of the campground.

In the past, campers and day visitor numbers have been unregulated. Council staff have provided estimates of up to 200 people onsite during the busiest periods of the year. It is understood that part of the intended effect of formalising the campground and providing a semi-permanent authoritative presence at the Site, is that visitation numbers will be brought under control, along with water use practices. The Client has also indicated that the campground may be closed at certain (off-peak) times of the year, in which case, the caretaker would not be present.

Based on 'conceptual' plans for the proposal, wastewater generating facilities will include:

- 41 non-powered camp sites;
- informal camping area (5 sites);
- care takers residence (lodge);
- camp kitchen / recreation space (fire proof shelter);
- amenities building (9 WC, 2 urinals, 6 basins and 7 showers); and
- day visitor toilet (separate to the north).

The relative contributions to the total wastewater flows generated by the proposed facilities at the Site are based on flow allowances from Table H4 in the *AS/NZS 1547:2012* and the following assumptions.

Camp Sites

The central camping area will consist of 41 (non-powered) camp sites, as well as 5 informal camp sites (46 camp sites in total). Typical campsite occupancy is estimated at three (3) persons per camp site, equating to a maximum of 138 persons (46 camp sites x 3 persons per camp site).

Based on a design wastewater flow allowance of 50L/person/day, the anticipated maximum daily wastewater generation from the camp sites during the peak holiday season is 6,900L/day.

Caretakers Residence

A caretaker's residence is to be constructed, which is assumed to house two (2) caretakers potentially year-round to look after the facility. Based on a design flow allowance of

120L/person/day, the typical daily wastewater generation expected from the caretaker's residence is 240L/day.

Day Visitors

The Site also attracts numerous day visitors who will utilise the proposed picnic area, boat ramp, walking tracks, etc. The day visitor parking area is separate from the campground and will be formalised to include 31 car spaces and a dedicated toilet. Based on a conservative allowance of 15L/person/day and 50 people using the toilet each day during the peak holiday season, wastewater generation from use of the day toilet is estimated at 750L/day.

Total Wastewater Generation

Wastewater generation patterns for the Site are expected to be highly variable throughout the year, depending on the season. Following development of the campground and day visitor facilities, a peak wastewater generation volume of **7,640L/day** has been anticipated for 'peak' usage periods (i.e. summer school holiday from Christmas to New Year).

Given the isolated location of the Site, peak occupancy periods throughout the year are expected to be relatively short, with brief shoulder periods of approximately 70% maximum occupancy (5,490L/day), decreasing to 20% occupancy or less during off-peak periods (1,890L/day).

To optimise the OSSM system design, reduce the risk of poor treatment performance and land application area (LAA) stress, it is important to moderate (balance) variable system inflows. As part of the analysis, a preliminary flow balance assessment was undertaken to determine the most practical wastewater storage size to manage flows during the most limiting (peak) wastewater generation period of the year, whist optimising the OSSM system sizing and design.

3.2 Wastewater Flow Balancing

Flow balancing involves moderating wastewater delivery to the treatment system in order to eliminate surge flows that can cause short circuiting of the treatment processes. It also allows for optimisation of the treatment and land application area sizing by incrementally treating 'peak' flows upon entering lower generation periods.

Analysis shows that a minimum volume of 50,000L would be necessary to adequately balance 'peak' wastewater generation at the campground. Based on this, a balanced 'design' hydraulic load of **4,000L/day** is manageable and has been adopted for the proposed development. For reference, a copy of the flow balancing assessment calculations is presented in Appendix D.

3.3 Water Conservation

Formalisation of the available camping area and the permanent presence of a Site caretaker will help regulate the number of campers, while strict water use controls such as token/coin-based shower usage and water saving fixtures will also help to minimise wastewater generation and optimise OSSM system performance.

All new facilities are recommended to be fitted with 'full' water reduction fixtures, in accordance with BASIX requirements. The Water Efficiency Labelling Scheme (WELS, 2006) provides efficiency ratings and flow rates for internal water use fixtures, based on the technical specifications outlined in AS/NZS 6400. Full water reduction fixtures include:

- Taps – 6L/minute (5 star rating);
- Toilets – 4.5/3L dual flush pan and cistern (4 star rating); and
- Showers – 6L/minuted (3 star rating).

4 Wastewater Quality

4.1 Influent Quality

Wastewater generated from Site activities is expected to be largely 'domestic' in nature, being predominantly generated from typical (WC, shower) usage by campers/day visitors and staff. It is expected that the majority of food preparation will occur at individual camp sites, or in the camp kitchen facility. In either case, excess food waste including scraps and oils/grease will be maintained separate from the OSSM system and managed through the solid waste stream. As such, untreated wastewater is expected to have characteristics similar to that described in Table 3 below; which incorporates information from DLG (1998).

Table 3: Raw Wastewater Characteristics

Parameter	Loading	Greywater %	Blackwater %
Daily Flow		65	35
Biochemical Oxygen Demand	200-300mg/L	35	65
Suspended Solids	200-300mg/L	40	60
Total Nitrogen	20-100mg/L	20-40	60-80
Total Phosphorus	10-25mg/L	50-70	30-50
Faecal Coliforms	10^3 – 10^{10}cfu/100ml	Medium – High	High

The contaminants in sanitary (domestic) wastewater have the potential to create undesirable public health concerns and pollute waterways unless managed appropriately. As a result, sanitary wastewater must be treated appropriately to remove the majority of pollutants to enable attenuation of the remaining pollutants through soil processes and plant uptake.

4.2 Treated Effluent Quality

The selected treatment system is required to achieve the minimum effluent quality standards outlined in Table 11 in the DLG (1998), and where applicable, Table 1 in Chapter G8 of Council's DCP (2014). The effluent standard relevant to each OSSM option is presented below in Table 4.

Table 4: Target Effluent Quality

Parameter	Primary Effluent (Option A)	Secondary Effluent (Option B/C)
Biochemical Oxygen Demand	<150mg/L	<20mg/L [1]
Suspended Solids	<50	<30mg/L [1]

1. Value from Table 1 in Chapter G8 DCP (2014).

Successful performance of the selected treatment system relies on periodic monitoring and maintenance, which will be the responsibility of the Owner. Secondary treatment systems should be serviced by a suitably qualified technician at the prescribed intervals.

5 Existing OSSM system

Generated wastewater from the existing amenities building is currently treated in a concrete septic tank (approximately 2,000L) and discharged through 100mm vitrified clay pipe (VCP) soakage area, located beneath a nearby constructed surface drainage swale. This was evidenced by fragments of VCP found scattered across the ground surface in the vicinity, which may have occurred during the construction of the drainage swale. Despite this, there were no obvious signs of ground saturation or surcharge.

Given that the proposed development will include a day visitor's toilet, permanent manager's residence, WC/shower block and a camp kitchen, wastewater generation is expected to significantly increase at the campground. Therefore, it is recommended to decommission and replace the existing OSSM system with one capable of servicing the new development.

6 OSSM System Upgrade Options

The campground area is at low elevation, relative to the proposed buildings, and is subject to regular ground disturbances from tent pegs, campfires, traffic movements, etc. There are also large amounts of angular rock (20mm to 300mm diameter) in the soil profile, which can create preferential pathways for land applied effluent resulting in downslope seepage and potential surface failure to a public access area or the Dam.

Therefore, the constraints imposed by the proposed development combined with the site and soil conditions mean that OSSM upgrade options are limited to those that utilise pump transfer to a LAA located in an upslope position with restricted public access. Power at the Site is limited to solar, with battery storage and a back-up generator. A petrol powered 'trash pump' will likely be stored onsite for fire-fighting, which would provide an additional level of redundancy for effluent transfer in the event of pump or power failure.

The most practical and recommended land application method for the Site is absorption beds. Monthly water balances were undertaken to determine the required LAA sizing to assimilate the design effluent load (4,000L/day). Two different LAA size options were determined, based on the adoption of a 'Primary' or 'Secondary' treatment (see Table 4).

In total, three (3) separate options were short-listed as the most suitable OSSM designs for the Site and were investigated further to determine the most viable option. These options are denoted as A, B and C. Option A involves use of a lower quality (primary) treatment and a larger LAA to compensate, while Options B and C both use secondary treatment, which allows the required LAA to be substantially reduced. Nominal treatment system and LAA locations for each of these options are shown in Figures 2 and 3.

Brief descriptions and cost estimates for each option are provided in the following sections. For visual reference, Figure 4 presents a process flow diagram showing the approximate layout of the system components that are essential to each option.

6.1 Option A – Primary Effluent to Absorption Beds

This option involves installation of a 3,000L septic (primary treatment) tank to service the day visitor/parking public toilet and a separate ≥10,000L septic tank to service the caretaker's residence and the campground amenities building. All primary treated effluent will drain to a ~50,000L flow balance tank before being timed dosed to eight (8) shallow absorption beds dosed using automatic-sequencing valves or distribution boxes. Each bed, with dimensions 0.4m deep, 1.2m wide and 25m long will be located upslope to the south of the campground. Effluent will be transferred using a low-flow/high-head solar powered pump (battery back-up possible).

A minimum 1:60 fall (~3m elevation) is required to allow gravity displacement (100mm drain pipe) from the day visitor car park to the proposed campground amenities building. It is expected that this will be achievable (to be confirmed), or alternately, solar powered pump transfer would be required.

