1 May 2019

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Via email: Mike.Bardsley@hdc.nsw.gov.au

Honeysuckle Precinct Groundwater Management Options Review

Dear Mike,

1. Introduction and Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Hunter Development Corporation (HDC) to undertake a groundwater management options review for the Honeysuckle precinct (the site). The site is located between the Throsby Creek basin, Honeysuckle Drive and Hannell and Hunter Streets (refer **Figure 1.1**) within the Newcastle City Council (NCC) local government area and comprises the following:

- **Sub-Precinct 1** - Fig Tree Park (FTP), Throsby, Lee 5, Lee 4, Wickham Urban Village (WUV), Lee 5 South, Park Residential and Worth Place Park (WPP);
- **Sub-Precinct 2** - Lee Wharf Stages 4 and 5, Wright Lane and Wright Lane Carpark; and
- **Sub-Precinct 3** - Railway Institute Building (RIB).

Figure 1.1: Honeysuckle Precinct

JBS&G understands that HDC requires the review to inform management of groundwater during future redevelopment of the site.

2. Scope of Work

The following key elements form the scope of work for this review:

- A review of historical groundwater data, including a data gap assessment in relation to the adequacy of the dataset for making informed decisions on groundwater management during redevelopment works.
- A review of likely options for groundwater management for various areas including:
  - an assessment of the likelihood of success of options for various areas given the historical groundwater quality dataset, and taking into account appropriate regulatory guidance / approval requirements.
  - an assessment of which areas are least suitable for basement structures on the basis of any major constraints due to groundwater contamination and / or risk of seepage.
  - any data gaps that are evident and that should be addressed by HDC (or any future proponents seeking approvals or licences).
  - an indicative budgetary cost estimate for implementation of each of the groundwater management options.
- Preparation of this letter report.

3. Documents for Review

A comprehensive list of reports provided to JBS&G, which contain reference to groundwater data for the site, and which were reviewed for this letter report is provided in **Table 3.1**.

Table 3.1: Summary of Historical Investigation Reports Reviewed

Site Area	Historical Reports Available for Review
Park Residential	PB (2002a), *Environmental Site Assessment, Park Residential, (Part Lot 1111 DP1027135), Honeysuckle, NSW*, November 2002, Parsons Brinckerhoff (PB) Australia Pty Limited. PB (2003), *Additional Groundwater Investigation, Honeysuckle NSW*, April 2003. RCA (2004a), *Contaminant Delineation and Remedial Action Plan, Park Residential*, March 2004, RCA Australia (RCA) Pty Ltd. Environ (2005), *Site Audit Report, Honeysuckle Development Park Residential,* September 2005, Environ Australia (Environ) Pty Ltd.
Worth Place Park	PB (2002b), *Environmental Site Assessment, Worth Place Park, (Lot 8 DP 883474), Honeysuckle, NS*W, November 2002. PB (2003), *Additional Groundwater Investigation, Honeysuckle NSW*, April 2003. RCA (2006a), *Contaminant Delineation and Revised Remedial Action Plan, Worth Place Park, Honeysuckle Development Estate*, February 2006. Environ (2011), *Site Audit Report*, *Worth Place Park*, February 2011.
Lee Wharf 4	PB (2002c), *Environmental Site Assessment, Lee 4, (Part Lot 1111 DP 1027135), Honeysuckle, NSW,* November 2002. PB (2003), *Additional Groundwater Investigation, Honeysuckle NSW*, April 2003. JBS (2007a), *Supplementary Contamination Assessment, Honeysuckle Development Corporation, Cottage Creek Remediation, Lee 4, Honeysuckle Drive, Newcastle NSW,* October 2007, JBS Environmental (JBS) Pty Ltd. Environ (2007), *Site Audit Report – Remedial Action Plan, Lee 4 Honeysuckle Drive*, December 2007.
Lee Wharf 5	PB (2002d), *Environmental Site Assessment, Lee 5, (Part Lot 1111 DP 1027135), Honeysuckle, NSW,* November 2002. PB (2003), *Additional Groundwater Investigation, Honeysuckle NSW*, April 2003. RCA (2003), *Remedial Action Plan, Lot 22, Lee 5 South Honeysuckle Development Estate*, 19 June 2003. JBS (2007b), *Supplementary Contamination Assessment, Honeysuckle Development Corporation, Lee 5, Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW,* July 2007.

Site Area	Historical Reports Available for Review
Lee 5 South	PB (2002e), *Environmental Site Assessment, Lee 5 South, (Part Lot 1111 DP 1027135), Honeysuckle, NSW*, May 2002, Rev B. Environ (2004), *Summary Site Audit Report, Honeysuckle Development, Lot 22 and Part Lot 23 Lee 5 South*, June 2004. RCA (2004b), *Implementation of Remedial Action Plan – Lot 22 and Part Lot 23, Lee 5 South, Honeysuckle Development Estate*, April 2004.
Wickham Urban Village	DP (2002), *Report on Geo-Environmental Assessment, Wickham Urban Village, Stewart Avenue, Wickham*, October 2002, Douglas Partners (DP) Pty Ltd. DP (2005), *Report on Additional Contamination Assessment, Wickham Urban Village, Stewart Avenue, Wickham*, August 2005. CMJA (2005), *Summary Site Audit Report, Wickham Urban Village, Wickham NSW*, October 2005, C.M. Jewell & Associates (CMJA) Pty Ltd. GHD (2011), *Site Audit of Remediation Action Plan Wickham Urban Village and Honeysuckle Drive, Newcastle NSW*, October 2011, GHD Australia (GHD) Pty Ltd.
Throsby	PB (2002f), *Environmental Site Assessment, Throsby, (Part Lot 1111 DP 1027135), Honeysuckle, NSW,* November 2002. JBS (2007b), *Supplementary Contamination Assessment, Throsby, Part Lot 230 DP 1094812, Honeysuckle Dr, Newcastle NSW,* June 2007. Environ (2008), *Site Audit Report, Remediation Action Plan, Throsby, Honeysuckle Drive, Newcastle,* February 2008.
Fig Tree Park	PB (2002g), *Environmental Site Assessment, Fig Tree Park, (Lot 105 DP 1015391), Honeysuckle, NSW*, November 2002. RCA (2004c), *Remedial Action Plan, Fig Tree Park Stage 2, Honeysuckle Development* Estate, February 2004. RCA (2006b), *Groundwater Monitoring and Validation, Fig Tree Park Stage 1 Works, Honeysuckle Development Estate*, February 2006. RCA (2008), *Groundwater Contamination Assessment, Fig Tree Park Stage 2, Honeysuckle Development Estate*, February 2008.
Lee Wharf Stage 4 and 5	DP (1993), *Report on Contamination Assessment, Proposed Commercial Development, Civic Workshops Area, Honeysuckle Project, Honeysuckle Newcastle*, June 1993. RCA (1998a), *Geochemical Investigation, Lot HB5c, Honeysuckle Redevelopment, Newcastle NSW*, October 1998. RCA (1998b), *Geochemical Investigation, Lot HB5d, Honeysuckle Redevelopment, Newcastle NSW*, October 1998. Coffey (2013), *Summary of Previous Contamination Assessments, Honeysuckle Central, Honeysuckle Drive, Newcastle NSW*, 17 May 2013, Coffey Environments Australia (Coffey) Pty Ltd.
Wright Lane and Wright Lane Carpark	DP (1993), *Report on Contamination Assessment, Proposed Commercial Development, Civic Workshops Area, Honeysuckle Project, Honeysuckle Newcastle*, June 1993. PB (2002h), *Environmental Site Assessment, Wright Lane, (Part Lot 9 DP 883474), Honeysuckle, NSW*, November 2002. CH2M HILL (2012), *Wright Lane, Newcastle, Phase 1 and 2 Environmental Site Assessment*, February 2012, CH2M HILL Australia (CH2M HILL) Pty Ltd. Environ (2013), *Site Audit Report, Wright Lane Car Park, Newcastle*, June 2013, Environ.
Railway Infrastructure Building	RCA (2006c), *Revised Phase 2 Environmental Site Assessment and Contaminant Delineation Works, Lot 2 DP1037267, RIB Site, Hunter Street, Newcastle*, September 2006. Environ (2011), *Interim Advice Letter No. 1 – Review of Remedial Action Plan for 'RIB' Site, Hunter Street, Newcastle*, 27 May 2011.

4. Review Summary

A comprehensive review of the historical groundwater assessments conducted for each area listed in **Table 3.1** is provided in **Attachment 2**. A review of the most recent groundwater assessment for each area is shown below in **Table 4.1**.

4.1 Data Gap Assessment

As noted in the individual area reviews provided in **Attachment 2**, JBS&G considers the significant work conducted in the past to have adequately characterised the nature and extent of groundwater contamination. However, with the exception of the Wright Land and Wright Lane

Carpark area, the investigation reports reviewed were prepared approximately 10 years ago. While it is understood that for the majority of these areas little development has occurred in the interim, the significant time since the monitoring means that current groundwater conditions may be different than that presented in the historical reports.

As a result, it is considered that there is a gap in the groundwater data set in regards to the lack of contemporary observations. Furthermore, numerous historical assessment and summary site audit reports reference undefined up-gradient sources for observed groundwater contamination at many of the areas within each sub-precinct of the site which may have continued to impact the areas. Additionally, for some groundwater management options (notably sewer disposal) some additional analytes (such as sulphate) not typically collected during contamination assessment may be required before disposal can be confirmed.

4.2 Review of Options for Groundwater Management

JBS&G has conducted a review of the options available for managing groundwater disposal, should it be required during redevelopment of any of the areas within the site. Site specific review of the management options, including an assessment of the likelihood of each management option being successful; as well as an assessment on whether or not the site conditions are suitable for basement construction, is presented in the tables provided in **Attachment 2**.

