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28 October 2011

Dear Murray

Royal Randwick Racecourse
Spectator Precinct - DGR Report - Randwick racecourse_spectator_sept2010 Issue

As part of the Spectator Precinct 75w planning process Arup have been asked to review the current architectural documents listed below and advise the impacts to the recommendations made within the above DGR report.

The buildings form essentially remains the same although it has shortened a little.

| Title | Number | Rev |
|----------------------------------|--------|-----|
| Existing Roof Plan | DA-05 | B |
| Proposed Roof Plan | DA-06 | B |
| Proposed Site Plan | DA-07 | B |
| Proposed Site Elevations | DA-08 | B |
| Previous DOP Scheme Overlay | DA-09 | B |
| Grandstand Basement 1 | DA-10 | B |
| Grandstand Ground | DA-11 | B |
| Grandstand Level 1 | DA-12 | B |
| Grandstand Level 2 | DA-13 | B |
| Grandstand Level 3 | DA-14 | B |
| Grandstand Level 4 | DA-15 | B |
| Grandstand Level 5 | DA-16 | B |
| Grandstand Level 6 | DA-17 | B |
| Grandstand Level Plant | DA-18 | B |
| Grandstand Level Roof | DA-19 | B |
| QEII Section A-A (Existing) | DA-20 | B |
| QEII Section A-A (Demolition) | DA-21 | B |
| QEII Section A-A (Proposed) | DA-22 | B |
| Paddock Sect B-B & Link Sect C-C | DA-23 | B |
| Elevation NW-SE | DA-24 | B |
| Elevation SW-NE | DA-25 | B |

| | | |
|-------------------------|-------|---|
| Parade Ring Ground | DA-30 | B |
| Parade Ring Level 1 | DA-31 | B |
| Section A-A & B-B | DA-32 | B |
| Section C-C & D-D & E-E | DA-33 | B |
| View Analysis – V2 | DA-52 | B |
| View Analysis – V3 | DA-53 | B |
| View Analysis – V4 | DA-54 | B |
| View Analysis – V6 | DA-56 | B |
| View Analysis – V7 | DA-57 | B |
| View Analysis – V8 | DA-58 | B |
| Cut & Fill Plan | DA-60 | B |

Having reviewed the above documents we confirm that the new building configuration does not alter the recommendations made within the original DGR report and no amendments are required to the report.

Yours sincerely



Carly Waterhouse
Hydrogeologist

Australian Jockey Club

Spectator Precinct

Ground water Management, Ground
Water Dependant EcoSystems

ISSUE | September 2010

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This report takes into account the particular
instructions and requirements of our client.




It is not intended for and should not be relied
upon by any third party and no responsibility is
undertaken to any third party.

Job number 220759

ARUP

Document Verification

ARUP

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| Document ref | | 20759 | | | | | |
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| | | Signature | | | | | |
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Issue Document Verification with Document



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1 Executive summary

This report has been produced in response to the Director Generals Part 3A Planning requirements MP 10-0097 for the refurbishment of the Spectator Precinct on the Western side of the Royal Randwick Racecourse property.

It addresses groundwater management and use across the Spectator Precinct and specifically responds to:

DGR-10:

The Environmental Assessment (EA) must address the following key issues:

- *Identify groundwater issues and potential degradation to groundwater sources and identify mitigation measures required to remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent **groundwater environment** or water uses.*
- *Provide details of the presence and distribution of Groundwater Dependent **Ecosystems** in the vicinity of the site and identify any potential impacts as a result of the proposal, and any mitigation measures required to address identified impacts.*

Appendix B item 13:

The following relevant documentation shall be submitted:

- *Identifying groundwater issues and potential degradation to the groundwater source that may be encountered during excavation. The assessment should identify contingency measures to manage any potential impacts.*

Principle receptors comprise the pristine groundwater in the Botany Bay Sandstone aquifer. A Groundwater Dependent Ecosystem (GDE) has been identified, however this is 2km away and therefore the aquifer itself is the nearest and most vulnerable receptor.

In conclusion the abstraction of groundwater during construction, and the recharge of stormwater post development are considered to have minimal impact to groundwater and ecosystems.

Several mitigation measures have been proposed to manage the risk of contaminant migration into the aquifer during construction, and following completion of the works. Implementation of these measures will ensure that the impact of the development on the Botany Bay Sands aquifer is controlled.

2 Introduction

The redevelopment of the existing Spectator Precinct will see the existing Queen Elizabeth II Grandstand refurbished and construction of a new Paddock Grandstand including basement levels, a new parade ring and spectator amenities such as Kiosks and landscaped areas.