Septic tank sizing is based on a minimum 24-hour settling time and allowance for sludge accumulation, in accordance with Section 5.4.2.2 of the AS/NZS1547:2012. The highly variable use of the proposed facilities means that sludge accumulation will also vary significantly. Based on average daily loading, sludge pump out frequencies of 5 years (day visitor parking) and 2 years (campground amenities) have been estimated for these tank sizes to ensure that the required minimum settling time for treatment is maintained. Table 5 (below) presents a summary of the essential components of the described OSSM system option, as well as the benefits, limitations and approximate costs associated with construction and installation.

Table 5: OSSM Option A Summary and Cost Estimate

Option	Description	Benefit	Limitation	Approximate Cost
A	3kL septic tank (day visitor carpark) draining via 100mm PVC pipe to 10kL septic / 50kL flow balancing tank (campground). Pump transfer of primary effluent to LAA using solar powered high-head pump fitted with pump timer and low/high level float switch activation. 8 x shallow absorption beds dosed using automatic-sequencing valves or distribution boxes. Bed dimensions 0.4m deep, 1.2m wide and 25m long.	Low maintenance. Low cost. Single pump required, adjacent to power source.	Larger LAA requirement, with additional hydraulic losses for distribution.	**Car park septic** $2,500 **Septic/balance tank** $25,000 **Labour and excavation** $15,000 **Miscellaneous Pipework, fittings** $2,500 **Absorption bed materials** $8,500 **Native Grass / turf** $8,000

6.2 Option B – Reed Bed System to Absorption Beds

This option will utilise the same collection / treatment / balancing components as Option 'A', followed by a secondary treatment step prior to discharging effluent to the LAA. From the 50kL balance tank, primary effluent would be time-dosed to reed beds for further treatment before effluent is collected in a dosing chamber.

Reed bed systems are a low maintenance; passive treatment system design that are commonly used in remote areas for secondary or tertiary effluent treatment. They are particularly effective at reducing BOD and suspended solids concentrations. Preliminary sizing calculations were undertaken to determine the minimum sizing requirement to achieve secondary effluent quality, prior to discharge.

Based on a reed bed depth of 0.75m, a minimum surface area of 76m^2 would be required. Small modular reed beds are commonly used to enable flexibility of installation and ease of management. Assuming installation of 2.5m x 3.6m prefabricated beds, a minimum of nine (9) beds would be required, as shown in Figure 4.

The 'secondary' treated effluent would then be collected and stored in a 1,000L dosing tank. Because the preferred location of the reed beds is also upslope from the campground, it may be possible to use a passive effluent dosing mechanism (siphon or Flout) to provide periodic low-pressure effluent doses to the absorption beds to ensure even distribution.

Based on secondary effluent quality, only four (4) of the previously described absorption beds would be required.

Table 6: OSSM Option B Summary and Cost Estimate

Option	Description	Benefit	Limitation	Approximate Cost
B	3kL septic tank (day visitor carpark) draining via 100mm PVC pipe to 10kL septic / 50kL flow balancing tank (campground). Pump transfer of primary effluent to LAA using solar powered high-head pump fitted with pump timer and low/high level float switch activation. 76m^2 reed bed system; draining to ≥1kL effluent dosing (flout/siphon) tank; delivering regular low pressure-dosed effluent. 4 x shallow absorption beds dosed using gravity distribution boxes. Bed dimensions 0.4m deep, 1.2m wide and 25m long.	Single pump required, adjacent to power source. Reliable effluent quality with low BOD/TSS to minimise the load to the absorption beds. Reduced LAA footprint and LAA cost. Relatively simple installation. Slightly smaller footprint requirement than option C.	Requires active management of reed bed cells. May attract mosquitos and other unwanted pests. Cost is significantly more than option A.	**Car park septic** $2,500 **Septic/balance tank** $25,000 **Labour and excavation** $25,000 **Reed Bed materials** $50,000 **Miscellaneous Pipework, fittings** $2,500 **Absorption bed materials** $4,500 **Native Grass / turf** $4,000

6.3 Option C – Intermittent Sand Filter to Absorption Beds

As with Option B, this option will utilise the same collection / treatment / balancing components as Option 'A', followed by a secondary treatment step prior to discharging effluent to the LAA. From the 50kL balance tank, primary effluent would be time-dosed to a sand filter system further treatment before effluent is collected in a dosing chamber.

Single pass (intermittent) sand filters involve frequent small doses of primary quality effluent distributed across the surface of a graded sand bed fitted with underdrains. A high-quality effluent is produced that is low in BOD, TSS, turbidity, ammonia and faecal coliforms. Preliminary sizing calculations were undertaken to determine the minimum sizing requirement to achieve secondary effluent quality, prior to discharge.

Based on a filter depth of 1m, a minimum surface area requirement of 80m^2 would be required. Treated effluent captured in the sand filter underdrains would then flow into a 1,000L dosing tank and be distributed to the absorption beds, as described for Option B.

Table 7: OSSM Option C Summary and Cost Estimate

Option	Description	Benefit	Limitation	Approximate Cost
C	3kL septic tank (day visitor carpark) draining via 100mm PVC pipe to 10kL septic / 50kL flow balancing tank (campground). Pump transfer of primary effluent to LAA using solar powered high-head pump fitted with pump timer and low/high level float switch activation. 80m^2 x 1m deep intermittent sand filter treatment system; draining to ≥1kL effluent dosing (flout/siphon) tank; delivering regular low pressure-dosed effluent . 4 x shallow absorption beds dosed using gravity distribution boxes. Bed dimensions 0.4m deep, 1.2m wide and 25m long.	Single pump required, adjacent to power source. Reliable effluent quality with low TSS to minimise the risk of pipe blockage in the absorption beds. Reduced LAA footprint and LAA cost. Low maintenance secondary treatment with very low TSS.	Higher installation cost. Expensive to refurbish filter media in the event of failure. Slightly larger treatment footprint required than option B. Cost is significantly more than option A.	**Car park septic** $2,500 **Septic/balance tank** $25,000 **General labour** $30,000 **Sand filter materials and install** $45,000 **Miscellaneous Pipework, fittings** $3,000 **Absorption bed materials** $4,500 **Native Grass / turf** $4,000

7 Recommendation

Each of the proposed OSSM options are considered sustainable for servicing the proposed development and pose negligible risk to both public health and the environment. There is however a significant difference in the upfront cost, practicality of installation, area requirement and ongoing management between Option A and Options B / C. Therefore, we recommend OSSM Option A.

Appendix A

Figures

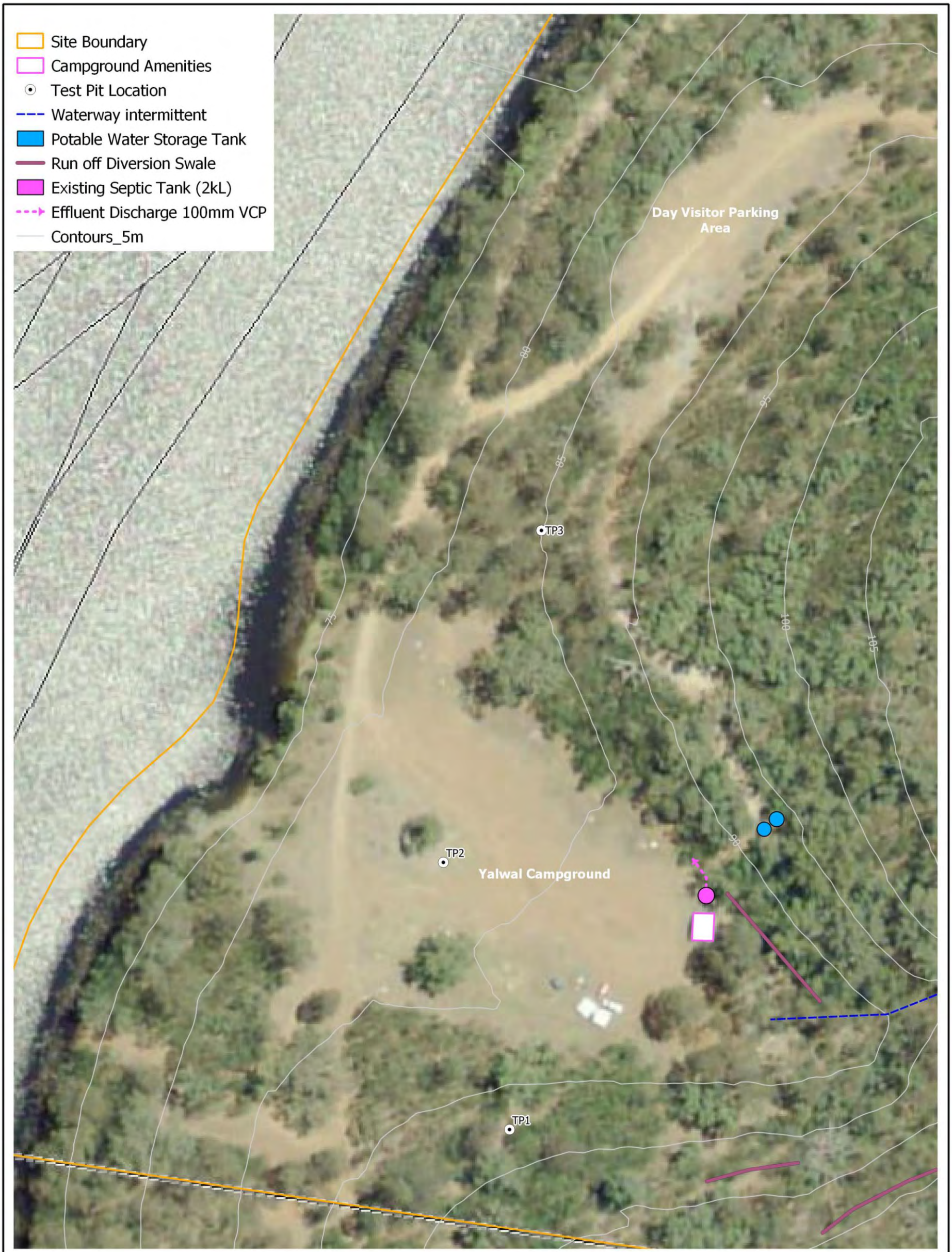

Figure 1: Site Plan Showing Existing OSSM System and Test Pit Locations

2256: Onsite Sewage Management System Design for Proposed Facilities at Yalwal Campground

