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# REPORT ON

# INVESTIGATION AND ASSESSMENT FOR ON-SITE EFFLUENT MANAGEMENT AT LOT 6 DP 31237, No. 3 CLIVE CRESCENT, BAYVIEW

PREPARED FOR: MR. P. FITZGIBBON

SUBMITTED TO: NORTHERN BEACHES COUNCIL – DA 2024/1661

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## 1. INTRODUCTION

This report outlines the results of an investigation and assessment for on-site effluent management at Lot 6 DP 31237, No. 3 Clive Crescent, Bayview. The investigation was performed at the request of Mr. R. De Giglio of RCD Projects, acting on behalf of Mr. Fitzgibbon. The report will be submitted to Northern Beaches Council as part of DA 2024/1661.

As shown in the accompanying plan, Figure 1, the unsewered property has an area of 4134m$^2$ that comprises an existing dwelling, swimming pool, gazebo with limited plumbing, pool house with a range of plumbing and associated features.

Reference is made to the letter from the Development Advisory Service Team at Northern Beaches Council to Mr. Fitzgibbon C/- Gyde Consulting dated 5/12/24. The provision of this report address point 2 in the letter entitled 'Onsite Water Management System/Septic Report'. The basis of the Development Application submitted to Council pertaining to effluent management is the conversion of the existing pool house into a secondary dwelling. As noted in the letter, this is due to the load on the existing wastewater management system being altered (i.e. increased). Whilst this is the case, there is no works proposed on the dwelling that will increase the existing number of bedrooms and maximum design effluent volume from it.

Further to the details above, this report relates to the existing dwelling, pool house to be converted to a secondary dwelling and the gazebo.

As to be detailed in Sections 3 and 5, it is important to acknowledge that the property has various considerable physical constraints to the land application of effluent. When assessing the potential options for effluent management, this is exacerbated by the fact that there is no access for vehicles or earthmoving equipment to the eastern part of the property downslope of the features of development which is where the existing treatment system and disposal area is located. Furthermore, it is considered that there is no usable land available and logistically feasible for effluent disposal in the near vicinity of the features of development. These factors provide considerable limitations from both effluent treatment and land application perspectives on the property because feasible options for these are only possible in the eastern part of the site as described.

As a function of the considerable physical constraints, a 'best-fit' solution is applied to on-site effluent management and where possible, appropriate guidelines and standards are adhered to – i.e. known as a 'best practicable option' from AS/NZS 1547 (2012). These are based on maintaining a secondary level of effluent treatment and providing a substantially larger area for the land application of treated effluent (i.e. largest possible area) in a much better location than that currently utilised, albeit in the same general vicinity in the eastern part of the property. This will provide a positive outcome and substantial beneficial effects with regards to the land application of treated effluent.

A best practicable outcome is defined in AS/NZS 1547 (2012) as being 'the option for wastewater servicing, treatment and land application that best meets public health, environmental and economic objectives'. Reliance on Council is also required to accept the best practicable option and some variations to guidelines and standards to achieve the best result possible for on-site effluent management in light of the lack of a reticulated sewer service. Furthermore, it is important to acknowledge that with the conversion of the pool house to a secondary dwelling, there is only a 25% increase in the current maximum design effluent volume from the dwelling and gazebo.

## 2. PROPOSAL FOR ON-SITE EFFLUENT MANAGEMENT AND DESIGN WASTEWATER VOLUME

As confirmed with Mr. De Giglio and based on the logistical aspects of having no available access to the rear of the property for vehicles and earthmoving machinery as detailed in Section 1, the proposal for effluent management from the existing dwelling, pool house to be converted to a secondary dwelling and the gazebo comprises the following components (Figure 1):

1. The continued use of the existing aerated wastewater treatment system **(AWTS)**. This comprises a single treatment tank which is a Biocycle 5800 model that is known to have a capacity to treat up to 2000 litres of effluent per day. This exceeds the maximum design effluent volume detailed near the end of this Section. The AWTS is serviced on a quarterly basis as required and is therefore known to be operating properly. Observations

during the site meeting and investigation also show that the AWTS is structurally sound and lacks odours emanating from it which is an indicator of proper operation and treatment.

2. The decommissioning of the existing arrangement for the land application of treated effluent. This involves a single surface irrigation line with only two sprinklers which are estimated to cover an area of no more than about $40m^2$.
3. Provision of a new and much larger area for surface spray irrigation. The sprinklers for this and the spray radius they cover must be placed where there is soil coverage and not where there is exposed sandstone.

This report is submitted to Council as part of the approval process for the proposed works at the subject site and proposal for effluent management. Blue Mountains Geological and Environmental Services is not responsible or liable for the installation, operation, maintenance and on-going performance of both the existing AWTS and new area to be established for land application.

The main environmental concern with the AWTS in general is considered to be the levels of nitrates, phosphates and faecal coliforms generated, particularly if prescribed treatment levels are not achieved. Reference to the Guidelines in Department of Local Government et. al. (1998) shows the expected quality of wastewater after treatment in an AWTS, which is given in Table 1. Design figures may not be indicative of long-term operational characteristics, and an AWTS must be well maintained and operated to achieve this quality on a continuous basis.

Aerated systems rely on biological activity for proper system operation. Changes to the effluent loadings, in the form of either a significant increase or decrease, may result in poor system performance. It is suggested that an AWTS must be operated continuously and the power must not be turned off, as intermittent use may require servicing of the system at each start up.

