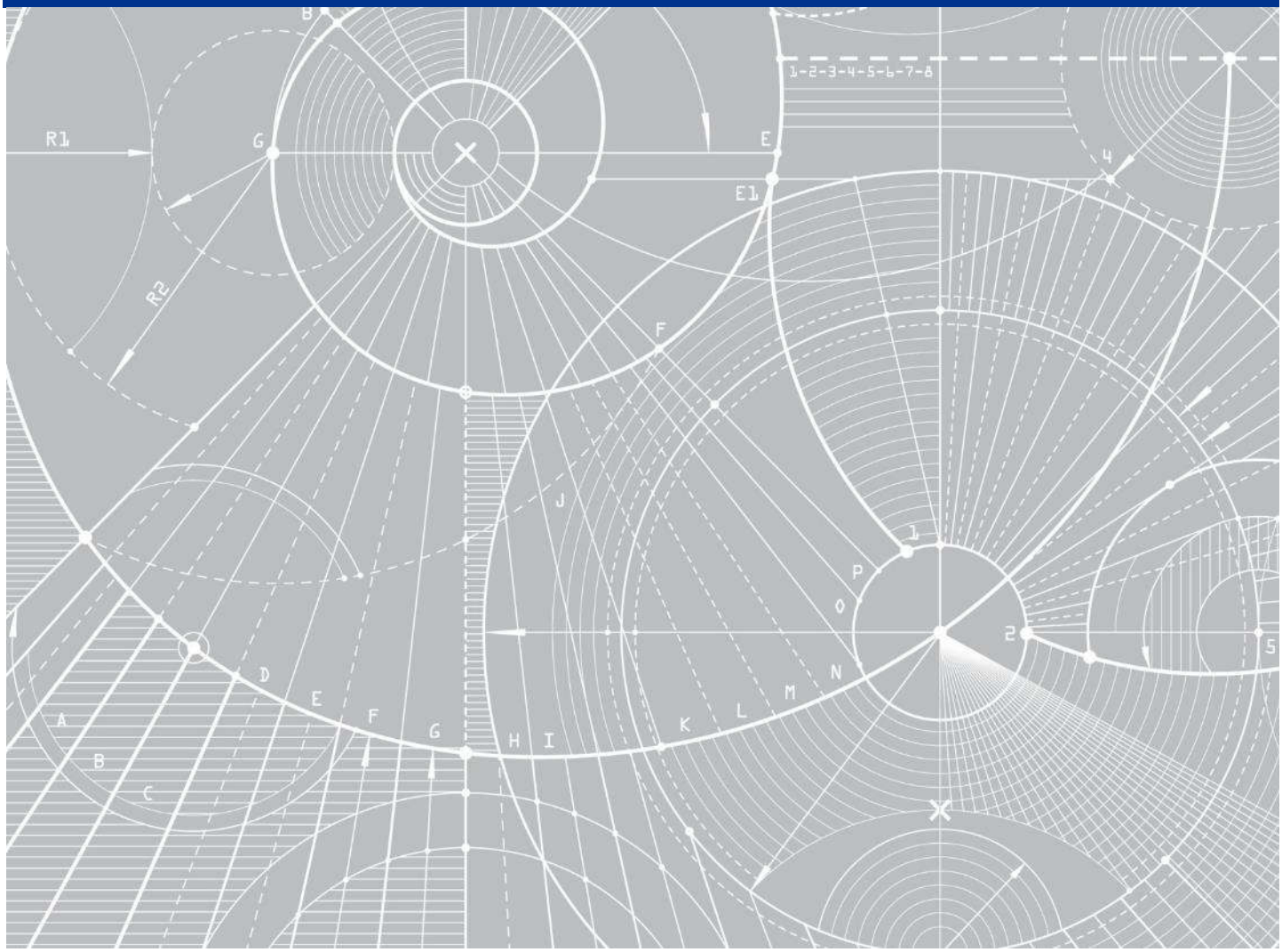
Site Audit Report 282 by Dr Ian Swane

REMEDIATION STRATEGY FOR PROPOSED GEORGES COVE MARINA DEVELOPMENT

AT 146 NEWBRIDGE ROAD, MOOREBANK NSW 2170

Final | 27 APRIL 2019



IAN SWANE & ASSOCIATES

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1. Introduction

1.1 Background Information

This Site Audit Report (SAR) contains the results of a Statutory Site Audit for the proposed Georges Cove Marina development (the 'Marina site'), which is to occupy the southern part of the Benedict Sand & Gravel Moorebank site ('Benedict site') at 146 Newbridge Road, Moorebank NSW 2170. The Benedict site is legally defined as Lot 7 in DP1065574, has an area of 222,740 m^2 (22.274 ha) and is located in the Liverpool City Council ("Council) local government area (LGA). A subdivision plan of the Benedict site is provided in **Figure 1-1** followed by a 2016 Google aerial photo in **Figure 1-2**. The Marina site is 13 ha in size and its location relative to the Benedict site shown in a January 2017 survey plan in **Figure 1-3**.

The Marina site is zoned for Public recreation (RE1), Private recreation (RE2) and Infrastructure Drainage (SP2) and is to be developed for a marina, commercial and apartment buildings, with the waterway to be connected to the Georges River. Benedict and Mirvac also propose to redevelop the northern part of the Benedict site for a residential subdivision, which is the subject of a separate site audit. The proposed layout of the Georges Cove Marina and northern residential subdivision is provided in **Figure 1-4**.

The audit has been undertaken by Dr Ian Swane (NSW EPA Accreditation No. 9821) in accordance with the NSW Contaminated Lands Management Act 1997 (as amended). For annual return purposes to the NSW EPA, the audit is number 282 in the records of the Site Auditor. The site audit was commissioned by Ernest Dupere from Benedict Industries Pty Ltd ('Benedict') on 7/07/15 and 9/11/18. The audit has been conducted in accordance with a proposal dated 2/07/15.

The Benedict site has a history of agricultural land use up to the mid-1980's, which included a dairy farm. The land use then changed to industrial, when it was used as a sand quarry that involved a dredging operation. Much of the northern part of the Benedict site was then used as a solid waste landfill (non-putrescible), which filled voids created by sand extraction by mainly demolition waste and raised the elevation of the groundsurface to reduce flood risks. The southern part of the Benedict site, which is the Marina site, continued to be used for sand extraction.

From 1997 the Marina site operated as Benedict Sand and Gravel. The northern part of the Benedict site was used as a materials recycling centre, with the industrial operations including among other things quarrying, importing raw materials, fuel storage in an above ground storage tank (AST) and dumping of waste materials. The southern part of the Benedict site continued to be used for sand extraction.

The Site Auditor checked the NSW EPA website[1] on 5/04/19 and found that the Marina site and land within 200 m of it were not recorded as having been Declared land. The closest regulated site was the ABB Australia industrial facility at 1 Bapaume, Moorebank, located some 4 km west-south-west of the Marina site.

The NSW EPA website also showed that the Benedict site had been reported to the NSW EPA as a suspected contaminated site under the CLM Act sometime between 2016 and 2017. A former landfill adjacent to the southern boundary of the Benedict site was also reported to the NSW EPA sometime after October 2018. No other land within 200 m of the Marina site had been reported to the NSW EPA.

All site audit work reported in this SAR has been undertaken by the Site Auditor, since all matters that needed to be audited and documented herein were within the expertise of the Site Auditor and no assistance was required from the Site Auditor's Audit Support Team.

The Site Auditor is also undertaking statutory site audits for the northern part of the Benedict site that is to be used for a residential subdivision and the former landfill adjacent to the southern boundary of the Marina site. A Section B SAS / SAR (Ref [77]) numbered 264B and dated 23/01/18 reviewed and approved a remediation strategy for the northern land. No SAS/SAR has yet been issued for the former landfill adjacent to the southern boundary of the Marina site.

[1] www.epa.nsw.gov.au/clm

Figure 1-1 Subdivision Plan of Benedict Site & Surrounding Area (Source: Appn C7, Ref [11])

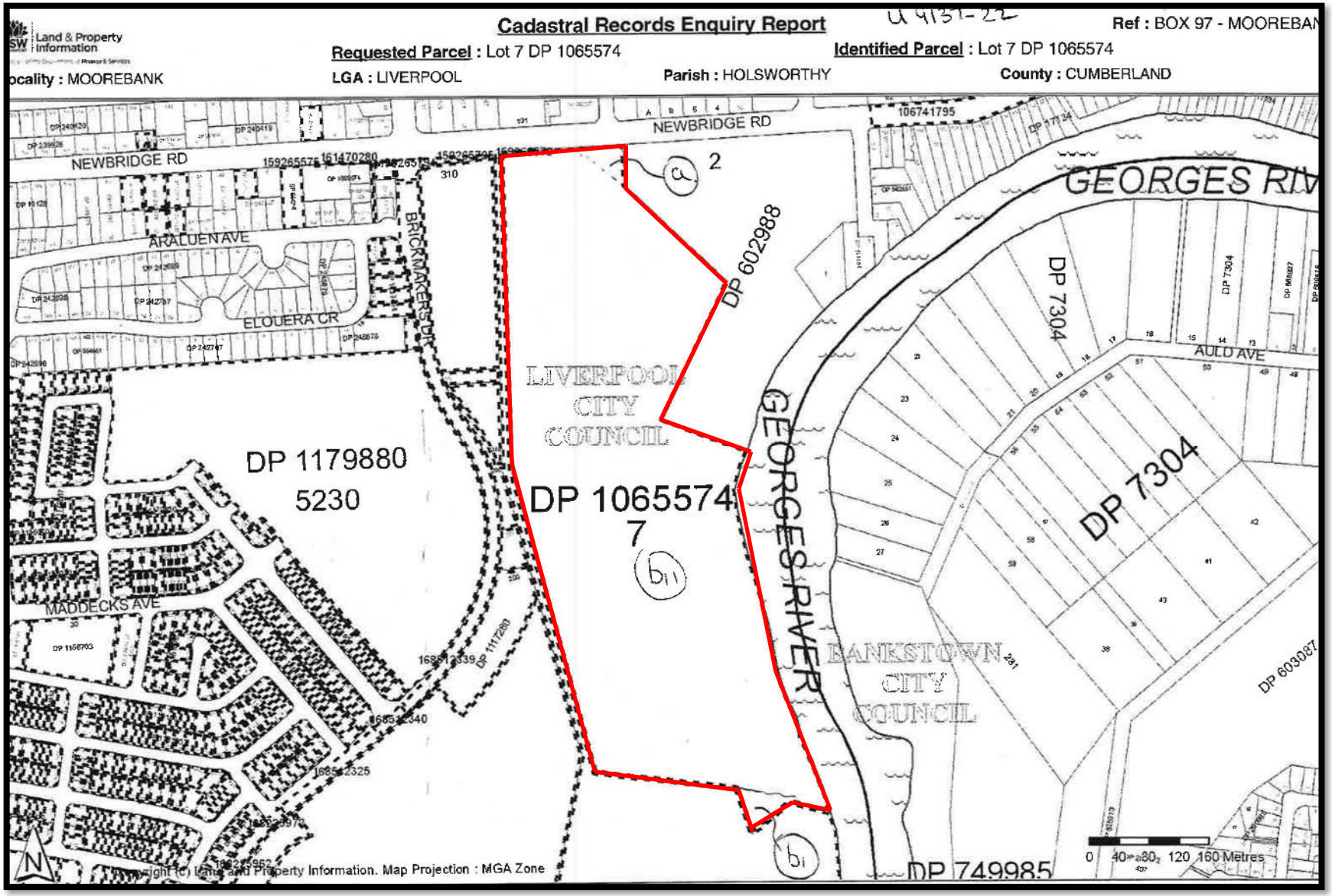


Figure 1-2 Google Aerial Photo of Benedict Site and Surrounding Land (Downloaded 5/04/19)

Figure 1-3 January 2017 Survey Plan of Benedict Site (Source: Ref [80])

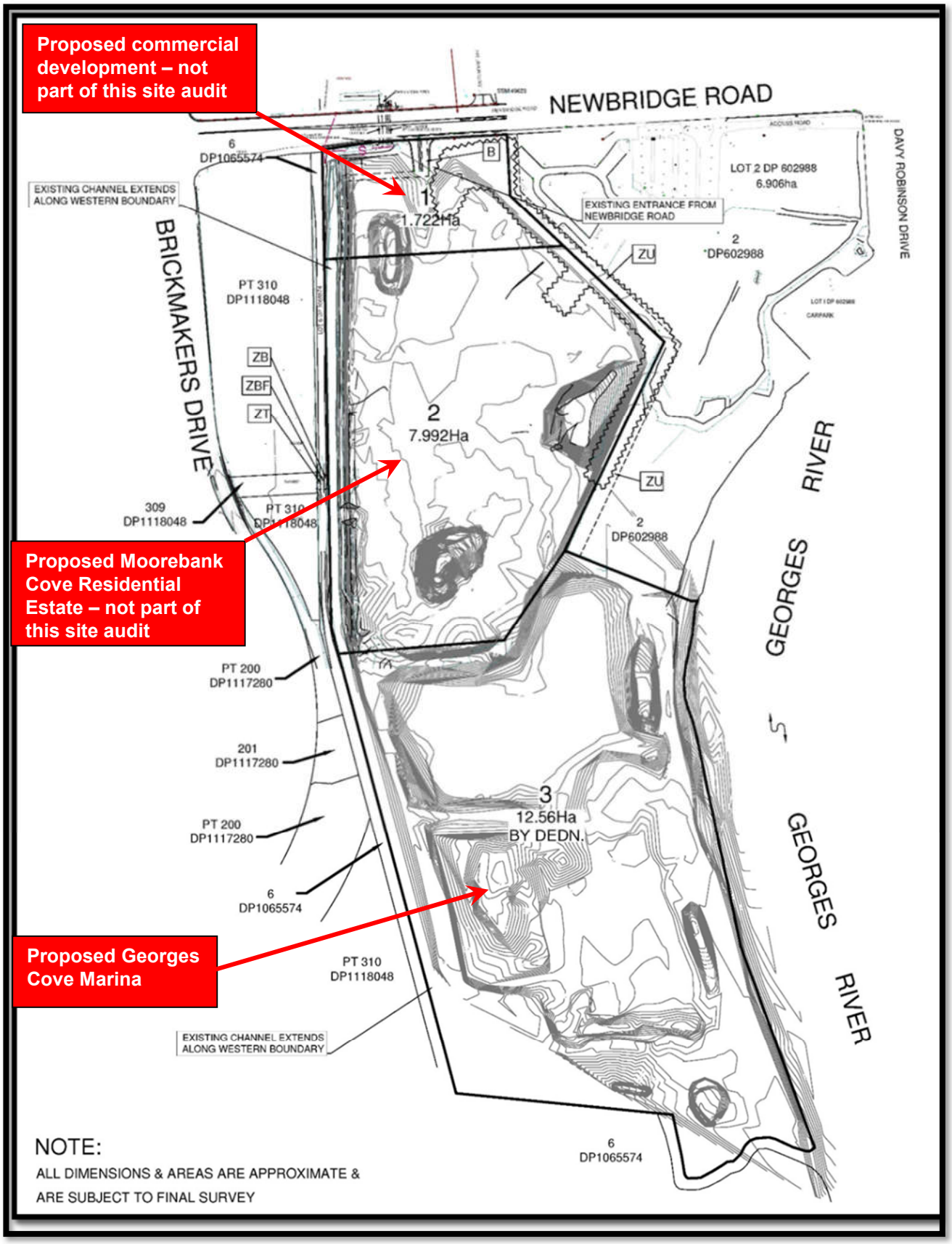


Figure 1-4 Proposed Layout of Georges Cove Marina (Source: Figure 1.2, Ref [13])

1.2 Purpose and Scope of the Audit

The purpose of the audit was to determine whether:

- The nature and extent of the contamination had been appropriately determined;
- The remedial action plan (RAP) was appropriate for a proposed residential land use; and
- The Marina site can be made suitable for the land uses required by the proposed Georges Cove Marina development if it was remediated in accordance with the RAP.

The audit was also prepared as part of a Development Application for the proposed remediation work and redevelopment of the Marina site. In particular, the SAR and accompanying SAS (**Appendix G**) were prepared to address the Secretary's Environmental Assessment Requirements (SEAR 912) that were issued for the project on 9 October 2018 and provided in an email from Council to EMM on 25/10/18 (Ref [79]). A copy of these SEARs are provided in **Appendix E**.

The scope of work undertaken for this SAR comprised the following tasks:

- Undertake all necessary site audit work that allowed a Section B SAS / SAR for the northern part of the Benedict site to be issued on 23/01/18 (Ref [77]);
- Inspect the Marina site and meet with the Client;
- Review ESAs and relevant documents that were prepared for the Marina site between 1999 and 2018;
- Review a RAP prepared for the remediation of the Site (Ref [8]); and
- Prepare this SAR and a Section B SAS.

The environmental consultants who conducted investigations and produced contamination assessments reviewed by this site audit comprise:

- Douglas Partners (DP): Conducted PSIs, DSIs and LFG surveys at the Benedict site that also included specific investigations at the Marina site;
- EMM: Conducted a PSI, a Supplementary site investigation (SPI) and developed a RAP for the Marina site; and
- EIS and J&K Geotechnics (J&K): Conducted geotechnical site investigations and LFG surveys at the Benedict site; conducted PSIs and developed a conceptual remediation strategy for the Lot 6 landfill property to the south of the Marina site.

1.3 Standards & Methodology

1.3.1 NSW EPA Approved Guidelines

The site audit was undertaken in accordance with the provisions of the NSW Contaminated Land Management Act 1997 (as amended) and the requirements of the NSW EPA as specified in their endorsed documents, as listed on the NSW EPA website[2]. These documents that were relevant to the site audit and were available at the time of this SAR, comprised:

Guidelines under the CLM Act

- Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (3rd edition), (NSW EPA, October 2017)
- Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (NSW EPA, September 2015)
- Guidelines for Consultants Reporting on Contaminated Sites (NSW EPA, August 2011)

[2] www.epa.nsw.gov.au/clm/guidelines.htm

- Guidelines for the Assessment and Management of Groundwater Contamination (NSW DECC, March 2007)
- Sampling Design Guidelines (NSW EPA, September 1995)

Other NSW EPA-approved Publications

- Australian Drinking Water Guidelines (NHMRC & NRMMC, August 2018)
- Environmental Guidelines Solid Waste Landfills, Second edition (NSW EPA, April 2016)
- British Standards Institution (February 2016) "*BS8485:2015 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*"
- CIRIA (August 2014) "*Good practice on the testing and verification of protection systems for buildings against hazardous ground gases*". CIRIA C735
- Technical Note: Investigation of Service Station Sites (NSW EPA, April 2014)
- Best Practice Note – Landfarming (NSW EPA, April 2014)
- The National Environment Protection Measure (Assessment of Site Contamination) Measure 1999 (NEPC 1999), which was replaced as of 16 May 2013 by the April 2013 version
- Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases (NSW EPA, November 2012)
- Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards (Department of Health and Ageing and EnHealth Council, Commonwealth of Australia, 2012)
- Vapour Intrusion: Technical Practice Note (NSW DECCW, September 2010)
- Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (NSW DECCW, August 2009)
- British Standards Institution (October 2007) "*British Standard BS 8485:2007, Code of practice for the characterization and remediation from ground gas in affected developments*" [3]
- Guidance on the management of landfill gas (UK Environment Agency, 2004), being a guideline referred to by the NSW EPA (April 2016)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000), which were replaced on 29/08/18 by the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Governments (ANZG) 2018) hereafter referred to as the ANZG 2018 water quality guidelines
- Stuart LS, Batley GE and Chariton AA (May 2013) "*Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines*". CSIRO Land and Water Science Report 08/07
- Composite Sampling, by Lock WH (National Environmental Health Forum Monographs, Soil Series No. 3, 1996, SA Health Commission, Adelaide)
- Written advice provided by the NSW EPA to Site Auditors
- Relevant Australian Standards

Waste materials to be removed from the Site need to be assessed in accordance with the latest EPA waste guidelines.

1.3.2 NSW Planning Requirements

The site audit was undertaken in accordance with the provisions of the:

- State Environment Planning Policy (SEPP) No 55 – Remediation of Land; and

[3] LFG management approach adopted by the NSW EPA in Section 5.3, NSW EPA (November 2012)

- Liverpool City Council contaminated land policy as given on their website at http://www.liverpool.nsw.gov.au/environment/pollution#contaminated .

1.3.3 Decision Process

The Site Auditor has assessed the risks posed by ground contamination at the Site by following the *'Decision-making process for assessing urban redevelopment sites'* as given in Appendix A of the NSW EPA (October 2017) '*Contaminated Land Management, Guidelines for the NSW Site Auditor Scheme (3rd edition)'*, which involved ten issues.

The first issue in the NSW EPA decision process is that:

'all site assessment, remediation and validation reports follow applicable guidelines'.

The Data Quality Indicators (DQI's) and assessment criteria that the Site Auditor set for the environmental assessments conducted at the Site are summarised in **Table 1-1**.

Table 1-1 Data Quality Indicators and Evaluation Criteria

DQI	Evaluation Criteria
Documentation completeness	• DQO process properly described • Site properly identified • Site history adequately known • The conceptual site contamination model for the site is known to a high level of confidence • The site conditions adequately known • Completion of field calibration records, borehole logs, chain of custody documentation, laboratory test certificates from NATA-registered laboratories
Data completeness	• Sampling density comparison meets NSW EPA (1996) *'Sampling Design Guidelines'* for all potential contaminants of concern at all areas of environmental concern • Use of systematic and judgemental sampling to provide sufficient data representative of all AECs
Data comparability	• Use of appropriate techniques for the sampling, storage and transportation of samples • Use of NATA certified laboratory using NEPM procedures
Data representativeness	• Good sampling coverage of all areas of environmental concern at the site, and selection of representative samples • Location, distribution & extent of samples appropriate to characterise contamination at all AECs
Precision and accuracy for sampling and analysis	• Use properly trained and qualified field personnel • Blind field duplicates to be collected at a minimum rate of 1 in 10 • RPD's to be less than 30% for inorganic and 50% for organic analyses • Acceptable levels for equipment rinsate blanks • Achieve laboratory QC criteria

These DQI's and criteria were set by the Site Auditor in order to assess the reliability and adequacy of the data provided by the Environmental Consultants. The DQI's were used by the Site Auditor to identify any areas in the documentation where the level of non-compliance was considered to be significant.

The remaining issues in the NSW EPA decision process are that:

- *'any aesthetic issues relating to site soils have been adequately addressed';*

- *soils have been assessed against relevant health-based investigation levels and potential for migration of contamination from soils to groundwater has been considered';*
- *groundwater (where relevant) has been assessed against relevant health-based investigation levels and, if required, any potential impacts to buildings and structures from the presence of contaminants considered.'*
- *hazardous ground gases (where relevant) have been assessed against relevant health-based investigation levels and screening values'*
- *any issues relating to local area background soil concentrations that exceed relevant investigation levels have been adequately addressed in the site assessment report(s);*
- *the impacts of chemical mixtures have been assessed;*
- *any potential ecological risks have been assessed;*
- *any evidence of, or potential for, migration of contaminants from the site has been appropriately addressed, including potential risks to off-site receptors, and reported to the site owner or occupier; and*
- *the site management strategy (where relevant) is appropriate including post-remediation environmental plans.'*

The Site Auditor applied this 10-step decision process to the review of the investigation reports and RAP prepared for the Marina site.

1.4 Information Reviewed

The environmental reports reviewed for this audit (in approximate chronological order) comprised:

1. Douglas Partners (24 June 1999) "*Proposed Environmental Monitoring Program, Sorting, Recovery and Transfer (SRT) Facility, 146 Newbridge Road, Moorebank*". Document No: 27879 prepared for Benedict Reclamations
2. Douglas Partners (May 2002) "*Report on Preliminary Contamination Assessment, Proposed Residential Development,146 Newbridge Road, Moorebank*". Document No: 43479 prepared for Benedict Sand and Gravel
3. EIS (June 2009) "*Environmental Site Assessment for Proposed Earthworks at Lot 6 DP1065574 Newbridge Road, Moorebank*". Document E22833K-GWRPT prepared for Concrete Recyclers Pty Ltd
4. EIS (July 2010) "*Groundwater Assessment for Proposed Earthworks for New Concrete Recycling Plant at Lot 6 DP1065574 Newbridge Road, Moorebank*". Document E22833K rpt3 prepared for Concrete Recyclers
5. EIS (19 December 2013) "*Report to Benedict Industries Pty Ltd on Stage 1 Environmental Site Assessment for Proposed Residential Development at 146 Newbridge Road, Moorebank, NSW*". Document No: E26930KBrpt
6. EMM (28 July 2015) "*Preliminary Investigation of Contamination, Proposed Georges Cove Marina*". Document No: J14149RP1 prepared for Benedict Industries
7. EMM (11 March 2016) "*Supplementary Preliminary Investigation, Proposed Georges Cove Marina*". Document No: J14149RP1 prepared for Benedict Industries
8. EMM (11 March 2016b) "*Remediation Action Plan, Proposed Georges Cove Marina*". Document No: J14149RP1 prepared for Benedict Industries
9. Douglas Partners (2 September 2016) "*Detailed Site Investigation, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.03 prepared for Benedict Industries
10. Douglas Partners (17 March 2017) "*Groundwater Data Review, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.06 prepared for Benedict Industries, 22 pages
11. Douglas Partners (15 December 2017) "*Remedial Action Plan, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.06 (Revision 5) prepared for Benedict Industries Pty Ltd

12. Douglas Partners (28 May 2018) "*Preliminary Site Investigation, Proposed Rezoning (Area 1) and Georges Cove Marina (Area 2), 146 Newbridge Road, Moorebank*". Document 71459.10 prepared for Mirvac Homes NSW Pty Ltd and Tanlane Pty Ltd
13. EMM (4 July 2018) "*Environmental Impact Statement Addendum, Georges Cove Marina, Volume 1 – Main report*". Prepared for Benedict Industries Pty Ltd
14. Douglas Partners (31 August 2018) "*Landfill Gas Monitoring Events, Oct & Dec 2017, Feb, Apr & Aug 2018, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.09.R.011.Rev0 prepared for Benedict Industries Pty Ltd
15. Douglas Partners (6 September 2018) "*Surface Water Sampling, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.09.R.014.Rev1 prepared for Benedict Industries Pty Ltd
16. Douglas Partners (17 September 2018) "*Data Summary Report, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.09 prepared for Benedict Industries Pty Ltd
17. EMM (14 November 2018) Email providing ammonia monitoring results for dredge pond (copy provided in **Appendix E**)

Other information reviewed for this audit comprised:

70. Liverpool City Council (29 August 2008) "*Liverpool Local Environmental Plan 2008, Acid sulfate soil map – sheet ASS-014 and sheet ASS-015*"
71. Liverpool City Council (29 August 2008) "*Liverpool Local Environmental Plan 2008, Urban release area map – sheet URA-014 and sheet URA-015*"
72. Liverpool City Council (1 September 2017 & 19 April 2013) "*Liverpool Local Environmental Plan 2008, Land zoning map – sheet LZN-014 and sheet LZN-015*"
73. Liverpool City Council (17 August 2012 & 19 April 2013) "*Liverpool Local Environmental Plan 2008, Environmentally significant land map – sheet ESL-014 and sheet ESL-015*"
74. Liverpool City Council (11 June 2015) "*Liverpool Local Environmental Plan 2008, Flood planning area map – sheet FLD-014 and sheet FLD-015*"
75. Matthew Freeburn (22 August 2013) "*Plan Showing Levels, Contours and Stockpile Volumes as at 20-08-13, 146 Newbridge Road, Moorebank*". Drawing No: CC6-SURVEY4-32825 EPA 20-08-13 (provided in Appendix C1, Ref [11])
76. JMD Development Consultants (24 January 2017) Drawing "*Plan of Existing Features Over Stage 1, Moorebank Cove – Stage 2, Newbridge Road, Moorebank*". Drawing No: 14005-DS1 prepared for Mirvac Homes (provided in Appendix B, Ref [32])
77. Ian Swane & Associates (23 January 2018) "*Site Audit Report, Site Audit 264B by Dr Ian Swane, Review of Remediation Strategy for Residential Development at 146 Newbridge Road, Moorebank NSW 2170*" (includes site audit statement)
78. Alyazichi Y.M., Jones B.G., McLean E.J., Pease J and Brown H (2017) '*Geochemical assessment of trace element pollution in surface sediments from the Georges River, Southern Sydney, Australia*'. Archives of Environmental Contamination and Toxicology, 72 (2), 247-259
79. Liverpool City Council (25 October 2018) Email from Boris Santana, Senior Development Planner, titled 'Georges Cove Marina consultation with RMS' including a copy of updated SEAR 912 (copy provided in **Appendix E**)

The Site Auditor is unaware of the existence of any other relevant documents that provided information on site conditions. Additional information was obtained by the Site Auditor when an inspection of the Marina site was conducted on 13/11/18, with a photographic record provided in **Appendix F**. The Site Auditor also inspected the Benedict site on eleven occasions between 23/06/15 and 29/10/18 and the southern landfill site on 23/10/18.

1.5 Chronology of Site Audit Program

A chronology of activities relevant to the site audit work completed to-date is:

- 7 July 2015 – The Site Auditor was engaged to undertake a statutory site audit for the Benedict site and issued formal notification to the NSW EPA of its commencement;
- 23 January 2018 – The Site Auditor issued a Section B SAS and SAR numbered 264B, which reviewed and approved the remediation strategy for the northern part of the Benedict site (Ref [77]);
- 25 October 2018 – Council sent an email to EMM (Ref [79]) providing planning advice regarding an EIS for the Marina site and provided a copy of the updated SEARs 912 they received on 9/10/18 (copy of email provided in **Appendix E**);
- 9 November 2018 - The Site Auditor was directed by Benedict to commence a statutory site audit for the southern part of the Benedict site (the Marina site) and issued formal notification to the NSW EPA of its commencement;
- 14 November 2018 – EMM sent an email to the Site Auditor (Ref [17]) that provided the latest set of ammonia results for the dredge pond and a copy of the Council 25/10/18 email (Ref [79]);
- 7 April 2019 – The Site Auditor completed a review of the available documentation and issued a draft Section B SAS to Benedict / EMM for their review and approval;
- 10 April 2019 – Benedict / EMM provided feedback and approved a draft SAS; and
- 27 April 2019 – The Site Auditor issued a Section B SAS / SAR.

1.6 Abbreviations

ABC	Ambient background concentration
ACL	Added contaminant limit
ACM	Asbestos containing material
AEC	Area of Environmental Concern
AF	Asbestos fines
AHD	Australian Height Datum
AMP	Asbestos management plan
ANZECC	Australia and New Zealand Environment and Conservation Council
ASS	Acid sulphate soil
B&D waste	Building and demolition waste
bgl	Below ground level
BTEX	Benzene, toluene, ethyl benzene, xylenes
BTEXN	BTEX and naphthalene
CCA	Copper chrome arsenate
CEC	Cation exchange capacity
CGS	Characteristic gas situation
COC	Chain of custody
COV	Coefficient of variation
CQA	Construction quality assurance
CSI	Contaminated site investigation
DCP	Development control plan

DEC	Department of Environment and Conservation NSW
DECC	Department of Environment and Climate Change NSW
DECCW	Department of Environment, Climate Change and Water NSW
DOH	Department of Health (WA)
DP	Douglas Partners
DPE	Department of Planning and Environment (NSW)
DQI	Data quality indicator
DQO	Data quality objective
DSI	Detailed site investigation
EA	Environment Australia
EFCP	Electrical friction cone penetrometer
EI	Environmental Investigations Australia
EIL	Ecological investigation level
EIS	Environmental impact statement
EMP	Environmental management plan
EPA	Environment Protection Authority (NSW)
EPL	Environmental Protection License
ERP	Site emergency response plan
ES	Environmental Strategies
ESA	Environmental site assessment
ESD	Ecologically sustainable development
FA	Fibrous asbestos
FMP	Fill Management Protocol for Imported VENM Cap Construction
FSL	Finished surface level
GIL	Groundwater investigation level
GME	Groundwater monitoring event
GPS	Global positioning system
GSV	Gas screening values
GSW	General Solid Waste
GTA	Geotechnical Testing Authority
HAZMAT	Hazardous materials assessment
HDPE	High density polyethylene
HEIC	High energy impact compaction
HGG	Hazardous ground gas
HHERA	Human health and ecological risk assessment
HIL	Health investigation level
JRPP	Joint Regional Planning Panel
J&K	Jeffery & Katauskas

kg	Kilograms
L	Litres
LCS	Laboratory control sample
LEC	Land and Environment Court (NSW)
LFG	Landfill gas
LFGMS	Landfill gas mitigation system
LGA	Local Government Area
LOP	Level of protection
LOR	Limit of reporting
LTEMP	Long Term Environmental Management Plan
M	Metres
MAHs	Monocyclic aromatic hydrocarbons
mg	Milligrams
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NIOSH	National Institute for Occupational Safety and Health (USA)
NMOC	Non-methane organic compounds
NRMMC	Natural Resource Management Ministerial Council
NSW	New South Wales
OCP	Organochlorine pesticides
OHSP	Occupational health and safety plan
OSD	On-site detention basin
PAH	Polycyclic aromatic hydrocarbons
PASS	Potential acid sulphate soil
PCBs	Polychlorinated Biphenyls
PCOC	Potential contaminant of concern
PID	Photoionisation detector
POEO	Protection of the Environment Operations (Act) 1997 (NSW)
PPE	Personal Protective Equipment
ppm	parts per million
PQL	Practical quantification limit
PSI	Preliminary site investigation
QA	Quality assurance
QC	Quality control
RAC	Remediation Acceptance Criteria
RAP	Remediation Action Plan
RPD	Relative percent difference
RL	Reduced level

RSW	Restricted Solid Waste
SAC	Soil acceptance criteria
SAQP	Sampling and analysis quality plan
SD	Standard deviation
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State environment planning policy
SIL	Soil investigation level
SMDD	Standard maximum dry density
SMF	Synthetic mineral fibre
SMP	Site management plan
SOMC	Standard optimum moisture content
SOP	Standard operating procedure
SPI	Supplementary site investigation
SQGV	Sediment quality guideline values
SVOCs	Semi volatile organic compounds
SWIL	Surface water investigation level
SWMP	Soil and water management plan
SWMS	Site work method statement
TBT	Tributyltin
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solids
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TRH	Total recoverable hydrocarbons
TSS	Total suspended solids
UCL	Upper confidence limit
UFP	Unexpected Finds Protocol
USA	United States of America
US EPA	United States Environmental Protection Agency
VENM	Virgin excavated natural material
VHCs	Volatile halogenated compounds
VMP	Voluntary Management Proposal
VOCs	Volatile organic compounds
WHO	World Health Organisation
WHS	Worker health safety
WMP	Waste management plan
µg	Micrograms

2. Review of CSI Data Quality

This section of the SAR assesses the adequacy of the data provided by contaminated site investigations (CSIs) in reports prepared for the Marina site, the larger Benedict site and the adjacent landfill site to the south between 1999 and 2018 (Refs [1] - [16]) in terms of their compliance with NSW EPA reporting requirements. The main reports include:

- *Preliminary site investigations (PSI's);*
- *Detailed site investigations (DSIs);*
- *Acid sulphate soil (ASS) assessments;*
- *Groundwater investigations; and*
- *Hazardous ground gas assessments.*

2.1 Documentation Completeness

2.1.1 DQO Process

The Site Auditor assessed the appropriateness of the ESAs using the following DQO process, which is considered to meet NSW EPA requirements:

- **Step 1: State the Problem** – Potential contamination at the Site may affect its use for the proposed development. There is also the potential for off-site migration of contamination that needs to be considered.
- **Step 2: Identify the Decisions** – These include
  - To assess the likelihood and/or extent of significant contamination which may have resulted from activities at the Site;
  - Identify contamination that may be occurring at the Site and non-compliance with environmental regulations;
  - Recommend management strategies which may be required at the Site, including additional investigations and/or remediation works;
  - Determine whether, at the time the SAR was complete, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would enable the specified use of the Site in the future; and
  - Determine whether, at the time the SAR was complete, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would prevent the migration of unacceptable levels of contamination from the Site.
- **Step 3: Identify Inputs to the Decisions** – These include:
  - Existing site information, site history, regional geology, topography, hydrogeology and background conditions;
  - The use of proper investigation techniques;
  - Development of an appropriate conceptual site model (CSM) for assessing contamination risks; and
  - The use of appropriate site assessment criteria and compare results as measured against these criteria.
- **Step 4: Define the Study Boundaries** – The property boundaries and the legal property definitions.
- **Step 5: Develop a Decision Rule** – The decision rules in characterising contamination at or migrating from the Site were:
  - Laboratory test results to be measured against EPA-approved criteria;

- The Site would be deemed not contaminated if soil, groundwater and soil vapour concentrations were within background levels, QA/QC data demonstrate acceptable reliability and representativeness, results generally meet regulatory criteria, results are from NATA accredited laboratories, detection limits are below assessment criteria and the results can be shown to be of minimal concern; and
- The Site posed a low contamination risk to off-site land if soil, groundwater and soil vapour concentrations at the property boundaries were within background levels, QA/QC data demonstrate acceptable reliability and representativeness, results generally meet regulatory criteria, results are from NATA accredited laboratories, detection limits are below assessment criteria and the results can be shown to be of minimal concern.

- **Step 6: Specify Limits on Decision Errors** – These include:
  - The acceptable limits for inter/intra laboratory duplicate sample comparisons are laid out within the fieldwork protocols; and
  - The acceptable limits for laboratory QA/QC parameters are based upon the laboratory reported acceptable limits and those stated within the NEPM 2013 guidelines.
- **Step 7: Optimise the Design for Obtaining Data** – Identify the most resource-effective sampling and analysis design for general data that are expected to satisfy the DQOs. This may involve the use of field screening tests and use of biased sampling.

A summary of the Data Quality Indicators (DQI's) for the field and laboratory testing programs are specified in **Table 1-1**.

2.1.2 Site Location Details

The Benedict site is legally defined as Lot 7 in DP1065574, has an area of 222,740 m^2 (22.274 ha) and is located in the Liverpool City Council ("Council) local government area (LGA). A subdivision plan of the Benedict site is provided in **Figure 1-1** followed by a 2016 Google aerial photo in **Figure 1-2**. The Marina site is 13 ha in size and its location relative to the Benedict site shown in a January 2017 survey plan in **Figure 1-3**.

A summary of the Marina site location details provided by the ESAs is presented in **Table 2-1**. The ESAs[4] advised that the Benedict site is located in an area of Moorebank that was predominantly commercial / industrial but over the past 5 years the area south of Newbridge Road has been undergoing redevelopment for residential land use.

The Benedict site is bounded by:

- Newbridge Road then a large industrial area to the north;
- An existing entry / dirt road to the west then Brickmakers Drive then a newly created residential subdivision;
- A residential subdivision under construction and vacant bushland / reserve to the east, with the Georges River located 100 m to the east and south-east of the Benedict site; and
- A vacant property to the south that was formerly a concrete recycling facility and an historic landfill.

An historic survey plan of the Marina site and surrounding land showing the lot dimensions and area is provided in **Figure 2-1**. An extract of the current zoning plan for the Marina site and nearby land is provided in **Figure 2-2**, with an extract of Council's Urban Release Zoning Map for the area provided in **Figure 2-3**.

[4] Sectn 4.2, Ref [5]

Table 2-1: Summary of Site Location Details

Parameter	Detail	References
Site name	Marina site within Benedict Recycling Centre	Appn C11, Ref [5]
Address/location	146 Newbridge Road, Moorebank NSW 2170	Sectn 4.1, Ref [5]; Sectn 2.1, Ref [6]; Sectn 1.1, Ref [12]
Legal property description	Benedict site = Lot 7 in DP1065574 in the City of Liverpool, Parish of Holsworthy Marina site = Southern part of Lot 7	Sectn 4.1 & Appn C7, Ref [5]; Sectn 2.1, Ref [6]; Sectn 1.1, Ref [12]
Local Government Area	Liverpool City Council	Sectn 4.1, Ref [5]; Sectn 2.1, Ref [6]
Site area	Benedict site = 22.31 ha Marina site = 13 ha	Appns C7 & C8, Ref [5]; Sectn 1, Ref [6]; Sectn 1.1, Ref [12]
Owner	Tanlane Pty Ltd (Benedict Industries)	Sectn 4.1, Ref [5]; Sectn 2.1, Ref [6]
Developer	Tanlane Pty Ltd (Benedict Industries)	Sectn 4.1, Ref [5]; Sectn 1.1, Ref [12]
Past Zoning	Rural then commercial / industrial	Sectn 4.1 & Appn C8, Ref [5]
Current zoning	Marina site: • RE1 – Public Recreation • RE2 – Private Recreation • SP2 – Infrastructure Drainage	Sectns 1.1, 4.1, Appns C2 & C9, Ref [5]; Sectn 2.1, Ref [6]; Ref [72]
Future zoning	Parts of Area 2 of the Marina site (Figure 1-3) are to be rezoned to allow residential terraces, apartments and commercial activities.	Refs [12] & [13]
Surrounding land use	North: Proposed residential subdivisions East: Georges River South: Vacant property formerly a concrete recycling plant / landfill West: New residential subdivision	Sectns 4.2, 4.5 & Appn C, Ref [5]; Sectn 4.7, Ref [6]

Legend:
Inadequate information provided in investigation reports

The Benedict site (including the Marina site) is part of an Urban Release Area approved by Council and the NSW Government.

The Site Auditor assessed the accuracy of the site location information provided in the ESA reports by:

- Comparing the multiple lines of evidence provided by the source data, which included a survey plan (**Figure 1-1**) and land title certificate (**Figure 1-2**);
- Comparing the supplied data with other publicly available data obtained from Council records and their website (Refs [70] – [74]);
- Reviewing drawings included in the Local Environment Plan;
- Examining the most recent Google aerial photo of the Marina site**;** and
- Inspecting the Marina site on 13/11/18, with a photographic record provided in **Appendix F**. The Site Auditor also inspected the Benedict site on eleven occasions between 23/06/15 and 29/10/18 and the southern landfill site on 23/10/18.

The Site Auditor considered the information on site location details provided in the ESAs met or was close to meeting the documentation completeness DQO.

Figure 2-1 Historic Survey Plan of Benedict Site & Surrounding Land (Source: Appn C7, Ref [5])

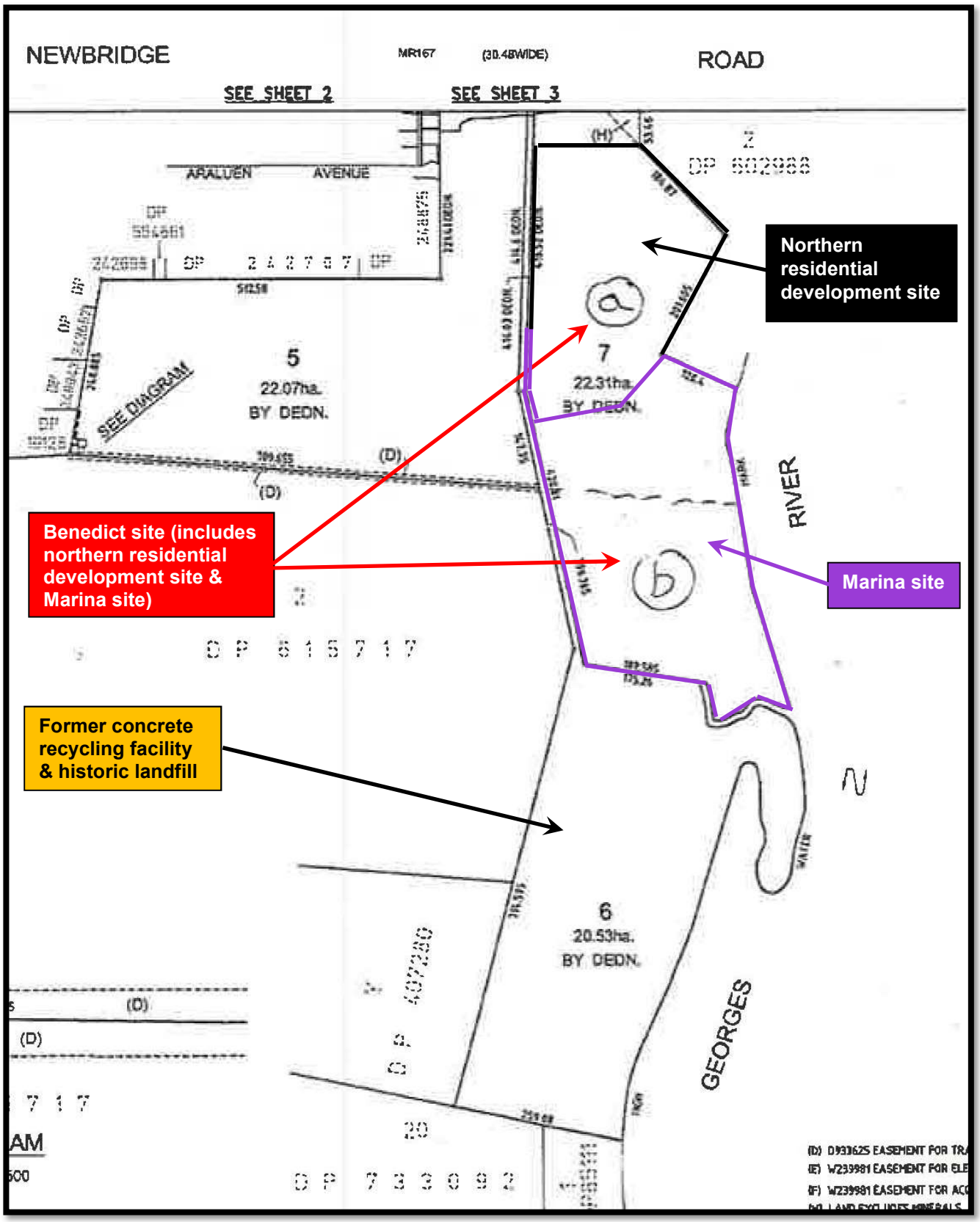
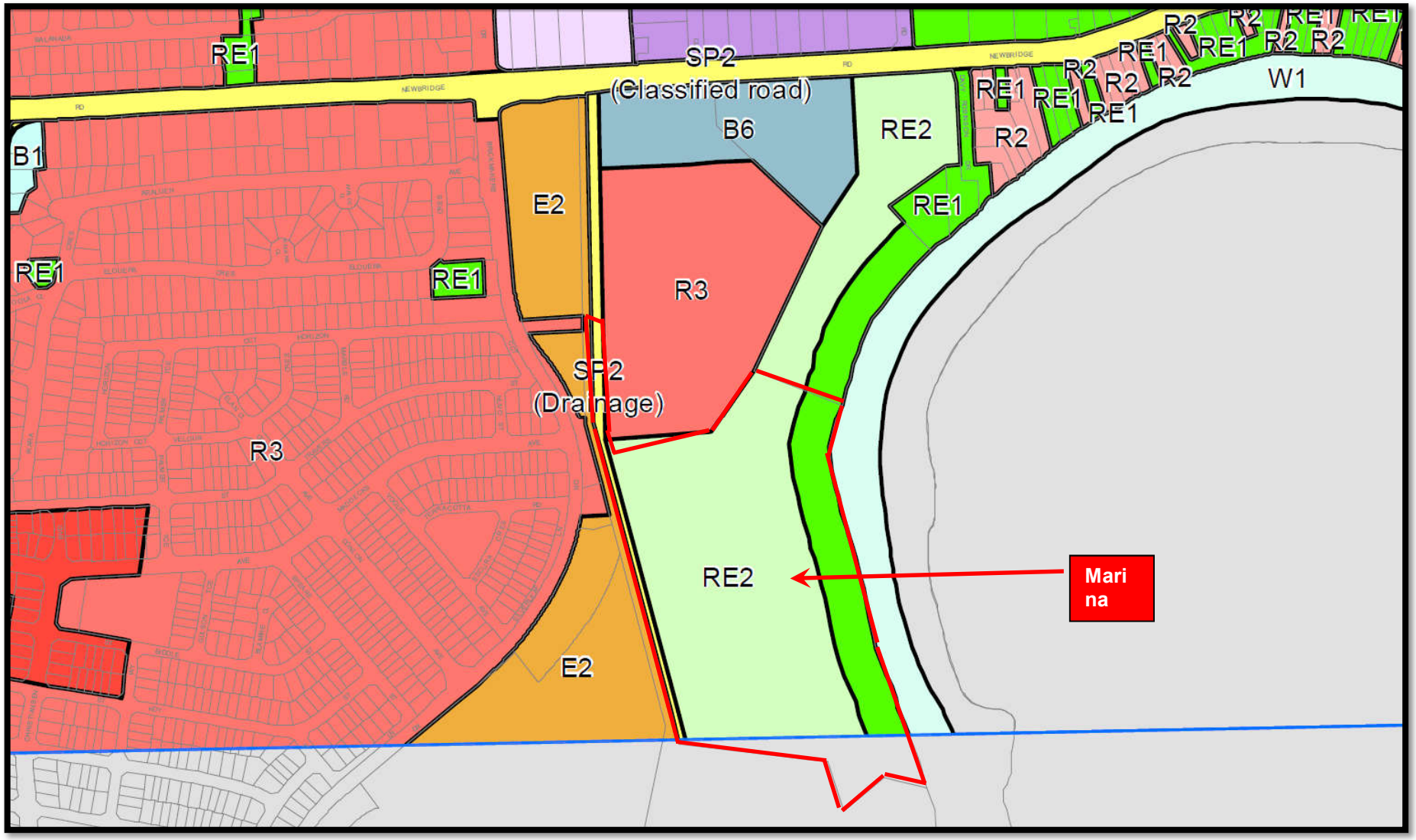


Figure 2-2 Extract of Council Zoning Plan for Marina site & Surrounding Land (Source: Ref [72])



Legend for Figure 2-2

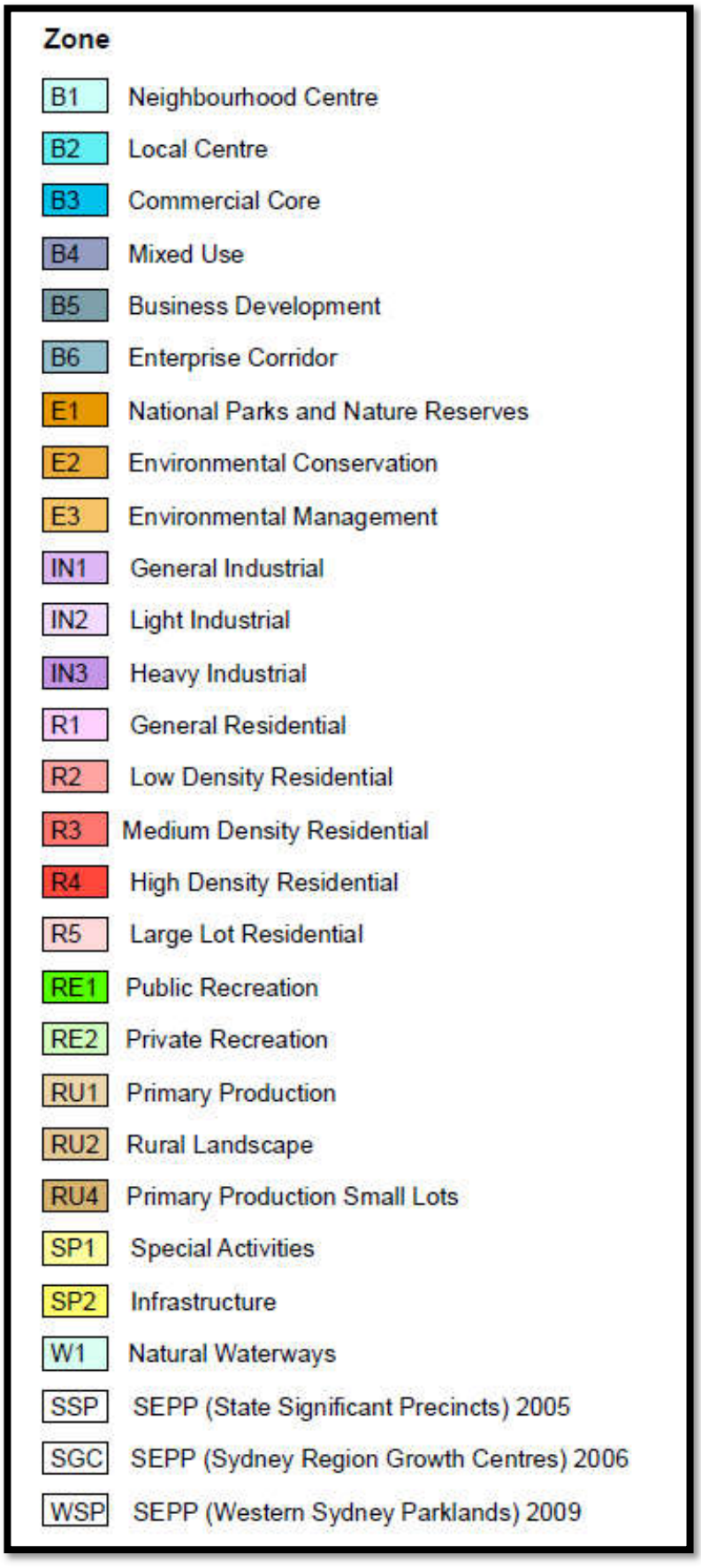
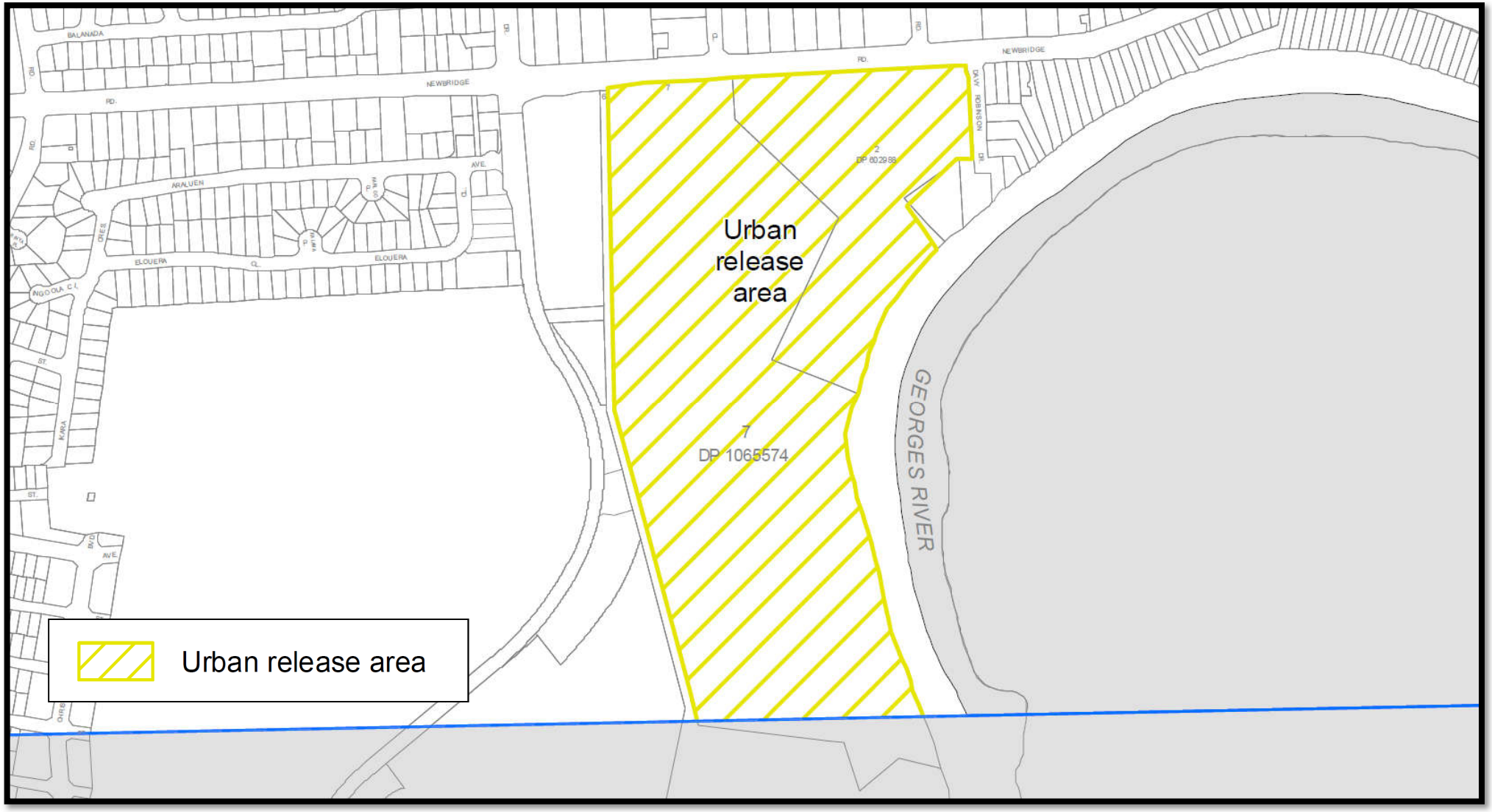


Figure 2-3 Extract of Council's Urban Release Zoning Map for Site (Source: Ref [71])



2.1.3 Site History Details

Audit approach

The area occupied by the 13 ha Marina site is part of a precinct south of Newbridge Road that has a long history of soil extraction and landfill operations. These include:

- Lot 7 in DP1065574: The 22.3 ha area forms the Benedict site, with the southern part forming the 13ha Marina site;
- Lot 6 in DP1065574: The 21.6 ha area is a historic landfill and concrete recycling operation that is presently vacant land owned by EQ Riverside P/L; and
- A former Boral clay quarry and brickworks to the west of the Marina site that was redeveloped for residential land use in the past 5 – 10 years.

The Site Auditor considers the main contamination risks relevant to the Marina site are likely to be posed by:

- Materials that remain at the Marina site;
- Contamination that maybe migrating from the northern part of the Benedict site onto the Marina site; and
- Contamination that maybe migrating from the former Lot 6 southern landfill onto the Marina site.

Consequently, the Site Auditor has reviewed site history details available for the Benedict site, the Marina site, and the former Lot 6 southern landfill. A detailed review of the site history for the former Boral operation to the west of the Marina site has not been undertaken because:

- The contamination risks that this land may pose to the Marina site are likely to be low since Council considered this area was suitable for residential development some 5 – 10 years ago after it was subject to a remediation program sometime after 2003[5]; and
- The contamination risks posed by the western land can be assessed based on monitoring wells located along the western boundary of the Marina site, since groundwater is likely to migrate in an easterly direction towards the Georges River.

Available documentation

The historical data provided by the available assessment reports are summarised in **Table 2-2**, with copies of selected historic aerial photos provided in **Figure 2-4**.

Table 2-2: Summary of Site History Details

Site History Detail	References
Property zoning and land use changes	Appns C2 & C9, Ref [5]
Property title search	Sectn 5.2 & Appn C7, Ref [5]; Sectns 4.2 & 4.3, Ref [12]
Review of aerial photographs (1930, 1951, 1961, 1970, 1982, 1991, 2000, 2005)	Sectn 5.1 & Appn C6, Ref [5]; Sectn 3.2 & Appn A, Ref [6]; Sectns 4.2 & 4.3, Ref [12]
Review of site photographs	Appn C3, Ref [5]
Data provided by former owners/tenants/local Council	Sectn 5.3, Appns C8 & C9, Ref [5]; Sectn 3.3 & Appn B, Ref [6]; Sectns 4.2 & 4.3, Ref [12]
Inventory of chemicals and wastes associated with site use and their on-site storage location	Sectn 6.1, Ref [5]

[5] Section 3.5, Ref [6]

Site History Detail	References
Possible contaminant sources & potential off-site effects	Sectn 6.1, Ref [5]
Site layout plans	Appn C1, Ref [5]
Sewer and underground service plans	Sectn 4.6 & Appn C4, Ref [5]
Extent of any filling or dumping at the site	Sectns 6.1, 9.1, Figure 5, Ref [5]; Sectn 3, Ref [6]
Descriptions of manufacturing processes / operations	Drwg 2, Ref [1]; Sectn 5, Ref [5]; Sectn 3.3, Ref [6]
Details and locations of former underground storage tanks (USTs) and above ground storage tanks (ASTs)	Sectns 4.4, 4.7, 5.4, Appn C10, Ref [5]; Sectn 3.8, Ref [6]
Product spill and loss history	Sectn 6.1, Ref [5]; Sectn 3, Ref [6]
Discharges to land, water and air	Sectn 6.1 & Appn C11, Ref [5]; Sectn 3.7, Ref [6]
Disposal locations	Sectns 6.1, 9.1, Figure 5, Ref [5]; Sectn 3, Ref [6]
Relevant complaint history	Sectn 5.5 & Appn C11, Ref [5]; Sectn 3, Ref [6]
Local site knowledge of residents and staff – both present and former	Sectn 4.7, Ref [5]; Sectn 3.3, Ref [6]
Summary of local literature about the site, including newspaper articles	Appn C8, Ref [5]
Details of building and related permits, licences, approval and trade waste agreements	Sectns 4.10, 5.3 – 5.5, Appns C8 & C11, Ref [5]; Sectns 3.3 – 3.8 & Appn B, Ref [6]
Historical use of adjacent land	Sectn 5.1 & Appn C6, Ref [5]; Sectn 3.2, Ref [6]
Local usage of ground/surface waters, and locations of bores/pumps	Sectn 4.11 & Appn C5, Ref [5]; Sectn 5, Ref [9]
Integrity assessment	Sectns 5.6 & 5.7, Ref [5]

Legend:

Inadequate information provided in investigation reports

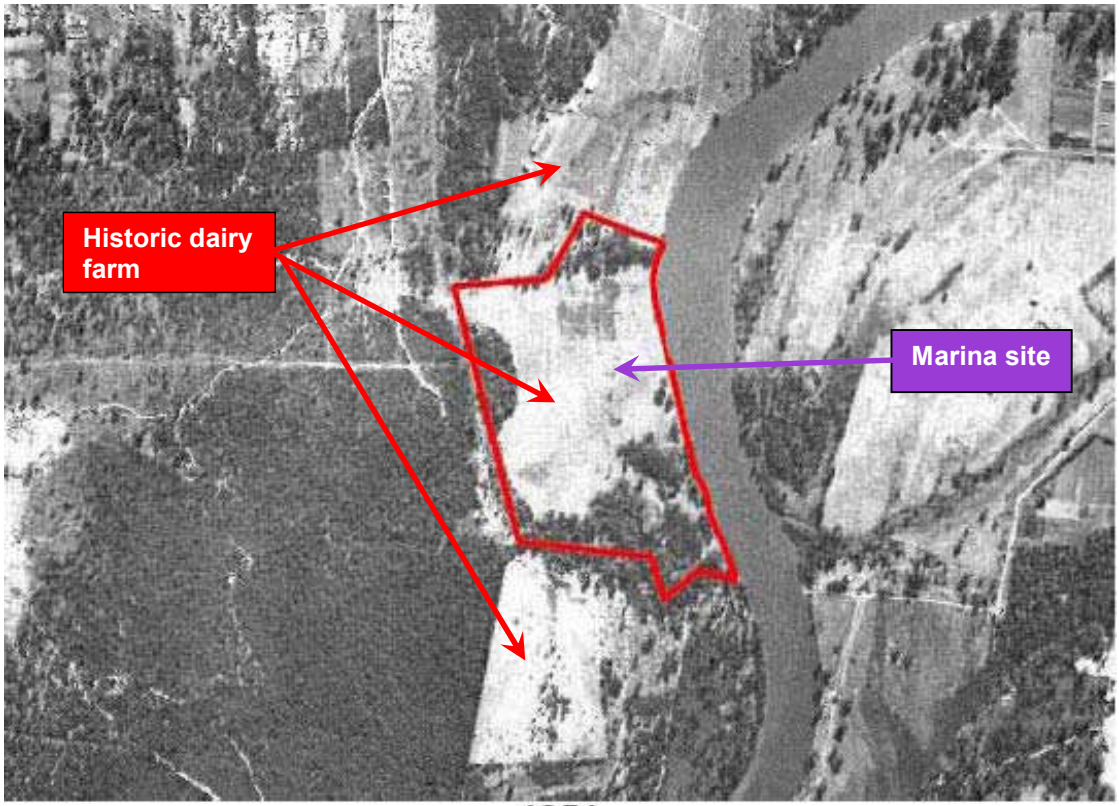
Benedict site

The EIS 2013 PSI[6] advised that the main historical features of the Benedict site (including the Marina site) were:

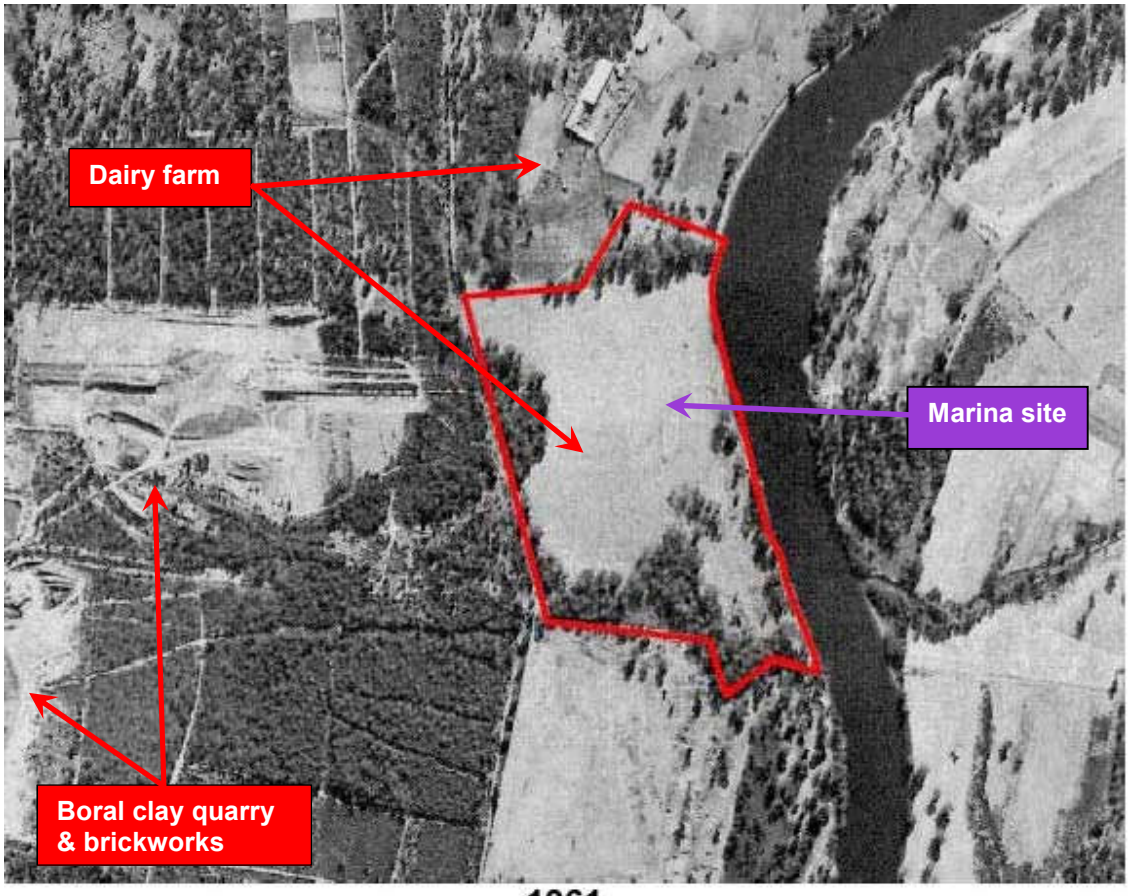
- 1798 to 1930's: Part of a land grant to John Wextead and James Healey. Vacant land owned by several individuals;
- 1930's to mid-1980's: Broad acre agricultural uses mainly as a dairy owned by Echo Dairies Pty Ltd from 1965;
- Mid-1980's to 1997: Sand extraction by Echo Dairies together with large sections of the Site being filled with material of unknown quality. Numerous material stockpiles were present, which indicated the commencement of waste processing and dredging activity; and
- 1997 to present: Owned by Tanlane Pty Limited and operated as Benedict Sand and Gravel. Sand extraction continued, followed by waste disposal and use as a materials recycling centre.

[6] Sections 5, 6 & Appn C7, Ref [5]

Figure 2-4 Historic Aerial Photos of Marina site (Source: Appn A, Ref [6])

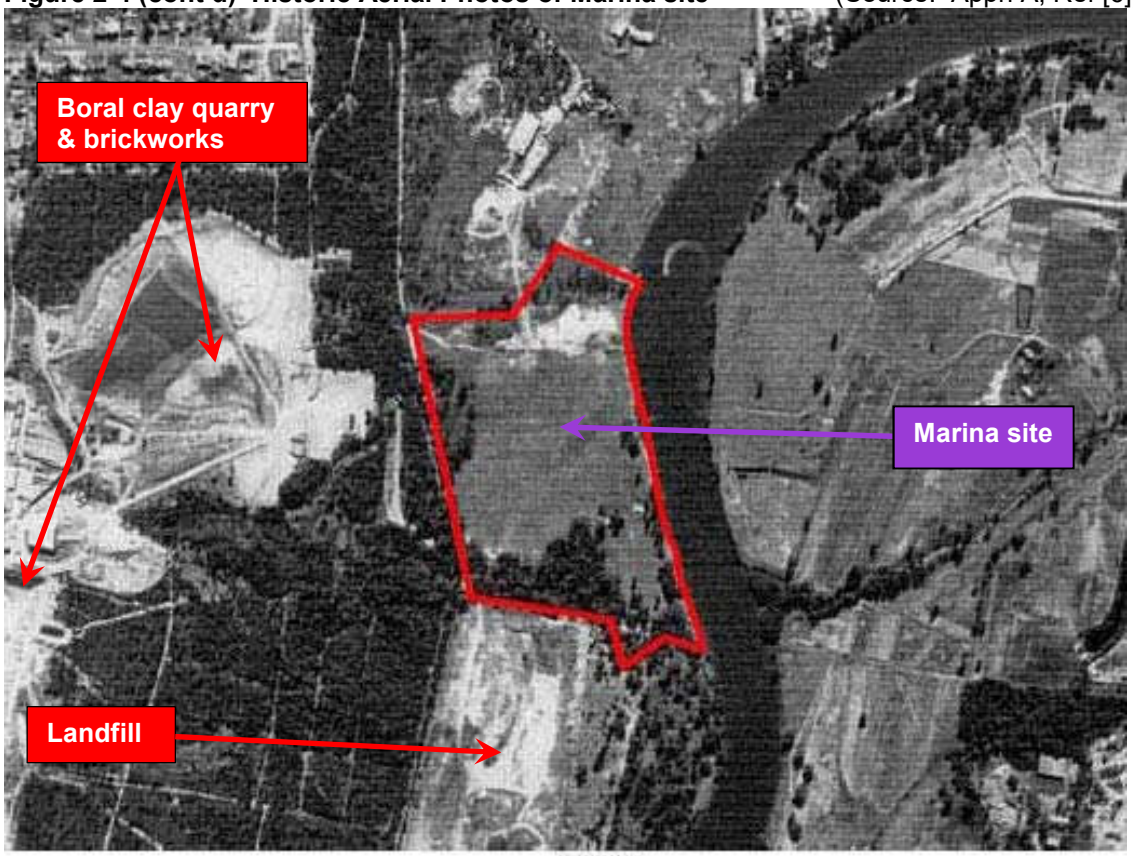


1951

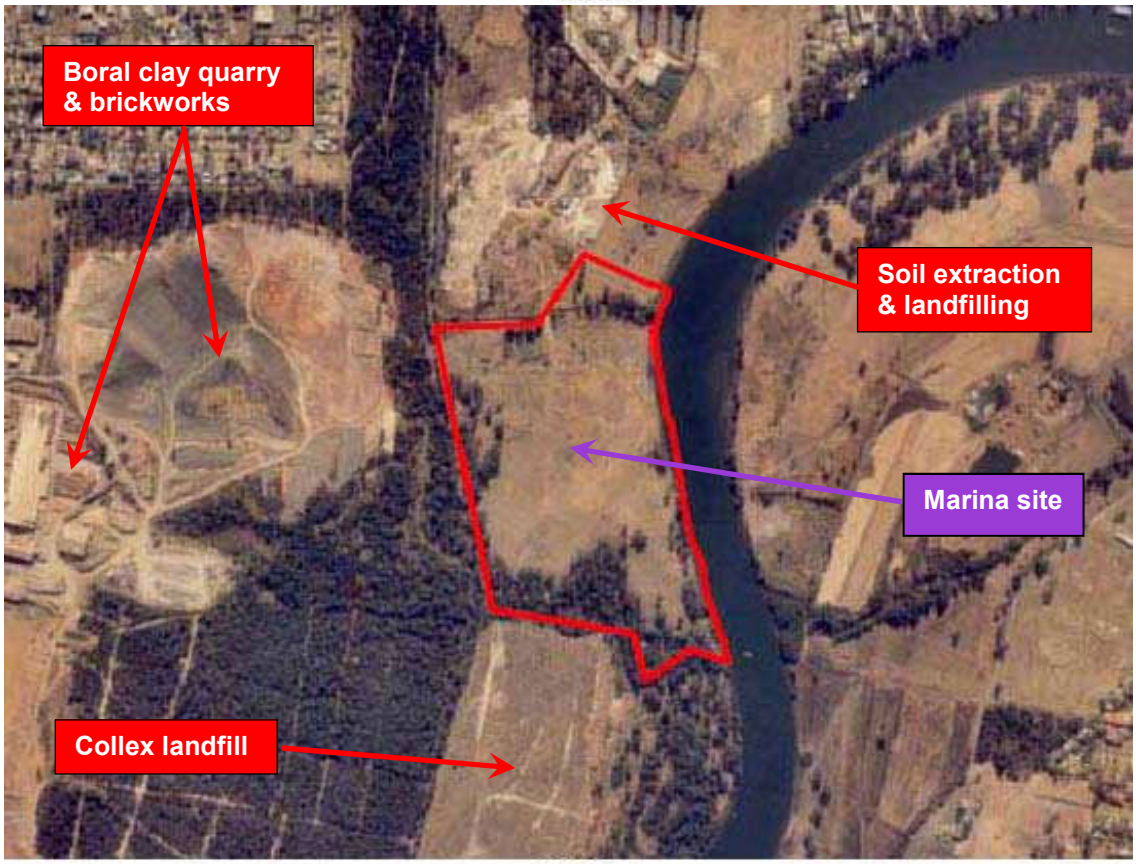


1961

Figure 2-4 (cont'd) Historic Aerial Photos of Marina site (Source: Appn A, Ref [6])

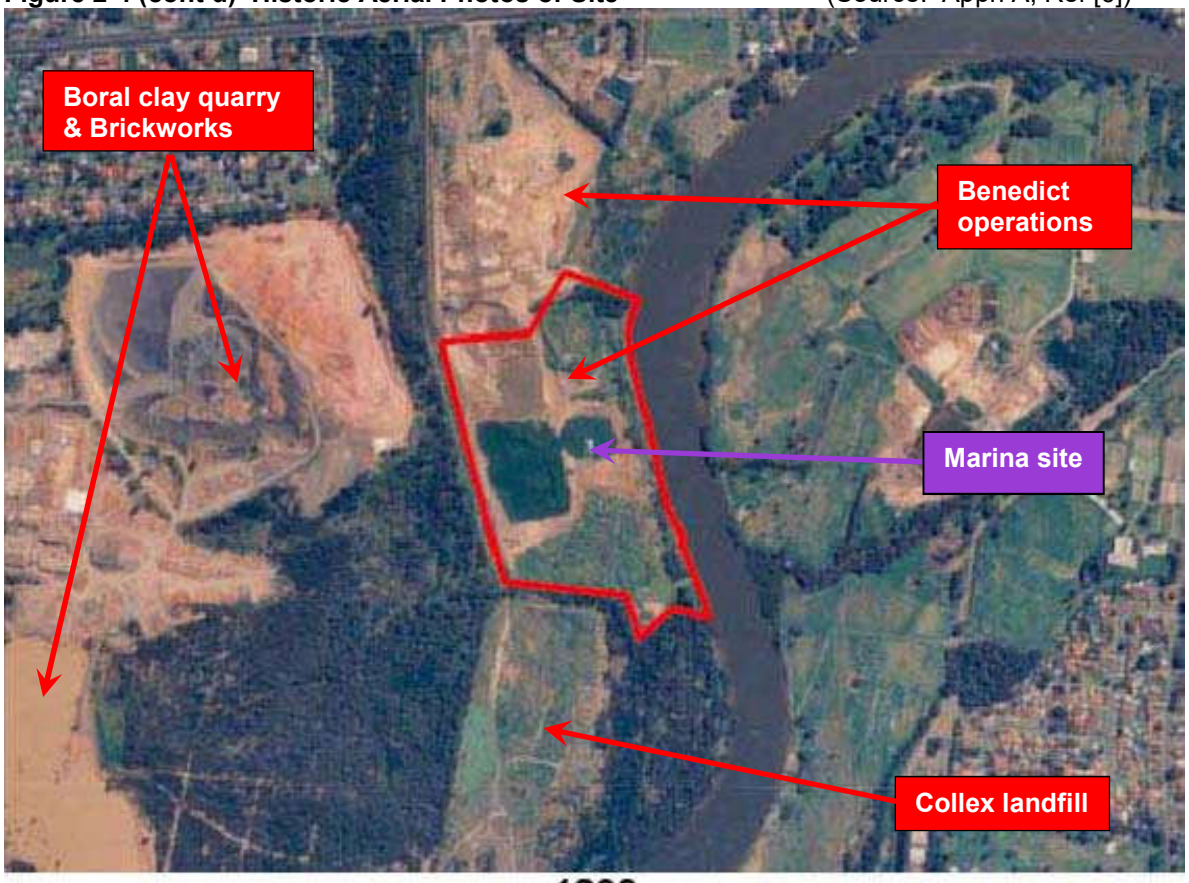


1978

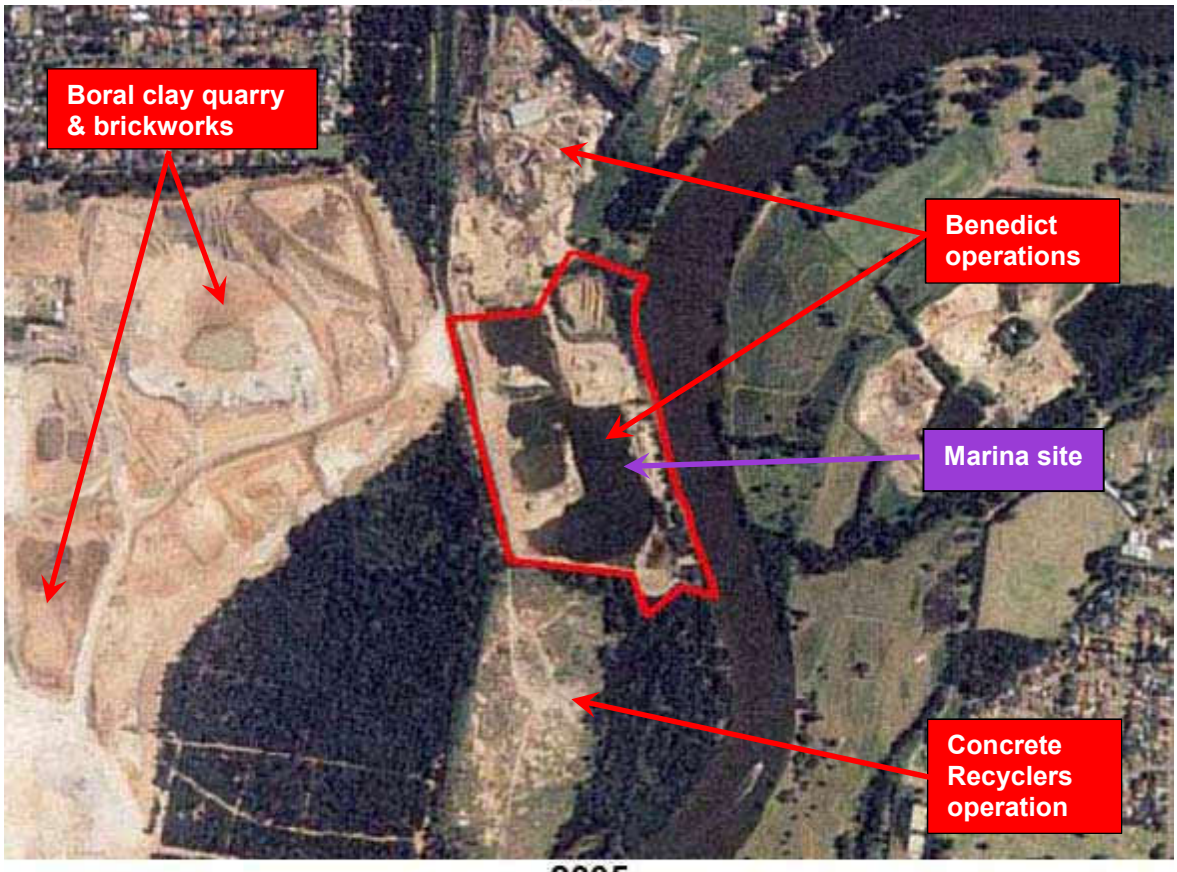


1986

Figure 2-4 (cont'd) Historic Aerial Photos of Site (Source: Appn A, Ref [6])

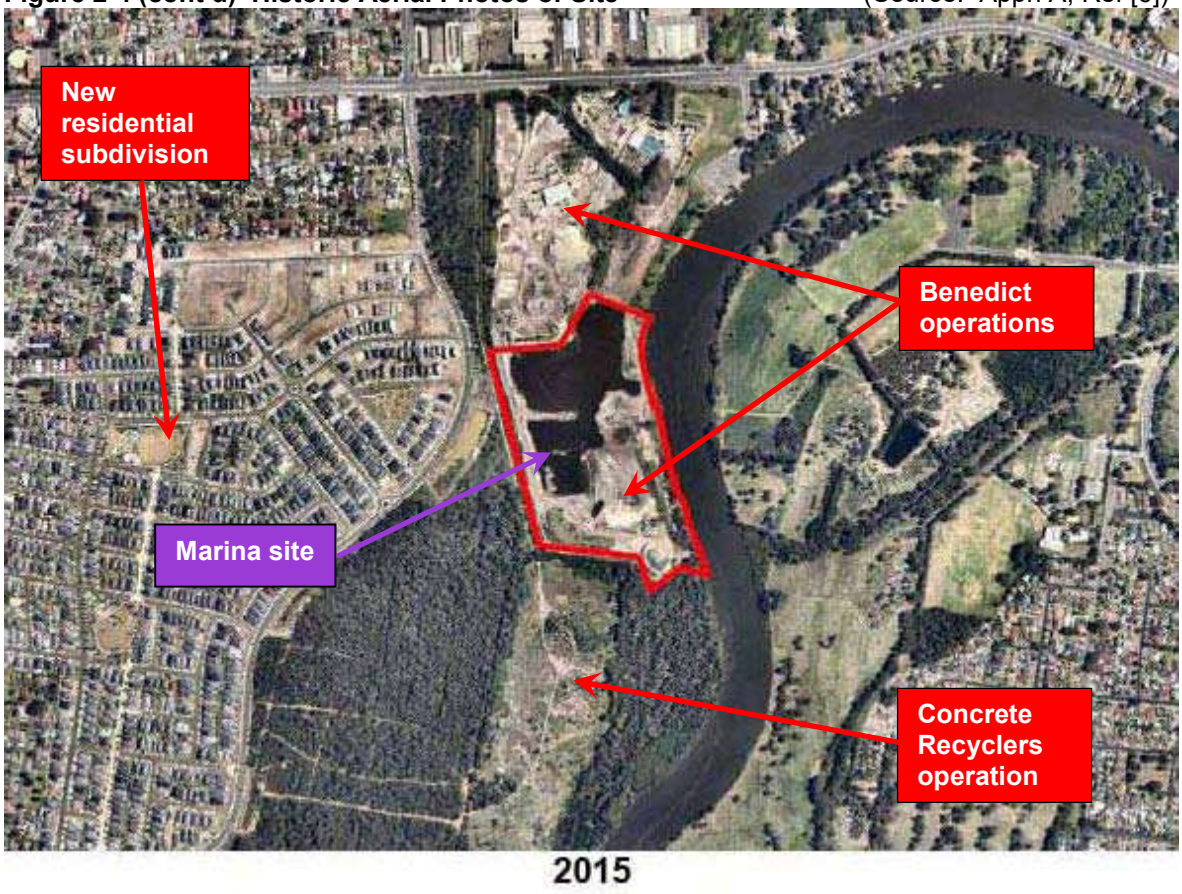


1998



2005

Figure 2-4 (cont'd) Historic Aerial Photos of Site (Source: Appn A, Ref [6])



Particular features of the site history given by the ESAs relevant to the assessment of contamination risks at the Benedict site are:

- Historic land title plans show the irregular southern boundary of the Benedict site was formed by a watercourse that flowed into the Georges River.
- 1999 – A proposed waste recycling facility and inert waste landfill was being proposed in the sand extraction site that existed at the time. A primary goal of the facility was to ensure that only wastes that could not be beneficially reused were landfilled on-site (Ref [1]). The landfilled materials were to be inert and non-leachable and suitable for disposal in a high water table environment. DP prepared an environmental monitoring program that aimed to ensure that the landfilled wastes (i.e.: non-recyclable portion) were completely inert and would have no impact on the local environment, particularly on groundwater and surface water resources.
- 2000 – The NSW EPA issued Licence 4612 for the Benedict site, which remains active. The Licence allowed crushing, grinding or separating; land-based extractive activity; water-based extractive activity, landfilling in designated areas, dredging. Materials that were permitted to be imported and used to backfill the sand quarry were Virgin Excavated Natural Material (VENM) and PASS placed underwater. Some of these permitted activities have since been removed when the NSW EPA issued variations to the Licence.
- 2001 - The NSW EPA issued Licence 10490 for the Benedict site, which remains active. The Licence allowed the recovery of general waste, recovery of waste tyres, the storage of waste tyres, and the storage of other types of waste. The Licence also allowed crushing, grinding and separating works. The waste streams that were permitted to be processed at the Benedict site included VENM, General Solid Waste (GSW) – non putrescibles, general or specific exempted waste, wood waste, paper or cardboard, gyprock, glass, building and demolition waste, asphalt waste, and waste tyres. Some of these permitted activities have since been removed when the NSW EPA issued variations to the Licence.

- 2001 and 2002 – The NSW EPA issued two non-compliance notices under Licence 4612.
- 2005 – The NSW EPA issued Clean-Up Notice No: 1051596 for a breach of Licence 10490 involving the presence of bonded asbestos fragments (fibro) in some stockpiles.
- 2007 – Council issued a Development Consent for a road bridge over the western drainage canal, which lapsed in April 2009.
- 2011 - The NSW EPA issued a non-compliance notice under Licence 10490 for storing GSW in excess of 25,000 m^3.
- 2012 – Penalty notice No: 3085764799 was issued by the NSW EPA.
- 2013 – Penalty notice No: 3085766119 was issued by the NSW EPA.

The EIS 2013 PSI[7] advised that the Scheduled Activities undertaken at the Benedict site included:

- Land-based extractive activity and water-based extractive activity (i.e. dredging)
- Crushing, grinding or separating;
- Storage / transfer / separation of various waste streams;
- Importation of VENM and PASS for backfilling the sand quarry;
- Dredging activities;
- Landfilling activities;
- Recovery, storage and processing (non-thermal) of general waste including VENM, GSW – non putrescibles, general or specific exempted waste, wood waste, paper or cardboard, gyprock, glass, building and demolition waste, asphalt waste, and waste tyres; and
- Receipt of materials containing asbestos.

A 2013 survey plan of the Benedict site showing the material stockpiles is provided in **Figure 2-5**, with a 1999 flow chart of Benedict's proposed waste processing operation provided in **Figure 2-6**.

Marina site

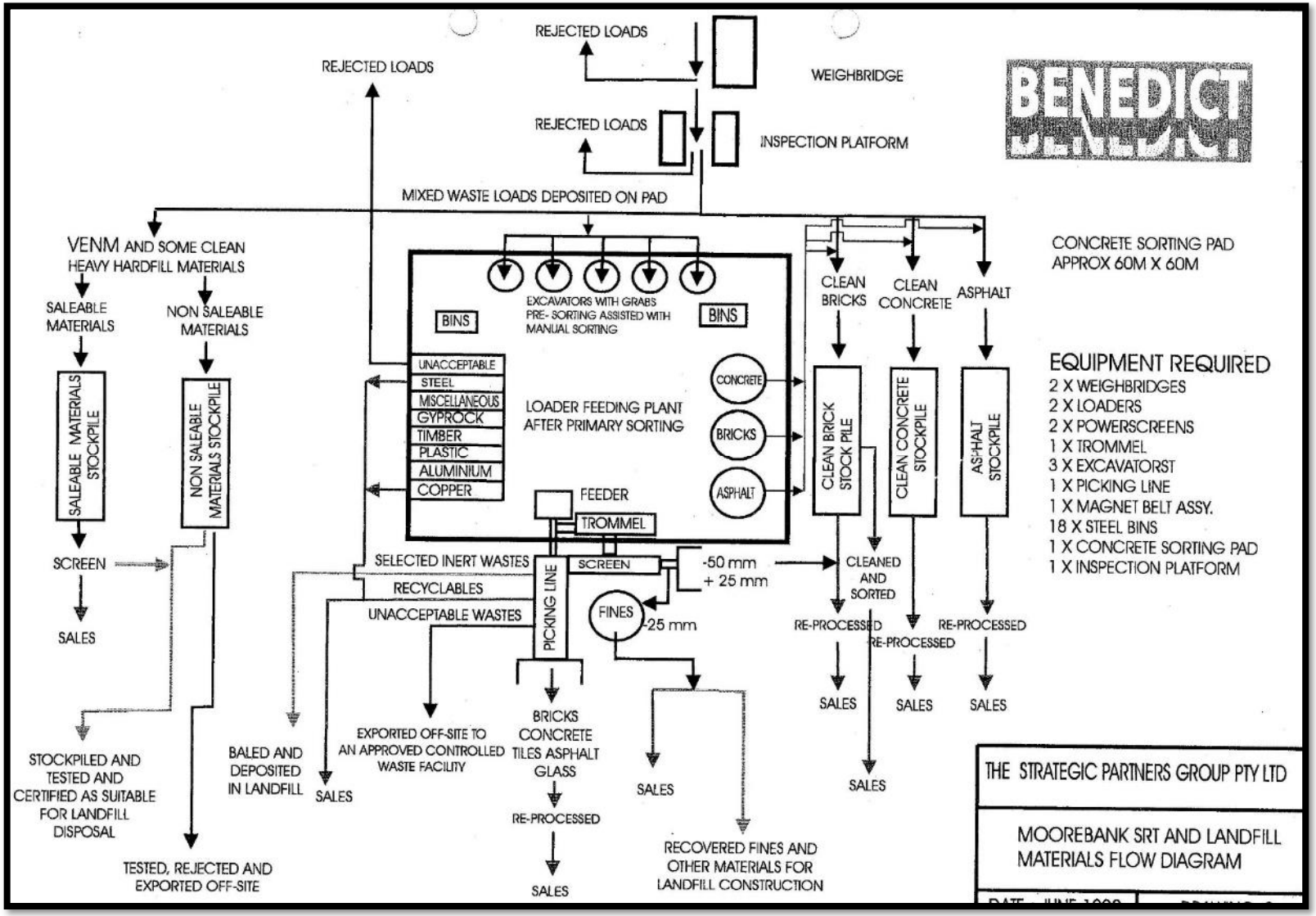
Particular features of the site history given by the ESAs[8] relevant to the assessment of contamination risks at the Marina site are:

- In 1993, the Land and Environment Court granted consent for Benedict to extract sand from Lot 7 via dredging and dry extraction methods. The approval required the rehabilitation of Lot 7 on cessation of extractive industries with the importation and processing of waste materials permitted to fill empty cells to return these areas to their natural landform. The excavated areas were to be filled with the imported fill materials to natural floodplain levels, then have the topsoil replaced and be grassed for use as grazing land. No dredge ponds would remain that could be utilised to form a marina basin.
- The 2005 aerial photo showed the dredge pond occupied about 70% of the Marina site and had been extended to the southern and northern boundaries of the Marina site (**Figure 2-4**).
- The 2015 aerial photo showed that more than 3 ha at the southern part of the dredge pond had been filled in while the dredge pond extending into the north-eastern corner. Some of the fill contained anthropogenic material.
- The Marina site presently contains a large dredge pond (approximately 6 ha) and tailings from the sand washery consisting of sand fines. Sand extraction by dredge has taken place to maximum depths of approximately 15 m in places. The disposal of VENM is permitted within the current Environment Protection Licence (EPL).

[7] Section 5.7, Ref [5]
[8] Sections 2.2, 3.2 & 3.3, Ref [6]

Figure 2-5 2013 Stockpile & Survey Plan of Northern Part of Benedict Site (Source: Appn C, Ref [5])

Figure 2-6 1999 Flow Chart of Benedict's Proposed Waste Processing Operation (Source: Drwg 2, Ref [1])



- Benedict holds a current EPL (license number 4612) for the Benedict site (including the Marina site, with resource recovery and waste storage as the scheduled activities. Additional activities relate to crushing, grinding or separating, and extractive activities (land and water based).
- A license variation was issued (Notice Number 1046512) to Benedict in May 2005 that allowed the storage / disposal of VENM, including PASS underwater, on the marina site and lists monitoring requirements. Approximately 1,000 tonnes of PASS has been disposed of on-site.
- No manufacturing and industrial processes have occurred at the Marina site and there is no evidence of chemical or fuel storage.
- Final restoration of the Marina site has not commenced and the dredge pond created from the sand extraction operations remains. The 1993 consent and EPL (number 4612) permit the restoration of Lot 7 back to natural surface levels via the importation of fill materials. Approval of the marina proposal will remove this need within the Marina site.
- Data on ammonia levels in surface water was measured quarterly and was provided in Ref [17] for the period 18/09/15 – 21/05/18.

Lot 6 southern landfill

ESAs[9] prepared by EIS advised that Collex operated a landfill at Lot 6 from July 1972. Details of the landfill construction included:

- The landfill was constructed by first building a clay dam around the property at a height of RL+3 mAHD;
- The base of the southern section of the landfill was reported to have been lined with clay, while the northern part was not lined;
- The landfill was divided into north and south sections by a natural clay ridge that lay on a NE – SW axis across the central part of the property;
- Wastes disposed at the landfill were reported to be restricted to dry non-putrescible industrial wastes such as builders rubble and used paper;
- As filling progressed a 0.6m thick compacted clay cap was placed on top of the fill;
- A 1989 report advised that leachate breakouts were reported to have occurred from 1978 to the time the report was issued. The breakouts caused dead and unhealthy vegetation. A sample of leachate breakout was found to contain the PCBs and the OCPs lindane and dieldrin;
- Drainage channels were constructed around the landfill to collect and remove surface water run-off from the landfill and drain to the Georges River;
- Landfilling ceased in 1979;
- Cracking and depressions were observed in the surface capping layer;
- Historic analysis of groundwater within the Lot 6 southern landfill measured elevated concentrations of heavy metals, phenolic compounds, VOCs, petroleum hydrocarbons, pesticides and ammonia. The data suggested that some of these compounds were impacting groundwater outside the Lot 6 southern landfill;
- BOD concentrations increased over the 1977 to 1980 period from 50 mg/L to 3,500 mg/L, then falling back to 50 mg/L. The high BOD concentrations suggested the presence of putrescible material in the landfill; and
- Methane gas was measured in boreholes.

[9] Section 5, Ref [3]; Section 5, Ref [4]; Section 4.1, Ref [

Site Auditor review

The Site Auditor assessed the accuracy of the historical assessments provided in the ESA reports by:

- Comparing the multiple lines of evidence provided by the source data;
- Comparing the supplied data with other publicly available data obtained from Council and NSW EPA records;
- Checking that the conclusions were consistent with the site condition data (**Section 2.1.4**);
- Checking that the contaminants of concern agree with the recommendations given in the Contaminated Sites Monograph Series No. 3 (1994) *'Identification and Assessment of Contaminated Land, Improving Site History Appraisal'* and relevant NSW EPA guidelines; and
- Inspecting the Marina site on 13/11/18, with a photographic record provided in **Appendix F**. The Site Auditor also inspected the Benedict site on eleven occasions between 23/06/15 and 29/10/18 and the southern landfill site on 23/10/18.

The Site Auditor considered the site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites. Data gaps identified were:

- Historic records on the quality and quantity of fill placed over more than 3 ha of the southern part of the Marina site sometime between 2005 and 2015;
- Groundwater monitoring data that needed to be collected as a condition of POEO Licence 4612; and
- Copies of annual reports that needed to be prepared by the two POEO Licenses.

The Site Auditor considered that significant data gaps remained in the documentation available on the contamination risks posed by the Lot 6 southern landfill. The data gaps were:

- Verifiable data on landfill construction, operation and closure; and
- Detailed investigation of groundwater contamination and soil gas migration towards the Marina site.

The Site Auditor considered the data gaps in the historic data could be addressed by data provided by site investigations involving subsurface drilling, in-situ screening tests, sample collection and laboratory testing. A review of the investigations that have been conducted at the Marina site and their ability to address these data gaps is documented in **Section 3**.

Compliance with SEAR 912 Requirements

The SEAR 912 conditions for the proposed marina development (Ref [79]) requires a detailed appraisal of the site's history including the northern part of the Marina site. The Site Auditor considers this section of the SAR addresses this requirement.

2.1.4 Site Conditions

The site condition data provided by the ESAs is summarised in **Table 2-3**.

Table 2-3: Summary of Site Condition Details

Site Condition Detail	References
Topography and Surface Conditions	
Regional and site topography	**Sectns 4.3, 4.4, Fig 2, Appn C8, Ref [5]; Sectn 4.1, Ref [6]**
Regional and site drainage patterns	Sectn 4.12 & Appn C8, Ref [5]; Sectn 4.4, Ref [6]
Flood potential	Sectns 4.10, 5.3.2, Appns C8 & C9, Ref [5]; Sectn 4.4, Ref [6]
Conditions at site boundary (e.g. type and condition of fencing, soil stability and erosion)	Sectn 4.4 & Appn C8, Ref [5]; Sectn 4.1, Ref [6]
On-site developments, buildings and roads	Sectn 4.4, Figure 2 & Appn C8, Ref [5]; Sectn 4.1, Ref [6]
Sewer and service plans	No structures present in Marina site
Hazardous building materials	No buildings present in Marina site
Surface conditions (e.g. paving, vegetation, buildings)	Sectn 4.4 & Appn C8, Ref [5]; Sectn 4.1, Ref [6]
Visible signs of contamination & odours at ground surface	Sectns 4.4, 5.5 & Appn C11, Ref [5]; Sectn 4.1, Ref [6]
Visible signs of plant stress	Sectn 4.4 & Appn C8, Ref [5]; Sectn 4.1, Ref [6]
Presence of USTs, drums, wastes and fill materials	Sectns 4.4, 4.7, 5.4, Appn C10, Ref [5]; Sectn 4.1, Ref [6]
Geology and Hydrogeology	
Regional and structural geology	Sectn 4.8, Ref [5]; Sectn 5, Ref [9]; Sectn 4.1, Ref [12]
Borehole & test pit logs	Appn B, Ref [2]; Appn A, Ref [5]; Appn D, Ref [7]; Appn E, Ref [12]
Site stratigraphy	**Sectn 9.1, Ref [5]; Sectn 4.3, Ref [6]; Appn D, Ref [7]**
Fill	Sectn 9.1, Ref [5]; Sectn 4.3, Ref [6]
Acid sulfate soils	Sectns 4.9, 4.10, 5.3.2 & Appn C9, Ref [5]; Sectn 4.6, Ref [6]; Sectn 5, Ref [9]; Sectn 4.1, Ref [12]
On-site wells and springs	Sectn 4.11 & Appn C5, Ref [5]; Sectn 5, Ref [9]; Sectn 4.1, Ref [12]
Nearby wells and springs	
Hydrogeological system operating at the site	Sectns 4.11, 9.4 & Figure 4, Ref [5]; Sectn 4.5, Ref [6]; Sectn 5, Ref [9]; Sectn 4.1, Ref [12]
Background water quality	Sectn 8.1, Ref [6]
Local meteorology	Sectn 4.13 & Appn C5, Ref [5]; Sectn 4.2, Ref [6]
Surrounding Environment	
Location of nearest groundwater receptors	Sectns 4.2, 4.11 & Appn C5, Ref [5]; Sectn 5, Ref [9]
Location of nearest surface water receptors	
Surrounding land uses and details of local sensitive environments (e.g. rivers, lakes, creeks, wetlands, local habitat areas, endangered flora and fauna)	Sectns 4.10, 5.3.2, Appns C8 & C9, Ref [5]
Surrounding areas that may pose a pollution hazard to the site	Sectn 5.1, Ref [6]

Legend:

Inadequate information provided in investigation reports

The main site features described by the ESAs relevant to the assessment of contamination risks at the Site are:

- **Topography, drainage & flood potential**: The ESAs described the Benedict site as being part of an undulating regional topography, with site elevations ranging from 1 to 8 m AHD. The Site topographic has been significantly altered due to the sand extraction and landfill operations that occurred since the mod-1980's. The Benedict site was originally part of a low lying area (partially wetland) that was been raised by 5 – 7m. Relatively steep batters (25 – 40^{o}) are located along the south, east and western boundaries, with some of the batters benched.

  Relatively large surface water bodies / dams were located within the Marina site created by mining / dredging activities. A major stormwater drain forms the western boundary of the Benedict site.

  Surface water runoff at the Marina site predominantly drains towards the dredge pond. A small portion of the Marina site to the east of the dredge pond could drain towards the Georges River.

  The Section 149 Certificate identified the Benedict site as having a high flood risk, with a copy of Council's Flood Planning Area map provided in **Figure 2-7**.

- **On-site development**: The EIS 2013 PSI described the majority of the Benedict site as being covered by large dredged areas that extended below river levels and stockpiles of various types of soil and waste material. At the time the 2013 PSI was issued, the northern part of the Benedict site that is proposed to be redeveloped for a residential subdivision contained from north to south:

  - The main site entrance and access road off Newbridge Road, an old single storey cottage and stockpiled materials A metal waste dump was present that contained metal pipes, pugmills, boilers, metal containers and various other metal objects. Numerous oil drums, car batteries and other metal waste was located in a small shed and two shipping containers. Labels indicated on the drums contained industrial gear oil, transmission fluids, HP gear oil, etc. An AST and bowser were located within a concrete bund. PVC drums containing sodium hypochlorite were located to the north of the bund. The base and walls of the bund were plastered with concrete and no major cracks were visible. Another bowser was located north of the main warehouse building.
  - The main process buildings that included a large warehouse and two silos, an office, weighbridge, truck waste facility, asphalt sealed carpark. A waste washing plant was located further south, with wastewater draining into ponds; and
  - Stockpiles that predominantly contained sand, glass, residue, gravel and dirt. A large wash plant was located in the south-eastern corner, which processed sand dredged from the large pond located further south at the Marina site.

  A site inspection conducted by EMM on 29/05/15 found the Marina site to be mostly occupied by stockpiles and the main dredge pond, as shown in **Figure 2-8**. Unpaved access roads were located along the western and eastern sides of the Marina site.

  A number of large stockpiles were observed on the Marina site during the inspection, which consisted of soil and overburden from on-site dredging activities. The stockpiles in the centre / north of Lot 7, to the north of Marina site, typically covered an area of 10 - 20 m^2 and were 2 - 3 m high. The stockpiles on-site to the east of the dredge pond were smaller. There was a large mound (as opposed to a temporary stockpile) measuring approximately 140 m by 60 m and 10 m high across the south-west corner of the Marina site. The mound, originally constructed of fill, stripping and overburden, was vegetated with grasses and small shrubs.

- **Surface conditions and vegetation**: The EIS 2013 PSI described most area of the Benedict site as unsealed and disturbed by sand extraction, landfilling, material processing and stockpiling activities. Vegetation across most areas of the Benedict site was cleared by the earlier broadacre agricultural activities and then the sand extraction operation. Weeds and grass tend to grow in areas were little activity has occurred for several years.

  A site inspection conducted by EMM on 29/05/15 found dense vegetation on the eastern boundary of the Marina site along the Georges River western bank. Dense vegetation, predominantly grasses and medium sized trees, surrounded the Marina site to the south and west.

Figure 2-7 Extract of Council's Flood Planning Area Map (Source: Ref [74])

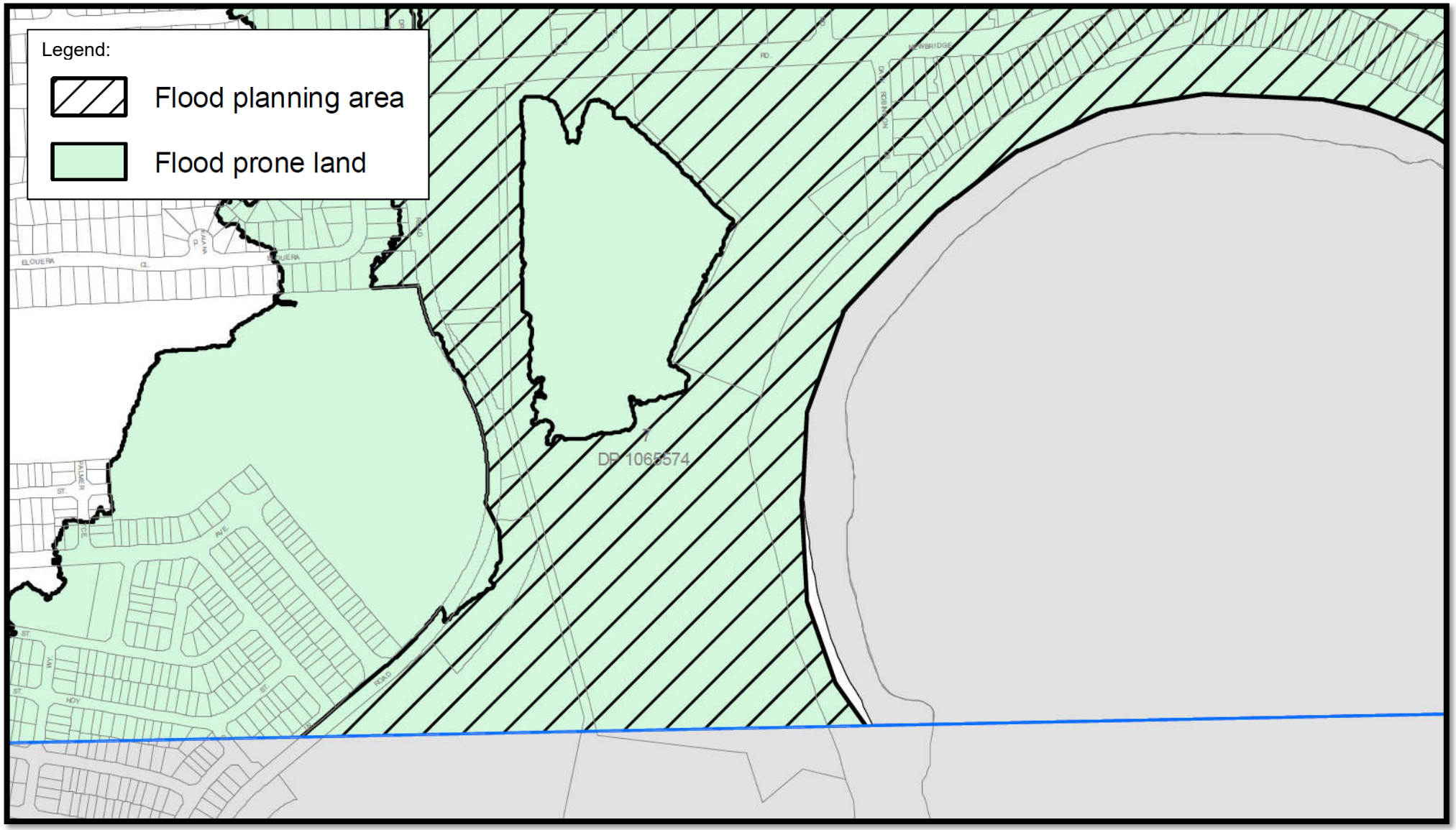


Figure 2-8 Stockpile Locations at Audit & Benedict site in 2015 (Source: Figure 4.1, Ref [6])

- **USTs / ASTs & Chemical Storage**: WorkCover records indicated that the Benedict site had no licenses to store Dangerous Goods. However, an AST with two bowsers were present together with numerous chemical drums and an oil storage area. No USTs were present at the Benedict site.

  The Marina site had no history or showed evidence of chemical storage.

- **Visible signs of contamination & odours at ground surface**: For the Benedict site, the EIS 2013 PSI identified:

  - Leachate flowing from the northern face of stockpile SP1, which contained 42,000 m^3 of glass and soil located in the NW part of the Benedict site (**Figure 2-5**). The source of the leachate was the glass in the stockpile;
  - An area of dumped rubbish was located on the northern toe of stockpile SP2 in the NE part of the Benedict site. The rubbish was described as including tyres, boulders, metal fragments, etc;
  - The NSW EPA and WorkCover identified the presence of bonded asbestos fragments (fibro) in some stockpiles on 4/05/05 and again on 23/08/05, which resulted in Clean-up Notice No: 1051596 being issued. The Notice advised that suspected asbestos was found in stockpiles of:
    - Mixed demolition waste being loaded into a trammel;
    - Mixed inert waste being sorted by an excavator and loaded onto trucks for off-site disposal;
    - Sorted concrete and brick waste awaiting crushing in mobile plant;
    - Roadbase material;
    - Minus 10mm and 20mm crushed concrete and brick aggregate; and
    - Washed aggregate coming out of a screen/washer.

  A site inspection conducted by EMM on 29/05/15 at the Marina site found discarded pipes, assumed to be associated with dredging operations, along the western boundary of the dredge pond with isolated occurrences of rubbish observed across the Marina site. There were no hydrocarbon stains or odours noted during the site inspection.

- **Regional and structural geology**: The 1:100,000 geological map of Penrith indicates that the Benedict site is underlain by fluvial deposits possibly over Ashfield Shales. The northern part of the Benedict site was underlain by Tertiary aged clayey sand and clay, while the central and southern sections (the Marina site) were underlain by Quaternary deposits of sand and silty clay.

- **Stratigraphy**: The ESAs[10] showed that in 1994 six boreholes (labelled BS-1 to BS-6) were drilled by Dames & Moore around the dredge pond of the Marina site at the locations shown in **Figure 2-16**. The borelogs showed the boreholes were drilled to depths of 7.0 – 7.75 mbgl through natural alluvial soil comprising silty sand coloured mid to dark brown with a medium fine grading becoming coarser with depth. The logs showed no anthropogenic material of physical evidence of contamination was present. Copies of these borelogs are provided in **Appendix A**. EMM advised that the alluvial soils were 11 – 17m thick, thickest nearest the Georges River and thinning towards the west and north where the contact with the older Tertiary clay soils occurred, as shown in **Figure 2-9**.

- **Acid sulfate soil (ASS) risk**: The DLWC ASS Risk Map showed the Benedict site was located in a 'High Probability Risk Area' associated with low lying swamp areas. The depth of occurrence was 1 – 3mbgl and associated with alluvial plans, alluvial swamps, alluvial levees and sand plains. The Section 149 Certificate identified the Benedict site as having a Class 1 or Class 2 ASS risk. An extract of Council's ASS map is provided in **Figure 2-10**.

[10] Section 4.3.1, Ref [6]; Appn D, Ref [7]; Section 4.1, Ref [12]

Figure 2-9 Regional Geology (Source: Figure 1, Ref [12])

Figure 2-10 Extract of Council's ASS Map (Source: Ref [70])

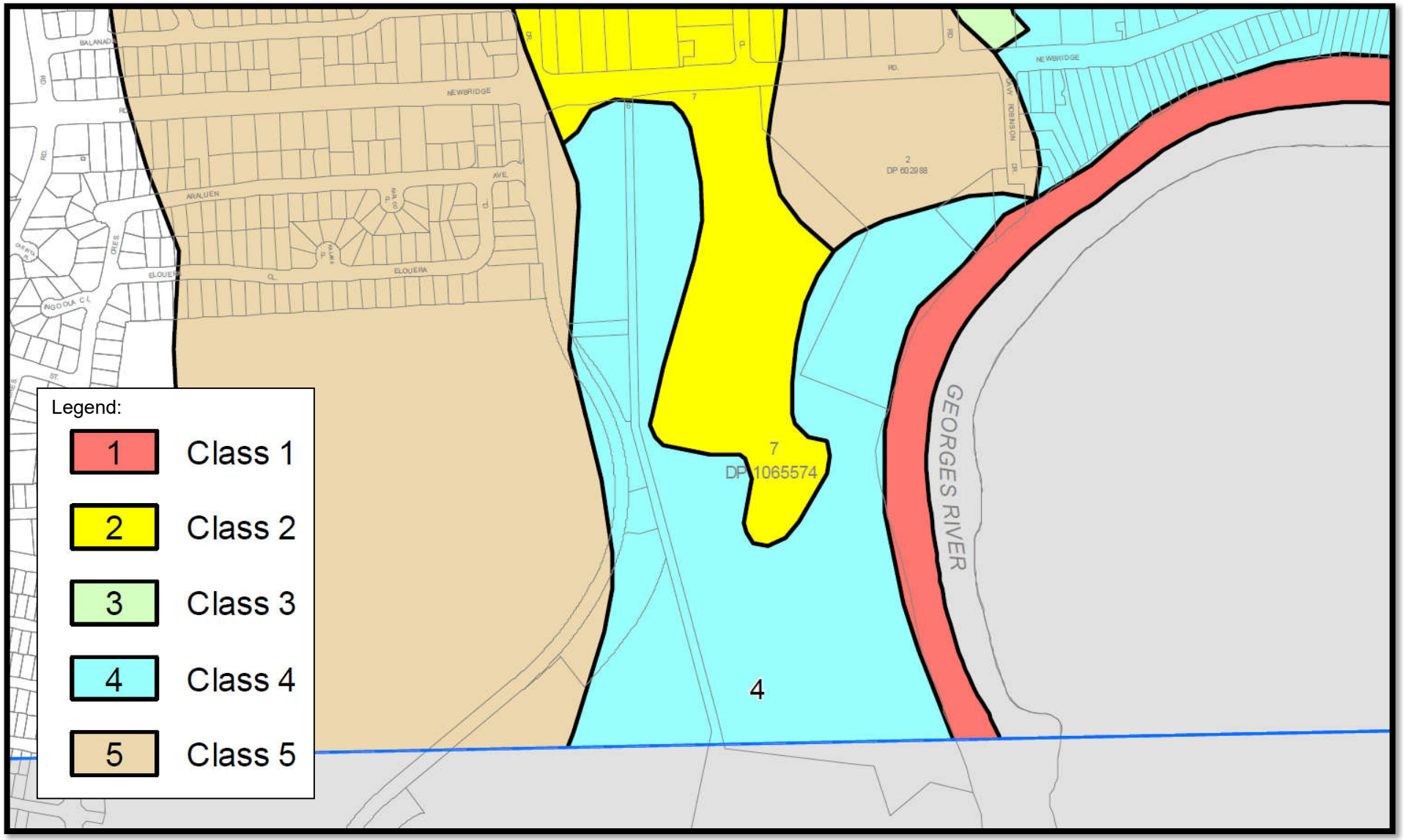


Figure 2-11 Plan of Licensed Groundwater Bores (Source: Appn C5, Ref [5])

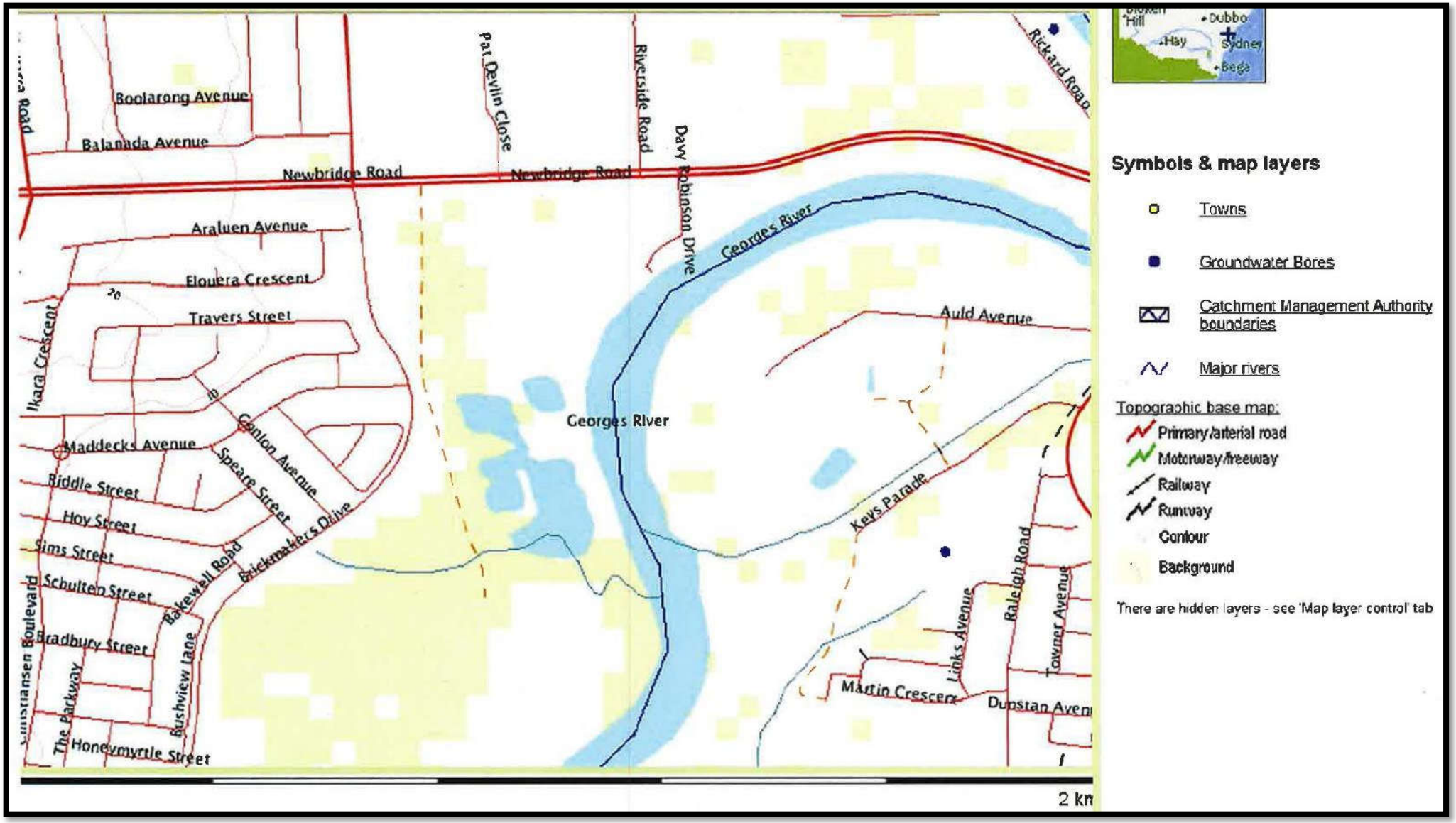


Figure 2-12 Extract of Council's Environmentally Significant Land Map (Source: Ref [73])

- **Hydrogeology**: The ESAs advised that the unconsolidated deposits beneath the Marina site form a single, unconfined aquifer. Groundwater levels are shallow, typically 2 - 3 m bgl and are in hydraulic connection with the river tidal levels. The measured permeability in the monitoring wells adjacent to Georges River ranged from 12 to 47 m/day averaging 30 m/day, while permeabilities of less than 1m/day were measured in the finer sediments on the western side of the Marina site. Horizontal flow is expected to dominate due to the relatively impermeable underlying Wianamatta Group Shales.

  The ESAs concluded that:

  - There was an overall flow of groundwater in a south-easterly direction towards the Georges River;
  - Groundwater flows in the zone adjacent to the river are likely to be influenced by the intrusion of brackish / saline river water at depth, with fresh water flows towards the river concentrated in the shallow zone at approximately 5 - 6 m depth;
  - Groundwater at depth adjacent to the Georges River can be influenced by relatively higher salinity water from the adjacent creek; and
  - A search of the NSW Office of Water registered bore database did not identify registered bores at the Marina site or within a radius of 400 m around the site. A copy of the DLWC licensed well map is provided in **Figure 2-11**.

- **Nearest surface water & groundwater receptors**: The nearest off-site groundwater and surface water receptor is the Georges River that will be connected to the Marina site when the proposed marina has been completed. The two licensed bores located 800 m and 1.2 km from the Site are not considered to be potential receptors.

- **Nearest sensitive environments**: The Section 149 Certificate identified the Benedict site as being in an environmentally sensitive and foreshore area due to the surrounding reserves and close proximity to the Georges River. The land is also subject to a tree preservation provision. However, the land does not contain Critical Habitat, a Conservation Area, an item of Environmental Heritage, biodiversity certificated land and is not affected by the Native Vegetation Act 2003. An extract of Council's environmentally significant land is provided in **Figure 2-12**.

The Site Auditor assessed the accuracy of the site condition assessments provided in the ESA reports by:

- Comparing the multiple lines of evidence provided by the source data;
- Comparing the supplied data with other publicly available data obtained from Council and NSW EPA records;
- Checking that the conclusions were consistent with the historical data (**Section 2.1.3**); and
- Inspecting the Marina site on 13/11/18, with a photographic record provided in **Appendix F**. The Site Auditor also inspected the Benedict site on eleven occasions between 23/06/15 and 29/10/18 and the southern landfill site on 23/10/18.

The Site Auditor considered the site condition data provided in the ESAs was close to meeting the documentation completeness DQO. Data gaps identified were:

- Up-to-date survey plan of Marina site showing topographic contours of the terrain and bathymetric contours of the dredge pond; and
- Stratigraphic cross-sections showing the variation in subsurface conditions across the Marina site.

The Site Auditor considered the data gaps in the site condition data could be addressed by conducting detailed site investigations across the Site. A review of these investigations and their ability to address these data gaps is documented in **Section 3**.

2.1.5 Preliminary Conceptual Site Model for Contamination

The EMM 2015 PSI[11] developed a preliminary Conceptual Site Model (CSM) for contamination across the Marina site that considered the source – pathway – receptor linkages. An updated CSM was then provided in the EMM 2016 RAP[12]. The DP 2018 PSI subsequently developed a CSM for the western part of the Marina site. For the purpose of this SAR, the Site Auditor has assessed the adequacy of the CSM provided in the EMM 2016 RAP since it was developed for the whole Marina site and formed the basis of which their RAP was prepared.

Contaminant Sources & Contaminants of Concern

The EMM 2016 RAP considered there were six potential sources for contamination at the Marina site, these being:

- **On-site fill**: Generally inert fill containing bricks, rubble, etc. but with some anthropogenic debris such as plastics may generate leachate or may have been introduced to the dredge pond as the pond was excavated. Therefore the fill may have contributed metals, nutrients and PAHs to the groundwater and dredge pond.
- **Urban runoff**: Largely in the unlined stormwater drain west of the Marina site that is expected to contain metals, ammonia, nutrients and PAHs with some seepage to groundwater.
- **Runoff and process water from northern recycling operation**: These water inflows included:
  - Materials such as concrete, bricks and glass were being recycled that involved sorting, crushing, washing and stockpiling;
  - Materials being washed using pond water that was returned to the pond; and
  - Runoff from the Marina site.

  Given that the recycled waste materials were being inspected prior to being accepted by the recycling facility, there was a low risk these activities were a source of metal or organic contaminants. However, these activities had the potential to introduce ammonia and nutrients to the dredge pond.
- **Old landfill to north of Marina site**: Potential source of metals, ammonia, nutrients and PAHs to the basin and Georges River through groundwater seepage.
- **Old landfill to south of Marina site**: Potential source of metals, ammonia, nutrients and PAHs, contributing to contamination of groundwater and the dredge pond sediments.
- **Georges River water**: Suspended sediment, and bed sediment.

The potential areas of concern (AECs) and contaminants of concern identified by EMM are summarised in **Table 2-4**, with a conceptual site model (CSM) showing source – pathway linkages provided in **Figure 2-13**.

[11] Section 5.1, Ref [6]
[12] Section 3.2.3, Ref [8]

Table 2-4: Potential Contaminants of Concern & Sources

Potential Contaminant Sources	Heavy metals (1)	TPH & BTEX	PAHs	Other VOCs	OCPs & OPPs	PCBs	Asbestos	PFAS	Nutrients	Degradation products (2)
On-site Fill	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban runoff along western drain	✓	✓	✓	✓	✓	✓		✓	✓	✓
Runoff & process water from northern recycling operation	✓	✓	✓	✓	✓	✓		✓	✓	✓
Old landfill to north of Marina site	✓	✓	✓	✓	✓	✓		✓	✓	✓
Old landfill to south of Marina site	✓	✓	✓	✓	✓	✓		✓	✓	✓
Georges River water	✓				✓	✓		✓	✓	
Potential ASS	**SPOCAS**									

Legend:

✓ Additional potential sources of contamination and contaminants of concern included by Site Auditor

(1) Arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc

(2) Ammonia, methane, carbon dioxide, carbon monoxide, hydrogen sulphide

The Site Auditor considers the contaminant sources identified by EMM were appropriate and consistent with the historic and site condition data with the addition of **Georges River sediment**. This is because a recent 2017 University of Wollongong study (Ref [78]) found upper Georges River sediments to have elevated heavy metal concentrations that exceed the ANZECC & NHMRC (2000) ISQG low criteria, as shown by the results presented in **Figure 2-15** and **Table 2-5**. There is also a risk of Georges River sediments being contaminated by other chemicals because:

- The NSW EPA issued a '*Dietary advice for fish caught in Botany Bay and Georges River*' on 15/12/17 due to PFAS contamination;
- NSW Industry and Investment has issued a fish advisory[13] not to eat fish or shellfish caught in the Georges River and its tributaries upstream from Rabaul Road Boat Ramp at Georges Hall, including Prospect Creek, Cabramatta Creek and Chipping Norton Lake and Salt Pan Creek and its tributaries, upstream of Henry Lawson Drive at Padstow. This restriction is due to industrial pollutants being found in this area (**Figure 2-14**);
- The NSW Government has closed the whole of the Georges River to oyster cultivation[14]; and

[13] https://www.dpi.nsw.gov.au/fishing/closures/location-closures/botany-bay-and-georges-river
[14] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/831517/botany-bay-and-georges-river-closed-waters.pdf

Figure 2-13 EMM Preliminary CSM Showing AECs and Exposure Pathways (Source: Figure 3.1, Ref [8])

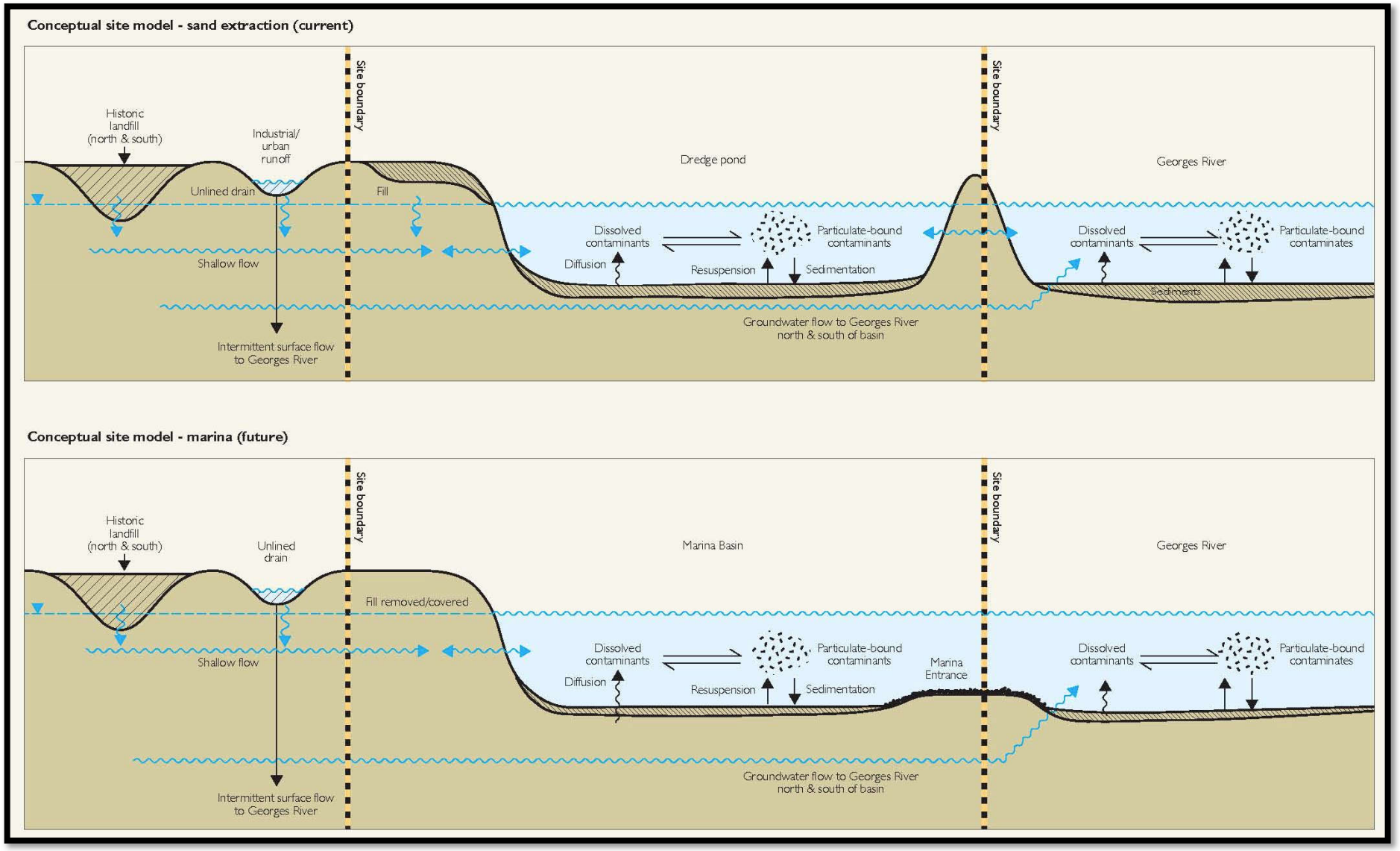


Figure 2-14 NSW Industry & Investment Fish Advisory Map

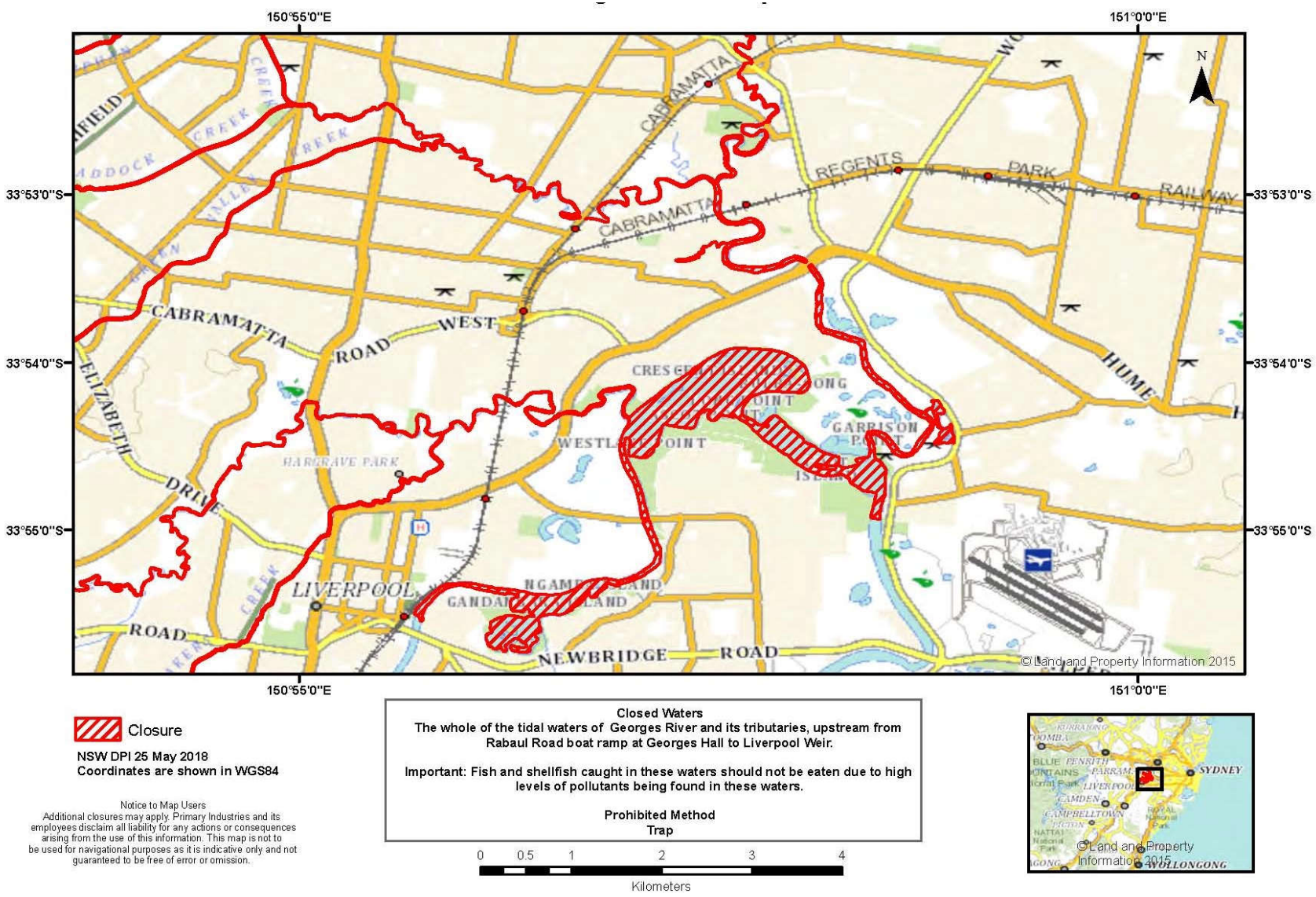
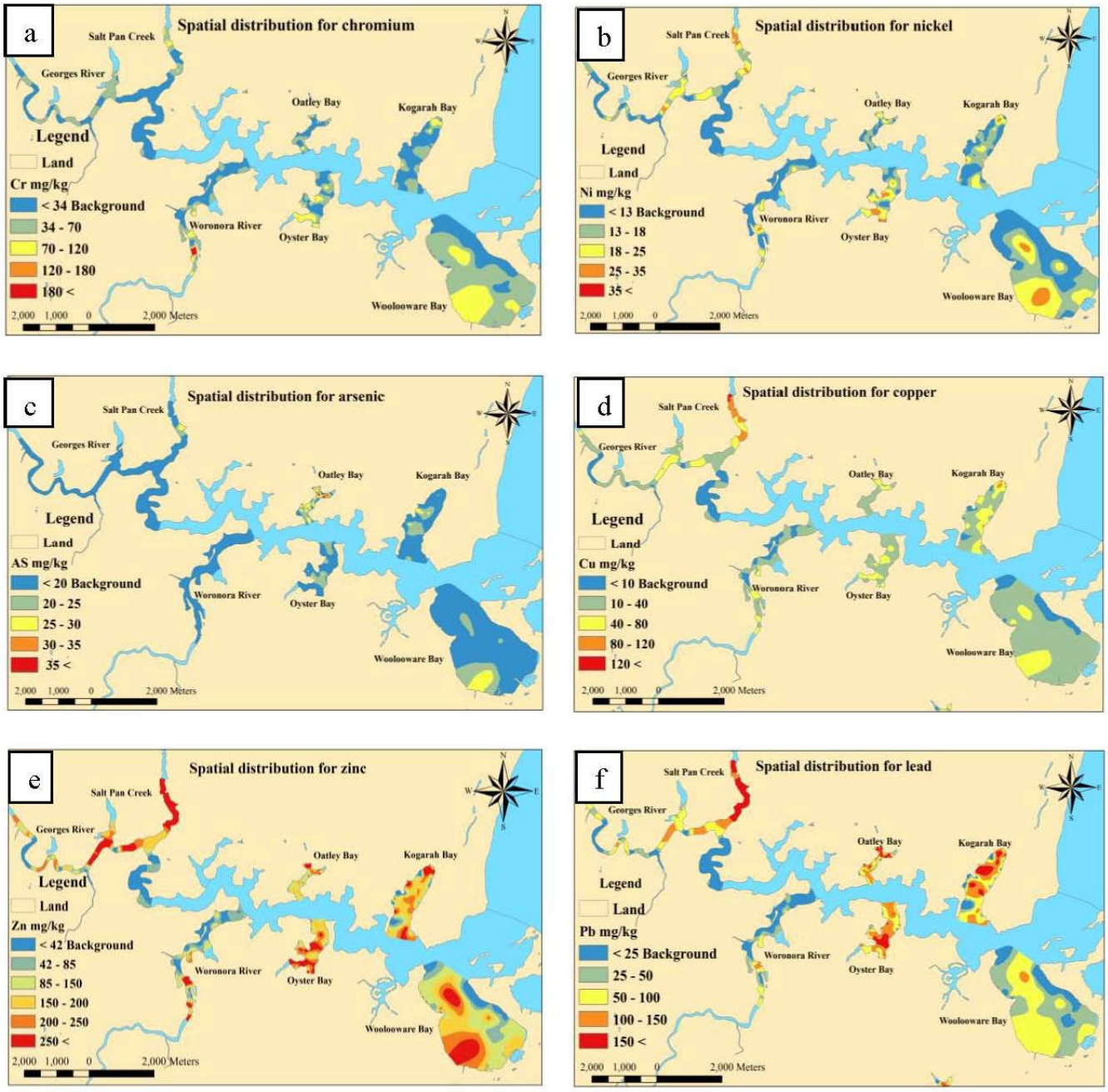


Figure 2-15 Heavy metal contamination in Georges River Sediments (Source: Figure 4, Ref [78])



- The NSW Government has closed the whole of Salt Pan Creek at the Henry Lawson Drive Road Bridge to catching fish and shellfish[15].

Sediments in the Georges River will be able to migrate as suspended sediment and be deposited in the Marina site when the former dredge pond is opened to the Georges River. The Site Auditor addressed this data gap in the EMM CSM by including Georges River sediment as a potential source of contamination in the CSM adopted by this site audit.

15 https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/831525/salt-pan-creek-closed-waters.pdf

Table 2-5 Heavy metal contamination in Georges River Sediments (Source: Table 3, Ref [78])

Trace elements Sites	Cr mg/kg	Ni mg/kg	Cu mg/kg	Zn mg/kg	As mg/kg	Pb mg/kg	References
Woolooware Bay							
Range	6-99	1.1-26	9-58	8-314	1.2-22	3.3-104	Present study
Mean ±SD	43±24	12±7	21±2	116±74	11±6	37±24	
Woronora River							
Range	4-84	0.7-24	3-55	9-329	1-19	4-105	Present study
Mean ±SD	33± 25	10±7	19±16	92±87	6±5	30±28	
Georges River							
Range	4-68	1.3-27	3-60	11-431	2-20	4-154	Present study
Mean ±SD	27±19	10±7	23±17	132±113	8±6	48±54	
Salt Pan Creek							
Range	24-86	17-30	74-138	349-789	11-26	138-268	Present study
Mean ± SD	57±23	23±5	102±21	556±144	16±4	188±38	
Kogarah Bay							
Range	7-91	1-28	5-100	11-433	2-28	5.4-235	(Alyazichi et al., 2015a)
Mean ±SD	33±24	12±7	37±24	158±99	12±8	87±60	
Oyster Bay							
Range	9-127	7-39	10-63	43-386	1.9-26	14-198	(Alyazichi et al., 2015b)
Mean ±SD	51±32	19±7	35±13	204±84	15±6	98±48	
Oatley Bay							
Range	7.9-130	6.6-30	7-156.6	38-915	6-42	14-582.2	(Pease, 2007)
Mean ± SD	40 ± 22	14.5 ± 5	40 ± 25	196 ±134	23 ± 8	117 ± 81	
Botany Bay							
Range	NA	NA	<50- >200	<200- >1500	NA	<100->400	(Birch et al., 1996)
Sydney Harbour							
Range	7-698	17-86	13-1078	46-2246	NA	44-1319	(Irvine and Birch, 1998)
Mean	118	38	124	548		268	
Derwent estuary							
Range	<5-183	<2-35	<2-1182	<2-22593	1-657	4-3866	(Jones et al., 2003a)
Mean ±SD	63±33	16±1	106±184	2103±3897	51±97	580±763	
Huon River							
Range	50-80	<2-28	7-32	<2-66	4-25	<2-48	(Jones et al., 2003a)
Mean± SD	71± 8	20± 6	17± 6	40± 18	16± 6	25± 12	
Burrill Lake							
Range	NA	3-20	5-80	3-82	2.9-22	0-32	(Killian, 1999)
Mean± SD		11±4	32±24	29±23	11±6	13±9	
Port Hunter	21-167	44-156	19-283	32-5161	NA	25-843	(Birch et al., 1997)
ISQG / Low	80	21	65	200	20	50	(ANZECC and NHMRC, 2000)
ISQG / High	370	52	270	410	70	220	(ANZECC and NHMRC, 2000)

NA is not available.

The Site Auditor considered the available data supported the need for the CSM to include additional contaminants of concern, which are listed in **Table 2-4**. These additional analytes were TPH / BTEX, other VOCs, OCPs / OPPs, asbestos and PFAS. They were included in the CSM because these contaminants are known general pollutants associated with uncontrolled imported fill and waste disposed to landfill.

Environmental Media

The EMM 2016 RAP[16] considered there are seven environmental media that had the potential to be or become contaminated. These are:

- **Site soils**: Fill that extends at least 4 mbgl. This is primarily construction and demolition waste. There is the potential that the dredge pond contains some of this fill as a result of the excavation of the pond.

[16] Section 3.2.2, Ref [8]

- **Basin sediments**: The floor of the dredge basin is covered by fine sediments. The operating dredge resuspends these sediments into the water column. When the marina is opened, the basin sediments will be contiguous with Georges River sediments.
- **Georges River sediments**: Contaminated sediments in the Georges River have the potential to migrate into the marina basin once the dredge basin is connected to the Georges River,
- **Groundwater**: Migrating from offsite properties and moving through the site towards the Georges River. The groundwater flow is expected to be influenced by surface water inputs and the Georges River water level that changes due to river flow and tides (depending on the distance from the river).
- **Surface water**:
  - A large unlined stormwater drain runs along the western boundary of the Marina site that drains stormwater from the Chipping Norton industrial area to the north of Newbridge Road. It is separated from the Marina site by a levee running from Newbridge Road to the southern end of the Marina site and then discharges to the Georges River immediately south of the site. As the drain is unlined and adjacent to the Marina site, some of the stormwater in the drain will seep to groundwater. Contaminant concentrations in the drain will be highly variable and depend on many factors including flow, period since last rain, rainfall intensity, and rainfall duration. It would be extremely difficult to characterise average concentrations (or loads) in such a highly variable system;
  - Basin (dredge pond) water was used as part of the northern processing operations; and
  - Surface water runoff from the northern part of the Benedict site to the dredge basin.
- **Basin water**: In 2016 the dredge pond was reportedly about 6 ha in size and about 2.9 m deep. A cutter suction dredge was being used to recover material from the basin as part of sand extraction operations. There was no opening between the dredge pond and the Georges River, which continued to the time this SAR was issued. In 2016 water in the dredge pond was reported to be brackish with a mean salinity of 8.7 g/L (salinity of seawater is 35 g/L) and was considered to be generally well mixed. The dredge pond will form the marina basin which will open to the river. EMM estimated that up to 40% to 60% of the water in the marina basin would be exchanged between each peak and trough of a tidal cycle.
- **Georges River water**: The Marina site is located toward the top of the estuarine section of the Georges River. In 2016 EMM reported that the river adjacent to the Marina site carried stormwater runoff from highly urbanised sub catchments upstream, including wet weather sewage discharges from three Sewage Treatment Plants (STPs): Glenfield, Liverpool and Fairfield. The Georges River Catchment Built Environment and Foreshore Access Study (DIPNR 2004) states that in the section of the river between Liverpool Weir and Sandy Point Bridge "*Water quality is generally poor and affected by urban influences including discharge from sewage treatment plants, sewage overflows, discharge from industrial activities and contaminated run-off.*" River ecosystems included mangroves, benthos (i.e. organisms living in or on the sediment in the base of the river) and nekton/plankton (i.e. free-swimming/ drifting organisms within the water column).

The Site Auditor considered the available data supported the environmental media identified by EMM and included in the CSM with the addition of **soil gas**, due to potential contamination risks posed by LFG migrating from the nearby landfill to the north and south of the Marina site. The Site Auditor addressed this data gap by including soil gas in the CSM adopted by this site audit.

Receptors

The EMM 2016 RAP[17] identified potential receptors in the CSM as being:

- Recreational users of the proposed marina waterway, open space areas, and Georges River;
- The aquatic ecosystem within the proposed marina waterway and Georges River; and

[17] Section 3.5, Ref [8]

- The benthic flora and fauna in the sediments in the proposed marina waterway and Georges River.

The Site Auditor considered additional potential receptors need to be included in the CSM, these being:

- Construction and maintenance workers involved in the proposed marina development;
- Future apartment owners; and
- Commercial workers at the proposed marina.

The Site Auditor addressed this data gap by including these additional potential receptors in the CSM adopted by this site audit.

2.1.6 Fieldwork Documentation

Overview

Field and laboratory data used by environmental consultants for the Marina site were obtained by several ESAs performed over a long 20 year period between 1999 and 2018. The scope of work and methodologies used by these ESAs varied significantly. For the purpose of this SAR, the Site Auditor has reviewed all relevant ESA data in order to assess the adequacy of the data as a whole and the potential contamination risks that need to be addressed to make the Marina site suitable for its intended uses.

Fieldwork to investigate contamination at the Marina site was documented in the DP 1999 ESA (Ref [1]), the EMM 2015 PSI (Ref [6]), the EMM 2016 SPI (Ref [7]), the DP 2018 PSI (Ref [12]) and the DP 2018 ESA (Ref [15]). EMM[18] also advised that quarterly surface water monitoring of the dredge pond and Georges River have been undertaken by WaterTest for many years as required by an EPL held for the Benedict site, with a copy of data provided for the 18/09/15 – 21/05/18 period provided in **Appendix E**.

The EMM 2015 PSI[19] mentioned that a few other investigations had been undertaken at the Marina site, which have not been considered by this SAR. The data provided by these investigations are considered to be out-dated because they focused on groundwater and surface water quality and were conducted more than five years ago. These investigations comprised:

- Dames & Moore (September 1994) '*Report on Hydrogeological Investigations for Pollution Control Approval*';
- Dames & Moore (December 1994) '*Report on Groundwater Sampling*';
- Worley Parsons (October 2010) '*Preliminary Marina Concept Design and Environmental Assessment'*; and
- Marine Pollution Research (June 2010) '*Aquatic Ecology Aspects & Environmental Assessment of Marine Concept Design*'

The scope of field work documented in the DP 1999 ESA comprised six logs for boreholes (BS-1 to BS-6) drilled to depths of 7.0 – 7.75 mbgl that were drilled by Dames & Moore in 1994. The borehole locations are shown in **Figure 2-16**. The boreholes were used to construct groundwater monitoring wells. The logs show the stratigraphy of the land around the eastern, northern and southern sides of the Marina site.

The scope of field and laboratory test work completed by the EMM 2015 PSI comprised:

- A site inspection conducted on 29/05/15;
- Nine test pits (TP-1 to TP-9) mostly excavated to depths of 0.5 m, the exception being TP-9 that was excavated to 2.0 m. Grab samples were collected at 0.5 m depth at all test pits with an additional sample collected at 2.0m from TP-9;
- Surface sediment grab samples collected from six locations (SD-1 to SD-6) in the dredge pond;

[18] Section 2, Ref [7] & EMM (14/11/18) email to Site Auditor
[19] Section 8.1, Ref 6]

- Surface water samples collected from three locations (WAT-1 to WAT-3) in the dredge pond; and
- Laboratory analysis of samples collected.

The scope of field and laboratory test work completed by the EMM 2016 SPI comprised:

- Seven 7 test pits (TP-10 to TP-16) were excavated to depths of 1.3 – 3.5m. Grab samples were collected at various depths in fill and at the fill / natural soil interface at practically all locations, the exception being at TP-10 where no samples were collected;
- Dredge pond sediment grab samples collected at 12 locations (SD-7, SP9 to SD-16, SD-18 & SD-19);
- Shallow and deep dredge pond water samples collected at 5 locations (WAT-4s to WAT-8s, WAT-4d to WAT-8d). Samples were collected on 9/11/15, with a second round of samples tested for dissolved heavy metals collected on or about 13/12/15;
- One round of groundwater samples were collected from Dames & Moore wells MP-3 to MP-5 on 17/11/15; and
- Laboratory analysis of samples collected.

The sample locations for the EMM 2015 PSI and EMM 2016 SPI are shown in **Figures 2-17** and **2-18**.

The scope of field and laboratory test work completed by the DP 2018 PSI and DP 2018 ESA comprised:

- A site inspection conducted on 16/03/18;
- Two test pits (TP101 & TP102) excavated to a depth of 3.0 m;
- Three LFG monitoring wells (MW101 – MW103) drilled to a maximum depth of 5.5 m (until groundwater was reached);
- Laboratory analysis of samples collected;
- Collected bi-monthly surface water samples over a 12 month period at four locations (SW1 – SW4) between 17/05/17 and 20/03/18. The samples collected in the 6 monitoring rounds were chemically tested.

A summary of the fieldwork documentation provided by the investigation reports is presented in **Table 2-6**.

Table 2-6: Summary of Fieldwork Documentation

Fieldwork Documentation	DP 1999 ESA (Ref [1]) & WaterTest data (Ref [17])	EMM 2015 PSI (Ref [6])	EMM 2016 SPI (Ref [7])	DP 2018 PSI & ESA (Refs [12] & [15])
Topographic survey plan of site conditions at time of investigation	--	**Not provided**	**Not provided**	**Not provided**
Sampling location plan	Dwg 3, Ref [1] Fig, Ref [17]	Fig 6.1; Dwg 3, Ref [1]	Figs 2.1 & 2.2; Drwg 3, Ref [1]	Drwg 2
Investigation and soil / sediment sampling techniques	--	Sectns 6.2, 6.2.2	Sectns 2.1 & 2.2	Sectn 11.1
GW well construction & groundwater sampling procedures	--	--	Sectn 2.1.4	--
Surface water sampling procedures	--	Sectn 6.2.3	Sectn 2.1.3	Ref [15]
Soil & sediment sample field records	--	**Not provided**	**Appn C**	**--**
Borehole & test pit logs	Appn D, Ref [7]	**Not provided**	**Not provided**	Appn E
GW well construction log	--	Appn D, Ref [7]	Appn D, Ref [7]	--
Well collar surveyed	--	--	Appn D	Appn E

Fieldwork Documentation	DP 1999 ESA (Ref [1]) & WaterTest data (Ref [17])	EMM 2015 PSI (Ref [6])	EMM 2016 SPI (Ref [7])	DP 2018 PSI & ESA (Refs [12] & [15])
Decontamination procedures	--	Sectns 6.2.2 & 7.1	Sectn 2.2	Sectn 11
Headspace and borehole volatile gas measurements using a PID	--	**Not tested**	**Not tested**	Appn E
Gas well construction & LFG sampling techniques	--	--	--	Sectns 11.2 & 11.3
Calibration records for field equipment	--	**Not provided**	**Not provided**	**Sectns 11.1, 11.3 & Appn F**
LFG field records	--	--	--	Appn F
Surface water field test records	--	**Not provided**	Appn C	**Not provided**
Well development field records	--	--	Appn C	--
Sample preservation methods	--	Sectns 6.3 & 7.1	Sectn 2.2	Sectn 11
Description of field screening protocols	--	Sectn 6.2	Sectn 2.1	Sectn 8
Use of a NATA-registered chemical laboratory/ies	--	Sectn 6.3 & Appn E	Appn B	Sectn 12.4

Legend:

Inadequate information provided in investigation reports

Assessment of Fieldwork Documentation Completeness

The Site Auditor identified data gaps in the fieldwork documentation provided by the ESAs. These comprised:

- All ESAs:
  - Topographic survey plan of the Marina site showing the location and extent of stockpiles and filling at time of investigation.
- EMM 2015 PSI:
  - Logs for the 9 tests pits;
  - Field records for test pits, sediment sampling and surface water tests;
  - PID headspace tests on soil samples collected in the field; and
  - Details on the water quality meter used or calibration records for the tests conducted on the dredge pond surface water.
- EMM 2016 SPI:
  - Logs for the 7 additional tests pits;
  - Field records for test pits and sediment sampling;
  - PID headspace tests on soil samples collected in the field; and
  - Details on the water quality meter used and calibration records for the tests conducted on groundwater and the dredge pond surface water.
- DP 2018 PSI & ESA:
  - A copy of the PID calibration certificate; and
  - Surface water field test records.