N

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Environmental Consultants

0 10 20 30 40 50 m
(Approx Scale)

Revision	1
Drawn	NB
Approved	MS

197 Main Road Cardiff NSW 2285 Australia Telephone + 61 2 4954 4996
Email mail@whiteheadenvironmental.com.au Website www.whiteheadenvironmental.com.au

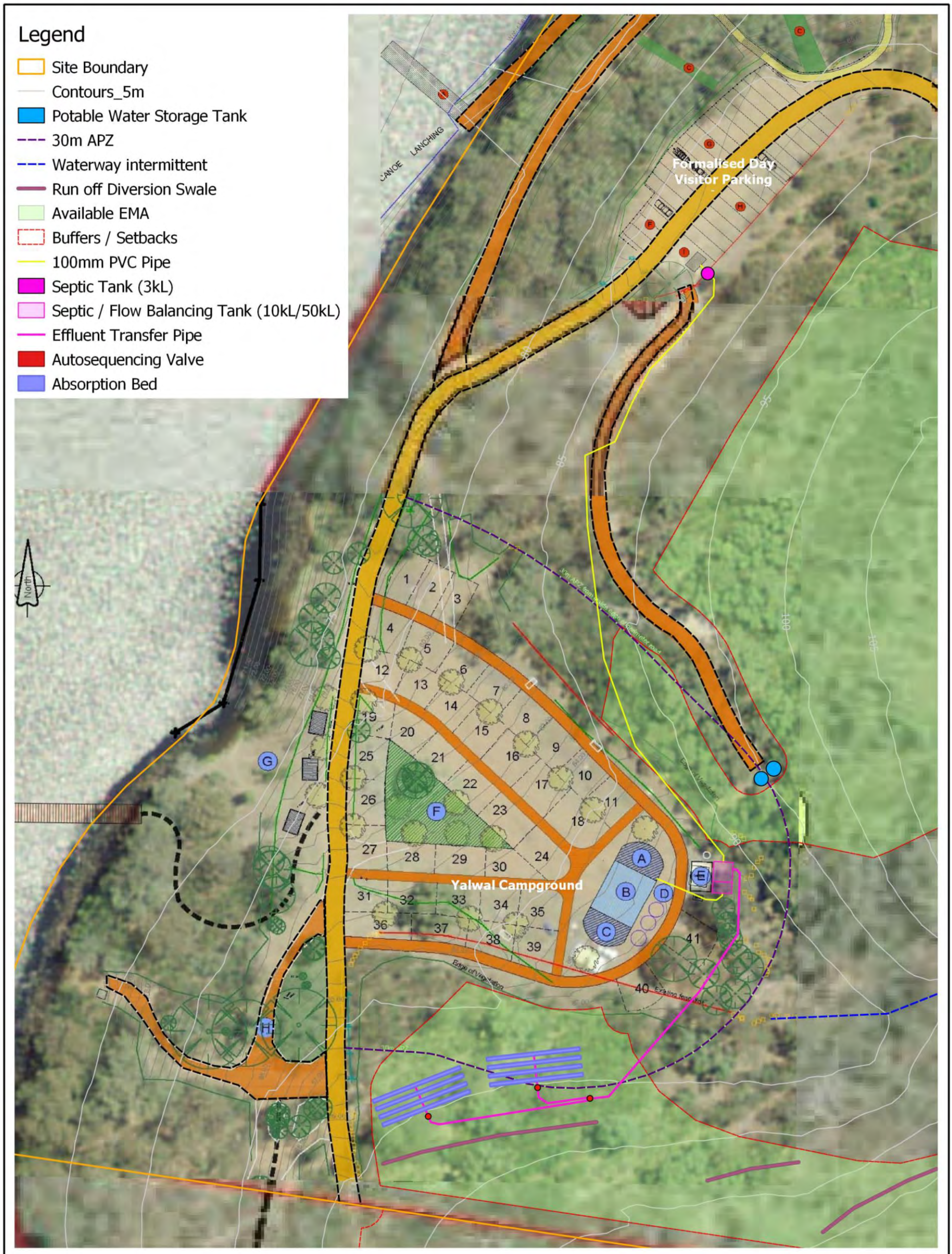

Figure 2: OSSM System Upgrade Layout - Option A

2256: Wastewater Management System Design for Proposed Facilities at Yalwal Campground

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Environmental Consultants

0 10 20 30 40 50 m
(Approx Scale)

Revision	1
Drawn	NB
Approved	MS

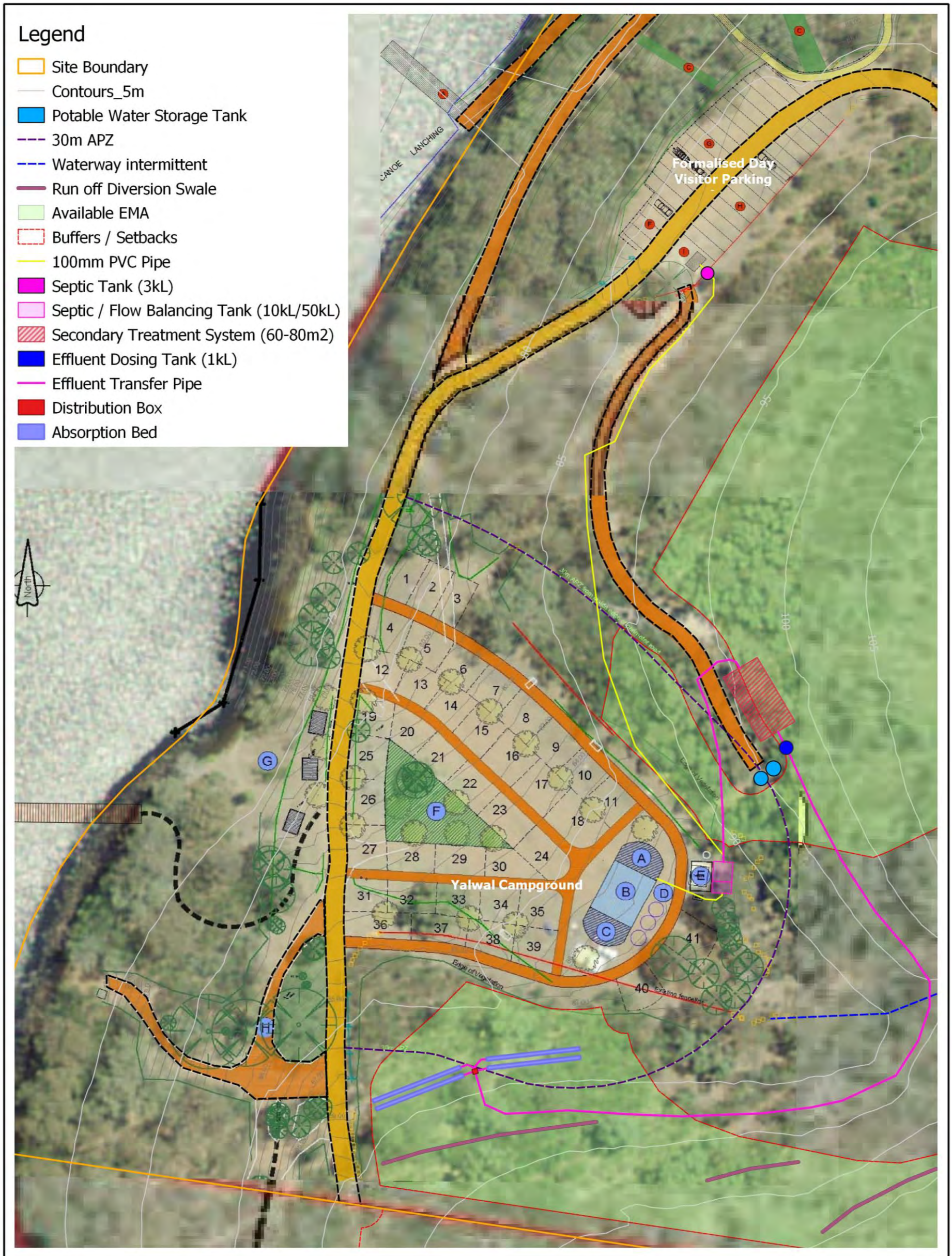

Figure 3: OSSM System Upgrade Layout - Option B & C

2256: Onsite Sewage Management System Design for Proposed Facilities at Yalwal Campground