Based on the data reviewed, JBS&G considers disposal to stormwater, disposal to sewer and/or re-injection to be generally viable options at each of the areas within the Honeysuckle Precinct. While use of groundwater for dust suppression may be suitable this methodology is generally only relevant for low flow rates and therefore is not considered further.

Assuming that concentrations of heavy metals remain similar to those reported in the most recent groundwater sampling events, it is considered that documentation could be prepared justifying direct disposal (with little or no treatment) of dewater to sewer or stormwater (stormwater disposal is unlikely to be acceptable for dewater from Lee Wharf Stage 4 and 5) . Provision of a screening level risk assessment may be required for some areas to demonstrate that the concentrations of heavy metals present will not harm the receiving environment. Where hydrocarbons (TRH/PAHs) are found within groundwater above ANZECC or Hunter Water Trade Wastewater guidelines, treatment (potentially by simple filtration with activated carbon) may be required to reduce concentrations to acceptable levels.

In cases where disposal to stormwater is preferred then treatment of the discharge to limit suspended solids (i.e. sediment) may also need to be considered, depending on the method of extraction. For example, suspended solids concentrations in groundwater extracted from spearpoints/wells may be negligible, whereas pumping directly from excavations may result in relatively high concentrations.

4.3 Regulatory Framework for Groundwater Management

Where dewatering/aquifer interference is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. The following sections provide a brief summary of requirements applicable to management of dewatering required during redevelopment of the site.

4.3.1 NSW DPI Water

NSW Department of Primary Industries (DPI) Water follows the provisions of the following acts, policies and guidelines (among others) in regulating and approving licences to extract groundwater for temporary construction dewatering purposes:

- NSW *Water Act 1912* (Water Act);
- NSW *Water Management Act 2000* (WM Act)*;*
- NSW *Aquifer Interference Policy,* September 2012[1];
- NSW DPI Water *Guideline for completing an application for a Controlled Activity Approval,* April 2012[2]*;* and
- NSW Office of Water *Guidelines on applying for a water licence under the Water Act 1912,* August 2010[3].

The NSW *Aquifer Interference Policy*, which applies to all aquifer interference activities, including projects which require dewatering such as for the construction and maintenance of buildings, roads and other civil works, as well as injection works used to transmit water into an aquifer, defines minimal impact considerations that enable assessment of proposals against the provisions of the WM Act. DPI Water will require developers to meet general terms of approval specific to each project in their application to take water for dewatering purposes.

Further, controlled activities are governed under the NSW *Water Management Act 2000*, and include erecting a building, excavating or depositing material on or under waterfront land. Waterfront land includes the bed of any river, lake or estuary, and any land lying within 40 metres inland of the mean high water mark of the estuary. Applications for controlled activity approvals also need to be made to DPI Water.

4.3.2 Protection of the Environment Operations Act

The NSW *Protection of the Environment Operations Act 1997* (POEO Act) provides the statutory framework for managing water pollution in NSW. Schedule 1 of the POEO Act outlines various activities for which an environment protection licence (EPL) is required. Treatment of more than 100 megalitres of contaminated groundwater is listed as a scheduled activity under the POEO Act and requires an EPL. Where an EPL is issued for an activity, the NSW EPA regulates that activity. However, since the activities which may be undertaken to manage groundwater at the site are unlikely to require an EPL due to the low volumes expected to be treated, and in line with the POEO Act provisions, the local council is the regulatory authority, in this case, Newcastle City Council.

In general, regulatory authorities refer to the Australian and New Zealand *Guidelines for fresh and marine water quality* 2000[4] (ANZECC 2000), when considering the environmental value of waterways for the purposes of assessing whether or not to issue pollution notices[5].

Where the chosen groundwater management option was disposal to stormwater, then for most areas in the Honeysuckle Precinct Newcastle City Council would need to approve the discharge. However, Hunter Water maintains the Cottage Creek stormwater channel, and discharge to this stormwater asset would need Hunter Water approval.

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1 http://www.water.nsw.gov.au/__data/assets/pdf_file/0004/549175/nsw_aquifer_interference_policy.pdf

2 http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/547154/guidelines-for-completing-an-application-for-a-controlled-activity-approval.pdf

3 http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/547235/licence_wa1912_applying_for_licence.pdf

4 ANZECC (2000), Australian and New Zealand *Guidelines for fresh and marine water quality* 2000; published by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), October 2000.

5 Further information on how regulatory authorities apply the ANZECC 2000 guidelines can be found in the NSW EPA Guideline on Considering Environmental Values of Water when Issuing Prevention Notices: http://www.epa.nsw.gov.au/resources/epa/envvalueswater06171.pdf

4.3.3 Hunter Water Trade Wastewater

Disposal to the Hunter Water sewer system may be the most viable option in some instances, e.g. where heavy metal concentrations preclude disposal to stormwater. In which case the proponent will be required to seek approval from Hunter Water to discharge water under a Trade Waste Agreement.

The Hunter Water Trade Wastewater Standard is more generous in terms of the concentration of suspended solids, heavy metals and TPHs allowable in discharges, as compared to ANZECC 2000 trigger values. However, it should be noted that Hunter Water does not allow any detectable concentrations of PAHs within long term trade wastewater discharges (longer than six months). For short term discharges, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994.

Volumetric limits also need to be considered if disposal to the sewer network is preferred.

4.4 Budgetary Estimates

It is understood that HDC requires budgetary estimates for each of the identified groundwater management options and is discussed below.

4.4.1 Dewatering System

The installation of a dewatering system is required for all options. The type of system (spears, excavation dewatering, central well) will be determined by the builder by consideration of site specific hydrogeology and the building design. Costing of this component of the groundwater management system is therefore not included as part of the budgetary estimates.

4.4.2 Injection System

In the case that re-injection of dewater is the preferred option costs for its construction would be similar to that of the dewatering system. Potential costs for treatment of dewater (if required) are presented below.

4.4.3 Stormwater Discharge

In the case that stormwater discharge is the preferred option then costs for discharge are minimal and comprise piping to the discharge point and any engineering works required at the point of discharge. Potential costs for treatment of dewater (if required) are presented below.

4.4.4 Sewer Discharge

In the case that sewer discharge is the preferred option then costs include those for piping to the discharge point, engineering works required at the point of discharge as well as Hunter Water connection and ongoing fees (based on both flow rate and mass load). Potential costs for treatment of dewater (if required) are presented below

4.4.5 Groundwater Treatment

The detailed reviews provided in **Attachment 2** identify common groundwater quality issues across the Honeysuckle Precinct including the following:

- Low levels of TPH and PAHs including some minor exceedances of low reliability toxicant trigger values (TTVs) presented in ANZECC (2000) for some PAHs; and
- Minor exceedances of TTVs for heavy metals (particularly zinc).

These issues are most relevant to discharge to stormwater and for reinjection but in the case of PAHs may also be relevant to sewer discharge. Whether treatment of the dewater to address the identified contamination is required prior to discharge will be influenced by a number of site specific factors (such as basement design, flow rates, groundwater controls implemented during basement construction, dilution of identified impact during gross pumping, potentially unidentified site impact, regulatory environment) many of which are unknown until preparation of the development approval/detailed building design/completion of data gap assessments. As a result, the budgetary estimates provided below for water treatment are subject to a high degree of uncertainty.

Potential requirements for groundwater treatment include removal of suspended solids, pH adjustment (both to meet water quality guidelines and to aid in heavy metal removal) and removal of hydrocarbons (TPH/PAHs). Potential costs for these are presented as follows:

- Removal of Suspended Solids: approximately $1,000 per week assuming filtration only (no flocculation);
- pH adjustment: ranging from $500 per week up to $3,000 per week depending on flow rate and filtration requirements; and
- Treatment for TPH/PAHs: ranging from $2,500 per week to $10,000 per week depending on flow rate, contaminant mass loading and discharge limits.

Table 4.1: Summary of Most Recent Groundwater Monitoring Event for each Area within the Honeysuckle Precinct

Site Area	Summary of most recent GME			
	Date	No. of Wells sampled	COPCs Tested	Key findings
Park Residential	November 2003 (site specific reference: RCA 2004)	2	TPH/BTEX/PAHs and 8 Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	• TPH/BTEX - below the laboratory LOR. • PAHs - <LOR, or, where detected <ANZECC 2000 95% low reliability trigger values. • Heavy metals - Zinc results (41 µg/L and 17 µg/L) marginally exceed ANZECC trigger value of 15 µg/L. Other metals <ANZECC trigger values.
Worth Place Park	November 2003 (RCA 2006a)	3	TPH/BTEX/PAHs and 8 Metals	• TPH/BTEX/PAHs – results low or <ANZECC 2000 95% marine trigger values. • Heavy metals – results exceeding ANZECC 2000 95% marine trigger values for chromium (WP/MW8), copper (WP/MW8), and zinc (3 wells).
Lee Wharf 4	April 2007 (JBS 2007a)	4	TPH/BTEX/PAHs and 9 Metals (As, Cd, Cr, Cu, Pb, Mn, Hg, Ni, Zn)	• BTEX - below the laboratory LOR. • TPH - below the laboratory LOR, or below criteria. • PAHs – phenanthrene (in 1 sample); anthracene (2 samples); fluoranthrene (3 samples); and benzo(a)pyrene (1 sample) detected above the adopted criteria. • Heavy metals – either <LOR or below criteria, with the exception of samples from well “OldMW1” and MW07/1 which had concentrations of manganese reported above the ANZECC 2000 95% marine ecosystem criteria.
Lee Wharf 5	April/May 2007 (JBS 2007b)	2	TPH/BTEX/PAHs and 9 Metals	• TPH/BTEX - below the laboratory LOR. • PAHs – fluoranthene exceeded the adopted criteria in one sample, otherwise PAHs <LOR or below criteria. • Heavy metals – zinc and arsenic exceed ANZECC criteria, otherwise either <LOR or below criteria.
Lee 5 South	March & August 2003 (Environ 2004)	6	TPH/BTEX/PAHs and 8 Metals	Environ (2004): summarises reports by PB and RCA (each from 2003) which JBS&G has not been provided: • BTEX and TPH (C6-C9) - below the laboratory LOR; TPH C29-C26 was detected at a low level in one of the down-gradient wells. • PAHs – elevated above ANZECC low level guidelines in up-gradient wells, and concluded that PAH impacts likely occurring due to off-site and up-gradient sources. • Heavy metals - likely that the source of elevated levels of heavy metals detected in the groundwater is located off-site and up-gradient, or are the result of a widespread regional source.

