Preliminary Stormwater and Servicing Report

for

Reeves Street, Somersby

for Darkinjung Local Aboriginal Land Council

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Contents

1. Introduction

Northrop Consulting Engineers have been engaged by Darkinjung Local Aboriginal Land Council (DLALC) to prepare a Preliminary Stormwater and Servicing Report to support the Rezoning Proposal for Lot 481, DP 1184693 Reeves Street Somersby. The report provides an overview of the stormwater and flood management requirements for the site as well as the availability of water, sewer, gas, electrical and communication infrastructure. The report aims to demonstrate that the site has capacity to accommodate the proposed rezoning and outline any further investigation that may be required.

1.1 Site Description

The site is located within the Central Coast suburb of Somersby on the southern side of Reeves Street. Illustrated in Figure 1 below, the site is bordered by the M1 Pacific Motorway to the west, existing rural residential properties to the north and bushland to the south and east. Currently undeveloped the land is predominately vegetated with the exception of several fire trails which transverse the site. The area to be rezoned is 124.1ha, and the overall site has an area of 178ha,the land is characterised by gently undulating to moderate slopes with average grades ranging from 4 to 12%.

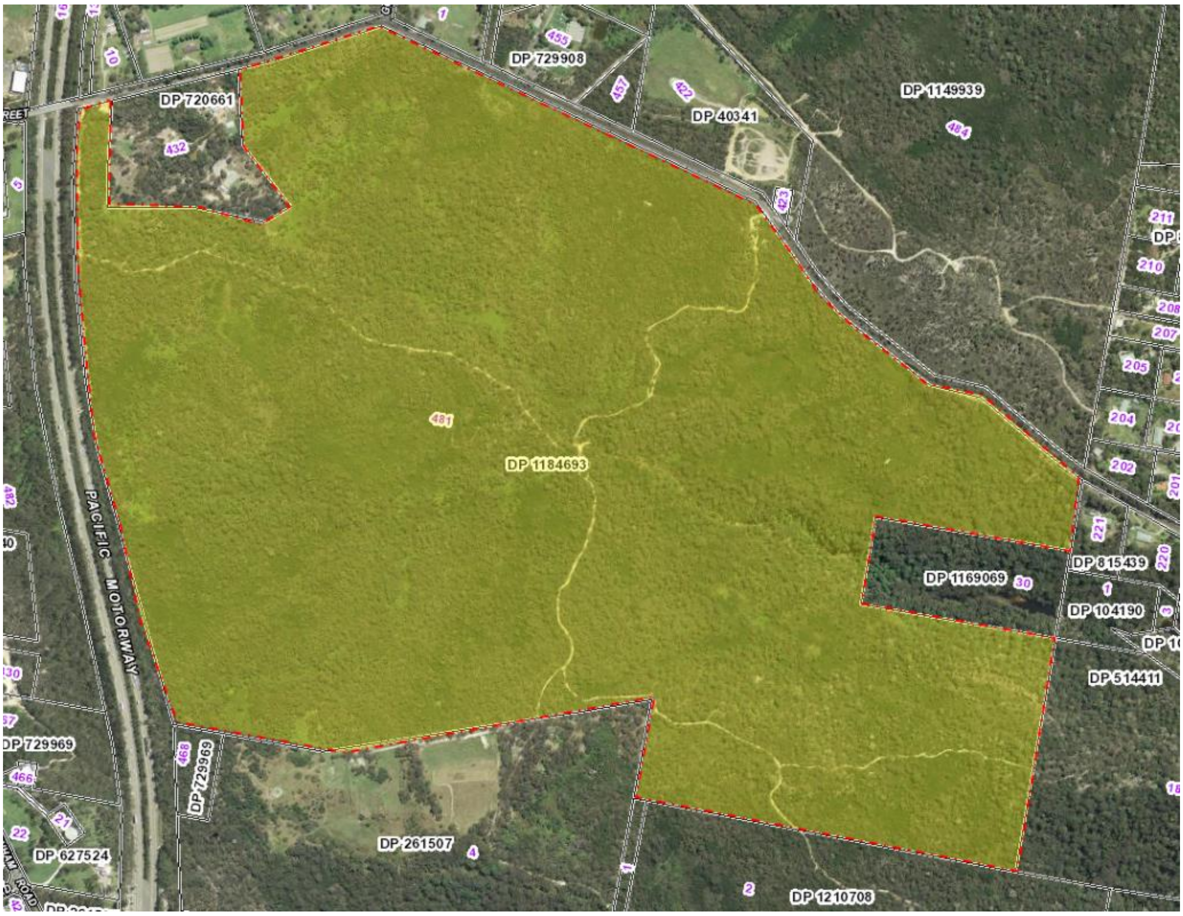

Figure 1 – Existing Site (Aerial image source https://maps.six.nsw.gov.au/)

1.2 Proposed Development

The intended development proposes to subdivide the site to provide approximately 14 rural residential/ environmental living allotments and one residual lot for environmental conservation. The rural residential allotments are proposed along the Reeves Street site frontage. The remaining site area is to be rezoned C2 environmental conservation.

To facilitate this proposal the rezoning application is seeking to:

- Rezone land fronting Reeves Street from RU2 (Rural Landscape) to C4 (Environmental Living).
- Rezone the residual land within the site from RU2 (Rural Landscape) to C2 (Environmental Conservation.
- Amend the LEP (Local Environmental Plan) Minimum Lot Size to facilitate future rural style residential lots.

Figure 2 below illustrates the indicative proposed structure plan.