It would be prudent, as with on-site or reticulated sewer, to continue the water usage minimisation scheme in the dwelling and other features generating effluent. Whilst the AWTS provides for re-use of all domestic effluent by application to the land, reducing the loads to be treated and discharged will significantly decrease the potential for adverse environmental impacts. As confirmed with Mr. De Giglio, the dwelling and other features where applicable have a set of water-limiting devices/appliances including low flow showerheads, low litreage dual flush toilets, aerator taps and a front loading washing machine. These fixtures and water limiting devices are now required as part of the BASIX scheme in Local Government.

TABLE 1: EXPECTED QUALITY OF WASTEWATER AFTER TREATMENT IN AN AERATED SYSTEM

| **PARAMETER** | **CONCENTRATION** | **FAILURE INDICATOR** |
|---|---|---|
| BIOCHEMICAL OXYGEN DEMAND (BOD) | <20mg/L | >50mg/L |
| SUSPENDED SOLIDS | <30mg/L | >50mg/L |
| TOTAL NITROGEN (N) | 25 - 50mg/L | not applicable |
| TOTAL PHOSPHORUS (P) | 10 - 15mg/L | not applicable |
| FAECAL COLIFORMS NON-DISINFECTED EFFLUENT | up to $10^4$ cfu/100mL | not applicable |
| FAECAL COLIFORMS DISINFECTED EFFLUENT | <30cfu/100mL | >100cfu/100mL |
| DISSOLVED OXYGEN | >2mg/L | <2mg/L |

It is suggested to utilise 'environmentally friendly' cleaning, washing and detergent products to reduce the levels of P, as well as sodium, discharged into the existing AWTS and area to be utilised for land application. Furthermore, reducing the amounts of such products used would also be beneficial to the environment. Reference to the Figure in Appendix 1 shows the sodium contents in grams/wash for a variety of laundry detergents used in both front and top-loading washing machines (from Dr. R. Patterson, Lanfax Labs). It is recommended to utilise laundry detergents with the lowest sodium content as practical. Cross-matching low sodium products with low P ones would also be beneficial.

In addition to the details above, it is important to ensure that cleaning and detergent products are compatible for use with an on-site effluent treatment system. Such products can kill off bacteria in a treatment device, which results in ineffective treatment (particularly with respect to faecal coliforms). Use of harsh bleaches and disinfectants should be avoided, but only used sparingly if necessary. Alkalinity and P contents in cleaning products can also have an influence on performance and the treatment levels achieved. However, with low P products, a relatively higher alkalinity is required in order to get an appropriate level of cleaning, which can adversely impact upon a treatment system.

As confirmed with Mr. De Giglio, the following details are provided in relation to wastewater generation at the subject site:

- The property is serviced with a reticulated water supply.
- The existing dwelling comprises five bedrooms and lacks any rooms that can be viewed as a ‘potential bedroom’.
- The dwelling is currently occupied by only two persons.
- When the pool house is converted to a secondary dwelling it will comprise one bedroom and there will be no change to the existing features generating effluent which include two toilets, two hand-basins, two showers and a kitchenette sink.
- The existing gazebo is fitted with a kitchenette sink only and has no potential to be used for overnight habitation.

For the gazebo, usage of the kitchenette sink is at the expense of the same not being used in the dwelling and pool house when converted to a secondary dwelling. This scenario is akin to that in a shed for example. Therefore, no addition will be applied to the gazebo beyond the maximum design effluent volume assigned to the dwelling and pool house when converted to a secondary dwelling.

Design effluent volume calculations are based on the maximum potential occupancy level of the dwelling, which is dependent on the number of bedrooms. Reference to Table J1 in AS/NZS 1547 (2012) shows that a five bedroom dwelling has a population equivalent of eight persons. This represents an ample allowance for two persons in three of the bedrooms and one person/bedroom in the remaining two bedrooms. Furthermore, allowance is made for a maximum of two persons in the pool house when converted to a secondary dwelling. This results in a maximum potential occupancy of ten persons in both structures.

Reference to Table H1 in AS/NZS 1547 (2012) shows that the typical wastewater design flow from dwellings with reticulated water supplies is 150 litres/person/day.

Based on the details above, the design output of effluent is:

| | | | |
|---|---|---|---|
| * | Dwelling - 8 persons x 150 litres/person/day | = | 1200 litres/day + |
| * | Secondary dwelling - 2 persons x 150 litres/person/day | = | 300 litres/day |
| * | TOTAL | = | 1500 litres/day. |

The volume above exceeds the treatment capacity of the existing AWTS to be retained. To re-iterate, it is imperative to ensure that appropriate water-conservation practices are continued in the dwelling so the maximum design effluent volume above is not exceeded – i.e. ideally kept as low as possible. However, with an expected scenario of much less than ten full-time occupants on the site, the actual output of effluent will be much less than the maximum.

## 3. SITE DESCRIPTION

The property comprises an elongate-shaped parcel of land that is situated off the northern end of Clive Crescent. Reference to Figure 1 shows the location of the existing features of development in the approximate upslope western half of the property. There are also easements along the northern and western boundaries at 0.915m in width known to be referred to an easement A, B and C for pipeline. Reference to Figure 1 shows that this assumed drainage easement for stormwater along the northern boundary which is relevant from an effluent disposal perspective is piped within a short distance of the property at the northwestern boundary and extends further from it as a man-made open channel.