Site Area	Summary of most recent GME			
	Date	No. of Wells sampled	COPCs Tested	Key findings
Wickham Urban Village	February 2005 (DP 2005)	9	TPH/BTEX/PAHs and 8 Metals	• TRH/BTEX - below the laboratory LOR • PAHs – generally <PQL, excepting 2 samples at Bore 101 and Bore 108, where concentrations of Total PAHs of 5.15 µg/L and 6.18 µg/L respectively were reported, marginally exceeding the NSW EPA (1994) guideline (3 µg/L). • Heavy Metals – sample results exceeded ANZECC 2000 95% marine criteria for chromium, copper, nickel and zinc, otherwise <PQL or below criteria. • Also noted that one sample was collected from Newcastle Harbour, which had reported concentrations of COPCs, where detectable, generally higher than or similar to, those reported for groundwater samples.
Throsby	March & April 2007 (JBS 2007c)	7	TPH/BTEX/PAHs and 9 Metals	• TPH/BTEX - <LOR or below criteria. • PAHs – fluoranthene and benzo(a)pyrene marginally exceed adopted criteria (i.e. laboratory PQL) in one sample (TH/MW02), otherwise below criteria. • Heavy Metals – arsenic (2 of 7 samples) and manganese (6 samples) exceed ANZECC 95% marine ecosystem criteria in samples from across the site.
Fig Tree Park	Stage 1: January 2006 (RCA 2006b) Stage 2: November 2007 (RCA 2008)	Stage 1: 1 Stage 2: 1	Stage 1: TPH/BTEX/PAHs/VOCs Stage 2: TPH/PAHs/8 Metals	Stage 1: • BTEX/VOCs below the laboratory LOR. • Minor TPHs detected, sum of TPHs 550 µg/L • Minor PAH detections in excess of low reliability ANZECC 2000 95% marine trigger values: o benzo(a)pyrene concentration 0.6 µg/L (exceeds 0.2 µg/L TV); and o fluoranthene concentration of 1.6 µg/L (exceeds 1.4 µg/L TV). • Metals not analysed. Stage 2: • TPHs below the laboratory LOR. • Minor PAHs detected, but below low reliability ANZECC 2000 95% marine trigger values. • Minor copper (3 µg/L) exceedance, in relation to ANZECC (2000) 95% marine criteria (1.3 µg/L).
Lee Wharf Stage 4 and 5	September 1998 (RCA 1998a and 1998b)	2	TPH/BTEX/Total PAHs/Total OCPs/Total PCBs/8 Metals	• TPH/BTEX/Total PAHs/Total OCPs/Total PCBs below the laboratory LOR. • Zinc concentrations (112 and 89 µg/L) exceed ANZECC (2000) 95% marine criteria (15 µg/L). • Copper concentrations (8 and 18 µg/L) exceed ANZECC (2000) 95% marine criteria (1.3 µg/L).

Site Area	Summary of most recent GME			
	Date	No. of Wells sampled	COPCs Tested	Key findings
Wright Lane and Wright Lane Carpark	October 2011 (CH2M HILL 2012)	3	TPH/BTEX/PAHs and 8 Metals	• PAH, TPH, and BTEX were below the laboratory LOR. • Minor arsenic (up to 17 µg/L), copper (1.3 µg/L) and zinc (15 µg/L) exceedances, in relation to ANZECC (2000) 95% marine criteria.
Railway Infrastructure Building	October 2005 (RCA 2006c)	3	TPH/BTEX/PAHs and 8 Metals	• BTEX were below the laboratory LOR. • TPH (C_{15}-C_{28}) detected in each well, 1000 µg/L, 2800 µg/L and 800 µg/L, which brought Total TPH (C_6-C_{36}) above the adopted screening criteria of 600 µg/L(1). • Minor arsenic (up to 6 µg/L) and zinc (113 µg/L) exceedances, in relation to ANZECC 2000 95% marine criteria.

(1) Dutch Intervention Level for mineral oil – 600 µg/L; *Environmental Quality Objectives in the Netherlands*, Dutch Ministry of Housing, Spatial Planning and Environment, 1994.

5. Conclusions and Recommendations

JBS&G has made the following conclusions from the review of historical groundwater data for the site:

- There is a data gap with regard to the lack of contemporary groundwater data for each area in the Honeysuckle Precinct, with the exception of Wright Lane and Wright Lane Carpark.
- The lack of contemporary data for most sites may require addressing prior to regulatory approval for groundwater management options.
- Based on groundwater contamination status, each of the sites should be suitable for basement construction, assuming treatment and approved disposal of groundwater can be arranged in line with the regulatory framework outlined above.
- Budgetary estimates for groundwater treatment (if required) range from approximately $1,000 to $14,000 per week depending on flow rates, mass loading and discharge limits. It is noted that the estimates do not include fixed costs (dewatering system, approvals, connection fees, discharge fees) and any monitoring requirements.

Should you require clarification, please contact the undersigned on 02 8245 0300 or by email gdasey@jbsg.com.au.

Yours sincerely:

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Reviewed/Approved by:

Greg Dasey
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Attachments:
Attachment 1 - Limitations
Attachment 2 – Review Summary Tables for Each Area of the Honeysuckle Precinct

Table A: Site Summary – Park Residential

Parameter	Description
SITE STATUS	
Site Name:	Park Residential
Sub-Precinct:	1
Lot/DP:	Part of Lot 2000 in DP 1145678
Lot Size:	Approximately 7 300 m^2 [1]
Address:	Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	B4 - Mixed Use (LEP 2012[2])
Current Land Use:	Carpark (NearMap 2015[3])
Existing Site Cover:	Bitumen or concrete (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the Site Audit Report (Environ 2005), the site's general geological profile is as follows: • 0 to 2.0 – Fill: sands and gravelly sands; • 2.0 to 4.0 – Dredged reworked natural: estuarine silts, sands and clays; • >4.0 – Natural: Estuarine silts, sands and clays.
Hydrology/Drainage:	Stormwater is likely to flow into a stormwater system that discharges into Newcastle Harbour (the nearest surface water receptor) (Environ 2005).
Hydrogeology:	Groundwater is tidally influenced and was encountered at approximately 2 mbgs (RCA 2005).
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs, heavy metals.
Number of groundwater wells	Historically (3 in total): • PB (2002a) – PRMW10; • RCA (2004) – BH1 and BH2. Active currently: unknown whether any monitoring wells remain in service on the site.

1 Environ 2005, *Site Audit Report Honeysuckle Development Park Residential*, September 2005 Ref: 31-0069H
2 *Newcastle Local Environmental Plan* 2012
3 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: PB (2002a) • TPH/BTEX/PAHs – results <LOR • Heavy metals – results <ANZECC 2000 95% marine trigger values PB (2003) No direct measurement of groundwater conditions in Park Residential area, however results from Worth Place Park and Lee 4 as follows: • TPH – results <LOR, with one exception: TPH C15-28 116 µg/L at Lee 4 (L4MW19) • BTEX – results <LOR • PAHs detected in L4MW19 – Total PAHs 15 µg/L > NSW EPA guidelines; fluoranthene 8 µg/L > low reliability ANZECC 95% trigger value of 1.4 µg/L; but naphthalene <LOR and <ANZECC 2000 95% marine trigger values. • Heavy metals – results <ANZECC 2000 95% marine trigger values. RCA (2004) • TPH/BTEX - <LOR • PAHs - <LOR, or, where detected <ANZECC 2000 95% low reliability trigger values. • Heavy metals - Zinc results (41 µg/L and 17 µg/L) marginally exceed ANZECC trigger value of 15 µg/L. Other metals <ANZECC trigger values. _____ Based on the Site Audit Report (Environ 2005), the northwest section of the site was subject to remediation. Remediation was conducted via excavation of sandy gravel associated with the former bitumen road. Remediation was successfully validated to the satisfaction of the Site Auditor. Nevertheless, concentrations of As, Cd, Cu, Pb, Ni and Zn exceeded the provisional phytotoxicity guidelines set by the NSW EPA (1998). Some minor impacts from PAHs were noted in groundwater which is most likely sourced from offsite areas. It was recommended that groundwater should not be used on site unless it has been demonstrated to be suitable for site specific uses. No remediation of groundwater was undertaken.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.

Parameter	Description
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of PAHs. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are within acceptable range for discharge to sewer. Discharge to the Throsby Creek section of the port, or stormwater may be possible if hydrocarbon and PAH concentrations are shown to remain below the limit of reporting or ANZECC guideline trigger values (or if treatment is undertaken), and if suitable justification can be provided to the relevant authority that the environmental risk posed by slightly elevated zinc concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if historic contamination levels are shown to persist. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines. Some pre-treatment may be required to remove PAHs and TRH from the waters prior to reinjection.
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).