Aspects of the proposed refurbishment of the Spectator Precinct which are relevant to potential groundwater issues includes:

- A new stand with basement areas of several metres depth, with RL26.5m in some places, part of the main service corridor will be at RL24.5m.
- The parade ring will involve an excavation of 4m depth.
- A tunnel for the passage of horses will be constructed from the parade ring to the existing track and will have a base level of RL27.5m.
- Slight increase in permeable area to 14,759m² due to the increase of soft permeable landscaping.

The site overlay below shows the Spectator Precinct's location on the site adjacent to the intersection of Alison Road and Doncaster Avenue.

The NSW Government Department of Planning have stipulated that a Environmental Assessment (EA) must address the following key groundwater issues:

- Identify groundwater issues and potential degradation to groundwater sources and identify mitigation measures required to remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent groundwater environment or water uses.
- Provide details of the presence and distribution of Groundwater Dependent Ecosystems in the vicinity of the site and identify any potential impacts as a result of the proposal, and any mitigation measures required to address identified impacts.

These issues form the objectives of this assessment.

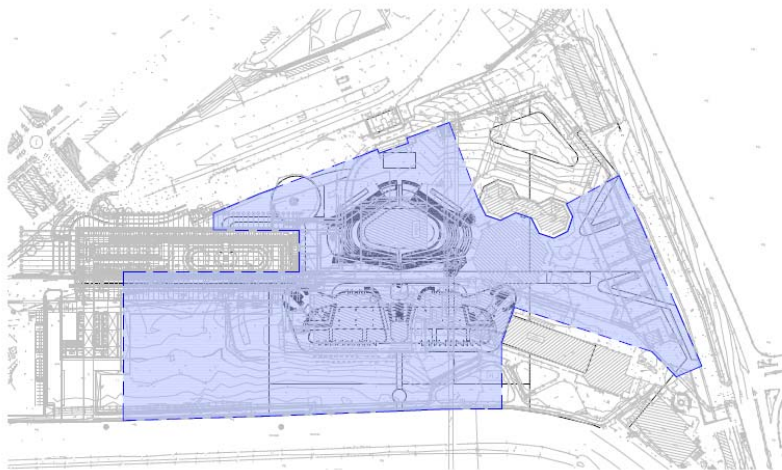


Figure 1 Spectator precincts location

3 Ground Conditions

3.1 Geology

The 1:250,000 Sydney Geological Map [5] indicates that the site is underlain by quaternary deposits of alluvium, gravel, sand, silt and clay (Botany Beds) overlying the Hawkesbury Sandstone bedrock. This has been confirmed by a recent site investigation by Douglas and Partners [2].

The geology of the site is summarised in Table 1 below:

| Strata | Depth to top of strata(m) | Thickness of strata (m) |
|----------------------|---|-------------------------|
| Fill | 0 | 1-3 |
| Botany Sand Beds | 1-3 | <35 |
| Hawkesbury Sandstone | Approx. 30m in the area of the existing grandstands | Unknown |

3.1.1 Fill

Filling materials mainly comprise sand with varying proportions of sandstone, concrete and other rubble material [3]. Fill depth is usually between 1 and 3m, with the greatest thickness of filling generally located in the area of the existing grandstands and raised lawn viewing areas [3].

In recent investigations in the stands area and parade ring area, Cone Penetration Tests (CPT) encountered shallow depths of filling with a thickness of 0 to 0.74m [2].

3.1.2 Botany Sand Beds

Randwick Racecourse is located within the Botany Basin. The Botany Basin is a sediment filled topographic depression, lying between Port Jackson and Port Hacking.

During the Tertiary geological period, a system of steep sided valleys (palaeochannels) were eroded into the Hawkesbury sandstone. These valleys were filled during the Quaternary geological period with approximately 30 m of unconsolidated Aeolian sands, incalated with minor clay and peat deposits. These deposits form the Botany Sand Beds.

The Botany Sand Beds consist of fine and medium grained sands of marine origin. They often contain minor layers or lenses of peat or silty clay.

In the stands and parade ring areas, these deposits have been proved to a depth of 18m [2]. It was noted that the upper 3 to 4m of the sand profile is typically loose and loose to medium dense. The sand density increases with depth.

3.1.3 Hawkesbury Sandstone

The Botany Sand beds are underlain by the Hawkesbury Sandstone. This outcrops to the east of the site, east of Randwick [5].

Bedrock comprising weathered sandstone has generally been encountered at depths ranging from approximately 5m at the southern end of the racecourse precinct, to about 30m in the area of the existing grandstands [3].