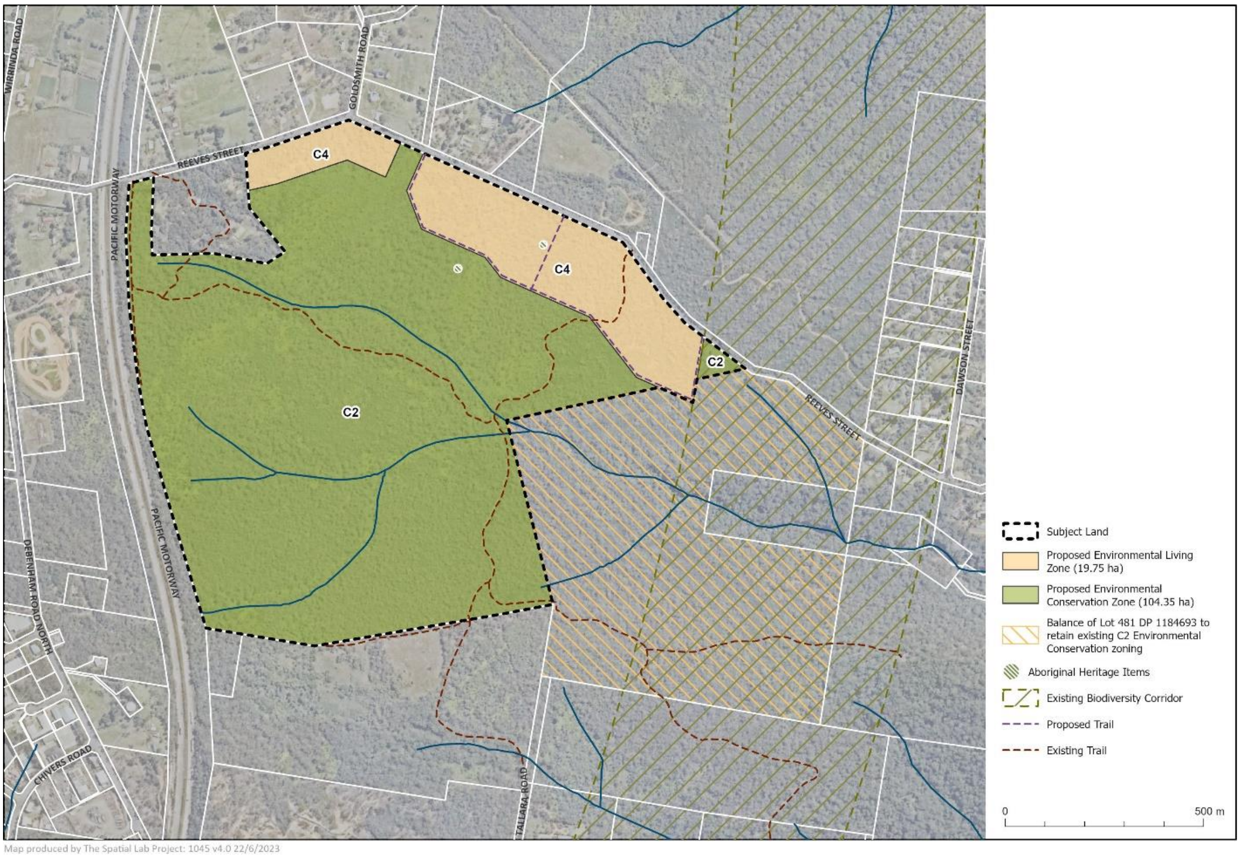

Figure 2 – Updated Plan

2. Stormwater and Flooding

2.1 Existing Catchment

Natural drainage across the site is predominately characterised by Fountain Creek which is a tributary of Narara Creek. Runoff flows in an easterly direction within a number of first order drainage lines before converging into a second order creek prior to crossing the site boundary. The existing watercourses are illustrated below in Figure 3.

Figure 3 – Existing Watercourses (Aerial image source https://maps.six.nsw.gov.au/)

2.1.1 Riparian Corridors

To ensure adequate protection is provided to the existing water courses riparian corridors are to be established along each identified tributary. In accordance the Department of Industry Water guidelines the riparian corridor widths have been determined by watercourse order as classified under the Strahler System using current 1:25 000 topographic maps. Drawing SK-01 *Fountain Creek Flooding and Riparian Corridor Extents* provided in Appendix A illustrates the determined creek order and corresponding corridor widths.

2.2 Hydrological Assessment

A preliminary hydrological assessment of the contributing catchment using the RAFTS (Runoff Analysis and Flow Training Simulation) software package was undertaken to establish the existing catchment hydrology during a 1% AEP (Annual Exceedance Probability) storm event. RAFTS uses a deterministic runoff routing model to simulate catchment runoff processes and is recognised in ARR (Australian Rainfall and Runoff) 2016 as one of the available tools for flood routing within Australian catchments.

The runoff hydrographs produced from the RAFTS model were used to determine the peak flows for a range of 1% AEP storm events. The peak median ensemble flow rates were then used to predict the flood inundation across the site.

2.2.1 Methodology

A contributing catchment of 238.4ha was delineated using LiDAR aerial imagery, refer drawing SK-01 provided in Appendix A. The majority of the catchment was modelled to reflect a 100% pervious fraction with the exception of the western sub-catchments which were modelled with an impervious fraction of 5% to represent the existing rural developments and Motorway.

Input parameters for the model were as follows:

- Rainfall data was obtained from the Bureau of Meteorology using 2016 intensities and temporal patterns.
- Initial and continuing losses for the undeveloped pervious areas were set a 58mm and 3.2mm respectively in accordance with the area specific data obtained from ARR2016.
- Initial and continuing losses for the developed areas west of the site were set a 1.5mm and 0mm respectively as recommended in ARR2016.
- Catchment slopes were determined using LiDAR contour data.
- Catchment roughness was estimated at 0.06 based on the degree of vegetation cover.
- Lag times between sub-catchments were estimated with guidance from the Queensland Urban Drainage Manual (QUDM), based on average channel gradient and longitudinal channel distance.

2.2.2 Results

The peak median ensemble flow rates were determined at three locations along Fountain Creek for the 1% AEP storm event. Table 1 below summaries these flow rates with the three cross-section locations indicated on drawing SK-01. The anticipated flood inundation extents were then determined at each location using these peak flow rates and Manning's Equation. By interpolating between each cross-section the estimated flood extents were deduced, refer drawing SK-01. As illustrated flood inundation waters are not expected to extend beyond the riparian corridors. Based on this preliminary assessment the proposed development is not considered to be affected by flooding and no further investigation is recommended.

Table 1- 1% AEP Peak Flows & Flood Inundation Widths

Cross-Section	1% AEP Flowrate (m^3/s)	Flow Width (m)	Flow Depth (m)
1	16.3035	15.0	0.8
2	46.4335	18.0	1.0
3	55.4205	28.3	1.4

2.3 Stormwater Management

Stormwater management of the future individual allotments is proposed onsite in accordance with typical mitigation measures for rural residential developments. With an expected average lot size of greater than 1.4ha the post-developed impervious fraction is anticipated to be less than 5%. Development of the lots is therefore not expected to have a significant impact on the downstream flow regime and onsite detention measures are deemed unnecessary.

The majority of the 5% impervious fraction introduced by any future dwelling is anticipated to be roof area. Roof water runoff is to be harvested for onsite reuse, with all opportunities for collection to be optimised. As the proposed allotments fall away from Reeves Street towards Fountain Creek it is anticipated that any hardstand pavements will sheet in a south easterly direction without collection or concentration. Sheeted runoff will infiltrate through a vegetated buffer over 250m wide before reaching Fountain Creek. The buffer will aid in the removal of suspended pollutants and attached nutrients to adequately treat runoff prior to entering the downstream watercourse. Rainwater harvesting in conjunction with infiltration of the sheeting runoff is expected to satisfy the stormwater quality requirements for the proposed development. Modelling of the proposed treatment train to illustrate compliance with the required pollutant load reduction targets is recommended to be undertaken as part of the detailed subdivision application.

3. Service Infrastructure

3.1 Water

No potable water infrastructure mains service the site. In accordance with the stormwater management philosophy future dwellings will be required to provided individual rainwater tanks to maximise the onsite harvesting potential. A water balance assessment to optimise tank storage volumes is recommended to be undertaken as part of the detailed subdivision application.

3.2 Sewer

No sewer infrastructure mains service the site. To manage sewerage, all dwellings will be required to provide an individual onsite wastewater treatment system. A preliminary onsite wastewater disposal assessment has been undertaken to identify anticipated effluent disposal rates, suitable treatment and disposal mechanisms and typical application areas required for effluent disposal. The assessment was prepared in accordance with AS1547-2012 'On-Site Domestic Wastewater Management (AS1547), the Department of Environment and Conservation (DCE) Environmental Guideline 'Use of Treated Effluent for Irrigation' and requirements of the Environment and Health Protection Guideline 'On-site sewage Management for Single Households'.

3.2.1 Assumed Subsurface Conditions

A desktop study (Australian Soil Resource Information System (ASRIS) and eSPADE) has identified that the site falls predominantly within the Sydney Town Soil Landscape and partially within the Somersby soil Landscape. Soil landscape profiles are provided in Appendix B.

The Sydney Town Soil Landscape is characterised by undulating to rolling low hills and moderately inclined slopes on quartz sandstone, with occasional rock benches. Dominant soils include loose brown sandy loam, earth brown sandy clay loam, strong pedal clay, and grey mottled sandy clay loam atop quartz sandstone. The landscape is generally limited by erosion, waterlogging, high permeability, acidic soil and poor fertility.

The Somersby Soil Landscape is characterised by gently undulating to rolling rises on weathered sandstone with no rock outcrops. Dominant soils include loose dark brown sandy loam, earthy yellow-brown sandy clay loam, pallid grey sandy clay, friable sandstone and saturated pallid grey-yellow-brown sandy clay loam. The landscape is generally limited by waterlogging, erosion, stoniness, fertility and high permeability.