Parameter	Description
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.

Table B: Site Summary – Worth Place Park

Parameter	Description
SITE STATUS	
Site Name:	Worth Place Park
Sub-Precinct:	1
Lot/DP:	Lot 2 DP 1167364[1]
Lot Size:	Approximately 10 600 m^2 [2]
Address:	Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	RE1 – Public Recreation (LEP 2012[3])
Current Land Use:	Open space (NearMap 2015[4])
Existing Site Cover:	Grass covered (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the Site Audit Report (Environ 2011), the site's general geological profile is as follows: • 0 to 0.5 – Fill: sands and gravelly sands. Some fill underlying asphalt is black in colour with one location reporting 'tar, viscous, black'; • 0.5 to 2.0 – Fill: Dredged reworked natural material, including estuarine silts, sands and clays; • 2 to 2.5 – Fill: Boulders and cobbles (bedrock was not encountered during the investigations to a maximum depth of 4m.
Hydrology/Drainage:	Surface water is likely to flow towards the harbour (Environ 2011).
Hydrogeology:	Groundwater is tidally influenced and was encountered at approximately 2 mbgs (PB 2002).
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs, heavy metals and OCPs.
Number of groundwater wells	Historically (3 identified): • PB (2002b) – WP/MW8 and PR/MW15; • PB (2003) – WP/MW18; Active currently: unknown whether any monitoring wells remain in service on the site.

1 It is noted that only the western half of the site is included in Sub-Precinct 1 and as such, site details discussed in this summary only pertain to the western portion of the site.

2 Environ 2011, *Site Audit Report Worth Place Park*, February 2011, Project Number: AS120069F

3 *Newcastle Local Environmental Plan* 2012

4 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: PB (2002b) • TPH/BTEX/PAHs – results <LOR • Heavy metals – results exceed ANZECC 2000 95% marine trigger values in one sample from WP/MW8 for cobalt, copper, chromium, lead, nickel and zinc. PB (2003): • TPH/BTEX/PAHs – results <LOR • Heavy metals – results <ANZECC 2000 95% marine trigger values. RCA (2006a) – reports on results of sampling undertaken in 2003 by RCA at three wells (BH1, WP/MW8 and PR/MW15), which showed • TPH/BTEX/PAHs – results low or <ANZECC 2000 95% marine trigger values (concentrations not given). • Heavy metals – results exceeding ANZECC 2000 95% marine trigger values for chromium (WP/MW8), copper (WP/MW8), and zinc (3 wells). _____ Based on the Site Audit Report (Environ 2011), the western portion of the site has contamination issues including petroleum hydrocarbon and PAH contamination in soil. This contamination has been capped with a geofabric marker layer and a 0.5 m cap of soil. Groundwater quality is considered to be consistent with that across the Honeysuckle Precinct and consistent with the contamination status of fill across the area.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of PAHs. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are likely within acceptable range for discharge to sewer. Discharge to the Throsby Creek section of the port, or stormwater may be possible if hydrocarbon and PAH concentrations are shown to remain below the limit of reporting or ANZECC guideline trigger values (or if treatment is undertaken), and), and if suitable justification can be provided to the relevant authority that the environmental risk posed by slightly elevated zinc concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if historic contamination levels are shown to persist. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines. Some pre-treatment may be required to remove PAHs and TRH from the waters prior to reinjection.

Parameter	Description
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the site. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs, and justification of zinc concentrations. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs, and justification of zinc concentrations.

Table C: Site Summary – Lee Wharf 4

Parameter	Description
SITE STATUS	
Site Name:	Lee Wharf 4
Sub-Precinct:	1
Lot/DP:	Part Lot 2000 DP 1145678
Lot Size:	Approximately 7 644 m^2 [1]
Address:	Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	B4 - Mixed Use and RE1 Public Recreation (LEP 2012[2])
Current Land Use:	Vacant land (NearMap 2015[3])
Existing Site Cover:	Bitumen or concrete (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the Site Audit Report (Environ 2007[4]), the site's general geological profile is as follows: • 0 to 1.0 – Fill: gravelly sand, slag and concrete; • 1.0 to 3.0 – Fill: grey to yellow sands with gravel, some clay; • 3.0 to 4.0 – Fill: Grey sand with shell fragments; and • 4.0 to 5.0 – Natural: alluvial sand or clayey sand with organic material.
Hydrology/Drainage:	Given the general bitumen/concrete surface, infiltration is expected to be limited. Surface water is likely to flow into Newcastle Harbour to the north of the site, or to the northwest into the floodway before being directed to the harbour (JBS 2007[5]).
Hydrogeology:	Groundwater is tidally influenced and was encountered at approximately 2 mbgs (Environ 2007).
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs, heavy metals, asbestos
Number of groundwater wells	Historically (6 in total): • PB (2002c) – L4/MW2 and L4/MW13; • PB (2003) – L4/MW19 and L4/MW20; • JBS (2007a) – MW07/1 and MW07/2 Active currently: unknown whether any monitoring wells remain in service on the site.

1 Environ Australia (Environ) (2013), *Environmental Management Plan, Temporary Footpath Extension, Honeysuckle Precinct, Newcastle,* 11 December 2013, Ref: AS130357

2 *Newcastle Local Environmental Plan* 2012

3 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/

4 Environ Australia (Environ) (2007), *Site Audit Report, Remediation Action Plan, Lee 4, Honeysuckle Drive, Newcastle*, December 2007, Ref: AS120642A

5 JBS Environmental (JBS) (2007), *Remedial Action Plan, Lee 4, Part Lot 230 DP 1094812, Honeysuckle Dr, Newcastle NSW 2300,* October 2007, Ref: JBS40184-11574

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: PB (2002c): • TPH/BTEX - <LOR • PAHs – Total PAHs concentrations of 14 μg/L and 7 μg/L exceed NSW EPA guideline (3 μg/L) for assessing service station sites; and fluoranthene concentrations of 3 μg/L in each well marginally exceed low reliability trigger value of 1.4 μg/L (ANZECC 2000). • Heavy Metals – copper, lead and zinc concentrations marginally exceed ANZECC 2000 95% marine ecosystem criteria PB (2003): • BTEX - <LOR • TPH - <LOR or below criteria • PAHs - <LOR in one sample (L4/MW20); but in sample from L4/MW19: Total PAHs concentration of 15 μg/L exceeds NSW EPA guideline (3 μg/L) for assessing service station sites; and fluoranthene concentration of 8 μg/L marginally exceeds low reliability trigger value of 1.4 μg/L (ANZECC 2000). • Heavy Metals - <LOR or below criteria JBS (2007a): • BTEX - <LOR • TPH - <LOR or below criteria • PAHs – phenanthrene (in 1 sample – 1.1 μg/L); anthracene (2 samples – up to 0.4 μg/L); fluoranthrene (3 samples – up to 2.6 μg/L); and benzo(a)pyrene (1 sample – 0.2 μg/L) detected above the adopted criteria. Its noted that in the absence of high reliability trigger values in ANZECC 2000, JBS adopted the detection limit as the screening criteria. • Heavy metals – either <LOR or below criteria, with the exception of samples from well "OldMW1" and MW07/1 which had concentrations of manganese reported above the ANZECC 2000 95% marine ecosystem criteria. _____ A Remedial Action Plan (JBS 2007) has been developed for the site, however no remediation has been conducted. Contamination issues previously identified and summarised in Environ (2013) include PAH and manganese contamination within shallow fill soils across the site. It is also noted that soil stockpiles were present on the site.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.

Parameter	Description
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of PAHs. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are likely within acceptable range for discharge to sewer. Discharge to the Throsby Creek section of the port, or stormwater may be possible if hydrocarbon and PAH concentrations are shown to remain below the limit of reporting or ANZECC guideline trigger values (or if treatment is undertaken), and if a suitable degree of risk analysis can show the environmental risk posed by slightly elevated manganese concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if historic contamination levels are shown to persist. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines. Some pre-treatment may be required to remove PAHs from the waters prior to reinjection.
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**:

Parameter	Description
	Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.

Table D: Site Summary – Lee Wharf 5

Parameter	Description
SITE STATUS	
Site Name:	Lee Wharf 5
Sub-Precinct:	1
Lot/DP:	Part Lot 230 DP 1094812
Lot Size:	Approximately 4 373 m^2 [1]
Address:	Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	B4 Mixed Use and RE1 Public Recreation (LEP 2012[2])
Current Land Use:	Commercial building and carpark to the west, with remaining site vacant (NearMap 2015[3])
Existing Site Cover:	Asphalt and concrete (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the Site Audit Report (Environ 2008[4]), the site's general geological profile is as follows: • 0.0 to 0.7m – Fill: gravelly sand, fine basalt gravels, slag and concrete; • 0.7 to 2.5 m – Fill: grey to yellow dredged sands with gravels, some clay, organic matter and wood fragments; and • 2.5 to >4.5 m – Natural: alluvial brown clayey sand.
Hydrology/Drainage:	Stormwater is likely to flow to the northeast towards Newcastle Harbour (the nearest surface water receptor) (JBS 2007[5]).
Hydrogeology:	Groundwater is tidally influenced and was encountered at approximately 2 mbgs (Environ 2008).
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs, heavy metals.
Number of groundwater wells	Historically (3 identified): • PB (2002d) – L5/MW5; • PB (2003) – L5/MW11; • JBS (2007) –MW07/2 Active currently: unknown whether any monitoring wells remain in service on the site.