The Site Auditor has assessed the significance of these data gaps on assessing contamination risks at the Marina site in **Section 3**.

The Site Auditor considers the quarterly ammonia data produced by the Benedict EPL for the dredge pond and Georges River met the fieldwork documentation DQO even though the only data provided by EMM was a sample location plan and spreadsheet of test results for the 29/01/16 – 21/05/18 period. This is because the data is understood to have been provided to the NSW EPA on a regular basis throughout the EPL period and no non-compliances with the monitoring data are indicated on the NSW EPA license registers (**Section 2.1.3**).

2.1.7 Laboratory Documentation

A summary of the laboratory documentation provided by the ESAs is presented in **Table 2-7**.

Table 2-7: Summary of Laboratory Documentation

Laboratory Documentation	DP 1999 ESA (Ref [1]) & WaterTest data (Ref [17])	EMM 2015 PSI (Ref [6])	EMM 2016 SPI (Ref [7])	DP 2018 PSI & ESA (Refs [12] & [15])
A copy of chain-of-custody forms acknowledging receipt date, time & identity of samples included in shipments	--	**Not provided**	**Not provided**	Appn H & Ref [15]
Laboratory test certificates	--	**Appn E**	Appn B	Appn H & Ref [15]
Description of the surrogates and spikes used	--	Appn E	Appn B	Appn H & Ref [15]
Record of holding times and a comparison with method specifications	--	Appn E	Appn B	Appn H & Ref [15]
Analytical test methods used by the NATA-registered laboratory	--	Appn E	Appn B	Appn H & Ref [15]
Laboratory accreditation for analytical methods used	--	Appn E	Appn B	Appn H & Ref [15]

Legend:

Inadequate information provided in investigation reports

The Site Auditor identified data gaps in the laboratory documentation provided by the ESAs. These comprised:

- EMM 2015 PSI:
  - Copy of completed chain-of-custody (COC) forms; and
  - Lab test certificate for any of the dredge pond sediment samples tested for ammonia and Total Organic Carbon (TOC).
- EMM 2016 SPI: Copy of completed COC forms.

The Site Auditor has assessed the significance of these data gaps on assessing contamination risks at the Marina site in **Section 3**.

The Site Auditor considers the quarterly ammonia data produced by the Benedict EPL for the dredge pond and Georges River met the lab documentation DQO even though the only data provided by EMM was a sample location plan and spreadsheet of test results for the 29/01/16 – 21/05/18 period. This is because the data is understood to have been provided to the NSW EPA on a regular basis throughout the EPL period and no non-compliances with the monitoring data are indicated on the NSW EPA license registers (**Section 2.1.3**).

2.1.8 Contamination Assessment Documentation

A summary of the contamination assessment documentation provided by the ESAs is provided in **Table 2-8**. Copies of the available figures and summary tables are provided in **Appendix A** to this report. The Site Auditor checked the accuracy of these figures and tables by means of checkprints.

Table 2-8: Summary of Contamination Assessment Documentation

Assessment Documentation	DP 1999 ESA (Ref [1]) & WaterTest data (Ref [17])	EMM 2015 PSI (Ref [6])	EMM 2016 SPI (Ref [7])	DP 2018 PSI & ESA (Refs [12] & [15])
Stratigraphic cross-sections across the Site	--	**Not provided**	**Not provided**	**Not provided**
Summary of all results in a table that: • shows all essential details such as sample numbers and sample depth • shows assessment criteria • highlights all results exceeding the assessment criteria	Ref [17]	Appn D	Appn A	Appn C
Summary of PID data	--	Not tested	Not tested	Appn E
Statistical analysis of the soil data	--	**Not provided**	**Not provided**	**Not provided**
Site plans showing all sample locations, sample identification numbers and sampling depths	--	Fig 6.1	**Figs 2.1 & 2.2**	Drwg 2
Site plans showing the extent of soil & groundwater contamination exceeding selected assessment criteria for each sample depth	--	No contamination reported	**Not provided**	**Not provided**
Assessment of aesthetically impacted materials across the Site	--	**Not provided**	**Not provided**	**Not provided**
Assessment of ASS risks	--	Sectn 9.1.1	--	--
Soil contamination assessment (e.g. contaminants of concern, contaminant sources, magnitude of contamination, extent, risk to receptors)	--	Sectn 9.1	Sectns 5.1, 5.5, 5.6 & 6.1	Sectns 12 & 13
Sediment contamination assessment (e.g. contaminants of concern, contaminant sources, magnitude of contamination, extent of contamination, risk to receptors)		Sectn 9.2	Sectns 5.2, 5.5, 5.6 & 6.1	--
Groundwater equi-potential contours and flow directions	--	GW tidally influenced	GW tidally influenced	--
Groundwater contamination assessment (e.g. contaminants of concern, contaminant sources, magnitude of contamination, presence of NAPL, extent of plumes, fate & transport, attenuation potential, risk to receptors)	--	Sectn 9.4	Sectns 5.4, 5.5, 5.6 & 6.1	--
Surface water contamination assess/t	Ref [17]	Sectn 9.3	Sectns 5.3, 5.5, 5.6 & 6.1	Ref [15]
Site plans showing methane / LFG concentrations & distribution	--	--	--	**Not provided**
LFG data & risk assessment	--	--	--	Sectns 12 & 13

Legend:

Inadequate information provided in investigation reports

The only error identified in the EMM 2016 SPI lab data summary sheets was that the title for EMM Table 4 should have referred to groundwater rather than surface water samples.

The Site Auditor identified data gaps /errors in the contamination assessment documentation provided by the ESAs. These comprised:

- All ESAs:
  - Stratigraphic cross-sections through the Marina site;
  - Assessment of aesthetically impacted materials across the Marina site;
  - Plans showing the extent of soil and groundwater contamination across the Marina site;
  - Statistical analysis of soil contamination data; and
  - Site plans showing methane / LFG concentrations and distribution.
- EMM 2015 PSI: The Site Auditor identified some errors in the lab data summary sheets. Most of the errors were not considered to be significant because they had no bearing on the assessment of contamination risks at the Marina site. The exceptions are:
  - Table2: The soil sample from TP5 at 0.5 m detected PCBs at 0.2 mg/kg; and
  - Table 3: The sediment sample at SD-5 detected BaP at 1.2 mg/kg, giving a BaP TEQ concentration of 1.4 – 2.0 mg/kg.
- EMM 2016 SPI:
  - Figure 2.1 did not show sediment sample locations SD-8 and SD-17 and the report did not explain whether these locations were investigated but not reported; and
  - Figure 2.1 showed sediment sample locations SD-9, SD-12, SD-20 to SD-22 but no laboratory test data or field records were provided.

The Site Auditor has assessed the significance of these data gaps / errors on assessing contamination risks at the Marina site in **Section 3**.

The Site Auditor considers the quarterly ammonia data produced by the Benedict EPL for the dredge pond and Georges River met the documentation DQO even though the only data provided by EMM was a sample location plan and spreadsheet of test results for the 29/01/16 – 21/05/18 period. This is because the data is understood to have been provided to the NSW EPA on a regular basis throughout the EPL period and no non-compliances with the monitoring data are indicated on the NSW EPA license registers (**Section 2.1.3**).

2.2 Data Completeness and Representativeness

2.2.1 Soils

Methodology and Data Summary

The datasets that the Site Auditor considers to be relevant to the assessment of contamination risks from soils at the Marina site are:

- Shallow soils (0 – 0.5m): The soils in this dataset are most susceptible to being contaminated from activities that occur at the ground surface;
- Fill: The soils in this dataset are contaminated by substances present in the fill; and
- Natural soils underlying fill: The soils in this dataset are considered to have a low risk of being significantly contaminated since there is a low risk of historic activities occurring at the site that posed a risk of contaminating natural soils.

Other datasets are not considered relevant for assessing contamination risks from site soils. These other datasets and the reasons for their exclusion from assessment by this site audit include:

- Soils in the vicinity of UPSS: The historic data indicate that there is a low risk of such infrastructure being present at the Marina site; and
- Soils in the vicinity of old buildings that had been demolished and were at risk of being contaminated by the spillage of hazardous building materials or the spraying of pesticides: The historic data indicate that there is a low risk of such infrastructure being present at the Marina site.

The soil investigation and sampling locations used by the ESAs are shown in **Figures 2-16** to **2-19**, with a summary of the sample datasets that were laboratory tested provided in **Table 2-9**.

Table 2-9a: Summary of Lab Tests on Soil Samples – Shallow Soils (0 – 0.5m)

Sample Location	Sample Depth (m)	Metals (1)	TPH / BTEX	PAHs	OCPs / OPPs	Other VOCs	PCBs	Phenols (total)	Asbestos	SPOCAS (2)
EMM 2015 PSI										
TP-1	0.5	✓	✓	✓						
TP-2	0.5	✓	✓	✓						
TP-3	0.5	✓	✓	✓						
TP-4	0.5	✓	✓	✓						
TP-5	0.5	✓	✓	✓	✓		✓			
TP-6	0.5	✓	✓	✓						
TP-7	0.5	✓	✓	✓						
TP-8	0.5	✓	✓	✓						
TP-9	0.5	✓	✓	✓	✓		✓			
EMM 2016 SPI										
DP 2018 PSI										
TP101	0.2-0.3	✓	✓	✓	✓		✓	✓	✓	
TP102	0.2-0.3, 0.4-0.5	✓	✓	✓	✓		✓	✓	✓	
Total No. Locations		**11**	**11**	**11**	**4**	**0**	**4**	**2**	**2**	**0**

Legend:

Frequency does not meet the data completeness DQO

Notes:

1. For the EMM 2015 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Fe, Mg, Ni, Pb & Zn. For the EMM 2016 SPI, Al and Mn was also tested while Mg was not tested. For the DP 2018 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Ni, Pb & Zn
2. SPOCAS = Suspension Peroxide Oxidation Combined Acidity & Sulfur

Table 2-9b: Summary of Lab Tests on Soil Samples - Fill

Sample Location	Sample Depth (m)	Metals (1)	TPH / BTEX	PAHs	OCPs / OPPs	Other VOCs	PCBs	Phenols (total)	Asbestos	SPOCAS (2)
EMM 2015 PSI										
TP-3	0.5	✓	✓	✓						
TP-5	0.5	✓	✓	✓	✓		✓			
TP-6	0.5	✓	✓	✓						
TP-7	0.5	✓	✓	✓						

Sample Location	Sample Depth (m)	Metals (1)	TPH / BTEX	PAHs	OCPs / OPPs	Other VOCs	PCBs	Phenols (total)	Asbestos	SPOCAS (2)
EMM 2016 SPI										
TP11	2.75	✓	✓	✓	✓		✓			
TP12	1.5	✓	✓	✓						
TP13	1.5	✓	✓	✓						
TP14	3.1	✓	✓	✓						
TP15	3.1	✓	✓	✓						
TP-16	1.1	✓	✓	✓	✓		✓			
DP 2018 PSI										
TP101	0.2-0.3, 1.9-2.0, 2.8-2.9	✓	✓	✓	✓		✓	✓	✓	
TP102	0.2-0.3, 0.4-0.5, 0.1-1.0	✓	✓	✓	✓		✓	✓	✓	
Total No. Locations		**12**	**12**	**12**	**5**	**0**	**5**	**2**	**2**	**0**

Legend:

Frequency does not meet the data completeness DQO

Notes:

1. For the EMM 2015 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Fe, Mg, Ni, Pb & Zn. For the EMM 2016 SPI, Al and Mn was also tested while Mg was not tested. For the DP 2018 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Ni, Pb & Zn
2. SPOCAS = Suspension Peroxide Oxidation Combined Acidity & Sulfur

Table 2-9c: Summary of Lab Tests on Soil Samples – Natural Soil

Sample Location	Sample Depth (m)	Metals (1)	TPH / BTEX	PAHs	OCPs / OPPs	Other VOCs	PCBs	Phenols (total)	Asbestos	SPOCAS
EMM 2015 PSI										
TP-1	0.5	✓	✓	✓						
TP-2	0.5	✓	✓	✓						
TP-4	0.5	✓	✓	✓						
TP-8	0.5	✓	✓	✓						
TP-9	0.5, 2.0	✓	✓	✓	✓		✓			
Total No. Locations		**5**	**5**	**5**	**1**	**0**	**1**	**0**	**0**	**0**

Legend:

Frequency does not meet the data completeness DQO

Notes:

1. For the EMM 2015 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Fe, Mg, Ni, Pb & Zn. For the EMM 2016 SPI, Al and Mn was also tested while Mg was not tested.
2. SPOCAS = Suspension Peroxide Oxidation Combined Acidity & Sulfur

Figure 2-16: 1994 Borehole Locations (Source: Drwg 3, Ref [1])

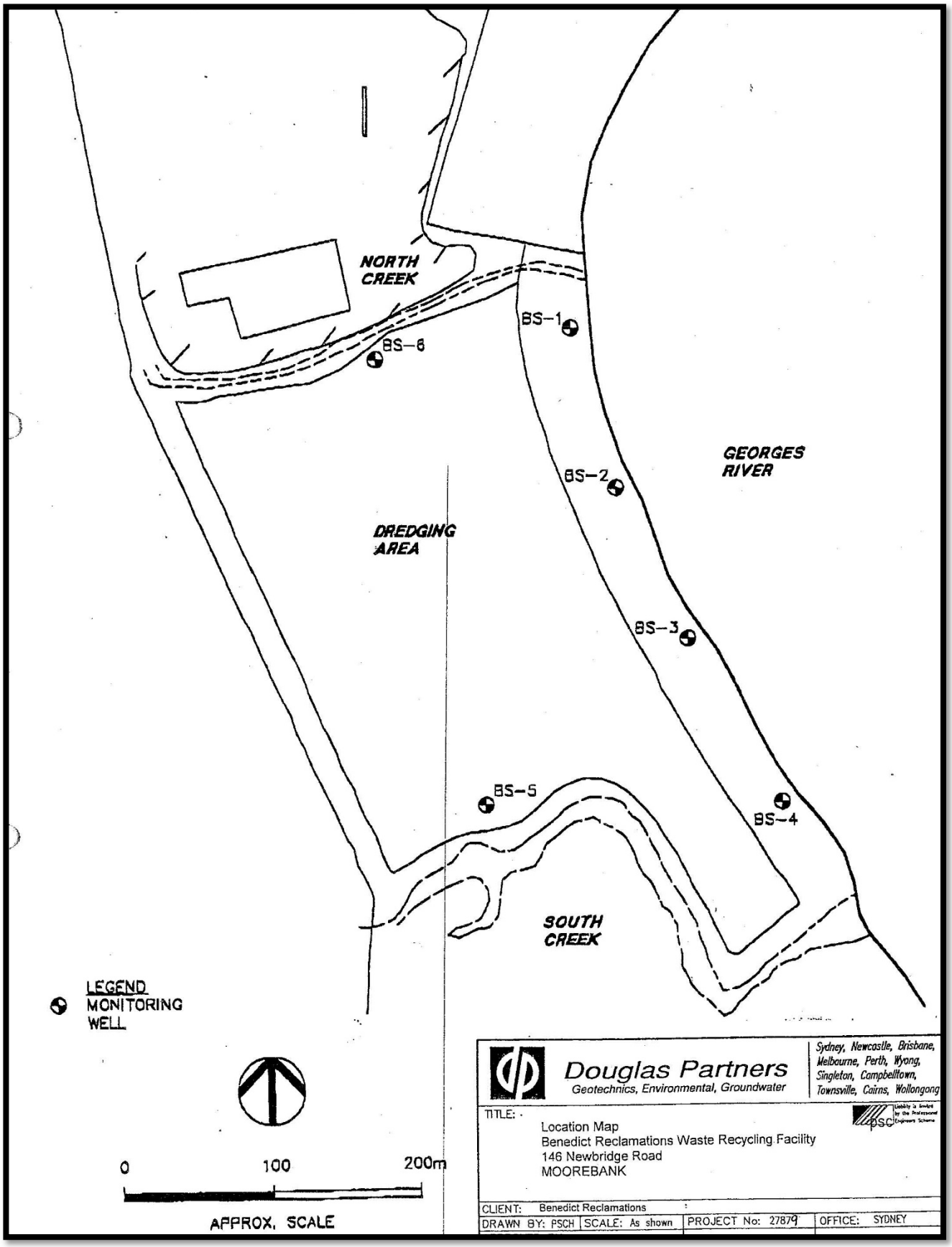


Figure 2-17: EMM 2015 & 2016 Sample Locations (Source: Figure 2.1, Ref [7])

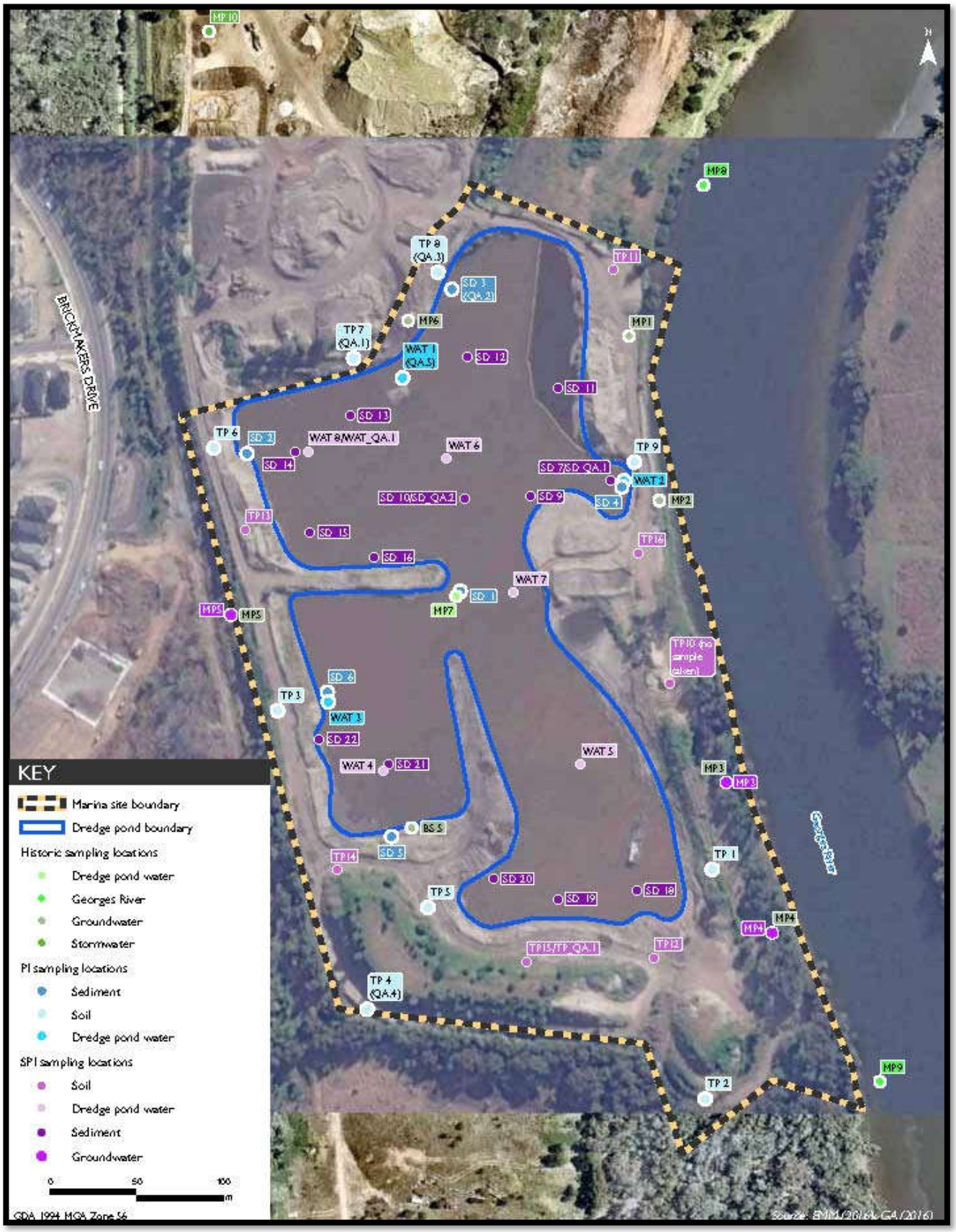


Figure 2-18: EMM 2016 Dredge Pond Sediment Sample Locations (Source: Figure 2.2, Ref [7])

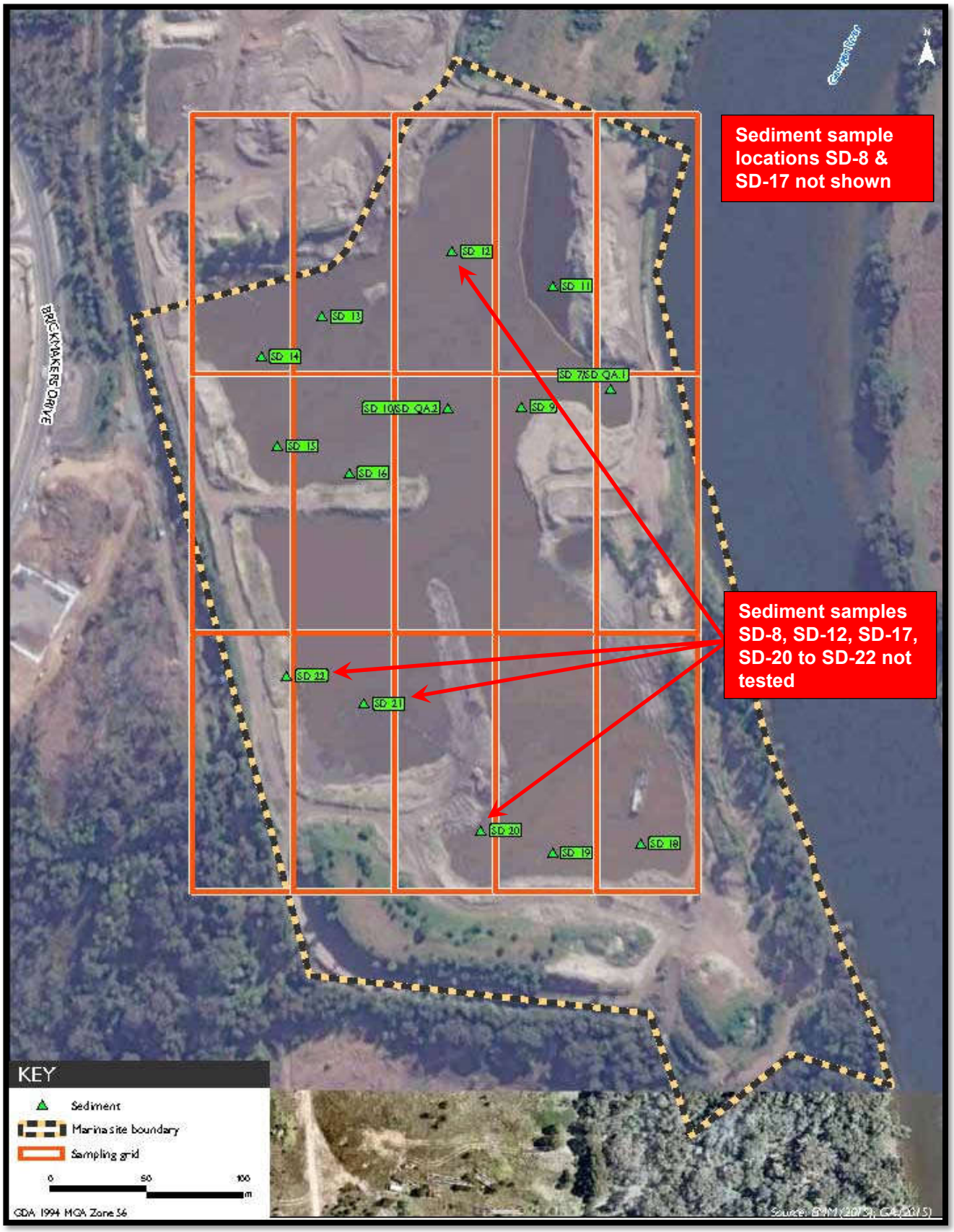
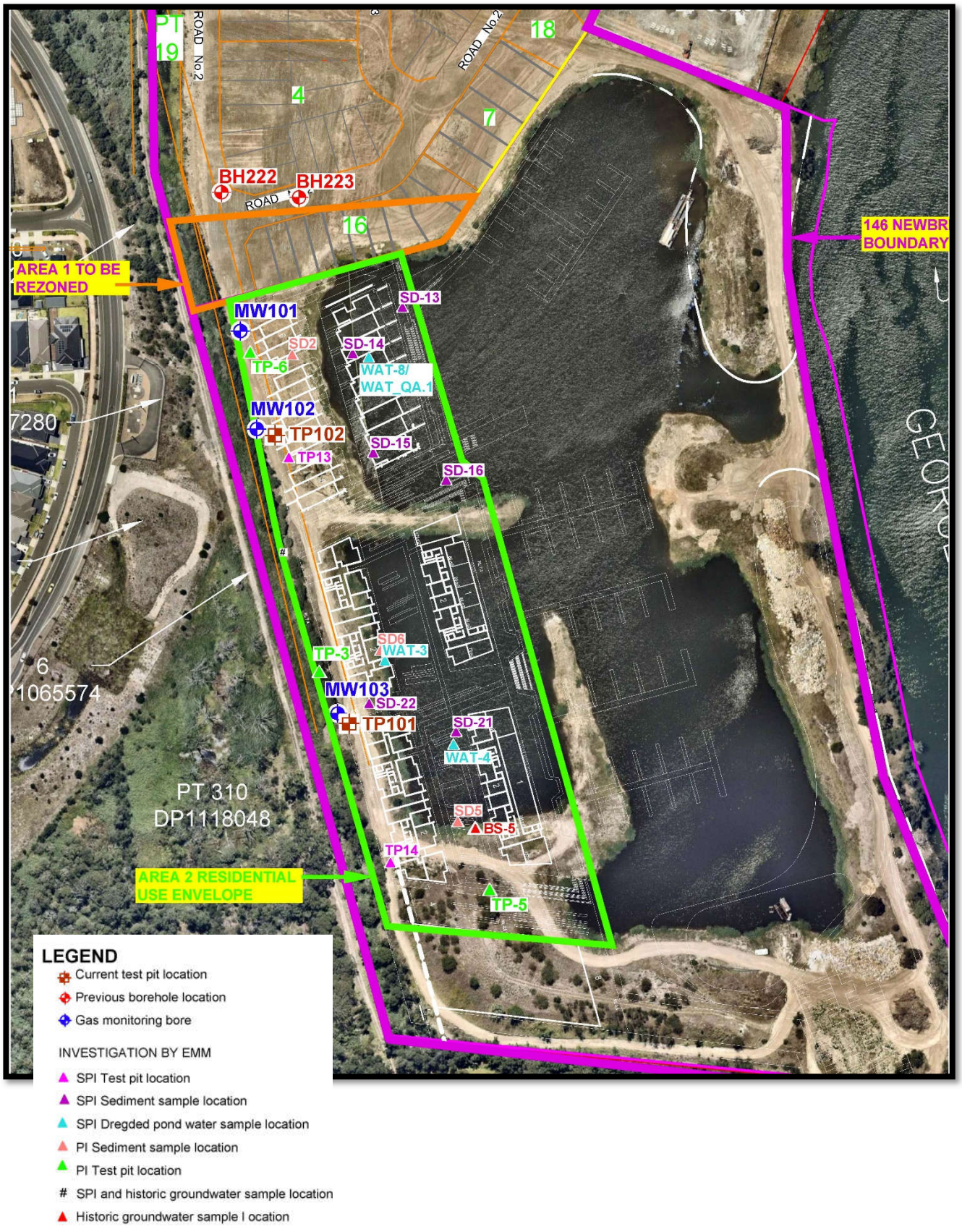


Figure 2-19: DP 2018 Sample Locations (Source: Drwg 2, Ref [12])



The DP 2018 PSI[20] based their assessment on the minimum required soil sampling locations at the Marina site on the recommendations made by the NSW EPA (1995) guidelines concerning identifying circular hot spots. The Site Auditor considers that contamination in shallow soils and fill may occur as hot-spots because there was potential for:

- Shallow soils to have been locally impacted by activities at the site; and
- A load of fill that was brought onto the site to have been contaminated.

For these two soil datasets, the Site Auditor considers that 77 sampling locations would meet NSW EPA requirements (based on sampling 55 locations for every 5 ha) assuming the current dredge pond occupies 6 ha of the Marina site, as reported by the EMM 2015 PSI[21], which means the onshore area covers 7 ha.

For the natural soil underlying fill dataset, the Site Auditor considers the contamination risks are unlikely to be associated with hot-spots because there is a low risk of historic activities occurring at the site that posed a risk of contaminating these soils. Contamination of natural soils underlying fill is likely to involve a broadscale laydown mechanism associated with leaching of contaminants from overlying fill. The Site Auditor has designed a data completeness DQO for natural soils based on the use of Procedure C in the NSW EPA (1995) Sampling Design Guidelines. This procedure determines the number of samples required for determining the proportion of contamination and uses the equation:

$$n = [\ 1.65 \text{ sqrt } \{P_0(1-P_0)\} - 0.84 \text{ sqrt } \{P_1(1-P_1)\}\ ]^2 / (P_0 - P_1)^2$$

where:

- n = Number of samples needed
- P_0 = Maximum allowable proportion of an area or a stockpile of soil that has concentrations exceeding an acceptable limit
- P_1 = Expected proportion of an area or a stockpile of soil that has concentrations exceeding an acceptable limit

The Site Auditor considers reasonable input parameters for characterising the quality of natural soils at the Marina site are:

- P_0 = 0.10 (i.e. No more than 10% of the site can have concentrations exceeding soil investigation levels)
- P_1 = 0.0 (i.e. No part of the site is found to have concentrations exceeding the soil investigation levels)

The result of the calculation is that natural soils at 25 sample locations need to be investigated, assuming fill covers the entire Marina site. For a 7 ha onshore area this number of samples is equivalent to one sample per 2,800 m^2, which corresponds to a 52.9m x 52.9m grid. The Site Auditor considers this frequency should be simplified to one sample per 2,500 m^2 or a 50m x 50m grid, which corresponds to 28 sample locations.

DQO Review for Shallow Soils (0 - 0.5m)

The Site Auditor considers the data completeness and representativeness DQOs for shallow soils at the Marina site were not met by the ESA data because:

- Shallow soils across the onshore area were investigated at 2 – 11 sampling locations, which was well below the minimum of 77 locations recommended by NSW EPA guidelines;
- No grid-based site inspection was undertaken for determining the presence of visible asbestos;

[20] Section 9.1, Ref [12]
[21] Section 2.2, Ref [5]

- Only 2 locations were tested for asbestos; and
- No soils were tested from locations in the southern area and the two reclaimed spits that projected out from the shoreline.

DQO Review for Fill

The Site Auditor considers the data completeness and representativeness DQOs for fill at the Marina site were not met by the ESA data because:

- Fill material across the onshore area was investigated at 2 – 12 sampling locations, which was well below the minimum of 77 locations recommended by NSW EPA guidelines;
- Only 2 locations were tested for asbestos;
- No soils were tested from locations in the southern area and the two reclaimed spits that projected out from the shoreline;
- Stockpiled waste material covered most of the onshore area, which may require additional samples to be collected;
- The fill thickness was not determined at EMM TP-3, TP-5, TP-10 and DP TP101, TP102, MW101, MW102; and
- The volume of fill material that presently remains at the Marina site is not known.

DQO Review for Natural Soils Underlying Fill

The Site Auditor considers the data completeness and representativeness DQOs for natural soils underlying fill at the Marina site were not met by the ESA data because:

- Natural soil across the onshore area was investigated at 1 - 5 sampling locations, which was well below the 28 locations assessed by the Site Auditor; and
- No data was provided on the leachate generation potential of fill.

The Site Auditor has assessed the significance of these data gaps on assessing contamination risks at the Marina site in **Section 3**.

2.2.2 Sediments

Methodology and Data Summary

The Site Auditor considers there is only one dataset relevant to the assessment of contamination risks from sediments at the Marina site, this being shallow sediments (0 – 0.1 m) in the existing dredge pond. This is because these sediments have the highest risk of being contaminated and being disturbed by the proposed development.

The sediment sampling locations investigated by the ESAs in the dredge pond are shown in **Figures 2-17** and **2-18**, with a summary of the samples that were laboratory tested provided in **Table 2-10**.

None of the ESAs designed a data completeness DQO in accordance with NSW EPA requirements. The Site Auditor addressed this data gap by the following assessment.

For the shallow sediments in the dredge pond, the Site Auditor considers the contamination risks are unlikely to be associated with hot-spots because there is a low risk of historic activities occurring at the site that posed a risk of contaminating these sediments. Sediment contamination is likely to involve a broadscale laydown mechanism associated with the settling of suspended solids stirred up by the dredging operation and the return of fines to the dredge pond. The Site Auditor has designed a data completeness DQO for the sediments based on the use of Procedure C in the NSW EPA (1995) Sampling Design Guidelines, similar to the approach used for natural soils underlying fill.

Table 2-10: Summary of Lab Tests on Sediment Samples from Dredge Pond

Sample Location	Sample Depth (m)	Metals (1)	TPH / BTEX	PAHs	OCPs/OPPs	Other VOCs	PCBs	Phenols (total)	Nutrients (2)	TOC
EMM 2015 PSI										
SD-1	Surface	✓	✓	✓					✓	✓
SD-2	Surface	✓	✓	✓	✓				✓	✓
SD-3	Surface	✓	✓	✓			✓		✓	✓
SD-4	Surface	✓	✓	✓					✓	✓
SD-5	Surface	✓	✓	✓					✓	✓
SD-6	Surface	✓	✓	✓	✓		✓		✓	✓
EMM 2016 SPI										
SD-7	Surface	✓	✓	✓					✓	
SD-9	Surface	✓	✓	✓					✓	
SD-10	Surface	✓	✓	✓					✓	
SD-11	Surface	✓	✓	✓					✓	
SD-13	Surface	✓	✓	✓					✓	
SD-14	Surface	✓	✓	✓					✓	
SD-15	Surface	✓	✓	✓					✓	
SD-16	Surface	✓	✓	✓	✓		✓		✓	
SD-18	Surface	✓	✓	✓	✓		✓		✓	
SD-19	Surface	✓	✓	✓	✓		✓		✓	
Total No. Locations		**16**	**16**	**16**	**5**	**0**	**5**	**0**	**16**	**6**

Legend:

Frequency does not meet the data completeness DQO

Notes:

1. For the EMM 2015 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Fe, Mg, Ni, Pb & Zn. For the EMM 2016 SPI, Al and Mn was also tested while Mg was not tested.
2. For the EMM 2015 PSI, the nutrients comprise ammonia (as N). For the EMM 2016 SPI, the nutrients comprise ammonia, nitrite, nitrate, TKN and total N.

Based on a P_0 of 0.10, a P_1 of 0.0, shallow sediments need to be investigated at 25 sample locations. For a dredge pond area of 6 ha, this number of samples is equivalent to one sample per 2,400 m^2, which corresponds to a 49.0m x 49.0m grid. The Site Auditor considers this frequency should be simplified to one sample per 2,500 m^2 or a 50m x 50m grid, which corresponds to 24 sample locations.

DQO Review for Shallow Sediments

The Site Auditor considers the data completeness and representativeness DQOs for sediments in the dredge pond at the Marina site were not met by the ESA data because:

- Shallow sediment in the dredge pond was investigated at 5 - 16 sampling locations, which was well below the 24 locations assessed by the Site Auditor;
- Only three sample locations were situated within the central part of the dredge pond, these being SD10, SD13 and SD14 in the northern part of the dredge pond. No sediment samples were collected in the central part of the southern dredge pond; and
- No sediment samples from the Georges River were collected adjacent to the Marina site, which would provide information on background sediment quality relevant to the proposed development.

The Site Auditor has assessed the significance of these data gaps on assessing contamination risks at the Marina site in **Section 3**.

2.2.3 Groundwater

The groundwater sampling locations investigated by the ESAs are shown in **Figure 2-17**, with a summary of the samples that were laboratory tested provided in **Table 2-11**.

Table 2-11: Summary of Tests on Groundwater Samples

Sample ID	Dames & Moore Well ID	Metals (1)	TPH / BTEX	PAHs	OCPs/OPPs	Other VOCs	PCBs	Phenols (total)	Nutrients (2)	Field parameters (3)
EMM 2016 SPI (17/11/15)										
MP-3	BS-3	✓	✓	✓					✓	✓
MP-4	BS-4	✓	✓	✓					✓	✓
MP-5	Construction of well not known	✓	✓	✓					✓	✓
Total No. Locations		**6**	**6**	**6**	**0**	**0**	**0**	**0**	**6**	**6**

Legend:

Frequency does not meet the data completeness DQO

Notes:

1. For the EMM 2015 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Fe, Ni, Pb & Zn. For the EMM 2016 SPI, Al and Mn was also tested.
2. For the EMM 2015 PSI, the nutrients comprise ammonia (as N). For the EMM 2016 SPI, the nutrients comprise ammonia, nitrite, nitrate, TKN and total N.
3. The field parameters comprised temperature, Electrical Conductivity (EC), pH, Dissolved Oxygen (DO) and Redox.

The Marina site consists of relatively thin strips of land surrounding a waterbody, with the site bounded by former quarry sites and landfills to the north, south and west. Groundwater from these surrounding areas may flow through the site, with groundwater at the Marina site also being tidally influenced. The Site Auditor considers the main groundwater issues that the NSW EPA would need to be assessed are:

- Characterise groundwater quality along the northern, southern and western boundaries for all likely substances that may be present and identify any off-site sources of groundwater contamination that may impact the site;
- Characterise groundwater quality within the main fill areas at the Marina site for all likely substances that may be present and identify any on-site sources of groundwater contamination;
- The migration of groundwater contamination into the existing dredge pond and the Georges River and assess impacts on potential receptors; and
- Assess the influence of water quality in the Georges River of the on-site groundwater quality.

The minimum scope of fieldwork needed to meet these requirements is considered to involve:

- Install groundwater wells at the north-west and south-west corners of the site with two additional wells along each of the northern, southern and western sides of the site;
- Install an additional two groundwater wells in the large existing fill mounds at the southern end of the site;

- All wells need to penetrate the regional water table to an extent that will allow representative discrete samples to be collected;
- Test a minimum of one round of groundwater samples for the potential contaminants of concern. If contamination is found, then additional monitoring rounds may need to be tested to allow trends to be established for the potential contaminants of concern;
- If groundwater contamination is found and there is a risk to off-site receptors, then conduct sufficient testing to allow the risks to these receptors to be determined;
- Collect and test groundwater samples from a range of depths if a potential contaminant of concern has a density greater than water;
- Analyse groundwater samples for parameters relevant to a monitored natural attenuation (MNA) analysis if a contaminant plume is present; and
- If the fate and transport of groundwater contamination is a concern, then conduct field tests to determine the hydraulic properties of the strata that form the hydrogeological system.

The Site Auditor considers the data provided by the ESAs met some of the NSW EPA requirements, these being:

- Well MP5 was located on the western property boundary and provided data on groundwater flows from the former off-site brickpit area;
- All three wells penetrated the regional water table to an extent that allowed representative discrete samples to be collected; and
- One round of groundwater monitoring was conducted at the wells.

However, the Site Auditor considers the data provided by the ESAs did not meet the following requirements:

- No wells were located in the north-west and south-west corner of the site and no wells were located along the northern and southern property boundaries adjacent to former off-site landfills;
- The dredge pond monitoring data (Ref [17]) indicate that dredging did not cease until October 2016, some 11 months after groundwater samples were collected from the wells. This meant there is a risk that the groundwater quality data measured by the wells was impacted by poor water quality conditions in the dredge pond; and
- No groundwater samples were tested for OCPs, other VOCs, phenols or PFAS, which are contaminants of potential concern due to the proximity of the Marina site to off-site former landfills.

The Site Auditor has assessed the significance of these data gaps on assessing contamination risks at the Marina site in **Section 3**.

2.2.4 Surface Water

The surface water sampling locations investigated by the ESAs in the dredge pond and Georges River are shown in **Figures 2-17** to **2-21**, with a summary of the samples laboratory tested provided in **Table 2-12**.

Table 2-12: Summary of Lab Tests on Surface Water Samples from Dredge Pond

Sample ID & Depth	Sample Location	Metals (1)	TPH / BTEX	PAHs	OCPs / OPPs/ & PCBs	Other VOCs	PFAS	Phenols (total)	Nutrients (2)	Field parameters (3)	TDS, SS, TOC, COD, BOD
EMM 2015 PSI (3/06/15)											
WAT-1 (shallow)	North pond	✓	✓	✓					✓	✓	
WAT-2 (shallow)	North pond	✓	✓	✓					✓	✓	
WAT-3 (shallow)	South Pond	✓	✓	✓					✓	✓	
EMM 2016 SPI (9/11/15 – 3/12/15)											
WAT-4 (shallow & deep)	South pond	✓	✓	✓					✓	✓	✓
WAT-5 (shallow & deep)	South pond	✓	✓	✓					✓	✓	✓
WAT-6 (shallow & deep)	North pond	✓	✓	✓					✓	✓	✓
WAT-7 (shallow & deep)	South pond	✓	✓	✓					✓	✓	✓
WAT-8 (shallow & deep)	North pond	✓	✓	✓					✓	✓	✓
DP 2018 ESA (17/05/17 – 20/03/18)											
SW1	Georges R up- stream	✓	✓	✓	✓		✓	✓	✓		
SW2	North pond	✓	✓	✓	✓		✓	✓	✓		
SW3	North pond	✓	✓	✓	✓		✓	✓	✓		
SW4	Georges R opp. site	✓	✓	✓	✓		✓	✓	✓		
WaterTest quarterly monitoring data for 29/01/16 – 21/05/18 period											
A (shallow)	North pond								**117**		
B (shallow)	South pond								**117**		
C (shallow)	South pond								**117**		
D (shallow)	Georges River								**117**		
Total No. Samples	**North pond**	**6**	**6**	**6**					**121**	**4**	**2**
	South pond	**4**	**4**	**4**					**238**	**4**	**3**
	Georges River	**2**	**2**	**2**					**117**		

Legend:

Frequency does not meet the data completeness DQO

Notes:

1. For the EMM 2015 PSI, the suite of heavy metals comprised As, Cd, Cr, Cu, Hg, Fe, Ni, Pb & Zn. For the EMM 2016 SPI, Al and Mn was also tested.
2. For the EMM 2015 PSI, the nutrients comprise ammonia (as N). For the EMM 2016 SPI, the nutrients comprise ammonia, nitrite, nitrate, TKN, total N, total P, Reactive P. The WaterTest quarterly monitoring data only tested for ammonia
3. Field parameters comprise temperature, electrical conductivity (EC), pH, dissolved oxygen (DO), Redox potential

Figure 2-20 Surface Water Monitoring Locations for Quarterly Ammonia Monitoring (Source: Ref [17])

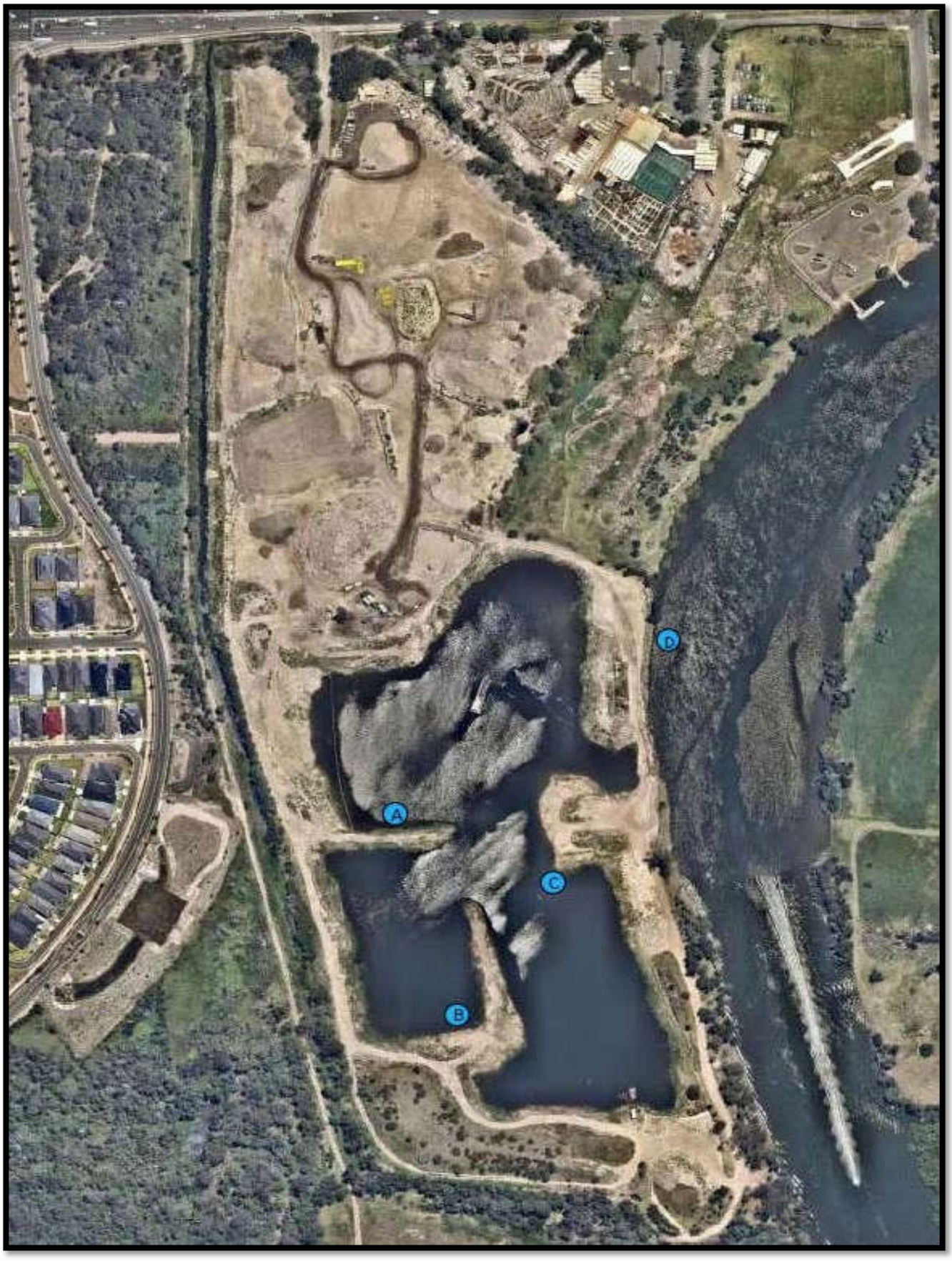


Figure 2-21: Surface Water Sampling Locations for DP 2018 ESA (Source: Figure 1, Ref [15])

The Site Auditor considers the NSW EPA requirements for characterising surface water contamination at the Marina site involved defining:

- The background water quality in the Georges River adjacent to the site;
- Characterise present water quality in the dredge pond for all likely substances that may be present and identify potential sources of contamination;
- Characterise the potential quality of water in the dredge pond that may occur during construction work and potential impacts to receptors in the Georges River if the water was allowed to escape; and
- Characterise the potential quality of water at the Marina site following completion of construction work and potential impacts to receptors in the Georges River.

The Site Auditor considers contamination at the Marina site, if present, should not pose a significant impact to the surface water quality in the drainage channel that runs along the western and southern boundaries of the site. This is because practically all flows in the drainage channel would be from the up-gradient industrial estate and Newbridge Road, which are likely to pose the main pollution risk to surface water flows in the drainage channel.

The minimum scope of fieldwork needed to meet these requirements is considered to involve:

- Three rounds of water samples collected from the Georges River adjacent to the Marina site tested for all contaminants of concern;
- Three rounds of water samples from the northern and southern parts of the dredge pond collected during the period when dredging was occurring. These tests would provide data on the likely surface water quality that would occur during marina construction. Samples should be collected around the pond edge and in the central parts and tested for all contaminants of concern; and
- Three rounds of water samples from the northern and southern parts of the dredge pond collected after dredging had ceased for more than 12 months. These tests would provide data on the likely surface water quality that would occur in the marina waterway after the completion of construction work. Samples should be collected around the pond edge and in the central parts and tested for all contaminants of concern.

The Site Auditor considers the data provided by the ESAs met or were close to meeting some of the NSW EPA requirements, these being:

- 117 rounds of data were available to define the background concentration of ammonia in the Georges River adjacent to the Marina site;
- Two samples close to the edge of the northern pond (WA-1 & WAT-2) were tested for the main contaminants of concern. An additional sample (location A) was tested for ammonia;
- Two samples from the middle of the northern pond (WA-6 & WAT-8) were tested for the main contaminants of concern;
- Two samples close to the edge of the southern pond (WA-3 & WAT-7) were tested for the main contaminants of concern. Two additional samples (locations B & C) were tested for ammonia; and
- Two samples from the middle of the southern pond (WA-4 & WAT-5) were tested for the main contaminants of concern.

However, the Site Auditor considered the data provided by the ESAs did not meet the following requirements:

- No 2015 – 2016 data was provided to define the background concentration of ammonia in the Georges River adjacent to the Marina site for the potential contaminants of concern other than ammonia;
- The dredge pond monitoring data (Ref [17]) indicate that dredging did not cease until October 2016, some 10 - 16 months after surface water samples were collected from the pond. This meant there is a risk that the surface water quality data obtained by EMM in 2015 - 2016 was representative of poor water quality conditions caused by dredging and not post-dredging conditions; and

- No 2015 – 2016 samples from within the dredge pond were tested for OCPs, other VOCs, PCBs, phenols and PFAS.

The Site Auditor has assessed the significance of these data gaps on assessing contamination risks at the Marina site in **Section 3**.

2.2.5 Landfill Gas

The DP 2018 PSI[22] advised that LFG was investigated at three gas monitoring wells (MW101 – MW103) installed to a depth of 4.0 – 5.5 mbgl. Wells were constructed using class 18 uPVC machine slotted screen and blank sections. The screened section of each well was backfilled with a washed sand filter pack to approximately 0.5 m above the screened interval. Each well was completed with a hydrated bentonite plug generally 0.4 m thick and concrete at the surface with a 0.5 - 1.0 m stick-up and well cap with gas sampling nipple. The wells were located along the western side of the Site where a major fill platform is to be placed and a marine building constructed as shown in **Figure 1-4**. The well locations are shown in **Figure 2-19**.

The Marina site presently consists of relatively thin strips of land surrounding a waterbody, with the site bounded by former quarry sites and landfills to the north, south and west. The proposed marina development (**Figure 1-4**) is to involve the placement of a large fill platform along the western side of the site and reshaping the southern end of the site for carparking. Other parts of the Marina site are to remain thin strips of open space land with no significant structures.

The historical and site condition data (**Sections 2.1.3 & 2.1.4**) indicate that there are four potential sources of LFG that have the potential to impact the suitability of the Marina site for its intended uses. These are:

- Naturally occurring methane present in estuarine muds that may be filled and built over by the proposed marina development;
- Fill that had been placed on-site containing degradable material such as timber;
- LFG migrating from the former C&D landfill to the north of the Marina site; and
- LFG migrating from the former Collex landfill to the south of the Marina site.

These four potential LFG sources had the potential to impact the Maritime Building to be constructed along the western and southern sides of the Marina site and buried services installed along the northern, southern and western sides of the Marina site. The Site Auditor considers the former brickpit to the west of the Marina site poses a low LFG risk because the area had been the subject of remediation work and then developed as a standard residential precinct for the past 5 – 10 years.

The Site Auditor considers the main LFG issues that the NSW EPA would need to be assessed are:

- Characterise naturally occurring LFG levels at other parts of the Benedict site where stratigraphic conditions would be similar to those that will exist at the Maritime Building area proposed by the marina development. These stratigraphic conditions would consist of estuarine soils overlain by several metres of fill;
- Characterise LFG quality within the main fill areas at the Marina site and identify any on-site LFG sources; and
- Characterise LFG concentrations along the northern, southern and western boundaries and identify any off-site LFG sources that may impact the site.

In terms of well design and monitoring, the NSW EPA recommends that:

- A sufficient number of monitoring wells are installed at the Marina site to enable LFG to be characterised. The Site Auditor considers this spacing should not be less than 50 m, which corresponds to the maximum spacing recommended by the UK Environment Agency (2004) guideline

[22] Section 11.2, Ref [12]

for off-site monitoring borehole spacing[23] and the CIRIA (2007) guideline for moderate risk older landfills to be redeveloped for a high sensitivity land use (e.g. residential);

- The wells should be deep enough to cover all potential unsaturated pathways for gas from the waste. The wells should extend to the minimum reported groundwater level, the greatest depth of the waste, or 10 m below underground utilities or manholes within 50 m of the landfill[24]; and
- Six monthly monitoring of on-site monitoring wells for CH_4, CO_2, O_2, atmospheric pressure, differential pressure, temperature and meteorological data[25].

The minimum scope of fieldwork needed to meet these requirements is considered to involve:

- Install not less than three LFG monitoring wells in the northern part of the Benedict site where the stratigraphic conditions consist of estuarine soils overlain by several metres of fill;
- Install LFG monitoring wells at:
  - The north-west and south-west corners of the Marina site;
  - An additional five wells along the southern and northern boundaries of the site to achieve a 50 m spacing;
  - An additional six wells along the western boundary of the site to achieve a 50 m spacing;
  - An additional two LFG wells in the large fill mounds at the southern end of the site;
- Conduct LFG testing for a minimum of three rounds at six monthly intervals.

The Site Auditor considers the data provided by the ESAs met some of the NSW EPA requirements, these being:

- Well MW101 was located near the north-western corner of the Marina site;
- Wells MW102 and MW103 were located along the western side of the Marina site;
- The 4.0 – 5.5 m deep wells were deep enough to cover all potential unsaturated pathways for gas from the waste, with most wells extending down close to the groundwater table;
- Each monitoring event involved measuring the main LFG analytes (CH_4, CO_2, O_2, CO and H_2S); and
- Two rounds of LFG monitoring were conducted at each well on 20/03/18 and 9/04/18.

However, the Site Auditor considers the data provided by the ESAs did not meet the following requirements:

- No wells were located:
  - At the south-west corner of the Marina site;
  - Along the southern and northern boundaries of the Marina site;
  - At a spacing of 50 m along the western boundary of the Marina site – an additional 4 wells need to be installed; and
  - In the large fill mounds at the southern end of the Marina site.
- Only two monitoring rounds were undertaken over a 3-week period.

The Site Auditor has assessed the significance of these data gaps on assessing contamination risks at the Marina site in **Section 3**.

[23] Table 8.1 in UK Environment Agency (2004) and Section 5 in NSW EPA (April 2016)
[24] Section 5, NSW EPA (April 2016)
[25] Table 5.4, UK Environment Agency (2004)

2.3 Data Comparability

A summary of the data comparability documentation provided by the ESAs is provided in **Table 2-13**.

Table 2-13: Summary of Data Comparability

Data Comparability	DP 1999 ESA (Ref [1]) & WaterTest data (Ref [17])	EMM 2015 PSI (Ref [6])	EMM 2016 SPI (Ref [7])	DP 2018 PSI & ESA (Refs [12] & [15])
Appropriate field screening techniques	--	**Sectn 6.2**	**Sectn 2.1**	Sectn 8
Appropriate asbestos inspection & screening techniques	--	**Sectns 6.2 & 6.2.2**	**Sectn 2.1**	**Sectn 11.1**
Appropriate calibration of field equipment	--	**Not provided**	**Not provided**	**Sectns 11.1, 11.3 & Appn F**
Appropriate soil / sediment sampling techniques	--	Sectns 6.2, 6.2.2	Sectns 2.1 & 2.2	Sectn 11.1
Appropriate groundwater sampling techniques	--	--	**Sectn 2.1.4**	--
Appropriate surface water sampling techniques	--	**Sectn 6.2.3**	**Sectn 2.1.3**	Ref [15]
Appropriate LFG sampling techniques	--	--	--	Sectns 11.2 & 11.3
Appropriate sample splitting techniques	--	**Not provided**	**Not provided**	Appn G
Appropriate decontamination procedures	--	Sectn 6.2.2	Sectn 2.2	Sectn 11
Appropriate containers (including preservation) used for soil samples	--	Sectns 6.3 & 7.1	Sectn 2.2	Sectn 11
Appropriate sample storage and transportation	--	Sectns 6.3 & 7.1	Sectn 2.2	Sectn 11
Appropriate management of chain of custody forms	--	**Copies not provided**	**Copies not provided**	Sectn 11.1 & Appn H
Samples tested within recommended holding times	--	**Sectn 6.3**	Sectn 3.3	Sectn 12.5 & Appn G
The laboratory test methods complied with the NEPM (2013) guidelines	--	Appn E	Appn B	Sectn 12.5 & Appn G
Lab test methods appropriate for CSM	--	**Appn E**	**Appn B**	Sectn 12.5 & Appn G
Appropriate PQL's for the analytes tested	--	Appn E	Appn B	Sectn 12.5 & Appn G

Legend:

Inadequate information provided in investigation report

The Site Auditor considers the investigation procedures used by the ESAs did not meet the data comparability DQO in the following areas:

- All ESAs:
  - Use of appropriate asbestos inspection and screening techniques;
  - Appropriate calibration of PIDs since no calibration certificates were provided;
  - Sediment samples tested by EMM did not use a silica-gel cleanup extraction procedure to remove naturally occurring organic material and prevent false positives of middle to heavy-end petroleum fractions being generated in TRH tests; and
  - The dredge pond monitoring data (Ref [17]) indicate that dredging did not cease until October 2016, some 10 - 16 months after surface water samples were collected from the pond. This meant there is a risk that the surface water quality data obtained by EMM in 2015 and 2016 was

representative of poor water quality conditions caused by dredging and not post-dredging conditions. Detections of PAH may be due to suspended sediment in the water column containing natural ash residues present in the estuarine soils. Heavy metal concentrations measured by the lab may have been more elevated than ambient conditions due to the high suspended sediment load in the water sample and increased reliance on field filtering.

- EMM 2015 PSI:
  - It is not known if appropriate field screening techniques were used that targeted suspect soils at the Marina site because no test pit logs, descriptions of the soil samples tested, or description of field screening and sample selection protocols were provided;
  - It is not known if samples were appropriately managed because no copies of COC forms were provided;
  - It is not known if the surface water quality measurements taken in the field used appropriately calibrated equipment because no copy of calibration certificates was provided;
  - It is not known if representative duplicate samples were collected because no descriptions were provided of the sample splitting techniques used;
  - All soil samples collected from the nine test pits exceeded the recommended holding time for mercury by 12 – 13 days; and
  - All surface water samples exceeded the recommended holding time for pH by 1 day.
- EMM 2016 SPI:
  - It is not known if appropriate field screening techniques were used that targeted suspect soils at the Marina site because no test pit logs or description of field screening and sample selection protocols were provided;
  - No description was provided on the use of filters for groundwater samples tested for dissolved heavy metals;
  - No data was provided showing that groundwater field parameters had stabilised prior to sampling;
  - It is not known if samples were appropriately managed because no copies of COC forms were provided;
  - It is not known if the surface water quality measurements taken in the field used appropriately calibrated equipment because no copy of calibration certificates was provided;
  - It is not known if the deeper surface water samples were collected at a depth of 2m or 3m due to discrepancies between the depth given in the report text and the summary table and the lack of data in the field records[26]; and
  - It is not known if representative duplicate samples were collected because no descriptions were provided of the sample splitting techniques used.

The Site Auditor has assessed the significance of these data gaps / deficiencies on assessing contamination risks at the Marina site in **Section 3**.

2.4 Precision & Accuracy

A summary of the available information relevant to an assessment of the precision and accuracy of the data is provided in **Table 2-14**.

[26] Section 2.1.3 of the EMM 2016 SPI gives the depth for the deeper surface water samples as 3m, while the laboratory test certificates give the depth as 2 m.

Table 2-14: Summary of Precision & Accuracy Compliance

Precision & Accuracy	DP 1999 ESA (Ref [1]) & WaterTest data (Ref [17])	EMM 2015 PSI (Ref [6])	EMM 2016 SPI (Ref [7])	DP 2018 PSI & ESA (Refs [12] & [15])
Use of properly trained and qualified field personnel	--	**Not specified**	Sectn 2	Sectn 11.1
Blind field duplicates collected at a minimum rate of 1 in 10	--	Appn D	**Sectn 3.1.2 & Appn A**	Appn G
RPD's less than 30% for inorganic and 50% for organic analyses	--	Sectn 7.1.1	**Sectn 3.1.2 & Appn A**	Appn G
Acceptable levels for equipment rinsate blanks	--	**Not tested**	**Sectn 3.1.4 & Appn A**	Not required
Acceptable levels for field & trip blanks	--	**Not tested**	Sectn 3.1.3 & Appn A	Appn G
Acceptable levels for laboratory-prepared trip spike results for volatile analytes	--	Appn E	Sectn 3.1.3 & Appn A	Appn G
Laboratory QC criteria achieved	--	Sectn 7.2 & Appn E[27]	Sectn 3.2 & Appn A[28]	Sectn 12.5, Appns G & H

Note:

The NSW EPA acceptance criteria for method blanks and spike recovery results are specified in Section 8 of AS4482.1-1997.

Legend:

Inadequate information provided in investigation reports

The Site Auditor considers the investigation procedures used by the ESAs did not meet the data precision and accuracy DQO in the following areas:

- EMM 2015 PSI:
  - It is not known if properly trained and qualified field personnel were used; and
  - No rinsate, field blanks or trip blanks were tested.
- EMM 2016 SPI:
  - No duplicate samples were tested for the dredge pond surface water samples collected on or about 3/12/15 and tested for heavy metals; and
  - Rinsate samples for surface water testing (SD-RINSATE & WAT-RINSATE) measured elevated heavy metals (copper 374 - 397 µg/L), ammonia (0.24 – 0.28 mg/L) and other nutrient concentrations, TRH C6-C9 (30 - 50 µg/L), which suggested the wash water was collected from the dredge pond or another on-site source rather than being deionised water.

The Site Auditor has assessed the significance of these data gaps / deficiencies on assessing contamination risks at the Marina site in **Section 3**.

[27] The lab certificates indicate that the phenol tests did not meet the lab QC criteria. However, phenols were not tested by the EMM 2015 PSI

[28] The lab certificates indicate that the phenol tests did not meet the lab QC criteria. However, phenols were not tested by the EMM 2016 SPI

3. Review of Contamination Assessments

This section of the SAR report assesses the adequacy of the contamination assessments made by in the ESAs for the Marina site and their compliance with NSW EPA reporting requirements. The assessments cover:

- *Aesthetic issues for relevant environmental media (Section 3.1);*
- *Background contaminant levels for relevant environmental media (Section 3.2);*
- *Chemical mixtures (Section 3.3);*
- *Soil contamination (Section 3.4);*
- *Sediment contamination (Section 3.5);*
- *LFG (Section 3.6);*
- *Groundwater contamination (Section 3.7);*
- *Surface water contamination (Section 3.8);*
- *Off-site migration potential of contamination (Section 3.9);*
- *Assessment of contamination risks and linkages (Section 3.10); and*
- *Site management strategy (Section 3.11).*

3.1 Aesthetic Issues

3.1.1 Methodology

The second check in the NSW EPA decision is that '*any aesthetic issues relating to site soils have been adequately addressed*'.

The Site Auditor considers the aesthetic issues of relevance to the Marina site and its intended land uses are:

- No accessible odorous or stained soils / sediments;
- No excessive levels of anthropogenic materials in shallow soils accessible to future users;
- No LNAPL or odorous groundwater; and
- Surface water to comply with the visual amenity environmental values for the Georges River specified by the NSW EPA[29] and summarised in **Table 3-1**.

Table 3-1 Visual Amenity Environmental Values for the Georges River (Source: NSW EPA website)

Indicator	Numerical Criteria (trigger values)
Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%
	Natural hue of the water should not be changed by more than 10 points on the Munsell Scale
	The natural reflectance of the water should not be changed by more than 50%
Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, not should they be detectable by odour
	Waters should be free from floating debris and litter
Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts

[29] https://www.environment.nsw.gov.au/ieo/georgesriver/maptext-03.htm#wq02

The ESAs did not provide an assessment of aesthetic issues at the Marina site. The Site Auditor addressed this data gap by reviewing the available data provided by the ESAs.

3.1.2 Soils

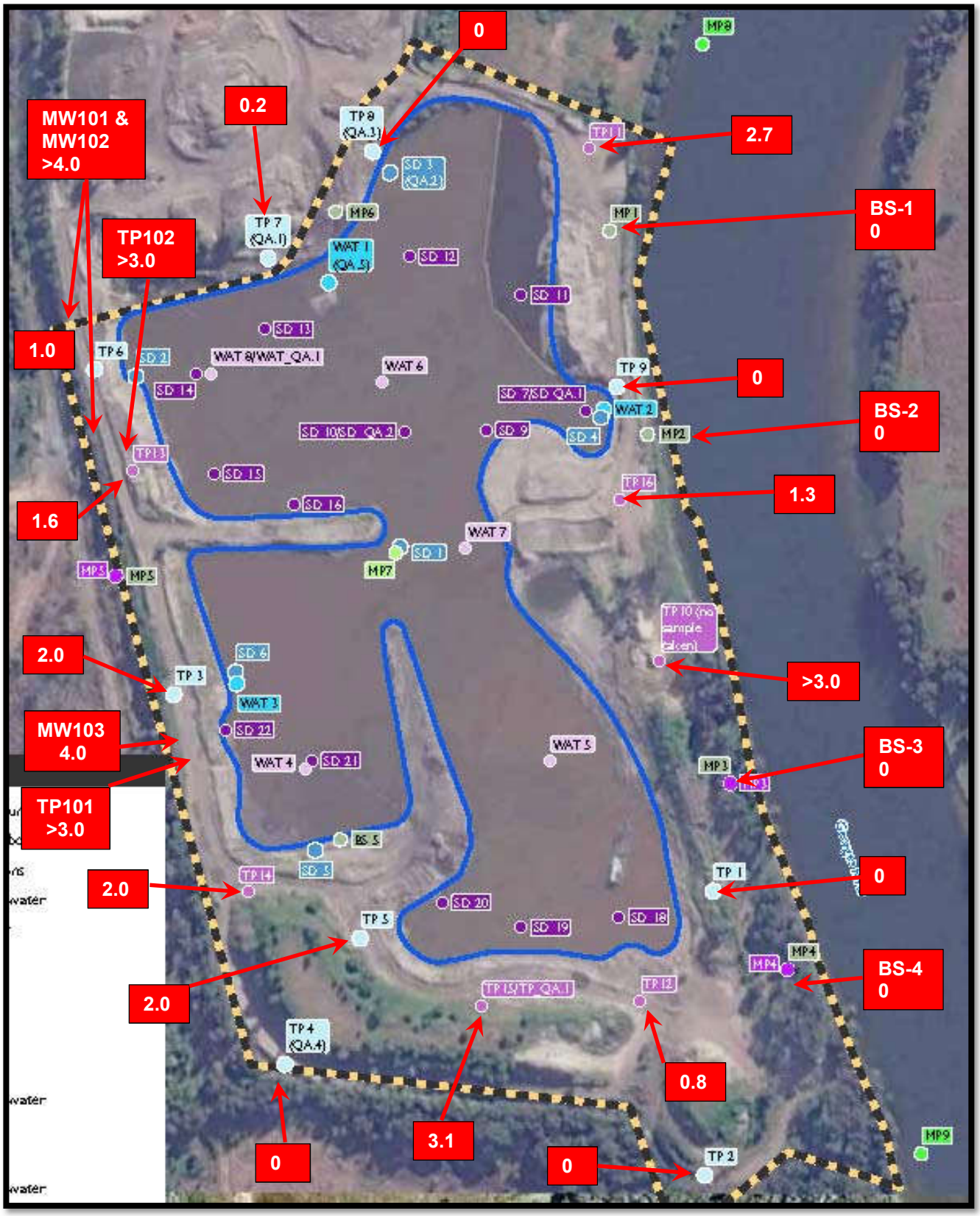
The nature and extent of fill at the Marina site is an important consideration in assessing aesthetic issues relating to site soils. The ESAs[30] advised that much of the Marina site was covered by fill with an average depth of 2.5 m. A summary of the fill descriptions provided by the ESAs at test pits and boreholes is provided in **Table 3-2**, with a plot of measured fill depth provided in **Figure 3-1**.

Table 3-2 Summary of Fill Descriptions Provided by ESAs

ESA	Testpit / Borehole	Fill Depth (m)	Fill Description	PID (ppm)
DP 1999 ESA	BS-1	0.0		
	BS-2	0.0		
	BS-3	0.0		
	BS-4	0.0		
	BS-5	0.0		
	BS-6	0.0		
EMM 2015 PSI	TP-1	0.0		
	TP-2	0.0		
	TP-3	2.0	Fill contained road base and debris, including plastic and pipe fragments	
	TP-4	0.0		
	TP-5	2.0	Fill contained road base and debris, including plastic and pipe fragments	
	TP-6	1.0	Fill contained road base and debris, including plastic and pipe fragments	
	TP-7	0.2	??	
	TP-8	0.0		
EMM 2016 SPI	TP-9	0.0		
	TP-10	>3.0	Bricks with minimal sand/clay matrix. Water table at 3.0m	
	TP-11	2.7	Brown sand, gravel with plastic and tyres	
	TP-12	0.8	Bricks with minimal sand/clay matrix	
	TP-13	1.6	Brown clay with polypipe, wire and plastic waste	
	TP-14	3.5	Grey/brown sand, gravel with plastic and tyres	
	TP-15	3.1	Light brown clay with plastic, tyres, tiles and glass	
	TP-16	1.3	Brown sand, gravel with plastic	
DP 2018 PSI	TP101	>3.0	(0-0.6m): Silty sand some gravel, glass and wood fragments, trace shell and **asbestos fragments**	7 - 8
			(0.6->3.0m): Clay some brick fragments, gravel with trace wood and tile fragments	6 - 8
	TP102	>3.0	Silt sand some gravel and brick / tile / crushed sandstone / glass fragments, trace rootlets, charcoal, plastic, slag / terracotta pipe / **bonded asbestos fragments**. Brick and concrete fragments below 1.5m and metal fragments below 2.5m	7 - 13
	MW101	>4.0	(0-2.0m): Silty sand some gravel, trace charcoal	
			(2.0->4.0m): Clay some gravel	
	MW102	>4.0	Silty sand, some gravel, glass and brick fragments	
	MW103	4.0	(0-1.5m): Silty sand some gravel, glass fragments	
			(1.5-4.0m): Clay sand with gravel and some brick fragments	

[30] Section 5.1, Ref [7]

Figure 3-1 Depth of Fill Across Site as Recorded by ESAs (Units: m)



From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the aesthetic condition of site soils does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Historic records on the quality and quantity of fill placed over more than 3 ha of the southern part of the Marina site sometime between 2005 and 2015 (**Section 2.1.3**);
- Topographic survey plan of the Marina site showing the location and extent of stockpiles and filling (**Sections 2.1.4 & 2.1.6**);
- Logs for 16 test pits excavated for the EMM 2015 PSI and EMM 2016 SPI (**Section 2.1.6**);
- Stratigraphic cross-sections through the Marina site (**Sections 2.1.4 & 2.1.8**); and
- Assessment of aesthetically impacted materials across the Marina site (**Section 2.1.8**).

Despite these data gaps, the Site Auditor considers that sufficient data was provided indicating that the aesthetic condition of site soils can be characterised as follows:

- Much of the fill consists of sandy / clayey soils contains construction and demolition waste. There was no evidence of putrescible or industrial types of waste at the locations investigated;
- The fill was placed as part of filling operations associated with the use of the Benedict waste and recycling operations;
- Much of the Marina site is covered by fill that is mainly present in raised areas and stockpiles, with low lying areas containing little fill. One exception was location TP-10 where fill extended below the water table; and
- At the time the ESAs were conducted between 2015 and 2018, fill greater than 3m thick was present along the western, southern and eastern sides of the site;
- No evidence of odorous / stained soil was reported, with PID screening tests measuring low concentrations (< 10ppm) consistent with typical background levels;
- Some buried fill is likely to contain a high proportion of anthropogenic material;
- Fragments of bonded asbestos were identified in fill in the two test pits excavated by DP in 2018. It is likely that bonded asbestos contamination was also present at some of the EMM investigation locations but were not recorded;
- The variability of fill material across the Marina site suggests that the fill was not placed in a controlled and compacted manner; and
- The Site Auditor inspected the Marina site in November 2018 and found no evidence of aesthetic issues.

This data comprises:

- The site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites (**Section 2.1.3**);
- The Marina site has been managed by Benedict under EPLs for the past 20 years and no major breaches have been recorded; and
- The ESAs provided aesthetic data from 27 test pit and borehole locations that were spread across the site. The data was considered to be generally consistent with the historic information and suitable for determining the general condition of fill across the Marina site.

The EMM 2016 SPI[31] advised that the potential aesthetic soil impacts posed by anthropogenic debris in the fill material are considered to be of limited relevance as the majority of the existing fill will either be below sealed surfaces or building footprints, or will be removed from the Marina site to prepare the landform for development.

[31] Section 5.1, Ref [7]

The Site Auditor considers the weight of evidence supports the conclusion that aesthetic issues relating to soils at the Marina site are capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- There is a low risk of odorous or stained fill being present in significant quantities that may impact the suitability of the site for the intended land uses;
- Fill at the Marina site should be capable of being reused for the proposed development appropriate controls are implemented to manage aesthetic issues and contamination such as bonded asbestos fragments;
- There is anthropogenic material in the fill that would be unsuitable for use as shallow soil that may become exposed. Examples of these unsuitable materials include large brick and concrete fragments, tyres and fill containing a high proportion of C&D waste. The presence of this material at the site can be managed by removal or appropriate earthwork controls;
- Bonded asbestos fragments are likely to be present in low concentrations in much of the fill containing C&D waste. The presence of this material needs to be managed by means of an Asbestos Management Plan (AMP) prepared for the earthworks and involve removal, burial and/or capping in-situ;
- The likely extent of contaminated soil that may need to be remediated will depend on the final design of the proposed development;
- The aesthetic condition of site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls; and
- It should be feasible to manage the presence of additional contamination and/or Unexpected Finds encountered during bulk earthworks by including an appropriate contingency plan and Unexpected Finds protocol.

3.1.3 Sediments

The EMM 2016 SPI[32] described the shallow sediment samples collected within the dredge pond as grey to brown silt and sand with no odour and no vegetation. Particle size distribution tests were conducted on 5 sediment samples, which measured fines (<75 µm) at 85 - 100%, sand (75 µm – 2mm) at <1 – 15%, and gravel (2 – 6mm) at <1%.

The Site Auditor considers the lab results indicated the shallow sediment is likely to be more accurately described as silt, with a trace to some sand. Such a description would be consistent with the sand extraction operation that occurred at the Marina site, where the dredging operation removed the sand fraction for export off-site while the fine fraction was returned to the dredge pond.

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the aesthetic condition of site sediments does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Field records for the sediment sampling conducted by the EMM 2015 PSI and EMM 2016 SPI (**Section 2.1.6**); and
- Assessment of aesthetically impacted materials across the Marina site (**Section 2.1.8**).

Despite these data gaps, the Site Auditor considers sufficient data was provided indicating that the aesthetic condition of site sediments can be characterised as follows:

- The shallow sediment is likely to be more accurately described as silt, with a trace to some sand;
- The shallow sediment was likely to have been deposited during dredging operations when the fine fraction was returned to the dredge pond and allowed to settle out;
- No evidence of anthropogenic material in sediment was reported by the ESAs; and

[32] Section 4.2, Ref [7]

- The sediments were reported to have no odour.

This data comprises:

- The site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites (**Section 2.1.3**);
- The Marina site has been managed by Benedict under EPLs for the past 20 years and no major breaches have been recorded;
- The contamination / aesthetic risks for shallow sediments in the dredge pond are unlikely to be associated with hot-spots because there is a low risk of historic activities occurring at the site that posed a risk of contaminating these sediments. Sediment contamination / aesthetic impacts are likely to involve a broadscale laydown mechanism associated with the settling of suspended solids stirred up by the dredging operation and the return of fines to the dredge pond (**Section 2.2.2**);
- The ESAs investigated the shallow sediments in the dredge pond at 16 sampling locations, which was 67% of the 24 locations recommended by the Site Auditor for assessing contamination risks (**Section 2.2.2**); and
- The Site Auditor inspected the dredge pond in November 2018 and found no evidence of aesthetic issues.

The Site Auditor considers the weight of evidence supports the conclusion that aesthetic issues relating to shallow sediments at the Marina site have been or are capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- There is a low risk of odorous or stained shallow sediments being present in significant quantities that may impact the suitability of the site for the intended land uses;
- All sediment in the proposed waterway is expected to remain permanently submerged in the proposed development; and
- Any sediment that may need to be disturbed as part of the proposed development could be managed by removal or appropriate earthwork controls.

3.1.4 Groundwater

The ESAs provided no assessment of the aesthetic condition of groundwater at the Marina site. The Site Auditor addressed this deficiency by reviewing the available data.

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the aesthetic condition of site groundwater does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Historic groundwater monitoring data that needed to be collected as a condition of POEO Licence 4612 (**Section 2.1.3**);
- Assessment of aesthetically impacted materials across the Marina site (**Section 2.1.8**);
- The construction of well MP-5 was not documented (**Section 2.1.6**); and
- No wells were located in the north-west and south-west corner of the site and no wells were located along the northern and southern property boundaries adjacent to former off-site landfills (**Section 2.2.3**).

Despite these data gaps, the Site Auditor considers sufficient data was provided indicating that there is a low risk of groundwater posing unacceptable aesthetic impacts to the intended uses of the site. This is because:

- The site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites (**Section 2.1.3**);
- The Marina site has been managed by Benedict under EPLs for the past 20 years and no major breaches have been recorded;

- The ESAs provided aesthetic data from 3 groundwater monitoring wells (MP-3 to MP-5) spread around the site;
- Field records provided in the EMM 2016 SPI indicate that the groundwater samples collected from wells MP-3 to MP-5 showed no evidence of discolouration, separate phase contaminants (i.e. LNAPL and DNAPL) or anthropogenic odours[33];
- The laboratory tests conducted on groundwater samples from wells MP-3 to MP-5 measured non-detectible petroleum hydrocarbon and PAH concentrations, which supported the absence of chemical odours and separate phase hydrocarbons (**Section 3.7.3**);
- Data on the aesthetic condition of groundwater in the northern part of the Benedict site was available from seven wells, with the results reviewed by the Site Auditor and documented in a site audit report dated 23/01/18[34]. The locations of these wells are shown in **Figure 3-2**;
- Much of the groundwater from the former landfill at the northern part of the Benedict site flows into the dredge pond. None of the 7 groundwater monitoring wells at the north Benedict site detected the presence of separate phase hydrocarbons, which are indicative of leaks of fuels and other types of organic chemicals[35];
- The ESAs provided data on surface water quality in the dredge pond, which is the main receptor for groundwater flowing from filled areas of the site; and
- The Site Auditor inspected the Marina site in November 2018 and found no evidence of aesthetic issues.

3.1.5 Surface Water

The ESAs provided no assessment of the aesthetic condition of surface water in the dredge pond at the Marina site. The Site Auditor addressed this deficiency by reviewing the available data.

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the aesthetic condition of surface water in the dredge pond does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

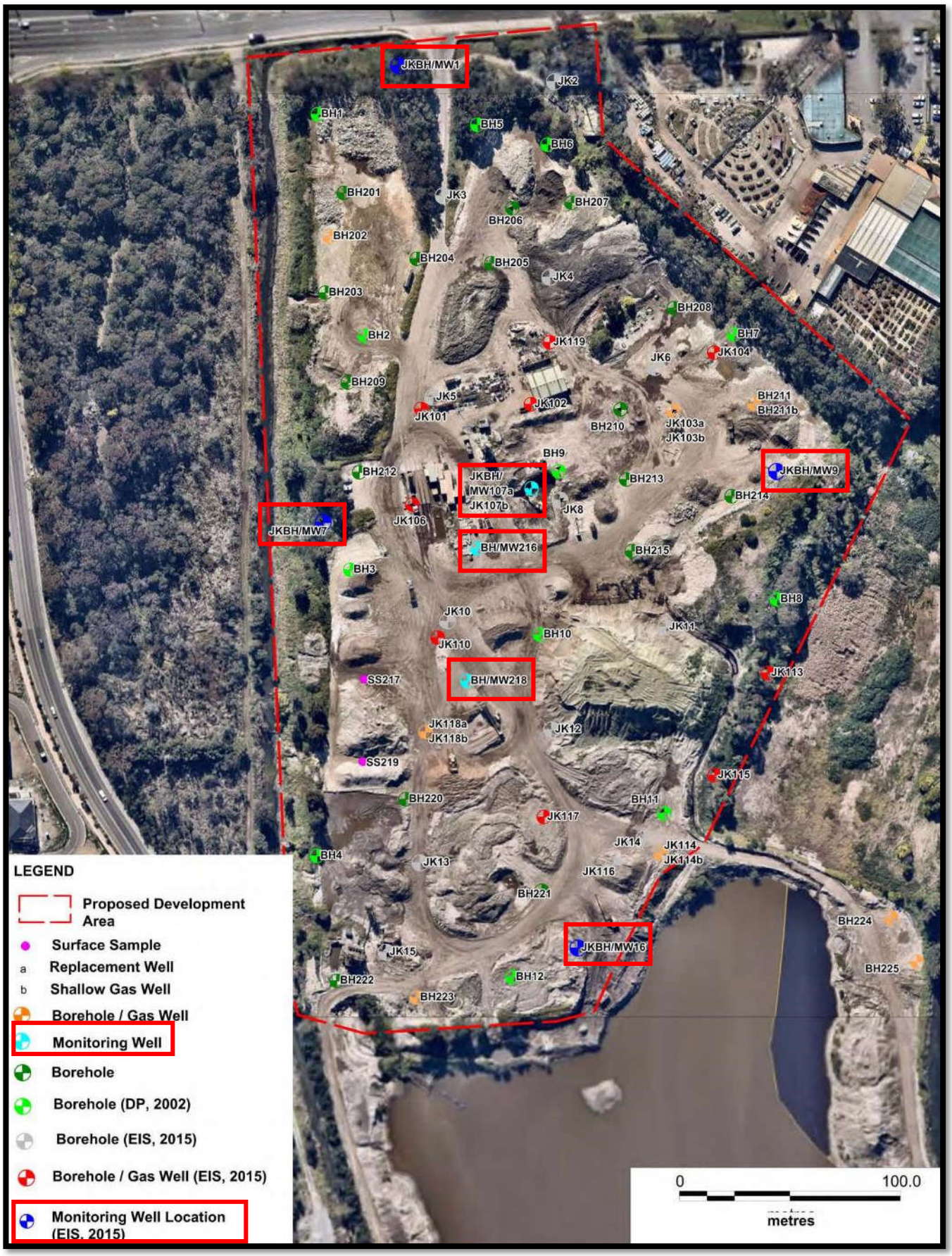
- Field records for dredge pond water sampling in the EMM 2015 PSI (**Section 2.1.6**);
- Assessment of aesthetically impacted materials across the Marina site (**Section 2.1.8**); and
- The dredge pond monitoring data (Ref [17]) indicate that dredging did not cease until October 2016, some 10 - 16 months after surface water samples were collected from the pond. This meant there is a risk that the surface water quality data obtained by EMM in 2015 was representative of poor water quality conditions caused by dredging and not post-dredging conditions (**Sections 2.2.4 & 2.3**).

Despite these data gaps, the Site Auditor considers sufficient data was provided indicating that there is a low risk of surface water in the dredge pond posing unacceptable aesthetic impacts to the intended uses of the Marina site post-construction when disturbance to the shallow sediments should be minimal . This is because:

- The site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites (**Section 2.1.3**);
- The Marina site has been managed by Benedict under EPLs for the past 20 years and no major breaches have been recorded;
- The EMM 2016 SPI report provided aesthetic data from five surface water sample locations (WAT-4 to WAT-8) spread around the dredge pond. The field records showed none of the samples were odorous or had a sheen;

[33] A natural sulphur smell typical of estuarine sediments / mangrove muds was recorded at well MP-3
[34] Sections 3.1 & 3.6, Ref [77]
[35] Section 3.1, Ref [77]

Figure 3-2: Sampling Locations in Northern Part of Benedict Site (Source: Drwg 2, Ref [9])



- The laboratory tests conducted on groundwater samples from wells MP-3 to MP-5 measured non-detectible petroleum hydrocarbon and PAH concentrations, which supported the absence of chemical odours and separate phase hydrocarbons (**Section 3.7.3**);
- Much of the groundwater from the former landfill at the northern part of the Benedict site flows into the dredge pond. None of the 7 groundwater monitoring wells at the north Benedict site detected the presence of separate phase hydrocarbons, which are indicative of leaks of fuels and other types of organic chemicals[36] (**Section 3.7.4**);
- Laboratory test data were available for 8 sample locations spread around the dredge pond for the main contaminants of concern, with quarterly monitoring data for ammonia available for 3 locations within the dredge pond for the 29/01/16 – 21/05/18 period (**Section 2.2.4**); and
- The Site Auditor inspected the dredge pond in November 2018 and found no evidence of aesthetic issues.

The Site Auditor considers that sediments that may need to be excavated to construct the marina waterway have the potential to pose an aesthetic impact to surface water during the construction period. This is because:

- The fine grained nature of the sediment means it will cause a significant increase in suspended sediment levels in surface water, which in turn will impact water quality;
- The investigations conducted by the EMM 2015 PSI and EMM 2016 SPI showed that surface water in the dredge pond had a poor quality when dredging activities were occurring (**Section 3.8.3**);
- The quarterly surface water monitoring data collected between 29/01/16 and 21/05/18 showed that ammonia levels decreased significantly to low concentrations two months after dredging activities had ceased; and
- Excavated sediment should be buried on-site below the water table unless tests show the material is not PASS.

The Site Auditor considers the weight of evidence supports the conclusion that aesthetic impacts to surface water quality during the construction period are capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- The management of fine grained sediments as part of waterway developments in Sydney is a common occurrence;
- Opening of the dredge pond to the Georges River can be programmed to occur towards the end of the proposed marina development;
- Silt curtains can be used to prevent suspended sediments from entering the Georges River during the opening of the dredge pond to the Georges River;
- The likely extent of contaminated sediment that may need to be excavated will depend on the final design of the proposed development;
- Monitoring of surface water quality in the dredge pond indicate that the water quality in the dredge pond is similar to background levels in the Georges River after dredging activities in the dredge pond ceased. This means that impacts to the Georges River, if any, would be transient and short term; and
- Management measures to minimise the transfer of sediments from the dredge pond to the Georges River can be designed and documented in a RAP, supported by an environmental monitoring program undertaken as part of a validation program.

[36] Section 3.1, Ref [77]

3.2 Background Contaminant Levels

The sixth check in the NSW EPA decision process is that '*any issues relating to local area background soil concentrations that exceed relevant investigation levels have been adequately addressed in the site assessment report(s).'*

The Site Auditor considers the environmental media relevant to contamination risks at the Site are soils, LFG, groundwater and surface water.

3.2.1 Soils

The DP 2018 PSI assumed that background soil quality at the Marina site was consistent with typical Australian soils. This was indicated by the ESAs[37] adopting typical ambient concentrations when deriving EILs. This was also the approach adopted by ESAs conducted for the northern part of the Benedict site that was reviewed by the Site Auditor in SAR 264[38].

The Site Auditor considered the weight of evidence supported this conclusion because:

- The geological data indicated that the area was an alluvial floodplain where soil quality would be naturally high;
- The historical data indicated that the Marina site and local area was used for agricultural activities for many years; and
- There are no regulated properties located close to the Marina site.

For this SAR, the Site Auditor adopted the conservative approach that all soil contamination at the Marina site was the result of activities that have occurred at the Benedict site.

3.2.2 Sediments

The ESAs did not collect and test sediment samples from the Georges River adjacent to the Marina site to establish background levels in sediments relevant to the Marina site. However, the EMM 2016 SPI did review a study by Birch et al (1996)[39] that investigated the distribution of heavy metals in surficial sediments of the Georges River and the Botany Bay estuary, which was used in planning for the extensive dredging associated with the construction of an additional runway at Sydney's international airport.

This study found that sediments of the Georges River and tributaries have high copper, zinc and lead concentrations. The maximum copper, lead and zinc concentrations in the main channel were 80 mg/kg, 110 mg/kg and 340 mg/kg, respectively. Higher concentrations were measured in bays and tributaries, where flow is lower and where there are historic contamination sources (maximum copper, lead and zinc concentrations were 457 mg/kg, 924 mg/kg and 2,641 mg/kg, respectively). The concentrations of these metals are generally higher in the upstream sections of the Georges River compared to lower in the estuary, possibly due to lower flushing in the upper river compared to frequent tidal flow flushing in the lower estuary.

The Site Auditor considers the results of the Birch et al (1996) study confirmed the potential for the Georges River sediment to be included in the CSM as a potential source of contamination to the Marina site (**Section 2.1.5**). To further assess this risk, the Site Auditor reviewed a more recent study conducted by the University of Wollongong in 2017 (Ref [78]), which found upper Georges River sediments to have elevated heavy metal concentrations that exceed the ANZECC & NHMRC (2000) ISQG low criteria, as shown by the results presented in **Figure 2-15** and **Table 2-5**. There is also a risk of Georges River sediments being contaminated by other chemicals because:

[37] Tables H-1 & H-2, Ref [5]; Section 11.1.2, Ref [9]
[38] 3.2.1, Ref [77]
[39] Birch GF, Evenden D and Teutsch MW (1996) '*Dominance of Point Source in Heavy Metal Distributions in Sediments of a Major Sydney Estuary (Australia)*'. Environmental Geology 28(4), pp 169-174

- The NSW EPA issued a '*Dietary advice for fish caught in Botany Bay and Georges River*' on 15/12/17 due to PFAS contamination;
- NSW Industry and Investment has issued a fish advisory[40] not to eat fish or shellfish caught in the Georges River and its tributaries upstream from Rabaul Road Boat Ramp at Georges Hall, including Prospect Creek, Cabramatta Creek and Chipping Norton Lake and Salt Pan Creek and its tributaries, upstream of Henry Lawson Drive at Padstow. This restriction is due to industrial pollutants being found in this area (**Figure 2-14**);
- The NSW Government has closed the whole of the Georges River to oyster cultivation[41]; and
- The NSW Government has closed the whole of Salt Pan Creek at the Henry Lawson Drive Road Bridge to catching fish and shellfish[42].

Sediments in the Georges River will be able to migrate as suspended sediment and be deposited in the Marina site when the former dredge pond is opened to the Georges River. The Site Auditor addressed this data gap in the EMM CSM by including Georges River sediment as a potential source of contamination in the CSM adopted by this site audit.

For the purpose of this SAR, the Site Auditor considers it is reasonable to adopt background heavy metals concentrations in shallow sediments based on the mean plus one standard deviation (SD) concentrations provided by the 2017 University of Wollongong study, as summarised in **Table 2-5**. These concentrations are:

- Arsenic: Mean = 8 mg/kg, SD = 6 mg/kg ➔ Adopted background = 14 mg/kg
- Chromium: Mean = 27 mg/kg, SD = 19 mg/kg ➔ " " = 46 mg/kg
- Copper: Mean = 23 mg/kg, SD = 17 mg/kg ➔ " " = 40 mg/kg
- Lead: Mean = 48 mg/kg, SD = 54 mg/kg ➔ " " = 102 mg/kg
- Nickel: Mean = 10 mg/kg, SD = 7 mg/kg ➔ " " = 17 mg/kg
- Zinc: Mean = 132 mg/kg, SD = 113 mg/kg ➔ " " = 245 mg/kg

In the absence of site-specific data for other contaminants, the Site Auditor has estimated likely background levels for other contaminants of concern based on comparisons between heavy metal concentrations. The site audit also recommends that sampling of sediments in the Georges River adjacent to the Marina site be undertaken as part of a program of additional investigations to be undertaken as part of detailed design work for the proposed development.

3.2.3 LFG

The DP 2016 DSI[43] that was conducted for the northern part of the Benedict site advised that two 'background' landfill gas wells (BH224 & BH225) were sampled on 27/10/15 and 10/02/16. The wells were located in the north-eastern part of the Marina site on the strip of land between the Georges River and the dredge pond, as shown in **Figures 3-3** and **3-4**.

[40] https://www.dpi.nsw.gov.au/fishing/closures/location-closures/botany-bay-and-georges-river
[41] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/831517/botany-bay-and-georges-river-closed-waters.pdf
[42] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/831525/salt-pan-creek-closed-waters.pdf
[43] Section 14.2.1, Ref [9]

Figure 3-3: Peak Methane Contours in North Benedict site 27/10/15 (Source: Drwg 5, Ref [9])

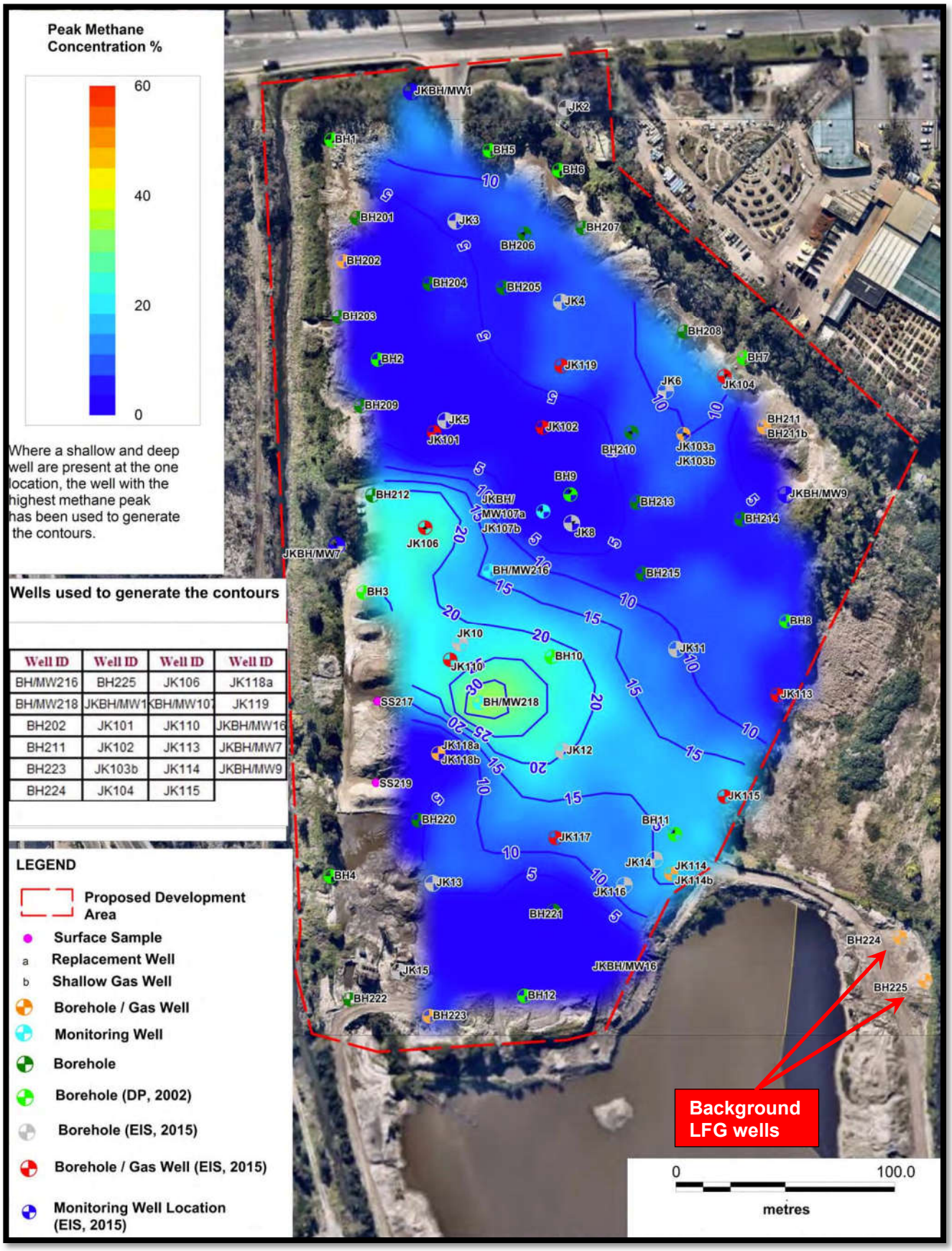
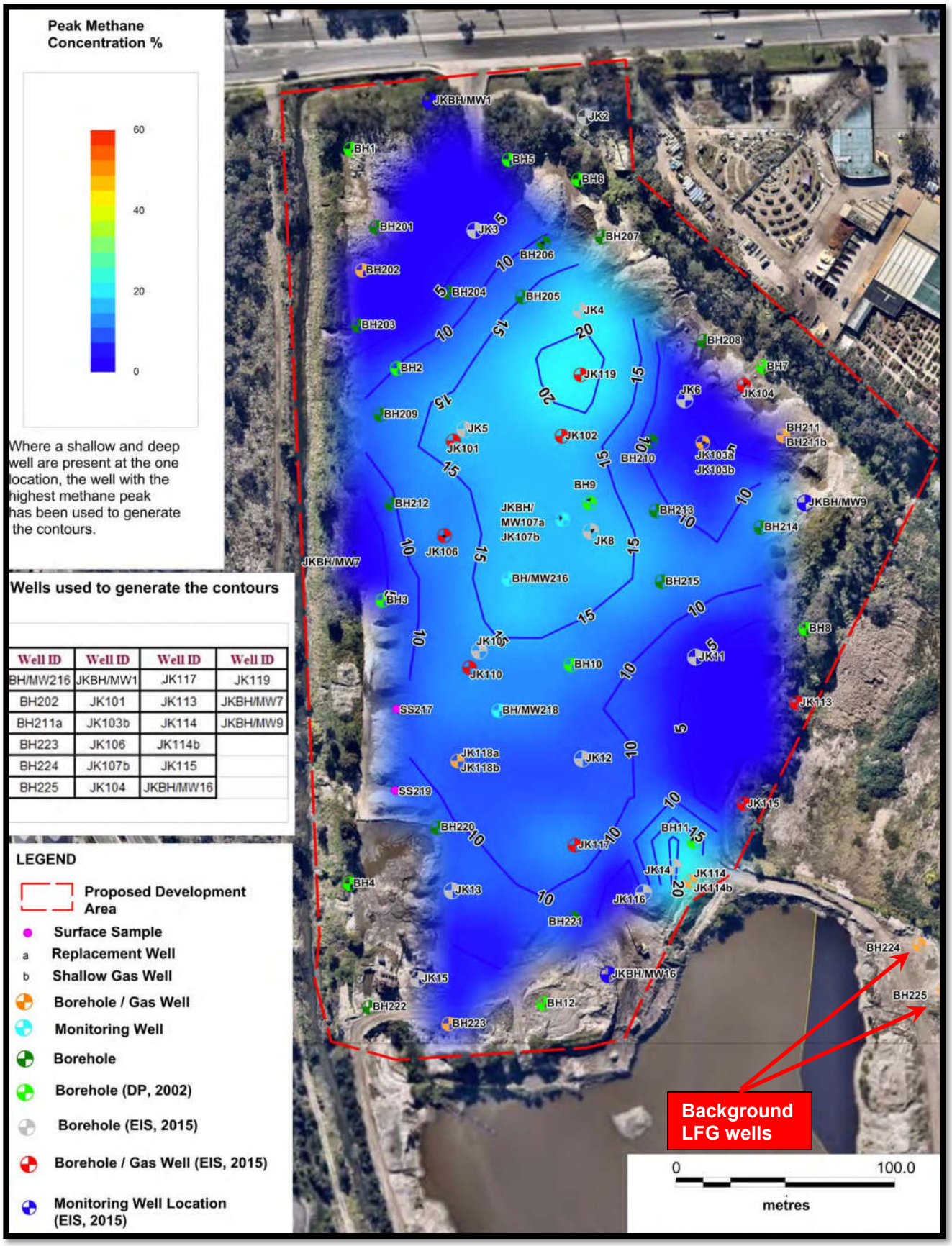


Figure 3-4: Peak Methane Contours in North Benedict site 10/02/16 (Source: Drwg 8, Ref [9])



The wells recorded maximum methane concentrations of 0.1 %v/v and 0.2 %v/v, which was well below the 1% (volume/volume) threshold level for further investigation and corrective action given in the NSW EPA (2016) '*Solid waste landfills*' guideline. These results indicate that the local estuarine alluvial soils (possibly swamp deposits) are unlikely to be contributing a significant amount of methane to subsurface soils at the Marina site.

The Site Auditor considered the weight of evidence supported this conclusion because:

- The two 'background' locations were situated in an area having only shallow fill (0.7 m thick), as shown by the logs for boreholes BH224 and BH225;
- The two 'background' locations were situated far enough away for the deep fill area at the former landfill in the northern part of the Benedict site, which meant there was a low risk of the LFG migrating to these 'background' locations; and
- The LFG investigations conducted by the DP 2016 DSI were considered to meet the DQOs for the reasons given in SAR 264B[44].

Based on these results, the Site Auditor considers that all LFG measured at the Marina site should be considered as having been generated by materials placed at the site or migrating from off-site sources. Such an approach is the same one adopted by the site audit conducted for the northern part of the Benedict site that was documented in SAR 264B[45].

3.2.4 Groundwater

The ESAs provided no assessment of the background groundwater quality appropriate for use in contamination assessments for the Marina site. The Site Auditor considers an assessment of background groundwater quality could be made by reviewing the data provided by monitoring well JKBH/MW1 located adjacent to the northern, up-gradient boundary of the Benedict site. This sample location is shown in **Figure 3-10**. Samples from this location were collected on 25/10/13 by EIS (Ref [5]) and 2/10/15 by DP (Ref [9]), with the results summarised in **Table 3-3**.

Table 3-3 Summary of Groundwater Concentrations at Background Well JKBH/MW1

Analyte	Groundwater Concentrations (µg/L)	
	Round 1 25/10/13	Round 2 2/10/15
Metals		
Arsenic	2	1 – 3
Cadmium	<0.1	<0.1 – 0.1
Chromium	<2	<1
Copper	<1	<1 – 5
Lead	<1	<1
Manganese	**--**	**950 – 985**
Mercury	<0.05	<0.01
Nickel	**4**	**30 - 46**
Zinc	**8**	**97 - 245**
Other Inorganics		
pH	7.6	6.95
Ammonia	**--**	**2,560 – 3,200**
Chloride	--	750 mg/L
Nitrate	--	10 – 30
Nitrite	--	<5 - <10
Nitrogen (total oxidised)	--	30
Phosphorus	**--**	**<50 – 3,580**

[44] Section 2, Ref [77]
[45] Section 3.2.2, Ref [77]

Analyte	Groundwater Concentrations (µg/L)	
	Round 1 25/10/13	Round 2 2/10/15
Sulphate (as SO_4)	**--**	**1,100 mg/L**
Petroleum Hydrocarbons & MAHs		
C6-C10 & C10-C36	--	<10 - <100
BTEX	<1 - <2	<1 - <2
Other MAHs	--	<1
PAHs & Phenols		
PAHs	<0.1 - <0.2	<0.1
Phenol	--	<1
Other Hydrocarbons		
VHCs	<1 - <10	<1 - <10
Halogenated hydrocarbons	<1 - <10	<1 - <10
Halogenated benzenes	<1 - <10	<1
Halogenated phenols	--	<1
PCBs	<0.01	<0.01
OCPs (Dieldrin)	**0.004**	**<0.001 – 0.001**
OCPs (DDE)	**0.001**	**<0.001**
OCPs (DDT)	**0.001**	**<0.001**
OCPs (All others)	<0.001	<0.001
OPPs (Chlorpyrifos)	**0.014**	**<0.01**
OPPs	<0.001	<0.01 - <0.02
Fungicides & Other	--	<0.005 - <10

The Site Auditor considers the weight of evidence supports the conclusion that groundwater flowing onto the Benedict site may have a background quality with elevated concentrations of:

- Some heavy metals: Nickel (4 – 46 µg/L) and zinc (8 – 245 µg/L);
- Some nutrients: Ammonia (2,560 – 3,200 µg/L), phosphorus (<50 – 3,580 µg/L) and sulphate (1,100 mg/L);
- Some OCPs: Dieldrin, DDE and DDT (0.001 – 0.004 µg/L); and
- An OPP: Chlorpyrifos (0.014 µg/L).

The Site Auditor considers these results were consistent with the history and physical conditions at the local area. The Site Auditor considers that additional background groundwater quality data may need to be collected as part of a validation program if the above analytes were found to be flowing through the Marina site and into the Georges River at concentrations exceeding default Investigation Levels given in NSW EPA-endorsed guidelines. This issue is further discussed in **Section 3.7.1**.

3.2.5 Surface Water

The ESAs provided no assessment of the background surface water quality appropriate for use in contamination assessments for the Marina site. The Site Auditor considers that an assessment of background surface water quality could be made by reviewing the data provided by:

- Surface water sample SW1 was collected from the Georges River adjacent to the dredge pond on 1/10/15. This sample location is shown in **Figure 3-31** with the results documented in DP 2016 DSI (Ref [9]). This sample was collected when dredging and recycling operations were still occurring in the dredge pond and at the north Benedict site; and
- Surface water samples SW1 and SW4 were collected from the Georges River were collected bi-monthly over 6 sampling rounds between 17/05/17 and 20/03/18. Sample location SW1 was situated up-stream of the Marina and north Benedict sites, while sample location SW4 was located adjacent to

the dredge pond, as shown in **Figure 3-32**. The results of this monitoring were documented in the DP 2018 ESA (Ref [15]). These samples were collected after dredging operations had ceased in 2017, recycling operations at the north Benedict site had been significantly scaled back in 2017, and landform preparation work had been completed at the north Benedict site.

These surface water monitoring results are summarised in **Table 3-4**.

Table 3-4 Summary of Background Surface Water Concentrations

Analyte	1/10/15 Adjacent to dredge pond	17/05/17 – 20/03/18 Adjacent to dredge pond	17/05/17 – 20/03/18 Up-stream
Metals			
Arsenic	<1	<1	<1 – 1
Cadmium	<0.1	<0.1	<0.1
Chromium	<1	<1	<1
Copper	2	<1 – 4	1 – 3
Lead	<1	<1	<1
Manganese	12	9 – 39	45 – 83
Mercury	<0.05	<0.05	<0.05
Nickel	1	2	2
Zinc	6	4 - 12	6 - 13
Other Inorganics			
pH	7.55	--	--
Ammonia (N)	25	<5 - 54	5 - 50
Chloride	6,900 mg/L	--	--
Nitrate	290	5 - 27	40 - 290
Nitrite	6	<5	<5 - 5
Nitrogen (total oxidised)	--	--	--
Phosphorus	<50	<50 - 80	<50 - 70
Sulphate (as SO_4)	890 mg/L	--	--
Petroleum Hydrocarbons & MAHs			
C6-C10 & C10-C36	<10 - <100	<10	<10
BTEX	<1 - <2	<1 - <2	<1 - <2
Other MAHs	<1	<1	<1
PAHs & Phenols			
PAHs	<0.1	<1	<1
Phenol	<1	<50	<50
Other Hydrocarbons			
VHCs	<1 - <10	--	--
Halogenated hydrocarbons	<1 - <10	--	--
Halogenated benzenes	<1	--	--
Halogenated phenols	<1	--	--
PCBs	<0.01	<0.01	<0.01
OCPs (Dieldrin)	0.001	<0.001 – 0.002	<0.001 - 0.001
OCPs (All others)	<0.001	<0.001	<0.001
OPPs	<0.01 - <0.02	<0.002	<0.002
Fungicides & Other	<0.005 - <10	<0.002	<0.002
PFAS			
PFOS	--	0.01	0.01
PFOA	--	<0.01	<0.01

Analyte	1/10/15 Adjacent to dredge pond	17/05/17 – 20/03/18 Adjacent to dredge pond	17/05/17 – 20/03/18 Up-stream
PFOS+PFHxS	--	0.02	0.02

Note: Units µg/L unless otherwise stated

The Site Auditor considers the sample data support the conclusion that the surface water quality in the Georges River in 2015 and consistent with the quality measured in 2017 – 2018. This indicates that dredging and recycling operations occurring in the dredge pond and at the Benedict site in 2015 were not having any measurable effect on the water quality in the Georges River.

The Site Auditor also considers the weight of evidence supports the conclusion that surface water in the Georges River that flows near the Marina site may have a background quality with elevated concentrations. The mean plus one standard deviation (SD) concentrations for these analytes are:

- The heavy metals copper (3 µg/L), manganese (78 µg/L), nickel (2 µg/L) and zinc (11 µg/L);
- The nutrient phosphorus (77 µg/L);
- The OCP dieldrin (0.001 µg/L); and
- The PFAS compounds PFOS (0.01 µg/L) and PFOS+PFHxS (0.02 µg/L)

The Site Auditor considers these results are consistent with the history and physical conditions at the local area and the Georges River. The Site Auditor considers that additional background surface water quality data may need to be collected as part of a validation program if the above analytes were found to be flowing through the Marina site and into the Georges River at concentrations exceeding default Investigation Levels given in NSW EPA-endorsed guidelines. This issue is further discussed in **Section 3.7.1**.

3.3 Chemical Mixtures

The seventh check in the NSW EPA decision process is that '*the impacts of chemical mixtures have been assessed*'.

The ESAs did not provide any assessment of additional contamination risks posed by chemical mixtures. The main contaminants of concern, in terms of additive risks posed by chemical mixtures, are contaminants considered to be carcinogenic. These types of contaminants of concern at the Site comprise benzene, OCPs, PCBs, VHCs and PAHs (principally BaP).

The Site Auditor has assessed the available data and considered there were unlikely to be any additional risks to human health or the environment from chemical mixtures because these analytes were not measured at elevated concentrations at the Marina site, as indicated by the reviews of contamination assessments provided in following parts of **Section 3**.

3.4 Soil Contamination

The third check in the NSW EPA decision process is that '*soils have been assessed against relevant health-based investigation levels and potential for migration of contamination from soils to groundwater has been considered*'.

The eighth check in the NSW EPA decision process is that '*any potential ecological risks have been assessed'*.

3.4.1 Soil Assessment Criteria

Soil Investigation Levels (SILs) currently approved by the NSW EPA are provided in the NEPM (2013) guidelines. SILs were given in the NEPM (2013) guideline for four types of land uses:

A residential with garden / accessible soil (home-grown produce < 10% of fruit and vegetable intake; no poultry), also includes children's day care centres, preschools and primary schools

B residential with minimal opportunities for soil access includes dwellings with fully and permanently paved yard space such as high-rise buildings and flats

C public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. It does not include undeveloped public open space (such as urban bushland and reserves) which should be subject to a site-specific assessment where appropriate

D commercial / industrial such as shops, offices, factories and industrial sites.

The proposed marina development involves a range of land uses comprising:

- Commercial D for the proposed Marina Building and carpark areas along the western and southern sides of the site;
- Recreation C for open space areas; and
- Residential B for the proposed Marina Building.

The ESAs adopted a range of SILs, comprising EMM 2015 PSI – Residential B, EMM 2016 SPI – Residential B, and DP 2018 PSI – Residential A. For the purpose of the SAR, the Site Auditor has adopted SILs based on the most sensitive of these land uses, which is:

- Recreational C HILs for most contaminants of concern and exposure pathways; and
- Residential B HILs for TRH and BTEX vapour intrusion; and
- Residential B and Recreational C EILs adopted by site audit SAR 264B for north Benedict site[46].

SILs were adopted from the NEPM (2013) guidelines where available. For analytes and exposure pathways not addressed by the NEPM guidelines, the Site Auditor adopted SILs from sources accepted by the NSW EPA, comprising:

- CRC CARE HIL direct contact criteria for petroleum hydrocarbons;
- USEPA (November 2018) HILs for resident soil;
- Canadian Council of Ministers of the Environment (CCME) residential / parkland EILs for cadmium and mercury (inorganic); and
- CRC CARE (2017) Technical Report No: 39 EIL for BaP.

The SILs adopted by the Site Auditor for this SAR are summarised in **Table 3-5**.

[46] Section 3.4.1, Ref [77]

Table 3-5 Soil Investigation Levels

Substances	HILs (mg/kg)			EILs (mg/kg)
	HIL C (direct contact/ ingestion)	HIL B (vapour intrusion)	Management Limits (Residential B)	
Metals / Metalloids (in sand)				
Arsenic (total)	300	--	--	100
Cadmium	90	--	--	10 (6)
Chromium (III)	--	--	--	450
Chromium (VI)	300	--	--	--
Copper	17,000	--	--	230
Lead	600	--	--	1,100
Manganese	14,000 (5)			--
Mercury (inorganic)	80	--	--	6.6 (6)
Nickel	1,200	--	--	300
Zinc	30,000	--	--	850
Other Organics				
Aldrin + Dieldrin	10	--	--	--
Chlordane	70	--	--	--
Chlorpyriphos	250	--	--	--
DDT+DDD+DDE	400	--	--	180
Heptachlor	10	--	--	--
PAHs (total)	300	--	--	--
Benzo(a)pyrene	3 (BaP TEQ)	--	--	20(4)
PCBs (total)	1	--	--	--
Petroleum Hydrocarbons (in sand at 0 to <1m)				
TRH F1 (C6-C10)	5,100 (3)	45	700	180
TRH F2 (>C10-C16)	3,800 (3)	110	1,000	120
TRH F3 (>C16-C34)	5,300 (3)	--	2,500	300
TRH F4 (>C34-C40)	7,400 (3)	--	10,000	2,800
Benzene	120 (3)	0.5	--	50
Toluene	18,000 (3)	160	--	85
Ethylbenzene	5,300 (3)	55	--	70
Xylenes (total)	15,000 (3)	40	--	105
Naphthalene	1,900	3	--	170
Chlorinated Solvents (1)				
Cis-1,2-dichloroethylene	160		--	--
Tetrachloroethylene (PERC)	24		--	--
Trichloroethylene	0.94		--	--
1,2,4-trimethylbenzene	300		--	--
Chlorobenzene	280		--	--
1,2-dichlorobenzene	1800		--	--
1,4-dichlorobenzene	2.6		--	--
1,1-dichloroethylene	230		--	--
1,1-dichloroethane	3.6		--	--
Trans-1,2-dichloroethylene	1,600		--	--
Chloroform	0.32		--	--
Vinyl chloride	0.059		--	--
Asbestos				
FA & AF (friable asbestos)	0.001% w/w	--	--	--
Bonded ACM	0.02% w/w	--	--	--

Substances	HILs (mg/kg)			EILs (mg/kg)
	HIL C (direct contact/ ingestion)	HIL B (vapour intrusion)	Management Limits (Residential B)	
All forms of asbestos	No visible asbestos for surface soil	--	--	--
PFAS				
PFOS + PFHxS	1	--	--	
PFOS		--	--	1
PFOA	10	--	--	10

Legend:

Adopted soil investigation level (SIL)

1. USEPA (November 2018) RSLs for resident soil
2. Vapour intrusion criteria used most critical exposure scenario based on 0 to <1m depth and mainly sand soil (except for F1 where lowest criteria given for silt)
3. Additional petroleum hydrocarbon criteria provided by the CRC CARE guidelines
4. CRC CARE (2017) Technical Report No: 39
5. HIL B NEPM criteria adopted since it is marginally lower than HIL C
6. CCME residential / parkland criteria

3.4.2 Shallow Soil (0 – 0.5m) Contamination

Review of Sample Data

The EMM 2015 PSI and the DP 2018 PSI collected samples of shallow soil from 11 locations spread around the onshore areas of the Marina site, with these locations shown in **Figure 3-5**.

The samples measured:

- Low heavy metals concentrations all below the HILs and EILs (11 sample locations tested). The measured concentration ranges were:
  - Arsenic <5 – 10 mg/kg (EIL 100 mg/kg)
  - Cadmium <0.4 - <1 mg/kg (EIL 10 mg/kg)
  - Chromium (total) 3 – 33 mg/kg (HIL CrVI 300 mg/kg)
  - Copper <5 – 176 mg/kg (EIL 230 mg/kg)
  - Lead <5 – 144 mg/kg (HIL 600 mg/kg)
  - Mercury (inorg) <0.1 – 0.1 mg/kg (EIL 6.6 mg/kg)
  - Nickel <2 - 15 mg/kg (EIL 300 mg/kg)
  - Zinc <5 - 309 mg/kg (EIL 850 mg/kg)
- Low petroleum hydrocarbon concentrations all below the HILs and EILs (11 sample locations tested). The measured concentration ranges were:
  - TRH F1 (C6-C10) <10 - <25 mg/kg (HIL 45 mg/kg)
  - TRH F2 (>C10-C16) <50 mg/kg (HIL 110 mg/kg)
  - TRH F3 (>C16-C34) <100 - 210 mg/kg (EIL 300 mg/kg)
  - TRH F4 (>C34-C40) <100 – 110 mg/kg (EIL 2,800 mg/kg)
  - Benzene <0.2 mg/kg (HIL 0.5 mg/kg)

Figure 3-5: Shallow Soil Sample Locations and SIL Exceedances

- Toluene <0.5 mg/kg (EIL 85 mg/kg)
- Ethylbenzene <0.5 mg/kg (HIL 55 mg/kg)
- Xylenes <0.2 mg/kg (HIL 40 mg/kg)
- Naphthalene <0.5 - <1 (HIL 3 mg/kg)

- Low PAH concentrations all below the HILs and EILs (11 sample locations tested). The measured concentration ranges were:
  - Total PAHs <0.5 – 8.9 mg/kg (HIL 300 mg/kg)
  - BaP (TEQ) <0.5 – 1.3 mg/kg (HIL 3 mg/kg)
  - BaP <0.5 – 0.8 mg/kg (EIL 20 mg/kg)
- Low PCB concentrations (<0.05 - 0.2 mg/kg) all below the HILs and EILs (4 sample locations tested)
- OCPs at non-detectible concentrations <0.05 - <0.2 mg/kg (4 sample locations tested)
- OPPs at non-detectible concentrations <0.05 - <0.1 mg/kg (4 sample locations tested)
- Phenolics (total) at non-detectible concentrations <5 mg/kg (2 sample locations tested)
- **Bonded asbestos fragments present in the 2 samples tested by DP 2016 PSI but non-detectible free asbestos fibres**

The only exceedances of the SILs measured in shallow soil samples was the presence of some bonded asbestos fragments at DP test pits TP101 and TP102, as shown in **Figure 3-5**.

The ESAs provided limited conclusions regarding the contamination risks posed by shallow soils. The EMM 2016 SPI[47] concluded that there was no significant soil contamination at the Marina site and that contamination issues would not preclude the proposed future land use as a proposed marina development. The DP 2018 PSI[48] concluded that the western part of the Martina site would be suitable for the proposed land uses provided that further investigation was undertaken for asbestos contamination and that procedures be included in a RAP for its management.

Compliance with DQOs

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the characterisation of contamination in shallow soils does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Logs and field records for 9 test pits in the EMM 2015 PSI (**Section 2.1.6**);
- PID headspace tests on soil samples collected in the field by the EMM 2015 PSI (**Section 2.1.6**);
- A copy of the PID calibration certificate from the DP 2018 PSI (**Section 2.1.6**)
- A copy of completed COC forms from the EMM 2015 PSI (**Section 2.1.7**);
- Shallow soils across the onshore area were investigated at 2 – 11 sampling locations, which was well below the minimum of 77 locations recommended by NSW EPA guidelines (**Section 2.2.1**);
- No grid-based site inspection was undertaken for determining the presence of visible asbestos (**Section 2.2.1**);
- Only 2 locations were tested for asbestos (**Section 2.2.1**);
- No soils were tested from locations in the southern area and the two reclaimed spits that projected out from the shoreline (**Section 2.2.1**);

[47] Section 6.1, Ref [7]
[48] Section 13, Ref [12]

- It is not known whether appropriate asbestos inspection and screening techniques were used in the field by the ESAs (**Section 2.3**);
- It is not known if the PID used in the DP 2018 DSI was appropriately calibrated (**Section 2.3**);
- It is not known if appropriate field screening techniques were used that targeted suspect soils at the Marina site because no test pit logs, descriptions of the soil samples tested, or description of field screening and sample selection protocols were provided by the EMM 2015 PSI (**Section 2.3**);
- It is not known if samples were appropriately managed by the EMM 2015 PSI because no copies of COC forms were provided (**Section 2.3**);
- It is not known if representative duplicate samples were collected because no descriptions were provided of the sample splitting techniques used by the EMM 2015 PSI **(Section 2.3**);
- All soil samples collected by the EMM 2015 PSI from the nine test pits exceeded the recommended holding time for mercury by 12 – 13 days (**Section 2.3**);
- It is not known if properly trained and qualified field personnel were used by the EMM 2015 PSI (**Section 2.4**); and
- No rinsate, field blanks or trip blanks were tested by the EMM 2015 PSI (**Section 2.4**).

Despite these data gaps, the Site Auditor considers that sufficient data was provided indicating that it is reasonable to characterise contamination in shallow soils across the onshore areas as follows:

- 95% UCL average contaminant levels in shallow soils are likely to be below the SILs appropriate for the intended land uses;
- Fragments of bonded asbestos contamination probably exist in shallow soils generally at low concentrations. These shallow soils consist of areas where fill has been placed and/or removed. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soils; and
- Hot-spots of contamination that exceed 2.5 times the SILs, if present, are likely to be localised and of a manageable number.

This data comprises:

- The site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites (**Section 2.1.3**);
- The Marina site has been managed by Benedict under EPLs for the past 20 years and no major breaches have been recorded;
- Much of the fill consists of sandy / clayey soils contains construction and demolition waste. There was no evidence of putrescible or industrial types of waste at the locations investigated;
- Contamination that has been found at the Marina site is consistent with construction and demolition waste;
- No evidence of odorous / stained soil was reported, with PID screening tests measuring low concentrations (< 10ppm) consistent with typical background levels;
- All shallow soil samples measured low concentrations below the SILs for practically all contaminants of concern. The exception was the presence of bonded asbestos fragments reports at the two test pits excavated for the DP 2018 PSI; and
- Laboratory test data was obtained for 55 fill samples collected in the northern part of the Benedict site that was reviewed as part of SAR 264B[49]. The data show that practically all samples measured contaminant levels below the HILs and EILs applicable for the Marina. Further details are provided in **Section 3.4.3**.

[49] Section 3.4.2, Ref [77]

Ability to Manage Contamination

The Site Auditor considers the weight of evidence supports the conclusion that shallow soil contamination at the Marina site is capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- The marina development will involve a major earthworks program that will significantly alter the current landform. This means that the existing quality of shallow soils will not be relevant to the risks posed by contamination in the final landform and that such data can best be obtained as part of a validation program undertaken upon completion of the bulk earthworks;
- 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses;
- Fragments of bonded asbestos contamination probably exist in shallow soils generally at low concentrations. These shallow soils consist of areas where fill has been placed. Visible asbestos can be readily removed from the final ground surface achieved by the proposed development or capped with clean soils;
- Hot-spots of contamination that exceed 2.5 times the SILs, if present, are likely to be localised and of a manageable number;
- The proposed development is reported to involve the removal of fill from the Marina site or its capping with clean soils[50];
- Fill at the Marina site should be capable of being reused for the proposed development appropriate controls are implemented to manage aesthetic issues and contamination such as bonded asbestos fragments;
- Bonded asbestos fragments are likely to be present in low concentrations in much of the fill containing C&D waste. The presence of this material needs to be managed by means of an AMP prepared for the earthworks and involve removal, burial and/or capping in-situ;
- The likely extent of contaminated soil that may need to be remediated will depend on the final design of the proposed development;
- The remediation of contamination in site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls; and
- It should be feasible to manage the presence of additional contamination and/or Unexpected Finds encountered during bulk earthworks by including an appropriate contingency plan and Unexpected Finds protocol.

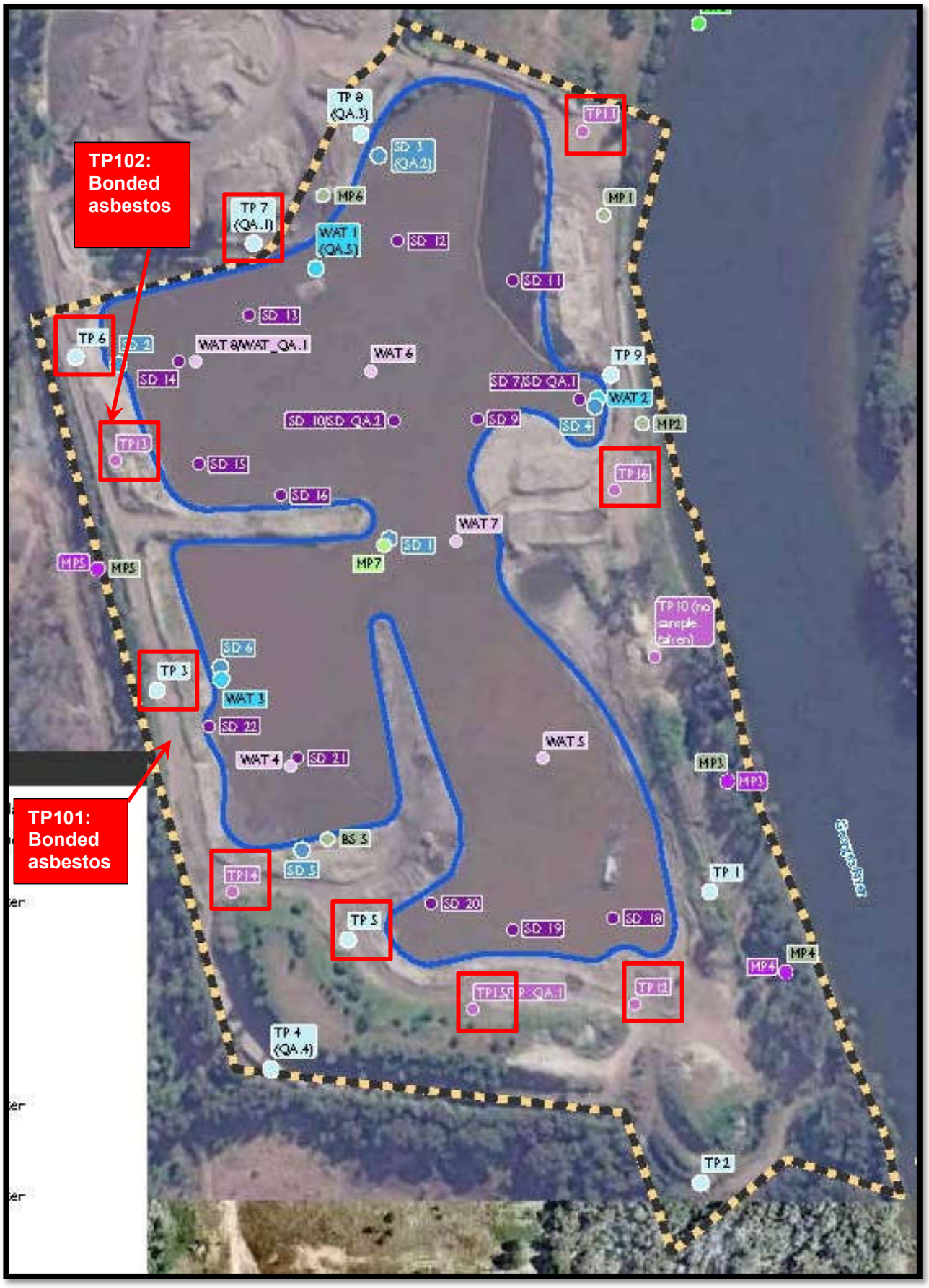
3.4.3 Contamination in Fill

Review of Sample Data

The EMM 2015 PSI, the EMM 2016 SPI and the DP 2018 PSI collected samples of fill from 12 locations spread around the onshore areas of the Marina site, with these locations shown in **Figure 3-6**.

[50] Section 5.1, Ref [7]

Figure 3-6: Fill Sample Locations and SIL Exceedances



The samples measured:

- Low heavy metals concentrations all below the HILs and EILs (12 sample locations tested). The measured concentration ranges were:
  - Arsenic <5 – 10 mg/kg (EIL 100 mg/kg)
  - Cadmium <0.4 – 1 mg/kg (EIL 10 mg/kg)
  - Chromium (total) 3 – 40 mg/kg (HIL CrVI 300 mg/kg)
  - Copper <5 – 190 mg/kg (EIL 230 mg/kg)
  - Lead 7 – 144 mg/kg (HIL 600 mg/kg)
  - Mercury (inorg) <0.1 – 0.1 mg/kg (EIL 6.6 mg/kg)
  - Nickel 6 - 17 mg/kg (EIL 300 mg/kg)
  - Zinc 21 - 345 mg/kg (EIL 850 mg/kg)
- Low petroleum hydrocarbon concentrations all below the HILs and EILs (12 sample locations tested). The measured concentration ranges were:
  - TRH F1 (C6-C10) <10 - <25 mg/kg (HIL 45 mg/kg)
  - TRH F2 (>C10-C16) <50 mg/kg (HIL 110 mg/kg)
  - TRH F3 (>C16-C34) <100 - 240 mg/kg (EIL 300 mg/kg)
  - TRH F4 (>C34-C40) <100 – 110 mg/kg (EIL 2,800 mg/kg)
  - Benzene <0.2 mg/kg (HIL 0.5 mg/kg)
  - Toluene <0.5 mg/kg (EIL 85 mg/kg)
  - Ethylbenzene <0.5 - <1 mg/kg (HIL 55 mg/kg)
  - Xylenes <0.2 - <1 mg/kg (HIL 40 mg/kg)
  - Naphthalene <0.1 - <1 (HIL 3 mg/kg)
- Low PAH concentrations all below the HILs and EILs (12 sample locations tested). The measured concentration ranges were:
  - Total PAHs <0.5 – 8.9 mg/kg (HIL 300 mg/kg)
  - BaP (TEQ) <0.5 – 2.2 mg/kg (HIL 3 mg/kg)
  - BaP 0.1 – 1.5 mg/kg (EIL 20 mg/kg)
- Low PCB concentrations (<0.05 - 0.2 mg/kg) all below the HILs and EILs (5 sample locations tested)
- OCPs at non-detectible concentrations <0.05 - <0.2 mg/kg (5 sample locations tested)
- OPPs at non-detectible concentrations <0.05 - <0.1 mg/kg (5 sample locations tested)
- Phenolics (total) at non-detectible concentrations <5 mg/kg (2 sample locations tested)
- **Bonded asbestos fragments present in the 2 samples tested by DP 2016 PSI but non-detectible free asbestos fibres**

The only exceedances of SILs measured in fill samples involved the presence of some bonded asbestos fragments at DP test pits TP101 and TP102, as shown in **Figure 3-6**.

The ESAs provided limited conclusions regarding the contamination risks posed by fill. The EMM 2016 SPI[51] concluded that there was no significant soil contamination at the Marina site and that contamination issues would not preclude the proposed future land use as a proposed marina development. The DP 2018 PSI[52]

[51] Section 6.1, Ref [7]
[52] Section 13, Ref [12]

concluded that the western part of the Martina site would be suitable for the proposed land uses provided that further investigation was undertaken for asbestos contamination and that procedures be included in a RAP for its management.

Compliance with DQOs

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the characterisation of contamination in fill does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Logs and field records for 9 test pits in the EMM 2015 PSI and the 7 additional tests pits excavated by the EMM 2016 SPI (**Section 2.1.6**);
- PID headspace tests on soil samples collected in the field by the EMM 2015 PSI and EMM 2016 SPI (**Section 2.1.6**);
- A copy of the PID calibration certificate from the DP 2018 PSI (**Section 2.1.6**)
- A copy of completed COC forms from the EMM 2015 PSI and EMM 2016 SPI (**Section 2.1.7**);
- Fill material across the onshore area was investigated at 2 – 12 sampling locations, which was well below the minimum of 77 locations recommended by NSW EPA guidelines (**Section 2.2.1**);
- Only 2 locations were tested for asbestos (**Section 2.2.1**);
- No soils were tested from locations in the southern area and the two reclaimed spits that projected out from the shoreline (**Section 2.2.1**);
- Stockpiled waste material covered most of the onshore area, which may require additional samples to be collected (**Section 2.2.1**);
- The fill thickness was not determined at EMM TP-3, TP-5, TP-10 and DP TP101, TP102, MW101, MW102 (**Section 2.2.1**);
- The volume of fill material that presently remains at the Marina site is not known (**Section 2.2.1**);
- It is not known whether appropriate asbestos inspection and screening techniques were used in the field by the ESAs (**Section 2.3**);
- It is not known if the PID used in the DP 2018 DSI was appropriately calibrated (**Section 2.3**);
- It is not known if appropriate field screening techniques were used that targeted suspect soils at the Marina site because no test pit logs, descriptions of the soil samples tested, or description of field screening and sample selection protocols were provided by the EMM 2015 PSI and EMM 2016 SPI (**Section 2.3**);
- It is not known if samples were appropriately managed by the EMM 2015 PSI and EMM 2016 SPI because no copies of COC forms were provided (**Section 2.3**);
- It is not known if representative duplicate samples were collected because no descriptions were provided of the sample splitting techniques used by the EMM 2015 PSI and EMM 2016 SPI **(Section 2.3**);
- All soil samples collected by the EMM 2015 PSI from the nine test pits exceeded the recommended holding time for mercury by 12 – 13 days (**Section 2.3**);
- It is not known if properly trained and qualified field personnel were used by the EMM 2015 PSI (**Section 2.4**); and
- No rinsate, field blanks or trip blanks were tested by the EMM 2015 PSI (**Section 2.4**).

Despite these data gaps, the Site Auditor considers that sufficient data was provided indicating that it is reasonable to characterise the contamination in fill across the onshore areas as follows:

- 95% UCL average contaminant levels in fill are likely to be below the SILs appropriate for the intended land uses;

- Fragments of bonded asbestos contamination probably exist in fill generally at low concentrations. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soils; and
- Hot-spots of contamination that exceed 2.5 times the SILs, if present, are likely to be localised and of a manageable number.

This data comprises the same data obtained from the Marina site, as previously described in **Section 3.4.2**, together with the laboratory test data on the 55 fill samples collected in the northern part of the Benedict site that was reviewed as part of SAR 264B[53]. The data showed that practically all samples measured contaminant levels below the HILs and EILs applicable for the Marina site. The main findings were:

- **Heavy metals:** Practically all samples measured concentrations below the HIL criteria. The few exceedances were:
  - Sample BH203 2.9-3.35m: Lead 860 mg/kg;
  - Sample BH221 2.9-3.35m: Lead 620 mg/kg.

  Practically all samples measured concentrations below the EIL criteria. The few exceedances were:
  - Sample JK7 2.7-3.0m: Chromium 2,800 mg/kg (EIL Cr III 450 mg/kg);
  - Sample BH222 0.9-1.35m: Copper 250 mg/kg (EIL 230 mg/kg); and
  - Sample BH223 2.0-2.45m: Copper 540 mg/kg.

  These exceedances were scattered across the northern part of the Benedict site.
- **TRH:** Practically all samples measured concentrations below the HIL criteria and at non-detectible concentrations. The few exceedances were:
  - Sample JK7 5.8-6.0m: >C10-C16 (F2) 240 mg/kg (HIL 110 mg/kg).
  - Sample JK13 0.0-0.2m: >C10-C16 (F2) 190 mg/kg.
- **BTEXN & VOCs:** All samples measured non-detectible concentrations.
- **PAHs:** Practically all samples measured concentrations below the HIL criteria. The few exceedances were:
  - Sample JK12 1.3-1.5m: BaP TEQ 13 mg/kg (HIL 3 mg/kg);
  - Sample JK103a 2.9-3.35m: BaP TEQ 17 mg/kg;
  - Sample BH207 0.1-0.2m: BaP TEG 29 mg/kg;
  - Sample BH209 0.9-1.35m: BaP TEQ 14 mg/kg;
  - Sample BH210 0.1-0.2m: BaP TEQ 4.2 mg/kg;
  - Sample BH222 0.9-1.35m: BaP TEQ 5.4 mg/kg;

  These exceedances were scattered across the northern part of the Benedict site. Only four of the samples measured BaP TEQ concentrations greater than the HIL hotspot criteria of 7.5 mg/kg.

  The BaP TEQ concentrations across the Site gave a 95% UCL average concentration less than the HIL criteria of 3 mg/kg.
- **Phenols**: All samples measured non-detectible concentrations.
- **Cyanide**: All samples measured concentrations below the HIL criteria with practically all samples measuring non-detectible concentrations. The maximum concentration measured was 4.4 mg/kg at BH209 1.9-2.35m.
- **OCPs:** All samples measured concentrations below the HIL criteria, with practically all samples measuring non-detectible concentrations.

[53] Section 3.4.2, Ref [77]

- **OPPs:** All samples measured non-detectible concentrations.
- **PCBs:** Practically all samples measured non-detectible concentrations. The one exception was sample BH220 0.1-0.2m that measured 3.7 mg/kg, which exceeded the HIL criteria (1 mg/kg).
- **Asbestos:** Bonded asbestos fragments were recorded in 9 of the 65 borehole logs provided by the ESAs. The asbestos fragments were randomly distributed in the fill across much of the northern part of the Benedict site.

Ability to Manage Contamination

The Site Auditor considers the weight of evidence supports the conclusion that contaminated fill at the Marina site is capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- It is understood that the marina development will involve a major earthworks program that will significantly alter the current landform and involve the removal and/or relocation of a large amount of the existing fill. This means that the existing quality of fill will not be relevant to the risks posed by contamination in the final landform and that such data can best be obtained as once the earthworks design has been completed and additional investigations undertaken prior to the commencement of bulk earthworks;
- 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses;
- Fragments of bonded asbestos contamination probably exist in fill generally at low concentrations. Visible asbestos can be readily removed from the final ground surface achieved by the proposed development or capped with clean soils;
- Hot-spots of contamination that exceed 2.5 times the SILs, if present, are likely to be localised and of a manageable number;
- The proposed development is reported to involve the removal of fill from the Marina site or its capping with clean soils[54];
- Fill at the Marina site should be capable of being reused for the proposed development appropriate controls are implemented to manage aesthetic issues and contamination such as bonded asbestos fragments;
- Bonded asbestos fragments are likely to be present in low concentrations in much of the fill containing C&D waste. The presence of this material needs to be managed by means of an AMP prepared for the earthworks and involve removal, burial and/or capping in-situ;
- The likely extent of contaminated soil that may need to be remediated will depend on the final design of the proposed development;
- The remediation of contamination in site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls; and
- It should be feasible to manage the presence of additional contamination and/or Unexpected Finds encountered during bulk earthworks by including an appropriate contingency plan and Unexpected Finds protocol.

3.4.4 Contamination Risks in Natural Soil Underlying Fill

Review of Sample Data

The EMM 2015 PSI collected samples of natural soil from 5 locations spread around the onshore areas of the Marina site, with these locations shown in **Figure 3-7**.

[54] Section 5.1, Ref [7]

Figure 3-7: Natural Soil Sample Locations

The samples measured:

- Low heavy metals concentrations all below the HILs and EILs (5 sample locations tested). The measured ranges were:
  - Arsenic <5 – 10 mg/kg (EIL 100 mg/kg)
  - Cadmium <1 mg/kg (EIL 10 mg/kg)
  - Chromium (total) 8 – 16 mg/kg (HIL CrVI 300 mg/kg)
  - Copper <5 – 67 mg/kg (EIL 230 mg/kg)
  - Lead 20 - 33 mg/kg (HIL 600 mg/kg)
  - Mercury (inorg) <0.1 mg/kg (EIL 6.6 mg/kg)
  - Nickel <2 - 9 mg/kg (EIL 300 mg/kg)
  - Zinc <5 - 71 mg/kg (EIL 850 mg/kg)
- Non-detectible petroleum hydrocarbon concentrations all below the HILs and EILs (5 sample locations tested). The detection limits were:
  - TRH F1 (C6-C10) <10 mg/kg (HIL 45 mg/kg)
  - TRH F2 (>C10-C16) <50 mg/kg (HIL 110 mg/kg)
  - TRH F3 (>C16-C34) <100 mg/kg (EIL 300 mg/kg)
  - TRH F4 (>C34-C40) <100 mg/kg (EIL 2,800 mg/kg)
  - Benzene <0.2 mg/kg (HIL 0.5 mg/kg)
  - Toluene <0.5 mg/kg (EIL 85 mg/kg)
  - Ethylbenzene <0.5 mg/kg (HIL 55 mg/kg)
  - Xylenes <0.2 mg/kg (HIL 40 mg/kg)
  - Naphthalene <0.5 (HIL 3 mg/kg)
- Non-detectible PAH concentrations all below the HILs and EILs (5 sample locations tested). The detection limits were:
  - Total PAHs <0.5 mg/kg (HIL 300 mg/kg)
  - BaP (TEQ) <0.5 mg/kg (HIL 3 mg/kg)
  - BaP <0.5 mg/kg (EIL 20 mg/kg)
- Non-detectible PCB concentrations (<0.1 mg/kg) all below the HILs and EILs (1 sample location tested)
- OCPs at non-detectible concentrations <0.05 - <0.2 mg/kg (1 sample location tested)
- OPPs at non-detectible concentrations <0.05 - <0.1 mg/kg (1 sample location tested)

Compliance with DQOs

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the characterisation of contamination in natural soil underlying fill does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Logs and field records for 9 test pits in the EMM 2015 PSI (**Section 2.1.6**);
- PID headspace tests on soil samples collected in the field by the EMM 2015 PSI (**Section 2.1.6**);
- A copy of completed COC forms from the EMM 2015 PSI (**Section 2.1.7**);
- Natural soil across the onshore area was investigated at 1 - 5 sampling locations, which was well below the 28 locations assessed by the Site Auditor (**Section 2.2.1**);
- No data was provided on the leachate generation potential of fill (**Section 2.2.1**);

- It is not known if the PID used in the DP 2018 DSI was appropriately calibrated (**Section 2.3**);
- It is not known if appropriate field screening techniques were used that targeted suspect soils at the Marina site because no test pit logs, descriptions of the soil samples tested, or description of field screening and sample selection protocols were provided by the EMM 2015 PSI (**Section 2.3**);
- It is not known if samples were appropriately managed by the EMM 2015 PSI because no copies of COC forms were provided (**Section 2.3**);
- It is not known if representative duplicate samples were collected because no descriptions were provided of the sample splitting techniques used by the EMM 2015 PSI **(Section 2.3**);
- All soil samples collected by the EMM 2015 PSI from the nine test pits exceeded the recommended holding time for mercury by 12 – 13 days (**Section 2.3**);
- It is not known if properly trained and qualified field personnel were used by the EMM 2015 PSI (**Section 2.4**); and
- No rinsate, field blanks or trip blanks were tested by the EMM 2015 PSI (**Section 2.4**).

Despite these data gaps, the Site Auditor considers that sufficient data was provided indicating that it is reasonable to characterise the contamination in natural soils underlying fill across the onshore areas as follows:

- 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses; and
- There is a low risk of broadscale hot-spot contamination that exceed 2.5 times the SILs.

This data comprises:

- The site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites (**Section 2.1.3**);
- The Marina site has been managed by Benedict under EPLs for the past 20 years and no major breaches have been recorded;
- Much of the fill consists of sandy / clayey soils contains construction and demolition waste. There was no evidence of putrescible or industrial types of waste at the locations investigated;
- Contamination that has been found at the Marina site is consistent with construction and demolition waste;
- No evidence of odorous / stained soil was reported, with PID screening tests measuring low concentrations (< 10ppm) consistent with typical background levels;
- All natural soil samples measured low concentrations below the SILs for all contaminants of concern;
- Laboratory test data was obtained for 55 fill samples collected in the northern part of the Benedict site that was reviewed as part of SAR 264B[55]. The data showed that practically all samples measured contaminant levels below the HILs and EILs applicable for the Marina. Further details are provided in **Section 3.4.3**; and
- Laboratory test data was obtained for 9 natural soil samples collected in the northern part of the Benedict site that was reviewed as part of SAR 264B[56]. The data showed that all samples measured contaminant levels below the HILs and EILs applicable for the Marina and at concentrations generally consistent with typical background levels for Australian soils.

[55] Section 3.4.2, Ref [77]
[56] Section 3.4.2, Ref [77]

Ability to Manage Contamination

The Site Auditor considers the weight of evidence supports the conclusion that there is a low risk of significant contamination of natural soil at the Marina site and that any contamination found in natural soils can be addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- The historical data indicate that the Marina site has no history of chemical use and that the site has been used for dredging. Fill that has been placed at the site mainly consists of sandy / clayey soils contains construction and demolition waste, which has a low leachate generation potential;
- 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses;
- Hot-spots of contamination that exceed 2.5 times the SILs, if present, are likely to be localised and of a manageable number;
- The likely extent of contaminated soil that may need to be remediated will depend on the final design of the proposed development;
- The remediation of contamination in site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls; and
- It should be feasible to manage the presence of additional contamination and/or Unexpected Finds encountered during bulk earthworks by including an appropriate contingency plan and Unexpected Finds protocol.

3.4.5 Compliance with SEAR 912 Requirements

The SEAR 912 conditions for the proposed marina development (Ref [79]) requires the inadequacies of the dredge pond assessment provided by the ESAs to be addressed. The Site Auditor considers that:

- Additional data relevant to the assessment of dredge pond contamination risks at the Marina site was reviewed for this SAR. This additional data comprised:
  - A detailed review of the history of the Marina and Benedict sites (**Section 2.1.3**); and
  - A detailed review of asbestos contamination in fill at the northern part of the Benedict site (**Section 3.4.3**)
- Sufficient data has been provided indicating that it is reasonable to characterise asbestos contamination in shallow soils across the onshore areas as consisting of fragments of bonded asbestos contamination that probably exist in shallow soils generally at low concentrations. These shallow soils consist of areas where fill has been placed and/or removed. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soils;
- Shallow soil contamination at the Marina site is capable of being addressed in a feasible and practical manner by the development work;
- The remediation of contamination in site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls. The design and procedures to be adopted by the validation program should be specified in a RAP; and
- It should be feasible to manage the presence of additional contamination and/or Unexpected Finds encountered during bulk earthworks by including an appropriate contingency plan and Unexpected Finds protocol in a RAP.

The Site Auditor considers that this SAR addresses the requirements of SEAR 912 to the extent necessary to allow a consent for the proposed marina development to be issued in accordance with SEPP 55 and NSW EPA guidance, provided future remediation and validation work is subject to a statutory site audit.

3.4.6 Acid Sulphate Soils

The ESAs conducted for the Marina and north Benedict site advise that the Benedict site is located in an ASS risk area. The EIS 2013 PSI (Ref [5]) conducted SPOCAS tests on five fill samples and three underlying natural soil samples, with the results summarised in **Table 3-6**.

The DP 2016 DSI[57] advised that the data collected by the EIS 2013 DSI indicated that the majority of the eight SPOCAS test results were within the acidic to very acidic range. The adopted SPOS criterion of 0.03% was exceeded for samples of both fill and natural soils, which suggested that some potential ASS may have been used to fill the Benedict site. DP concluded that the natural soils below the water table were likely to pose a much greater risk in terms of potential acid generation because:

- The two highest SPOS results recorded by EIS (2013) were from natural soils; and
- Much of the fill was located above the water table, which meant it had been exposed to oxygen for many years that would have caused the partial oxidation of any PASS if present.

The DP 2016 DSI recommended that excavation work undertaken at the Benedict site would need to include procedures for managing disturbance to ASS if there was a requirement for deep excavation work to occur, particularly into the natural soils underlying the fill layer. The Site Auditor considers the available data supports this recommendation for the Marina site.

The Site Auditor considers the weight of evidence supports the conclusion that ASS excavated by the proposed development can managed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- The Marina site is located in an ASS risk area;
- The likely extent of ASS that may need to be excavated will depend on the final design of the proposed development; and
- It is routine practice to manage ASS encountered during site work by implementing procedures documents in an ASS management plan.

[57] Section 17.1.4, Ref [9]

Table 3-6: Summary of SPOCAS Test Results (Source: Table E, Ref [5])

Sample Reference	Sample Depth (m)	Sample Description	pH_{KCL}	TAA pH 6.5	pH_{ox}	TPA pH 6.5	TSA pH 6.5	S_{POS} %w/w	Ca A %w/w	Mg A %w/w	Liming Rate kg $CaCO_3$/tonne
JK1	1.3-1.5	Fill - Silty Clay	6.1	5	4.5	30	25	0.08	0.017	LPQL	4.2
JK3	3.5-3.8	Fill - Silty Clay	8.8	LPQL	7	LPQL	LPQL	0.2	0.55	0.025	LPQL
JK3	5.7-6.0	Silty Clay	6.5	LPQL	3	170.0	170	0.4	0.05	LPQL	15
JK5	6.3-6.5	Clayey Silt	6.4	LPQL	4.9	LPQL	LPQL	0.03	LPQL	0.006	1.7
JK15	2.8-3.0	Fill - Silty Clayey Sand	8.3	LPQL	7.4	LPQL	LPQL	0.06	0.72	0.013	LPQL
JK15	4.3-4.5	Fill - Silty Sand	6.2	LPQL	3.3	65	62	0.13	LPQL	LPQL	6.4
JK16	1.8-2.0	Fill - Silty Sand	10.1	LPQL	8	LPQL	LPQL	0.01	0.48	0.027	LPQL
JK16	4.3-4.5	Silty Sand	5.6	5	2.6	85	80	0.31	0.008	LPQL	15
Total Number of Samples			8	8	8	8	8	8	8	8	8
Minimum Value			5.6	5	2.6	30	25	0.01	0.008	0.006	1.7
Maximum Value			10.1	5	8	170	170	0.4	0.72	0.027	15

EXPLANATION:

Action criteria are defined as follows:

- coarse textured soils (sands to loamy sands):
  - pH < 5
  - TAA/TSA/TPA (pH 5.5) > 18mol H^+/tonne
  - S_{pos} > 0.03% sulfure oxidisable

Values Exceeding Action Criteria **VALUE**

Abbreviations:

pH_{KCL} : pH of filtered 1:20, 1M KCL extract, shaken overnight

TAA pH 6.5 : Total Actual Acidity in 1M KCL extract titrated to pH6.5

pH_{ox} : pH filtered 1:20 1M KCl after peroxide digestion

TPA : Total Potential Acidity, 1M KCL peroxide digest titrated to pH6.5

TSA: Total Sulfide Acidity

S_{POS}: Peroxide oxidisable Sulfur (SP - SKCL)

Ca $_A$/Mg $_A$: Calcium/Magnesium reacted with acid generated by peroxide digest

Calcium and Magnesium values used to estimate additional Ca/Mg from acid-shell/carbonate/dolomite reaction

Reference: ASSMAC (Acid Sulfate Soils management Advisory Committee - Acid Sulfate Soil Manual, August 1998).

