26 November 2008

Ann-Maree Carruthers
Major Development Assessment
Department of Planning
23-33 Bridge Street
Sydney NSW 2001

Dear Ann-Maree,

Redlake Mixed Use Development at Tomago, NSW

Further to your e-mail of 21 October 2008, we have reviewed ADW Johnson's responses to queries raised by the Department of Planning about water management at the Redlake development at Tomago. Their responses indicate some improvements to the water management scheme, and they have provided information to address some of the gaps in the Environmental Assessment Report, however some concerns also remain.

The design of the infiltration area is a particular concern, and we have suggested how this could be modified during the detailed design to make it more robust. Our other major concern is that ADW Johnson still make a number of claims which aren't fully substantiated – for example, that there will be zero wastewater discharge from the development, and that the stormwater treatment wetlands will achieve 99.8% TSS removal, 98.7% TP removal and 98.3% TN removal. These appear to be very good results, however they are well beyond what could normally be achieved with the treatment systems proposed. On the basis of the brief concept design details presented in the Environmental Assessment Report, it is difficult to see how such ambitious outcomes will be able to be delivered through the detailed design, construction and operational stages of the project.

This letter summarises the key elements of the proposed water management scheme, and also includes the results of a simple cross-check on the likely water management outcomes. This assessment has indicated that while the scheme is unlikely to achieve a "no impact solution", the management measures proposed by ADW Johnson do have the potential to deliver a satisfactory water management outcome if they are designed and delivered well (Section 1 below).

We have also recommended a set of water management conditions to apply to the development, to help ensure that the concept design intent is realised through the detailed design, construction and operation process (Section 2 below).

Section 3 concludes with some general remarks about the approval process for water management elements in this type of project.

Please do not hesitate to contact me on 9331 1215 or alexa@equatica.com.au if you have any queries regarding this letter.

Regards

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1. SUMMARY AND REVIEW OF WATER MANAGEMENT STRATEGY

There are three key receiving water environments downstream of the proposed development site:

- The Tomago sand beds groundwater aquifer
- Kooragang wetlands
- The Hunter River (downstream of the Kooragang wetlands)

The following two sections look at the water management strategy upstream of the Tomago sand beds and the Kooragang wetlands/Hunter River. Section 1.3 looks at the overall water balance for the site.

1.1 Stormwater flows to Tomago sand beds

For 11.4 ha of the site which will drain to the Tomago sand beds, the stormwater treatment strategy is centred on a 1.3 ha infiltration area. A 7.25 ha hardstand area will drain to the infiltration area, with the only pre-treatment being gross pollutant removal. Rainwater tank overflows will also drain to the infiltration area.

Based on a total area of 11.4 ha, infiltration area of 1.3 ha and hardstand area of 7.25 ha, the roof area is estimated as 2.65 ha. This scenario was modelled in MUSIC to check how the infiltration area would behave. In MUSIC, 6-minute rainfall data for Sydney was used in place of data for Williamtown. This should only have a very small impact on the results, as rainfall is very similar between these two locations, as shown in Figure 1.