Potential limitations to the on-site irrigation of treated effluent were identified using Section 4 of 'On-site Management for Single Households', including the following:

- Limited depth to bedrock for lots located within the Sydney Town soil landscape. Property owners will have to locate their on-site system within their lot to avoid any rock outcrops or build up appropriate fill pads to allow adequate effluent disposal. As the lots would be approximately 1ha of developable land, finding a suitable location within the site is expected to be achievable.
- Isolated areas may be subject to waterlogged soils. If such soils are identified during detailed design and planning, it is recommended disposal application areas should avoid the waterlogged soil.
- pH in the range of 4.5-7 expected, a soil treatment may need to be applied to the dispersal area if required to support the selected surface vegetation.

- Low fertility may affect plant growth in the dispersal area. Soil fertility across disposal areas could typically be improved via the addition of organic matter such as compost. As such, low fertility soils shouldn't pose a major limitation to on-site application of treated wastewater.

The general site topography is considered appropriate for on-site application of treated wastewater as slope, flooding, land area availability, buffer distances to downstream watercourses or sensitive environments, permeability and fill are not limiting factors. Furthermore, the limiting factors given above are considered to be manageable for wastewater dispersal.

From the characteristic soil landscapes and site assessment, it is assumed for the purpose of irrigation area calculations that the dominant soil type is a clay loam. The design loading rate (DLR) or design irrigation rate (DIR) have been adopted from AS1547, where 10mm/day DLR for trench application methods, 8mm/day DLR for mound methods and 3.5mm/day Design Irrigation Rate (DIR) for surface and subsurface irrigation methods have been used in dispersal area design calculations.

3.2.2 Design Effluent Loading Rates

The expected hydraulic loading for each lot has been estimated based on a five-bedroom residential dwelling (up to 8 people assumed, which is considered conservative) with use of tank water supply. Rates for household wastewater flow were adopted from Table H1 of AS1547-2012. The daily wastewater flow of each lot has been estimated as follows:

- Daily wastewater flow = 120 L/person/day x 8 persons

  = 960 L/day

As such, the required allowance on each lot for wastewater management in the order of 960L/day has been used in dispersal area design calculations.

3.2.3 Dispersal Area

Six methods of dispersal area calculations were undertaken to determine the approximate dispersal area required for each individual lot of the proposed rezoning, as follows:

- Nominated area method – Calculates the minimum dispersal area required by reducing the wet weather storage to zero.
- Nitrogen loading Method – Calculates area based on treated effluent with total nitrogen content of 20mg/L and average vegetation uptake rate of 25mg/m2/day. The average maximum uptake rate for the vegetation is based on the ability of the vegetation to use the nutrient before it passes through the root zone. We note that 20mg/L is the minimum TN treatment levels anticipated from NSW Health accredited secondary wastewater treatment systems. This figure may be reduced following the selection of an appropriate treatment system and confirmation of associated treatment levels.
- Phosphorus loading method – Calculates area based on treated effluent with a total phosphorus content of 5mg/L and an average maximum vegetation uptake rate of 3mg/m2/day. The phosphorus absorption capacity of the soil is also used to calculate the area where soil absorption rate is based on the ability of the soil to bind the phosphorus and prevent it being washed through the soil profile. We note that 5mg/L is the minimum TP treatment levels anticipated from NSW Health accredited secondary wastewater treatment systems. This figure may be reduced following the selection of an appropriate treatment system and confirmation of associated treatment levels.
- Minimum area method – uses a combination of regional climatic records, weekly effluent volume and the design irrigation rate to determine the minimum required dispersal area.

- Effluent landscaped mound sizing method – calculated the required mound basal area by using rainfall and evaporation data as well as the long-term application rate of soils on the site.
- Absorption trench sizing method – uses a combination of regional climatic records, weekly effluent volume and the long-term acceptance rate to determine the minimum required dispersal area given a nominated trench depth.

The required dispersal area for each sizing method above based off the assumed effluent loading rate and soils are provided in Table 2.

Table 2- On-site effluent dispersal areas and volumes

Sizing Method	Dispersal Area (m^2)	Wet Weather Storage (m^3)
Nominated area	1,330	0
Nitrogen loading	768	12
Phosphorus loading	619	16
Minimum area	294	76
Effluent landscaped mound	105	-
Absorption trench	115	-

The dispersal areas noted in Table 2 above denote the primary irrigation area required on each lot for the associated sizing method. A secondary application area of equal size is recommended on each lot so that the primary area can be rested or duplicated in the event that effluent flow rates are increased, or the primary area becomes waterlogged and ineffective.

As shown in Table 2, calculations determined that the method requiring the largest irrigation area is the nominated area method for irrigation. As this area is approximately 10% of the developable lot area (and 20% when considering a secondary area allowance), as such it may not be suitable for use on the site due to the site limitations noted in section 3.2.1 limiting the available dispersal area.

3.2.4 Recommendations

Based on the information provided in this report, it is believed that the existing site limitations can be easily overcome, and the site is suitable for the onsite application of treated domestic wastewater.

Surface application via spray irrigation requires a considerable land application area (refer to Nominated Area, Nitrogen and Phosphorus Loading Methods for further details), and may not be suitable for all lots, particularly those that contain existing intermittent watercourses. As such, we recommend wastewater be applied via subsurface irrigation only, via the minimum area, effluent landscaped mound or absorption trench methods noted in the preceding sections of this report. These areas require only a small area for effluent disposal which we expect to be easily accommodated during the detailed design phase for each dwelling.

The on-site wastewater system should be regularly monitored and maintained to ensure correct operation. Signs of system failure include surface ponding, effluent run off, erosion, poor vegetation growth, odours, formation of surface crusts and leaching of soil.

Occupants should make a continued effort to reduce the strength of effluent entering the treatment system. Methods to reduce effluent strength include:

- Using minimum recommended amounts of low phosphate biodegradable liquid detergents and cleaning agents

- Avoiding large quantities of bleach, disinfectants and whiteners
- Minimising solid waste entering the septic system, especially non-biodegradable items such as plastic

Vegetation across the effluent dispersal area must be regularly mowed / pruned to maintain the highest possible evapotranspiration rates. Any clippings from the dispersal area should be discarded away from the area to avoid increased nutrient loads in the area.

Suggested buffer setbacks outlined in 'Onsite Sewerage Management for Single Households' should be adopted for the wastewater system. The suggested buffer distances are reproduced in Table 3 for below ground application system. Refer to the reference documents if any spray irrigation dispersal method is adopted.

Table 3– Buffer distance requirements for absorption trench

Feature	Recommended Buffer Distance (m)	
	Upslope of feature	Downslope of feature
Building	6	3
Pool	6	3
Dam	40	40
Permanent Water	100	100
Intermittent Water	40	40
Property Boundary	12	6

Further to items in the above table it is also noted that the final layout of the disposal areas will also need to consider the Environment & Health Protection Guidelines – On-site Sewage Management for Single Households, which note the minimum buffer distance from any on-site wastewater disposal to the Coastal Upland Swamp is to be at least 40m.

Due to the rural nature of the site, the recommended subsurface dispersal method, and if the guidance and recommendations in this report are adopted, it is considered that the health and environmental impacts of the system are minimal.

3.3 Gas

Jemena have advised that properties along Reeves Street do not current have access to piped gas. The number and nature of the future lots are not likely to require future extension to mains. Should future lot owners require gas then bottled services can be arranged through local suppliers.

3.4 Electrical

Electrical infrastructure current existing along Reeves Street servicing residential development to the north. Given the number and nature of the proposed future development it is expected that this system will have capacity to service the site. Further detailed investigations and liaison will be undertaken at Development Application Phase of the development.

3.5 Communications

Communications infrastructure current existing along Reeves Street servicing residential development to the north. Given the number and nature of the proposed future development it is expected that this system will have capacity to service the site. Further detailed investigations and liaison will be undertaken at Development Application Phase of the development.

4. Conclusion

Based on the assessment undertaken to date, the site is capable of accommodating the future development envisaged under the Planning Proposal on the grounds of stormwater flooding and essential services. As outlined above the site is considered to have sufficient capacity to accommodate the proposed rezoning with further investigations only required to support the detailed design of the subdivision application.