3.2 Hydrogeology

There are two aquifers underlying the site, these are:

- The Botany Sand Beds
- The Hawkesbury Sandstone

Due to relatively shallow workings at the Randwick Racecourse site and the depth to the Hawkesbury Sandstone (>30m) beneath the Spectator precinct, the potential degradation risk to groundwater within the Hawkesbury Sandstone is considered minor as compared to groundwater in the Botany Sand Beds. This assessment therefore takes a tiered approach to risk assessment, and will assume the maximum risk to the Hawkesbury Sandstone will be less than or equal to the Botany Sand Beds.

3.2.1 Aquifer Properties

The Botany Sand Beds are an unconfined aquifer system. They are bound to the west by thick clay deposits and to the east by rock outcrops of the Hawkesbury Sandstone.

The aquifer is generally considered highly vulnerable to contamination due to the permeability of the sands and the generally shallow water table. The NSW Government is continuing its management of groundwater use in areas that sit above the Botany Sand Beds aquifer. A precautionary approach was adopted as a number of contaminated sites have resulted in the contamination of groundwater in the aquifer and there has been an increase in groundwater use in the area.

Recharge to the aquifer occurs in the elevated region around Centennial Park and Moore Park to the north of the site.

A summary of the Botany Bay Sands aquifer properties can be found in Table 2 below:

| Parameter | Value |
|--|--|
| Aquifer thickness | <35m [1] |
| Saturated aquifer thickness | 15-20m [3] |
| Yield | 1-41 L/sec (ave 5 L/s) [1] |
| Depth to water table | 0-35m av <5m [1] |
| No. of Licensed Abstraction Points (98/99) | 491 [1] |
| No. of Licenses (98/99) | 430 [1] |
| Porosity | 0.25 to 0.3 [1] |
| Hydraulic conductivity | 20m/day (clean sands), 5-10m/day (silty or peaty sands), less than 4m/day (sandy peat or clay) [3] |
| Infiltration rates | 10 ⁻⁵ m/s (flat grassed area) [4] |

3.2.2 Groundwater Levels

Groundwater monitoring of the Botany Sand Beds has occurred in the past in and around the Randwick Racecourse area although it is sporadic. Some groundwater monitoring has occurred with the recent ground investigation though the sampling method is not considered particularly reliable (groundwater levels were measured in CPT holes) [2]. However, it is considered that the monitoring undertaken to date is adequate at this stage and further monitoring may be required in the future.

Groundwater levels vary between 26.2 to 26.7mAHD in the vicinity of the Spectator Precinct (2.9 to 5.9 mbgl).

Groundwater flow is generally from north to south, and south-easterly towards Alexandra Canal, the main surface water systems within the bay (Figure 2). The groundwater table is considered to be generally shallow with a moderate gradient of 40m in 8km (0.05) [1].

Groundwater levels fluctuate over time in response to recharge, groundwater pumping and where the water table is shallow, due to evaporative transpiration losses [1]. Variations of up to 2m due to long-term seasonal, climatic, well pumping and other factors have been reported [3].