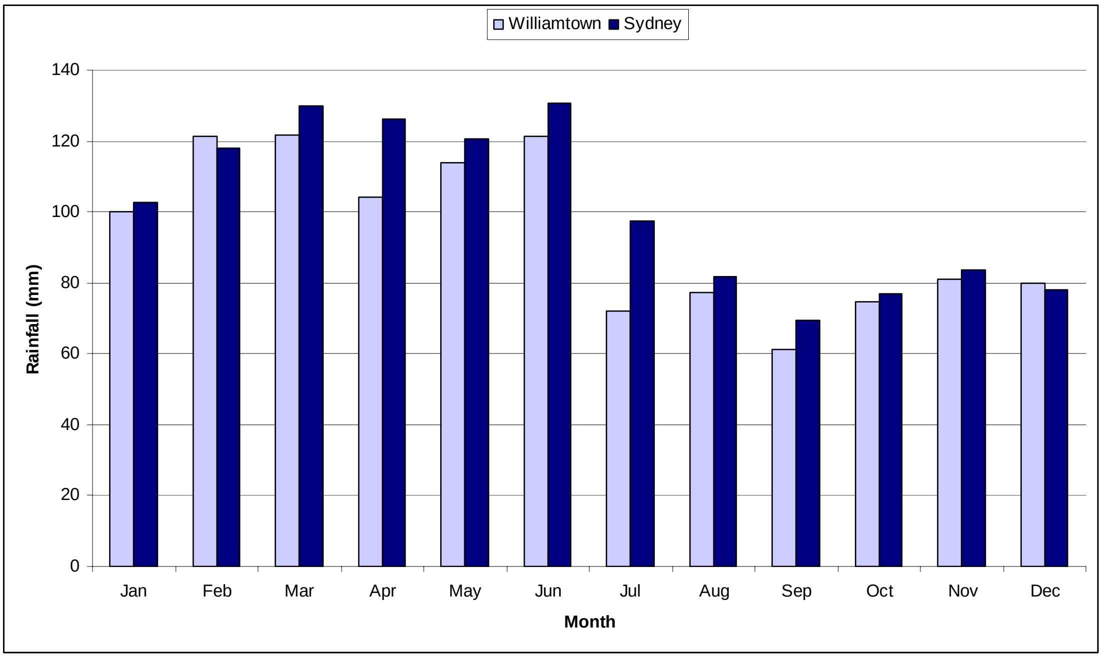

Figure 1: Mean monthly rainfall comparison for Williamtown and Sydney

The results showed that:

- Assuming a hydraulic conductivity of 180-360 mm/hr (typical for sand), the infiltration area would be able to accept all of the flows from its catchment (i.e. no overflow would occur)
- Even if the hydraulic conductivity is as low as 100 mm/hr, overflows would be very rare

Therefore the infiltration area is appropriately sized, however the lack of pre-treatment is still a significant concern. Blockage is the key management issue in this type of system. If the surface of the system is not maintained, fine sediment can build up, or a biological surface crust can form over time. Figure 2 shows a similar infiltration basin on sandy soil, where moss on the surface indicates that a surface crust is forming.

Figure 2: Infiltration basin on sandy soils (Salt development, Kingscliff NSW)

In addition, the infiltration area cannot be expected to behave like a bioretention system, as bioretention systems are designed with a specific soil media with a defined particle size distribution and hydraulic conductivity (see FAWB's specifications, available for download from: http://www.monash.edu.au/fawb/publications/). The in-situ soils are likely to have a much higher hydraulic conductivity. This allows a high throughput, but reduced residence time and correspondingly reduced treatment performance. It also includes a deep extended detention (up to 1.3 m). This depth is a concern because it will:

- Cause compaction of the soils, reducing hydraulic conductivity
- Allow fine particles to settle in the extended detention (as in a sediment basin) accelerating surface clogging
- Limit vegetation growth (as few plants will survive such deep inundation). This is important because vegetation plays a key role in pollutant removal.

In addition, the depth to the groundwater table beneath the infiltration area is only approximately 0.5 m. There is a risk that the infiltration system may cause local mounding of groundwater levels, bringing the groundwater above the surface in the infiltration area. The current concept design is therefore at high risk of failure during the operation stage.

Hunter Water has indicated that groundwater from this site is not likely to flow towards their water extraction points; however stormwater infiltration may affect other existing or future users, or groundwater-dependent ecosystems.

The infiltration strategy would be improved with the following additional investigations and design modifications:

1. A geotechnical investigation to provide more detailed information on the soil and groundwater properties within and down-gradient of the infiltration area. This should include the establishment of groundwater monitoring wells which would remain in place post-development.
2. Incorporation of additional pre-treatment to protect the infiltration area from high sediment loads, and ensure that the water which enters the sand beds aquifer is of reasonable quality (see further comments below).
3. Re-design of the infiltration area to reduce the extended detention depth, but allow some overflows in large storm events (see further comments below).