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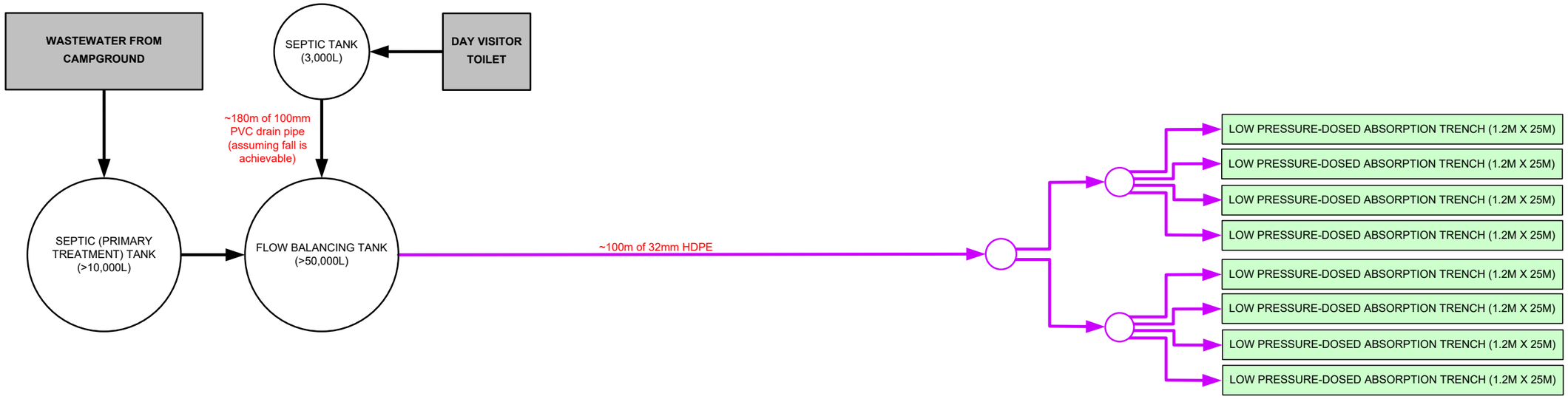
Environmental Consultants

0 10 20 30 40 50 m
(Approx Scale)

Revision	1
Drawn	NB
Approved	MS

Option A – Secondary Treated Effluent to Pressure-dosed Absorption Beds



Option B / C – Secondary Treated Effluent via Reed Beds / Sand Filter to Low pressure-dosed Absorption Beds

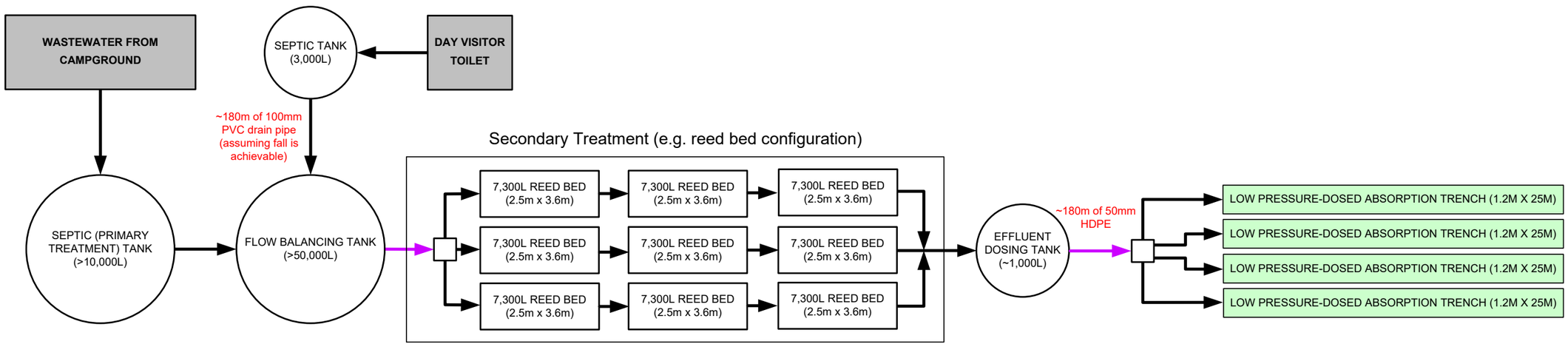


FIGURE 4: PROCESS FLOW DIAGRAM SHOWING OSSM SYSTEM LAYOUT OPTIONS

GRAVITY DISPLACEMENT
PRESSURISED TRANSFER
DISTRIBUTION BOX
AUTOMATIC SEQUENCING VALVE

Whitehead & Associates
Environmental Consultants

Project: 2256
Site: Yalwal Campground, Yalwal NSW
Drawn: NB
Date: 20/11/18
Scale: NTS

197 Main Road Cardiff NSW 2285 Australia Telephone + 61 2 4954 4996
Email mail@whiteheadenvironmental.com.au Website www.whiteheadenvironmental.com.au

Appendix B

Soil Borelogs

Whitehead & Associates
Environmental Consultants Pty Ltd
nmental Consultants Pty Ltd

Key to Soil Borelogs

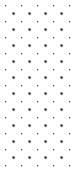
Symbols

W	Watertable depth	●	Sample collected
X	Depth of refusal		

Moisture condition

D	Dry
SM	Slightly moist
M	Moist
VM	Very moist
W	Wet / saturated

Graphic Log and Textures



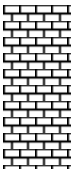
S - Sand
LS - Loamy sand
CS - Clayey sand

CL - Clay loam
SCL - Sandy clay loam
SiCL - Silty clay loam

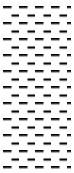
Gravel (G)

SL - Sandy loam

LC - Light clay
SC - Sandy clay



Parent material (stiff)



L - Loam
LFS - Loam fine sandy
SiL - Silty loam

MC - Medium clay
HC - Heavy clay

Parent material (weathered)

197 Main Road Cardiff NSW 2285 Australia Telephone + 61 2 4954 4996
Email mail@whiteheadenvironmental.com.au Website www.whiteheadenvironmental.com.au

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Shoalhaven City Council	**Test Pit No:**	**TP1**
Site:	Yalwal Campground	Excavated/logged by:	Nicholas Banbrook
Date:	8 November 2018	Excavation type:	Hand Auger
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		100mm	A	L	Weak to moderate	7.5YR 2.5/3	Nil	2-10%	SM	
0.2		200mm	B1	CL	Moderate rough peds	5YR 3/3	Nil	10-20%	D	
0.3		1100mm	B2	CL	Moderate rough peds	5YR 4/3	Red	30-40% Angular mudstone to siltstone cobbles	D	
0.4										
0.5										
0.6										
0.7										
0.8										
0.9										
1.0										
1.1										
1.2										
1.3	Terminated at 1,200mm depth									
1.4										
1.5										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Shoalhaven City Council	**Test Pit No:**	**TP2**
Site:	Yalwal Campground	Excavated/logged by:	Nicholas Banbrook
Date:	8 November 2018	Excavation type:	Hand Auger
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		350mm	A	SiCL	Moderate	7.5YR 2.5/1	Nil	2-10% Angular Mudstone / Siltstone Cobbles	SM	Numerous large angular boulders on the ground surface
0.2										
0.3										
0.4	Refusal on Floaters at 350mm									
0.5										
0.6										
0.7										
0.8										
0.9										
1.0										
1.1										
1.2										
1.3										
1.4										
1.5										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Shoalhaven City Council	**Test Pit No:**	**TP3**
Site:	Yalwal Campground	Excavated/logged by:	Nicholas Banbrook
Date:	8 November 2018	Excavation type:	Hand Auger
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		200mm	A	LC	Moderate	7.5YR 3/3	Red/Orange	2-10%	SM	
0.2										
0.3		950mm	B	MC	Moderate	2.5YR 4/4	Red	2-10%	D	
0.4										
0.5										
0.6										
0.7										
0.8										
0.9										
1.0	Refusal on Boulder at 950mm									
1.1										
1.2										
1.3										
1.4										
1.5										

Appendix C

Soil Laboratory Data

Sheet 1 - Soil Sampling Schedule and Results of pH, EC and Emerson Aggregate Test Analysis

Site	Sample Name	Sample Depth (mm)	Texture Class	EAT [1]	Rating [2]	pH_f [3]	$pH_{1:5}$ [4]	Rating	$EC_{1:5}$ (µS/cm)	ECe (dS/m) [5]	Rating	Other analysis [6]
TP1	1-A	100	L	8	Low	n/a	5.1	Strongly acid	69	0.69	Non-saline	
	1-B1	200	CL	7	Low	n/a	5.2	Strongly acid	26	0.23	Non-saline	
	1-B2	1100	LC	2(1)	Mod	n/a	5.7	Moderately acid	26	0.21	Non-saline	
TP2	2-A	350	CL	7	Low	n/a	5.7	Moderately acid	97	0.87	Non-saline	
TP3	3-A	200	LC	2(2)	Mod	n/a	5.4	Strongly acid	36	0.29	Non-saline	
	3-B	950	MC	2(1)	Mod	n/a	5.7	Moderately acid	42	0.29	Non-saline	

Notes:- (also refer Interpretation Sheet 1)

[1] The modified Emerson Aggregate Test (EAT) provides an indication of soil susceptibility to dispersion.

