Bovis Lend Lease

Darling Walk

Dewatering Management Plan

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Bovis Lend Lease

Darling Walk

Dewatering Management Plan

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1 Introduction

1.1 General

Lend Lease Developments propose the redevelopment of the site currently occupied by Sega World in Darling Harbour, Sydney. The site is bounded by Harbour Street to the east, the Western Distributor to the north, the Darling Harbour Children's Playground and Tumbalong Park to the west and south west, and the pedestrian bridges linking Tumbalong Park and Liverpool Street to the south. The site is illustrated in Figure 1.

Bovis Lend Lease is the Main Contractor for the redevelopment. Arup have been commissioned as structural and geotechnical engineers and have been requested to prepare a Dewatering Management Plan (DMP) for the proposed development.

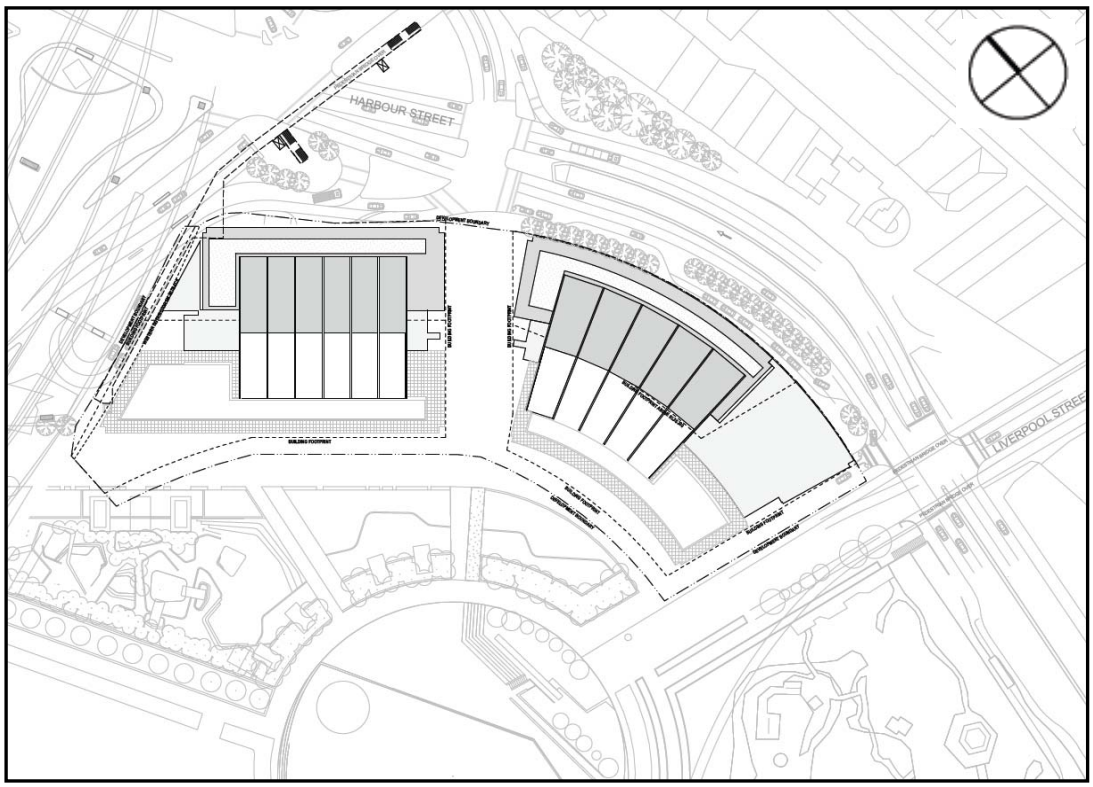

Figure 1 - Site plan

1.2 Background

The proposed development will include the construction of a nine (9) storey building with a four (4) level basement. The basement will be constructed over approximately the southern two thirds of the site (refer Figure 1). The existing ground surface ranges in elevation from approximately 3.20m to 4.20m Australian Height Datum (AHD). The lower basement level will have a finished floor level at approximately – 8.0m AHD. Minor localised excavations beyond this depth will be required for lift pits and footings, possibly including piled foundations. Therefore, the maximum depth of excavation will be between approximately 12 and 14m below the existing ground surface level (+3.7m AHD).