3.5 Sediment Contamination

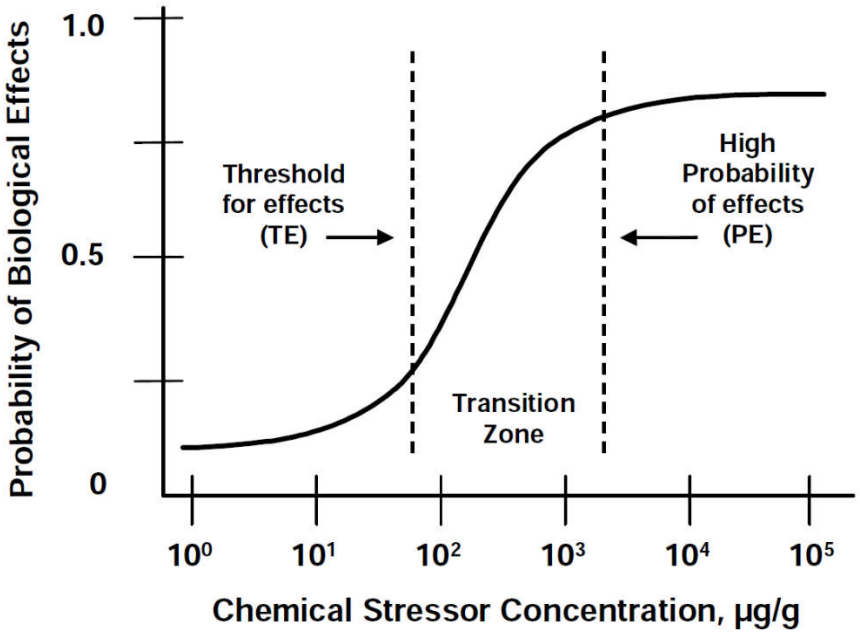
The eighth check in the NSW EPA decision process is that '*any potential ecological risks have been assessed*'.

3.5.1 Sediment Assessment Criteria

The NSW EPA[58] advises that guidance for assessing contamination of sediments is contained in Revision of the ANZECC / ARMCANZ Sediment Quality Guidelines, CSIRO Land and Water Science Report 08/07 (Simpson, Batley & Chariton 2013). Where assessment of sediments has been undertaken, site auditors must check the consultant has applied these guidelines and any updates to these guidelines.

The CSIRO guidelines provide two sets of ecological criteria, comprising sediment quality guideline values (SQGVs) and SQG-high vales. The lower trigger value, SQGV, represents the threshold for effects and the SQG-high values represent the high probability of effects referred to in **Figure 3-8**. A summary of the SQGVs are provided in **Table 3-7**.

Figure 3-8: Generalised Concentration-Response Relationship for Contaminated Sediments



(Source: Figure 2, CSIRO 2013)

It should be noted that the sediment quality guideline values (SQGVs) are presented on a dry weight basis. This does not imply that samples should be dried before analysis resulting in potential losses of some analytes, but that results should be corrected for moisture content. For all the organic contaminants listed and for tributyltin (TBT), values are normalised to 1% organic carbon rather than expressing as mg/kg organic carbon as is sometimes done. If the sediment organic carbon content is markedly higher than 1%, the SQGV should be reduced accordingly, since additional carbon binding sites reduce contaminant bioavailability. The CSIRO recommends that the use of normalisation should, however, be limited to organic carbon concentrations between 0.2 and 10%. At lower organic carbon concentrations, other physical and chemical factors influence the partitioning process for hydrophobic organics, while at higher values the organic carbon is likely to be dominated by oils or tars.

[58] Section 4.2.4, NSW EPA (2017) '*Guidelines for the NSW Site Auditor Scheme (3rd edition)*'

Table 3-7: Sediment Quality Guideline Values (Source: Table 2, CSIRO 2013)

CONTAMINANT	GUIDELINE VALUE	SQG-HIGH
METALS (mg/kg dry weight) [a]		
Antimony	2.0	25
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1.0
Nickel	21	52
Silver	1.0	4.0
Zinc	200	410
METALLOIDS (mg/kg dry weight) [a]		
Arsenic	20	70
ORGANOMETALLICS		
Tributyltin (µg Sn/kg dry weight, 1% TOC) [c, d]	9.0	70
ORGANICS (µg/kg dry weight, 1% TOC) [b, c]		
Total PAHs [e]	10,000	50,000
Total DDT	1.2	5.0
p.p'-DDE	1.4	7.0
o,p'- + p,p'-DDD	3.5	9.0
Chlordane	4.5	9.0
Dieldrin [f]	2.8	7.0
Endrin [f]	2.7	60
Lindane	0.9	1.4
Total PCBs	34	280
Total petroleum hydrocarbons (TPHs) (mg/kg dry weight) [g]	280	550

[a] Primarily adapted from the ERL/ERM values of Long et al. (1995).
[b] Primarily adapted from TEL and PEL values of MacDonald et al. (2000) and CCME (2002)
[c] Normalised to 1% organic carbon within the limits of 0.2 to 10%. Thus if a sediment has (i) 2% OC, the '1% normalised' concentration would be the measured concentration divided by 2, (ii) 0.5% OC, then the 1% normalised value is the measured value divided by 0.5, (iii) 0.15% OC, then the 1% normalised value is the measured value divided by the lower limit of 0.2.
[d] Basis of revision is described in Appendix A2.
[e] The SQGV and SQG-High values for total PAHs (sum of PAHs) are described in Appendix A3 and include the 18 parent PAHs: naphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, phenanthrene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo(a)pyrene, perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(e)pyrene, benzo(ghi)perylene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Where non-ionic organic contaminants like PAHs are the dominant chemicals of potential concern (COPCs), the use of ESB approach is desirable, and is applied as outlined in Appendix A3, that includes a further 16 alkylated PAHs (generally listed as C1-/C2-/C3-/C4-alkylated).
[f] Where dieldrin or endrin are the major COPCs, it is recommended that ESB approaches are applied as described in the Appendix A4.
[g] Origin described in the Appendix A5.

The recommended application of the SQGs involves a tiered, decision-tree approach, in keeping with the risk-based approach introduced in the water quality guidelines. Following this framework, the total concentrations of contaminants are compared to the SQGVs and if the contaminant concentrations exceed one or a number of the SQGVs, further investigations should be initiated to determine whether there is indeed an environmental risk associated with the exceedance. The SQGVs are not to be used on a pass/fail basis. The decision tree adopted by the CSIRO guideline is provided in **Figure 3-9**.

The CSIRO (2013) SQGVs were subsequently adopted by the Australian New Zealand Water Quality Guidelines in 2018 and are available on the internet[59].

The EMM 2015 PSI and the EMM 2016 SPI adopted sediment criteria from the ANZECC and ARMCANZ (2000) guidelines, which have been superseded by the CSIRO (2013) trigger values. The Site Auditor has addressed this deficiency in the ESAs by adopting the SQGVs provided by the CSIRO (2013) guideline.

3.5.2 Dredge Pond Sediment Contamination

Review of Sample Data

The EMM 2015 PSI and the EMM 2016 SPI collected and tested samples of shallow sediment from 16 locations spread around the dredge pond, with these locations shown in **Figure 3-10**. The samples measured:

- Low heavy metals concentrations not exceeding the SQGVs were measured at all sample locations for arsenic, cadmium, chromium and nickel. The measured ranges were:
  - Arsenic <5 – 17 mg/kg (SQGV 20 mg/kg & SQGV-high 70 mg/kg)
  - Cadmium <1 mg/kg (SQGV 1.5 mg/kg & SQGV-high 10 mg/kg)
  - Chromium (total) <2 – 43 mg/kg (SQGV 80 mg/kg & SQGV-high 370 mg/kg)
  - Nickel <2 - 21 mg/kg (SQGV 21 mg/kg & SQGV-high 52 mg/kg)

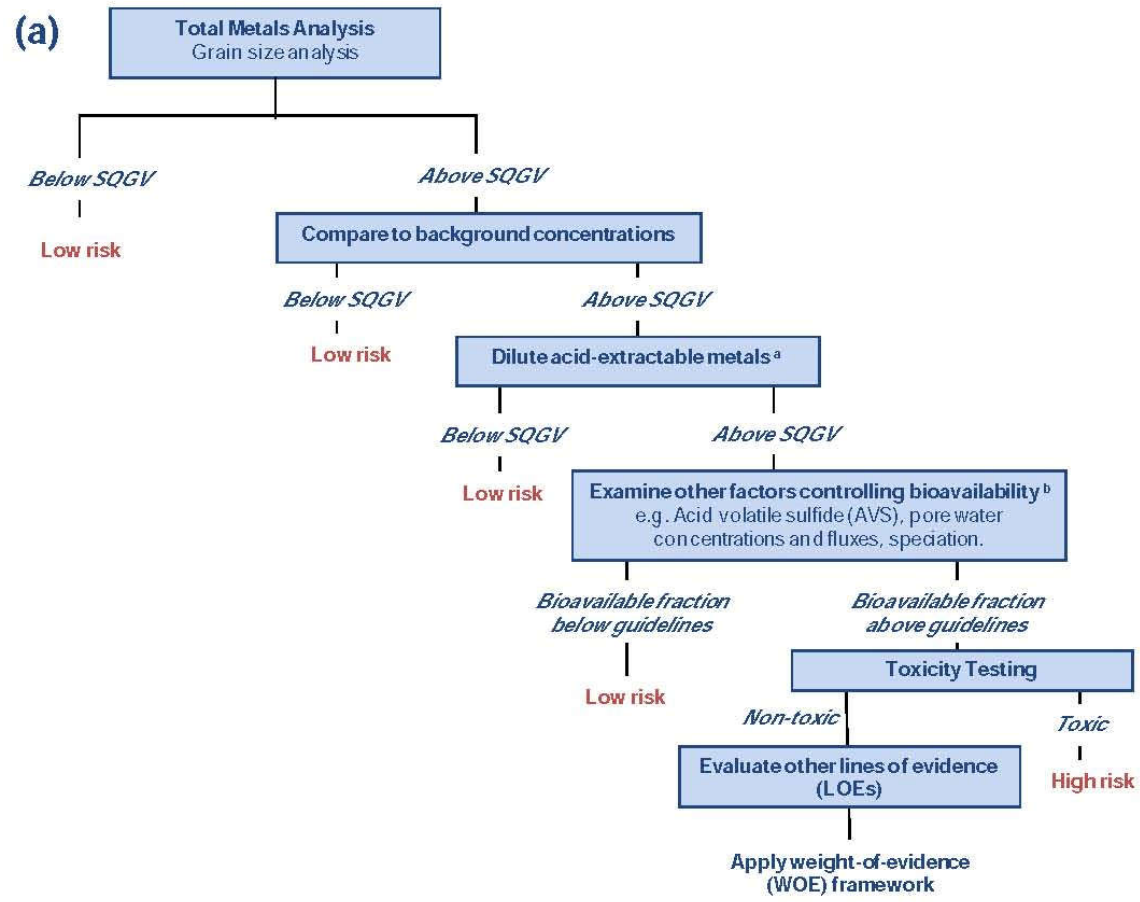
  The measured concentrations for these metals were consistent with or below the adopted background levels (**Section 3.2.2**).
- Elevated heavy metals concentrations that exceeded the SQGV and sometimes the SQGV-high were measured at some sample locations for copper, lead, mercury and zinc. The measured ranges and 95% UCL average concentrations were:
  - Copper <5 – 99 mg/kg, **95% UCL 80 mg/kg** (**SQGV 65 mg/kg** & SQGV-high 270 mg/kg)
  - Lead 11 – 270 mg/kg, **95% UCL 210 mg/kg** (**SQGV 50 mg/kg** & SQGV-high 220 mg/kg)
  - Mercury <0.1 – 0.7mg/kg, **95% UCL 0.5mg/kg** (**SQGV 0.15mg/kg** & SQGV-high 1.0mg/kg)
  - Zinc 16 - 388mg/kg, **95% UCL 300mg/kg** (**SQGV 200mg/kg** & SQGV-high 410mg/kg)

  The 95% UCL concentrations for these metals also exceed the adopted background levels (**Section 3.2.2**), which were: copper 40 mg/kg, lead 102 mg/kg, zinc 245 mg/kg (a mercury background level is unavailable).
- TPH concentrations were measured below the SQGV at most sample locations (10 of 16). No individual sample concentration exceeded the SQGV-high criteria but the 95% UCL average concentration was above the SQGV. The measured range and 95% UCL average concentration were:

  TPHs <43 - 680 mg/kg, **95% UCL 372 mg/kg 1%TOC (SQGV 280 mg/kg** & SQGV-high 550 mg/kg 1% TOC)

[59] http://www.waterquality.gov.au/anz-guidelines/guideline-values/default/sediment-quality-toxicants

Figure 3-9: Decision Tree for Contaminated Sediment Assessment (Source: Figure 1, CSIRO 2013)



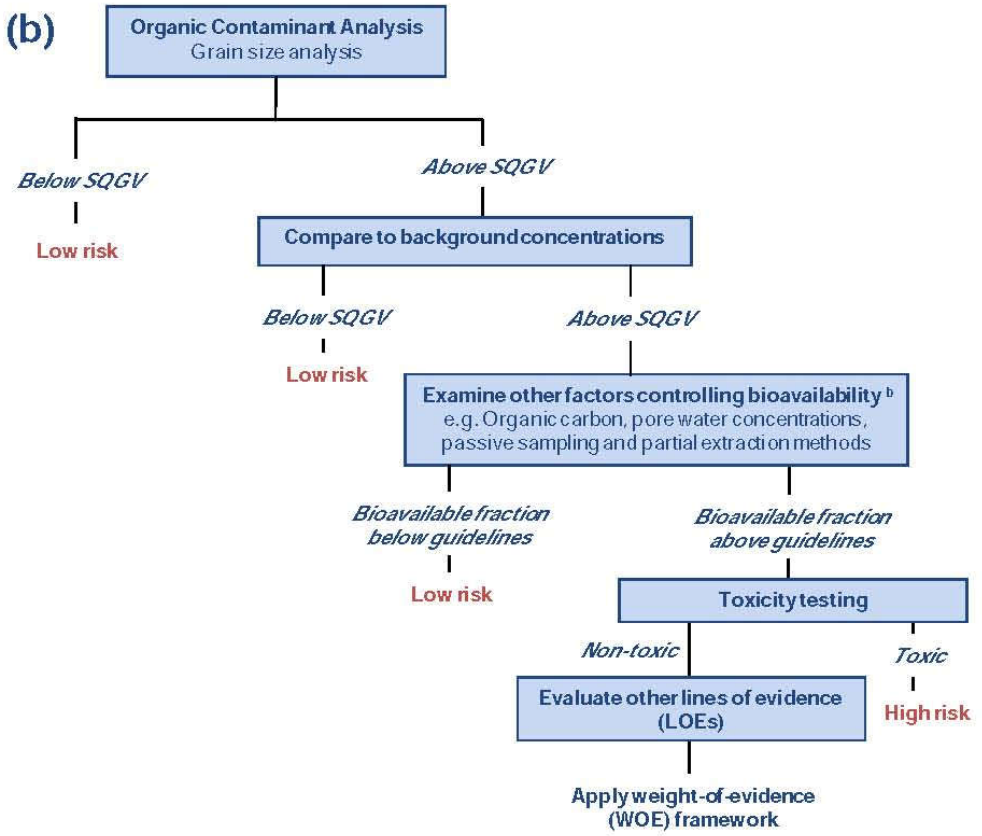
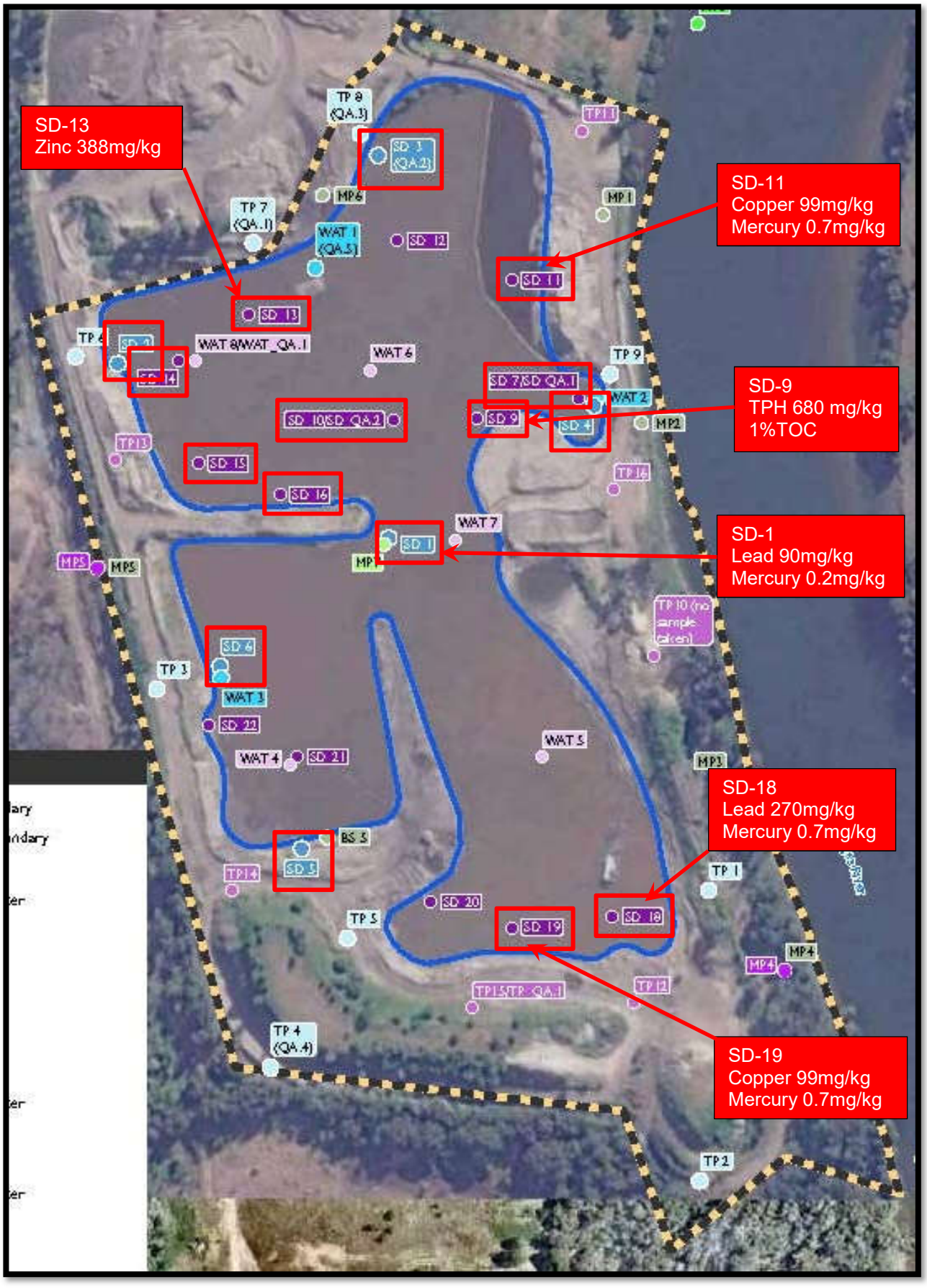


Figure 3-10: Shallow Sediment Sample Locations & Maximum Concentrations Exceeding SQGV



- Low PAH concentrations below the SQGV were measured at all sample locations. The measured range was:

  Total PAHs <0.5 – 8.9 mg/kg 1% TOC (SQGV 10 mg/kg & SQGV-high 50 mg/kg 1% TOC)

- Non-detectible PCB concentrations (<0.1 mg/kg 1% TOC) but the PQL exceeded the SQGV (SQGV 0.034 mg/kg & SQGV-high 0.28 mg/kg 1% TOC)
- Non-detectible OCP concentrations (<0.05 mg/kg TOC) but the PQL exceeded the SQGV (SQGV 0.9-4.5 µg/kg & SQGV-high 1.4 – 60 µg/kg 1% TOC)

The main findings of the EMM 2016 SPI[60] were:

- The dredge pond sediment was contaminated with copper, lead, mercury and zinc concentrations that exceeded the ANZECC & ARMCANZ (2000) ISQG-low criteria and that lead concentrations also exceeded the ISQG-high criteria. As the Marina site is in the upstream section of the Georges River, metal concentrations in the Georges River sediments are expected to be at the higher end of the range adjacent to the dredge pond;
- The dredge pond sediment had elevated TOC and ammonia concentrations;
- PAH concentrations in some of the sediment samples exceeded the ISQG-low and ISQG-high criteria; and
- The sources of elevated contaminant levels in the dredge pond sediments are likely to include runoff from the urban and industrial catchment into the unlined stormwater drain along the western boundary of the Marina site boundary, which previously discharged onto the site and attached itself to the fine grained sediment. As the sand was removed from site via dredging, the contaminants that were bound to the fine-grained sediment would have been concentrated.

Compliance with DQOs

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the characterisation of contamination in the dredge pond sediments does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Field records for the 16 locations where sediment samples were collected and laboratory tested (**Section 2.1.6**);
- A copy of completed COC forms from the EMM 2015 PSI and EMM 2016 SPI (**Section 2.1.7**);
- Lab test certificates for any of the dredge pond sediment samples tested for ammonia and TOC (**Section 2.1.8**);
- Shallow sediment in the dredge pond was investigated at 5 - 16 sampling locations, which was well below the 24 locations assessed by the Site Auditor (**Section 2.2.2**);
- Only three sample locations were situated within the central part of the dredge pond, these being SD10, SD13 and SD14 in the northern part of the dredge pond. No sediment samples were collected in the central part of the southern dredge pond (**Section 2.2.2**);
- No sediment samples from the Georges River were collected adjacent to the Marina site, which would provide information on background sediment quality relevant to the proposed development (**Section 2.2.2**);
- Sediment samples were not tested using a silica-gel cleanup extraction procedure to remove naturally occurring organic material and prevent false positives of middle to heavy-end petroleum fractions being generated in TRH tests (**Section 2.3**);
- It is not known if sediment samples were appropriately managed because no copies of COC forms were provided (**Section 2.3**);

[60] Sections 5.2, 5.5.2 & 6.1, Ref [7]

- It is not known if representative duplicate sediment samples were collected because no descriptions were provided of the sample splitting techniques **(Section 2.3**);
- It is not known if properly trained and qualified field personnel were used by the EMM 2015 PSI (**Section 2.4**); and
- No rinsate, field blanks or trip blanks were tested by the EMM 2015 PSI (**Section 2.4**).

Despite these data gaps, the Site Auditor considers that sufficient data was provided indicating that it is reasonable to characterise the contamination in the shallow sediment in the dredge pond as follows:

- The shallow sediments in the dredge pond are contaminated with copper, lead, zinc and possibly mercury at concentrations that exceed background levels in the Georges River and SQGVs. However, all UCL concentrations were below the SQG-high criteria. The measured 95% UCL average concentrations and adopted background / SQGV levels for these metals are:
  - Copper 95% UCL 80 mg/kg (Adopted background 40 mg/kg, SQGVs 65 - 270 mg/kg)
  - Lead 95% UCL 210 mg/kg (Adopted background 102 mg/kg, SQGVs 50 - 220 mg/kg)
  - Mercury 95% UCL 0.5mg/kg (Adopted background not established, SQGVs 0.15 - 1 mg/kg)
  - Zinc 95% UCL 300mg/kg (Adopted background 245 mg/kg, SQGVs 200 - 410 mg/kg)
- The shallow sediments in the dredge pond are likely to be contaminated by nutrients such as ammonia at concentrations that exceed background levels in the Georges River. This is because ammonia concentrations were measured at 2.4 – 48.6 mg/kg, with higher ammonia concentrations associated with higher organic carbon levels;
- There is a low risk of the shallow sediments in the dredge pond having average concentrations that exceed the SQGV and adopted background levels for other heavy metals (arsenic, cadmium, chromium, nickel), TPH, PAHs; and
- There is a low risk of the shallow sediments in the dredge pond being contaminated with PCBs and OCPs sourced from the Benedict site.

This data comprises:

- The site history data provided in the ESAs was close to meeting the documentation completeness DQO for the Marina and Benedict sites (**Section 2.1.3**);
- The Marina site has been managed by Benedict under EPLs for the past 20 years and no major breaches have been recorded;
- The 16 samples that were collected and tested from the dredge pond provided a statistically significant and consistent picture of contamination in the shallow sediment;
- The coefficient of variation (COV) vales measured for the metals was less than 1.2, which supported their statistical modelling as a normal distribution;
- The available TOC data provided by the 6 samples from EMM 2015 PSI were consistent and gave a range of 0.32 – 1.92% and an average concentration of 1.14%. The adoption of TOC at 1% for the sediment samples tested by the EMM 2016 SPI is considered reasonable;
- The TPH exceedances may be false positives and not representative of actual concentrations. This is because sediment samples were not tested using a silica-gel cleanup extraction procedure to remove naturally occurring organic material and prevent false positives of middle to heavy-end petroleum fractions being generated in TPH tests;
- The CSIRO (2013) SQGV for PAH of 10 mg/kg was much higher than the low-reliability PAH criteria provided in the ANZECC & ARMCANZ (2000) guideline and meant that none of the sediment samples from the dredge pond exceeded the SQGV;
- Contamination that has been found at the Marina site is consistent with construction and demolition waste;

- No evidence of odorous / stained soil was reported, with PID screening tests measuring low concentrations (< 10ppm) consistent with typical background levels;
- Laboratory test data was obtained for 55 fill samples collected in the northern part of the Benedict site that was reviewed as part of SAR 264B[61]. The data show that practically all samples measured contaminant levels below the HILs and EILs applicable for the Marina. Further details are provided in **Section 3.4.3**; and
- No significant PCB or OCP contamination was found by investigations conducted at the north Benedict site and these analytes were not detected in surface water samples collected from the dredge pond in 2017 – 2018 (**Section 3.8.5**).

Ability to Manage Contamination

The EMM 2016 SPI[62] concluded that there is the potential for the contaminants in the dredge pond sediment to impact ecological values in the Georges River when the marina basin is first opened to the river (acute impacts) and/or during of marina operations (chronic impacts).

The Site Auditor considers the weight of evidence supports the EMM conclusions. This is because:

- The shallow sediments in the dredge pond are contaminated with copper, lead, zinc and possibly mercury and nutrients at concentrations that exceed background levels in the Georges River. Consequently, the Georges River sediments can be removed from the CSM as a potential source of contamination to the Marina site;
- The sources of elevated contaminant levels in the dredge pond sediments are likely to include runoff from the urban and industrial catchment into the unlined stormwater drain along the western boundary of the Marina site boundary, which previously discharged onto the site and attached itself to the fine grained sediment. As the sand was removed from site via dredging, the contaminants that were bound to the fine-grained sediment would have been concentrated; and
- The proposed marina development will involve opening the dredge pond to the Georges River.

The Site Auditor considers the data indicate that the quality of the dredge pond sediments are similar to the sediments that were measured by the 2017 University of Wollongong study in Salt Pan Creek, Kogarah Bay and Oatley Bay, as indicated in **Table 2-5**.

The EMM 2016 SPI recommended that:

- Management measures be implemented to minimise the transfer of sediments from the dredge pond to the Georges River; and
- Further investigation of dredge pond sediment management is required.

The Site Auditor considers the weight of evidence supports the conclusion that contamination of the dredge pond sediments at the Marina site is capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- Sufficient data was obtained by the ESAs which meant the contamination status of sediments in the dredge pond is known to a sufficient level to allow the design of a management strategy;
- The management of contaminated sediments as part of waterway developments in Sydney is a common occurrence;
- Opening of the dredge pond to the Georges River can be programmed to occur towards the end of the proposed marina development;
- Silt curtains can be used to prevent suspended sediments from entering the Georges River during the opening of the dredge pond to the Georges River;

[61] Section 3.4.2, Ref [77]
[62] Sections 5.2, 5.5.2 & 6.1, Ref [7]

- The likely extent of contaminated sediments that may need to be remediated will depend on the final design of the proposed development;
- Monitoring of surface water quality in the dredge pond indicate that the water quality in the dredge pond is similar to background levels in the Georges River after dredging activities in the dredge pond ceased. This means that impacts to the Georges River, if any, would be transient and short term; and
- Management measures to minimise the transfer of sediments from the dredge pond to the Georges River can be designed and documented in a RAP, supported by an environmental monitoring program undertaken as part of a validation program.

3.5.3 Compliance with SEAR 912 Requirements

The SEAR 912 conditions for the proposed marina development (Ref [79]) requires the inadequacies of the dredge pond assessment provided by the ESAs to be addressed. The Site Auditor considers that:

- Additional data relevant to the assessment of sediment contamination risks at the Marina site was reviewed for this SAR. This additional data comprised:
  - A detailed review of the history of the Marina and Benedict sites (**Section 2.1.3**);
  - The review of a more recent study conducted by the University of Wollongong in 2017 (Ref [78]) into sediment contamination along the upper Georges River (**Section 3.2.2**);
  - The application of the CSIRO (2013) SQGV for assessing contamination risks in sediments at the Marina site, which superseded the ANZECC & ARMCANZ (2000) criteria used by the ESAs. The use of these criteria complied with current NSW EPA guidance and removed PAHs as a contaminant of concern;
  - The review of the sediment data by the Site Auditor identified that the detection of TPH in sediments at the Marina site are likely to be false positives due to the absence of a silica-gel cleanup procedure in the laboratory tests undertaken by EMM;
  - The review of the sediment data by the Site Auditor concluded that shallow sediments in the dredge pond are contaminated with copper, lead, zinc and possibly mercury and nutrients at concentrations that exceed background levels in the Georges River. The quality of the dredge pond sediments are similar to the sediments in Salt Pan Creek, Kogarah Bay and Oatley Bay;
- Contamination of the dredge ponds sediments at the Marina site is capable of being addressed in a feasible and practical manner by the development work; and
- Management measures to minimise the transfer of sediments from the dredge pond to the Georges River can be designed and documented in a RAP, supported by an environmental monitoring program undertaken as part of a validation program.

The Site Auditor considers that this SAR addresses the requirements of SEAR 912 to the extent necessary to allow a consent for the proposed marina development to be issued in accordance with SEPP 55 and NSW EPA guidance, provided future remediation and validation work is subject to a statutory site audit.

3.6 Landfill Gas

The fifth check in the NSW EPA decision process is that '*hazardous ground gases (where relevant) have been assessed against relevant health-based investigation levels and screening values'.*

The eighth check in the NSW EPA decision process is that '*any potential ecological risks have been assessed'*.

The ninth check in the NSW EPA decision process is that '*any evidence of, or potential for, migration of contaminants from the site has been appropriately addressed, including potential risks to off-site receptors, and reported to the site owner or occupier'*.

3.6.1 LFG Assessment Criteria

LFG contains a range of gaseous compounds. The NSW EPA (2012) hazardous ground gas guideline advises that:

- Methane (CH_4) is a flammable gas that is explosive in the concentration range 5% to 15% v/v in air (somewhat different ranges may apply in atmospheres with enhanced or reduced oxygen concentrations). It is also potentially an asphyxiant if its presence displaces oxygen thereby resulting in an environment with low oxygen concentration. It is less dense than air.
- Carbon dioxide (CO_2) is an asphyxiant and toxic gas that is significantly denser than air.
- Carbon monoxide (CO) is an acutely toxic gas that is also flammable and potentially explosive. It has neutral buoyancy in air.
- Hydrogen is a flammable, potentially explosive gas that is much less dense than air.
- Hydrogen sulphide (H_2S) is a flammable and acutely toxic gas that is denser than air. It is highly odorous, and a nuisance, at low concentrations.
- Trace gases may also be present depending on the nature of the source material, particularly if landfilled wastes are involved, including volatile organic compounds.

LFG threshold levels are provided in the NSW EPA (2016) Solid Waste Landfills guideline, comprising:

- **Landfill gas surface emissions**: The threshold level for further investigation and corrective action is 500 parts per million (volume/volume) of methane at any point on the landfill surface for intermediate and finally-capped areas;
- **Landfill gas sub-surface**: The threshold levels for further investigation and corrective action are detection of methane at concentrations above 1% (volume/volume) and carbon dioxide at concentrations of 1.5% (volume/volume) above established natural background levels;
- **Gas accumulation in enclosed structures**: The threshold level for further investigation and corrective action is detection of methane at concentrations above 1% (volume/volume).

The NSW EPA (2012) guidelines adopted LFG criteria from CIRIA (2007), which had been originally modified from Wilson and Card (2007). The criteria consist of two parts, namely:

- Gas screening value (GSV) = maximum borehole gas flow rate (L/hr) x maximum gas concentration (%); and
- Characteristic gas situation (CGS) is a risk ranking derived from Table 6 in the NSW EPA (2012) guideline.

The GSV and CGS are summarised in the table reproduced from NSW EPA (2012) on the next page.

Table 6: Modified Wilson and Card classification

	Gas screening value threshold (L/hr)	Characteristic gas situation	Risk classification	Additional factors	Typical sources
	<0.07	1	Very low risk	Typically methane <1% v/v and/or carbon dioxide <5% v/v, otherwise consider increase to Situation 2	Natural soils with low organic content Typical fill
	<0.7	2	Low risk	Borehole flow rate not to exceed 70 L/hr, otherwise consider increase to Situation 3	Natural soils with high organic content Fill
	<3.5	3	Moderate risk		Old inert waste landfill Flooded mine workings
	<15	4	Moderate to high risk	Consider need for Level 3 risk assessment	Mine workings susceptible to flooding Closed putrescible waste landfill
	<70	5	High risk	Level 3 risk assessment required	Shallow, un-flooded abandoned mine workings
	>70	6	Very high risk		Recent putrescible waste landfill

Notes:

1. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Section 3.4.
2. Source of gas and generation potential must be identified in the conceptual site model.
3. Soil gas investigation should be in accordance with the guidance provided in Section 3.4.
4. Where there is no detectable flow, the lower measurement limit of the instrument should be used.
5. To determine a GSV of <0.07, instruments capable of making accurate concentration measurement to 0.5% v/v and flow measurement to 0.1 L/hr are recommended.

The DP 2018 PSI adopted LFG criteria recommended by the NSW EPA (2012) guidelines. The Site Auditor considered the adoption of these LFG assessment criteria was appropriate because:

- It was based on the NSW EPA (2012) guidelines; and
- The criteria remained unchanged in the most recent version of British Standard BS 8485:2015 "*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*" (refer Table 2).

3.6.2 LFG Assessment for Marina Site – DP 2018 PSI

The DP 2018 PSI documented the only LFG monitoring conducted at the Marina site. DP reported that the work involved the construction of three gas monitoring wells (MW101 – MW103) along the western site boundary adjacent to where buildings and carparks are proposed to be constructed (**Figure 2-19**). The wells were constructed to depths of 4.0 - 5.5 mbgl using class 18 uPVC machine slotted screen and blank sections. The screened section of each well was backfilled with a washed sand filter pack to approximately 0.5 m above the screened interval. Each well was completed with a hydrated bentonite plug generally 0.4 m thick and concrete at the surface with a 0.5 - 1.0 m stick-up and well cap with gas sampling nipple.

DP reported that monitoring of gas concentrations and flow rates was undertaken using a calibrated GA5000 on 20/03/18 and 9/04/18. Monitoring involved:

- Atmospheric pressure was recorded prior to monitoring;
- The inlet hose of a GAG000 was connected to the well gas cap using a 'quick connect' fitting; and
- Peak and stabilised readings of carbon dioxide, methane, hydrogen sulphide, carbon monoxide and oxygen were recorded upon stabilisation of parameters and at 30 second intervals for a period of five minutes.

A summary of the monitoring results is provided in **Table 3-8**.

Table 3-8: DP 2018 PSI LFG Monitoring Results (Source: Table 9, Ref [12])

MW	Date	Flow Rate Peak (L/h) [1]	Methane Peak %	CO_2 Peak %	GSV= flow x highest Methane or CO_2	CGS [2]
MW101	20/3/2018	<0.1	0.1	11.1	0.011	2
	9/4/2018	-0.1	0.0	10.9	0.011	2
MW102	20/3/2018	<0.1	2.1	4.2	0.004	2
	9/4/2018	<0.1	0.0	4.6	0.005	1
MW103	20/3/2018	<0.1	0.1	4.8	0.005	1
	9/4/2018	0.1	0.0	4.5	0.005	1

Notes to table:

1. The flow rate used to calculate the GSV was the detection limit of the instrument for <0.1 L/h readings and negative readings were assumed as the equivalent positive reading as recommended in NSW EPA (2012)
2. Where methane >1% or CO_2 >5% CGS was increased to Situation 2 as per Table 6 of NSW EPA (2012)

DP[63] advised that:

- The maximum recorded concentration of methane was 2.1% at MW102 on 20/03/18 and the maximum recorded concentration of CO_2 was 11.1% at MW101 on 20/03/18;
- The LFG results indicate generally low concentration and flow readings with a calculated CGS of 1 for all three monitoring wells. However, as per Table 6 is NSW EPA (2012), consideration should be given to raising the CGS to 2 where methane exceeds 1% and/or CO_2 exceeds 5%; and
- The LFG management approach adopted by the NSW EPA (2012) guidelines was based on British Standard BS 8485:2007, which was superseded by the 2015 version. BS 8495:2015 Code of Practice for Design of Protective Measures for Ground Gases resulted in some changes to the required gas protection guidance values and scoring system for protection measures that were provided in Tables 7 and 8 of the NSW EPA (2012) guideline. If continued monitoring indicates that a CGS if 2 is appropriate for the Marina site, then relevant measure(s) or system element(s) required to achieve a score consistent with what is required based on the CGS of 2 which is 3.5 points.

The Site Auditor considers the weight of evidence supports the findings made by DP based on the monitoring undertaken. This is because the documentation indicated that the monitoring and risk assessment were undertaken in accordance with NSW EPA guidance.

DP[64] concluded that whilst the initial screening for LFG indicated a generally low risk, given the results across the rest of the Benedict site, the final gas risk profile would need to be confirmed through additional monitoring events and on completion of the final landform. If ultimately it was deemed that LFG protection systems were required in Area 2, it is anticipated that such measures could be addressed in a RAP. DP understood that buildings being proposed by the marina development involve suspended slabs under which mitigation systems could be readily incorporated into the design, if necessary.

The Site Auditor agrees with the DP recommendation for additional LFG monitoring to be undertaken at the Marina site. This is because of data gaps in meeting the data completeness and representativeness DQOs, as previously described in **Section 2.2.5**. These data gaps comprise:

- No wells were located:
  - At the south-west corner of the Marina site;
  - Along the southern and northern boundaries of the Marina site;
  - At a spacing of 50 m along the western boundary of the Marina site – an additional 4 wells need to be installed; and
  - In the large fill mounds at the southern end of the Marina site.
- Only two monitoring rounds were undertaken over a 3-week period.

Despite these data gaps, the Site Auditor considers the weight of evidence supports the conclusion that LFG risks at the Marina site are capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because of:

- A CGS of 2 is considered to represent a conservative basis on which to design the marina development. Additional LFG monitoring undertaken during the design stage may justify a reduction in the CGS design parameter;
- Sufficient data was obtained by the DP 2018 PSI which meant the risks posed by LFG at the Marina site are known to a sufficient level to allow the design of a management strategy;
- Background methane levels measured at the north-eastern corner of the Marina site indicate that the local estuarine alluvial soils (possibly swamp deposits) are unlikely to be contributing a significant amount of methane to subsurface soils at the Marina site (**Section 3.2.3**);

[63] Section 12.3, Ref [12]
[64] Section 13, Ref [12]

- Much of the western area of the Marina site is presently part of the dredge pond and does not contain fill material (other than deposited sediments). Consequently, there is a low risk that construction of filled areas required by the proposed development will cause the generation of LFG at levels that will need to be managed provided the fill used to construct these areas contains no degradable material. Such earthwork controls can be documented in a RAP;
- Levels northern part of Benedict site, as reviewed in **Section 3.6.3**;
- Levels to south of Marina site, as reviewed in **Section 3.6.4**; and
- The nature and extent of LFG mitigation measures that may be required will depend on the final design of the proposed development.

3.6.3 LFG Risks Posed by Northern Part of Benedict Site

SAR 264B (Ref [77]) reviewed the LFG data provided by investigations conducted for the northern part of the Benedict site between 2014 and 2016. Four monitoring rounds were conducted in the 2015 – 2016 period, with the results documented in the DP 2016 DSI (Ref [9]). Monitoring was undertaken at 14 - 25 gas wells installed across the Site, with plots of the methane contours over the last two monitoring rounds provided in **Figures 3-11** and **3-12**. Summaries of the LFG sampling conducted in these last two rounds are provided in **Tables 3-9** and **3-10**. The wells that were monitoring near the northern boundary or in the north-eastern corner of the Marina site comprised BH223 – BH225, JK114 and JK114b.

An additional seven LFG monitoring rounds have been conducted between 28/06/17 and 14/08/18 and the results documented in a data summary report prepared by DP dated 17/09/18 (Ref [16]). Extracts of the peak methane contour plots for the part of the north Benedict site closest to the Marina site for the three monitoring rounds conducted in 2018 are provided in **Figure 3-13**.

DP[65] reported that the 2017 – 2018 monitoring was undertaken using a geoprobe rig fitted with a temporary driven-probe sampling device and, where possible, readings were taken at various depths to 3 m in areas where fill depths are less than 8 m and various depths to 6 m in areas where the fill depth exceeds 8 m. Obstructions in fill were not found to be overly problematic for the adopted probe system. A GA5000 landfill gas meter was used for the gas monitoring. Gases measured included methane, carbon dioxide, oxygen, hydrogen sulfide and carbon monoxide. Measurements were taken at several depths at each monitoring location as the probe was withdrawn with the single-use sampling port open.

The data indicate that peak methane concentrations near the northern boundary of the Marina site in 2018 generally ranged between 0 and 20%, with a hot-spot at P03E of approximately 50% measured on 23/04/18. The Site Auditor understands that Benedict subsequently excavated this area to remove buried timber, with the data obtained by the next monitoring round conducted on 14/08/18 indicating that the hot-spot had been removed.

DP also calculated the average site-wide methane concentrations for each monitoring round conducted in the northern part of the Benedict site since 2014, with a summary of the data provided in **Table 3-11** and a time-plot provided in **Figure 3-14**.

[65] Section 2.3.2, Ref [16]

Figure 3-11: Peak Methane Concentration Contours 27/10/15 (Source: Drwg 5, Ref [9])

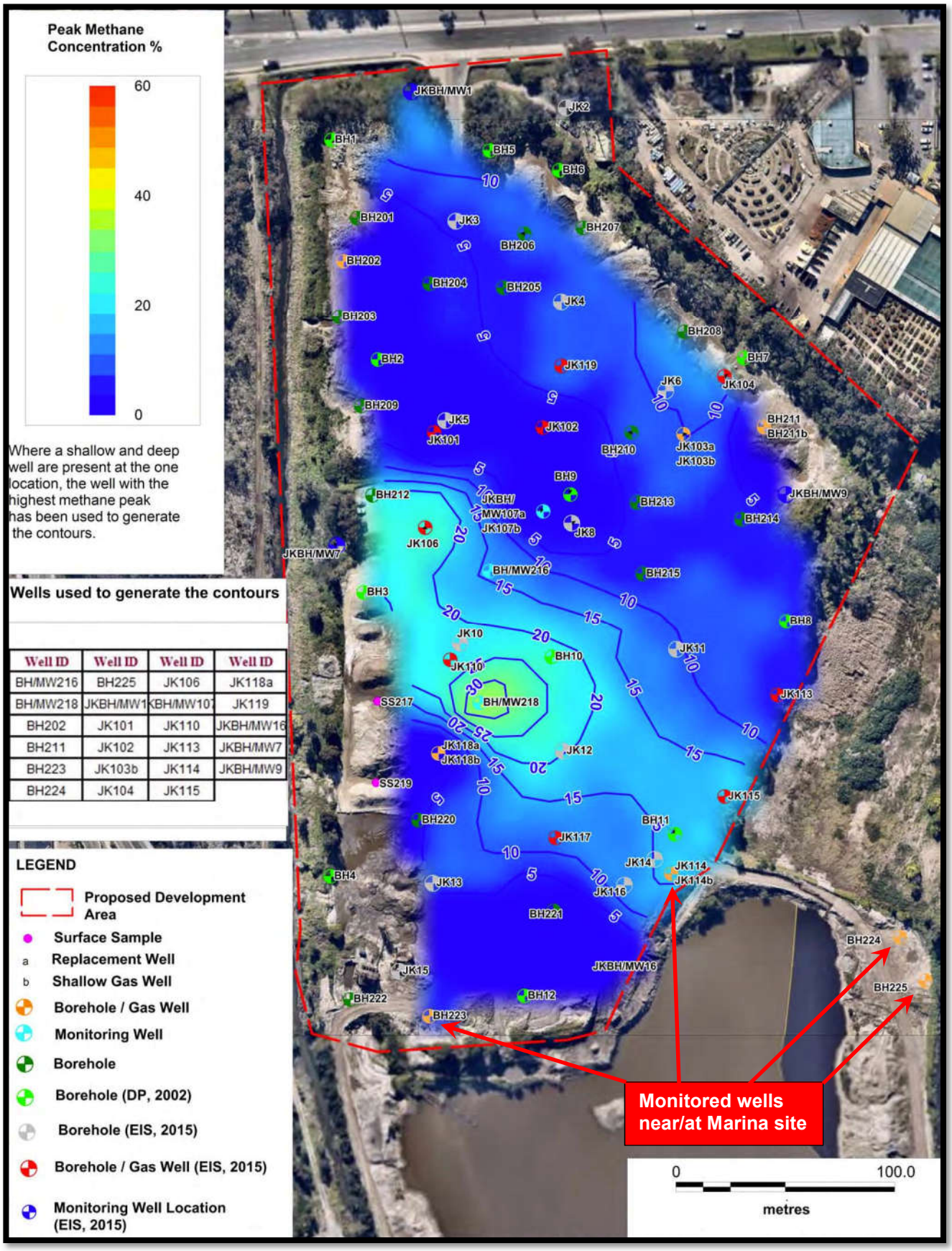


Figure 3-12 Peak Methane Concentration Contours 10/02/16 (Source: Drwg 8, Ref [9])

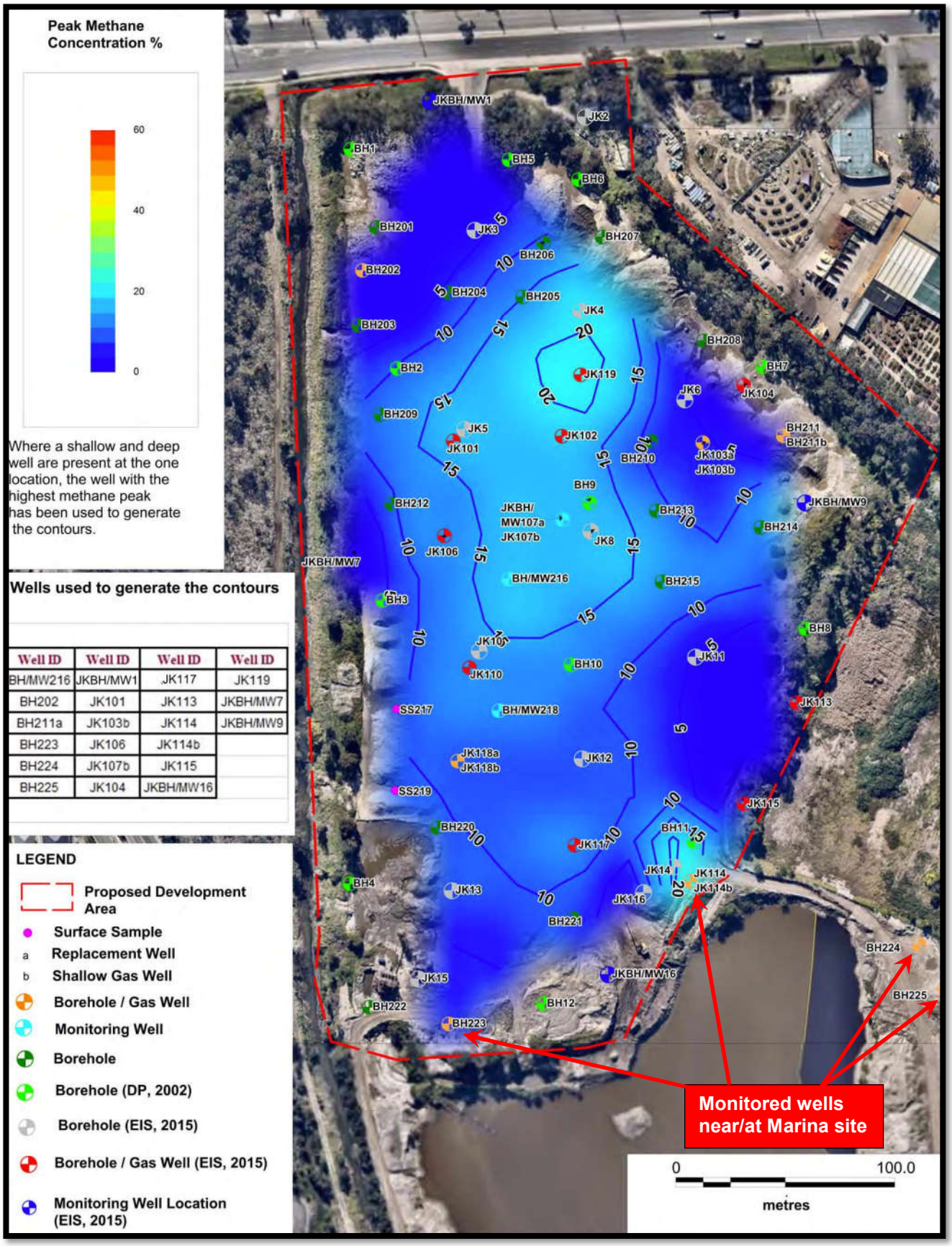


Table 3-9: LFG Sample Results for 27/10/15 (Source: Table 15, Ref [9])

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1, 2]
BH/MW216	0.1	14.7	0.01	6.7	0.01	2
BH/MW218	-0.2	32.5	<0.01	13.8	<0.01	3
BH202	0.4	0.8	<0.01	13.2	0.05	2
BH211	0.4	0	<0.01	1.7	0.01	1
BH211b	0.3	0	<0.01	3.9	0.01	1
BH223	0.6	3.7	0.02	8.2	0.05	2
BH224	0.4	0	<0.01	10.3	0.04	2
BH225	0.2	0	<0.01	9.6	0.02	2
JKBH/MW1	0.2	0	<0.01	2.2	<0.01	1
JKBH/MW7	0.3	8.5	0.03	3.2	0.01	2
JKBH/MW9	0.2	0	<0.01	3.2	0.01	1
JKBH/MW16	0.2	2.8	0.01	8.3	0.02	2
JK101	0.3	14.1	0.04	10.2	0.03	2
JK102	0.2	13.2	0.03	6.6	0.01	2
JK103a	0.4	0	<0.01	1.7	0.01	1
JK103b	0.6	1.1	0.01	0.7	<0.01	2
JK104	0.5	0	<0.01	1.7	0.01	1
JK106	0.4	10	0.04	3.3	0.01	2
JKBH/MW107a	0.1	15	0.02	5.2	0.01	2
JK107b	0.2	14.4	0.03	2.9	0.01	2
JK110	0.1	25	0.03	6.4	0.01	3
JK113	0.2	1	<0.01	4.5	0.01	1
JK114	0.1	21.2	0.02	6.4	0.01	3
JK114b	0.3	19.1	0.06	7.5	0.02	2
JK115	0.3	7.2	0.02	7	0.02	2
JK118a	0.3	15.2	0.05	5.1	0.02	2
JK118b	0.3	14.5	0.04	4.8	0.01	2
JK119	0.6	16.2	0.1	5.8	0.03	2
Max Value	**0.6**	**32.5**	**0.20**	**13.8**	**0.08**	**3**

Notes to table:

1. Where methane >1% or CO_2 >5% CGS has been increased to Situation 2 as per Table 6 of NSW EPA (2012)
2. Where methane >20% CGS has been increased to Situation 3 as per Table 7 of NSW EPA (2012)

Atmospheric pressure start 1022 mb to 1026 mb – pressure increasing

Table 3-10: LFG Sample Results for 10/02/16 (Source: Table 16, Ref [9])

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1, 2]
BH/MW216	0.3	16.1	0.05	5.2	0.02	2
BH202	0.2	1.1	<0.01	3.4	0.01	2
BH211a	0.1	1.1	<0.01	5	0.01	2
BH211b	0.2	0.5	<0.01	1.9	<0.01	1
BH223	0.1	3.7	<0.01	10	0.01	2
BH224	0.3	0.1	<0.01	14.4	0.04	2
BH225	0.3	0.2	<0.01	12.1	0.04	2
JKBH/MW1	0.1	0.2	<0.01	3.4	<0.01	1
JKBH/MW7	0	0.5	<0.01	6.8	<0.01	2
JKBH/MW9	0.2	17.5	0.04	23.8	0.05	2
JKBH/MW16	0.3	0.1	<0.01	9.7	0.03	2
JK101	0.3	15.7	0.05	11.4	0.03	2
JK103	6.8	1.7	0.12	0.6	0.04	2
JK103a	0.3	0.9	<0.01	0.2	<0.01	1
JK103b	0.3	5.1	0.02	2.6	0.01	2
JK106	0	14.2	<0.01	6.7	<0.01	2
JKBH/MW107a	0.3	16.4	0.05	0.9	<0.01	2
JK107b	0.2	17.3	0.03	3.8	0.01	2
JK104	0.2	0.5	<0.01	2.3	<0.01	1
JK113	0.1	0.1	<0.01	1	<0.01	1
JK114	0.2	25.3	0.05	4.7	0.01	3
JK114b	0.3	0.1	<0.01	0	<0.01	1
JK115	0.2	0.1	<0.01	0	<0.01	1
JK117*	0.6	11.7	0.07	6.8	0.04	2
JK119	0.4	21.3	0.09	6.9	0.03	3
Max Value	**6.8**	**25.3**	**1.72**	**23.8**	**1.62**	**3**

Notes to table:

1. Where methane >1% or CO_2 >5% CGS has been increased to Situation 2 as per Table 6 of NSW EPA (2012)
2. Where methane >20% CGS has been increased to Situation 3 as per Table 7 of NSW EPA (2012)

*JK117 was inaccessible for previous monitoring events due to stockpile placement

Atmospheric pressure start 1016 mb end 1011 mb – pressure decreasing

Figure 3-13 Peak Methane Concentration Contours February – August 2018 (Source: Ref [16])

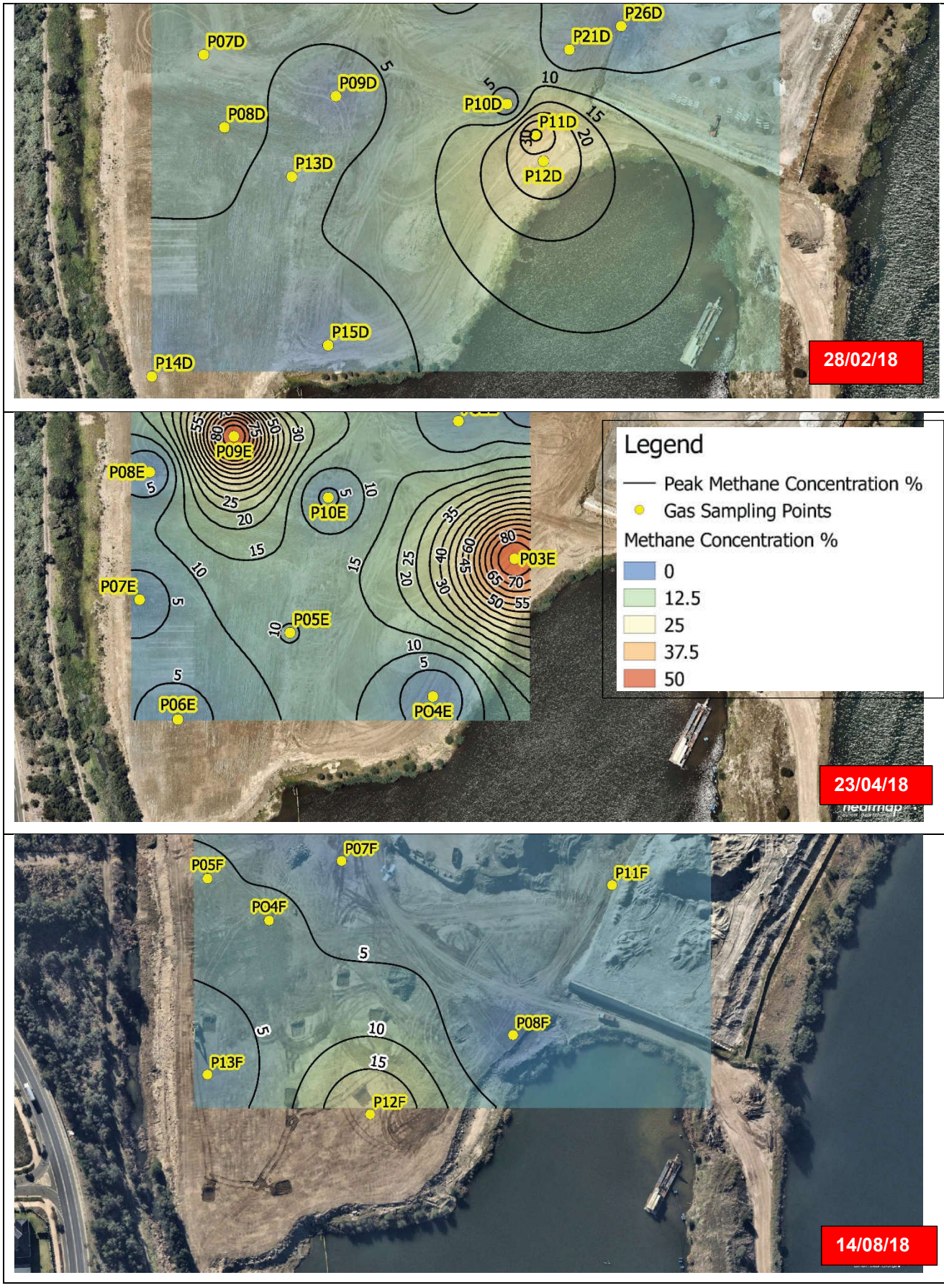
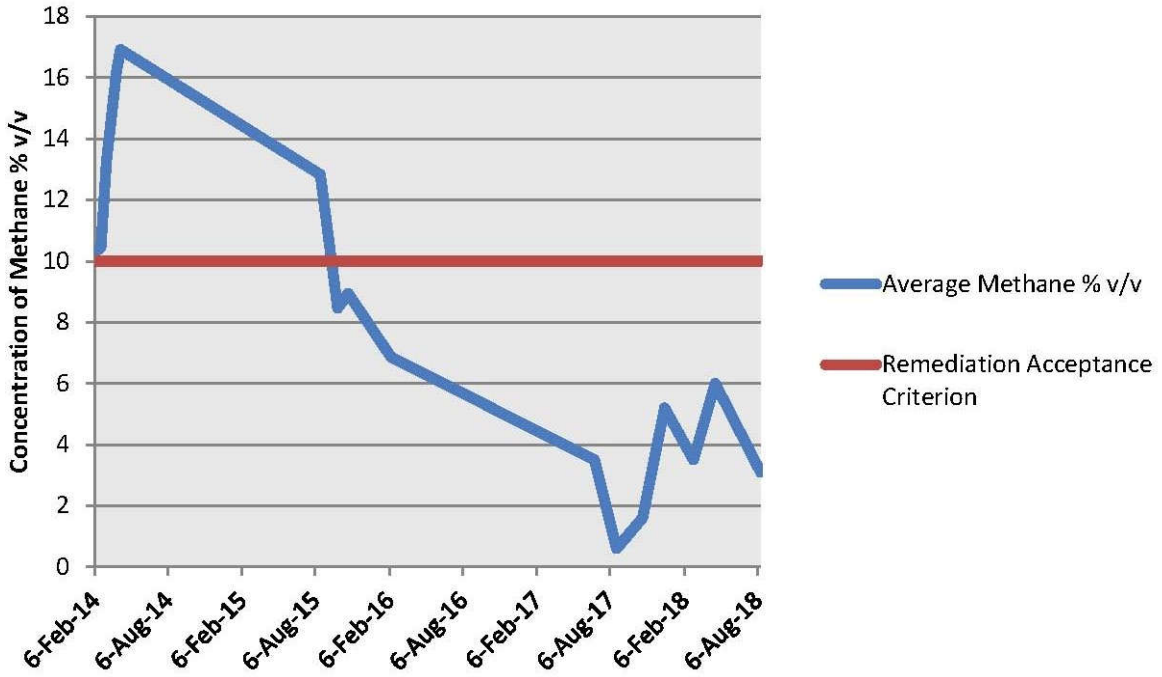


Table 3-11: LFG Sample Results for 10/02/16 (Source: Table 2, Ref [16])

By	Date	mb	Number of Wells	Methane %v/v			CO_2 %v/v		
				Average	Maximum	Minimum	Average	Maximum	Minimum
EIS	06-Feb-14	1017-1018	17	10.28	29.3	0	8.23	29.3	0.3
EIS	21-Feb-14	1016-1019	17	10.46	24	0	8.52	31.3	0.5
EIS	07-Mar-14	1018-1021	17	13.25	35	0	9.19	33.1	0.1
EIS	01-Apr-14	1020	15	16.23	37.2	0.1	10.35	35.2	0.3
EIS	11-Apr-14	1003	17	16.92	65.4	0	7.96	34.5	0
DP	19-Aug-15	1024	14	12.83	24.6	0.5	6.91	15.9	1.7
DP	01-Oct-15	1023-1032	26	8.46	24.2	0	5.53	14.5	0.2
DP	27-Oct-15	1022-1026	28	8.94	32.5	0	5.86	13.8	0.7
DP	10-Feb-16	1016-1011	25	6.86	25.3	0.1	5.74	23.8	0
DP	28-Jun-17	1020-1022	20	3.5	26.5	0	2.7	14.2	0.1
DP	22-Aug-17	1018-1019	17	0.6	10	0	1	6	0.1
DP	25-Oct-17	1000-1013	23	1.6	27.4	0	0.3	10.4	0
DP	19-Dec-17	1010-1014	20	5.2	48.2	0	3.3	15.8	0
DP	28-Feb-18	1013-1008	26	3.5	31.2	0.1	3.9	14.8	0.1
DP	23-Apr-18	1021-1017	20	6	85.7	0	3.9	14.5	0.1
DP	14-Aug-18	1022-1018	15	3.1	20.1	0	3.2	21.3	0.1

Figure 3-14 Site-wide average concentration of methane vs time for Northern Part of Benedict Site



(Source: Figure 1, Ref [16])

DP[66] advised that a significant amount of remedial effort occurred at the north Benedict site between 2015 and 2018 involving the removal of some gas 'hotspots' by the excavation and removal of organic material such as buried timber prior to being backfilled. This resulted in the site-wide average methane concentration falling at a more rapid rate between 2015 and 2017.

From the LFG monitoring data DP concluded that:

- The site-wide methane concentrations have been tapering off since the main remedial efforts occurred in 2015 and 2016. Additional remedial efforts (hotspot removal) also occurred in 2017 and 2018;
- The major 'hotspots' identified during the monitoring have been remediated (i.e. improved) which has influenced the site-wide average methane concentration;
- The site-wide average methane concentrations post-remediation of 'hotspots' remains well below the levels required to meet the adopted CGS of 3 when coupled with the adopted flow rate; and
- The downward trend is noted to have occurred after the initial remediation works of the 'hotspots'.

With regard to the potential for LFG from the north Benedict site to migrate southwards, DP[67] advised that there will be no complete gas migration pathway to the Marina site. This is because the design of the proposed residential development at the north Benedict site involves a LFG venting system along its southern boundary adjacent to the Marina site, as shown in **Figures 3-15** and **3-16**. The system design involves a permeable rock retaining wall along the southern boundary adjoining the proposed marina (existing dredge pond). For the eastern part of the boundary, additional protection will be provided by the interface with the proposed waterway. For the western part of the boundary, additional protection will be provided by constructing marina buildings using suspended slabs that will form void spaces.

The Site Auditor considers the weight of evidence supports the conclusion that contamination risks posed by LFG migrating from the north Benedict site onto the Marina site are capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- A large amount of LFG data has been collected for the north Benedict site between 2014 and 2018;
- Sufficient data has been obtained that shows the site-wide average methane concentration has significantly decreased over the 2014 – 2018 period, with much of the reduction due to the removal of organic material from fill at the north Benedict site;
- LFG mitigation measures at the north Benedict site have been designed using a CGS of 3, which is considered to be a conservative value;
- A CGS of 2 is considered to represent a conservative basis on which to design the marina development. Additional LFG monitoring undertaken during the design stage may justify a reduction in the CGS design parameter;
- The design of the proposed residential development at the north Benedict site involves a LFG venting system along its southern boundary adjacent to the Marina site. The system design involves a permeable rock retaining wall along the southern boundary adjoining the proposed marina (existing dredge pond). For the eastern part of the boundary, additional protection will be provided by the interface with the proposed waterway. For the western part of the boundary, additional protection will be provided by constructing marina buildings using suspended slabs that will form void spaces; and
- Management measures to minimise LFG risks from the north Benedict site can be designed and documented in a RAP, supported by a LFG monitoring program undertaken as part of a validation program.

[66] Section 2.3.2, Ref [16]
[67] Section 2.6, Ref [16]

Figure 3-15 Proposed LFG Mitigation Measures along Northern Boundary of Marina Site – Eastern End (Source: Figure 7, Ref [16])

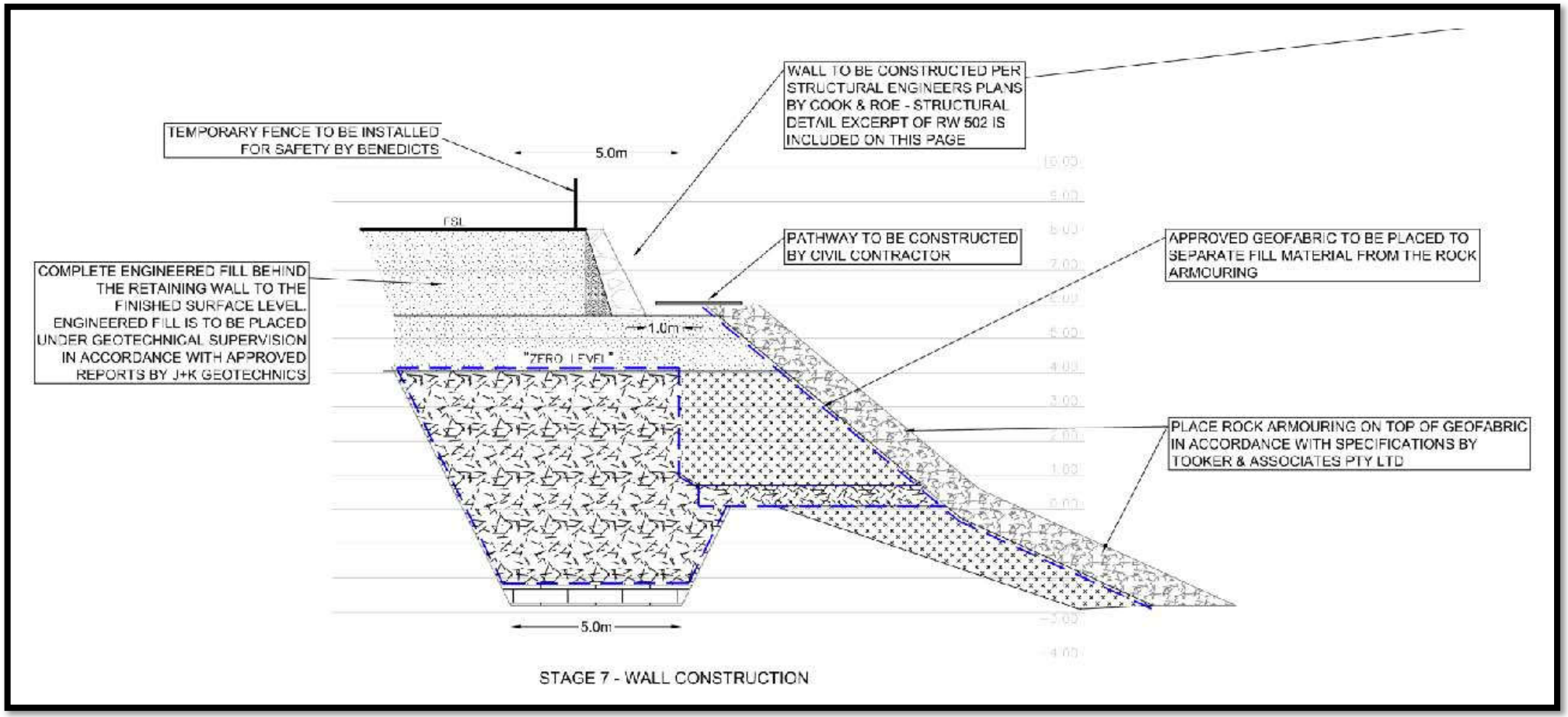
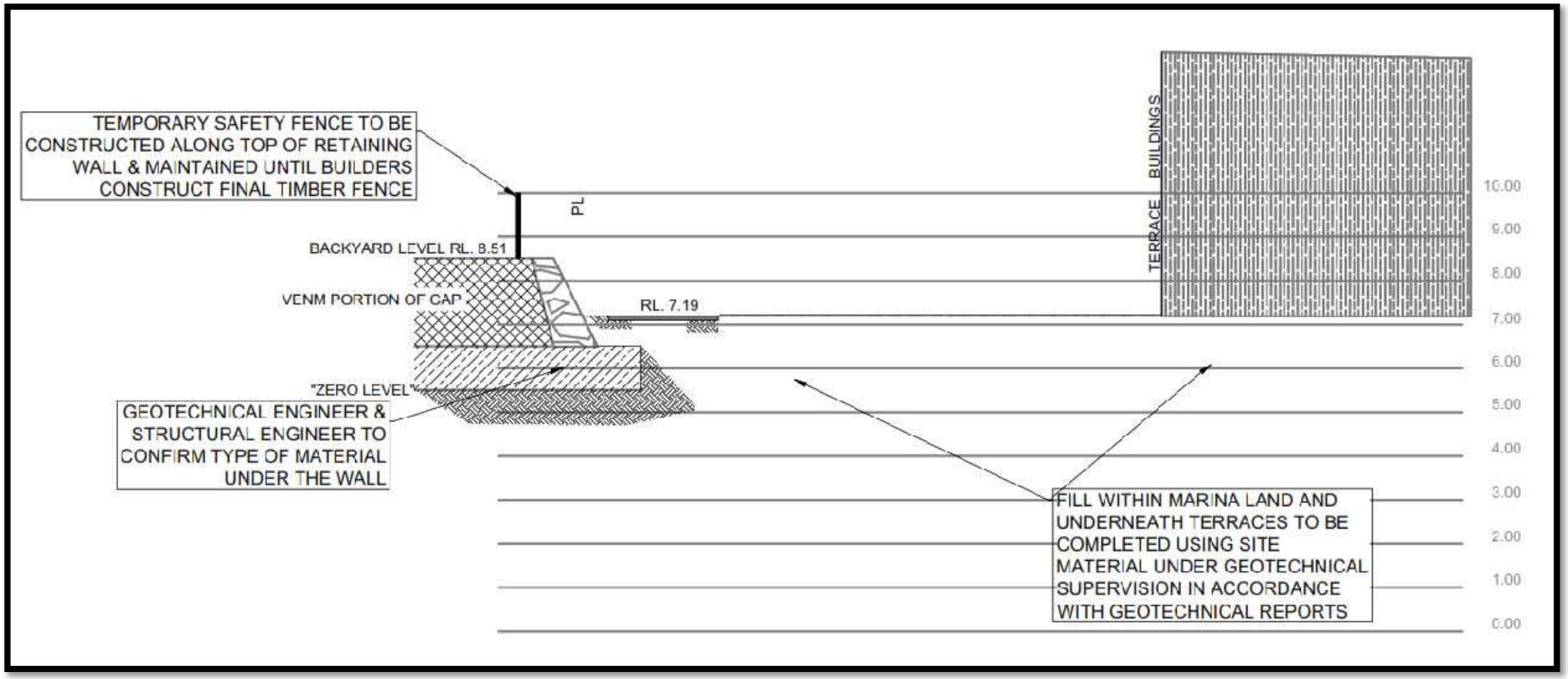


Figure 3-16 Proposed LFG Mitigation Measures along Northern Boundary of Marina Site – Western End (Source: Figure 8, Ref [16])



3.6.4 LFG Risks Posed by Southern Landfill

Risks posed by LFG at the former landfill at Lot 6 to the south of the Marina site were investigated by EIS in 2009 and 2010. The scope of these investigations involved:

- EIS 2009 ESA (Ref [3]): Monitoring of LFG from 3 boreholes (JK1 – JK3) using a LFG analyser, with the measurements taken from the top of the borehole during drilling. The location and methane levels measured are shown in **Figure 3-17**; and
- EIS 2010 GME (Ref [4]): Monitoring of LFG from 6 boreholes (BH212 – BH217) using a LFG analyser, with the measurements taken from the top of the borehole during drilling. The location and methane levels measured are shown in **Figure 3-18**.

The Site Auditor considers the LFG concentrations measured by EIS represent lower bound estimates of the subsurface LFG levels at the former landfill site and that higher concentrations may be present. This is because:

- The measurements were taken at the top of boreholes during borehole drilling. Higher LFG levels would have been measured if monitoring had been conducted in LFG monitoring wells designed and constructed in accordance with NSW EPA guidance;
- Only one round of LFG monitoring was undertaken at each location; and
- Data gaps in the documentation provided in the EIS reports, which meant that the data quality did not meet DQO's consistent with NSW EPA guidance.

The data most relevant to the Marina site is provided by boreholes BH215 – BH217, since they were located in the northern part of the former landfill site nearest the southern boundary of the Marina site. At these boreholes, LFG concentrations were measured at 2 – 4% methane v/v. No conclusions were provided in the EIS reports regarding the potential for LFG to migrate from Lot 6 across the southern boundary of the Marina site.

The Site Auditor considers the weight of evidence supports the conclusion that contamination risks posed by LFG migrating from the former Lot 6 landfill onto the Marina site are probably low and capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP. This is because:

- The southern boundary of the Marina site is formed by an open stormwater drain where water levels are tidal. This drain should form a hydraulic barrier to the migration of LFG onto the Marina site from the former Lot 6 landfill;
- The EIS 2010 GME measured low LFG levels (0 – 4% v/v) in the six wells located in the northern part of the former landfill site;
- A CGS of 2 is considered to represent a conservative basis on which to design the marina development. Additional LFG monitoring undertaken during the design stage may justify a reduction in the CGS design parameter;
- It is possible for a LFG venting system to be constructed along the southern boundary of the Marina site using a design similar to that proposed by the residential development to be constructed for the north Benedict site; and
- Management measures to manage LFG risks from the former Lot 6 landfill can be designed and documented in a RAP, supported by a LFG monitoring program undertaken as part of a validation program.

Figure 3-17 Maximum LFG Levels Measured by EIS 2009 ESA (Source: Figure 2, Ref [3])

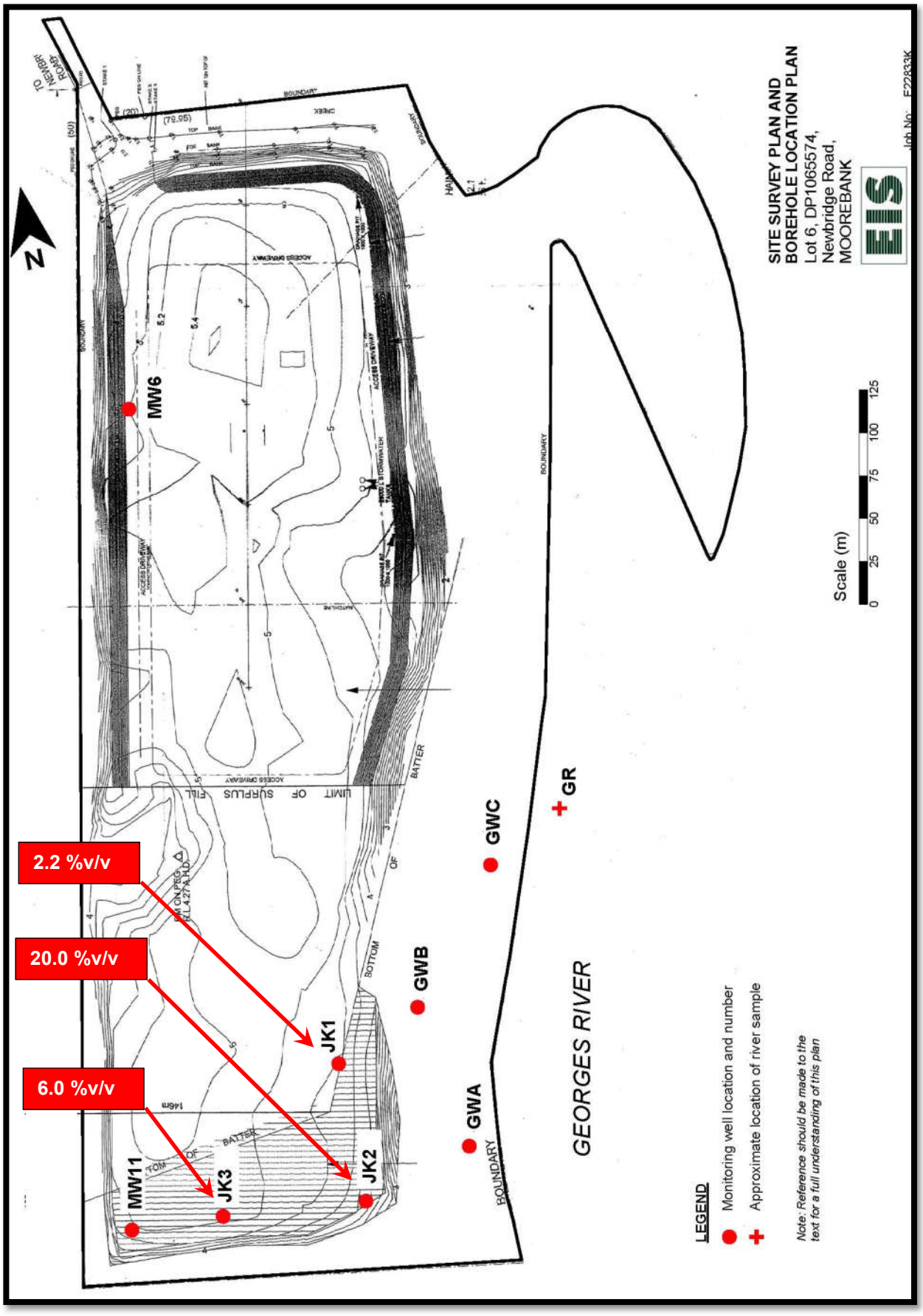
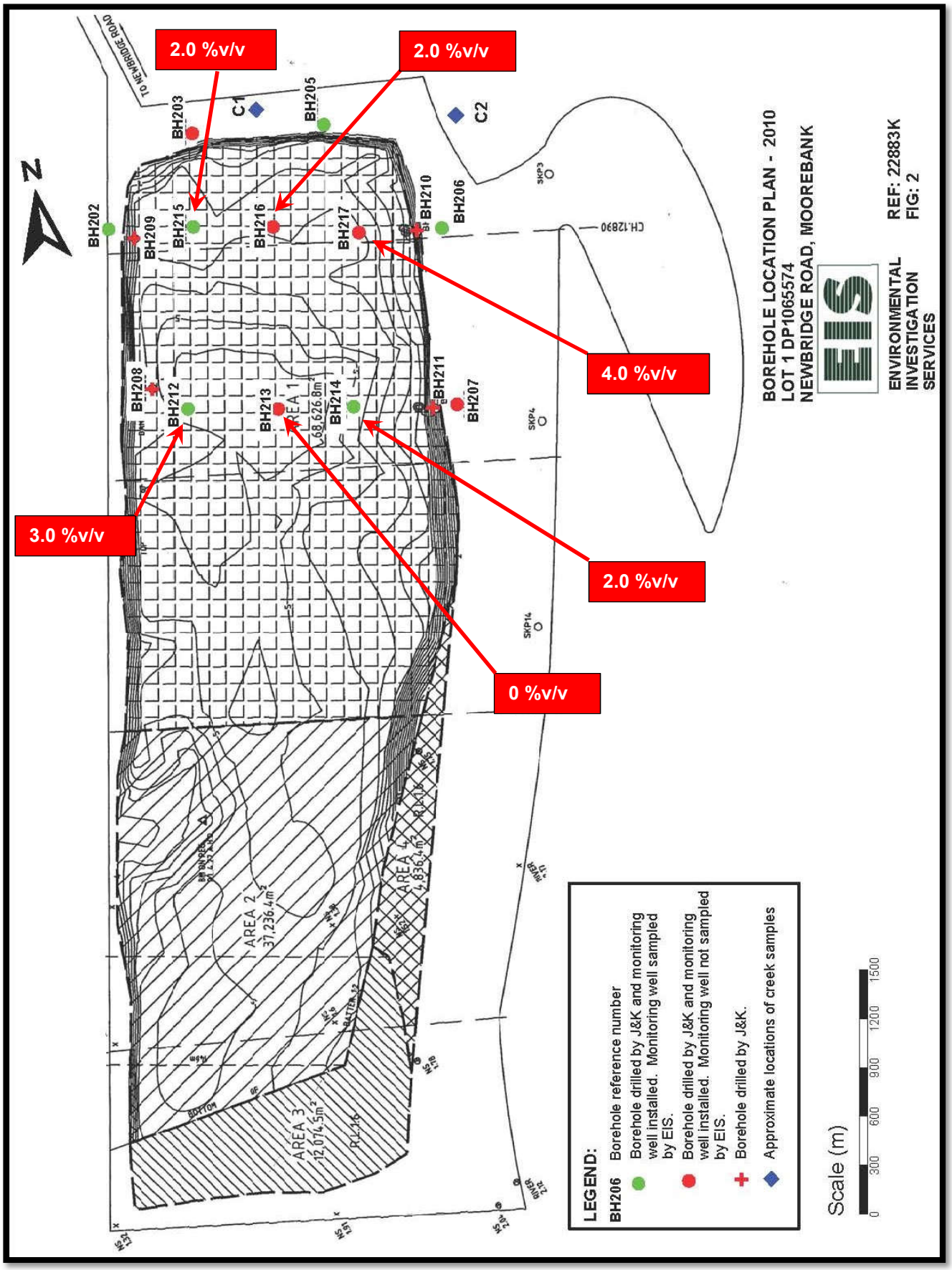


Figure 3-18 Maximum LFG Levels Measured by EIS 2010 GME (Source: Figure 2, Ref [4])



3.6.5 Compliance with SEAR 912 Requirements

The SEAR 912 conditions for the proposed marina development (**Section 1.2**) required a review of a LFG assessment for the Marina site that includes monitoring at the Marina site at locations where structures are proposed and on the northern-western boundary between the marina and the northern section of the site. This is because the three LFG monitoring wells used in the DP 2018 PSI were primarily located near the western boundary of a proposed marina building and that the extent of LFG monitoring may not have been adequately defined.

The Site Auditor considers that:

- Additional data relevant to the assessment of LFG risks at the Marina site was reviewed for this SAR. This additional data comprised:
  - Background methane levels measured at the north-eastern corner of the Marina site indicate that the local estuarine alluvial soils (possibly swamp deposits) are unlikely to be contributing a significant amount of methane to subsurface soils at the Marina site (**Section 3.2.3**);
  - Much of the western area of the Marina site is presently part of the dredge pond and does not contain fill material (other than deposited sediments). Consequently, there is a low risk that construction of filled areas required by the proposed development will cause the generation of LFG at levels that will need to be managed provided the fill used to construct these areas contains no degradable material. Such earthwork controls can be documented in a RAP;
  - The results of a LFG monitoring program conducted at the north Benedict site between 2004 and 2018 (**Section 3.6.3**);
  - Mitigation measures proposed to address LFG risks along the northern boundary of the Marina site (**Section 3.6.3**);
  - The results of a LFG monitoring program conducted at the former southern landfill between 2009 and 2010 (**Section 3.6.4**);
- The design of the proposed residential development at the north Benedict site involves a LFG venting system along its southern boundary adjacent to the Marina site. The system design involves a permeable rock retaining wall along the southern boundary adjoining the proposed marina (existing dredge pond). For the eastern part of the boundary, additional protection will be provided by the interface with the proposed waterway. For the western part of the boundary, additional protection will be provided by constructing marina buildings using suspended slabs that will form void spaces;
- Much of the western area of the Marina site is presently part of the dredge pond and does not contain fill material (other than deposited sediments). Consequently, there is a low risk that construction of filled areas required by the proposed development will cause the generation of LFG at levels that will need to be managed provided the fill used to construct these areas contains no degradable material. Such earthwork controls can be documented in a RAP; and
- Management measures to minimise LFG risks from the north Benedict site and the former Lot 6 southern landfill can be designed and documented in a RAP, supported by a LFG monitoring program undertaken as part of a validation program.

The Site Auditor considers that this SAR addresses the requirements of SEAR 912 to the extent necessary to allow a consent for the proposed marina development to be issued in accordance with SEPP 55 and NSW EPA guidance, provided future remediation and validation work is subject to a statutory site audit.

3.7 Groundwater Contamination

The fourth check in the NSW EPA decision process is that *'groundwater (where relevant) has been assessed against relevant health-based investigation levels and, if required, any potential impacts to buildings and structures from the presence of contaminants considered.'*

The eighth check in the NSW EPA decision process is that '*any potential ecological risks have been assessed'*.

The ninth check in the NSW EPA decision process is that '*any evidence of, or potential for, migration of contaminants from the site has been appropriately addressed, including potential risks to off-site receptors, and reported to the site owner or occupier'.*

3.7.1 Groundwater Assessment Criteria

As previously discussed in **Section 2.1.5**, the potential exposure pathways and receptors of groundwater contamination that need to be considered at the Site are:

- Lateral migration of contaminants in groundwater which provides base flow to water bodies:
  - **The aquatic ecosystem within the proposed marina waterway and Georges River**; and
  - **Recreational users of the Marina site**.
- Vapour intrusion pathway from VOCs:
  - **Future apartment owners in the marina building**
  - Recreational and open space users of the Marina site
  - Construction and maintenance workers involved in the proposed marina development.

Groundwater investigation levels (GILs) needed to be adopted by the ESAs to address these potential exposure pathways and receptors, the most critical one's being:

- Marine and freshwater protection levels for aquatic ecosystems;
- Recreational water criteria; and
- Vapour intrusion from volatile substances in groundwater for Residential B land use.

At the time the ESAs were issued, the NSW EPA had endorsed the use of the water quality trigger levels given in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000). These guidelines provided criteria for aquatic ecosystems (marine and fresh waters), primary industries, recreational water and drinking water. Drinking water criteria were more recently provided in the NHMRC (November 2016) *"Australian Drinking Water Guidelines" (ADWG)*.

These guidelines have since been superseded by the Australian New Zealand Guidelines (ANZG) 2018 water quality criteria that were introduced on 29/08/18 and the NHMRC (August 2018) ADWG. For the purpose of this site audit, the criteria provided in these later guidelines have been adopted by the Site Auditor for assessing risks posed by contaminated groundwater.

The NEPM (2013) guidelines[68] also advised that *"At the point of use or exposure, GILs may be considered as response levels: the response may include further investigation or management as appropriate. Contaminant levels marginally in excess of the GILs do not imply unacceptability or that a significant human health or ecosystem risk is likely to be present. The decision on whether clean-up is required (and, if so, to what extent) should be based on site-specific assessment. Risk assessment is one aspect of making the decision though other considerations such as practicality, timescale, effectiveness, cost, durability, relevant regulatory policy, and community acceptance are also important"*.

[68] Refer Section 3.5 in NEPM (2013) "*Schedule B6 Guideline on The Framework for Risk-Based Assessment of Groundwater Contamination*"

The GILs adopted by the ESAs were specified in the EMM 2016 SPI[69] as:

- The lower of the ANZECC & ARMCANZ (2000) 95% marine and freshwater protection levels; and
- Recreational water criteria based on 10 times the NHMRC (2011) Drinking Water criteria (health and aesthetic).

The Site Auditor considers these GILs do not meet current NSW EPA requirements since they had either been superseded by more recent criteria approved by the NSW EPA or there were data gaps in the criteria adopted. The Site Auditor has addressed these deficiencies by adopting the following GILs:

- The ANZG 2018 water quality criteria for 95% marine protection levels since the water quality in the Georges River adjacent to the Marina site is tidal and marine quality protection levels have been adopted for the north Benedict site;
- NEMP (2018) PFAS water quality criteria for marine and freshwater protection levels;
- NHMRC (August 2018) Drinking Water criteria (health and aesthetic) multiplied by a factor of 10 to derive recreational criteria;
- US EPA (November 2018) RSLs for tapwater for analytes not covered by NHMRC (2018) guidelines;
- NEMP (2018) PFAS drinking water criteria multiplied by a factor of 10 to derive recreational criteria; and
- NEPM (2013) groundwater HSLs for vapour intrusion.

The Site Auditor also adjusted some of the GILs to address background levels measured in the Georges River. These levels correspond to concentrations measured by the DP 2016 DSI in surface water sample SW1 from the Georges River (**Section 3.2.4**). These comprised:

- The marine protection level for copper adjusted to 3 µg/L;
- The marine protection level for phosphorus adjusted to 77 µg/L; and
- The recreational water criteria for sulphate was adjusted to 890 mg/l.

The GILs adopted by the Site Auditor for this SAR are summarised in **Table 3-12**.

[69] Section 2.5.3, Ref [7]

Table 3-12: Adopted GILs

Substances	Aquatic protection[1] (µg/L)	Recreational water[3,4] (µg/L)	Vapour intrusion[5] (µg/L)
Metals			
Aluminium (pH>6.5)	--	(200)	--
Arsenic (III)	13	100	--
Arsenic (V)	24		--
Cadmium	0.7	20	--
Chromium (III)	27.4	500	--
Chromium (VI)	4.4		--
Copper	3 [11]	(1,000)	--
Lead	4.4	100	--
Manganese	80	(100)	--
Mercury (inorganic)	0.1	10	--
Nickel	7	200	--
Zinc	15	(3,000)	--
Other Inorganics			
Ammonia	0.91 mg/L (as N)	0.50 mg/L (as NH_3) or 0.411 (as N) [12]	--
Nitrate	0.70 mg/L (as N)	500 mg/L (as nitrate)	--
Nitrite	--	30 mg/L (as nitrite)	--
Nitrogen (Total oxidised)	300 [10]	--	--
Phosphorus	77 [11]	--	--
pH (pH units)	7.0 – 8.5 [10]	6.5 – 8.5	--
Petroleum Hydrocarbons & MAHs			
C6-C10 less BTEX (F1)	--	--	1,000
>C10-C16 less naphthalene (F2)	--	--	1,000
Benzene	700	10	800 - 900
Toluene	180	(25)	NL
Ethylbenzene	5	(3)	NL
Xylenes (total)	75 – 350	(20)	NL
1,2,4-trimethylbenzene	--	56 [8]	--
1,3,5-trimethylbenzene	--	600 [8]	--
PAHs & Phenol			
Naphthalene	50	1.7 [8]	--
Anthracene	0.1	18,000 [8]	--
Fluoranthene	1.0	8,000 [8]	--
Phenanthrene	0.6	--	--
Benzo(a)pyrene	0.1	0.1	--
Phenol	400	--	--
VHCs			
1,1,1-trichloroethane	270	80,000 [8]	--
1,1,2-trichloroethane	1,900	2.8 [8]	--
1,2-dichloroethane	1900	30	--
1,1-dichloroethene	700	300	--
Carbon tetrachloride	240	30	--
Chloroform (trichloromethane)	370	2.2 [8]	--
Trichloroethene (TCE)	330	4.9 [8]	--
1,1,2,2-tetrachloroethane	400	0.76 [8]	--
Tetrachloroethene (PCE)	70	500	--
Chloroethene	100	3	--

Substances	Aquatic protection[1] (µg/L)	Recreational water[3,4] (µg/L)	Vapour intrusion[5] (µg/L)
(Vinyl chloride)			
Halogenated Benzenes			
1,2,3-trichlorobenzene	3	(5)	--
1,2,4-trichlorobenzene	20		--
1,2-dichlorobenzene	160	(1)	--
1,3-dichlorobenzene	260	(20)	--
1,4-dichlorobenzene	60	(0.3)	--
Chlorobenzene	55	(10)	--
Hexachlorobenzene	0.05	PQL (<0.01) [8]	--
PCBs			
Arochlor 1242	0.3	PQL (<0.01) [8]	--
Arochlor 1254	0.01	PQL (<0.01) [8]	--
OCPs			
Aldrin	PQL (<0.01)	3	--
Dieldrin	0.01		--
Chlordane	--	20	--
DDE	PQL (<0.01)	--	--
DDT	PQL (<0.01)	90	--
Endosulfan	0.01	200	--
Endrin	PQL (<0.01)	23	--
Lindane	PQL (<0.01)	100	--
Heptachlor	PQL (<0.01)	3	--
OPPs			
Azinophos methyl	0.01	300	--
Chlorpyrifos	PQL (<0.01)	100	--
Demeton-S	4	4.2 [8]	--
Diazinon	0.01	40	--
Malathion	0.05	700	--
Parathion	PQL (<0.01)	200	--
PFAS [9]			
PFOS	0.13	--	--
PFOA	220	5.6	--
PFOS+PFHxS	--	0.7	--

Notes

(1) Marine water protection levels from ANZG (2018) guidelines where available
(2) Not used
(3) NHMRC (August 2018) drinking water criteria used where available
(4) 10 x Drinking Water health criteria or equal to Drinking Water aesthetic criteria
(5) NEPM (2013) vapour levels
(6) Not used
(7) Not used
(8) 10 x US EPA (November 2018) RSLs – tapwater
(9) NEMP (2018) criteria
(10) Estuarine GIL based on ANZECC (2000) SE Australia estuary value (Table 3.3.2)
(11) GIL adjusted to account for background levels measured in the Georges River
(12) NH3 = NH3-N x 1.21589
( ) Aesthetic drinking water and recreational criteria

3.7.2 Hydrogeological Assessment

The EMM 2015 PSI[70] described the hydrogeological conditions that exist at the Marina site based on the results of a Dames & Moore 1994 report. EMM advised that:

- The unconsolidated deposits beneath the Marina site form a single, unconfined aquifer;
- Groundwater levels are shallow, typically 2 - 3 mbgl and are in hydraulic connection with river tidal levels;
- The measured permeability in monitoring wells adjacent to Georges River ranged from 12 to 47 m/day averaging 30 m/day, while a permeability of less than 1 m/day was measured in the finer sediments on the western side of the Marina site;
- Horizontal flow is expected to dominate due to the relatively impermeable underlying Wianamatta Group Shales;
- There is an overall flow of groundwater in a south-easterly direction towards the Georges River. Groundwater flows through land adjacent to the river are likely to be influenced by the intrusion of brackish/saline river water at depth, with fresh water flows towards the river concentrated in the shallow zone at approximately 5 - 6 m depth; and
- Groundwater at depth adjacent to the Georges River can be influenced by relatively higher salinity water from the adjacent creek.

However, neither the EMM 2015 PSI or other ESAs provided data and a hydrogeological assessment that could be independently reviewed by the Site Auditor. The Site Auditor addressed this data gap by reviewing hydrogeological assessments that had been made by other studies for the land to the north and south of the Marina site, namely:

- The north Benedict site located to the north of the Marina site: EIS 2013 PSI[71], DP 2016 DSI[72] and the DP 2018 data review[73]; and
- The former Lot 6 landfill located to the south of the Marina site: EIS 2010 GME[74].

North Benedict Site

The assessments were based on groundwater levels and field parameters measured in monitoring wells on 25/10/13, 17/09/15 and 1/10/15. Plots of the 2015 levels are provided in **Figures 3-19** and **3-20**, with a summary of the field parameters measured by the DP 2016 DSI provided in **Table 3-13**. No LNAPL was observed during sampling.

The ESAs concluded that:

- On 17/09/15, the depth to groundwater ranged from 1.76 m bgl to 6.45 m bgl, while the groundwater elevations ranged from RL-0.48m AHD to RL+3.08m AHD;
- Groundwater generally flows towards the Georges River to the east and south-east of the north Benedict site. Localised flows were anticipated to also occur towards the dredge ponds at the Marina site;
- The gauging undertaken on 17/09/15 showed that groundwater was mounded within the north Benedict site and flowing radially towards adjacent water bodies and low points; and

[70] Section 4.5, Ref [6]
[71] Section 9.4, Ref [5]
[72] Section 13.4, Ref [9]
[73] Ref [10]
[74] Ref [4]

Figure 3-19: Groundwater Contours for North Benedict site 17/09/15 (Source: Drwg 7, Ref [10])

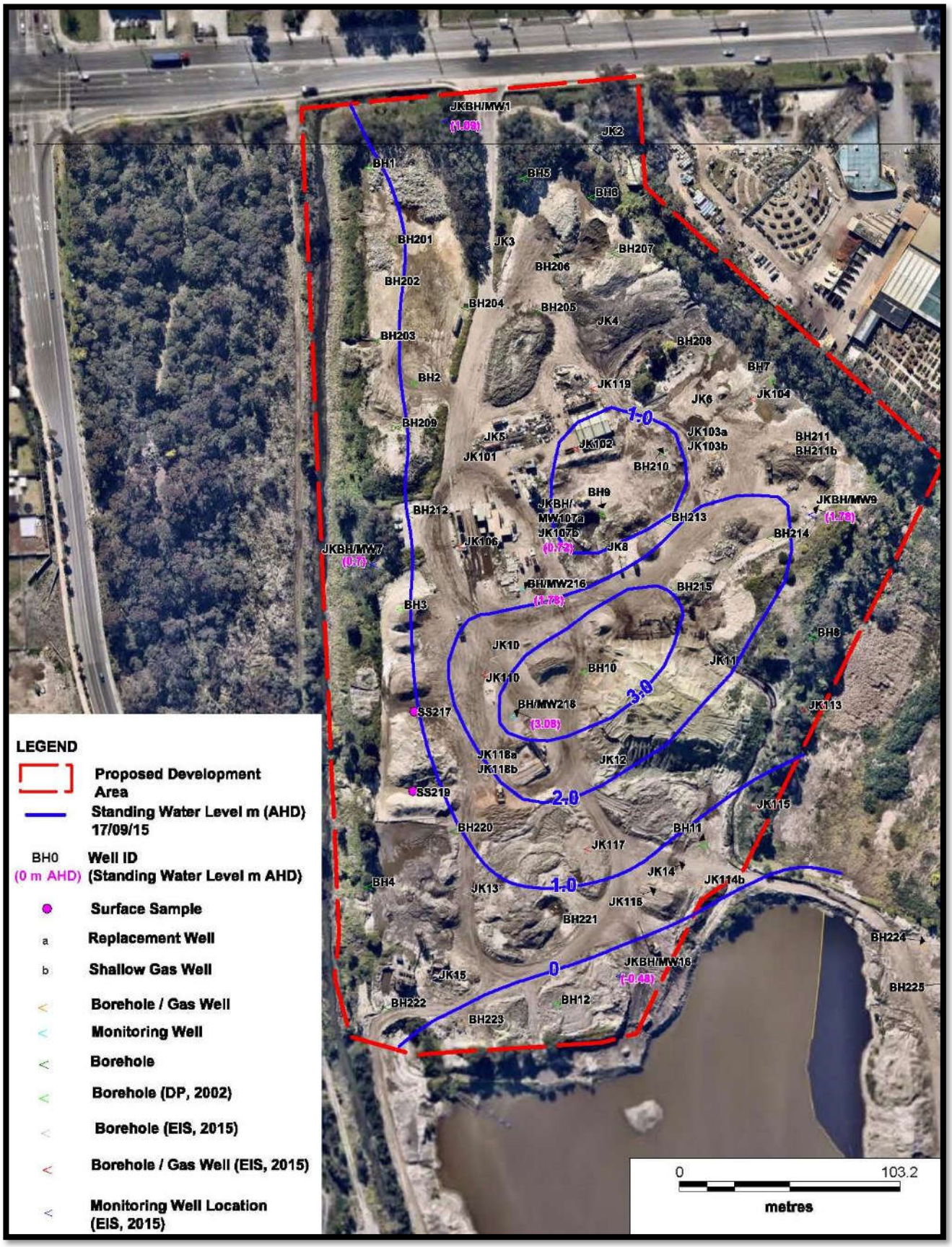


Figure 3-20: Groundwater Contours for North Benedict site 1/10/15 (Source: Drwg 8, Ref [10])

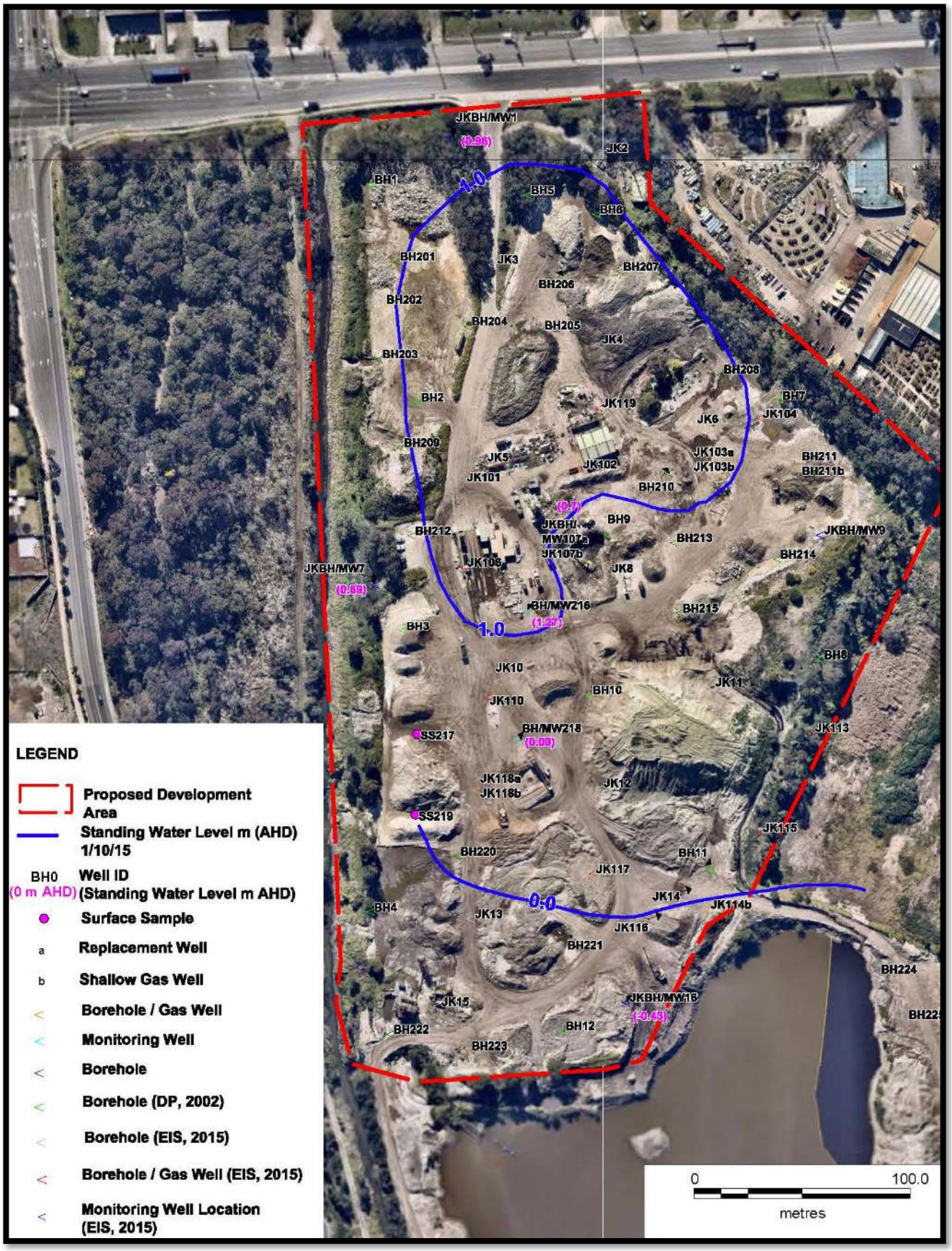


Table 3-13: Groundwater and Surface Water Field Parameters (Source: Table 19, Ref [10])

Well / Sample ID	Temp. (°C)	DO (mg/L)	TDS (ppm)	EC* (µS/cm)	pH	Redox (mV)
Groundwater Samples						
BH/MW216	20.0	2.16	7200	11 250	6.84	-83
BH/MW218	-	-	-	-	-	-
JKBH/107a	24.3	3.33	2140	3344	6.98	-56
JKBH/MW1	17.5	3.45	3080	4813	6.95	-34
JKBH/MW7#	-	-	-	-	-	-
JKBH/MW9#	-	-	-	-	-	-
JKBH/MW16	25.0	2.09	5940	9281	5.43	-37
Surface Water Samples						
SW1	21.1	7.15	11640	18 188	7.55	40
SW2	25.4	0.43	6320	9875	7.20	-68
SW3	19.5	2.31	3290	5141	7.10	-15

Notes to table:
*Calculated from TDS result
well was bent and could not fit bailer or pump in

- Washing and soil processing facilities undertaken in the central part of the north Benedict site resulted in high levels of surface water infiltration, which caused groundwater mounding. Once the washing and processing operations had ceased, surface water infiltration reduced significantly and the groundwater surface receded to its normal level, which is most probably controlled by water levels in the southern dredge pond and the Georges River[75]. The Site Auditor considers the available data supported these conclusions.

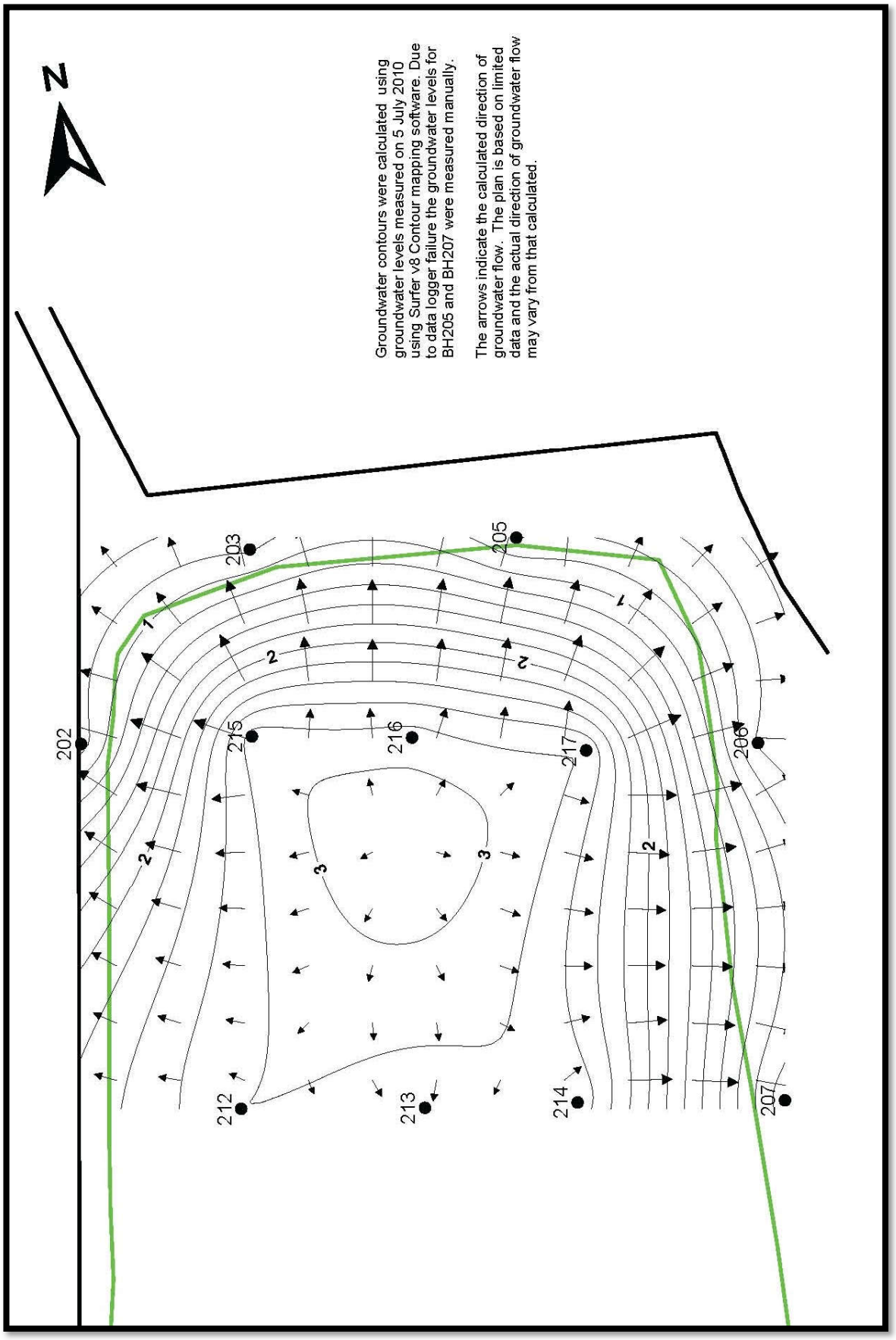
Southern Lot 6 Former Landfill

The hydrogeological conditions in the northern part of Lot 6 nearest the Marina site were assessed by the EIS 2010 GME using 11 groundwater monitoring wells (BH202, BH203, BH205 – BH207, BH212 – BH217). The elevations of these well collars were measured followed by water levels 12/01/10. A plot of the groundwater equipotential contours is provided in **Figure 3-21**.

EIS[76] concluded that the data indicated that there was mounding of groundwater inside the former landfill and that groundwater appeared to be flowing out of the landfill to the north towards the Marina site, east towards the Georges River and to the west. The Site Auditor considered the data supported this conclusion.

[75] J&K Geotechnics (12 May 2017) Letter "*Groundwater Regime, 146 Newbridge Road, Moorebank*". 1 page
[76] Section 10.1, Ref [4]

Figure 3-21: Groundwater Contours for Southern Landfill Site (Northern Part) 12/01/10



(Source: Figure 3, Ref [4])

Site Auditor Review

Data on hydrogeological conditions at the Marina site is available from the subsurface data provided by the ESAs for the Marina site together with hydrogeological assessments provided for the north Benedict site and the southern Lot 6 former landfill. The Site Auditor considers this data supports the description of the hydrogeological conditions provided in the EMM 2015 PSI together with the following additional conclusions:

- Groundwater from the north Benedict site and from the southern Lot 6 former landfill would flow into the Marina site; and
- There is a risk that contaminated groundwater present in the north Benedict site and/or the southern Lot 6 former landfill could impact the quality of water in the dredge pond. This risk needs to be assessed.

3.7.3 Groundwater Contamination – Marina Site

The EMM 2015 PSI[77] provided a description of groundwater quality assessments provided by Dames & Moore (1994) and Marine Pollution Research (2010). However, the Site Auditor was unable to audit this information since no data was provided. Consequently, the information on groundwater quality provided in the EMM 2015 PSI has not been relied upon by the site audit.

Groundwater quality data for the Marina site was provided in the EMM 2016 SPI report. The investigation involved the collection of one round of groundwater samples from Dames & Moore wells MP-3 to MP-5 on 17/11/15, which were tested for field parameters, heavy metals, nutrients, TRH, BTEX and PAHs.

Review of Sample Data

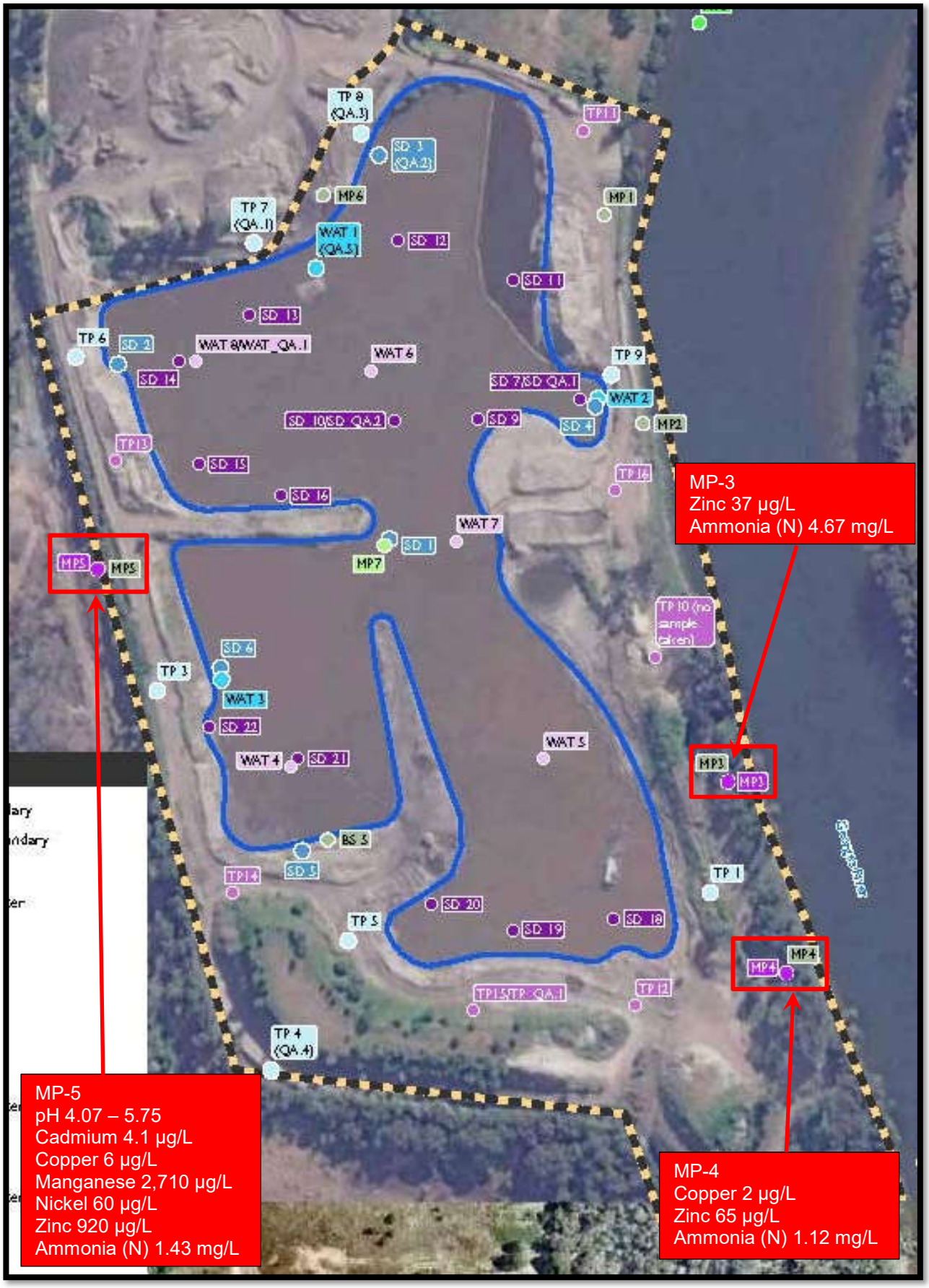
In terms of the protection of the marine aquatic environment, the samples collected from wells MP-3 to MP-5 measured:

- Acidic pH levels were outside the marine GIL range (7 - 8.5) at well MP-5 at 4.07 – 5.75
- Low heavy metals concentrations below marine GILs at all well locations for arsenic, chromium, lead and mercury. The measured ranges were:
  - Arsenic <1 – 10 µg/L (Marine GIL 13 – 24 µg/L)
  - Chromium (total) <1 µg/L (Marine GIL 4.4 – 27.4 µg/L)
  - Lead <1 - 2 µg/L (Marine GIL 4.4 µg/L)
  - Mercury <0.1 µg/L (Marine GIL 0.1 µg/L)
- Elevated heavy metals concentrations that exceeded marine GILs at some well locations for cadmium, copper, manganese, nickel and zinc. The exceedances were:
  - Cadmium 4.1 µg/L at MP-5 (Marine GIL 0.7 µg/L)
  - Copper 2 & 6 µg/L at MP-4 & MP-5, respectively (Background GIL 3 µg/L)
  - Manganese 2,710 µg/L at MP-5 (Marine GIL 80 µg/L)
  - Nickel 60 µg/L at MP-5 (Marine GIL 7 µg/L)
  - Zinc 37, 65 & 920 µg/L at MP-3, MP-4 & MP-5, respectively (Marine GIL 15 µg/L)
- Elevated ammonia (as N) levels that exceeded the marine GIL of 0.91 mg/L at all wells. The results were 4.67 mg/L at well MP-3, 1.12 mg/L at well MP-4 and 1.43 mg/L at well MP-5.
- Non-detectible concentrations at all wells for TRH, BTEX and PAHs.

The exceedances of the marine GILs are summarised in **Figure 3-22**.

[77] Section 8.1.5, Ref [6]

Figure 3-22: Exceedances of Marine GILs for Wells Sampled on 17/11/15



For the protection of recreational receptors, the samples collected from wells MP-3 to MP-5 measured most contaminants of concern at concentrations below the recreational GILs. The few exceptions were:

- Acidic pH levels outside the recreational GIL range (6.5 - 8.5) at well MP-5 at 4.07 – 5.75; and
- Elevated ammonia (as N) levels that exceeded the recreational GIL of 0.41 mg/L were measured at all wells. The results were 4.67 mg/L at well MP-3, 1.12 mg/L at well MP-4 and 1.43 mg/L at well MP-5.

For the protection of Residential B apartment users from vapour intrusion, the samples collected from wells MP-3 to MP-5 measured all volatile contaminants of concern at concentrations below the vapour intrusion GILs.

The ESAs provided no conclusions regarding groundwater contamination at the Marina site. The Site Auditor has addressed this data gap by reviewing the available data.

Compliance with DQOs

From the data quality assessment provided in **Section 2**, the Site Auditor considers the data provided by the ESAs regarding the assessment of groundwater contamination at the Marina site does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Historic groundwater monitoring data that needed to be collected as a condition of POEO Licence 4612 (**Section 2.1.3**);
- Stratigraphic cross-sections showing the variation in subsurface conditions across the Marina site (**Sections 2.1.4** & **2.1.8**);
- Details on the water quality meter used and calibration records for the tests conducted on groundwater (**Section 2.1.6**);
- A copy of completed COC forms from the EMM 2016 SPI (**Section 2.1.7**);
- No wells were located in the north-west and south-west corner of the site and no wells were located along the northern and southern property boundaries adjacent to former off-site landfills (**Section 2.2.3**);
- The dredge pond monitoring data (Ref [17]) indicate that dredging did not cease until October 2016, some 11 months after groundwater samples were collected from the wells. This meant there is a risk that the groundwater quality data measured by the wells was impacted by poor water quality conditions in the dredge pond (**Section 2.2.3**);
- No groundwater samples were tested for OCPs, other VOCs, phenols or PFAS, which are contaminants of potential concern due to the proximity of the Marina site to off-site former landfills (**Section 2.2.3**);
- No description was provided on the use of filters for groundwater samples tested for dissolved heavy metals (**Section 2.3**);
- No data was provided showing that groundwater field parameters had stabilised prior to sampling (**Section 2.3**);
- It is not known if samples were appropriately managed because no copies of COC forms were provided (**Section 2.3**); and
- It is not known if representative duplicate samples were collected because no descriptions were provided of the sample splitting techniques used (**Section 2.3**).

Site Auditor Review

Despite the data gaps in the ESAs, the Site Auditor considers that sufficient data was provided that support the following conclusions relevant to the risks posed by groundwater at the Marina site:

- The highest contaminant concentrations were measured by well MP-5 on the western boundary of the Marina site. The most likely source of this contamination was poor surface water quality that existed in the dredge pond at the time the samples were collected on 17/11/15 when dredging operations were still occurring. Dredging of sands would have caused the water in the dredge pond to have a high suspended solids content and be highly aerated, which probably lead to the mobilisation of naturally

occurred substances (heavy metals, ammonia) into the dredge pond that impacted groundwater quality around the Marina site;

- The available data indicate that dredging operations ceased in October 2016, some 11 months after the groundwater samples were collected (**Section 2.2.3**). It is likely that a significant improvement in groundwater quality at well MP5 has since occurred;
- Groundwater at the eastern wells MP-3 and MP-4 met most marine GILs when sampled on 17/11/15, with only relatively minor exceedances being measured. The significant improvement in groundwater quality compared in well MP-5 is considered to indicate the attenuation effect caused by the proximity of these two wells to the Georges River;
- The elevated ammonia (N) concentration measured at well MP-3 (4.67 mg/L) may be due to peaty/ mangrove mud soils in the area of the well, given that the ammonia concentrations at the other two wells (1.12 – 1.43 mg/L) were close to the marine GIL of 0.91 mg/L; and
- The EMM 2016 SPI data supported no conclusions regarding the migration of contaminated groundwater from the north Benedict site or the southern Lot 6 former landfill. To address these data gaps, the Site Auditor reviewed groundwater contamination data available in other ESAs for these adjacent sites.

Evidence for the likely significant improvement in groundwater quality across the Marina site is given by the results of surface water monitoring conducted in the dredge pond during 2018, which are reviewed in **Section 3.8**.

3.7.4 Groundwater Contamination – North Benedict Site

Review of Sample Data

Groundwater contamination assessments for the north Benedict site are available from the EIS 2013 PSI (Ref [5]) and the DP 2016 DSI (Ref [9]). These investigations involved the collection of groundwater samples from monitoring wells installed at the north Benedict site and chemically tested them for a range of contaminants. Tables that summarised the laboratory results were provided in EIS 2013 PSI Tables F & G and DP 2016 DSI Appendix D. Copies of these tables are provided in **Appendix B**.

The data was reviewed in SAR 264B and it showed:

- **Heavy metals:**
  - Practically all heavy metals were measured at concentrations below the recreational GILs. The exception was manganese that was measured at concentrations in the range 420 – 4,400µg/L, which exceeded the recreational GIL (100 µg/L).
  - Most heavy metals were measured at concentrations below the marine GILs. The exceptions were:
    - Arsenic (total): 33 µg/L at JKBH/MW9 (GIL 13 - 24 µg/L).
    - Copper: Several wells in both sampling rounds with a maximum of 17 µg/L at BH/MW218 (GIL 3 µg/L);
    - Lead: 7 µg/L at BH/MW218 (GIL 4.4 µg/L);
    - Manganese: 420 – 4,400 µg/L (GIL 80 µg/L);
    - Nickel: Several wells in both sampling rounds with a maximum of 160 µg/L at BH/MW218 (GIL 7 µg/L); and
    - Zinc: Several wells in both sampling rounds with a maximum of 245 µg/L at JKBH/MW1[78] (GIL 15 µg/L).

[78] Measured in duplicate sample BD1/021015

- **Other Inorganic Compounds:**
  - pH: Most samples were within the marine protection GIL (7.0 – 8.5) except at JKBH/MW9 (4.8).
  - Ammonia: All samples exceeded the marine GIL (0.91 mg/L) and the recreational GIL (0.50 mg/L), the concentration range being 3.20 – 30 mg/L;
  - Nitrate, nitrite and N: All samples measured concentrations below the GILs;
  - Phosphorus: Three of the six samples measured concentrations that exceeded the background GIL (77 µg/L), with a maximum of 3,580 µg/L measured at JKBH/MW1.
  - Sulphate: Two of the five samples measured concentrations that exceeded the recreational GIL (890 mg/L). The maximum of 1,700 mg/L was measured at JKBH/MW16.
- **TRH, BTEX and VOCs:** All samples measured non-detectible concentrations (PQL 1 - 10 µg/L).
- **PAHs & phenol:** Phenol and practically all PAHs were measured non-detectible concentrations (PQL 0.1 µg/L). The one exception was naphthalene measured at 0.2 µg/L (JKBH/MW16), which was below or close to all GILs.
- **OCPs:** Most OCPs were measured at non-detectible concentrations (PQL 0.001 µg/L). The three exceptions were DDE, DDD, DDT and dieldrin that were measured at:
  - DDE: 0.001 µg/L (JKBH/MW1);
  - DDD: 0.002 µg/L (JKBH/MW1), 0.001 µg/L (JKBH/MW7);
  - DDT: 0.001 µg/L (JKBH/MW1); and
  - Dieldrin: 0.001 - 0.004 µg/L (JKBH/MW1); 0.005 µg/L (JKBH/MW7); 0.003 - 0.004 µg/L (JKBH/MW16); 0.003 µg/L (JKBH/MW107A); 0.008 µg/L (BH/MW216); 0.076 µg/L (BH/MW218); 0.076 µg/L (BH/MW218).

  All detections were measured at concentrations at or below the GILs.
- **OPPs:** Practically all OPPs were measured non-detectible concentrations (PQL 0.001 µg/L). The one exception being chlorpyrifos that was measured in 3 of the 4 EIS wells at 0.014 µg/L (JKBH/MW1), 0.02 µg/L (JKBH/MW7) and 0.023 µg/L (JKBH/MW9). These chlorpyrifos concentrations exceeded the marine GIL (PQL 0.01 µg/L) but were below the recreational GIL.
- **PCBs:** All samples measured non-detectible concentrations (PQL 0.01 µg/L).

The Site Auditor considered the groundwater contamination found at the north Benedict site by the ESAs was consistent with its historical use as a landfill for predominantly demolition waste in the 1980's to 1997. No contamination was present in groundwater that indicated the disposal of significant quantities of other types of waste. The groundwater contamination found was considered to be typical of the many areas of reclaimed land that occur along the Georges River.

Site Auditor Review

The Site Auditor considers the available data indicate that groundwater at the north Benedict site was more contaminated than groundwater at the Marina site at the time of the October 2015 sampling round.

The extent of groundwater contamination at the north Benedict site was determined by plotting the laboratory data obtained for the most recent samples collected by the DP 2016 DSI on 1/10/15. Plots of the data for ammonia, phosphorus, sulphate, manganese and zinc are provided in **Figures 3-23** to **3-27**.

Figure 3-23: Ammonia Concentrations Measured 1/10/15 (unit mg/L)

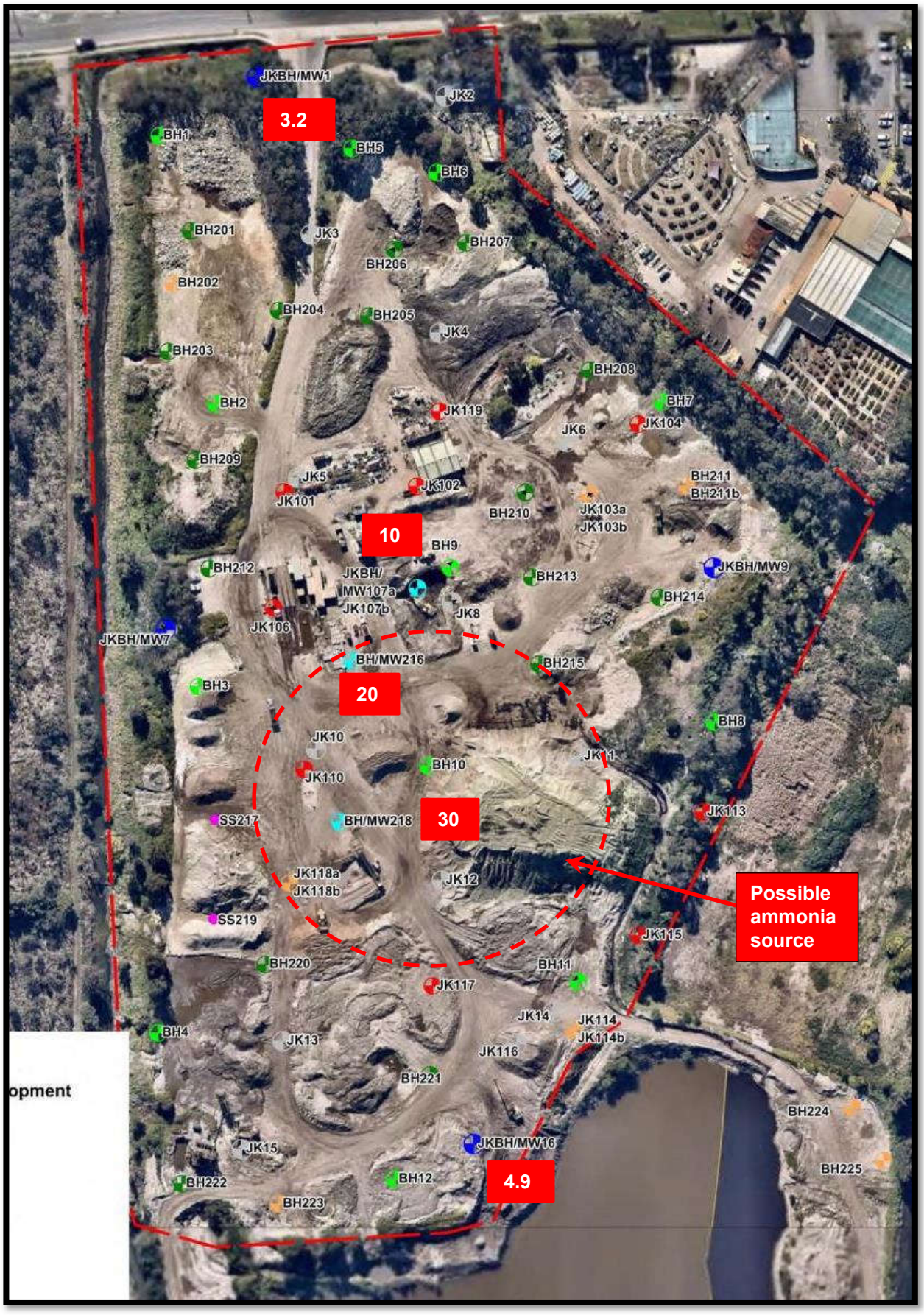


Figure 3-24: Phosphorus Concentrations Measured 1/10/15 (unit µg/L)

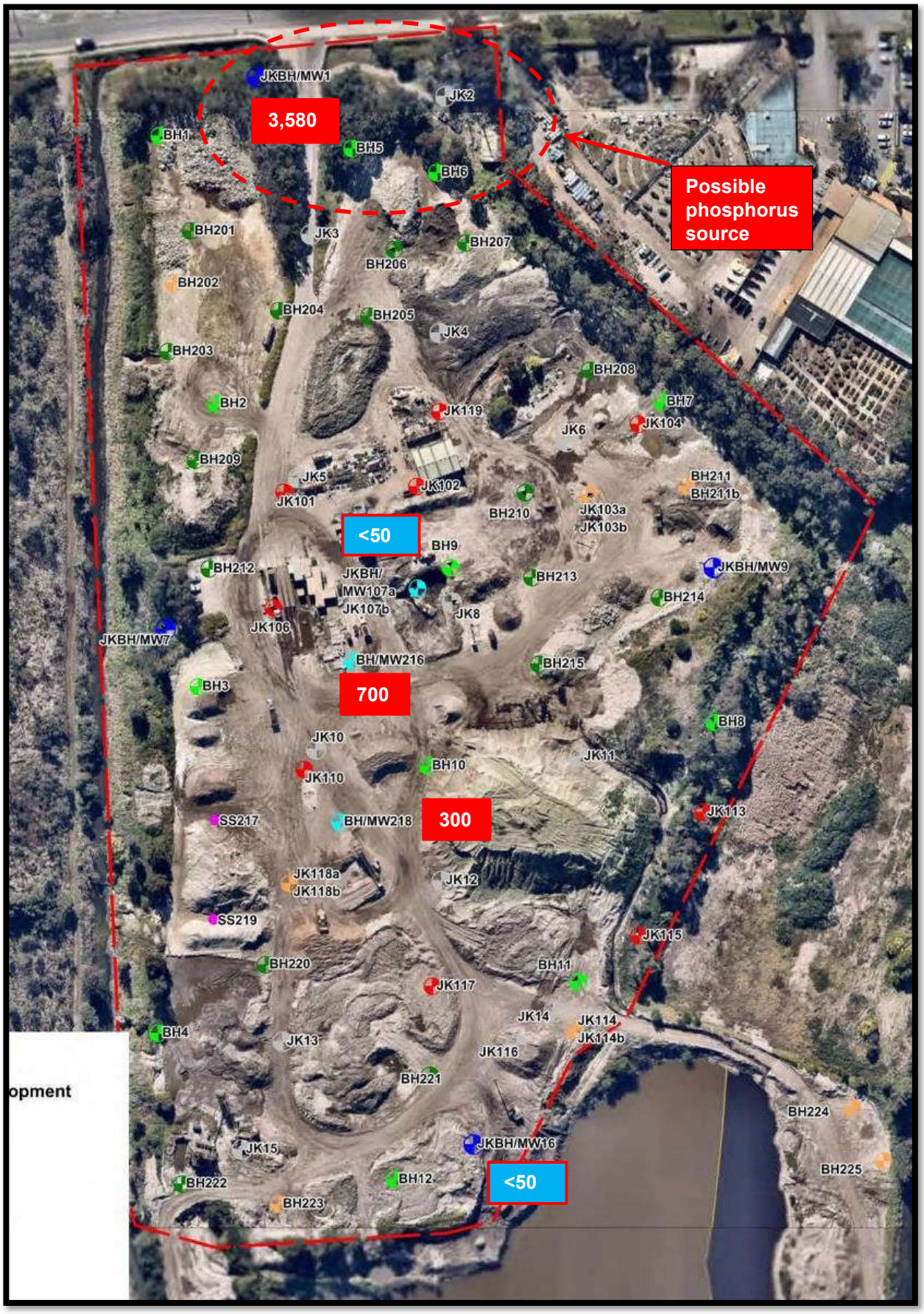


Figure 3-25: Sulphate Concentrations Measured 1/10/15 (unit mg/L)

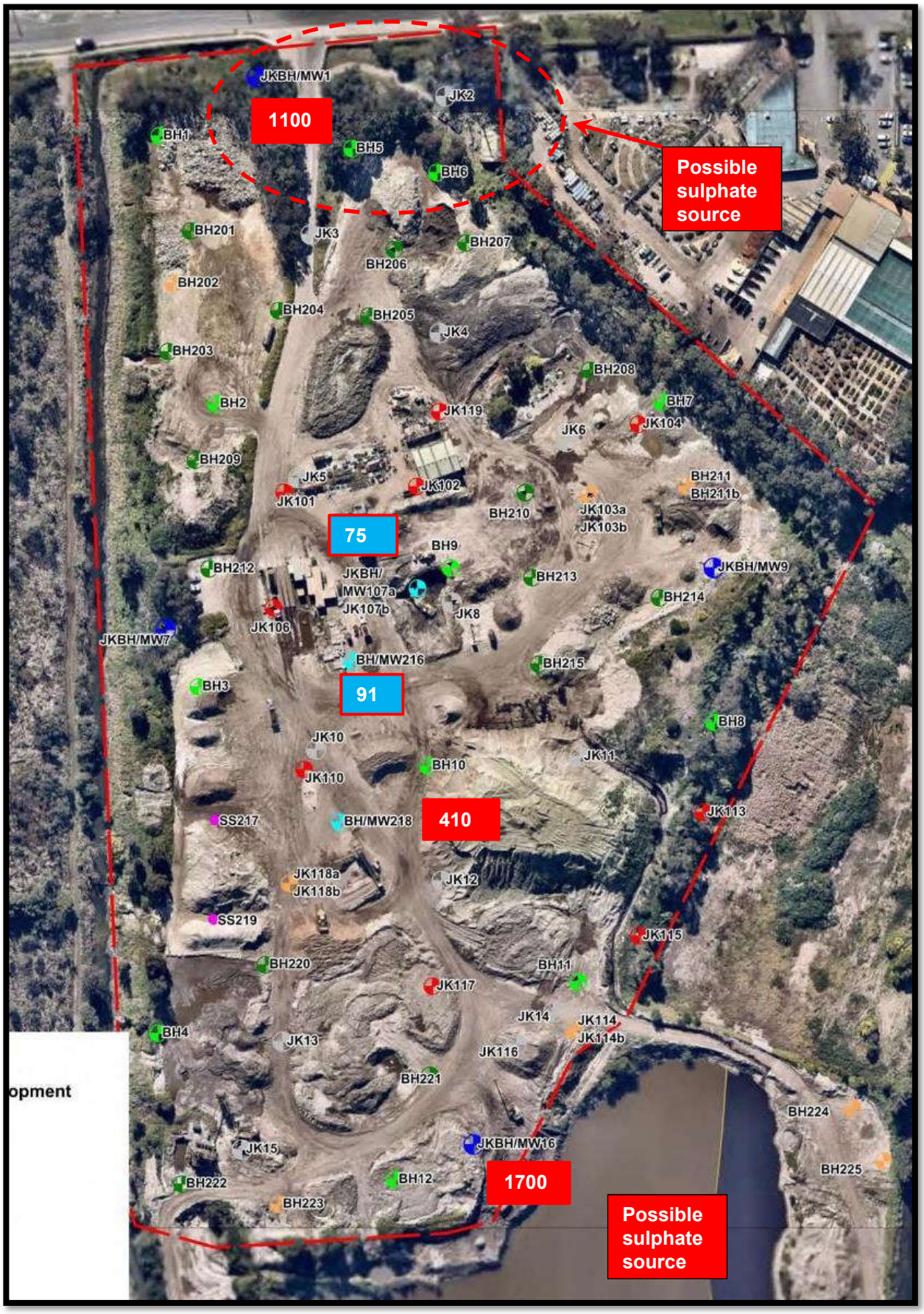


Figure 3-26: Manganese Concentrations Measured 1/10/15 (unit µg/L)

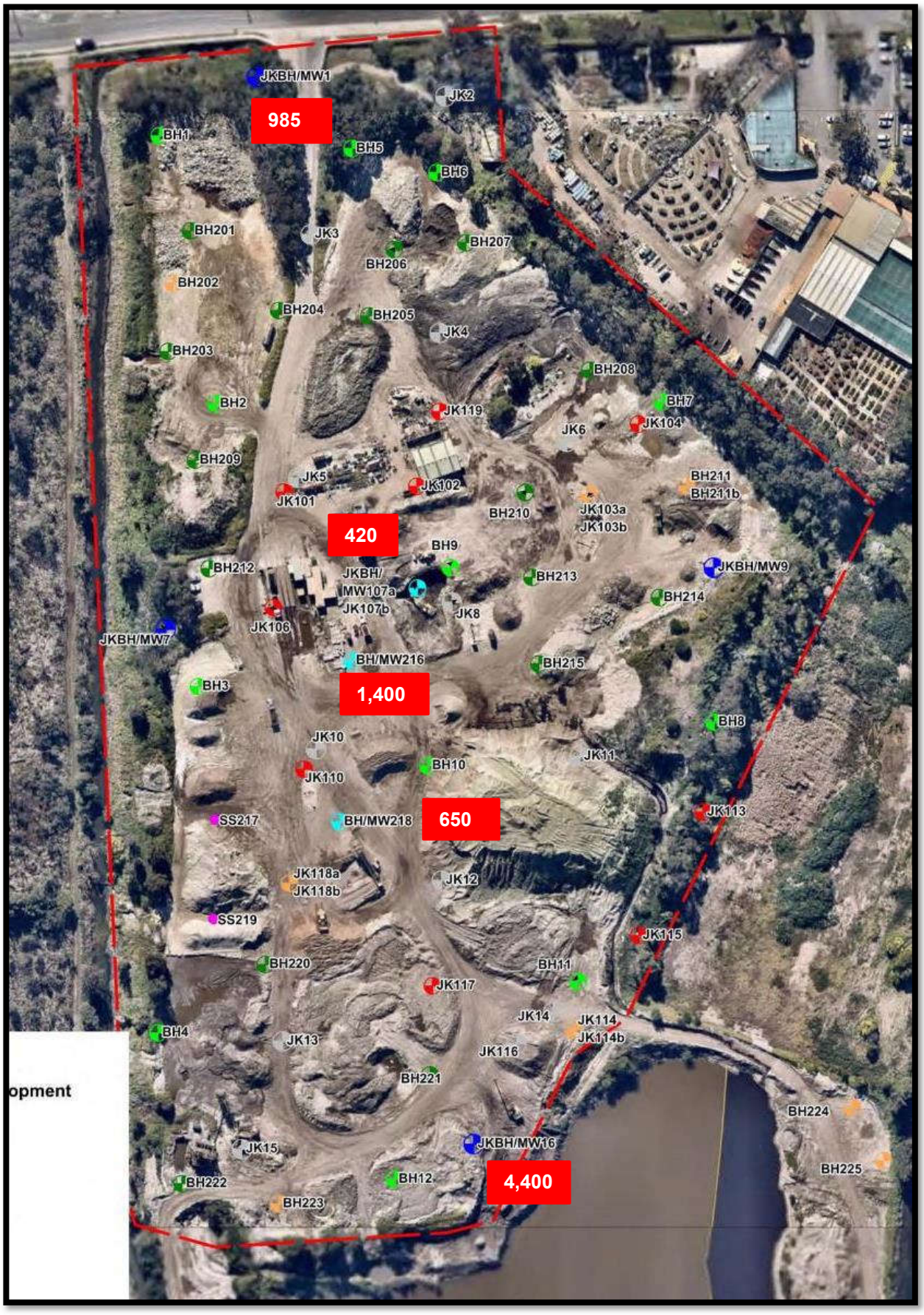
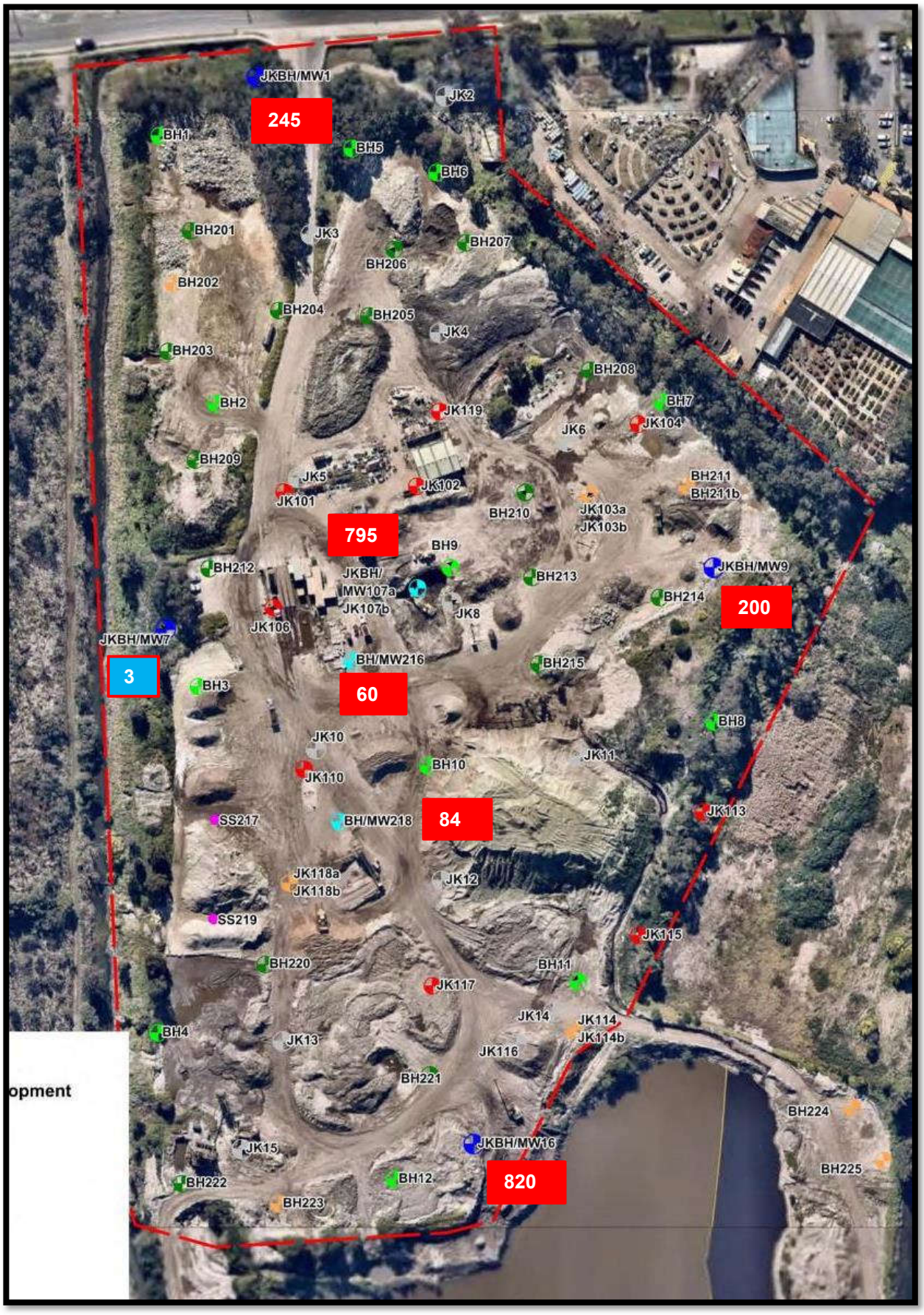


Figure 3-27: Zinc Concentrations Measured 1/10/15 (unit µg/L)



For these main contaminants of concern, the October 2015 data indicate that:

- Ammonia: Elevated ammonia levels exceeding the GILs occurred across the entire north Benedict site, with the highest concentrations towards the centre of the site;
- Phosphorus: The highest phosphorus levels were measured at the up-gradient, northern end of the north Benedict site, with there no clear trends across the site;
- Sulphate: The highest sulphate levels were measured at the up-gradient, northern end of the north Benedict site and at the down-gradient, southern end. There were no clear trends across the site; and
- Heavy metals (copper, manganese, nickel and zinc): Elevated heavy metal concentrations exceeding the GILs occurred across the entire north Benedict site. There were no clear trends across the site.

The Site Auditor considers the available data indicate that the most likely sources of groundwater contamination at the north Benedict site in October 2015 were:

- **Ammonia**: The decay of timber in the deep fill area located in the central - southern part of the site. Ammonia levels significantly decrease with distance away from this area. Dredging operations in the southern dredge pond may also represent another potential cause of elevated ammonia levels in the southern part of the north Benedict site.
- **Phosphorus**: An off-site source (e.g. runoff from surrounding areas such as the adjacent plant nursery) or material that had been temporarily stockpiled in the northern part of the site. Phosphorus levels significantly decreased with distance away from this area.
- **Sulphate**: An off-site source (e.g. runoff from surrounding areas such as the adjacent plant nursery), material that had been temporarily stockpiled in the northern part of the site. This may indicate impacts from site operations. The elevated sulphate level in the southern part of the north Benedict site may be due to dredging operations in the southern dredge pond.
- **Heavy metals (copper, manganese, nickel and zinc)**: The data did not support the identification of one or two sources. This may indicate impacts from site operations and/or the presence of many diffuse sources in the waste materials buried at the north Benedict site.

The Site Auditor considers that a significant improvement in groundwater quality is likely to have occurred at the north Benedict site since the October 2015 sampling round. This is because:

- Dredging operations had not ceased at the time of the October 2015 groundwater sampling round and would continue in the dredge pond for another 11 months. A photo of dredging operations taken by the Site Auditor on 23/06/15 is provided in **Figure 3-28**. No dredging operations have occurred at the dredge ponds for more than two years;
- The recycling operations that were being undertaken at the north Benedict site in 2015 involved the stockpiling of large quantities of organic material, soil and crushed glass that contained leachable organic material, nutrients and heavy metals, as shown in **Figure 3-28**. The stockpiling of large quantities of these materials ceased in 2017 when the landforms began to be prepared for redevelopment; and
- A major earthworks program was undertaken at the north Benedict site to remove buried timber, metal and rubbish from deep fill areas at the site. This involved the screening of the excavated materials into various fractions. The geotechnically suitable soil fraction was then used to backfill excavations. This work was undertaken between 2015 and 2018, with further details provided in SAR 264B[79].

Evidence for the likely significant improvement in groundwater quality at the north Benedict site is given by the results of surface water monitoring conducted in the dredge pond during 2018, which are reviewed in **Section 3.8**.

[79] Section 4.3, Ref [77]

Figure 3-28: Photos of Conditions at the North Benedict site on 23/06/15

Dredging operations

Material stockpiles

Figure 3-28 (cont'd): Photos of Conditions at the North Benedict site on 23/06/15

Crushed green glass stockpile

3.7.5 Groundwater Contamination – Southern Lot 6 Former Landfill

Review of Sample Data

Groundwater contamination assessments for the southern Lot 6 former landfill are provided by the EIS 2009 ESA (Ref [3]) and the EIS 2010 GMW (Ref [4]).

The EIS 2009 ESA involved the collection of groundwater samples from 7 monitoring wells installed at the southern end of the site and one well (MW6) installed at the northern end of the site near the boundary with the Marina site. One round of samples were collected from these wells on 5/05/09 and chemically tested them for a range of contaminants. Copies of tables that summarise the laboratory results are provided in **Appendix C**.

The EIS 2010 GME involved the collection of groundwater samples from 8 monitoring wells installed at the northern end of the site near the boundary with the Marina site. One round of samples were collected from these wells on 11 and 17/05/10 and chemically tested them for a range of contaminants. Copies of tables that summarise the laboratory results are provided in **Appendix C**.

The groundwater data most relevant to the Marina site is provided by wells sampled and tested in the northern part closest to the Marina site, these being the one northern wells sampled on 5/05/09 (MW6) and the 8 wells sampled on 11-17/05/10 (MW202, MW205, MW206, MW212, MW214, MW215, C1 and C2).

