TATTERSALL LANDER PTY LTD

STORMWATER MANAGEMENT REPORT

for

PROPOSED REZONING FOR FUTURE RESIDENTIAL DEVELOPMENT

SANDERLING AVENUE HAWKS NEST

LOT 1 DP 868540 & LOT 1 DP 1234229

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1.0 INTRODUCTION

This report has been prepared to support an application to rezone Lot 1 DP 1234229 to an R3 zoning, ultimately leading to the development of both Lot 1 DP 1234229 & Lot 1 DP 868540 as a residential complex. The site of the proposed development is located in Sanderling Avenue, Hawks Nest.

Figure 1: Locality Diagram

2.0 BACKGROUND INFORMATION

Part of the proposed development site (Lot 1 DP 868540) is currently utilised as the clubhouse (and associated facilities) for the Hawks Nest Golf Club. The clubhouse and carpark account for approximately 40% of the area of that lot. The remainder of the proposed development site (Lot 1 DP 1234229) predominantly consists of a vegetated sand dune.

3.0 SITE CONTEXT

Lot 1 DP 868540 is currently zoned R3. Lot 1 DP 1234229 is currently zoned RE1 and is proposed to be rezoned as R3 to enable development of both lots as one residential complex.

The site is situated on Sanderling Avenue, which provides access to the existing golf club and ultimately leads to a small carpark with access to the beach.

Review of site contours from available LiDAR data shows the proposed rezoning area to have no well-defined flow paths or hydraulic structures. Levels range from around 4.5m-7.2m AHD, and the irregular and undulating landform is typical of a coastal dunal system the site is a part of, albeit at the rear of the frontal dune.

A detailed geotechnical assessment has not been provided at this time, but a site investigation showed the site to be loose sands, typical of an aeolian sand dune system and consistent with much of the Hawks Nest area.

Given the sandy soil across the site and immediate surrounds (the neighbouring golf course to the west and Bennetts Beach to the east), groundwater is not expected to be a significant constrain to site drainage works. The water level in a near-by golf course dam (200m to the west) is approximately 2.0m AHD, and will be at 0.0m AHD at the coastline 200m to the east. Simple interpolation between these points would approximate a groundwater level at around 1.0m AHD, which is 4-6m below current surface levels.

The existing site can be seen in Figure 2;

Figure 2: Existing Site

4.0 PROPOSED DEVELOPMENT

The proposal is to rezone 1.487ha of land (being Lot 1 DP 1234229) to enable development of both Lot 1 DP 868540 & Lot 1 DP 1234229 as a residential complex. The current layout provided by the developer is a concept design only (and subject to change with lodgement of a Development Application) but consists of 292 units (with a mixture of one, two and three bedrooms) across ten four-storey apartment buildings and ten one-storey villa buildings.

Although subject to change, the concept layout has been utilised when preparing the required stormwater modelling as an indication of the scale of the development that will most likely form the future Development Application for the site.

The concept layout plan can be seen in Figure 3 below:

Figure 3: Concept Layout Plan

5.0 WATER QUALITY TARGETS

The Water Sensitive Design section of the Great Lakes Council Development Control Plan provides pollution reduction targets that need to be met.

Given the nature of the land proposed to be rezoned (Lot 1 DP 1234229) as a vegetated sand dune (i.e. with very low source levels of pollutants), a standalone analysis limited to that land would prove unrealistic to achieve the required pollutant reduction targets ('Neutral or Beneficial Effect' targets would be required). However, when the entire site (both Lot 1 DP 868540 and Lot 1 DP 1234229 combined) is considered, the opportunity is available to improve the water quality outcomes for the entire site.

When considered in its entirety, total development site has an impervious percentage greater than 10% due to the large footprint taken up by the existing clubhouse and carpark. As such, the water quality treatment train for this development should meet the percentage reduction targets in Table 1 below:

Table 1: Stormwater Quality Targets

	Percentage Reduction Target
Gross Pollutants (GP)	90%
Total Suspended Solids (TSS)	80%
Total Phosphorus (TP)	60%
Total Nitrogen (TN)	45%

6.0 CONSTRAINTS AND OPPORTUNITIES

As the current layout is only at concept design stage, there is the opportunity to consider water sensitive urban design and allow for the appropriate space requirements to implement an effective treatment train at this early stage.