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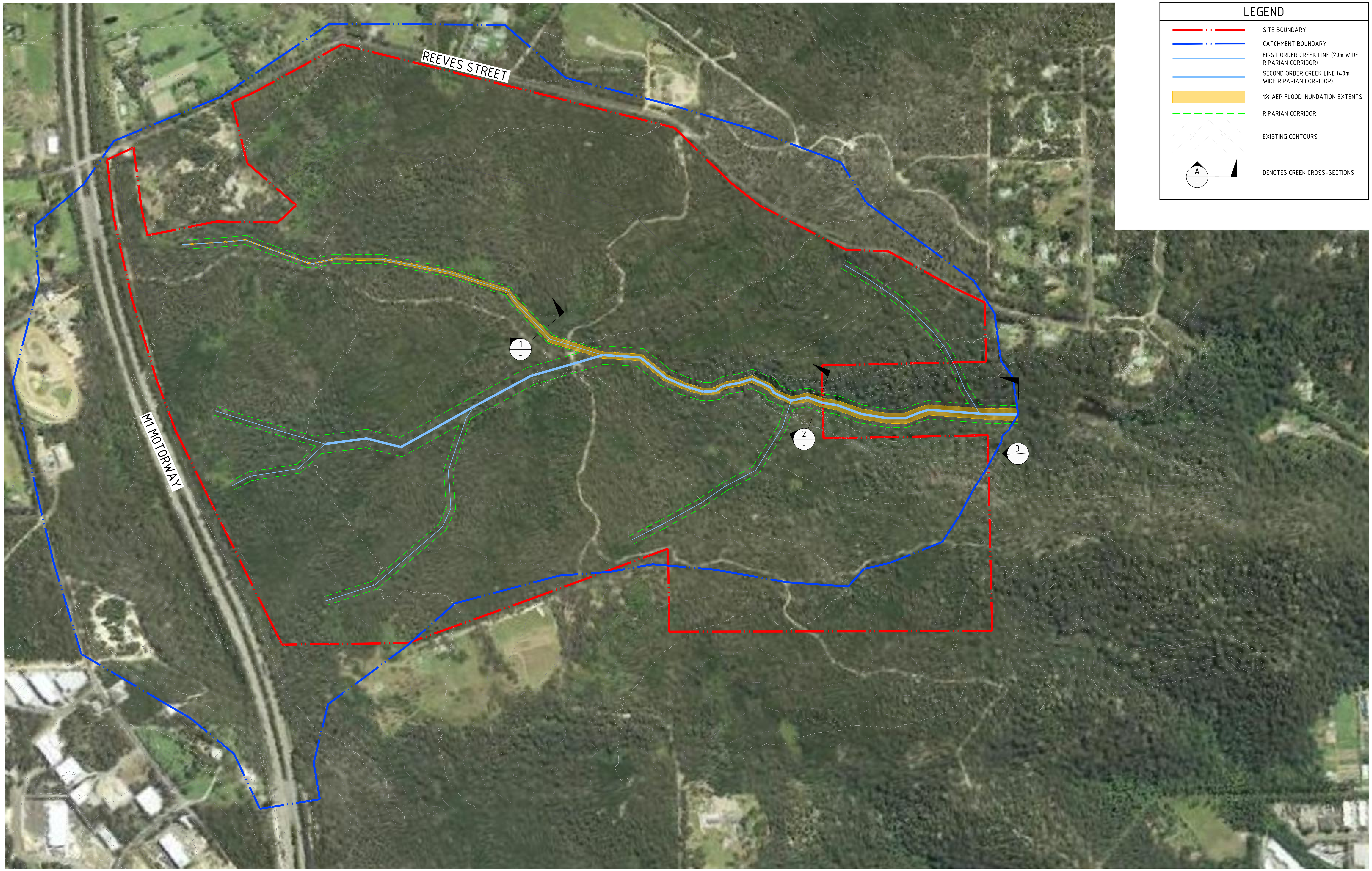
Appendix A

SK-01 Fountain Creek Riparian Corridor & Flood Extents



NL191021 - DARKINJUNG RE-ZONING, REEVES STREET SOMERSBY
FOUNTAIN CREEK RIPARIAN CORRIDOR AND FLOOD EXTENTS

SCALE 1:4000@ A1 0 40 80 120 160 200m

Appendix B

On-Site Wastewater System Information

SO SOMERSBY

Landscape—gently undulating to rolling rises on deeply weathered Hawkesbury Sandstone plateau. Local relief to 40 m; slopes <15%. Rock outcrop is absent. Crests are broad and convex, slopes are long, and drainage lines are narrow. Extensively cleared low eucalypt open-woodland and scrubland.

Soils—moderately deep to deep (100–300 cm) Yellow Earths (Gn2.24, Gn2.21, KS–Gn2.24, KS–Gn2.21) and Earthy Sands (Uc5.22, KS–Gn5.22) on crests and slopes with Grey Earths (Gn2.94) in poorly drained areas and Leached Sands (Uc2.23) and Siliceous Sands (Uc1.22) along drainage lines.

Limitations—localised permanent and seasonal waterlogging, moderate erosion hazard, stoniness, very low soil fertility, highly permeable soil.

LOCATION

Sandstone plateau surfaces of the Somersby Plateau between Mount Olive and Kulnura. Includes the rural centres of Kulnura and Central Mangrove. A small area occurs south of the Hawkesbury River near Maroota in the south-western corner of the sheet.

LANDSCAPE

Geology

Hawkesbury Sandstone—medium- to coarse-grained quartz sandstone with minor shale and laminite lenses. Deep (10 m) weathering in many areas of the sandstone is widespread. The deep weathering products are known as friable sandstone and have been described by Pecover (1984).

Topography

Gently undulating low rises to rolling rises on sandstone plateau surfaces. Local relief is up to 40 m. Slope gradients are generally <15%. Ridges and crests are broad (200–500 m). Slopes are smooth, gently inclined and long. Drainage lines are narrow. Rock outcrop is rarely present.

Vegetation

The original low eucalypt open-woodland and scrub have been extensively cleared. Common remaining indigenous species include scribbly gum (*Eucalyptus haemastoma*), brown stringybark (*E. capitellata*), red bloodwood (*E. gummifera*), smooth-barked apple (*Angophora costata*), blackbutt (*E. pilularis*) and old man banksia (*Banksia serrata*). Understorey species include flaky-barked tea-tree (*Leptospermum attenuatum*), hairpin banksia (*Banksia spinulosa* var. *spinulosa*), geebung (*Persoonia* spp.), gymea lily (*Doryanthus excelsa*), native heath (*Epacris* spp.), beard-heath (*Leucopogon* spp.) and waratah (*Telopea speciosissima*).
Poorly drained areas support scrubland of heath banksia (*Banksia ericifolia*) and dagger hakea (*Hakea teretifolia*).

Land Use

Land uses include market gardens, citrus orchards, cut flower nurseries, horse studs, and sand and gravel quarries. Improved pastures are commonly grazed by horses, cattle and some sheep. Hobby farms are undergoing rapid expansion. Small rural centres include Kulnura and Central Mangrove.

Existing Erosion

Minor to moderate sheet and rill erosion occur on land cleared for cultivation, especially when cultivation is not on the contour. Severe sheet and rill and minor gully erosion have occurred where soils have been disturbed by road construction, quarrying and overgrazing.

Included Soil Landscapes

Small areas of Sydney Town **(st)**, Gymea **(gy)** and Lambert **(la)** soil landscapes have been included.

SOILS

Dominant Soil Materials

so1—Loose dark brown sandy loam. Dark brown loamy sand or sandy loam with apedal single-grained structure and porous sandy fabric. It usually occurs as topsoil (A_1 horizon).