The proposed land application area **(LAA)** for secondary treated wastewater, i.e. where the surface spray irrigation lines will be established, is positioned downslope of all features of development in the east to southeastern part of the property and maintains the following set-back distances in plan view (Figure 1):

- A minimum of 10m east of the existing dwelling.

- 2 - 2.5m from the metal mesh fence at the eastern side of the features of development.
- 3 - 7m from the nearest southern boundary, which is in a marginally downslope position.
- A minimum of 6m from the eastern boundary, which is in the main downslope position.
- 15.5m from the northern boundary, where the terrain in the irrigation area does not fall towards it on the property.

Further to the final point above, the LAA is carefully located with regards to the important considerations, being to ensure that the terrain does not fall directly to the man-made drainage channel along the northern boundary and/or where it does at the more eastern LAA side, then in the flow path there is a distance of more than 40m to the channel to the east of the subject property.

The proposed LAA is predominantly devoid of vegetation and typically comprises a thin mulch layer with some bare ground, shrubs, ferns and small trees which appear to be wholly or predominantly native species. From a geomorphological perspective, the proposed surface irrigation area is contained on three 'steps' in the landform as described below:

1. First step closer to the dwelling on the upslope western side which is typically 2.5 - 3m wide on the flatter section.
2. Largest and second step in the middle part at a typical width of 3.5 - 6m at the flatter section.
3. The third and easternmost step on the downslope side that is about 3 - 4m wide where it comes to the point of the 6m buffer from the eastern boundary.

In addition to the points above, the total area delineated for land application in Figure 1 contains some surface to near surface colluvial sandstone cobbles and boulders, plus sandstone flagging placed on batters between the steps as noted below and probable bedrock.

The are also batter slopes leading from the first to second and second to third more gently sloping steps. The steps comprising the proposed LAA have a typical grade of $8^0$ - $11^0$ in an easterly direction as measured on the site with a clinometer, whilst the steps are contained on a steeper sideslope at the margins that has a typical grade of $20^0$. Off the downslope eastern side of the irrigation area there is a well-developed vegetation cover which constitutes a vegetated buffer zone. The LAA as a whole is well-elevated and affords exposure to the easterly to northerly aspect and prevailing winds.

The proposed LAA is situated at a typical elevation of about 70m. Observations during the site investigation show that the nearest 'water feature' within the relevant flow path (or land fall direction) of the spray irrigation area is the man-made drainage channel at a distance of more than 40m on the adjoining property to the east. Beyond this, reference to the Mona Vale 1:25,000 scale topographic map shows that there is an intermittent watercourse which is at a minimum distance of about 100m in the flow path from the LAA in an overall east-northeasterly direction – note that this distance in plan view is considerably increased along the ground surface. From this point, the intermittent watercourse trends in an overall easterly direction for about 450m before entering Pittwater at the western side of Maybanke Cove.

## 4. FIELDWORK METHODS

The initial phase of the fieldwork comprised a site inspection and ground survey on 2/4/25 aimed at delineating the preferred position of the LAA for secondary treated wastewater with respect to the location of the existing and proposed features of development and the geomorphological characteristics of the land.

Further to the ground survey, various 100mm diameter hand-auger holes were bored to a maximum depth of 1.4m across the proposed LAA. The auger holes were used to determine the physical characteristics of the subsurface strata and provide a representative description of this. Furthermore, various crow-bar 'depth probes' were utilised to assist with the assessment.

To assess soil permeability, results of the auger holes are related to the textural/structural classification in Table E1 in AS/NZS 1547 (2012) which enables determination of the soil category and corresponding indicative permeability value. An indicative permeability value can be converted to a design irrigation rate **(DIR)** from Table M1 in AS/NZS 1547 (2012).

## 5. GROUND SURVEY AND PHYSICAL CONSTRAINTS

The location of the proposed LAA for secondary treated wastewater has been carefully delineated on the site with Mr. De Giglio (Figure 1). Results from the ground survey indicate that the property is substantially affected by the following physical constraints to the land application of treated effluent:

- The moderate to steep grade of the terrain.
- The occurrence of some surface to near surface colluvial sandstone cobbles and boulders, plus sandstone flagging placed on batters and probable bedrock.
- The open man-made drainage channel within the easement inside the relevant northern boundary at 0.915m in width. As detailed in Section 3, the proposed LAA is carefully located with regards to ensure that the terrain does not fall directly to the man-made drainage channel along the northern boundary and/or where it does at the more eastern LAA side, then in the flow path there is a distance of more than 40m to the channel to the east of the subject property which satisfies the requirements in Table 5 of the guidelines in Department of Local Government et. al. (1998). The distance to the nearest natural intermittent watercourse and waterbody (i.e. Pittwater) also exceed the minimum requirements in the 1998 guidelines.

Further to the physical constraints, the area taken up by the existing features of development that are contained on relatively gently sloping terrain, as well as buffer distances from these and property boundaries, plus the lack of access to the rear eastern part of the property for vehicles and earthmoving equipment, poses substantial limitations to the land application of treated effluent. This has led to the proposal for the land application of secondary treated effluent by surface spray irrigation over the largest area available.