1 Environ (2008), *Site Audit Report Remediation Action Plan, Lee 5, Honeysuckle Drive, Newcastle*, January 2008, Ref: 31-0642B

2 *Newcastle Local Environmental Plan* 2012

3 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/

4 Environ Australia (Environ 2004), *Summary Site Audit Report, Remediation Action Plan, Lee 5, Honeysuckle Drive, Newcastle,* January 2008, Ref: 31-0642B

5 JBS Environmental (JBS) (2007b), *Remedial Action Plan, Lee 5, Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle, NSW,* October 2007, Ref: JBS 40184-11629

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: PB (2002d): • TPH/BTEX/PAHs - <LOR • Heavy metals – either <LOR or below criteria PB (2003): Report not cited directly, however RCA RAP (2003) summarised the PB (2003) findings as "metals detected were considered indicative of the natural regional conditions and the PAH contamination was not detected in the down gradient bores". JBS (2007): • TPH/BTEX - <LOR • PAHs – Fluoranthene exceeded the adopted criteria in one sample, otherwise PAHs <LOR or below criteria. • Heavy metals – zinc and arsenic exceed ANZECC criteria, otherwise either <LOR or below criteria. _____ Based on groundwater investigations conducted at the site, it is considered that invasive remediation methods are unnecessary. The removal of impacted fill material during remediation is considered satisfactory to reduce the risk of contaminant migration (Environ 2008). A Remedial Action Plan for the site has been completed (JBS 2007), however no remediation has been conducted.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of PAHs. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are likely within acceptable range for discharge to sewer. Discharge to the Throsby Creek section of the port, or stormwater may be possible if hydrocarbon and PAH concentrations are shown to remain below the limit of reporting or ANZECC guideline trigger values (or if treatment is undertaken), and if suitable justification can be provided to the relevant authority to demonstrate that the slightly elevated zinc and arsenic concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if historic contamination levels are shown to persist. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines. Some pre-treatment may be required to remove PAHs and TRH from the waters prior to reinjection.

Parameter	Description
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.

Table E: Site Summary – Lee 5 South

Parameter	Description
SITE STATUS	
Site Name:	Lee 5 South
Sub-Precinct:	1
Lot/DP:	Lot 22 DP1072217, part Lot 2000 DP 1145678, and part Lot 100 DP 1096718
Lot Size:	Approximately 5 535 m^2 (Sixmaps 2015[1]). Including approximately 733 m^2 of floodway and areas immediately to the west and east of the floodway (50 m wide, including floodway) (HDC 2015[2])
Address:	Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	Flood way and areas immediately adjacent are zoned as RE1 – Public Recreation. The eastern grassed lot is zoned B3 – Commercial Core (LEP 2012[3])
Current Land Use:	Open space and floodway (NearMap 2015[4])
Existing Site Cover:	Most of the site is covered by grass (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in Douglas Partners (DP 2013[5]), the site's general geological profile is as follows: • 0 to 3.1 – Fill: Gravelly sand/gravelly clay/clayey sand, including ash, coal chitter, shell, and traces of brick and scrap metal; • 3.1 to 6 – Natural: alluvial soils; • 6 to 15 – Natural: medium dense to dense sand; and • >15 – Natural: stiff to hard clay with bedrock.
Hydrology/Drainage:	Stormwater is likely to flow into Cottage creek, located to the west of the site, and discharge into Newcastle Harbour (the nearest surface water receptor).
Hydrogeology:	Groundwater was encountered at approximately 2 mbgs, and generally flows in a north-easterly direction towards Newcastle Harbour. Tidal influences are expected to be present on the site (PB 2003[6]).
Contaminants of Potential Concern (COPCs):	Asbestos, petroleum hydrocarbons, PAHs, heavy metals.
Number of monitoring wells	Historically (7 identified): PB (2002e) – LS/MW5 Environ (2004) – B1, B2, and B3; BH1, BH2, and BH3 Active currently: unknown whether any monitoring wells remain in service on the site.

1 Sixmaps, https://maps.six.nsw.gov.au/, viewed 7 October 2015
2 Honeysuckle Development Corporation (HDC) (2015), *Constraints Plan*, 15 July 2015
3 *Newcastle Local Environmental Plan* 2012
4 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/
5 Douglas Partners (DP) (2013), *Report on Resource Recovery Exemption Feasibility Assessment – Proposed Reuse of Surplus Materials, Lot 22, Honeysuckle Drive, Newcastle*, December 2013
6 Parsons Brinckerhoff (PB) (2003), *Additional Groundwater Investigation, Honeysuckle, NSW,* April 2003

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: PB (2002e): • TPH/BTEX - <LOR • PAHs – fluoranthene exceeds the ANZECC low reliability trigger value; otherwise PAHs below criteria or LOR • Heavy metals – either <LOR or below criteria Environ (2004): summarises reports by PB and RCA (each from 2003) which JBS&G has not sited: • BTEX and TPH (C6-C9) - <LOR; TPH C29-C26 was detected at a low level in one of the down-gradient wells. • PAHs – elevated above ANZECC low level guidelines in up-gradient wells, and concluded that PAH impacts likely occurring due to off-site and up-gradient sources. • Heavy metals - likely that the source of elevated levels of heavy metals detected in the groundwater is located off-site and up-gradient, or are the result of a widespread regional source. • groundwater located approximately 3 mbgs at the site. • there is contamination in groundwater which appears to be migrating onto the site and could pass under the site. _____ Douglas Partners (2013) indicated that fill was not suitable for off-site reuse without further investigation. Contaminants are considered to be associated with former rail and port site uses and filling. Filling of the site was from sandy soils derived from other Honeysuckle sites in the area, which contained elevated PAH levels. However during remediation, delineation works identified that it was not feasible to remediate the sandy fill soils due to remaining hotspots occurring randomly, making them difficult to identify. The site is capped, and therefore RCA (2004b[7]) indicated that the site was suitable for commercial development as long as the Site Management Plan is adhered to. In addition, RCA (2004b) considered the elevated concentrations in groundwater at the site to be attributable to upgradient sources or are typical of regional conditions.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.

[7] RCA Australia (RCA) (2004), *Implementation of Remedial Action Plan – Lot 22 and Part Lot 23, Lee 5 South, Honeysuckle Development Estate,* April 2004

Parameter	Description
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of TPHs, PAHs and heavy metals. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are within acceptable range for discharge to sewer. Discharge to stormwater may be possible if treatment is undertaken to reduce hydrocarbon and PAH concentrations to below the ANZECC guideline trigger values, and if a suitable degree of risk analysis can show the environmental risk posed by slightly elevated heavy metal concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if treatment is undertaken. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines.
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).

Parameter	Description
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.

Table F: Site Summary – Wickham Urban Village

Parameter	Description
SITE STATUS	
Site Name:	Wickham Urban Village
Sub-Precinct:	1
Lot/DP:	Part Lot 2000 DP 1145678[1] [2]
Lot Size:	Approximately 12 000 m² [2] [3]
Address:	Off Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	B3 – Commercial Core (LEP 2012[4])
Current Land Use:	Vacant lot with some old structures and a road cutting through the site (NearMap 2015[5])
Existing Site Cover:	Majority of the site is covered by grass with some old structures and a concrete / bitumen roadway (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the RAP (GHD 2011[6]) Site Audit the general geological profile is as follows: • 0 to 2.7 m (generally less than 1.5 m) – Fill: sands and deleterious materials including slag (Zone 1); • 1.5 to 2.7 m – Fill: sand (Zone 2); and • 2.7 to 4 m – Fill: clayey sand (Zone 3).
Hydrology/Drainage:	Stormwater is likely to flow from the site towards Cottage Creek that subsequently discharges into Newcastle Harbour (the nearest surface water receptor) (GHD 2011).
Hydrogeology:	Groundwater was encountered at approximately 2 to 3 mbgs and is inferred to flow towards Newcastle Harbour (Environ 2014[7]).
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs, heavy metals, asbestos.
Number of monitoring wells	Historically (9 identified): DP (2002) – BH1, BH3, BH4, and BH5; DP (2005) – Bore 101, Bore 102, Bore 103, Bore 104, and Bore 108. Active currently: unknown whether any monitoring wells remain in service on the site.

1 It is noted that the Wickham Urban Village has previously included areas now considered to be part of the Throsby site (Area 2 and the Throsby Carpark). This summary considers the site to be the area formerly identified as Areas 3 to 8 in the Wickham Urban Village.

2 Only Areas 3 to 8 are considered in this site summary.

3 JBS Environmental (2011a), *Supplementary Environmental Site Assessment Wickham Urban Village and Honeysuckle Drive, Newcastle, NSW*, April 2011

4 *Newcastle Local Environmental Plan* 2012

5 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/

6 GHD (2011), *Site Audit of Remediation Action Plan Wickham Urban Village and Honeysuckle Drive, Newcastle NSW*, October 2011

7 Environ (2014), *Environmental Management Plan, Wickham Urban Village, Honeysuckle Precinct, Newcastle*, 11 March 2014

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: DP (2002): • TRH/BTEX/OCPs/PCBs - <PQL • PAHs – generally <PQL, except 2 samples at BH1 and BH4, where concentrations of Total PAHs of 4 μg/L and 31 μg/L respectively were reported, exceeding the NSW EPA (1994) guideline (3 μg/L). • Heavy Metals – sample results exceeded ANZECC 2000 95% marine criteria for zinc and copper in BH4, otherwise <PQL or below criteria. DP (2005): • TRH/BTEX - <PQL • PAHs – generally <PQL, excepting 2 samples at Bore 101 and Bore 108, where concentrations of Total PAHs of 5.15 μg/L and 6.18 μg/L respectively were reported, marginally exceeding the NSW EPA (1994) guideline (3 μg/L). • Heavy Metals – sample results exceeded ANZECC 2000 95% marine criteria for chromium, copper, nickel and zinc, otherwise <PQL or below criteria. • Also noted that one sample was collected from Newcastle Harbour, which reported concentrations of COPCs, where detectable, generally higher than or similar to, those reported for groundwater samples. _____ Douglas Partners concluded that site soils are not contributing to groundwater impact which also appears to be having minimal impact on receiving waters, and as a consequence that remediation of soils to protect groundwater or of groundwater to protect receiving waters was not necessary (DP 2005). The Summary Site Audit Report prepared by CM Jewell and Associates (CMJA 2005) agreed with this conclusion, further stating that the "risk to groundwater and to surface-water ecosystems have been shown to be minor". Subsequent audit reports prepared by Environ (2007) and GHD (2011) agree with this conclusion.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.