Groundwater levels have been recorded at between +0.3m AHD and -0.6m AHD during the recent environmental investigation. It is expected that these levels vary seasonally and that the groundwater levels are influenced by the tidal movements in Darling Harbour, to the east of the site.

It is likely that the quality of the groundwater removed during the construction period (approximately eleven months) will vary due to the possible in-situ oxidation of potential acid sulphate soils (PASS) and the ingress of groundwater from adjacent areas. This can impact on the receiving surface waters if not managed appropriately. As such, extracted groundwater should be monitored in accordance with the procedures specified within this DMP and mitigation measures adopted when required.

The construction contractor / project coordinator will be responsible for ensuring that the groundwater removed during construction complies with the release criteria specified in this DMP (i.e. prior to discharge from the site).

This DMP details the specific requirements for construction phase dewatering and includes the procedures for monitoring, auditing and treatment of dewatered groundwater, where required.

1.3 Receiving environment

It is proposed to discharge extracted groundwater into the adjacent Hay Lackey Street stormwater culvert. This stormwater network discharges into Darling Harbour which is situated approximately 120m to the east of the site.

During construction, groundwater and stormwater will be discharged to the stormwater system via a sedimentation basin located on the western side of the site. The sedimentation basin and its operation are described in the project Erosion and Sediment Control Report, Hyder Consulting (April 2008).

1.4 Objectives

The objectives of this DMP are to ensure that the proposed dewatering operations do not impact on the quality of the receiving surface waters. Where required, groundwater will be treated prior to discharge from the site.

2 Groundwater quality

2.1 Environmental and groundwater investigation

This section presents a brief summary of the conditions observed during the recent environmental and groundwater investigation carried out at the Darling Walk site (HLA, 2008). This investigation included the construction of seven monitoring wells to determine the existing groundwater level and quality. The locations of the monitoring wells are presented in Figure 2 (locations marked as MW).