In terms of the protection of the marine aquatic environment, the data showed:

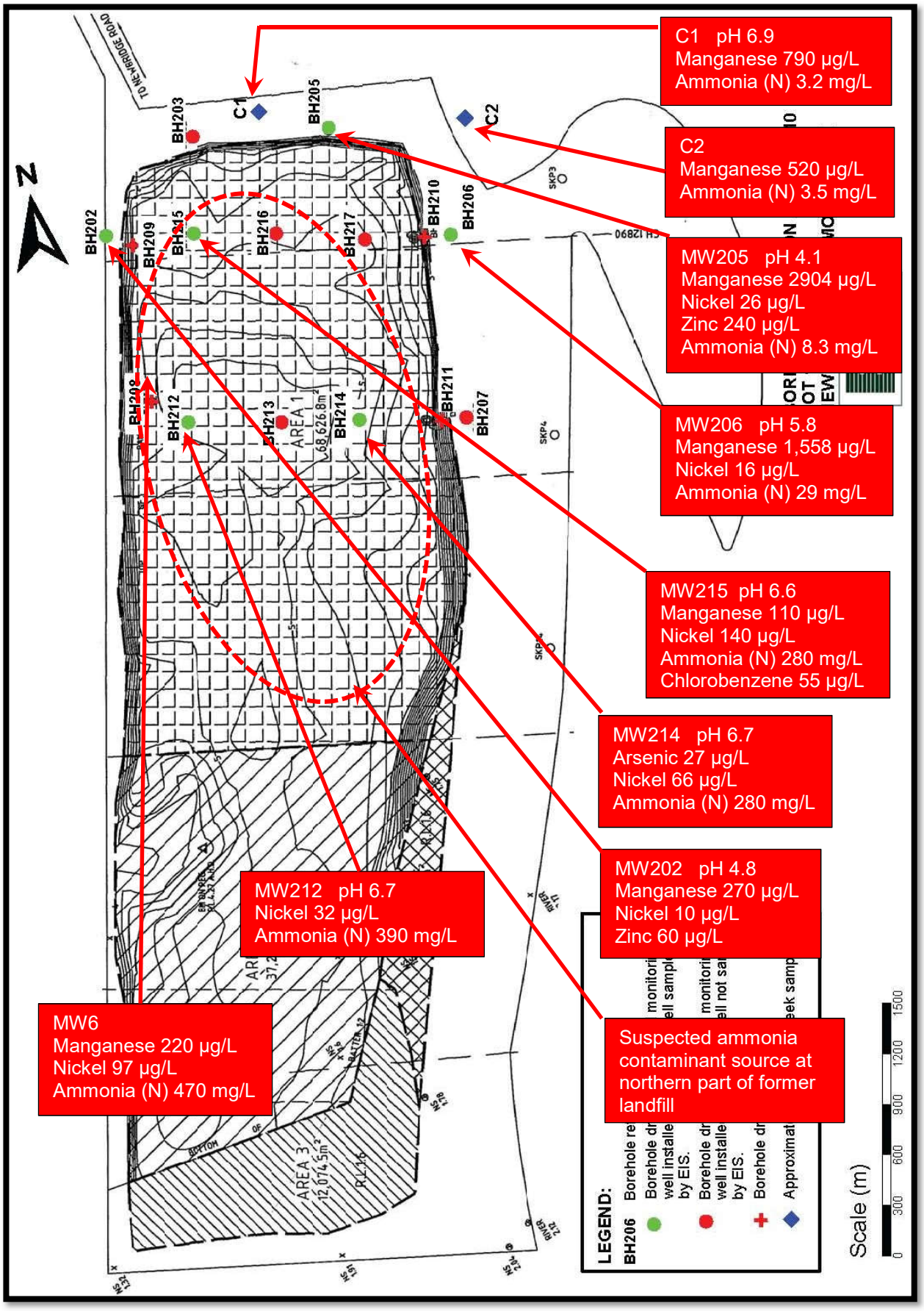
- Acidic pH levels were outside the marine GIL range (7 - 8.5) at practically all wells, the most acidic being well MW205 at 4.1. The pH at well C2 was 7.1 and met the marine GIL
- Low heavy metals concentrations below or close to the marine GILs at all well locations for cadmium, chromium, copper, lead and mercury. The measured ranges were:

- Cadmium <1 – 0.3 µg/L (Marine GIL 0.7 µg/L)
- Chromium (total) <1 – 31 µg/L (Marine GIL 4.4 – 27.4 µg/L)
- Copper <1 µg/L (Background GIL 3 µg/L)
- Lead <1 - 4 µg/L (Marine GIL 4.4 µg/L)
- Mercury <0.5 µg/L (Marine GIL 0.1 µg/L)

- Elevated heavy metals concentrations that exceeded marine GILs at some well locations for arsenic, manganese, nickel and zinc. The exceedances were:
  - Arsenic 27 µg/L at MW214 (Marine GIL 13 - 24 µg/L)
  - Manganese 220 µg/L at MW6, 470 µg/L at MW202, 2904 µg/L at MW205, 1558 µg/L at MW206, 110 µg/L at MW215, 790 µg/L at C1, 520 µg/L at C2 (Marine GIL 80 µg/L)
  - Nickel 97 µg/L at MW6, 10 µg/L at MW202, 26 µg/L at MW205, 16 µg/L at MW206, 32 µg/L at MW212, 66 µg/L at MW214, 140 µg/L at MW215 (Marine GIL 7 µg/L)
  - Zinc 60 µg/L at MW202, 240 µg/L at MW205 (Marine GIL 15 µg/L)
- Elevated ammonia (as N) levels that exceeded the marine GIL of 0.91 mg/L at practically all wells, the exception being at well MW202 (0.2 mg/L). The results were 470 mg/L at MW6, 8.3 mg/L at MW205, 29 mg/L at MW206, 390 mg/L at MW212, 280 mg/L at MW214, 280 mg/L at MW215, 3.2 mg/L at C1, 3.5 mg/L at C2.
- Non-detectible TRH C6-C9 concentrations for practically all samples, the exceptions being 54 µg/L at MW6, 220 µg/L at MW215. However, there is no marine GIL for this analyte.
- TRH C10-C36 in the range 690 – 3500 µg/L, with the maximum concentration measured at MW215. However, there is no marine GIL for this analyte. Non-detectible concentrations were measured at well C3. The C10-C36 detections may be false positives and indicative of natural organic matter rather than petroleum hydrocarbons, since the EIS report did not advise whether the water samples were tested using a silica-gel clean-up extraction procedure.
- BTEX below the marine GILs at all locations. Practically all samples measured non-detectible BTEX concentrations, the exceptions being benzene 42 µg/L at MW215 and m+p-Xylene 28 µg/L at MW214
- Non-detectible VOC concentrations at practically all locations. The exceptions were MW6, MW214 and MW215, which generally measured low concentrations of chlorobenzene, isopropylbenzene, N-propyl benzene, 1,2,4-trimethylbenzene and 1,4-dichlorobenzene. One exceedance of the marine GIL was measured at well MW215 for chlorobenzene at 55 µg/L (Marine GIL 55 µg/L)
- Low PAH concentrations below or close to the marine GILs at all locations. Maximum concentrations measured at MW214 and were:
  - Naphthalene 45 µg/L (Marine GIL 50 µg/L)
  - Anthracene 0.2 µg/L (Marine GIL 0.1 µg/L)
  - Fluoranthene 0.3 µg/L (Marine GIL 1.0 µg/L)
  - Phenanthrene 1.2 µg/L (Marine GIL 0.6 µg/L)
  - Benzo(a)pyrene <0.1 µg/L (Marine GIL <0.1 µg/L)
- Non-detectible OCP concentrations at practically all locations. The exceptions were dieldrin at 0.011µg/L at MW6, 0.02 µg/L at well C1, which were close to the marine GIL of 0.01 µg/L
- Non-detectible total phenolic concentrations at practically all locations. The exception was MW214 at 0.18 µg/L, which was well below the marine GIL of 400 µg/L
- Non-detectible OPP and PCB concentrations at all locations

The exceedances of the marine GILs are summarised in **Figure 3-29**.

Figure 3-29: Exceedances of Marine GILs for Northern Wells at Lot 6



For the protection of recreational receptors, the samples collected from the northern wells at the site measured most contaminants of concern at concentrations below the recreational GILs. The few exceptions were:

- Acidic pH levels outside the recreational GIL range (6.5 - 8.5) at MW202 4.8, MW205 4.1 and MW206 5.8;
- Manganese outside the recreational GIL (100 µg/L) were measured at most wells comprising MW6 220 µg/L; MW202 470 µg/L, MW205 2904 µg/L, MW206 1558 µg/L, MW215 110 µg/L, C1 790 µg/L, C2 520 µg/L;
- Elevated ammonia (as N) levels exceeded the recreational GIL (0.41 mg/L) at most wells comprising MW6 470 mg/L, MW205 8.3 mg/L, MW206 29 mg/L, MW212 390 mg/L, MW214 280 mg/L, MW215 280 mg/L, C1 3.2 mg/L, C2 3.5 mg/L;
- Naphthalene exceeded the recreational GIL (1.7 µg/L) at wells MW214 45 µg/L and MW215 8.7 µg/L; and
- Chlorobenzene exceeded the recreational GIL (10 µg/L) at wells MW214 14 µg/L and MW215 180 µg/L

The exceedances of the recreational GILs are summarised in **Figure 3-30**.

For the protection of Residential B apartment users from vapour intrusion, the samples collected from practically all wells in the northern part of the site measured volatile contaminants of concern at concentrations below the vapour intrusion GILs. The only exception was well MW6 that measured TPH C10-C14 at 950 µg/L and C15-C28 at 1900 µg/L, which probably meant the TPH F2 GIL of 1,000 µg/L was exceeded.

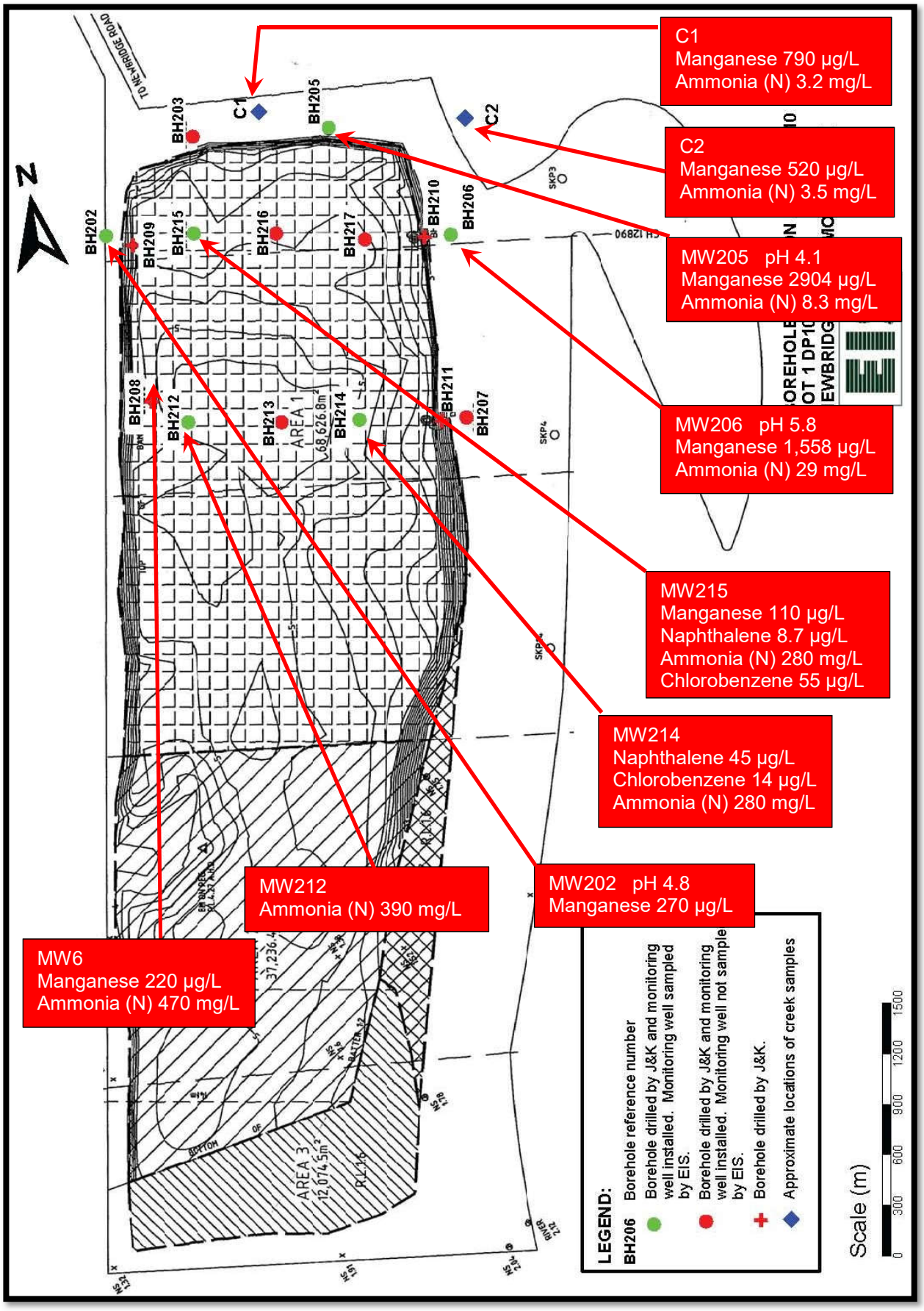
The ESAs provided no conclusions regarding the risks posed by groundwater contamination at the southern Lot 6 former landfill site to the Marina site. The Site Auditor has addressed this data gap by reviewing the available data.

Site Auditor Review

Despite the limited amount of data provided by the ESAs, the Site Auditor considers that sufficient data was provided that support the following conclusions relevant to the risks posed by groundwater contamination at the southern Lot 6 former landfill site to the Marina site:

- The highest ammonia levels in the northern part of the former landfill were 470 mg/L at MW 6 and 390 mg/L at well MW212 decreasing to 3.2 – 8.3 mg/L at the three wells located along the northern boundary adjacent to the Marina site (wells C1, C2 and MW205). The source concentrations exceeded the marine GIL (0.91 mg/L) and the recreational GIL (0.50 mg/L).
- A manganese and zinc hot-spot occurred near the boundary with the Marina site at MW205, where the maximum manganese and zinc concentrations were measured of 2,904 µg/L and 240 µg/L, respectively. These concentrations exceeded the manganese marine GIL (80 µg/L) and recreational GIL (100 µg/L) and exceeded the zinc marine GIL (15 µg/L). Other locations along the northern site boundary and away from MW205 measured much lower levels. The source of this contamination is unknown. Possibilities include a temporary stockpile of material that contained leachable manganese and zinc or the occurrence of localised excavation work in the area.
- A nickel hot-spot occurred in the north-western corner of the former landfill site, where the highest concentrations were measured of 97 µg/L (MW6) and 140 µg/L (MW215), which exceeded the marine GIL (7 µg/L). Locations along the northern site boundary and away from MW6 and MW215 measured much lower levels. The source of this contamination is unknown. Possibilities include a temporary stockpile of material that contained leachable nickel or the occurrence of localised excavation work in the area.
- An arsenic hot-spot occurred in the central part of the northern area, where the highest concentration of 27 µg/L (MW214) was measured, which marginally exceeded the marine GIL (13 - 24 µg/L). Locations along the northern site boundary and away from MW214 measured much lower levels. The source of this contamination is unknown. Possibilities include a temporary stockpile of material that contained leachable arsenic.

Figure 3-30: Exceedances of Recreational GILs for Northern Wells at Lot 6



- A naphthalene and chlorobenzene hot-spot occurred in the central part of the northern area, where the highest concentrations were measured. Naphthalene was measured at 45 µg/L (MW214) and 8.7 µg/L (MW215), which exceeded the recreational GIL (1.7 µg/L). Chlorobenzene was measured at 14 µg/L (MW214) and 55 (MW215), which exceeded the recreational GIL (10 µg/L). Locations along the northern site boundary and away from MW214 and MW215 measured much lower levels. The source of this contamination is unknown. Possibilities include a chemical spill or burial of waste in the area.
- The groundwater contamination found at the Lot 6 former landfill site is consistent with its historic use as a landfill for a largely unknown range of waste and as a concrete recycling operation.
- The northern part of the former landfill site is a source of groundwater contamination. This is shown by the presence of on-site, localised sources of ammonia, manganese, zinc, nickel, arsenic, naphthalene and chlorobenzene, as previously discussed.
- There is no evidence of a groundwater contamination plume migrating from the Marina site into the Lot 6 former landfill site. This is because:
  - The water table equipotential contours indicate that groundwater in the northern part of the former landfill site flows in a northerly direction towards the Marina site (**Section 3.7.2**);
  - The available data indicate that the northern part of the former landfill site is a source of groundwater contamination;
  - Groundwater at the Marina site was not found to be contaminated with arsenic, naphthalene and chlorobenzene (**Section 3.7.3**) as was found in the northern part of the former landfill site.
- There is no evidence of a groundwater contamination plume migrating from the Lot 6 former landfill site into the Marina site. This is because:
  - Wells C1, C2 and BH205 located adjacent to the Marina site boundary measured low ammonia levels of 3.2 – 8.3 mg/L relative to the other wells located further inside the former landfill site;
  - Wells C1 and C2 located adjacent to the Marina site boundary measured much lower heavy metals levels relative to the other wells located further inside the former landfill site. The pH at wells C1 and C2 was neutral and was not acidic as the other wells located further inside the former landfill site;
  - Groundwater at the Marina site was not found to be contaminated with arsenic, naphthalene and chlorobenzene (**Section 3.7.3**) as was found in the northern part of the former landfill site; and
  - The ammonia levels of 1.1 – 4.7 mg/L measured at the Marina site were much lower than the levels measured in the northern part of the Lot 6 former landfill site. The ammonia levels of 280 – 390 mg/L measured in the source zone in the northern part of the landfill site were 100 – 200 times higher than measured at the Marina site.

3.7.6 Ability to Manage Contamination

The ESAs provided no assessment as to the ability of the proposed marina development to manage groundwater contamination. The Site Auditor has addressed this data gap by reviewing the available data, with the results of the reviews documented in earlier parts of **Section 3.7**.

The Site Auditor considers the weight of evidence supports the conclusions that:

- Groundwater at the Marina site was contaminated above marine and recreational GILs when sampling was conducted in October 2015. The contaminants of concern identified by this sampling were pH, cadmium, copper, manganese, nickel, zinc and ammonia.
- Some potential contaminants of concern were not tested by groundwater investigations undertaken at the Marina site. These comprise OCPs, other VOCs, phenols and PFAS. The risk of significant groundwater contamination from these other contaminants is considered to be low due to the absence of exceedances in groundwater concentrations from investigations undertaken at the north Benedict site and the absence of elevated levels in soil samples tested at the Marina site. The low risk posed by these other potential contaminants can reasonably be addressed as part of an additional investigation undertaken during the design phase of the project.

- Other data gaps in groundwater investigations conducted at the Marina site can reasonably be addressed as part of an additional investigation undertaken during the design phase of the project. These investigations should, among other things, provide stratigraphic cross-sections showing the variation in subsurface conditions across the Marina site and be undertaken in accordance with NSW EPA guidance as detailed in this SAR.
- It is likely that a significant improvement in groundwater quality at the Marina site has occurred since groundwater investigations were undertaken in 2015. This is because:
  - The most likely source of groundwater contamination at the Marina site was poor surface water quality that existed in the dredge pond at the time the samples were collected in 2015 when dredging operations were still occurring. Dredging ceased in October 2016;
  - Recycling operations undertaken at the north Benedict site in 2015 involved the stockpiling of large quantities of organic material, soil and crushed glass that contained leachable organic material, nutrients and heavy metals. The stockpiling of large quantities of these materials ceased in 2017 when the landforms began to be prepared for redevelopment; and
  - A major earthworks program was undertaken at the north Benedict site to remove buried timber, metal and rubbish from deep fill areas at the site. This involved the screening of the excavated materials into various fractions. The geotechnically suitable soil fraction was then used to backfill excavations. This work was undertaken between 2015 and 2018.
- The improvement in groundwater quality that should have occurred since the groundwater investigations were undertaken in 2015 should be quantified. This can reasonably be addressed as part of an additional investigation undertaken during the design phase of the project.
- Localised, naturally occurring sources of ammonia contaminated groundwater probably exist at the Marina site due to the presence of peaty / mangrove mud soils in the area, as indicate by the investigation data collected in 2015 at well MP-3 located near the Georges River foreshore where ammonia (N) was measured at 4.67 mg/L. It is reasonable for this feature of the Marina site to be addressed as part of an additional investigation undertaken during the design phase of the project. The presence of such naturally occurring groundwater contamination may require the GILs for ammonia to be increased to background levels measured in areas where groundwater flows through peaty / mangrove mud soils.
- There is no evidence of a groundwater contamination plume migrating from the Marina site into the north Benedict site or the Lot 6 former landfill site.
- Groundwater at the Lot 6 former landfill to the south of the Marina site is contaminated with high levels of ammonia and manganese, together with localised sources of other heavy metals (arsenic nickel, zinc), naphthalene, chlorobenzene and TPH that exceed the marine, recreational and/or vapour intrusion GILs. There is no evidence of a groundwater contamination plume migrating from the Lot 6 former landfill site into the Marina site.
- The proposed development work at the Marina site should not extract groundwater such that it draws groundwater from the Lot 6 former landfill site onto the Marina site.

3.8 Surface Water Contamination

The eighth check in the NSW EPA decision process is that '*any potential ecological risks have been assessed*'.

The ninth check in the NSW EPA decision process is that '*any evidence of, or potential for, migration of contaminants from the site has been appropriately addressed, including potential risks to off-site receptors, and reported to the site owner or occupier'.*

3.8.1 Assessment Criteria

The relevant surface water investigation levels (SWILs) correspond to some of the marine protection and recreational water criteria provided in **Section 3.7.1** for groundwater.

3.8.2 Surface Water Investigations

The surface water quality in the dredge pond, western drainage channel and in the part of the Georges River adjacent to the Site have been extensively investigated by:

- **Historic sampling for EPL monitoring**: Undertaken by various consultants since 1993 as part of the Benedict EPL monitoring program. A review of this work was provided in the EMM 2015 PSI[80]. This monitoring work has been conducted by WaterTest since 1998. The positions of historic surface water sampling locations are shown in **Figure 3-31**.
- **EMM 2015 PSI** (Ref [6]): Collected three surface water samples (WAT-1 to WAT-3) from the dredge pond on 3/06/15, with the locations shown in **Figure 3-32**. The samples were chemically tested in a NATA-accredited laboratory for physiochemical parameters (temperature, EC, pH, TDS and Redox), ammonia, metals, TRH, BTEX and PAHs.
- **EMM 2016 SPI** (Ref [7]): Collected shallow and deep water samples from five additional locations (WAT-4 to WAT-8) from the southern dredge pond on 9/11/15, with the locations shown in **Figure 3-32**. The samples were chemically tested in a NATA-accredited laboratory for the same analytes as used in the EMM 2015 PSI.
- **DP 2016 DSI** (Ref [9]): Collected water samples from the three main surface water bodies located within the Marina site and the north Benedict site and chemically tested them for a range of contaminants. The three samples were collected from the Georges River foreshore (SW1), in the southern dredge pond (SW2), and in the western drainage channel (SW3), with the sample locations shown in **Figure 3-33**. The samples were chemically tested in a NATA-accredited laboratory for physiochemical parameters (temperature, EC, pH, TDS and Redox), nutrients and other inorganics (ammonia, chloride, nitrate, nitrite, total N, sulphate, phosphorus), metals (including manganese), TRH, BTEX, PAHs, VOCs, OCPs, OPPs and PCBs.
- **DP 2018 ESA** (Ref [15]): Collected bi-monthly surface water samples over a 12 month period at four locations (SW1 – SW4) between 17/05/17 and 20/03/18. SW1 was located near the Georges River foreshore upstream of the Marina site and provided data on background surface water data in the Georges River. SW2 and SW3 were located along the northern side of the dredge pond where groundwater would discharge into the pond from the north Benedict site. SW4 was located near the Georges River foreshore where the adjacent to the north-eastern corner of the Marina site. These sample locations are shown in **Figure 3-34**. The samples collected in the 6 monitoring rounds were chemically tested in a NATA-accredited laboratory for nutrients and other inorganics (ammonia, chloride, nitrate, nitrite, total N, sulphate, phosphorus), metals (including manganese), TRH, BTEX, PAHs, phenolics, OCPs, OPPs and PCBs and PFAS

Ammonium data from EPL surface water compliance monitoring in the dredge pond and the Georges River was also provided by EMM for the period 29/01/16 - 21/05/18 (Ref [17]). Sample data was provided for three locations in the dredge pond (labelled A, B, C) and a fourth location in the Georges River adjacent to the dredge pond (labelled D), with these locations shown in **Figure 3-35**.

[80] Sections 6.2.1 & 8.1, Ref [7]

Figure 3-31: Historic Surface Water Sampling Locations (Source: Figure 8.1, Ref [7])

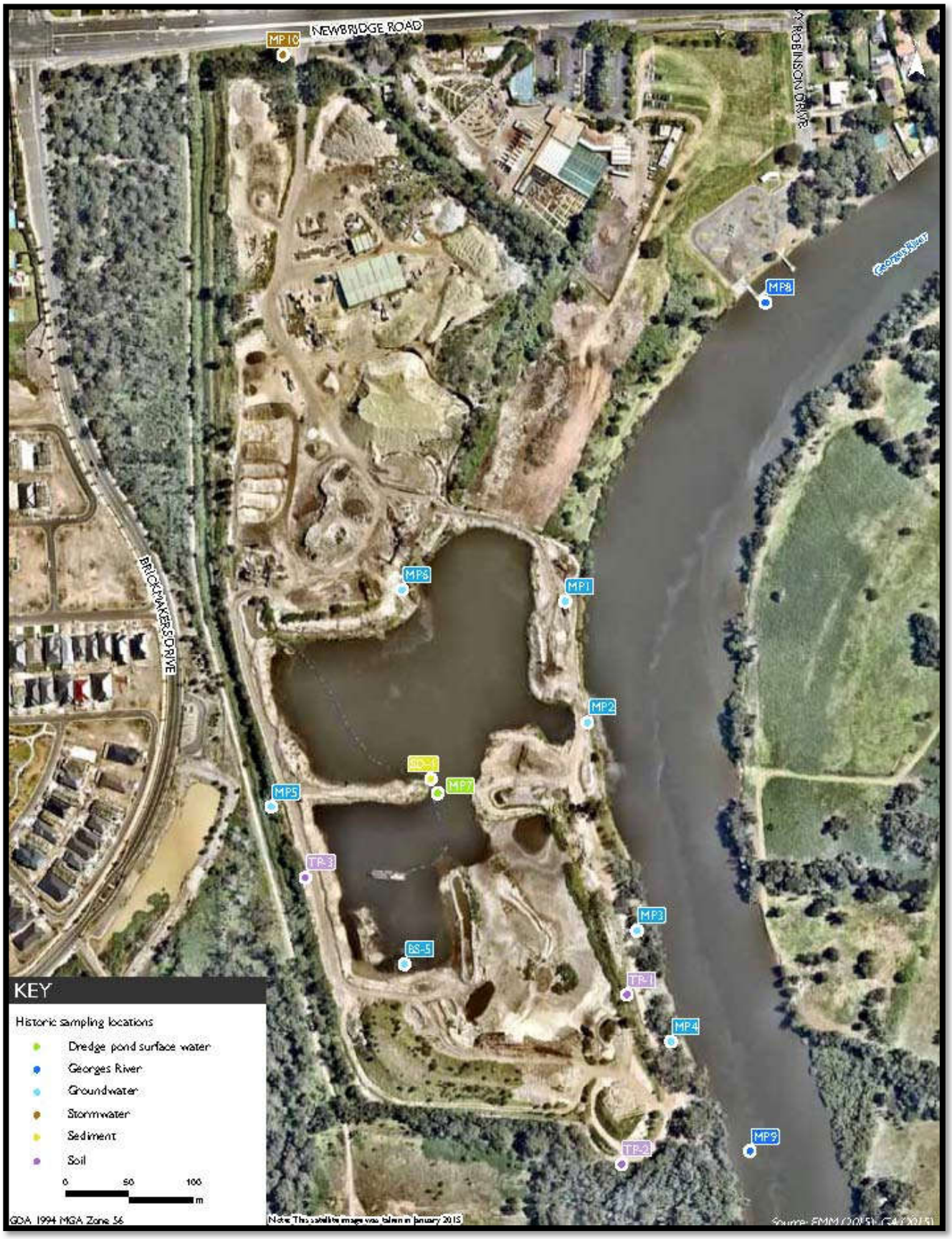


Figure 3-32: EMM 2015 & 2016 Surface Water Sampling Locations (Source: Fig 2.1, Ref [7])

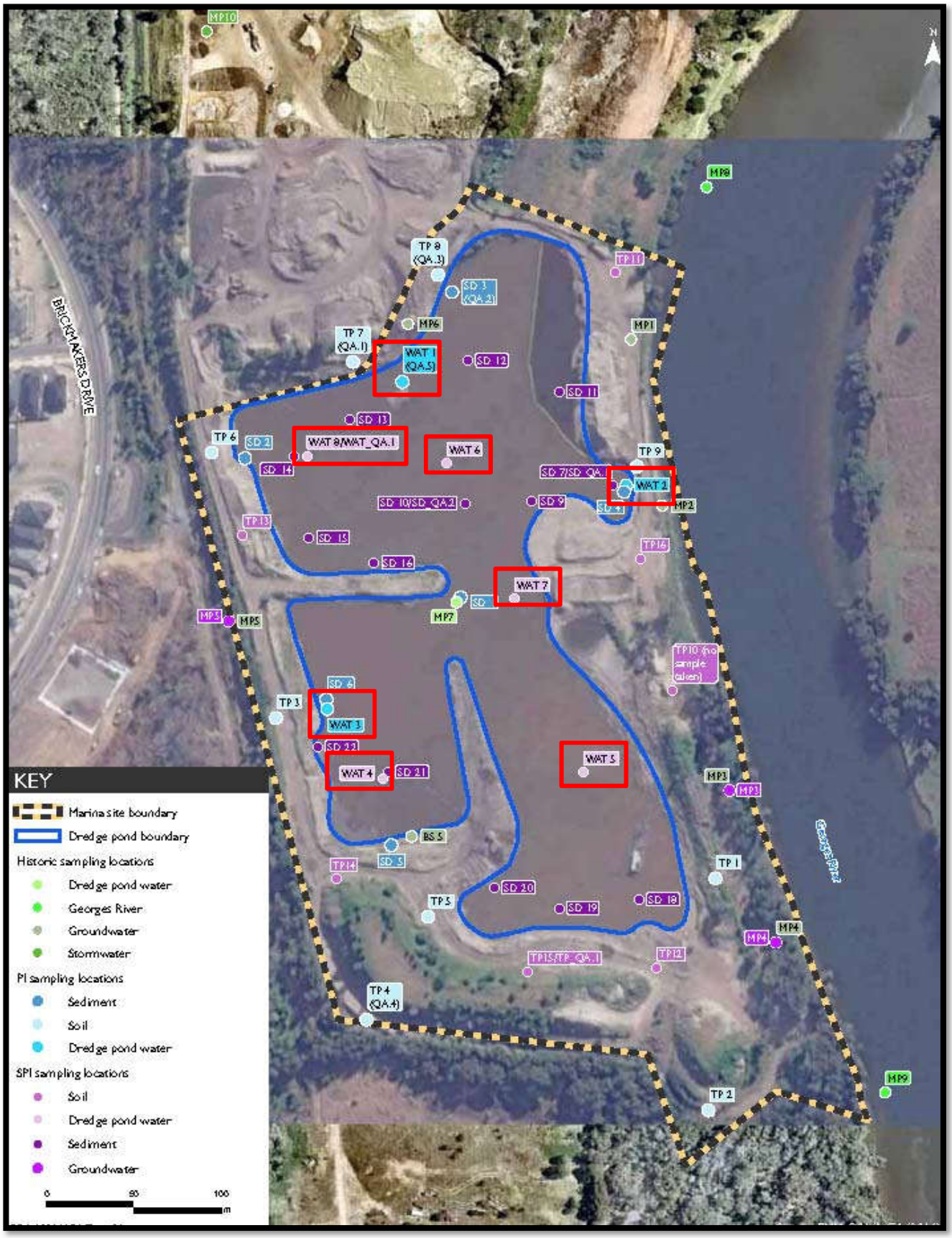
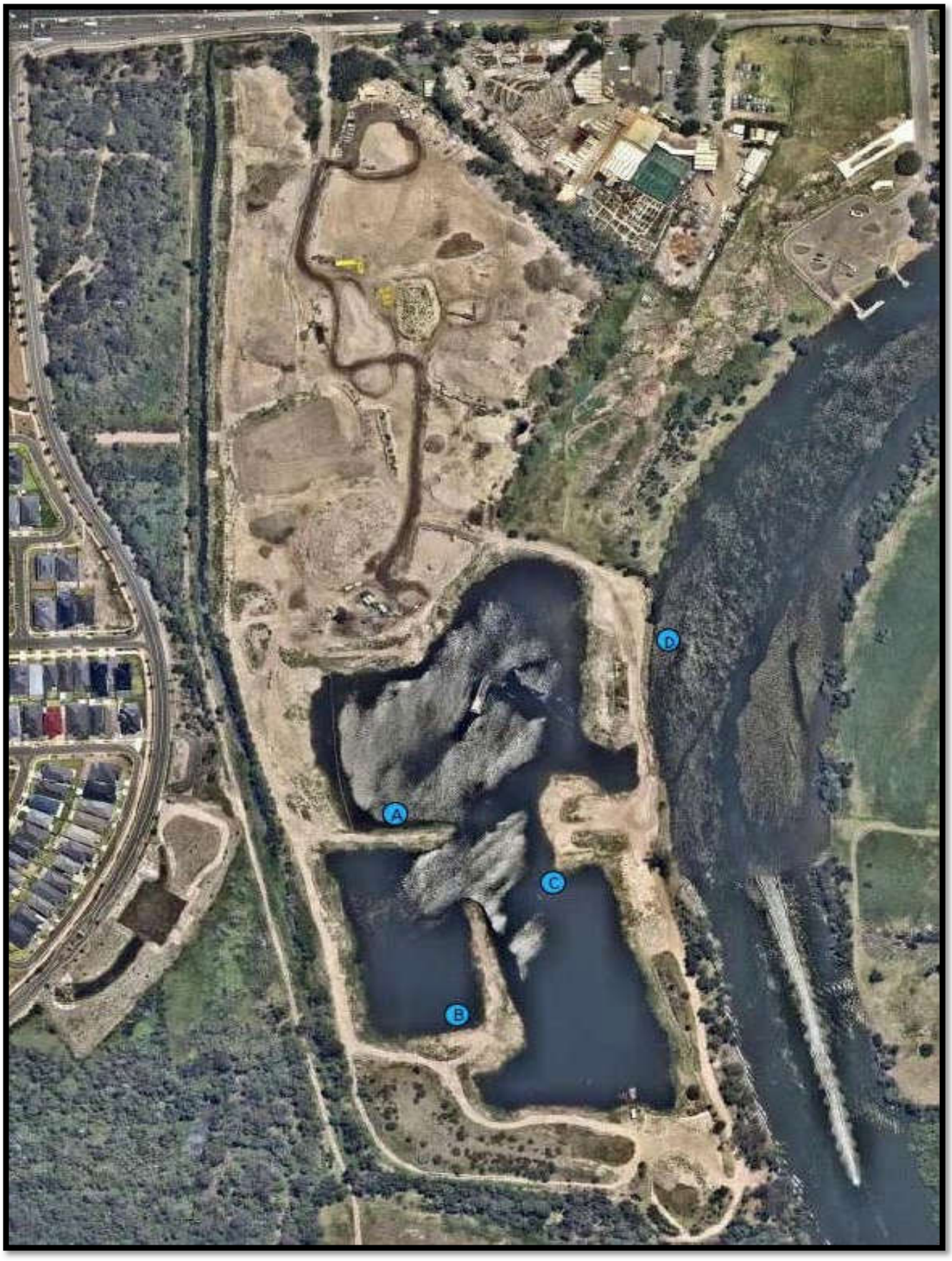


Figure 3-33: Surface Water Sampling Locations for DP 2016 DSI (Source: Drwg 9, Ref [10])

Figure 3-34: Surface Water Sampling Locations for DP 2018 ESA (Source: Figure 1, Ref [15])

Figure 3-35 Surface Water Monitoring Locations for Quarterly Ammonia Monitoring (Source: Ref [17])



3.8.3 Assessment of Surface Water Quality – 2015 to 2016

Review of Sample Data

Copies of laboratory summary tables of the surface water tests conducted by EMM and DP in 2015 – 2016 are provided in **Appendix A**. Surface water field parameters measured by the DP 2016 DSI are summarised in **Table 3-13**.

The 2015 – 2016 data show:

- **Heavy metals:** Practically all heavy metals were measured at concentrations below the SWILs. The exceptions were manganese, copper and zinc:
  - Samples from the dredge pond (SW2) and western drainage channel (SW3) measured manganese at 420 µg/L and 100 µg/L, respectively, which exceeded the marine SWIL (80 µg/L);
  - One sample from the dredge pond (WAT-7s) measured copper at 4 µg/L, which slightly exceeded the marine SWIL[81] (3 µg/L);
  - The sample from the western drainage channel (SW3) measured zinc at 18 µg/L, which exceeded the marine SWIL (15 µg/L); and
  - Practically all samples from the dredge pond (WAT-4 to WAT-8) measured elevated zinc concentrations that exceeded the marine SWIL, with a maximum of 345 µg/L.
- **Other Inorganic Compounds:**
  - pH: All samples were within the SWIL ranges;
  - Ammonia: DP samples from the dredge pond (SW2) and the western drainage channel (SW3) measured ammonia at 8.8 mg/L and 8.2 mg/L, respectively, which exceeded the marine SWIL (0.91 mg/L) and the recreational SWIL (100 µg/L). These results were similar to the three EMM samples (WAT-1 to WAT-3) collected from the dredge pond on 3/06/15, which measured ammonia in the range 11.6 – 13.2 mg/L. The ten EMM samples (WAT-4s/d to WAT-8s/d) collected from the dredge pond on 9/11/15 measured ammonia in the range 5.56 – 9.46 mg/L;
  - Nitrate and nitrite: All samples measured concentrations below the SWILs; and
  - Phosphorus: All samples collected by the DP 2016 DSI measured non-detectible concentrations (PQL 0.1 µg/L). However, the ten samples collected by EMM from the dredge pond (WAT-4s/d to WAT-8s/d) measured concentrations in the range 70 – 59,700 µg/L, with most samples exceeding the background SWIL (77 µg/L).
- **TRH, BTEX and VOCs:** All samples collected by the EMM 2015 PSI and DP 2016 DSI and most of the samples collected from the EMM 2016 SPI measured non-detectible concentrations (PQL 1 - 10 µg/L). Three samples collected from the dredge pond (WAT-6s, WAT-4d, WAT-8d) measured C10-C36 concentrations in the range 1520 – 4620 µg/L. However, these detections may be false positives and indicative of natural organic matter rather than petroleum hydrocarbons, since the EMM report did not advise whether the water samples were tested using a silica-gel clean-up extraction procedure.
- **PAHs & phenol:** All samples collected by the EMM 2015 PSI and DP 2016 DSI and most of the samples collected from the EMM 2016 SPI measured non-detectible concentrations (PQL 0.1 - 1µg/L). Three samples collected from the dredge pond (WAT-6s, WAT-4d, WAT-8d) measured high-end PAH concentrations in the range 23.1 - 108 µg/L. However, these detections may be false positives and indicative of ash particles in the suspended sediment rather than dissolved PAHs in the surface water, since the EMM report did not advise whether the suspended sediment in the water samples tested for organic contaminants were centrifuged and removed prior to testing.
- **OCPs:** Practically all OCPs were measured at non-detectible concentrations (PQL 0.001 µg/L). The one exception was dieldrin that was measured at:
  - 0.001 µg/L in the DP Georges River sample (SW1); and

[81] Adjusted for background levels in the Georges River

- 0.004 µg/L in the DP dredge pond sample (SW2).

All detections were measured at concentrations at or below the SWILs.

- **OPPs:** All OPPs were measured non-detectible concentrations (PQL 0.001 µg/L).
- **PCBs:** All samples measured non-detectible concentrations (PQL 0.01 µg/L).

Compliance with DQOs

From the data quality assessment provided in **Section 2**, the Site Auditor considers the 2015 – 2016 data provided by the ESAs regarding the assessment of surface water contamination at the Marina site does not meet the DQOs expected by the NSW EPA for a DSI. This is because of the following data gaps:

- Field records for surface water tests performed by the EMM 2015 PSI (**Section 2.1.6**);
- Details on the water quality meter used or calibration records for the tests conducted on the dredge pond surface water by the EMM 2016 PSI and EMM 2016 SPI (**Section 2.1.6**);
- Copy of completed COC) forms by the EMM 2015 PSI and EMM 2016 SPI (**Section 2.1.7**);
- No data was provided to define the background concentration of ammonia in the Georges River adjacent to the Marina site for the potential contaminants of concern other than ammonia (**Section 2.2.4**);
- The dredge pond monitoring data (Ref [17]) indicate that dredging did not cease until October 2016, some 10 - 16 months after surface water samples were collected from the pond. This meant there is a risk that the surface water quality data obtained by EMM in 2015 and 2016 was representative of poor water quality conditions caused by dredging and not post-dredging conditions (**Sections 2.2.4 & 2.3**);
- No surface water samples from within the dredge pond were tested for OCPs, other VOCs, PCBs, phenols and PFAS (**Section 2.2.4**);
- It is not known if samples from the EMM 2015 PSI and EMM 2016 SPI were appropriately managed because no copies of COC forms were provided (**Section 2.3**);
- It is not known if the surface water quality measurements taken in the field by the EMM 2015 PSI and EMM 2016 SPI used appropriately calibrated equipment because no copy of calibration certificates was provided (**Section 2.3**);
- It is not known if representative duplicate samples were collected because no descriptions were provided of the sample splitting techniques used (**Section 2.3**);
- All surface water samples from the EMM 2015 PSI exceeded the recommended holding time for pH by 1 day (**Section 2.3**);
- No description was provided on the use of filters for groundwater samples tested for dissolved heavy metals by the EMM 2016 SPI (**Section 2.3**); and
- It is not known if the deeper surface water samples were collected by the EMM 2016 SPI at a depth of 2m or 3m due to discrepancies between the depth given in the report text and the summary table and the lack of data in the field records (**Section 2.3**).

The Site Auditor has considered the significance of these data gaps when reviewing the surface water quality assessment provided for the 2015 – 2016 data.

Assessment of Surface Water Quality

The EMM 2015 PSI[82] and EMM 2016 SPSI[83] advised that:

- The surface water quality in the dredge pond met most of the assessment criteria, the main exception being ammonia;

[82] Section 9.3, Ref [6]
[83] Sections 4.3 & 5.3, Ref [7]

- The dredge pond water ammonia concentrations had been generally increasing since 2009;
- In the weeks preceding the PSI, a suction dredge had operated in the pond to remove accumulated fines. It was likely that the disturbance caused by the continuous suction dredging in the pond had resulted in a significant load of suspended fines in the water column. This may have included ammonia-enriched sediments;
- A dredge was operating during sampling for the SPI and caused suspending sediment and increasing the total suspended solid (TSS) concentrations;
- Another potential source considered was landfill leachate from the former landfills to the north and south of the southern dredge pond, mobilised via groundwater; and
- Further investigation and/or an ecological risk assessment is warranted to evaluate the source(s) of ammonia in groundwater and to quantify the potential risk to the environment.

The DP 2016 DSI[84] concluded that:

- The surface water data indicated that groundwater migrating from the north Benedict site was unlikely to be having an adverse impact on adjacent surface water, in particular, the Georges River;
- Impacts on other possible receptors of groundwater were unlikely or implausible (e.g. abstraction for drinking water); and
- No groundwater or surface water remediation was required.

Despite the data gaps in the ESAs, the Site Auditor considers the weight of evidence supports the conclusion that the poor surface water quality measured in the 2015 – 2016 period was due to:

- Disturbance caused by dredging operations and recycling operations at the north Benedict site for the reasons given in **Section 3.7.4**;
- Detections of TRH in a few of the samples collected from the dredge pond are most likely false positives caused by natural organic matter in the sediment that was stirred up by dredging operations and was not removed from samples prior to their extraction in the laboratory;
- Detections of heavy-end PAHs in a few of the samples collected from the dredge pond are most likely false positives caused by ash particles in the suspended sediment rather than dissolved PAHs in the surface water, since the suspended sediment was probably not removed from the water samples prior to testing. Furthermore, the laboratory tests did not detect any light end-PAHs that are readily soluble in water, while the heavy-end PAHs measured by the laboratory tests have a very low solubility in water and are unlikely to have been dissolved in the water samples; and
- The surface water data for the dredge pond is consistent with the historical use of the pond for sand extraction and the adjoining north Benedict site as an area that was filled with demolition rubble in the 1980s – 1997 and subsequently used as a recycling facility.

The Site Auditor expected a significant improvement to occur in surface water quality in the dredge pond after dredging operations had ceased in 2017, recycling operations at the north Benedict site had been significantly scaled back in 2017, and the landform preparation work had been completed.

3.8.4 Assessment of EPL Surface Water Data 2016 - 2018

Ammonium data from EPL surface water compliance monitoring in the dredge pond and the Georges River was provided by EMM for the period 29/01/16 - 21/05/18 (Ref [17]). This dataset spans the time before and after the time that dredging operations ceased at the Benedict site. Concentration - time plots for the three sample locations in the dredge pond are provided in **Figure 3-36**, with the data for the sampling location in the Georges River provided in **Figure 3-37**.

[84] Section 17.1.3, Ref [9]

Figure 3-36 Ammonia Concentration – Time Plots for 2016 – 2018 EPL Surface Water Data in Dredge Pond (Source: Ref [17])

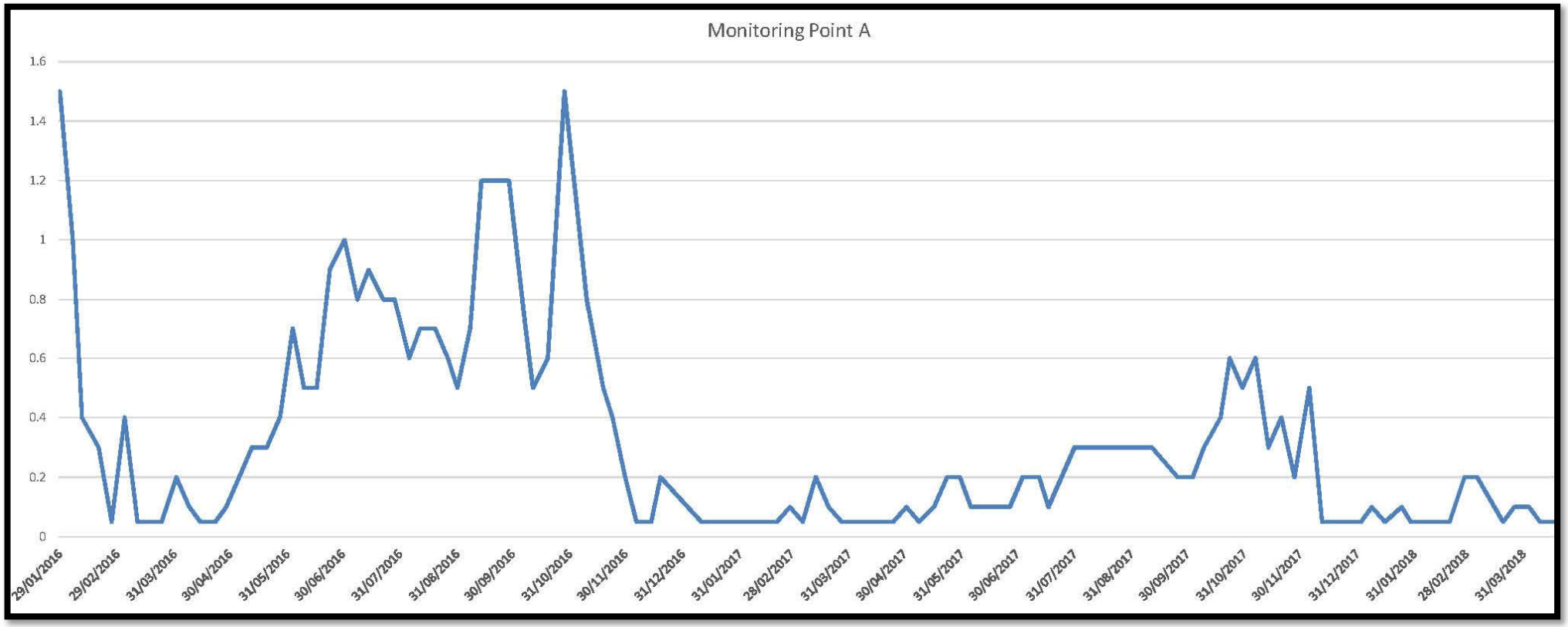


Figure 3-36 (cont'd) Ammonia Concentration – Time Plots for 2016 – 2018 EPL Surface Water Data in Dredge Pond (Source: Ref [17])

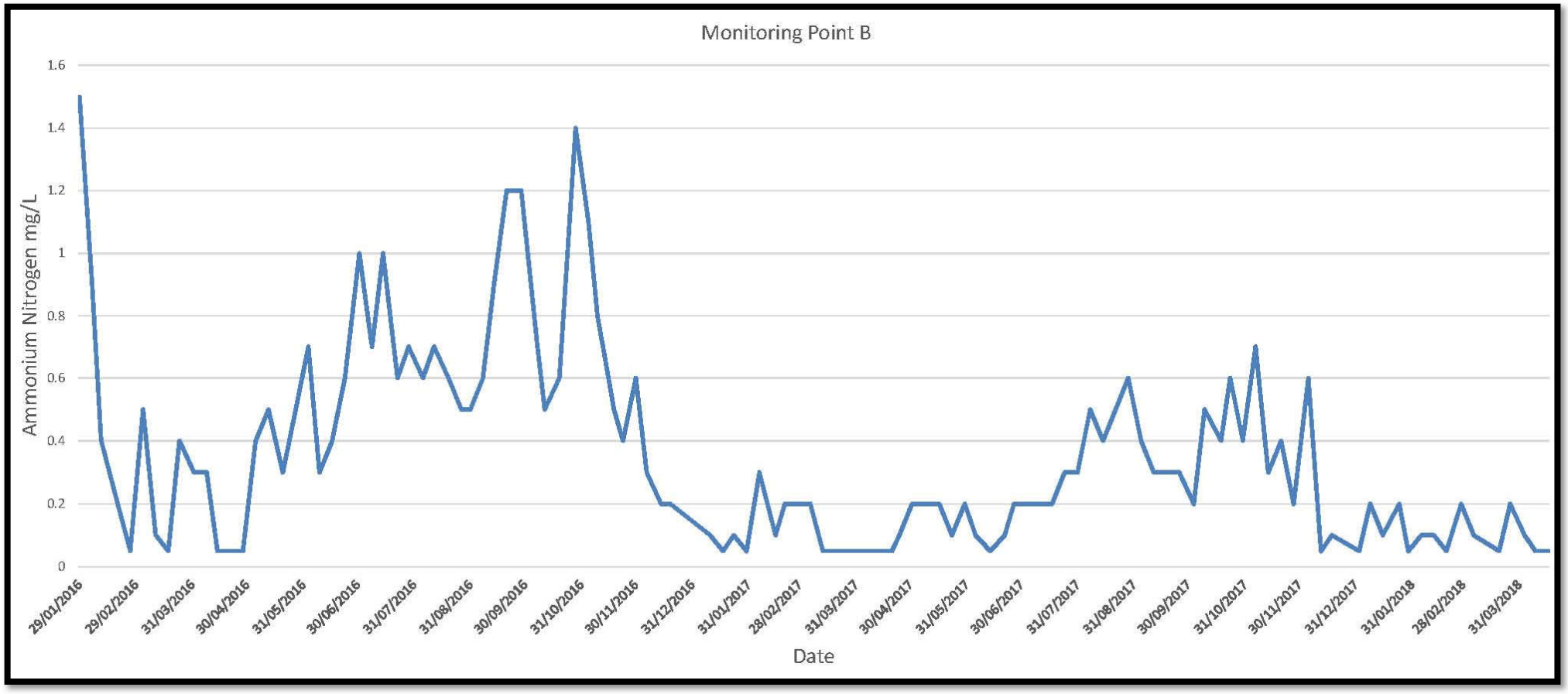


Figure 3-36 (cont'd) Ammonia Concentration – Time Plots for 2016 – 2018 EPL Surface Water Data in Dredge Pond (Source: Ref [17])

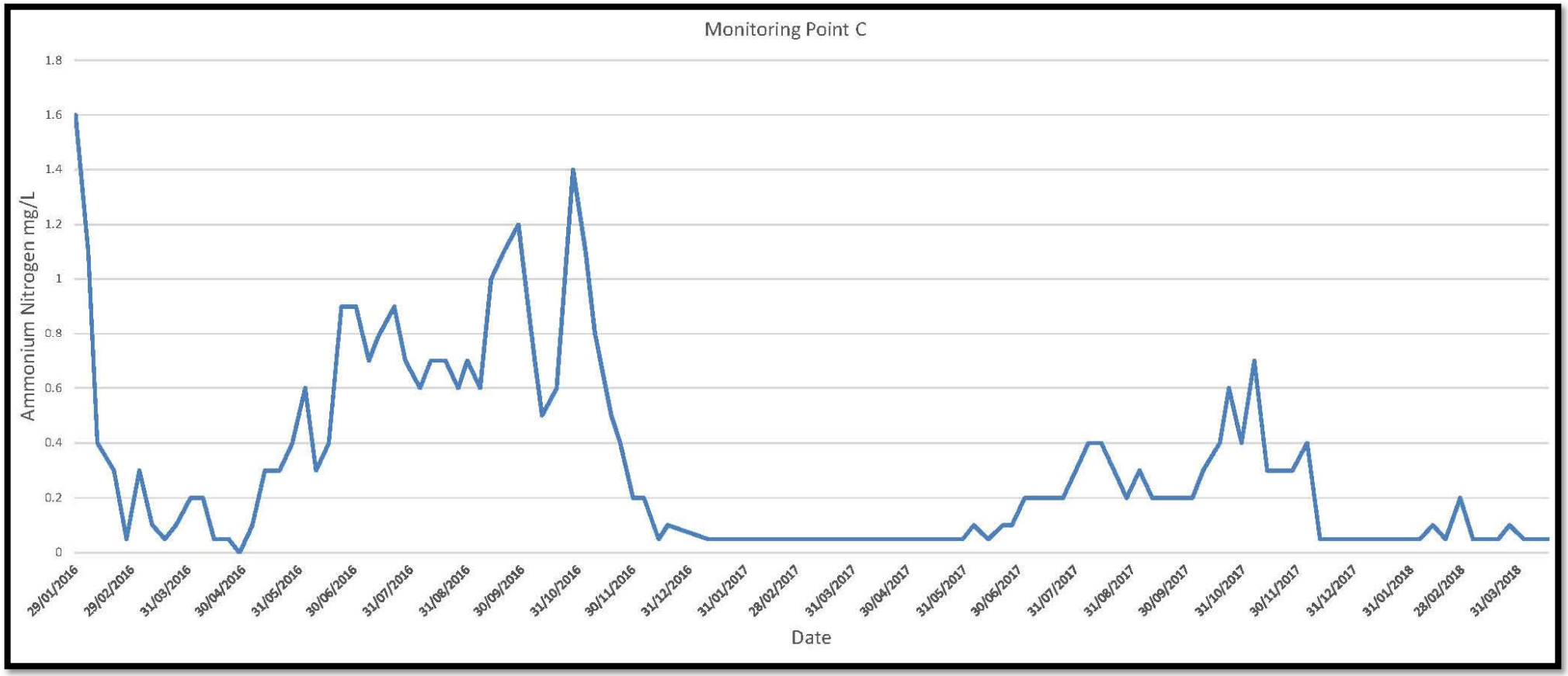
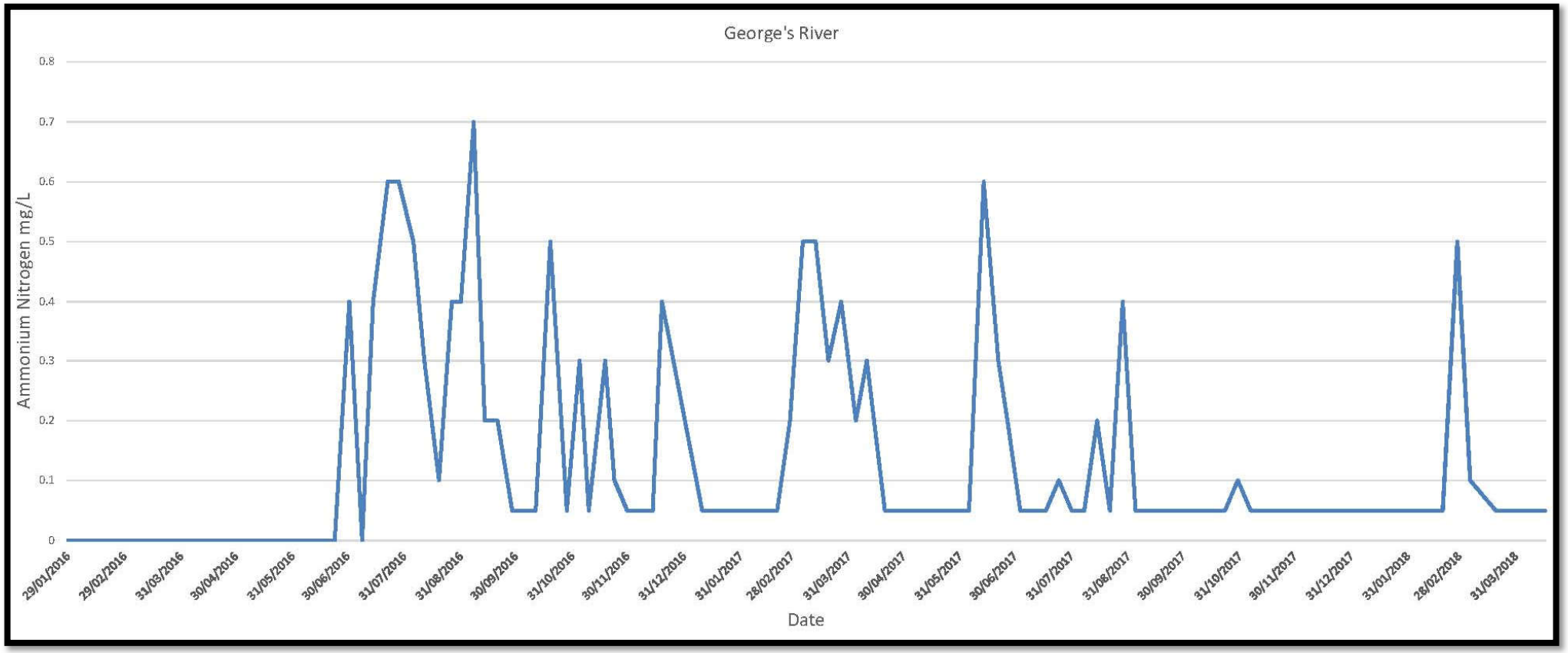


Figure 3-37 Ammonia Concentration – Time Plots for 2016 – 2018 EPL Surface Water Data in Georges River (Source: Ref [17])



The Site Auditor was not provided with copies of laboratory test certificates or other documentation normally included in an investigation report. However, the Site Auditor considers it is reasonable to assume that the data was of a quality acceptable to the NSW EPA since the data was generated and submitted to the NSW EPA as part of an EPL.

The data shows a significant reduction in ammonia concentrations of 5 – 10 times occurred in the dredge pond after dredging ceased in October 2016. Up to October 2016, ammonia concentrations exceeded the marine GIL of 0.91 mg/L. After January 2017, the measured ammonia concentrations in the dredge pond typically ranged from 0.1 to 0.6 mg/L. During the same time period, ammonia concentrations in the Georges River were measured to typically range from 0.1 to 0.6 mg/L.

The EPL monitoring data support the conclusions that, in terms of ammonia levels:

- A significant improvement in surface water quality in the dredge pond occurred when dredging ceased in October 2016;
- Contaminated groundwater is not migrating from the fill material at the Benedict site into the dredge pond or the Georges River; and
- Ammonia levels in the Georges River can vary significantly between sampling events, which is not associated with any activities at the Benedict site.

3.8.5 Assessment of Surface Water Quality – 2017 to 2018

Review of Sample Data

Copies of laboratory summary tables of the surface water tests conducted by DP in 2017 – 2018 are provided in **Appendix A**.

The data provided by the two sample locations (SW1 and SW4) in the Georges River have been reviewed as part of an assessment of background surface water quality in the Georges River, with the results presented in **Section 3.2.5**.

For the two sample locations (SW2 and SW3) in the dredge pond, the 2017 – 2018 data show a significant improvement in surface water quality that was consistent over the 6 sample rounds. Practically all contaminants of concern were measured at low concentrations consistent with or better than[85] the water quality in the Georges River with practically all analytes at concentrations below the SWILs.

The one exception was manganese, where the concentration range was 110 – 230 µg/L and slightly exceeded the marine SWIL of 80 µg/L and the recreational SWIL of 100 µg/L. The background manganese level in the Georges River[86] was calculated to be 78 µg/L (**Section 3.2.5**).

Compliance with DQOs

From the data quality assessment provided in **Section 2**, the Site Auditor considers the 2017 – 2018 data provided by the ESAs regarding the assessment of surface water contamination at the Marina site met the DQOs expected by the NSW EPA for a DSI.

[85] All samples collected from the dredge pond measured phosphorus at <50 µg/L, which was less than the concentration measured in the Georges River which generally ranged between 50 to 80 µg/L.
[86] Mean plus one SD

Assessment of Surface Water Quality

The DP 2018 ESA[87] concluded that since dredging operations ceased in 2017:

- A significant improvement has occurred in surface water quality in the dredge pond;
- Contaminated groundwater is not migrating from the fill material at the Benedict site into the dredge pond or the Georges River;
- No remediation work at the Marina site needs to be done to further improve surface water quality at the Marina site; and
- No further surface water monitoring is required to support these conclusions.

The Site Auditor considers the weight of evidence supports these conclusions. This evidence includes the EPL surface water monitoring results provided for the 29/01/16 - 21/05/18 period (**Section 3.8.4**) and the surface water monitoring data provided for the 2017 – 2018 period reviewed earlier in this section.

3.8.6 Compliance with SEAR 912 Requirements

The SEAR 912 conditions for the proposed marina development (Ref [79]) requires the inadequacies of the dredge pond assessment provided by the ESAs to be addressed. The Site Auditor considers that:

- Additional data relevant to the assessment of surface water contamination risks at the Marina site was reviewed for this SAR. This additional data comprised:
  - A detailed review of the history of the Marina and Benedict sites (**Section 2.1.3**);
  - The review of EPL surface water monitoring data collected for the dredge pond and the Georges River for the period 29/01/16 - 21/05/18 (**Section 3.8.4**);
  - The review of bi-monthly surface water monitoring data collected over a 12 month period between 17/05/17 and 20/03/18 after dredging operations had ceased in October 2016 (**Section 3.8.5**); and
  - The application of the latest ANZG 2018 marine water guidelines for the protection of the aquatic ecosystems and the latest NHMRC (August 2018) drinking water guidelines for the protection of recreational users.
- A significant improvement in surface water quality in the dredge pond has occurred since October 2016 when dredging operations ceased;
- Contaminated groundwater is not migrating from the fill material at the Benedict site into the dredge pond or the Georges River;
- No remediation work at the Marina site needs to be done to further improve surface water quality at the Marina site;
- No further surface water monitoring is required to support these conclusions; and
- The SEAR 912 requirements for the dredge pond assessment, with respect to surface water quality in the dredge pond, have been addressed by this SAR.

[87] Sections 5 & 6, Ref [15]

3.9 Off-site Migration of Contaminants

The ninth check in the NSW EPA decision process is that '*any evidence of, or potential for, migration of contaminants from the site has been appropriately addressed, including potential risks to off-site receptors, and reported to the site owner or occupier*'.

The Site Auditor considers the weight of evidence supports the conclusion that there is a low risk of contaminant migration from the Marina site to potential off-site receptors. This is because:

- Contaminated dredge pond sediments at the Marina site are capable of being prevented from migrating into the Georges River after the proposed marina development has been completed for the reasons given in **Section 3.5.2**;
- There is a low risk of LFG being present at the Marina site and migrating off-site at concentrations and flow rates that would pose unacceptable risks to off-site receptors for the reasons given in **Section 3.6**;
- There is a low risk of contaminated groundwater being present at the Marina site and migrating off-site at concentrations that would pose unacceptable risks of off-site receptors. This is because of the findings of groundwater assessments provided in **Section 3.7** and surface water quality assessments provided in **Section 3.8**; and
- There is a low risk of contaminated surface water being present at the Marina site and migrating off-site at concentrations that would pose unacceptable risks of off-site receptors for the reasons given in **Section 3.8**.

3.10 Assessment of Contamination Risks and Linkages

The Site Auditor considers the data provided by the ESAs shows that there is or a risk of contamination at the Marina site that makes it unsuitable for the proposed Marina development without a program of remediation work. The contamination of concern comprises:

- **Aesthetic issues in soils (Section 3.1.2)**:
  - Some buried fill is likely to contain a high proportion of anthropogenic material;
  - Fragments of bonded asbestos were identified in fill in the two test pits excavated by DP in 2018. It is likely that bonded asbestos contamination is present at other locations at filled areas of the Marina site; and
  - The variability of fill material across the Marina site indicates that the fill was not placed in a controlled and compacted manner.
- **Aesthetic issues in dredge pond sediments and surface water quality (Sections 3.1.3 & 3.1.5)**: Fine-grained sediments that may need to be excavated to construct the marina waterway have the potential to pose an aesthetic impact during the construction period.
- **Soil contamination** (**Section 3.4**):
  - Fragments of bonded asbestos may be randomly scattered across the ground surface at the Marina site. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soil;
  - Some of the fill would be unsuitable in its present form would for remaining at shallow depths and in areas potentially accessible to future users of the Marina site. This is because of fragments of bonded asbestos are likely to be randomly scattered in fill at the site. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soil; and
  - While the 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses, hot-spots of contamination that exceed 2.5 times the SILs are likely to be present. The available data indicates that such hot-spots should be localised and of a manageable number. Such hot-spots will need to be removed from the Marina site or capped with clean soil.

- **Acid sulphate soil (Section 3.4.6)**: The Marina site is located in an ASS risk area. Excavation work undertaken at the Marina site will need to include procedures for managing disturbance to ASS if there was a requirement for deep excavation work to occur, particularly into the natural soils underlying the fill layer.
- **Contaminated sediments in dredge pond (Section 3.5.2)**:
  - The shallow sediments in the dredge pond are contaminated with copper, lead, zinc and possibly mercury at concentrations that exceed background levels in the Georges River and SQGVs. However, all 95% UCL average concentrations were below the SQG-high criteria; and
  - The shallow sediments in the dredge pond are likely to be contaminated by nutrients such as ammonia at concentrations that exceed background levels in the Georges River. This is because ammonia concentrations were measured at 2.4 – 48.6 mg/kg, with higher ammonia concentrations associated with higher organic carbon levels.
- **Hazardous ground gas comprising LFG (Section 3.6)**:
  - Data gaps exist in the characterisation of LFG across the filled areas of the Marina site. However, sufficient data is available to support the adoption of a CGS of 2 for the design of the marina development. Additional LFG monitoring can be undertaken during the design stage, which may justify a reduction in the CGS design parameter;
  - Background methane levels measured at the north-eastern corner of the Marina site indicate that the local estuarine alluvial soils (possibly swamp deposits) are unlikely to be contributing a significant amount of methane to subsurface soils at the Marina site; and
  - Much of the western area of the Marina site is presently part of the dredge pond and does not contain fill material (other than deposited sediments). Consequently, there is a low risk that construction of filled areas required by the proposed development will cause the generation of LFG at levels that will need to be managed provided the fill used to construct these areas contains no degradable material. Such earthwork controls can be documented in a RAP.

3.11 Site Management Strategy

The tenth check in the NSW EPA decision process is that '*the site management strategy (where relevant) is appropriate including post-remediation environmental plans.'*

The EMM 2016 SPI[88] recommended that a RAP should be prepared to address potential acute and/or chronic impacts to the Georges River as a result of elevated metal, nutrient and PAH concentrations in the dredge pond water and sediment. The preliminary RAP should list the conditions for opening the dredge pond to the Georges River to prevent acute impacts. The risk of chronic impacts should be evaluated and appropriate management measures identified.

The Site Auditor considers the weight of evidence supports the need for a program of remediation and validation work at the Marina site to make it suitable for the proposed development and for a RAP to be prepared. However, the Site Auditor has identified additional issues than those mentioned by EMM that the RAP would need to address, as mentioned in **Section 3.10.**

Despite the shortcomings in the EMM recommendations for a RAP, the Site Auditor considers the weight of evidence supports the conclusion that contamination issues that presently exist at the Marina site are capable of being addressed in a feasible and practical manner by implementing procedures documented in a RAP.

For the case of aesthetic issues associated with site soils (**Section 3.1.2**), it is reasonable and practical for a RAP to address these issues based on the available data because:

- There is a low risk of odorous or stained fill being present in significant quantities that may impact the suitability of the site for the intended land uses;

[88] Section 6.2, Ref [7]

- Fill at the Marina site should be capable of being reused for the proposed development appropriate controls are implemented to manage aesthetic issues and contamination such as bonded asbestos fragments;
- There is anthropogenic material in the fill that would be unsuitable for use as shallow soil that may become exposed. Examples of these unsuitable materials include large brick and concrete fragments, tyres and fill containing a high proportion of C&D waste. The presence of this material at the site can be managed by removal or appropriate earthwork controls;
- Bonded asbestos fragments are likely to be present in low concentrations in much of the fill containing C&D waste. The presence of this material needs to be managed by means of an AMP prepared for the earthworks and involve removal, burial and/or capping in-situ;
- The likely extent of aesthetically impacted soil that may need to be remediated will depend on the final design of the proposed development;
- The aesthetic condition of site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls;
- The aesthetic condition of site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls; and
- It should be feasible to manage the presence of additional contamination and/or Unexpected Finds encountered during bulk earthworks by including an appropriate contingency plan and Unexpected Finds protocol.

For the case of aesthetic issues in dredge pond sediments and surface water quality (**Sections 3.1.3 & 3.1.5**), it is reasonable and practical for a RAP to address these issues based on the available data because:

- There is a low risk of odorous or stained shallow sediments being present in significant quantities that may impact the suitability of the site for the intended land uses;
- All sediment in the proposed waterway is expected to remain permanently submerged in the proposed development;
- Any sediment that may need to be disturbed as part of the proposed development could be managed by removal or appropriate earthwork controls;
- The management of fine grained sediments as part of waterway developments in Sydney is a common occurrence;
- Opening of the dredge pond to the Georges River can be programmed to occur towards the end of the proposed marina development;
- Silt curtains can be used to prevent suspended sediments from entering the Georges River during the opening of the dredge pond to the Georges River;
- Monitoring of surface water quality in the dredge pond indicate that the water quality in the dredge pond is similar to background levels in the Georges River after dredging activities in the dredge pond ceased. This means that impacts to the Georges River, if any, would be transient and short term;
- The likely extent of sediment may need to be remediated will depend on the final design of the proposed development; and
- Management measures to minimise the transfer of sediments from the dredge pond to the Georges River can be designed and documented in a RAP, supported by an environmental monitoring program undertaken as part of a validation program.

For the case of soil contamination at the Marina site (**Section 3.4**), it is reasonable and practical for a RAP to address these issues based on the available data because:

- The historical data indicate that the Marina site has no history of chemical use and that the site has been used for dredging. Fill that has been placed at the site mainly consists of sandy / clayey soils contains construction and demolition waste, which has a low leachate generation potential;

- The marina development will involve a major earthworks program that will significantly alter the current landform. This means that the existing quality of shallow soils and existing fill will not be relevant to the risks posed by contamination in the final landform and that such data would best be obtained as part of a validation program undertaken upon completion of the bulk earthworks;
- 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses;
- Visible asbestos can be readily removed from the final ground surface achieved by the proposed development or capped with clean soils;
- Hot-spots of contamination that exceed 2.5 times the SILs, if present, are likely to be localised and of a manageable number;
- The proposed development is reported to involve the removal of fill from the Marina site or its capping with clean soils;
- Fill at the Marina site should be capable of being reused for the proposed development appropriate controls are implemented to manage aesthetic issues and contamination such as bonded asbestos fragments;
- Bonded asbestos fragments are likely to be present in low concentrations in much of the fill containing C&D waste. The presence of this material needs to be managed by means of an AMP prepared for the earthworks and involve removal, burial and/or capping in-situ;
- The likely extent of contaminated soil that may need to be remediated will depend on the final design of the proposed development;
- The remediation of contamination in site soils can be managed by the proposed marina development implementing an appropriate validation program conducted as part of earthwork controls; and
- It should be feasible to manage the presence of additional contamination and/or Unexpected Finds encountered during bulk earthworks by including an appropriate contingency plan and Unexpected Finds protocol.

For the case of ASS excavated at the Marina site (**Section 3.4.6**), it is reasonable and practical for a RAP to address these issues based on the available data because:

- The Marina site is located in an ASS risk area;
- The likely extent of ASS that may need to be excavated will depend on the final design of the proposed development; and
- It is routine practice to manage ASS encountered during site work by implementing procedures documents in an ASS management plan.

For the case of contaminated sediments in the dredge pond (**Section 3.5.2**), it is reasonable and practical for a RAP to address these issues based on the available data because:

- Sufficient data was obtained by the ESAs which meant the contamination status of sediments in the dredge pond is known to a sufficient level to allow the design of a management strategy;
- The management of contaminated sediments as part of waterway developments in Sydney is a common occurrence;
- Opening of the dredge pond to the Georges River can be programmed to occur towards the end of the proposed marina development;
- Silt curtains can be used to prevent suspended sediments from entering the Georges River during the opening of the dredge pond to the Georges River;
- The likely extent of contaminated sediments that may need to be remediated will depend on the final design of the proposed development;

- Monitoring of surface water quality in the dredge pond indicate that the water quality in the dredge pond is similar to background levels in the Georges River after dredging activities in the dredge pond ceased. This means that impacts to the Georges River, if any, would be transient and short term; and
- Management measures to minimise the transfer of sediments from the dredge pond to the Georges River can be designed and documented in a RAP, supported by an environmental monitoring program undertaken as part of a validation program.

For the case of hazardous ground gas comprising LFG **(Section 3.6)**, it is reasonable and practical for a RAP to address these issues based on the available data because:

- A CGS of 2 is considered to represent a conservative basis on which to design the marina development. Additional LFG monitoring undertaken during the design stage may justify a reduction in the CGS design parameter;
- Sufficient data was obtained by the DP 2018 PSI which meant the risks posed by LFG at the Marina site are known to a sufficient level to allow the design of a management strategy;
- Background methane levels measured at the north-eastern corner of the Marina site indicate that the local estuarine alluvial soils (possibly swamp deposits) are unlikely to be contributing a significant amount of methane to subsurface soils at the Marina site;
- Much of the western area of the Marina site is presently part of the dredge pond and does not contain fill material (other than deposited sediments). Consequently, there is a low risk that construction of filled areas required by the proposed development will cause the generation of LFG at levels that will need to be managed provided the fill used to construct these areas contains no degradable material. Such earthwork controls can be documented in a RAP;
- A large amount of LFG data has been collected for the north Benedict site between 2014 and 2018;
- The design of the proposed residential development at the north Benedict site involves a LFG venting system along its southern boundary adjacent to the Marina site. The system design involves a permeable rock retaining wall along the southern boundary adjoining the proposed marina (existing dredge pond). For the eastern part of the boundary, additional protection will be provided by the interface with the proposed waterway. For the western part of the boundary, additional protection will be provided by constructing marina buildings using suspended slabs that will form void spaces;
- It is possible for a LFG venting system to be constructed along the southern boundary of the Marina site using a design similar to that proposed by the residential development to be constructed for the north Benedict site; and
- The nature and extent of LFG mitigation measures that may be required will depend on the final design of the proposed development.

A RAP was prepared by EMM dated March 2016 (Ref [8]). The Site Auditor's review of the RAP is documented in the following section.

4. Assessment of RAP

This section of the SAR assesses the adequacy of a remediation strategy and its compliance with NSW EPA reporting requirements for the Marina site that is to be used for a mix of commercial, recreational and high-density residential development. The remediation strategy was prepared by EMM and documented in a RAP dated 11 March 2016 (Ref [8]), which was prepared as part of documentation for a Development Application (DA).

4.1 Project Background

4.1.1 RAP Objectives

The EMM 2016 RAP[89] advised that its objectives were to:

- Outline the site-specific remediation goals;
- Determine the extent to which remediation is required; and
- Identify management and remediation actions.

The Site Auditor considers these objectives are consistent with regulatory requirements. Other RAP objectives specified in NSW EPA guidelines, SEPP55 guidelines and Liverpool Council's contaminated land policy that also need to be met by the RAP are:

- Set remediation goals that are likely to meet the conditions of a Development Consent so that the redevelopment area will be suitable for the proposed residential land uses and will pose no unacceptable risk to human health or the environment;
- Evaluate the range of remediation options available to address the existing site contamination issues, and thereby reduce risks to acceptable levels;
- Document the preferred remediation techniques and procedures;
- Establish the various safeguards required to complete the remediation work in a safe and environmentally acceptable manner;
- Identify the necessary approvals and licences required by regulatory authorities in order to enable the remediation works to proceed;
- Document a remediation strategy that will address on-site issues affecting future migration of contamination from the site; and
- Document a remediation strategy that will complement other regulatory requirements relevant to the remediation of contamination.

For the purpose of this SAR, the Site Auditor addressed these data gaps in the EMM 2016 RAP by including these additional objectives in this review.

4.1.2 Remediation Goals

The remediation goals stated in the EMM 2016 RAP[90] are to ensure that:

- The Marina site is suitable, from a contamination perspective, for the proposed uses — this will be achieved through the remediation of contaminated soil of the site, including unexpected finds;
- The risks to human health and ecology from onsite contaminant sources are reduced to an acceptable level — this will be achieved through the management and remediation actions during construction and operation of the marina basin; and

[89] Section 1.4, Ref [8]
[90] Section 4, Ref [8]

- The marina development does not increase the risks to the environment from offsite contaminant sources — this will be achieved through management and remediation actions during construction of the marina.

The Site Auditor considers the remediation goals specified by the EMM 2016 RAP are consistent with the following goals specified in NSW EPA guidelines[91], SEPP 55, ecological sustainable development (ESD) principles as specified in the CLM Act, and waste minimisation requirements.

- Render the site suitable for the proposed development. In doing so, the potentially complete exposure pathways between the source and receptors will need to be rendered incomplete;
- Adopt remediation criteria appropriate for the future use of the site to mitigate possible impacts to human health and the environment; and
- Mitigate possible off-site migration of contaminants.

Other remediation goals specified by NSW guidance that also need to be met by the RAP are:

- Demonstrate that the proposed remediation strategy for the site is environmentally justifiable, practical and technically feasible;
- Consider the principles of ecologically sustainable development in line with Section 9 of the Contaminated Land Management Act 1997;
- Minimise waste generation under the Waste Avoidance and Resource Recovery Act 2001; and
- Demonstrate that the plans for site management of remediation work considers issues related to worker health and safety, environmental management, community relations and site contingencies such as unexpected finds.

For the purpose of this SAR, the Site Auditor addressed these data gaps in the EMM 2016 RAP by assessing whether the remediation strategy documented in the RAP is capable of achieving the additional regulatory requirements described above.

4.1.3 Proposed Development

The EMM 2016 RAP[92] describes the proposed development as involving the construction and operation of marina and related facilities across the Marina site. During construction of the marina, a channel will be excavated through the bank of the Georges River, connecting the dredge pond / marina basin to the adjacent Georges River. A plan showing the proposed marina layout was provided in an EIS addendum prepared by EMM dated July 2018 (Ref [13]), with a copy of the plan provided in **Figure 1-4**.

The EMM plan shows the main features of the proposed development are:

- The marina basin and marina infrastructure;
- A large building to the west of the marina that is to be used for commercial operations (ground floor) and overlying residential apartments;
- Carparks along the western and southern sides of the site; and
- Land spits along the eastern side of the site separating it from the Georges River, with a narrow opening connecting the marina basin to the river.

For the purpose of this SAR, the assessment of contamination risks has been based on the following land uses:

- Commercial D for the proposed Marina Building and carpark areas along the western and southern sides of the site;

[91] Section 2.3, NSW EPA (August 2011) "*Guidelines for Consultants Reporting on Contaminated Sites*" and NSW EPA (March 2007) Groundwater Guidelines
[92] Section 1.1, Ref [8]

- Recreation C for open space areas; and
- Residential B for the proposed Marina Building.

4.1.4 SEPP55 Planning Requirements

The SEPP55 guidelines[93] specify four issues that a planning authority needs to consider when a RAP is received, these being:

- Can the site be appropriately remediated? Consider the RAP and any statement by the proponent's consultant certifying that remediation is practical. If necessary, consult a site auditor;
- Are the proposed clean-up criteria appropriate for the future use of the site, considering possible human health and environmental impacts? Consult a site auditor if necessary, or check EPA guidelines;
- Are the proposed plans for remediation work acceptable? For example, do they include an occupational health and safety plan, site environmental management plan, community relations plan, contingency plan? For more information consult the section on RAPs in the EPA's guidelines (1997b); and
- Is a site audit of the RAP necessary?

These issues are also reflected in Council's contaminated land policy.

The Site Auditor considers this SAR has met these requirements because:

- The developer engaged the Site Auditor to conduct a statutory site audit to review the ESAs and RAP;
- The Site Auditor reviewed the feasibility of remediating the Marina site, as documented in **Section 3.11**;
- The Site Auditor reviewed the suitability of the proposed clean-up criteria, as documented in **Section 4.5**; and
- The Site Auditor reviewed the proposed plans for the remediation work, as documented **in Section 4.6 – 4.8**.

4.1.5 NSW EPA Remediation Policy

The NSW EPA policy on the remediation of contaminated sites is specified by the National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended in May 2013 ("NEPM guidelines"). The NEPM guidelines[94] advise that when assessing contamination, the site assessor and others should take into account the preferred hierarchy of options for site clean-up and/or management which is:

- "*on-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and*
- *off-site treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or,*

if the above are not practicable,

- *consolidation and isolation of the soil on site by containment with a properly designed barrier; and*
- *removal of contaminated material to an approved site or facility, followed, where necessary, by replacement with appropriate material;*

or,

- *where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy.*

[93] Section 3.5.4, SEPP55 guidelines
[94] Section 16 in Volume 1 NEPM guidelines

When deciding which option to choose, the sustainability (environmental, economic and social) of each option should be considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking the option.

In cases where no readily available or economically feasible method is available for remediation, it may be possible to adopt appropriate regulatory controls or develop other forms of remediation.

It should be emphasised that the appropriateness of any particular option will vary depending on a range of local factors. Acceptance of any specific option or mix of options in any particular set of circumstances is therefore a matter for the responsible participating jurisdiction."

In this SAR, the Site Auditor assesses the EMM 2016 RAP compliance with NSW EPA remediation policy.

4.2 Documentation Completeness

NSW EPA guidelines[95] specify reporting requirements for a RAP. These and other requirements and the locations in the EMM 2016 RAP where documentation is provided concerning these requirements are summarised in **Table 4-1**.

Table 4-1: Documentation Completeness of EMM 2016 RAP

Item	EPA RAP Reporting Requirements	RAP Section (Ref [8])
1	Background, proposed development, RAP objectives, regulatory framework, scope of work	Section 1
2	Site identification	Section 1.1 & Figure 1.1
3	Site history, site condition, USTs/ASTs, surrounding environment, geology, ASS, hydrogeology, background soil and groundwater quality	Not provided
4	Previous investigations, contamination data, data quality, site characterisation & CSM	Sections 2, 3 & 5
5	Remediation goal	Section 4
6	Extent of remediation required	Sections 2.2 & 3.1
7	Assessment of possible remedial options and how risk can be reduced	Section 5 & Appendix A
8	Rationale for the selection of recommended remedial option	Section 5 & Appendix A
9	Basis for assessment criteria	Sections 2.2, 6.1.1
10	Remediation methodology & procedures	Section 6
11	Proposed testing to validate the site after remediation	Sections 6.1 & 6.2
12	Contingency plan if the selected remedial strategy fails	Section 6.2.2
13	Interim site management plan (before remediation), including e.g. fencing, erection of warning signs, stormwater diversion	Not provided
14	Site management plan (operational phase) – stormwater, soil management, noise, dust, odour, OH&S	Not provided

[95] Section 3.1, NSW EPA (August 2011) "*Guidelines for Consultants Reporting on Contaminated Sites*"

Item	EPA RAP Reporting Requirements	RAP Section (Ref [8])
15	Remediation schedule	Section 2.1, Ref [13]
16	Hours of operation	Not provided
17	Contingency plans to respond to site incidents, to obviate potential effects on surrounding environment and community	Not provided
18	Identification of regulatory compliance requirements such as licences and approvals	Not provided
19	Ongoing site monitoring	Sections 6.2.2 & 6.2.3
20	Names and phone numbers of appropriate personnel to contact during remediation	Not provided
21	Community relations plans, where applicable	Not provided
22	Staged progress reporting, where appropriate	Not provided
23	Long-term site management plan	Not provided
24	Conclusions and recommendations	Section 7.3

Legend:

Inadequate information provided in RAP

The Site Auditor considers the documentation provided in the EMM 2016 RAP did not met the NSW EPA reporting requirements, as shown by **Table 4-1**. The Site Auditor considers these data gaps can be addressed in a RAP addendum.

4.3 Extent of Remediation Required

The EMM 2016 RAP[96] advised that preliminary investigations identified the presence of soil, dredge pond sediment, dredge pond water and groundwater contamination at the Marina site and that this contamination was related to some metals, PAHs, ammonia and nutrients.

4.3.1 Soils

For soils, the EMM 2016 RAP[97] advised that PAHs (principally BaP), copper and zinc concentrations measured in a small number of soil samples exceeded EILs but that the contamination posed a low and acceptable risk to the proposed marina development. In terms of the extent of remediation required, EMM concluded that soil contamination issues do not pose an unacceptable risk to:

- Human health for the proposed development; and
- Ecological receptors because the marina design (i.e. locations of car parks, roads and buildings) will contribute to further reductions in the current risk level. No other ecological criteria applicable to soils will be exceeded.

However, the RAP statement that soil contamination issues do not pose an unacceptable risk was contradicted later in the RAP[98] when it advised that '*Soil in the site contains fill which includes anthropogenic debris. Some locations have elevated BaP, copper and zinc concentrations. Soil remediation will be relatively straight forward with contaminated soils removed or covered by impermeable surfaces. These will be managed through the remediation actions described in Section 6.1, including implementation of an unexpected finds protocol (see*

[96] Section 1.2, Ref [8]
[97] Section 2.2, Ref [8]
[98] Section 3.1, Ref [8]

Section 6.1.2). Given the relative simplicity of the soil contamination, it has not been extensively considered in the CSM other than as a potential source of contamination to the aquatic environment'. The Site Auditor addressed this inconsistency in the RAP by reviewing the available data, with the results documented in **Section 3**.

Based on the results of the review, the Site Auditor considers the available data supports the conclusion that there is or a risk of soil contamination at the Marina site that makes it unsuitable for the proposed Marina development without a program of further investigation and remediation work. The soil contamination of concern comprises:

- **Aesthetic issues in soils (Section 3.1.2)**:
  - Some buried fill is likely to contain a high proportion of anthropogenic material;
  - Fragments of bonded asbestos were identified in fill in the two test pits excavated by DP in 2018. It is likely that bonded asbestos contamination is present at other locations at filled areas of the Marina site; and
  - The variability of fill material across the Marina site indicates that the fill was not placed in a controlled and compacted manner.
- **Soil contamination** (**Section 3.4**):
  - Fragments of bonded asbestos may be randomly scattered across the ground surface at the Marina site. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soil;
  - Some of the fill would be unsuitable in its present form would for remaining at shallow depths and in areas potentially accessible to future users of the Marina site. This is because of fragments of bonded asbestos are likely to be randomly scattered in fill at the site. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soil; and
  - While the 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses, hot-spots of contamination that exceed 2.5 times the SILs are likely to be present. The available data indicates that such hot-spots should be localised and of a manageable number. Such hot-spots will need to be removed from the Marina site or capped with clean soil.
- **Acid sulphate soil (Section 3.4.6)**: The Marina site is located in an ASS risk area. Excavation work undertaken at the Marina site will need to include procedures for managing disturbance to ASS if there was a requirement for deep excavation work to occur, particularly into the natural soils underlying the fill layer.

The Site Auditor considers the EMM 2016 RAP did not define the extent of soil contamination that is present at the Marina site and the extent to which this contamination will need to be remediated. Despite this deficiency in the RAP, the Site Auditor considers that sufficient data exists that has allowed:

- The main soil contamination issues to be identified;
- The conclusion to be made that it will be feasible and practical to remediate contaminated soils present at the Marina site; and
- The conclusion to be made that a RAP addendum can be prepared that is capable of addressing soil contamination risks at the Marina site for the reasons given in **Section 3.11**.

4.3.2 Groundwater, Dredge Pond Water & Sediments

For groundwater, dredge pond water and sediment, the EMM 2016 RAP[99] advised that some metals, PAHs and ammonia have been measured at concentrations that present a potential ecotoxicological risk to the aquatic receiving environment in the Georges River. High nutrient concentrations also present a potential eutrophication risk. In terms of the extent of remediation required, the RAP concluded that:

- The elevated nutrient concentrations in the dredge pond water and the groundwater do not represent a risk to human health as swimming in the pond water (leading to potential ingestion of pond water / groundwater) is unlikely in the context of a commercial marina.
- The elevated BaP and mercury concentrations measured in the dredge pond water were associated with very high TSS concentrations caused by dredging operations that ceased in October 2017. Therefore, these contaminants are not considered to represent an unacceptable risk to human health if sediment remains on the base of the marina and are not resuspended into the water column.
- The highest ecological risks posed by contaminants in the groundwater, dredge pond water, dredge pond sediments are associated with:
  - lead and pyrene in dredge pond sediment;
  - ammonia in groundwater when it discharges to the Georges River;
  - total mercury and ammonia in dredge pond water; and
  - Eutrophication risks are a result of ammonia in the groundwater and ammonia, nitrogen and phosphorus in dredge pond water.

However, the RAP provided no assessment of the extent of remediation required for groundwater, dredge pond water and sediments at the Marina site. The Site Auditor addressed this deficiency by reviewing the available data, with the results documented in **Section 3**.

The Site Auditor considers that the available data supports for conclusion that there is a low risk of contaminated groundwater or surface water in the dredge pond that will need to be remediated, for the reasons given in **Sections 3.7** and **3.8**.

However, the Site Auditor considers the available data supports for conclusion that there are other risks of contamination from sediments at the Marina site that makes it unsuitable for the proposed Marina development without a program of remediation work. The forms of this contamination comprise:

- **Aesthetic issues in dredge pond sediments and surface water quality (Sections 3.1.3 & 3.1.5)**: Fine-grained sediments that may need to be excavated to construct the marina waterway have the potential to pose an aesthetic impact during the construction period.
- **Contaminated sediments in dredge pond (Section 3.5.2)**:
  - The shallow sediments in the dredge pond are contaminated with copper, lead, zinc and possibly mercury at concentrations that exceed background levels in the Georges River and the SQGVs. However, all 95% UCL average concentrations were below the SQG-high criteria; and
  - The shallow sediments in the dredge pond are likely to be contaminated by nutrients such as ammonia at concentrations that exceed background levels in the Georges River. This is because ammonia concentrations were measured at 2.4 – 48.6 mg/kg, with higher ammonia concentrations associated with higher organic carbon levels.

The Site Auditor considers the EMM 2016 RAP did not define the extent of sediment contamination that is present at the Marina site and the extent to which this contamination will need to be remediated / managed. Despite this deficiency in the RAP, the Site Auditor considers that sufficient data exists that has allowed:

- The main sediment contamination issues to be identified;

[99] Section 2.2, Ref [8]

- The conclusion to be made that it will be feasible and practical to remediate / manage contaminated sediments present at the Marina site; and
- The conclusion to be made that a RAP can be prepared that is capable of addressing sediment contamination risks at the Marina site for the reasons given in **Section 3.11**.

4.3.3 LFG

The EMM 2016 RAP made no mention of LFG or the risks that it may pose to the proposed development. The Site Auditor addressed this data gap by reviewing all available data relevant to LFG risks at the Marina site, with the results of the review documented in **Section 3.6**.

The Site Auditor concluded that:

- Data gaps exist in the characterisation of LFG across the filled areas of the Marina site. However, sufficient data is available to support the adoption of a CGS of 2 for the design of the marina development. Additional LFG monitoring can be undertaken during the design stage, which may justify a reduction in the CGS design parameter;
- Background methane levels measured at the north-eastern corner of the Marina site indicate that the local estuarine alluvial soils (possibly swamp deposits) are unlikely to be contributing a significant amount of methane to subsurface soils at the Marina site; and
- Much of the western area of the Marina site is presently part of the dredge pond and does not contain fill material (other than deposited sediments). Consequently, there is a low risk that construction of filled areas required by the proposed development will cause the generation of LFG at levels that will need to be managed provided the fill used to construct these areas contains no degradable material. Such earthwork controls can be documented in a RAP.

Despite this deficiency in the EMM 2016 RAP, the Site Auditor considers that sufficient data exists that has allowed:

- The main LFG contamination issues to be identified;
- The conclusion to be made that it will be feasible and practical to remediate / manage LFG at the Marina site; and
- The conclusion to be made that a RAP addendum can be prepared that is capable of addressing LFG contamination risks at the Marina site for the reasons given in **Section 3.11**.

4.4 Assessment of Remediation Technologies

4.4.1 Contaminated Soils

The EMM 2016 RAP provided no assessment of options for the remediation of contaminated soils at the Marina site. The different types of contaminated soils that will need to be remediated comprise:

- Aesthetically unsuitable fill due to the presence of a high proportion of anthropogenic material;
- Surface soils and fill contaminated with asbestos;
- Hot-spots; and
- ASS that needs to be excavated.

The Site Auditor considers that the remediation options applicable to these types of contaminated soil issues include, but may not be limited to (in order of the preferred NEPM hierarchy):

- Excavation and on-site treatment by screening or liming (for ASS) followed by on-site reuse;
- Excavation / scraping and hen-picking of asbestos fragments;
- Capping;

- Excavation and on-site burial; and
- Excavation and off-site disposal.

The Site Auditor considers these alternate technologies are all feasible and practical for the proposed marina development. The selection of the preferred approach will depend on the final design of the proposed development, cost and other project constraints. The Site Auditor considers this data gap in the EMM 2016 RAP can be addressed by the preparation of a RAP addendum.

4.4.2 Dredge Pond Sediments and Surface Water Quality

The EMM 2016 RAP provided no assessment of options for the remediation of contaminated surface water within the marina basin prior to its connection with the Georges River. The different modes of contamination in the dredged pond that will need to be addressed comprise:

- Contaminated surface water runoff from the north Benedict site flowing into the dredge pond
- Resuspension of dredge pond sediment due to the:
  - Excavation of dredge pond sediment;
  - Construction of the fill platform for the marina building;
  - Driving piles;
  - Dumping of rock rip-rap; and
  - Run-off from construction areas.

The Site Auditor considers that the alternate remediation / management options applicable to these types of contamination issues are matters closely linked with the detailed design of the proposed development and the development of appropriate construction procedures.

For the purpose of the RAP, the Site Auditor considers that a RAP addendum should:

- Assess the potential contamination risks associated with proposed development work in the dredge basin;
- Identify, describe and assess the suitability of alternate construction methodologies that could be used by the proposed development;
- Specify appropriate environmental performance criteria that could be used in specifications for the development work; and
- Specify a monitoring program that will validate compliance with the environmental performance criteria.

4.4.3 LFG

The EMM 2016 RAP provided no details on how LFG risks will be investigated and managed by the proposed development. The Site Auditor identified data gaps in the characterisation of LFG across the filled areas of the Marina site, but that sufficient data is available to support the adoption of a CGS of 2 for the design of the marina development. Additional LFG monitoring can be undertaken during the design stage, which may justify a reduction in the CGS design parameter.

The Site Auditor considers that a RAP addendum can be prepared that considers the alternate remediation / management options applicable for the proposed development designed to mitigate risks posed by a CGS of 2 and for the preferred strategy to then be selected. Alternatively, the data gaps in the assessment of LFG risks can be first addressed by an additional investigation, which may support a lowering of the CGS level to be adopted by a RAP addendum. It is recommended that only passive LFG management strategies be considered by the RAP addendum.

4.5 Remediation Acceptance Criteria

The Remediation Acceptance Criteria (RAC) specified by the EMM 2016 RAP comprised:

- NEPM (2013) HILs and EILs for soils that are to remain at the Marina site[100];
- VENM for imported fill[101];
- There must be no aesthetic issues associated with any fill (e.g. visible debris, staining or odours) that may be exposed when the marina site is operating[102]; and
- Site-specific water quality criteria to be achieved prior to connecting the marina basin to the Georges River based on 90th percentile (i.e. mean plus one SD) of Georges River levels[103].

The Site Auditor considered the RAC specified in the EMM 2016 RAP did not meet NSW EPA requirements because of the following data gaps:

- RACs for addressing aesthetic issues in soils and dredge pond sediments that may need to be excavated;
- The HILs and EILs from the NEPM (2013) that need to be applied to different parts of the Marina site, which vary depending on land use, background concentrations, soil type, depth, Cation Exchange Capacity (CEC), pH, clay content and grain size;
- RACs for the management of ASS that may be excavated;
- RACs for assessing the acceptability of water quality in the dredge pond during construction work prior to connecting the marina basin to the Georges River; and
- RACs for LFG investigation and validation.

The Site Auditor considers these data gaps in the EMM 2016 RAP can be addressed by the preparation of a RAP addendum.

4.6 Remediation Strategy for Contaminated Soils

The EMM 2016 RAP[104] described the remediation strategy for contaminated soils at the Marina site as involving:

1. Prior to commencing any remediation works the dredge infrastructure will be removed. Any signs of contamination (notably staining and petroleum odours) observed during this process will be recorded. If unexpected areas of potential contamination are identified, the Unexpected Finds protocol will be implemented.
2. The need for excavation and/or the introduction of fill for the site will be determined prior to the start of construction. Imported fill needs to be VENM, have an appropriate VENM certificate, be validated by the environmental consultant or certified by the supplier.
3. The existing soil stockpiles in the north of the site and the soil mound in the south of the site will be removed with validation soil samples taken from the stockpile footprints. The Unexpected Finds protocol will be implemented if required.
4. Areas where soil have been identified as having exceedances of the RAC will be remediated through the removal and appropriate disposal of soil and fill, or will be covered with an impermeable surface.
5. Any material proposed for off-site disposal or reuse will be characterised for waste classification in accordance with the NSW EPA Waste Classification Guidelines or with regard to a relevant resource

[100] Section 6.1.1, Ref [8]
[101] Section 6.1.1, Ref [8]
[102] Section 6.1.1, Ref [8]
[103] Section 6.2.2, Ref [8]
[104] Section 6.1, Ref [8]

recovery order and exemption issued under the Protection of the Environment Operations (POEO) Act 1997).

6. A validation survey of areas where soils will remain exposed will be conducted by a qualified environmental consultant following the completion of the landform. This will determine if contamination has been adequately removed, remediated and/or managed and no longer presents an unacceptable risk to human or environmental health.

The Site Auditor considers the contaminated soil remediation strategy described in the EMM 2016 RAP did not meet NSW EPA requirements because of the following data gaps:

- The RACs to be used for the remediation of contaminated soil at the Marina site were not clearly defined;
- Procedures for identifying any signs of contamination observed during the removal of dredging infrastructure;
- The extent of remediation of contaminated soil had not been defined;
- Procedures for identifying aesthetically impacted soils at the Marina site;
- The location, extent and characterisation of contamination in existing soil stockpiles had not been defined and procedures to address this data gap had not been described;
- The RAP considers all soil contamination at the Marina site as an Unexpected Find. The Site Auditor considers such an approach represents poor practice since the types of soil contamination at the Marina site that are described by the EMM 2016 RAP should be expected. The Site Auditor considers that an Unexpected Find should be defined as contamination whose presence at a site is unlikely and cannot reasonably be found by investigations conducted in accordance with regulatory requirements;
- A remediation strategy for aesthetically impacted soil;
- A remediation strategy for asbestos contaminated soil;
- A remediation strategy for the identification and remediation of hot-spots;
- A remediation / management strategy for managing excavated ASS;
- Procedures and protocols for classifying waste at the Marina site;
- Procedures and protocols for validating soils that are to remain at the Marina site; and
- Procedures for tracking excavated materials from cradle-to-grave.

The Site Auditor considers these deficiencies in the EMM 2016 RAP can be addressed by the preparation of a RAP addendum.

4.7 Remediation Strategy for Contaminated Surface Water

The remediation strategy described in the EMM 2016 RAP[105] for managing contamination risks associated with water quality during marina basin construction are summarised in **Table 4-2**.

[105] Section 6.2.2, Ref [8]

Table 4-2: EMM Strategy for Managing Contamination Risks Posed by Dredge Pond Sediments

Contamination Risk	RAP Remediation Strategy
Poor quality of water that existed in the dredge pond in 2016 associated with dredging operations at the Benedict site	Cease dredging (this happened in October 2016)
Contaminated surface water runoff from the north Benedict site flowing into the dredge pond	Construction drains at start of marina development work to intercept these flows
Development work conducted at the Marina site may impact water quality in the marina basin during construction	Connect the marina basin to the Georges River as the final stage of marina basin construction. Monitor the quality of water in the marina basin & only commence connection works when basin water quality is acceptable
Generation of surface water contamination during connection of marina basin to Georges River	Use silt curtains to minimise high TSS water entering the river

The Site Auditor considers the strategies provided in the EMM 2016 RAP for the management of water quality in the marina basin during construction are appropriate but more detail needs to be provided that address the following data gaps:

- RACs needed to be specified for assessing the acceptability of water quality in the marina basin.
- The required performance criteria, design, location and operation of interception drains along the boundary with the north Benedict site.
- Procedures to minimise impacts to water quality within the marina basin were not provided for the different types of construction work that will be required. These include:
  - Construction of the fill platform for the marina building;
  - Driving piles;
  - Excavation of dredge pond sediments;
  - Dumping of rock rip-rap; and
  - Run-off from construction areas.
- Detailed procedures and protocols for monitoring surface water quality in the marina basin. Manganese should also be included in the list of analytes needing to be monitored.
- The required performance criteria, design, location and operation of silt curtains.

4.8 Long-Term Management of Contamination

The EMM 2016 RAP[106] provided measures to manage contamination issues during operation of the marina. The Site Auditor considers these measures should be included in a long-term environment management plan (EMP) that should be attached to a Section A SAS following the plan's written approval by Council.

Additional long-term management measures that should be included in an EMP include, but may not be limited to, measures that:

- Protect any containment cells or capped areas used to remediate the Marina site; and
- Controls required by passive LFG management.

[106] Section 6.2.3, Ref [8]

The preparation of a long-term EMP for managing contamination risks that may remain at the Marina site would meet NSW EPA and Council requirements.

The SEAR 912 conditions for the proposed marina development (Ref [79]) requires the preparation and submission of a long-term EMP for the ongoing management of the Marina site. The Site Auditor considers this requirement can be meet by providing details of the EMP in a RAP addendum.

5. Conclusions

5.1.1 Overview

This SAR contains the results of a Statutory Site Audit for the proposed Georges Cove Marina development ('Marina site'), which is to occupy the southern part of the Benedict Sand & Gravel Moorebank site ('Benedict site') at 146 Newbridge Road, Moorebank. The Benedict site is legally defined as Lot 7 in DP1065574, has an area of 222,740 m^2 (22.274 ha) and is located in the Liverpool City Council LGA.

The Marina site is zoned for Public recreation (RE1), Private recreation (RE2) and Infrastructure Drainage (SP2) and is to be developed for a marina, commercial and apartment buildings, with the waterway to be connected to the Georges River. Benedict and Mirvac also propose to redevelop the northern part of the Benedict site for a residential subdivision, which is the subject of a separate site audit.

The Benedict site has a history of agricultural land use up to the mid-1980's, which included a dairy farm. The land use then changed to industrial, when it was used as a sand quarry that involved a dredging operation. Much of the northern part of the Benedict site was then used as a solid waste landfill (non-putrescible), which filled voids created by sand extraction by mainly demolition waste and raised the elevation of the ground surface to reduce flood risks. The southern part of the Benedict site, which is the Marina site, continued to be used for sand extraction.

From 1997 the Marina site operated as Benedict Sand and Gravel. The northern part of the Benedict site was used as a materials recycling centre, with the industrial operations including among other things quarrying, importing raw materials, fuel storage and dumping of waste materials. The southern part of the Benedict site continued to be used for sand extraction.

The Site Auditor checked the NSW EPA website and found that the Marina site and land within 200 m of it were not recorded as having been Declared land. The NSW EPA website also showed that the Benedict site had been reported to the NSW EPA as a suspected contaminated site under the CLM Act sometime between 2016 and 2017. A former landfill adjacent to the southern boundary of the Benedict site was also reported to the NSW EPA sometime after October 2018. No other land within 200 m of the Marina site has been reported to the NSW EPA.

The purpose of the audit was to determine whether:

- The nature and extent of the contamination had been appropriately determined;
- The RAP was appropriate for a proposed residential land use; and
- The Marina site can be made suitable for the land uses required by the proposed Georges Cove Marina development if it was remediated in accordance with the RAP.

The audit was also prepared as part of a DA for the proposed remediation work and redevelopment of the Marina site. In particular, the SAR and accompanying SAS (**Appendix G**) were prepared to address the Secretary's Environmental Assessment Requirements (SEAR 912) issued for the project.

5.1.2 Review of Nature and Extent of Contamination

For this SAR the Site Auditor has reviewed all available data relevant to the assessment of the nature and extent of contamination at the Marina site and surrounding land that poses a possible contamination risks to the Marina site.

The Site Auditor considers the data provided by the ESAs shows that there is or a risk of contamination at the Marina site that makes it unsuitable for the proposed Marina development without a program of additional investigation and remediation work. The contamination of concern comprises:

- **Aesthetic issues in soils (Section 3.1.2)**:
  - Some buried fill is likely to contain a high proportion of anthropogenic material;

- Fragments of bonded asbestos were identified in fill in the two test pits excavated by DP in 2018. It is likely that bonded asbestos contamination is present at other locations at filled areas of the Marina site; and
- The variability of fill material across the Marina site indicates that the fill was not placed in a controlled and compacted manner.

➢ **Aesthetic issues in dredge pond sediments and surface water quality (Sections 3.1.3 & 3.1.5)**: Fine-grained sediments that may need to be excavated to construct the marina waterway have the potential to pose an aesthetic impact during the construction period.

➢ **Soil contamination** (**Section 3.4**):

- Fragments of bonded asbestos may be randomly scattered across the ground surface at the Marina site. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soil;
- Some of the fill would be unsuitable in its present form would for remaining at shallow depths and in areas potentially accessible to future users of the Marina site. This is because of fragments of bonded asbestos are likely to be randomly scattered in fill at the site. Visible asbestos will need to be removed from the final ground surface achieved by the proposed development or capped with clean soil; and
- While the 95% UCL average contaminant levels are likely to be below the SILs appropriate for the intended land uses, hot-spots of contamination that exceed 2.5 times the SILs are likely to be present. The available data indicates that such hot-spots should be localised and of a manageable number. Such hot-spots will need to be removed from the Marina site or capped with clean soil.

➢ **Acid sulphate soil (Section 3.4.6)**: The Marina site is located in an ASS risk area. Excavation work undertaken at the Marina site will need to include procedures for managing disturbance to ASS if there was a requirement for deep excavation work to occur, particularly into the natural soils underlying the fill layer.

➢ **Contaminated sediments in dredge pond (Section 3.5.2)**:

- The shallow sediments in the dredge pond are contaminated with copper, lead, zinc and possibly mercury at concentrations that exceed background levels in the Georges River and SQGVs. However, all 95% UCL average concentrations were below the SQG-high criteria; and
- The shallow sediments in the dredge pond are likely to be contaminated by nutrients such as ammonia at concentrations that exceed background levels in the Georges River. This is because ammonia concentrations were measured at 2.4 – 48.6 mg/kg, with higher ammonia concentrations associated with higher organic carbon levels.

➢ **Hazardous ground gas comprising LFG (Section 3.6)**:

- Data gaps exist in the characterisation of LFG across the filled areas of the Marina site. However, sufficient data is available to support the adoption of a CGS of 2 for the design of the marina development. Additional LFG monitoring can be undertaken during the design stage, which may justify a reduction in the CGS design parameter;
- Background methane levels measured at the north-eastern corner of the Marina site indicate that the local estuarine alluvial soils (possibly swamp deposits) are unlikely to be contributing a significant amount of methane to subsurface soils at the Marina site; and
- Much of the western area of the Marina site is presently part of the dredge pond and does not contain fill material (other than deposited sediments). Consequently, there is a low risk that construction of filled areas required by the proposed development will cause the generation of LFG at levels that will need to be managed provided the fill used to construct these areas contains no degradable material. Such earthwork controls can be documented in a RAP.

The Site Auditor considers that the nature and extent of contamination at the Marina site has not met DQO's considered appropriate by the NSW EPA for a DSI. Despite these data gaps, the Site Auditor considers the weight of evidence supports the conclusion that contamination issues that presently exist at the Marina site are

capable of being addressed and for the site to be remediated in a feasible and practical manner to a condition suitable for its intended land uses for the reasons given in **Section 3.11**.

5.1.3 Suitability of EMM 2016 RAP

The proposed remediation strategy for the Marina site was documented in a RAP prepared by EMM dated 11 March 2016 (Ref [8]).

The Site Auditor considers the strategies provided in the EMM 2016 RAP for the management of water quality in the marina basin during construction are appropriate provided a more detailed description of the proposed strategy and additional procedures are provided. Data gaps also exist in the EMM 2016 RAP that need to be addressed. These include:

- Documentation that address additional RAP objectives and remediation goals required by regulatory guidance;
- Additional documentation required by NSW EPA reporting guidelines for a RAP;
- Additional remediation acceptance criteria; and
- Strategies for other types of contamination risks that need to be further investigated and/or remediated.

The Site Auditor considers it is important that these data gaps be addressed as part of a detailed design program since the proposed development will involve major changes to the landform including the removal of large quantities of presently stockpiled material. Furthermore, some of the important contamination issues that need to be managed arise from disturbance to sediments that exist in the dredge pond. The detailed design of the proposed development and the development of appropriate construction procedures will allow the further investigation work to better targeted and for a more comprehensive remediation strategy to be prepared in a more optimal manner.

The Site Auditor considers the weight of evidence reported in this SAR supports the conclusion that the Marina site can be made suitable for the land uses proposed by the marina development if the site is remediated in accordance with the EMM 2016 RAP subject to compliance with the following conditions:

1. Prior to the commencement of remediation work, a detailed design program is completed involving:
    a) A building design for the proposed development. Elements of the design relevant to the remediation of the site include, among other things, site layout plans, elevations and plan views, cross-sections, foundation design, use of suspended slabs and natural ventilation under buildings, areas to be sealed by pavement and building slabs, and buried service corridors.
    b) An earthworks plan for the proposed development. Elements of this plan relevant to the remediation of the site include, among other things, a detailed earthworks design, plans showing the areas of the site to be excavated and filled, the types of fill needing to be imported to the site, construction strategies, material management procedures, and accurate surveys of the existing and final ground surface.
    c) Data gap investigations for Area 2 and other fill areas at the site based on the needs of the project design in 1(a) and the earthworks plan in 1(b). The investigations are to involve asbestos in soil, groundwater quality along southern boundary and soil gas monitoring. The quality of existing fill that is to remain at the site also needs to be assessed in accordance with EPA guidance. The data obtained by these investigations is to be documented in a detailed site investigation (DSI) report.
    d) Preparation of a RAP Addendum that is to include documentation that address the data gaps identified in the SAR. This should include, among other things, environmental criteria, an Asbestos Management Plan, an acid sulphate soil management plan, an environmental management plan, protocols for opening the pond to the Georges River, material tracking from cradle-to-grave, contingency planning, validation and monitoring program.
    e) A Long-Term Environmental Management Plan (LTEMP) for the ongoing management of contamination that is to remain at the site.

2. No remediation work is to commence until a Section B SAS has been issued by the Site Auditor concluding that the DSI report, the detailed plans and strategies provided by the RAP Addendum, and the draft LTEMP meet NSW EPA guidance and address the Secretary's Environmental Assessment Requirements (SEAR 912) issued to Council on 9/10/18.
3. If a LTEMP is required by the adopted remediation strategy, no remediation work is to commence until written in-principal approval of the draft LTEMP is provided by the Site Auditor and Council.
4. Any modification to the RAP Addendum should not be implemented without prior written approval of the Site Auditor and Council.
5. Following the completion of remediation work at the site, a Section A SAS is issued by the Site Auditor confirming that the site is suitable for its intended land uses prior to commencement of the built form in that area. If a LTEMP is required by the remediated site, the Section A SAS can only be issued following the Site Auditor's receipt of written approval of the final version of the LTEMP.

The Site Auditor has completed Section B of a SAS, with a copy provided in **Appendix G**.

The Site Auditor has placed two comments on the SAS. These comments record key observations in light of the audit, which are not directly related to the suitability of the Site for the approved land use/s. Some of these observations cover aspects relating to the broader environmental context to aid Council's decision-making in relation to the site. These comments are:

1. This SAS should be read in conjunction with the site audit report (SAR).
2. As required by SEAR 912, the Site Auditor confirms that a DSI report needs to be provided to address potential data gaps between the submitted PSI reports and the RAP.

5.1.4 Compliance with SEAR 912

One of the objectives of this SAR was to consider and address the issues raised in the SEAR 912 conditions, as provided by Council.

These issues and the manner in which they have been addressed by the Site Auditor are documented in relevant sections of this SAR. The Site Auditor considers this SAR has addressed all issues raised in the SEAR 912 conditions.

6. Other Relevant Information

This SAR and the accompanying SAS relates to the proposed Georges Cove Marina development which is to occupy the southern part of the Benedict Sand & Gravel Moorebank site ('Benedict site') at 146 Newbridge Road, Moorebank NSW 2170. This SAR has been prepared in accordance with the Contaminated Land Management Act 1997 (as amended). Opinions and judgements expressed herein, which are based on our understanding and interpretation of current regulatory standards, should not be construed as legal opinions.

The audit report and statement have been prepared for Benedict Industries Pty Ltd (the 'Client') for the purposes nominated in the audit report. It is acknowledged that the audit report and statement may be used by Liverpool City Council and the NSW EPA in reaching their conclusions about the Site. The scope of work performed in connection with the audit review may not be appropriate to satisfy the needs of any other person. Any other person's use of, or reliance on, the audit report and statement, or the findings, conclusions, recommendations or any other material presented in them, is at that person's sole risk.

The audit was, and this report is, limited by and relies on the scope of work undertaken for this audit, the information made available to the Site Auditor by the Client and their environmental consultants through the documents provided to us, and also on our observations of the Marina site made during the audit period. The Site Auditor has taken this information to represent a fair and reasonable characterisation of the status of the land. Whilst all reasonable care has been taken, to the extent practical under normal auditing procedures, to assure adequacy of the information, the Site Auditor and Ian Swane & Associates cannot warrant that this is the case. If the information is subsequently determined to be false, inaccurate or incomplete, it is possible that the Site Auditor's conclusions, as expressed in the audit report and statement may change.

This Site Audit applies to the condition of the Marina site at the time the audit was undertaken. The Site Auditor and Ian Swane & Associates cannot be responsible for future activities that may result in changes to the site conditions. In the event that site conditions have since changed or are likely to change in the future, the Site Auditor recommends that the property owner engage an environmental consultant to confirm that the Site is being properly maintained to a condition suitable for its proposed land uses.

It must also be recognised that sub-surface conditions, including groundwater levels and contaminant concentrations, can change in a limited time. This should be borne in mind if the audit report and statement is used after a protracted delay.

There are always some variations in sub-surface conditions across a site that cannot be fully defined by investigation. No investigation, in practice, can be thorough enough to preclude the presence of materials on the subject property that presently, or in the future, may be considered hazardous. Hence it is possible that the measurements and values obtained from the sampling and testing presented do not represent the extremes of conditions which exist within the site.

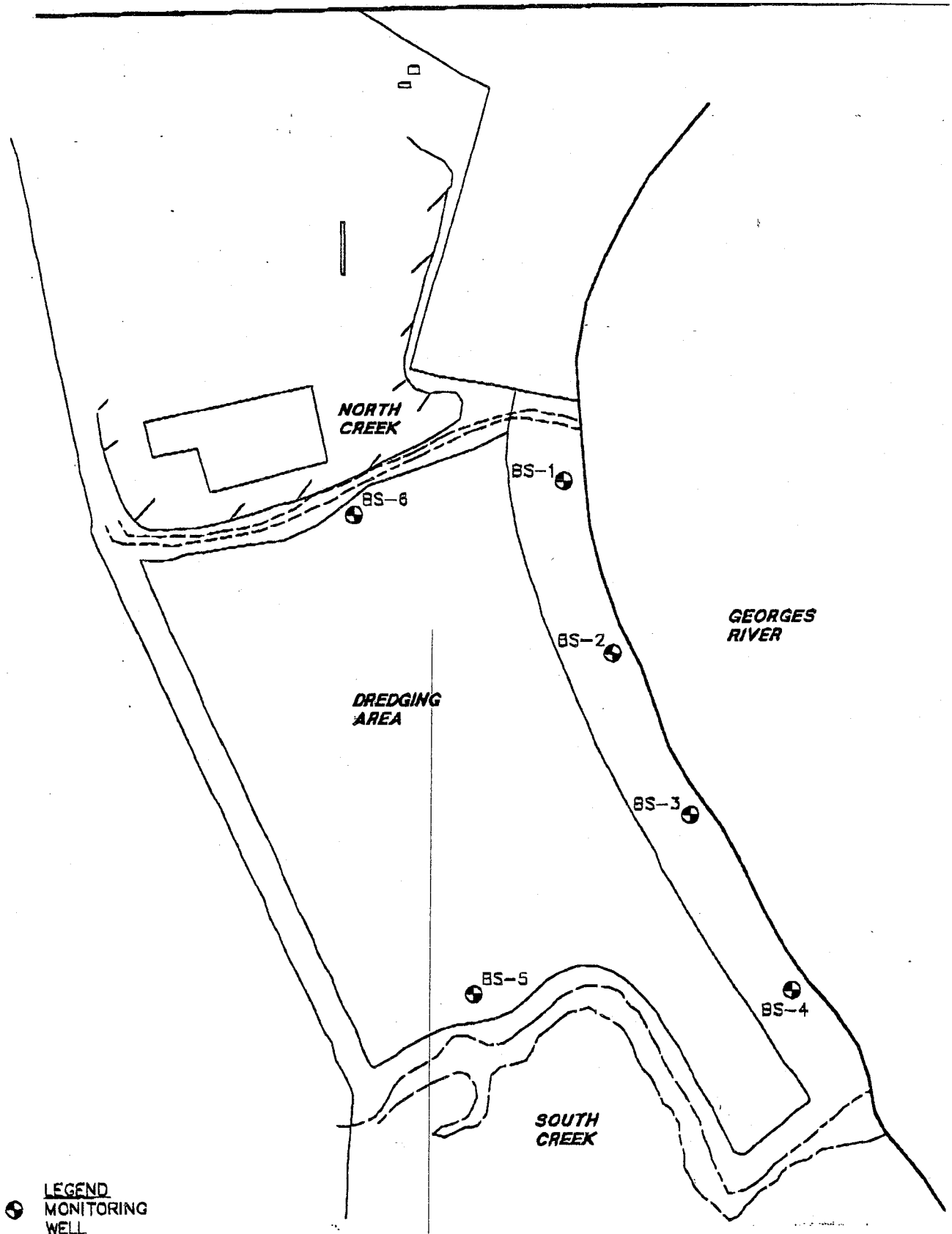
Because regulatory evaluation criteria are constantly changing, concentrations of contaminants present and considered to be acceptable at the time of this audit report and statement, may in the future become subject to different regulatory standards and require reassessment. It is not possible in a Site Audit Report to present all data that could be of interest to all readers of this report. Readers are therefore referred to the referenced documentation for further data.

Yours faithfully

Dr Ian C Swane (CPEng)
Accredited EPA Site Auditor in NSW, WA and NT
Ian Swane & Associates Pty Ltd

Appendix A. Figures & Tables from Investigation Reports for Marina Site

Douglas Partners (June 1999)
Proposed Environmental Monitoring Program



LEGEND
MONITORING WELL

0 100 200m

APPROX. SCALE

FILE: MBK-SITE.DWG
DATE: 08-09-94

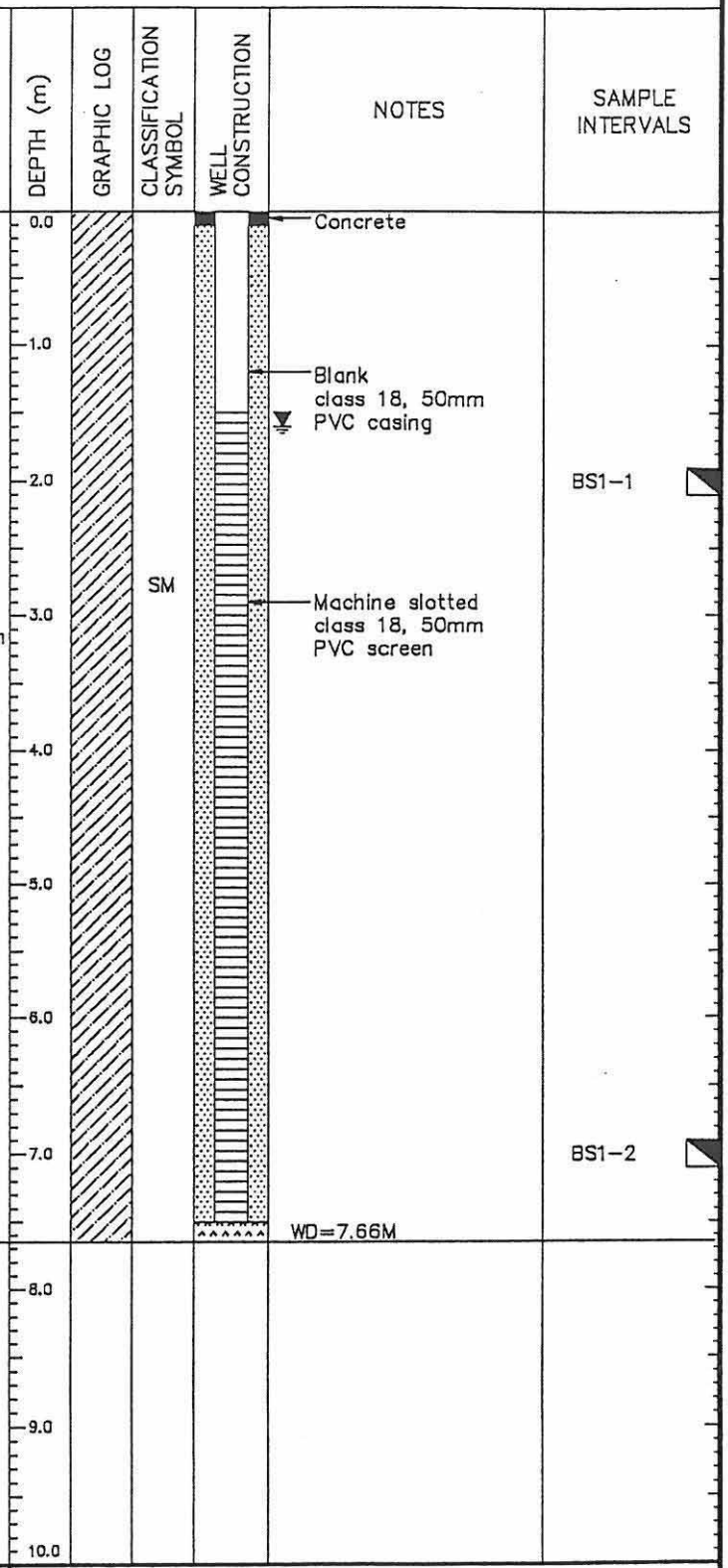
Douglas Partners
Geotechnics, Environmental, Groundwater

Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Singleton, Campbelltown, Townsville, Cairns, Wollongong

TITLE:
Location Map
Benedict Reclamations Waste Recycling Facility
146 Newbridge Road
MOOREBANK

CLIENT: Benedict Reclamations			
DRAWN BY: PSCH	SCALE: As shown	PROJECT No: 27879	OFFICE: SYDNEY
APPROVED BY: [illegible]		DATE: 4/1/1999	DRAWING No: 3

PROJECT: BENEDICT SAND AND GRAVEL	BOREHOLE: BS1	SHEET 1 of 1
Surface elevation: 2.21m AHD	Borehole location: –	
Date: 22–8–94	Drill type: Gemco	
Logged by: N.L. Checked by: M.H.	Drilling method: Hollow stem auger	



BENEDICT SAND AND GRAVEL
SAND EXTRACTION AT ECHO DAIRIES
MOOREBANK, N.S.W.

MONITORING WELL

DAMES & MOORE

29324–001–366

PROJECT: BENEDICT SAND AND GRAVEL	BOREHOLE: BS2	SHEET 1 of 1
Surface elevation: 2.47m AHD	Borehole location: –	
Date: 22–8–94	Drill type: Gemco	
Logged by: N.L. Checked by: M.H.	Drilling method: Hollow stem auger	

SOIL DESCRIPTION (GROUP NAME: colour; particle size; consistency; moisture content; structure; additional comments)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	WELL CONSTRUCTION	NOTES	SAMPLE INTERVALS
SILTY SAND: brown; sand fine gravel; pods of silty material forming cohesive lumps; dry and loose; no odours detected	0.0				Concrete	
as above but moist (not saturated)	1.0				Blank class 18, 50mm PVC casing	
becoming saturated	2.0					BS1–1
Sand fraction becoming coarse and constituting 40–50% of stratum	3.0		SM			
	4.0				Machine slotted class 18, 50mm PVC screen	
	5.0					
	6.0					
	7.0					BS2–2
					WD=7.58M	
END OF BOREHOLE AT 7.75M target depth	8.0					
	9.0					
	10.0					

BENEDICT SAND AND GRAVEL
SAND EXTRACTION AT ECHO DAIRIES
MOOREBANK, N.S.W.

MONITORING WELL

DAMES & MOORE

29324–001–366

PROJECT: BENEDICT SAND AND GRAVEL	BOREHOLE: BS3	SHEET 1 of 1

Surface elevation: 2.56m AHD

Borehole location: –

Date: 22–8–94

Drill type: Gemco

Logged by: N.L. Checked by: M.H.

Drilling method: Hollow stem auger

SOIL DESCRIPTION (GROUP NAME: colour; particle size; consistency; moisture content; structure; additional comments)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	WELL CONSTRUCTION	NOTES	SAMPLE INTERVALS
SILTY SAND: dark brown; sand fine; loose; silt forms cohesive pods; dry; no odours detected	0.0				Concrete	
					Blank class 18, 50mm PVC casing	
	1.0					
becoming moist	2.0					BS3–1
					Machine slotted class 18, 50mm PVC screen	
	3.0		SM			
silty sand; grey black; trace of coarse sand but otherwise fine;	4.0					
	5.0					
	6.0					
					PVC PLUG	
	7.0				WD=6.75M	BS3–2
END OF BOREHOLE AT 7.0M target depth	8.0					
	9.0					
	10.0					

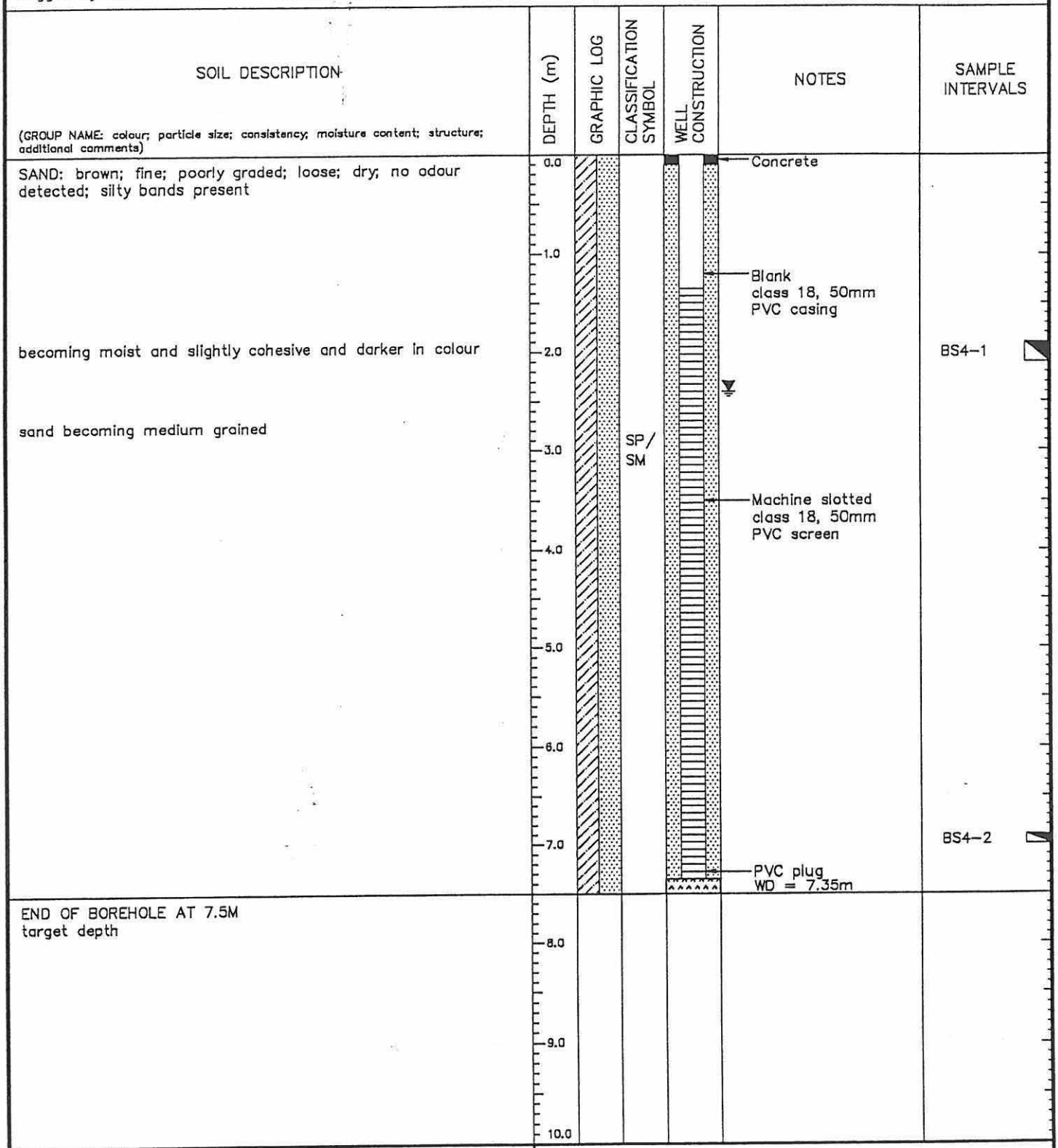
BENEDICT SAND AND GRAVEL
SAND EXTRACTION AT ECHO DAIRIES
MOOREBANK, N.S.W.

MONITORING WELL

DAMES & MOORE

29324–001–366

PROJECT: BENEDICT SAND AND GRAVEL	BOREHOLE: BS4	SHEET 1 of 1
Surface elevation: 2.95m AHD	Borehole location: –	
Date: 23–8–94	Drill type: Gemco	
Logged by: N.L. Checked by: M.H.	Drilling method: Hollow stem auger	



BENEDICT SAND AND GRAVEL
SAND EXTRACTION AT ECHO DAIRIES
MOOREBANK, N.S.W.

MONITORING WELL

DAMES & MOORE

29324–001–366

PROJECT: BENEDICT SAND AND GRAVEL	BOREHOLE: BS5	SHEET 1 of 1

Surface elevation: 2.45m AHD

Borehole location: –

Date: 23–8–94

Drill type: Gemco

Logged by: N.L. Checked by: M.H.

Drilling method: Hollow stem auger

SOIL DESCRIPTION (GROUP NAME: colour; particle size; consistency; moisture content; structure; additional comments)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	WELL CONSTRUCTION	NOTES	SAMPLE INTERVALS
SANDY SILT: rusty brown; loose; cohesive; sand fine; silt low plasticity and slightly moist	0.0				Concrete	
					Blank Class 18 50mm, PVC casing	
	1.0		ML			
as above but becoming moist						
becoming saturated and slightly more sandy; silty sands; grey brown; medium plasticity	2.0		SM			BS5–1
	3.0				Machine Slotted Class 18, 50mm PVC Screen	
slightly lighter brown in colour	4.0					
	5.0					
	6.0					
					PVC PLUG	
	7.0					BS5–2
END OF BOREHOLE AT 7.5M target depth	8.0					
	9.0					
	10.0					

BENEDICT SAND AND GRAVEL
SAND EXTRACTION AT ECHO DAIRIES
MOOREBANK, N.S.W.

MONITORING WELL

DAMES & MOORE

29324–001–366

PROJECT: BENEDICT SAND AND GRAVEL	BOREHOLE: BS6	SHEET 1 of 1

Surface elevation: 1.64m AHD

Borehole location: –

Date: 23–8–94

Drill type: Gemco

Logged by: N.L. Checked by: M.H.

Drilling method: Hollow stem auger

SOIL DESCRIPTION (GROUP NAME: colour; particle size; consistency; moisture content; structure; additional comments)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	WELL CONSTRUCTION	NOTES	SAMPLE INTERVALS
SILTY CLAY: dark brown; soft to firm; moist; slight odour	0.0		CL		Concrete Blank class 18, 50mm, PVC casing	
sandy silts; grey brown; saturated at 1m; grey brown; saturated; sand medium fine; cohesive; no particular odours	1.0		ML		Machine slotted class 18, 50mm PVC screen	BS6–1
Sand content becoming greater and constituting up to 30% of stratum	2.0 3.0 4.0 5.0 6.0					
	7.0				PVC plug	BS6–2
END OF BOREHOLE AT 7.0M target depth	8.0 9.0 10.0					

BENEDICT SAND AND GRAVEL
SAND EXTRACTION AT ECHO DAIRIES
MOOREBANK, N.S.W.