Parameter	Description
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of TPHs, PAHs and heavy metals. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are within acceptable range for discharge to sewer. Discharge to stormwater may be possible if treatment is undertaken to reduce hydrocarbon and PAH concentrations to below the ANZECC guideline trigger values, and if a suitable justification can be provided to show that the environmental risk posed by slightly elevated heavy metal concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if treatment is undertaken. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines.
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).

Parameter	Description
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.

Table G: Site Summary – Throsby

Parameter	Description
SITE STATUS	
Site Name:	Throsby
Sub-Precinct:	1
Lot/DP:	Part Lot 2000 DP 1145678[1]
Lot Size:	Majority of the site is approximately 2.57 hectares (ha) (Environ 2008[2]). The area formerly known as Area 2 of the Wickham Urban Village is approximately 2000 m^2 (JBS 2011[3]).
Address:	Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	B4 - Mixed Use (LEP 2012[4])
Current Land Use:	Carpark and storage area (NearMap 2015[5])
Existing Site Cover:	Bitumen or concrete (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the Site Audit Report (Environ 2008), the general geological profile is as follows: • 0 to 1.0 m – Fill: gravelly sand, dark brown slag and concrete; • 1.0 to 2.8 m – Fill: sand to clayey sand with slag (final depth varies across the site however, terminates immediately above the water table); and • >2.8 m – Alluvial sand or clayey sand, brown with organic material, wood fragments and coal seams. These dredged materials are located closer to the surface at the boundary with the Newcastle Harbour.
Hydrology/Drainage:	Stormwater is likely to flow into the Cottage Creek stormwater channel that discharges into Newcastle Harbour (the nearest surface water receptor) (JBS 2007[6]).
Hydrogeology:	Groundwater is assumed to be tidally influenced and was encountered at approximately 1.7 m at the southern end and 2.8 m at the northern end of the site. It is inferred that groundwater from the site flows into Newcastle Harbour (Environ 2008).
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs, heavy metals, asbestos.
Number of groundwater wells	Historically (7 identified): PB (2002f): TH/MW2, TH/MW9, TH/MW24, and TH/MW30; JBS (2007b): MW07/1, MW07/2, and MW07/3. Active currently: unknown whether any monitoring wells remain in service on the site.

1 It includes the area formerly known as Area 2 and the Throsby Carpark in the Wickham Urban Village.

2 Environ (2008), *Site Audit Report Remediation Action Plan Throsby, Honeysuckle Drive, Newcastle for Honeysuckle Development Corporation*, February 2008

3 JBS (2011), *Remedial Action Plan Wickham Urban Village and Honeysuckle Drive, Newcastle, NSW*, April 2011

4 *Newcastle Local Environmental Plan* 2012

5 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/

6 JBS (2007), *Remedial Action Plan, Honeysuckle Development Corporation, Throsby Part Lot 230 DP 1094812, Honeysuckle Drive, Newcastle NSW*, October 2007

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: PB (2002f): • TPH/BTEX/PAHs - <LOR or below criteria. • Heavy Metals – cobalt (2 of 4 samples), chromium (1 sample), copper (3 samples), lead (1 sample), and zinc (3 samples) exceed ANZECC 95% marine ecosystem criteria. JBS (2007b): • TPH/BTEX - <LOR or below criteria. • PAHs – fluoranthene and benzo(a)pyrene marginally exceed adopted criteria (i.e. laboratory PQL) in one sample (TH/MW02), otherwise below criteria. • Heavy Metals – arsenic (2 of 7 samples) and manganese (6 samples) exceed ANZECC 95% marine ecosystem criteria in samples from across the site. _____ Environ (2008): • Groundwater on the site is noted to have concentrations of metals and PAHs above the adopted ecological criteria. • Notes that RAP (JBS 2007c) conclusions and recommendations generally appropriate It is noted that remediation in line with the RAP (JBS 2007c) of the site has not occurred as of early-2017.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of TPHs, PAHs and heavy metals. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are within acceptable range for discharge to sewer. Discharge to stormwater may be possible if treatment is undertaken to reduce hydrocarbon and PAH concentrations to below the ANZECC guideline trigger values, and if suitable justification can be provided that shows the environmental risk posed by slightly elevated heavy metal concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if treatment is undertaken. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines.

Parameter	Description
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.

Table H: Site Summary – Fig Tree Park

Parameter	Description
SITE STATUS	
Site Name:	Fig Tree Park
Sub-Precinct:	1
Lot/DP:	Lot 105 DP 1015391
Lot Size:	Approximately 8 652 m^2 (HDC 2015[1])
Address:	81 Hannell Street, Wickham, NSW, 2293
Local Government Authority:	Newcastle City Council
Site Zoning:	RE1 – Public Recreation (LEP 2012[2])
Current Land Use:	Open space (NearMap 2015[3])
Existing Site Cover:	Mostly grass covered with a concrete / bitumen road (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the Site Audit Report Summary (Environ 2004[4]), the Stage 1 (northern) area general geological profile is as follows: • 0 to 1.4 m – Fill: Silty sand with occasional rubble, brick fragments and concrete; • 1.5 to 2.5 m – Fill: Sand with minor gravel including brick, concrete, rock and shell; and • >2.5 m – Natural: alluvial sands with occasional gravel. Based on RCA (2008[5]) the Stage 2 (southern) area has a similar lithology.
Hydrology/Drainage:	Stormwater is likely to flow east towards Newcastle Harbour (the nearest surface water receptor) (RCA 2006).
Hydrogeology:	In the northern portion of the site, groundwater was encountered at approximately 2 mbgs (RCA 2006[6]). In the south of the site, groundwater was deeper at approximately 2.5 to 3.0 mbgs (RCA 2004[7]). Groundwater generally flows in an easterly direction towards the Throsby Basin section of Newcastle Harbour.
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs including benzo(a)pyrene, and heavy metals are the main COPCs in Fig Tree Park, mainly restricted to the Stage 2 area. However, remaining TPH and PAH impacts following remediation in Stage 1 area are of concern near the seawall to the east and Mariner to the north. Further excavation in these areas was not possible during remediation.
Number of monitoring wells	Historically (6 identified): • PB (2002g) – FT/MW2 and FT/MW11; • RCA (2003) – BH1 and BH2; and • RCA (2004c) – BH3 and BH4. Active currently: unknown whether any monitoring wells remain in service on the site.

1 Honeysuckle Development Corporation (HDC) (2015), *Constraints Plan*, 15 July 2015
2 *Newcastle Local Environmental Plan* 2012
3 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/
4 Environ (2004), *Summary Site Audit Report – Honeysuckle Development Fig Tree Park Stage 1*, June 2004
5 RCA Australia (2008), *Environmental Management Plan – Fig Tree Park Stage 2, Honeysuckle Development Estate,* February 2008
6 RCA Australia (RCA) (2006), *Groundwater Monitoring and Validation DRAFT – Fig Tree Park Stage 1 Works, Honeysuckle Development Estate*, September 2006
7 RCA Australia (RCA) (2004), *Remedial Action Plan, Fig Tree Stage 2 Honeysuckle Development Estate*, February 2004

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: PB (2002g) • TPH – elevated within FT/MW2 (C15-C36) • BTEX/PAHs - <PQL • Heavy Metals – arsenic, copper and nickel elevated in FT/MW2 and cobalt, copper and zinc elevated in FT/MW11 above ANZECC 2000 95% marine ecosystem criteria. RCA (2003 – report not seen by JBS&G): A separate report by RCA (2006) summarised the findings of the RCA (2003) investigation as follows: • Results show that TPH and PAH levels are elevated in the area of the TPH hot spot within Stage 1 (northern portion of the site) and heavy metals are elevated in all bores. • The groundwater collected from BH2 contained both visual and olfactory evidence of fuel based contamination. RCA (2004c): Results of groundwater monitoring in Stage 2 (southern portion of the site): • TPH/BTEX below laboratory detection limits, • PAH concentrations either below the relevant guidelines or below laboratory detection limits. • Heavy Metals - elevated concentrations of heavy metals, particularly arsenic and zinc and to a lesser extent copper. RCA (2006b): • Presents the results of 8 monitoring rounds implemented at BH2 within Stage 1 following hot spot remediation (excavation and off-site disposal). • Results indicated that TPH and PAH concentrations had decreased significantly since the remediation works. However, benzo(a)pyrene and fluoranthene concentrations did exhibit a slight increase in the final monitoring round, conducted in January 2006. RCA (2008): • Presents the results of a monitoring round implemented at BH4 within Stage 2, which was the only bore identified as serviceable at the time. • Results indicated groundwater results (TPH/PAH/Heavy metals) were below the site criteria with the exception of cadmium, which was slightly above the guideline. _____ In the Stage 1 area (northern portion of the site), remedial works removed approximately 1200m^3 of PAH contaminated material, and approximately 900m^3 of TPH contaminated material. Groundwater remediation – in the form of a pump and treat system – was also conducted in the TPH excavation to reduce TPH and PAH concentrations (Environ 2004). Following remediation, the northern portion of the site was considered suitable for residential with minimal access to soil, recreational open space and commercial / industrial use, with the condition that abstraction of groundwater is prohibited other than for monitoring. This was due to the residual contamination near the sea wall and other remaining contaminants occurring at significant depth. It is understood that the area of residual contamination will be used for open space purposes (including a paved promenade) (Environ 2004). The Stage 2 area has not been remediated. PAH impacts have been identified in shallow fill soils, with the main contaminant of concern known to be benzo(a)pyrene (Environ 2013[8]).