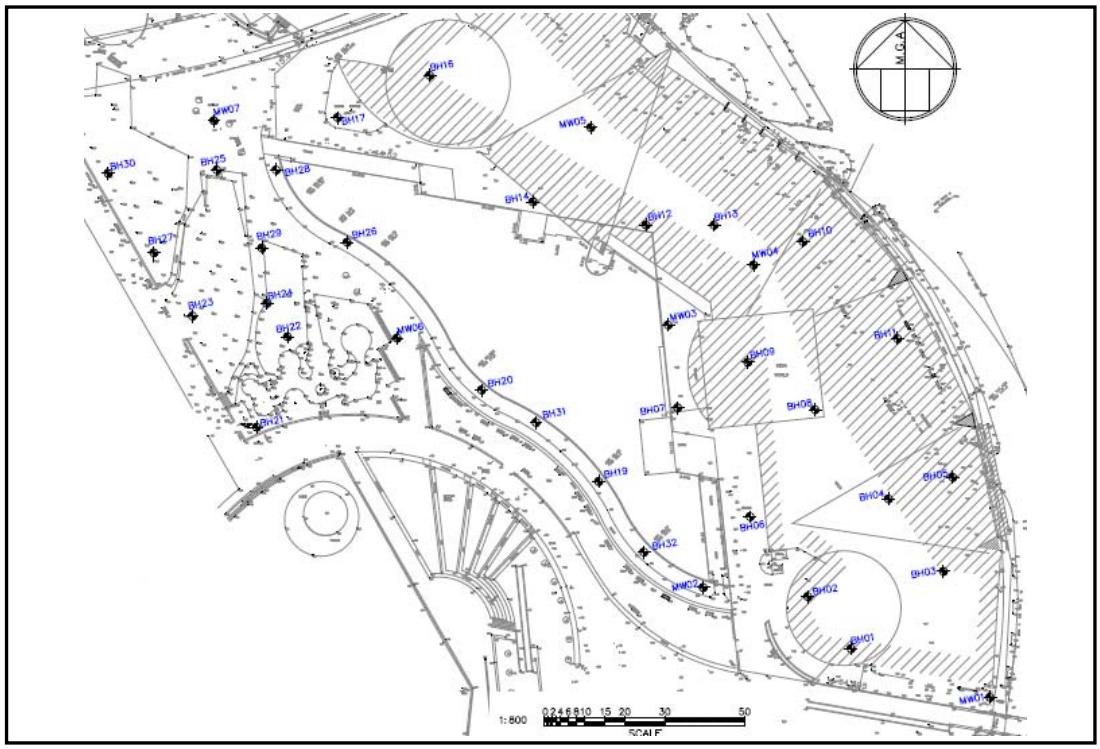

Figure 2 - Borehole and Monitoring Well Location Plan

2.2 Existing groundwater level

Groundwater was encountered during the investigation at between 1.6 metres below ground surface (m bgs) to 5.5 m bgs within the fill/surface soil strata. Monitoring wells were installed to depths ranging from 3.88 m bgs (MW05) to a maximum depth of 6.5 m bgs (MW06). Table 1 presents the groundwater levels observed within these monitoring wells.

Monitoring Well ID	Elevation (Top of Casing) m AHD	SWL (m BGS)	Groundwater Elevation (m AHD)
MW01	3.616	4.23	-0.6
MW02	3.334	3.64	-0.3
MW03	3.661	3.781	-0.1
MW04	4.086	4.585	-0.5
MW05	3.945	Dry	Not calculated
MW06	3.457	3.125	0.3
MW07	3.447	3.14	0.3

Table 1 – Groundwater Survey Data at Darling Walk Site

2.3 Existing groundwater quality

Assessment of the groundwater was undertaken for heavy metals, total petroleum hydrocarbons, monocyclic aromatic hydrocarbons, semi-volatile organic compounds, volatile organic compounds and polychlorinated biphenyls. The results were compared against the marine water setting of Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 2000). The concentrations were reported to be below the ANZECC, 2000 guidelines.

Laboratory analysis of selected soil samples collected from natural strata across the site within the groundwater saturated zone reported presence of Actual and Potential Acid Sulphate Soils.

2.4 Discharge quality requirements (performance requirements)

The City of Sydney water quality requirements for disposal of water to stormwater drains are as follows:

- Turbidity/Total Suspended Solids – water is to be clear and free of visible suspended soils (<10 NTU/ <50mg/L);
- Oils and greases – no visible oil or grease film (<10 mg/L);
- pH level is to be between 6.5 < pH < 8.5;

The collection of stormwater/groundwater on a project can be discharged to the stormwater system if it meets the City Of Sydney water quality requirements presented above. This would involve an analysis of the quality of receiving waterways and the water collected within the project boundary. This analysis would need to be carried out by a NATA accredited laboratory and the results and final report supplied to Bovis Lend Lease. Should inspection or testing give results that do not comply with the above requirement, treatment measures (such as the application of a pH neutral flocculent) and subsequent retesting/reinspection is required.

The analysis would also need to demonstrate that the collected water within the project is free of the following substances:

- nutrients, from fertilisers;
- herbicides and pesticides used in landscaping;
- acids from washing;
- building wastes and litter;
- paint and paint wastes; and
- oils, grease and fuel, from equipment operation and maintenance.