As shown in Figure 1, a total area of 599m$^2$ has been delineated for the land application of treated effluent. However, some surface to near-surface colluvial sandstone cobbles and boulders, plus sandstone flagging on batters and probable bedrock that are estimated to cover approximately 20 - 25% of the total area delineated for spray irrigation. This reduces the total area of 599m$^2$ by 150m$^2$ to an effective area of about 449m$^2$ – i.e. based on allowance for a 25% reduction. As detailed in Section 2, the sprinklers proper in the LAA and the spray radius they cover must be placed where there is soil coverage and not where there is exposed sandstone.

As part of the best-fit solution, the aim is to delineate the largest possible effective area of approximately 449m$^2$ for effluent disposal and apply the treated wastewater to the land in the most efficient and logistically feasible manner possible, being surface spray irrigation.

## 6. SUBSURFACE PROFILE

Reference to the Sydney 1:100,000 scale Soil Landscape map indicates that the proposed LAA and adjacent parts are underlain by the colluvial 'Watagan' group which occurs on rolling to very steep hills on fine-grained Narrabeen Group sediments (mainly interbedded laminite and shale with quartz to lithic quartz sandstone).

The soils of the Watagan group comprise shallow to deep (30 - 200cm), Lithosols/Siliceous Sands and Yellow Podzolic Soils on sandstones; moderately deep (100 - 200cm) Brown Podzolic Soils, Red Podzolic Soils and Gleyed Podzolic Soils on shales (Chapman and Murphy, 1989). Findings from the auger holes are considered to best equate with Lithosols/Siliceous Sands on sandstone bedrock.

The Watagan group is limited by mass movement hazard, steep slopes, severe soil erosion hazard, very strong acidity, low fertility, high aluminium toxicity and occasional rock outcrop (Chapman and Murphy, 1989).

Interspersed across the proposed LAA and immediately adjacent parts, observations and findings from the auger holes (and crow-bar depth probes) indicate that there are some surface to near-surface colluvial sandstone cobbles and boulders, plus sandstone flagging on batters and probable bedrock that are estimated to cover approximately 20 - 25% of the total area delineated for spray irrigation as detailed in Section 5. Whilst there is this material, observations and results from the auger holes and crow-bar depth probes show that there is typically good soil depth amongst the sandstone that will contribute to the absorption and assimilation of secondary treated effluent.

Where there is soil, estimated minimum depths range from about 0.15 - 0.35m over what is considered to be a small percentage of the whole LAA. Furthermore, average soil depth is estimated to be approximately 0.7m and the maximum observed in an auger hole was 1.4m above sandstone (and this could be greater in other parts) over what is considered to be the larger percentage of the LAA.

In light of the variability and occurrence of surface to near-surface sandstone exposures, two typical subsurface profiles are described below in accordance with the classification schemes in Australian Soil and Land Survey: Field Handbook (1990) and Table E1 in AS/NZS 1547, 2012 (Appendix 1); one being the minimum soil depth observed in an auger hole and the other being the maximum depth observed.

**Minimum Soil Depth Observed in an Auger Hole**

(i) LOAMY SAND – A Horizon

- observed from the surface to a depth of 0.35m.
- comprises dark-grey to black, fine to medium grained loamy sand with few ironstone and weathered sandstone fragments (i.e. 2 - 10% coarse fragments from Table E2 in AS/NZS 1547, 2012).
- soil category 2 for sandy loams from Table E1 in AS/NZS 1547 (2012).

(ii) WEATHERED SANDSTONE – C Horizon

- occurs at a depth of 0.35m.
- comprises inferred low to medium strength, light-grey and brown to orange-brown, fine to medium grained sandstone with possible harder ironstone bands.

**Maximum Soil Depth Observed in an Auger Hole**

(i) LOAMY SAND – A1 Horizon

- observed from the surface to a depth of 0.35m.
- comprises dark grey-brown to dark-brown, fine to medium grained loamy sand with few ironstone and weathered sandstone fragments (i.e. 2 - 10% coarse fragments).
- soil category 2 for sandy loams.

(ii) SANDY LOAM – A2 Horizon

- observed from a depth of 0.35 - 0.5m.

- comprises dark-brown, fine to medium grained sandy loam with few ironstone and weathered sandstone fragments (i.e. 2 - 10% coarse fragments).
- soil category 2 for sandy loams.

(iii) LOAMY SAND – B Horizon

- observed from a depth of 0.5 - 1.4m.
- comprises dark-grey, fine to medium grained sandy loam with few ironstone and weathered sandstone fragments (i.e. 2 - 10% coarse fragments).
- soil category 2 for sandy loams.

(iv) WEATHERED SANDSTONE – C Horizon

- occurs at a depth of 1.4m.
- comprises inferred low to medium strength, light-grey and brown to orange-brown, fine to medium grained sandstone with possible harder ironstone bands.

## 7. DESIGN IRRIGATION RATE AND SURFACE SPRAY IRRIGATION AREA

As detailed in Section 5 and part of the best-fit solution, a total area of 599m$^2$ is delineated for surface spray irrigation, which is reduced to an available area of about 449m$^2$ due to the scenario with surface to near-surface colluvial sandstone, probably bedrock and flagging placed on batters.

Based on all soils encountered across the LAA being in category 2, reference to Table M1 in AS/NZS 1547 (2012) shows that the DIR value is 5mm/day for surface spray irrigation. This DIR equates with a wastewater application rate of 5 litres/m$^2$/day. Based on this application rate, the area required for surface irrigation and the maximum design effluent volume from the existing dwelling, pool house when converted to a secondary dwelling and the gazebo is:

* 1500L/day divided by 5L/m$^2$/day = 300m$^2$.