MONITORING WELL

DAMES & MOORE

29324–001–366

EMM (28 July 2015)

PSI

\\Emgammsvr1\emgammJobs\2014\J14149 - 146 Newbridge Road Moorebank\GIS\02_Maps\GW005_SiteBoundary_20150728_10.mxd 28/07/2015

Marina site location and boundary

Georges Core Marina Development
Preliminary Investigation of Contamination

Figure 1.1

\\Emgammsvr1\emgammJobs\2014\J14149 - 146 Newbridge Road Moorebank\GIS\02_Maps\GW007_Stockpiles_20150728_06.mxd 28/07/2015

Approximate location of stockpiles

Georges Core Marina Development
Preliminary Investigation of Contamination

Figure 4.1

\\Emgammsvr1\emgammJobs\2014\J14149 - 146 Newbridge Road Moorebank\GIS\02_Maps\GW008_SurroundingLanduse_20150728_05.mxd 28/07/2015

Surrounding landuse

Georges Core Marina Development
Preliminary Investigation of Contamination

Figure 4.2

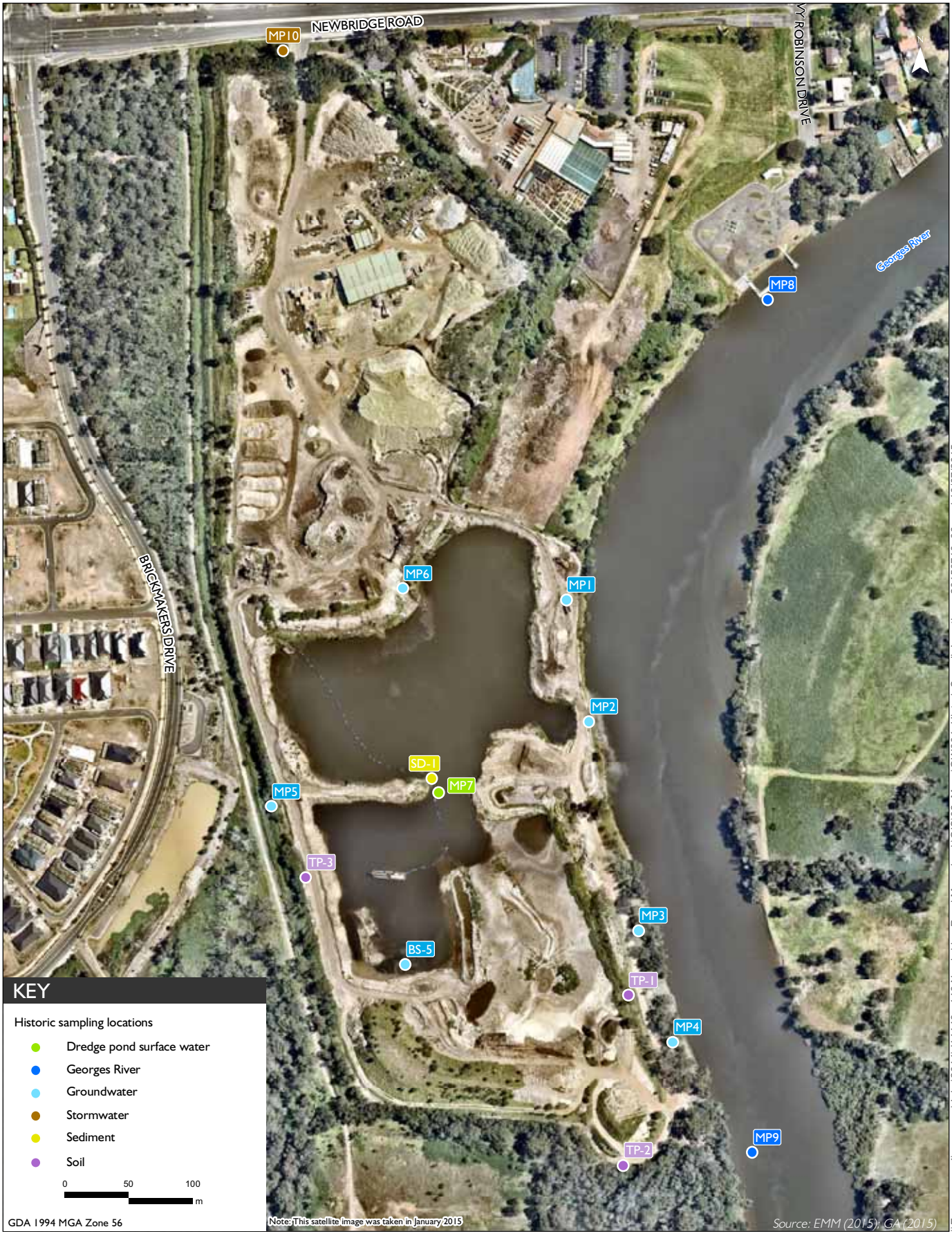
\\Emgammsvr1\emgammJobs\2014\J14149 - 146 Newbridge Road Moorebank\GIS\02_Maps\GW003_SamplingMethodology_20150717_08.mxd 17/07/2015

Preliminary investigation sampling locations

Georges Core Marina Development

Preliminary contaminated land assessment

Figure 6.1



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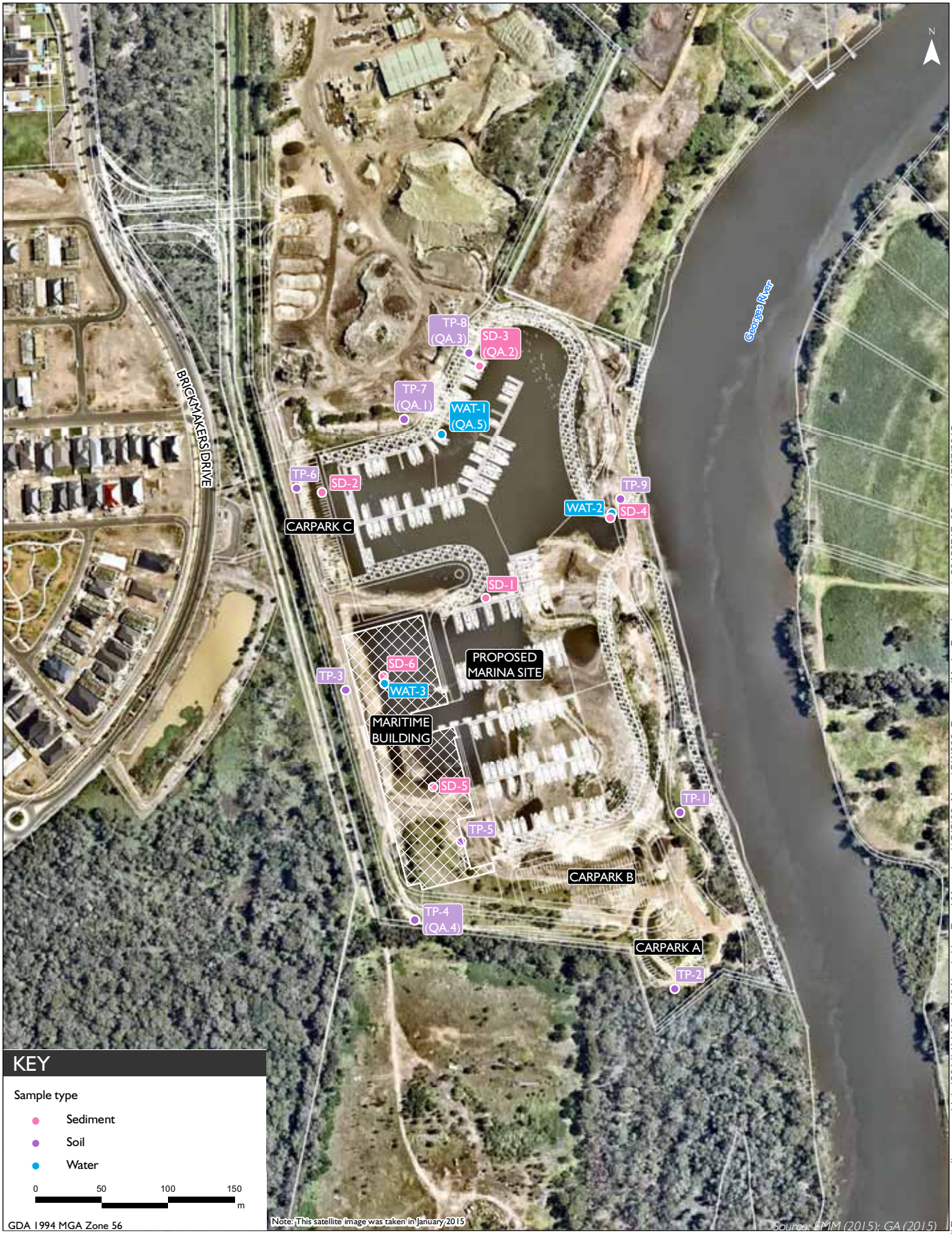
EMM

Historic sampling locations

Georges Core Marina Development

Preliminary contaminated land assessment

Figure 8.1



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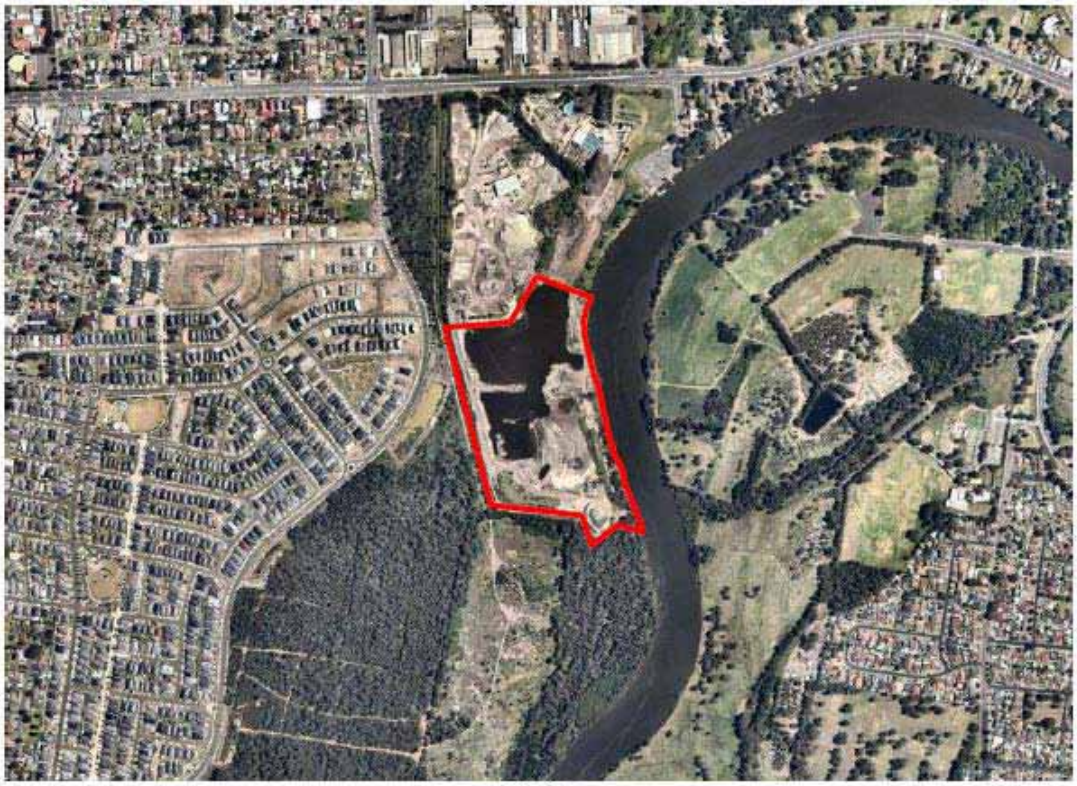
EMM

Sampling locations and proposed development location

Georges Core Marina Development
Preliminary contaminated land assessment
Figure 9.1



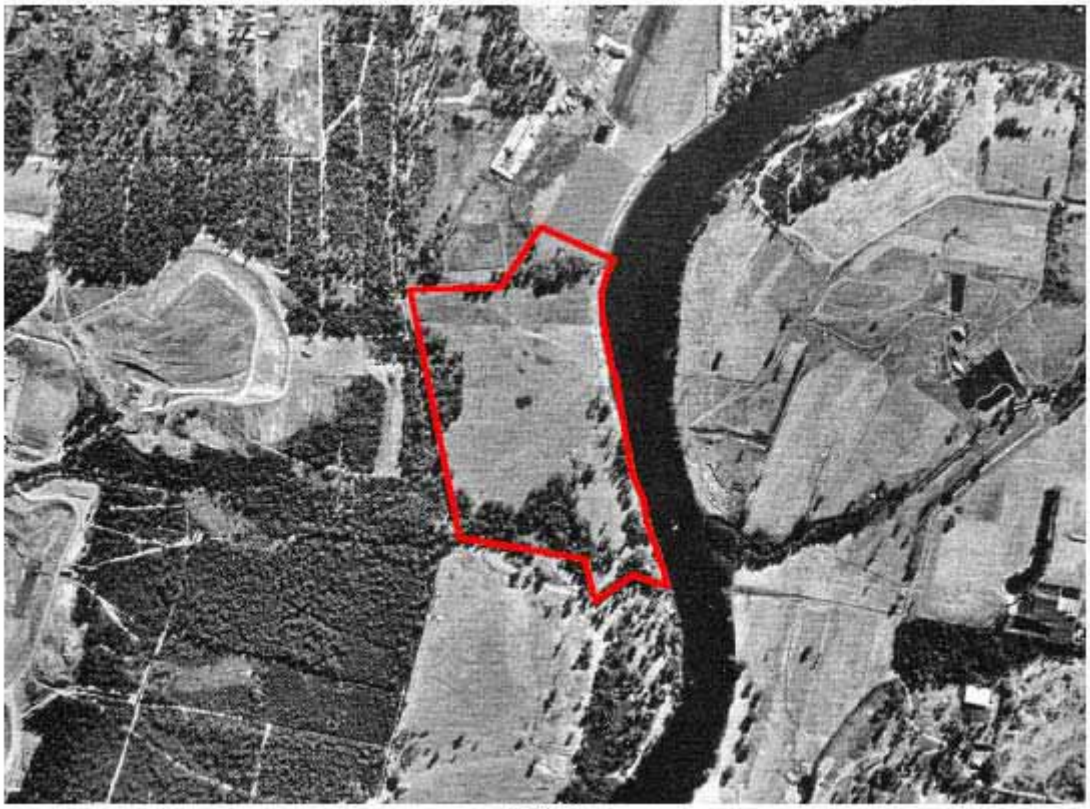
2015

2005

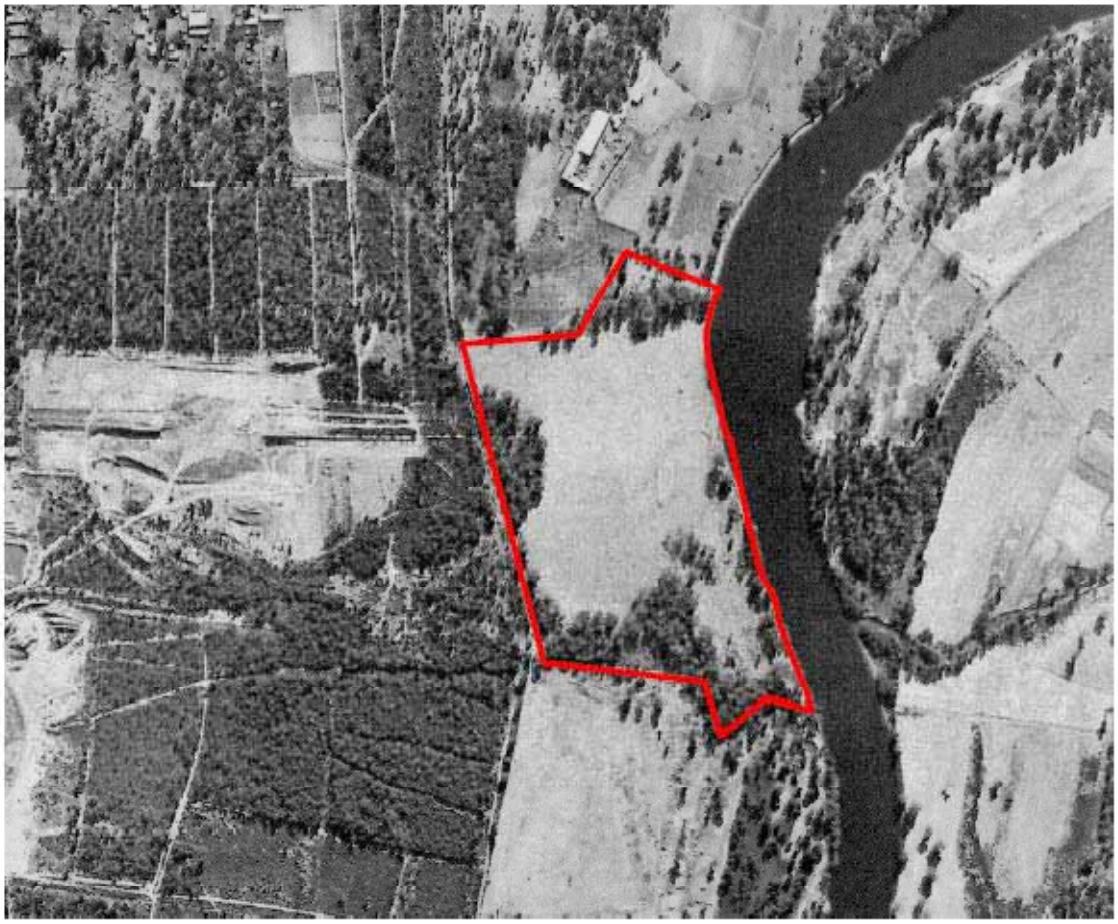
1998

1986

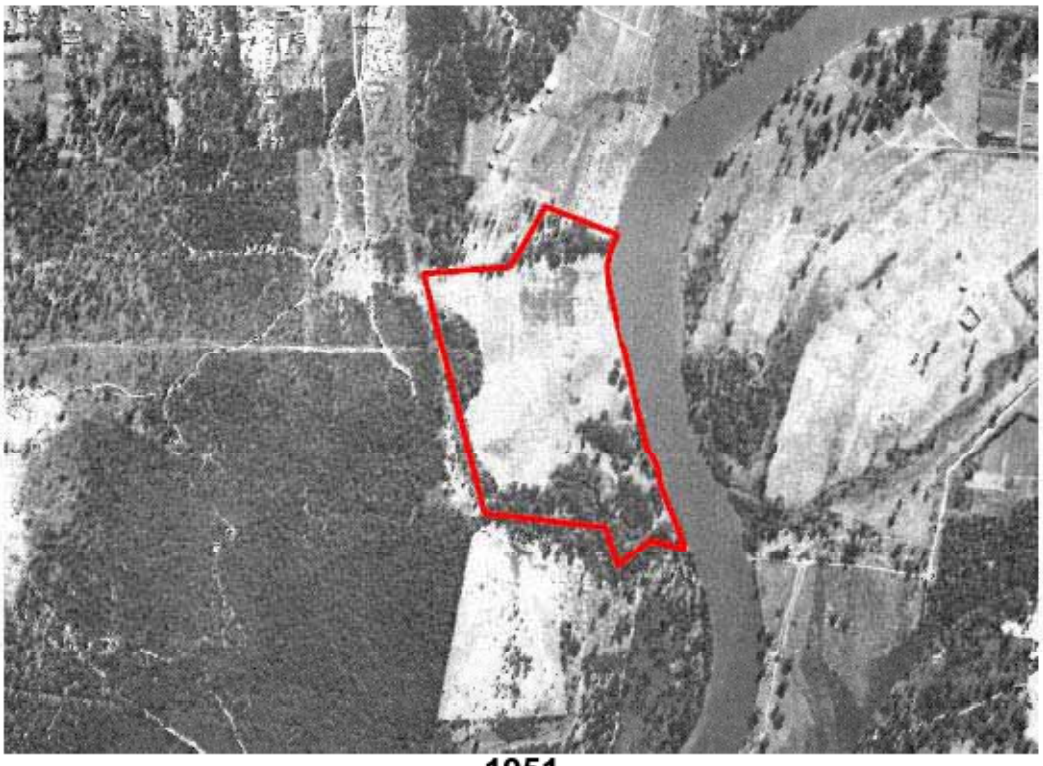
1978



1970



1961



1951

Summary Table 1: historic TPH exceedances above laboratory LOR

Location	Date	C10 - C14 fraction	C15 - C28 fraction	C29 - C36 fraction	C10 - C36 fraction sum
BS1	28/09/1993	<LOR	44	408	36
BS1	13/10/1993	<LOR	50	217	142
BS1	24/11/1993	<LOR	86	288	38
MP1	22/07/1999	<LOR	285	67	352
MP1	20/07/2001	<LOR	270	107	532
MP1	28/02/2001	86	161	<LOR	247
MP1	20/07/2001	<LOR	270	107	377
MP1	24/07/2009	92	170	<LOR	262
MP1	13/01/2011	<LOR	140	<LOR	140
BS2	28/09/1993	<LOR	56	<LOR	56
BS2	27/10/1993	<LOR	79	29	108
BS2	24/11/1993	<LOR	45	<LOR	<LOR
MP2	13/01/2011	<LOR	140	<LOR	140
BS3	28/09/1993	<LOR	53	<LOR	53
BS3	24/11/1993	<LOR	86	<LOR	86
MP3	24/07/2009	<LOR	390	<LOR	390
MP3	13/01/2011	<LOR	120	<LOR	120
BS4	28/09/1993	<LOR	68	<LOR	68
BS4	27/10/1993	<LOR	56	<LOR	56
BS4	24/11/1993	<LOR	37	<LOR	37
MP4	24/07/2009	<LOR	320	<LOR	320
BS5	28/09/1993	<LOR	75	<LOR	75
BS5	13/10/1993	<LOR	73	32	<LOR
BS5	27/10/1993	28	129	44	<LOR
BS5	10/11/1993	<LOR	118	<LOR	<LOR
BS5	24/11/1993	<LOR	102	<LOR	<LOR
MP5	20/07/1999	<LOR	103	50	153
MP5	19/07/2000	50	266	97	153
MP5	28/02/2001	50	483	267	800
MP5	20/07/2001	<LOR	130	137	267
MP5	24/01/2007	180	1020	80	1280
BS6	28/09/1993	<LOR	90	<LOR	<LOR
BS6	13/10/1993	<LOR	89	31	<LOR
BS6	27/10/1993	<LOR	119	25	<LOR
BS6	10/11/1993	<LOR	81	<LOR	<LOR
BS6	24/11/1993	<LOR	142	<LOR	<LOR
MP6	13/07/2009	170	850	190	1210

Summary Table 2 Analytical Results - Soil

Analytes	units	NEPM HIL(B)	NEMP EIL (urban residential & open space)	NEPM HSL (A&B) 0-<1 m, sand	NEPM ESL (urban residential & open space - coarse)	LOR	TP-1 0.5M	TP-2 0.5M	TP-3 0.5M	TP-4 0.5M	TP-5 0.5M	TP-6 0.5M	TP-7 0.5M	TP-8 0.5M	TP-9 0.5M	TP-9 2M	QA.1
Laboratory parameters							3-Jun-15										
pH		-	-	-	-	0.1	7.7	4	7.1	4.8	7.5	8.3	7.8	7.5	7.8	-	7.6
Metals																	
Arsenic	mg/kg	500	100	-	-	5	<5	10	7	8	6	<5	10	6	<5	<5	6
Cadmium	mg/kg	150	-	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	500	-	-	-	2	12	11	18	16	33	3	21	8	10	4	11
Copper	mg/kg	30000	-	-	-	5	17	8	65	9	176	<5	22	67	14	<5	25
Iron	mg/kg	-	-	-	-	50	14200	28600	18300	37400	20600	3060	22800	14500	9200	2900	16900
Lead	mg/kg	1200	-	-	-	5	25	22	112	20	144	7	30	33	24	<5	33
Nickel	mg/kg	1200	-	-	-	2	4	<2	10	9	15	7	14	4	3	<2	12
Zinc	mg/kg	60000	-	-	-	5	37	8	217	25	309	21	61	71	43	<5	108
Mercury	mg/kg	120	-	-	-	0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
TPH																	
C6 - C9 Fraction	mg/kg	-	-	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	-	-	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	-	-	-	-	100	<100	<100	**120**	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	mg/kg	-	-	-	-	100	<100	<100	**140**	<100	<100	<100	<100	<100	<100	<100	<100
C10 - C36 Fraction (sum)	mg/kg	-	-	-	-	50	<50	<50	**260**	<50	<50	<50	<50	<50	<50	<50	<50
TRH																	
C6 - C10 Fraction	mg/kg	-	-	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	-	-	-	180	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction	mg/kg	-	-	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
>C16 - C34 Fraction	mg/kg	-	-	-	300	100	<100	<100	**210**	<100	100	<100	<100	<100	<100	<100	<100
>C34 - C40 Fraction	mg/kg	-	-	-	2800	100	<100	<100	**110**	<100	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)		-	-	-	-	50	<50	<50	**320**	<50	100	<50	<50	<50	<50	<50	<50
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	-	-	110	120	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
BTEX		-	-	-	-												
Benzene	mg/kg	-	-	0.5	50	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	-	-	160	85	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	-	-	55	70	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylenes	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes - Total	mg/kg	-	-	40	105	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	mg/kg	-	170	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PAH		-	-	-	-												
Naphthalene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	**0.6**	<0.5	<0.5	<0.5	<0.5	**0.8**
Anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**2.3**	<0.5	**0.7**	**0.9**	<0.5	<0.5	<0.5	<0.5	**1.2**
Pyrene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**2.2**	<0.5	**0.8**	**0.8**	<0.5	<0.5	<0.5	<0.5	**1.2**
Benz(a)anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**0.9**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	mg/kg	-	-	-	0.7	0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Benzo(g.h.i)perylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of polycyclic aromatic hydrocarbons	mg/kg	400	-	-	-	0.5	<0.5	<0.5	8.9	<0.5	1.5	2.3	<0.5	<0.5	<0.5	<0.5	3.2
Benzo(a)pyrene TEQ (zero)	mg/kg	4	-	-	-	0.5	<0.5	<0.5	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (half LOR)	mg/kg	4	-	-	-	0.5	0.6	0.6	1.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (LOR)	mg/kg	4	-	-	-	0.5	1.2	1.2	1.6	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Total Polychlorinated biphenyls		-	-	-	-	0.05											
Total Polychlorinated biphenyls	mg/kg	1	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Pesticides																	
alpha-BHC	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Hexachlorobenzene (HCB)	mg/kg	15	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
beta-BHC	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
gamma-BHC	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
delta-BHC	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Heptachlor	mg/kg	10	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Aldrin	mg/kg	10	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Heptachlor epoxide	mg/kg		-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
trans-Chlordane	mg/kg		-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Total Chlordane (sum)	mg/kg	90	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
alpha-Endosulfan	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
cis-Chlordane	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Dieldrin	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
4.4`-DDE	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Endrin	mg/kg	20	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
beta-Endosulfan	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Endosulfan (sum)	mg/kg	400	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
4.4`-DDD	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Endrin aldehyde	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Endosulfan sulfate	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.2	-	-	-	<0.2	<0.2	-
4.4`-DDT	mg/kg	-	180	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Endrin ketone	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.2	-	-	-	<0.2	<0.2	-
Methoxychlor	mg/kg	500	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Sum of Aldrin + Dieldrin	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Sum of DDD + DDE + DDT	mg/kg	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
Dichlorvos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Demeton-S-methyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Monocrotophos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.2	-	-	-	<0.2	<0.2	-
Dimethoate	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Diazinon	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Chlorpyrifos-methyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Parathion-methyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.2	-	-	-	<0.2	<0.2	-
Malathion	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Fenthion	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Chlorpyrifos	mg/kg	340	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Parathion	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.2	-	-	-	<0.2	<0.2	-
Pirimphos-ethyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Chlorfenvinphos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Bromophos-ethyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Fenamiphos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Prothiofos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Ethion	mg/kg	-	-	-	-	0.5	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Carbophenothion	mg/kg	-	-	-	-	0.5	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-
Azinphos Methyl	mg/kg	-	-	-	-	0.5	-	-	-	-	<0.05	-	-	-	<0.05	<0.05	-

National Environment Protection Council (NEPC) (Assessment of Site Contamination) Measure 1999 (as amended in 2013a), *Schedule B1 Guideline on Investigation Levels for Soil and Groundwater.*

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Summary Table 3 Analytical Results - Dredge Pond Sediment

Analytes	units	ISQG (low)	ISQG (high)	LOR	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6	QA.2
Laboratory parameters					3-Jun-15						
pH		-		0.1	8.9	7.9	8.3	8	8.1	7.8	8.3
Metals											
Arsenic	mg/kg	20	70	5	<5	<5	<5	6	15	<5	<5
Cadmium	mg/kg	1.5	10	1	<1	<1	<1	<1	1	<1	<1
Chromium	mg/kg	80	370	2	13	<2	3	10	33	9	3
Copper	mg/kg	65	270	5	33	<5	16	26	96	21	6
Iron	mg/kg	-	-	50	9080	1660	2660	12200	31300	11800	2660
Lead	mg/kg	50	220	5	90	20	12	38	268	49	11
Nickel	mg/kg	21	52	2	8	<2	2	7	17	6	<2
Zinc	mg/kg	200	410	5	148	16	44	67	316	60	43
Mercury	mg/kg	0.15	1	0.1	0.2	<0.1	<0.1	<0.1	0.5	<0.1	<0.1
Nutrients											
Ammonia as N	mg/kg	-	-		45.1	2.4	10.2	7.8	48.6	8.1	-
Total organic carbon	%	-	-		1.75	0.32	0.66	1.15	1.92	1.04	-
TPH											
C6 - C9 Fraction	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	-	-	50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	-	-	100	**110**	<100	<100	<100	**180**	**120**	<100
C29 - C36 Fraction	mg/kg	-	-	100	**130**	<100	<100	<100	**460**	**120**	<100
C10 - C36 Fraction (sum)	mg/kg	-	-	250	**240**	<50	<50	<50	**640**	**240**	<50
TRH											
C6 - C10 Fraction	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	-	-	50	<10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction	mg/kg	-	-	100	<50	<50	<50	<50	<50	<50	<50
>C16 - C34 Fraction	mg/kg	-	-	100	**190**	<100	<100	<100	**490**	**200**	<100
>C34 - C40 Fraction	mg/kg	-	-	50	<100	<100	<100	<100	**340**	<100	<100
>C10 - C40 Fraction (sum)	mg/kg	-	-	50	**190**	<50	<50	<50	**830**	**200**	<50
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	-	-		<50	<50	<50	<50	<50	<50	<50
BTEX		-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylenes	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	mg/kg	-	-	0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	-	-	0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Xylenes - Total	mg/kg	-	-	1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	mg/kg	160	2100								
PAH				0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	mg/kg	160	2100	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	mg/kg	44	640	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	mg/kg	16	500	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	mg/kg	19	540	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**3.6**	<0.5
Phenanthrene	mg/kg	240	1500	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene	mg/kg	85	1100	0.5	**0.9**	<0.5	<0.5	<0.5	**2.2**	**4**	<0.5
Fluoranthene	mg/kg	-		0.5	**0.9**	<0.5	<0.5	0.5	**2.4**	**4.2**	<0.5
Pyrene	mg/kg	665	2600	0.5	<0.5	<0.5	<0.5	<0.5	**0.9**	**1.5**	<0.5
Benz(a)anthracene	mg/kg	261	1600	0.5	<0.5	<0.5	<0.5	<0.5	**0.9**	**1.4**	<0.5
Chrysene	mg/kg	384	2800	0.5	<0.5	<0.5	<0.5	<0.5	**0.9**	**1**	<0.5
Benzo(b+j)fluoranthene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	**1.2**	**1.3**	<0.5
Benzo(a)pyrene	mg/kg	430	1600	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	mg/kg	63	260	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	mg/kg	-	-	0.5	**1.8**	<0.5	<0.5	0.5	**8.5**	**17**	<0.5
Sum of polycyclic aromatic hydrocarbons	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	1.4	1.6	<0.5
Benzo(a)pyrene TEQ (zero)	mg/kg	-	-	0.5	0.6	0.6	0.6	0.6	1.7	1.9	0.6
Benzo(a)pyrene TEQ (half LOR)	mg/kg	-	-	0.5	1.2	1.2	1.2	1.2	2	2.2	1.2
Benzo(a)pyrene TEQ (LOR)		-	-	0.05							
Total Polychlorinated biphenyls				0.05	-	-	<0.05	-	-	<0.05	<0.05
Total Polychlorinated biphenyls	mg/kg	23	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Pesticides											
alpha-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Hexachlorobenzene (HCB)	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
beta-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
gamma-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
delta-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Heptachlor	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Aldrin	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Heptachlor epoxide	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
trans-Chlordane	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Total Chlordane (sum)	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
alpha-Endosulfan	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
cis-Chlordane	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Dieldrin	mg/kg	0.02	8	0.05	-	-	<0.05	-	-	<0.05	<0.05
4.4`-DDE	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Endrin	mg/kg	0.02	8	0.05	-	-	<0.05	-	-	<0.05	<0.05
beta-Endosulfan	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Endosulfan (sum)	mg/kg	-	-	0.2	-	-	<0.05	-	-	<0.05	<0.05
4.4`-DDD	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Endrin aldehyde	mg/kg	-	-	0.2	-	-	<0.2	-	-	<0.2	<0.2
Endosulfan sulfate	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
4.4`-DDT	mg/kg	-	-	0.05	-	-	<0.2	-	-	<0.2	<0.2
Endrin ketone	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Methoxychlor	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Sum of Aldrin + Dieldrin	mg/kg	-	-	0.2	-	-	-	-	-	-	-

Sum of DDD + DDE + DDT	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Dichlorvos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Demeton-S-methyl	mg/kg	-	-	0.05	-	-	<0.2	-	-	<0.2	<0.2
Monocrotophos	mg/kg	-	-	0.2	-	-	<0.05	-	-	<0.05	<0.05
Dimethoate	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Diazinon	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Chlorpyrifos-methyl	mg/kg	-	-	0.05	-	-	<0.2	-	-	<0.2	<0.2
Parathion-methyl	mg/kg	-	-	0.2	-	-	<0.05	-	-	<0.05	<0.05
Malathion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Fenthion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Chlorpyrifos	mg/kg	-	-	0.05	-	-	<0.2	-	-	<0.2	<0.2
Parathion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Pirimphos-ethyl	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Chlorfenvinphos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Bromophos-ethyl	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Fenamiphos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Prothiofos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Ethion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Carbophenothion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05	<0.05
Azinphos Methyl	mg/kg	-	-	0.05	-	-	<0.06	-	-	<0.05	<0.05

Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) 2000 *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

Summary Table 4 Analytical Results - Dredge Pond Surface Water									
Analyte	**unit**	**ANZECC/ARMCANZ 95% protection (freshwater)**	**ANZECC/ARMCANZ 95% protection (marine)**	**NHMRC 2008 Risks in Recreational Water**	LOR	WAT-1	WAT-2	WAT-3	QA.5
Field parameters						3-Jun-15			
Temperature	°C	-	-	-		16	14.7	15.1	16
EC	uS/cm	125-2200*	-	-		7392	7314	7305	7392
pH	pH units	-	-	-		7.73	7.44	7.54	7.73
Dissolved oxygen	mg/L	-	-	-		4.76	9.78	8.81	4.76
Redox	mV	-	-	-		-49.4	-15.5	-27.6	-49.4
Laboratory parameters									
pH		-	-	-	0.01	7.7	7.76	7.78	7.33
Metals									
Arsenic	mg/L	0.013	ID	0.07		0.004	0.003	0.003	0.003
Cadmium	mg/L	0.0002	0.0055	-		<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0044	0.5		<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.0014	0.0013	20		<0.001	0.001	0.001	0.001
Iron	mg/L	ID	ID	-		0.07	0.12	0.13	0.1
Lead	mg/L	0.0034	0.0044	0.1		<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.011	0.07	0.2		0.005	0.005	0.005	0.005
Zinc	mg/L	0.008	0.015	-		0.008	0.008	0.007	0.01
Nutrients									
Ammonia (as N)	mg/L	0.01*	0.01*	-	0.01	11.6	13.1	13.2	12.1
PAH									
Naphthalene	ug/L	16	70	-	1	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Acenaphthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Fluorene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Phenanthrene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Anthracene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Fluoranthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Pyrene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Chrysene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	ug/L	-	-	0.0001	0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0
Sum of polycyclic aromatic hydrocarbons	ug/L	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)	ug/L	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5
TPH									
C6 - C9 Fraction		-	-	-	20	<20	<20	<20	<20
C10 - C14 Fraction		-	-	-	50	<50	<50	<50	<50
C15 - C28 Fraction		-	-	-	100	<100	<100	<100	<100
C29 - C36 Fraction		-	-	-	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)		-	-	-	50	<50	<50	<50	<50
TRH									
C6 - C10 Fraction		-	-	-		<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)		-	-	-	20	<20	<20	<20	<20
>C10 - C16 Fraction		-	-	-	100	<100	<100	<100	<100
>C16 - C34 Fraction		-	-	-	100	<100	<100	<100	<100
>C34 - C40 Fraction		-	-	-	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)		-	-	-	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)		-	-	-	100	<100	<100	<100	<100
BTEX									
Benzene		0.95	0.7	0.01	1	<1	<1	<1	<1
Toluene		ID	ID	8	2	<2	<2	<2	<2
Ethylbenzene		ID	ID	3	2	<2	<2	<2	<2
meta- & para-Xylene		ID	ID	-	2	<2	<2	<2	<2
ortho-Xylene		0.35	ID	-	2	<2	<2	<2	<2
Total Xylenes		ID	ID	6	2	<2	<2	<2	<2
Sum of BTEX		-	-	-	1	<1	<1	<1	<1
Naphthalene		0.016	0.07	-	5	<5	<5	<5	<5

* = freshwater rivers

EMM
EMGA Mitchell McLennan

Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) 2000 *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

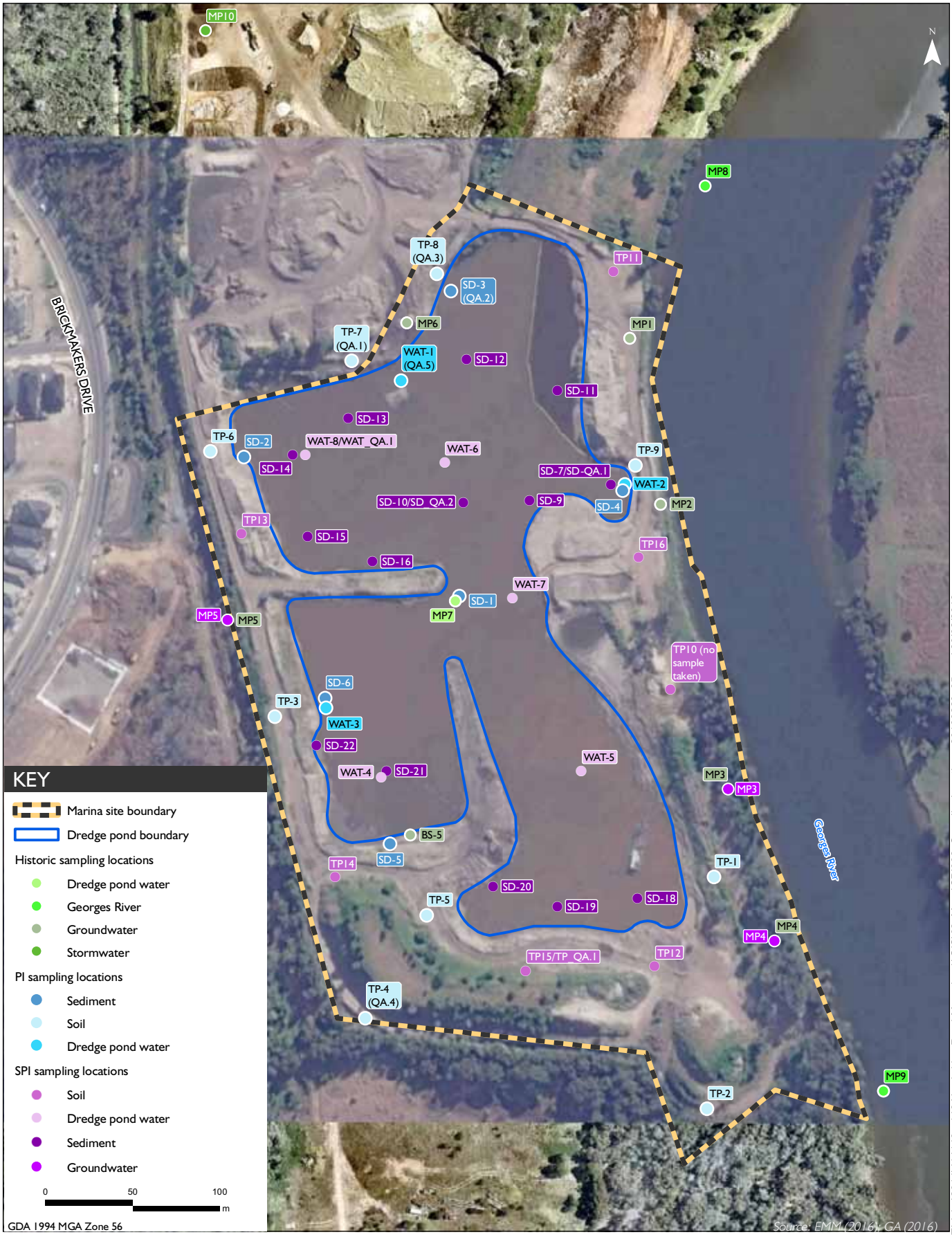
National Health and Medical Research Council (NHMRC) 2008 Guidelines for Managing Risks in Recreational Water

EMM (11 March 2016)
Supplementary Preliminary Investigation

Marina site location and boundary

Georges Cove Marina Development
Supplementary Preliminary Investigation

Figure 1.1



Sampling locations

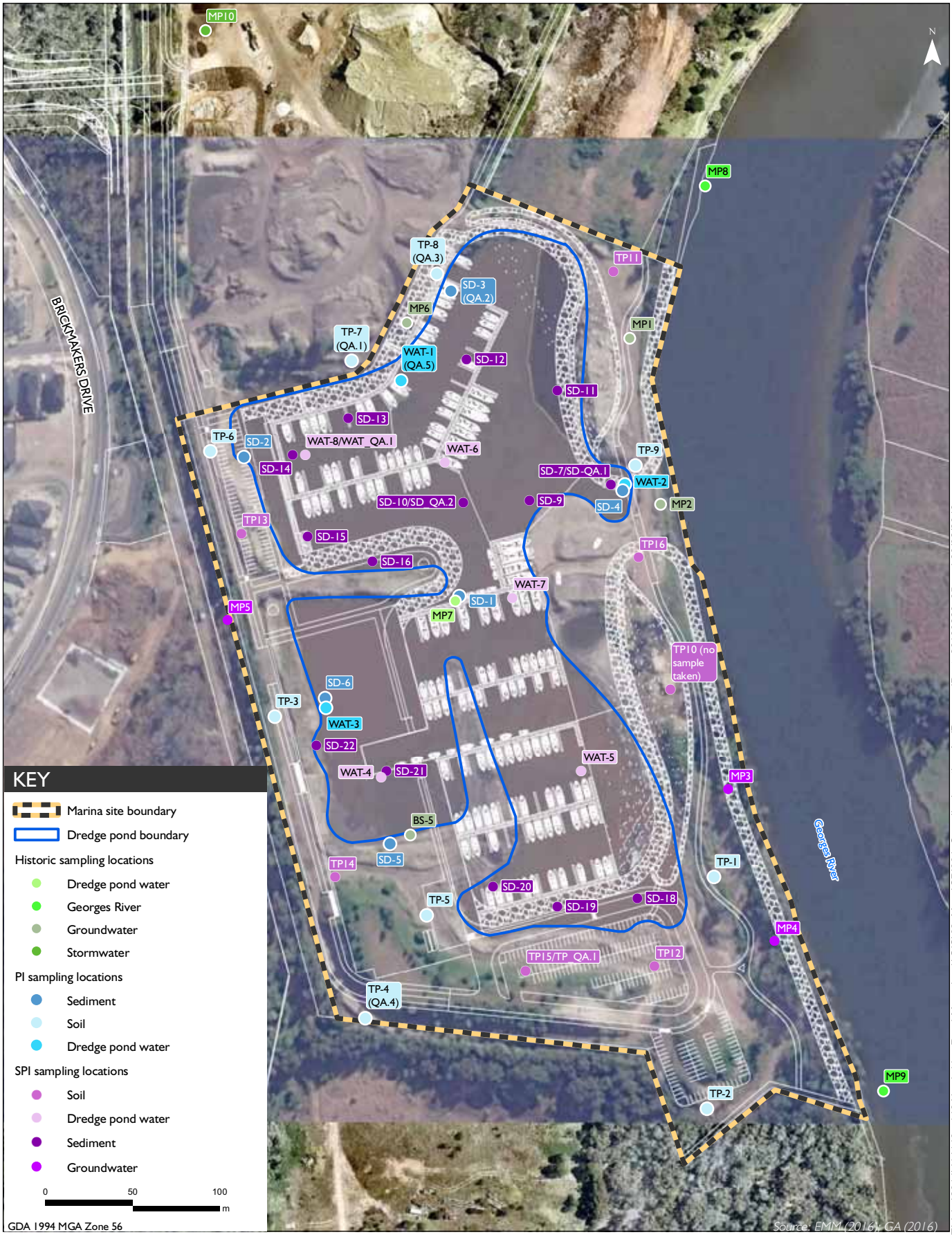
Georges Core Marina Development
Supplementary Preliminary Investigation

Figure 2.1

Dredge pond sampling locations (grid pattern)

Georges Cove Marina Development
Supplementary Preliminary Investigation

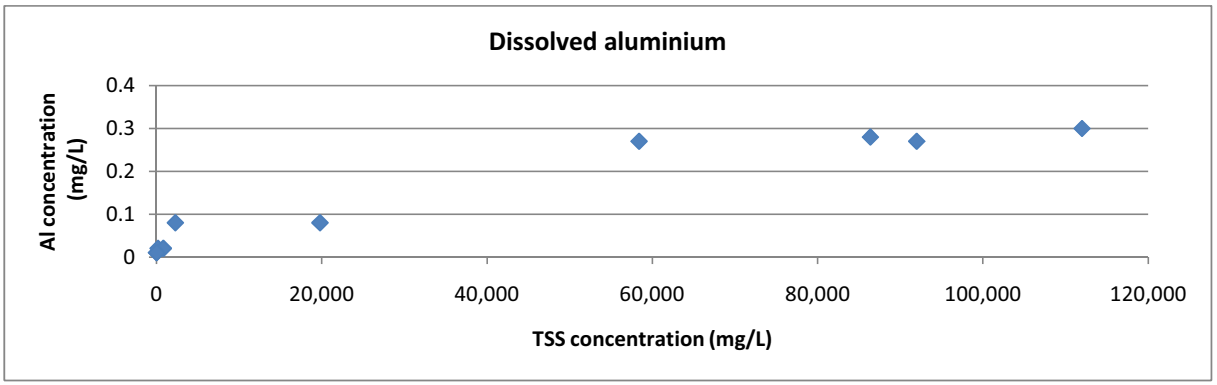
Figure 2.2

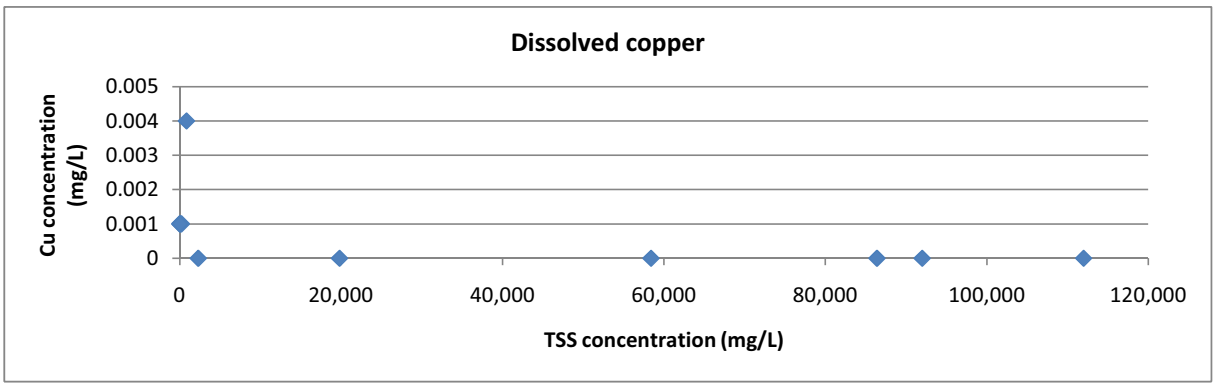


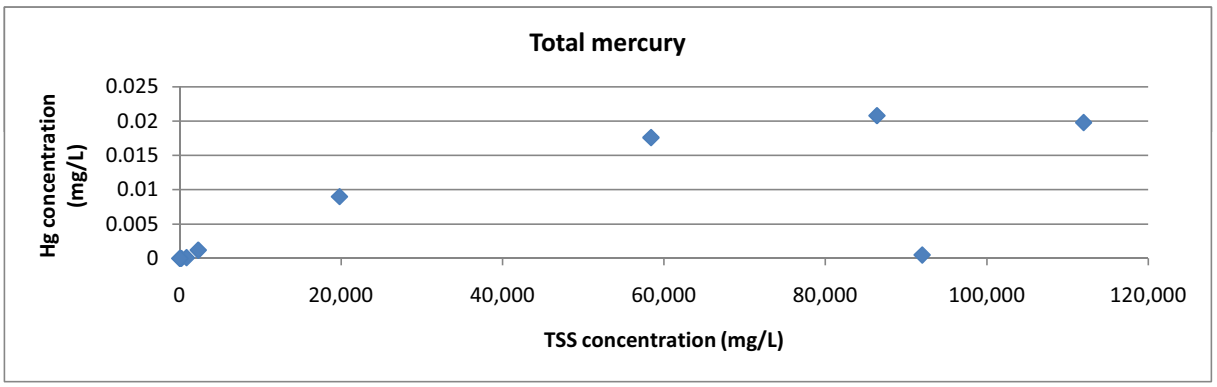
Sampling locations and proposed development

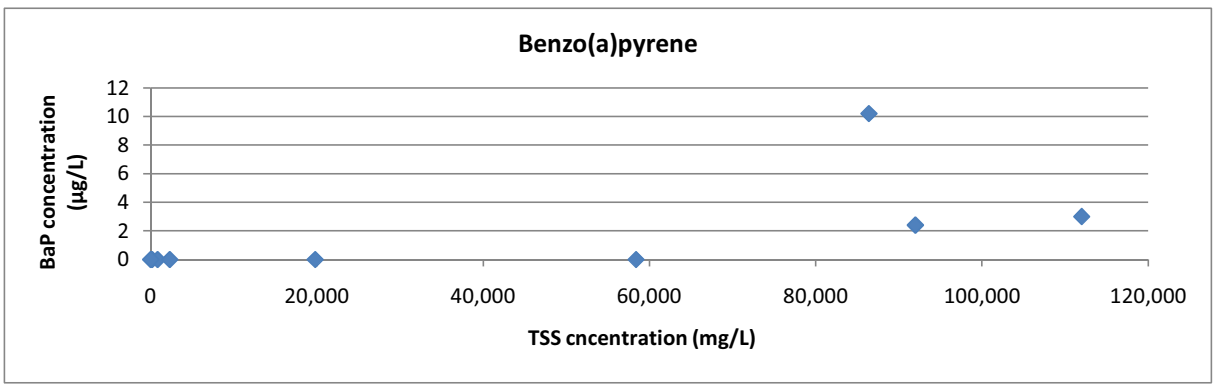
Georges Core Marina Development
Supplementary Preliminary Investigation

Figure 5.1







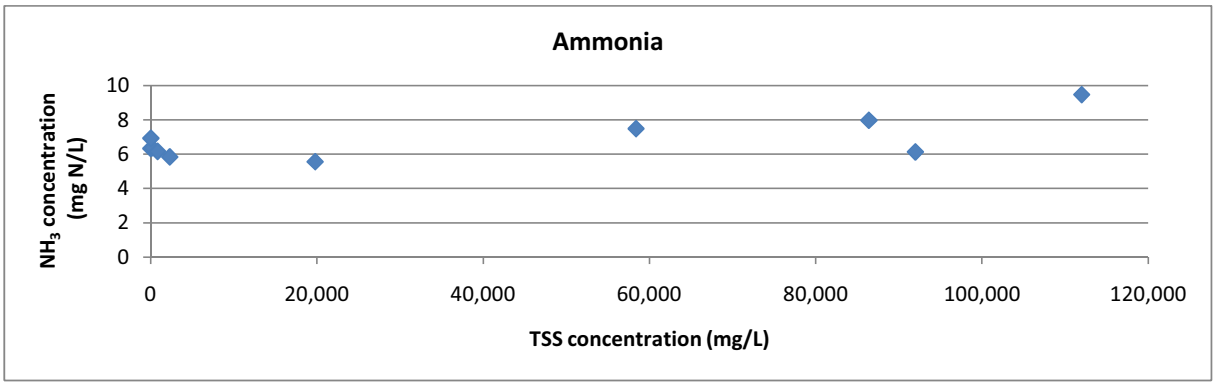


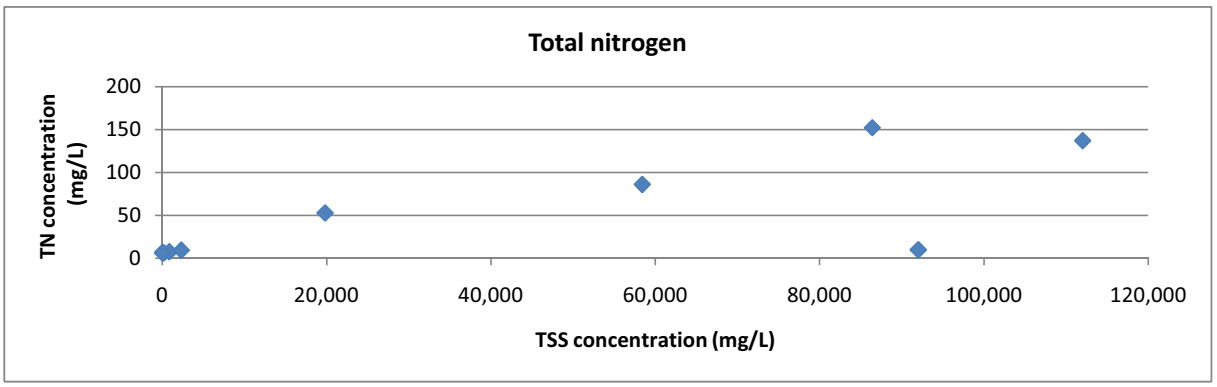
Metals and benzo(a)pyrene concentrations in the dredge pond

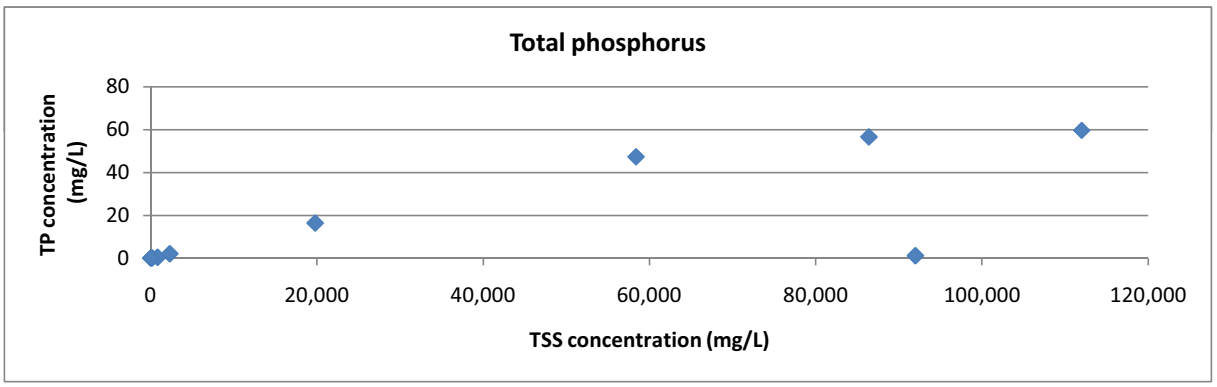
Georges Cove Marina Development

Supplementary Preliminary Investigation

Figure 5.2







Nutrient and ammonia concentrations in the dredge pond

Georges Cove Marina Development

Supplementary Preliminary Investigation

Figure 5.3

Table 5.2 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Metals*				
Aluminium	-	-	Freshwater TV exceeded in 6 samples. Exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L).	Freshwater TV exceeded by a factor of up to about 140 with the highest concentration in groundwater west of the basin. Low concentrations in groundwater adjacent to the Georges River.
Cadmium	-	-	-	Freshwater TV exceeded by a factor of about 20 and the marine TV (for protection of 99% if species) exceeded by a factor of about 6 in one sample from west of the basin. Lower concentrations in groundwater adjacent to the Georges River.
Copper	EIL exceeded in 2 samples by a factor of up to about 2.2.	ISQG-low exceeded in 10 samples but concentrations within range reported for the Georges River.	Freshwater and marine TVs exceeded in 1 sample.	Freshwater and marine TV exceeded by a factor of up to about 5 with the highest concentration in groundwater east of the basin. The highest concentration (0.005 mg/L) in groundwater is lower than the mean concentration in Georges River water (0.006 mg/L) (Marine Pollution Research 2010).
Lead	-	ISQG-low exceeded in 12 samples and the ISQG-high exceeded in 7 samples. Concentrations higher than in the main channel of the Georges River but within the range measured in bays and tributaries, where flow is lower and where there are historic contamination sources.	-	-

Table 5.2 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Manganese	-	-	-	Freshwater TV exceeded in one sample by a factor of about 1.4 with the highest concentration in groundwater west of the basin. Low concentrations (below Freshwater TV) in groundwater adjacent to the Georges River.
Nickel	-	-	-	Freshwater TV exceeded in one sample by a factor of about 5 with the highest concentration in groundwater west of the basin. Marine TV (for protection of 99% if species) exceeded by a factor of up to about 85 in one sample from west of the basin. Lower concentrations in groundwater adjacent to the Georges River.
Zinc	EIL exceeded in 3 samples by a factor of about 2.	ISQG-low exceeded in 10 samples but concentrations within range reported for the Georges River.	Freshwater and marine TVs exceeded. Concentrations correlated with TSS concentrations. Some exceedances (by a factor of about 2) in samples with low TSS concentrations (<1 g/L). However, these levels are similar to the mean concentration in the Georges River (Marine Pollution Research 2010).	Freshwater and marine TV exceeded by a factor of up to about 115 with the highest concentration in groundwater west of the basin.

Table 5.2 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Mercury (total)	-	ISQG-low exceeded in 12 samples.	Freshwater and marine TVs exceeded by total mercury concentrations in 6 samples. All exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L). Recreational guideline exceeded in 2 samples, both with high TSS concentrations (>58 g/L).	-
Nutrients				
Nitrate	-	-	Mean concentration exceeds TV for Lowland Rivers in 7 samples, by a factor of about 2.5.	-
Ammonia	-	-	Mean concentration exceeds TV for Lowland Rivers by a factor of about 400. Mean concentration exceeds freshwater and marine TVs by a factor of about 9.	Mean concentration exceeds TV for Lowland Rivers by a factor of about 120. Mean concentration exceeds freshwater and marine TVs by a factor of about 3. Lower concentrations in groundwater adjacent to the Georges River but still high.
Total nitrogen	-	Potential release of nutrients to water column and eutrophication risk.	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 95. Eutrophication risk.	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 10. Eutrophication risk.

Table 5.2 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Total phosphorus	-	-	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 370. Eutrophication risk	-
PAH				
Benzo(a) pyrene	ESL exceeded in two samples by a factor of about 1.6.	ISQG-low exceeded in 5 samples.	Recreational guideline value exceeded Exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L).	-
Chrysene	-	ISQG-low exceeded in 3 samples.	-	-
Phenanthrene	-	Concentrations below the LOR in all but one sample. ISQG-low and -high exceeded in 1 sample.	-	-
Pyrene	-	ISQG-low exceeded in 8 samples and the ISQG-high exceeded in 1 sample.	-	-
Benzo(a) anthracene	-	ISQG-low exceeded in 4 samples.	-	-

Notes: ** Dissolved.*

EIL: environmental investigation level, and ESL: environmental screen level (NEPC 2013).

ISQG: interim sediment quality guidelines, high and low trigger values: (ANZECC and ARMCANZ 2000).

Freshwater & marine TVs: freshwater and marine trigger values for slightly to moderately disturbed ecosystems, generally for the protection of 95% of freshwater/marine species (ANZECC and ARMCANZ 2000).

River: default trigger values for South-east Australia Lowland Rivers (ANZECC and ARMCANZ 2000).

Recreational: recreational guideline (NHMRC 2008).

Eutrophication, no assessment criteria exceedance, but concentration high enough to consider a potential eutrophication risk.

Summary Table 1 Analytical Results - Soil

Analytes	units	NEPM HIL(B)	NEMP EIL (urban residential & open space)	NEPM HSL (A&B) 0-<1 m, sand	NEPM ESL (urban residential & open space - coarse)	LOR	TP-1 0.5	TP-2 0.5	TP-3 0.5	TP-4 0.5	TP-5 0.5	TP-6 0.5	TP-7 0.5	TP-8 0.5	TP-9 0.5	TP-9 2
Laboratory parameters							3-Jun-15									
pH		-	-	-	-	0.1	7.7	4	7.1	4.8	7.5	8.3	7.8	7.5	7.8	-
Metals																
Aluminium	mg/kg	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-
Arsenic	mg/kg	500	100	-	-	5	<5	10	7	8	6	<5	10	6	<5	<5
Cadmium	mg/kg	150	-	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	500	198	-	-	2	12		18	16	33	3	21	8	10	4
Copper	mg/kg	30000	80	-	-	5	17	8	65	9	**176**	<5	22	67	14	<5
Iron	mg/kg	-	-	-	-	50	14200	28600	18300	37400	20600	3060	22800	14500	9200	2900
Lead	mg/kg	1200	1200	-	-	5	25	22	112	20	144	7	30	33	24	<5
Manganese	mg/kg	14000	-	-	-	5	-	-	-	-	-	-	-	-	-	-
Nickel	mg/kg	1200	35	-	-	2	4	<2	10	9	15	7	14	4	3	<2
Zinc	mg/kg	60000	145	-	-	5	37	8	**217**	25	**309**	21	61	71	43	<5
Mercury	mg/kg	120	-	-	-	0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TPH																
C6 - C9 Fraction	mg/kg	-	-	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	-	-	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	-	-	-	-	100	<100	<100	**120**	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	mg/kg	-	-	-	-	100	<100	<100	**140**	<100	<100	<100	<100	<100	<100	<100
C10 - C36 Fraction (sum)	mg/kg	-	-	-	-	50	<50	<50	**260**	<50	<50	<50	<50	<50	<50	<50
TRH																
C6 - C10 Fraction	mg/kg	-	-	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX	mg/kg	-	-	-	180	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction	**mg/kg**	-	-	-	-	**50**	**<50**	**<50**	**<50**	**<50**	**<50**	**<50**	**<50**	**<50**	**<50**	**<50**
>C16 - C34 Fraction	mg/kg	-	-	5800	300	100	<100	<100	**210**	<100	100	<100	<100	<100	<100	<100
>C34 - C40 Fraction	mg/kg	-	-	8100	2,800	100	<100	<100	**110**	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)		-	-	-	-	50	<50	<50	**320**	<50	100	<50	<50	<50	<50	<50
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	-	-	110	120	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
BTEX																
Benzene	mg/kg	-	-	0.5	50	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	-	-	160	85	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	-	-	55	70	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylenes	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes - Total	mg/kg	-	-	40	105	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	mg/kg	-	170	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PAH																
Naphthalene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**1.1**	<0.5	<0.5	**0.6**	<0.5	<0.5	<0.5	<0.5
Anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**2.3**	<0.5	**0.7**	**0.9**	<0.5	<0.5	<0.5	<0.5
Pyrene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**2.2**	<0.5	**0.8**	**0.8**	<0.5	<0.5	<0.5	<0.5

Analytes	units	NEPM HIL(B)	NEMP EIL (urban residential & open space)	NEPM HSL (A&B) 0-<1 m, sand	NEPM ESL (urban residential & open space - coarse)	LOR	TP-1 0.5	TP-2 0.5	TP-3 0.5	TP-4 0.5	TP-5 0.5	TP-6 0.5	TP-7 0.5	TP-8 0.5	TP-9 0.5	TP-9 2
Laboratory parameters							3-Jun-15									
Chrysene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	mg/kg	-	-	-	0.7	0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of polycyclic aromatic hydrocarbons	mg/kg	400	-	-	-	0.5	<0.5	<0.5	8.9	<0.5	1.5	2.3	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)	mg/kg	4	-	-	-	0.5	<0.5	<0.5	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (half LOR)	mg/kg	4	-	-	-	0.5	0.6	0.6	1.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (LOR)	mg/kg	4	-	-	-	0.5	1.2	1.2	1.6	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Total Polychlorinated biphenyls		-	-	-	-	0.05										
Total Polychlorinated biphenyls	mg/kg	1	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Pesticides																
alpha-BHC	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Hexachlorobenzene (HCB)	mg/kg	15	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
beta-BHC	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
gamma-BHC	**mg/kg**	-	-	-	-	**0.05**	-	-	-	-	**<0.05**	-	-	-	**<0.05**	**<0.05**
delta-BHC	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Heptachlor	mg/kg	10	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Aldrin	mg/kg	10	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Heptachlor epoxide	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
trans-Chlordane	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Total Chlordane (sum)	mg/kg	90	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
alpha-Endosulfan	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
cis-Chlordane	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Dieldrin	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
4.4`-DDE	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Endrin	mg/kg	20	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
beta-Endosulfan	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Endosulfan (sum)	mg/kg	400	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
4.4`-DDD	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Endrin aldehyde	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Endosulfan sulfate	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.2	-	-	-	<0.2	<0.2
4.4`-DDT	mg/kg	-	180	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Endrin ketone	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.2	-	-	-	<0.2	<0.2
Methoxychlor	mg/kg	500	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Sum of Aldrin + Dieldrin	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Sum of DDD + DDE + DDT	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Dichlorvos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Demeton-S-methyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Monocrotophos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.2	-	-	-	<0.2	<0.2

Analytes	units	NEPM HIL(B)	NEMP EIL (urban residential & open space)	NEPM HSL (A&B) 0-<1 m, sand	NEPM ESL (urban residential & open space - coarse)	LOR	TP-1 0.5	TP-2 0.5	TP-3 0.5	TP-4 0.5	TP-5 0.5	TP-6 0.5	TP-7 0.5	TP-8 0.5	TP-9 0.5	TP-9 2
Laboratory parameters							3-Jun-15									
Dimethoate	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Parathion-methyl	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.2	-	-	-	<0.2	<0.2
Malathion	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Fenthion	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Chlorpyrifos	mg/kg	340	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Parathion	mg/kg	-	-	-	-	0.2	-	-	-	-	<0.2	-	-	-	<0.2	<0.2
Pirimphos-ethyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Chlorfenvinphos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Bromophos-ethyl	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Fenamiphos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Prothiofos	mg/kg	-	-	-	-	0.05	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Ethion	mg/kg	-	-	-	-	0.5	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Carbophenothion	mg/kg	-	-	-	-	0.5	-	-	-	-	<0.05	-	-	-	<0.05	<0.05
Azinphos Methyl	mg/kg	-	-	-	-	0.5	-	-	-	-	<0.05	-	-	-	<0.05	<0.05

Analytes	units	NEPM HIL(B)	NEMP EIL (urban residential & open space)	NEPM HSL (A&B) 0-<1 m, sand	NEPM ESL (urban residential & open space - coarse)	LOR	TP-11	TP-12	TP-13	TP-14	TP-15	TP-16
Laboratory parameters							9-Nov-15					
pH		-	-	-	-	0.1	-	-	-	-	-	-
Metals												
Aluminium	mg/kg	-	-	-	-	50	4960	7840	5200	6210	6400	12400
Arsenic	mg/kg	500	100	-	-	5	<5	8	<5	8	<5	7
Cadmium	mg/kg	150	-	-	-	1	<1	1	<1	<1	<1	<1
Chromium	mg/kg	500	198	-	-	2	8	40	8	8	8	14
Copper	mg/kg	30000	80	-	-	5	22	**190**	24	10	40	14
Iron	mg/kg	-	-	-	-	50	7790	38300	23000	25700	10500	30100
Lead	mg/kg	1200	1200	-	-	5	44	115	53	11	52	25
Manganese	mg/kg	14000	-	-	-	5	95	286	215	76	106	279
Nickel	mg/kg	1200	35	-	-	2	5	17	8	17	10	7
Zinc	mg/kg	60000	145	-	-	5	82	**345**	95	23	142	48
Mercury	mg/kg	120	-	-	-	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
TPH												
C6 - C9 Fraction	mg/kg	-	-	-	-	10	<10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	-	-	-	-	50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	-	-	-	-	100	<100	**120**	**140**	<100	<100	<100
C29 - C36 Fraction	mg/kg	-	-	-	-	100	<100	**120**	**150**	<100	<100	<100
C10 - C36 Fraction (sum)	mg/kg	-	-	-	-	50	<50	**240**	**290**	<50	<50	<50
TRH												
C6 - C10 Fraction	mg/kg	-	-	-	-	10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	-	-	-	180	10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction	mg/kg	-	-	-	-	50	<50	<50	<50	<50	<50	<50
>C16 - C34 Fraction	mg/kg	-	-	5800	300	100	<100	**190**	**240**	<100	**150**	<100
>C34 - C40 Fraction	mg/kg	-	-	8100	2,800	100	<100	<100	<100	<100	<100	<100

Analytes	units	NEPM HIL(B)	NEMP EIL (urban residential & open space)	NEPM HSL (A&B) 0-<1 m, sand	NEPM ESL (urban residential & open space - coarse)	LOR	TP-11	TP-12	TP-13	TP-14	TP-15	TP-16
Laboratory parameters							**9-Nov-15**					
BTEX												
Benzene	mg/kg	-	-	0.5	50	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	-	-	160	85	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	-	-	55	70	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylenes	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes - Total	mg/kg	-	-	40	105	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	mg/kg	-	170	-	-	1	<1	<1	<1	<1	<1	<1
PAH												
Naphthalene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	<0.5	<0.5
Acenaphthylene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	<0.5	<0.5
Acenaphthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	<0.5	<0.5
Fluorene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	<0.5	<0.5
Phenanthrene	mg/kg	-	-	-	-	0.5	<0.5	**0.6**	<0.5	<0.8	**3.7**	<0.5
Anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	**0.8**	<0.5
Fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	**0.9**	<0.5	<0.8	**3.8**	<0.5
Pyrene	mg/kg	-	-	-	-	0.5	<0.5	**0.9**	<0.5	<0.8	**3.8**	<0.5
Benz(a)anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	**1.5**	<0.5
Chrysene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	**1.6**	<0.5
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	**0.5**	<0.5	<0.8	**1.7**	<0.5
Benzo(k)fluoranthene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	**0.6**	<0.5
Benzo(a)pyrene	mg/kg	-	-	-	0.7	0.5	<0.5	<0.5	<0.5	<0.8	**1.5**	<0.5
Indeno(1.2.3.cd)pyrene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	**0.6**	<0.5
Dibenz(a.h)anthracene	mg/kg	-	-	-	-	0.5	<0.5	<0.5	<0.5	<0.8	<0.5	<0.5
Sum of polycyclic aromatic hydrocarbons	mg/kg	400	-	-	-	0.5	<0.5	2.9	<0.5	<0.5	20.5	<0.5
Benzo(a)pyrene TEQ (zero)	mg/kg	4	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	2	<0.5
Benzo(a)pyrene TEQ (half LOR)	mg/kg	4	-	-	-	0.5	0.6	0.6	0.6	0.6	2.2	0.6
Benzo(a)pyrene TEQ (LOR)	mg/kg	4	-	-	-	0.5	1.2	1.2	1.2	1.2	2.5	1.2
Total Polychlorinated biphenyls		-	-	-	-	0.05						
Total Polychlorinated biphenyls	mg/kg	1	-	-	-	0.05	<0.1	-	-	-	-	<0.1
Pesticides												
alpha-BHC	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Hexachlorobenzene (HCB)	mg/kg	15	-	-	-	0.05	<0.05	-	-	-	-	<0.05
beta-BHC	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
gamma-BHC	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
delta-BHC	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Heptachlor	mg/kg	10	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Aldrin	mg/kg	10	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Heptachlor epoxide	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05

Analytes	units	NEPM HIL(B)	NEMP EIL (urban residential & open space)	NEPM HSL (A&B) 0-<1 m, sand	NEPM ESL (urban residential & open space - coarse)	LOR	TP-11	TP-12	TP-13	TP-14	TP-15	TP-16
Laboratory parameters							**9-Nov-15**					
trans-Chlordane	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Total Chlordane (sum)	mg/kg	90	-	-	-	0.05	<0.05	-	-	-	-	<0.05
alpha-Endosulfan	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
cis-Chlordane	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Dieldrin	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
4.4`-DDE	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Endrin	mg/kg	20	-	-	-	0.05	<0.05	-	-	-	-	<0.05
beta-Endosulfan	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Endosulfan (sum)	mg/kg	400	-	-	-	0.05	<0.05	-	-	-	-	<0.05
4.4`-DDD	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Endrin aldehyde	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Endosulfan sulfate	mg/kg	-	-	-	-	0.2	<0.05	-	-	-	-	<0.05
4.4`-DDT	mg/kg	-	180	-	-	0.05	<0.2	-	-	-	-	<0.2
Endrin ketone	mg/kg	-	-	-	-	0.2	<0.05	-	-	-	-	<0.05
Methoxychlor	mg/kg	500	-	-	-	0.05	<0.2	-	-	-	-	<0.2
Sum of Aldrin + Dieldrin	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Sum of DDD + DDE + DDT	mg/kg	-	-	-	-	0.05	<0.05	-	-	-	-	<0.05
Dichlorvos	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Demeton-S-methyl	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Monocrotophos	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Dimethoate	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Diazinon	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Chlorpyrifos-methyl	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Parathion-methyl	mg/kg	-	-	-	-	0.2	-	-	-	-	-	-
Malathion	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Fenthion	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Chlorpyrifos	mg/kg	340	-	-	-	0.05	-	-	-	-	-	-
Parathion	mg/kg	-	-	-	-	0.2	-	-	-	-	-	-
Pirimphos-ethyl	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Chlorfenvinphos	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Bromophos-ethyl	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Fenamiphos	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Prothiofos	mg/kg	-	-	-	-	0.05	-	-	-	-	-	-
Ethion	mg/kg	-	-	-	-	0.5	-	-	-	-	-	-
Carbophenothion	mg/kg	-	-	-	-	0.5	-	-	-	-	-	-
Azinphos Methyl	mg/kg	-	-	-	-	0.5	-	-	-	-	-	-

National Environment Protection Council (NEPC) (Assessment of Site Contamination) Measure 1999 (as amended in 2013a), *Schedule B1 Guideline on Investigation Levels for Soil and Groundwater.*

EMM

Summary Table 2 Analytical Results - Dredge Pond Sediment

Analytes	units	ISQG (low)	ISQG (high)	LOR	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6
Laboratory parameters					3-Jun-15					
pH	-	-	-	0.1	8.9	7.9	8.3	8	8.1	7.8
Metals										
Aluminium	mg/kg	-	-	50	-	-	-	-	-	-
Arsenic	mg/kg	20	70	5	<5	<5	<5	6	15	<5
Cadmium	mg/kg	1.5	10	1	<1	<1	<1	<1	1	<1
Chromium	mg/kg	80	370	2	13	<2	3	10	33	9
Copper	mg/kg	65	270	5	33	<5	16	26	96	21
Iron	mg/kg	-	-	50	9080	1660	2660	12200	31300	11800
Lead	mg/kg	50	220	5	90	20	12	38	268	49
Manganese	mg/kg	-	-		-	-	-	-	-	-
Nickel	mg/kg	21	52	2	8	<2	2	7	17	6
Zinc	mg/kg	200	410	5	148	16	44	67	316	60
Mercury	mg/kg	0.15	1	0.1	0.2	<0.1	<0.1	<0.1	0.5	<0.1
Nutrients										
Ammonia as N	mg/kg	-	-		45.1	2.4	10.2	7.8	48.6	8.1
Nitrite	mg/kg	-	-	0.1	-	-	-	-	-	-
Nitrate	mg/kg	-	-	0.1	-	-	-	-	-	-
Nitrite+nitrate	mg/kg	-	-	0.1	-	-	-	-	-	-
Total Kjeldahl nitrogen	mg/kg	-	-	20	-	-	-	-	-	-
Total nitrogen	mg/kg	-	-	20	-	-	-	-	-	-
Total organic carbon	%	-	-	-	1.75	0.32	0.66	1.15	1.92	1.04
TPH										
C6 - C9 Fraction	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	-	-	50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	-	-	100	**110**	<100	<100	<100	**180**	**120**
C29 - C36 Fraction	mg/kg	-	-	100	**130**	<100	<100	<100	**460**	**120**
C10 - C36 Fraction (sum)	mg/kg	-	-	50	**240**	<50	<50	<50	**640**	**240**
TRH										
C6 - C10 Fraction	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction	mg/kg	-	-	50	<50	<50	<50	<50	<50	<50
>C16 - C34 Fraction	mg/kg	-	-	100	**190**	<100	<100	<100	**490**	**200**
>C34 - C40 Fraction	mg/kg	-	-	100	<100	<100	<100	<100	**340**	<100
>C10 - C40 Fraction (sum)	mg/kg	-	-	50	**190**	<50	<50	<50	**830**	**200**
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	-	-	50	<50	<50	<50	<50	<50	<50
BTEX										
Benzene	mg/kg	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylenes	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes - Total	mg/kg	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	mg/kg	160	2100	1	<1	<1	<1	<1	<1	<1

Analytes	units	ISQG (low)	ISQG (high)	LOR	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6
Laboratory parameters					**3-Jun-15**					
PAH										
Naphthalene	mg/kg	0.16	2.1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	mg/kg	0.044	0.64	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	mg/kg	0.016	0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	mg/kg	0.019	0.54	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	mg/kg	0.24	1.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.6
Anthracene	mg/kg	0.85	1.1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	mg/kg	-		0.5	**0.9**	<0.5	<0.5	<0.5	**2.2**	**4**
Pyrene	mg/kg	0.665	2.6	0.5	0.9	<0.5	<0.5	0.5	2.4	4.2
Benz(a)anthracene	mg/kg	0.261	1.6	0.5	<0.5	<0.5	<0.5	<0.5	0.9	1.5
Chrysene	mg/kg	0.384	2.8	0.5	<0.5	<0.5	<0.5	<0.5	0.9	1.4
Benzo(b+j)fluoranthene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	**0.9**	**1**
Benzo(k)fluoranthene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	mg/kg	0.43	1.6	0.5	<0.5	<0.5	<0.5	<0.5	1.2	1.3
Indeno(1.2.3.cd)pyrene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	mg/kg	0.63	0.26	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of polycyclic aromatic hydrocarbons	mg/kg	-	-	0.5	**1.8**	<0.5	<0.5	0.5	**8.5**	**17**
Benzo(a)pyrene TEQ (zero)	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	1.4	1.6
Benzo(a)pyrene TEQ (half LOR)	mg/kg	-	-	0.5	0.6	0.6	0.6	0.6	1.7	1.9
Benzo(a)pyrene TEQ (LOR)	mg/kg	-	-	0.5	1.2	1.2	1.2	1.2	2	2.2
Total Polychlorinated biphenyls										
Total Polychlorinated biphenyls	mg/kg	0.023	-	0.05	-	-	<0.05	-	-	<0.05
Pesticides										
alpha-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Hexachlorobenzene (HCB)	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
beta-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
gamma-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
delta-BHC	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Heptachlor	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Aldrin	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Heptachlor epoxide	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
trans-Chlordane	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Total Chlordane (sum)	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
alpha-Endosulfan	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
cis-Chlordane	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Dieldrin	mg/kg	0.02	8	0.05	-	-	<0.05	-	-	<0.05
4.4`-DDE	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Endrin	mg/kg	0.02	8	0.05	-	-	<0.05	-	-	<0.05
beta-Endosulfan	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Endosulfan (sum)	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
4.4`-DDD	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Endrin aldehyde	mg/kg	-	-	0.2	-	-	<0.2	-	-	<0.2
Endosulfan sulfate	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
4.4`-DDT	mg/kg	-	-	0.2	-	-	<0.2	-	-	<0.2
Endrin ketone	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05

Analytes	units	ISQG (low)	ISQG (high)	LOR	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6
Laboratory parameters					3-Jun-15					
Methoxychlor	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Sum of Aldrin + Dieldrin	mg/kg	-	-	0.05	-	-	-	-	-	-
Sum of DDD + DDE + DDT	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Dichlorvos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Demeton-S-methyl	mg/kg	-	-	0.2	-	-	<0.2	-	-	<0.2
Monocrotophos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Dimethoate	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Diazinon	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Chlorpyrifos-methyl	mg/kg	-	-	0.2	-	-	<0.2	-	-	<0.2
Parathion-methyl	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Malathion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Fenthion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Chlorpyrifos	mg/kg	-	-	0.2	-	-	<0.2	-	-	<0.2
Parathion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Pirimphos-ethyl	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Chlorfenvinphos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Bromophos-ethyl	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Fenamiphos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Prothiofos	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Ethion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Carbophenothion	mg/kg	-	-	0.05	-	-	<0.05	-	-	<0.05
Azinphos Methyl	mg/kg	-	-	0.05	-	-	<0.06	-	-	<0.05

Analytes	units	ISQG (low)	ISQG (high)	LOR	SD-7	SD-9	SD-10	SD-11	SD-13	SD-14	SD-15	SD-16	SD-18	SD-19
Laboratory parameters					9-Nov-15									
pH	-	-	-	0.1	7.9	7.9	7.9	8	8	7.7	7.8	7.9	8.1	8.2
Metals														
Aluminium	mg/kg	-	-	50	21400	19900	18800	23500	15800	19600	21600	22700	24600	14900
Arsenic	mg/kg	20	70	5	16	14	15	17	12	14	15	15	17	12
Cadmium	mg/kg	1.5	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	80	370	2	37	36	32	43	30	27	34	36	40	27
Copper	mg/kg	65	270	5	88	87	70	99	71	54	82	93	97	99
Iron	mg/kg	-	-	50	30600	28700	29700	31900	25000	29900	30300	30300	33000	30200
Lead	mg/kg	50	220	5	249	230	190	264	197	134	229	239	270	209
Manganese	mg/kg	-	-		222	216	178	226	187	135	214	217	232	219
Nickel	mg/kg	21	52	2	19	18	17	21	16	15	18	19	20	17
Zinc	mg/kg	200	410	5	343	328	246	379	388	180	309	345	376	319
Mercury	mg/kg	0.15	1	0.1	0.6	0.6	0.4	0.7	0.4	0.2	0.5	0.5	0.7	0.7
Nutrients														
Ammonia as N	mg/kg	-	-		80	80	60	90	50	70	80	80	170	40
Nitrite	mg/kg	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3
Nitrate	mg/kg	-	-	0.1	0.5	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Nitrite+nitrate	mg/kg	-	-	0.1	0.5	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.4
Total Kjeldahl nitrogen	mg/kg	-	-	20	1660	1960	1290	1890	1900	1480	1290	1800	2260	1490
Total nitrogen	mg/kg	-	-	20	1660	1960	1290	1890	1900	1480	1290	1800	2260	1490
Total organic carbon	%	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH														
C6 - C9 Fraction	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Analytes	units	ISQG (low)	ISQG (high)	LOR	SD-7	SD-9	SD-10	SD-11	SD-13	SD-14	SD-15	SD-16	SD-18	SD-19
Laboratory parameters					**9-Nov-15**									
C10 - C14 Fraction	mg/kg	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	-	-	100	**200**	**320**	<100	**270**	**200**	<100	<100	**140**	**300**	**110**
C29 - C36 Fraction	mg/kg	-	-	100	**250**	**360**	<100	**320**	**230**	<100	<100	**160**	**330**	**140**
C10 - C36 Fraction (sum)	mg/kg	-	-	50	**450**	**680**	<50	**590**	**430**	<50	<50	**300**	**630**	**250**
TRH														
C6 - C10 Fraction	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	-	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
>C10 - C16 Fraction	mg/kg	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
>C16 - C34 Fraction	mg/kg	-	-	100	**380**	**570**	<100	**500**	**350**	<100	<100	**260**	**510**	**210**
>C34 - C40 Fraction	mg/kg	-	-	100	**160**	**270**	<100	**220**	**120**	<100	<100	<100	**180**	**100**
>C10 - C40 Fraction (sum)	mg/kg	-	-	50	**540**	**840**	<50	**720**	**470**	<50	<50	**260**	**690**	**310**
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
BTEX														
Benzene	mg/kg	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m&p-Xylenes	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of BTEX	mg/kg	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Xylenes - Total	mg/kg	-	-	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Naphthalene	mg/kg	160	2100	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
PAH														
Naphthalene	mg/kg	0.16	2.1	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Acenaphthylene	mg/kg	0.044	0.64	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Acenaphthene	mg/kg	0.016	0.5	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Fluorene	mg/kg	0.019	0.54	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Phenanthrene	mg/kg	0.24	1.5	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Anthracene	mg/kg	0.85	1.1	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Fluoranthene	mg/kg	-		0.5	**1.1**	**1.6**	<0.8	**1.2**	**1.6**	<0.8	<0.8	<0.8	**1.5**	<0.8
Pyrene	mg/kg	0.665	2.6	0.5	1.2	1.7	<0.8	1.4	1.7	<0.8	<0.8	<0.8	1.6	<0.8
Benz(a)anthracene	mg/kg	0.261	1.6	0.5	<0.8	0.8	<0.8	<0.8	0.9	<0.8	<0.8	<0.8	<0.8	<0.8
Chrysene	mg/kg	0.384	2.8	0.5	<0.8	<0.8	<0.8	<0.8	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Benzo(b+j)fluoranthene	mg/kg	-	-	0.5	**0.8**	**1.1**	<0.8	**1**	**1.2**	<0.8	<0.8	<0.8	**1.2**	<0.8
Benzo(k)fluoranthene	mg/kg	-	-	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Benzo(a)pyrene	mg/kg	0.43	1.6	0.5	<0.8	1	<0.8	<0.8	1	<0.8	<0.8	<0.8	0.9	<0.8
Indeno(1.2.3.cd)pyrene	mg/kg	-	-	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Dibenz(a.h)anthracene	mg/kg	0.63	0.26	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Benzo(g.h.i)perylene	mg/kg	-	-	0.5	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Sum of polycyclic aromatic hydrocarbons	mg/kg	-	-	0.5	**3.1**	**6.2**	<0.8	**3.6**	**7.2**	<0.8	<0.8	<0.8	**5.2**	<0.8
Benzo(a)pyrene TEQ (zero)	mg/kg	-	-	0.5	<0.8	1.2	<0.8	<0.8	1.2	<0.8	<0.8	<0.8	1	<0.8
Benzo(a)pyrene TEQ (half LOR)	mg/kg	-	-	0.5	0.7	1.5	0.6	0.7	1.5	0.6	0.6	0.6	1.4	0.6
Benzo(a)pyrene TEQ (LOR)	mg/kg	-	-	0.5	1.2	1.8	1.2	1.3	1.8	1.2	1.2	1.2	1.7	1.2
Total Polychlorinated biphenyls														
Total Polychlorinated biphenyls	mg/kg	0.023	-	0.05	-	-	-	-	-	-	-	<0.1	<0.1	<0.1

Analytes	units	ISQG (low)	ISQG (high)	LOR	SD-7	SD-9	SD-10	SD-11	SD-13	SD-14	SD-15	SD-16	SD-18	SD-19
Laboratory parameters					**9-Nov-15**									
Pesticides														
alpha-BHC	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
beta-BHC	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
gamma-BHC	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
delta-BHC	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Heptachlor	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Aldrin	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Heptachlor epoxide	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
trans-Chlordane	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Total Chlordane (sum)	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
alpha-Endosulfan	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
cis-Chlordane	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Dieldrin	mg/kg	0.02	8	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
4.4`-DDE	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Endrin	mg/kg	0.02	8	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
beta-Endosulfan	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Endosulfan (sum)	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
4.4`-DDD	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Endrin aldehyde	mg/kg	-	-	0.2	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Endosulfan sulfate	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
4.4`-DDT	mg/kg	-	-	0.2	-	-	-	-	-	-	-	<0.2	<0.2	<0.2
Endrin ketone	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Methoxychlor	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.2	<0.2	<0.2
Sum of Aldrin + Dieldrin	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Sum of DDD + DDE + DDT	mg/kg	-	-	0.05	-	-	-	-	-	-	-	<0.05	<0.05	<0.05
Dichlorvos	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Demeton-S-methyl	mg/kg	-	-	0.2	-	-	-	-	-	-	-	-	-	-
Monocrotophos	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Dimethoate	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Diazinon	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Chlorpyrifos-methyl	mg/kg	-	-	0.2	-	-	-	-	-	-	-	-	-	-
Parathion-methyl	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Malathion	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Fenthion	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Chlorpyrifos	mg/kg	-	-	0.2	-	-	-	-	-	-	-	-	-	-
Parathion	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Pirimphos-ethyl	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Chlorfenvinphos	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Bromophos-ethyl	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Fenamiphos	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Prothiofos	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Ethion	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Carbophenothion	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-
Azinphos Methyl	mg/kg	-	-	0.05	-	-	-	-	-	-	-	-	-	-

Summary Table 3 Analytical Results - Dredge Pond Surface Water

Analyte	unit	ANZECC/ARMCANZ 95% protection (freshwater)	ANZECC/ARMCANZ 95% protection (marine)	NHMRC 2008 Risks in Recreational Water	LOR	WAT-1	WAT-2	WAT-3	WAT-4s	WAT-5s	WAT-6s	WAT-7s	WAT-8s	WAT-4d	WAT-5d	WAT-6d	WAT-7d	WAT-8d
Field parameters						3-Jun-15			9-Nov-15									
Temperature	°C	-	-	-	0.01	16	14.7	15.1	22.4	24.1	23.5	22.4	22.7	22.1	22	23	22.5	22
EC	uS/cm	125-2200	-	-	1	7392	7314	7305	12529	12720	12495	12490	12469	12608	12685	12520	12513	11529
pH	pH units	6.5-8	-	-	0.001	7.73	7.44	7.54	8.39	7.99	8.33	8.87	8.84	8.18	8.15	8.32	8.64	8.6
Dissolved oxygen	mg/L	-	-	-	0.001	4.76	9.78	8.81	77.28	60.09	53.43	17.65	37.77	35.35	46.49	27.31	17.05	12.76
Redox	mV	-	-	-	0.01	-49.4	-15.5	-27.6	-123.6	-139.2	-140.9	-182.6	-154	-127.7	-142.2	-156.7	-178.9	-206.6
Laboratory parameters																		
pH	pH units	6.5-8	-	-	0.01	7.7	7.76	7.78	-	-	-	-	-	-	-	-	-	-
Total dissolved solids	mg/L	-	-	-	10	-	-	-	7710	7750	9210	8720	9070	8260	8680	9690	10400	7930
Suspended solids	mg/L	-	-	-	5	-	-	-	14	204	86400	836	58400	92000	24	19800	2300	112000
Alkalinity	mg/L																	
Hydroxide Alkalinity as CaCO3	mg/L	-	-	-	1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	-	-	-	1	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	-	-	-	1	-	-	-	193	186	227	188	227	269	194	190	179	320
Total Alkalinity as CaCO3	mg/L	-	-	-	1	-	-	-	193	186	227	188	227	269	194	190	179	320
Major ions	mg/L																	
Sulfate	mg/L	-	-	-	1	-	-	-	755	717	767	707	730	739	699	703	705	822
Chloride	mg/L	-	-	-	1	-	-	-	3540	3540	3630	3540	3510	3100	3530	3560	3540	3400
Calcium	mg/L	-	-	-	1	-	-	-	249	253	279	245	276	310	247	260	249	330
Magnesium	mg/L	-	-	-	1	-	-	-	213	219	225	214	218	178	213	212	212	204
Sodium	mg/L	-	-	-	1	-	-	-	2020	2090	2050	2070	2060	1840	2030	2030	2020	1920
Potassium	mg/L	-	-	-	1	-	-	-	80	82	78	80	77	71	80	79	81	72
Metals					LOR													
Aluminium	mg/L	0.055	ID	-	0.01	-	-	-	0.01	0.02	0.28	0.02	0.27	0.27	0.01	0.08	0.08	0.3
Arsenic	mg/L	0.013	ID	0.07	0.001	0.004	0.003	0.003	0.003	0.003	0.004	0.003	0.004	0.004	0.003	0.002	0.002	0.005
Cadmium	mg/L	0.0002	0.005/0.0007^	-	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0044	0.5	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Copper	mg/L	0.0014	0.0013	20	0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	0.004	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Iron	mg/L	ID	ID	-	0.05	0.07	0.12	0.13	<0.05	<0.05	0.19	<0.05	0.26	0.36	<0.05	0.99	0.06	0.41
Lead	mg/L	0.0034	0.0044	0.1	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.011	0.007/0.0007^	0.2	0.001	0.005	0.005	0.005	0.005	0.005	0.004	0.006	0.004	0.005	0.004	0.005	0.005	0.004
Manganese	mg/L	1.9	ID	5	0.001	-	-	-	0.37	0.369	0.507	0.342	0.458	0.47	0.361	0.442	0.363	0.551
Zinc	mg/L	0.008	0.015	-	0.005	0.008	0.008	0.007	0.016	0.015	0.249	0.016	0.302	0.298	0.009	0.345	0.207	0.321
Mercury (total in November 2015)	mg/L	0.0006/0.00006^	0.0004/0.0001^	0.01	0.0001	-	-	-	<0.0001	<0.0001	0.0208	0.0001	0.0176	0.0005	<0.0001	0.009	0.0012	0.0198
Nutrients																		
Ammonia (as N)	mg/L	0.02*/0.9	0.91	-	0.01	11.6	13.1	13.2	6.33	6.37	7.97	6.16	7.48	6.13	6.92	5.56	5.84	9.46
Nitrite	mg/L	0.04*	-	30	0.01	-	-	-	0.03	0.02	<0.01	0.03	<0.01	<0.01	0.02	<0.01	0.02	<0.01
Nitrate	mg/L	0.04*	-	500	0.01	-	-	-	0.11	0.05	0.05	0.32	0.04	0.05	0.03	0.04	0.07	0.03
Nitrite+nitrate	mg/L	-	-	-	0.01	-	-	-	0.14	0.07	0.05	0.35	0.04	0.05	0.05	0.04	0.09	0.03
Total Kjeldahl Nitrogen	mg/L	-	-	-	0.01	-	-	-	6.6	6	152	7	85.9	9.5	5.7	52.6	9.1	137
Total nitrogen	mg/L	0.5*	-	-	0.01	-	-	-	6.7	6.1	152	7.4	85.9	9.6	5.8	52.6	9.2	137
Total phosphorous	mg/L	0.05*	-	-	0.01	-	-	-	0.07	0.14	56.6	0.45	47.4	1.21	0.09	16.4	2.05	59.7
Reactive phosphorous	mg/L	-	-	-	0.01	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dissolved organic carbon	mg/L	-	-	-	1	-	-	-	12	19	57	22	17	19	14	16	15	60
Total organic carbon	mg/L	-	-	-	1	-	-	-	19	19	951	22	72	1590	28	81	33	1040
Chemical oxygen demand	mg/L	-	-	-	10	-	-	-	80	63	10100	170	7560	11500	94	2600	386	12100
Biochemical oxygen demand	mg/L	-	-	-	2	-	-	-	<2	<2	193	4	249	347	<2	240	9	414
Carbonaceous biochemical oxygen demand	mg/L	-	-	-	2	-	-	-	<2	<2	139	3	239	299	<2	202	<2	386
TPH																		
C6 - C9 Fraction	ug/L	-	-	-	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	ug/L	-	-	-	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	ug/L	-	-	-	100	<100	<100	<100	<100	<100	**2220**	<100	<100	**870**	<100	<100	<100	**830**
C29 - C36 Fraction	ug/L	-	-	-	50	<50	<50	<50	<50	<50	**2400**	<50	<50	**650**	<50	<50	<50	**760**
C10 - C36 Fraction (sum)	ug/L	-	-	-	50	<50	<50	<50	<50	<50	**4620**	<50	<50	**1520**	<50	<50	<50	**1590**
TRH																		
C6 - C10 Fraction	ug/L	-	-	-	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	ug/L	-	-	-	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	ug/L	-	-	-	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C16 - C34 Fraction	ug/L	-	-	-	100	<100	<100	<100	<100	<100	**3990**	<100	<100	**1200**	<100	<100	<100	**1230**
>C34 - C40 Fraction	ug/L	-	-	-	100	<100	<100	<100	<100	<100	**1300**	<100	<100	**330**	<100	<100	<100	**420**

Analyte	unit	ANZECC/ARMCANZ 95% protection (freshwater)	ANZECC/ARMCANZ 95% protection (marine)	NHMRC 2008 Risks in Recreational Water	LOR	WAT-1	WAT-2	WAT-3	WAT-4s	WAT-5s	WAT-6s	WAT-7s	WAT-8s	WAT-4d	WAT-5d	WAT-6d	WAT-7d	WAT-8d
Field parameters						3-Jun-15			9-Nov-15									
>C10 - C40 Fraction (sum)	ug/L	-	-	-	100	<100	<100	<100	<100	<100	**5290**	<100	<100	**1530**	<100	<100	<100	**1650**
>C10 - C16 Fraction minus Naphthalene (F2)	ug/L	-	-	-	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
BTEX																		
Benzene	ug/L	0.95	0.7	0.01	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/L	ID	ID	8	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	ug/L	ID	ID	3	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	ug/L	ID	ID	-	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
ortho-Xylene	ug/L	0.35	ID	-	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Xylenes	ug/L	ID	ID	6	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Sum of BTEX	ug/L	-	-	-	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	ug/L	0.016	0.07	-	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
PAH																		
Naphthalene	ug/L	16	70	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**2.8**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**5.1**	<1.0	<1.0	**1.2**	<1.0	<1.0	<1.0	**1.5**
Anthracene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**3.3**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**14.3**	<1.0	<1.0	**3.7**	<1.0	<1.0	<1.0	**4.6**
Pyrene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**19.5**	<1.0	<1.0	**4.9**	<1.0	<1.0	<1.0	**6.3**
Benz(a)anthracene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**8.1**	<1.0	<1.0	**1.7**	<1.0	<1.0	<1.0	**2.3**
Chrysene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**7.9**	<1.0	<1.0	**1.7**	<1.0	<1.0	<1.0	**2.2**
Benzo(b+j)fluoranthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**14.2**	<1.0	<1.0	**2.9**	<1.0	<1.0	<1.0	**3.4**
Benzo(k)fluoranthene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**6.4**	<1.0	<1.0	**1.2**	<1.0	<1.0	<1.0	**1.5**
Benzo(a)pyrene	ug/L	-	-	0.01	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**10.2**	<0.5	<0.5	**2.4**	<0.5	<0.5	<0.5	**3**
Indeno(1.2.3.cd)pyrene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**6.7**	<1.0	<1.0	**1.6**	<1.0	<1.0	<1.0	**2**
Dibenz(a.h)anthracene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**1.4**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	ug/L	-	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	**7.6**	<1.0	<1.0	**1.8**	<1.0	<1.0	<1.0	**2.3**
Sum of polycyclic aromatic hydrocarbons	ug/L	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	108	<0.5	<0.5	23.1	<0.5	<0.5	<0.5	29.1
Benzo(a)pyrene TEQ (zero)	ug/L	-	-	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	15.3	<0.5	<0.5	3.2	<0.5	<0.5	<0.5	4

* = South-east Australia Lowland River

^ = 99% protection value used

Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) 2000 *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

National Health and Medical Research Council (NHMRC) 2008 Guidelines for Managing Risks in Recreational Water

Summary Table 4 Analytical Results - Dredge Pond Surface Water

Analyte	unit	ANZECC/ARMCANZ 95% protection (freshwater)	ANZECC/ARMCANZ 95% protection (marine)	LOR	MP-3	MP-4	MP-5
Field parameters					**17-Nov-15**		
Temperature	°C	-	-	0.01	18.9	19.2	18.8
EC	uS/cm	125-2200*	-	1	12148	13263	1520
pH	pH units	6.5-8*	-	0.001	8.22	7.59	5.75
Dissolved oxygen	mg/L	-	-	0.001	11.71	3.31	17.93
Redox	mV	-	-	0.01	-148.7	-167.7	36.9
Laboratory parameters							
pH	pH units	6.5-8*	-	0.01	6.47	7.89	4.07
Total dissolved solids	mg/L	-	-	1	9210	8780	932
Dissolved metals							
Aluminium	mg/L	0.055	ID	0.01	0.4	0.06	7.83
Arsenic	mg/L	0.013	ID	0.001	0.007	0.01	<0.001
Cadmium	mg/L	0.0002	0.005/0.0007^	0.0001	<0.0001	<0.0001	0.0041
Chromium	mg/L	0.001	0.0044	0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.0014	0.0013	0.001	0.001	0.002	0.006
Iron	mg/L	ID	ID	0.05	28.2	4.87	3.36
Lead	mg/L	0.0034	0.0044	0.001	<0.001	<0.001	0.002
Manganese	mg/L	1.9	ID	0.001	0.331	0.367	2.71
Nickel	mg/L	0.011	0.007/0.0007^	0.001	0.007	0.003	0.06
Zinc	mg/L	0.008	0.015	0.005	0.037	0.065	0.92
Mercury	mg/L	0.0006	0.0001	0.0001	<0.0001	<0.0001	<0.0001
Nutrients							
Ammonia (as N)	mg/L	0.02*/0.9	0.91	0.01	4.67	1.12	1.43
Nitrite	mg/L	0.04*	-	0.01	<0.01	<0.01	<0.01
Nitrate	mg/L	0.04*	-	0.01	0.02	0.04	0.01
Nitrite+nitrate	mg/L	-	-	0.01	0.02	0.04	0.01
Total Kjeldahl Nitrogen	mg/L	-	-	0.01	5	1.8	7.6
Total nitrogen	mg/L	0.5*	-	0.01	5	1.8	7.6
Total organic carbon	mg/L	-	-	1	29	14	94
TPH							
C6 - C9 Fraction	ug/L	-	-	20	<20	<20	<20
C10 - C14 Fraction	ug/L	-	-	50	<50	<50	<50
C15 - C28 Fraction	ug/L	-	-	100	<100	<100	<100
C29 - C36 Fraction	ug/L	-	-	50	<50	<50	<50
C10 - C36 Fraction (sum)	ug/L	-	-	50	<50	<50	<50
TRH							
C6 - C10 Fraction	ug/L	-	-	20	<20	<20	<20
C6 - C10 Fraction minus BTEX (	ug/L	-	-	20	<20	<20	<20
>C10 - C16 Fraction	ug/L	-	-	100	<100	<100	<100
>C16 - C34 Fraction	ug/L	-	-	100	<100	<100	<100
>C34 - C40 Fraction	ug/L	-	-	100	<100	<100	<100
>C10 - C40 Fraction (sum)	ug/L	-	-	100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	ug/L	-	-	100	<100	<100	<100
BTEX							
Benzene	ug/L	0.95	0.7	1	<1	<1	<1
Toluene	ug/L	ID	ID	2	<2	<2	<2
Ethylbenzene	ug/L	ID	ID	2	<2	<2	<2
meta- & para-Xylene	ug/L	ID	ID	2	<2	<2	<2
ortho-Xylene	ug/L	0.35	ID	2	<2	<2	<2
Total Xylenes	ug/L	ID	ID	2	<2	<2	<2

Analyte	unit	ANZECC/ARMCANZ 95% protection (freshwater)	ANZECC/ARMCANZ 95% protection (marine)	LOR	MP-3	MP-4	MP-5
Laboratory ananlytes					**17-Nov-15**		
Sum of BTEX	ug/L	-	-	1	<1	<1	<1
Naphthalene	ug/L	0.016	0.07	5	<5	<5	<5
PAH							
Naphthalene	ug/L	16	70	1	<1.0	<1.0	<1.0
Acenaphthylene	ug/L	-	-	1	<1.0	<1.0	<1.0
Acenaphthene	ug/L	-	-	1	<1.0	<1.0	<1.0
Fluorene	ug/L	-	-	1	<1.0	<1.0	<1.0
Phenanthrene	ug/L	-	-	1	<1.0	<1.0	<1.0
Anthracene	ug/L	-	-	1	<1.0	<1.0	<1.0
Fluoranthene	ug/L	-	-	1	<1.0	<1.0	<1.0
Pyrene	ug/L	-	-	1	<1.0	<1.0	<1.0
Benz(a)anthracene	ug/L	-	-	1	<1.0	<1.0	<1.0
Chrysene	ug/L	-	-	1	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	ug/L	-	-	1	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	ug/L	-	-	1	<1.0	<1.0	<1.0
Benzo(a)pyrene	ug/L	-	-	0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	ug/L	-	-	1	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	ug/L	-	-	1	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	ug/L	-	-	1	<1.0	<1.0	<1.0
Sum of polycyclic aromatic hydrocarbons	ug/L	-	-	0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)	ug/L	-	-	0.5	<0.5	<0.5	<0.5

* = South-east Australia Lowland River

^ = 99% protection value used

Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) 2000 *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

National Health and Medical Research Council (NHMRC) 2008 Guidelines for Managing Risks in Recreational Water

Summary Table 5 RPD - Soil

Analytes	units	LOR	TP-7 0.5M	QA.1	RPD	TP-15	TP05QA	RPD
Laboratory parameters			3-Jun-15			9-Nov-15		
pH		0.1	7.8	7.6	0.6	-	-	
Metals								
Aluminium	mg/kg	50	-	-	-	6400	8660	7.5
Arsenic	mg/kg	5	10	6	13	2.5	8	26.2
Cadmium	mg/kg	1	<1	<1	-	<1	<1	-
Chromium	mg/kg	2	21	11	15.6	8	15	15.2
Copper	mg/kg	5	22	-	-	40	40	0.0
Iron	mg/kg	50	22800	16900	7.4	10500	18700	14.0
Lead	mg/kg	5	30	33	2.4	52	70	7.4
Manganese	mg/kg	5	-	-	-	106	186	13.7
Nickel	mg/kg	2	14	12	3.8	10	9	2.6
Zinc	mg/kg	5	61	108	-	142	121	4.0
Mercury	mg/kg	0.1	<0.1	-	-	0.5	0.1	33.3
TPH								
C6 - C9 Fraction	mg/kg	10	<10	<10	-	<10	<10	-
C10 - C14 Fraction	mg/kg	50	<50	<50	-	<50	<50	-
C15 - C28 Fraction	mg/kg	100	<100	<100	-	50	390	38.6
C29 - C36 Fraction	mg/kg	100	<100	<100		50	230	32.1
C10 - C36 Fraction (sum)	mg/kg	50	<50	<50	-	25	620	46.1
TRH								
C6 - C10 Fraction	mg/kg	10	<10	<10	-	<10	<10	-
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	-	<10	<10	-
>C10 - C16 Fraction	mg/kg	50	<50	<50	-	<50	<50	-
>C16 - C34 Fraction	mg/kg	100	<100	<100	-	150	560	28.9
>C34 - C40 Fraction	mg/kg	100	<100	<100	-	<100	<100	-
>C10 - C40 Fraction (sum)		50	<50	<50	-	150	560	28.9
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	50	<50	<50	-	<50	<50	-
BTEX								
Benzene	mg/kg	0.2	<0.2	<0.2	-	<0.2	<0.2	-
Toluene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
m&p-Xylenes	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
o-Xylene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Sum of BTEX	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Xylenes - Total	mg/kg	0.2	<0.2	<0.2	-	<0.2	<0.2	-
Naphthalene	mg/kg	1	<1	<1	-	<1	<1	-
PAH					-			
Naphthalene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Acenaphthylene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Acenaphthene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Fluorene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Phenanthrene	mg/kg	0.5	0.025	0.8	47.0	3.7	1.3	24.0
Anthracene	mg/kg	0.5	<0.5	<0.5	-	0.8	0.5	11.5
Fluoranthene	mg/kg	0.5	0.025	1.2	48.0	3.8	2	15.5
Pyrene	mg/kg	0.5	0.025	1.2	48.0	3.8	2.1	14.4
Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	-	1.5	0.8	15.2
Chrysene	mg/kg	0.5	<0.5	<0.5	-	1.6	0.8	16.7
Benzo(b+j)fluoranthene	mg/kg	0.5	<0.5	<0.5	-	1.7	0.9	15.4
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	-	0.6	<0.5	-
Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	-	1.5	0.9	12.5
Indeno(1.2.3.cd)pyrene	mg/kg	0.5	<0.5	<0.5	-	0.6	0.025	46.0
Dibenz(a.h)anthracene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Benzo(g.h.i)perylene	mg/kg	0.5	<0.5	<0.5	-	0.9	0.025	47.3
Sum of polycyclic aromatic hydrocarbons	mg/kg	0.5	0.025	3.2	-49	20.5	9.3	18.8
Benzo(a)pyrene TEQ (zero)	mg/kg	0.5	<0.5	<0.5	-	2	1.1	14.5
Benzo(a)pyrene TEQ (half LOR)	mg/kg	0.5	0.6	0.6	0	2.2	1.4	11.1
Benzo(a)pyrene TEQ (LOR)	mg/kg	0.5	1.2	1.2	0	2.5	1.7	9.5

RPD - Dredge Pond Surface Water								
Analyte	**unit**	LOR	WAT-1	QA.5	**RPD**	**WAT-8s**	WAT-QAs	**RPD**
Laboratory parameters			3-Jun-15			9-Nov-15		
pH	pH units	0.01	7.7	7.33	1.23	-	-	-
Total dissolved solids	mg/L	10	-	-	-	9070	9430	-0.97
Suspended solids	mg/L	5	-	-	-	58400	70700	-4.76
Alkalinity	mg/L							
Hydroxide Alkalinity as CaCO3	mg/L	1	-	-	-	<1	<1	-
Carbonate Alkalinity as CaCO3	mg/L	1	-	-	-	<1	<1	-
Bicarbonate Alkalinity as CaCO3	mg/L	1	-	-	-	227	239	-1.29
Total Alkalinity as CaCO3	mg/L	1	-	-	-	227	239	-1.29
Cations/anions	mg/L				-			
Sulfate	mg/L	1	-	-	-	730	794	-2.10
Chloride	mg/L	1	-	-	-	3510	3560	-0.35
Calcium	mg/L	1	-	-	-	276	280	-0.36
Magnesium	mg/L	1	-	-	-	218	218	0.00
Sodium	mg/L	1	-	-	-	2060	2060	0.00
Potassium	mg/L	1	-	-	-	77	77	0.00
Dissolved metals								
Aluminium	mg/L	0.1	-	-	-	448	192	20.00
Arsenic	mg/L	0.001	0.004	0.003	7	0.245	0.132	14.99
Cadmium	mg/L	0.0001	<0.0001	<0.0001	-	0.0186	0.0078	20.45
Chromium	mg/L	0.001	<0.001	<0.001	-	0.836	0.35	20.49
Copper	mg/L	0.001	0.0005	0.001	-17	2.06	0.838	21.08
Iron	mg/L	0.05	0.07	0.1	-9	876	739	4.24
Lead	mg/L	0.001	<0.001	<0.001	-	8.33	3.31	21.56
Nickel	mg/L	0.001	0.005	0.005	0	0.458	0.228	16.76
Manganese	mg/L	0.001	-	-	-	10.5	11	-1.16
Zinc	mg/L	0.005	0.008	0.01	-6	8.6	3.46	21.31
Mercury	mg/L	0.0001	-	-	-	0.0176	0.0134	6.77
Nutrients								
Ammonia (as N)	mg/L	0.01	11.6	12.1	-1	7.48	8.31	-2.63
Nitrite	mg/L	0.01	-	-	-	<0.01	<0.01	-
Nitrate	mg/L	0.01	-	-	-	0.04	0.05	-5.56
Nitrite+nitrate	mg/L	0.01	-	-	-	0.04	0.05	-5.56
Total Kjeldahl Nitrogen	mg/L	0.01	-	-	-	85.9	50.2	13.12
Total nitrogen	mg/L	0.01	-	-	-	85.9	50.2	13.12
Total phosphorous	mg/L	0.01	-	-	-	47.4	20.4	19.91
Reactive phosphorous	mg/L	0.01	-	-	-	0.005	0.02	-30.00
Dissolved organic carbon	mg/L	1	-	-	-	17	21	-5.26
Total organic carbon	mg/L	1	-	-	-	72	77	-1.68
Chemical oxygen demand	mg/L	10	-	-	-	7560	8560	-3.10
Biochemical oxygen demand	mg/L	2	-	-	-	249	235	1.45
Carbonaceous biochemical oxygen demand	mg/L	2	-	-	-	239	172	8.15
PAH								
Naphthalene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Acenaphthylene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Acenaphthene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Fluorene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Phenanthrene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Anthracene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Fluoranthene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Pyrene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Benz(a)anthracene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Chrysene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Benzo(b+j)fluoranthene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Benzo(k)fluoranthene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Benzo(a)pyrene	ug/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Indeno(1.2.3.cd)pyrene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Dibenz(a.h)anthracene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Benzo(g.h.i)perylene	ug/L	1	<1.0	<1.0	-	<1.0	<1.0	-
Sum of polycyclic aromatic hydrocarbons	ug/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-
Benzo(a)pyrene TEQ (zero)	ug/L	0.5	<0.5	<0.5	-	<0.5	<0.5	-
TPH					-			-
C6 - C9 Fraction	ug/L	20	<20	<20	-	<20	<20	-
C10 - C14 Fraction	ug/L	50	<50	<50	-	<50	<50	-
C15 - C28 Fraction	ug/L	100	<100	<100	-	<100	<100	-
C29 - C36 Fraction	ug/L	50	<50	<50	-	<50	<50	-
C10 - C36 Fraction (sum)	ug/L	50	<50	<50	-	<50	<50	-
TRH					-			-
C6 - C10 Fraction	ug/L		<20	<20	-	<20	<20	-
C6 - C10 Fraction minus BTEX (F	ug/L	20	<20	<20	-	<20	<20	-

Analyte	unit	LOR	WAT-1	QA.5	RPD	WAT-8s	WAT-QAs	RPD
Laboratory parameters			3-Jun-15			9-Nov-15		
>C10 - C16 Fraction	ug/L	100	<100	<100	-	<100	<100	-
>C16 - C34 Fraction	ug/L	100	<100	<100	-	<100	<100	-
>C34 - C40 Fraction	ug/L	100	<100	<100	-	<100	<100	-
>C10 - C40 Fraction (sum)	ug/L	100	<100	<100	-	<100	<100	-
>C10 - C16 Fraction minus Naphthalene (F2)	ug/L	100	<100	<100	-	<100	<100	-
BTEX					-			-
Benzene	ug/L	1	<1	<1	-	<1	<1	-
Toluene	ug/L	2	<2	<2	-	<2	<2	-
Ethylbenzene	ug/L	2	<2	<2	-	<2	<2	-
meta- & para-Xylene	ug/L	2	<2	<2	-	<2	<2	-
ortho-Xylene	ug/L	2	<2	<2	-	<2	<2	-
Total Xylenes	ug/L	2	<2	<2	-	<2	<2	-
Sum of BTEX	ug/L	1	<1	<1	-	<1	<1	-
Naphthalene	ug/L	5	<5	<5	-	<5	<5	-

RPD - Groundwater

Analyte	unit	LOR	MP-3	GW-QA	RPD	QA2 (interlab)	RPD
Laboratory parameters			9-Nov-15				
pH	pH units	0.01	6.47	6.42	0.19	-	
Total dissolved solids	mg/L	10	9210	8450	2.15	-	
Dissolved metals							
Aluminium	mg/L	0.1	0.4	0.4	0.00	0.4	0.00
Arsenic	mg/L	0.001	0.007	0.007	0.00	0.006	3.85
Cadmium	mg/L	0.0001	<0.0001	<0.0001	-	<0.001	-
Chromium	mg/L	0.001	<0.001	<0.001	-	<0.001	-
Copper	mg/L	0.001	0.001	<0.001	-	0.0005	16.67
Iron	mg/L	0.05	28.2	27.8	0.36	32	3.16
Lead	mg/L	0.001	<0.001	<0.001	-	<0.001	-
Manganese	mg/L	0.001	0.331	0.329	0.15	0.35	1.40
Nickel	mg/L	0.001	0.007	0.007	0.00	0.005	8.33
Zinc	mg/L	0.005	0.037	0.036	0.68	0.036	0.68
Mercury	mg/L	0.0001	<0.0001	<0.0001	-	<0.00005	-
Nutrients							
Ammonia (as N)	mg/L	0.01	4.67	5.19	2.64	4.5	0.93
Nitrite	mg/L	0.01	<0.01	<0.01	-	<0.005	-
Nitrate	mg/L	0.01	0.02	0.04	16.67	0.0025	38.89
Nitrite+nitrate	mg/L	0.01	0.02	0.04	16.67	-	-
Total Kjeldahl Nitrogen	mg/L	0.01	5	5.5	2.38	6.1	4.95
Total nitrogen	mg/L	0.01	5	5.5	2.38	6.1	4.95
Total organic carbon	mg/L	1	29	27	1.79	-	-
PAH							
Naphthalene	ug/L	1	<1.0	<1.0	-	-	-
Acenaphthylene	ug/L	1	<1.0	<1.0	-	-	-
Acenaphthene	ug/L	1	<1.0	<1.0	-	-	-
Fluorene	ug/L	1	<1.0	<1.0	-	-	-
Phenanthrene	ug/L	1	<1.0	<1.0	-	-	-
Anthracene	ug/L	1	<1.0	<1.0	-	-	-
Fluoranthene	ug/L	1	<1.0	<1.0	-	-	-
Pyrene	ug/L	1	<1.0	<1.0	-	-	-
Benz(a)anthracene	ug/L	1	<1.0	<1.0	-	-	-
Chrysene	ug/L	1	<1.0	<1.0	-	-	-
Benzo(b+j)fluoranthene	ug/L	1	<1.0	<1.0	-	-	-
Benzo(k)fluoranthene	ug/L	1	<1.0	<1.0	-	-	-
Benzo(a)pyrene	ug/L	0.5	<0.5	<0.5	-	-	-
Indeno(1.2.3.cd)pyrene	ug/L	1	<1.0	<1.0	-	-	-
Dibenz(a.h)anthracene	ug/L	1	<1.0	<1.0	-	-	-
Benzo(g.h.i)perylene	ug/L	1	<1.0	<1.0	-	-	-
Sum of polycyclic aromatic hydrocarbons	ug/L	0.5	<0.5	<0.5	-	-	-
Benzo(a)pyrene TEQ (zero)	ug/L	0.5	<0.5	<0.5	-	-	-
TPH							-
C6 - C9 Fraction	ug/L	20	<20	<20	-	<10	-
C10 - C14 Fraction	ug/L	50	<50	<50	-	<50	-
C15 - C28 Fraction	ug/L	100	<100	<100	-	<100	-
C29 - C36 Fraction	ug/L	50	<50	<50	-	<50	-
C10 - C36 Fraction (sum)	ug/L	50	<50	<50	-	-	-
TRH							
C6 - C10 Fraction	ug/L		<20	<20	-	<10	-
C6 - C10 Fraction minus BTEX (F1)	ug/L	20	<20	<20	-	<10	-
>C10 - C16 Fraction	ug/L	100	<100	<100	-	<50	-
>C16 - C34 Fraction	ug/L	100	<100	<100	-	<100	-
>C34 - C40 Fraction	ug/L	100	<100	<100	-	<100	-
>C10 - C40 Fraction (sum)	ug/L	100	<100	<100	-	-	-

Analyte	unit	LOR	MP-3	GW-QA	RPD	QA2 (interlab)	RPD
Laboratory parameters			9-Nov-15				
>C10 - C16 Fraction minus Naphthalene (F2)	ug/L	100	<100	<100	-	<50	-
BTEX							
Benzene	ug/L	1	<1	<1	-	<1	-
Toluene	ug/L	2	<2	<2	-	<1	-
Ethylbenzene	ug/L	2	<2	<2	-	<1	-
meta- & para-Xylene	ug/L	2	<2	<2	-	<2	-
ortho-Xylene	ug/L	2	<2	<2	-	<1	-
Total Xylenes	ug/L	2	<2	<2	-	-	-
Sum of BTEX	ug/L	1	<1	<1	-	-	-
Naphthalene	ug/L	5	<5	<5	-	<1	-

- Dredge pond sediment

Analytes	units	LOR	SD-3	QA.2	RPD	SD-7	SDQA1	RPD	SD-10	SD-QA.2	RPD
Laboratory parameters			3-Jun-15			9-Nov-15			9-Nov-15		
pH	-	0.1	8.3	8.3	0	7.9	7.9	0	7.9	8	-0.31
Metals											
Aluminium	mg/kg	50	-	-	-	21400	18200	4	18800	19000	-0.26
Arsenic	mg/kg	5	<5	<5	-	16	12	7	15	13	3.57
Cadmium	mg/kg	1	<1	<1	-	<1	<1	-	<1	<1	-
Chromium	mg/kg	2	3	3	0.0	37	36	1	32	32	0.00
Copper	mg/kg	5	16	6	23	88	77	3	70	91	-6.52
Iron	mg/kg	50	2660	2660	0.0	30600	24700	5	29700	28000	1.47
Lead	mg/kg	5	12	11	2.2	249	216	4	190	244	-6.22
Manganese	mg/kg		-	-	-	222	179	5	178	214	-4.59
Nickel	mg/kg	2	2	1	16.7	19	15	6	17	18	-1.43
Zinc	mg/kg	5	44	43	0.6	343	296	4	246	327	-7.07
Mercury	mg/kg	0.1	<0.1	<0.1	-	0.6	0.6	0	0.4	0.5	-5.56
Nutrients											
Ammonia as N	mg/kg		10.2	-	-	80	60	7	60	110	-14.71
Nitrite	mg/kg	0.1	-	-	-	<0.1	<0.1	-	<0.1	<0.1	-
Nitrate	mg/kg	0.1	-	-	-	0.5	0.5	0	0.1	0.5	-33.33
Nitrite+nitrate	mg/kg	0.1	-	-	-	0.5	0.5	0	0.1	0.5	-33.33
Total Kjeldahl nitrogen	mg/kg	20	-	-	-	1660	1540	2	1290	1950	-10.19
Total nitrogen	mg/kg	20	-	-	-	1660	1540	2	1290	1950	-10.19
Total organic carbon	%	-	0.66	-	-	-	-	-	-	-	-
TPH											
C6 - C9 Fraction	mg/kg	10	<10	<10	-	<10	<10	-	<10	<10	-
C10 - C14 Fraction	mg/kg	50	<50	<50	-	<50	<50	-	<50	<50	-
C15 - C28 Fraction	mg/kg	100	<100	<100	-	200	230	-3	50	300	-35.71
C29 - C36 Fraction	mg/kg	100	<100	<100	-	250	210	4	50	350	-37.50
C10 - C36 Fraction (sum)	mg/kg	250	<50	<50	-	450	440	1	25	650	-46.30
TRH											
C6 - C10 Fraction	mg/kg	10	<10	<10	-	<10	<10	-	<10	<10	-
C6 - C10 Fraction minus BTEX (F1)	mg/kg	50	<10	<10	-	<10	<10	-	<10	<10	-
>C10 - C16 Fraction	mg/kg	100	<50	<50	-	<50	<50	-	<50	<50	-
>C16 - C34 Fraction	mg/kg	100	<100	<100	-	380	350	2	50	540	-41.53
>C34 - C40 Fraction	mg/kg	50	<100	<100	-	160	130	5	50	240	-32.76
>C10 - C40 Fraction (sum)	mg/kg	50	<50	<50	-	540	480	3	25	780	-46.89
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg		<50	<50	-	<50	<50	-	<50	<50	-
BTEX								-			-
Benzene	mg/kg	0.2	<0.2	<0.2	-	<0.2	<0.2	-	<0.2	<0.2	-
Toluene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
m&p-Xylenes	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
o-Xylene	mg/kg	0.5	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Sum of BTEX	mg/kg	0.2	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-
Xylenes - Total	mg/kg	0.5	<0.2	<0.2	-	<0.2	<0.2	-	<0.2	<0.2	-
Naphthalene	mg/kg	1	<1	<1	-	<1	<1	-	<1	<1	-
PAH								-			-
Naphthalene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Acenaphthylene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Acenaphthene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Fluorene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Phenanthrene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Anthracene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Fluoranthene	mg/kg	0.5	<0.5	<0.5	-	1.1	0.9	5	0.4	1.6	-30.00
Pyrene	mg/kg	0.5	<0.5	<0.5	-	1.2	1	5	0.4	1.8	-31.82
Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	0.5	0.9	-14.29
Chrysene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Benzo(b+j)fluoranthene	mg/kg	0.5	<0.5	<0.5	-	0.8	0.4	17	0.4	1	-21.43
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	0.4	1	-21.43
Indeno(1.2.3.cd)pyrene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-

Analytes	units	LOR	SD-3	QA.2	RPD	SD-7	SDQA1	RPD	SD-10	SD-QA.2	RPD
Laboratory parameters			3-Jun-15			9-Nov-15			9-Nov-15		
Dibenz(a.h)anthracene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Benzo(g.h.i)perylene	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	<0.8	<0.8	-
Sum of polycyclic aromatic hydrocarbons	mg/kg	0.5	<0.5	<0.5	-	3.1	1.9	12	0.4	6.3	-44.03
Benzo(a)pyrene TEQ (zero)	mg/kg	0.5	<0.5	<0.5	-	<0.8	<0.8	-	0.4	1.2	-25.00
Benzo(a)pyrene TEQ (half LOR)	mg/kg	0.5	0.6	0.6	-	0.7	0.6	4	0.6	1.5	-21.43
Benzo(a)pyrene TEQ (LOR)	mg/kg	0.5	1.2	1.2	-	1.2	1.2	0	1.2	1.8	-10.00
Total Polychlorinated biphenyls											
Total Polychlorinated biphenyls	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Pesticides											
alpha-BHC	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Hexachlorobenzene (HCB)	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
beta-BHC	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
gamma-BHC	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
delta-BHC	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Heptachlor	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Aldrin	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Heptachlor epoxide	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
trans-Chlordane	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Total Chlordane (sum)	**mg/kg**	**0.05**	**<0.05**	**<0.05**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
alpha-Endosulfan	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
cis-Chlordane	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Dieldrin	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
4.4`-DDE	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Endrin	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
beta-Endosulfan	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Endosulfan (sum)	mg/kg	0.2	<0.05	<0.05	-	-	-	-	-	-	-
4.4`-DDD	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Endrin aldehyde	**mg/kg**	**0.2**	**<0.2**	**<0.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Endosulfan sulfate	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
4.4`-DDT	mg/kg	0.05	<0.2	<0.2	-	-	-	-	-	-	-
Endrin ketone	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Methoxychlor	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Sum of Aldrin + Dieldrin	mg/kg	0.2	-	-	-	-	-	-	-	-	-
Sum of DDD + DDE + DDT	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Dichlorvos	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Demeton-S-methyl	mg/kg	0.05	<0.2	<0.2	-	-	-	-	-	-	-
Monocrotophos	**mg/kg**	**0.2**	**<0.05**	**<0.05**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Dimethoate	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Diazinon	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Chlorpyrifos-methyl	mg/kg	0.05	<0.2	<0.2	-	-	-	-	-	-	-
Parathion-methyl	mg/kg	0.2	<0.05	<0.05	-	-	-	-	-	-	-
Malathion	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Fenthion	mg/kg	0.05	<0.05	<0.05	-	-	-	-	-	-	-
Chlorpyrifos	mg/kg	0.05	<0.2	<0.2	-	-	-	-	-	-	-
Parathion	**mg/kg**	**0.05**	**<0.05**	**<0.05**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Summary Table 6 TRIP SPIKE & BLANK WATER & RINSATE

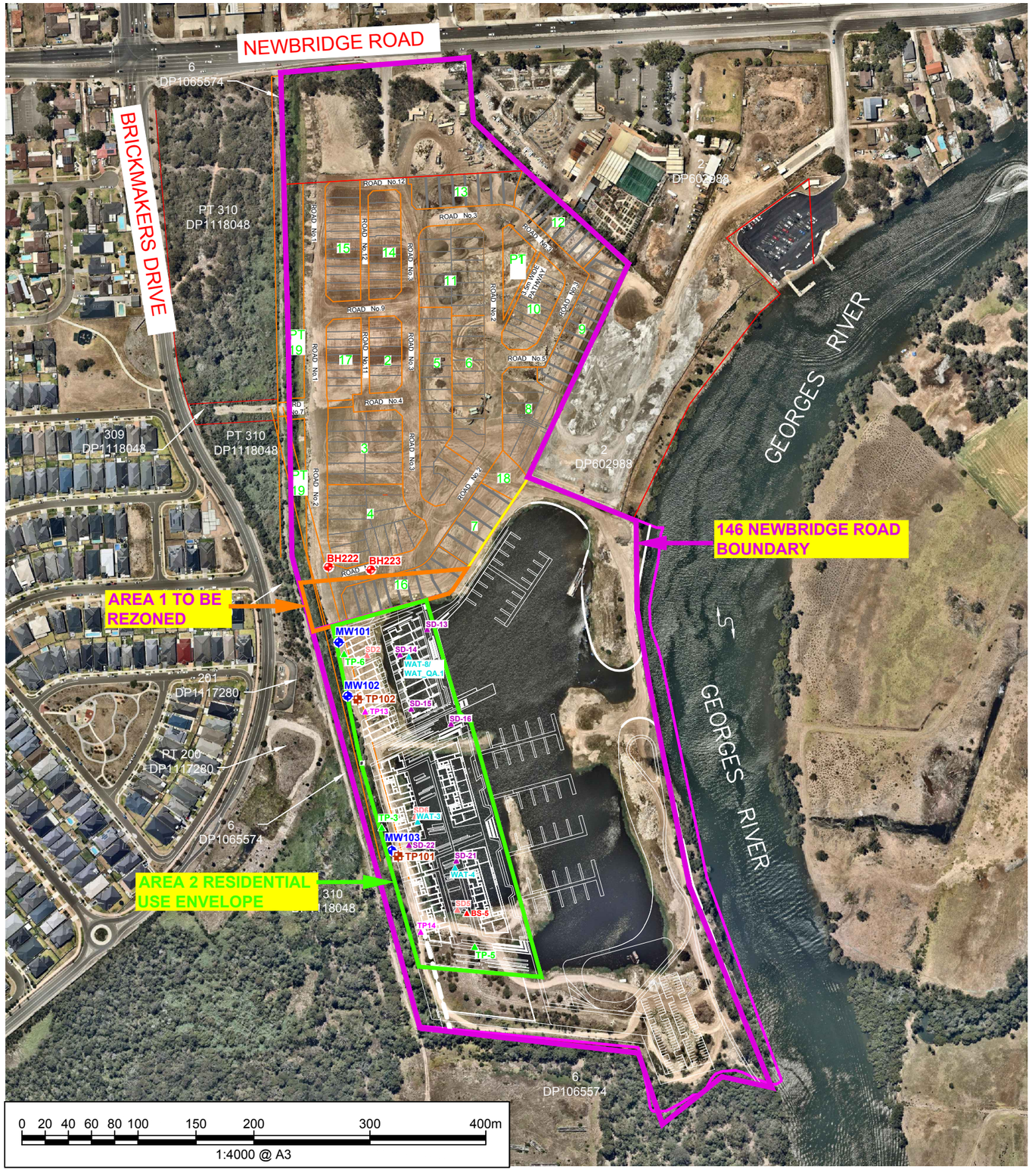
			TRIP SPIKE	Spike concetration	RPD	TRIP BLANK	SD-RINSATE	WAT-RINSATE	RINSATE
Analyte	**unit**	LOR	6-Nov-15						17-Nov-15
Laboratory parameters									
pH	pH units	0.01	-			-	7.65	-	7.72
Total dissolved solids	mg/L	10	-			-	-	108	129
Total suspended solids	mg/L	5	-			-	-	<5	-
Alkalinity	mg/L		-			-	-	-	-
Hydroxide Alkalinity as CaCO3	mg/L	1	-			-	-	<1	-
Carbonate Alkalinity as CaCO3	mg/L	1	-			-	-	<1	-
Bicarbonate Alkalinity as CaCO3	mg/L	1	-			-	-	47	-
Total Alkalinity as CaCO3	mg/L	1	-			-	-	47	-
Cations/anions	mg/L		-			-	-	-	-
Sulfate	mg/L	1	-			-	-	10	-
Chloride	mg/L	1	-			-	-	29	-
Calcium	mg/L	1	-			-	-	14	-
Magnesium	mg/L	1	-			-	-	6	-
Sodium	mg/L	1	-			-	-	16	-
Potassium	mg/L	1	-			-	-	2	-
Dissolved metals									
Aluminium	mg/L	0.1	-			-	<0.01	0.01	0.01
Arsenic	mg/L	0.001	-			-	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	-			-	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-			-	<0.001	<0.001	<0.001
Copper	mg/L	0.001	-			-	0.374	0.397	0.129
Iron	mg/L	0.05	-			-	<0.05	<0.05	<0.05
Lead	mg/L	0.001	-			-	<0.001	0.005	<0.001
Nickel	mg/L	0.001	-			-	0.016	0.003	<0.001
Manganese	mg/L	0.001	-			-	0.002	0.003	0.002
Zinc	mg/L	0.005	-			-	0.092	0.096	0.024
Mercury	mg/L	0.0001	-			-	<0.0001	<0.0001	<0.0001
Nutrients									
Ammonia (as N)	mg/L	0.01	-			-	**0.24**	**0.28**	**0.32**
Nitrite	mg/L	0.01	-			-	**0.03**	**0.02**	**0.02**
Nitrate	mg/L	0.01	-			-	**0.16**	**0.16**	**0.31**
Nitrite+nitrate	mg/L	0.01	-			-	**0.19**	**0.18**	**0.33**
Total Kjeldahl Nitrogen	mg/L	0.01	-			-	**0.6**	**0.4**	**0.4**
Total nitrogen	mg/L	0.01	-			-	**0.8**	**0.6**	**0.7**
Total phosphorous	mg/L	0.01	-			-	-	<0.01	-
Reactive phosphorous	mg/L	0.01	-			-	-	<0.01	-
Dissolved organic carbon	mg/L	1	-			-	-	<1	-
Total organic carbon	mg/L	1	-			-	-	<1	z
Chemical oxygen demand	mg/L	10	-			-	-	**12**	-
Biochemical oxygen demand	mg/L	2	-			-	-	<2	-
Carbonaceous biochemical oxygen demand	mg/L	2	-			-	-	<2	-
PAH									
Naphthalene	ug/L	1	-			-	<1.0	<1.0	<1.0
Acenaphthylene	ug/L	1	-			-	<1.0	<1.0	<1.0
Acenaphthene	ug/L	1	-			-	<1.0	<1.0	<1.0
Fluorene	ug/L	1	-			-	<1.0	<1.0	<1.0
Phenanthrene	ug/L	1	-			-	<1.0	<1.0	<1.0
Anthracene	ug/L	1	-			-	<1.0	<1.0	<1.0
Fluoranthene	ug/L	1	-			-	<1.0	<1.0	<1.0
Pyrene	ug/L	1	-			-	<1.0	<1.0	<1.0
Benz(a)anthracene	ug/L	1	-			-	<1.0	<1.0	<1.0
Chrysene	ug/L	1	-			-	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	ug/L	1	-			-	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	ug/L	1	-			-	<1.0	<1.0	<1.0
Benzo(a)pyrene	ug/L	0.5	-			-	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	ug/L	1	-			-	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	ug/L	1	-			-	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	ug/L	1	-			-	<1.0	<1.0	<1.0
Sum of polycyclic aromatic hydrocarbons	ug/L	0.5	-			-	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)	ug/L	0.5	-			-	<0.5	<0.5	<0.5
TPH									
C6 - C9 Fraction	ug/L	20	-			<20	**50**	**30**	**20**
C10 - C14 Fraction	ug/L	50	-			-	<50	<50	<50
C15 - C28 Fraction	ug/L	100	-			-	<100	<100	<100
C29 - C36 Fraction	ug/L	50	-			-	<50	<50	<50
C10 - C36 Fraction (sum)	ug/L	50	-			-	<50	<50	<50

Analyte	unit	LOR	TRIP SPIKE	Spike concetration	RPD	TRIP BLANK	SD-RINSATE	WAT-RINSATE	RINSATE
			6-Nov-15						17-Nov-15
TRH									
C6 - C10 Fraction	ug/L		-			<20	**50**	**30**	**30**
C6 - C10 Fraction minus BTEX (F1)	ug/L	20	-			<20	**50**	**30**	**30**
>C10 - C16 Fraction	ug/L	100	-			-	<100	<100	<100
>C16 - C34 Fraction	ug/L	100	-			-	<100	<100	<100
>C34 - C40 Fraction	ug/L	100	-			-	<100	<100	<100
>C10 - C40 Fraction (sum)	ug/L	100	-			-	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	ug/L	100	-			-	<100	<100	<100
BTEX									
Benzene	ug/L	1	18	20	-2.63	<1	<1	<1	<1
Toluene	ug/L	2	16	20	-5.56	<2	<2	<2	<2
Ethylbenzene	ug/L	2	17	20	-4.05	<2	<2	<2	<2
meta- & para-Xylene	ug/L	2	17	20	-4.05	<2	<2	<2	<2
ortho-Xylene	ug/L	2	17	20	-4.05	<2	<2	<2	<2
Total Xylenes	ug/L	2	34	-	-	<2	<2	<2	<2
Sum of BTEX	ug/L	1	85	-	-	<1	<1	<1	<1
Naphthalene	ug/L	5	18	-	-	<5	<5	<5	<5

TRIP SPIKE & BLANK SOIL

Analyte	unit	LOR	Trip spike 3	Trip Sprike Control 3	RPD	Trip spike 4	Trip Spike Control 4	RPD	TB
			6-Nov-15						
Laboratory parameters									
TPH									
C6 - C9 Fraction	mg/kg	10	25	30	-4.55	52	46	3.06	<10
TRH					-			-	
C6 - C10 Fraction	mg/kg	10	28	34	-4.84	58	52	2.73	<10
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	12	18	-10.00	33	28	4.10	<10
BTEX					-			-	
Benzene	mg/kg	0.2	0.3	0.2	10.00	0.4	0.4	0.00	<0.2
Toluene	mg/kg	0.5	7.4	7.2	0.68	11.9	11	1.97	<0.5
Ethylbenzene	mg/kg	0.5	1	1	0.00	1.6	1.5	1.61	<0.5
m&p-Xylenes	mg/kg	0.5	5	5	0.00	7.9	7.6	0.97	<0.5
o-Xylene	mg/kg	0.5	2.1	2.1	0.00	3.3	3.1	1.56	<0.5
Sum of BTEX	mg/kg	0.5	15.8	15.5	0.48	25.1	23.6	1.54	<0.5
Xylenes - Total	mg/kg	0.2	7.1	7.1	0	11.2	10.7	1.14	<0.2
Naphthalene	mg/kg	1	<1	<1	0	<1	<1	0.00	<1

Douglas Partners (28 May 2018)
PSI



Locality Plan

NOTE:
1: Base image from Nearmap.com (Dated 21.1.2018)
2: Test locations are approximate only and are shown with reference to existing features
3: Survey is from JMD Development Consultants Ref: 14005-GEO1

LEGEND

- Current test pit location
- Previous borehole location
- Gas monitoring bore

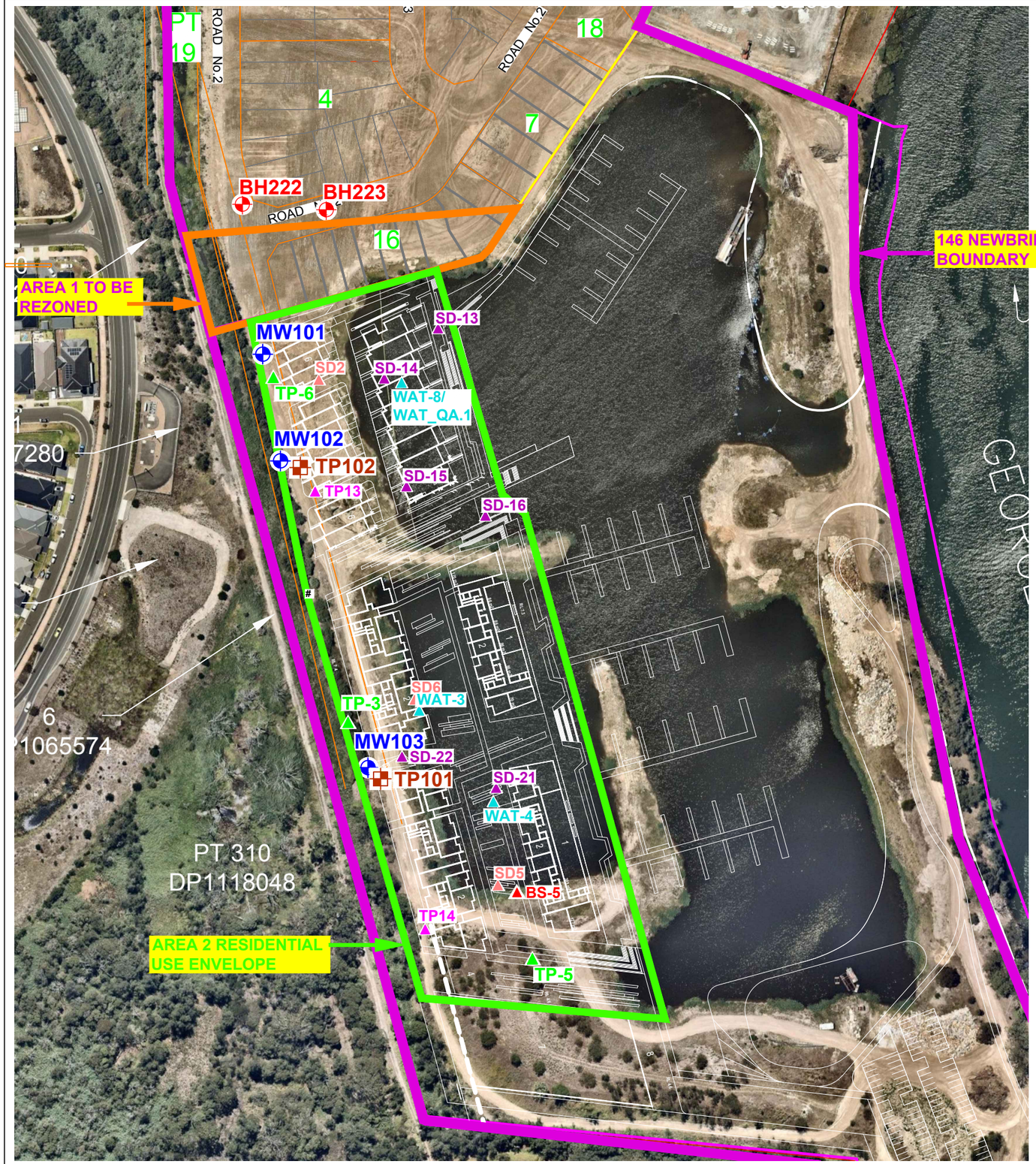
INVESTIGATION BY EMM

- SPI Test pit location
- SPI Sediment sample location
- SPI Dregded pond water sample location
- PI Sediment sample location
- PI Test pit location
- # SPI and historic groundwater sample location
- Historic groundwater sample l ocation

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Mirvac Homes Nsw Pty Ltd		TITLE: **Test Locations**
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Residential Development (Rezoning)**
SCALE: 1:4000 @ A3	DATE: 10.4.2018	**146 Newbridge Road, MOOREBANK**

PROJECT No: 71459.10
DRAWING No: 1
REVISION: 0



0 10 20 30 40 60 80 100 150 200m

1:2000 @ A3

NOTE:
1: Base image from Nearmap.com (Dated 21.1.2018)
2: Test locations are approximate only and are shown with reference to existing features
3: Survey is from JMD Development Consultants Ref: 14005-GEO1

LEGEND

- Current test pit location
- Previous borehole location
- Gas monitoring bore

INVESTIGATION BY EMM

- SPI Test pit location
- SPI Sediment sample location
- SPI Dregded pond water sample location
- PI Sediment sample location
- PI Test pit location
- # SPI and historic groundwater sample location
- Historic groundwater sample l ocation

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CLIENT: Mirvac Homes Nsw Pty Ltd		TITLE: **Test Locations**	PROJECT No: 71459.10
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Residential Development (Rezoning)**	DRAWING No: 2
SCALE: 1:2000 @ A3	DATE: 10.4.2018	**146 Newbridge Road, MOOREBANK**	REVISION: 0

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Table C1: Summary of Laboratory Results

| | | | | Metals | | | | | | | | TRH | | | | | | | BTEX | | | | | | | | PAH | | | | | | | | | | | | | | | | | | OCP | | | | | | | | | | | | | | | | | |

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Table C1: Summary of Laboratory Results

				OPP															PCB										
				g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Hexachlorobenzene	Methoxychlor	Azinophos methyl	Bromophos-ethyl	Chlorpyrifos	Chlorpyrifos-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenitrothion	Malathion	Parathion	Ronnel	Arochlor 1016	Arochlor 1221	Arochlor 1232	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	PCBs (Sum of total)	Phenolics Total	Asbestos
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	g/kg
PQL				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5	0.1/0.001
CRC Care Direct Contact HSL-A																														
CRC Care Direct Contact Intrusive Maintenance Worker																														
CRC Care Intrusive MW Soil HSL Vapour I, Sand 0-2m																														
NEPM 2013 EILs Res/Open Space Aged																														
NEPM 2013 Table 1A(1) HILs Res A Soil					6		10	300			160																	1		0.001
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Sand 0-1m																														
NEPM 2013 Table 1B(6) ESLs for Urban Res, Coarse Soil 0-2m																														
NEPM 2013 Table 1B(7) Management Limits in Res / Parkland, Coarse Soil																														
Field_ID	**Sample Dep**	**Sample Date**	**Matrix Description**																											
DP Results, Current Investigation April 2018																														
TP101	0.2-0.3	16/03/2018	Filling	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	NAD
B01/20180316	0.2-0.3	16/03/2018	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TP101	1.9-2	16/03/2018	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TP101	2.8-2.9	16/03/2018	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001
TP102	0.2-0.3	16/03/2018	Filling	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	<0.001
TP102	0.4-0.5	16/03/2018	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.001
TP102	0.9-1	16/03/2018	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TP101	-	16/03/2018	Material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Chrysotile
TP102	-	16/03/2018	Material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Chrysotile/Amosite
Trip Spike	-	16/03/2018	Soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trip Blank	-	16/03/2018	Soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EMM Results, Preliminary Investigation, July 2015																														
SOIL																														
TP-3	0.5	3/06/2018	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TP-5	0.5	3/06/2018	Filling	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.2	-	-	-	-	-	-	-	-	-	-
TP-6	0.5	3/06/2018	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-
SEDIMENT																														
SD-2	-	3/06/2018	Sediment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SD-5	-	3/06/2018	Sediment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SD-6	-	3/06/2018	Sediment	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.2	-	-	-	-	-	-	-	<0.05	-	-
EMM Results, Supplementary Preliminary Investigation, March 2016																														
SOIL																														
TP-13	1.5	9/11/2015	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TP-14	3.1	9/11/2015	Filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEDIMENT																													-	
SD-13	-	9/11/2015	Sediment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SD-14	-	9/11/2015	Sediment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SD-15	-	9/11/2015	Sediment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SD-16	-	9/11/2015	Sediment	<0.05	<0.05	<0.05	<0.05	<0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

EMM (4 July 2018)
EIS Addendum

Site location plan

Georges Cove Marina
Environmental Impact Statement Addendum
Figure 1.1

Site layout

Georges Cove Marina
Environmental Impact Statement Addendum
Figure 1.2

Dredge pond and Georges River sampling locations

Georges Cove Marina
Environmental Impact Statement Addendum
Figure 3.2

Douglas Partners (6 September 2018)
ESA

Figure 1: Surface Water Monitoring Points

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			Perfluoroalkylated Substances																									Nutrients				Metals - total								
			10:2 FTS*	4:2 FTS	8:2 FTS	4tPerfluorooctanesulf- amid oacetic acid	MePerfluorooctanesulf- amid oacetic acid	N-Et perfluorooctanesulfonamid -oethanol	N-Me perfluorooctanesulfonamid -oethanol	N-Methyl perfluorooctane sulfonamide	6:2 Fluorotelomer Sulfonate (6:2 FtS)	Perfluorobutanesulfonic acid	Perfluorobutanoic acid	Perfluorodecanesulfonic acid	Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluoroheptanesulfonic acid*	Perfluoroheptanoic acid	Perfluorohexanesulfonic acid	Perfluorohexanoic acid	Perfluorononanoic acid	Perfluorooctane sulfonamide	Perfluorooctanesulfonic acid PFOS	Perfluorooctanoate	Perfluoropentanesulfonic acid*	Perfluoropentanoic acid*	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	Ammonia	Nitrate (as N)	Nitrite (as N)	Phosphorus	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Manganese	Mercury	Nickel	Zinc
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.01	0.01	0.01	0.02	0.02	0.5	0.05	0.05	0.00001	0.01	0.02	0.02	0.02	0.05	0.01	0.01	0.01	0.01	0.01	0.1	0.01	0.00001	0.01	0.02	0.5	0.1	0.02	0.005	0.005	0.005	0.05	0.001	0.0001	0.001	0.001	0.001	0.005	0.00005	0.001	0.001
ANZECC 2000 FW 95%																														0.9	0.161				0.0002		0.0014	0.0034	1.9	0.0006	0.011	0.008
ANZECC 2000 LOW RELIABILITY FW																																										
ANZECC 2000 LOW RELIABILITY MW																																	0.0045					0.08				
ANZECC 2000 MW 95%																														0.91				0.0055		0.0013	0.0044		0.0004	0.07	0.015
ANZECC 2000 Physical and Chemical stressors**																														0.02			0.05									
ADWG 2011 Aesthetic																														0.5						1		0.1				3
Freshwater, 95% Protection, HEPA 2018																							0.13	0.22																			
Freshwater, 99% Protection, HEPA 2018																							0.00023	0.019																			
Interim Marine, 95% Protection, HEPA 2018																							0.13	0.22																			
Interim Marine, 99% Protection, HEPA 2018																							0.00023	0.019																			
Recreational Water (HEPA 2018)																								0.0056																			
Recreational water quality and aesthetics																															10	1		0.05	0.005	0.05	1	0.05	0.1	0.001	0.1	5
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																																										
2-4m																																										
Field_ID	**LocCode**	**Sampled Date**																																								
May- Full Suite																																									
SW1 (UGR)	Up-gradient Georges River	17/05/2017	<0.01	<0.01	<0.01	<0.02	<0.02	<0.5	<0.05	<0.05	<0.00001	<0.01	<0.02	<0.02	<0.02	<0.05	<0.01	<0.01	0.01	<0.01	<0.01	<0.1	0.01	<0.00001	<0.01	0.02	<0.5	<0.1	<0.02	0.005	0.29	<0.005	0.07	<0.001	<0.0001	<0.001	0.003	<0.001	0.049	<0.00005	0.002	0.006
BD1	Up-gradient Georges River	17/05/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	0.28	<0.005	0.08	<0.001	<0.0001	<0.001	0.002	<0.001	0.049	<0.00005	0.002	0.005
SW2 (P)	Pond	17/05/2017	<0.01	<0.01	<0.01	<0.02	<0.02	<0.5	<0.05	<0.05	<0.00001	<0.01	<0.02	<0.02	<0.02	<0.05	<0.01	0.02	0.03	0.03	<0.01	<0.1	0.04	0.00003	<0.01	0.03	<0.5	<0.1	<0.02	0.11	0.02	0.01	<0.05	0.002	<0.0001	<0.001	0.004	<0.001	0.15	<0.00005	0.002	0.004
SW3 (P)	Pond	17/05/2017	<0.01	<0.01	<0.01	<0.02	<0.02	<0.5	<0.05	<0.05	<0.00001	<0.01	<0.02	<0.02	<0.02	<0.05	<0.01	0.02	0.03	0.03	<0.01	<0.1	0.04	0.00003	<0.01	0.04	<0.5	<0.1	<0.02	0.096	0.02	0.01	<0.05	0.002	<0.0001	<0.001	0.002	<0.001	0.14	<0.00005	0.002	0.002
SW4 (DGR)	Down-gradient Georges River	17/05/2017	<0.01	<0.01	<0.01	<0.02	<0.02	<0.5	<0.05	<0.05	<0.00001	<0.01	<0.02	<0.02	<0.02	<0.05	<0.01	<0.01	0.01	<0.01	<0.01	<0.1	0.01	<0.00001	<0.01	<0.02	<0.5	<0.1	<0.02	0.012	0.27	<0.005	0.08	<0.001	<0.0001	<0.001	0.004	<0.001	0.039	<0.00005	0.002	0.007
Trip Blank	Trip Blank	17/05/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
July- Ammonia																																										
SW1 (UGR)	Up-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	-	-	-	-	-	-	-	-	-	-	-	-
BD1	Up-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	-	-	-	-	-	-	-	-	-	-	-	-
SW2/0.5 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-	-	-
SW2/1.0 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-	-
SW3/0.5 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11	-	-	-	-	-	-	-	-	-	-	-	-
SW3/1.0 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	-	-	-	-	-	-	-	-	-	-	-	-
September- Full Suite																																										
SW1 (UGR)	Up-gradient Georges River	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.054	<0.005	<0.05	<0.001	<0.0001	<0.001	0.003	<0.001	0.083	<0.00005	0.002	0.013
SW2 (P)	Pond	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.16	0.034	<0.05	0.002	<0.0001	<0.001	0.003	0.003	0.11	<0.00005	0.003	0.006
BD1/20170929	Pond	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.16	0.034	-	0.002	<0.0001	<0.001	0.003	0.003	0.11	<0.00005	0.003	0.006
SW3 (P)	Pond	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.18	0.17	0.038	<0.05	0.001	<0.0001	<0.001	0.002	<0.001	0.1	<0.00005	0.002	0.003
SW4 (DGR)	Down-gradient Georges River	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.054	0.07	<0.005	<0.05	<0.001	<0.0001	<0.001	0.002	<0.001	0.09	<0.00005	0.002	0.012
Trip Blank	Trip Blank	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
December- Ammonia																																										
SW1 (UGR)	Up-gradient Georges River	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.029	-	-	-	-	-	-	-	-	-	-	-	-
January- Full Suite																																										
SW1 (UGR)	Up-gradient Georges River	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.007	0.04	0.005	0.07	0.001	<0.0001	<0.001	0.001	<0.001	0.045	<0.00005	0.002	0.009
SW2 (P)	Pond	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.014	1.3	<0.005	<0.05	0.004	<0.0001	<0.001	0.001	<0.001	0.2	<0.00005	0.002	0.005
SW3 (P)	Pond	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.033	<0.005	<0.005	<0.05	0.004	<0.0001	<0.001	0.001	<0.001	0.21	<0.00005	0.002	0.002
BD1300118	Pond	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.039	<0.005	<0.005	0.06	0.004	<0.0001	<0.001	0.001	<0.001	0.23	<0.00005	0.002	0.004
SW4 (DGR)	Down-gradient Georges River	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.008	0.05	<0.005	0.07	<0.001	<0.0001	<0.001	<0.001	<0.001	0.039	<0.00005	0.002	0.004
TRIP BLANK	TRIP BLANK	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
March- Ammonia																																										
SW1 (UGR)	Up-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.029	-	-	-	-	-	-	-	-	-	-	-	-
BD1/20180320	Up-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.017	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.014	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.023	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.012	-	-	-	-	-	-	-	-	-	-	-	-

Notes

HEPA 2018 PFAS National Environmental Management Plan, January 2018, The Heads of EPAs Australia and New Zealand (HEPA)

** Based on ANZECC 2000 Table 3.3.2 Default trigger values for physical and chemical stressors for SE Australia for lowland rivers.

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			TRH										BTEX						PAH																	Polychlorinated Biphenyls							
			C10-C16	C16-C34	C34-C40	2-NAPHTHALENE	C6 - C9	C10 - C14	C15 - C28	C29-C36	C6-C10 less BTEX (F1)	C6-C10	Benzene	Ethylbenzene	Naphthalene	Toluene	Xylene (m & p)	Xylene (o)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(e)pyrene TEQ	Benzo(b,j+k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Total +ve PAHs	Total Phenolics	Arochlor 1016	Arochlor 1221	Arochlor 1232	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	KCBs (Sum of total)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.05	0.1	0.1	0.05	0.01	0.05	0.1	0.1	0.01	0.01	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	5	2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	1	0.05	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
ANZECC 2000 FW 95%													0.95		0.016			0.35													0.016							0.0006		0.00003		
ANZECC 2000 LOW RELIABILITY FW																																				0.000009	0.001	0.0003	0.0006	0.00003	0.00003	0.025	
ANZECC 2000 LOW RELIABILITY MW														0.005		0.18					0.00001		0.0002						0.0014				0.002									
ANZECC 2000 MW 95%													0.7		0.07																0.07												
ANZECC 2000 Physical and Chemical stressors**																																											
ADWG 2011 Aesthetic														0.003		0.025																											
Freshwater, 95% Protection, HEPA 2018																																											
Freshwater, 99% Protection, HEPA 2018																																											
Interim Marine, 95% Protection, HEPA 2018																																											
Interim Marine, 99% Protection, HEPA 2018																																											
Recreational Water (HEPA 2018)																																											
Recreational water quality and aesthetics													0.01										0.00001																					
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																																											
2-4m						1					1		0.8	NL	NL	NL																NL											
Field_ID	**LocCode**	**Sampled Date**																																									
May- Full Suite																																											
SW1 (UGR)	Up-gradient Georges River	17/05/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	0	0	0	0	0	0	0	0.00001
BD1	Up-gradient Georges River	17/05/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	17/05/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
SW3 (P)	Pond	17/05/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
SW4 (DGR)	Down-gradient Georges River	17/05/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Trip Blank	Trip Blank	17/05/2017	-	-	-	-	-	-	-	-	-	-	<0.001	<0.001	-	<0.001	<0.002	<0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
July- Ammonia																																											
SW1 (UGR)	Up-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BD1	Up-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2/0.5 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2/1.0 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3/0.5 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3/1.0 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
September- Full Suite																																											
SW1 (UGR)	Up-gradient Georges River	29/09/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
SW2 (P)	Pond	29/09/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
BD1/20170929	Pond	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	29/09/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
SW4 (DGR)	Down-gradient Georges River	29/09/2017	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
Trip Blank	Trip Blank	29/09/2017	-	-	-	-	<0.01	-	-	-	-	<0.01	<0.001	<0.001	-	<0.001	<0.002	<0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
December- Ammonia																																											
SW1 (UGR)	Up-gradient Georges River	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
January- Full Suite																																											
SW1 (UGR)	Up-gradient Georges River	30/01/2018	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
SW2 (P)	Pond	30/01/2018	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
SW3 (P)	Pond	30/01/2018	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
BD1300118	Pond	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	30/01/2018	<0.05	<0.1	<0.1	<0.05	<0.01	<0.05	<0.1	<0.1	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<5	<2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0	<0.05	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
TRIP BLANK	TRIP BLANK	30/01/2018	-	-	-	-	<0.01	-	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
March- Ammonia																																											
SW1 (UGR)	Up-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BD1/20180320	Up-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes

HEPA 2018 PFAS National Environmental Management Plan, Januar

** Based on ANZECC 2000 Table 3.3.2 Default trigger value

Douglas Partners
Geotechnics / Environment / Groundwater

			Organochlorine Pesticides																			Organophosphorous Pesticides										
			4,4-DDE	a-BHC	Aldrin	b-BHC	Chlordane (cis)	Chlordane (trans)	d-BHC	DDD	DDT	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Hexachlorobenzene	Methoxychlor	Mirex	Azinophos methyl	Bromophos-ethyl	Chlorpyrifos	Chlorpyrifos-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenitrothion	Malathion	Methyl parathion
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000002	0.000002	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000002	0.00001	0.00001	0.000009	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
ANZECC 2000 FW 95%											0.00001					0.00002	0.0002	0.00009					0.00002		0.00001		0.00001		0.00015		0.0002	0.00005	
ANZECC 2000 LOW RELIABILITY FW																																		
ANZECC 2000 LOW RELIABILITY MW					0.000003		0.000001	0.000001			0.0000004	0.00001	0.000005	0.000005				0.0000004			0.000004												
ANZECC 2000 MW 95%																0.000008									0.000009								
ANZECC 2000 Physical and Chemical stressors**																																		
ADWG 2011 Aesthetic																																		
Freshwater, 95% Protection, HEPA 2018																																		
Freshwater, 99% Protection, HEPA 2018																																		
Interim Marine, 95% Protection, HEPA 2018																																		
Interim Marine, 99% Protection, HEPA 2018																																		
Recreational Water (HEPA 2018)																																		
Recreational water quality and aesthetics					0.001						0.003	0.001				0.001	0.01	0.003					0.01	0.02	0.002		0.01	0.02	0.1	0.006	0.02	0.1	0.006
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																																		
2-4m																																		
Field_ID	**LocCode**	**Sampled Date**																																
May- Full Suite																																		
SW1 (UGR)	Up-gradient Georges River	17/05/2017	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	0.000001	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.00001	<0.000009	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
BD1	Up-gradient Georges River	17/05/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	17/05/2017	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000004	<0.000001	<0.000001	<0.000001	0.000003	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.00001	<0.000009	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
SW3 (P)	Pond	17/05/2017	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	0.000003	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.00001	<0.000009	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
SW4 (DGR)	Down-gradient Georges River	17/05/2017	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000004	<0.000001	<0.000001	<0.000001	0.000002	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.00001	<0.000009	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Trip Blank	Trip Blank	17/05/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
July- Ammonia																																		
SW1 (UGR)	Up-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BD1	Up-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2/0.5 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2/1.0 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3/0.5 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3/1.0 (P)	Pond	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	25/07/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
September- Full Suite																																		
SW1 (UGR)	Up-gradient Georges River	29/09/2017	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
SW2 (P)	Pond	29/09/2017	<0.000001	<0.000001	0.000004	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	0.000002	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
BD1/20170929	Pond	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	29/09/2017	<0.000001	<0.000001	0.000006	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	0.000002	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
SW4 (DGR)	Down-gradient Georges River	29/09/2017	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
Trip Blank	Trip Blank	29/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
December- Ammonia																																		
SW1 (UGR)	Up-gradient Georges River	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	13/12/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
January- Full Suite																																		
SW1 (UGR)	Up-gradient Georges River	30/01/2018	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
SW2 (P)	Pond	30/01/2018	<0.000001	<0.000001	<0.000001	<0.000001	0.000001	0.000001	<0.000001	<0.000001	<0.000001	0.000002	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
SW3 (P)	Pond	30/01/2018	<0.000001	<0.000001	<0.000001	<0.000001	0.000001	0.000001	<0.000001	<0.000001	<0.000001	0.000002	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
BD1300118	Pond	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	30/01/2018	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.000002	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000002	<0.00002	<0.0002	<0.000009	<0.0002	<0.00001	<0.0002	<0.00015	<0.0002	<0.0002	<0.00005	<0.0002
TRIP BLANK	TRIP BLANK	30/01/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
March- Ammonia																																		
SW1 (UGR)	Up-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BD1/20180320	Up-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW2 (P)	Pond	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW3 (P)	Pond	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW4 (DGR)	Down-gradient Georges River	20/03/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
HEPA 2018 PFAS National Environmental Management Plan, Januar

** Based on ANZECC 2000 Table 3.3.2 Default trigger value

	fenarthion	fonnel
	mg/L	mg/L
PQL	0.000004	0.0002
ANZECC 2000 FW 95%	0.000004	
ANZECC 2000 LOW RELIABILITY FW		
ANZECC 2000 LOW RELIABILITY MW		
ANZECC 2000 MW 95%		
ANZECC 2000 Physical and Chemical stressors**		
ADWG 2011 Aesthetic		
Freshwater, 95% Protection, HEPA 2018		
Freshwater, 99% Protection, HEPA 2018		
Interim Marine, 95% Protection, HEPA 2018		
Interim Marine, 99% Protection, HEPA 2018		
Recreational Water (HEPA 2018)		
Recreational water quality and aesthetics	0.03	0.06
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand		
2-4m		

Field_ID	LocCode	Sampled Date		
May- Full Suite				
SW1 (UGR)	Up-gradient Georges River	17/05/2017	<0.000004	<0.00001
BD1	Up-gradient Georges River	17/05/2017	-	-
SW2 (P)	Pond	17/05/2017	<0.000004	<0.00001
SW3 (P)	Pond	17/05/2017	<0.000004	<0.00001
SW4 (DGR)	Down-gradient Georges River	17/05/2017	<0.000004	<0.00001
Trip Blank	Trip Blank	17/05/2017	-	-
July- Ammonia				
SW1 (UGR)	Up-gradient Georges River	25/07/2017	-	-
BD1	Up-gradient Georges River	25/07/2017	-	-
SW2/0.5 (P)	Pond	25/07/2017	-	-
SW2/1.0 (P)	Pond	25/07/2017	-	-
SW3/0.5 (P)	Pond	25/07/2017	-	-
SW3/1.0 (P)	Pond	25/07/2017	-	-
SW4 (DGR)	Down-gradient Georges River	25/07/2017	-	-
September- Full Suite				
SW1 (UGR)	Up-gradient Georges River	29/09/2017	<0.000004	<0.0002
SW2 (P)	Pond	29/09/2017	<0.000004	<0.0002
BD1/20170929	Pond	29/09/2017	-	-
SW3 (P)	Pond	29/09/2017	<0.000004	<0.0002
SW4 (DGR)	Down-gradient Georges River	29/09/2017	<0.000004	<0.0002
Trip Blank	Trip Blank	29/09/2017	-	-
December- Ammonia				
SW1 (UGR)	Up-gradient Georges River	13/12/2017	-	-
SW2 (P)	Pond	13/12/2017	-	-
SW3 (P)	Pond	13/12/2017	-	-
SW4 (DGR)	Down-gradient Georges River	13/12/2017	-	-
January- Full Suite				
SW1 (UGR)	Up-gradient Georges River	30/01/2018	<0.000004	<0.0002
SW2 (P)	Pond	30/01/2018	<0.000004	<0.0002
SW3 (P)	Pond	30/01/2018	<0.000004	<0.0002
BD1300118	Pond	30/01/2018	-	-
SW4 (DGR)	Down-gradient Georges River	30/01/2018	<0.000004	<0.0002
TRIP BLANK	TRIP BLANK	30/01/2018	-	-
March- Ammonia				
SW1 (UGR)	Up-gradient Georges River	20/03/2018	-	-
BD1/20180320	Up-gradient Georges River	20/03/2018	-	-
SW2 (P)	Pond	20/03/2018	-	-
SW3 (P)	Pond	20/03/2018	-	-
SW4 (DGR)	Down-gradient Georges River	20/03/2018	-	-

Notes

HEPA 2018 PFAS National Environmental Management Plan, Januar

** Based on ANZECC 2000 Table 3.3.2 Default trigger value

Appendix B. Figures & Tables from Investigation Reports for North Benedict Site

Douglas Partners (May 2002)

PSI

LOT 1
DP 336613

NEWBRIDGE ROAD

LOT 1
DP 515738

LOT 2
DP 602988
"FLOWERPOWER"

RIVER

GEORGES

BH1
BH2
BH3
BH4
BH5
BH6
BH7
BH8
BH9
BH10
BH11
BH12

POND
MOUNT ECHO
TANK
WASH PLANT
UNDER BRIDGE
TRUCK WASH
SHED
BITUMEN ROAD
B-H- MAIL
WIRE MESH FENCE
SSM 26462
RL 2-607
RL 2-69

NOTES

CONTOUR INTERVAL 1 METRE

ORIGIN OF LEVELS ON A-H-D- TAKEN FROM SSM 26462 RL 2-607
SOURCE S-C-I-M-S- 3/11/97

DENNISON SURVEYING PTY LTD
ENGINEERING & CONSTRUCTION SURVEYING
5 COWELL STREET
(PO BOX 900) BLADESVILLE 2111
PH (02) 9879 4283 DX554 SYDNEY FAX 9879 7193

LEGEND

TEST BORE LOCATION

Douglas Partners
Geotechnics, Environment, Groundwater

Sydney, Newcastle, Brisbane, Melbourne, Perth, Wyong, Campbelltown, Townsville Cairns, Wollongong

TITLE:
Location of Test Bores
Preliminary Contamination Assessment
146 Newbridge Road
MOOREBANK

CLIENT: Benedict Sand and Gravel			
DRAWN BY: PSCH	SCALE: As shown	PROJECT No: 30410	OFFICE: SYDNEY
APPROVED BY:		DATE: 31.5.2002	DRAWING No: 1

F:\DRAWINGS2002\MAY2002\30410.dwg, 31/05/02 12:19:42

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6.3 Analytical Results for Soil Samples

The results of laboratory analysis for inorganic and organic contaminants (see Appendix C) in the soil samples are summarised in the following tables:-

- *Table 2 - Results of Laboratory Analysis for Heavy Metals;*
- *Table 3 - Results of Laboratory Analysis for TRH/BTEX;*
- *Table 4 - Results of Laboratory Analysis for PAH, PCB and Phenols;*
- *Table 5 - Results of Laboratory Analysis for OCP; and*
- *Table 6 - Results of Laboratory Analysis for OPP.*

Table 2 - Results of Laboratory Analysis for Heavy Metals

Sample ID	As (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Zn (mg/kg)
1/0.5	5	<1	14	11	29	<0.05	6	46
2/2.0	<5	<1	9	38	**300**	<0.05	27	**1500**
3/4.0	7	**6**	20	26	**480**	0.09	18	**5800**
4/2.0	5	<1	16	28	190	0.12	14	190
5/1.0	8	<1	41	18	33	<0.05	10	77
6/7.0	5	<1	18	11	17	<0.05	<4	24
7/4.0	6	<1	23	12	29	<0.05	7	120
8/1.0	<5	<1	13	29	40	<0.05	8	53
9/2.0	<5	<1	12	12	61	<0.05	5	85
10/4.0	7	<1	19	24	48	<0.05	17	75
11/1.0	<5	<1	11	12	51	0.05	4	82
12/7.0	6	<1	20	35	**320**	0.09	9	170
Z2*	<5	<1	25	52	**310**	0.11	20	**600**
95% UCL**	-	-	-	-	223	-	-	-
Site Assessment Criteria								
Column 1[1]	100	20	120 000	1 000	300	15	600	7 000
Column 5[2]	20	3	400	100	600	1	60	200

* Denotes field replicate of 2/2.0

** 95% upper confidence limit average concentration. Calculated using concentrations which are not identified as "hotspots" (i.e. >2.5 times the guideline threshold).