[2] Ratings describe the likely hazard associated with land application of treated wastewater.

[3] pH measured in the field using Raupac Indicator.

[4] pH measured on 1:5 soil:water suspensions using a *Hanna Combo* hand-held pH/EC/temp meter.

[5] Electrical conductivity of the saturated extract (Ece) = $EC_{1:5}$(µS/cm) x MF / 1000. Units are dS/m. MF is a soil texture multiplication factor.

[6] External laboratories used for the following analyses, if indicated:

- CEC (Cation exchange capacity)
- Psorb (Phosphorus sorption capacity)
- Bray Phosphorus
- Organic carbon
- Total nitrogen

Interpretation Sheet 1 - pH, EC & Emerson Aggregate Class

Interpretation of Soil pH (1:5 Soil:Water)
(rating based on Hazelton & Murphy (2007))

pH	Rating
0.00 to 4.50	Extremely acid
4.51 to 5.00	Very strongly acid
5.01 to 5.50	Strongly acid
5.51 to 6.00	Moderately acid
6.01 to 6.50	Slightly acid
6.51 to 7.30	Neutral
7.31 to 7.80	Mildly alkaline
7.81 to 8.40	Moderately alkaline
8.41 to 9.00	Strongly alkaline
9.01 to 14.00	Very strongly alkaline

preferred range

Multiplier Factors for Calculating ECe
(taken from Hazelton & Murphy (2007))

Texture Class	Applicable Soil Textures	MF
S	Sand, loamy sand, clayey sand	17
SL	sandy loam, fine sandy loam	11
L	loam, loam fine sandy, silty loam	10
CL	clay loam, sandy clay loam	9
LC	light clay	8
MC	medium clay	7
HC	heavy clay	6

Interpretation of ECe (1:5 Soil:Water)
(rating based on Hazelton & Murphy (2007))

Ece (dS/m)	Rating
0.00 to 2.00	Non-saline
2.01 to 4.00	Slightly saline
4.01 to 8.00	Moderately saline
8.01 to 16.00	Highly saline
16.00 up	Extremely saline

increasing hazard

Interpretation of Emerson Aggregate Class
(rating describes likelihood of dispersion)

EAT Class	Rating
1	High
2(1)	Mod
2(2)	Mod
2(3)	High
2(4)	High
3(1)	Low
3(2)	Low
3(3)	Mod
3(4)	Mod
4	Low
5	Low
6	Low
7	Low
8	Low

Sheet 2 - Results of External Laboratory Analysis

Site	Depth (mm)	CEC (me/100g)	Rating	Ca (mg/kg)	Rating	Mg (mg/kg)	Rating	Na (mg/kg)	Rating	K (mg/kg)	Rating	ESP (%)	Rating	P-sorp. (mg/kg)	Rating
TP1	0-1100	12.7	M	645	L	993	VH	79	M	80	L	2.7	NS	800	VH

Interpretation Sheet 2 - CEC, P-Sorption, Bray P, Organic carbon, Total nitrogen

Interpretation of CEC
(rating based on Hazelton & Murphy (2007))

Rating	CEC (me/100g)	Ca (mg/kg)	Mg (mg/kg)	Na (mg/kg)	K (mg/kg)
VL	0.00 to 6.00	0.00 to 400.00	0.00 to 36.50	0.00 to 23.00	0.00 to 78.20
L	6.01 to 12.00	400.01 to 1000.00	36.51 to 121.50	23.01 to 69.00	78.21 to 117.00
M	12.01 to 25.00	1000.01 to 2000.00	121.51 to 365.00	69.01 to 161.00	117.01 to 274.00
H	25.01 to 40.00	2000.01 to 4000.00	365.01 to 972.00	161.01 to 460.00	274.01 to 782.00
VH	40.01 up	4000.01 up	972.01 up	460.01 up	782.01 up

VL=very low , L=low , M=medium, H=high, VH=very high

Interpretation of ESP
(rating based on Hazelton & Murphy (2007))

Rating	ESP (%)	Description
NS	0.00 to 6.00	Non-sodic
S	6.01 to 15.00	Sodic
SS	15.01 to 25.00	Strongly sodic
VSS	25.01 up	Very strongly sodic

↓ increasing hazard

Interpretation of Phosphorus Sorption Capacity
(rating based on Hazelton & Murphy (2007))

Rating	P-sorption (mg/kg)	Description
L	0.00 to 125.00	Low
M	125.01 to 250.00	Medium
MH	250.01 to 400.00	Medium-High
H	400.01 to 600.00	High
VH	600.01 up	Very high

↑ increasing hazard

Phone Office/Lab (02) 6775 1157

email: lanfaxlabs@bigpond.com.au
Website: http://www.lanfaxlabs.com.au
Lab address: 493 Old Inverell Road
Postal address: PO Box 4690 Armidale NSW 2350
Director: Dr Robert Patterson FIEAust, CPSS, CPAg
Soil Scientists and Environmental Engineers

Lanfax Laboratories
ABN 72 212 385 096
Quality Assurance and Quality Control by Approved Methods

17th November 2018

Whitehead & Associates
197 Main Road
Cardiff NSW 2285

Soil Report: Job No. 2256 - Yalwal Campground Nowra
Received 14th November 2018, sample date 8th November 2018
Samples dried to 50°C, crushed and sieved to minus 2 mm prior to analysis

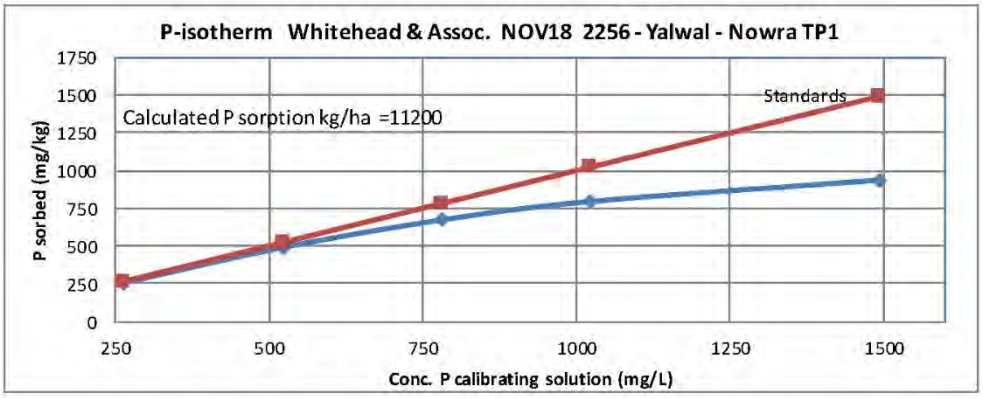
	Whitehead & Assoc.- NOV18												
Site Location	Exc.Al+H	Ca		K		Mg		Na		Base Sat.	ESP	CEC	Ca/Mg
Sample ID	cmol+/kg	mg/kg	cmol+/kg	mg/kg	cmol+/kg	mg/kg	cmol+/kg	mg/kg	cmol+/kg	%	%	cmol+/kg	ratio
Whitehead& A - Yalwal-2256	0.8	645	3.22	80	0.20	993	8.17	79	0.34	93.7	2.7	12.7	0.4

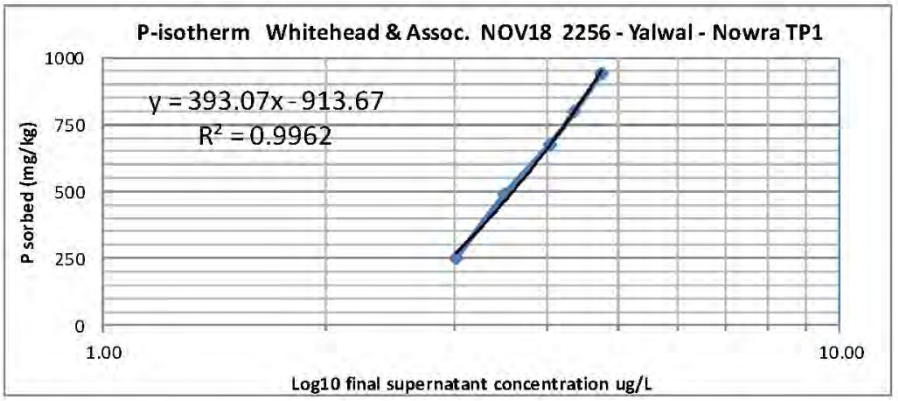
Site Location	pHw	pHca	EC
Sample ID	units	units	uS/cm
Whitehead& A - Yalwal-2256	6.10	4.90	30

Methods: Rayment & Lyons 2011
P sorption modified method 9J1 - elevated equilibrating solutions, ICP determination of P
Cations: Method 15D3, no pretreatment
Exchangeable Acidity: Method 15G1

Yours faithfully,

Dr Robert Patterson FIEAust, CPSS(3), CPAg
Soil Scientist and Environmental Engineer





Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
26.1	1.03	250.8	Whitehead & Assoc. NOV18	96.1
52.2	3.21	489.4	2256 - Yalwal - Nowra TP1	93.8
78.1	10.71	674.3		86.3
102.3	22.58	797.6		77.9
149.2	55.13	940.7		63.1