A suggested target for pre-treatment is that stormwater flows should meet DECC's draft pollutant load reduction targets (85% reduction in total suspended solid loads, 65% reduction in phosphorus loads and 45% reduction in nitrogen loads) prior to entering the infiltration system. This is not an onerous requirement – basic MUSIC modelling indicates that a bioretention system of approximately 1,500 m^2, including 0.2 m extended detention and a 0.6 m filter, could meet these targets for the subject catchment. This represents only 12% of the infiltration area.

In terms of the extended detention depth, a suggested maximum is 0.3 m. MUSIC modelling shows that with this extended detention depth, 99.6-99.9% of mean annual flows would infiltrate to the sand beds and 0.1-0.4% would overflow (the ranges representing infiltration rates of 180-360 mm/hr). Therefore there is no need to use a greater depth. Minimising the depth should also allow the design to incorporate a greater buffer between the surface level of the infiltration system and the groundwater table below.

1.2 Stormwater flows to Kooragang wetlands and Hunter River

For the 130 ha of the site which will drain to the Kooragang wetlands, the stormwater treatment strategy involves swales to convey stormwater flows through the development, and wetlands at the downstream end. The proposed wetland area is 13 ha. As indicated by ADW Johnson, the wetland area is larger than that typically required to meet DECC's draft pollutant load reduction targets. However the performance of the stormwater treatment train has been overstated in their report and correspondence.

A MUSIC model was set up for the post-development scenario as described in the EAR:

- Total area of 129.9 ha, including 115.4 ha catchment, 1.5 ha swales and 13 ha wetlands
- Road area – 20% of catchment (23.08 ha)
- Lot area – 80% of catchment (92.32 ha), including:

- o 75% roofs (69.24 ha)
  - o 20% hardstand (18.464 ha)
  - o 5% pervious area (4.616 ha)
- The 13 ha wetland area was divided into 1.3 ha inlet pond and 11.7 ha macrophyte zone
- The 1.5 ha swale area was modelled as 890 m long, as the EAR (Volume 4, Figure 6) shows approximately this length of swales upstream of the wetlands

The model was based on 6 minute rainfall data and monthly potential evapotranspiration data from Sydney. Sydney data is considered reasonable for this site, as discussed above. The results are summarised in Table 1. Note that the results which exclude infiltration are more realistic for this site, as the soils have been described as "waterlogged".

Table 1: Expected stormwater quality outcomes from the swales + wetlands

Scenario:	Excluding infiltration	Including 0.36 mm/hr infiltration from wetlands and swales, as assumed by ADW Johnson
Inflow (ML/year)	1,280	1,280
Outflow (ML/year)	1,100	795
% reduction in flow	14.4%	37.8%
% reduction in total suspended solids (TSS) loads	90.9%	92.2%
% reduction in total phosphorus (TP) loads	72.4%	78.6%
% reduction in total nitrogen (TN) loads	57.9%	67.6%

These results are not as good as those stated in the EAR, but are in excess of the targets recommended by DECC and therefore the proposed stormwater treatment strategy is suitable for the site.

1.3 Water balance

ADW Johnson has reiterated that the site water management scheme will achieve the same water balance outcome pre- and post-development, including:

- Zero wastewater discharge from the WesTrac site
- Equivalent infiltration to the Tomago Sand Beds
- Closely equivalent annual stormwater runoff volumes to the Kooragang wetlands

The Westrac wastewater treatment plant throughput has been estimated at 35 kL/day (Environmental Assessment Report Appendix F), and it will all be used for irrigation of a 1.5 ha area. This would require an average application rate of 2.3 mm/day or 850 mm/year. This is a relatively high application rate for the site's waterlogged soils, but could be feasible if adequate topsoil is provided and suitable vegetation is planted. Salt accumulation and nutrient leaching are both key risks. Storage will be important to store water when irrigation rates are limited (e.g. in wet periods and over winter). ADW Johnson has not indicated whether storage has been considered.