1 NSW EPA Contaminated Sites: *Guidelines for the NSW Site Auditor Scheme* (1998). Health-Based Investigation Levels for residential sites with gardens and accessible soil.

2 NSW EPA Contaminated Sites: *Guidelines for the NSW Site Auditor Scheme* (1998). Provisional phytotoxicity based investigation levels for sandy loams pH 6-8.

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Table 3 - Results of Laboratory Analysis for TRH/BTEX

Sample ID	Total Recoverable Hydrocarbons (TRH)				Monocyclic Aromatic Hydrocarbons (BTEX)			
	C6-C9 (mg/kg)	C10-C14 (mg/kg)	C15-C28 (mg/kg)	C29-C36 (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethyl Benzene (mg/kg)	Xylene (mg/kg)
1/0.5	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
2/2.0	<20	<20	110	<50	<0.5	<0.5	<0.5	<1.5
3/4.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
4/2.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
5/1.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
6/7.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
7/4.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
8/1.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
9/2.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
10/4.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
11/1.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
12/7.0	<20	<20	<50	<50	<0.5	<0.5	<0.5	<1.5
Site Assessment Criteria								
Guideline[1]	65	1 000			1	1.4	3.1	14

1 NSW EPA (1994) Contaminated Sites. *Guidelines for Assessing Service Station Sites*.

Table 4 - Results of Laboratory Analysis for PAH and PCB

Sample ID	Total PAH (mg/kg)	Benzo(a)pyrene (mg/kg)	Total PCB (mg/kg)	Phenols (mg/kg)
1/0.5	4.810	0.37	<0.90	<0.50
2/2.0	1.300	0.11	<0.90	<0.50
3/4.0	5.990	0.38	<0.90	<0.50
4/2.0	6.820	0.51	<0.90	<0.50
5/1.0	9.120	0.53	<0.90	<0.50
6/7.0	0.0	<0.05	<0.90	<0.50
7/4.0	3.570	0.24	<0.90	<0.50
8/1.0	11.29	1.0	<0.90	<0.50
9/2.0	0.31	0.07	<0.90	<0.50
10/4.0	0.0	<0.05	<0.90	<0.50
11/1.0	1.380	0.14	<0.90	<0.50
12/7.0	1.520	0.10	<0.90	<0.50
95% UCL*	-	0.44	-	-
Site Assessment Criteria				
Column 1[1]	20	1	10	8500

* 95% upper confidence limit average concentration. Calculated using concentrations which are not identified as "hotspots" (i.e. >2.5 times the guideline threshold).

1 NSW EPA Contaminated Sites: *Guidelines for the NSW Site Auditor Scheme* (1998). Health-Based Investigation Levels for residential sites with gardens and accessible soil.

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Table 5 - Results of Laboratory Analysis for OCP

Sample ID	Organochlorine Pesticides (OCP)				
	Aldrin (mg/kg)	Dieldrin (mg/kg)	Chlordane (mg/kg)	DDT (mg/kg)	Heptachlor (mg/kg)
1/0.5	<0.1	<0.1	<0.1	<0.1	<0.1
2/2.0	<0.1	<0.1	<0.1	<0.1	<0.1
3/4.0	<0.1	<0.1	<0.1	<0.1	<0.1
4/2.0	<0.1	<0.1	<0.1	<0.1	<0.1
5/1.0	<0.1	<0.1	<0.1	<0.1	<0.1
6/7.0	<0.1	<0.1	<0.1	<0.1	<0.1
7/4.0	<0.1	<0.1	<0.1	<0.1	<0.1
8/1.0	<0.1	<0.1	<0.1	<0.1	<0.1
9/2.0	<0.1	<0.1	<0.1	<0.1	<0.1
10/4.0	<0.1	<0.1	<0.1	<0.1	<0.1
11/1.0	<0.1	<0.1	<0.1	<0.1	<0.1
12/7.0	<0.1	<0.1	<0.1	<0.1	<0.1
Site Assessment Criteria					
Column 1[1]	10 (Aldrin+Dieldrin)		50	200	10

1 NSW EPA Contaminated Sites: *Guidelines for the NSW Site Auditor Scheme* (1998). Health-Based Investigation Levels for residential sites with gardens and accessible soil.

Table 6 - Results of Laboratory Analysis for OPP

Sample ID	Organophosphate Pesticides (OPP)			
	Chlorpyrifos (mg/kg)	Fenitrothion (mg/kg)	BromofosEthyl (mg/kg)	Ethion (mg/kg)
1/0.5	<0.1	<0.1	<0.1	<0.1
2/2.0	<0.1	<0.1	<0.1	<0.1
3/4.0	<0.1	<0.1	<0.1	<0.1
4/2.0	<0.1	<0.1	<0.1	<0.1
5/1.0	<0.1	<0.1	<0.1	<0.1
6/7.0	<0.1	<0.1	<0.1	<0.1
7/4.0	<0.1	<0.1	<0.1	<0.1
8/1.0	<0.1	<0.1	<0.1	<0.1
9/2.0	<0.1	<0.1	<0.1	<0.1
10/4.0	<0.1	<0.1	<0.1	<0.1
11/1.0	<0.1	<0.1	<0.1	<0.1
12/7.0	<0.1	<0.1	<0.1	<0.1
Site Assessment Criteria				
Column 1[1]	-	-	-	-

1 NSW EPA Contaminated Sites: *Guidelines for the NSW Site Auditor Scheme* (1998). Health-Based Investigation Levels for residential sites with gardens and accessible soil.

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6.5 QA/QC Procedures and Results

Quality assurance/quality control procedures comprised an integral part of this Contamination Assessment, and included both field and laboratory QA/QC procedures.

6.5.1 Field QC Procedures

The field QC comprised the collection of replicate samples during the course of sampling. In total, 67 soil samples were obtained from the subject site, six of which were replicate samples. Replicate sample Z2 and its respective original sample 2/2.0 were submitted for analysis along with 10 other selected soil samples. The replicate was analysed for heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn) and the comparative results of analysis are included in Table 2. Relative Percentage Differences (RPD) were calculated as an assessment of the result consistency.

Relative Percentage Difference

A measure of the consistency of results is derived by the calculation of relative percentage differences (RPDs) for replicate samples. Generally, an RPD of ± 30% is considered acceptable by the EPA, however, certain exceptions apply. The RPDs, which were calculated using the heavy metal concentrations, for the replicate sample (Z2) and its respective original sample (2/2.0) are tabulated below.

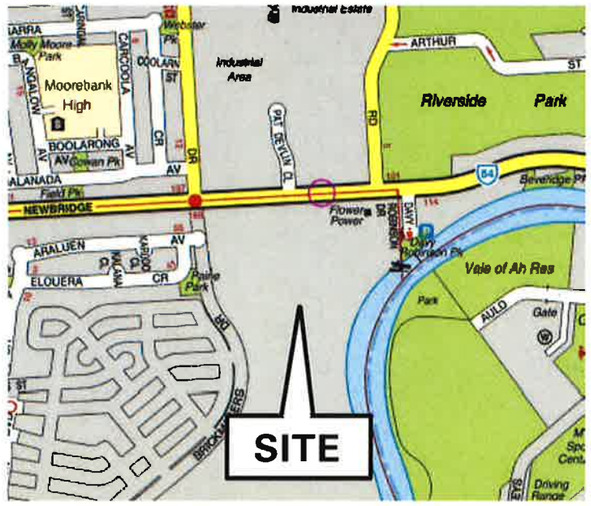
Table 7 - RPD Results

Sample ID	As (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Zn (mg/kg)
2/2.0	<5	<1	9	38	300	<0.05	27	1500
Z2	<5	<1	25	52	310	0.11	20	600
%RPD	**0**	**0**	**94**	**31**	**3**	**75**	**30**	**86**
PQL*	<2.0	<1.0	<2.0	<2.0	<2.0	<0.01	<2.0	<2.0

* Practical Quantitation Limit

Table 7 indicates that all RPD results fall within the typical acceptable range (± 30%) except for Cr Hg and Zn. However, the contaminant concentrations for Hg in both the original sample and its replicate are less than ten times the practical quantification limit (2.0 mg/kg). With respect to Cr and Zn, the concentrations in all samples are well below the adopted site assessment guidelines of 120000 mg/kg for Cr and 7000 mg/kg for Zn. Under such circumstances, the RPD values are considered to be acceptable and the overall RPD results obtained indicate an acceptable consistency between the sample and replicate.

EIS (19 December 2013)
PSI



N

NOTES:
Figure 1 has been recreated from UBD on disc (version 5.0) and NSW Department of Lands SIX Maps. Figure is not to scale.

UBD Map ref: 270D6, D7, E6 to E8

Reference should be made to the report text for a full understanding of this plan.

EIS
ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E26930KB	SITE LOCATION PLAN
Figure: 1	Address: 146 NEWBRIDGE ROAD, MOOREBANK, NSW

LEGEND:

- Approximate site boundary
- BH1 (2.5) — Borehole location, number and depth of fill (m)
- Groundwater monitoring well location

NOTES:
Figure 2 has been recreated from the survey plan prepared by Freeburn Surveying Pty Ltd (Ref: 32825, dated 22/8/13).

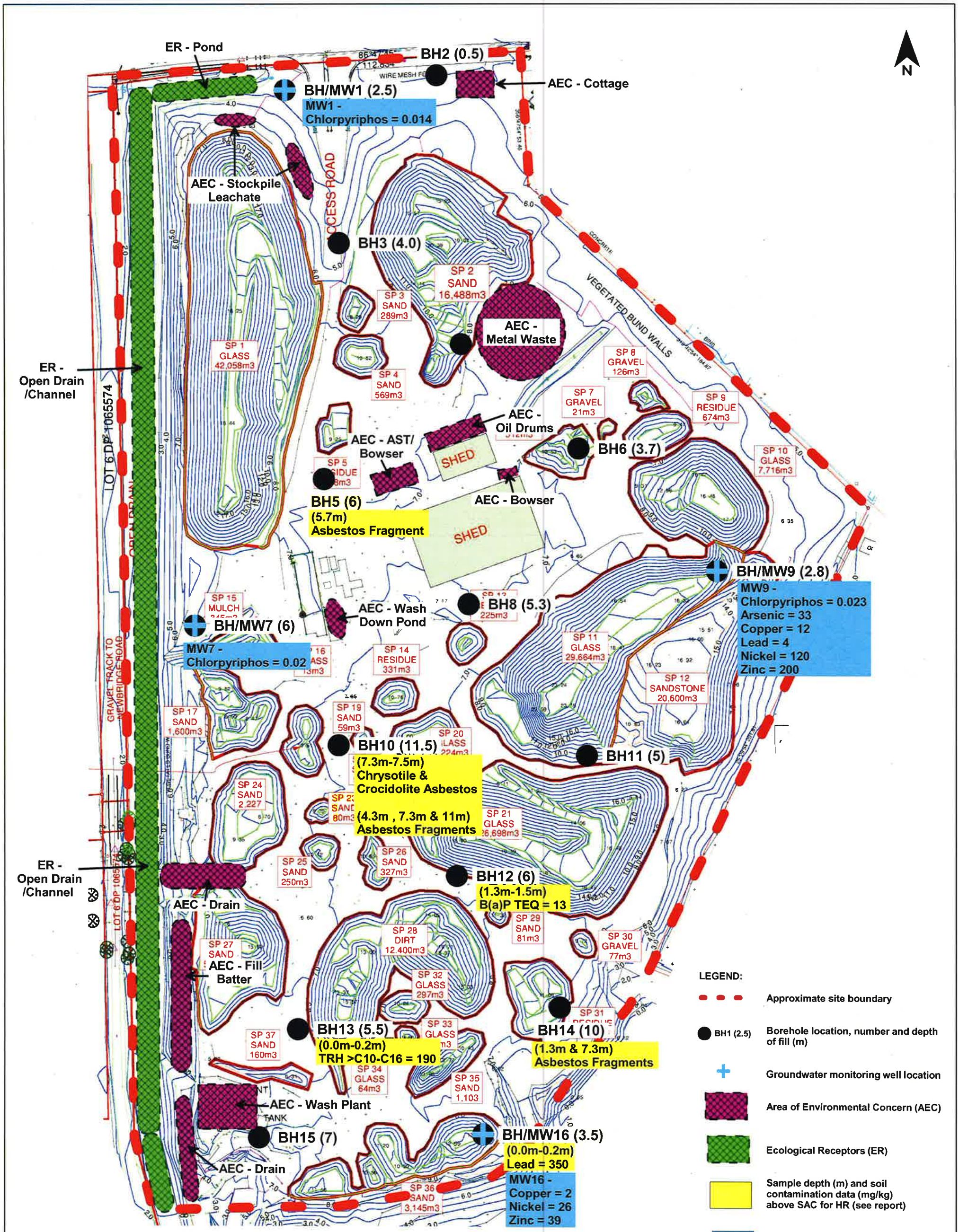
The borehole locations presented on this plan have been established using a hand held GPS unit with an accuracy of +/- 5m.

Reference should be made to the report text for a full understanding of this plan.

Approximate Scale (m): 0 20 40 60 80 100

ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E26930KB	BOREHOLE LOCATION PLAN
Figure: 2	Address: 146 NEWBRIDGE ROAD, MOOREBANK, NSW



NOTES:
Figure 2 has been recreated from the survey plan prepared by Freeburn Surveying Pty Ltd (Ref: 32825, dated 22/8/13).

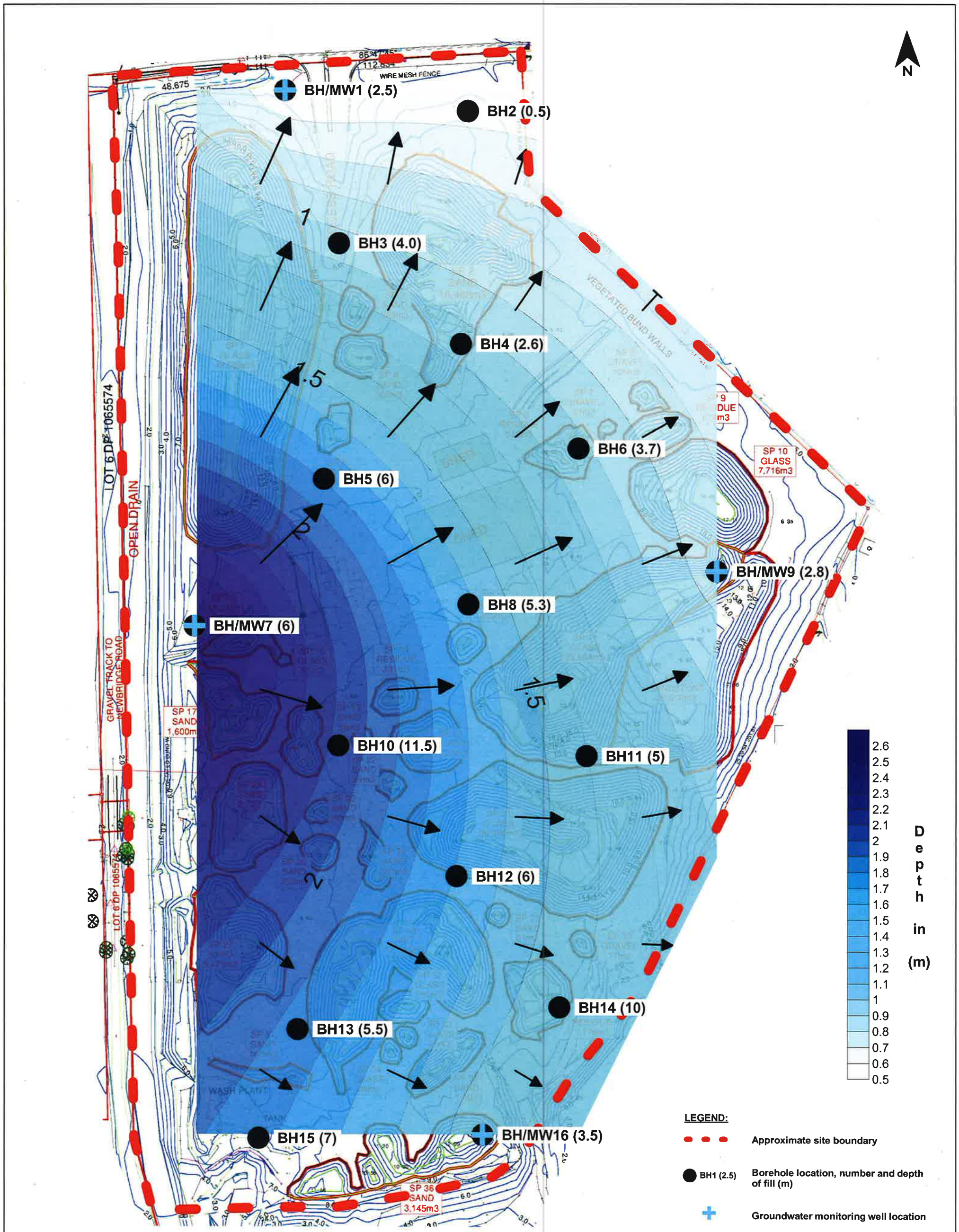
The borehole locations presented on this plan have been established using a hand held GPS unit with an accuracy of +/- 5m.

Reference should be made to the report text for a full understanding of this plan.

Approximate Scale (m): 0 20 40 60 80 100

EIS ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E26930KB	AEC & SITE CONTAMINATION DATA PLAN
Figure: 3	Address: 146 NEWBRIDGE ROAD, MOOREBANK, NSW



NOTES:
Figure 2 has been recreated from the survey plan prepared by Freeburn Surveying Pty Ltd (Ref: 32825, dated 22/8/13).

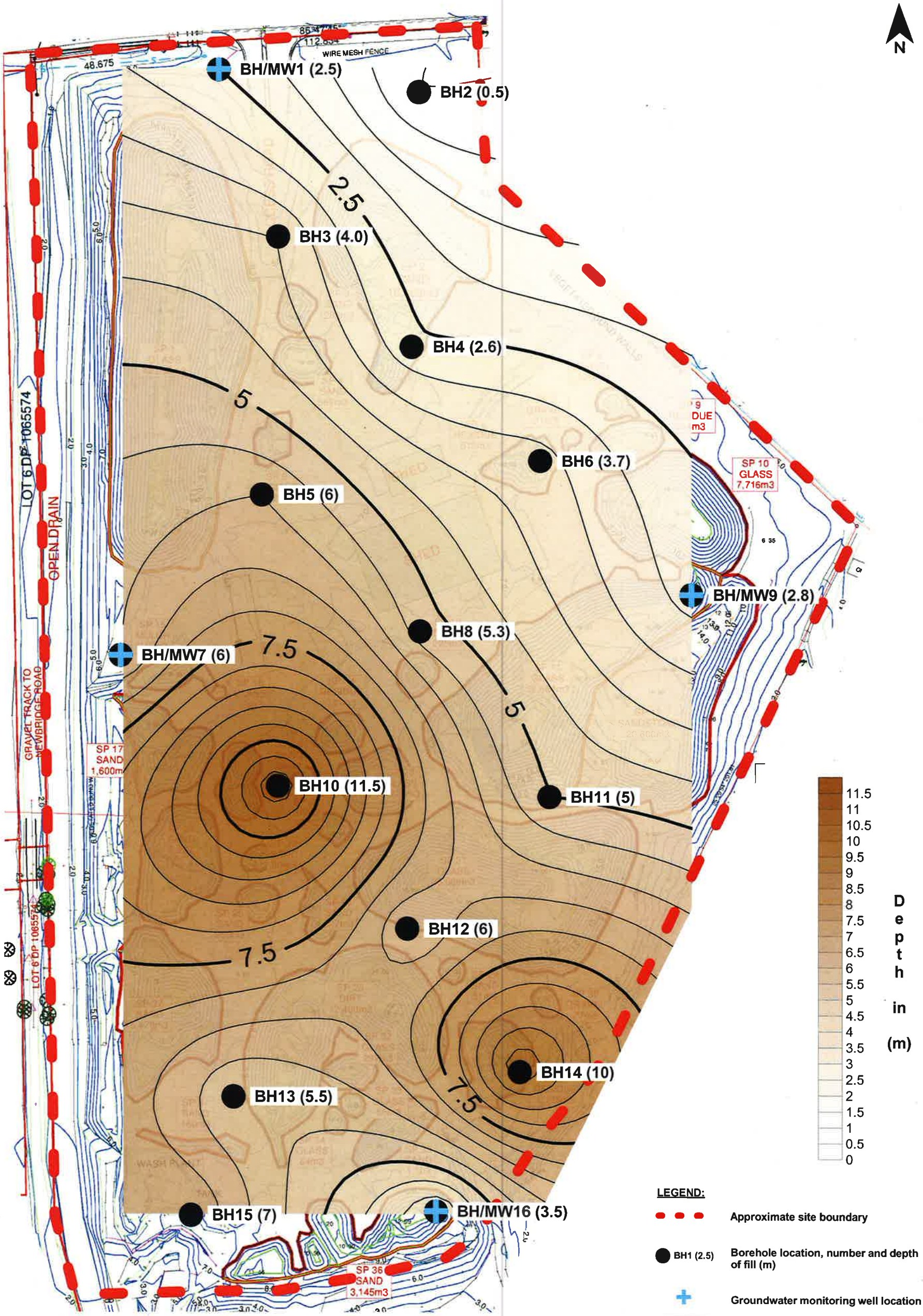
The borehole locations presented on this plan have been established using a hand held GPS unit with an accuracy of +/- 5m.

Reference should be made to the report text for a full understanding of this plan.

Approximate Scale (m): 0 20 40 60 80 100

ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E26930KB	GROUNDWATER CONTOUR PLAN
Figure: 4	Address: 146 NEWBRIDGE ROAD, MOOREBANK, NSW



LEGEND:

- Approximate site boundary
- BH1 (2.5) — Borehole location, number and depth of fill (m)
- Groundwater monitoring well location
- Fill depth contour, fill depth RL (from surface) (based on JK Borehole logs)

NOTES:

Figure 2 has been recreated from the survey plan prepared by Freeburn Surveying Pty Ltd (Ref: 32825, dated 22/8/13).

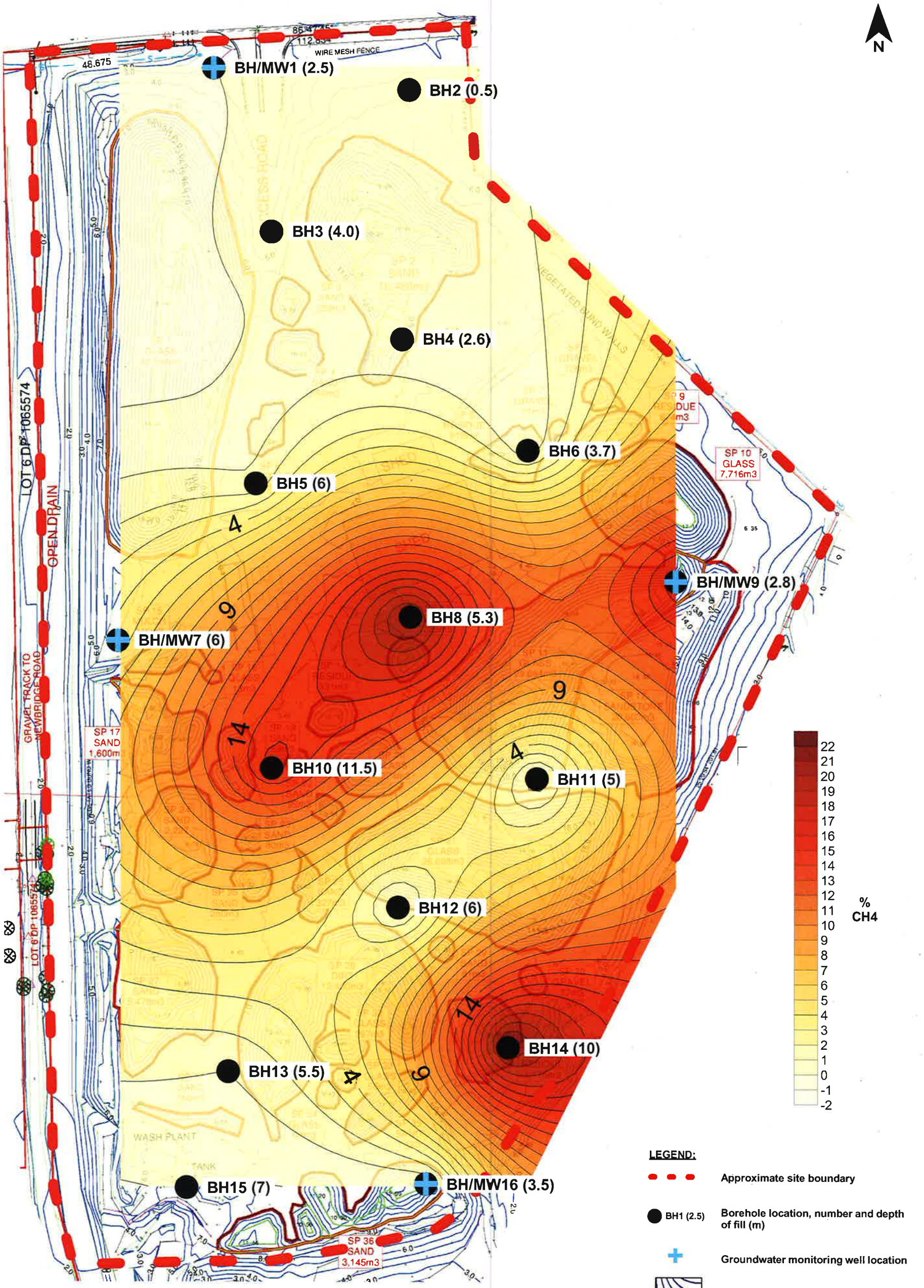
The borehole locations presented on this plan have been established using a hand held GPS unit with an accuracy of +/- 5m.

Reference should be made to the report text for a full understanding of this plan.

Approximate Scale (m): 0 20 40 60 80 100

ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E26930KB	FILL DEPTH PLAN
Figure: 5	Address: 146 NEWBRIDGE ROAD, MOOREBANK, NSW



NOTES:
Figure 2 has been recreated from the survey plan prepared by Freeburn Surveying Pty Ltd (Ref: 32825, dated 22/8/13).

The borehole locations presented on this plan have been established using a hand held GPS unit with an accuracy of +/- 5m.

Reference should be made to the report text for a full understanding of this plan.

Approximate Scale (m): 0 20 40 60 80 100

EIS ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E26930KB	METHANE (CH4) CONCENTRATION PLAN
Figure: 6	Address: 146 NEWBRIDGE ROAD, MOOREBANK, NSW

TABLE A-1
SOIL LABORATORY RESULTS COMPARED TO HIL
All data in mg/kg unless stated otherwise

			HEAVY METALS									PAHs		ORGANOCHLORINE PESTICIDES (OCPs)							OP PESTICIDES (OPPs)	TOTAL PCBs	ASBESTOS FIBRES
			Arsenic	Cadmium	Chromium	Chromium VI	Copper	Lead	Mercury	Nickel	Zinc	Total PAHs	B(a)P TEQ [2]	HCB	Endosulfan	Methoxychlor	Aldrin & Dieldrin	Chlordane	DDT, DDD & DDE	Heptachlor	Chlorpyrifos		
PQL - Envirolab Services			4	0.5	1	1	1	1	0.1	1	1	-	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	100
Site Assessment Criteria (SAC) [1]			100	20	nsl	100	6000	300	40	400	7400	300	3	10	270	300	6	50	240	6	160	1	Detect/Not Detect
Sample Reference	**Sample Depth**	**Sample Description**																					
JK1	0.0-0.2	Fill - Silty Sand Clay	8	0.4	31	NA	68	170	0.1	44	230	13.2	2	LPQL	LPQL	LPQL	0.1	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK1	1.3-1.5	Fill - Silty Clay	9	0.5	37	NA	74	200	0.1	41	220	5.57	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK1	2.7-3.0	Silty Clay	LPQL	LPQL	14	NA	11	16	LPQL	2	7	0.2	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK2	0.0-0.2	Fill - Silty Sand	5	LPQL	11	NA	36	45	LPQL	9	88	2.14	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK2	0.8-1.0	Silty Clay	5	LPQL	23	NA	10	30	LPQL	5	11	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK3	0.3-0.5	Fill - Silty Sand	LPQL	LPQL	21	NA	76	60	LPQL	9	63	7.25	1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK3	3.5-3.8	Fill - Silty Clay	8	LPQL	17	NA	44	96	0.1	7	250	0.69	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK3	4.3-4.5	Silty Clay	6	LPQL	10	NA	11	32	LPQL	3	470	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK4	0.0-0.2	Fill - Silty Sand	5	LPQL	24	NA	34	46	LPQL	13	77	3.13	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK4	1.3-1.5	Fill - Silty Clay	10	LPQL	20	NA	110	68	0.2	13	100	3.18	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK5	0.0-0.2	Fill - Silty Sand	4	LPQL	15	NA	32	110	0.2	10	120	15.1	2	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK5	0.65-0.95	Fill - Silty Clay	4	0.5	19	NA	68	160	0.2	13	200	7.69	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK5	3.0-3.15	Fill - Silty Clay	7	LPQL	17	NA	30	83	0.1	9	150	8.95	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK5	6.0-6.2	Clayey Silt	5	LPQL	13	NA	15	24	LPQL	3	39	0.61	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK6	0.05-0.2	Fill - Gravelly Clayey Sand	LPQL	LPQL	28	NA	57	23	LPQL	28	42	21.1	3	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK6	1.3-1.5	Fill - Clayey Sand	6	LPQL	15	NA	32	46	LPQL	10	52	7.31	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK6	3.0-3.45	Fill - Silty Clay	6	LPQL	13	NA	25	37	LPQL	14	100	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK7	0.0-0.2	Fill - Silty Clay	LPQL	LPQL	110	NA	56	9	LPQL	9	25	4.27	1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK7[a]	2.7-3.0	Fill - Clayey Sandy Gravel	11	LPQL	2800	LPQL	91	97	0.1	59	130	3.2	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK7	5.8-6.0	Fill - Gravelly Sandy Clay	7	LPQL	33	NA	48	100	0.1	9	140	8.5	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK8	0.0-0.2	Fill - Silty Sand	LPQL	LPQL	11	NA	34	35	LPQL	7	100	3.39	1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK8	2.7-3.0	Fill - Sandy Gravelly Clay	5	LPQL	33	NA	48	47	LPQL	19	120	0.27	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK8	4.3-4.5	Fill - Sandy Clay	7	LPQL	14	NA	38	27	LPQL	9	70	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK9	0.0-0.2	Fill - Silty Sand	LPQL	LPQL	18	NA	29	29	LPQL	10	53	2.47	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detected
JK9	0.5-0.7	Fill - Silty Sandy Clay	7	LPQL	17	NA	150	86	0.2	8	270	2.22	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK9	2.6-2.8	Fill - Silty Sandy Clay	5	LPQL	16	NA	58	51	LPQL	6	81	7.25	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Number of Samples			26	26	26	1	26	26	26	26	26	26	26	9	9	9	9	9	9	9	9	9	9
Maximum Value			11	0.5	2800	LPQL	150	200	0.2	59	470	21.1	3	LPQL	LPQL	LPQL	0.1	LPQL	LPQL	LPQL	LPQL	LPQL	nc

Explanation:

1 - Site Assessment Criteria (SAC): NEPM 2013, HIL-A: 'Residential with garden/accessible soils; children's day care centers; preschools; and primary schools'

2 - B(a)P TEQ - Benzo(a)pyrene Toxicity Equivalence Quotient has been calculated based on 8 carcinogenic PAHs and their Toxic Equivalence Factors (TEFs) outlined in NEPM 2013

a - Hexavalent Chromium (Cr VI) results are presented in Envirolab Report 99558-A

Concentration above the SAC **VALUE**

Abbreviations:

PAHs: Polycyclic Aromatic Hydrocarbons
B(a)P: Benzo(a)pyrene
PQL: Practical Quantitation Limit
LPQL: Less than PQL
OPP: Organophosphorus Pesticides
OCP: Organochlorine Pesticides
PCBs: Polychlorinated Biphenyls
UCL: Upper Level Confidence Limit on Mean Value
HILs: Health Investigation Levels
NA: Not Analysed
nc: Not Calculated
nsl: No Set Limit
SAC: Site Assessment Criteria
NEPM: National Environmental Protection Measure

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TABLE A-2
SOIL LABORATORY RESULTS COMPARED TO HIL
All data in mg/kg unless stated otherwise

			HEAVY METALS									PAHs		ORGANOCHLORINE PESTICIDES (OCPs)							OP PESTICIDES (OPPs)	TOTAL PCBs	ASBESTOS FIBRES
			Arsenic	Cadmium	Chromium	Chromium VI	Copper	Lead	Mercury	Nickel	Zinc	Total PAHs	B(a)P TEQ [2]	HCB	Endosulfan	Methoxychlor	Aldrin & Dieldrin	Chlordane	DDT, DDD & DDE	Heptachlor	Chlorpyrifos		
PQL - Envirolab Services			4	0.5	1	1	1	1	0.1	1	1	-	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	100
Site Assessment Criteria (SAC) [1]			100	20	nsl	100	6000	300	40	400	7400	300	3	10	270	300	6	50	240	6	160	1	Detect/Not Detect
Sample Reference	**Sample Depth**	**Sample Description**																					
JK10	0.0-0.2	Fill - Silty Gravelly Sand	LPQL	LPQL	6	NA	30	33	LPQL	4	68	0.5	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detect
JK10	1.3-1.5	Fill - Clayey Sand	LPQL	LPQL	10	NA	17	34	0.1	6	44	3.87	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK10	2.7-3.0	Fill - Silty Sandy Gravel	8	0.4	22	NA	64	270	0.6	12	230	1.35	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	Not Detect
JK10	5.7-6.0	Fill - Sandy Clay	5	0.6	17	NA	120	170	0.4	11	400	8.11	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK10	7.3-7.5	Fill - Sandy Clay	9	LPQL	20	NA	57	140	0.2	6	220	3.82	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	**Chrysotile & Crocidolite Asbestos**
JK11	0.0-0.2	Fill - Gravelly Clayey Sand	5	LPQL	19	NA	150	68	0.1	14	150	2.25	LPQL	LPQL	LPQL	LPQL	5.2	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detect
JK11	4.0-4.5	Fill - Clayey Gravelly Sand	LPQL	LPQL	18	NA	8	11	LPQL	6	32	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK11	6.0-6.45	Silty Clay	LPQL	LPQL	7	NA	9	8	LPQL	1	5	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK12	0.0-0.2	Fill - Silty Gravelly Sand	LPQL	LPQL	10	NA	31	43	LPQL	5	96	2.65	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK12	0.5-0.7	Fill - Silty Gravelly Sand	LPQL	LPQL	68	NA	56	11	LPQL	6	27	10.12	1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detect
JK12	1.3-1.5	Fill - Silty Gravelly Sand	LPQL	LPQL	7	NA	47	81	LPQL	4	57	139.1	**13**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK12	4.3-4.5	Fill - Silty Sand	15	3.2	25	NA	190	270	0.1	42	640	1.55	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK13	0.0-0.2	Fill - Silty Sand	LPQL	LPQL	9	NA	34	38	LPQL	5	120	2.74	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detect
JK13	0.8-1.0	Fill - Sandy Clay	4	LPQL	9	NA	25	75	LPQL	4	97	2.17	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK13	2.7-3.0	Fill - Sandy Clayey Gravel	10	3.5	26	NA	43	180	0.1	10	250	2.3	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK14	0.0-0.2	Fill - Silty Sand	5	LPQL	14	NA	46	93	0.1	9	220	3.87	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detect
JK14	2.7-3.0	Fill - Silty Clay	6	LPQL	17	NA	54	71	0.1	11	230	6.96	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK14	7.3-7.5	Fill - Silty Sand	5	LPQL	11	NA	30	89	0.2	6	260	1.24	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK14	8.7-9.0	Fill - Silty Sand	6	LPQL	12	NA	41	190	0.1	8	230	2.65	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK15	0.0-0.2	Fill - Silty Sand	LPQL	LPQL	5	NA	40	12	0.3	6	37	2.13	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detect
JK15	0.3-0.5	Fill - Silty Sand	6	LPQL	3	NA	12	26	LPQL	2	52	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK15	2.8-3.0	Fill - Silty Clayey Sand	8	LPQL	18	NA	83	110	0.1	13	170	12.6	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK15	5.7-6.0	Fill - Silty Sand	LPQL	LPQL	4	NA	4	9	LPQL	8	21	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK16	0.0-0.2	Fill - Silty Sand	5	LPQL	15	NA	36	**350**	0.1	14	250	14.7	1	LPQL	LPQL	LPQL	0.4	LPQL	LPQL	LPQL	LPQL	LPQL	Not Detect
JK16	1.3-1.5	Fill - Silty Sand	LPQL	LPQL	26	NA	26	24	LPQL	22	80	6.27	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JK16	2.7-3.0	Fill - Clayey Sand	9	LPQL	16	NA	15	25	LPQL	11	64	4.01	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Number of Samples			26	26	26	0	26	26	26	26	26	26	26	7	7	7	7	7	7	7	7	7	9
Maximum Value			15	3.5	68	0	190	350	0.6	42	640	139.1	13	LPQL	LPQL	LPQL	5.2	LPQL	LPQL	LPQL	LPQL	LPQL	nc

Explanation:

1 - Site Assessment Criteria (SAC): NEPM 2013, HIL-A: 'Residential with garden/accessible soils; children's day care centers; preschools; and primary schools'

2 - B(a)P TEQ - Benzo(a)pyrene Toxicity Equivalence Quotient has been calculated based on 8 carcinogenic PAHs and their Toxic Equivalence Factors (TEFs) outlined in NEPM 2013

Concentration above the SAC **VALUE**

Abbreviations:

PAHs: Polycyclic Aromatic Hydrocarbons
B(a)P: Benzo(a)pyrene
PQL: Practical Quantitation Limit
LPQL: Less than PQL
OPP: Organophosphorus Pesticides
OCP: Organochlorine Pesticides
PCBs: Polychlorinated Biphenyls
UCL: Upper Level Confidence Limit on Mean Value
HILs: Health Investigation Levels
NA: Not Analysed
nc: Not Calculated
nsl: No Set Limit
SAC: Site Assessment Criteria
NEPM: National Environmental Protection Measure

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TABLE B-1
SOIL LABORATORY RESULTS COMPARED TO HSL
All data in mg/kg unless stated otherwise

				C_6-C_{10} (F1)	$>C_{10}$-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	PID [2]
PQL - Envirolab Services				25	50	0.2	0.5	1	3	1	
HSL Land Use Category [1]				RESIDENTIAL WITH ACCESSIBLE SOIL							
Sample Reference	**Sample Depth**	**Depth Category**	**Soil Category**								
JK1	0.0-0.2	0m to < 1m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK1	1.3-1.5	1m to <2m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK1	2.7-3.0	2m to <4m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK2	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK2	0.8-1.0	0m to < 1m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK3	0.3-0.5	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK3	3.5-3.8	2m to <4m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK3	4.3-4.5	4m +	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK4	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK4	1.3-1.5	1m to <2m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK5	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK5	0.65-0.95	0m to < 1m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK5	3.0-3.15	2m to <4m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK5	6.0-6.2	4m +	Silt	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK6	0.05-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.5
JK6	1.3-1.5	1m to <2m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK6	3.0-3.45	2m to <4m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.4
JK7	0.0-0.2	0m to < 1m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK7	2.7-3.0	2m to <4m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK7	5.8-6.0	4m +	Clay	LPQL	240	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK8	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK8	2.7-3.0	2m to <4m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK8	4.3-4.5	4m +	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK9	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK9	0.5-0.7	0m to < 1m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK9	2.6-2.8	2m to <4m	Clay	LPQL	53	LPQL	LPQL	LPQL	LPQL	LPQL	0
Total Number of Samples [3]				26	26	26	26	26	26	26	26
Maximum Value				LPQL	240	LPQL	LPQL	LPQL	LPQL	LPQL	0.5

Explanation:
1 - Site Assessment Criteria (SAC): NEPM 2013
2 - Field PID values obtained during the investigation

Concentration above the SAC VALUE

Abbreviations:

UCL: Upper Level Confidence Limit on Mean Value
HSLs: Health Screening Levels
na: Not Analysed
nc: Not Calculated
NL: Not Limiting
PQL: Practical Quantitation Limit
LPQL: Less than PQL
SAC: Site Assessment Criteria
NEPM: National Environmental Protection Measure

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SITE ASSESSMENT CRITERIA

				C_6-C10 (F1)	$>C_{10}$-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene
PQL - Envirolab Services				25	50	0.2	0.5	1	3	1
HSL Land Use Category [1]				RESIDENTIAL WITH ACCESSIBLE SOIL						
Sample Reference	**Sample Depth**	**Depth Category**	**Soil Category**							
JK1	0.0-0.2	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
JK1	1.3-1.5	1m to <2m	Clay	90	NL	1	NL	NL	310	NL
JK1	2.7-3.0	2m to <4m	Clay	150	NL	2	NL	NL	NL	NL
JK2	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK2	0.8-1.0	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
JK3	0.3-0.5	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK3	3.5-3.8	2m to <4m	Clay	150	NL	2	NL	NL	NL	NL
JK3	4.3-4.5	4m +	Clay	290	NL	3	NL	NL	NL	NL
JK4	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK4	1.3-1.5	1m to <2m	Clay	90	NL	1	NL	NL	310	NL
JK5	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK5	0.65-0.95	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
JK5	3.0-3.15	2m to <4m	Clay	150	NL	2	NL	NL	NL	NL
JK5	6.0-6.2	4m +	Silt	190	NL	2	NL	NL	NL	NL
JK6	0.05-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK6	1.3-1.5	1m to <2m	Sand	70	240	0.5	220	NL	60	NL
JK6	3.0-3.45	2m to <4m	Clay	150	NL	2	NL	NL	NL	NL
JK7	0.0-0.2	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
JK7	2.7-3.0	2m to <4m	Sand	110	440	0.5	310	NL	95	NL
JK7	5.8-6.0	4m +	Clay	290	NL	3	NL	NL	NL	NL
JK8	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK8	2.7-3.0	2m to <4m	Clay	150	NL	2	NL	NL	NL	NL
JK8	4.3-4.5	4m +	Clay	290	NL	3	NL	NL	NL	NL
JK9	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK9	0.5-0.7	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
JK9	2.6-2.8	2m to <4m	Clay	150	NL	2	NL	NL	NL	NL

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TABLE B-2
SOIL LABORATORY RESULTS COMPARED TO HSL
All data in mg/kg unless stated otherwise

				C_6-C_{10} (F1)	$>C_{10}$-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	PID [2]
PQL - Envirolab Services				25	50	0.2	0.5	1	3	1	
HSL Land Use Category [1]				RESIDENTIAL WITH ACCESSIBLE SOIL							
Sample Reference	**Sample Depth**	**Depth Category**	**Soil Category**								
JK10	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK10	1.3-1.5	1m to <2m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK10	2.7-3.0	2m to <4m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK10	5.7-6.0	4m+	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK10	7.3-7.5	4m+	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK11	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.4
JK11	4.0-4.5	4m+	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	1.9
JK11	6.0-6.45	4m+	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.4
JK12	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK12	0.5-0.7	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK12	1.3-1.5	1m to <2m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK12	4.3-4.5	4m+	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK13	0.0-0.2	0m to < 1m	Sand	LPQL	190	LPQL	LPQL	LPQL	LPQL	LPQL	1
JK13	0.8-1.0	0m to < 1m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK13	2.7-3.0	2m to <4m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK14	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK14	2.7-3.0	2m to <4m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK14	7.3-7.5	4m+	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK14	8.7-9.0	4m+	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK15	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK15	0.3-0.5	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK15	2.8-3.0	2m to <4m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK15	5.7-6.0	4m+	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK16	0.0-0.2	0m to < 1m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK16	1.3-1.5	1m to <2m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK16	2.7-3.0	2m to <4m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
Total Number of Samples [3]				26	26	26	26	26	26	26	26
Maximum Value				LPQL	190	LPQL	LPQL	LPQL	LPQL	LPQL	1.9

Explanation:
1 - Site Assessment Criteria (SAC): NEPM 2013
2 - Field PID values obtained during the investigation

Concentration above the SAC VALUE

Abbreviations:

UCL: Upper Level Confidence Limit on Mean Value	PQL: Practical Quantitation Limit
HSLs: Health Screening Levels	LPQL: Less than PQL
na: Not Analysed	SAC: Site Assessment Criteria
nc: Not Calculated	NEPM: National Environmental Protection Measure
NL: Not Limiting	

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December, 2013

SITE ASSESSMENT CRITERIA

				C_6-C10 (F1)	$>C_{10}$-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene
PQL - Envirolab Services				25	50	0.2	0.5	1	3	1
HSL Land Use Category [1]				RESIDENTIAL WITH ACCESSIBLE SOIL						
Sample Reference	**Sample Depth**	**Depth Category**	**Soil Category**							
JK10	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK10	1.3-1.5	1m to <2m	Sand	70	240	0.5	220	NL	60	NL
JK10	2.7-3.0	2m to <4m	Sand	110	440	0.5	310	NL	95	NL
JK10	5.7-6.0	4m+	Clay	290	NL	3	NL	NL	NL	NL
JK10	7.3-7.5	4m+	Clay	290	NL	3	NL	NL	NL	NL
JK11	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK11	4.0-4.5	4m+	Sand	200	NL	0.5	540	NL	170	NL
JK11	6.0-6.45	4m+	Clay	290	NL	3	NL	NL	NL	NL
JK12	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK12	0.5-0.7	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK12	1.3-1.5	1m to <2m	Sand	70	240	0.5	220	NL	60	NL
JK12	4.3-4.5	4m+	Sand	200	NL	0.5	540	NL	170	NL
JK13	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK13	0.8-1.0	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
JK13	2.7-3.0	2m to <4m	Sand	110	440	0.5	310	NL	95	NL
JK14	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK14	2.7-3.0	2m to <4m	Clay	150	NL	2	NL	NL	NL	NL
JK14	7.3-7.5	4m+	Sand	200	NL	0.5	540	NL	170	NL
JK14	8.7-9.0	4m+	Sand	200	NL	0.5	540	NL	170	NL
JK15	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK15	0.3-0.5	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK15	2.8-3.0	2m to <4m	Sand	110	440	0.5	310	NL	95	NL
JK15	5.7-6.0	4m+	Sand	200	NL	0.5	540	NL	170	NL
JK16	0.0-0.2	0m to < 1m	Sand	45	110	0.5	160	55	40	3
JK16	1.3-1.5	1m to <2m	Sand	70	240	0.5	220	NL	60	NL
JK16	2.7-3.0	2m to <4m	Sand	110	440	0.5	310	NL	95	NL

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TABLE C
SUMMARY OF LABORATORY RESULTS - VOLATILE ORGANIC COMPOUNDS (VOCs)

Sample Reference	Sample Depth (m)	Sample Description	Total VOCs
JK12[a]	0.5-0.7	Fill - Silty Gravelly Sand	ALPQL
JK6[b]	0.05-0.2	Fill - Gravelly Clayey Sand	ALPQL
JK7[b]	0.0-0.2	Fill - Silty Clay	ALPQL
JK7[b]	5.8-6.0	Fill - Gravelly Sandy Clay	ALPQL
JK9[b]	0.5-0.7	Fill - Silty Sandy Clay	ALPQL
JK13[b]	0.0-0.2	Fill - Silty Sand	ALPQL
Total Number of Samples			6
Minimum Value			ALPQL
Maximum Value			ALPQL

EXPLANATION:

a - Reference should be made to Envirolab Report 99467-A for more information on individual values

b - Reference should be made to Envirolab Report 99558-A for more information on individual values

Values Exceeding Action Criteria | **VALUE**

Abbreviations:

ALPQL: All Values Less than PQL

PQL: Practical Quantitation Limit

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TABLE D
SUMMARY OF LABORATORY RESULTS - ASBESTOS IN MATERIAL

Sample Reference	Sample Depth (m)	Sample Description	Asbestos
JK5	5.7	Material	**Chrysotile asbestos detected, Amosite asbestos detected**
JK10	4.3-4.5	Material	**Chrysotile asbestos detected, Amosite asbestos detected**
JK10	7.3-7.5	Material	**Chrysotile asbestos detected, Crocidolite asbestos detected**
JK10	11	Material	**Chrysotile asbestos detected, Crocidolite asbestos detected**
JK14	1.3-1.5	Material	No asbestos detected
JK14	7.3-7.5	Material	**Chrysotile asbestos detected**
S1	-	Material	**Chrysotile asbestos detected, Amosite asbestos detected, Crocidolite asbestos detected**
Total Number of Samples			7

EXPLANATION:

a - Reference should be made to Envirolab Report 99467-A for more information on individual values

Values Exceeding Action Criteria **VALUE**

Abbreviations:

ALPQL: All Values Less than PQL
PQL: Practical Quantitation Limit

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TABLE E
SUMMARY OF LABORATORY RESULTS - ACID SULFATE SOILS ANALYSIS (POCAS)

Sample Reference	Sample Depth (m)	Sample Description	pH_{KCL}	TAA pH 6.5	pH_{ox}	TPA pH 6.5	TSA pH 6.5	S_{POS} %w/w	Ca A %w/w	Mg A %w/w	Liming Rate kg $CaCO_3$/tonne
JK1	1.3-1.5	Fill - Silty Clay	6.1	5	**4.5**	**30**	**25**	**0.08**	0.017	LPQL	4.2
JK3	3.5-3.8	Fill - Silty Clay	8.8	LPQL	7	LPQL	LPQL	**0.2**	0.55	0.025	LPQL
JK3	5.7-6.0	Silty Clay	6.5	LPQL	**3**	**170.0**	**170**	**0.4**	0.05	LPQL	15
JK5	6.3-6.5	Clayey Silt	6.4	LPQL	**4.9**	LPQL	LPQL	0.03	LPQL	0.006	1.7
JK15	2.8-3.0	Fill - Silty Clayey Sand	8.3	LPQL	7.4	LPQL	LPQL	**0.06**	0.72	0.013	LPQL
JK15	4.3-4.5	Fill - Silty Sand	6.2	LPQL	**3.3**	**65**	**62**	**0.13**	LPQL	LPQL	6.4
JK16	1.8-2.0	Fill - Silty Sand	10.1	LPQL	8	LPQL	LPQL	0.01	0.48	0.027	LPQL
JK16	4.3-4.5	Silty Sand	5.6	5	**2.6**	**85**	**80**	**0.31**	0.008	LPQL	15
Total Number of Samples			8	8	8	8	8	8	8	8	8
Minimum Value			5.6	5	2.6	30	25	0.01	0.008	0.006	1.7
Maximum Value			10.1	5	8	170	170	0.4	0.72	0.027	15

EXPLANATION:

Action criteria are defined as follows:

- coarse textured soils (sands to loamy sands):
  - pH < 5
  - TAA/TSA/TPA (pH 5.5) > 18mol H^+/tonne
  - S_{POS} > 0.03% sulfure oxidisable

Values Exceeding Action Criteria **VALUE**

Abbreviations:

pH_{KCL} : pH of filtered 1:20, 1M KCL extract, shaken overnight

TAA pH 6.5 : Total Actual Acidity in 1M KCL extract titrated to pH6.5

pH_{ox} : pH filtered 1:20 1M KCl after peroxide digestion

TPA : Total Potential Acidity, 1M KCL peroxide digest titrated to pH6.5

TSA: Total Sulfide Acidity

S_{POS}: Peroxide oxidisable Sulfur (SP - SKCL)

Ca_A/Mg_A: Calcium/Magnesium reacted with acid generated by peroxide digest

Calcium and Magnesium values used to estimate additional Ca/Mg from acid-shell/carbonate/dolomite reaction

Reference: ASSMAC (Acid Sulfate Soils management Advisory Committee - Acid Sulfate Soil Manual, August 1998).

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TABLE F
SUMMARY OF GROUNDWATER LABORATORY RESULTS
All results in µg/L unless stated otherwise.

	PQL Envirolab Services	GIL - ANZECC 2000 [1] Fresh Waters	GIL - US EPA [3]	GIL - Drinking Water [2]	SAMPLES MW1	MW7	MW9	MW16
Field Measurements [4]								
Dissolved oxygen (ppm)	-	nsl	-	>85%[d]	0.5	0.5	0.6	1.6
Redox potential (mV)	-	nsl	-	nsl	-77.2	151.7	250.5	-8
pH	-	6.5 - 8.5[i]	-	6.5 - 8.5[d]	6.45	6.96	4.25	6.72
Conductivity (µS/cm)	-	nsl	-	nsl	3,092	6,447	2,225	12,535
Temperature °C	-	nsl	-	nsl	19.6	20.7	25.5	20.3
Inorganic Compounds and Parameters								
pH	0.1	6.5 - 8.5[i]	-	6.5 - 8.5[d]	7.6	8	4.8	7.4
Electrical Conductivity (µS/cm)	1	nsl	-	nsl	3,500	7,100	2,300	14,000
Hardness (mgCaCo3/L)	3	nsl	-	200[d]	800	1400	110	3400
Heavy Metals								
Arsenic (As III)	1	24	-	10	2	2	33	1
Cadmium	0.1	0.2	-	2	LPQL	LPQL	LPQL	LPQL
Chromium (total)	2	3.3[a#]	-	nsl	LPQL	LPQL	2	1
Copper	1	1.4	-	2000	LPQL	LPQL	12	2
Lead	1	3.4	-	10	LPQL	LPQL	4	LPQL
Mercury (inorganic)	0.05	0.6	-	1	LPQL	LPQL	LPQL	LPQL
Nickel	1	11	-	20	4	5	120	26
Zinc	1	8	-	3000[d]	6	3	200	39
Monocyclic Aromatic Hydrocarbons (BTEX Compounds)								
Benzene	1	950[a]	-	1	LPQL	LPQL	LPQL	LPQL
Toluene	1	180[a]	-	800	LPQL	LPQL	LPQL	LPQL
Ethylbenzene	1	80[a]	-	300	LPQL	LPQL	LPQL	LPQL
m + p-xylene	2	75[m]	-	nsl	LPQL	LPQL	LPQL	LPQL
o-xylene	1	350[a]	-	nsl	LPQL	LPQL	LPQL	LPQL
Total xylenes	3	nsl	-	600	LPQL	LPQL	LPQL	LPQL
Volatile Organic Compounds (VOCs)								
Total VOCs	-	nsl	-	-	ALPQL	ALPQL	ALPQL	ALPQL
Polycyclic Aromatic Hydrocarbons (PAHs)								
Naphthalene	0.1	16[a]	0.14	nsl	LPQL	LPQL	LPQL	0.2
Acenaphthylene	0.1	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Acenaphthene	0.1	nsl	400	nsl	LPQL	LPQL	LPQL	LPQL
Fluorene	0.1	nsl	220	nsl	LPQL	LPQL	LPQL	LPQL
Phenanthrene	0.1	0.6[c]	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Anthracene	0.1	0.01[c]	1300	nsl	LPQL	LPQL	LPQL	LPQL
Fluoranthene	0.1	1[c]	630	nsl	LPQL	LPQL	LPQL	LPQL
Pyrene	0.1	nsl	87	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(a)anthracene	0.1	nsl	0.029	nsl	LPQL	LPQL	LPQL	LPQL
Chrysene	0.1	nsl	2.9	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(b,k)fluoranthene	0.2	nsl	0.029[r]	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(a)pyrene	0.1	0.1[c]	0.003	0.01	LPQL	LPQL	LPQL	LPQL
Indeno(1,2,3-c,d)pyrene	0.1	nsl	0.029	nsl	LPQL	LPQL	LPQL	LPQL
Dibenzo(a,h)anthracene	0.1	nsl	0.003	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(g,h,i)perylene	0.1	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Total PAHs	-	nsl	nsl	nsl	LPQL	LPQL	LPQL	0.2
Organochlorine Pesticides (OCPs)								
Aldrin	0.001	0.001[a]	-	0.3	LPQL	LPQL	LPQL	LPQL
Chlordane	0.001	0.03[c]	-	1	LPQL	LPQL	LPQL	LPQL
DDE	0.001	0.03[a]	nsl	nsl	0.001	LPQL	LPQL	LPQL
DDT	0.001	0.006[c]	-	9	0.001	LPQL	LPQL	LPQL
Dieldrin	0.001	0.01[a]	-	0.3	0.004	0.005	LPQL	0.004
Endosulfan	0.001	0.03[c]	-	20	LPQL	LPQL	LPQL	LPQL
Endrin	0.001	0.01[c]	11	nsl	LPQL	LPQL	LPQL	LPQL
Heptachlor	0.001	0.01[c]	-	0.3	LPQL	LPQL	LPQL	LPQL
Methoxychlor	0.001	0.005[c]	-	300	LPQL	LPQL	LPQL	LPQL
Organophosphate Pesticides (OPPs)								
Dichlorovos	0.001	nsl	-	5	LPQL	LPQL	LPQL	LPQL
Mevinphos (Phesdrin)	0.001	nsl	-	5	LPQL	LPQL	LPQL	LPQL
Naled	0.001	nsl	73	nsl	LPQL	LPQL	LPQL	LPQL
Phorate	0.001	nsl	7.3	nsl	LPQL	LPQL	LPQL	LPQL
Dimethoate	0.001	0.15[a]	-	7	LPQL	LPQL	LPQL	LPQL
Diazinon	0.001	0.01[a]	-	4	LPQL	LPQL	LPQL	LPQL
Disulfoton	0.001	nsl	-	4	LPQL	LPQL	LPQL	LPQL
Chlorpyriphos-methyl	0.001	nsl	370	nsl	LPQL	LPQL	LPQL	LPQL
Methyl Parathion	0.001	nsl	-	nsl	LPQL	LPQL	LPQL	LPQL
Ronnel (fenchlorphos)	0.001	nsl	1800	nsl	LPQL	LPQL	LPQL	LPQL
Fenitrothion	0.001	0.2[a]	-	10	LPQL	LPQL	LPQL	LPQL
Malathion	0.001	0.05[a]	730	70	LPQL	LPQL	LPQL	LPQL
Chlorpyriphos	0.001	0.01	-	10	0.014	0.02	0.023	LPQL
Bromophos-ethyl	0.001	nsl	-	10	LPQL	LPQL	LPQL	LPQL
Methidathion	0.001	nsl	-	6	LPQL	LPQL	LPQL	LPQL
Phenamiphos	0.001	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Ethion	0.001	nsl	-	4	LPQL	LPQL	LPQL	LPQL
Phosalone	0.001	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Azinphos-methyl	0.001	0.01[c]	-	3	LPQL	LPQL	LPQL	LPQL
Coumaphos	0.001	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Polychlorinated Biphenyls (PCBs)								
Total PCBs	0.01	nsl	nsl	nsl	ALPQL	ALPQL	ALPQL	ALPQL

EXPLANATION:

1 - ANZECC Australian Water Quality Guidelines for Fresh Waters, 2000 - Trigger Values for protection of 95% of species
2 - NHMRC Australian Drinking Water Guidelines (2011)
3 - In the absence of Australian guidelines, the USEPA (2010) Region 9 Screening Levels for tapwater have been adopted as a preliminary screening tool
4 - Field Measurements obtained during sampling on 6-11-13

a - In the absence of a high reliability guideline concentration, the moderate or low reliability guideline concentration has been quoted
c - 99% trigger values adopted due to the potential for bioaccumulation effects
d - In the absence of a health guideline the aesthetic guideline concentration has been quoted
i - ANZECC 2000 - Level for NSW Lowland Rivers.
m - Guideline value adopted for m-Xylene. We note that the m-Xylene guideline value is 75ug/L and the p-Xylene guideline value is 200ug/L. However these two isomers cannot be distinguished analytically. Therefore EIS have adopted the more conservative guideline value
r - The more conservative value for Benzo(b)fluoranthene has been adopted
a# - The GIL for Cr III has been adopted as Cr VI is relatively unstable and breakdown rapidly

Concentration above the GIL — VALUE

ABBREVIATIONS:

na: Not Analysed
nsl: No Set Limit
GIL - Groundwater Investigation Levels
PQL: Practical Quantitation Limit
LPQL: Less than Practical Quantitation Limit
ALPQL: All results less than the PQL
(-) : Not Applicable

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TABLE G
GROUNDWATER LABORATORY RESULTS COMPARED AGAINST THE HSLs
All data in µg/L unless stated otherwise

				C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	
PQL - Envirolab Services				10	50	1	1	1	3	1	PID [2]
Land Use Category [1]				LOW DENSITY RESIDENTIAL							
Sample Reference	**Water Depth**	**Depth Category**	**Soil Category**								
MW1	1.65	0m to <2m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA
MW7	4.58	4m to <8m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA
MW9	5.75	4m to <8m	Clay	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA
MW16	4.49	4m to <8m	Sand	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	NA
Total Number of Samples				4	4	4	4	4	4	4	0
Maximum Value				LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0

Explanation:
1 - Groundwater Investigation Levels (GILs): NEPM 2013
2 - Field PID values obtained during the investigation

Concentration above the SAC — VALUE
Site specific assesment required — VALUE

Abbreviations:
UCL: Upper Level Confidence Limit on Mean Value
HSLs: Health Screening Levels
NA: Not Analysed
nc: Not Calculated
NL: Not Limiting
PQL: Practical Quantitation Limit
LPQL: Less than PQL
SAC: Site Assessment Criteria
NEPM: National Environmental Protection Measure
SSA: Site Specific Assessment

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HSL GROUNDWATER ASSESSMENT CRITERIA

				C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene
PQL - Envirolab Services				10	50	1	1	1	3	1
Land Use Category [1]				LOW DENSITY RESIDENTIAL						
Sample Reference	**Water Depth**	**Depth Category**	**Soil Category**							
MW1	1.65	0m to <2m	Clay	SSA	SSA	SSA	SSA	SSA	SSA	SSA
MW7	4.58	4m to <8m	Clay	NL	NL	5000	NL	NL	NL	NL
MW9	5.75	4m to <8m	Clay	NL	NL	5000	NL	NL	NL	NL
MW16	4.49	4m to <8m	Sand	1000	1000	800	NL	NL	NL	NL

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TABLE F
SUMMARY OF GROUNDAWATER LABORATORY RESULTS
All results in µg/L unless stated otherwise.

	PQL Envirolab Services	GIL - ANZECC 2000 [1] Fresh Waters	GIL - US EPA [3]	GIL - Drinking Water [2]	SAMPLES MW1	MW7	MW9	MW16
Field Measurements [4]								
Dissolved oxygen (ppm)	-	nsl	-	>85% [d]	0.5	0.5	0.6	1.6
Redox potential (mV)	-	nsl	-	ns	-77.2	151.7	250.5	-8
pH	-	6.5 - 8.5 [i]	-	6.5 - 8.5 [d]	**6.45**	6.96	**4.25**	6.72
Conductivity (µS/cm)	-	nsl	-	ns	3,092	6,447	2,225	12,535
Temperature °C	-	nsl	-	ns	19.6	20.7	25.5	20.3
Inorganic Compounds and Parameters								
pH	0.1	6.5 - 8.5 [i]	-	6.5 - 8.5 [d]	7.6	8	**4.8**	7.4
Electrical Conductivity (µS/cm)	1	nsl	-	ns	3,500	7,100	2,300	14,000
Hardness (mgCaCo3/L)	3	nsl	-	200 [d]	**800**	**1400**	110	**3400**
Heavy Metals								
Arsenic (As III)	1	24	-	10	2	2	**33**	1
Cadmium	0.1	0.2	-	2	LPQL	LPQL	LPQL	LPQL
Chromium (total)	2	3.3 [a#]	-	ns	LPQL	LPQL	2	1
Copper	1	1.4	-	2000	LPQL	LPQL	**12**	**2**
Lead	1	3.4	-	10	LPQL	LPQL	**4**	LPQL
Mercury (inorganic)	0.05	0.6	-	1	LPQL	LPQL	LPQL	LPQL
Nickel	1	11	-	20	4	5	**120**	**26**
Zinc	1	8	-	3000 [d]	6	3	**200**	**39**
Monocyclic Aromatic Hydrocarbons (BTEX Compounds)								
Benzene	1	950 [a]	-	1	LPQL	LPQL	LPQL	LPQL
Toluene	1	180 [a]	-	800	LPQL	LPQL	LPQL	LPQL
Ethylbenzene	1	80 [a]	-	300	LPQL	LPQL	LPQL	LPQL
m+p-xylene	2	75 [m]	-	nsl	LPQL	LPQL	LPQL	LPQL
o-xylene	1	350 [a]	-	nsl	LPQL	LPQL	LPQL	LPQL
Total xylenes	3	nsl	-	600	LPQL	LPQL	LPQL	LPQL
Volatile Organic Compounds (VOCs)								
Total VOCs	-	nsl	-	-	ALPQL	ALPQL	ALPQL	ALPQL
Polycyclic Aromatic Hydrocarbons (PAHs)								
Naphthalene	0.1	16 [a]	0.14	nsl	LPQL	LPQL	LPQL	**0.2**
Acenaphthylene	0.1	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Acenaphthene	0.1	nsl	400	nsl	LPQL	LPQL	LPQL	LPQL
Fluorene	0.1	nsl	220	nsl	LPQL	LPQL	LPQL	LPQL
Phenanthrene	0.1	0.6 [c]	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Anthracene	0.1	0.01 [c]	1300	nsl	LPQL	LPQL	LPQL	LPQL
Fluoranthene	0.1	1 [c]	630	nsl	LPQL	LPQL	LPQL	LPQL
Pyrene	0.1	nsl	87	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(a)anthracene	0.1	nsl	0.029	nsl	LPQL	LPQL	LPQL	LPQL
Chrysene	0.1	nsl	2.9	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(b,k)fluoranthene	0.2	nsl	0.029 [r]	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(a)pyrene	0.1	0.1 [c]	0.003	0.01	LPQL	LPQL	LPQL	LPQL
Indeno(1,2,3-c,d)pyrene	0.1	nsl	0.029	nsl	LPQL	LPQL	LPQL	LPQL
Dibenzo(a,h)anthracene	0.1	nsl	0.003	nsl	LPQL	LPQL	LPQL	LPQL
Benzo(g,h,i)perylene	0.1	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Total PAHs	-	nsl	nsl	nsl	LPQL	LPQL	LPQL	0.2
Organochlorine Pesticides (OCPs)								
Aldrin	0.001	0.001 [a]	-	0.3	LPQL	LPQL	LPQL	LPQL
Chlordane	0.001	0.03 [c]	-	1	LPQL	LPQL	LPQL	LPQL
DDE	0.001	0.03 [a]	nsl	nsl	0.001	LPQL	LPQL	LPQL
DDT	0.001	0.006 [c]	-	9	0.001	LPQL	LPQL	LPQL
Dieldrin	0.001	0.01 [a]	-	0.3	0.004	0.005	LPQL	0.004
Endosulfan	0.001	0.03 [c]	-	20	LPQL	LPQL	LPQL	LPQL
Endrin	0.001	0.01 [c]	11	nsl	LPQL	LPQL	LPQL	LPQL
Heptachlor	0.001	0.01 [c]	-	0.3	LPQL	LPQL	LPQL	LPQL
Methoxychlor	0.001	0.005 [c]	-	300	LPQL	LPQL	LPQL	LPQL
Organophosphate Pesticides (OPPs)								
Dichlorovos	0.001	nsl	-	5	LPQL	LPQL	LPQL	LPQL
Mevinphos (Phesdrin)	0.001	nsl	-	5	LPQL	LPQL	LPQL	LPQL
Naled	0.001	nsl	73	nsl	LPQL	LPQL	LPQL	LPQL
Phorate	0.001	nsl	7.3	nsl	LPQL	LPQL	LPQL	LPQL
Dimethoate	0.001	0.15 [a]	-	7	LPQL	LPQL	LPQL	LPQL
Diazinon	0.001	0.01 [a]	-	4	LPQL	LPQL	LPQL	LPQL
Disulfoton	0.001	nsl	-	4	LPQL	LPQL	LPQL	LPQL
Chlorpyriphos-methyl	0.001	nsl	370	nsl	LPQL	LPQL	LPQL	LPQL
Methyl Parathion	0.001	nsl	-	nsl	LPQL	LPQL	LPQL	LPQL
Ronnel (fenchlorphos)	0.001	nsl	1800	nsl	LPQL	LPQL	LPQL	LPQL
Fenitrothion	0.001	0.2 [a]	-	10	LPQL	LPQL	LPQL	LPQL
Malathion	0.001	0.05 [a]	730	70	LPQL	LPQL	LPQL	LPQL
Chlorpyriphos	0.001	0.01	-	10	**0.014**	**0.02**	**0.023**	LPQL
Bromophos-ethyl	0.001	nsl	-	10	LPQL	LPQL	LPQL	LPQL
Methidathion	0.001	nsl	-	6	LPQL	LPQL	LPQL	LPQL
Phenamiphos	0.001	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Ethion	0.001	nsl	-	4	LPQL	LPQL	LPQL	LPQL
Phosalone	0.001	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Azinphos-methyl	0.001	0.01 [c]	-	3	LPQL	LPQL	LPQL	LPQL
Coumaphos	0.001	nsl	nsl	nsl	LPQL	LPQL	LPQL	LPQL
Polychlorinated Biphenyls (PCBs)								
Total PCBs	0.01	nsl	nsl	nsl	ALPQL	ALPQL	ALPQL	ALPQL

EXPLANATION:
1 - ANZECC Australian Water Quality Guidelines for Fresh Waters, 2000 - Trigger Values for protection of 95% of species
2 - NHMRC Australian Drinking Water Guidelines (2011)
3 - In the absence of Australian guidelines, the USEPA (2010) Region 9 Screening Levels for tapwater have been adopted as a preliminary screening tool
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r - The more conservative value for Benzo(b)fluoranthene has been adopted
a# - The GIL for Cr III has been adopted as Cr VI is relatively unstable and breakdown rapidly

Concentration above the GIL **VALUE**

ABBREVIATIONS:
na: Not Analysed
nsl: No Set Limit
GIL - Groundwater Investigation Levels
PQL: Practical Quantitation Limit
LPQL: Less than Practical Quantitation Limit
ALPQL: All results less than the PQL
(-) : Not Applicable

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TABLE H-1
SOIL LABORATORY RESULTS COMPARED AGAINST THE EILs and ESLs
All data in mg/kg unless stated otherwise

Land Use Category [1]			URBAN RESIDENTIAL AND PUBLIC OPEN SPACE																		
						AGED HEAVY METALS-EILs						EILs		ESLs							
			pH	CEC ($cmol_c/kg$)	Clay Content (% clay)	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Naphthalene	DDT	$>C_6$-C_{10}	$>C_{10}$-C_{16}	$>C_{16}$-C_{34}	$>C_{34}$-C_{40}	Benzene	Toluene	Ethylbenzene	Total Xylenes	B(a)P
PQL - Envirolab Services			-	1	-	4	1	1	1	1	1	0.05	0.1	25	50	100	100	0.2	0.5	1	3	0.05
Ambient Background Concentration (ABC) [2]			-	-	-	nsl	13	28	nsl	5	122	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl
Sample Reference	Sample Depth	Soil Texture	Average Values from Table I [3]																		
JK1	0.0-0.2	Fine	8.64	25.43	13.75	8	31	68	170	44	230	LPQL	LPQL	LPQL	LPQL	240	180	LPQL	LPQL	LPQL	LPQL	1.2
JK1	1.3-1.5	Fine	8.64	25.43	13.75	9	37	74	200	41	220	LPQL	NA	LPQL	LPQL	300	190	LPQL	LPQL	LPQL	LPQL	0.47
JK1	2.7-3.0	Fine	8.64	25.43	13.75	LPQL	14	11	16	2	7	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK2	0.0-0.2	Coarse	8.64	25.43	13.75	5	11	36	45	9	88	LPQL	LPQL	LPQL	LPQL	220	LPQL	LPQL	LPQL	LPQL	LPQL	0.24
JK2	0.8-1.0	Fine	8.64	25.43	13.75	5	23	10	30	5	11	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK3	0.3-0.5	Coarse	8.64	25.43	13.75	LPQL	21	76	60	9	63	LPQL	LPQL	LPQL	LPQL	120	140	LPQL	LPQL	LPQL	LPQL	0.75
JK3	3.5-3.8	Fine	8.64	25.43	13.75	8	17	44	96	7	250	LPQL	NA	LPQL	LPQL	180	160	LPQL	LPQL	LPQL	LPQL	0.09
JK3	4.3-4.5	Fine	8.64	25.43	13.75	6	10	11	32	3	470	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK4	0.0-0.2	Coarse	8.64	25.43	13.75	5	24	34	46	13	77	LPQL	LPQL	LPQL	LPQL	170	230	LPQL	LPQL	LPQL	LPQL	0.33
JK4	1.3-1.5	Fine	8.64	25.43	13.75	10	20	110	68	13	100	LPQL	NA	LPQL	LPQL	150	140	LPQL	LPQL	LPQL	LPQL	0.28
JK5	0.0-0.2	Coarse	8.64	25.43	13.75	4	15	32	110	10	120	LPQL	LPQL	LPQL	LPQL	110	LPQL	LPQL	LPQL	LPQL	LPQL	1.4
JK5	0.65-0.95	Fine	8.64	25.43	13.75	4	19	68	160	13	200	LPQL	NA	LPQL	LPQL	170	110	LPQL	LPQL	LPQL	LPQL	0.78
JK5	3.0-3.15	Fine	8.64	25.43	13.75	7	17	30	83	9	150	LPQL	NA	LPQL	LPQL	290	120	LPQL	LPQL	LPQL	LPQL	0.85
JK5	6.0-6.2	Fine	8.64	25.43	13.75	5	13	15	24	3	39	LPQL	NA	LPQL	LPQL	140	LPQL	LPQL	LPQL	LPQL	LPQL	0.11
JK6	0.05-0.2	Coarse	8.64	25.43	13.75	LPQL	28	57	23	28	42	LPQL	LPQL	LPQL	LPQL	490	750	LPQL	LPQL	LPQL	LPQL	2.4
JK6	1.3-1.5	Coarse	8.64	25.43	13.75	6	15	32	46	10	52	LPQL	NA	LPQL	LPQL	220	340	LPQL	LPQL	LPQL	LPQL	0.81
JK6	3.0-3.45	Fine	8.64	25.43	13.75	6	13	25	37	14	100	LPQL	NA	LPQL	LPQL	140	230	LPQL	LPQL	LPQL	LPQL	LPQL
JK7	0.0-0.2	Fine	8.64	25.43	13.75	LPQL	110	56	9	9	25	LPQL	LPQL	LPQL	LPQL	320	690	LPQL	LPQL	LPQL	LPQL	0.57
JK7	2.7-3.0	Coarse	8.64	25.43	13.75	11	2800	91	97	59	130	LPQL	NA	LPQL	LPQL	210	240	LPQL	LPQL	LPQL	LPQL	0.3
JK7	5.8-6.0	Fine	8.64	25.43	13.75	7	33	48	100	9	140	LPQL	NA	LPQL	240	700	340	LPQL	LPQL	LPQL	LPQL	0.7
JK8	0.0-0.2	Coarse	8.64	25.43	13.75	LPQL	11	34	35	7	100	LPQL	LPQL	LPQL	LPQL	240	150	LPQL	LPQL	LPQL	LPQL	0.39
JK8	2.7-3.0	Fine	8.64	25.43	13.75	5	33	48	47	19	120	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.07
JK8	4.3-4.5	Fine	8.64	25.43	13.75	7	14	38	27	9	70	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK9	0.0-0.2	Coarse	8.64	25.43	13.75	LPQL	18	29	29	10	53	LPQL	LPQL	LPQL	LPQL	220	240	LPQL	LPQL	LPQL	LPQL	0.18
JK9	0.5-0.7	Fine	8.64	25.43	13.75	7	17	150	86	8	270	LPQL	NA	LPQL	LPQL	2300	700	LPQL	LPQL	LPQL	LPQL	0.22
JK9	2.6-2.8	Fine	8.64	25.43	13.75	5	16	58	51	6	81	LPQL	NA	LPQL	53	470	160	LPQL	LPQL	LPQL	LPQL	0.65
Total Number of Samples			26	26	23	26	26	26	26	26	26	26	9	26	26	26	26	26	26	26	26	26
Maximum Value			8.64	25.43	13.75	11	2800	150	200	59	470	LPQL	LPQL	LPQL	240	2300	750	LPQL	LPQL	LPQL	LPQL	2.4

Explanation:
1 - Site Assessment Criteria (SAC): NEPM 2013
2 - ABC Values for selected metals has been adopted from the published background concentrations presented in Olszowy et al (1995), Trace Element Concentrations in Soils from Rural and Urban New South Wales (old/new Suburbs high traffic 25th percentile values quoted)
3 - The average values for pH, % Clay and CEC are presented in Table I

Concentration above the SAC **VALUE**

Abbreviations:
EILs: Ecological Investigation Levels
B(a)P: Benzo(a)pyrene
nsl: No Set Limit
UCL: Upper Level Confidence Limit on Mean Value
ESLs: Ecological Screening Levels
PQL: Practical Quantitation Limit
LPQL: Less than PQL
SAC: Site Assessment Criteria
NEPM: National Environmental Protection Measure
NA: Not Analysed
nc: Not Calculated

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EIL AND ESL ASSESSMENT CRITERIA

Land Use Category [1]			URBAN RESIDENTIAL AND PUBLIC OPEN SPACE																		
						AGED HEAVY METALS-EILs						EILs		ESLs							
			pH	CEC ($cmol_c/kg$)	Clay Content (% clay)	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Naphthalene	DDT	$>C_6$-C_{10}	$>C_{10}$-C_{16}	$>C_{16}$-C_{34}	$>C_{34}$-C_{40}	Benzene	Toluene	Ethylbenzene	Total Xylenes	B(a)P
PQL - Envirolab Services			-	1	-	4	1	1	1	1	1	0.05	0.1	25	50	100	100	0.2	0.5	1	3	0.05
Ambient Background Concentration (ABC) [2]			-	-	-	nsl	13	28	nsl	5	122	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl
Sample Reference	Sample Depth	Soil Texture	Average Values from Table I																		
JK1	0.0-0.2	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	1300	5600	60	105	125	45	0.7
JK1	1.3-1.5	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK1	2.7-3.0	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK2	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK2	0.8-1.0	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK3	0.3-0.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK3	3.5-3.8	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK3	4.3-4.5	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK4	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK4	1.3-1.5	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK5	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK5	0.65-0.95	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK5	3.0-3.15	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK5	6.0-6.2	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK6	0.05-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK6	1.3-1.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK6	3.0-3.45	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK7	0.0-0.2	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	1300	5600	60	105	125	45	0.7
JK7	2.7-3.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK7	5.8-6.0	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK8	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK8	2.7-3.0	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK8	4.3-4.5	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK9	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK9	0.5-0.7	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710		180	120	1300	5600	60	105	125	45	0.7
JK9	2.6-2.8	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7

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EIS

TABLE H-2
SOIL LABORATORY RESULTS COMPARED AGAINST THE EILs and ESLs
All data in mg/kg unless stated otherwise

Land Use Category [1]			URBAN RESIDENTIAL AND PUBLIC OPEN SPACE																		
						AGED HEAVY METALS-EILs						EILs		ESLs							
			pH	CEC ($cmol_c/kg$)	Clay Content (% clay)	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Naphthalene	DDT	$>C_6$-C_{10}	$>C_{10}$-C_{16}	$>C_{16}$-C_{34}	$>C_{34}$-C_{40}	Benzene	Toluene	Ethylbenzene	Total Xylenes	B(a)P
PQL - Envirolab Services			-	1	-	4	1	1	1	1	1	0.05	0.1	25	50	100	100	0.2	0.5	1	3	0.05
Ambient Background Concentration (ABC) [2]			-	-	-	nsl	13	28	nsl	5	122	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl
Sample Reference	Sample Depth	Soil Texture	Average Values from Table I [3]																		
JK10	0.0-0.2	Coarse	8.64	25.43	13.75	LPQL	6	30	33	4	68	LPQL	LPQL	LPQL	LPQL	130	LPQL	LPQL	LPQL	LPQL	LPQL	0.1
JK10	1.3-1.5	Coarse	8.64	25.43	13.75	LPQL	10	17	34	6	44	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.37
JK10	2.7-3.0	Coarse	8.64	25.43	13.75	8	22	64	270	12	230	LPQL	NA	LPQL	LPQL	160	LPQL	LPQL	LPQL	LPQL	LPQL	0.15
JK10	5.7-6.0	Fine	8.64	25.43	13.75	5	17	120	170	11	400	LPQL	NA	LPQL	LPQL	410	LPQL	LPQL	LPQL	LPQL	LPQL	0.81
JK10	7.3-7.5	Fine	8.64	25.43	13.75	9	20	57	140	6	220	LPQL	NA	LPQL	LPQL	220	110	LPQL	LPQL	LPQL	LPQL	0.32
JK11	0.0-0.2	Coarse	8.64	25.43	13.75	5	19	150	68	14	150	LPQL	LPQL	LPQL	LPQL	260	150	LPQL	LPQL	LPQL	LPQL	0.25
JK11	4.0-4.5	Coarse	8.64	25.43	13.75	LPQL	18	8	11	6	32	LPQL	NA	LPQL	LPQL	120	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK11	6.0-6.45	Fine	8.64	25.43	13.75	LPQL	7	9	8	1	5	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK12	0.0-0.2	Coarse	8.64	25.43	13.75	LPQL	10	31	43	5	96	LPQL	NA	LPQL	LPQL	160	LPQL	LPQL	LPQL	LPQL	LPQL	0.25
JK12	0.5-0.7	Coarse	8.64	25.43	13.75	LPQL	68	56	11	6	27	LPQL	LPQL	LPQL	LPQL	500	900	LPQL	LPQL	LPQL	LPQL	0.72
JK12	1.3-1.5	Coarse	8.64	25.43	13.75	LPQL	7	47	81	4	57	LPQL	NA	LPQL	LPQL	360	LPQL	LPQL	LPQL	LPQL	LPQL	8.6
JK12	4.3-4.5	Coarse	8.64	25.43	13.75	15	25	190	270	42	640	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.15
JK13	0.0-0.2	Coarse	8.64	25.43	13.75	LPQL	9	34	38	5	120	LPQL	LPQL	LPQL	190	890	280	LPQL	LPQL	LPQL	LPQL	0.24
JK13	0.8-1.0	Fine	8.64	25.43	13.75	4	9	25	75	4	97	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.17
JK13	2.7-3.0	Coarse	8.64	25.43	13.75	10	26	43	180	10	250	LPQL	NA	LPQL	LPQL	450	240	LPQL	LPQL	LPQL	LPQL	0.2
JK14	0.0-0.2	Coarse	8.64	25.43	13.75	5	14	46	93	9	220	LPQL	LPQL	LPQL	LPQL	110	LPQL	LPQL	LPQL	LPQL	LPQL	0.37
JK14	2.7-3.0	Coarse	8.64	25.43	13.75	6	17	54	71	11	230	LPQL	NA	LPQL	LPQL	170	LPQL	LPQL	LPQL	LPQL	LPQL	0.36
JK14	7.3-7.5	Coarse	8.64	25.43	13.75	5	11	30	89	6	260	LPQL	NA	LPQL	LPQL	150	LPQL	LPQL	LPQL	LPQL	LPQL	0.14
JK14	8.7-9.0	Coarse	8.64	25.43	13.75	6	12	41	190	8	230	LPQL	NA	LPQL	LPQL	130	LPQL	LPQL	LPQL	LPQL	LPQL	0.25
JK15	0.0-0.2	Coarse	8.64	25.43	13.75	LPQL	5	40	12	6	37	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0.13
JK15	0.3-0.5	Coarse	8.64	25.43	13.75	6	3	12	26	2	52	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK15	2.8-3.0	Coarse	8.64	25.43	13.75	8	18	83	110	13	170	LPQL	NA	LPQL	LPQL	260	170	LPQL	LPQL	LPQL	LPQL	1.1
JK15	5.7-6.0	Coarse	8.64	25.43	13.75	LPQL	4	4	9	8	21	LPQL	NA	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
JK16	0.0-0.2	Coarse	8.64	25.43	13.75	5	15	36	350	14	250	LPQL	LPQL	LPQL	LPQL	140	LPQL	LPQL	LPQL	LPQL	LPQL	1.1
JK16	1.3-1.5	Coarse	8.64	25.43	13.75	LPQL	26	26	24	22	80	LPQL	NA	LPQL	LPQL	170	200	LPQL	LPQL	LPQL	LPQL	0.37
JK16	2.7-3.0	Coarse	8.64	25.43	13.75	9	16	15	25	11	64	LPQL	NA	LPQL	LPQL	120	160	LPQL	LPQL	LPQL	LPQL	0.31
Total Number of Samples			26	26	23	26	26	26	26	26	26	26	7	26	26	26	26	26	26	26	26	26
Maximum Value			8.64	25.43	13.75	15	68	190	350	42	640	LPQL	LPQL	LPQL	190	890	900	LPQL	LPQL	LPQL	LPQL	8.6

Explanation:
1 - Site Assessment Criteria (SAC): NEPM 2013
2 - ABC Values for selected metals has been adopted from the published background concentrations presented in Olszowy et al (1995), Trace Element Concentrations in Soils from Rural and Urban New South Wales (old/new Suburbs high traffic 25th percentile values quoted)
3 - The average values for pH, % Clay and CEC are presented in Table I

Concentration above the SAC — VALUE

Abbreviations:
EILs: Ecological Investigation Levels
B(a)P: Benzo(a)pyrene
nsl: No Set Limit
UCL: Upper Level Confidence Limit on Mean Value
ESLs: Ecological Screening Levels
PQL: Practical Quantitation Limit
LPQL: Less than PQL
SAC: Site Assessment Criteria
NEPM: National Environmental Protection Measure
NA: Not Analysed
nc: Not Calculated

E26930KBrpt
December, 2013

EIL AND ESL ASSESSMENT CRITERIA

Land Use Category [1]			URBAN RESIDENTIAL AND PUBLIC OPEN SPACE																		
						AGED HEAVY METALS-EILs						EILs		ESLs							
			pH	CEC ($cmol_c/kg$)	Clay Content (% clay)	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Naphthalene	DDT	$>C_6$-C_{10}	$>C_{10}$-C_{16}	$>C_{16}$-C_{34}	$>C_{34}$-C_{40}	Benzene	Toluene	Ethylbenzene	Total Xylenes	B(a)P
PQL - Envirolab Services			-	1	-	4	1	1	1	1	1	0.05	0.1	25	50	100	100	0.2	0.5	1	3	0.05
Ambient Background Concentration (ABC) [2]			-	-	-	nsl	13	28	nsl	5	122	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl	nsl
Sample Reference	Sample Depth	Soil Texture	Average Values from Table I [3]																		
JK10	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK10	1.3-1.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK10	2.7-3.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK10	5.7-6.0	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK10	7.3-7.5	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK11	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK11	4.0-4.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK11	6.0-6.45	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK12	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK12	0.5-0.7	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK12	1.3-1.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK12	4.3-4.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK13	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK13	0.8-1.0	Fine	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	1300	5600	60	105	125	45	0.7
JK13	2.7-3.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK14	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK14	2.7-3.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK14	7.3-7.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK14	8.7-9.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK15	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK15	0.3-0.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK15	2.8-3.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK15	5.7-6.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK16	0.0-0.2	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	180	180	120	300	2800	50	85	70	105	0.7
JK16	1.3-1.5	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7
JK16	2.7-3.0	Coarse	8.64	25.43	13.75	100	413	248	1100	355	1082	710	--	180	120	300	2800	50	85	70	105	0.7

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TABLE I
SUMMARY OF LABORATORY RESULTS - ECOLOGY PARAMETERS

Sample Reference	Sample Depth (m)	Sample Description	pH (1:5 soil:water)	Clay (% w/w)	Ca (meq/100g)	K (meq/100g)	Mg (meq/100g)	Na (meq/100g)	CEC (med/100g)
JK1	0.0-0.2	Fill - Silty Sand Clay	7.1	24	12	1	2.6	0.32	16
JK7	0.0-0.2	Fill - Silty Clay	10.7	4	22	0	1	0.27	23
JK9	0.5-0.7	Fill - Silty Sand Clay	9.4	21	37	0.8	0.61	0.42	39
JK13	0.0-0.2	Fill - Silty Sand	8.1	11	16.0	0	0.42	0.2	17
JK16	0.0-0.2	Fill - Silty Sand	8.4	16	31	0	1	0.56	33
JK2	0.0-0.2	Fill - Silty Sand	7.9	10	22	0	1	0.26	24
JK3	0.3-0.5	Fill - Silty Sand	9.8	8	NA	NA	NA	NA	NA
JK5	0.65-0.95	Fill - Silty Clay	7.7	16	25	0.3	0.31	0.22	26
Total Number of Samples			8	8	7	7	7	7	7
Minimum Value			7.1	4	12	0	0	0.2	16
Maximum Value			10.7	24	37	1	3	0.56	39
Average Value			8.64	13.75	23.57	0.41	0.98	0.32	25.43

EXPLANATION:

The average values of the ecological parameters have been used in calcualting the EILs in Table H.

ABBREVIATIONS:

Ca - Calcium
K - Potassium
Mg - Magnesium
Na - Sodium
CEC - Cation Exchange Capacity

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TABLE J-1
SOIL INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK5 (0-0.2)	Arsenic	4	4	LPQL	4	NC
Dup Ref = Dup A	Cadmium	0.5	LPQL	LPQL	NC	NC
	Chromium	1	15	12	13.5	22.2
Envirolab Report: 99467	Copper	1	32	34	33	6.1
	Lead	1	110	90	100	20.0
	Mercury	0.1	0.2	0.1	0.15	66.7
	Nickel	1	10	9	9.5	10.5
	Zinc	1	120	110	115	8.7
	Naphthalene	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	0.1	0.1	0.1	0.0
	Acenaphthene	0.1	0.2	LPQL	0.2	NC
	Fluorene	0.1	0.1	LPQL	0.1	NC
	Phenanthrene	0.1	1.1	1.3	1.2	16.7
	Anthracene	0.1	0.4	0.4	0.4	0.0
	Fluoranthene	0.1	2.6	2.8	2.7	7.4
	Pyrene	0.1	2.5	2.8	2.65	11.3
	Benzo(a)anthracene	0.1	1.3	1.3	1.3	0.0
	Chrysene	0.1	1.1	1.2	1.15	8.7
	Benzo(b)&(k)fluorant	0.2	2.2	2.1	2.15	4.7
	Benzo(a)pyrene	0.05	1.4	1.4	1.4	0.0
	Indeno(123-cd)pyrene	0.1	1	0.8	0.9	22.2
	Dibenzo(ah)anthracene	0.1	0.2	0.2	0.2	0.0
	Benzo(ghi)perylene	0.1	0.9	0.7	0.8	25.0
	TRH >C6-C9 (F1)	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	110	150	130	30.8
	TRH >C34-C40	100	LPQL	LPQL	NC	NC
	Benzene	0.5	LPQL	LPQL	NC	NC
	Toluene	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	LPQL	LPQL	NC	NC
	m+p-xylene	2	LPQL	LPQL	NC	NC
	o-xylene	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE J-2
SOIL INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK10 (0-0.2)	Arsenic	4	LPQL	LPQL	NC	NC
Dup Ref = Dup B	Cadmium	0.5	LPQL	LPQL	NC	NC
	Chromium	1	6	8	7	28.6
Envirolab Report: 99467	Copper	1	30	24	27	22.2
	Lead	1	33	37	35	11.4
	Mercury	0.1	LPQL	0.1	0.1	NC
	Nickel	1	4	5	4.5	22.2
	Zinc	1	68	92	80	30.0
	Naphthalene	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	LPQL	LPQL	NC	NC
	Acenaphthene	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	LPQL	LPQL	NC	NC
	Phenanthrene	0.1	LPQL	LPQL	NC	NC
	Anthracene	0.1	LPQL	LPQL	NC	NC
	Fluoranthene	0.1	0.2	0.2	0.2	0.0
	Pyrene	0.1	0.2	0.2	0.2	0.0
	Benzo(a)anthracene	0.1	LPQL	0.1	0.1	NC
	Chrysene	0.1	LPQL	0.1	0.1	NC
	Benzo(b)&(k)fluorant	0.2	LPQL	0.2	0.2	NC
	Benzo(a)pyrene	0.05	0.1	0.13	0.115	26.1
	Indeno(123-cd)pyrene	0.1	LPQL	LPQL	NC	NC
	Dibenzo(ah)anthracene	0.1	LPQL	LPQL	NC	NC
	Benzo(ghi)perylene	0.1	LPQL	LPQL	NC	NC
	TRH >C6-C9 (F1)	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	130	140	135	7.4
	TRH >C34-C40	100	LPQL	LPQL	NC	NC
	Benzene	0.5	LPQL	LPQL	NC	NC
	Toluene	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	LPQL	LPQL	NC	NC
	m+p-xylene	2	LPQL	LPQL	NC	NC
	o-xylene	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE J-3
SOIL INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK12 (1.3-1.5)	Arsenic	4	LPQL	LPQL	NC	NC
Dup Ref = Dup C	Cadmium	0.5	LPQL	LPQL	NC	NC
	Chromium	1	7	6	6.5	15.4
Envirolab Report: 99467	Copper	1	47	45	46	4.3
	Lead	1	81	73	77	10.4
	Mercury	0.1	LPQL	LPQL	NC	NC
	Nickel	1	4	6	5	40.0
	Zinc	1	57	52	54.5	9.2
	Naphthalene	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	0.1	LPQL	NC	NC
	Acenaphthene	0.1	1.5	0.7	1.1	72.7
	Fluorene	0.1	1	0.5	0.75	66.7
	Phenanthrene	0.1	14	6.8	10.4	69.2
	Anthracene	0.1	4.3	1.9	3.1	77.4
	Fluoranthene	0.1	32	18	25	56.0
	Pyrene	0.1	29	16	22.5	57.8
	Benzo(a)anthracene	0.1	12	6.6	9.3	58.1
	Chrysene	0.1	11	6.2	8.6	55.8
	Benzo(b)&(k)fluorant	0.2	16	8.6	12.3	60.2
	Benzo(a)pyrene	0.05	8.6	4.6	6.6	60.6
	Indeno(123-cd)pyrene	0.1	4.8	2.5	3.65	63.0
	Dibenzo(ah)anthracene	0.1	0.9	0.4	0.65	76.9
	Benzo(ghi)perylene	0.1	3.9	2.1	3	60.0
	TRH >C6-C9 (F1)	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	360	290	325	21.5
	TRH >C34-C40	100	LPQL	120	NC	NC
	Benzene	0.5	LPQL	LPQL	NC	NC
	Toluene	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	LPQL	LPQL	NC	NC
	m+p-xylene	2	LPQL	LPQL	NC	NC
	o-xylene	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria | VALUE |

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE J-4
SOIL INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK1 (0.0-0.2)	Arsenic	4	8	9	8.5	11.8
Dup Ref = Dup F	Cadmium	0.5	0.4	0.4	0.4	0.0
	Chromium	1	31	31	31	0.0
Envirolab Report: 99558	Copper	1	68	62	65	9.2
	Lead	1	170	140	155	19.4
	Mercury	0.1	0.1	0.1	0.1	0.0
	Nickel	1	44	42	43	4.7
	Zinc	1	230	200	215	14.0
	Naphthalene	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	LPQL	LPQL	NC	NC
	Acenaphthene	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	LPQL	LPQL	NC	NC
	Phenanthrene	0.1	1.3	0.7	1	60.0
	Anthracene	0.1	0.3	0.2	0.25	40.0
	Fluoranthene	0.1	2.4	2.5	2.45	4.1
	Pyrene	0.1	2.3	2.5	2.4	8.3
	Benzo(a)anthracene	0.1	0.9	0.9	0.9	0.0
	Chrysene	0.1	0.9	0.8	0.85	11.8
	Benzo(b)&(k)fluorant	0.2	1.8	1.8	1.8	0.0
	Benzo(a)pyrene	0.05	1.2	1.2	1.2	0.0
	Indeno(123-cd)pyrene	0.1	1	0.7	0.85	35.3
	Dibenzo(ah)anthracene	0.1	0.1	LPQL	0.1	NC
	Benzo(ghi)perylene	0.1	1	0.7	0.85	35.3
	TRH >C6-C9 (F1)	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	240	230	235	4.3
	TRH >C34-C40	100	180	180	180	0.0
	Benzene	0.5	LPQL	LPQL	NC	NC
	Toluene	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	LPQL	LPQL	NC	NC
	m+p-xylene	2	LPQL	LPQL	NC	NC
	o-xylene	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE J-5
SOIL INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK6 (0.05-0.2)	Arsenic	4	LPQL	LPQL	NC	NC
Dup Ref = Dup I	Cadmium	0.5	LPQL	LPQL	NC	NC
	Chromium	1	28	62	45	75.6
Envirolab Report: 99558	Copper	1	57	76	66.5	28.6
	Lead	1	23	26	24.5	12.2
	Mercury	0.1	LPQL	LPQL	NC	NC
	Nickel	1	28	34	31	19.4
	Zinc	1	42	47	44.5	11.2
	Naphthalene	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	LPQL	LPQL	NC	NC
	Acenaphthene	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	LPQL	LPQL	NC	NC
	Phenanthrene	0.1	0.4	0.5	0.45	22.2
	Anthracene	0.1	0.2	0.2	0.2	0.0
	Fluoranthene	0.1	3.5	3.4	3.45	2.9
	Pyrene	0.1	3.6	3.5	3.55	2.8
	Benzo(a)anthracene	0.1	1.7	1.7	1.7	0.0
	Chrysene	0.1	1.6	1.6	1.6	0.0
	Benzo(b)&(k)fluorant	0.2	4.1	3.7	3.9	10.3
	Benzo(a)pyrene	0.05	2.4	2.1	2.25	13.3
	Indeno(123-cd)pyrene	0.1	1.6	1.5	1.55	6.5
	Dibenzo(ah)anthracene	0.1	0.3	0.2	0.25	40.0
	Benzo(ghi)perylene	0.1	1.7	1.5	1.6	12.5
	TRH >C6-C9 (F1)	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	490	490	490	0.0
	TRH >C34-C40	100	750	900	825	18.2
	Benzene	0.5	LPQL	LPQL	NC	NC
	Toluene	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	LPQL	LPQL	NC	NC
	m+p-xylene	2	LPQL	LPQL	NC	NC
	o-xylene	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE K-1
SOIL INTER-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	Envirolab (VIC) PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK8 (0.0-0.2)	Arsenic	4	4	LPQL	LPQL	NC	NC
Dup Ref = Dup D	Cadmium	0.4	0.4	LPQL	LPQL	NC	NC
	Chromium	1	1	9	15	12	50.0
Envirolab Report: 99467 (Primary)	Copper	1	1	34	42	38	21.1
Environlab VIC QA Report: 2762	Lead	1	1	25	39	32	43.8
	Mercury	0.1	0.1	LPQL	LPQL	NC	NC
	Nickel	1	1	7	13	10	60.0
	Zinc	1	1	79	100	89.5	23.5
	Naphthalene	0.1	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	0.1	LPQL	LPQL	NC	NC
	Acenaphthene	0.1	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	0.1	LPQL	LPQL	NC	NC
	Phenanthrene	0.1	0.1	0.2	0.2	0.2	0.0
	Anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Fluoranthene	0.1	0.1	0.6	0.7	0.65	15.4
	Pyrene	0.1	0.1	0.6	0.6	0.6	0.0
	Benzo(a)anthracene	0.1	0.1	0.3	0.3	0.3	0.0
	Chrysene	0.1	0.1	0.3	0.2	0.25	40.0
	Benzo(b)&(k)fluorant	0.2	0.2	0.6	0.6	0.6	0.0
	Benzo(a)pyrene	0.05	0.05	0.39	0.4	0.395	2.5
	Indeno(123-cd)pyrene	0.1	0.1	0.2	0.2	0.2	0.0
	Dibenzo(ah)anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Benzo(ghi)perylene	0.1	0.1	0.2	0.2	0.2	0.0
	TRH >C6-C9 (F1)	25	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	100	240	230	235	4.3
	TRH >C34-C40	100	100	150	180	165	18.2
	Benzene	0.2	0.2	LPQL	LPQL	NC	NC
	Toluene	0.5	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	1	LPQL	LPQL	NC	NC
	m + p-xylene	2	2	LPQL	LPQL	NC	NC
	o-xylene	1	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria | VALUE |

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE K-2
SOIL INTER-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	Envirolab (VIC) PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK2 (0.8-1)	Arsenic	4	4	5	4	4.5	22.2
Dup Ref = Dup E	Cadmium	0.4	0.4	LPQL	LPQL	NC	NC
	Chromium	1	1	23	21	22	9.1
Envirolab Report: 99467 (Primary)	Copper	1	1	10	10	10	0.0
Environlab VIC QA Report: 2762	Lead	1	1	30	29	29.5	3.4
	Mercury	0.1	0.1	LPQL	LPQL	NC	NC
	Nickel	1	1	5	4	4.5	22.2
	Zinc	1	1	11	12	11.5	8.7
	Naphthalene	0.1	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	0.1	LPQL	LPQL	NC	NC
	Acenaphthene	0.1	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	0.1	LPQL	LPQL	NC	NC
	Phenanthrene	0.1	0.1	LPQL	LPQL	NC	NC
	Anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Fluoranthene	0.1	0.1	LPQL	LPQL	NC	NC
	Pyrene	0.1	0.1	LPQL	LPQL	NC	NC
	Benzo(a)anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Chrysene	0.1	0.1	LPQL	LPQL	NC	NC
	Benzo(b)&(k)fluorant	0.2	0.2	LPQL	LPQL	NC	NC
	Benzo(a)pyrene	0.05	0.05	LPQL	LPQL	NC	NC
	Indeno(123-cd)pyrene	0.1	0.1	LPQL	LPQL	NC	NC
	Dibenzo(ah)anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Benzo(ghi)perylene	0.1	0.1	LPQL	LPQL	NC	NC
	TRH >C6-C9 (F1)	25	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	100	LPQL	LPQL	NC	NC
	TRH >C34-C40	100	100	LPQL	LPQL	NC	NC
	Benzene	0.2	0.2	LPQL	LPQL	NC	NC
	Toluene	0.5	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	1	LPQL	LPQL	NC	NC
	m + p-xylene	2	2	LPQL	LPQL	NC	NC
	o-xylene	1	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria | VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE K-3
SOIL INTER-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	Envirolab (VIC) PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: JK15 (2.8-3)	Arsenic	4	4	8	6	7	28.6
Dup Ref = Dup H	Cadmium	0.4	0.4	LPQL	LPQL	NC	NC
	Chromium	1	1	18	17	17.5	5.7
Envirolab Report: 99558 (Primary)	Copper	1	1	83	71	77	15.6
Environlab VIC QA Report: 2762	Lead	1	1	110	100	105	9.5
	Mercury	0.1	0.1	0.1	0.1	0.1	0.0
	Nickel	1	1	13	12	12.5	8.0
	Zinc	1	1	170	140	155	19.4
	Naphthalene	0.1	0.1	0.2	LPQL	0.2	NC
	Acenaphthylene	0.1	0.1	0.2	0.3	0.25	40.0
	Acenaphthene	0.1	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	0.1	0.2	LPQL	0.2	NC
	Phenanthrene	0.1	0.1	1.6	2.1	1.85	27.0
	Anthracene	0.1	0.1	0.4	0.4	0.4	0.0
	Fluoranthene	0.1	0.1	2	2	2	0.0
	Pyrene	0.1	0.1	2.1	2.1	2.1	0.0
	Benzo(a)anthracene	0.1	0.1	1.1	1	1.05	9.5
	Chrysene	0.1	0.1	0.9	1	0.95	10.5
	Benzo(b)&(k)fluorant	0.2	0.2	1.6	1.8	1.7	11.8
	Benzo(a)pyrene	0.05	0.05	1.1	1.1	1.1	0.0
	Indeno(123-cd)pyrene	0.1	0.1	0.6	0.6	0.6	0.0
	Dibenzo(ah)anthracene	0.1	0.1	0.1	0.1	0.1	0.0
	Benzo(ghi)perylene	0.1	0.1	0.5	0.7	0.6	33.3
	TRH >C6-C9 (F1)	25	25	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	100	260	270	265	3.8
	TRH >C34-C40	100	100	170	120	145	34.5
	Benzene	0.2	0.2	LPQL	LPQL	NC	NC
	Toluene	0.5	0.5	LPQL	LPQL	NC	NC
	Ethylbenzene	1	1	LPQL	LPQL	NC	NC
	m+p-xylene	2	2	LPQL	LPQL	NC	NC
	o-xylene	1	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE L
GROUNDWATER INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in µg/L unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample = MW9	Arsenic	1	33	32	32.5	3.1
Dup Ref = Dup GF2	Cadmium	0.1	LPQL	LPQL	NC	NC
	Chromium	1	2	1	1.5	66.7
Envirolab Report: 100418	Copper	1	12	12	12	0.0
	Lead	1	4	4	4	0.0
	Mercury	0.5	LPQL	LPQL	NC	NC
	Nickel	1	120	120	120	0.0
	Zinc	1	200	210	205	4.9
	Naphthalene	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	LPQL	LPQL	NC	NC
	Acenaphthene	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	LPQL	LPQL	NC	NC
	Phenanthrene	0.1	LPQL	LPQL	NC	NC
	Anthracene	0.1	LPQL	LPQL	NC	NC
	Fluoranthene	0.1	LPQL	LPQL	NC	NC
	Pyrene	0.1	LPQL	LPQL	NC	NC
	Benzo(a)anthracene	0.1	LPQL	LPQL	NC	NC
	Chrysene	0.1	LPQL	LPQL	NC	NC
	Benzo(b)&(k)fluorant	0.2	LPQL	LPQL	NC	NC
	Benzo(a)pyrene	0.1	LPQL	LPQL	NC	NC
	Indeno(123-cd)pyrene	0.1	LPQL	LPQL	NC	NC
	Dibenzo(ah)anthracene	0.1	LPQL	LPQL	NC	NC
	Benzo(ghi)perylene	0.1	LPQL	LPQL	NC	NC
	TRH >C6-C9 (F1)	10	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	LPQL	LPQL	NC	NC
	TRH >C34-C40	100	LPQL	LPQL	NC	NC
	Benzene	1	LPQL	LPQL	NC	NC
	Toluene	1	LPQL	LPQL	NC	NC
	Ethylbenzene	1	LPQL	LPQL	NC	NC
	m+p-xylene	2	LPQL	LPQL	NC	NC
	o-xylene	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE M
GROUNDWATER INTER-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in µg/L unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	Envirolab (VIC) PQL	INITIAL	REPEAT	MEAN	RPD %
Primary Sample: MW7	Arsenic	1	1	2	2	2	0.0
Dup Ref = DupGF1	Cadmium	0.1	0.1	LPQL	LPQL	NC	NC
	Chromium	1	1	LPQL	1	1	NC
Envirolab Report: 100418 (Primary)	Copper	1	1	LPQL	LPQL	NC	NC
Environlab VIC QA Report: 2831	Lead	1	1	LPQL	LPQL	NC	NC
	Mercury	0.05	0.05	LPQL	LPQL	NC	NC
	Nickel	1	1	5	5	5	0.0
	Zinc	1	1	3	7	5	80.0
	Naphthalene	0.1	0.1	LPQL	LPQL	NC	NC
	Acenaphthylene	0.1	0.1	LPQL	LPQL	NC	NC
	Acenaphthene	0.1	0.1	LPQL	LPQL	NC	NC
	Fluorene	0.1	0.1	LPQL	LPQL	NC	NC
	Phenanthrene	0.1	0.1	LPQL	LPQL	NC	NC
	Anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Fluoranthene	0.1	0.1	LPQL	LPQL	NC	NC
	Pyrene	0.1	0.1	LPQL	LPQL	NC	NC
	Benzo(a)anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Chrysene	0.1	0.1	LPQL	LPQL	NC	NC
	Benzo(b)&(k)fluorant	0.2	0.2	LPQL	LPQL	NC	NC
	Benzo(a)pyrene	0.1	0.1	LPQL	LPQL	NC	NC
	Indeno(123-cd)pyrene	0.1	0.1	LPQL	LPQL	NC	NC
	Dibenzo(ah)anthracene	0.1	0.1	LPQL	LPQL	NC	NC
	Benzo(ghi)perylene	0.1	0.1	LPQL	LPQL	NC	NC
	TRH >C6-C9 (F1)	10	10	LPQL	LPQL	NC	NC
	TRH >C10 - C16 (F2)	50	50	LPQL	LPQL	NC	NC
	TRH >C16-C34	100	100	LPQL	740	740	NC
	TRH >C34-C40	100	100	LPQL	LPQL	NC	NC
	Benzene	1	1	LPQL	LPQL	NC	NC
	Toluene	1	1	LPQL	LPQL	NC	NC
	Ethylbenzene	1	1	LPQL	LPQL	NC	NC
	m + p-xylene	2	2	LPQL	LPQL	NC	NC
	o-xylene	1	1	LPQL	LPQL	NC	NC

EXPLANATION:

The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:

Results > 10 times PQL = RPD value < = 50% are acceptable
Results between 5 & 10 times PQL = RPD value < = 75% are acceptable
Results < 5 times PQL = RPD value < = 100% are acceptable

RPD Results Above the Acceptance Criteria | VALUE |

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
na: Not Analysed
nc: Not Calculated
OCP: Organochlorine Pesticides
OPP: Organophosphorus Pesticides
PCBs: Polychlorinated Biphenyls
TPH: Total Petroleum Hydrocarbons

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TABLE N
SUMMARY OF QA/QC - TRIP SPIKE AND TRIP BLANK RESULTS

ANALYSIS	Envirolab PQL		$TB1^S$ 18/10/2013 99467	$TB2^S$ 21/10/2013 99467	$TB1^S$ 22/10/2013 99558	$TB2^S$ 23/10/2013 99558	$TS1^S$ 22/10/2013 99467	TS^W 6/11/2013 100418
	mg/kg	µg/L	mg/kg	mg/kg	mg/kg	mg/kg	% Recovery	% Recovery
Benzene	1	1	LPQL	LPQL	LPQL	LPQL	67%	105%
Toluene	1	1	LPQL	LPQL	LPQL	LPQL	87%	102%
Ethylbenzene	1	1	LPQL	LPQL	LPQL	LPQL	104%	104%
m+p-xylene	2	2	LPQL	LPQL	LPQL	LPQL	104%	108%
o-xylene	1	1	LPQL	LPQL	LPQL	LPQL	104%	108%

EXPLANATION:

^{W} Sample type (water)

^{S} Sample type (sand)

BTEX concentrations in trip spikes are presented as % recovery

Values above PQLs/Acceptance criteria VALUE

ABBREVIATIONS:

PQL: Practical Quantitation Limit
LPQL: Less than PQL
(-) : Not Applicable / Not Analysed
OPP: Organophosphorus Pesticides
OCP: Organochlorine Pesticides
PCBs: Polychlorinated Biphenyls
TB: Trip Blank
TS: Trip Spike
RS: Rinsate Sample
na: Not Analysed
nc: Not Calculated
TPH: Total Petroleum Hydrocarbons

Copyright Environmental Investigation Services

SSM 26462 RL 2.807 ADOPTED FOR DATUM
CO ORDINATES ON MGA ORIGIN SSM 26462
GROUND SURVEY DISTANCES FROM SSM 26462

SSM 49623
RL 3.275

NEWBRIDGE ROAD

GOVERNOR MACQUARIE DRIVE

DAVY ROBINSON DRIVE

GEORGES RIVER

ROADWAY

ACCESS ROAD

LOT 2 DP 602988
6.906ha

LOT 1 DP 602988
CARPARK

"FLOWERPOWER"

LOT 6 DP 1065574

OPEN DRAIN

GRAVEL TRACK TO NEWBRIDGE ROAD

SHED

SHED

WASH PLANT

TANK

SWAMP

SWAMP

SWAMP

310 DP 1118048

310 DP 1118048

a) LOT 309 DP 1118048 REGISTERED 16.10.2007 (18m wide)

VEGETATED BUND WALLS

WIRE MESH FENCE

TRAFFIC ISLAND

CONCRETE

PLANT DISPLAY AREA

GRAVEL DRIVE

LOG BARRIER

CYCLONE WIRE & ELECTRIC FENCE

BOAT RAMP

MEAN HIGH WATER MARK IS BOUNDARY

DEED BDY

SP 1 GLASS 42,058m3
SP 2 SAND 16,488m3
SP 3 SAND 289m3
SP 4 SAND 569m3
SP 5 RESIDUE 218m3
SP 6 RESIDUE 512m3
SP 7 GRAVEL 21m3
SP 8 GRAVEL 126m3
SP 9 RESIDUE 674m3
SP 10 GLASS 7,716m3
SP 11 GLASS 29,664m3
SP 12 SANDSTONE 20,600m3
SP 13 RESIDUE 225m3
SP 14 RESIDUE 331m3
SP 15 MULCH 345m3
SP 16 GLASS 13m3
SP 17 SAND 1,800m3
SP 18 SAND 662m3
SP 19 SAND 59m3
SP 20 GLASS 1,224m3
SP 21 GLASS 26,698m3
SP 22 SAND 99m3
SP 23 SAND 80m3
SP 24 SAND 2,227
SP 24 20,635m3
SP 25 SAND 250m3
SP 26 SAND 327m3
SP 27 SAND 5,478m3
SP 28 DIRT 12,400m3
SP 29 SAND 81m3
SP 30 GRAVEL 77m3
SP 31 RESIDUE 1,175m3
SP 32 GLASS 297m3
SP 33 GLASS 55m3
SP 34 GLASS 54m3
SP 35 SAND 1,103
SP 36 SAND 3,145m3
SP 37 SAND 160m3

LIC N° 10490

NOTES:

- The position of features are indicative only.
- Services shown hereon have been located where possible by field survey. Prior to any excavation or construction on the site, the relevant authority should be contacted for possible location of any other services including those which may be underground.
- 101.50 indicates natural surface level.
- Contours shown depict the general topography. They do not represent exact levels other than at spot levels shown.
- Relationship of improvements to boundaries is diagrammatic only. Where offsets are critical they should be confirmed by further survey.
- Bearings and distances are by title only. No boundary investigation has been carried out.
- The shapes, sizes, position, heights and species of trees are approximate only. Further field inspection should be carried out where tree details are considered to critically affect design.

Client: BENEDICT SAND & GRAVEL	Project: PLAN SHOWING LEVELS, CONTOURS AND STOCKPILE VOLUMES AS AT 20-08-13 146 NEWBRIDGE ROAD, MOOREBANK.	FREEBURN SURVEYING	MATTHEW FREEBURN LAND, ENGINEERING & MINING SURVEYOR SUITE 2, FIRST FLOOR, "SURVEYOR HOUSE" 2 CASTLEREAGH STREET PENRITH 2750	Telephone 02 4721 2289 Fax 02 4721 5646 email matthew@freeburnsurveyors.com	Date: 22/08/2013 | Ref: 32825 | Sheet 1 of 1 Scale 1: 1000 | Datum: AHD | Contour: 1.0m Surveyor: CD | Drawn By: CD | Checked: MF CC6 - SURVEY 4 - 32825 EPA 20-08-13 | A1 SHEET

Liverpool Local Environmental Plan 2008

Land zoning map - sheet LZN-014

Zone

- B1 Neighbourhood Centre
- B2 Local Centre
- B3 Commercial Core
- B4 Mixed Use
- B5 Business Development
- B6 Enterprise Corridor
- E1 National Parks and Nature Reserves
- E2 Environmental Conservation
- E3 Environmental Management
- IN1 General Industrial
- IN2 Light Industrial
- IN3 Heavy Industrial
- R1 General Residential
- R2 Low Density Residential
- R3 Medium Density Residential
- R4 High Density Residential
- R5 Large Lot Residential
- RE1 Public Recreation
- RE2 Private Recreation
- RU1 Primary Production
- RU2 Rural Landscape
- RU4 Primary Production Small Lots
- SP1 Special Activities
- SP2 Infrastructure
- W1 Natural Waterways
- WSP SEPP Western Sydney Parklands

Cadastre

Cadastre 24/5/2012 © Land and Property Information

N

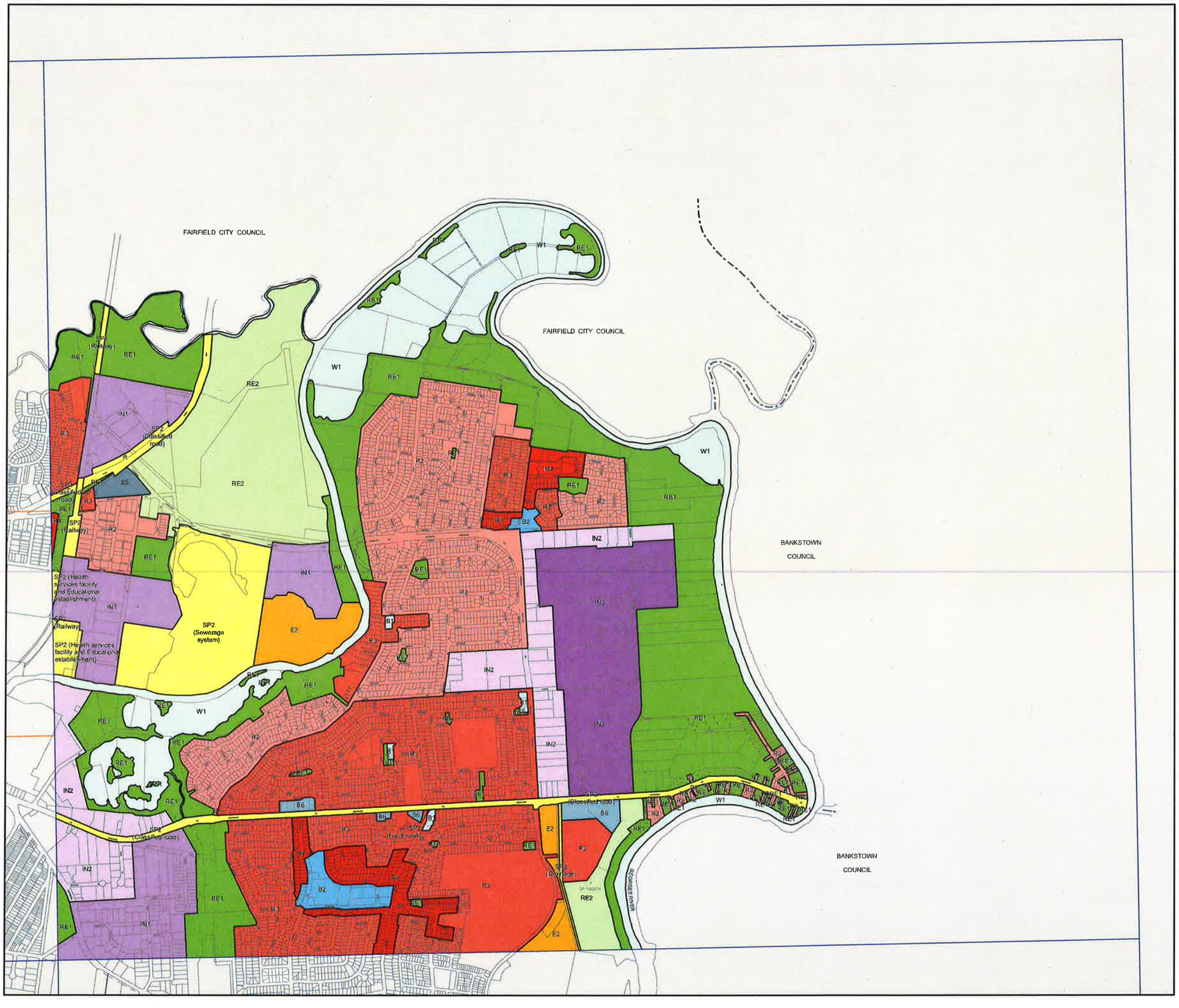
0 200 400 600 800

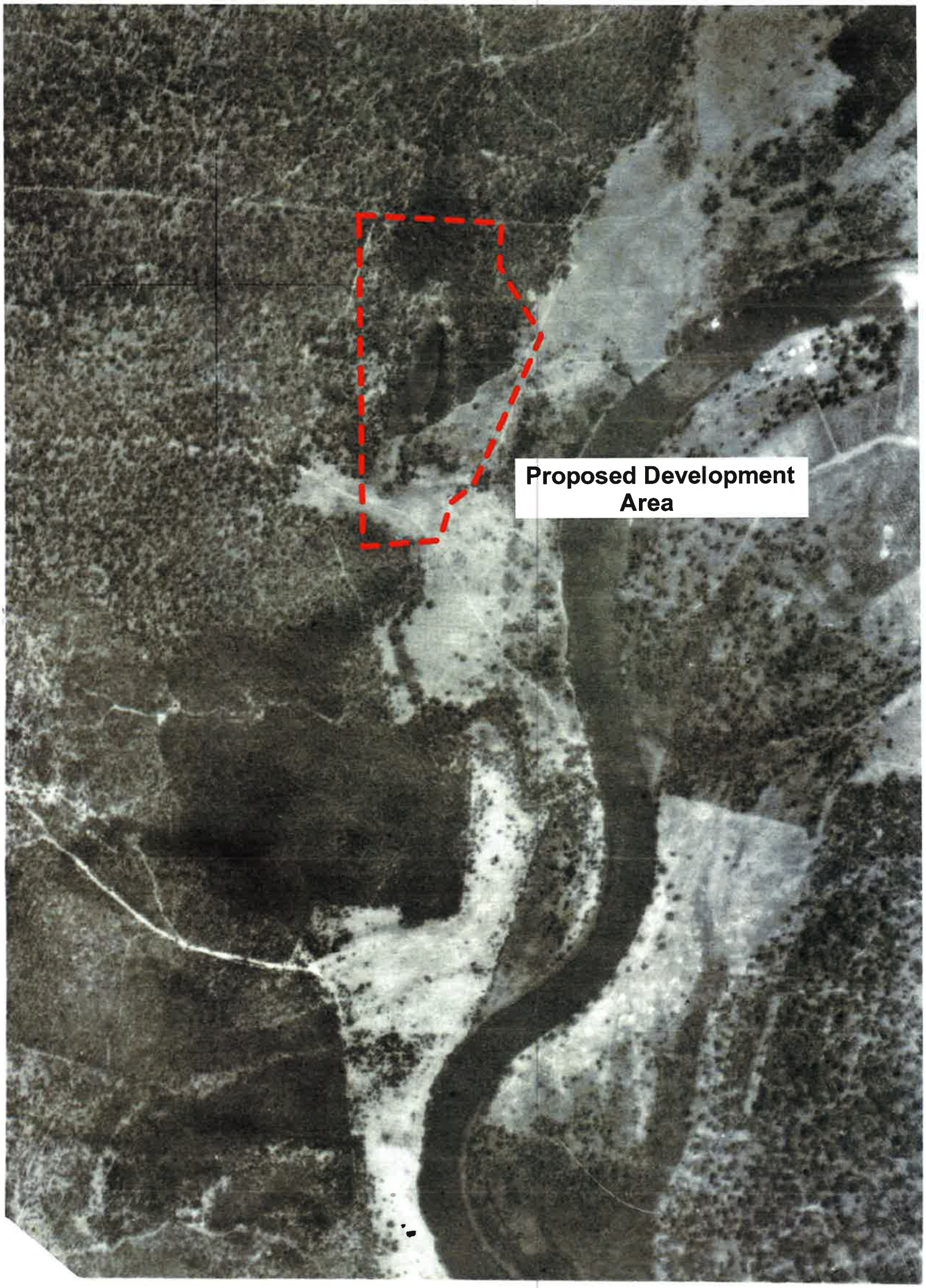
Metres

Scale: 1:20,000 @ A3

Projection GDA 1994
MGA Zone 56

Map identification number:
4900_COM_LZN_014_020_20120524





LEGEND:

Approximate site boundary

N

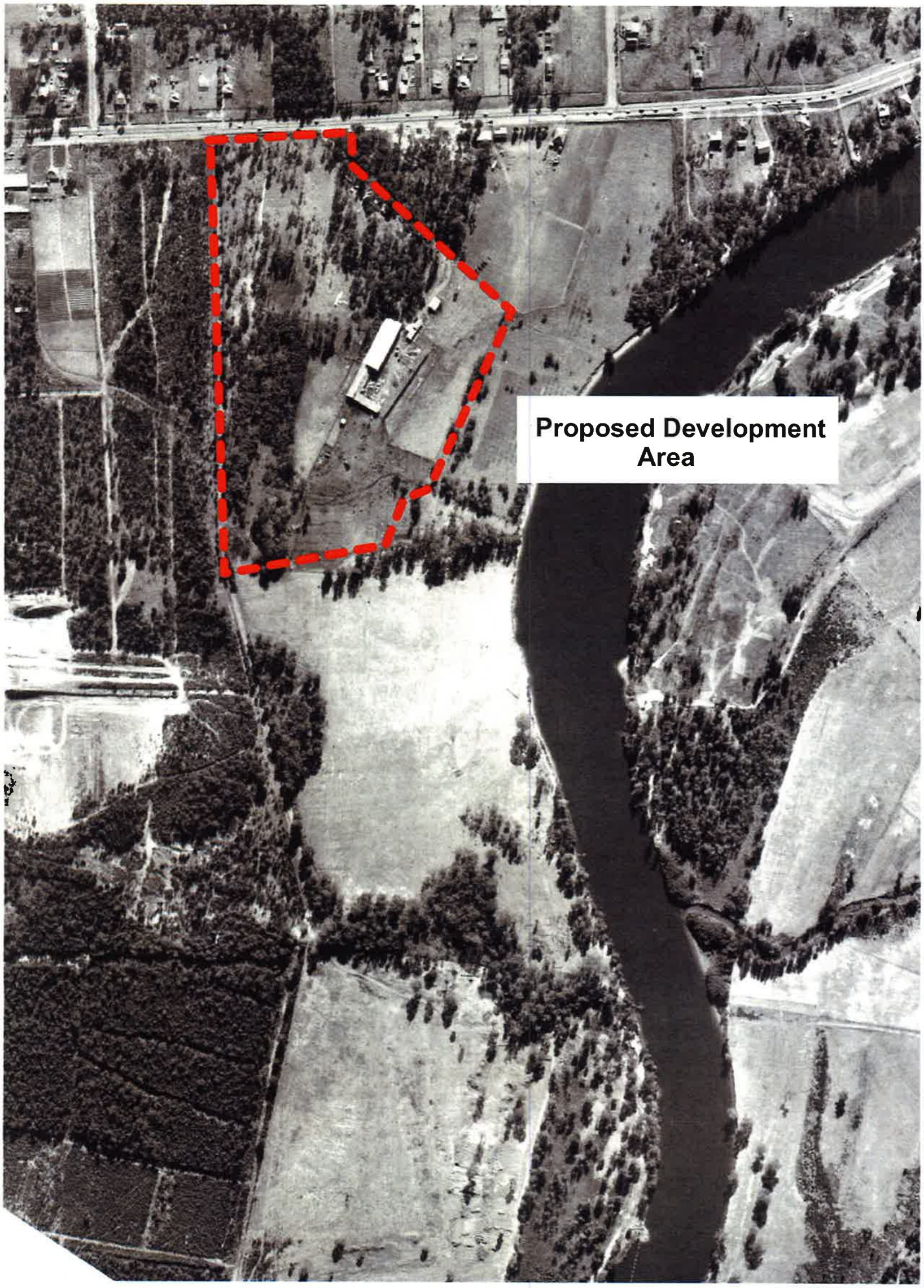
ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: **E26930KB**	Title: **1930 AERIAL PHOTOGRAPH**
	Figure: **C6-1**	Address: **146 NEWBRIDGE ROAD, MOOREBANK, NSW**

LEGEND:

Approximate site boundary

N

ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: **E26930KB**	Title: **1951 AERIAL PHOTOGRAPH**
	Figure: **C6-2**	Address: **146, NEWBRIDGE ROAD, MOOREBANK, NSW**

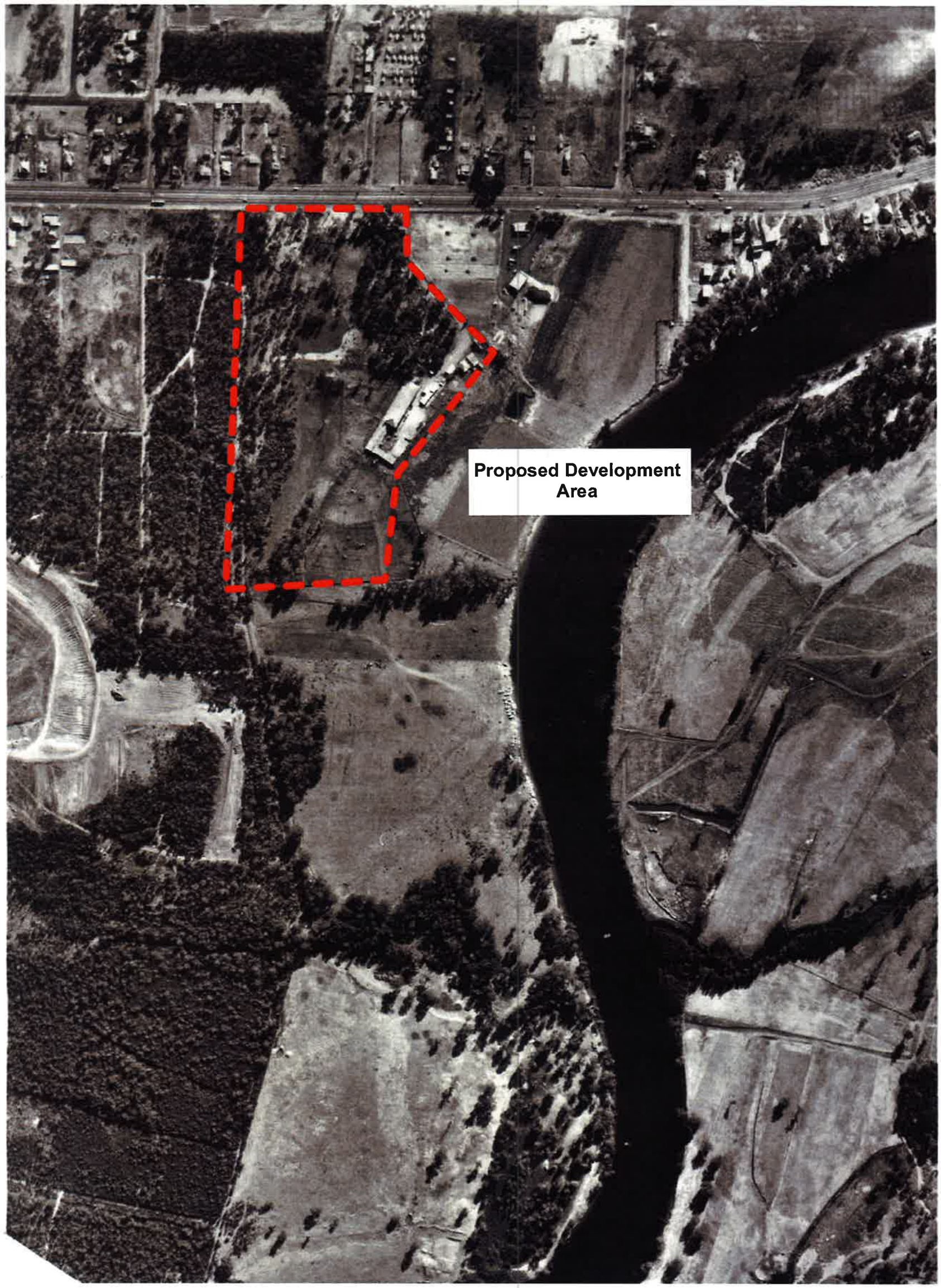


LEGEND:

— — **Approximate site boundary**

N

ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: **E26930KB**	Title: **1961 AERIAL PHOTOGRAPH**
	Figure: **C6-3**	Address: **146 NEWBRIDGE ROAD MOOREBANK, NSW**



LEGEND:

Approximate site boundary

N

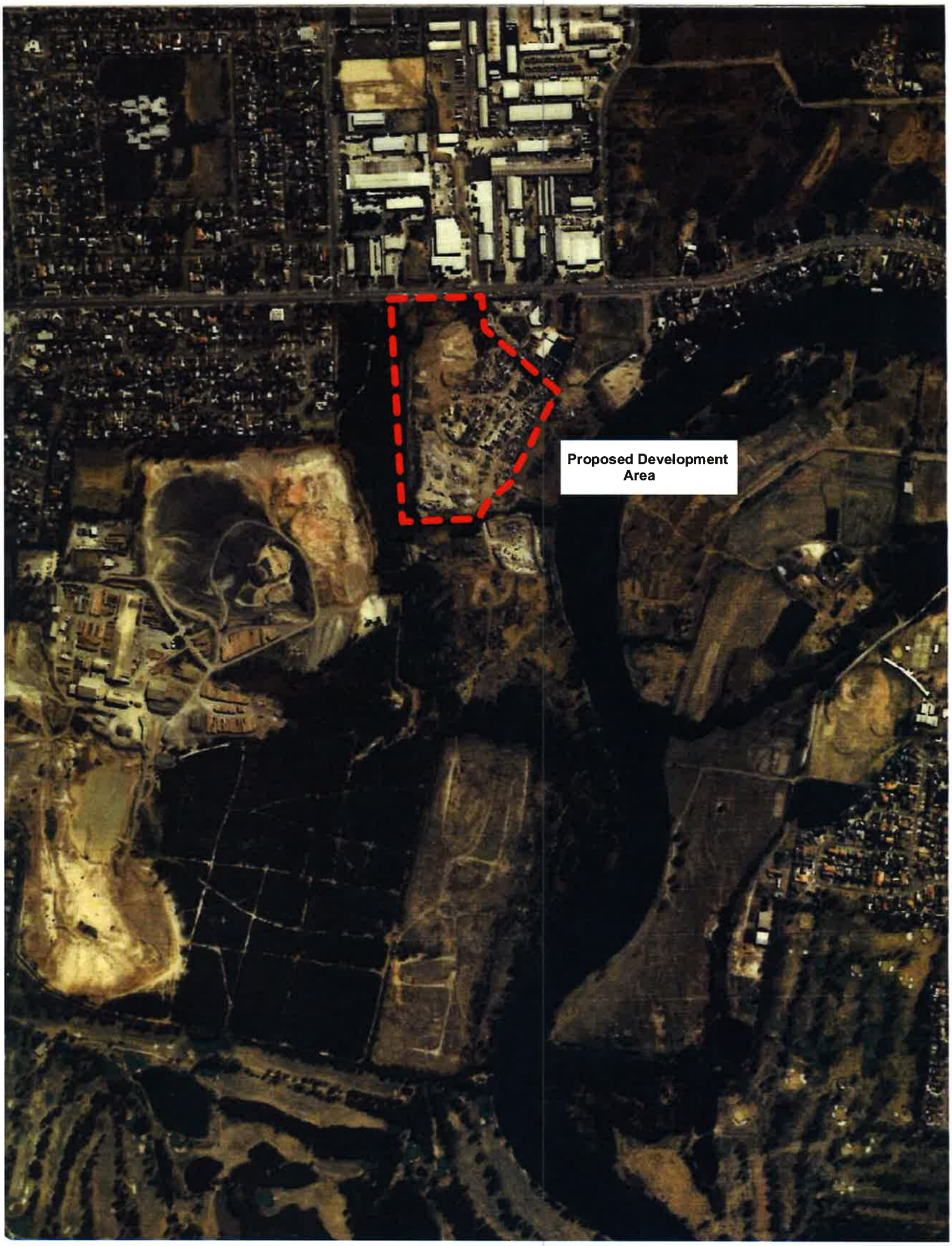
ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: **E26930KB**	Title: **1970 AERIAL PHOTOGRAPH**
	Figure: **C6-4**	Address: **146 NEWBRIDGE ROAD, MOOREBANK, NSW**

LEGEND:

Approximate site boundary

N

EIS ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: **E26930KB**	Title: **1982 AERIAL PHOTOGRAPH**
	Figure: **C6-5**	Address: **146 NEWBRIDGE ROAD, MOOREBANK, NSW**



LEGEND:

— — — **Approximate site boundary**

N

ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: **E26930KB**	Title: **1991 AERIAL PHOTOGRAPH**
	Figure: **C6-6**	Address: **146 NEWBRIDGE ROAD, MOOREBANK, NSW**

LEGEND:

Approximate site boundary

N

ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: E26930KB	Title: 2000 AERIAL PHOTOGRAPH
	Figure: C6-7	Address: 146 NEWBRIDGE ROAD, MOOREBANK NSW

Legend

Approximate site boundary

N

Approximate Scale (m):		Project Number:	Title:
Not to Scale	ENVIRONMENTAL INVESTIGATION SERVICES	E26930KB	2005 AERIAL PHOTOGRAPH
		Figure: C6-8	Address: 146 NEWBRIDGE ROAD MOOREBANK, NSW

DBYD Address:
146 Newbridge Rd
Moorebank NSW 2170

DBYD Job No: 6782871

DBYD Sequence No: 31036320

Copyright Reserved Sydney Water 2013

No warranty is given that the information shown is complete or accurate.

SYDNEY WATER CORPORATION

Scale: 1:1500

Date of Production: 14/10/2013

Plan 1 of 1

Cable Plan

Telstra

For all Telstra DBYD plan enquiries -
email - Telstra.Plans@team.telstra.com
For urgent onsite contact only - ph 1800 653 935 (bus hrs)

TELSTRA CORPORATION LIMITED A.C.N. 051 775 556

Generated On 14/10/2013 17:46:50

Sequence Number: 31038317

CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.

The above plan must be viewed in conjunction with the Mains Cable Plan on the following page

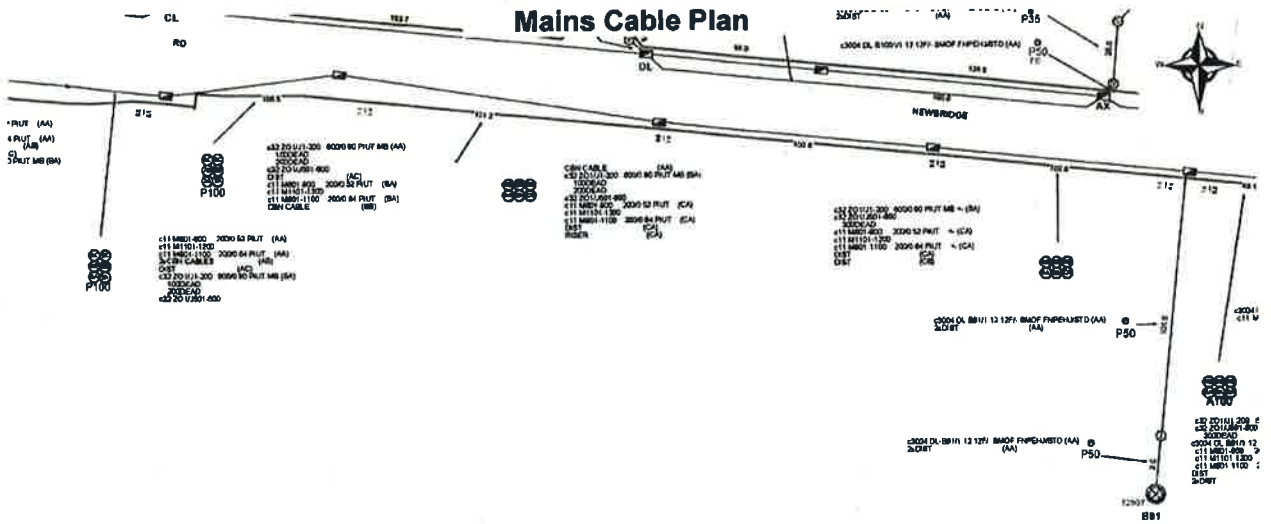
WARNING - Due to the nature of Telstra underground plant and the age of some cables and records, it is impossible to ascertain the precise location of all Telstra plant from Telstra's plans. The accuracy and/or completeness of the information supplied can not be guaranteed as property boundaries, depths and other natural landscape features may change over time, and accordingly the plans are indicative only. Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for any inaccuracy shown on the plans.

It is your responsibility to locate Telstra's underground plant by careful hand pot-holing prior to any excavation in the vicinity and to exercise due care during that excavation.

Please read and understand the information supplied in the duty of care statement attached with the Telstra plans. TELSTRA WILL SEEK COMPENSATION FOR LOSS CAUSED BY DAMAGE TO ITS PLANT.

Telstra plans and information supplied are valid for 60 days from the date of issue. If this timeframe has elapsed, please reapply for plans.

Mains Cable Plan



Telstra For all Telstra DBYD plan enquiries - email - Telstra.Plans@team.telstra.com For urgent onsite contact only - ph 1800 653 935 (bus hrs)	Sequence Number: 31038317
TELSTRA CORPORATION LIMITED A.C.N. 051 775 556	CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.
Generated On 14/10/2013 17:47:00	

WARNING - Due to the nature of Telstra underground plant and the age of some cables and records, it is impossible to ascertain the precise location of all Telstra plant from Telstra's plans. The accuracy and/or completeness of the information supplied can not be guaranteed as property boundaries, depths and other natural landscape features may change over time, and accordingly the plans are indicative only. Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for any inaccuracy shown on the plans.

It is your responsibility to locate Telstra's underground plant by careful hand pot-holing prior to any excavation in the vicinity and to exercise due care during that excavation.

Please read and understand the information supplied in the duty of care statement attached with the Telstra plans. TELSTRA WILL SEEK COMPENSATION FOR LOSS CAUSED BY DAMAGE TO ITS PLANT.

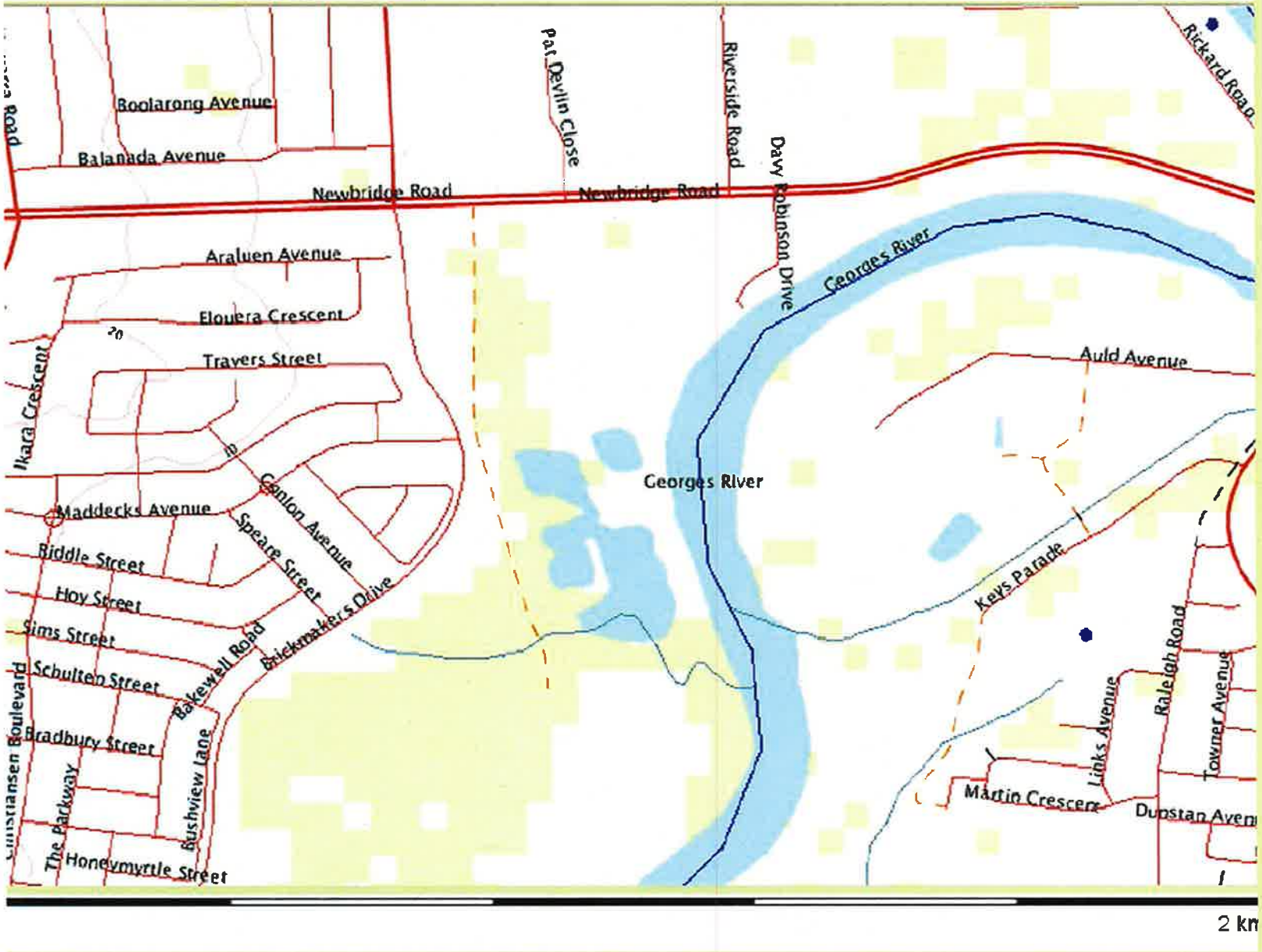
Telstra plans and information supplied are valid for 60 days from the date of issue. If this timeframe has elapsed, please reapply for plans.

ATLAS Home Map Topics Search within m

oundwater,)

Add to map | Sort map layers | Find a place | Legend | Map layer co

p tools



Symbols & map layers

- Towns
- Groundwater Bores
- Catchment Management Authority boundaries
- Major rivers

Topographic base map:

- Primary/arterial road
- Motorway/freeway
- Railway
- Runway
- Contour
- Background

There are hidden layers - see 'Map layer control' tab

Land & Property Information

Cadastral Records Enquiry Report

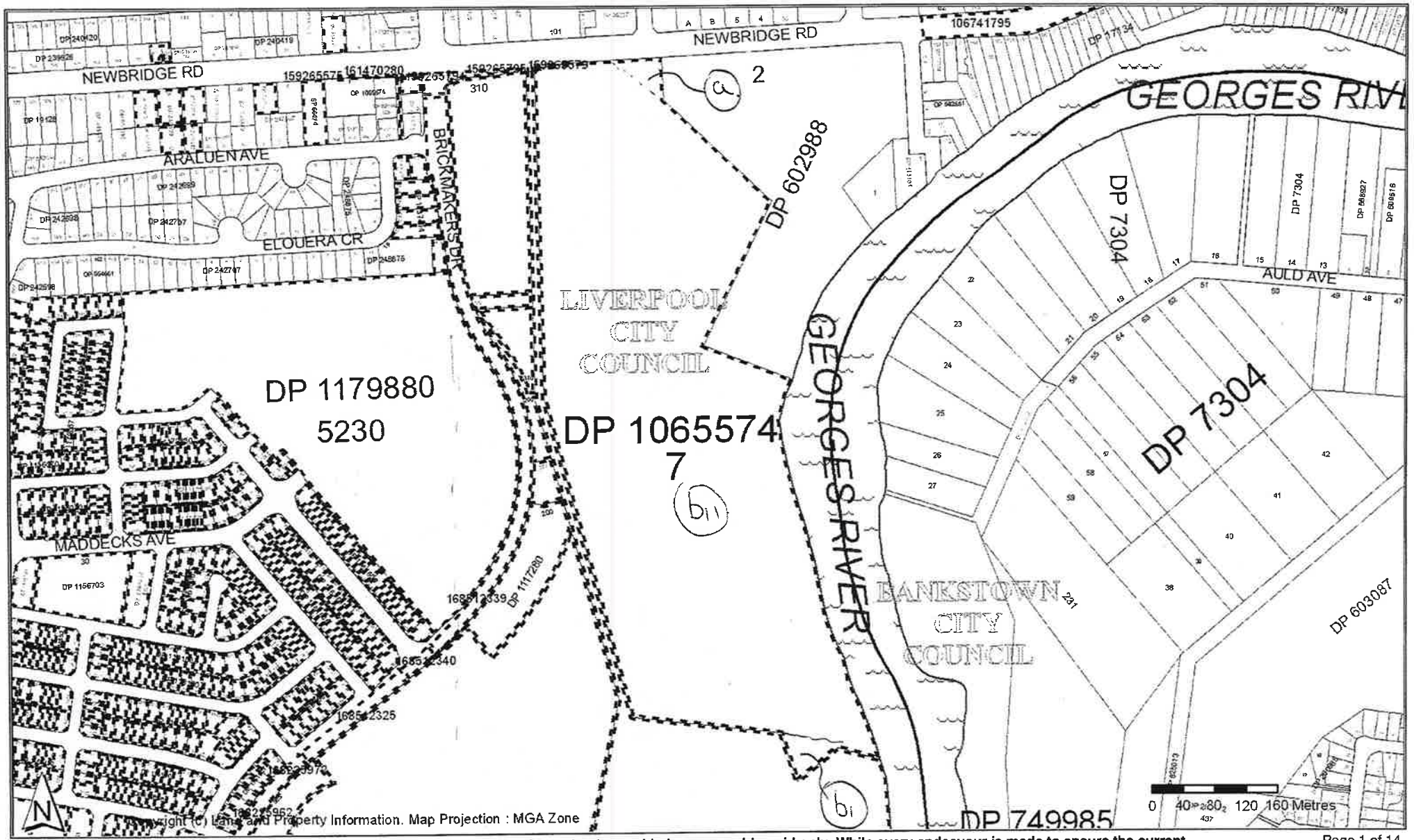
U 9137-22

Ref : BOX 97 - MOOREBANK

Requested Parcel : Lot 7 DP 1065574

Identified Parcel : Lot 7 DP 1065574

Locality : MOOREBANK **LGA :** LIVERPOOL **Parish :** HOLSWORTHY **County :** CUMBERLAND



Report Generated 12:29:29 PM, 16 October, 2013

Copyright © Land and Property Information ABN: 84 104 377 806

This information is provided as a searching aid only. While every endeavour is made to ensure the current cadastral pattern is accurately reflected, the Registrar General cannot guarantee the information provided. For all ACTIVITY PRIOR to SEPT 2002 you must refer to the RGs Charting and Reference Maps.

Req:R387751 /Doc:CT 10148-243 CT /Rev:17-Feb-2011 /Sts:OK.SC /Prt:15-Oct-2013 09:36 /Pgs:ALL /Seq:1 of 2
Ref:ALS /Src:T

[redacted]

CERTIFICATE OF TITLE

PROPERTY ACT, 1900, as amended.