Calculated P sorption kg/ha = 11200

P-isotherm Whitehead & Assoc. NOV18 2

Std line	filtrate	X-axis	Y-axis
	C	Log C	
	ugP/L		
261	1027	3.01	250.8
522	3209	3.51	489.4
781	10714	4.03	674.3
1023	22581	4.35	797.6
1492	55126	4.74	940.7

Appendix D

Flow Balance Modelling

Flow Balancing Assessment - Yalwal Campground OSSM System

Date	Weekday	Daily Wastewater Input (L)	Daily Wastewater Output (L)	Stored Wastewater (L)	Stored Wastewater from Previous Day (L)	Cumulative Wastewater Storage (L)	Cumulative Storage Managed by Pumpout (L)	Pump out (as required)	Balancing Storage Volume Required (L)
									51,300
1/12/2018	Saturday	1,890	4,000	-2,110	0	0	0		
2/12/2018	Sunday	1,890	4,000	-2,110	0	0	0		
3/12/2018	Monday	1,890	4,000	-2,110	0	0	0		
4/12/2018	Tuesday	1,890	4,000	-2,110	0	0	0		
5/12/2018	Wednesday	1,890	4,000	-2,110	0	0	0		
6/12/2018	Thursday	1,890	4,000	-2,110	0	0	0		
7/12/2018	Friday	1,890	4,000	-2,110	0	0	0		
8/12/2018	Saturday	1,890	4,000	-2,110	0	0	0		
9/12/2018	Sunday	1,890	4,000	-2,110	0	0	0		
10/12/2018	Monday	1,890	4,000	-2,110	0	0	0		
11/12/2018	Tuesday	1,890	4,000	-2,110	0	0	0		
12/12/2018	Wednesday	1,890	4,000	-2,110	0	0	0		
13/12/2018	Thursday	1,890	4,000	-2,110	0	0	0		
14/12/2018	Friday	1,890	4,000	-2,110	0	0	0		
15/12/2018	Saturday	1,890	4,000	-2,110	0	0	0		
16/12/2018	Sunday	1,890	4,000	-2,110	0	0	0		
17/12/2018	Monday	1,890	4,000	-2,110	0	0	0		
18/12/2018	Tuesday	5,490	4,000	1,490	0	1,490	1,490		
19/12/2018	Wednesday	5,490	4,000	1,490	1,490	2,980	2,980		
20/12/2018	Thursday	5,490	4,000	1,490	2,980	4,470	4,470		
21/12/2018	Friday	5,490	4,000	1,490	4,470	5,960	5,960		
22/12/2018	Saturday	5,490	4,000	1,490	5,960	7,450	7,450		
23/12/2018	Sunday	7,640	4,000	3,640	7,450	11,090	11,090		
24/12/2018	Monday	7,640	4,000	3,640	11,090	14,730	14,730		
25/12/2018	Tuesday	7,640	4,000	3,640	14,730	18,370	18,370		
26/12/2018	Wednesday	7,640	4,000	3,640	18,370	22,010	22,010		
27/12/2018	Thursday	7,640	4,000	3,640	22,010	25,650	25,650		
28/12/2018	Friday	7,640	4,000	3,640	25,650	29,290	29,290		
29/12/2018	Saturday	7,640	4,000	3,640	29,290	32,930	32,930		
30/12/2018	Sunday	7,640	4,000	3,640	32,930	36,570	36,570		
31/12/2018	Monday	7,640	4,000	3,640	36,570	40,210	40,210		
1/01/2019	Tuesday	7,640	4,000	3,640	40,210	43,850	43,850		
2/01/2019	Wednesday	5,490	4,000	1,490	43,850	45,340	45,340		
3/01/2019	Thursday	5,490	4,000	1,490	45,340	46,830	46,830		
4/01/2019	Friday	5,490	4,000	1,490	46,830	48,320	48,320		
5/01/2019	Saturday	5,490	4,000	1,490	48,320	49,810	49,810		
6/01/2019	Sunday	5,490	4,000	1,490	49,810	51,300	51,300		
7/01/2019	Monday	1,890	4,000	-2,110	51,300	49,190	49,190		
8/01/2019	Tuesday	1,890	4,000	-2,110	49,190	47,080	47,080		
9/01/2019	Wednesday	1,890	4,000	-2,110	47,080	44,970	44,970		
10/01/2019	Thursday	1,890	4,000	-2,110	44,970	42,860	42,860		
11/01/2019	Friday	1,890	4,000	-2,110	42,860	40,750	40,750		
12/01/2019	Saturday	1,890	4,000	-2,110	40,750	38,640	38,640		
13/01/2019	Sunday	1,890	4,000	-2,110	38,640	36,530	36,530		
14/01/2019	Monday	1,890	4,000	-2,110	36,530	34,420	34,420		
15/01/2019	Tuesday	1,890	4,000	-2,110	34,420	32,310	32,310		
16/01/2019	Wednesday	1,890	4,000	-2,110	32,310	30,200	30,200		
17/01/2019	Thursday	1,890	4,000	-2,110	30,200	28,090	28,090		
18/01/2019	Friday	1,890	4,000	-2,110	28,090	25,980	25,980		
19/01/2019	Saturday	1,890	4,000	-2,110	25,980	23,870	23,870		
20/01/2019	Sunday	1,890	4,000	-2,110	23,870	21,760	21,760		
21/01/2019	Monday	1,890	4,000	-2,110	21,760	19,650	19,650		
22/01/2019	Tuesday	1,890	4,000	-2,110	19,650	17,540	17,540		
23/01/2019	Wednesday	1,890	4,000	-2,110	17,540	15,430	15,430		
24/01/2019	Thursday	5,490	4,000	1,490	15,430	16,920	16,920		
25/01/2019	Friday	7,640	4,000	3,640	16,920	20,560	20,560		
26/01/2019	Saturday	7,640	4,000	3,640	20,560	24,200	24,200		
27/01/2019	Sunday	7,640	4,000	3,640	24,200	27,840	27,840		
28/01/2019	Monday	5,490	4,000	1,490	27,840	29,330	29,330		
29/01/2019	Tuesday	1,890	4,000	-2,110	29,330	27,220	27,220		
30/01/2019	Wednesday	1,890	4,000	-2,110	27,220	25,110	25,110		
31/01/2019	Thursday	1,890	4,000	-2,110	25,110	23,000	23,000		
1/02/2019	Friday	1,890	4,000	-2,110	23,000	20,890	20,890		
2/02/2019	Saturday	1,890	4,000	-2,110	20,890	18,780	18,780		
3/02/2019	Sunday	1,890	4,000	-2,110	18,780	16,670	16,670		
4/02/2019	Monday	1,890	4,000	-2,110	16,670	14,560	14,560		
5/02/2019	Tuesday	1,890	4,000	-2,110	14,560	12,450	12,450		
6/02/2019	Wednesday	1,890	4,000	-2,110	12,450	10,340	10,340		
7/02/2019	Thursday	1,890	4,000	-2,110	10,340	8,230	8,230		
8/02/2019	Friday	1,890	4,000	-2,110	8,230	6,120	6,120		
9/02/2019	Saturday	1,890	4,000	-2,110	6,120	4,010	4,010		
10/02/2019	Sunday	1,890	4,000	-2,110	4,010	1,900	1,900		
11/02/2019	Monday	1,890	4,000	-2,110	1,900	0	0		
12/02/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
13/02/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
14/02/2019	Thursday	1,890	4,000	-2,110	0	0	0		
15/02/2019	Friday	1,890	4,000	-2,110	0	0	0		
16/02/2019	Saturday	1,890	4,000	-2,110	0	0	0		
17/02/2019	Sunday	1,890	4,000	-2,110	0	0	0		
18/02/2019	Monday	1,890	4,000	-2,110	0	0	0		
19/02/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
20/02/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
21/02/2019	Thursday	1,890	4,000	-2,110	0	0	0		
22/02/2019	Friday	1,890	4,000	-2,110	0	0	0		
23/02/2019	Saturday	1,890	4,000	-2,110	0	0	0		
24/02/2019	Sunday	1,890	4,000	-2,110	0	0	0		
25/02/2019	Monday	1,890	4,000	-2,110	0	0	0		
26/02/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
27/02/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
28/02/2019	Thursday	1,890	4,000	-2,110	0	0	0		