Occasionally weak sub-angular blocky structure is present with rough ped fabric. The colour is usually brown (10YR 3/3) or brownish black (7.5YR 3/2 –7.5YR 3/3) and often becomes lighter with depth. The pH ranges between strongly acid (pH 4.5) and slightly acid (pH 6.5). Small rounded ironstone nodules are rare. Charcoal and roots are common.

so2—Earthy yellowish brown sandy clay loam. Bright brown clayey sand to sandy clay loam with apedal massive structure and porous earthy fabric. It occurs as subsoil (B horizon).

Texture often increases gradually from clayey sand to light sandy clay loam or sandy clay loam with depth. The surface condition is hardsetting when exposed. Colours are bright and are commonly yellowish brown (10YR 6/8, 2.5YR 6/6, 2.5YR 6/7, 2.5YR 6/8) and brown (7.5YR 5/8). The pH ranges from moderately acid (pH 5.0) to slightly acid (pH 6.0). Rounded, gravel-sized ironstone nodules are often abundant. These are either concretionary nodules or small iron oxide coated stones. Charcoal fragments and roots are rare. Faunal casts and channels are widespread and common in the upper zone of this material. These channels have often been infilled with **so1** topsoil material.

so3—Pallid grey sandy clay. Pallid grey sandy clay loam to light clay with apedal massive structure and earthy porous fabric. This generally occurs as deep subsoil and is commonly found overlying bedrock (B_3 or C soil horizon).

Colour ranges from light grey (10YR 8/1, 10YR 8/2, 7.5YR 8/2, 2.5Y 8/1) to dull yellow orange (10YR 7/2, 2.5Y 7/2) or greyish yellow (10YR 7/3). Red and orange mottles may be present and become larger and less abundant with increasing depth. The pH ranges from strongly acid (pH 4.5) to slightly acid (pH 6.0). Hard iron indurated nodules are often present. Roots are rare and unbranching.

so4—Friable sandstone. Strongly weathered sandstone with a distinct sugary appearance. It occurs as deeply weathered parent material (C horizon).

Texture is commonly clayey sand which often becomes sandier with depth. Structure is apedal and massive, and fabric is usually sandy or occasionally earthy. Colour varies from light grey (10YR 8/1) to dull yellow orange (10YR 7/2). It is readily disrupted by a moderate force. Disrupted particles have a feel and appearance similar to sugar crystals. The pH ranges from extremely acid (pH 3.5) to moderately acid (pH 5.0). Strongly weathered fragments of sandstone are commonly found at depth, and roots are few with minimal branching except where bedrock is approached. Rusty coloured piped mottles often follow root traces.

so5—Saturated pallid greyish yellow brown sandy clay loam. Pallid loamy sand to sandy loam to sandy clay loam with apedal massive structure and earthy porous fabric. It occurs as subsoil in wet areas (B or C horizon).

Surface condition is loose. This material is characterised by pallid soil colours such as greyish yellow brown (10YR 6/2) and dull yellowish brown (10YR 5/4). Rusty coloured piped mottles are present around root channels. The pH ranges from strongly acid (pH 4.0) to moderately acid (pH 5.5). Stone fragments and charcoal fragments are rare, and roots are few to common.

Occurrence and Relationships

There is little variation in soil types within this soil landscape. Total soil depth appears to be correlated with slope gradient (Hawkins *et al.* 1984).

In areas where slopes are gentle (e.g., <5%) soils often exceed 300 cm in depth whilst the shallowest soils (50–100 cm) are often found on the steeper slopes. Friable sandstone bedrock can extend to many metres below the soil. Ironstone nodules and rock fragments are common on the crests and upper slopes and are often absent in lower slope positions.

Up to 30 cm of loose dark brown loamy sand **(so1)** overlies up to 300 cm of earthy yellowish brown sandy clay loam **(so2)**. Often up to 100 cm pallid grey sandy clay loam **(so3)** and >100 cm of friable sandstone **(so4)** occur below **so2** [Yellow Earths (Gn2.24, Gn2.21 KS–Gn2.24, KS–Gn2.21) and Earthy Sands (Uc5.22, Ks-Uc5.22)].

In poorly drained areas with scrublands or heathlands. Dark organic-rich sandy topsoils **(so1)** overlie up to 100 cm of saturated pallid greyish yellow brown sandy clay loam **(so5)** [Grey Earths (Gn2.94)]. Deep gleyed sands occur along drainage lines [Siliceous Sands (Uc1.22), Leached Sands (Uc2.23)].

Laterite (indurated iron concretory nodules) occurs as a capping on some crests. This material has often been quarried for road base.

LIMITATIONS TO DEVELOPMENT

Landscape Limitations

Laterite rock outcrop (localised)
Waterlogging (localised)
Moderate erosion hazard
Seasonal waterlogging (localised)
Permanent waterlogging (localised)

Soil Limitations

so1	Stoniness (localised) Very low fertility Low available water-holding capacity High erodibility Very strongly acid High potential aluminium toxicity High permeability
so2	Stoniness (localised) Low available water-holding capacity Hardsetting surface Very low fertility Sodicity Very strongly acid High potential aluminium toxicity
so3	Very low fertility Very strongly acid Sodicity Very high potential aluminium toxicity High erodibility

so4	Very low fertility Very strongly acid High aluminium toxicity High erodibility Sodicity
so5	Low available water-holding capacity Very low fertility Extremely acid Very high potential aluminium toxicity Sodicity High erodibility

Fertility

Fertility of soil materials is very low. The soils are very strongly to extremely acid, with very low to low available water-holding capacities and very low nutrient status and CECs. However, the soils are deep and well drained and can be productive with suitable fertiliser and lime applications. General fertility is low.

Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
so1	0.021	moderate	very high	low
so2	0.017	low	low	low
so3	0.046	high	high	low
so4	0.041	high	high	low
so5	0.029	moderate	high	low

Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
grazing	slight	slight	slight
cultivation	moderate	moderate	slight
urban	moderate	moderate	slight

Foundation Hazard

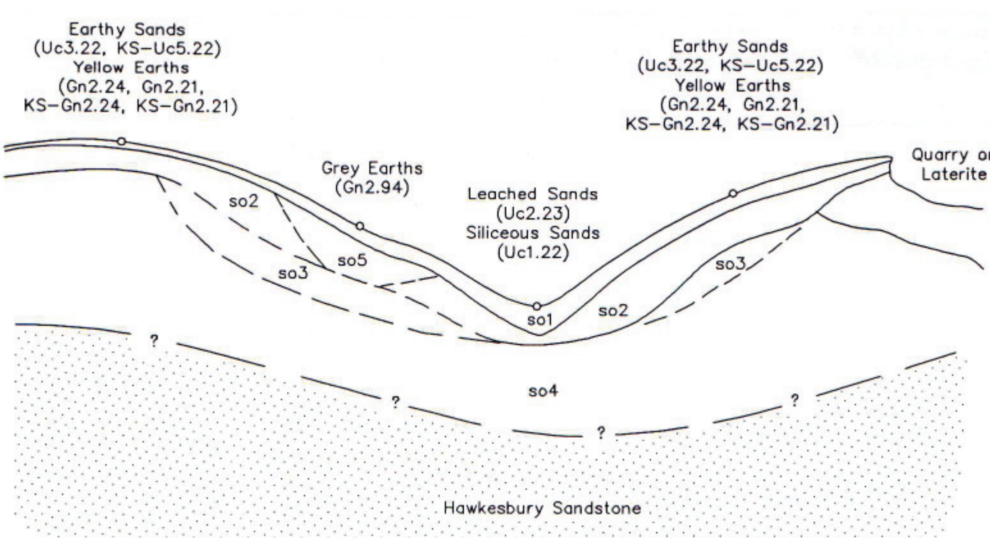
Low. Soils are stable. Depth to subsoil is <30 cm, total soil depth is >200 cm.

Urban Capability

Generally low limitations for urban development except for steeper slopes and poorly drained areas which have moderate limitations for urban development.

Rural Capability

Moderate limitations for cultivation and low limitations for grazing.