3 Scope of Dewatering

3.1 Groundwater volumes

Groundwater to be dealt with during construction will originate from two distinct sources;

1. Groundwater contained within the fill and soils overlying the rock;
2. Flow through the sandstone bedrock.

The anticipated groundwater volumes / inflows from each of these sources are discussed below.

The fill and soils overlying the sandstone bedrock will contain a significant volume of water within the voids in the soil mass. Preliminary estimates of this volume are approximately 8,500 m^3 based on a simplified stratigraphy and assuming the soil is fully saturated with a bulk density, ρ_b of 1.9 Mg/m^3 and specific gravity, Gs of 2.65. It is anticipated that the majority of this water will be removed from site with the soil during bulk excavation. Any free water will be removed from site using sump and pump methods.

In general, the groundwater flows through defects in the sandstone rock mass are anticipated to be relatively minor. Should major structure be encountered within the rock mass (faults, joint swarms etc), significant local groundwater inflows may be possible. Preliminary estimates suggest that inflows into the excavation could be in the order of 100 litres/hour (0.01 m^3/hr) through the sandstone rock mass and up to 1000 litres/hour (1 m3/hr) based on 25% of the rock mass containing significant structure in the form of joints with small openings. It is believed that a fault zone runs through the site therefore the inflow could possibly increase significantly. The inflow of water through the joint openings and possible fault zone could be controlled through grouting of such features.

3.2 Dewatering level

It has been indicated that excavations of up to approximately 12 to 14m below ground surface level will be required to construct the basement. The excavation will penetrate the fill and surficial material and be founded in Hawkesbury Sandstone. The full depth of the surficial materials and highly weathered Sandstone will be retaining using an embedded retaining wall, which can be considered water tight for the purpose of this dewatering plan. The retaining wall will prevent all but minor groundwater flows into the basement from the materials above the sandstone. As such the groundwater draw down around the site will be negligible. Groundwater flow can be expected through the sandstone; however, these flows are anticipated to be of sufficiently low volume as not to cause drawdown outside of the basement.

The diversion of the stormwater culvert around the southern side of the site will involve excavation which will generally be above the groundwater table, with the exception of the western extent of the diversion, near the existing pond. Minor dewatering may be required in this area to enable the diversion works to be completed. Drawdown of approximately 1m would be required. Minor inflows along the remainder of the length of the diversion may be experienced if perched groundwater in encountered.

Given the construction methods described above, the only significant dewatering will be undertaken within the basement excavation itself. Given that the excavation will be encompassed within a retaining wall, the drawdown of groundwater outside of the site is anticipated to be negligible.

3.3 Dewatering method

The concept design of the basement retaining wall is a solider pile wall with jet grout infill between the piles. Dewatering within the confines of the basement wall will be undertaken using sump and pump methods.

The conceptual design of the basement indicates a permanently drained basement i.e. the structure is not designed to withstand hydrostatic pressures. As such, permanent dewatering will be required from within the basement. Flows from the dewatering system in the permanent situation will be governed by flow through the sandstone rock mass and leakage through the basement retaining wall. These flows will be minimised during construction through grouting of defects in the rock mass and the basement walls. The design groundwater inflow in the permanent case will be approximately 100 – 200 litres/hour (0.01 – 0.02m³/hr), depending on the amount of rock structure encountered and the success of any associated grouting exercise.

Preliminary consideration of the stormwater diversion suggests that interlocking sheet piles will be used to provide temporary support to the excavation. Where dewatering is required, it is anticipated that this can also be achieved using sump and pump methods. Alternatively, spear point dewatering outside of the excavation may be employed. Dewatering from within the excavation, using sump and pump methods, will minimise the extent of drawdown.

3.4 Draw down effects

Dewatering may induce settlement due to the associated increase in vertical effective stress in the ground. As discussed in the preceding sections, the draw down effects around the site are anticipated to be minimal due to the proposed method of basement construction. Hence, associated settlements are anticipated to be minimal.