Loading Scenario
Off-peak
Shoulder Period
Christmas Holidays

Flow Balancing Assessment - Yalwal Campground OSSM System

Date	Weekday	Daily Wastewater Input (L)	Daily Wastewater Output (L)	Stored Wastewater (L)	Stored Wastewater from Previous Day (L)	Cumulative Wastewater Storage (L)	Cumulative Storage Managed by Pumpout (L)	Pump out (as required)	Balancing Storage Volume Required (L)
									51,300
1/03/2019	Friday	1,890	4,000	-2,110	0	0	0		
2/03/2019	Saturday	1,890	4,000	-2,110	0	0	0		
3/03/2019	Sunday	1,890	4,000	-2,110	0	0	0		
4/03/2019	Monday	1,890	4,000	-2,110	0	0	0		
5/03/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
6/03/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
7/03/2019	Thursday	1,890	4,000	-2,110	0	0	0		
8/03/2019	Friday	1,890	4,000	-2,110	0	0	0		
9/03/2019	Saturday	1,890	4,000	-2,110	0	0	0		
10/03/2019	Sunday	1,890	4,000	-2,110	0	0	0		
11/03/2019	Monday	1,890	4,000	-2,110	0	0	0		
12/03/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
13/03/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
14/03/2019	Thursday	1,890	4,000	-2,110	0	0	0		
15/03/2019	Friday	1,890	4,000	-2,110	0	0	0		
16/03/2019	Saturday	1,890	4,000	-2,110	0	0	0		
17/03/2019	Sunday	1,890	4,000	-2,110	0	0	0		
18/03/2019	Monday	1,890	4,000	-2,110	0	0	0		
19/03/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
20/03/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
21/03/2019	Thursday	1,890	4,000	-2,110	0	0	0		
22/03/2019	Friday	1,890	4,000	-2,110	0	0	0		
23/03/2019	Saturday	1,890	4,000	-2,110	0	0	0		
24/03/2019	Sunday	1,890	4,000	-2,110	0	0	0		
25/03/2019	Monday	1,890	4,000	-2,110	0	0	0		
26/03/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
27/03/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
28/03/2019	Thursday	1,890	4,000	-2,110	0	0	0		
29/03/2019	Friday	1,890	4,000	-2,110	0	0	0		
30/03/2019	Saturday	1,890	4,000	-2,110	0	0	0		
31/03/2019	Sunday	1,890	4,000	-2,110	0	0	0		
1/04/2019	Monday	1,890	4,000	-2,110	0	0	0		
2/04/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
3/04/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
4/04/2019	Thursday	1,890	4,000	-2,110	0	0	0		
5/04/2019	Friday	1,890	4,000	-2,110	0	0	0		
6/04/2019	Saturday	1,890	4,000	-2,110	0	0	0		
7/04/2019	Sunday	1,890	4,000	-2,110	0	0	0		
8/04/2019	Monday	1,890	4,000	-2,110	0	0	0		
9/04/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
10/04/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
11/04/2019	Thursday	1,890	4,000	-2,110	0	0	0		
12/04/2019	Friday	1,890	4,000	-2,110	0	0	0		
13/04/2019	Saturday	1,890	4,000	-2,110	0	0	0		
14/04/2019	Sunday	1,890	4,000	-2,110	0	0	0		
15/04/2019	Monday	1,890	4,000	-2,110	0	0	0		
16/04/2019	Tuesday	5,490	4,000	1,490	0	1,490	1,490		
17/04/2019	Wednesday	5,490	4,000	1,490	1,490	2,980	2,980		
18/04/2019	Thursday	5,490	4,000	1,490	2,980	4,470	4,470		
19/04/2019	Friday	7,640	4,000	3,640	4,470	8,110	8,110		
20/04/2019	Saturday	7,640	4,000	3,640	8,110	11,750	11,750		
21/04/2019	Sunday	7,640	4,000	3,640	11,750	15,390	15,390		
22/04/2019	Monday	7,640	4,000	3,640	15,390	19,030	19,030		
23/04/2019	Tuesday	7,640	4,000	3,640	19,030	22,670	22,670		
24/04/2019	Wednesday	7,640	4,000	3,640	22,670	26,310	26,310		
25/04/2019	Thursday	7,640	4,000	3,640	26,310	29,950	29,950		
26/04/2019	Friday	7,640	4,000	3,640	29,950	33,590	33,590		
27/04/2019	Saturday	5,490	4,000	1,490	33,590	35,080	35,080		
28/04/2019	Sunday	5,490	4,000	1,490	35,080	36,570	36,570		
29/04/2019	Monday	5,490	4,000	1,490	36,570	38,060	38,060		
30/04/2019	Tuesday	1,890	4,000	-2,110	38,060	35,950	35,950		
1/05/2019	Wednesday	1,890	4,000	-2,110	35,950	33,840	33,840		
2/05/2019	Thursday	1,890	4,000	-2,110	33,840	31,730	31,730		
3/05/2019	Friday	1,890	4,000	-2,110	31,730	29,620	29,620		
4/05/2019	Saturday	1,890	4,000	-2,110	29,620	27,510	27,510		
5/05/2019	Sunday	1,890	4,000	-2,110	27,510	25,400	25,400		
6/05/2019	Monday	1,890	4,000	-2,110	25,400	23,290	23,290		
7/05/2019	Tuesday	1,890	4,000	-2,110	23,290	21,180	21,180		
8/05/2019	Wednesday	1,890	4,000	-2,110	21,180	19,070	19,070		
9/05/2019	Thursday	1,890	4,000	-2,110	19,070	16,960	16,960		
10/05/2019	Friday	1,890	4,000	-2,110	16,960	14,850	14,850		
11/05/2019	Saturday	1,890	4,000	-2,110	14,850	12,740	12,740		
12/05/2019	Sunday	1,890	4,000	-2,110	12,740	10,630	10,630		
13/05/2019	Monday	1,890	4,000	-2,110	10,630	8,520	8,520		
14/05/2019	Tuesday	1,890	4,000	-2,110	8,520	6,410	6,410		
15/05/2019	Wednesday	1,890	4,000	-2,110	6,410	4,300	4,300		
16/05/2019	Thursday	1,890	4,000	-2,110	4,300	2,190	2,190		
17/05/2019	Friday	1,890	4,000	-2,110	2,190	80	80		
18/05/2019	Saturday	1,890	4,000	-2,110	80	0	0		
19/05/2019	Sunday	1,890	4,000	-2,110	0	0	0		
20/05/2019	Monday	1,890	4,000	-2,110	0	0	0		
21/05/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
22/05/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
23/05/2019	Thursday	1,890	4,000	-2,110	0	0	0		
24/05/2019	Friday	1,890	4,000	-2,110	0	0	0		
25/05/2019	Saturday	1,890	4,000	-2,110	0	0	0		
26/05/2019	Sunday	1,890	4,000	-2,110	0	0	0		
27/05/2019	Monday	1,890	4,000	-2,110	0	0	0		
28/05/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
29/05/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
30/05/2019	Thursday	1,890	4,000	-2,110	0	0	0		
31/05/2019	Friday	1,890	4,000	-2,110	0	0	0		

Flow Balancing Assessment - Yalwal Campground OSSM System

Date	Weekday	Daily Wastewater Input (L)	Daily Wastewater Output (L)	Stored Wastewater (L)	Stored Wastewater from Previous Day (L)	Cumulative Wastewater Storage (L)	Cumulative Storage Managed by Pumpout (L)	Pump out (as required)	Balancing Storage Volume Required (L)
									51,300
1/06/2019	Saturday	1,890	4,000	-2,110	0	0	0		
2/06/2019	Sunday	1,890	4,000	-2,110	0	0	0		
3/06/2019	Monday	1,890	4,000	-2,110	0	0	0		
4/06/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
5/06/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
6/06/2019	Thursday	5,490	4,000	1,490	0	1,490	1,490		
7/06/2019	Friday	7,640	4,000	3,640	1,490	5,130	5,130		
8/06/2019	Saturday	7,640	4,000	3,640	5,130	8,770	8,770		
9/06/2019	Sunday	7,640	4,000	3,640	8,770	12,410	12,410		
10/06/2019	Monday	5,490	4,000	1,490	12,410	13,900	13,900		
11/06/2019	Tuesday	1,890	4,000	-2,110	13,900	11,790	11,790		
12/06/2019	Wednesday	1,890	4,000	-2,110	11,790	9,680	9,680		
13/06/2019	Thursday	1,890	4,000	-2,110	9,680	7,570	7,570		
14/06/2019	Friday	1,890	4,000	-2,110	7,570	5,460	5,460		
15/06/2019	Saturday	1,890	4,000	-2,110	5,460	3,350	3,350		
16/06/2019	Sunday	1,890	4,000	-2,110	3,350	1,240	1,240		
17/06/2019	Monday	1,890	4,000	-2,110	1,240	0	0		
18/06/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
19/06/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
20/06/2019	Thursday	1,890	4,000	-2,110	0	0	0		
21/06/2019	Friday	1,890	4,000	-2,110	0	0	0		
22/06/2019	Saturday	1,890	4,000	-2,110	0	0	0		
23/06/2019	Sunday	1,890	4,000	-2,110	0	0	0		
24/06/2019	Monday	1,890	4,000	-2,110	0	0	0		
25/06/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
26/06/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
27/06/2019	Thursday	1,890	4,000	-2,110	0	0	0		
28/06/2019	Friday	1,890	4,000	-2,110	0	0	0		
29/06/2019	Saturday	1,890	4,000	-2,110	0	0	0		
30/06/2019	Sunday	1,890	4,000	-2,110	0	0	0		
1/07/2019	Monday	1,890	4,000	-2,110	0	0	0		
2/07/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
3/07/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
4/07/2019	Thursday	1,890	4,000	-2,110	0	0	0		
5/07/2019	Friday	1,890	4,000	-2,110	0	0	0		
6/07/2019	Saturday	1,890	4,000	-2,110	0	0	0		
7/07/2019	Sunday	1,890	4,000	-2,110	0	0	0		
8/07/2019	Monday	1,890	4,000	-2,110	0	0	0		
9/07/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
10/07/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
11/07/2019	Thursday	1,890	4,000	-2,110	0	0	0		
12/07/2019	Friday	1,890	4,000	-2,110	0	0	0		
13/07/2019	Saturday	1,890	4,000	-2,110	0	0	0		
14/07/2019	Sunday	1,890	4,000	-2,110	0	0	0		
15/07/2019	Monday	1,890	4,000	-2,110	0	0	0		
16/07/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
17/07/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
18/07/2019	Thursday	1,890	4,000	-2,110	0	0	0		
19/07/2019	Friday	1,890	4,000	-2,110	0	0	0		
20/07/2019	Saturday	1,890	4,000	-2,110	0	0	0		
21/07/2019	Sunday	1,890	4,000	-2,110	0	0	0		
22/07/2019	Monday	1,890	4,000	-2,110	0	0	0		
23/07/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
24/07/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
25/07/2019	Thursday	1,890	4,000	-2,110	0	0	0		
26/07/2019	Friday	1,890	4,000	-2,110	0	0	0		
27/07/2019	Saturday	1,890	4,000	-2,110	0	0	0		
28/07/2019	Sunday	1,890	4,000	-2,110	0	0	0		
29/07/2019	Monday	1,890	4,000	-2,110	0	0	0		
30/07/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
31/07/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
1/08/2019	Thursday	1,890	4,000	-2,110	0	0	0		
2/08/2019	Friday	1,890	4,000	-2,110	0	0	0		
3/08/2019	Saturday	1,890	4,000	-2,110	0	0	0		
4/08/2019	Sunday	1,890	4,000	-2,110	0	0	0		
5/08/2019	Monday	1,890	4,000	-2,110	0	0	0		
6/08/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
7/08/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
8/08/2019	Thursday	1,890	4,000	-2,110	0	0	0		
9/08/2019	Friday	1,890	4,000	-2,110	0	0	0		
10/08/2019	Saturday	1,890	4,000	-2,110	0	0	0		
11/08/2019	Sunday	1,890	4,000	-2,110	0	0	0		
12/08/2019	Monday	1,890	4,000	-2,110	0	0	0		
13/08/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
14/08/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
15/08/2019	Thursday	1,890	4,000	-2,110	0	0	0		
16/08/2019	Friday	1,890	4,000	-2,110	0	0	0		
17/08/2019	Saturday	1,890	4,000	-2,110	0	0	0		
18/08/2019	Sunday	1,890	4,000	-2,110	0	0	0		
19/08/2019	Monday	1,890	4,000	-2,110	0	0	0		
20/08/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
21/08/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
22/08/2019	Thursday	1,890	4,000	-2,110	0	0	0		
23/08/2019	Friday	1,890	4,000	-2,110	0	0	0		
24/08/2019	Saturday	1,890	4,000	-2,110	0	0	0		
25/08/2019	Sunday	1,890	4,000	-2,110	0	0	0		
26/08/2019	Monday	1,890	4,000	-2,110	0	0	0		
27/08/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
28/08/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
29/08/2019	Thursday	1,890	4,000	-2,110	0	0	0		
30/08/2019	Friday	1,890	4,000	-2,110	0	0	0		
31/08/2019	Saturday	1,890	4,000	-2,110	0	0	0		