10148243

NEW SOUTH WALES

Application No.7206

Prior Titles Vol.4550 Fol.217
Vol.5655 Fol.222

Vol. 10148 Fol. 243

CANCELLED

MA

1st Edition issued 27-10-1965

Fol. 243 Vol. 10148 (Page 1)

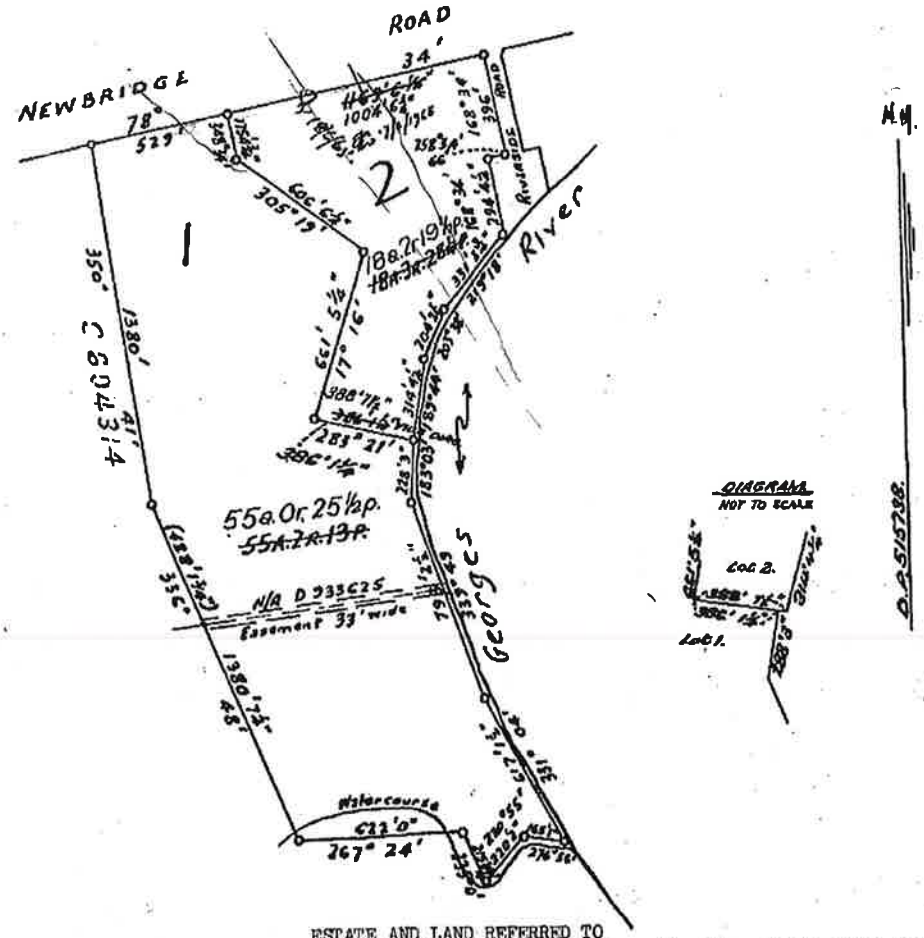
SEE AUTO FOLIO

I certify that the person described in the First Schedule is the registered proprietor of the undermentioned estate in the land within described subject nevertheless to such exceptions encumbrances and interests as are shown in the Second Schedule.

Witness J. Charles

Registrar General.

PLAN SHOWING LOCATION OF LAND



S

ESTATE AND LAND REFERRED TO

Estate in Fee Simple in Lot 1 in Deposited Plan 515738 at Moorebank in the City of Liverpool Parish of Holsworthy and County of Cumberland being part of Portion 28 granted to John Wextead on 6-4-1798 and part of Portion 29 granted to James Healey on 6-4-1798 excepting thereout all coal and minerals under that part of the land above described edged brown in Deposited Plan 515738.

FIRST SCHEDULE (continued overleaf)

~~JOHN PARKER CORBEN Junior, of Moorebank, Agriculturist, as to that part of the land above described formerly comprised in Certificate of Title Volume 4550 Folio 217 and ECHO DAIRIES PTY. LIMITED, as to that part formerly comprised in Certificate of Title Volume 5655 Folio 222.~~

Registrar General.

SECOND SCHEDULE (continued overleaf)

GRM 1. Reservations and conditions, if any, contained in the Crown Grants above referred to.
2. ~~Easement created by Notice of Resumption No.D933625 affecting that part of the land above described shown as easement 33 feet wide in the plan hereon.~~ Released 443/14

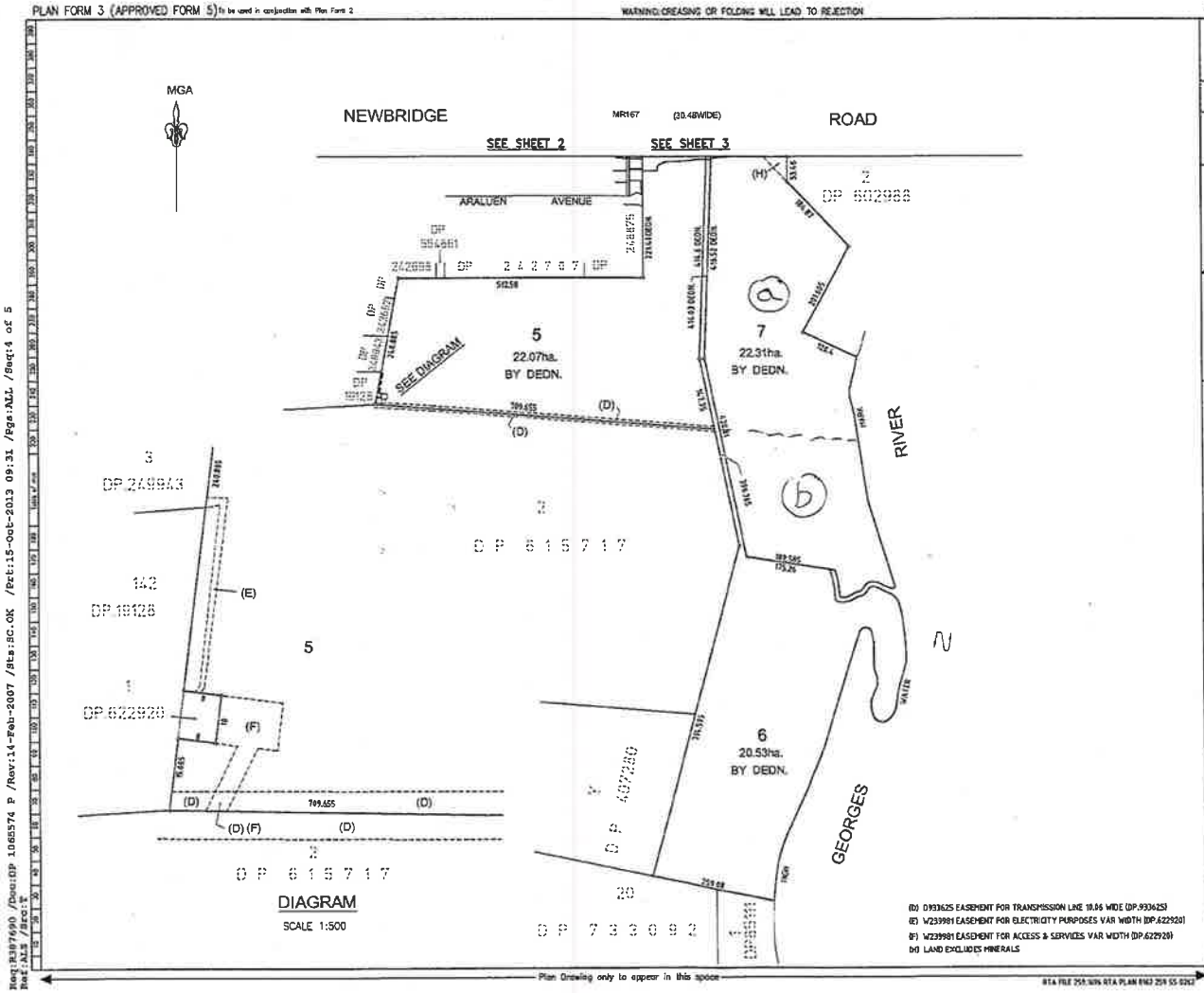
Registrar General.

NOTE: ENTRIES RULED THROUGH AND AUTHENTICATED BY THE SEAL OF THE REGISTRAR GENERAL ARE CANCELLED.

PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON

WARNING: THIS DOCUMENT MUST NOT BE REMOVED FROM THE LAND TITLES OFFICE.

PLAN FORM 3 (APPROVED FORM 5) To be used in conjunction with Plan Form 2 | WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION | e-plan



DP1065574

Registered: 24-03-2004

This is sheet * of my plan in * sheets dated 3-FEB-2004

SEE SIGNATURES FORM

Registered Land Surveyor under the Surveying Act 2002

This is sheet of the plan of sheets annexed by my Certificate No. of

Authorised Person/General Manager/Accredited Certifier

LGA:	LIVERPOOL CITY
Locality:	MOOREBANK
Parish:	HOLSWORTHY
County:	CUMBERLAND

For use where space is insufficient in any panel on Plan Form 2

Reduction Ratio 1:5000

*OFFICE USE ONLY

Req:R397690 /Doc:DP 1065574 P /Rev:14-Feb-2007 /Sts:SC.OK /Pct:15-Oct-2013 09:31 /Pgs:ALL /Seq:4 of 5
Ref:ALS /Src:T

Plan Drawing only to appear in this space

RTA FILE 258/606 RTA PLAN 8963 259 SS 0263

SURVEYOR'S REFERENCE: 102575 (SP3167 RTA)

PLAN FORM 2 (APPROVED FORM 3)

Plan drawing only to appear in this space

e-plan

DP1065574 Ⓔ

OFFICE USE ONLY

SIGNATURES AND SEALS ONLY

FOR SIGNATURES AND SEALS SEE SIGNATURES FORM

THIS PLAN IS EXEMPT FROM SUBDIVISION CERTIFICATION PURSUANT TO A DECISION BETWEEN QUAP, RTA & LPI NSW - SEE 1997M6 ITEM 21 - LAND IN THIS PLAN COMPRISES ONLY ROAD OR ROAD AND RESIDUE

SEE SIGNATURES FORM

AUTHORISED OFFICER
ROADS & TRAFFIC AUTHORITY, NSW

Department of Lands Approval

(Authorised Officer) ... in approving this plan certify that all necessary approvals in regard to the allocation of the land shown hereon have been given.

Signature: .....

Date: .....

File Number: .....

Office: .....

Subdivision Certificate

I certify that the provisions of s 109J of the Environmental Planning and Assessment Act 1979 have been satisfied in relation to the proposed ... set out hereon

* (Insert 'Subdivision' or 'new road')

* Authorised Person/General Manager/Accredited Certifier

Consent Authority: .....

Date of Endorsement: .....

Accreditation No: .....

Subdivision Certificate No: .....

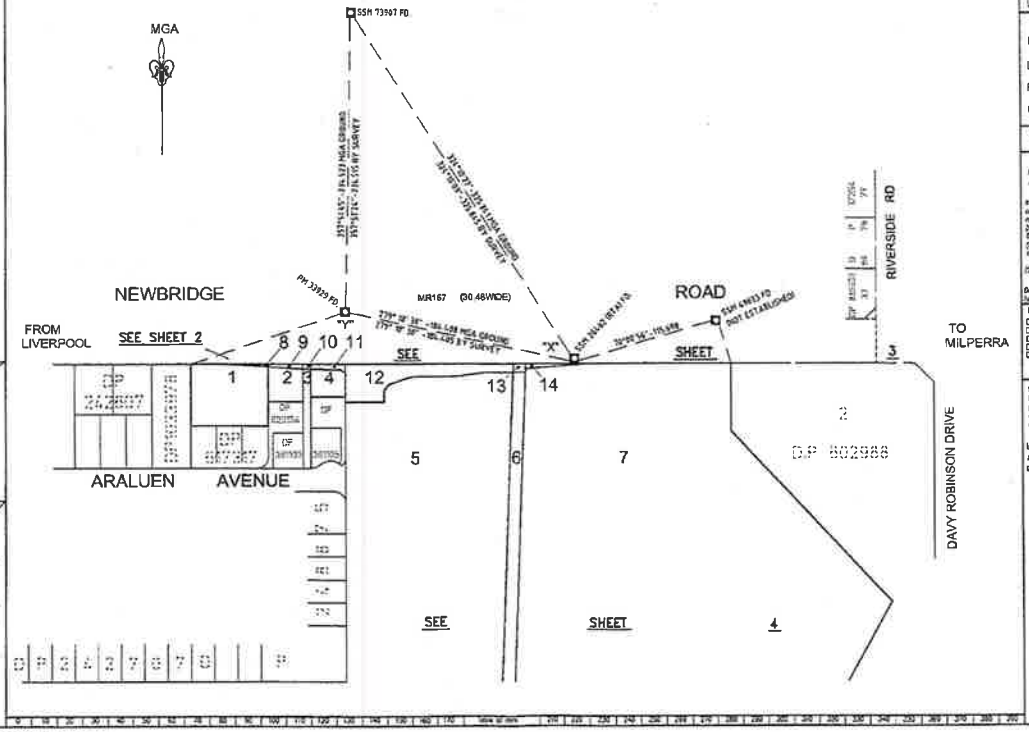
File No: .....

* Strike out inapplicable

SURVEYOR'S (PRACTICE) REGULATION 2001: CLAUSE 32(2)
M.G.A. COORDINATES

MARK	EASTING	NORTHING	ZONE	CLASS	ORDER
PM 33929	311 637.651	6243 901.364	56	B	2
SSM 26462	311 819.638	6243 871.255	56	C	4
SSM 73907	311 628.903	6244 135.452	56	B	2

SOURCE: M.G.A. COORDINATES ADOPTED FROM L.P.I.
DATED 17-NOV-2003
COMBINED SCALE FACTOR 1.000036



Registered: 24-03-2004

Title System: TORRENS

Purpose: ROADS ACT 1993

Ref. Map: U9137-22

Last Plan: DP261101, DP617317, DP336813, DP822923

PLAN OF: LAND TO BE ACQUIRED FOR THE PURPOSES OF THE ROADS ACT, 1993

Lengths are in metres. Reduction Ratio 1:2000

LGA: LIVERPOOL CITY

Locality: MOOREBANK

Parish: HOLSWORTHY

County: CUMBERLAND

This is sheet 1 of my plan in 4 sheets. (Delete if inapplicable)

Surveying Regulation, 2001

I, DAVID WILLIAM TWIG
of CLEMENT & REID PTY LTD
PO BOX 144 FAIRFIELD NSW 1860
a surveyor registered under the Surveying Act 2002, hereby certify that the survey represented in this plan is accurate, has been made in accordance with the Surveying Regulation, 2001 and was completed on 3-02-2004
The survey relates to LOTS 1 & 2 in DP1065574 & COMMENCE (here specify the land actually surveyed, or specify any land shown in the plan that is not the subject of the survey)

SEE SIGNATURES FORM

(Signature)
Registered Land Surveyor under the Surveying Act 2002
Datum Line: "E" "N"
Type: Urban/Rural

Plans used in preparation of survey / compilation

DP 3619	DP 247647	DP 247877	DP 1028211
DP 27754	DP 247697	DP 247963	DP 1028213
DP 35128	DP 247698	DP 261101	DP 1028913
DP 45111	DP 247699	DP 261102	DP 1047289
DP 1019774	DP 247701	DP 328274	DP 1047318

CONTINUED ON SHEET 2

PANEL FOR USE ONLY for statements of intention to dedicate public roads or to create public reserves, drainage reserves, easements, restrictions on the use of land or positive covenants.

LOTS 8-14 INCLUSIVE ARE REQUIRED FOR ROAD & AFTER CONSTRUCTION WILL BE DEDICATED AS PUBLIC ROAD UNDER SECTION 10 OF THE ROADS ACT, 1993

APPROVED

SEE SIGNATURES FORM

MANAGER, SURVEY SERVICES
OPERATIONS
ROADS & TRAFFIC AUTHORITY, NSW

SURVEYOR'S REFERENCE: 10575 (CHECKLIST) (SP3967 RTA) Edn 04/01 - CLAUSE 43 (2A)

WARNING CREASING OR FOLDING WILL LEAD TO REJECTION

RTA FILE 259.1076 RTA PLAN 9167 259 SS 0262

Req:R397690 /Doc:DP 1065574 P /Rev:14-Feb-2007 /Sts:SC.OK /Prt:15-Oct-2013 09:31 /Pgs:ALL /Seq:1 of 5
Ref:ALS /Src:T

PLAN FORM 3 (APPROVED FORM 5) To be used in conjunction with Plan Form 2

WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION

e-plan

DP1065574

Registered: 24-03-2004

This is sheet 2 of my plan in 4 sheets dated 3-FEB-2004

SEE SIGNATURES FORM

Registered Land Survey under the Surveying Act 2002

This is sheet of the plan of sheets covered by my Certificate No. of

Certified Person/Corporate Surveyor/Accredited Certifier

LGA: LIVERPOOL CITY

Locality: MOOREBANK

Parish: HOLSWORTHY

County: CUMBERLAND

For use where space is insufficient in any panel on Plan Form 2.

Plans used in preparation of survey

DP 534661	DP 622920
DP 565512	DP 625154
DP 582988	DP 733052
DP 615717	DP 819953
DP 617317	DP 1033978

*OFFICE USE ONLY

LOTS 1 & 8
LOT 601 D.P. 617317
C.T. 601/617317

LOTS 3 & 10
LOT 25 D.P. 261101
C.T. 25/261101

LOTS 2 & 9
LOT 122 D.P. 625154
C.T. 122/625154

LOTS 4 & 11
LOT 21 D.P. 261101
C.T. 21/261101

MGA

NEWBRIDGE

MR167 (30.48WIDE)

ROAD

SWIDROW

FROM NUWARRA ROAD

TO DAVY ROBINSON DRIVE

ARALUEN

AVENUE

SHEET 5

SEE SHEET 4

SCHEDULE OF SHORT BOUNDARIES		
No.	BEARING	DISTANCE
(A)	251° 49' 25"	5.985
(B)	272° 19' 15"	5.775
(C)	174° 47' 05"	8.685
(D)	352° 47' 05"	4.32
(E)	259° 28' 56"	5.575
(F)	267° 47' 15"	10.62
(G)	267° 47' 15"	2.125
(H)	289° 09' 45"	3.935
(J)	356° 47' 05"	3.845
(K)	86° 47' 05"	6.095
(L)	174° 47' 05"	4.045
(M)	289° 09' 45"	8.6

SCHEDULE OF SHORT & CURVED BOUNDARIES				
No.	BEARING	DISTANCE	ARC	RADIUS
(A)	277° 27' 05"	5.985		
(B)	176° 47' 05"	2.42		
(C)	277° 27' 05"	6.355		
(D)	86°47'05"	45.85		
(E)	86°47'05"	27.43		
(F)	86°47'05"	27.435		
(G)	84°47'35"	0.875	0.875	12.19
(H)	64°52'35"	7.79	7.93	12.19
(J)	82°25'25"	15.68	15.735	12.19
(K)	126°05'55"	2.825	2.83	12.19
(L)	174°47'05"	3.71		
(M)	117°47'05"	4.735		

(A) T 866515 EASEMENT FOR ELECTRICITY PURPOSES (DP 776651)
(B) DP261101 EASEMENT TO DRAIN WATER 15 WIDE
(C) DP261101 EASEMENT TO DRAIN WATER 2.5 WIDE
(G) BENEFITED BY EASEMENT TO DRAIN WATER 15 WIDE (DP261101)

Plan Drawing only to appear in this space

SURVEYOR'S REFERENCE: 102675 (SP3167 RTA)

RTA FILE 258 MNA RTA PLAN 0167 259 SS 2362

Req:R397690 /Doc:DP 1065574 P /Rev:14-Feb-2007 /Sts:SC.OK /Pct:15-Oct-2013 09:31 /Pgs:ALL /Seq:2 of 5
Ref:ALS /Src:TP

PLAN FORM 3 (APPROVED FORM 5) To be used in conjunction with Plan Form 2

WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION

e-plan

DP1065574

Registered: 24-03-2004

This is sheet 3 of my plan of 4 sheets dated 3-FEB-2004

SEE SIGNATURES FORM

Registered Land Survey under the Surveying Act 2002

This is sheet of the plan of sheets covered by my Certificate No. of

Authorised Person/General Manager/Accredited Certifier

LGA: LIVERPOOL CITY

Locality: MOOREBANK

Parish: HOLSWORTHY

County: CUMBERLAND

For use where space is insufficient in any panel on Plan Form 2.

*OFFICE USE ONLY

Retention Ratio: 1:1000

LOTS 5 & 12
LOT 2 D.P. 622920
C.T. 2/622920

LOTS 6 & 13
LOT 1 D.P. 235613
C.T. 1/235613

LOTS 7 & 14
LOT 1 D.P. 515738
C.T. 1/515738

SCHEDULE OF SHORT BOUNDARIES

No.	BEARING	DISTANCE
(1)	178° 54' 05"	4.165
(2)	178° 54' 05"	12.491
(3)	268° 54' 18"	10.065
(4)	358° 54' 05"	6.57
(5)	88° 47' 55"	10.065
(6)	178° 54' 05"	6.595
(7)	243° 49' 50"	8.45
(8)	263° 49' 50"	8.315
(9)	269° 54' 45"	5.95
(10)	251° 49' 35"	5.985
(11)	242° 19' 15"	5.715
(12)	176° 47' 05"	8.885

MGA

NEWBRIDGE ROAD

MR167 (30.48 WIDE)

RIVERSIDE ROAD

DAVY ROBINSON DRIVE

ARALUEN AVENUE

ADJOINS

FROM NUWARRA ROAD

11 | 12 1911m² | 13 66.2m² | 14 99.2m²

4 | 5 | 6 | 7 | 2 DP 602988

SEE SHEET 4

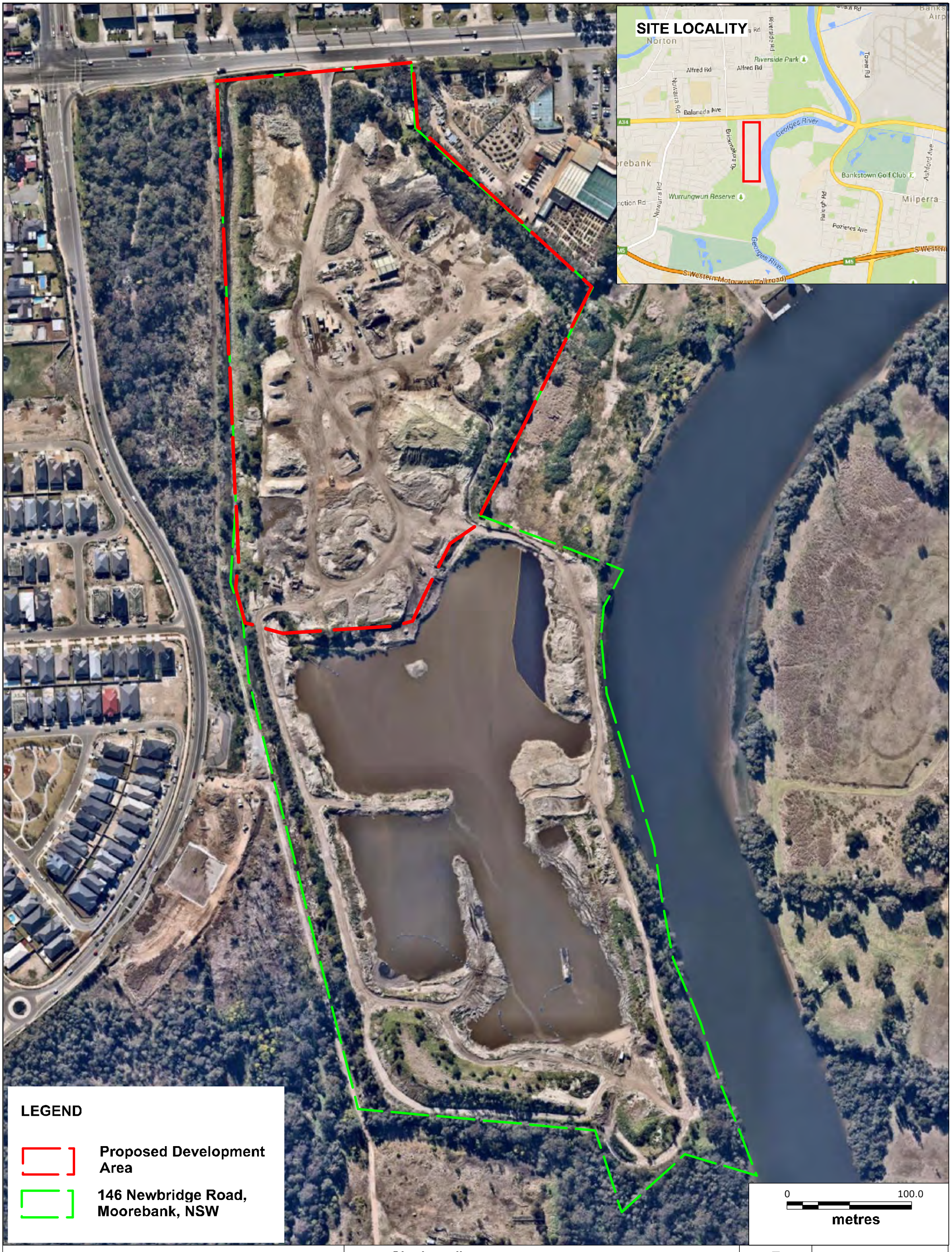
Plan Drawing only to appear in this space

SURVEYOR'S REFERENCE: 102675 (SP167 RTA)

RTA FILE 259.1696 RTA PLAN 0167 259 55 0282

Req:R397690 /Doc:DP 1065574 P /Rev:14-Feb-2007 /Sts:SC.OK /Prt:15-Oct-2013 09:31 /Pgs:ALL /Seq:3 of 5
Ref:ALS /Src:TS

Douglas Partners (2 September 2016)
DSI



Douglas Partners
Geotechnics / Environment / Groundwater

TITLE: Site Locality
Detailed Site Investigation
146 Newbridge Road, Moorebank, NSW

MGA

OFFICE: Sydney
DRAWN BY: MJC
DATE: 14.10.2015

CLIENT: Benedict Industries Pty Ltd

PROJECT No: 71459.03

DRAWING No: 1

REVISION: A

SCALE: As shown

Douglas Partners
Geotechnics / Environment / Groundwater

TITLE: Test Locations
Detailed Site Investigation
146 Newbridge Road, Moorebank, NSW

MGA

OFFICE: Sydney
DRAWN BY: MJC
DATE: 17.2.2016

CLIENT: Benedict Industries Pty Ltd
PROJECT No: 71459.03
DRAWING No: 2
REVISION: A
SCALE: As shown

Peak Methane Concentration %

60

40

20

0

Where a shallow and deep well are present at the one location, the well with the highest methane peak has been used to generate the contours.

Well ID	Well ID	Well ID
BH1	JK103	JK115
JKBH/MW16	JK104	JK119
JKBH/MW17	JK106	
JKBH/MW9	JK110	
JK101	JK113	
JK102	JK114	

LEGEND

- Proposed Development Area
- Surface Sample
- a Replacement Well
- b Shallow Gas Well
- Borehole / Gas Well
- Monitoring Well
- Borehole
- Borehole (DP, 2002)
- Borehole (EIS, 2015)
- Borehole / Gas Well (EIS, 2015)
- Monitoring Well Location (EIS, 2015)

JKBH/MW1, JK2, BH1, BH5, BH6, BH201, JK3, BH207, BH206, BH202, BH204, BH205, JK4, BH203, BH208, BH2, JK119, BH7, JK6, JK104, BH209, JK5, JK101, JK102, BH211, BH211b, BH210, JK103a, JK103b, BH9, BH212, JKBH/MW107a, JK107b, JK106, JK8, BH213, JKBH/MW9, BH214, JKBH/MW7, BH/MW216, BH215, BH3, BH8, JK10, JK110, BH10, JK11, JK113, SS217, BH/MW218, JK118a, JK118b, JK12, SS219, JK115, BH220, JK117, BH11, JK14, JK114, JK114b, BH4, JK13, JK116, BH221, BH224, JK15, JKBH/MW16, BH225, BH222, BH12, BH223

0 100.0 metres

Douglas Partners Geotechnics / Environment / Groundwater	TITLE: Peak Methane Concentration Contours 19/8/15 Detailed Site Investigation 146 Newbridge Road, Moorebank, NSW	N MGA	OFFICE: Sydney DRAWN BY: MJC DATE: 17.02.2016
CLIENT: Benedict Industries Pty Ltd	PROJECT No: 71459.03	DRAWING No: 3	REVISION: A / SCALE: As shown

Peak Methane Concentration %

60

40

20

0

Where a shallow and deep well are present at the one location, the well with the highest methane peak has been used to generate the contours.

Wells used to generate the contours

Well ID	Well ID	Well ID	Well ID
BH/MW216	JK101	JK110	JK119
BH/MW218	JK102	JK113	JKBH/MW7
BH202	JK103b	JK114	JKBH/MW9
BH211	JK104	JK115	
BH223	JK106	JKBH/MW16	
JKBH/MW1	JK107b	JK118a	

LEGEND

- Proposed Development Area
- Surface Sample
- a Replacement Well
- b Shallow Gas Well
- Borehole / Gas Well
- Monitoring Well
- Borehole
- Borehole (DP, 2002)
- Borehole (EIS, 2015)
- Borehole / Gas Well (EIS, 2015)
- Monitoring Well Location (EIS, 2015)

JKBH/MW1, JK2, BH1, BH5, BH6, BH201, JK3, BH207, BH206, BH202, BH204, BH205, JK4, BH203, BH208, BH2, JK119, BH7, JK104, JK6, BH209, JK5, JK101, JK102, BH211, BH211b, BH210, JK103a, JK103b, BH9, BH212, JKBH/MW107a, JK107b, BH213, JKBH/MW9, BH214, JK106, JK8, JKBH/MW7, BH/MW216, BH215, BH3, BH8, JK10, JK11, BH10, JK110, JK113, SS217, BH/MW218, JK118a, JK118b, JK12, SS219, JK115, BH220, BH11, JK117, JK14, JK114, JK114b, BH4, JK13, JK116, BH221, BH224, JK15, JKBH/MW16, BH225, BH222, BH12, BH223

0 100.0 metres

Douglas Partners Geotechnics / Environment / Groundwater	TITLE: Peak Methane Concentration Contours 1/10/15 Detailed Site Investigation 146 Newbridge Road, Moorebank, NSW	N MGA	OFFICE: Sydney DRAWN BY: MJC DATE: 17.02.2016
CLIENT: Benedict Industries Pty Ltd	PROJECT No: 71459.03	DRAWING No: 4	REVISION: A / SCALE: As shown

Peak Methane Concentration %

60
40
20
0

Where a shallow and deep well are present at the one location, the well with the highest methane peak has been used to generate the contours.

Wells used to generate the contours

Well ID	Well ID	Well ID	Well ID
BH/MW216	BH225	JK106	JK118a
BH/MW218	JKBH/MW1	KBH/MW107	JK119
BH202	JK101	JK110	JKBH/MW16
BH211	JK102	JK113	JKBH/MW7
BH223	JK103b	JK114	JKBH/MW9
BH224	JK104	JK115	

LEGEND

- Proposed Development Area
- Surface Sample
- a Replacement Well
- b Shallow Gas Well
- Borehole / Gas Well
- Monitoring Well
- Borehole
- Borehole (DP, 2002)
- Borehole (EIS, 2015)
- Borehole / Gas Well (EIS, 2015)
- Monitoring Well Location (EIS, 2015)

0 100.0
metres

Douglas Partners
Geotechnics / Environment / Groundwater

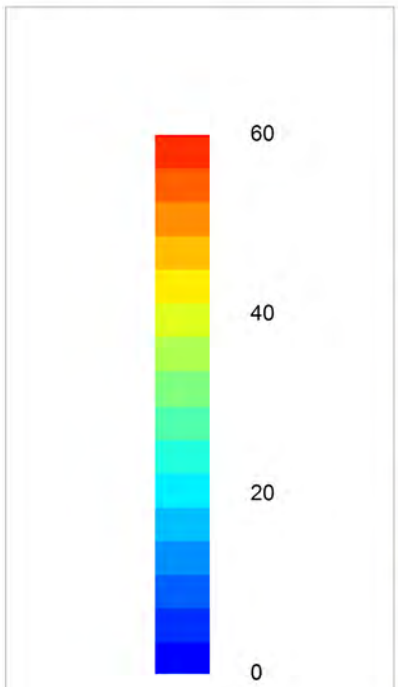
TITLE: Peak Methane Concentration Contours 27/10/15
Detailed Site Investigation
146 Newbridge Road, Moorebank, NSW

MGA

OFFICE: Sydney
DRAWN BY: MJC
DATE: 17.02.2016

CLIENT: Benedict Industries Pty Ltd | PROJECT No: 71459.03 | DRAWING No: 5 | REVISION: A | SCALE: As shown

Peak Methane Concentration %



Where a shallow and deep well are present at the one location, the well with the highest methane peak has been used to generate the contours.

Wells used to generate the contours

Well ID	Well ID	Well ID	Well ID
BH/MW216	JKBH/MW1	JK117	JK119
BH202	JK101	JK113	JKBH/MW7
BH211a	JK103b	JK114	JKBH/MW9
BH223	JK106	JK114b	
BH224	JK107b	JK115	
BH225	JK104	JKBH/MW16	

LEGEND

- Proposed Development Area
- Surface Sample
- a Replacement Well
- b Shallow Gas Well
- Borehole / Gas Well
- Monitoring Well
- Borehole
- Borehole (DP, 2002)
- Borehole (EIS, 2015)
- Borehole / Gas Well (EIS, 2015)
- Monitoring Well Location (EIS, 2015)

0 100.0 metres

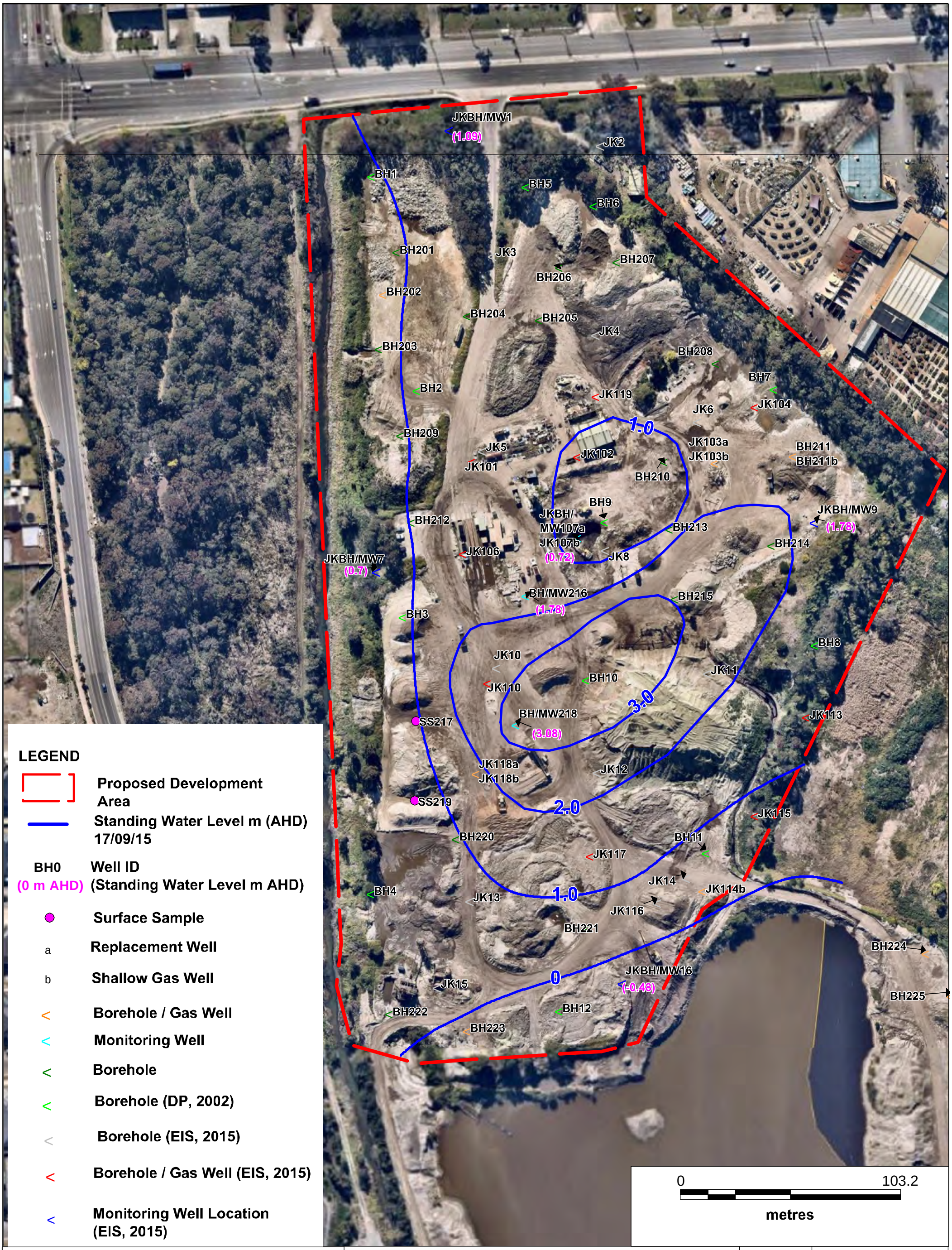
N MGA

Douglas Partners
Geotechnics / Environment / Groundwater

TITLE: Peak Methane Concentration Contours 10/2/16
Detailed Site Investigation
146 Newbridge Road, Moorebank, NSW

OFFICE: Sydney
DRAWN BY: MJC
DATE: 17.02.2016

CLIENT: Benedict Industries Pty Ltd | PROJECT No: 71459.03 | DRAWING No: 6 | REVISION: A | SCALE: As shown

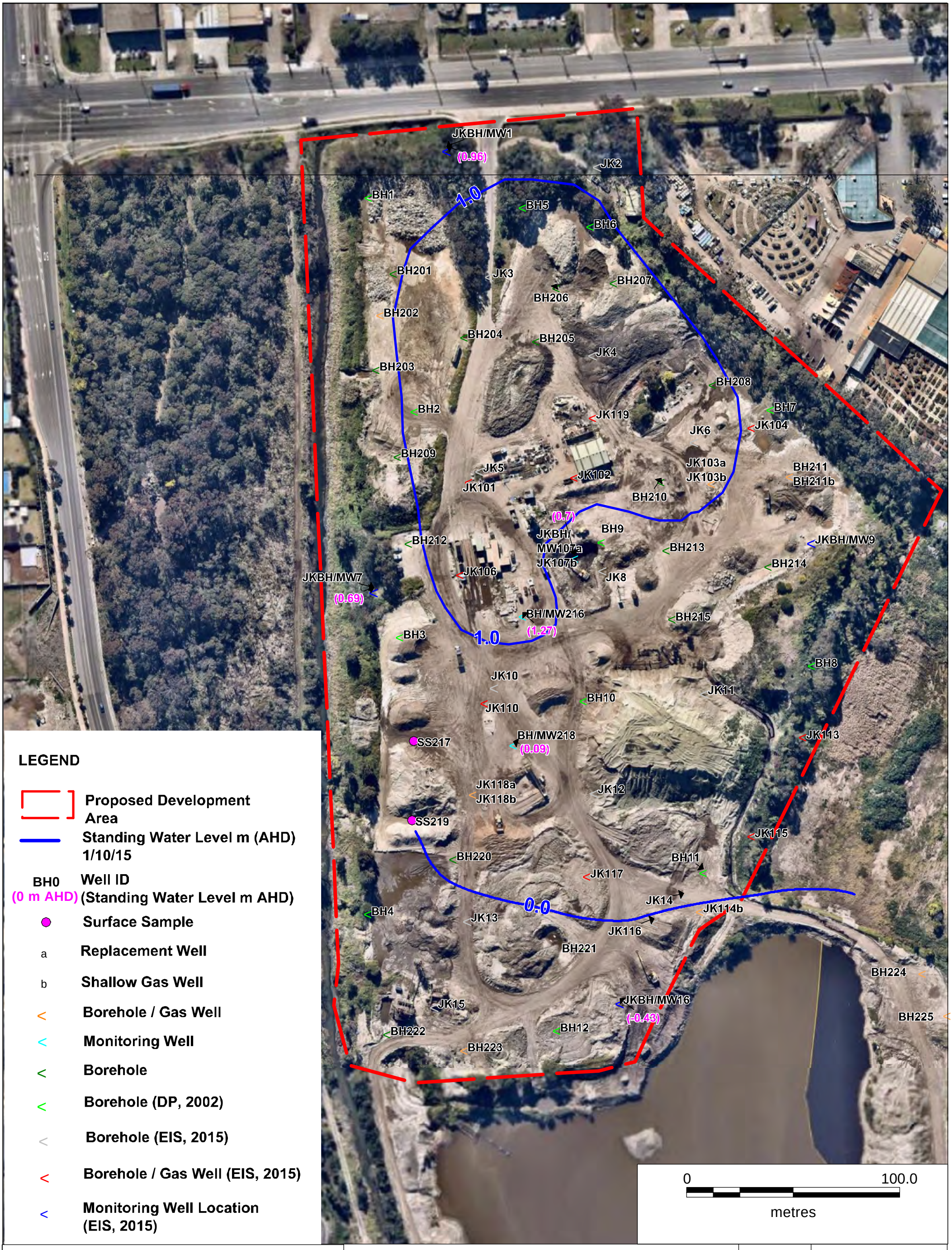


Douglas Partners
Geotechnics / Environment / Groundwater

TITLE: Standing Water Level (17.09.15)
Detailed Site Investigation
146 Newbridge Road, Moorebank, NSW

OFFICE: Sydney
DRAWN BY: BAH
DATE: 19.02.16

CLIENT: Benedict Industries Pty Ltd
PROJECT No: 71459.03
DRAWING No: 7
REVISION: A
SCALE: As shown



LEGEND

- Proposed Development Area
- Standing Water Level m (AHD) 1/10/15
- BH0 (0 m AHD) — Well ID (Standing Water Level m AHD)
- Surface Sample
- a — Replacement Well
- b — Shallow Gas Well
- Borehole / Gas Well
- Monitoring Well
- Borehole
- Borehole (DP, 2002)
- Borehole (EIS, 2015)
- Borehole / Gas Well (EIS, 2015)
- Monitoring Well Location (EIS, 2015)

Douglas Partners
Geotechnics / Environment / Groundwater

TITLE: Standing Water Level (1.10.15)
Detailed Site Investigation
146 Newbridge Road, Moorebank, NSW

MGA

OFFICE: Sydney
DRAWN BY: BAH
DATE: 18.02.2016

CLIENT: Benedict Industries Pty Ltd
PROJECT No: 71459.03
DRAWING No: 8
REVISION: A
SCALE: As shown

Douglas Partners
Geotechnics / Environment / Groundwater

TITLE: Surface Water Sample Locations
Detailed Site Investigation
146 Newbridge Road, Moorebank, NSW

MGA

OFFICE: Sydney
DRAWN BY: MJC
DATE: 19.02.2016

CLIENT: Benedict Industries Pty Ltd
PROJECT No: 71459.03
DRAWING No: 9
REVISION: A
SCALE: As shown

Photo 1 – Installed JK114b (shallow gas well) adjacent to JK114

Photo 2 – Stockpiles in the vicinity of BH220

Douglas Partners Geotechnics / Environment / Groundwater	**Detailed Site Investigation** **146 Newbridge Road** **Moorebank**	PROJECT: 71459.03 PLATE No: 1 REV: 0
	CLIENT: Benedict Industries Pty Ltd	DATE: 14/03/16

Photo 3 – Installed BH211a (shallow gas well) adjacent to BH211

Photo 4 – Typical fill composition (trial remediation excavation at former JK107)

Douglas Partners Geotechnics / Environment / Groundwater	**Detailed Site Investigation** **146 Newbridge Road** **Moorebank**	PROJECT: 71459.03 PLATE No: 2 REV: 0
	CLIENT: Benedict Industries Pty Ltd	DATE: 14/03/16

Photo 5 – Looking north from the dredge pond at the southern site boundary

Photo 6 – Start of trial remediation excavation near JK102

Douglas Partners Geotechnics / Environment / Groundwater	**Detailed Site Investigation** **146 Newbridge Road** **Moorebank**	PROJECT:	71459.03
		PLATE No:	3
		REV:	0
	CLIENT: Benedict Industries Pty Ltd	DATE:	14/03/16

Photo 7 – Metal cable in fill at BH201 wrapped around auger

Photo 8 – Fill excavated from trial remediation excavation at former JK107

Douglas Partners Geotechnics / Environment / Groundwater	**Detailed Site Investigation** **146 Newbridge Road** **Moorebank**	PROJECT: 71459.03 PLATE No: 4 REV: 0
	CLIENT: Benedict Industries Pty Ltd	DATE: 14/03/16

No fragments of ACM were observed in drill cuttings whilst drilling.

Selected photographs taken during the various components of fieldwork are included in Appendix A.

13.2 Field Screening Results for Soil

Replicate soil samples collected in zip-lock plastic bags were allowed to equilibrate under ambient temperatures before screening for total photoionisable compounds (i.e. VOC) using a calibrated PID. Results of sample screening are shown on borehole logs presented in Appendix E. The PID readings were all generally low ranging between <5 ppm to 11 ppm. The screening results suggest the general absence of gross VOC contamination. The PID calibration certificate is presented in Appendix F.

13.3 Landfill Gas Sampling Results

Landfill gas monitoring was undertaken on 19 August 2015, 1 October 2015, 27 October 2015 and 10 February 2016. The results, along with the CSV and CGS are summarised in the following tables.

Table 13: Landfill Gas Sampling Results for 19/08/15

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1,2]
JKBH/MW1	0.2	1.3	<0.01	1.7	<0.01	2
JKBH/MW16	0.2	22	0.04	6.7	0.01	3
JKBH/MW7	0.2	14	0.03	9.6	0.02	2
JKBH/MW9	0.3	20.9	0.06	6.1	0.02	3
JK101	0.2	14	0.03	7.7	0.02	2
JK102	0.1	13.2	0.01	7.8	0.01	2
JK103	0.1	0.8	<0.01	1.9	<0.01	1
JK104	0.1	0.5	<0.01	3.1	<0.01	1
JK106	0.2	16.1	0.03	4.2	0.01	2
JK110	0.4	23.2	0.09	6.3	0.03	3
JK113	0.1	9.9	0.01	15.9	0.02	2
JK114	0.2	24.6	0.05	8	0.02	3
JK115	0.2	8.6	0.02	11.1	0.02	2
JK119	0.9	10.5	0.09	6.7	0.06	2
Max Value	**0.9**	**24.6**	**0.22**	**15.9**	**0.14**	**3**

Notes to table:

1. Where methane >1% or CO_2 >5% CGS has been increased to Situation 2 as per Table 6 of NSW EPA (2012)
2. Where methane >20% CGS has been increased to Situation 3 as per Table 7 of NSW EPA (2012)

Atmospheric pressure start 1024 mb end 1024 mb – pressure steady

Table 14: Landfill Gas Sampling Results for 1/10/15

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1,2]
BH/MW216	0.2	16	0.03	6.3	0.01	2
BH/MW218	0.2	24.2	0.05	10.2	0.02	3
BH202	0.2	1.1	<0.01	12.4	0.02	2
BH211	0.3	0	<0.01	1.5	<0.01	1
BH211b	-	0	-	3.7	-	-
BH223	0.2	1.1	<0.01	3.4	0.01	2
JKBH/MW1	0.2	0	<0.01	2	<0.01	1
JKBH/MW7	0.2	4.1	0.01	7	0.01	2
JKBH/MW9	0.1	0	<0.01	2.9	<0.01	1
JK101	0.3	14.3	0.04	7.3	0.02	2
JK102	0.3	12	0.04	6.4	0.02	2
JK103a	0.7	0.7	<0.01	3.1	0.02	1
JK103b	0.3	1.4	<0.01	1.2	<0.01	2
JK104	0.2	0	<0.01	4	0.01	1
JK106	0.4	13.2	0.05	4.5	0.02	2
JKBH/MW107a	0.4	3	0.01	0.2	<0.01	2
JK107b	0.2	10.2	0.02	5.6	0.01	2
JK110	0.5	19	0.1	6.3	0.03	2
JK113	0.4	6	0.02	14.5	0.06	2
JK114	0.2	22.2	0.04	5.3	0.01	3
JK114b	0.2	20.2	0.04	7.2	0.01	3
JK115	0.2	0.6	<0.01	9.1	0.02	1
JKBH/MW16	0.3	8.5	0.03	6.5	0.02	2
JK118a	0.3	17.3	0.05	5.7	0.02	2
JK118b	0.2	12.9	0.03	4.5	0.01	2
JK119	0.7	11.9	0.08	3.1	0.02	2
Max Value	**0.7**	**24.2**	**0.17**	**14.5**	**0.10**	**3**

Notes to table:

1. Where methane >1% or CO_2 >5% CGS has been increased to Situation 2 as per Table 6 of NSW EPA (2012)
2. Where methane >20% CGS has been increased to Situation 3 as per Table 7 of NSW EPA (2012)

Atmospheric pressure start 1023 end1032 mb – pressure increasing

Table 15: Landfill Gas Sampling Results for 27/10/15

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1,2]
BH/MW216	0.1	14.7	0.01	6.7	0.01	2
BH/MW218	-0.2	32.5	<0.01	13.8	<0.01	3
BH202	0.4	0.8	<0.01	13.2	0.05	2
BH211	0.4	0	<0.01	1.7	0.01	1
BH211b	0.3	0	<0.01	3.9	0.01	1
BH223	0.6	3.7	0.02	8.2	0.05	2
BH224	0.4	0	<0.01	10.3	0.04	2

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1,2]
BH225	0.2	0	<0.01	9.6	0.02	2
JKBH/MW1	0.2	0	<0.01	2.2	<0.01	1
JKBH/MW7	0.3	8.5	0.03	3.2	0.01	2
JKBH/MW9	0.2	0	<0.01	3.2	0.01	1
JKBH/MW16	0.2	2.8	0.01	8.3	0.02	2
JK101	0.3	14.1	0.04	10.2	0.03	2
JK102	0.2	13.2	0.03	6.6	0.01	2
JK103a	0.4	0	<0.01	1.7	0.01	1
JK103b	0.6	1.1	0.01	0.7	<0.01	2
JK104	0.5	0	<0.01	1.7	0.01	1
JK106	0.4	10	0.04	3.3	0.01	2
JKBH/MW107a	0.1	15	0.02	5.2	0.01	2
JK107b	0.2	14.4	0.03	2.9	0.01	2
JK110	0.1	25	0.03	6.4	0.01	3
JK113	0.2	1	<0.01	4.5	0.01	1
JK114	0.1	21.2	0.02	6.4	0.01	3
JK114b	0.3	19.1	0.06	7.5	0.02	2
JK115	0.3	7.2	0.02	7	0.02	2
JK118a	0.3	15.2	0.05	5.1	0.02	2
JK118b	0.3	14.5	0.04	4.8	0.01	2
JK119	0.6	16.2	0.1	5.8	0.03	2
Max Value	**0.6**	**32.5**	**0.20**	**13.8**	**0.08**	**3**

Notes to table:

1. Where methane >1% or CO_2 >5% CGS has been increased to Situation 2 as per Table 6 of NSW EPA (2012)
2. Where methane >20% CGS has been increased to Situation 3 as per Table 7 of NSW EPA (2012)

Atmospheric pressure start 1022 mb to 1026 mb – pressure increasing

Table 16: Landfill Gas Sampling Results for 10/02/16

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1,2]
BH/MW216	0.3	16.1	0.05	5.2	0.02	2
BH202	0.2	1.1	<0.01	3.4	0.01	2
BH211a	0.1	1.1	<0.01	5	0.01	2
BH211b	0.2	0.5	<0.01	1.9	<0.01	1
BH223	0.1	3.7	<0.01	10	0.01	2
BH224	0.3	0.1	<0.01	14.4	0.04	2
BH225	0.3	0.2	<0.01	12.1	0.04	2
JKBH/MW1	0.1	0.2	<0.01	3.4	<0.01	1
JKBH/MW7	0	0.5	<0.01	6.8	<0.01	2
JKBH/MW9	0.2	17.5	0.04	23.8	0.05	2
JKBH/MW16	0.3	0.1	<0.01	9.7	0.03	2
JK101	0.3	15.7	0.05	11.4	0.03	2
JK103	6.8	1.7	0.12	0.6	0.04	2

Well ID	Flow Rate Peak	Methane Peak %	GSV	CO_2 Peak %	GSV	CGS [1,2]
JK103a	0.3	0.9	<0.01	0.2	<0.01	1
JK103b	0.3	5.1	0.02	2.6	0.01	2
JK106	0	14.2	<0.01	6.7	<0.01	2
JKBH/MW107a	0.3	16.4	0.05	0.9	<0.01	2
JK107b	0.2	17.3	0.03	3.8	0.01	2
JK104	0.2	0.5	<0.01	2.3	<0.01	1
JK113	0.1	0.1	<0.01	1	<0.01	1
JK114	0.2	25.3	0.05	4.7	0.01	3
JK114b	0.3	0.1	<0.01	0	<0.01	1
JK115	0.2	0.1	<0.01	0	<0.01	1
JK117*	0.6	11.7	0.07	6.8	0.04	2
JK119	0.4	21.3	0.09	6.9	0.03	3
Max Value	**6.8**	**25.3**	**1.72**	**23.8**	**1.62**	**3**

Notes to table:

1. Where methane >1% or CO_2 >5% CGS has been increased to Situation 2 as per Table 6 of NSW EPA (2012)
2. Where methane >20% CGS has been increased to Situation 3 as per Table 7 of NSW EPA (2012)

*JK117 was inaccessible for previous monitoring events due to stockpile placement

Atmospheric pressure start 1016 mb end 1011 mb – pressure decreasing

The peak methane concentration data for each of the landfill gas monitoring events have been used to generate concentration contours on the following drawings in Appendix A:

- Drawing 3 - Peak Methane Concentration Contours 19/08/15;
- Drawing 4 - Peak Methane Concentration Contours 1/10/15;
- Drawing 5 - Peak Methane Concentration Contours 27/10/15; and
- Drawing 6 - Peak Methane Concentration Contours 10/02/16.

Field sampling records are included in Appendix G.

Where a shallow and deep gas well is present at the one location, the well with the highest methane peak was used to generate the contours. It should also be noted that some wells have been destroyed due to the site owner undertaking a further trial remediation excavation at the south-western portion of the site.

13.4 Groundwater Levels

Groundwater wells, including those installed by J&K, were surveyed using a dGPS. Groundwater levels were gauged on 17 September 2016 using an electronic oil/water interface meter prior to developing the wells. The measured water levels are shown in the following two tables.

Table 17: Summary of Groundwater Level Measurements 17/09/15 (Well Development)

Well ID	Ground Level * m (AHD)	Top of Casing* m (AHD)	SWL m (bgl)	SWL m (AHD)
BH/MW216	7.27	7.99	5.49	1.78
BH/MW218	7.69	8.39	4.61	3.08
JKBH/107a	7.15	7.85	6.43	0.72
JKBH/MW1	2.85	3.32	1.76	1.09
JKBH/MW7	6.51	7.09	5.81	0.70
JKBH/MW9	6.57	7.10	4.79	1.78
JKBH/MW16	5.61	5.86	6.09	-0.48

Notes to table:
*Surveyed by dGPS and top of casing measured from ground level
AHD – Australian Height Datum
SWL – standing water level
bgl – below ground level

Table 18: Summary of Groundwater Level Measurements 1/10/15 (Well Sampling)

Well ID	Ground Level * m (AHD)	Top of Casing* m (AHD)	SWL m (bgl)	SWL m (AHD)
BH/MW216	7.27	7.99	6.00	1.27
BH/MW218	7.69	8.39	7.60	0.09
JKBH/107a	7.15	7.85	6.45	0.70
JKBH/MW1	2.85	3.32	1.89	0.96
JKBH/MW7#	6.51	7.09	5.82	0.69
JKBH/MW9#	6.57	7.10	-	-
JKBH/MW16	5.61	5.86	6.04	-0.43

Notes to table:
*Surveyed by dGPS and top of casing measured from ground level
AHD – Australian Height Datum
SWL – standing water level
bgl – below ground level
well was bent and could not fit bailer or pump in

Based on the groundwater level measurements, groundwater was flowing to the north towards Newbridge Road, east towards the Georges River, to the south towards the ponds and to the west towards the open drainage channel. The inferred groundwater level contours are shown on Drawing 7 and 8, Appendix A. Essentially groundwater appears to be mounded within the site and flowing radially towards adjacent water bodies and low points. This is to be expected as the permeability of fill at the site is likely to be higher than the natural landforms surrounding the site and water bodies are located to the east, south and west of the site.

Field parameters were measured whilst sampling, however, there was insufficient water in BH/MW218. The field parameters are summarised in the following table.

Table 19: Summary of Field Parameters (Groundwater and Surface Water)

Well / Sample ID	Temp. (°C)	DO (mg/L)	TDS (ppm)	EC* (µS/cm)	pH	Redox (mV)
Groundwater Samples						
BH/MW216	20.0	2.16	7200	11 250	6.84	-83
BH/MW218	-	-	-	-	-	-
JKBH/107a	24.3	3.33	2140	3344	6.98	-56
JKBH/MW1	17.5	3.45	3080	4813	6.95	-34
JKBH/MW7#	-	-	-	-	-	-
JKBH/MW9#	-	-	-	-	-	-
JKBH/MW16	25.0	2.09	5940	9281	5.43	-37
Surface Water Samples						
SW1	21.1	7.15	11640	18 188	7.55	40
SW2	25.4	0.43	6320	9875	7.20	-68
SW3	19.5	2.31	3290	5141	7.10	-15

Notes to table:
*Calculated from TDS result
well was bent and could not fit bailer or pump in

For groundwater, temperature ranged between 17.5 and 25.0°C. There was some dissolved oxygen (2.09 to 3.45 mg/L) measured in all wells. The pH of the groundwater was slightly acidic ranging between 5.43 and 6.98 pH units. The electrical conductivity ranged between 3344 and 11 250 µs/cm reflecting values typical of brackish water. Redox potential (Eh) ranged between -83 and -37 mV.

No LNAPL was observed whilst sampling.

Three discrete surface water bodies were sampled and the locations are shown on Drawing 9, Appendix A. For surface water, temperature ranged between 19.5 and 25.4°C. There was some dissolved oxygen (0.43 to 7.15 mg/L) measured in all locations. The pH of the surface water was slightly acidic ranging between 7.10 and 7.55 pH units. The electrical conductivity ranged between 5141 and 18 188 µs/cm reflecting values typical of brackish to saline water. Redox potential (Eh) ranged between -15 and 40 mV.

13.5 Analytical Laboratory Results

Summary results tables including analytical results and relevant assessment criteria are appended as follows:

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Table 1: Summary Results for Metals

Test Location ID	Depth (m)	As [3]	Cd	Cr	Cu	Pb [4]	Hg [5,6]	Ni	Zn	Mn
BH/MW216	0.1-0.2	<4	0.8	13	28	54	<0.1	9	130	200
BH/MW216	3.9-4.35	7	<0.4	21	26	66	0.1	11	83	230
BH/MW216	5.9-6.35	17	<0.4	21	23	51	<0.1	9	170	130
BH/MW218	0.9-1.35	<4	<0.4	4	2	4	<0.1	3	13	68
BH/MW218	2.9-2.35	5	<0.4	14	46	37	<0.1	13	64	110
BH/MW218	5.9-6.35	5	<0.4	15	7	11	<0.1	2	3	5
BH201	0.1-0.2	<4	0.4	7	32	56	<0.1	5	110	61
BH201	0.9-1.35	4	1	15	79	110	0.1	9	170	160
BH202	0.9-1.35	<4	<0.4	45	47	13	<0.1	11	32	1500
BH202	1.9-2.35	6	0.5	26	50	170	0.1	15	140	180
BH203	0.1-0.2	<4	<0.4	7	46	44	<0.1	5	100	87
BH203	0.9-1.35	7	<0.4	14	19	36	<0.1	6	70	40
BH203	2.9-3.35	7	0.5	15	160	860	0.2	14	380	150
BH204	0.1-0.2	<4	<0.4	5	24	47	<0.1	3	83	44
BH204	1.9-2.35	5	<0.4	15	56	72	<0.1	5	140	130
BH204	3.9-4.35	7	<0.4	11	64	150	0.1	16	210	80
BH205	0.9-1.35	<4	<0.4	46	15	12	<0.1	19	25	92
BH205	2.9-3.35	6	<0.4	9	7	13	<0.1	2	5	8
BH205	3.9-4.35	8	<0.4	15	15	15	<0.1	2	15	9
BH206	0.1-0.2	5	<0.4	17	30	140	0.2	15	140	160
BH206	0.9-1.35	8	<0.4	15	22	16	<0.1	11	30	450
BH206	2.35-2.9	<4	<0.4	16	8	25	<0.1	3	9	37
BH206	4.35-4.9	17	<0.4	19	10	32	<0.1	11	30	120
BH207	0.1-0.2	<4	<0.4	25	53	16	<0.1	26	40	490
BH207	0.9-1.35	5	<0.4	15	18	21	<0.1	6	55	73
BH208	1.9-2.35	<4	<0.4	18	21	55	<0.1	13	470	190
BH208	0.9-1.35	<4	<0.4	10	19	32	<0.1	5	44	42
BH208	3.9-4.35	7	<0.4	30	13	26	<0.1	5	16	6
BH209	0.1-0.2	6	<0.4	18	82	98	0.1	13	210	270
BH209	0.9-1.35	<4	<0.4	21	37	35	<0.1	10	75	450
BH209	1.9-2.35	5	<0.4	17	55	35	<0.1	9	66	150
BH209	3.9-4.35	7	0.4	19	25	150	<0.1	10	140	190
BH210	0.1-0.2	<4	<0.4	10	63	11	<0.1	14	33	280
BH210	2.0-2.45	5	<0.4	12	4	10	<0.1	2	5	15
BH211	0.1-0.2	<4	<0.4	12	19	21	<0.1	9	54	200
BH211	0.9-1.35	<4	<0.4	10	5	10	<0.1	2	4	18
BH211	2.9-2.35	4	<0.4	17	3	24	<0.1	4	6	42
BH212	0.1-0.2	<4	<0.4	28	67	16	<0.1	11	39	800
BH212	2.9-3.35	6	0.6	16	41	130	0.1	9	240	120
BH213	0.1-0.2	8	<0.4	19	21	19	<0.1	14	43	200
BH213	2.9-3.35	5	<0.4	13	4	18	<0.1	3	27	27
BH214	0.1-0.2	<4	<0.4	18	46	17	<0.1	11	48	240
BH214	2.2-2.65	<4	<0.4	6	14	54	<0.1	8	33	67
BH215	0.9-1.35	<4	<0.4	9	10	28	<0.1	4	50	61
BH215	1.9-2.35	<4	<0.4	4	17	19	<0.1	2	11	13
BH220	0.1-0.2	4	0.8	16	47	190	0.2	11	290	610
BH221	0.1-0.2	<4	<0.4	11	14	30	0.1	4	69	110
BH221	1.9-2.35	4	<0.4	14	16	92	<0.1	6	78	120
BH221	2.9-3.35	7	0.6	15	45	620	0.2	9	290	180
BH221	3.9-4.35	17	0.7	25	24	86	<0.1	8	150	130
BH222	0.1-0.2	<4	<0.4	16	32	22	<0.1	26	52	560
BH222	0.9-1.35	<4	<0.4	12	85	22	<0.1	12	77	220
BH223	2.0-2.45	5	<0.4	17	540	79	0.2	10	110	190
JK103a	0.1-0.2	<4	<0.4	73	78	6	<0.1	11	26	2300
JK103a	1.9-2.35	<4	<0.4	4	18	31	<0.1	1	14	51
JK103a	2.9-3.35	<4	<0.4	12	22	49	<0.1	9	66	170
JK103a	5.9-6.35	<4	<0.4	3	3	3	<0.1	<1	1	1
JK107a	0.1-0.2	<4	<0.4	9	19	38	<0.1	5	79	87
JK107a	1.9-2.35	10	<0.4	17	29	98	<0.1	10	110	89
JK107a	7.9-8.35	<4	<0.4	5	5	6	<0.1	1	2	2
JK107a	8.9-9.35	<4	<0.4	3	3	6	<0.1	<1	4	3
JK118a	0.1-0.2	<4	<0.4	4	17	15	<0.1	5	25	110
JK118a	1.9-2.35	<4	<0.4	9	12	63	<0.1	6	87	120
JK118a	4.9-5.35	<4	<0.4	15	15	10	<0.1	2	9	9
SS217	0.0-0.1	5	<0.4	9	18	25	<0.1	6	55	120
SS219	0.0-0.1	<4	<0.4	9	24	45	<0.1	7	80	120
BD1/070815	-	8	0.6	13	49	35	<0.1	43	160	340
BD2/080915	-	5	<0.4	9	42	90	0.1	6	75	79
BD3/090915	-	4	0.5	12	27	140	0.1	8	170	100
BD5/100915	-	6	<0.4	16	56	93	<0.1	10	250	85
BD4/100915	-	9	<1	18	23	25	<0.1	6	35	254
BD6/100915	-	6	<1	8	15	14	<0.1	7	15	152
BD7/100915	-	10	<1	30	13	27	<0.1	2	11	<5
BH222(T)	0.9-1.35	<4	<0.4	23	250	42	<0.1	16	160	270
BH204 (T)	3.9-4.35	6	<0.4	13	31	180	<0.1	8	150	110
BH206 (T)	2.35-2.9	<4	<0.4	16	10	35	<0.1	2	10	49
BH/MW216 (T)	5.9-6.35	14	<0.4	18	18	43	<0.1	7	210	74
Laboratory PQL		4	0.4	1	1	1	0.1	1	1	1
NEPM HIL A [1, 2]		100	20	100 [7]	6000	300	40	400	7400	3800
EILs [8] - Urban residential/Public open space		100	NC	450	230	1100	NC	300	850	NC

Notes to Table:

All results in mg/kg on a dry weight basis

NA - Not Applicable

NC - No Criteria

NT - Not Tested

PQL - Practical Quantitation Limits

1 - Health Based Criteria for Residential with Accessible Soils Land Use

2- HIL generally applies to the top 3m of soil

3- HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7)

4- HIL is based on blood lead models (adult lead model where 50% bioavailability has been considered) Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7)

5- Assessment of methyl mercury should only be considered if there is evidence of its potential source

6- HIL does not address elemental mercury

7 - Chromium (VI)

8- EILs refer to contamination present in soil for at least two years

exceeds NEPM Health-Based Criteria for Residential with accessible soil Landuse

Underlined results exceed NPEM Ecological Investigation Levels for Urban residential/Public open space

BD1/070815 is the replicate sample of JK107a/1.9-2.35 m (Envirolab)

BD2/080915 is the replicate sample of BH213/2.9-3.35 m (Envirolab)

BD3/090915 is the replicate sample of BH212/2.9-3.35 m (Envirolab)

BD5/100915 is the replicate sample of BH207/0.9-1.35 m (Envirolab)

BD4/100915 is the replicate sample of BH201/0.9-1.35 m (ALS)

BD6/100915 is the replicate sample of BH206/0.9-1.35 m (ALS)

BD7/100915 is the replicate sample of BH208/3.9-4.35 m (ALS)

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Table 2: Summary Results for Hydrocarbons

Test Location ID	Depth (m)	TRH				TRH (NEPC, 2013)						BTEX				PAHs
		C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	F1 (C_6-C_{10}-BTEX)	F2 (>C_{10}-C_{16} - Napthalene)	C_6-C_{10}	>C_{10}-C_{16}	>C_{16}-C_{34}	>C_{34}-C_{40}	Benzene	Toluene	Ethyl Benzene	Xylenes	Naphthalene
BH/MW216	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH/MW216	3.9-4.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH/MW216	5.9-6.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH/MW218	0.9-1.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH/MW218	2.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH/MW218	5.9-6.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH202	0.9-1.35	<25	<50	<100	240	<25	<50	<25	<50	200	330	<0.5	<1	<2	<1	<1
BH201	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH201	0.9-1.35	<25	<50	<100	110	<25	<50	<25	<50	110	130	<0.5	<1	<2	<1	<1
BH202	1.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH203	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	110	<100	<0.5	<1	<2	<1	<1
BH203	0.9-1.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH203	2.9-3.35	<25	<50	<100	200	<25	<50	<25	<50	210	170	<0.5	<1	<2	<1	<1
BH204	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	110	<100	<0.5	<1	<2	<1	<1
BH204	1.9-2.35	<25	<50	<100	120	<25	<50	<25	<50	170	<100	<0.5	<1	<2	<1	<1
BH204	3.9-4.35	<25	<50	<100	140	<25	<50	<25	<50	150	130	<0.5	<1	<2	<1	<1
BH205	0.9-1.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH205	2.9-3.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH205	3.9-4.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH206	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	120	<100	<0.5	<1	<2	<1	<1
BH206	0.9-1.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH206	2.35-2.9	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH206	4.35-4.9	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH207	0.1-0.2	<25	<50	850	1200	<25	<50	<25	<50	1700	1300	<0.5	<1	<2	<1	<1
BH207	0.9-1.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH208	1.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH208	0.9-1.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH208	3.9-4.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH209	0.1-0.2	<25	<50	160	250	<25	<50	<25	<50	330	170	<0.5	<1	<2	<1	<1
BH209	0.9-1.35	<25	<50	370	910	<25	<50	<25	<50	990	1100	<0.5	<1	<2	<1	<1
BH209	1.9-2.35	<25	<50	<100	140	<25	<50	<25	<50	140	150	<0.5	<1	<2	<1	<1
BH209	3.9-4.35	<25	<50	<100	150	<25	<50	<25	<50	120	130	<0.5	<1	<2	<1	<1
BH210	0.1-0.2	<25	<50	260	570	<25	<50	<25	<50	680	580	<0.5	<1	<2	<1	<1
BH210	2.0-2.45	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH211	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH211	0.9-1.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH211	2.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH212	0.1-0.2	<25	<50	230	640	<25	<50	<25	<50	640	840	<0.5	<1	<2	<1	<1
BH212	2.9-3.35	<25	<50	100	250	<25	<50	<25	<50	280	160	<0.5	<1	<2	<1	<1
BH213	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH213	2.9-3.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH214	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH214	2.2-2.65	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH215	0.9-1.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH215	1.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH220	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	130	<100	<0.5	<1	<2	<1	<1
BH221	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH221	1.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BH221	2.9-3.35	<25	<50	<100	<100	<25	<50	<25	<50	110	<100	<0.5	<1	<2	<1	<1
BH221	3.9-4.35	<25	<50	220	<100	<25	<50	<25	<50	270	<100	<0.5	<1	<2	<1	<1
BH222	0.1-0.2	<25	<50	400	590	<25	<50	<25	<50	890	340	<0.5	<1	<2	<1	<1
BH222	0.9-1.35	<25	<50	450	790	<25	<50	<25	<50	990	890	<0.5	<1	<2	<1	<1
BH223	2.0-2.45	<25	<50	<100	110	<25	<50	<25	<50	100	130	<0.5	<1	<2	<1	<1
JK103a	0.1-0.2	<25	<50	110	550	<25	<50	<25	<50	460	860	<0.5	<1	<2	<1	<1
JK103a	1.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK103a	2.9-3.35	<25	<50	460	360	<25	<50	<25	<50	720	240	<0.5	<1	<2	<1	<1
JK103a	5.9-6.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK107a	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK107a	1.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK107a	7.9-8.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK107a	8.9-9.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK118a	0.1-0.2	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK118a	1.9-2.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
JK118a	4.9-5.35	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
SS217	0.0-0.1	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
SS219	0.0-0.1	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BD1/070815	-	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BD2/080915	-	<25	<50	<100	<100	<25	<50	<25	<50	<100	<100	<0.5	<1	<2	<1	<1
BD3/090915	-	<25	<50	<100	<100	<25	<50	<25	<50	110	<100	<0.5	<1	<2	<1	<1
BD5/100915	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BD4/100915	-	<25	<50	<100	<100	<25	<50	<25	<50	110	<100	<0.5	<1	<2	<1	<1
BD6/100915	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BD7/100915	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Laboratory PQL		25	50	100	100	25	50	25	50	100	100	0.2	0.5	1	1	1
NEPM HSL A [6] SAND		NC	NC			45/70/110/200 [1]	110/240/440/NL [1]	NC	NC	NC	NC	0.5/0.5/0.5/0.5 [1]	160/220/310/540 [1]	55/NL/NL/NL [1]	40/60/95/170 [1]	3/NL/NL/NL [1]
NEPM HSL A [6] SILT		NC	NC			40/65/100/190 [2]	230/NL/NL/NL [2]	NC	NC	NC	NC	0.6/0.7/1/2 [2]	390/NL/NL/NL [2]	NL/NL/NL/NL [2]	95/210/NL/NL [2]	4/NL/NL/NL [2]
NEPM HSL A [6] CLAY		NC	NC			50/90/150/290 [3]	280/NL/NL/NL [3]	NC	NC	NC	NC	0.7/1/2/3 [3]	480/NL/NL/NL [3]	NL/NL/NL/NL [3]	110/310/NL/NL [3]	5/NL/NL/NL [3]
CRC HSL for Intrusive Worker by Vapour Intrusion		NC	NC			NC	NC	NL	NL	NL	NL	77	NL	NL	NL	NL
CRC HSL A for Direct Contact - Resident		NC	NC			NC	NC	4400	3300	4500	6300	100	14000	4500	12000	1400
CRC HSL for Intrusive Worker by Direct Contact		NC	NC			NC	NC	82000	62000	85000	120000	1100	120000	85000	130000	29000
NEPM ESL Residential A,B,C [4, 7] - Coarse Soils		NC	NC			180 *	NC	NC	120 *	300	2800	50	85	70	105	170 [8]
NEPM ESL Residential A,B,C [4, 7] - Fine Soils		NC	NC			180 *	NC	NC	120 *	1300	5600	65	105	125	45	170 [8]
Management limits for TPH fractions in coarse soils - Residential A, B, C [5]		NC	NC			NC	NC	700	1000	2500	10000	NC	NC	NC	NC	NC
Management limits for TPH fractions in fine soils - Residential A, B, C [5]		NC	NC			NC	NC	800	1000	3500	10000	NC	NC	NC	NC	NC

Notes to Table:

All results in mg/kg on a dry weight basis

NC - No Criteria

PID - Photoionisation Detector

PQL - Practical Quantitation Limits

NL - Not Limiting

1- Soil HSLs for vapour intrusion (mg/kg) for SAND samples recovered from 0 m to <1 m / 1 m to <2 m / 2 m to <4 m / >=4 m

2- Soil HSLs for vapour intrusion (mg/kg) for SILT samples recovered from 0 m to <1 m / 1 m to <2 m / 2 m to <4 m / >=4 m

3- Soil HSLs for vapour intrusion (mg/kg) for CLAY samples recovered from 0 m to <1 m / 1 m to <2 m / 2 m to <4 m / >=4 m

4- ESLs are of low reliability except where indicated by * which indicates that the ESLs are of moderate reliability

5- Management limits are applied after consideration of relevant ESLs and HSLs

6- Multiplication factor may be applied (for depths >2m) subject to favourable biodegradation conditions - refer to 2.4.10 NEPC (2013)

7- ESLs apply from the surface to 2 m depth below finished surface/ground level

8- Ecological Investigation Level (EIL) - this value relates to fresh contamination

exceeds NEPM HSL Health-Based Criteria for Residential with accessible soils Landuse

exceeds NEPM management limits for TRH fractions in coarse/fine soils - Residential Landuse

Underlined results exceed the NEPM ESL guideline values for Residential with accessible Soils Landuse

Bold results exceed the CRC CARE guideline values for HSL

BD1/070815 is the replicate sample of JK107a/1.9-2.35 m (Envirolab)

BD2/080915 is the replicate sample of BH213/2.9-3.35 m (Envirolab)

BD3/090915 is the replicate sample of BH212/2.9-3.35 m (Envirolab)

BD5/100915 is the replicate sample of BH207/0.9-1.35 m (Envirolab)

BD4/100915 is the replicate sample of BH201/0.9-1.35 m (ALS)

BD6/100915 is the replicate sample of BH206/0.9-1.35 m (ALS)

BD7/100915 is the replicate sample of BH208/3.9-4.35 m (ALS)

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Table 3: Summary Results for PAH, OCP, OPP, PCB, Phenols and Cyanide

Test Location ID	Depth (m)	Total PAH	Naphthalene	B(a)P	B(a)P TEQ	Total OCP	Aldrin + Dieldrin	Chlordane	DDT+DDE+ DDD	Endosulfan	Endrin	Heptachlor	HCB	Methoxychlor	Total OPP	Chlorpyrifos	PCB [3]	Total Phenols	Total Cyanide
BH/MW216	0.1-0.2	2.6	<0.1	0.2	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH/MW216	3.9-4.35	0.53	<0.1	0.07	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH/MW216	5.9-6.35	0.47	<0.1	0.1	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH/MW218	0.9-1.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH/MW218	2.9-2.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	0.6
BH/MW218	5.9-6.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH201	0.1-0.2	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	0.6
BH201	0.9-1.35	0.28	<0.1	0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH202	0.9-1.35	4.5	<0.1	0.4	0.6	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH202	1.9-2.35	1.8	<0.1	0.2	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH203	0.1-0.2	1.6	<0.1	0.1	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH203	0.9-1.35	1.2	<0.1	0.1	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH203	2.9-3.35	17	<0.1	1.5	2.1	0.3	0.3	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH204	0.1-0.2	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH204	1.9-2.35	0.51	<0.1	0.08	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<1	<5	<0.5
BH204	3.9-4.35	1.9	<0.1	0.2	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<1	<5	<0.5
BH205	0.9-1.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH205	2.9-3.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH205	3.9-4.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH206	0.1-0.2	17	<0.1	1.1	1.7	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH206	0.9-1.35	<1.45	<0.1	<0.05	<0.5	-		-	-	- -		-	-	-	-	-	-	-	-
BH206	2.35-2.9	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH206	4.35-4.9	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	0.5
BH207	0.1-0.2	250	0.4	20	29	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	0.6	<0.1	<0.7	<5	<0.5
BH207	0.9-1.35	<1.45	<0.1	<0.05	<0.5	-		-	-	- -		-	-	-	-	-	-	-	-
BH208	1.9-2.35	8.5	<0.1	0.65	1	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH208	0.9-1.35	1.9	<0.1	0.2	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH208	3.9-4.35	-	-	-		--		-	-	- -		-	-	-	-	-	-	-	-
BH209	0.1-0.2	13	<0.1	1.1	1.7	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH209	0.9-1.35	110	<0.1	9.5	14	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH209	1.9-2.35	10	<0.1	0.86	1.3	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	4.4
BH209	3.9-4.35	0.76	<0.1	0.1	<0.5	0.2	0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH210	0.1-0.2	28	<0.1	2.8	4.2	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH210	2.0-2.45	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH211	0.1-0.2	0.59	<0.1	0.07	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH211	0.9-1.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH211	2.9-2.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH212	0.1-0.2	7	<0.1	0.4	0.7	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH212	2.9-3.35	3.9	<0.1	0.4	0.7	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	0.5
BH213	0.1-0.2	3.6	<0.1	0.3	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH213	2.9-3.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH214	0.1-0.2	2.5	<0.1	0.2	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH214	2.2-2.65	0.3	<0.1	0.06	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH215	0.9-1.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH215	1.9-2.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH220	0.1-0.2	0.43	<0.1	0.1	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	3.7	<5	<0.5
BH221	0.1-0.2	0.36	<0.1	0.09	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH221	1.9-2.35	0.54	<0.1	0.09	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH221	2.9-3.35	2.9	<0.1	0.3	<0.5	0.1	0.1	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH221	3.9-4.35	0.49	<0.1	0.06	<0.5	0.3	<0.2	<0.2	0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH222	0.1-0.2	2.1	<0.1	0.1	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH222	0.9-1.35	46	2.5	3.6	5.4	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BH223	2.0-2.45	6.9	<0.1	0.51	0.8	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK103a	0.1-0.2	5	<0.1	0.56	1	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK103a	1.9-2.35	0.38	<0.1	0.08	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK103a	2.9-3.35	150	0.6	13	17	1	<0.2	<0.2	0.7	0.1	0.2	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK103a	5.9-6.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK107a	0.1-0.2	2.8	<0.1	0.3	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK107a	1.9-2.35	0.33	<0.1	0.07	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK107a	7.9-8.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK107a	8.9-9.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK118a	0.1-0.2	1.9	<0.1	0.2	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK118a	1.9-2.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
JK118a	4.9-5.35	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
SS217	0.0-0.1	1.3	<0.1	0.1	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	-
SS219	0.0-0.1	3.4	<0.1	0.3	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	-
BD1/070815	-	<1.45	<0.1	<0.05	<0.5	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BD2/080915	-	7.5	<0.1	0.77	1.2	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BD3/090915	-	3.3	<0.1	0.4	0.6	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.7	<5	<0.5
BD5/100915	-	-	--		--		--		-	-	-		-	-	-	-	-	-	-
BD4/100915	-	<0.5	<0.1	<0.05	1.2	<2.0	<0.2	<0.2	<0.3	<0.3	<0.1	<0.2	<0.1	<0.1	<0.8	<0.1	<0.1	<5	<0.5
BD6/100915	-	-	--		--		--		-	-	-		-	-	-	-	-	-	-
BD7/100915	-	-	--		--		--		-	-	-		-	-	-	-	-	-	-
Laboratory PQL		0.05/0.2	1	0.05	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5	0.5
NEPM HIL A [1]		300	NC	NC	3	NC	6	50	240	270	10	6	10	300	NC	160	1	3000 [4]	250
NEPM EIL Residential A,B,C [2]		NC	170	NC	NC	NC	NC	NC	180[5]	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
NEPM ESL Residential A,B,C [2] - Fine and Coarse Soils		NC	NC	0.7	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Notes to Table:

All results in mg/kg on a dry weight basis

NC - No Criteria

NT - Not Tested

PQL - Practical Quantitation Limits

TEQ - Toxicity Equivalent Quotient

Total PAH - Sum of positive and PQL values

1 - Health Based Criteria for Residential with Accessible Soils Land Use

2- ESLs apply from the surface to 2 m depth below finished surface/ground level

3- PCB HILs relates to non-dioxin-like PCB only

4- Criterion based on phenol

5- Criterion is for DDT only

exceeds NEPM Health-Based Criteria for Residential with Accessible Soils Landuse

Underline results exceed NEPM EIL or ESL

BD1/070815 is the replicate sample of JK107a/1.9-2.35 m (Envirolab)

BD2/080915 is the replicate sample of BH213/2.9-3.35 m (Envirolab)

BD3/090915 is the replicate sample of BH212/2.9-3.35 m (Envirolab)

BD5/100915 is the replicate sample of BH207/0.9-1.35 m (Envirolab)

BD4/100915 is the replicate sample of BH201/0.9-1.35 m (ALS)

BD6/100915 is the replicate sample of BH206/0.9-1.35 m (ALS)

BD7/100915 is the replicate sample of BH208/3.9-4.35 m (ALS)

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Table 4: Summary Results for TCLP Metals and PAH

Test Location ID	Depth (m)	As	Cd	Cu	Cr		Pb	HgNi		Zn	Total PAH
JK103a	2.9-3.35	-			--		--		-	-	0.029	
BH221	2.9-3.35	<0.05	<0.01		<0.01	<0.01	0.2	<0.0005	<0.02		1.1	-
BH222	0.9-1.35	-			--		--		-	-	<0.016	
BH209	0.9-1.35	-			--		--		-	-	<0.016	
BH203	2.9-3.35	<0.05	0.01		<0.01	0.04	1	<0.0005	<0.02		1.8	-
BH207	0.1-0.2	-			--		--		-	-	<0.016	

Notes to Table:

All results in mg/L

Appendix C

Summary of Non-Methane Organic Compound Results

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Table 1: Summary Results of Soil Gas Analysis (NMOC)

Benedict Industries Pty Ltd

| | | |

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Table 1: Summary Results of Soil Gas Analysis (NMOC)

Benedict Industries Pty Ltd

				genated Hydrocarbons			Halogenated Benzenes					VOCs			Solvents																PAH/Phenols
				Bromomethane	Dichlorodifluoromethane	Trichlorofluoromethane	1,2,4-trichlorobenzene	1,2-dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene	Chlorobenzene	1,3-Butadiene	Acrolein	Methyl Methacrylate	1,4-Dioxane	Methyl Ethyl Ketone	2-hexanone (MBK)	4-Methyl-2-pentanone	Carbon disulfide	Cyclohexane	Ethanol	Ethyl acetate	Heptane	Hexane	MTBE	Tetrahydrofuran	Vinyl acetate	Naphthalene
				µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	ug/m3	µg/m3	µg/m3	µg/m3	µg/m3	ug/m3	µg/m3	µg/m3	µg/m3	µg/m3
PQL				1	2	9.2	6.3	8.3	7	3	3	2	1	1	2	1	1	3.2	5	2	1	1	6.0	7.1	9.2	8	1	1	3.1	3.1	5.28	6
NEPM 2013 Table 1A(2) Res A Soil Vap VOCC HILs																															
NEPM 2013 Table 1A(5) Res Soil Vapour HSL A/B for Vapour Intrusion, Sa																															
0-1m																														800	
Field_ID	**LocCode**	**WellCode**	**Sampled_Date-Time**																												
BH/MW216	BH/MW216		27/10/2015	<1.9	**210**	<2.8	<3.7	<3	<3	<3	<2	<1	<1	<2	<1.8	<1.5	<2	<2	<1.6	**88**	**18**	<1.8	**4**	**4**	**7**<1.8	<1.5	<1.8	**7**
BD1	BH/MW216		27/10/2015	<1.9	**230**	<2.8	<3.7	<3	<3	<3	<2	<1	<1	<2	<1.8	<1.5	<2	<2	<1.6	**98**	**19**	<1.8	**5**	**5**	**3**<1.8	<1.5	<1.8	**4**
JK101	JK101		27/10/2015	<1.9	**20**	<2.8	<3.7	<3	<3	<3	<2	<1	<1	<2	<1.8	<1.5	<2	<2	**6**	**110**	**22**	<1.8	**30**	**100**	<1.8	<1.5	<1.8	**10**
JK107B	JK107B		27/10/2015	<1.9	**120**	<2.8	<3.7	<3	<3	<3	<2	<1	<1	<2	<1.8	<1.5	<2	<2	**2**	**130**	**17**	<1.8	**10**	**38**	<1.8	<1.5	<1.8	**10**

Appendix D

Summary of Groundwater and Surface Water Results

			Inorganics						Metals													
			Ammonia (as N)	Chloride	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Sulphate	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Copper (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Nickel (Filtered)	Phosphorus	Zinc (Filtered)	C10-C16	C16-C34	C34-C40
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.005	1	0.005	0.005		1	0.001	0.0001	0.001	0.001	0.001	0.001	0.00005	0.001	0.01	0.001	0.05	0.1	0.1
ANZECC 2000, Marine Waters, 95% of Species			0.91							0.0007		0.0013	0.0044		0.0001	0.007		0.015			
ANZECC 2000 LOW RELIABILITY MW									0.0045					0.08							
ANZECC 2000 Fresh Waters GILs for 95% of Species			0.9		0.161					0.0002	0.0274	0.0014	0.0034	1.9	0.00006	0.011		0.008			
ANZECC 2000 LOW RELIABILITY FRESH WATER																					
ADWG 2011 Aesthetic			0.5					250				1		0.1				3			
ADWG 2011 Drinking Water					11.5	0.9		500	0.01	0.002		2	0.01	0.5	0.001	0.02					
ANZECC 2000 Recreational water quality and aesthetics			0.1	400	10	1		400	0.05	0.005	0.05	1	0.05	0.1	0.001	0.1		5			
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																					
2-4m																					
4-8m																					
>8m																					
Field_ID	**LocCode**	**Sampled_Date-Time**																			
BH/MW216	BH/MW216	1-Oct-15	20	2200	<0.005	<0.005	-	91	0.002	<0.0001	0.001	0.001	0.001	1.4	<0.00005	0.009	0.7	0.06	<0.05	<0.1	<0.1
BH/MW218	BH/MW218	1-Oct-15	30	2300	<0.25	<0.25	-	410	0.011	<0.0001	0.19	0.017	0.007	0.65	<0.00005	0.16	0.3	0.084	<0.05	<0.1	<0.1
JKBH/MW1	JKBH/MW1	2-Oct-15	3.2	750	0.01	<0.005	-	1100	0.001	0.0001	<0.001	0.005	<0.001	0.95	<0.00005	0.03	<0.05	0.097	<0.05	<0.1	<0.1
BD1/021015	BD1/021015	2-Oct-15	2.56	-	0.03	<0.01	0.03	-	0.003	<0.0001	<0.001	<0.001	<0.001	0.985	<0.0001	0.046	3.58	0.245	<0.1	<0.1	<0.1
JKBH/MW107A	JKBH/MW107A	1-Oct-15	10	700	0.006	<0.005	-	75	0.003	<0.0001	<0.001	0.007	<0.001	0.42	<0.00005	0.012	<0.05	0.079	<0.05	<0.1	<0.1
JKBH/MW16	JKBH/MW16	1-Oct-15	4.9	3400	0.02	<0.005	-	1700	<0.001	0.0001	<0.001	0.004	<0.001	4.4	<0.00005	0.02	<0.05	0.82	<0.05	<0.1	<0.1
R1/021015	R1/021015	2-Oct-15	-	-	-	-	-	-	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.005	<0.00005	<0.001	-	<0.001	<0.05	<0.1	<0.1
SW1	SW1	1-Oct-15	0.025	6900	0.29	0.006	-	890	<0.001	<0.0001	<0.001	0.002	<0.001	0.012	<0.00005	0.001	<0.05	0.006	<0.05	<0.1	<0.1
SW2	SW2	1-Oct-15	8.4	2700	0.11	0.08	-	590	0.002	<0.0001	<0.001	<0.001	<0.001	0.42	<0.00005	0.005	<0.05	0.005	<0.05	<0.1	<0.1
BD2/011015	SW2	1-Oct-15	8.2	-	0.16	0.083	-	-	0.002	<0.0001	<0.001	<0.001	<0.001	0.4	<0.00005	0.005	<0.05	0.005	<0.05	<0.1	<0.1
SW3	SW3	2-Oct-15	0.017	91	0.02	<0.005	-	12	<0.001	<0.0001	<0.001	<0.001	<0.001	0.1	<0.00005	0.002	<0.05	0.018	<0.05	<0.1	<0.1

			TRH								BTEX								
			F2-NAPHTHALENE	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of total)	C10 - C40 (Sum of total)	C6-C10 less BTEX (F1)	C6-C10	Benzene	Ethylbenzene	Toluene	Total BTEX	Xylene (m & p)	Xylene (o)	Xylene Total	1,2,4-trimethylbenzene	1,3,5-trimethylbenzene
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.05	0.01	0.05	0.1	0.05			0.01	0.01	0.001	0.001	0.001		0.002	0.001		0.001	0.001
ANZECC 2000, Marine Waters, 95% of Species												0.5								
ANZECC 2000 LOW RELIABILITY MW													0.005	0.18				0.625		
ANZECC 2000 Fresh Waters GILs for 95% of Species												0.95					0.35			
ANZECC 2000 LOW RELIABILITY FRESH WATER																				
ADWG 2011 Aesthetic													0.003	0.025				0.02		
ADWG 2011 Drinking Water												0.001	0.3	0.8				0.6		
ANZECC 2000 Recreational water quality and aesthetics												0.01								
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																				
2-4m			1							1		0.8	NL	NL				NL		
4-8m			1							1		0.8	NL	NL				NL		
>8m			1							1		0.9	NL	NL				NL		
Field_ID	**LocCode**	**Sampled_Date-Time**																		
BH/MW216	BH/MW216	1-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001
BH/MW218	BH/MW218	1-Oct-15	<0.05	<0.1	<0.05	<0.1	<0.1	-	-	<0.01	<0.1	<0.01	<0.01	<0.01	-	<0.02	<0.01	-	<0.01	<0.01
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001
BD1/021015	BD1/021015	2-Oct-15	<0.1	<0.02	<0.05	<0.1	<0.05	<0.05	<0.1	<0.02	<0.02	<0.001	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	-	-
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001
R1/021015	R1/021015	2-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	-	-
SW1	SW1	1-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001
SW2	SW2	1-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001
BD2/011015	SW2	1-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001
SW3	SW3	2-Oct-15	<0.05	<0.01	<0.05	<0.1	<0.1	-	-	<0.01	<0.01	<0.001	<0.001	<0.001	-	<0.002	<0.001	-	<0.001	<0.001

			MAH																	
			Isopropylbenzene	n-butylbenzene	n-propylbenzene	p-isopropyltoluene	sec-butylbenzene	Styrene	tert-butylbenzene	1,1,1,2-tetrachloroethane	1,1,1-trichloroethane	1,1,2,2-tetrachloroethane	1,1,2-trichloroethane	1,1-dichloroethane	1,1-dichloroethene	1,1-dichloropropene	1,2,3-trichloropropane	1,2-dibromo-3-chloropropane	1,2-dichloroethane	1,2-dichloropropane
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
ANZECC 2000, Marine Waters, 95% of Species													1.9							
ANZECC 2000 LOW RELIABILITY MW															0.7					
ANZECC 2000 Fresh Waters GILs for 95% of Species													6.5							
ANZECC 2000 LOW RELIABILITY FRESH WATER											0.27	0.4	1.9						1.9	0.9
ADWG 2011 Aesthetic								0.004												
ADWG 2011 Drinking Water								0.03							0.03				0.003	
ANZECC 2000 Recreational water quality and aesthetics															0.0003				0.01	
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																				
2-4m																				
4-8m																				
>8m																				
Field_ID	**LocCode**	**Sampled_Date-Time**																		
BH/MW216	BH/MW216	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BH/MW218	BH/MW218	1-Oct-15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BD1/021015	BD1/021015	2-Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
R1/021015	R1/021015	2-Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW1	SW1	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SW2	SW2	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BD2/011015	SW2	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SW3	SW3	2-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

			Chlorinated Hydrocarbons																
			1,3-dichloropropane	2,2-dichloropropane	Bromochloromethane	Bromodichloromethane	Bromoform	Carbon tetrachloride	Chlorodibromomethane	Chloroethane	Chloroform	Chloromethane	cis-1,2-dichloroethene	cis-1,3-dichloropropene	Dibromomethane	Hexachlorobutadiene	Trichloroethene	Tetrachloroethene	trans-1,2-dichloroethene	trans-1,3-dichloropropene
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
ANZECC 2000, Marine Waters, 95% of Species																				
ANZECC 2000 LOW RELIABILITY MW																				
ANZECC 2000 Fresh Waters GILs for 95% of Species																				
ANZECC 2000 LOW RELIABILITY FRESH WATER			1.1					0.24			0.37			0.0008			0.33	0.07		0.0008
ADWG 2011 Aesthetic																				
ADWG 2011 Drinking Water																0.0007		0.05		
ANZECC 2000 Recreational water quality and aesthetics								0.003									0.03	0.01		
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																				
2-4m																				
4-8m																				
>8m																				
Field_ID	**LocCode**	**Sampled_Date-Time**																		
BH/MW216	BH/MW216	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BH/MW218	BH/MW218	1-Oct-15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BD1/021015	BD1/021015	2-Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
R1/021015	R1/021015	2-Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW1	SW1	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SW2	SW2	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BD2/011015	SW2	1-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SW3	SW3	2-Oct-15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

			Halogenated Hydrocarbons				Halogenated Benzenes										Solvents	PA
			Vinyl chloride	1,2-dibromoethane	Bromomethane	Dichlorodifluoromethane	Trichlorofluoromethane	1,2,3-trichlorobenzene	1,2,4-trichlorobenzene	1,2-dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene	2-chlorotoluene	4-chlorotoluene	Bromobenzene	Chlorobenzene	Hexachlorobenzene	Cyclohexane	7,12-dimethylbenz(a)anthracene
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.01	0.001	0.01	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000001	0.001	
ANZECC 2000, Marine Waters, 95% of Species									0.02										
ANZECC 2000 LOW RELIABILITY MW			0.1																
ANZECC 2000 Fresh Waters GILs for 95% of Species								0.003	0.085	0.16	0.26	0.06							
ANZECC 2000 LOW RELIABILITY FRESH WATER								0.003		0.16	0.26	0.06							
ADWG 2011 Aesthetic										0.001	0.02	0.0003							
ADWG 2011 Drinking Water			0.0003	0.001	0.001					1.5		0.04							
ANZECC 2000 Recreational water quality and aesthetics																			
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																			
2-4m																			
4-8m																			
>8m																			
Field_ID	**LocCode**	**Sampled_Date-Time**																	
BH/MW216	BH/MW216	1-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-
BH/MW218	BH/MW218	1-Oct-15	<0.1	<0.01	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.000001	<0.01	-
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-
BD1/021015	BD1/021015	2-Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.00001	-	<0.0001
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-
R1/021015	R1/021015	2-Oct-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.000001	-	-
SW1	SW1	1-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-
SW2	SW2	1-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-
BD2/011015	SW2	1-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-
SW3	SW3	2-Oct-15	<0.01	<0.001	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.000001	<0.001	-

																		PAH/Phenols
		Benzo[b+j]fluoranthene	2,4-dimethylphenol	2-methylnaphthalene	2-methylphenol	2-nitrophenol	3-&4-methylphenol	3-methylcholanthrene	4-chloro-3-methylphenol	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL										0.0001	0.0001	0.0001	0.0001	0.00005	0.0002	0.0001	
ANZECC 2000, Marine Waters, 95% of Species																	
ANZECC 2000 LOW RELIABILITY MW												0.00001		0.0002			
ANZECC 2000 Fresh Waters GILs for 95% of Species																	
ANZECC 2000 LOW RELIABILITY FRESH WATER																	
ADWG 2011 Aesthetic																	
ADWG 2011 Drinking Water																	
ANZECC 2000 Recreational water quality and aesthetics														0.00001			
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																	
2-4m																	
4-8m																	
>8m																	
Field_ID	**LocCode**	**Sampled_Date-Time**															
BH/MW216	BH/MW216	1-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
BH/MW218	BH/MW218	1-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
JKBH/MW1	JKBH/MW1	2-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
BD1/021015	BD1/021015	2-Oct-15	<0.0001	<0.001	<0.0001	<0.001	<0.001	<0.002	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	-	<0.0001	<0.0001
JKBH/MW107A	JKBH/MW107A	1-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
JKBH/MW16	JKBH/MW16	1-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
R1/021015	R1/021015	2-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
SW1	SW1	1-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
SW2	SW2	1-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
BD2/011015	SW2	1-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-
SW3	SW3	2-Oct-15	-	-	-	-	-	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	-

													Halogenated Phenols					
			Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	PAHs (Sum of total)	Phenanthrene	Phenol	Phenolics Total	Pyrene	2,4,5-trichlorophenol	2,4,6-trichlorophenol	2,4-dichlorophenol	2,6-dichlorophenol	2-chlorophenol	Pentachlorophenol
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.0001	0.0001	0.0001	0.0001	0.0001	0.0001		0.0001		0.05	0.0001						
ANZECC 2000, Marine Waters, 95% of Species								0.05			0.4								0.011
ANZECC 2000 LOW RELIABILITY MW					0.0014					0.002									
ANZECC 2000 Fresh Waters GILs for 95% of Species								0.016			0.32				0.003	0.12		0.34	0.0036
ANZECC 2000 LOW RELIABILITY FRESH WATER																			
ADWG 2011 Aesthetic															0.002	0.0003		0.0001	
ADWG 2011 Drinking Water									0.00001						0.02	0.2		0.3	0.01
ANZECC 2000 Recreational water quality and aesthetics														0.001	0.01				0.01
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																			
2-4m								NL											
4-8m								NL											
>8m								NL											
Field_ID	**LocCode**	**Sampled_Date-Time**																	
BH/MW216	BH/MW216	1-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
BH/MW218	BH/MW218	1-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
BD1/021015	BD1/021015	2-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001	<0.001	-	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
R1/021015	R1/021015	2-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
SW1	SW1	1-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
SW2	SW2	1-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
BD2/011015	SW2	1-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-
SW3	SW3	2-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	-	<0.0001	-	<0.05	<0.0001	-	-	-	-	-	-

			Polychlorinated Biphenyls							SVOCs				
			Arochlor 1016	Arochlor 1221	Arochlor 1232	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	PCBs (Sum of total)	Benzo(e)pyrene	Coronene	EPN	Perylene	4,4-DDE
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001					0.000001
ANZECC 2000, Marine Waters, 95% of Species															
ANZECC 2000 LOW RELIABILITY MW															
ANZECC 2000 Fresh Waters GILs for 95% of Species						0.0003		0.00001							
ANZECC 2000 LOW RELIABILITY FRESH WATER			0.000009	0.001	0.0003	0.0006	0.00003	0.00003	0.025						
ADWG 2011 Aesthetic															
ADWG 2011 Drinking Water															
ANZECC 2000 Recreational water quality and aesthetics															
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand															
2-4m															
4-8m															
>8m															
Field_ID	**LocCode**	**Sampled_Date-Time**													
BH/MW216	BH/MW216	1-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
BH/MW218	BH/MW218	1-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
BD1/021015	BD1/021015	2-Oct-15	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001	<0.00001
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
R1/021015	R1/021015	2-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
SW1	SW1	1-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
SW2	SW2	1-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
BD2/011015	SW2	1-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001
SW3	SW3	2-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	<0.000001

													Organochlorine Pesticide
			a-BHC	Aldrin	b-BHC	chlordane	Chlordane (cis)	Chlordane (trans)	d-BHC	DDD	DDT	DDT+DDE+DDD	Dieldrin	Endosulfan
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.000001	0.000001	0.000001		0.000001	0.000001	0.000001	0.000001	0.000001		0.000001	
ANZECC 2000, Marine Waters, 95% of Species														0.000005
ANZECC 2000 LOW RELIABILITY MW				0.000003			0.000001	0.000001			0.0000004	0.0000005	0.00001	
ANZECC 2000 Fresh Waters GILs for 95% of Species						0.00003					0.000006			0.00003
ANZECC 2000 LOW RELIABILITY FRESH WATER														
ADWG 2011 Aesthetic														
ADWG 2011 Drinking Water											0.009			0.02
ANZECC 2000 Recreational water quality and aesthetics				0.001		0.006					0.003		0.001	0.04
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand														
2-4m														
4-8m														
>8m														
Field_ID	**LocCode**	**Sampled_Date-Time**												
BH/MW216	BH/MW216	1-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000008	-
BH/MW218	BH/MW218	1-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000076	-
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000001	-
BD1/021015	BD1/021015	2-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000003	-
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000003	-
R1/021015	R1/021015	2-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	<0.000001	-
SW1	SW1	1-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000001	-
SW2	SW2	1-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000004	-
BD2/011015	SW2	1-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	0.000004	-
SW3	SW3	2-Oct-15	<0.000001	<0.000001	<0.000001	-	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	-	<0.000001	-

	s											
	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	Endrin ketone	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Methoxychlor	Oxychlordane	Azinophos methyl
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.00001
ANZECC 2000, Marine Waters, 95% of Species				0.000004								
ANZECC 2000 LOW RELIABILITY MW	0.000005	0.000005						0.0000004		0.000004		
ANZECC 2000 Fresh Waters GILs for 95% of Species				0.00001			0.0002	0.00001				
ANZECC 2000 LOW RELIABILITY FRESH WATER												
ADWG 2011 Aesthetic												
ADWG 2011 Drinking Water							0.01	0.0003		0.3		0.03
ANZECC 2000 Recreational water quality and aesthetics				0.001			0.01	0.003				0.01
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand												
2-4m												
4-8m												
>8m												

Field_ID	LocCode	Sampled_Date-Time											
BH/MW216	BH/MW216	1-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
BH/MW218	BH/MW218	1-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
BD1/021015	BD1/021015	2-Oct-15	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005	<0.00001	<0.00001	<0.00001	<0.00002
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
R1/021015	R1/021015	2-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
SW1	SW1	1-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
SW2	SW2	1-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
BD2/011015	SW2	1-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001
SW3	SW3	2-Oct-15	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001

	Bolstar (Sulprofos)	Bromophos-ethyl	Carbophenothion	Azinphos Ethyl	Chlorfenvinphos	Chlorfenvinphos E	Chlorfenvinphos Z	Chlorpyrifos	Chlorpyrifos-methyl	Coumaphos	Demeton-O	Demeton-S	Diazinon	Dichlorvos
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL				0.00001		0.00001	0.00001	0.00001	0.00001				0.00001	0.00001
ANZECC 2000, Marine Waters, 95% of Species								0.000009						
ANZECC 2000 LOW RELIABILITY MW														
ANZECC 2000 Fresh Waters GILs for 95% of Species								0.00001					0.00001	
ANZECC 2000 LOW RELIABILITY FRESH WATER														
ADWG 2011 Aesthetic														
ADWG 2011 Drinking Water	0.01	0.01						0.01					0.004	0.005
ANZECC 2000 Recreational water quality and aesthetics	0.02	0.02	0.001		0.01			0.002					0.01	0.02
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand														
2-4m														
4-8m														
>8m														

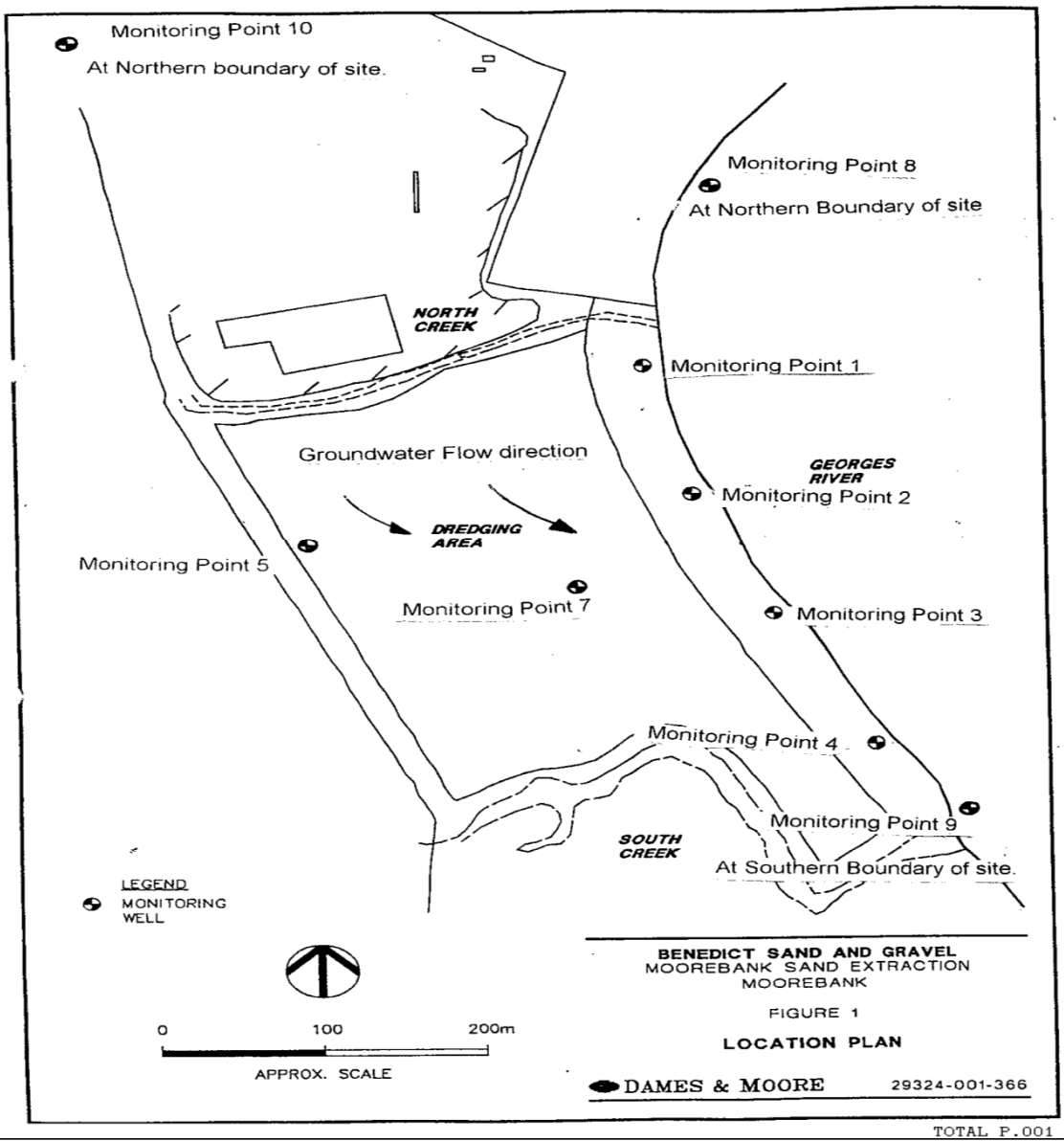
Field_ID	LocCode	Sampled_Date-Time													
BH/MW216	BH/MW216	1-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
BH/MW218	BH/MW218	1-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
JKBH/MW1	JKBH/MW1	2-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
BD1/021015	BD1/021015	2-Oct-15	<0.00005	<0.0001	<0.00002	<0.00002	<0.00002	-	-	<0.00002	<0.0002	<0.00001	<0.00002	<0.00002	<0.00001	<0.0002
JKBH/MW107A	JKBH/MW107A	1-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
JKBH/MW16	JKBH/MW16	1-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
R1/021015	R1/021015	2-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
SW1	SW1	1-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
SW2	SW2	1-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
BD2/011015	SW2	1-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001
SW3	SW3	2-Oct-15	-	-	-	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	<0.00001	<0.00001

			Organophosphorous Pesticides												
			Dimethoate	Disulfoton	Ethion	Ethoprop	Fenitrothion	Fensulfothion	Fenthion	Malathion	Methidathion	Methyl parathion	Mevinphos (Phosdrin)	Monocrotophos	Omethoate	Phorate
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL			0.00001		0.00001		0.00001		0.00001	0.00001		0.00001				
ANZECC 2000, Marine Waters, 95% of Species																
ANZECC 2000 LOW RELIABILITY MW																
ANZECC 2000 Fresh Waters GILs for 95% of Species			0.00015				0.0002			0.00005						
ANZECC 2000 LOW RELIABILITY FRESH WATER																
ADWG 2011 Aesthetic																
ADWG 2011 Drinking Water			0.007	0.004	0.004	0.001	0.007	0.01	0.007	0.07	0.006	0.0007	0.005	0.002	0.001	
ANZECC 2000 Recreational water quality and aesthetics			0.1	0.006	0.006	0.001	0.02	0.02		0.1	0.06	0.006	0.006	0.002	0.0004	
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																
2-4m																
4-8m																
>8m																
Field_ID	**LocCode**	**Sampled_Date-Time**														
BH/MW216	BH/MW216	1-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
BH/MW218	BH/MW218	1-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
JKBH/MW1	JKBH/MW1	2-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
BD1/021015	BD1/021015	2-Oct-15	<0.00002	<0.00005	<0.00002	<0.00001	<0.002	<0.00001	<0.00005	<0.00002	<0.0001	<0.0005	<0.00002	<0.00002	<0.00001	<0.0001
JKBH/MW107A	JKBH/MW107A	1-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
JKBH/MW16	JKBH/MW16	1-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
R1/021015	R1/021015	2-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
SW1	SW1	1-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
SW2	SW2	1-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
BD2/011015	SW2	1-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-
SW3	SW3	2-Oct-15	<0.00001	-	<0.00001	-	<0.00001	-	<0.00001	<0.00001	-	<0.00001	-	-	-	-

										Pesticides							
			Prothiofos	Pyrazophos	Ronnel	Terbufos	Thiometon	Trichloronate	Tetrachlorvinphos	Acephate	Demeton-S-methyl	Fenamiphos	Formothion	Parathion	Pirimiphos-methyl	Pirimphos-ethyl	Profenofos
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PQL											0.00001			0.00001	0.00001	0.00001	
ANZECC 2000, Marine Waters, 95% of Species																	
ANZECC 2000 LOW RELIABILITY MW																	
ANZECC 2000 Fresh Waters GILs for 95% of Species														0.000004			
ANZECC 2000 LOW RELIABILITY FRESH WATER																	
ADWG 2011 Aesthetic																	
ADWG 2011 Drinking Water				0.02		0.0009	0.004		0.1	0.008		0.0005	0.05	0.02	0.09	0.0005	0.0003
ANZECC 2000 Recreational water quality and aesthetics				1	0.06		0.02			0.02			0.1	0.03	0.06	0.001	0.0006
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																	
2-4m																	
4-8m																	
>8m																	
Field_ID	**LocCode**	**Sampled_Date-Time**															
BH/MW216	BH/MW216	1-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
BH/MW218	BH/MW218	1-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
JKBH/MW1	JKBH/MW1	2-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
BD1/021015	BD1/021015	2-Oct-15	<0.0001	<0.0001	<0.01	<0.00001	<0.0005	<0.0005	<0.00001	<0.0005	<0.00002	<0.00001	<0.02	<0.0002	<0.00001	<0.00001	<0.00001
JKBH/MW107A	JKBH/MW107A	1-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
JKBH/MW16	JKBH/MW16	1-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
R1/021015	R1/021015	2-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
SW1	SW1	1-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
SW2	SW2	1-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
BD2/011015	SW2	1-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-
SW3	SW3	2-Oct-15	-	-	-	-	-	-	-	-	<0.00001	-	-	<0.00001	<0.00001	<0.00001	-

								Fungicides	Other
		Sulfotepp	Temephos	Trichlorfon	Bensulide	Demeton-O & Demeton-S	Naftalofos	Fosetyl-al	Triazophos
		mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L
PQL									
ANZECC 2000, Marine Waters, 95% of Species			0.00005						
ANZECC 2000 LOW RELIABILITY MW									
ANZECC 2000 Fresh Waters GILs for 95% of Species									
ANZECC 2000 LOW RELIABILITY FRESH WATER									
ADWG 2011 Aesthetic									
ADWG 2011 Drinking Water			0.4	0.007					
ANZECC 2000 Recreational water quality and aesthetics			0.03	0.01					
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand									
2-4m									
4-8m									
>8m									
Field_ID	**LocCode**	**Sampled_Date-Time**							
BH/MW216	BH/MW216	1-Oct-15	-	-	-	-	-	-	-
BH/MW218	BH/MW218	1-Oct-15	-	-	-	-	-	-	-
JKBH/MW1	JKBH/MW1	2-Oct-15	-	-	-	-	-	-	-
BD1/021015	BD1/021015	2-Oct-15	<0.000005	<0.00002	<0.00002	<0.1	<0.02	<1	<0.01	<0.000005
JKBH/MW107A	JKBH/MW107A	1-Oct-15	-	-	-	-	-	-	-	-
JKBH/MW16	JKBH/MW16	1-Oct-15	-	-	-	-	-	-	-	-
R1/021015	R1/021015	2-Oct-15	-	-	-	-	-	-	-	-
SW1	SW1	1-Oct-15	-	-	-	-	-	-	-	-
SW2	SW2	1-Oct-15	-	-	-	-	-	-	-	-
BD2/011015	SW2	1-Oct-15	-	-	-	-	-	-	-	-
SW3	SW3	2-Oct-15	-	-	-	-	-	-	-	-

Douglas Partners (17 March 2017)
Groundwater Data Review


Monitoring Point 10
At Northern boundary of site.
Monitoring Point 8
At Northern Boundary of site
NORTH CREEK
Monitoring Point 1
Groundwater Flow direction
GEORGES RIVER
Monitoring Point 2
DREDGING AREA
Monitoring Point 5
Monitoring Point 7
Monitoring Point 3
Monitoring Point 4
Monitoring Point 9
SOUTH CREEK
At Southern Boundary of site.
LEGEND
MONITORING WELL
0
100
200m
APPROX. SCALE
BENEDICT SAND AND GRAVEL
MOOREBANK SAND EXTRACTION
MOOREBANK
FIGURE 1
LOCATION PLAN
DAMES & MOORE
29324-001-366

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 1 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date									
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016	19/10/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	150	320	206	150			320			170			185
Aluminium (Al)	mg/L		2	2	0.1	0.1	0	0.1						0.1			
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01			
Barium (Ba)	mg/L		2	2	0.1	0.4	0	0.4						0.1			
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01			
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01			
Conductivity	uS/cm		4	4	7090	12500	9813	7560			12100			7090			12500
Copper (Cu)	mg/L		2	2	0.01	0.03	0	0.03						0.01			
Iron (Fe)	mg/L		2	2	0.01	0.12	0	0.01						0.12			
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01			
Manganese (Mn)	mg/L		4	4	0.1	0.21	0	0.12			0.1			0.21			0.1
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001			0.00001
Nitrate + Nitrite (oxidised	mg/L		4	4	0.1	0.53	0	0.1			0.1			0.36			0.53
Nitrogen-Ammonia	mg/L		4	4	0.1	1.4	1	1.4			0.1			1.1			0.8
Organochlorine Pesticides	ug/L		1	1	0.2	0.2	0	0.2									
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1			
Polycyclic Aromatic	ug/L		1	1	5	5	5	5									
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01			
Total Dissolved Solids	mg/L		4	4	4610	8200	6395	4920			7850			4610			8200
Total Organic Carbon	mg/L		4	4	10	22	15	22			15			10			12
Total Petroleum	ug/L		2	2	100	100	100	100						100			
Zinc (Zn)	mg/L		2	2	0.01	0.8	0	0.8						0.01			
pH	pH		12	12	7.3	8.7	8	7.3	7.9	7.8	8.7	7.8	7.6	7.3	7.6	7.3	7.4

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 2 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	130	320	204	130			320			160		
Aluminium (Al)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.2	0	0.2						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	6910	12400	9698	7280			12200			6910		
Copper (Cu)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Iron (Fe)	mg/L		2	2	0.02	0.17	0	0.02						0.17		
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Manganese (Mn)	mg/L		4	4	0.1	0.21	0	0.21			0.1			0.21		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.51	0	0.1			0.1			0.44		
Nitrogen-Ammonia	mg/L		4	4	0.1	1.4	1	1.4			0.1			0.92		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	4510	8050	6303	4750			7900			4510		
Total Organic Carbon	mg/L		4	4	8	20	13	20			13			9		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.01	0.28	0	0.28						0.01		
pH	pH		12	12	7.1	8.6	8	7.2	7.9	8.1	8.6	7.9	7.5	7.3	7.4	7.1

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited

2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 3

Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	1	16	10	11			1			12		
Aluminium (Al)	mg/L		2	2	0.2	0.4	0	0.4						0.2		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	6320	11400	7848	6410			11400			7260		
Copper (Cu)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Iron (Fe)	mg/L		2	2	0.02	0.07	0	0.02						0.07		
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Manganese (Mn)	mg/L		4	4	0.12	0.24	0	0.16			0.2			0.24		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.1	0	0.1			0.1			0.1		
Nitrogen-Ammonia	mg/L		4	4	0.4	2.1	1	1.1			2.1			0.84		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	4140	7390	5115	4180			7390			4750		
Total Organic Carbon	mg/L		4	4	7	26	17	23			7			26		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.12	0.64	0	0.64						0.12		
pH	pH		12	12	3.5	6.2	5	5.1	4.6	3.5	4.3	5.2	5.8	5.0	5.0	5.1

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 4 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	99	160	127	140			99			110		
Aluminium (Al)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	11230	16100	13958	14000			14500			11230		
Copper (Cu)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Iron (Fe)	mg/L		2	2	0.04	0.13	0	0.04						0.13		
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Manganese (Mn)	mg/L		4	4	0.14	0.3	0	0.27			0.14			0.18		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.1	0	0.1			0.1			0.1		
Nitrogen-Ammonia	mg/L		4	4	0.5	2.9	1	2.9			0.5			0.56		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	7330	10400	9068	9100			9440			7330		
Total Organic Carbon	mg/L		4	4	5	13	10	13			5			10		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.02	0.13	0	0.13						0.02		
pH	pH		12	12	6.3	6.5	6	6.4	6.5	6.5	6.4	6.3	6.5	6.5	6.5	6.4

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 5 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	1	89	29	1			89			1		
Aluminium (Al)	mg/L		2	2	5.6	6.3	6	5.6						6.3		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	1330	5790	3143	1330			5790			2170		
Copper (Cu)	mg/L		2	2	0.01	0.1	0	0.1						0.01		
Iron (Fe)	mg/L		2	2	0.85	45	23	0.85						45		
Lead (Pb)	mg/L		2	2	0.01	0.04	0	0.04						0.01		
Manganese (Mn)	mg/L		4	4	1.7	5.4	4	3.2			1.7			5.4		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.46	0	0.1			0.1			0.46		
Nitrogen-Ammonia	mg/L		4	4	1	19	11	1			16			7.7		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	870	3760	2048	870			3760			1420		
Total Organic Carbon	mg/L		4	4	9	51	28	9			51			14		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.02	1.2	1	1.2						0.02		
pH	pH		12	12	3.6	6.5	5	4.0	4.2	5.4	5.6	5.6	3.9	6.5	3.6	5.0

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 7 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	70.5	220	159	71			220			180		
Aluminium (Al)	mg/L		2	2	0.1	0.25	0	0.3						0.1		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.15	0	0.2						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	6570	12400	9504	6845			12400			6570		
Copper (Cu)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Iron (Fe)	mg/L		2	2	0.02	0.11	0	0.02						0.11		
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Manganese (Mn)	mg/L		4	4	0.1	0.21	0	0.19			0.1			0.21		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.4	0	0.1			0.1			0.24		
Nitrogen-Ammonia	mg/L		4	4	0.1	1.25	1	1.25			0.1			0.84		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	4280	8050	6166	4465			8050			4280		
Total Organic Carbon	mg/L		4	4	8	21.5	13	22			13			9		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.01	0.46	0	0.46						0.01		
pH	pH		12	12	6.15	8.4	7	6.2	7.2	7.8	8.4	7.9	6.8	7.3	7.2	7.2

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 8 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	72	115	87	75			115			72		
Aluminium (Al)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	4750	32900	17013	4750			23200			7200		
Copper (Cu)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Iron (Fe)	mg/L		2	2	0.05	0.16	0	0.05						0.16		
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Manganese (Mn)	mg/L		4	4	0.03	0.08	0	0.08			0.03			0.05		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.8	0	0.6			0.1			0.8		
Nitrogen-Ammonia	mg/L		4	4	0.1	0.3	0	0.3			0.1			0.23		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	3090	21300	11050	3090			15100			4710		
Total Organic Carbon	mg/L		4	4	1	4	2	4			1			2		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.01	0.04	0	0.04						0.01		
pH	pH		12	12	6.6	7.5	7	6.6	6.9	7.2	7.5	7.4	6.9	7.2	7.2	7.0

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 9 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	72	135	92	72			135			72		
Aluminium (Al)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	5240	38200	20418	5240			29600			8630		
Copper (Cu)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Iron (Fe)	mg/L		2	2	0.03	0.11	0	0.03						0.11		
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Manganese (Mn)	mg/L		4	4	0.02	0.05	0	0.02			0.04			0.05		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.77	0	0.62			0.1			0.77		
Nitrogen-Ammonia	mg/L		4	4	0.1	0.3	0	0.3			0.1			0.26		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	3410	24800	13283	3410			19300			5620		
Total Organic Carbon	mg/L		4	4	1	4	2	4			1			1		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.01	0.02	0	0.02						0.01		
pH	pH		12	12	6.8	7.4	7	6.9	6.9	7.1	7.4	7.4	6.8	7.2	7.2	7.0

Sampling frequency

Every month
Every 3 months
Every 6 months

Benedict Industries Pty Limited 2016 Annual

Moorebank - 146 Newbridge Road, Moorebank NSW 2170

EPA Licence No: 4612

Water Monitoring Requirements:

Grab samples are required to be taken every 3/6 month

Location of Monitoring Points:

Monitoring Point 10 Boreholes labelled on map titled "Location Plan" submitted to the EPA on 14 March 200

Summary of Results:

Pollutant	Unit of Measure	100 Percentile Concentration Limit	No. of Samples Required by Licence	No. of Samples Collected & Analysed	Lowest sample value	Highest sample value	Mean of samples	Sample Date								
								21/01/2016	19/02/2016	11/03/2016	13/04/2016	11/05/2016	20/06/2016	19/07/2016	19/08/2016	21/09/2016
Alkalinity (as $CaCO_3$)	mg/L	*No limits apply - sampling for monitoring purposes only*	4	4	110	180	141	180			135			140		
Aluminium (Al)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Arsenic (As)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Barium (Ba)	mg/L		2	2	0.1	0.1	0	0.1						0.1		
Cadmium (Cd)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Chromium (Cr)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Conductivity	uS/cm		4	4	580	1000	803	1000			580			850		
Copper (Cu)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Iron (Fe)	mg/L		2	2	0.01	0.02	0	0.01						0.02		
Lead (Pb)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Manganese (Mn)	mg/L		4	4	0.01	0.1	0	0.01			0.03			0.04		
Mercury (Hg)	mg/L		4	4	0.00001	0.0001	0	0.0001			0.0001			0.0001		
Nitrate + Nitrite (oxidised Nitrogen)	mg/L		4	4	0.1	0.28	0	0.1			0.2			0.28		
Nitrogen-Ammonia	mg/L		4	4	0.1	0.6	0	0.1			0.1			0.15		
Organochlorine Pesticides	ug/L		2	2	0.2	0.2	0	0.2						0.2		
Phenols	mg/L		2	2	0.01	0.1	0	0.01						0.1		
Polycyclic Aromatic Hydrocarbons	ug/L		2	2	5	5	5	5						5		
Selenium (Se)	mg/L		2	2	0.01	0.01	0	0.01						0.01		
Total Dissolved Solids	mg/L		4	4	380	640	523	640			380			560		
Total Organic Carbon	mg/L		4	4	6	10	8	10			8			6		
Total Petroleum Hydrocarbons	ug/L		2	2	100	100	100	100						100		
Zinc (Zn)	mg/L		2	2	0.01	0.04	0	0.01						0.04		
pH	pH		12	12	6.9	8.1	7	7.3	7.4	7.2	7.5	7.7	6.9	7.6	7.4	7.5

Sampling frequency

Every month
Every 3 months
Every 6 months

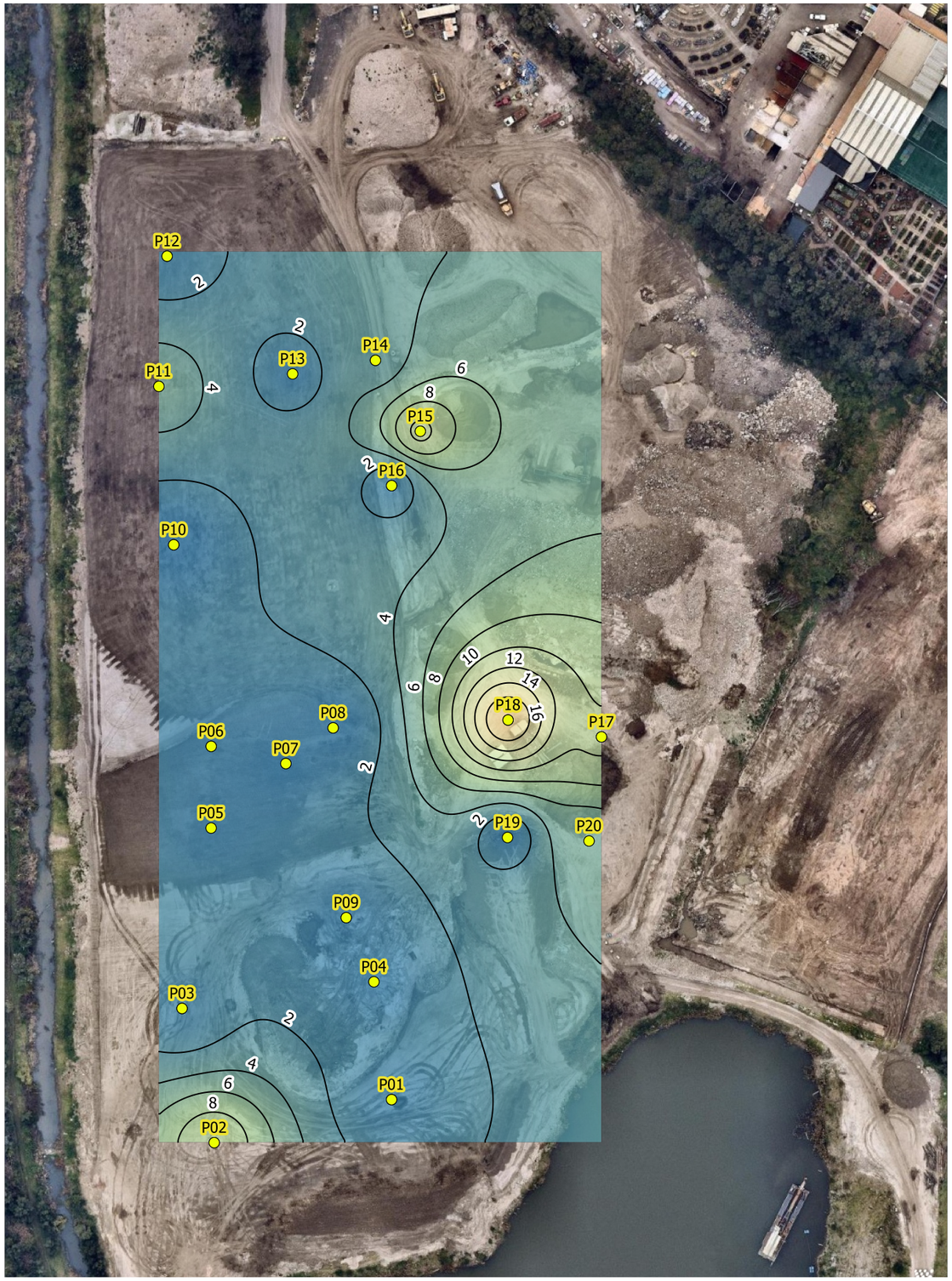
AMMONIA WATER SAMPLING LOCATIONS

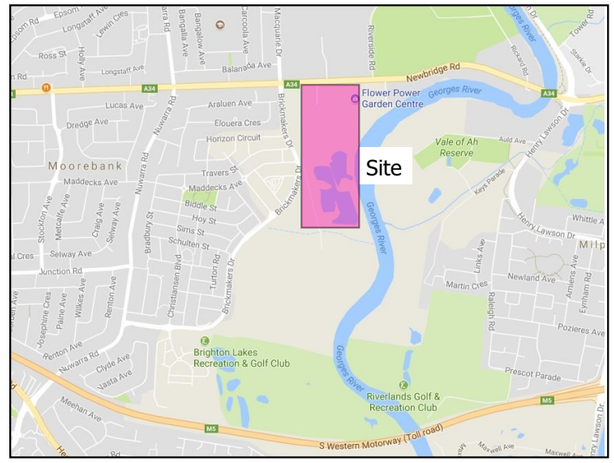
AMMONIUM NITROGEN mg/L		MBK pond monitoring points in house				Comments
	Georges River	Mix A,B,C	A	B	C	
23/01/2017	<0.1	N/T	<0.1	0.1	<0.1	No dredging
17/01/2017	<0.1	N/T	<0.1	<0.1	<0.1	No dredging
10/01/2017	<0.1	N/T	<0.1	0.1	<0.1	No dredging
19/12/2016	0.4	N/T	0.2	0.2	0.1	No dredging
14/12/2016	<0.1	N/T	<0.1	0.2	<0.1	No dredging
6/12/2016	<0.1	N/T	0.2	0.3	0.2	No dredging
30/11/2016	<0.1	N/T	0.2	0.6	0.2	No dredging
23/11/2016	0.1	N/T	0.4	0.4	0.4	No dredging
18/11/2016	0.3	N/T	0.5	0.5	0.5	No dredging
9/11/2016	<0.1	N/T	0.8	0.8	0.8	No dredging
4/11/2016	0.3	N/T	1.1	1.1	1.1	No dredging
28/10/2016	<0.1	N/T	1.5	1.4	1.4	No dredging
19/10/2016	0.5	N/T	0.6	0.6	0.6	Dredging
11/10/2016	<0.1	N/T	0.5	0.5	0.5	No dredging
7/10/2016	<0.1	N/T	0.7	0.7	0.7	No dredging
28/09/2016	<0.1	N/T	1.2	1.2	1.2	No dredging
20/09/2016	0.2	N/T	1.2	1.2	1.1	No dredging
13/09/2016	0.2	N/T	1.2	0.9	1.0	No dredging
7/09/2016	0.7	N/T	0.7	0.6	0.6	Dredging
31/08/2016	0.4	N/T	0.5	0.5	0.7	No dredging
26/08/2016	0.4	N/T	0.6	0.5	0.6	No dredging
19/08/2016	0.1	N/T	0.7	0.6	0.7	No dredging
11/08/2016	0.3	N/T	0.7	0.7	0.7	No dredging
5/08/2016	0.5	N/T	0.6	0.6	0.6	No dredging
28/07/2016	0.6	N/T	0.8	0.7	0.7	No dredging
22/07/2016	0.6	N/T	0.8	0.6	0.9	No dredging
14/07/2016	0.4	N/T	0.9	1	0.8	No dredging
8/07/2016	N/T	N/T	0.8	0.7	0.7	No dredging
1/07/2016	0.4	N/T	1.0	1.0	0.9	No dredging
23/06/2016	N/T	N/T	0.9	0.6	0.9	No dredging

16/06/2016	N/T	N/T	0.5	0.4	0.4	No dredging
9/06/2016	N/T	N/T	0.5	0.3	0.3	No dredging
3/06/2016	N/T	N/T	0.7	0.7	0.6	No dredging
27/05/2016	N/T	N/T	0.4	0.5	0.4	No dredging
20/05/2016	N/T	N/T	0.3	0.3	0.3	No dredging
12/05/2016	N/T	N/T	0.3	0.5	0.3	No dredging
5/05/2016	N/T	N/T	0.2	0.4	0.1	No dredging
28/04/2016	N/T	N/T	0.1	<0.1	<0.1	No dredging
22/04/2016	N/T	N/T	<0.1	<0.1	<0.1	No dredging
14/04/2016	N/T	N/T	<0.1	<0.1	<0.1	No dredging
8/04/2016	N/T	N/T	0.1	0.3	0.2	No dredging
1/04/2016	N/T	N/T	0.2	0.3	0.2	No dredging
24/03/2016	N/T	N/T	<0.1	0.4	0.1	No dredging
18/03/2016	N/T	N/T	<0.1	<0.1	<0.1	No dredging
11/03/2016	N/T	N/T	<0.1	0.1	0.1	No dredging
4/03/2016	N/T	N/T	0.4	0.5	0.3	No dredging
26/02/2016	N/T	N/T	<0.1	<0.1	<0.1	No dredging
19/02/2016	N/T	N/T	0.3	0.2	0.3	No dredging
10/02/2016	N/T	N/T	0.4	0.4	0.4	No dredging
5/02/2016	N/T	N/T	1.0	0.9	1.1	No dredging
29/01/2016	N/T	N/T	1.5	1.5	1.6	No dredging
22/01/2016	N/T	1.3				No dredging
15/01/2016	N/T	0.5				No dredging
8/01/2016	N/T	1.7				No dredging
18/12/2015	N/T	5.6				No dredging - 23/12/15 - 5/1/16
11/12/2015	N/T	2.9				Dredging
4/12/2015	N/T	3.3				Dredging
27/11/2015	N/T	3.5				Dredging
20/11/2015	N/T	3.3				Dredging
13/11/2015	N/T	6.0				Dredging
6/11/2015	N/T	6.9				Dredging
30/10/2015	N/T	10				Dredging
23/10/2015	N/T	11				Dredging

16/10/2015	N/T	12				Dredging
12/10/2015	N/T	N/T				Dredging
8/10/2015	N/T	6.3				Dredging
1/10/2015	0.2	9.5	10	9.4	9.2	Dredging
25/09/2015	<0.1	9.4				Dredging
18/09/2015		3.5				Dredging

Douglas Partners (31 August 2018)
LFG Events 2018





Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Location

Methane Concentration %

- 0
- 7.5
- 15
- 22.5
- 30

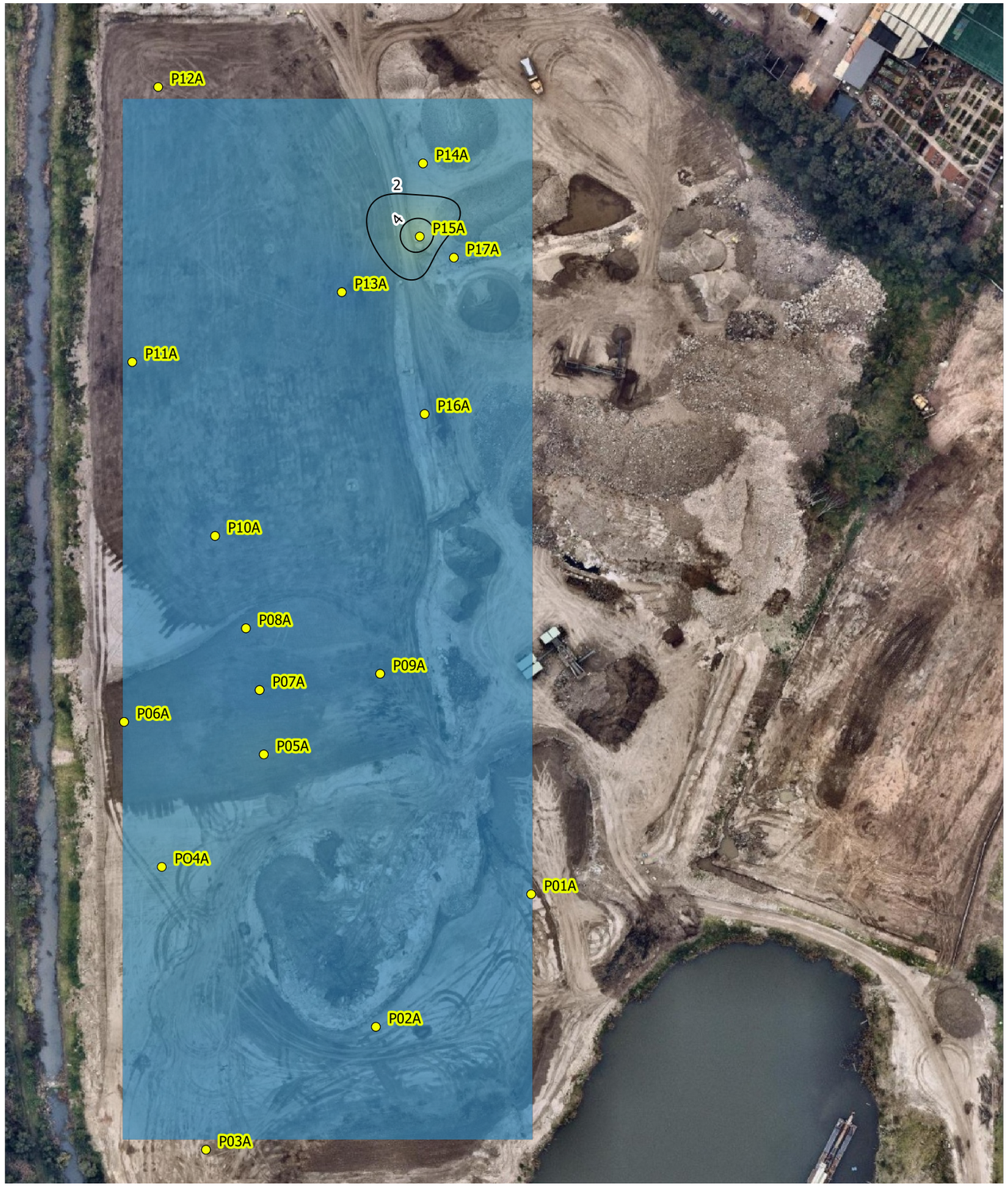
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:1700 @ A3	DATE:	6.10.2017

TITLE: **Validation Monitoring**
June 2017 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	1
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 7.5
- 15
- 22.5
- 30

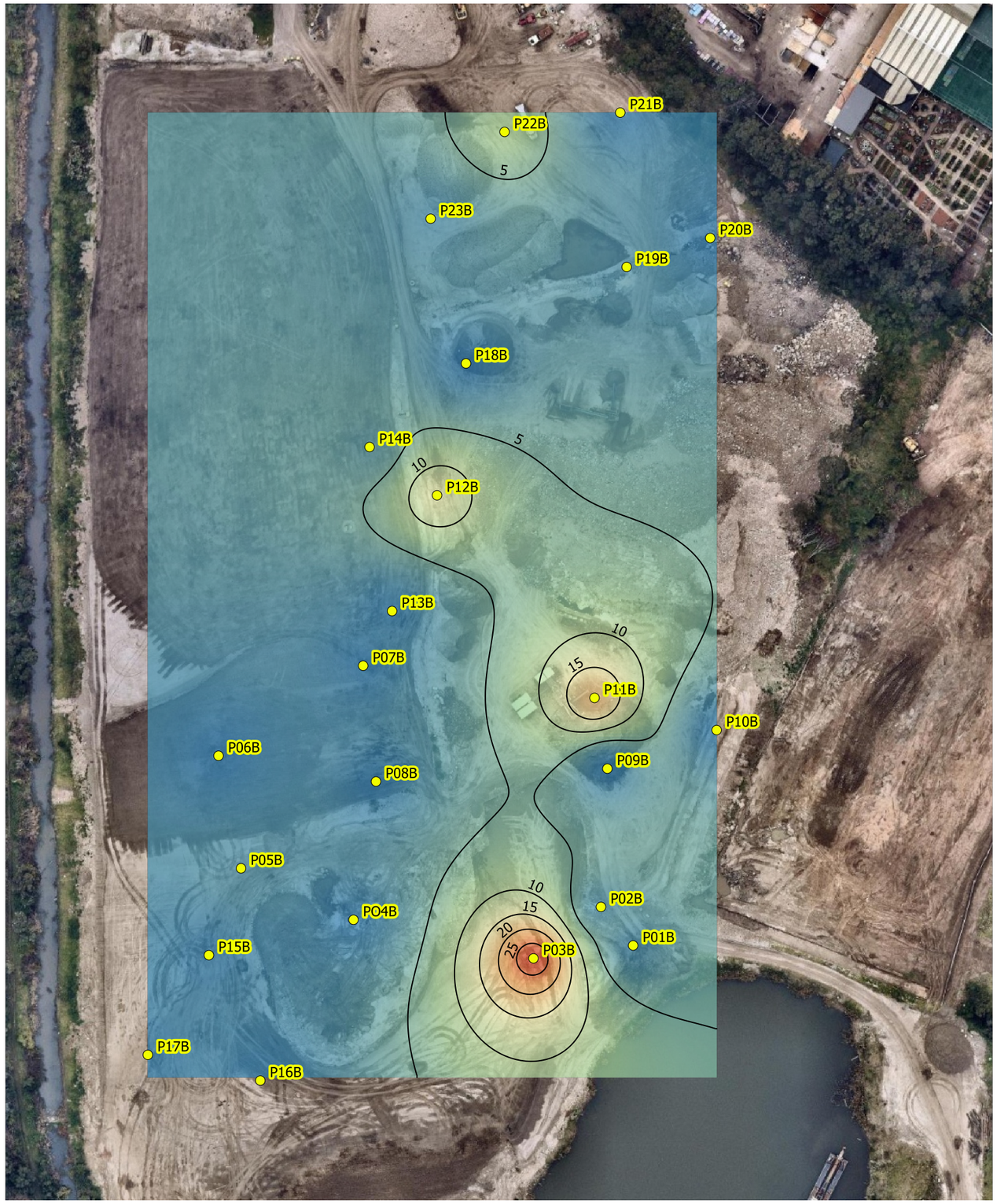
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:1500 @ A3	DATE:	21.9.2017

TITLE: **Validation Monitoring**
August Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	2
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 7.5
- 15
- 22.5
- 30

Source: Nearmap, flown 09 August 2017

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:1500 @ A3	DATE:	03.11.2017

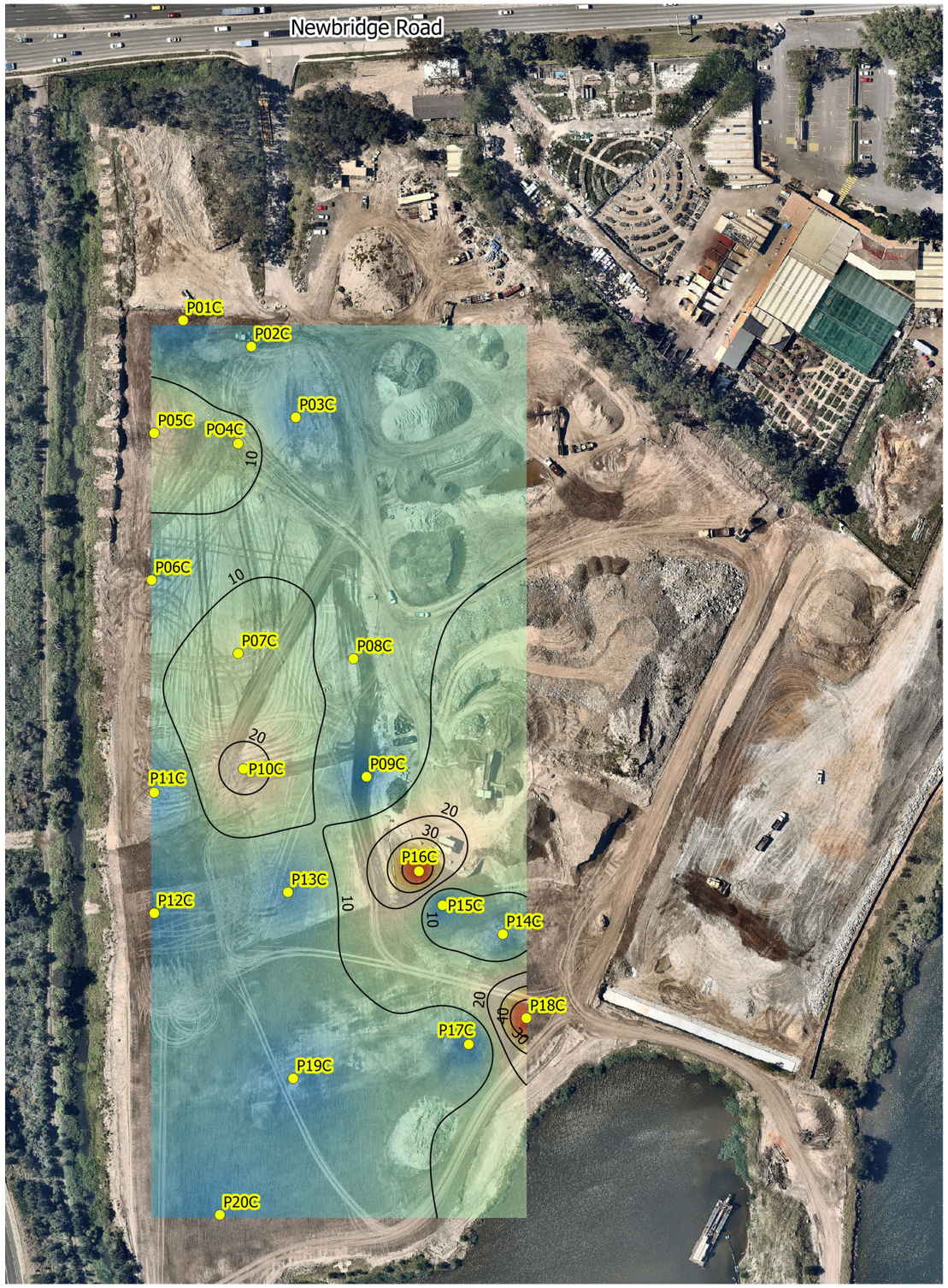
TITLE: **Validation Monitoring**

October 2017 Methane Concentration Map

146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	3
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 12.5
- 25
- 37.5
- 50

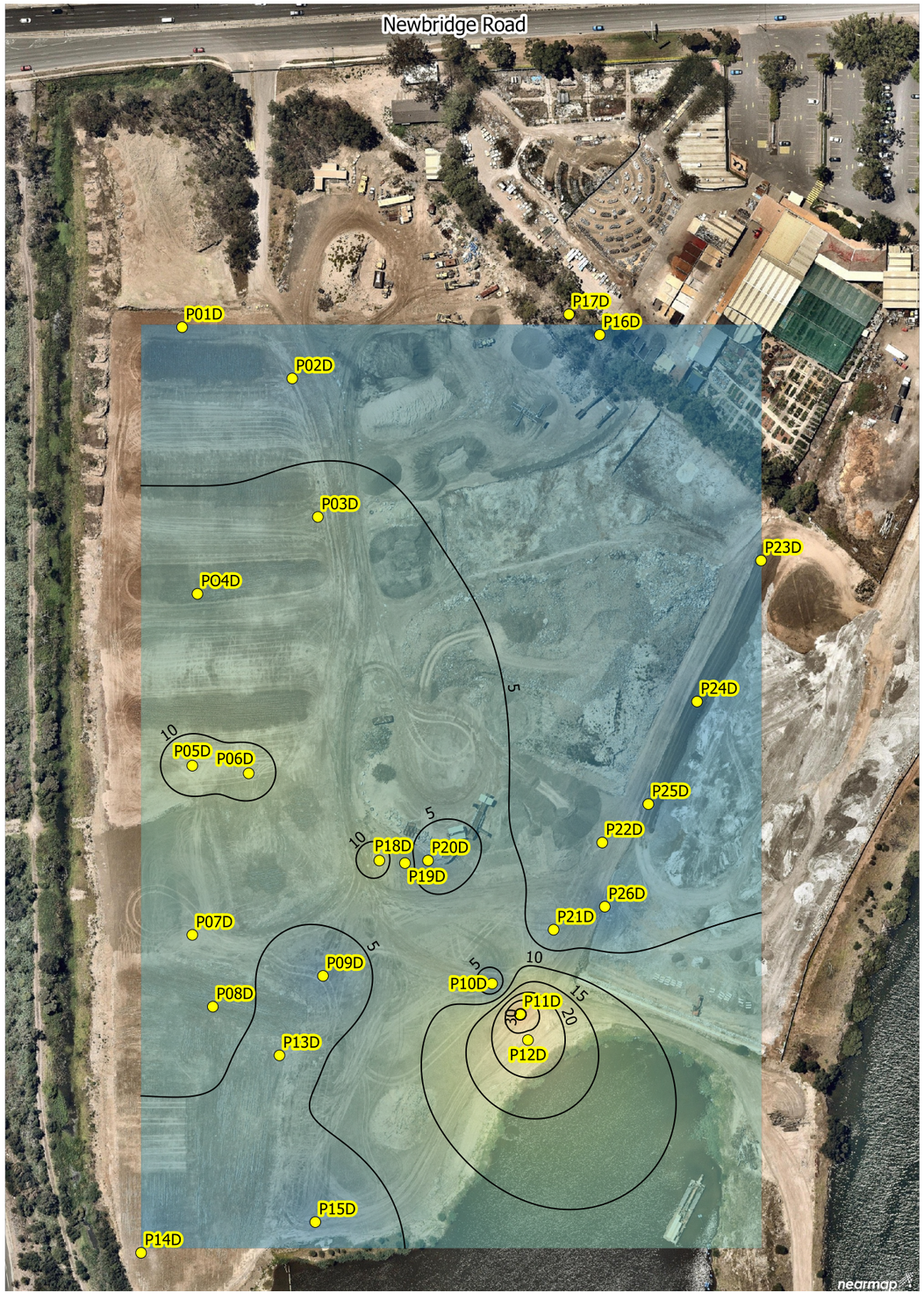
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:2000 @ A3	DATE:	08.01.2018

TITLE: **Validation Monitoring**
December 2017 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 12.5
- 25
- 37.5
- 50