The equation indicates that an area of 300m$^2$ is required for spray irrigation. However, it is proposed to increase this to the approximate available area of 449m$^2$ – i.e. + about 149m$^2$, or just under an additional 50%. An area of 449m$^2$ is also about 11 times larger than the estimated existing surface irrigation area at no more than 40m$^2$ for what is only a 25% increase in the maximum design effluent volume from the dwelling and gazebo when the pool house is converted to a secondary dwelling.

In summary,

* PROPOSED LAA = effective area of 449m$^2$ to be established with surface spray irrigation lines.

7.1 Preparation and Management of the Land Application Area

It is important to ensure that the surface spray irrigation system utilised effectively covers the usable area delineated for land application with soil coverage so the hydraulic and nutrient loads can be adequately catered for by the soils and vegetation cover.

Reference to Gardner et. al. (1997) indicates that loading rate should be balanced by allowable sinks. Allowable sinks for N are denitrification/volatilisation (typically 15 - 20% loss) and plant uptake, which depends on the plant yield and N concentration in the vegetation. Provided the vegetation in an irrigation area is harvested and removed on a regular basis (years for trees, months for grasses/pasture), it will provide a sustainable and recurrent sink for N.

Allowable sinks for P are plant uptake (generally 8 - 10 times less than N uptake) and the storage capacity of the soil (may account for up to 30% of the P loading). Reference to Gardner et. al., 1997) indicates that for sandy soils, the P front moves downwards at a rate of about 20 years/metre of soil depth for a P concentration of about 10mg/litre of effluent. The many adsorption sites for P in soils and aquifers suggest that adverse groundwater consequences of P leaching are likely to be the exception rather than the rule.

To raise the pH of the expected very strongly acidic soils and address the high potential aluminium toxicity (see Section 6), as well as the sodium content in the treated effluent, it is suggested to apply agricultural lime and gypsum across the LAA and adjacent parts and lightly incorporate into the top 50 - 100mm of soil. Lime and gypsum can be applied at suggested rates of approximately 0.3 - 0.4kg/m$^2$ (i.e. 3 - 4kg/m$^3$) and 0.1kg/m$^2$ respectively (i.e. 1kg/m$^3$) in and adjacent to the LAA. The addition of lime and gypsum will also enhance plant growth, the uptake of nutrients and assist to maintain the soil structure in the medium to longer term periods. It is understood that liquefied versions of lime and gypsum are also available.

Lime and gypsum can be purchased from plant nurseries, landscape and rural supply stores and it is suggested to reapply the additives and carefully incorporate into the soils as required every three to five years for example. Note that it would be prudent to contact the NSW Agriculture Department to assess any advice they can provide regarding soil additives, application methods and rates.

Research by the NSW Agriculture Department shows that to help with the spreading of soil additives such as lime and gypsum across areas of pasture and increase their positive attributes, the 'Long Worm' (deep burrowing), 'Turgid Worm' (topsoil burrowing) and 'Trap Worm' (middle layers) should be introduced. These worms can be provided in the LAA to assist with transferring lime and gypsum to the subsoil to effectively raise soil pH and address the sodium content in the treated effluent. The addition of worms will also improve overall soil condition and drainage.

To enhance the performance of the proposed LAA and concurrently enhance the levels of evapotranspiration, it is suggested that the following measures are implemented:

1. Carefully eradicate weeds without the loss of soil depth.
2. Establish a grass cover in all or part of the irrigation area and/or utilise a thin mulch layer to about 20mm in thickness with appropriate plantings that do not adversely shade the irrigation area and maintain the maximum possible sun and wind exposure. Note that too thick a mulch layer will adversely hold too much moisture in the soil and reduce the levels of evapotranspiration and no areas of bare soil must remain.
3. If grass is utilised, it must be properly managed by being mown regularly with the cutting harvested and removed to avoid the recycling of nutrients (i.e. N and P compounds) back into the soils.

It is important that all upslope surface runoff is effectively diverted away from the LAA so that it has to ideally only cater for treated effluent and direct rainfall. This can be in the form of a shallow dish-drain or contour bank for example. However, this would be logistically difficult or unfeasible at the subject site. The location of the existing features of development in conjunction with the drainage channel along most of the northern boundary and extending eastwards beyond the property assist to maintain upslope runoff away. Note that no obvious signs of upslope runoff were evident across the LAA by way of erosion and deposition of soil at the time of the site investigation.

In the event of weed proliferation due to the discharge of treated effluent, it is suggested that adequate eradication measures are implemented to prevent their possible spread beyond the margins of the LAA.

Stormwater provisions associated with the features of development, including the swimming pool and supplementary tank water supply, must not be directed towards the proposed LAA or adversely impact upon its proper functioning. Based on observations and discussions with Mr. De Giglio on the property, it appears that excess stormwater is diverted to the assumed drainage easement or easements which offers no potential to adversely impact upon the proposed spray irrigation area.

Once established, clean watering of vegetation in and adjacent to the surface spray irrigation area must also not be carried out unless totally necessary, for example during extended periods of low or nil rainfall if the vegetation is dying off.

## 8. OPERATION AND MAINTENANCE OF AERATED SYSTEM

For the effluent management system to continue to work well the supplier, service agent, owners and residents must be committed to its management, whilst the AWTS must continue to be serviced on a quarterly basis. Quarterly services as part of maintenance agreements normally involve inspection of the mechanical, electrical and functioning parts of the system to ensure they are operating properly, replacement of chlorine tablets for disinfection and a check of the LAA. A properly operated and maintained system should meet the expected parameters for wastewater quality (see Table 1, Section 2).