The highly vegetated, sandy, irregular nature of the rezoning portion of the existing site presents constraints in relation to the relatively high runoff water quality standards and negligible off-site discharges. Conversely, the sandy nature of the site also offers the opportunity to employ infiltration measures for site discharges.

Opportunities also exist on the development site as a whole for removal of the currently untreated runoff from the existing clubhouse and carpark. Potential opportunities may also exist for stormwater capture and reuse in irrigation on the adjacent golf course.

7.0 SOIL AND WATER MANAGEMENT

As this report has been prepared in support of an application to rezone part of the site, rather than an application for development, it is premature to be considering specific erosion and sediment control measures (i.e. in accordance with Landcom's 'Blue Book"). A more comprehensive report would need to be prepared in support of any future Development Application, which would address site-specific requirements of the Blue Book.

Given the topography of the site and the nature of the sandy soil, it is anticipated that erosion risk will be relatively low and should be able to be adequately addressed with standard construction erosion control measures such as silt fencing and sandbagging.

8.0 INTEGRATED WATER CYCLE MANAGEMENT

As mentioned, a more comprehensive report would need to be prepared in support of any future Development Application, but it is expected that all dwellings will be serviced with reticulated water and sewer from the MidCoast Water Services network.

In line with BASIX and WSUD principles, runoff from future dwelling roof areas is to be directed into rainwater tanks for reuse by the dwellings. Refer to Section 10 of this report for further details (based on the concept design). Potential opportunities could also be explored for stormwater capture and reuse in irrigation on the adjacent golf course.

There may also be opportunities to utilise a MidCoast Water Services recycled water supply for ground irrigation within this development.

9.0 STORMWATER MANAGEMENT - HYDROLOGY

The nature of urban development is that it significantly increases the amount of impervious surface in a catchment, which in turn can decrease runoff times and create higher peak flow rates. It is important with new developments that measures are put in place to prevent increases in runoff from the site and resulting downstream flash flooding.

A detailed geotechnical assessment has not been provided at this point, but a site investigation showed the site to be loose sands, typical of an aeolian sand dune system. Combined with the irregular and undulating topography, it is expected that there would be no meaningful stormwater runoff from the existing site. Waters would typically infiltrate directly in minor rainfall events, and in more major events be caught in the natural depressions on and adjacent to the site until infiltration occurs.

Post-development, it is expected a degree of site regrading would be undertaken which would remove most of the existing informal depression storages, along with significant increases in impermeable surfaces. In order to maintain existing flow regimes stormwater will need to be detained and disposed of via engineered infiltration devices. Runoff should to be appropriately treated as prescribed in Section 10 before disposal via infiltration can occur.

Numerous options are available to achieve the required infiltration disposal, a combination of which may be utilised;

- unlined base of biofilter systems,
- larger scale above ground infiltration basins (in the APZ area for example),
- below ground tanks (such as various proprietary modular or tunnel drainage systems or structural tanks with permeable bases)
- use of permeable pipes across the site where conveyance is also required,
- offsite in the existing informal depressions in the adjacent dune area,
- offsite infiltration on golf course lands/storage and reuse for golf course irrigation.

Detailed sizing calculations can be done at DA stage when geotechnical data and a more confirmed development proposal has been developed but as an indication, based on 240mm/hr continuing infiltration rates, the estimated 9,000sq.m impervious area on the rezone land might require a system with around 750m^2 surface area and 750m^3 storage, and the entire DA site with 21,000sq.m impervious area might require a system with around 1,800m^2 surface area and 1,800m^3 storage.

It is noted that infiltration systems should typically not be placed in close proximity to road pavement subgrades or building footings to remove any influence of continually wet or greatly varying soil moisture levels on the structural integrity of these assets. This can pose significant constraints to the use of infiltration on some sites, particularly where heavy soils are encountered. Further specialist geotechnical advice should be sought at DA stage, but it is expected that the sandy soils and relatively low groundwater should mean this will have a minimal impact on this particular site.

10.0 STORMWATER MANAGEMENT – WATER QUALITY MODEL

10.1 BACKGROUND

The quality of runoff generated by the site is important to ensure the preservation of the downstream environments as an increased proportion of impervious area can lead to a subsequent increase in the quantities of suspended solids, phosphorus and nitrogen entering storm water runoff. The aim of this section of the study is to determine what measures need to be undertaken as part of the future development to meet the water quality objectives set out in Table 1 in Section 5 of this report.