Council's consent conditions for the wastewater treatment system are quite comprehensive, which should help ensure that potential issues associated with effluent irrigation are picked up during the detailed design stage. However it would also be prudent to refer to DECC's "Environmental Guidelines: use of effluent by irrigation" (available for download from http://www.environment.nsw.gov.au/mao/effluentreuse.htm) for information on specific design considerations for an effluent irrigation scheme.

The infiltration to the Tomago sand beds should be able to meet pre-development rates, providing that mounding is not an issue and that the infiltration capacity is maintained in the infiltration area. Water quality is the main concern here, as discussed above.

It is unlikely that the runoff volumes to the Kooragang wetlands will remain as low as the existing situation, as the water balance here involves some optimistic assumptions (as outlined in ADW Johnson's responses to the Department of Planning):

- The potential evapotranspiration (PET) rate quoted by ADW Johnson is 1,731 mm/year, which is very high for the central NSW coast. 1,731 mm/year is more typical of Rockhampton than Tomago. The Bureau of Meteorology's areal PET map for Australia is shown in Figure 3 and shows that the PET at the site is between 1,300 and 1,400 mm/year (note that the PET values in MUSIC should be areal PET rather than point PET). Evapotranspiration losses are therefore overestimated.
- ADW Johnson has assumed that seepage (infiltration) will occur from both the swales and the wetlands at 0.36 mm/hr. Given that the lower parts of the site (where the wetlands will be located) are described as "waterlogged, generally covered with standing water" (EAR Appendix F, Vol 1, p.4) it is not reasonable to assume that any infiltration will occur from the wetlands. Wetlands are in fact usually designed to retain water, to avoid management issues associated with widely fluctuating water levels. Infiltration from the swales will also be minimal, as the swales should only contain water for a brief period during runoff. Seepage losses are therefore also overestimated.
- Substantial rainwater demands are assumed for the industrial subdivision, but rainwater demands are difficult to predict without any details on the type of industry. Many industrial sites have very low water demands, e.g. warehousing operations. Assumptions about rainwater demands and rainwater tank sizing have been compared in Table 2 for the Westrac site and the industrial subdivision. On a per hectare basis, the industrial subdivision is expected to have much higher rainwater demands and much larger rainwater tanks than the Westrac site. In the absence of information about the nature of the future development in the industrial subdivision, these assumptions are unreasonable.