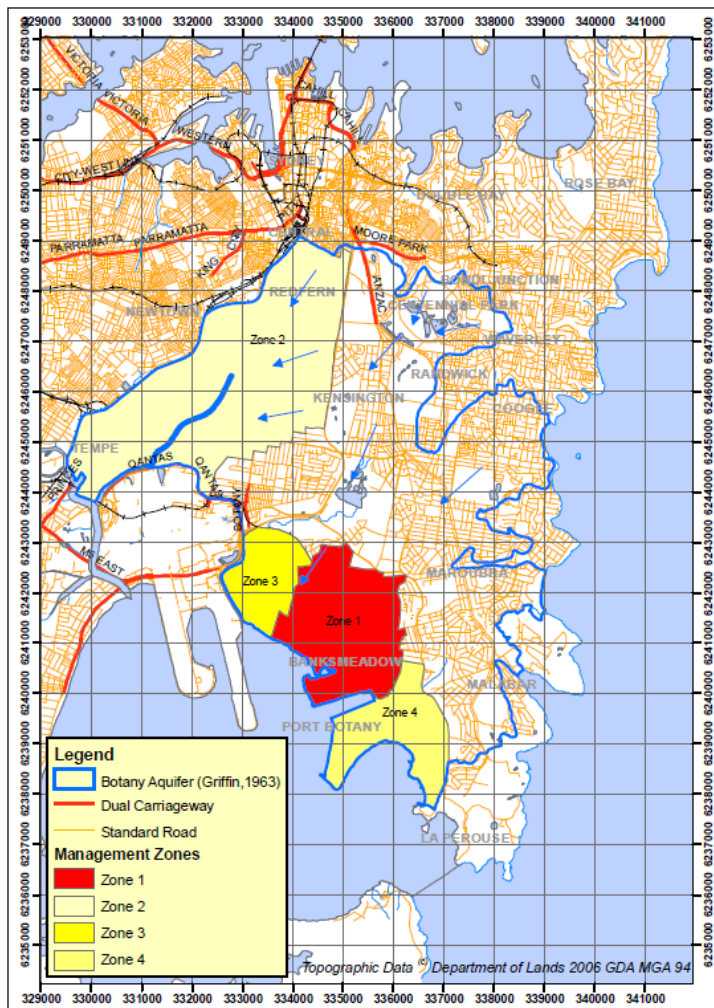


Figure 2 Groundwater management zones and flow directions

3.2.3 Abstractions

The aquifer is widely used for groundwater abstraction with up to 500 groundwater abstraction points (1998/1999). Extracted groundwater is used for industrial, domestic and irrigation purposes. Groundwater is extracted at the racecourse for irrigation [3].

Currently 28% of the Botany Aquifer is subject to a ban on domestic groundwater use and an abstraction exclusion area has been declared for about 9% of the aquifer (Zone 1 in red on Figure 2). This is due to the presence of contamination in this area.

Excellent quality low salinity groundwater resources are available in the north-east of the aquifer in the suburbs of Randwick. Available water in this area generally complies with drinking water standards with the exception of iron, and bacterial indicators. Degraded water quality near the top of the watertable and where fertilizers are applied (e.g. Randwick race course, golf courses) and for a full range of water parameters is yet to be assessed.

3.2.4 Groundwater Dependent Ecosystems

A report produced in 2006 investigating the Botany Bay Sands Beds, published by the National Water Commission, identified that there is a lack of scientific information regarding local groundwater dependent ecosystems [1].

The area immediately surrounding the site (<2km) is dominated by residential and commercial development. An initial study has been undertaken to identify the locations of possible Groundwater Dependent Ecosystems (GDE) using satellite imagery of the area. Potential nearby GDE's, and their potential connection with groundwater in the Botany Bay Sand Beds beneath the site is summarised in the table below.

| Name | Distance from site | Hydrological connection to the site | Risk Rating |
|--------------------------|--------------------------------------|--|-------------|
| Centennial Park Ponds | 150m north of the Spectator Precinct | Natural flow gradients drive groundwater from Randwick Racecourse, in the opposite direction to Centennial Park. (i.e. to the south/south-east). Centennial Park Ponds are therefore located up gradient of the site. Furthermore water within these ponds drain into the aquifer, rather than water from the aquifer recharging the ponds [1]; | No risk |
| Glebe Gully Reserve | 1.1km east of the Stables Precinct | There is no hydraulic connection between the groundwater beneath Randwick Racecourse and that beneath the Glebe Gully Reserve. The GGR is located within a separate groundwater catchment area on the Hawkesbury sandstone. | No risk |
| Eastlake Golf Club lakes | 2.1km south of the Stables Precinct | The Eastlake Golf Club lakes are over 2km from the site. There is a potential hydraulic connection between the | Low |

| Name | Distance from site | Hydrological connection to the site | Risk Rating |
|------|--------------------|--|-------------|
| | | Randwick Racecourse and Eastlake Golf Club, as groundwater may migrate through the Botany Bay Sand Beds. | |

This is not an exhaustive list of GDE's surrounding the Randwick Racecourse site, though may be considered to represent the most significant GDE's within the vicinity of the development.

4 Impact Assessment

An assessment of the groundwater issues and potential degradation to groundwater sources both during and post-construction of the Spectator Precinct has been undertaken. For each issue the degree of risk has been assessed and mitigation measures have been proposed where appropriate.

4.1 During Construction

4.1.1 Migration of contaminants

During construction and renovation of the Spectator Precinct, there is a risk that contaminants migrate into the aquifer via runoff into the stormwater system which infiltrates the ground. Potential contaminants may include:

- Hydrocarbons from fuel stored on site or from refuelling vehicles;
- Suspended sediments; and
- Other potentially hazardous chemicals stored on site associated with building works

The NSW State Groundwater Quality Protection Policy (DLWC, 1998) stipulates that groundwater quality should be protected so that beneficial use is not downgraded. Given that the site overlies a particularly pristine and uncontaminated portion of the Botany Bay Sands aquifer, management of the potential contaminant risk is required.

Mitigation measures

Proposed mitigation measures include:

- The reconfigured stormwater system will remain offline until the system is complete and the site is sufficiently stabilised. Swale sand/metal pillows in geotextile fabric will cover any existing stormwater inlets and gully inlets to prevent runoff entering the system prematurely.
- All fuel or chemicals stored on site during construction shall be kept within bunded areas in double skinned containers.