[8] Environ (2013), *NEPM 2013 Review – Five Sites in the Honeysuckle Precinct*, 5 December 2013

Parameter	Description
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed almost a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of TPHs, PAHs and heavy metals. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are within acceptable range for discharge to sewer. Discharge to stormwater may be possible if treatment is undertaken to reduce hydrocarbon and PAH concentrations to below the ANZECC guideline trigger values, and if suitable justification can be provided that shows the environmental risk posed by slightly elevated heavy metal concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if treatment is undertaken. Water injected during such activities should be shown to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines.

Parameter	Description
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.

Table I: Site Summary – Lee Wharf Stage 4 and 5

Parameter	Description
SITE STATUS	
Site Name:	Lee Wharf Stage 4 and 5
Sub-Precinct:	2
Lot/DP:	Lots 1 to 3 DP 1163346
Lot Size:	Approximately 8 546 m^2 (HDC 2015[1])
Address:	Honeysuckle Drive, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	B4 - Mixed Use (LEP 2012[2])
Current Land Use:	Open space (NearMap 2015[3])
Existing Site Cover:	Grass cover (NearMap 2015)
Lithology and Expected Depth of Fill Material:	Based on Coffey (2013[4]), the site's general geological profile is as follows: • 0 to 1.9m – Fill: gravelly sand, including coal and slag; and • 2.0 to >4.0 m - Alluvial saturated sand including shell fragments.
Hydrology/Drainage:	Stormwater is likely to flow north into a stormwater system that discharges into Newcastle Harbour (the nearest surface water receptor).
Hydrogeology:	Groundwater is tidally influenced and was encountered between 2 to 3 mbgs (Coffey 2008).
Topography:	Less than 10 mAHD.
Contaminants of Potential Concern (COPCs):	Petroleum hydrocarbons, PAHs, heavy metals, asbestos. It is noted that an electrical substation was noted to be present at the site in 1993. Although Coffey reported PCB concentrations below the LOR, there is the potential that these samples were not collected from the area near the former substation. As such, PCB is considered to be a COPC in the former electrical substation areas.
Number of monitoring wells	Historically (5 identified): DP (1993): one adjacent to the site boundary (P45); RCA (1998a): GW1; RCA (1998b): GW1; Coffey (2004): BHE20 and BHE21 Active currently: unknown whether any monitoring wells remain in service on the site.

1 Honeysuckle Development Corporation (HDC) (2015), *Constraints Plan*, 15 July 2015
2 *Newcastle Local Environmental Plan* 2012
3 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/
4 Coffey Environments Australia (Coffey) (2013), *Summary of Previous Contamination Assessments, Honeysuckle Central, Honeysuckle Drive, Newcastle, NSW*, 17 May 2013, Ref: 20903AD-AD

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: DP (1993): Results indicated groundwater contamination was minor, with concentrations generally decreasing along the inferred flow lines, from background to down-gradient bores, with the exception of arsenic and cadmium. However, DP recommended further testing to better characterise the nature and extent of groundwater contamination issues. Golders (1993) – results of this study were summarised in a Woodward-Clyde report (1996), which concluded that contamination levels in the study area were similar to those identified to the east by DP (1993). RCA (1998a): • TPHs/BTEX/PAHs/OCPs/PCBs – non detect; • Heavy metals – only copper (8 μg/L) and zinc (89 μg/L) concentrations identified as elevated in comparison to ANZECC 2000 95% marine ecosystem criteria. RCA (1998b): • TPHs/BTEX/PAHs/OCPs/PCBs – non detect; • Heavy metals – copper (18 μg/L) and zinc (112 μg/L) concentrations identified as elevated in comparison to ANZECC 2000 95% marine ecosystem criteria. Coffey (2004) - Reported not seen by JBS&G, but summarised in Coffey (2013), as follows: The results showed concentrations of contaminants below adopted criteria, with the exception of: • Copper exceeded the protection of 95% of species in a marine ecosystem guideline (1.3μg/L) in samples BHE20 (2μg/L) and BHE21 (3μg/L); • Zinc exceeded the protection of 95% of species in a marine ecosystem guideline (15μg/L) in sample BHE20 (145μg/L); _____ The contamination status summarised in Coffey (2013) indicates that fill up to 2m contains heavy metals, medium fraction petroleum hydrocarbons and PAHs above suitable levels for residential land use with limited soil access. Groundwater at the site contained heavy metal impacts, including copper, zinc, manganese and lead. An additional assessment of groundwater may be required depending on whether basements are proposed to be developed on the site. Coffey (2013) indicate that no remediation is proposed for the site. Instead, contamination will be managed by capping and a site management plan.
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed almost a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of groundwater may be limited by the presence of heavy metals. For example, it will be difficult to justify disposal to stormwater or via re-injection, given the concentrations of zinc observed at the site, which are almost 10 times the 95% ANZECC 2000 trigger value, and more than three times the 80% ANZECC 2000 trigger value. Concentrations of metals, BTEX, TPH and PAH observed in historical studies are within acceptable range for discharge to sewer.

Parameter	Description
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. Unlikely to require treatment for any COPCs reviewed (pH and other water quality parameters may require adjustment prior to disharge). **Discharge to stormwater/harbour**: Unlikely to be successful. **Re-injection into neighbouring property**: Unlikely to be successful.

Table J: Site Summary – Wright Lane and Wright Lane Carpark

Parameter	Description
SITE STATUS	
Site Name:	Wright Lane and Wright Lane Carpark
Sub-Precinct:	2
Lot/DP:	Lot 4 DP 1111305 (Wright Lane) and Lot 21 DP 1165985 (Wright Lane Carpark)
Lot Size:	Approximately 4 268 m^2 (Wright Lane) (HDC 2015[1]) and approximately 5 759 m^2 (Wright Lane Carpark) (Environ 2013[2])
Address:	Wright Lane and Wright Lane Carpark, Newcastle, NSW 2300
Local Government Authority:	Newcastle City Council
Site Zoning:	B4 - Mixed Use (LEP 2012[3])
Current Land Use:	Roadway and carpark (NearMap 2015[4])
Existing Site Cover:	Bitumen or concrete with a small, fenced off, grass covered area (i.e historical railway turntable (Environ 2013)) (NearMap 2015)
Lithology and Expected Depth of Fill Material:	**Wright Lane:** As stated in the PB ESA report (2002[5]), this portion of the site's general geological profile is as follows: • 0.1 to 1 m (max 4 mbgs) – Fill: light grey/brown/black, sandy gravel/gravely sand, fine to medium grained gravel; and • 1 to <5 m – Alluvial sand: dark grey/black/light brown, medium to coarse grained, some gravel and shell fragments. **Wright Lane Carpark:** As stated in the Site Audit Report (Environ 2013), this portion of the site's general geological profile is as follows: • 0 to 0.8 mbgs – Fill: sandy gravels, gravelly sands and silty sands containing ash, slag and coal fragments. Extends to 2.6 mbgs (below the water table) at around TP5 and RCABH5; and • 0.8 to >5 mbgs – Sands (medium grained, mostly saturated around 2.5m). It may be fill overlying natural sands.
Hydrology/Drainage:	Surface runoff is captured by the concrete drainage system and directed offsite through a series of stormwater drains towards the Hunter River (CH2MHill 2013[6] and Environ 2003[7]).
Hydrogeology:	**Wright Lane:** Groundwater is tidally influenced and is inferred to flow to the north towards Newcastle Harbour (Environ 2003) **Wright Lane Carpark:** Groundwater flows in a northerly direction toward the Hunter River. Flow rates are estimated to be between 9 to 13 m per year. Groundwater is considered to be brackish and unsuitable for use (Environ 2013).

1 Honeysuckle Development Corporation (HDC) (2015), *Constraints Plan*, 15 July 2015
2 Environ 2013, *Site Audit Report Wright Lane Car Park Newcastle*, 11 June 2013, Ref: AS121614
3 *Newcastle Local Environmental Plan* 2012
4 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/
5 Parsons Brinckerhoff (2002), *Environmental Site Assessment, Wright Lane, (Part Lot 9 DP 883474), Honeysuckle, NSW*, November 2002
6 CH2MHill (2013), *Wright Lane, Newcastle, NSW Environmental Management Plan*, Rev 1, 16 May 2013
7 Environ 2003, *Summary Site Audit Report Honeysuckle Development Wright Lane*, April 2003, Ref: 31-0069