■ *Schematic cross-section of the Somersby soil landscape illustrating the occurrence and relationship of the dominant soil materials.*

st SYDNEY TOWN

Landscape—undulating to rolling low hills and moderately inclined slopes on quartz sandstone (Hawkesbury Sandstone and Terrigal Formation: Narrabeen Group) along the edge of the Somersby Plateau and as ridges and crests in the Macdonald Ranges and Watagan Mountains. Local relief to 80 m. Slope gradients 5–25%. Ridges and crests are moderately broad, slopes moderately inclined and drainage lines narrow. Occasional rock benches are present. Extensively cleared low eucalypt open-woodland.

Soils—shallow to deep (<50–>150 cm) Yellow Earths (Gn2.21, Gn2.24), Earthy Sands (Uc5.22) and some Siliceous Sands (Uc1.21) on crests and slopes; shallow to moderately deep (<50–>150 cm) Siliceous Sands (Uc1.21), Leached Sands (Uc2.23) and Grey Earths (Gn2.81) in poorly drained areas and drainage lines; moderately deep (100–150 cm) Yellow Podzolic Soils (Dy2.21, Dy5.21) and Gleyed Podzolic Soils (Dg4.53) associated with shale lenses.

Limitations—very high erosion hazard, permanent waterlogging (localised), highly permeable, strongly acid soils with very low fertility.

LOCATION

Undulating to rolling low hills and slopes along the edge of the Somersby Plateau from Maroota in the south-west to the Watagan Forest in the far north. Also occurs on ridges and crests in the Watagan Mountains and Macdonald Ranges.

LANDSCAPE

Geology

Hawkesbury Sandstone—medium- to coarse-grained quartz sandstone with minor shale and laminite lenses; and Narrabeen Group—Gosford Subgroup—Terrigal Formation (as identified on provisional geology maps): lithic/quartz sandstone, siltstone and claystone. Field survey indicates the dominant lithology present is coarse quartz sandstones.

Topography

Undulating to rolling low hills and moderately inclined slopes. Local relief is up to 80 m. Slope gradients are generally 5–25%. Ridges and crests where present are moderately broad (100–300 m), slopes are uneven, moderately inclined and waxing; and drainage lines are narrow and incised. Sandstone benches are occasionally present and are often exposed along drainage lines.

Vegetation

The original low eucalypt open-woodland and scrub have been extensively cleared. Common remaining indigenous species include scribbly gum (*Eucalyptus haemastoma*), brown stringybark (*E. capitellata*), red bloodwood (*E. gummifera*), smooth-barked apple (*Angophora costata*), sydney peppermint (*E. piperita*) and old man banksia (*Banksia serrata*). Common understorey shrubs include grey spider flower (*Grevillea* spp.), flaky-barked tea-tree (*Leptospermum attenuatum*) and drumsticks (*Isopogon* spp.).

Poorly drained areas support scrubland of heath banksia (*Banksia ericifolia*) and dagger hakea (*Hakea teretifolia*).

In the Watagan and Olney State Forests plantations of blackbutt (*Eucalyptus pilularis*) and blue-leaved stringybark (*E. agglomerata*) occur.

Land Use

A wide range of land uses occurs. Most of the area has been cleared and now supports kikuyu pastures used for grazing of horses, cattle and some sheep. Some citrus orchards can be found. Hobby farms are numerous and undergoing rapid expansion. Logging activities are carried out in Olney and Watagan State Forests. Undisturbed bushland occurs in Yengo National Park and Mangrove Creek Dam Catchment Area. Areas of Crown Land are used by horses, motor cycles and 4WD vehicles.

Existing Erosion

Moderate to severe sheet erosion and rilling have occurred where the vegetation has been extensively cleared for development (e.g., Somersby Industrial Estate).

Included Soil Landscapes

Small areas of Somersby **(so)**, Gymea **(gy)** and Lambert **(la)** soil landscapes have been included.

SOILS

Dominant Soil Materials

st1—Loose brown sandy loam. Loose brown loamy sand or sandy loam with apedal single-grained structure and porous sandy fabric. It usually occurs as topsoil (A_1 horizon).

Occasionally a weak sub-angular blocky structure is present with a rough ped fabric. The colour varies considerably and ranges from dark brown (10YR 3/2) when organic matter content is high to greyish yellow brown (10YR 6/2, 10YR 5/2, 10YR 4/2) when organic matter content is low. Colour often becomes lighter with depth. The pH ranges between strongly acid (pH 4.5) and slightly acid (pH 6.5). Sandstone rock fragments, charcoal and roots are commonly present.

st2—Earthy bright brown sandy clay loam. Bright brown clayey sand to sandy clay loam with apedal massive structure and porous earthy fabric. It usually occurs as subsoil (B horizon).

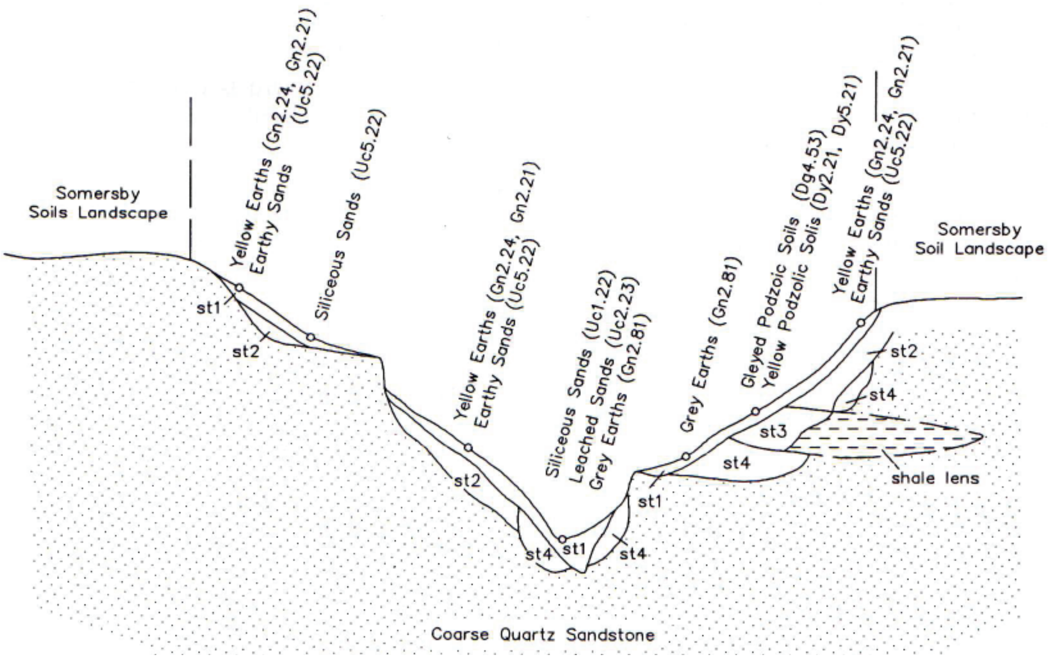
Texture often increases gradually from clayey sand to light sandy clay loam or sandy clay loam with depth. The surface condition is hardsetting when exposed. Colours are bright and are commonly yellowish brown (10YR 6/8, 2.5YR 6/6, 2.5YR 6/7, 2.5YR 6/8) and brown (7.5YR 5/8). The pH ranges from moderately acid (pH 5.0) to slightly acid (pH 6.0). Sandstone rock fragments are common, but charcoal fragments and roots are few. Faunal casts and channels are widespread and common in the upper zone of this material. These channels have often been infilled with **st1** (topsoil).

st3—Strongly pedal clay. Light to medium clay with strongly pedal structure and rough-faced ped fabric. It commonly occurs as subsoil derived from shale lenses within the Hawkesbury Sandstone (B or C horizon).