Although only minor settlements are anticipated, dilapidation surveys of neighbouring structures should be conducted by a suitably qualified engineer. Inspections should be undertaken prior to the commencement of construction (including dewatering), and following completion of construction and the restoration of groundwater levels. A dilapidation report prepared for each of the structures inspected.

Dewatering operations have the potential to impact on potential acid sulfate soils within the zone of draw down. The use of a pile and jet grout retaining wall for the basement construction and inter-locking sheet-piling for the stormwater diversion excavation will minimise draw down and minimise the potential for the in-situ oxidation of PASS soils.

3.5 Treatment of Dewatered Groundwater

Based on the groundwater quality results recorded, it is expected that extracted groundwater may require treatment prior to discharge, to reduce suspended solids, raise pH, and encourage the flocculation of naturally occurring iron and aluminium.

An on site treatment with discharge to stormwater could be implemented providing that there is no chemical contamination (as specified in Section 2.4).

Treatment options could include the use of a mobile specialist plant for this procedure and may prove more cost effective than a procedure of pumping out and/or on site storage of this water.

3.6 Dewatering contingency

In the event that groundwater quality cannot satisfy the performance criteria, additional on-site treatment or discharge to sewer may be employed. An application to Sydney Water's Trade Waste Department must be submitted and approved prior to any temporary connection being made to the sewer.

3.7 Groundwater quality monitoring requirements

Ongoing water quality monitoring would need to be performed. The contractor engaged to undertake this work (Bulk Earthworks or Maintenance Subcontractor or nominated Stormwater/ Sediment Control contractors) would need to provide a methodology detailing

the frequency of sampling and on site procedures to ensure discharge does not exceed the stated criteria.

The subcontractor will be responsible for the following inspection activities and reporting requirements:

- Perform daily visual inspection of stormwater diversions and sediment/ erosion control devices ensuring they are operating effectively and at full capacity.
- Maintain erosion and sediment control measures in a functioning condition until all earthwork activities are completed and the site is rehabilitated.
- Devise and implement appropriate remedial measures where any controls or devices are not functioning effectively or are inappropriate.
- Ensure rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
- The Site Manager will maintain records and comments on the condition of existing erosion and run-off controls (drains, silt fences, catch drains etc.) de-watering procedures and test results, and any site instruction issued to Subcontractors to undertake remedial works.
- Maintain rainfall data will be filed on site.
- Record and report any incidents of poor drainage or uncontrolled discharge.
- Water quality parameters will meet relevant discharge limits for either re-use on-site or discharge from site via a controlled discharge.
- All daily inspection reports, environmental incidents and controlled discharge records will be maintained and may be reviewed during any Environmental Audit performed on the site.

4 Summary

A summary of the requirements of this Dewatering Management Plan are summarised in Table 2.

Issue	Procedure
Responsible Person	The construction contractor / project coordinator will be responsible for ensuring the implementation of appropriate treatment of dewatered groundwater as outlined in this document.
Operational Policy	To ensure that all dewatered groundwater is effectively treated prior to discharge to the stormwater network.
Performance Criteria	The treatment system must be capable of meeting the performance criteria as set out in Section 2.4.
Implementation Strategy	All dewatered groundwater will be treated to an acceptable quality prior to being discharged to the stormwater network.
Monitoring	As specified in Section 3.7.
Auditing	The Consulting Environmental Engineer or Environmental Scientist will undertake monthly audits of the water quality monitoring data to ensure that all discharges to the stormwater network comply with the performance criteria specified in Section 2.4.
Reporting	The subcontractor responsible for dewatering will keep records of all test results and quantities of treatment agents applied during dewatering operations. All records will be available for inspection on site during the construction phase.
Corrective Action	It the treatment system fails to meet the relevant criteria, additional treatment systems and/or treatment methods will be employed as necessary. Daily monitoring will be undertaken until the recorded value(s) meets the performance criteria.

Table 2 – Summary of requirements