Flow Balancing Assessment - Yalwal Campground OSSM System

Date	Weekday	Daily Wastewater Input (L)	Daily Wastewater Output (L)	Stored Wastewater (L)	Stored Wastewater from Previous Day (L)	Cumulative Wastewater Storage (L)	Cumulative Storage Managed by Pumpout (L)	Pump out (as required)	Balancing Storage Volume Required (L)
									51,300
1/09/2019	Sunday	1,890	4,000	-2,110	0	0	0		
2/09/2019	Monday	1,890	4,000	-2,110	0	0	0		
3/09/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
4/09/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
5/09/2019	Thursday	1,890	4,000	-2,110	0	0	0		
6/09/2019	Friday	1,890	4,000	-2,110	0	0	0		
7/09/2019	Saturday	1,890	4,000	-2,110	0	0	0		
8/09/2019	Sunday	1,890	4,000	-2,110	0	0	0		
9/09/2019	Monday	1,890	4,000	-2,110	0	0	0		
10/09/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
11/09/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
12/09/2019	Thursday	1,890	4,000	-2,110	0	0	0		
13/09/2019	Friday	1,890	4,000	-2,110	0	0	0		
14/09/2019	Saturday	1,890	4,000	-2,110	0	0	0		
15/09/2019	Sunday	1,890	4,000	-2,110	0	0	0		
16/09/2019	Monday	1,890	4,000	-2,110	0	0	0		
17/09/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
18/09/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
19/09/2019	Thursday	1,890	4,000	-2,110	0	0	0		
20/09/2019	Friday	1,890	4,000	-2,110	0	0	0		
21/09/2019	Saturday	1,890	4,000	-2,110	0	0	0		
22/09/2019	Sunday	1,890	4,000	-2,110	0	0	0		
23/09/2019	Monday	1,890	4,000	-2,110	0	0	0		
24/09/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
25/09/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
26/09/2019	Thursday	1,890	4,000	-2,110	0	0	0		
27/09/2019	Friday	1,890	4,000	-2,110	0	0	0		
28/09/2019	Saturday	1,890	4,000	-2,110	0	0	0		
29/09/2019	Sunday	1,890	4,000	-2,110	0	0	0		
30/09/2019	Monday	1,890	4,000	-2,110	0	0	0		
1/10/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
2/10/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
3/10/2019	Thursday	1,890	4,000	-2,110	0	0	0		
4/10/2019	Friday	5,490	4,000	1,490	0	1,490	1,490		
5/10/2019	Saturday	7,640	4,000	3,640	1,490	5,130	5,130		
6/10/2019	Sunday	7,640	4,000	3,640	5,130	8,770	8,770		
7/10/2019	Monday	7,640	4,000	3,640	8,770	12,410	12,410		
8/10/2019	Tuesday	5,490	4,000	1,490	12,410	13,900	13,900		
9/10/2019	Wednesday	1,890	4,000	-2,110	13,900	11,790	11,790		
10/10/2019	Thursday	1,890	4,000	-2,110	11,790	9,680	9,680		
11/10/2019	Friday	1,890	4,000	-2,110	9,680	7,570	7,570		
12/10/2019	Saturday	1,890	4,000	-2,110	7,570	5,460	5,460		
13/10/2019	Sunday	1,890	4,000	-2,110	5,460	3,350	3,350		
14/10/2019	Monday	1,890	4,000	-2,110	3,350	1,240	1,240		
15/10/2019	Tuesday	1,890	4,000	-2,110	1,240	0	0		
16/10/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
17/10/2019	Thursday	1,890	4,000	-2,110	0	0	0		
18/10/2019	Friday	1,890	4,000	-2,110	0	0	0		
19/10/2019	Saturday	1,890	4,000	-2,110	0	0	0		
20/10/2019	Sunday	1,890	4,000	-2,110	0	0	0		
21/10/2019	Monday	1,890	4,000	-2,110	0	0	0		
22/10/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
23/10/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
24/10/2019	Thursday	1,890	4,000	-2,110	0	0	0		
25/10/2019	Friday	1,890	4,000	-2,110	0	0	0		
26/10/2019	Saturday	1,890	4,000	-2,110	0	0	0		
27/10/2019	Sunday	1,890	4,000	-2,110	0	0	0		
28/10/2019	Monday	1,890	4,000	-2,110	0	0	0		
29/10/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
30/10/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
31/10/2019	Thursday	1,890	4,000	-2,110	0	0	0		
1/11/2019	Friday	1,890	4,000	-2,110	0	0	0		
2/11/2019	Saturday	1,890	4,000	-2,110	0	0	0		
3/11/2019	Sunday	1,890	4,000	-2,110	0	0	0		
4/11/2019	Monday	1,890	4,000	-2,110	0	0	0		
5/11/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
6/11/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
7/11/2019	Thursday	1,890	4,000	-2,110	0	0	0		
8/11/2019	Friday	1,890	4,000	-2,110	0	0	0		
9/11/2019	Saturday	1,890	4,000	-2,110	0	0	0		
10/11/2019	Sunday	1,890	4,000	-2,110	0	0	0		
11/11/2019	Monday	1,890	4,000	-2,110	0	0	0		
12/11/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
13/11/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
14/11/2019	Thursday	1,890	4,000	-2,110	0	0	0		
15/11/2019	Friday	1,890	4,000	-2,110	0	0	0		
16/11/2019	Saturday	1,890	4,000	-2,110	0	0	0		
17/11/2019	Sunday	1,890	4,000	-2,110	0	0	0		
18/11/2019	Monday	1,890	4,000	-2,110	0	0	0		
19/11/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
20/11/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
21/11/2019	Thursday	1,890	4,000	-2,110	0	0	0		
22/11/2019	Friday	1,890	4,000	-2,110	0	0	0		
23/11/2019	Saturday	1,890	4,000	-2,110	0	0	0		
24/11/2019	Sunday	1,890	4,000	-2,110	0	0	0		
25/11/2019	Monday	1,890	4,000	-2,110	0	0	0		
26/11/2019	Tuesday	1,890	4,000	-2,110	0	0	0		
27/11/2019	Wednesday	1,890	4,000	-2,110	0	0	0		
28/11/2019	Thursday	1,890	4,000	-2,110	0	0	0		
29/11/2019	Friday	1,890	4,000	-2,110	0	0	0		
30/11/2019	Saturday	1,890	4,000	-2,110	0	0	0		