10.2 MUSIC MODELLING

MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the Cooperative Research Centre for Catchment Hydrology. MUSIC provides the ability to model both quality and quantity of runoff generated by catchments. Therefore MUSIC can simulate annual stormwater volumes, and expected annual pollutant loadings.

MUSIC is designed to model stormwater runoff systems in urban catchments. It is used to simulate a range of temporal and spatial scales. Catchment modelling can be performed for areas up to 100 km^2, with times steps from 6 minutes to 24 hours to match the range of spatial scale. This enables long term modelling of continuous historical rainfall data from pluviograph sources, and reflects the ability to account for temporal variation in data for an annual rainfall series directly.

MUSIC also has the ability to model a number of treatment devices, and measure their effectiveness in terms of the quantity and quality of runoff downstream. This allows determination of the degree of reduction in annual pollutant loadings.

It is important to note that the MUSIC simulation relies heavily on input variables and it is usually recommended that MUSIC models be calibrated to local conditions wherever possible. When calibration is not possible default values can be used, or variables can be sourced from values recommended for stormwater modelling in NSW from a technical report prepared for the DECC by the Co-operative Research Centre titled "*Stormwater Flow and*

Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures" (Fletcher et al, 2004).

Given the scale of the proposed development site and hence the MUSIC model, it was determined to be unreasonable to perform a calibration in this instance.

10.2.1 CLIMATE / RAINFALL

To accurately model a site of this size, continuous rainfall record spanning at least five years with a six minute timestep is required. Rainfall data was obtained from the Bureau of Meteorology in the form of a historic pluviograph record from the Williamstown rainfall gauge. It is situated approximately 34km from the site and is of similar elevation and temporal pattern.

The rainfall record was analysed, and the ten years of data between the dates of 1/1/1997 and 31/12/2006 was chosen. This was based on advice received for a peer-reviewed MUSIC model carried out by Tattersall Lander on another development in the Tea Gardens / Hawks Nest area. This data produced a mean annual rainfall of 1131mm. It was noted that the long term average rainfall (obtained from the Bureau of Meteorology) for Nelson Bay (approximately 13km from the site) is 1348mm. The ten year pluviograph data was scaled appropriately to bring the mean annual rainfall in line with this long term average (again based on advice received for the previous model). For the purpose of this report, all rainfall events in the nominated ten year period have been modelled.

10.2.2 EVAPORATION

To accurately model the outcome of water quality treatment measures, monthly potential evapotranspiration (PET) data is required. Monthly average areal potential evapotranspiration values were read from maps in the ‘Climate Atlas of Australia, Evapotranspiration’ (BoM, 2001), and are displayed below in Table 2:

Table 2: Monthly Areal Potential Evapotranspiration Figures

Month	Potential Evapotranspiration (mm)
January	180
February	135
March	135
April	90
May	70
June	50
July	50
August	70
September	95
October	135
November	150
December	175
Total	**1335**

10.2.3 NODE PARAMETERS

The MUSIC model was used to simulate the pollutant export generated during a ten year period of average rainfall. Rainfall-runoff parameters for Sand soils were adopted from Section 3.6.4.3 of the Draft NSW MUSIC Modelling Guidelines (2010) and typical pollutant concentrations derived from Fletcher et al. The adopted parameters can be seen in Figure 4 and Table 3 below.

Note that a Rainfall Threshold of 1.5mm/day was adopted for the “Sealed Road” node and 0.3mm/day was adopted for the “Roof” node per Table 3.6 in the Draft NSW MUSIC Modelling Guidelines (2010). A Rainfall Threshold of 1.0mm/day adopted for all other nodes.