The effectiveness of the system will, in part, depend on how it is used and maintained. A guide to good maintenance procedures, from Department of Local Government (1998), is listed below:

**DO**

- continue to have the AWTS inspected and serviced four times per year by an approved contractor.
- continue to have the system service include assessment of sludge and scum levels and performance of the LAA.
- have the AWTS desludged at least every three years.
- have the disinfection chamber inspected and tested quarterly to ensure correct disinfection levels.
- keep a record of pumping, inspections, and other maintenance.
- learn the location and layout of the treatment system and LAA.
- use biodegradable liquid detergents such as concentrates with low sodium and P levels (see Appendix 1).
- conserve water – deliberate attention to this issue is imperative due to the physically constrained nature of the property and potential to over-use this resource from the reticulated supply which will enhance the performance/life span of the AWTS and assist to ensure that the LAA does not become hydraulically overloaded.

**DON'T**

- put bleaches, disinfectants and spot removers for example in large quantities into the AWTS via the sinks or toilet.
- allow any foreign material such as nappies, sanitary napkins, condoms and other hygiene products to enter the system.
- use more than the recommended amounts of detergents.
- put fats and oils down the drain and keep food waste out of the system – this is considered to be particularly important because food scraps can result in a higher than acceptable BOD level and excess oils/fats/greases can overload or hinder the performance of any type of effluent treatment system. Use of a strainer in the kitchen/kitchenette sinks is required and promoting the removal of excess food waste/oils from plates with paper towelling before washing would reduce the input of fats and organic material into the AWTS (paper towelling can be composted).
- switch off the power to the AWTS, even when the dwelling and/or secondary dwelling are unoccupied.

## 9. CONCLUSION

(i) An investigation and assessment has been undertaken for on-site effluent management at Lot 6 DP 31237, No. 3 Clive Crescent, Bayview. The unsewered property has an area of $4134m^2$.

(ii) The property is occupied by an existing dwelling five bedroom dwelling, swimming pool, gazebo with a kitchenette sink, pool house with a range of plumbing and associated features. The proposed development pertinent to this report comprises the conversion of the pool house to a secondary dwelling with one bedroom. A best-fit solution is applied to on-site effluent management and where possible, appropriate guidelines and standards have been adhered to.

(iii) The proposal for effluent management from the existing dwelling, pool house to be converted to a secondary dwelling and the gazebo comprises the following components:

1. The continued use of the existing AWTS.
2. The decommissioning of the existing arrangement for the land application of treated effluent. This involves a single surface irrigation line with only two sprinklers which are estimated to cover an area of no more than about $40m^2$.
3. Provision of a new and much larger area for surface spray irrigation. The sprinklers for this and the spray radius they cover must be placed where there is soil coverage and not where there is exposed sandstone.

(iv) The maximum design effluent volume from the existing dwelling, pool house when converted to a secondary dwelling and gazebo is 1500 litres/day.

(v) The proposed LAA where the surface spray irrigation lines will be established is situated off the downslope eastern side of all features of development in the east to southeastern part of the property.

(vi) An area of 300m$^2$ is required for spray irrigation based on the maximum design effluent volume. As part of the best-fit solution, it is proposed to increase this to the approximate available area lacking sandstone exposures of 449m$^2$ – i.e. + about 149m$^2$, or just under an additional 50%. Such an area is approximately 11 times larger than the estimated existing surface irrigation area for what is only a 25% increase in the maximum design effluent volume from the dwelling and gazebo when the pool house is converted to a secondary dwelling. Guidelines in relation to the management of the existing AWTS and proposed LAA should also be followed.