Structure is strongly pedal when dry and apedal when saturated. Peds range from 20–60 mm and are sub-angular blocky to angular blocky in shape. Colours are most often pale but can vary according to site drainage characteristics. Colour ranges from bright reddish brown (5YR 5/6) in well-drained areas to light grey (10YR 8/1) in poorly drained areas. Red, orange and grey mottles are often present. The pH ranges from strongly acid (pH 4.0) to slightly acid (pH 6.0). Stratified ironstone gravels are common, but roots and charcoal fragments are usually rare or absent.

st4—Grey massive mottled sandy clay loam. Pale coloured clayey sand to sandy clay loam with apedal massive structure and porous earthy fabric. It generally occurs as subsoil in wet areas (B_2 or B_3 horizon).

This material is characterised by pallid grey soil colours such as light grey (2.5Y 7/1) and greyish yellow (2.5Y 6/2). In wet situations there are often rusty piped mottles around root traces. The pH ranges from extremely acid (pH 3.5) to moderately acid (pH 5.5). Sandstone and charcoal fragments are rare or absent and roots are few.



■ *Schematic cross-section of the Sydney Town soil landscape illustrating the occurrence and relationship of the dominant soil materials.*

Occurrence and Relationships

Crests and slopes. Generally up to 30 cm of loose brown loamy sand **(st1)** overlies up to 150 cm of earthy bright brown sandy clay loam **(st2)**. Occasionally up to 50 cm of grey massive mottled sandy clay loam **(st4)** occurs at depth above sandstone bedrock [Yellow Earths (Gn2.24, Gn2.21) and Earthy Sands (Uc5.22)]. Occasional sandstone benches are covered by up to 30 cm of **st1** [Siliceous Sands (Uc1.21)] or up to 50 cm of **st2** [Yellow Earths (Gn2.24) and Earthy Sands (Uc5.22)]. In poorly drained areas up to 20 cm of **st1** overlies up to 150 cm of **st4** [Grey Earths (Gn2.81)].

Drainage lines. Either bedrock or up to 100 cm of **st1** occurs [Siliceous Sands (Uc1.22), Leached Sands (Uc2.23)]. Occasionally up to 100 cm of **st4** occurs below **st1** [Grey Earths (Gn2.81)]. Total soil depth varies considerably from 0–150 cm, and the boundaries between **st1** and **st4** are gradational.

Shale lenses. Occasional shale lenses occur with up to 15 cm of **st1** which overlies 50–150 cm of strongly pedal clay subsoil **(st3)** [Yellow Podzolic Soils (Dy2.21, Dy5.21), Gleyed Podzolic Soils (Dg4.53)]. Total soil depth ranges from 50–150 cm, and the boundary between the soil materials is sharp.

LIMITATIONS TO DEVELOPMENT

Landscape Limitations

Very high erosion hazard
Waterlogging (localised)
Seasonal waterlogging (localised)
High run-on
Rock outcrop (localised)

Soil Limitations

st1
Stoniness (localised)
Very low fertility
Low available water-holding capacity
Strongly acid
High permeability
High erodibility
High potential aluminium toxicity
Strong sodicity

st2
Stoniness (localised)
Low available water-holding capacity
Strongly acid
Hardsetting surface
Very low fertility
High erodibility
Strong sodicity
High potential aluminium toxicity

st3
Low wet bearing strength (localised)
Low permeability (localised)
Low available water-holding capacity
Strongly acid
Very low fertility
High potential aluminium toxicity
Moderate erodibility
Strong sodicity

st4
Strongly acid
Very low fertility
Low available water-holding capacity
High potential aluminium toxicity
Strong sodicity

Fertility

The fertility of the soil materials is very low. The soils of this unit are generally strongly acid, with low water-holding capacities and low to very low nutrient status and CECs. All soil materials are sodic and have a high potential aluminium toxicity. Soil depth varies considerably and occasional rock outcrops limit root penetration. The general soil fertility is very low.

Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
st1	0.016	low	high	low
st2	0.025	moderate	high	low
st3	0.030	moderate	moderate	low
st4	0.019	low	low	low

Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
grazing	moderate	moderate	slight
cultivation	high–very high	very high	slight
urban	high	very high	slight

Foundation Hazard

The foundation hazard is low. The soils are relatively stable. Depth to subsoil is <20 cm. Total soil depths are generally 50–150 cm.

Urban Capability

This soil landscape has moderate limitations for urban development.

Rural Capability

This soil landscape has high to severe limitations for regular cultivation and moderate limitations for grazing.

Minimum Area Method

A monthly water balance based on minimum permissible irrigation area, hydraulic loading and climate.
in accordance with "Onsite Sewage Management for Single Households".

JOB NO.: NL191021
LOCATION: Darkinjung Land Somersby
CLIENT: Darkinjung LALC
DATE: 22.08.23
RAIN DATA FROM: Gosford North (Glennie Street)
EVAPORATION DATA FROM: Sydney Airport (61km away)

Min Area Req	0.027	Ha
Min Area Req	274.29	m2

Design Wastewater Flow	Q	l/day	960.00	120L/day/ person- Assuming 5br/ 8 person per lot (considered conservative)												
Design Percolation Rate	R	mm/wk	24.5													
Parameter	**Symbol**	**Formula**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	Total
Days in Month	D	-	days	31	28	31	30	31	30	31	31	30	31	30	31	365.0
Precipitation	P	-	mm/month	138.9	168	149.7	146.2	125.1	135.8	77.3	71.1	66.3	80.2	104.1	89.7	1352.4
Evaporation	E	-	mm/month	223.2	179.2	167.4	126	89.9	75	83.7	114.7	147	179.8	195	229.4	1810.3
Crop Factor	C	-	-	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Outputs																
Evapotranspiration	ET	E x C	mm/month	156.24	125.44	117.18	88.2	62.93	52.5	58.59	80.29	102.9	125.86	136.5	160.58	1267.2
Percolation	B	(R /7) x D	mm/month	108.5	98.0	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs		(ET + B)	mm/month	264.7	223.4	225.7	193.2	171.4	157.5	167.1	188.8	207.9	234.4	241.5	269.1	2544.7
INPUTS																
Precipitation	P	-	mm/month	138.9	168	149.7	146.2	125.1	135.8	77.3	71.1	66.3	80.2	104.1	89.7	1352.4
Possible Effluent Irrigation	W	(ET + B) - P	mm/month	125.8	55.4	76.0	47.0	46.3	21.7	89.8	117.7	141.6	154.2	137.4	179.4	1192.3
Actual Effluent Production	I	H/12	mm/month	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	1192.3
Inputs		P + I	mm/month	238.3	267.4	249.1	245.6	224.5	235.2	176.7	170.5	165.7	179.6	203.5	189.1	2544.7
Storage	S	(P + W) - (ET + B)	mm/month	-26.5	43.9	23.4	52.4	53.0	77.7	9.6	-18.3	-42.2	-54.8	-38.0	-80.0	
Cumulative Storage	M	-	mm	0.0	43.9	67.3	119.7	172.7	250.3	259.9	241.6	199.3	144.5	106.5	26.5	
Storage per Day			mm/day	0.0	1.6	0.8	1.7	1.7	2.6	0.3	0.0	0.0	0.0	0.0	0.0	8.7

Irrigation Area	**L**	**365 X Q / H**	**m^2**	**294**	Approx 17.1m square				
				1 Days	***3 Days***	4 Days	7 Days	14 Days	Total
Wet Weather Storage	**V**	**Largest M**	**mm**	**2.6**	***8***	**10**	**18**	**36**	**259.9**
		(V x L)/1000	**m^3**	**0.8**	***2***	**3**	**5**	**11**	**76.4**
			L	**761**	***2282***	**3043**	**5325**	**10651**	**76,385**

Effluent Volume =	960.00	L/day			
Crop =	Fescue		Psorb of Soil =	150	mg/kg
Average Yield =	14	tonnes/ha		865.3846154	kg/Ha
% N =	2.4			0.086538462	kg/m^2
% P =	0.4				
Reduction Factor =	0.5				
Nitrogen Loading			***Phosphorus Loading***		
N Concentration =	20	mg/L	P Concentration =	5	
N uptake by Veg	25	mg/m2/day	P Uptake by Veg =	0.055	kg/m^2
Nitrogen Irrigation Area =	768		Phosphorus Irrigation Area =	618.9130435	

Evapotranspiration Trench Design.