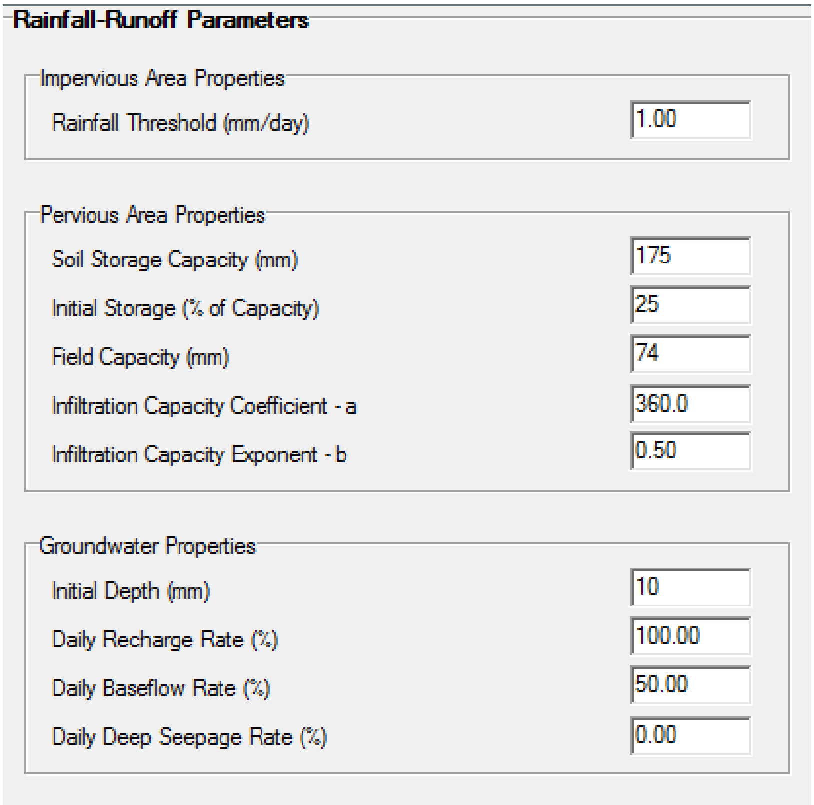

Figure 4: Adopted Rainfall-Runoff MUSIC Parameters

Table 3: Adopted MUSIC Pollutant Generation Parameters

	Residential	**Roof**	**Road**
Baseflow TSS Mean (mg/L)	16	-	16
Stormflow TSS Mean (mg/L)	140	20	270
Baseflow TP Mean (mg/L)	0.14	-	0.14
Stormflow TP Mean (mg/L)	0.25	0.13	0.5
Baseflow TN Mean (mg/L)	1.3	-	1.3
Stormflow TN Mean (mg/L)	2	2	2.2

10.2.4 PROPOSED DEVELOPMENT POLLUTANT ANALYSIS

The concept plan for the proposed development was modelled to determine expected pollutant loads and the effectiveness of the proposed water treatment measures. The catchment was broken up into different areas depending on the surface type, including:

- Roofs areas (measured directly off concept design plans) were modelled as “Roof” nodes with 100% impervious area;
- Courtyard areas for the ground floor apartments and villas (measured directly off concept design plans) were modelled as “Residential” nodes with an assumption of 50% impervious area;
- Road areas (measured directly off concept design plans) were modelled as “Sealed Road” nodes with 100% impervious area;
- “Forecourt” areas (i.e. the large paved areas in front of and between the buildings), together with facilities such as the tennis court and impervious areas around the swimming pools, (measured directly off concept design plans) were modelled as “Sealed Road” nodes with 100% impervious area. Note that the swimming pools themselves were excluded from the model, as these typically overflow to the sewer network;
- Remaining urban pervious areas were modelled as “Residential” nodes with 10% DCIA to account for any additional sheds, paths, landscaping, paved courtyards etc that may be connected to site drainage.

As the layout is only at the concept stage, various treatment scenarios were modelled to determine a viable solution that is capable of meeting the required targets for a development of this scale. Modelled treatment nodes include:

- Rainwater tanks:
    - It was assumed that roof water from each of the 20 villas would drain to individual 2kL rainwater tanks for reuse. Captured water from these tanks has been modelled for reuse in toilet and laundry only. Tank water reuse rates were adopted for a dwelling with two occupants from Table 3-12 in the 2010 Draft NSW Music Modelling Guidelines – an internal water reuse rate of 0.25kL/day/dwelling and zero external reuse (in recognition of the nature of the villas, with no individual external gardens). It has been assumed that 100% of the roof areas of the villas will be connected to the tanks;

  - It was assumed that large scale rainwater tanks would be included in each of the 10 apartment buildings (e.g. as a communal tank in the basement or carpark of each unit). Captured water from these tanks has been modelled for reuse in toilet and laundry only. Tank water reuse rates were adopted from Table 3-12 in the 2010 Draft NSW Music Modelling Guidelines (dependent upon the number of bedrooms in each apartment) – each two-bedroom apartment was assumed to have two occupants (an internal water reuse rate of 0.25kL/day/dwelling) and each three-bedroom apartment (including penthouses) was assumed to have three occupants (an internal water reuse rate of 0.36kL/day/dwelling). There was no external reuse modelled for these tanks (in recognition of the nature of the apartment buildings, with no individual external gardens). It has been assumed that 100% of the roof areas of the apartments will be connected to the tanks. Various sizes were modelled to determine a scenario that provides a viable option in conjunction with the rest of the treatment train.