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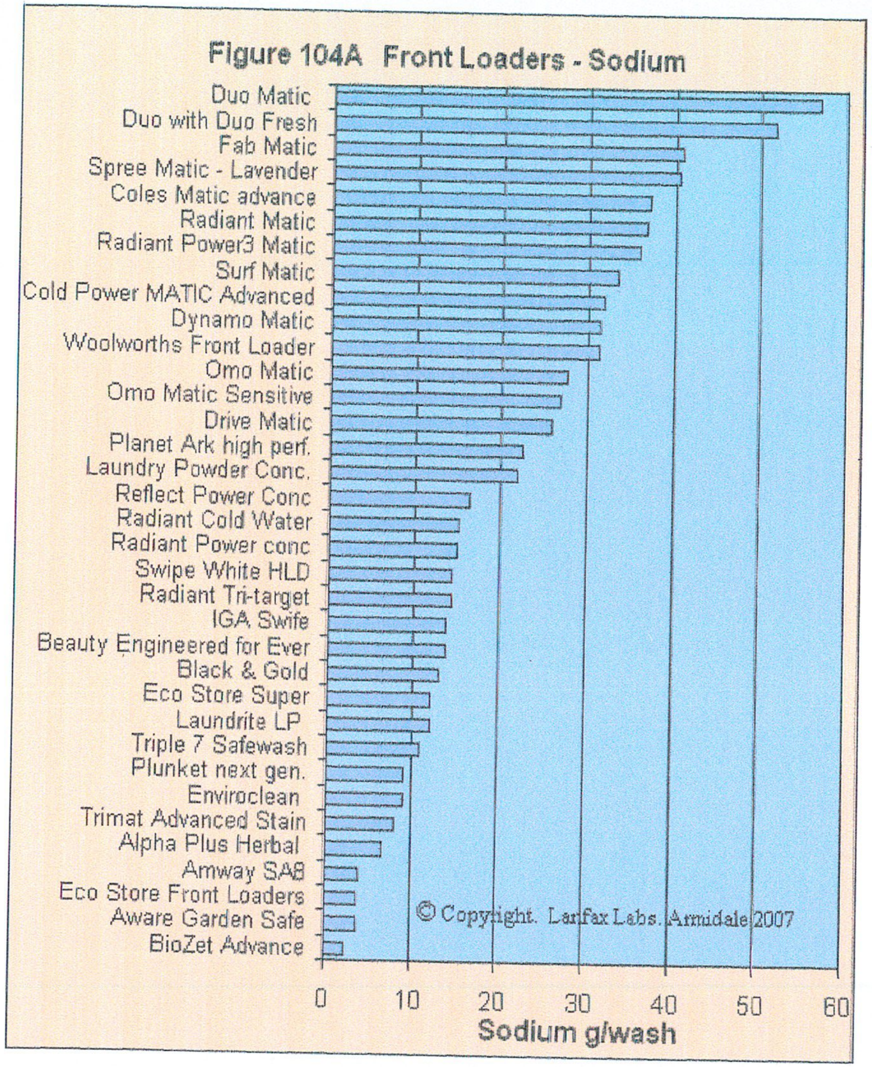
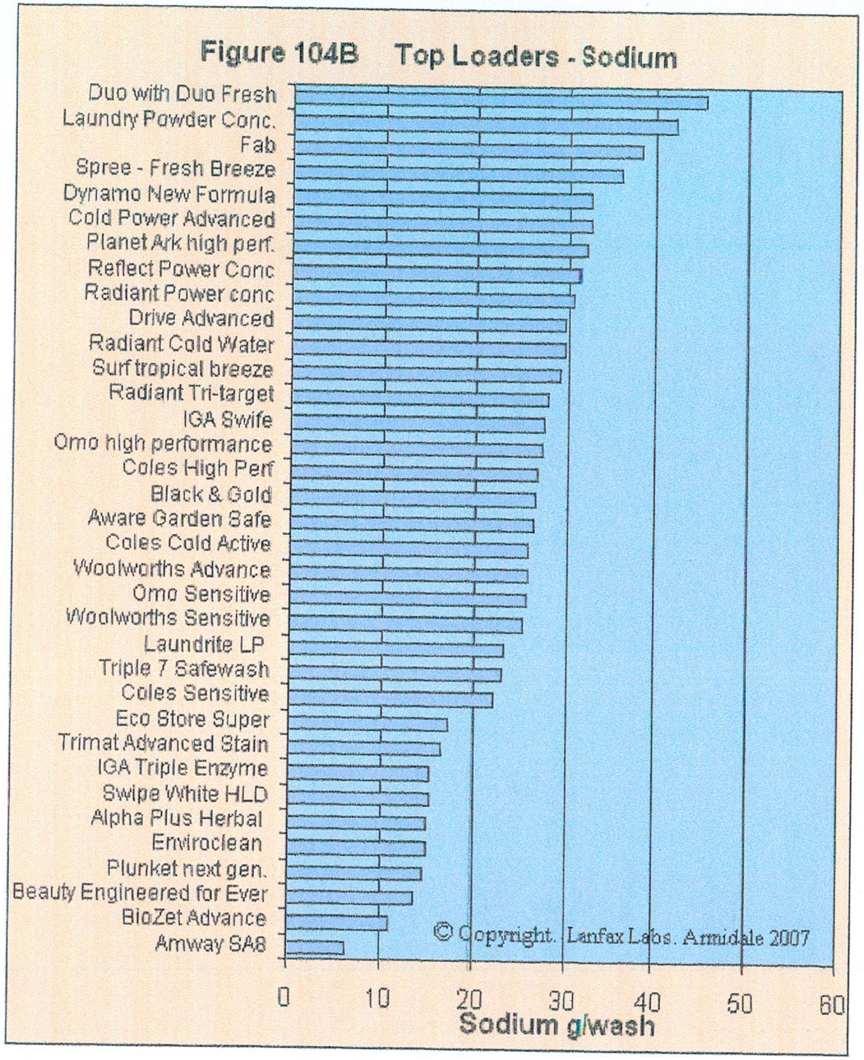
**APPENDIX 1**

SODIUM CONTENTS FOR A VARIETY OF LAUNDRY DETERGENTS AND SOIL CLASSIFICATIONS




Dr Robert Patterson, Lanfax Labs, Armidale NSW. Laundry Products Research **49 Laundry Detergents Powders (updated 24th November 2007) www. lanfaxlabs.com.au Accessed 9/5/08.**