JOB NO.: NL191021
LOCATION: Darkinjung Land Somersby
CLIENT: Darkinjung LALC
DATE: 20.01.0
RAIN DATA FROM: Gosford North (Glennie Street)
EVAPORATION DATA FROM: Sydney Airport (61km away)

LTAR =	10	L/m²/day
Void Space Factor =	0.3	(Durable Imported Fill.)
Rainfall Runoff Coefficient =	0.25	
Pan Evaproration Crop Factor =	0.7	
Design Daily Effluent Flow =	960	L/d

Month	Days	Pan Evaporation	Evapo - transpirtation	Rainfall	Retained Rainfall	LTAR	Disposal Rate	Effluent Applied	Area Required
Jan	31	223.2	156	138.9	104	310	362	29760	82
Feb	28	179.2	125	168	126	280	279	26880	96
Mar	31	167.4	117	149.7	112	310	315	29760	95
Apr	30	126	88	146.2	110	300	279	28800	103
May	31	89.9	63	125.1	94	310	279	29760	107
Jun	30	75	53	135.8	102	300	251	28800	115
Jul	31	83.7	59	77.3	58	310	311	29760	96
Aug	31	114.7	80	71.1	53	310	337	29760	88
Sep	30	147	103	66.3	50	300	353	28800	82
Oct	31	179.8	126	80.2	60	310	376	29760	79
Nov	30	195	137	104.1	78	300	358	28800	80
Dec	31	229.4	161	89.7	67	310	403	29760	74
		1810.3		1352.4					
								Max =	115
								Min =	74
								Average =	91

Month	Trial Area	Application Rate	Disposal Rate Per Month		Increased Depth	Depth of Efflluent	Increase	Depth
Dec	101							0
Jan		295	362.1	-67	-225	0	-225	0
Feb		266	279.4	-13	-44	0	-44	0
Mar		295	314.9	-20	-68	0	-68	0
Apr		285	278.6	7	22	0	22	22
May		295	279.1	16	52	22	52	74
Jun		285	250.7	34	115	74	115	189
Jul		295	310.6	-16	-53	189	-53	136
Aug		295	337.0	-42	-141	136	-141	0
Sep		285	353.2	-68	-227	0	-227	0
Oct		295	375.7	-81	-270	0	-270	0
Nov		285	358.4	-73	-244	0	-244	0
Dec		295	403.3	-109	-362	0	-362	0

MUST RETURN TO ZERO

Area = 101 m^2
Depth = 0.339 m (Depth + 150mm topsoil + freeboard allowance)

Selected Depth	Selected Width	Design Length
0.45 m	1.0 m	101.0 m
0.45 m	2.0 m	50.5 m
0.45 m	3.0 m	33.7 m
0.45 m	4.0 m	25.3 m
0.45 m	5.0 m	20.2 m
0.45 m	6.0 m	16.8 m
0.45 m	7.0 m	14.4 m
0.45 m	8.0 m	12.6 m
0.45 m	9.0 m	11.2 m
0.45 m	10.0 m	10.1 m

Nominated Area Method.

A monthly water balance used to determine Wet Weather Storage for
with a nominated Irrigation Area in accordance to "Onsite Sewage Management for SIngle Households".

JOB NO.: NL191021
LOCATION: Darkinjung Land Somersby
CLIENT: Darkinjung LALC
DATE: 22.08.23
RAIN DATA FROM: Gosford North (Glennie Street)
EVAPORATION DATA FROM: Sydney Airport (61km away)

Design Wastewater Flow	Q	l/day	960
Design Percolation Rate	R	mm/wk	24.5
Land Area	L	m2	1330.0

Approx 36.5m square

This has been optimised to ensure no cumulative storage is required

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in Month	D	-	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P	-	mm/month	138.9	168	149.7	146.2	125.1	135.8	77.3	71.1	66.3	80.2	104.1	89.7	1352.4
Evaporation	E	-	mm/month	223.2	179.2	167.4	126	89.9	75	83.7	114.7	147	179.8	195	229.4	1810.3
Crop Factor	C	-	-	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Inputs																
Precipitation	P	-	mm/month	138.9	168	149.7	146.2	125.1	135.8	77.3	71.1	66.3	80.2	104.1	89.7	1352.4
Effluent Irrigation	W	(Q x D)/L	mm/month	22.4	20.2	22.4	21.7	22.4	21.7	22.4	22.4	21.7	22.4	21.7	22.4	263.5
Inputs		(P + W)	mm/month	161.3	188.2	172.1	167.9	147.5	157.5	99.7	93.5	88.0	102.6	125.8	112.1	1615.8586
Outputs																
Evapotranspiration	ET	E x C	mm/month	156.24	125.44	117.18	88.2	62.93	52.5	58.59	80.29	102.9	125.86	136.5	160.58	1267.2
Percolation	B	(R/7) x D	mm/month	108.5	98.0	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs		(ET + B)	mm/month	264.7	223.4	225.7	193.2	171.4	157.5	167.1	188.8	207.9	234.4	241.5	269.1	2544.7
Storage	S	(P + W) - (ET + B)	mm/month	-103.5	-35.2	-53.6	-25.3	-24.0	0.0	-67.4	-95.3	-119.9	-131.8	-115.7	-157.0	-928.9
Cumulative Storage	M	-	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Storage per Day			mm/day	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

				1 Days	*3 Days*	4 Days	7 Days	14 Days	Total
Storage	**V**	**Largest M**	**mm/day**	**0.0**	***0***	**0**	**0**	**0**	**0**
		(V x L)/1000	**m3**	**0.0**	***0***	**0**	**0**	**0**	**0**
			L	**0**	***0***	**0**	**0**	**0**	**0**

Dispersal area calculations

Soil Characteristics:

Characteristic Soil Classification:	Clay Loam		
Design Irrigation Rate	DIR.	=	24.5 mm/week (Irrigation Systems)
Design Loading Rate	DLR	=	10mm/day (Trench)
		=	8mm/day (Mound)
Assumed Daily Design Flow:	q_d	=	960 L/day

Effluent Dispersal Calculations:

Below are details of the Nitrogen Loading Method, Phosphorus Loading Method and Effluent Landscaped Mound Method:

1. Nitrogen Loading Method

Aerated Wastewater System Effluent Dispersal Area in Accordance With "On-Site Sewage Management For Single Households" Guidelines.

Total Nitrogen Concentration	TN	= 20 mg/L
Loading Rate	L_n	= 25 mg/m^2/day
Irrigation Area: $A_n = (TN \times q_d)/L_n$		= 672m^2

2. Phosphorus Loading Method

Below is a worked example of the method used to calculate the required irrigation area for effluent with specific phosphorus concentration and soil with a specific phosphorus sorption capacity.

Total phosphorus concentration in treated effluent		= 5mg/L
Effluent produced		= 960L/day
Phosphorus sorption capacity of the soil	=	150 mg/kg (Assumed average)
	=	865.38g/Ha
	=	0.0865 kg/m^2 (over 50 years)
Phosphorus uptake by plants	=	3 mg/m^2/day
	=	54750 mg/ m^2 (over 50 years)
	=	0.055 kg / m^2
Phosphorus produced	=	87.60 kg (over 50 years)

Dispersal Area Required= Phosphorus Produced / (Phosphorus adsorbed + Phosphorus uptake)

Area Required = 87.60 / (0.0865+ 0.055)

= 619m^2

3. Effluent Landscaped Mound Sizing Method

Effluent produced =960L/day

=0.96m^3/day

DLR (mound) =8mm/day

=0.008m/day

Mound size required = effluent produced/design loading rate

=120m^2