- A biofiltration system has been modelled, including a 0.3m detention depth and 0.4m filter depth. Various configurations were modelled to determine a scenario that provides a viable option in conjunction with the rest of the treatment train.

It was determined that the following treatment train will provide a viable option for the concept design layout:

- 2kL rainwater tanks on each of the 20 villa buildings (100% roof area captured) with reuse as described above;
- 25kL rainwater tanks on each of the 10 apartment buildings (100% roof area captured) with reuse as described above;
- A biofiltration system with a filter media area of 189m^2, total footprint of 576m^2, surface area (for modelling purposes) of 381m^2, detention depth of 0.3m and filter depth of 0.4m and treating runoff from the following source nodes:
  - Road areas;
  - Forecourt areas (together with the tennis court and impervious areas around swimming pools);
  - Courtyard areas (for the ground floor apartments and villas); and
  - Rainwater tank overflows.

Such a biofiltration system could be incorporated into the design as a series of 'roadside' biofilters, and the relative dimensions of the modelled biofilter assume this to be the case (total footprint of 160m length and 3.6m width). Other configurations of 'roadside' biofilters could also achieve the targets (such as a longer yet narrower biofilter). Note that it is not necessary for the biofilter to be a single unit – several smaller, separate biofilters could also achieve the same result. It should also be noted that a single large biofilter could also achieve the required reduction targets, and the relative areas of filter media and total footprint would depend on the geometry of the design.

The figure below shows the layout of the model:

Figure 5: Proposed Development (Concept Design) MUSIC Model

10.2.5 COMPARISON OF POLLUTANT RESULTS

The pollutant sources (i.e. if the development was to proceed without any treatment train) were compared to the residual pollutant loads (i.e. post-treatment, using the treatment train described on the previous pages) are compared in the table below to ensure that the Stormwater Quality Targets have been met.

Table 4: Comparison of Pre and Post-Development Pollutant Loads

	Sources	Residual	% Reduction	Target	Compliance
TSS (kg/yr)	4310	736	82.9%	80%	Yes
TP (kg/yr)	9.46	3.79	60%	60%	Yes
TN (kg/yr)	68.7	29.1	57.6%	45%	Yes
GP (kg/yr)	699	52.3	92.5%	90%	Yes

11.0 COSTS

All stormwater infrastructure will be installed by the developer and will remain in private ownership for the life of the development. As no costs are to be incurred by Council, a detailed analysis has not been provided in this report.

12.0 OPERATION AND MAINTENANCE PLAN

As the design is at concept stage only, a specific plan regarding operation and maintenance has not been prepared. Such a plan would be included in a more comprehensive report at the Development Application stage.

13.0 CONCLUSIONS

While it is recognised that a standalone analysis of the land proposed to be rezoned (Lot 1 DP 1234229) would prove that it is unrealistic to achieve the required runoff water quality targets, consideration of both Lot 1 DP 1234229 and Lot 1 DP 868540 together allows the opportunity to improve the water quality outcomes for the entire site.

The results derived from modelling procedures indicate that long term water quality and quantity constraints can be appropriately addressed in the proposed development, through the following measures:

- Implementation of 2kL rainwater tanks on each of the 20 villas, with captured water reused in the toilets and laundries of the villas;
- Implementation of 25kL rainwater tanks on each of the 10 apartment buildings, with captured water reused in the toilets and laundries of those apartments;
- Construction of a ‘roadside’ biofilter (or series of ‘roadside’ biofilters) of approximately $576m^2$ total footprint area (based on 3.6m width) or equivalent;
- Integration of infiltration systems in the ultimate development design to discharge treated stormwater from the site without increasing flows on adjacent lands.

Note that the rainwater tank sizes used for modelling purposes are the minimum required to meet the water quality targets (based on the concept layout). Larger tanks may be required to meet BASIX requirements.

14.0 <u>REFERENCES</u>

Draft NSW MUSIC Modelling Guidelines, 2010, BMT WBM

Music Version 5.0 User Manual, 2011, eWater

Policy 11: Land Development Guidelines, Section 13 Water Sensitive Urban Design, 2007, Gold Coast Council

Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, 2004, Fletcher et al

WSUD Engineering Procedures: Stormwater, 2005, Melbourne Water