**TABLE E1**
**ASSESSMENT OF SOIL TEXTURES**

| Soil category | Classification | Properties | Typical clay content% (see Note) |
|---|---|---|---|
| 1 | Sand | Very little to no coherence; cannot be moulded; single grains stick to fingers | Less than 5 |
| 2 | Loamy sand | Slight coherence; forms a fragile cast that just bears handling; gives a very short (5 mm) ribbon that breaks easily: discolours the fingers | 5 – 10 |
| | Sandy loam | Forms a cast but will not roll into a coherent ball; individual sand grains can be seen and felt; gives a ribbon 15 – 25 mm long | 10 – 20 |
| 3 | Fine sandy loam | As for sandy loams, except that individual sand grains are not visible, although they can be heard and felt; gives a ribbon 15 – 25 mm long | 10 – 20 |
| | Loam | As for sandy loams but cast feels spongy, with no obvious sandiness or silkiness; may feel greasy if much organic matter is present; forms a thick ribbon about 25 mm long | 10 – 25 |
| | Silty loam | As for loams but not spongy; very smooth and silky; will form a very thin ribbon 25 mm long and dries out rapidly | 10 – 25 |
| 4 | Sandy clay loam | Can be rolled into a ball in which sand grains can be felt; forms a ribbon 25 – 40 mm long | 20 – 30 |
| | Fine sandy clay | As for sandy clay loam, except that individual sand grains loam are not visible although they can be heard and felt; forms a ribbon 40 – 50 mm long | 20 – 30 |
| | Clay loam | Can be rolled into a ball with a rather spongy feel; slightly plastic; smooth to manipulate; will form a ribbon 40 – 50 mm long | 25 – 35 |
| | Silty clay loam | As for clay loams but not spongy; very smooth and silky; will form a ribbon about 40 – 50 mm long; dries out rapidly | 25 – 35 |
| 5 | Sandy clay | Forms a plastic ball in which sand grains can be seen, felt or heard; forms a ribbon 50 – 75 mm long | 35 – 45 |
| | Light clay | Smooth plastic ball that can be rolled into a rod; slight resistance to shearing between thumb and forefinger; forms a ribbon 50 – 75 mm long | 35 – 40 |
| | Silty clay | As for light clay but very smooth and silky; will form a ribbon about 50 – 75 mm long but very fragmentary; dries out rapidly | 40 – 50 |
| 6 | Medium clay | Smooth plastic ball, handles like plasticine and can be moulded into rods without fracture; some resistance to ribboning, forms a ribbon 75 mm or more long | 40 – 55 |
| | Heavy clay | Smooth plastic ball that handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to ribboning; forms a ribbon 75 mm or more in length | 50 or more |

NOTE: The typical clay content figures are included for information only.

## SOIL CLASSIFICATION

| *Field Texture Grade* | | *Behaviour of moist bolus* | *Approximate clay content (%)* |
|---|---|---|---|
| S | *Sand* | coherence nil to very slight; cannot be moulded; sand grains of medium size; single sand grains adhere to fingers. | commonly less than 5% |
| LS | *Loamy sand* | slight coherence; sand grains of medium size; can be sheared between thumbs and forefinger to give minimal ribbon of about 5mm. | about 5% |
| CS | *Clayey sand* | slight coherence; sand grains of medium size; sticky when wet; many sand grains stick to fingers; will form minimal ribbon of 5-15mm; discolours fingers with clay stain. | 5%-10% |
| SL | *Sandy loam* | bolus coherent but very sandy to touch; will form ribbon of 15-25mm; dominant sand grains are of medium size and are readily visible. | 10%-20% |
| L | *Loam* | bolus coherent and rather spongy; smooth feel when manipulated but with no obvious sandiness or 'silkiness'; may be somewhat greasy to the touch if much organic matter is present; will form ribbon of about 25mm. | about 25% |
| ZL | *Silty Loam* | coherent bolus; very smooth to often silky when manipulated; will form ribbon of about 25mm. | about 25% and with silt 25% or more |
| SCL | *Sandy clay loam* | strongly coherent bolus; sandy to touch; medium size sand grains visible in finer matrix; will form ribbon of 25-40mm. | 20%-30% |
| CL | *Clay loam* | coherent plastic bolus; smooth to manipulate; will form ribbon of 40-50mm. | 30%-35% |
| CLS | *Clay loam, sandy* | coherent plastic bolus; medium size sand grains visible in finer matrix; will form ribbon of 40-50mm. | 30%-35% |
| ZCL | *Silty clay loam* | coherent plastic bolus; plastic and often silky to the touch; will form ribbon of 40-50mm. | 30%-35% and with silt 25% or more |
| LC | *Light clay* | plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger; will form ribbon of 50-75mm. | 35-40% |
| LMC | *Light medium clay* | plastic bolus; smooth to touch; slight to moderate resistance to ribboning shear; will form ribbon of about 75mm. | 40%-45% |
| MC | *Medium clay* | smooth plastic bolus; handles like plasticine and can be modelled into rods without fracture; has moderate resistance to ribboning shear; will form ribbon of 75mm or more. | 45%-55% |
| MHC | *Medium heavy clay* | smooth plastic bolus; handles like plasticine; can be modelled into rods without fracture; has moderate to firm resistance to ribboning shear; will form ribbon of 75mm or more. | 50% or more |
| HC | *Heavy clay* | smooth plastic bolus; handles like stiff plasticine; can be modelled into rods without fracture; has firm resistance to ribboning shear; will form ribbon of 75mm or more. | 50% or more |

From: Australian Soil and Land Survey: Field Handbook 1990

FIGURE 1: PLAN SHOWING THE EXISTING FEATURES OF DEVELOPMENT AND COMPONENTS OF THE EFFLUENT MANAGEMENT SYSTEM AT LOT 6 DP 31237, No. 3 CLIVE CRESCENT, BAYVIEW