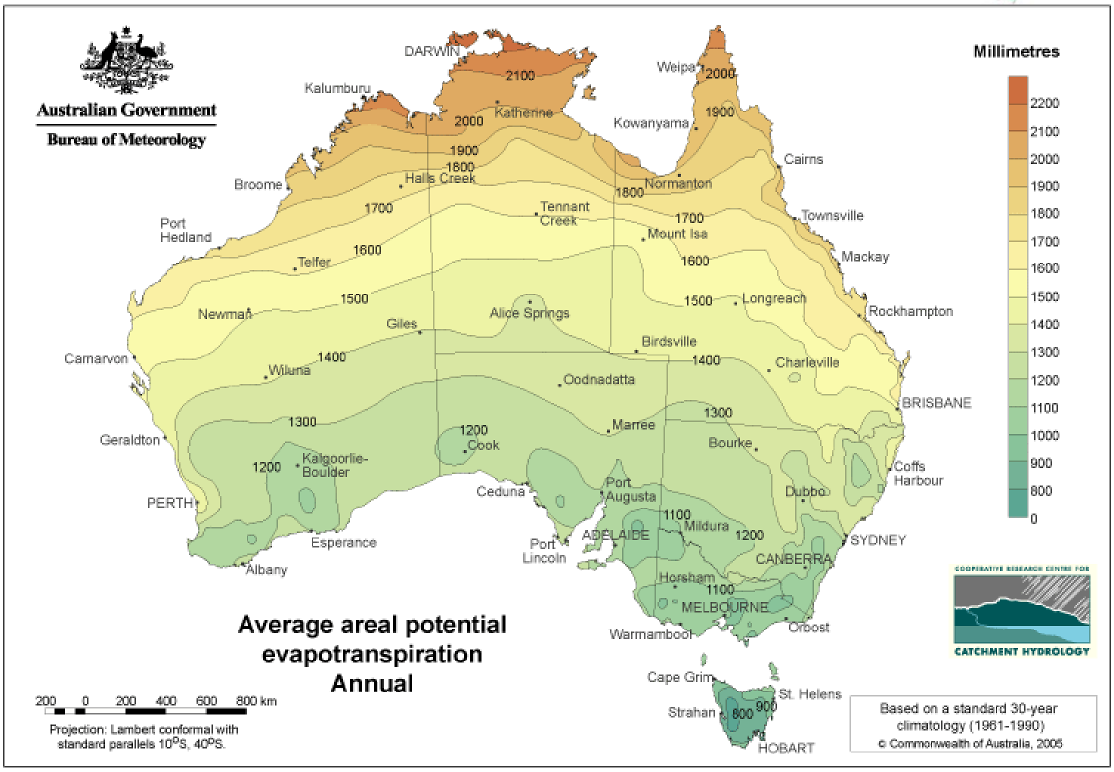

Figure 3: Areal potential evapotranspiration across Australia (Bureau of Meteorology)

Table 2: Rainwater demands and tank sizing

Site:		Westrac	Typical 0.5 ha lot in the industrial subdivision
Area (ha)		26	0.5
Rainwater tank volume	Total volume (kL)	1,000-5,000	250
	Volume per unit area (kL/ha)	38-190	500
Rainwater demands	Total demand (kL/day)	32.5	6
	Demand per unit area (kL/ha/day)	1.25	12
Key references		EAR Appendix F, Volume 3, Table 7	EAR Appendix F, Vol 4, p.9

A simple MUSIC model with 1271 mm/year PET, excluding rainwater tank demands and excluding infiltration indicates that the swales and wetlands (13 ha) would only reduce site runoff by approximately 14% (see results in Table 1). If the site runoff is 973 ML/year (as estimated by ADW Johnson), it would be reduced to 837 ML/year.

This change in annual runoff volumes is not necessarily a bad outcome for the site – an increase in annual runoff is almost impossible to avoid when a site is developed. A concern arises here because there is a potential impact on the SEPP14 and RAMSAR listed wetlands downstream. Wetlands are sensitive to the frequency and duration of low and high flow spells, rather than the total annual runoff volume. The development has the potential to increase the frequency and duration of inundation in the wetland, and this change to the hydrologic regime can have a significant impact on wetland processes and ecosystem function. As noted by ADW Johnson, the presence of drainage lines through the wetlands should minimise the impact of increased post-development flows, however this requires further investigation at the detailed design stage, including the following investigations:

- Developing a good understanding of the hydrologic regime in the wetlands downstream, and considering how the hydrologic regime will potentially be impacted by the development. The HCCREMS' "WSUD solutions for catchments above wetlands" guideline provides a framework for this analysis, which is likely to involve:
    - An ecosystem assessment to determine appropriate ecosystem health objectives. A key part of this assessment should be an assessment of the downstream wetland's hydrologic regime.
    - Modelling of the stormwater drainage channels to understand their capacity to contain post-development flows under a range of tidal conditions
    - Monitoring of water levels in the wetland using a sufficient number of water level monitoring stations to give accurate coverage.
    - Monitoring of local catchment surface inflows to the wetland to determine the response of the wetland to the local catchment flows.
- Designing controls for the site to ensure that the wetland inundation regime will not be substantially altered by the development.

2. RECOMMENDED DEVELOPMENT CONDITIONS

2.1 Construction stage conditions

As outlined above, the main concern with the proposed water management strategy is that it won't be able to achieve the results outlined in the Environmental Assessment Report. However with some minor modifications and more detailed analysis, it should be able to meet DECC's pollutant load reduction targets as well as the hydrology objectives in HCCREMS' "WSUD solutions for catchments above wetlands" guideline. Council's proposed conditions ensure that stormwater drainage and flooding requirements are clear. Some additional conditions are suggested for the stormwater management scheme, to ensure that water quality and hydrology objectives are also clear:

- Demonstrate that DECC's pollutant load reduction targets (TSS – 85%, TP – 65% and TN – 45%) will be met upstream of any point where stormwater is discharged to a receiving environment (including upstream of the sand beds infiltration area)
- Demonstrate that downstream of the infiltration area, the Tomago sand beds can accept stormwater flows without significant impacts on groundwater levels or water quality
- Demonstrate that the site stormwater management strategy will protect the Kooragang wetlands from changes in the hydrologic regime

2.2 Operation stage conditions (monitoring)

Section 1 discussed the establishment of a groundwater monitoring scheme for the Tomago Sand beds and a water level/hydrology monitoring scheme for the Kooragang wetlands. These schemes should commence before development and continue post-development to provide information on potential and actual impacts on these two key receiving environments. Once it is established that the development is not having an impact on these environments, these monitoring schemes could be concluded.

Monitoring of specific stormwater treatment systems is difficult, as parameter concentrations can vary widely in grab samples. Random grab samples of inflows and outflows are of little value in determining treatment system performance. To get an accurate picture of treatment system performance, in terms of pollutant load removal, requires a substantial monitoring effort, including:

- At least 30 to 50 storm events
- Within each event, continuous monitoring of flows and regular samples (e.g. using an autosampler) are required over the whole duration of the event
- Inflows, outflows and bypass flows should all be monitored
- Analytes should include TSS, TP and TN at a minimum. Heavy metals and pathogens may also be included

This type of monitoring costs in the order of $75,000 to 100,000 per treatment device (for 30-50 events), which is a reasonable investment for a site of this scale. This sort of monitoring should be undertaken following stormwater treatment system establishment, to verify that the treatment systems are operating as expected.

The function of stormwater treatment systems should also be monitored as part of the operation and maintenance regime. Key attributes to check are:

- Vegetation health (periodic weeding and re-planting may be required)
- Scour and erosion
- Build-up of sediment and debris at inlets and outlets
- The rate of drawdown of the extended detention after a rain event. In a wetland this will indicate whether the design hydraulic retention time (e.g. 72 hours) is being achieved. In a bioretention or infiltration system, it will indicate whether the hydraulic conductivity is reducing due to clogging, compaction or surface crusting
- In bioretention systems, hydraulic conductivity can also be tested during dry weather via an in-situ infiltration test

Suggested monitoring requirements for the operation stage are therefore as follows:

- A groundwater monitoring regime shall be designed and implemented for the Tomago sand beds, to ensure that the development will not impact on groundwater levels or water quality in the aquifer.
- A water level and flow monitoring regime shall be designed and implemented for the Kooragang wetlands, to ensure that the development will not impact on wetland hydrology in the area downstream of the site.
- Following the completion of the development and establishment of the stormwater treatment systems, load-based monitoring shall be undertaken to confirm that the stormwater treatment systems are meeting their design intent.
- Stormwater treatment systems shall be regularly maintained to ensure they continue to operate as designed. Routine maintenance activities shall include weeding and replanting, removing sediment and debris, checking for and repairing scour and erosion and checking the rate of drawdown after rain events.

3. COMMENTS ON THE APPROVAL PROCESS FOR WATER MANAGEMENT ELEMENTS

Our investigations for this project have highlighted some broader issues with the approval process for water management elements within developments – particularly those developments upstream of sensitive aquatic environments. These issues go beyond the Redlake project at Tomago, but are raised here as points for future consideration:

- NSW lacks clear planning controls for developments upstream of sensitive receiving waters (such as wetlands). e.g. SEPP14 focuses on direct impacts and says nothing about impacts arising in a wetland's catchment
- Existing water management guidelines are relatively new and not yet applied consistently
- When a proponent makes unreasonable claims about what their water management strategy will achieve, it is not easy to check these claims without a detailed independent technical review
- After development conditions are applied, unless there is follow up assessment of their implementation, the good intent of a concept design can be eroded during the detailed design, construction and operation stages.

As discussed, we will follow up this report with some further thoughts on options to address these challenges.