Parameter	Description
Contaminants of Potential Concern (COPCs):	**Wright Lane:** Petroleum hydrocarbons, metals, polycyclic aromatic hydrocarbons (PAHs), and asbestos **Wright Lane Carpark:** Petroleum hydrocarbons, heavy metals, oils and grease, asbestos (Environ 2013). It is also considered that PCB is a COPC based on the presence of PCB at RCA BHI (0.5-0.6) and RCABH5 (0.5-0.6).
Number of groundwater monitoring wells	Historically (7 identified): DP (1993) – P45 and P47; PB (2002h) – WL/MW4 and WL/MW10; CH2M HILL (2012) – MW01, MW02, and MW03. Active currently: unknown whether any monitoring wells remain in service on the site.
Contamination Status:	Historic groundwater investigation summary: DP (1993): Results indicated groundwater contamination was minor, with concentrations generally decreasing along the inferred flow lines, from background to down-gradient bores, with the exception of arsenic and cadmium. However, DP recommended further testing to better characterise the nature and extent of groundwater contamination issues. PB (2002h): • TPH/BTEX/PAHs - <LOR • Heavy metals – copper marginally exceeded the ANZECC 95% marine ecosystem criteria in both samples (0.004 and 0.002 mg/L) and zinc in one sample (0.02 mg/L). CH2M HILL (2012): Groundwater samples collected had reported levels of contamination above the ANZECC 95% marine ecosystem criteria for zinc (15 μg/L) and copper (1.3 μg/L) in MW01 (16 μg/L) and MW03 (4 μg/L) respectively. The exceedances were only slightly above the adopted criteria and assessed as likely representative of local groundwater conditions. _____ In summary, the Environ Site Audit Report (2013) concludes the groundwater contamination status at the site is "consistent with the site history and soil concentrations. The results indicate that concentrations of some heavy metals are slightly above guidelines. … The Auditor considers that the groundwater investigations undertaken are sufficient to assess groundwater conditions and impacts to groundwater that may have occurred from the site."
Data gap assessment	JBS&G generally agrees with the conclusions of Environ (2013) in regards to the contamination status of groundwater within the Wright Lane and Wright Lane Carpark area. Given the data show the level of groundwater impacts remain relatively stable from 1993 through to 2012, it is considered that the most recent data provide a reliable basis on which groundwater management decisions could be made.
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal of untreated groundwater may be possible. Concentrations of metals, BTEX, TPH and PAH observed in historical studies are within acceptable range for discharge to sewer, and are likely to be acceptable to Newcastle City Council for disposal to stormwater and NSW DPI for re-injection.

Parameter	Description
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. Unlikely to require treatment for any COPCs reviewed (pH and other water quality parameters may need adjusting). **Discharge to stormwater/harbour**: Likely to succeed. Unlikely to require treatment for any COPCs reviewed (pH and other water quality parameters may need adjusting/treatment e.g. sediment). **Re-injection into neighbouring property**: Reasonably likely to succeed. Unlikely to require treatment for any COPCs reviewed (pH and other water quality parameters may need adjusting/treatment e.g. sediment).

Table K: Site Summary – Railway Infrastructure Building

Parameter	Description
SITE STATUS	
Site Name:	Railway Infrastructure Building (RIB)
Sub-Precinct:	3
Lot/DP:	Lot 2 DP 1037867
Lot Size:	Approximately 2 147m^2 (HDC 2015[1])
Address:	540 Hunter Street, Newcastle, NSW
Local Government Authority:	Newcastle City Council
Site Zoning:	B3 – Commercial Core (LEP 2012[2])
Current Land Use:	Carpark and open (grassed) space (NearMap 2015[3])
Existing Site Cover:	Bitumen or concrete in areas used for parking and grass cover in the remaining areas (NearMap 2015)
Lithology and Expected Depth of Fill Material:	As stated in the Site Audit Report (Environ 2011[4]), the site's general geological profile is as follows: • 0 to 0.2 - Concrete • 0.2 to 2.7 – Fill: sandy clay/silty sand, with building rubble, bricks, concrete, and some ash in western portion of the site; and • 2.0 to >4.5 – Natural: estuarine sands.
Hydrology/Drainage:	Stormwater is likely to flow north into a stormwater system that discharges into Newcastle Harbour (the nearest surface water receptor).
Hydrogeology:	Groundwater was encountered between 2 and 2.6 mbgs (Environ 2011).
Contaminants of Potential Concern (COPCs):	Asbestos, petroleum hydrocarbons, PAHs, heavy metals.
Number of groundwater monitoring wells	Historically (5 identified): RCA (1998a) – BH1 and BH2; and RCA (2006c) – S1, S3 and S4.

1 Honeysuckle Development Corporation (HDC) (2015), *Constraints Plan*, 15 July 2015
2 *Newcastle Local Environmental Plan* 2012
3 NearMap Imagery dated 8 May 2015, http://maps.au.nearmap.com/
4 Environ Australia (Environ) (2011), *Interim Advice Letter No. 1 – Review of Remedial Action Plan for 'RIB' Site, Hunter Street, Newcastle*, 27 May 2011, Ref: AS120468

Parameter	Description
Contamination Status:	Historical groundwater investigation summary: RCA (1998a), report not seen by JBS&G, but summary provided in RCA (2006): Elevated concentrations of metals (Copper, Lead and Mercury) were detected at both groundwater bores. All groundwater samples were analysed for metals, TPH, BTEX and PAH. RCA (1998b), report not seen by JBS&G, but summary provided in RCA (2006): Concentrations of metals discharging to the harbour were low, and groundwater contaminant levels were similar or lower than concentrations in the harbour, with the exception of Lead. The following conclusions were drawn: • The groundwater concentrations are generally typical of background levels in the Newcastle area, rather than from site specific sources. • The load of contaminants is minimal compared to the contaminant load from the stormwater system. • Soil contaminant levels at the Honeysuckle sites are generally not contributing to the groundwater concentrations. RCA (2006c): • BTEX – <LOR in all wells • TPH (C_6-C_{36}) – exceeded Dutch Intervention Value (600µg/L) adopted for the study in all three samples (1055µg/L, 2855µg/L and 1705µg/L) • Zinc results from all three wells exceeded ANZECC trigger values for the protection of 95% of marine species. • Arsenic and benzo(a)pyrene results from all three wells marginally exceeded ANZECC low reliability trigger values for the protection of 95% of marine species. _____ Remediation of groundwater was not considered required as elevated concentrations of TPH, PAHs, Arsenic and Zinc identified at the site are similar to background concentrations found in the Honeysuckle Precinct and generally across the Newcastle area, indicating that soil contamination at the site has not significantly contributed to groundwater contamination (Environ 2011).
Data gap assessment	Given the site history (JBS&G 2016), and the associated COPCs, JBS&G considers the status of groundwater quality to have been adequately characterised. However, it is noted that the assessments and subsequent audit statements were completed more than a decade prior to this review. While it is understood no site activities have occurred since that have the potential to significantly impact groundwater, the current status of groundwater is uncertain. Noting the above, a data gap exists in the current understanding of groundwater at the site due to the lack of contemporary data.

Parameter	Description
Options for groundwater management	If the contamination status is generally unchanged from that identified in historical investigations, then disposal options of untreated groundwater may be limited by the presence of PAHs and heavy metals. For example, detection of any PAHs above 0.001 mg/L will preclude discharge to sewer under Hunter Water Trade Waste Discharge Standards, if the discharge occurs for more than six months. For short term discharges of less than six months, Hunter Water *may* elect to adopt a higher allowable limit for otherwise prohibited discharges, including PAHs, so long as the discharge does not affect compliance of wastewater treatment plant operations. In such cases, Hunter Water will refer to the National Water Quality Management Strategy "Guidelines for Sewerage Systems – Acceptance of Trade Waste (Industrial Waste)" 1994. Concentrations of metals, BTEX and TPH observed in historical studies are within acceptable range for discharge to sewer. Treatment to remove PAHs may be required. Discharge to stormwater may be possible if treatment is undertaken to reduce hydrocarbon and PAH concentrations to below the limit of reporting or ANZECC guideline trigger values, and if suitable justification can be provided that shows the environmental risk posed by slightly elevated heavy metal concentrations is not unacceptable. Re-injection of water derived from de-watering activities into neighbouring properties may be acceptable if historic contamination levels are shown to persist. Water injected during such activities should be treated as with the stormwater disposal scenario so as to not impact on beneficial uses of the receiving aquifer, as well as generally meeting the ANZECC guidelines.
Approval requirements for management options	Where dewatering is required as part of the proposed development the approval authority is required to take into consideration potential impacts associated with the dewatering (and subsequent disposal/discharge) during the approval process. This consideration is required to include consultation/referral to other relevant authorities. **Dewatering**: Extraction of groundwater requires an approval from the NSW Department of Primary Industries (DPI) Water for a water supply works in accordance with the Water Management Act 2000. DPI requires information regarding water quality, flow rates, predicted drawdown, assessment of potential impacts of dewatering on adjacent water users/structures, disposal location, proposed monitoring program and evidence of approval for the proposed development. **Discharge to sewer**: For discharge to sewer a Trade Waste Agreement is required with Hunter Water Corporation. Recent experience indicates that water quality requirements can be flexible where the proposed discharge period is relatively short (i.e. less than six months). **Discharge to stormwater/harbour**: Discharge to stormwater is generally regulated by the asset owner, i.e. Newcastle City Council for the stormwater system in the vicinity of the Park Residential area. In the case that direct discharge to the harbour is required then the relevant authority is potentially the Port or EPA. **Re-injection into neighbouring property**: Re-injection of water is defined as an aquifer interference activity. As a result, an approval is required from NSW DPI Water. It is noted that where injection is proposed it will need to be identified as the disposal pathway during the application for a dewatering approval and will be assessed by DPI during this approval (i.e. a separate approval is unlikely to be required).

Parameter	Description
Likelihood of success	The following statements assume historical data is fully representative of current groundwater conditions at the site. Variation of any one compound may significantly alter the likelihood of success of the management options listed. **Discharge to sewer**: Reasonably likely to succeed. However, likelihood of success will be primarily influenced by flow rate issues, i.e. sewer diameter in vicinity of the development and its capacity to take water (beyond scope of this review), rather than contamination levels. Recent experience indicates that sewer discharge may require treatment to remove PAHs. **Discharge to stormwater/harbour**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs. **Re-injection into neighbouring property**: Reasonably likely to succeed. May require treatment to remove TRH/PAHs.