4.1.2 Dewatering

The base slab levels of the basement and the tunnel range between 26.5m and 27.5mRL, and the base slab of the main service corridor will be 24.5mRL. These

levels are either below or just above the recently measured groundwater levels of 26.7mRL.

Localised dewatering will have to be considered for construction of these structures. This may include a trench or point source wells surrounding the proposed structures to produce a localised drawdown of 3m.

It is estimated that for a clean sand with a hydraulic conductivity of 20m/day, the radius of influence would be 90m (using Sidcardt's equation). The radius of influence comprises the distance from the pumped well (or dewatered trench) at which the drawdown of water level in the aquifer equals zero.

The risk of groundwater degradation due to dewatering is considered low due to the following:

- Because the total amount of dewatering required is just 3m, the radius of influence due to the pumping would not extend beyond the boundaries of the Randwick Racecourse, and therefore the only extraction that will be affected will be the Randwick Racecourse's own irrigation borehole;
- Pumping will only occur for a short period of time during construction. This is unlikely to be longer than a month. Groundwater levels are likely to recover quickly following cessation of pumping.
- Groundwater is currently extracted at the site for irrigation. Water pumped from the dewatering scheme, assuming that it remains untainted by the extraction process, shall be used to supplement the current extraction. The volume of water from the licensed extraction could therefore be reduced during this period limiting any affect on the groundwater resource.

No mitigation measures are required for dewatering impacts.

4.2 Post Construction

4.2.1 Stormwater Volumes

The existing Spectator Precinct stormwater drains by gravity through a series of surface inlet pits and piped below the race track level draining to the existing inner and outer detention/infiltration basins located in the south western corner of the property.

The proposed new development involves removal of some impervious areas, incorporating an equal or slightly greater area of soft permeable landscaping. This will result in additional localised aquifer recharge around the Spectator Precinct and reduced recharge volumes through the infiltration basins. The overall total volume of water infiltrating into the aquifer will not change therefore this is not considered to have an overall impact in terms of flow volumes.

4.2.2 Migration of Contaminants

It is possible that storm water may include contaminants mobilised from the hardstanding. Potential contaminants can include hydrocarbons from vehicle use within the Spectator Precinct and suspended sediments within the stormwater.

The NSW State Groundwater Quality Protection Policy (DLWC, 1998) stipulates that groundwater quality should be protected so that beneficial use is not downgraded. Mitigation measures are required and appropriate management of first-flush stormwater which can often contain high suspended solids and contaminant concentrations.

Mitigation measures

The current stormwater infiltration ponds are deemed sufficient to mitigate the risk of contaminants into the aquifer post-construction. The current stormwater system includes interceptor drains which intercept possible hydrocarbons or suspended sediments prior to reaching the infiltration ponds.

In addition, the north-eastern Botany Bay Sand aquifer is comprised mostly of quartz sand, the sediment would also contain trace quantities of iron minerals, silt clay and shell fragments. The sands would likely act as an effective filtration and attenuation medium for a range of constituents including trace metals and pathogens.

Therefore the risk to groundwater from potential contaminants within the stormwater flow is considered negligible.

5 Summary

Principle receptors comprise the pristine groundwater in the Botany Bay Sandstone aquifer. A GDE has been identified, however this is 2km away and therefore the aquifer itself is the nearest and most vulnerable receptor.

The abstraction of groundwater during construction, and the recharge of stormwater post development are considered to have minimal impact to groundwater.

Several mitigation measures have been proposed to manage the risk of contaminant migration into the aquifer during construction, and following completion of the works. Implementation of these measures will ensure that the impact of the development on the Botany Bay Sands aquifer is controlled.

References

- [1] Timms, W A, Acworth R I, Merrick N and Badenhop A M, 2006. Pre-feasibility assessment of managed aquifer recharge in the Botany Aquifer for the National Water commission, Technical report 2006/33, November 2006.
- [2] Douglas Partners, 2010. Report on Preliminary Geotechnical Assessment, Proposed development of Spectator Precinct Royal Randwick Racecourse, Randwick, Prepared for The Australian Jockey Club, Project 71976 September 2010.
- [3] Douglas Partners, 2007. Letter to Bligh Voller Nield Architecture. Previous geotechnical investigations at Royal Randwick Racecourse, November 2007.
- [4] Water Research Laboratory, 2007. Letter to Bligh Voller Nield Architecture, Preliminary comments – infiltration rates to the Botany Aquifer at Randwick Race Course.
- [5] 1:250,000 Sydney geological series Sheets S1 56-5