50 0 50 100 m

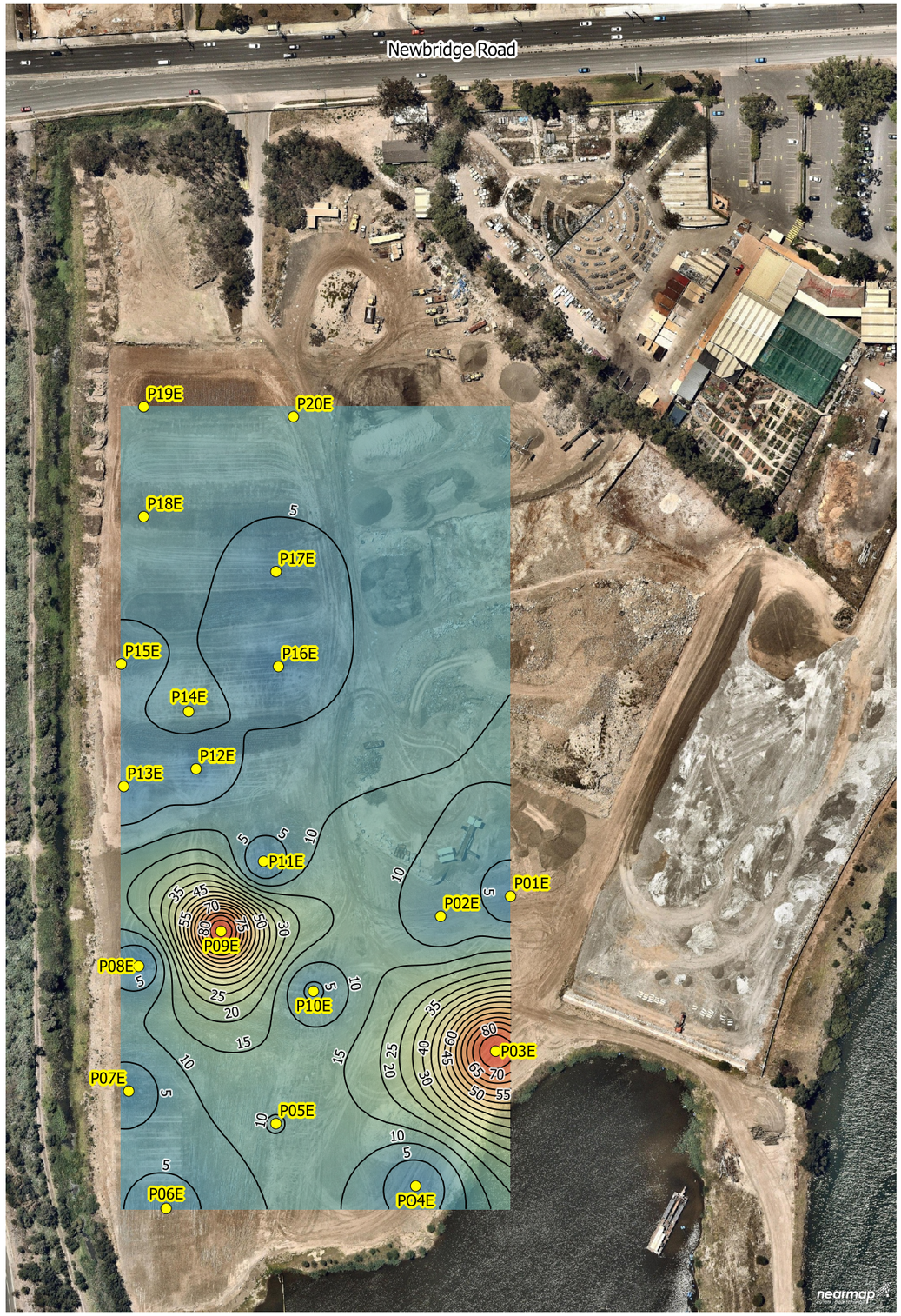
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:2100 @ A3	DATE:	16.03.2018

TITLE: **Validation Monitoring**
February 2018 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 15
- 30
- 45
- 60
- 75
- 90

50 0 50 100 m

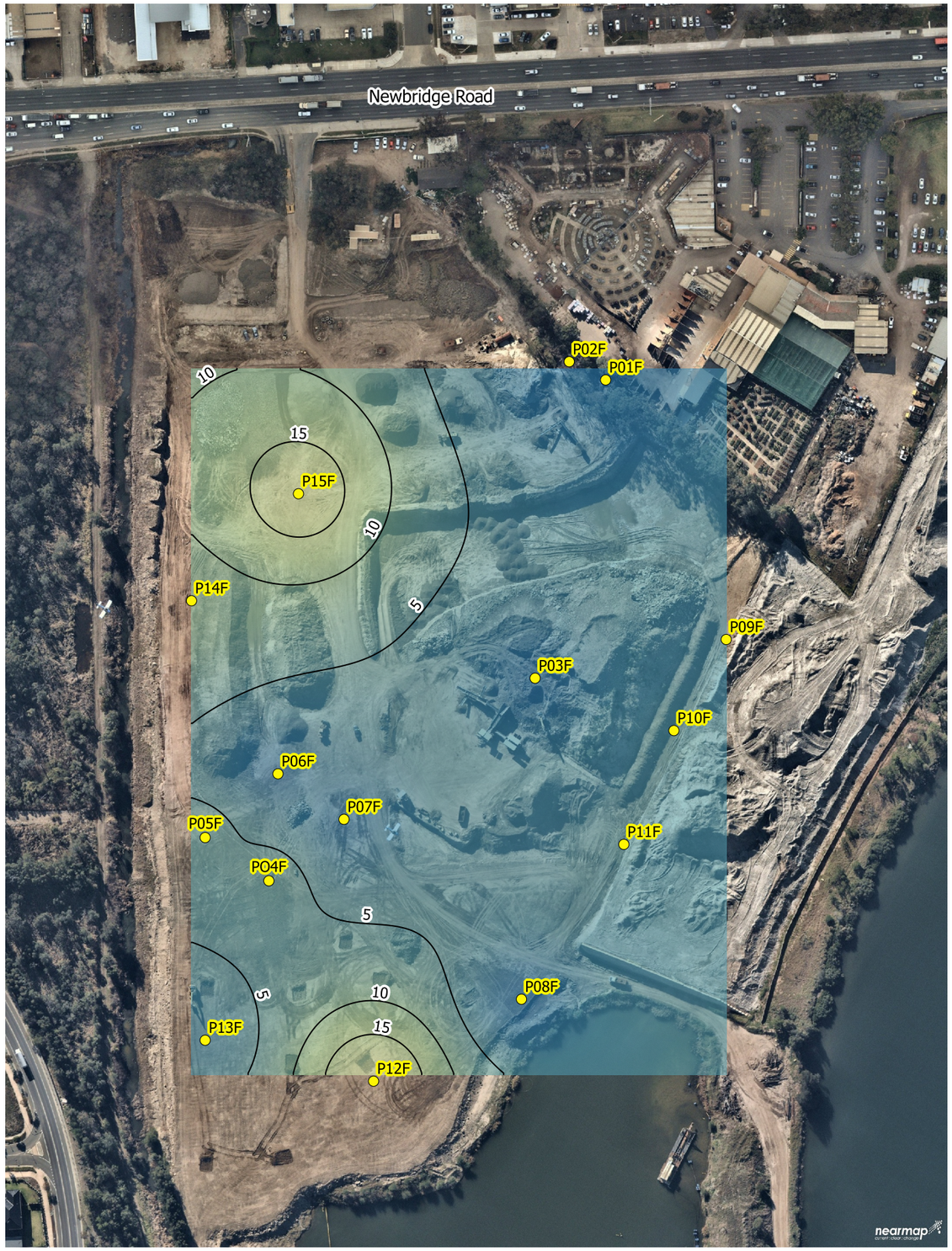
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	NW
SCALE:	1:2000 @ A3	DATE:	26.04.2018

TITLE: **Validation Monitoring**
April 2018 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 12.5
- 25
- 37.5
- 50

50 0 50 100 m

Douglas Partners
Geotechnics / Environment / Groundwater

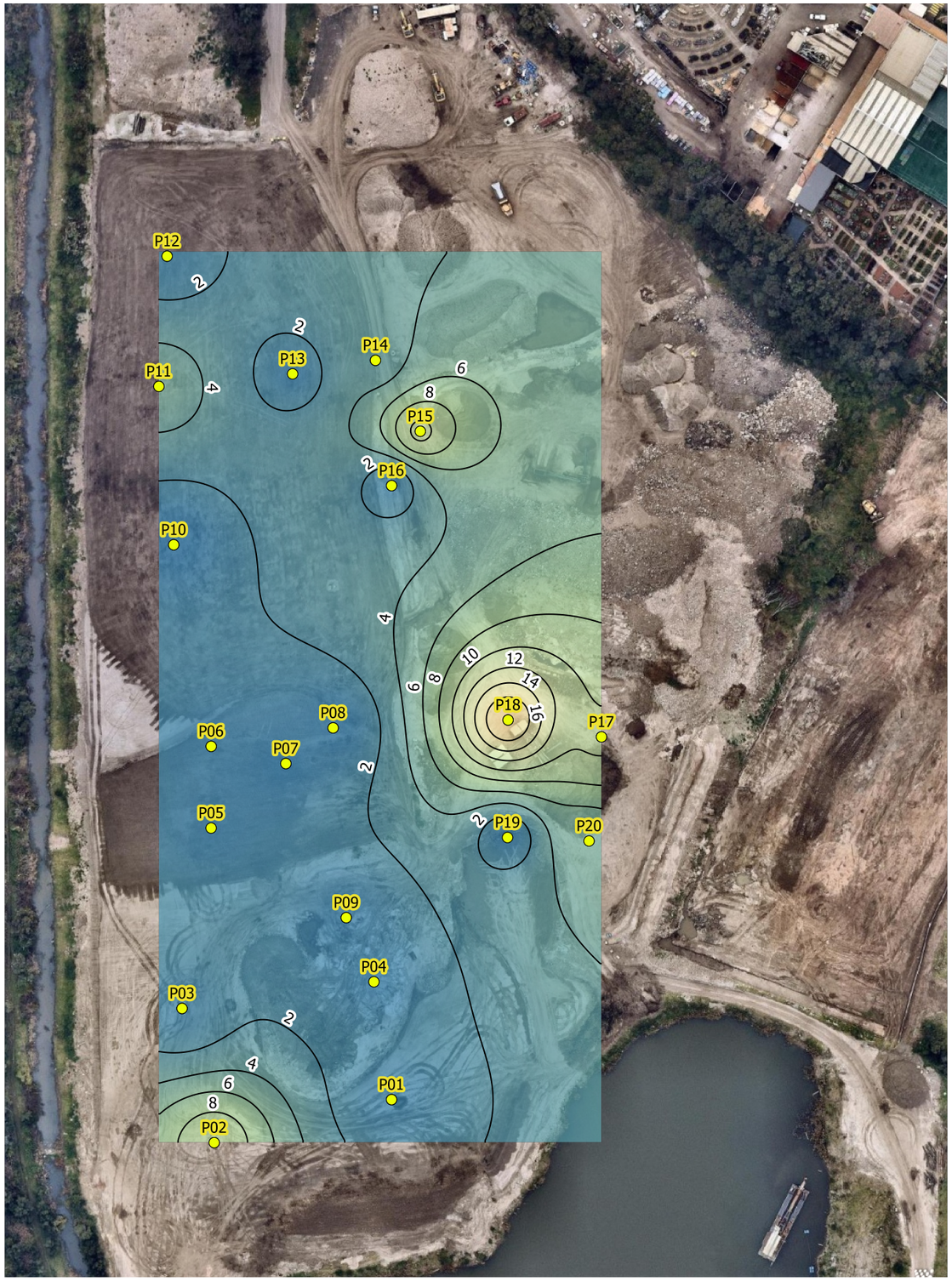
CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	NW
SCALE:	1:2000 @ A3	DATE:	17.8.2018

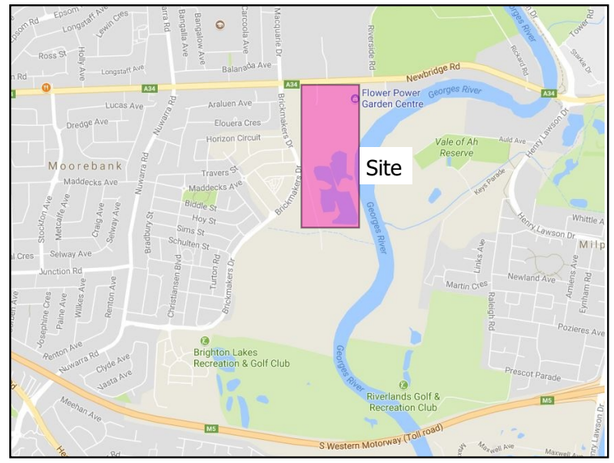
TITLE: **Validation Monitoring**
August 2018 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	7
REVISION:	0

Douglas Partners (17 September 2018)
Data Summary Report





Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Location

Methane Concentration %

- 0
- 7.5
- 15
- 22.5
- 30

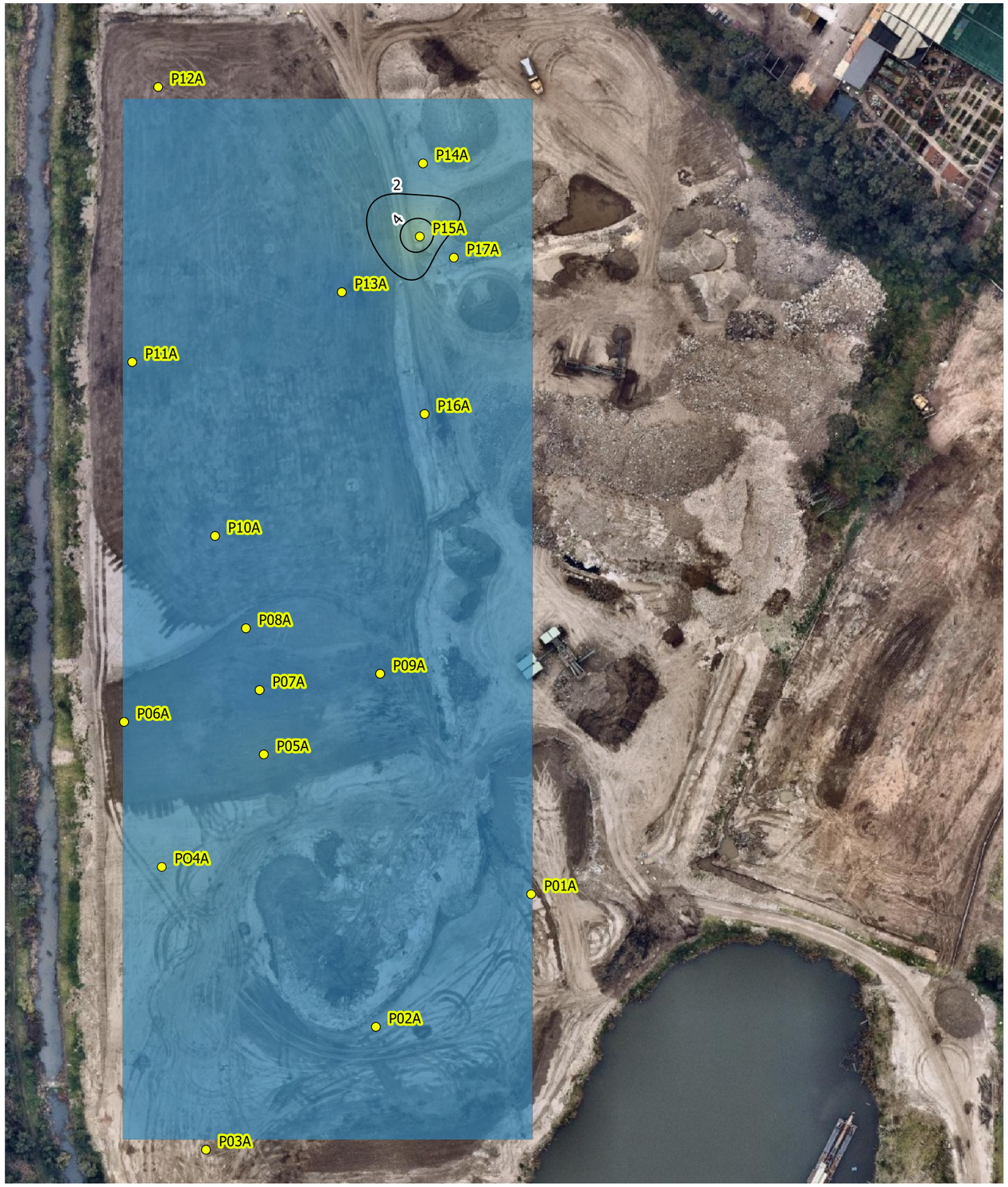
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:1700 @ A3	DATE:	6.10.2017

TITLE: **Validation Monitoring**
June 2017 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	1
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 7.5
- 15
- 22.5
- 30

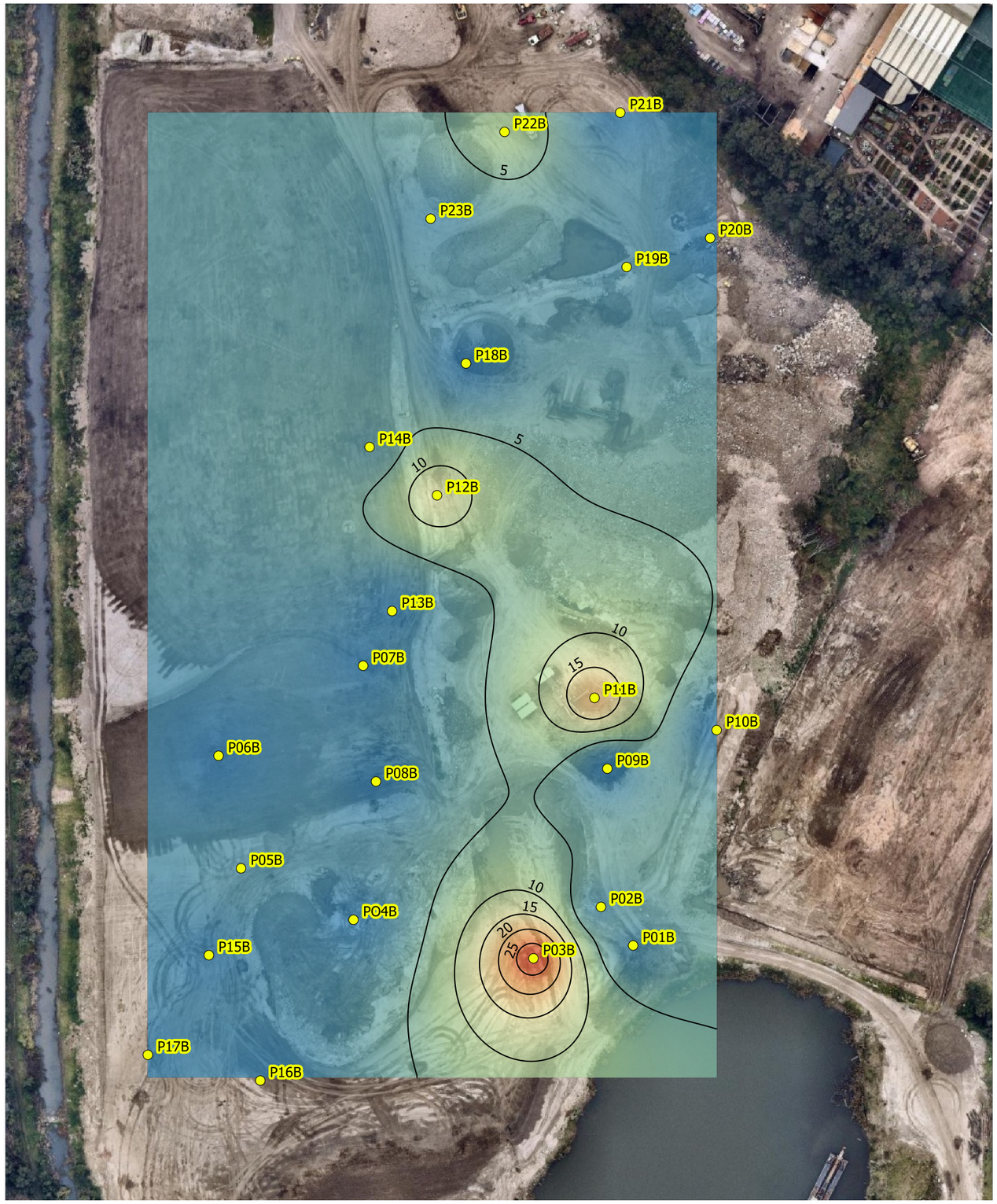
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:1500 @ A3	DATE:	21.9.2017

TITLE: **Validation Monitoring**
August Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	2
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 7.5
- 15
- 22.5
- 30

Source: Nearmap, flown 09 August 2017

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:1500 @ A3	DATE:	03.11.2017

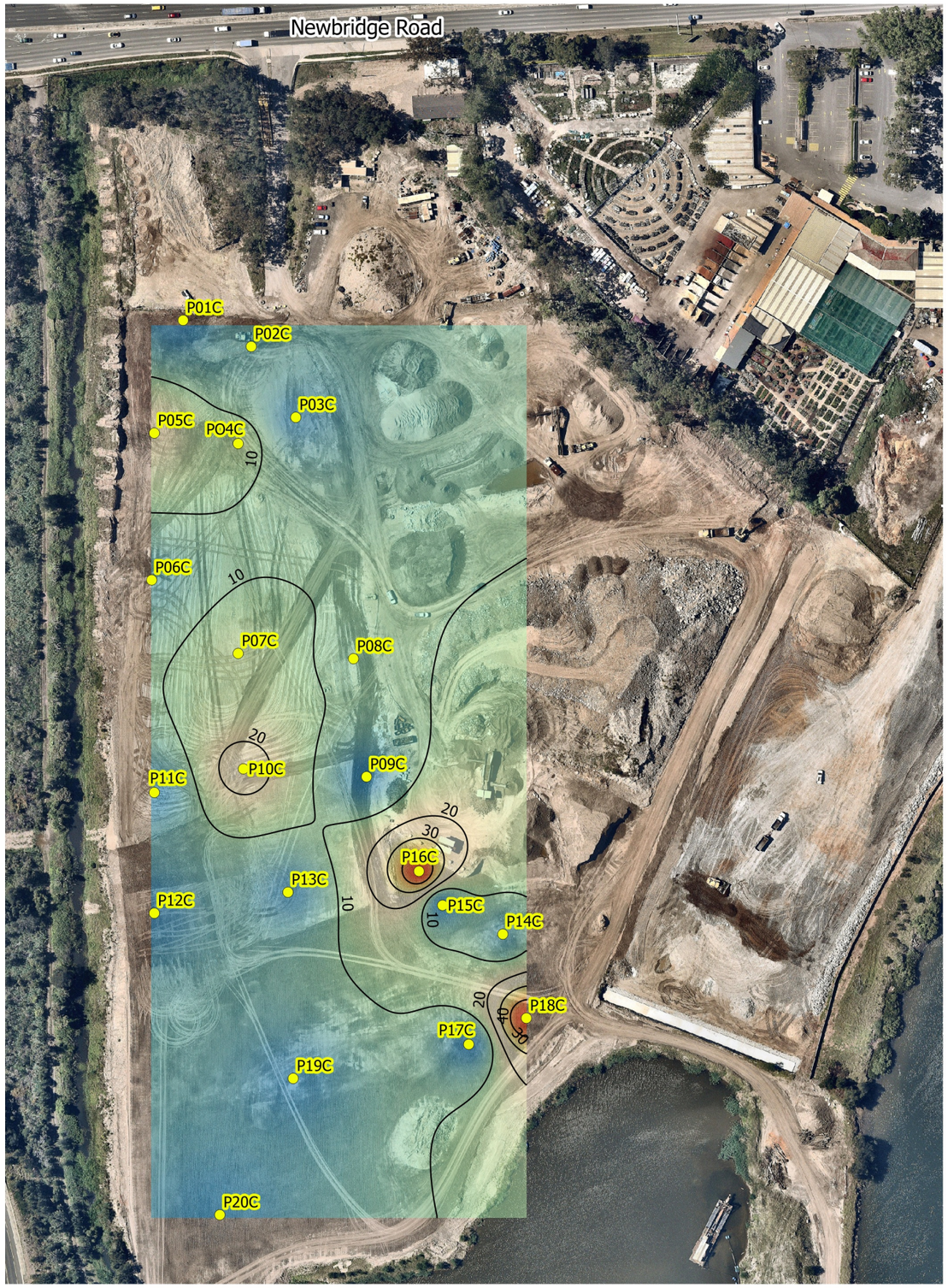
TITLE: **Validation Monitoring**

October 2017 Methane Concentration Map

146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	3
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 12.5
- 25
- 37.5
- 50

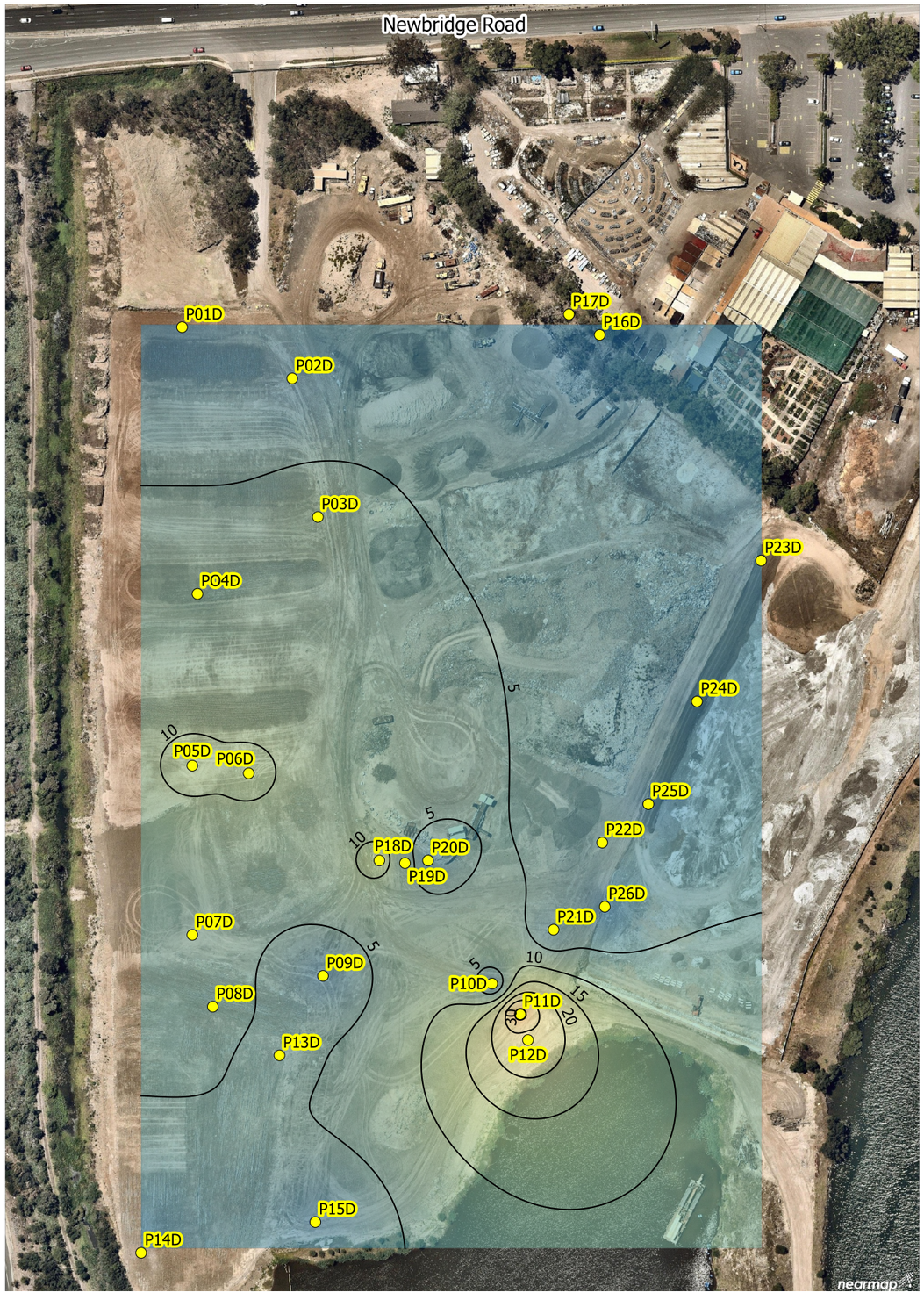
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:2000 @ A3	DATE:	08.01.2018

TITLE: **Validation Monitoring**
December 2017 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 12.5
- 25
- 37.5
- 50

50 0 50 100 m

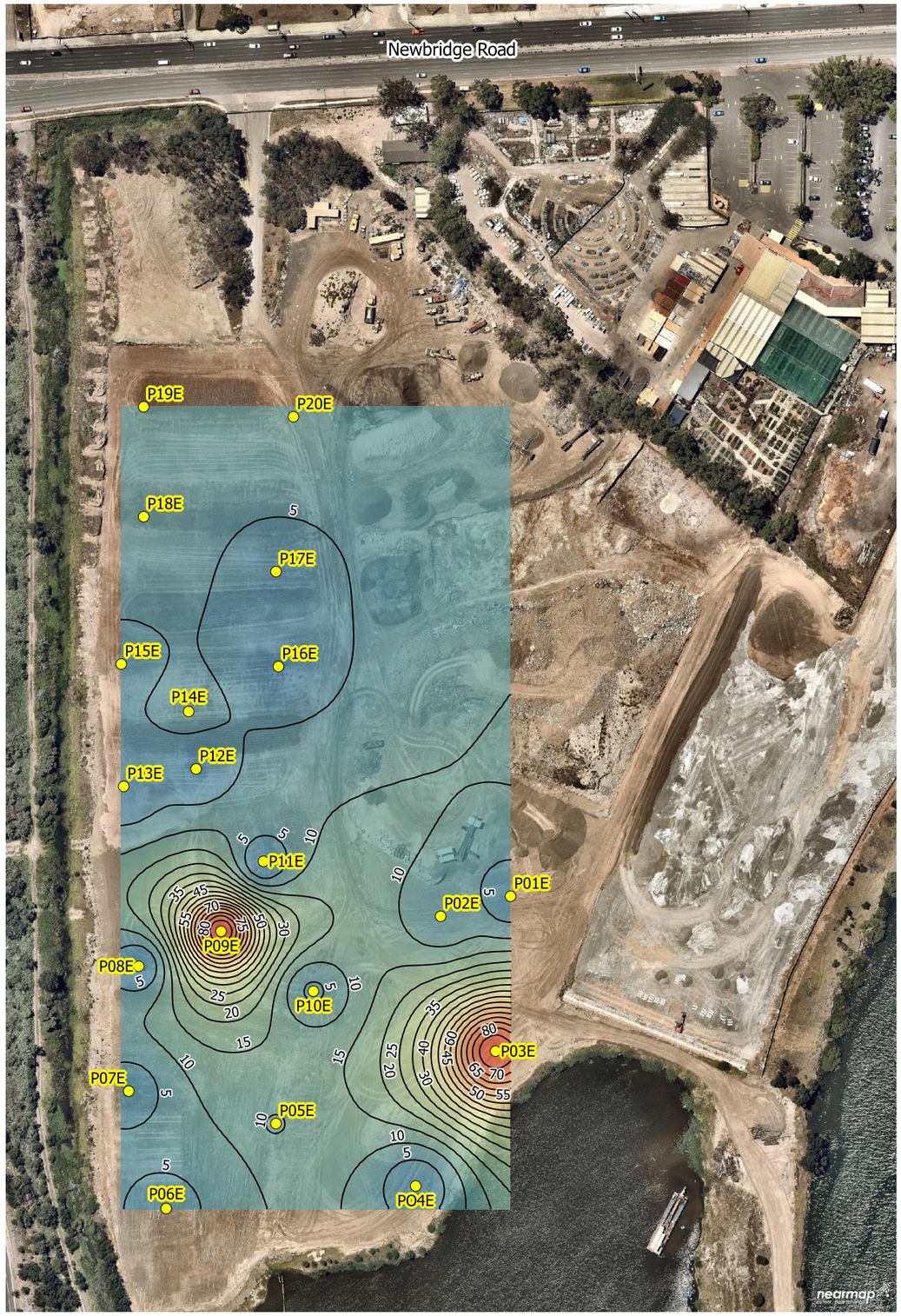
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	CB
SCALE:	1:2100 @ A3	DATE:	16.03.2018

TITLE: **Validation Monitoring**
February 2018 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 15
- 30
- 45
- 60
- 75
- 90

50 0 50 100 m

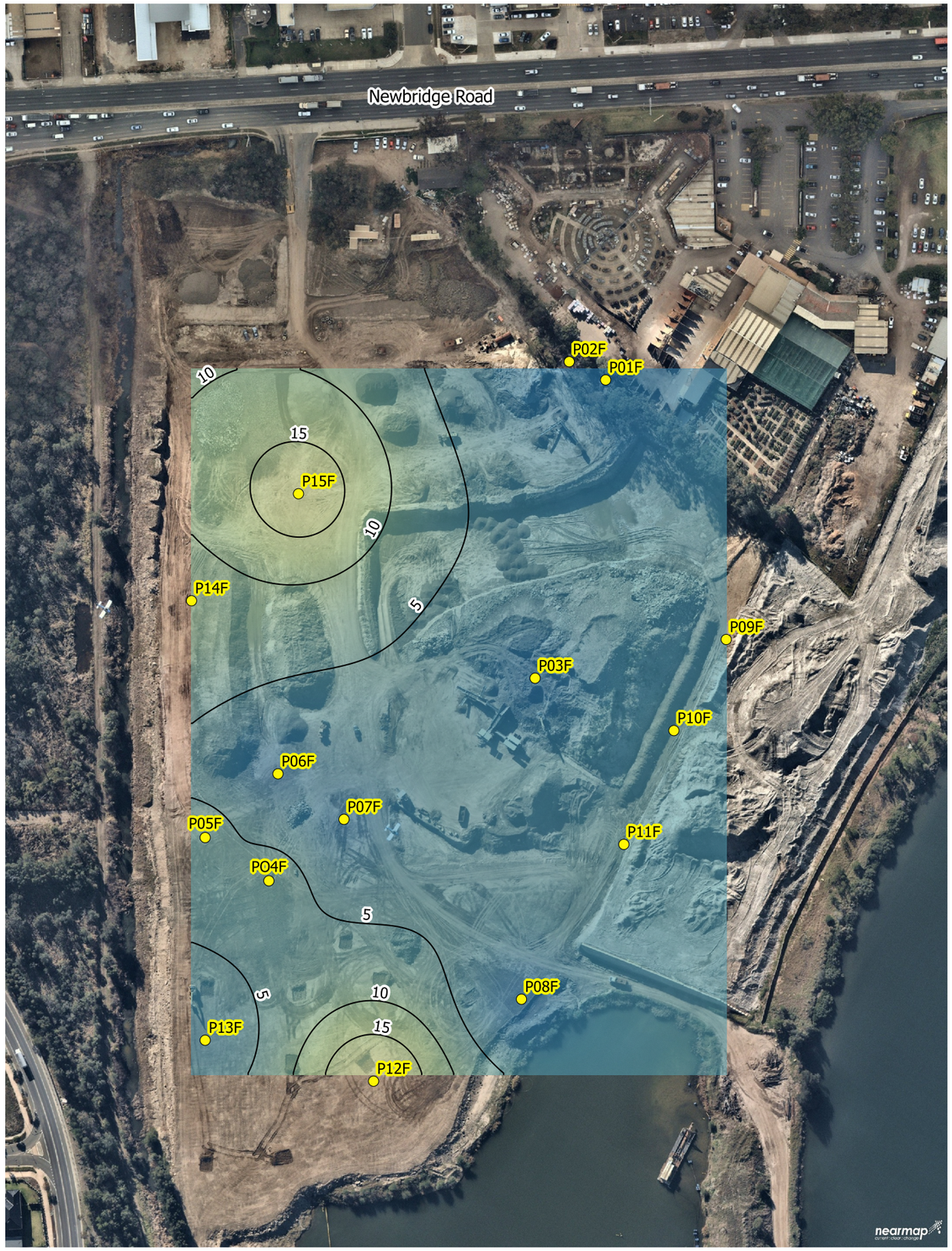
Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	NW
SCALE:	1:2000 @ A3	DATE:	26.04.2018

TITLE: **Validation Monitoring**
April 2018 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	
REVISION:	0



Locality Plan

Legend

- Peak Methane Concentration %
- Gas Sampling Points

Methane Concentration %

- 0
- 12.5
- 25
- 37.5
- 50

50 0 50 100 m

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Benedict Pty Ltd		
OFFICE:	Sydney	DRAWN BY:	NW
SCALE:	1:2000 @ A3	DATE:	17.8.2018

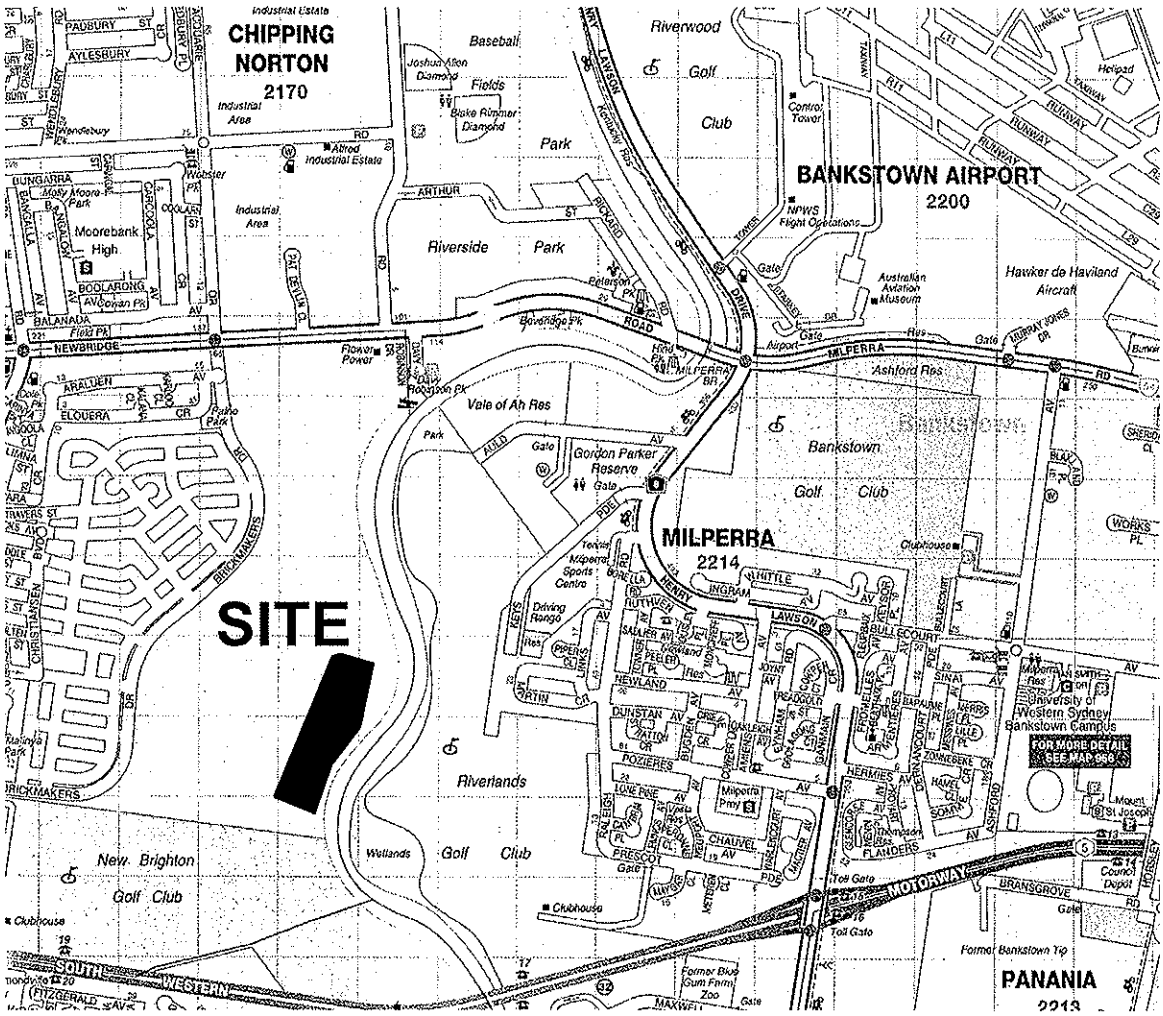
TITLE: **Validation Monitoring**
August 2018 Methane Concentration Map
146 Newbridge Road, Moorebank

N

PROJECT No:	71459.09
DRAWING No:	7
REVISION:	0

Appendix C. Figures & Tables from Investigation Reports for Lot 6 Southern Landfill

EIS (June 2009)
ESA



Recreated from UBD
Sydney
Ref: 270 E10

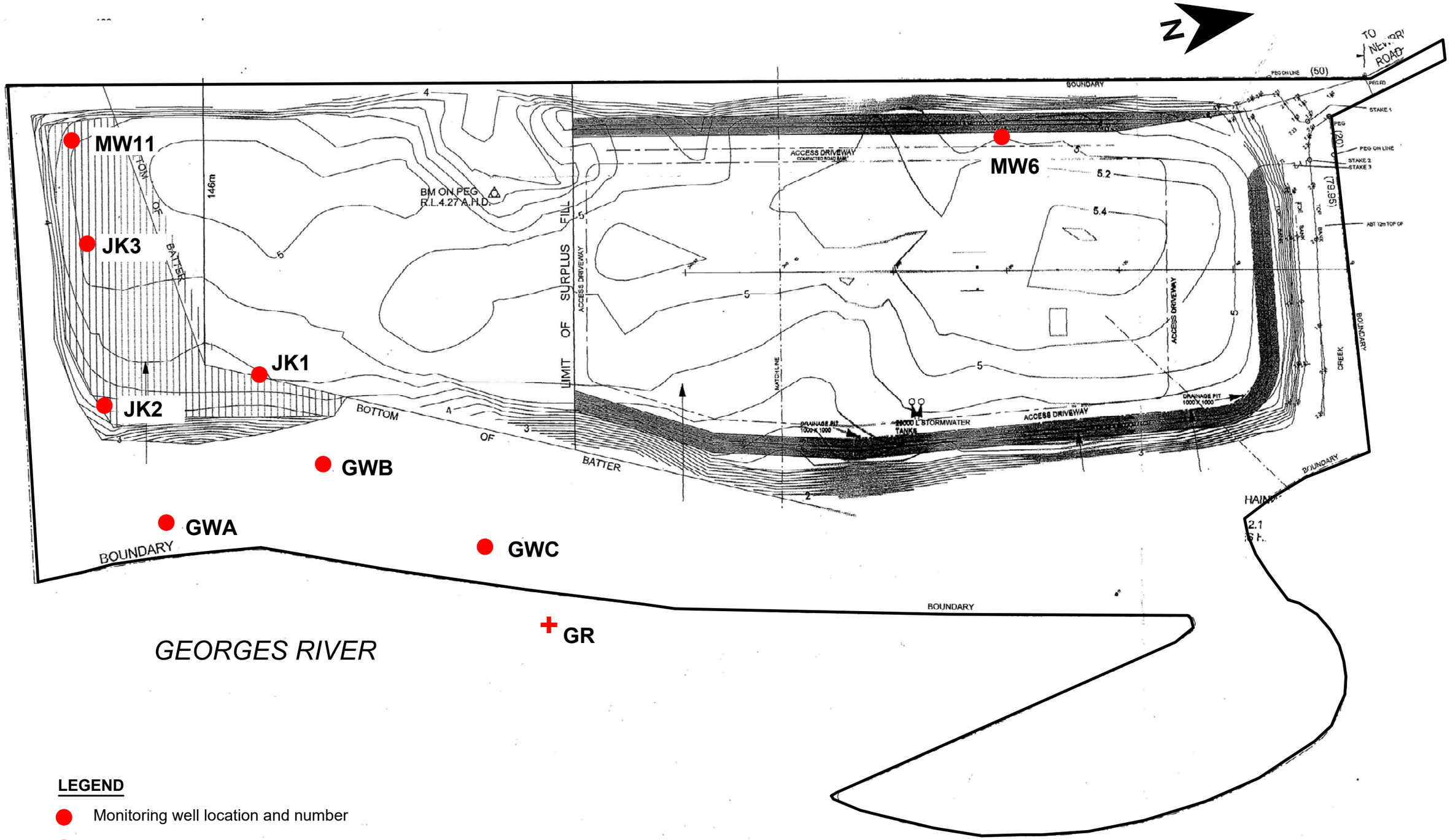
SITE LOCATION PLAN

Lot 6, DP1065574,
Newbridge Road,
MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22833K
Figure: 1

Note: Reference should be made to the text for a full understanding of this plan



LEGEND

- Monitoring well location and number
- Approximate location of river sample

Note: Reference should be made to the text for a full understanding of this plan

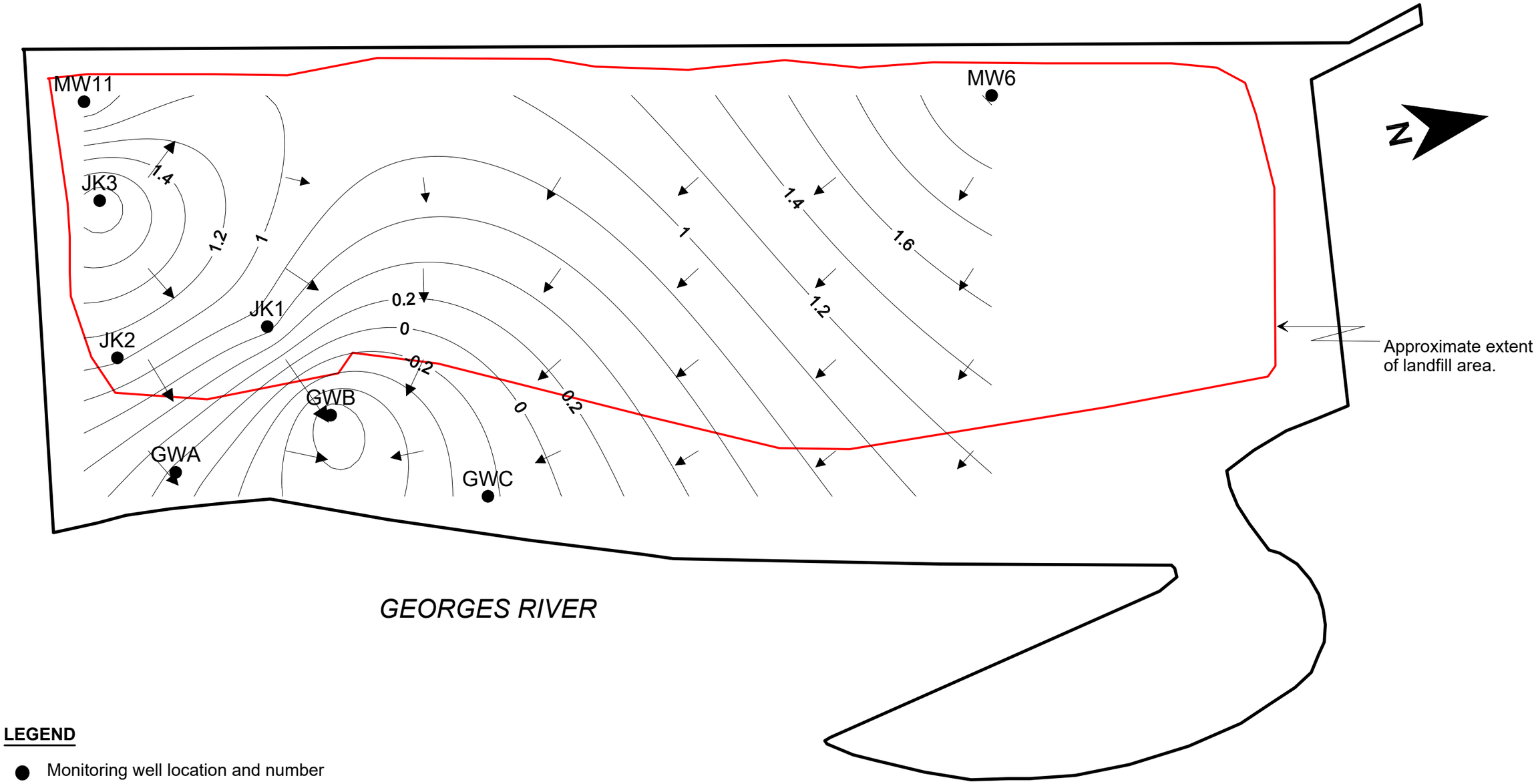
Scale (m)

0 5 10 15 20 25 50 75 100 125 150 175 200 225 250

SITE SURVEY PLAN AND BOREHOLE LOCATION PLAN
Lot 6, DP1065574, Newbridge Road, MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22833K
Figure: 2



LEGEND

● Monitoring well location and number

Arrows show the direction of groundwater flow calculated from groundwater data. The groundwater contours have been claculated form a limited series of data points and may not be an accurate representation of ther actual conditions.

Approximate scale (m)

0 30 60 90 120 150

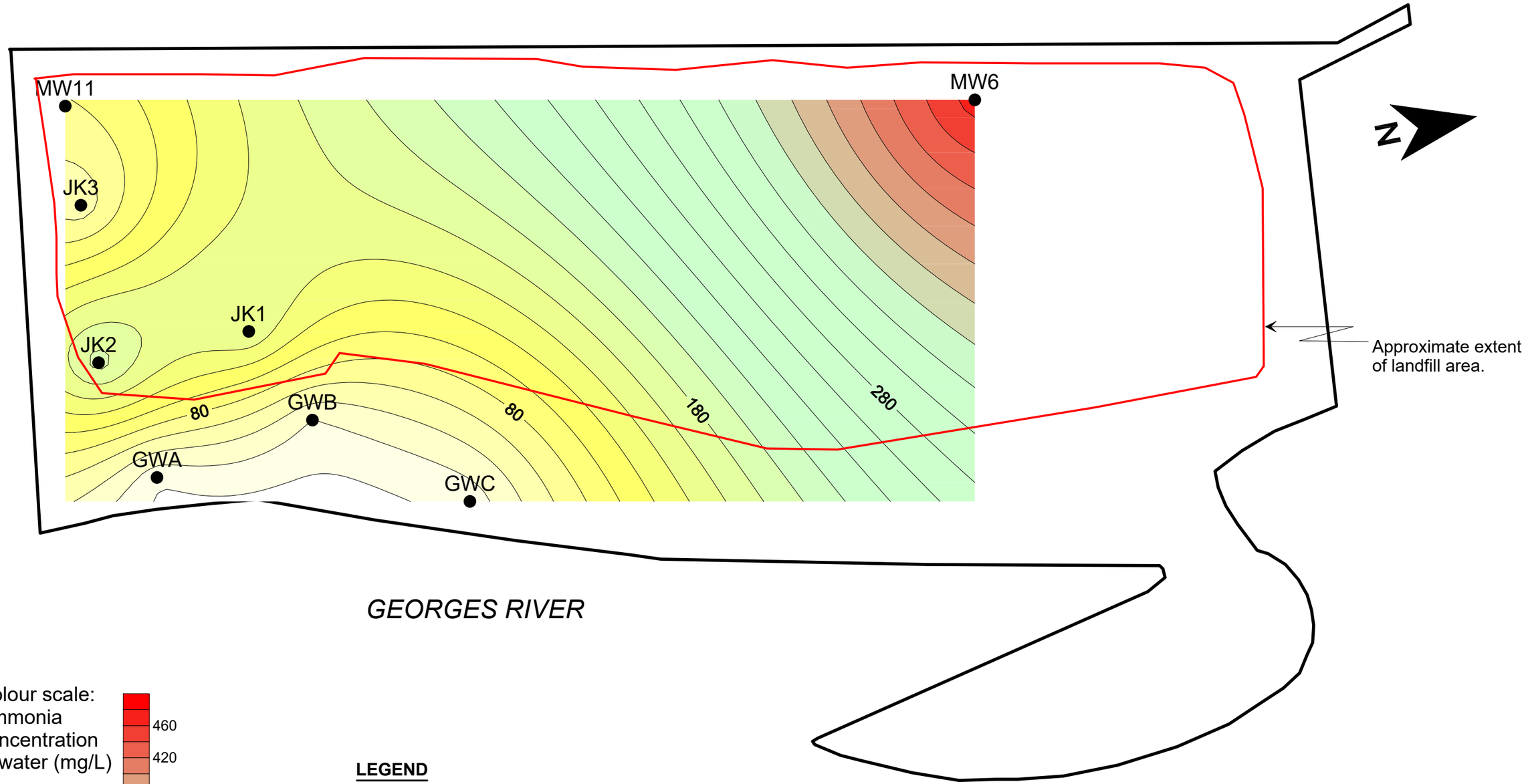
Note: Reference should be made to the text for a full understanding of this plan

GROUNDWATER CONTOUR PLAN

Lot 6, DP1065574,
Newbridge Road,
MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22833K
Figure: 3



Colour scale: Ammonia concentration in water (mg/L)

460
420
380
340
300
260
220
180
140
100
60
20
-20

LEGEND

● Monitoring well location and number

The contours have been calculated form a limited series of data points and may not be an accurate representation of ther actual conditions.

Approximate scale (m)

0 30 60 90 120 150

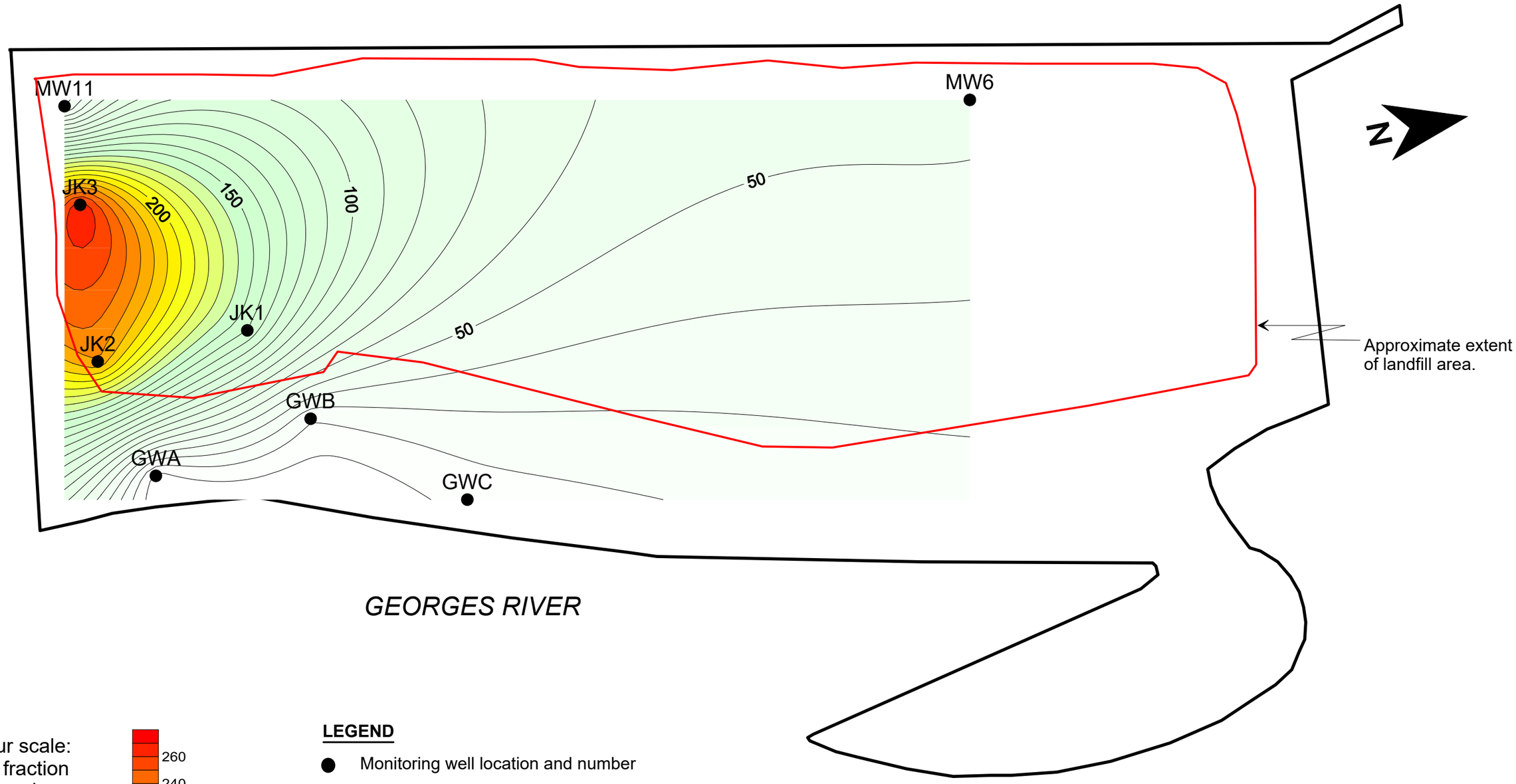
Note: Reference should be made to the text for a full understanding of this plan

CONTOUR PLAN: AMMONIA IN GROUNDWATER

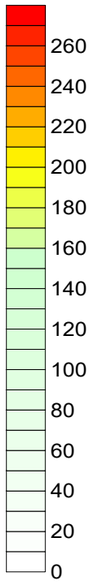
Lot 6, DP1065574,
Newbridge Road,
MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22833K
Figure: 4



Colour scale:
Light fraction
hydrocarbon
contration
in water (mg/L)



LEGEND

● Monitoring well location and number

The contours have been calculated form a limited series of data points and may not be an accurate representation of ther actual conditions.

Approximate scale (m)

0 30 60 90 120 150

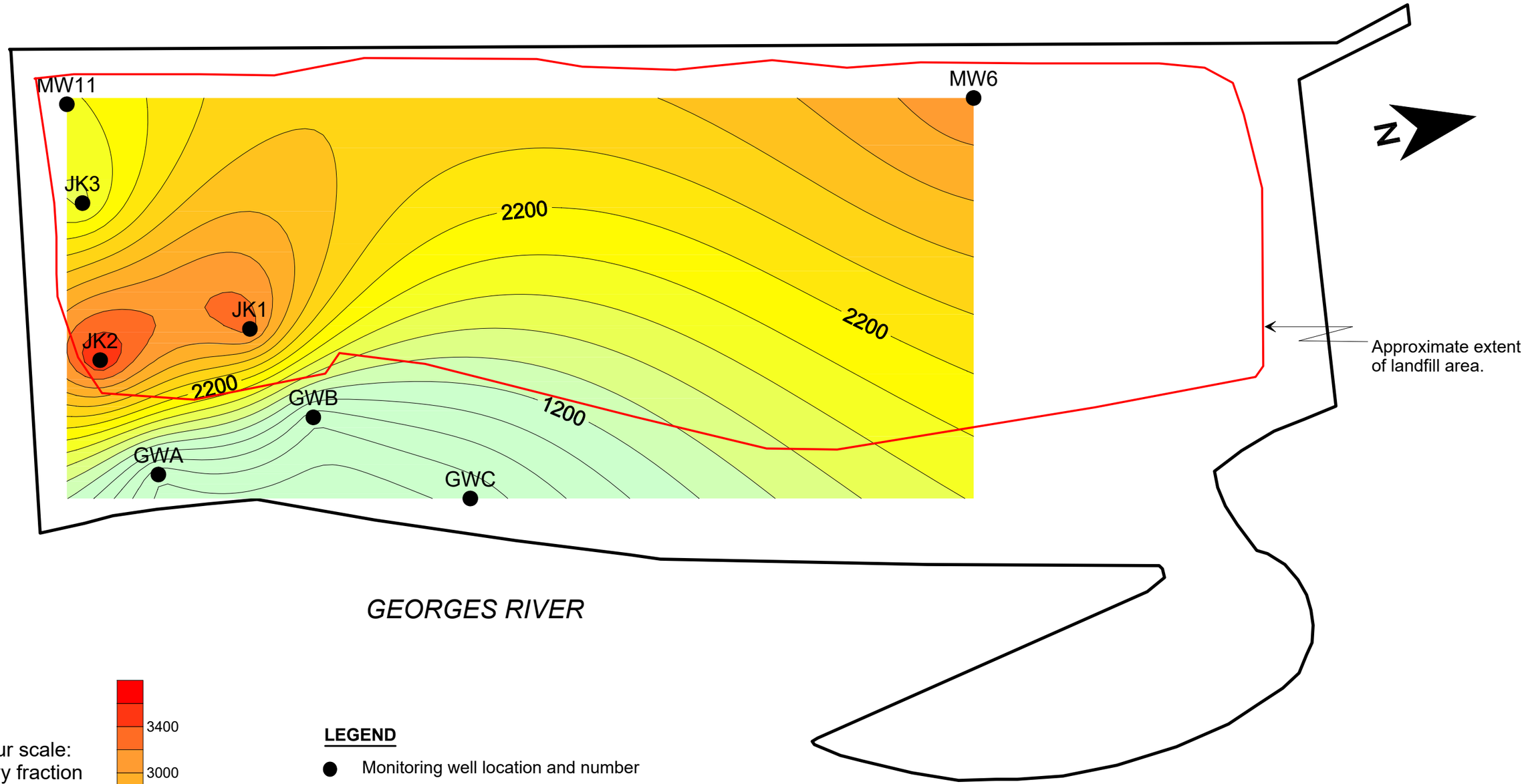
Note: Reference should be made to the text for a full understanding of this plan

CONTOUR PLAN: LIGHT FRACTION HYDROCARBONS IN GROUNDWATER

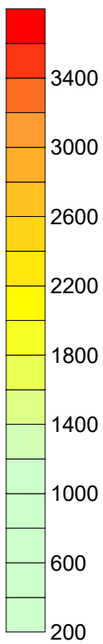
Lot 6, DP1065574,
Newbridge Road,
MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22833K
Figure: 5



Colour scale:
Heavy fraction
hydrocarbon
contration
in water (mg/L)

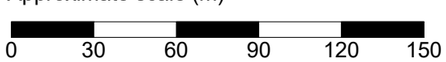


LEGEND

● Monitoring well location and number

The contours have been calculated form a limited series of data points and may not be an accurate representation of ther actual conditions.

Approximate scale (m)



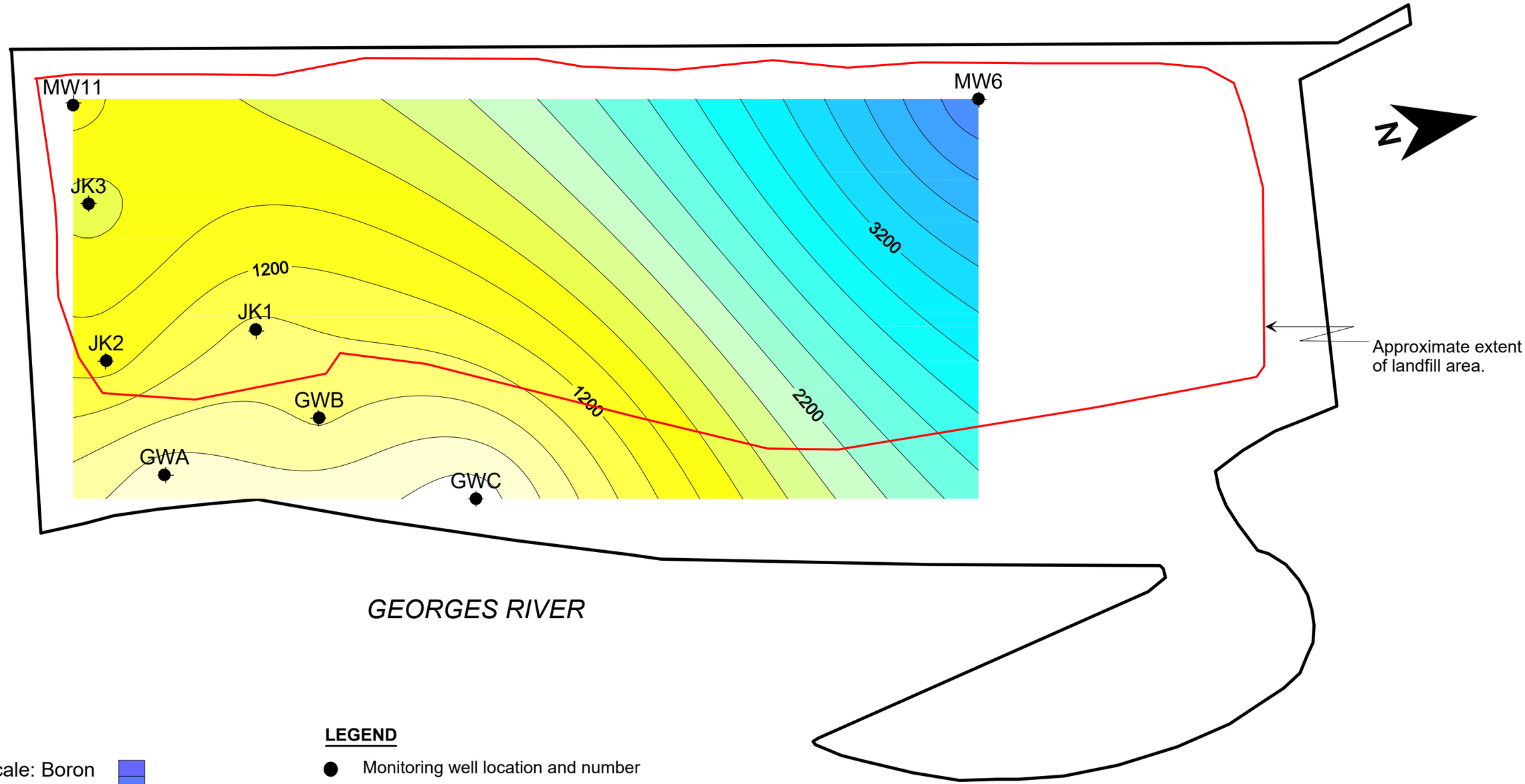
Note: Reference should be made to the text for a full understanding of this plan

CONTOUR PLAN: HEAVY FRACTION HYDROCARBONS IN GROUNDWATER

Lot 6, DP1065574,
Newbridge Road,
MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22833K
Figure: 6



Colour scale: Boron concentration in water (mg/L)

4200
3800
3400
3000
2600
2200
1800
1400
1000
600
200

LEGEND

● Monitoring well location and number

The contours have been calculated form a limited series of data points and may not be an accurate representation of ther actual conditions.

Approximate scale (m)

0 30 60 90 120 150

Note: Reference should be made to the text for a full understanding of this plan

CONTOUR PLAN: BORON IN GROUNDWATER

Lot 6, DP1065574,
Newbridge Road,
MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E22833K
Figure: 7

TABLE B
SUMMARY OF LABORATORY TEST DATA
SOIL CHARACTERISATION ASSESSMENT
All data in mg/kg unless stated otherwise

ANALYTE			HEAVY METALS								PAHs			ORGANOCHLORINE PESTICIDES					OP	PCBs	PETROLEUM HYDROCARBONS								PID
																					Petroleum Hydrocarbons					Benzene	Toluene	Ethyl Benzene	Total Xylenes	VALUES
			Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total PAHs	B(a)P	Total Phenols	Aldrin and Dieldrin	Chlordane	DDT, DDD & DDE	Heptachlor	PESTICIDES	PCBs	C_6-C_9	C_{10}-C_{14}	C_{15}-C_{28}	C_{29}-C_{36}	C_{10} - C_{36}					
PQL - Envirolab Services			4	0.5	1	1	1	0.1	1	1	-	0.05	5	0.1	0.1	0.1	0.1	0.1	0.1	25	50	100	100	250	0.5	0.5	1	3	
Site Assessment Criteria ^			500 *	100 *	60% *	5000 *	1500 *	75 *	3000 *	35000 *	100 *	5 *		50 *	250 *	1000 *	50 *	0.1 ^^	50 *	65 #	NSL	NSL	NSL	1000 #	1 #	1.4 #	3.1 #	14 #	
Location	Depth in met	DESCRIPTION																											
JK1	GL	Fill: silty clay	5	LPQL	15	13	25	LPQL	2	21	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK1	1-1.5	Fill: silty clay	LPQL	LPQL	38	24	11	LPQL	16	51	0.6	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	68	400	LPQL	518	LPQL	LPQL	LPQL	LPQL	0
JK1	2.5-3	Fill: silty clay	9	0.6	29	26	34	LPQL	12	***370***	5	<0.25	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	65	3000	2300	**5365**	LPQL	LPQL	LPQL	LPQL	0
JK2	GL	Fill: silty clay	9	0.6	23	14	38	LPQL	2	27	0.28	0.08	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK2	2.5-3	Fill: silty clay	16	0.6	37	72	90	LPQL	7	190	35.1	1.7	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	120	220	LPQL	390	LPQL	LPQL	LPQL	LPQL	16.5
JK2	5-6	Silty Clay	5	LPQL	15	15	19	LPQL	7	30	3	0.1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK3	0.5-0.95	Fill: silty sandy clay	7	LPQL	39	30	64	LPQL	21	70	5.3	0.4	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	0
JK3	2.5-3	Fill: silty gravelly sand	LPQL	LPQL	99	18	120	LPQL	33	110	5.1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	270	1300	LPQL	**1620**	LPQL	LPQL	LPQL	LPQL	0
JK3	5.5-6	Silty Clay	16	LPQL	14	9	14	LPQL	9	14	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	8.8
Total no. of samples			9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Maximum Value			16	0.6	99	72	120	LPQL	33	370	35.1	1.7	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	270	3000	2300	5365	LPQL	LPQL	LPQL	LPQL	16.5
Mean Value			8	LPQL	34	25	46	NC	12	98	6.2	0.28	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	946.4	NC	NC	NC	NC	2.8

EXPLANATION:
^ Site Assessment Criteria: Guideline concentrations adopted for the investigation as outlined below:
* National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC Guidelines) Health Investigation Levels (HIL) - Column F, Commercial/Industrial
# NSW DECC (EPA) Guidelines for Assessing Service Station Sites - 1994
^^ In the absence of Australian guidelines, the laboratory PQL has been adopted as the site assessment criteria

Concentration above the Site Assessment Criteria **VALUE**

ABBREVIATIONS:
PAHs: Polycyclic Aromatic Hydrocarbons
B(a)P: Benzo(a)Pyrene
PQL: Practical Quantitation Limit
LPQL: Less than PQL
NA: Not Analysed
NC: Not Calculated
OP: Organophosphorus Pesticides
PID: Photoionisation Detector
PCBs: Polychlorinated Biphenyles
NSL: No Set Limit

TABLE C
SUMMARY OF LABORATORY TEST DATA
WATER ANALYSIS

	Units	PQL	Site Assessment Criteria	Drinking Water 2004 [2]									
Sample					MW6	MW11	JK1	JK2	JK3	GWA	GWB	GWC	GR
Date Sampled					5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	8/05/2009
Volatile Organic Compounds													
Dichlorodifluoromethane	µg/L	<10	390'		<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloromethane	µg/L	<10	160 '		<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	µg/L	<10	100~		<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromomethane	µg/L	<10	8.7 '		<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroethane	µg/L	<10	4.6 '		<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane	µg/L	<10	1300 '		<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	µg/L	<1	700~	30	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trans-1,2-dichloroethene	µg/L	<1	120 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-dichloroethane	µg/L	<1	90 '		<1	<1	<1	<1	<1	<1	8.7	<1	<1
Cis-1,2-dichloroethene	µg/L	<1	61 '		2.4	2.5	<1	<1	<1	<1	<1	<1	<1
Bromochloromethane	µg/L	<1	-		<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	<1	370 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
2,2-dichloropropane	µg/L	<1	-		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-dichloroethane	µg/L	<1	1900 ~	3	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,1-trichloroethane	µg/L	<1	270 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-dichloropropene	µg/L	<1	-		<1	<1	<1	<1	<1	<1	<1	<1	<1
Cyclohexane	µg/L	<1	10000 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	<1	240 ~	3	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzene	µg/L	<1	950 ~	1	<1	<1	**4.8**	**39**	**95**	<1	<1	<1	<1
Dibromomethane	µg/L	<1	-		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-dichloropropane	µg/L	<1	900 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	<1	330 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
Bromodichloromethane	µg/L	<1	1.1 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
trans-1,3-dichloropropene	µg/L	<1	0.1 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
cis-1,3-dichloropropene	µg/L	<1	0.1 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,2-trichloroethane	µg/L	<1	6500 ~		<1	<1	<1	<1	<1	6.9	<1	<1	<1
Toluene	µg/L	<1	180 ~		<1	<1	3	<1	<1	<1	3.3	10	<1
1,3-dichloropropane	µg/L	<1	1100 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibromochloromethane	µg/L	<1	0.13 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-dibromoethane	µg/L	<1	0.0056 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloroethene	µg/L	<1	70 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,1,2-tetrachloroethane	µg/L	<1	0.43 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
Chlorobenzene	µg/L	<1	55 ~	300	6.9	6.7	30	**190**	**210**	1.4	<1	<1	<1
Ethylbenzene	µg/L	<1	80 ~		<1	<1	**100**	2.2	<1	<1	<1	<1	<1
Bromoform	µg/L	<1	8.5 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
m+p-xylene	µg/L	<2	200 ~ +75 ~		<2	<2	26	2	<2	<2	<2	<2	<2
Styrene	µg/L	<1	2100 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	400 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
o-xylene	µg/L	<1	350 ~		<1	<1	3.3	<1	<1	<1	<1	<1	<1
1,2,3-trichloropropane	µg/L	<1	0.0056 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
Isopropylbenzene	µg/L	<1	30 ~		<1	<1	7.3	5.3	4.3	<1	<1	<1	<1
Bromobenzene	µg/L	<1	20 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
n-propyl benzene	µg/L	<1	240 '		<1	<1	10	7.8	7	<1	<1	<1	<1
2-chlorotoluene	µg/L	<1	-		<1	<1	<1	<1	<1	<1	<1	<1	<1
4-chlorotoluene	µg/L	<1	-		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,3,5-trimethyl benzene	µg/L	<1	12 '		<1	<1	6.7	<1	<1	<1	<1	<1	<1
Tert-butyl benzene	µg/L	<1	240 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2,4-trimethyl benzene	µg/L	<1	12 '		<1	<1	**46**	3.3	<1	<1	<1	<1	<1
1,3-dichlorobenzene	µg/L	<1	260 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
Sec-butyl benzene	µg/L	<1	240 '		<1	<1	3.2	1.4	<1	<1	<1	<1	<1
1,4-dichlorobenzene	µg/L	<1	60 ~	40	<1	<1	3.5	15	7	<1	<1	<1	<1
4-isopropyl toluene	µg/L	<1	-		<1	<1	1.4	<1	<1	<1	<1	<1	<1
1,2-dichlorobenzene	µg/L	<1	160 ~	1500	<1	<1	<1	<1	2.4	<1	<1	<1	<1
n-butyl benzene	µg/L	<1	240 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2-dibromo-3-chloropropane	µg/L	<1	0.048 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2,4-trichlorobenzene	µg/L	<1	85 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1
Hexachlorobutadiene	µg/L	<1	0.86 '		<1	<1	<1	<1	<1	<1	<1	<1	<1
1,2,3-trichlorobenzene	µg/L	<1	3 ~		<1	<1	<1	<1	<1	<1	<1	<1	<1

Continued....

TABLE C (continued)
SUMMARY OF LABORATORY TEST DATA
WATER ANALYSIS

	Units	PQL	Site Assessment Criteria	Drinking Water 2004 [2]									
Sample					MW6	MW11	JK1	JK2	JK3	GWA	GWB	GWC	GR
Date Sampled					5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	8/05/2009
Petrloleum Hydrocarbons													
Benzene	µg/L	<1	950 ~		<1	<1	4.8	39	95	<1	<1	<1	<1
Toluene	µg/L	<1	180 ~		<1	<1	3	<1	<1	6.9	3.3	10	<1
Ethylbenzene	µg/L	<1	80 ~	300	<1	<1	100	2.2	<1	<1	<1	<1	<1
m+p-xylene	µg/L	<2	200 ~ +75 ~		<2	<2	26	2	<2	<2	<2	<2	<2
o-xylene	µg/L	<1	350 ~		<1	<1	3.3	<1	<1	<1	<1	<1	<1
TPH C_6 - C_9	µg/L	<10	150 ^		54	36	140	**230**	**270**	<10	21	14	<10
TPH C_{10} - C_{14}	µg/L	<50	600 ^		**950**	**430**	**780**	**670**	**390**	72	**350**	92	<50
TPH C_{15} - C_{28}	µg/L	<100			**1900**	**1200**	**2000**	**2200**	**1200**	310	**260**	320	<100
TPH C_{29} - C_{36}	µg/L	<100			**320**	**330**	**520**	**780**	**150**	<100	**<100**	<100	<100
Total C10 - C36			600 ^		**3170**	**1960**	**3300**	**3650**	**1740**	382	**610**	412	0
Polycyclic Aromatic Hydroacrbons													
Naphthalene	µg/L	<0.1	16~		12	0.1	4.9	**71**	3.5	<0.1	0.9	<0.1	<0.1
Acenaphthylene	µg/L	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	µg/L	<0.1	370 '		<0.1	<0.1	0.3	13	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	µg/L	<0.1	240 '		0.1	<0.1	0.2	7.5	0.2	<0.1	<0.1	<0.1	<0.1
Phenanthrene	µg/L	<0.1	2~		0.1	<0.1	0.3	**11**	0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	µg/L	<0.1	0.4~		<0.1	<0.1	<0.1	**1.9**	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	µg/L	<0.1	1.4~		<0.1	<0.1	<0.1	1.2	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	µg/L	<0.1	180 '		<0.1	<0.1	0.1	1.2	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	µg/L	<0.1	0.092 '		<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	µg/L	<0.1	9.2 '		<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b+k)fluoranthene	µg/L	<0.2	0.092 '		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	µg/L	<0.1	0.2~	0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	µg/L	<0.1	0.092 '		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	µg/L	<0.1	0.0092 '		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	µg/L	<0.1	-		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Organochlorine pesticides													
HCB	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor	µg/L	<0.001	0.09~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor Epoxide	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin	µg/L	<0.001	0.001~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
gamma-BHC (Lindane)	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
delta-BHC	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane	µg/L	<0.001	0.08~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane	µg/L	<0.001	0.08~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Oxychlordane	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Dieldrin	µg/L	<0.001	0.01~		**0.011**	<0.01	<0.01	<0.1	0.0055	<0.001	<0.001	<0.001	<0.001
p,p-DDE	µg/L	<0.001	0.03~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
p,p-DDD	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
p,p-DDT	µg/L	<0.001	0.01~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin Aldehyde	µg/L	<0.001	0.02~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin Ketone	µg/L	<0.001	0.02~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-Endosulfan	µg/L	<0.001	0.2~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
beta-Endosulfan	µg/L	<0.001	0.2~		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	µg/L	<0.001	-		<0.01	<0.01	<0.01	<0.1	<0.001	<0.001	<0.001	<0.001	<0.001
Organophosphorous pesticides													
Demeton-S-methyl	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Dichlorvos	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Diazinon	µg/L	<0.010	0.001~		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Dimethoate	µg/L	<0.010	0.05~		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Chlorpyrifos	µg/L	<0.010	0.001~		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Chlorpyrifos methyl	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Malathion	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Fenthion	µg/L	<0.010	0.01~		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Azinphos Ethyl	µg/L	<0.010	0.002~		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Azinphos Methyl	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Chlorfenvinphos (E)	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Chlorfenvinphos (Z)	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Ethion	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Fenitrothion	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Parathion (Ethyl)	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Parathion (Methyl)	µg/L	<0.010	0.01~		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Primiphos Ethyl	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010
Primiphos Methyl	µg/L	<0.010	-		<0.1	<0.1	<0.1	<1	<0.1	<0.010	<0.010	<0.010	<0.010

Continued....

TABLE C (continued)
SUMMARY OF LABORATORY TEST DATA
WATER ANALYSIS

	Units	PQL	Site Assessment Criteria	Drinking Water 2004 [2]									
Sample					MW6	MW11	JK1	JK2	JK3	GWA	GWB	GWC	GR
Date Sampled					5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	5/05/2009	8/05/2009
Polychlorinated Biphenyls													
Aroclor 1016	µg/L	<0.010	0.001~		<0.1	<0.1	<0.1	<1	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1221	µg/L	<0.010	1~		<0.1	<0.1	<0.1	<1	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1232	µg/L	<0.010	0.3~		<0.1	<0.1	<0.1	<1	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1242	µg/L	<0.010	0.6 "		0.33	<0.1	<0.1	<1	0.24	<0.010	<0.010	<0.010	<0.010
Aroclor 1248	µg/L	<0.010	0.03~		<0.1	<0.1	<0.1	<1	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1254	µg/L	<0.010	0.03 "		<0.1	<0.1	<0.1	<1	<0.010	<0.010	<0.010	<0.010	<0.010
Aroclor 1260	µg/L	<0.010	25~		<0.1	<0.1	<0.1	<1	<0.010	<0.010	<0.010	<0.010	<0.010
Total PCB's (as above)	µg/L	<0.010	-		0.33	<0.1	<0.1	<1	0.24	<0.010	<0.010	<0.010	<0.010
Total Phenolics (as Phenol)	mg/L	<0.05	320 "		0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Heavy metals, Anion, Cations and Nutrients													
Arsenic-Dissolved	µg/L	<1	13 "	7	4	6	3	9	3	4	4	4	<1
Beryllium-Dissolved	µg/L	<0.5	0.13~		<0.5	<0.5	<0.5	<0.5	<0.5	**14**	<0.5	5.7	<0.5
Boron-Dissolved	µg/L	<5	370 "	4000	**4200**	**1300**	**940**	**1300**	**1700**	**480**	**840**	260	**800**
Cadmium-Dissolved	µg/L	<0.1	0.2 "	2	0.3	0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.2	0.1
Cobalt-Dissolved	µg/L	<1	2.8~		**20**	**7**	**3**	**4**	**5**	**24**	**9**	**65**	<1
Chromium-Dissolved	µg/L	<1	3.3~		**31**	**20**	**9**	**8**	**4**	**3**	**9**	**6**	<1
Copper-Dissolved	µg/L	<1	1.4 "	2000	<1	<1	<1	<1	<1	<1	<1	<1	**2**
Lead-Dissolved	µg/L	<1	3.4 "	10	3	1	<1	<1	<1	<1	**92**	**9**	<1
Manganese-Dissolved	µg/L	<5	1700 "	500	220	1400	1200	160	560	**3200**	530	770	35
Mercury-Dissolved	µg/L	<0.5	0.6 "	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel-Dissolved	µg/L	<1	11 "	20	**97**	**20**	10	**18**	7	**17**	**21**	**52**	<1
Zinc-Dissolved	µg/L	<1	8 "		**12**	**46**	**12**	**16**	4	**220**	**19000**	**1100**	**13**
Calcium - Dissolved	mg/L	<0.03	-		28	21	190	400	250	110	11	20	74
Potassium - Dissolved	mg/L	<0.03	-		1230	160	51	44	50	51	54	55	79
Sodium - Dissolved	mg/L	<0.03	-		3100	1300	200	140	210	1600	870	1100	2250
Magnesium - Dissolved	mg/L	<0.03	-		76	94	62	80	73	240	39	53	210
Hydroxide Alkalinity (OH^-)	mg/L	<0.1	-		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as	mg/L	<0.1	-		2900	310	1500	1900	1500	<0.1	340	<0.1	70
Carbonate Alkalinity as	mg/L	<0.1	-		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity	mg/L	<0.1	-		2900	310	1500	1900	1500	<0.1	340	<0.1	70
Sulphate, SO4	mg/L	<5	-	500	<5	1300	95	620	<5	600	47	550	430
Chloride (titration) - water	mg/L	<20	-	250	5000	2100	410	600	300	3200	1900	2300	3700
Ionic Balance	%		-		-6.7	-14	-28	-33	-14	-3.2	-18	-17	2.7
pH	pH Units		6.5-8.5 [+]	6.5-8.5	7	6.1	6.9	6.9	6.8	4.3	6.2	4	7.4
Electrical Conductivity	µS/cm	<1	-		18000	8000	3100	3600	2800	8500	5100	5800	9100
Total Dissolved Solids	mg/L	<5	-		10000	5900	1300	2300	1500	6200	3400	4000	6700
Total Suspended Solids	mg/L	<5	-		340	1600	15000	31000	4000	110	2600	230	8
Nitrate as N in water	mg/L	<0.1	0.7 "	50	0.1	**1.4**	<0.1	0.1	<0.1	0.5	0.7	0.4	0.1
Nitrite as N in water	mg/L	<0.01	-	3	0.02	0.27	0.01	0.01	<0.01	<0.01	0.25	<0.01	<0.01
Phosphate as P in water	mg/L	<0.05	-		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phosphorus - Total	mg/L	<0.05	-		0.96	9	27	2.4	1.2	0.45	2	0.23	<0.05
Ammonia as N in water	mg/L	<0.1	2.1-2.5	0.5	**470**	**77**	**160**	**190**	**46**	**3.2**	**19**	**7.2**	<0.1
BOD5	mg/L	<2	-		47	130	21	1000	24	24	75	18	<4
Total Organic Carbon	mg/L	<1	-		230	290	140	600	87	28	160	36	6
Field measurements													
pH					6.81	5.75	nm	6.58	6.64	8.32	5.84	3.77	7.01
Conductivity	µS/cm				14910	7080	nm	3480	2775	5390	6160	5710	9360
Dissolved oxygen	mg/L				0.7	0.3	nm	0.3	0.7	0.2	1.3	1.2	4.1

EXPLANATION:

[2] NHMRC Australian Drinking Water Guidelines (2004)

~ ANZECC Australian Water Quality Guidelines for Fresh Waters, 2000 - Trigger Values for protection of 95% of species- low to moderate reliability

" ANZECC Australian Water Quality Guidelines for Fresh Waters, 2000 - Trigger Values for protection of 95% of species- high reliability

' USEPA Region 9 Superfund - Preliminary Remedation Goal (PRG) for tapwater

^ In the absence of high reliability NSW EPA or ANZECC guidelines for TPH, the Airport (environment Protection) regulations (1997), Schedule 2 water Pollution Accepted Limits; Table 1.03 - Accepted Limits of Contamination have been quoted

[+] ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters, 2000 - Level for NSW Lowland Rivers.

Concentration above the Site Assessment Criteria **VALUE**

TABLE D
GROUNDWATER INTER-LABORATORY DUPLICATE RESULTS
QA/QC - RELATIVE PERCENTAGE DIFFERENCES

SAMPLE	ANALYSIS	INITIAL (mg/L)	REPEAT (mg/L)	MEAN (mg/L)	RPD %
Intra-laboratory Groundwater sample ID = JK3 Dup ID = DupA	C_6-C_9 TPH	270	230	250	16
	C_{10}-C_{14} TPH	390	440	415	12
	C_{15}-C_{28} TPH	1200	1200	1200	0
	C_{29}-C_{36} TPH	150	<100	150	NC
	Benzene	95	92	93.5	3
	Toluene	<1	<1	NC	NC
	Ethylbenzene	<1	<1	NC	NC
	Total Xylenes	<2	<2	NC	NC

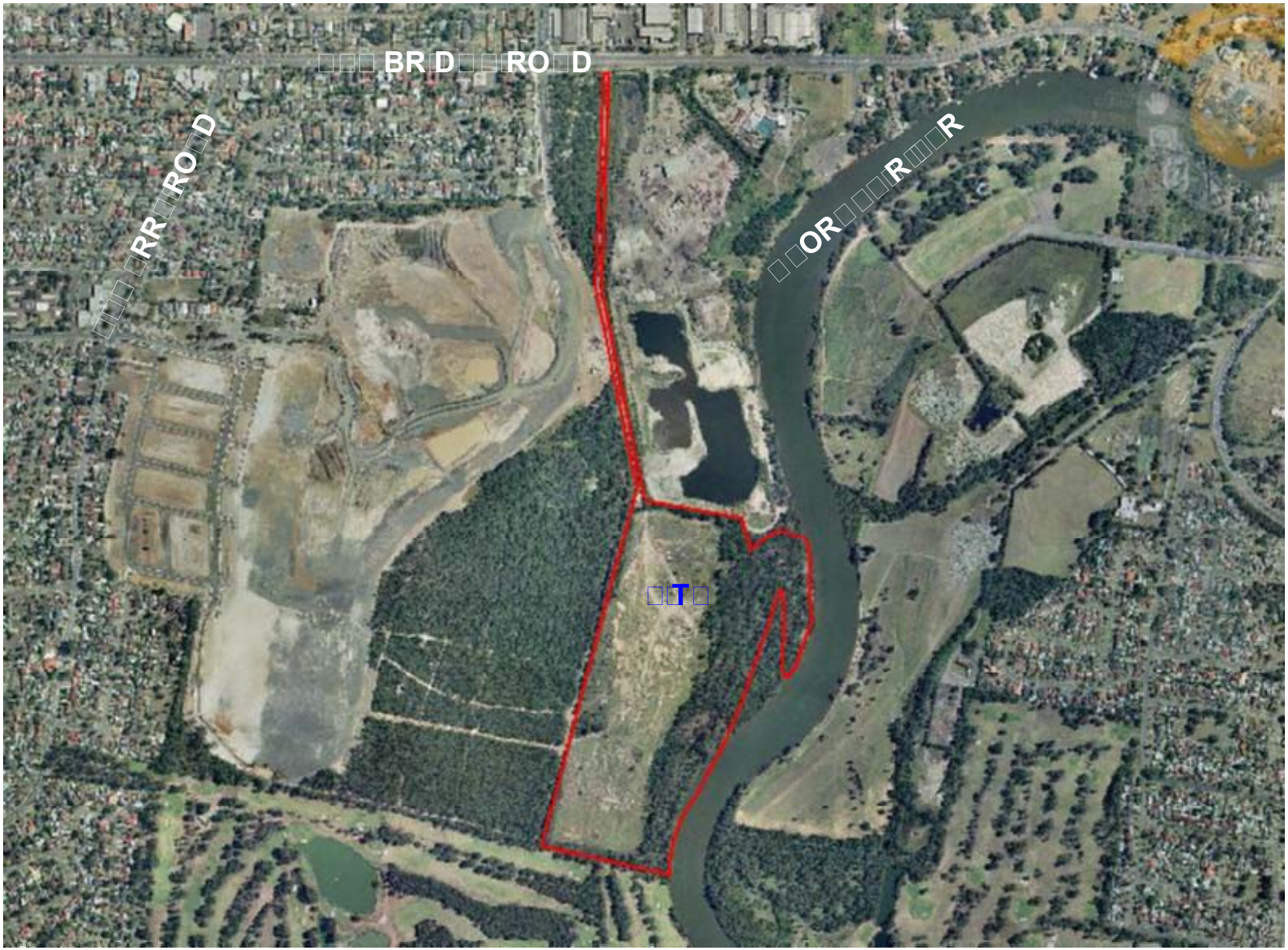
ABBREVIATIONS:
PQL: Practical Quantitation Limit
LPQL: Less than PQL
NA: Not Analysed
NC: Not Calculated

TABLE E
WATER LEVELS - 5 MAY 2009

Monitoring Well	AHD (m)	SWL (m)	Water RL (m)
MW6	4.92	2.69	2.23
MW11	4.58	3.99	0.59
JK1	4.58	3.9	0.68
JK2	4.07	3.03	1.04
JK3	4.77	2.78	1.99
GWA	1.94	1.99	-0.05
GWB	2.13	3.09	-0.96
GWC	2.16	2.4	-0.24

AHD - Australian Height Datum
SWL - Standing water Level
RL - Relative level

EIS (July 2010) GME



LOT 6, DP 1065574, NEWBRIDGE ROAD, MOOREBANK
KEY PLAN

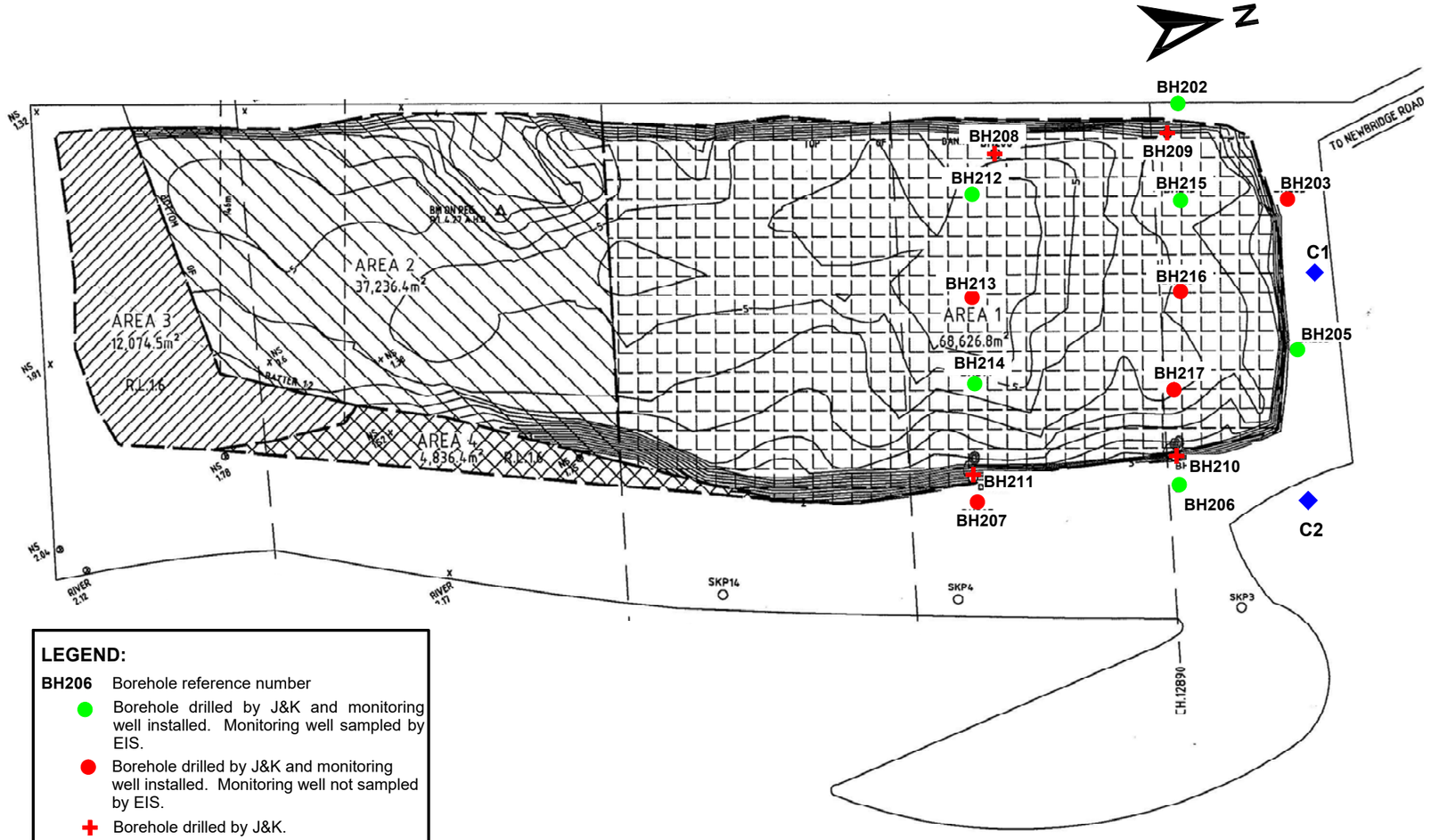
NOT TO SCALE

Image Source: Department of Lands, Six Viewer

EIS

Ref No. M22833SA2
Figure No: 1

DRAFT



LEGEND:

BH206 Borehole reference number

- Borehole drilled by J&K and monitoring well installed. Monitoring well sampled by EIS.
- Borehole drilled by J&K and monitoring well installed. Monitoring well not sampled by EIS.
- Borehole drilled by J&K.
- Approximate locations of creek samples

Scale (m)

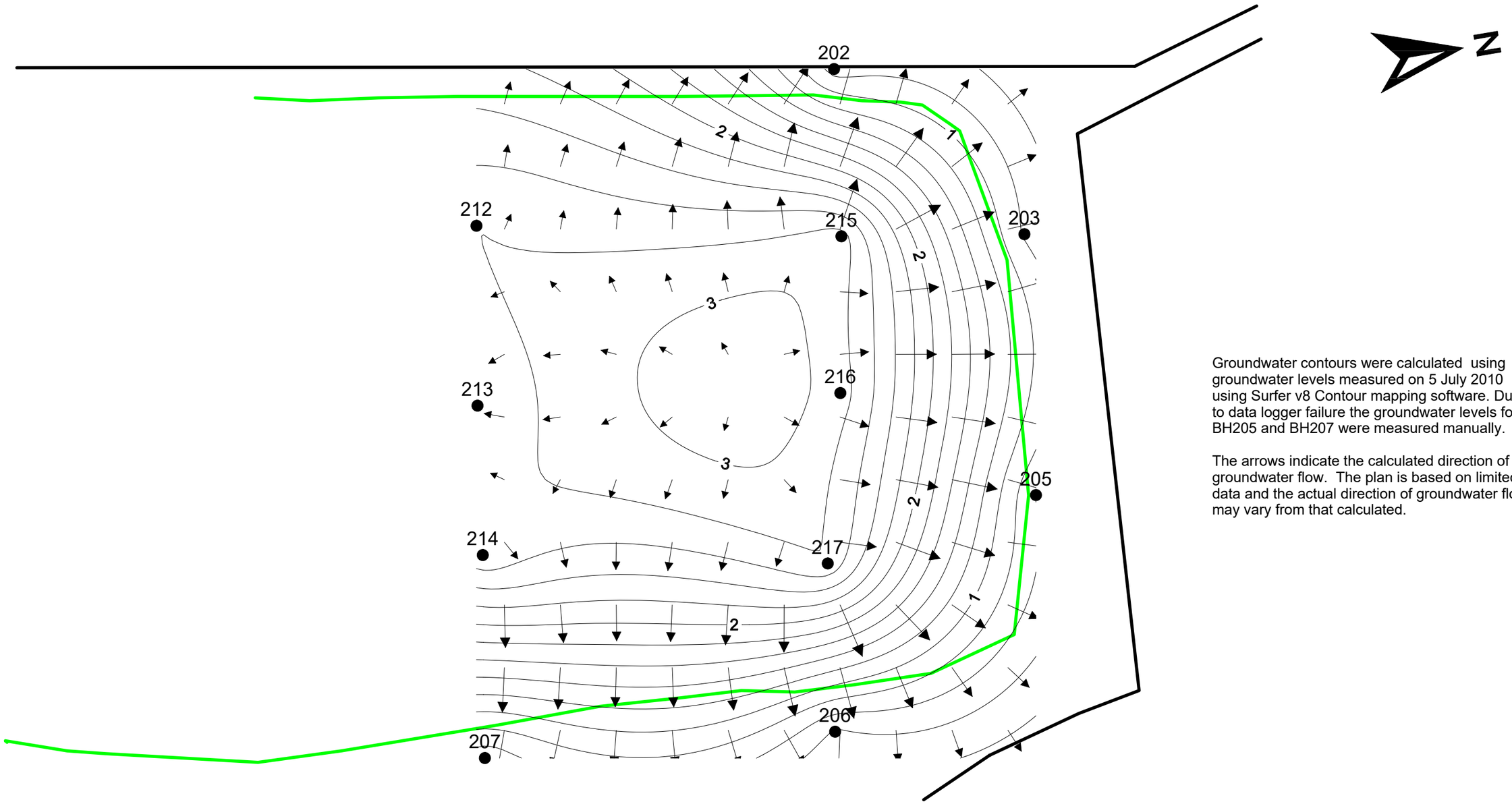
0 300 600 900 1200 1500

BOREHOLE LOCATION PLAN - 2010
LOT 1 DP1065574
NEWBRIDGE ROAD, MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

REF: 22883K
FIG: 2

DRAFT



Groundwater contours were calculated using groundwater levels measured on 5 July 2010 using Surfer v8 Contour mapping software. Due to data logger failure the groundwater levels for BH205 and BH207 were measured manually.

The arrows indicate the calculated direction of groundwater flow. The plan is based on limited data and the actual direction of groundwater flow may vary from that calculated.

Scale (m)

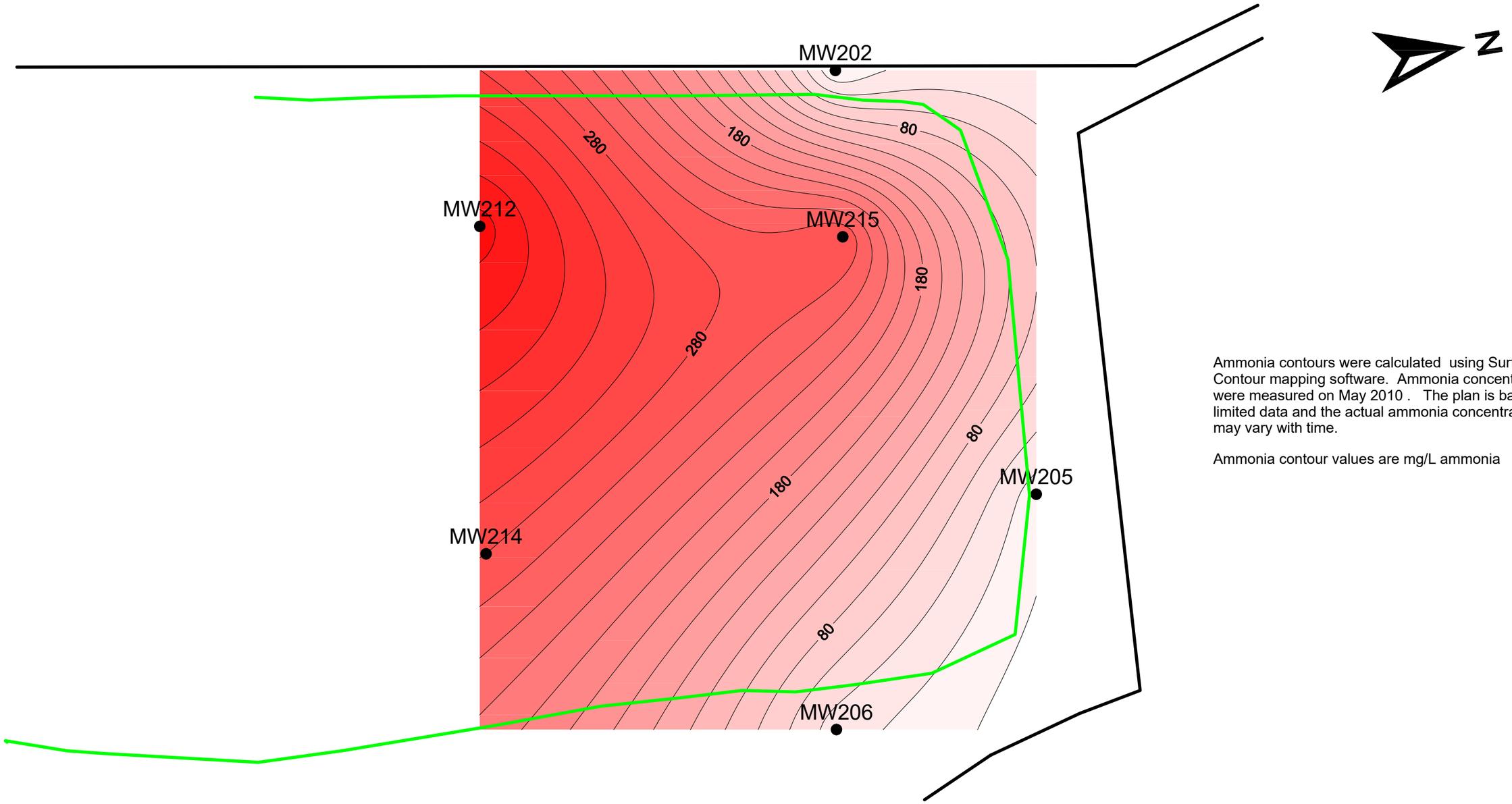
0 300 600 900 1200 1500

GROUNDWATER CONTOUR PLAN - 5 JULY 2010
LOT 1 DP1065574
NEWBRIDGE ROAD, MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

REF: 22883K
FIG: 3

DRAFT



Ammonia contours were calculated using Surfer v8 Contour mapping software. Ammonia concentrations were measured on May 2010 . The plan is based on limited data and the actual ammonia concentrations may vary with time.

Ammonia contour values are mg/L ammonia

Scale (m)

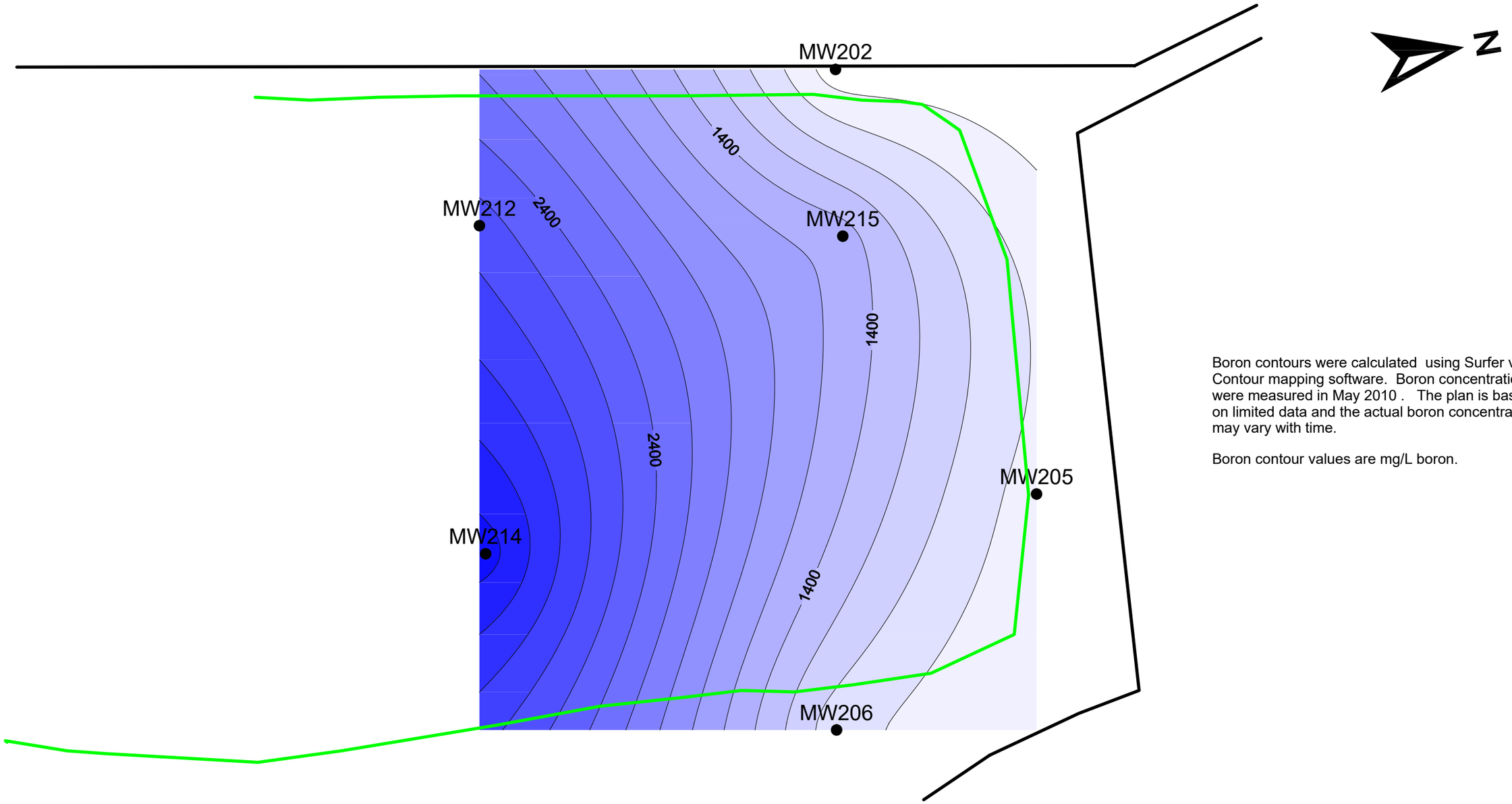
0 300 600 900 1200 1500

AMMONIA CONCENTRATION CONTOUR
PLAN LOT 1 DP1065574
NEWBRIDGE ROAD, MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

REF: E22883K
FIG: 4

DRAFT



Boron contours were calculated using Surfer v8 Contour mapping software. Boron concentrations were measured in May 2010 . The plan is based on limited data and the actual boron concentrations may vary with time.

Boron contour values are mg/L boron.

Scale (m)

0 300 600 900 1200 1500

BORON CONCENTRATION CONTOUR
PLAN LOT 1 DP1065574
NEWBRIDGE ROAD, MOOREBANK

ENVIRONMENTAL INVESTIGATION SERVICES

REF: E22883K
FIG: 5

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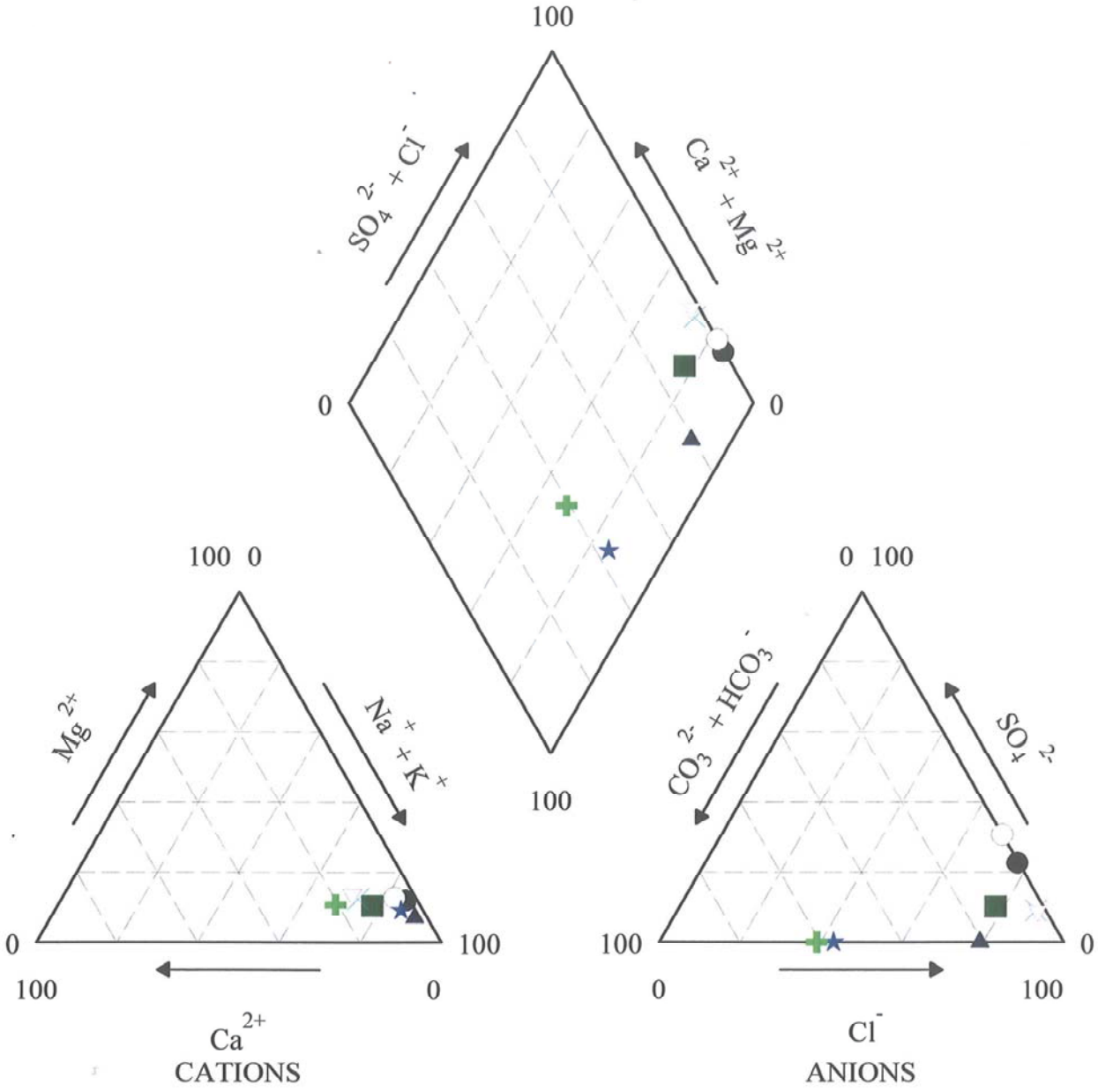
PIPER DIAGRAM OF WATER DATA



EXPLANATION

- MW202 - Outside landfill
- MW205 - Outside landfill
- MW206 - Outside landfill
- MW212 - Inside landfill
- MW214 - Inside landfill
- MW215 - Inside landfill
- C1 - Creek
- C2 - Creek

EIS

□□□RO□M□□T□□
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TABLE B
SUMMARY OF LABORATORY TEST DATA
WATER ANALYSIS

			Site Assessment Criteria	Drinking Water 2004 [2]	SAMPLE REFERENCE (SAMPLED 2010)							
	Units	PQL			MW202	MW205	MW206	MW212	MW214	MW215	C1	C2
Volatile Organic Compounds												
Dichlorodifluoromethane	µg/L	<10	390'		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chloromethane	µg/L	<10	190 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Vinyl Chloride	µg/L	<10	100~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Bromomethane	µg/L	<10	8.7 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chloroethane	µg/L	<10	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Trichlorofluoromethane	µg/L	<10	1300 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,1-Dichloroethene	µg/L	<1	700~	30	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Trans-1,2-dichloroethene	µg/L	<1	110 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,1-dichloroethane	µg/L	<1	7300 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Cis-1,2-dichloroethene	µg/L	<1	370 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Bromochloromethane	µg/L	<1	730'		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chloroform	µg/L	<1	370 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
2,2-dichloropropane	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2-dichloroethane	µg/L	<1	1900 ~	3	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,1,1-trichloroethane	µg/L	<1	270 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,1-dichloropropene	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Cyclohexane	µg/L	<1	13000 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Carbon tetrachloride	µg/L	<1	240 ~	3	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
BBenzænzenæne	µµgg//LL	<<11	950950	11	LPQLPQLL	LPQLPQLL	LPQLPQLL	LPQLPQLL	LPQLPQLL	4242	LPQLPQLL	LPQLPQLL
Dibromomethane	µg/L	<1	8.2'		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2-dichloropropane	µg/L	<1	900 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Trichloroethene	µg/L	<1	330 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Bromodichloromethane	µg/L	<1	730 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
trans-1,3-dichloropropene	µg/L	<1	40 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
cis-1,3-dichloropropene	µg/L	<1	40 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,1,2-trichloroethane	µg/L	<1	6500 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Toluene	µg/L	<1	180 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,3-dichloropropane	µg/L	<1	1100 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Dibromochloromethane	µg/L	<1	730 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2-dibromoethane	µg/L	<1	18 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Tetrachloroethene	µg/L	<1	70 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,1,1,2-tetrachloroethane	µg/L	<1	1100 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chlorobenzene	µg/L	<1	55 ~	300	LPQL	LPQL	LPQL	LPQL	14	**180**	LPQL	LPQL
Ethylbenzene	µg/L	<1	80 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Bromoform	µg/L	<1	730 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
m+p-xylene	µg/L	<2	200 ~ +75 ~		LPQL	LPQL	LPQL	LPQL	28	LPQL	LPQL	LPQL
Styrene	µg/L	<1	1600 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,1,2,2-tetrachloroethane	µg/L	<1	400 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
o-xylene	µg/L	<1	350 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2,3-trichloropropane	µg/L	<1	0.62 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Isopropylbenzene	µg/L	<1	30 ~		LPQL	LPQL	LPQL	LPQL	12	LPQL	LPQL	LPQL
Bromobenzene	µg/L	<1	288 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
n-propyl benzene	µg/L	<1	240 '		LPQL	LPQL	LPQL	LPQL	12	LPQL	LPQL	LPQL
2-chlorotoluene	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
4-chlorotoluene	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,3,5-trimethyl benzene	µg/L	<1	370 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Tert-butyl benzene	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2,4-trimethyl benzene	µg/L	<1	15 '		LPQL	LPQL	LPQL	LPQL	**39**	LPQL	LPQL	LPQL
1,3-dichlorobenzene	µg/L	<1	260 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Sec-butyl benzene	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,4-dichlorobenzene	µg/L	<1	60 ~	40	LPQL	LPQL	LPQL	LPQL	17	17	LPQL	LPQL
4-isopropyl toluene	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2-dichlorobenzene	µg/L	<1	160 ~	1500	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
n-butyl benzene	µg/L	<1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2-dibromo-3-chloropropane	µg/L	<1	0.39 '		LPQL	LPQL	LPQL	L L	L P L Q	L P L Q	L P L Q	L P P Q Q L
1,2,4-trichlorobenzene	µg/L	<1	85 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Hexachlorobutadiene	µg/L	<1	037 '		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
1,2,3-trichlorobenzene	µg/L	<1	3 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL

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TABLE B (continued)
SUMMARY OF LABORATORY TEST DATA
WATER ANALYSIS

DRAFT

	Units	PQL	Site Assessment Criteria	Drinking Water 2004 [2]	SAMPLE REFERENCE (SAMPLED MAY 2010)							
					MW202	MW205	MW206	MW212	MW214	MW215	C1	C2
Petrloleum Hydrocarbons												
Benzene	µµgg/L	<1	950 ~		LPQL	LPQL	LPQL	LPQL	LPQL	42	LPQL	LPQL
Toluene	µg/L	<1	180 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Ethylbenzene	µg/L	<1	80 ~	300	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
m+p-xylene	µg/L	<2	200 ~ +75 ~		LPQL	LPQL	LPQL	LPQL	28	LPQL	LPQL	LPQL
o-xylene	µg/L	<1	350 ~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
TPH C_6 - C_9	µg/L	<10	150 ^		LPQL	LPQL	LPQL	LPQL	LPQL	**220**	LPQL	LPQL
TPH C_{10} - C_{14}	µg/L	<50	600 ^		LPQL	LPQL	63	430	640	470	53	LPQL
TPH C_{15} - C_{28}	µg/L	<100			480	640	640	1100	1400	2700	610	LPQL
TPH C_{29} - C_{36}	µg/L	<100			210	220	290	250	290	330	260	LPQL
Total C10 - C36			600 ^		**690**	**860**	**993**	**1780**	**2330**	**3500**	**923**	LPQL
Polycyclic Aromatic Hydroacrbons												
Naphthalene	µg/L	<0.1	16~		0.2	LPQL	0.1	1.6	**45**	8.7	0.1	LPQL
Acenaphthylene	µg/L	<0.1			LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Acenaphthene	µg/L	<0.1	2200 '		LPQL	LPQL	LPQL	0.1	0.7	0.2	0.4	0.2
Fluorene	µg/L	<0.1	1500 '		LPQL	LPQL	LPQL	0.2	0.4	0.2	LPQL	LPQL
Phenanthrene	µg/L	<0.1	2~		0.3	0.2	0.2	0.3	1.2	0.3	0.2	LPQL
Anthracene	µg/L	<0.1	0.4~		LPQL	LPQL	LPQL	LPQL	0.2	LPQL	LPQL	LPQL
Fluoranthene	µg/L	<0.1	1.4~		LPQL	LPQL	LPQL	LPQL	0.3	LPQL	LPQL	LPQL
Pyrene	µg/L	<0.1	1100 '		0.1	LPQL	LPQL	LPQL	0.2	LPQL	LPQL	LPQL
Benzo(a)anthracene	µg/L	<0.1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chrysene	µg/L	<0.1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Benzo(b+k)fluoranthene	µg/L	<0.2	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Benzo(a)py( ) p y rene	µµgg/L	<0.1	0.2~	0.01	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Indeno(1,2,3-c,d)pyrene	µg/L	<0.1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Dibenzo(a,h)anthracene	µg/L	<0.1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Benzo(g,h,i)perylene	µg/L	<0.1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Organochlorine pesticides												
HCB	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Heptachlor	µg/L	<0.001	0.09~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Heptachlor Epoxide	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Aldrin	µg/L	<0.001	0.001~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
gamma-BHC (Lindane)	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
alpha-BHC	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
beta-BHC	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
delta-BHC	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
trans-Chlordane	µg/L	<0.001	0.08~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
cis-Chlordane	µg/L	<0.001	0.08~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Oxychlordane	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Dieldrin	µg/L	<0.001	0.01~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	**0.02**	LPQL
p,p-DDE	µg/L	<0.001	0.03~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
p,p-DDD	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
p,p-DDT	µg/L	<0.001	0.01~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Endrin	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Endrin Aldehyde	µg/L	<0.001	0.02~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Endrin Ketone	µg/L	<0.001	0.02~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
alpalpha-Endosulfaan	µµgg//LL	<<00.001	0.0 2 2~~		LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL
beta-Endosulfan	µg/L	<0.001	0.2~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Endosulfan Sulfate	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Methoxychlor	µg/L	<0.001	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Organophosphorous pesticides												
Demeton-S-methyl	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Dichlorvos	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Diazinon	µg/L	<0.010	0.001~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Dimethoate	µg/L	<0.010	0.05~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chlorpyrifos	µg/L	<0.010	0.001~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chlorpyrifos methyl	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Malathion	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Fenthion	µg/L	<0.010	0.01~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Azinphos Ethyl	µg/L	<0.010	0.002~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Azinphos Methyl	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chlorfenvinphos (E)	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Chlorfenvinphos (Z)	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Ethion	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Fenitrothion	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Parathion (Ethyl)	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Parathion (Methyl)	µg/L	<0.010	0.01~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Primiphos Ethyl	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
PrimPrimipiphos Meethhyl	µµgg//LL	<0.010	0.010 -		LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL	LPQLLPQL

Continued….

TABLE B (continued)
SUMMARY OF LABORATORY TEST DATA
WATER ANALYSIS

DRAFT

Sample	Units	PQL	Site Assessment Criteria	Drinking Water 2004 [2]	SAMPLE REFERENCE (SAMPLED MAY 2010) MW202	MW205	MW206	MW212	MW214	MW215	C1	C2
Polychlorinated Biphenyls												
Aroc Aroclor lor 1016 1016	µg µg//LL	<0 <0.010	01000.001	001~	LPQL LPQLL	LPQL LPQLL	LPQL LPQLL	LPQL LPQLL	LPQL LPQLL	LPQL LPQLL	LPQL LPQLL	LPQL LPQLL
Aroclor 1221	µg/L	<0.010	1~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Aroclor 1232	µg/L	<0.010	0.3~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Aroclor 1242	µg/L	<0.010	0.6 "		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Aroclor 1248	µg/L	<0.010	0.03~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Aroclor 1254	µg/L	<0.010	0.03 "		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Aroclor 1260	µg/L	<0.010	25~		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Total PCB's (as above)	µg/L	<0.010	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Total Phenolics (as Phenol)	mg/L	<0.05	320 "		LPQL	LPQL	LPQL	LPQL	0.18	LPQL	LPQL	LPQL
Heavy metals, Anion, Cations and Nutrients												
Arsenic-Dissolved	µg/L	<1	13 "	7	3	6	3	3	**27**	11	3	3
Beryllium-Dissolved	µg/L	<0.5	0.13~		**2**	**4**	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Boron-Dissolved	µg/L	<5	370 "	4000	**470**	**700**	**860**	**2700**	**3500**	**1500**	**780**	**1200**
Cadmium-Dissolved	µg/L	<0.1	0.2 "	2	0.1	**0.3**	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Cobalt-Dissolved	µg/L	<1	2.8~		**6**	**6**	**24**	**8**	**1**	**5 1**	**1** LPQL	LPQL
Chromium-Dissolved	µg/L	<1	3.3~		3	**5**	**7**	**20**	**26**	**6**	LPQL	LPQL
Copper-Dissolved	µg/L	<1	1.4 "	2000	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Lead-Dissolved	µg/L	<1	3.4 "	10	1	**4**	LPQL	LPQL	2	2	LPQL	LPQL
Manganese-Dissolved	µg/L	<5	1700 "	500	470	**2904**	1558	57	67	110	790	520
Mercury-Dissolved	µg/L	<0.5	0.6 "	1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Nickel-Dissolved	µg/L	<1	11 "	20	10	**26**	**16**	**32**	**66**	**140**	4	5
Zinc-Dissolved	µg/L	<1	8 "		**60**	**240**	**9**	**11**	**9***	**14**	3	2
CaC l i lcium - DDii ssoM eedg/L/L		<0 <0.03	03 -		1717	6565	140140	7878	5151	160160	420420	460460
Potassium - Dissolved	mg/L	<0.03	-		36	110	77	730	110	110	100	120
Sodium - Dissolved	mg/L	<0.03	-		570	1100	1000	2200	840	540	2400	2400
Magnesium - Dissolved	mg/L	<0.03	-		44	96	74	110	51	50	220	250
Hydroxide Alkalinity (OH^-)	mg/L	<0.1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Bicarbonate Alkalinity as	mg/L	<0.1	-		6	LPQL	420	1900	2500	1800	230	220
Carbonate Alkalinity as	mg/L	<0.1	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Total Alkalinity	mg/L	<0.1	-		6	LPQL	420	1900	2500	1800	230	220
Sulphate, SO4	mg/L	<5	-	500	310	960	280	7.5	2	0.81	660	740
Chloride (titration) - water	mg/L	<20	-	250	780	1600	1600	4200	1100	670	4800	5500
Ionic Balance	%		-		2.6	-0.92	1	-10	-27	-18	-1.9	-7.7
pH	pH Units		6.5-8.5 [+]	6.5-8.5	**4.8**	**4.1**	**5.8**	6.7	6.7	6.6	6.9	7.1
Electrical Conductivity	µS/cm	<1	-		2800	5600	5100	12000	6300	4800	11000	12000
Total Dissolved Solids	mg/L	<5	-		2000	4000	3500	6900	2600	2200	9900	11000
Total Suspended Solids	mg/L	<5	-		330	400	430	130	170	150	9	150
Nitrate as N in water	mg/L	<0.1	0.7 "	50	0.3	0.2	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Nitrite as N in water	mg/L	<0.01	-	3	LPQL	LPQL	0.03	LPQL	0.01	0.08	LPQL	LPQL
Phosphate as P in water	mg/L	<0.05	-		LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL
Phosphorus - Total	mg/L	<0.05	-		0.1	0.1	0.4	0.4	2.3	0.8	0.1	0.3
Ammonia as N in water	mg/L	<0.1	2.1-2.5	0.5	0.2	**8.3**	**29**	**390**	**280**	**280**	**3.2**	**3.5**
BOD5	mg/L	<2	-		8	5	15	2	5 2	4 2	29	2
Total Orgganic Carbon	gmg/L	<1	-		27	44	78	130	120	120	19	20
Field measurements												
pH					4.83	4.1	6.62	6.99	6.93	6.87	7.26	7.69
Conductivity	µS/cm				2821	6248	5220	12757	7087	5179	10420	13417
Redox	mV				83	131.8	82.6	7.6	0.2	70.3	114.7	50
Dissolved oxygen	mg/L				0.1	0.4	0.1	0.1	0.1	0.1	1.4	1.5

EXPLANATION:

[2] NHMRC Australian Drinking Water Guidelines (2004)

~ ANZECC Australian Water Quality Guidelines for Fresh Waters, 2000 - Trigger Values for protection of 95% of species- low to moderate reliability "
ANZECC Australian Water Quality Guidelines for Fresh Waters, 2000 - Trigger Values for protection of 95% of species- high reliability

' USEPA Region 9 Superfund - Preliminary Remedation Goal (PRG) for tapwater 2010

^ In the absence of high reliability NSW EPA or ANZECC guidelines for TPH, the Airport (environment Protection) regulations (1997), Schedule 2 water Pollution Accepted Limits; Table 1.03 - Accepted Limits of Contamination have been quoted

[+] ANZECC Australian Water Quality Guidelines for Fresh and Marine Waters, 2000 - Level for NSW Lowland Rivers.

Concentration above the Site Assessment Criteria **VALUE**

* The higher zinc result detected in the inter lab duplicate (DUP2) has been substituted for the primary result.

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TABLE C
GROUNDWATER INTRA-LABORATORY DUPLICATE RESULTS
QA/QC - RELATIVE PERCENTAGE DIFFERENCES

Sample	Anlaysis	Units	MW202	Dup 1	MEAN	RPD %
Intra-laboratory Groundwater sample ID = MW202 Dup ID = Dup1	Dichlorodifluoromethane	µg/L	LPQL	LPQL	nc	nc
	Chloromethane	µg/L	LPQL	LPQL	nc	nc
	Vinyl Chloride	µg/L	LPQL	LPQL	nc	nc
	Bromomethane	µg/L	LPQL	LPQL	nc	nc
	Chloroethane	µg/L	LPQL	LPQL	nc	nc
	Trichlorofluoromethane	µg/L	LPQL	LPQL	nc	nc
	1,1-Dichloroethene	µg/L	LPQL	LPQL	nc	nc
	Trans-1,2-dichloroethene	µg/L	LPQL	LPQL	nc	nc
	1,1-dichloroethane	µg/L	LPQL	LPQL	nc	nc
	Cis-1,2-dichloroethene	µg/L	LPQL	LPQL	nc	nc
	Bromochloromethane	µg/L	LPQL	LPQL	nc	nc
	Chloroform	µg/L	LPQL	LPQL	nc	nc
	2,2-dichloropropane	µg/L	LPQL	LPQL	nc	nc
	1,2-dichloroethane	µg/L	LPQL	LPQL	nc	nc
	1,1,1-trichloroethane	µg/L	LPQL	LPQL	nc	nc
	1,1-dichloropropene	µg/L	LPQL	LPQL	nc	nc
	Cyclohexane	µg/L	LPQL	LPQL	nc	nc
	Carbon tetrachloride	µg/L	LPQL	LPQL	nc	nc
	Benzene	µg/L	LPQL	LPQL	nc	nc
	Dibromomethane	µg/L	LPQL	LPQL	nc	nc
	1,2-dichloropropane	µg/L	LPQL	LPQL	nc	nc
	Trichloroethene	µg/L	LPQL	LPQL	nc	nc
	Bromodichloromethane	µg/L	LPQL	LPQL	nc	nc
	trans-1,3-	µg/L	LPQL	LPQL	nc	nc
	cis-1,3-dichloropropene	µg/L	LPQL	LPQL	nc	nc
	1,1,2-trichloroethane	µg/L	LPQL	LPQL	nc	nc
	Toluene	µg/L	LPQL	LPQL	nc	nc
	1,3-dichloropropane	µg/L	LPQL	LPQL	nc	nc
	Dibromochloromethane	µg/L	LPQL	LPQL	nc	nc
	1,2-dibromoethane	µg/L	LPQL	LPQL	nc	nc
	Tetrachloroethene	µg/L	LPQL	LPQL	nc	nc
	1,1,1,2-tetrachloroethane	µg/L	LPQL	LPQL	nc	nc
	Chlorobenzene	µg/L	LPQL	LPQL	nc	nc
	Ethylbenzene	µg/L	LPQL	LPQL	nc	nc
	Bromoform	µg/L	LPQL	LPQL	nc	nc
	m+p-xylene	µg/L	LPQL	LPQL	nc	nc
	Styrene	µg/L	LPQL	LPQL	nc	nc
	1,1,2,2-tetrachloroethane	µg/L	LPQL	LPQL	nc	nc
	o-xylene	µg/L	LPQL	LPQL	nc	nc
	1,2,3-trichloropropane	µg/L	LPQL	LPQL	nc	nc
	Isopropylbenzene	µg/L	LPQL	LPQL	nc	nc
	Bromobenzene	µg/L	LPQL	LPQL	nc	nc
	n-propyl benzene	µg/L	LPQL	LPQL	nc	nc
	2-chlorotoluene	µg/L	LPQL	LPQL	nc	nc
	4-chlorotoluene	µg/L	LPQL	LPQL	nc	nc
	1,3,5-trimethyl benzene	µg/L	LPQL	LPQL	nc	nc
	Tert-butyl benzene	µg/L	LPQL	LPQL	nc	nc
	1,2,4-trimethyl benzene	µg/L	LPQL	LPQL	nc	nc
	1,3-dichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	Sec-butyl benzene	µg/L	LPQL	LPQL	nc	nc
	1,4-dichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	4-isopropyl toluene	µg/L	LPQL	LPQL	nc	nc
	1,2-dichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	n-butyl benzene	µg/L	LPQL	LPQL	nc	nc
	1,2-dibromo-3-	µg/L	LPQL	LPQL	nc	nc
	1,2,4-trichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	Hexachlorobutadiene	µg/L	LPQL	LPQL	nc	nc
	1,2,3-trichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	Arsenic-Dissolved	µg/L	3	3	3	0
	Beryllium-Dissolved	µg/L	2	2	2	0
	Boron-Dissolved	µg/L	470	480	475	2
	Cadmium-Dissolved	µg/L	0.1	0.1	0.1	0
	Cobalt-Dissolved	µg/L	6	6	6	0
	Chromium-Dissolved	µg/L	3	3	3	0
	Copper-Dissolved	µg/L	LPQL	1	nc	nc
	Lead-Dissolved	µg/L	1	1	1	0
	Manganese-Dissolved	µg/L	470	450	460	4
	Mercury-Dissolved	µg/L	LPQL	LPQL	nc	nc
	Nickel-Dissolved	µg/L	10	10	10	0
	Zinc-Dissolved	µg/L	60	60	60	0
	Ammonia as N in water	mg/L	0.2	0.3	0.25	40

ABBREVIATIONS:
PQL: Practical Quantitation Limit
LPQL: Less than PQL
nc: Not Calculated

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TABLE D
GROUNDWATER INTER-LABORATORY DUPLICATE RESULTS
QA/QC - RELATIVE PERCENTAGE DIFFERENCES

	Sample	Units	MW214	Dup 2	Mean	RPD
Inter-laboratory Groundwater sample ID = MW214 Dup ID = Dup2	Dichlorodifluoromethane	µg/L	LPQL	LPQL	nc	nc
	Chloromethane	µg/L	LPQL	LPQL	nc	nc
	Vinyl Chloride	µg/L	LPQL	LPQL	nc	nc
	Bromomethane	µg/L	LPQL	LPQL	nc	nc
	Chloroethane	µg/L	LPQL	LPQL	nc	nc
	Trichlorofluoromethane	µg/L	LPQL	LPQL	nc	nc
	1,1-Dichloroethene	µg/L	LPQL	LPQL	nc	nc
	Trans-1,2-dichloroethene	µg/L	LPQL	LPQL	nc	nc
	1,1-dichloroethane	µg/L	LPQL	LPQL	nc	nc
	Cis-1,2-dichloroethene	µg/L	LPQL	LPQL	nc	nc
	Bromochloromethane	µg/L	LPQL	LPQL	nc	nc
	Chloroform	µg/L	LPQL	LPQL	nc	nc
	2,2-dichloropropane	µg/L	LPQL	LPQL	nc	nc
	1,2-dichloroethane	µg/L	LPQL	LPQL	nc	nc
	1,1,1-trichloroethane	µg/L	LPQL	LPQL	nc	nc
	1,1-dichloropropene	µg/L	LPQL	LPQL	nc	nc
	Cyclohexane	µg/L	LPQL	na	nc	nc
	Carbon tetrachloride	µg/L	LPQL	LPQL	nc	nc
	Benzene	µg/L	LPQL	7.8	7.8	nc
	Dibromomethane	µg/L	LPQL	LPQL	nc	nc
	1,2-dichloropropane	µg/L	LPQL	LPQL	nc	nc
	Trichloroethene	µg/L	LPQL	LPQL	nc	nc
	Bromodichloromethane	µg/L	LPQL	LPQL	nc	nc
	trans-1,3-dichloropropene	µg/L	LPQL	na	nc	nc
	cis-1,3-dichloropropene	µg/L	LPQL	LPQL	nc	nc
	1,1,2-trichloroethane	µg/L	LPQL	LPQL	nc	nc
	Toluene	µg/L	LPQL	LPQL	nc	nc
	1,3-dichloropropane	µg/L	LPQL	LPQL	nc	nc
	Dibromochloromethane	µg/L	LPQL	LPQL	nc	nc
	1,2-dibromoethane	µg/L	LPQL	LPQL	nc	nc
	Tetrachloroethene	µg/L	LPQL	LPQL	nc	nc
	1,1,1,2-tetrachloroethane	µg/L	LPQL	LPQL	nc	nc
	Chlorobenzene	µg/L	14	13	13.5	7
	Ethylbenzene	µg/L	LPQL	5.4	nc	nc
	Bromoform	µg/L	LPQL	LPQL	nc	nc
	m+p-xylene	µg/L	28	19	23.5	38
	Styrene	µg/L	LPQL	LPQL	nc	nc
	1,1,2,2-tetrachloroethane	µg/L	LPQL	LPQL	nc	nc
	o-xylene	µg/L	LPQL	LPQL	nc	nc
	1,2,3-trichloropropane	µg/L	LPQL	LPQL	nc	nc
	Isopropylbenzene	µg/L	12	10	11	18
	Bromobenzene	µg/L	LPQL	LPQL	nc	nc
	n-propyl benzene	µg/L	12	11	11.5	9
	2-chlorotoluene	µg/L	LPQL	LPQL	nc	nc
	4-chlorotoluene	µg/L	LPQL	LPQL	nc	nc
	1,3,5-trimethyl benzene	µg/L	LPQL	LPQL	nc	nc
	Tert-butyl benzene	µg/L	LPQL	LPQL	nc	nc
	1,2,4-trimethyl benzene	µg/L	39	27	33	36
	1,3-dichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	Sec-butyl benzene	µg/L	LPQL	LPQL	nc	nc
	1,4-dichlorobenzene	µg/L	17	10	13.5	52
	4-isopropyl toluene	µg/L	LPQL	LPQL	nc	nc
	1,2-dichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	n-butyl benzene	µg/L	LPQL	LPQL	nc	nc
	1,2-dibromo-3-chloropropane	µg/L	LPQL	LPQL	nc	nc
	1,2,4-trichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	Hexachlorobutadiene	µg/L	LPQL	LPQL	nc	nc
	1,2,3-trichlorobenzene	µg/L	LPQL	LPQL	nc	nc
	Naphthalene	µg/L	45	70	57.5	43
	Arsenic-Dissolved	µg/L	27	17	22	45
	Beryllium-Dissolved	µg/L	LPQL	LPQL	nc	nc
	Boron-Dissolved	µg/L	3500	3800	3650	8
	Cadmium-Dissolved	µg/L	LPQL	LPQL	nc	nc
	Cobalt-Dissolved	µg/L	15	15	15	0
	Chromium-Dissolved	µg/L	26	27	26.5	4
	Copper-Dissolved	µg/L	LPQL	LPQL	nc	nc
	Lead-Dissolved	µg/L	2	LPQL	nc	nc
	Manganese-Dissolved	µg/L	67	36	51.5	60
	Mercury-Dissolved	µg/L	LPQL	LPQL	nc	nc
	Nickel-Dissolved	µg/L	66	75	70.5	13
	Zinc-Dissolved	µg/L	4	9	6.5	77
	Ammonia as N in water	mg/L	280	460	370	49

ABBREVIATIONS:
PQL: Practical Quantitation Limit
LPQL:: Less than PQL
nc: Not Calculated
na: Not analysed

TABLE E
SUMMARY OF METHANE GAS CONCENTRATIONS

Borehole	Approximate Depth	Methane Gas (V/V)
JK212	0.65 m	2%
JK212	1.5 m	3%
JK212	3 m	3%
JK212	4.5 m	2%
JK213	0-6.45 m	0%
JK214	3 m	1%
JK214	4.5 m	2%
JK214	6 m	2%
JK215	1.5 m	1%
JK215	3 m	2%
JK216	0.9 m	2%
JK216	2 m	2%
JK217	0.95 m	2%
JKJK217217	1.1.5555 mm	2%2%
JK217	3 m	3%
JK217	4.5 m	4%

Methane gas concentrations recorded in geotechnical boreholes during drilling.

Appendix D. Figures and Tables from RAP

Marina site location and boundary

Georges Cove Marina Development
Remediation action plan

Figure 1.1

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Metals*				
Aluminium	-	-	Freshwater TV exceeded in 6 samples. Exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L).	Freshwater TV exceeded by a factor of up to about 140 with the highest concentration in groundwater west of the basin. Low concentrations in groundwater adjacent to the Georges River.
Cadmium	-	-	-	Freshwater TV exceeded by a factor of about 20 and the marine TV (for protection of 99% if species) exceeded by a factor of about 6 in one sample from west of the basin. Lower concentrations in groundwater adjacent to the Georges River.
Copper	EIL exceeded in 2 samples by a factor of up to about 2.2.	ISQG-low exceeded in 10 samples but concentrations within range reported for the Georges River.	Freshwater and marine TVs exceeded in 1 sample.	Freshwater and marine TV exceeded by a factor of up to about 5 with the highest concentration in groundwater east of the basin. The highest concentration (0.005 mg/L) in groundwater is lower than the mean concentration in Georges River water (0.006 mg/L) (Marine Pollution Research 2010).
Lead	-	ISQG-low exceeded in 12 samples and the ISQG-high exceeded in 7 samples. Concentrations higher than in the main channel of the Georges River but within the range measured in bays and tributaries, where flow is lower and where there are historic contamination sources.	-	-

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Manganese	-	-	-	Freshwater TV exceeded in one sample by a factor of about 1.4 with the highest concentration in groundwater west of the basin. Low concentrations (below Freshwater TV) in groundwater adjacent to the Georges River.
Nickel	-	-	-	Freshwater TV exceeded in one sample by a factor of about 5 with the highest concentration in groundwater west of the basin. Marine TV (for protection of 99% if species) exceeded by a factor of up to about 85 in one sample from west of the basin. Lower concentrations in groundwater adjacent to the Georges River.
Zinc	EIL exceeded in 3 samples by a factor of about 2.	ISQG-low exceeded in 10 samples but concentrations within range reported for the Georges River.	Freshwater and marine TVs exceeded. Concentrations correlated with TSS concentrations. Some exceedances (by a factor of about 2) in samples with low TSS concentrations (<1 g/L). However, these levels are similar to the mean concentration in the Georges River (Marine Pollution Research 2010).	Freshwater and marine TV exceeded by a factor of up to about 115 with the highest concentration in groundwater west of the basin.

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Mercury (total)	-	ISQG-low exceeded in 12 samples.	Freshwater and marine TVs exceeded by total mercury concentrations in 6 samples. All exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L). Recreational guideline exceeded in 2 samples, both with high TSS concentrations (>58 g/L).	-
Nutrients				
Nitrate	-	-	Mean concentration exceeds TV for Lowland Rivers in 7 samples, by a factor of about 2.5.	-
Ammonia	-	-	Mean concentration exceeds TV for Lowland Rivers by a factor of about 400. Mean concentration exceeds freshwater and marine TVs by a factor of about 9.	Mean concentration exceeds TV for Lowland Rivers by a factor of about 120. Mean concentration exceeds freshwater and marine TVs by a factor of about 3. Lower concentrations in groundwater adjacent to the Georges River but still high.
Total nitrogen	-	Potential release of nutrients to water column and eutrophication risk.	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 95. Eutrophication risk.	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 10. Eutrophication risk.

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Total phosphorus	-	-	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 370. Eutrophication risk	-
PAH				
Benzo(a) pyrene	ESL exceeded in two samples by a factor of about 1.6.	ISQG-low exceeded in 5 samples.	Recreational guideline value exceeded Exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L).	-
Chrysene	-	ISQG-low exceeded in 3 samples.	-	-
Phenanthrene	-	Concentrations below the LOR in all but one sample. ISQG-low and -high exceeded in 1 sample.	-	-
Pyrene	-	ISQG-low exceeded in 8 samples and the ISQG-high exceeded in 1 sample.	-	-
Benzo(a) anthracene	-	ISQG-low exceeded in 4 samples.	-	-

Notes: ** Dissolved.*

EIL: environmental investigation level, and ESL: environmental screen level (NEPC 2013).

ISQG: interim sediment quality guidelines, high and low trigger values: (ANZECC and ARMCANZ 2000).

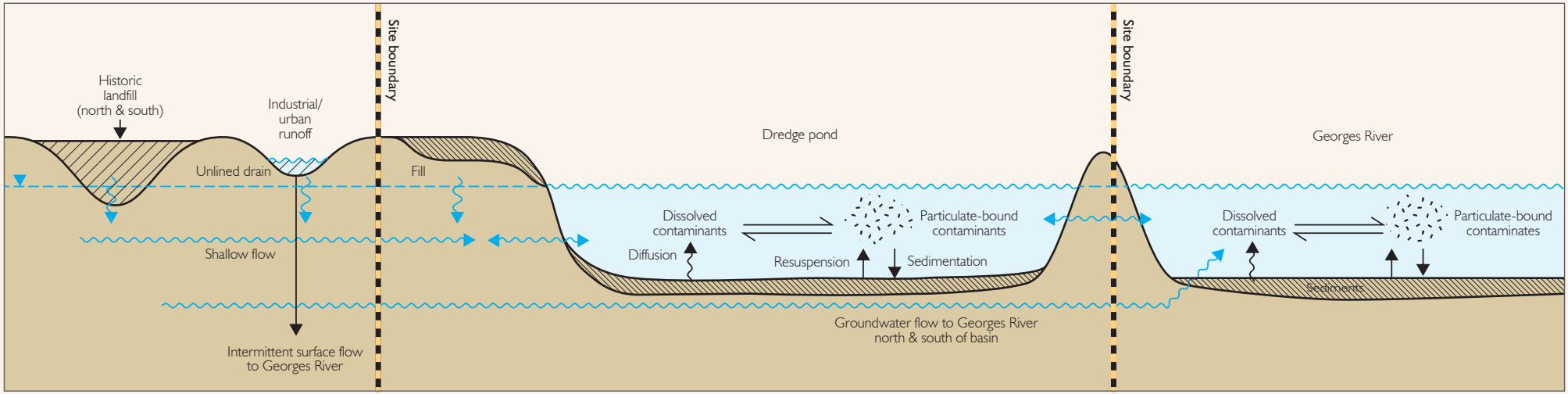
Freshwater & marine TVs: freshwater and marine trigger values for slightly to moderately disturbed ecosystems, generally for the protection of 95% of freshwater/marine species (ANZECC and ARMCANZ 2000).

River: default trigger values for South-east Australia Lowland Rivers (ANZECC and ARMCANZ 2000).

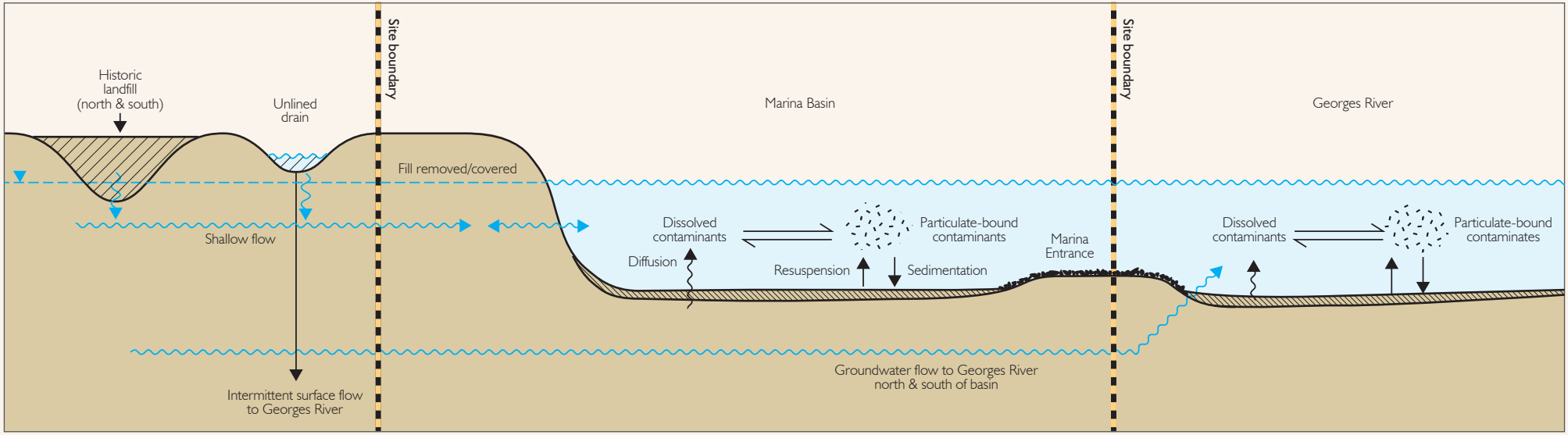
Recreational: recreational guideline (NHMRC 2008).

Eutrophication, no assessment criteria exceedance, but concentration high enough to consider a potential eutrophication risk.

Conceptual site model - sand extraction (current)



Conceptual site model - marina (future)



EMM

Conceptual site model
Remediation action plan
Georges Core Marina Development
Figure 3.1

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
Metals															
1	Surface water: urban runoff in unlined drain seeps to groundwater	Dissolved metals	Groundwater												
2		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Off-site source. Marina development will not change source or pathway. Lining the drain would change the pathway (less via groundwater, more via surface flow) but not the fate (discharge to river)	y	y	y	None	None
3		Dissolved metals	River water	Absorption to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
4		Particulate bound metals	River water	Particle settling	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	y	y	y	None	None
5	Surface water: urban runoff in unlined drain seeps to groundwater	Dissolved metals	Groundwater												
6		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and discharge to basin.	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Off-site source. Marina development will not change source or pathway. Ongoing input so redirection (eg in-ground barriers) would not change fate (flow to Georges River).	y	n	y	See basin water management	None
7		Dissolved metals	Basin water	Absorption of metals to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	y	y	y	Basin water management: - allow time for metals to be adsorbed. - basin water monitoring of prior to opening basin - open basin only when site-specific water quality assessment criteria acheived - contingency water treatment if required (eg flocculent)	None Ongoing chemical treatment of basin/river water is not viable
8		Particulate bound metals	Basin water	Particle settling	Particulate bound metals	Basin sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	Risk only when basin is contiguous with river Metals most immobile and generally lowest risk when associated with the sediment	y	n	y	None	None
9		Particulate bound metals	Basin sediment	Resuspension of sediments by dredge or propellers	Particulate bound metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Small number of boats 15-20 m long and no boats more than 20 m long	y	n	y	See basin water management	Prevent sediment resuspension from prop wash by providing adequate clearance and enforcing speed limit (4 knots)
10		Particulate bound metals	Basin water	Desorption of metals from suspended particulates	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	y	y	y	See basin water management	Prevent sediment resuspension
11		Particulate bound metals	Basin sediment	Desorption of metals from sediment and diffusion to overlying water column	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Slow chemical processes that may be accelerated by bioturbation. Metals likely to remain largely adsorbed on particles	y	n	y	See basin water management	None
12	Surface water: urban runoff in unlined drain - surface flow discharges directly to river	Dissolved metals and particulate bound metals	River water												

Table A.1 Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
13		Dissolved metals and particulate bound metals	River water	Direct surface water discharge to river when drain is flowing	Dissolved metals and particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Historic discharge. Drain and discharge point to river off-site.	y	n	y	None	None
14	Leachate from landfills to north and/or south of the site	Dissolved metals	Groundwater												
15		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved metals	River water	-	Levels above baseline/ANZECC WQTVs - potential toxicity	Levels exceed recreational guidelines	Need to be managed at the source. Measures on site could only redirect flows. A contamination assessment for area north of the site is underway. No remediation was required during recent approcal of site to the south	y	n	y	None	None
16		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and discharge to basin	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	y	n	y	See basin water management	None. Ongoing chemical treatment of basin/river water is not viable
17	Process water/surface water runoff from north of the site	Dissolved metals and particulate bound metals	Surface water												
18		Dissolved metals and particulate bound metals	Surface water	Direct surface water discharge to basin	Dissolved metals and particulate bound metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Basin water will cease to be used for processing at the cessation of recycling facility activities north of the site.	y	y	y	Cease processing to north of site Prevent surface water runoff from offsite running directly into basin Direct surface runoff to treatment area in north-west of basin See basin water management	Prevent surface water runoff from offsite running directly into basin Direct surface runoff to treatment area in north-west of basin
19		Dissolved metals	Basin water	Direct water flow to river	Dissolved metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	n	y	y	See basin water management	Marina designed to promote frequent flushing (40-60% per tidal cycle), preventing dissolved and particulate metal accumulation and increasing concentrations.
20		Particulate bound metals	Basin water	Direct water flow to river	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	n	y	y	See basin water management	None
21		Particulate bound metals	Basin sediment	Movement of sediment along bed to river	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	n	n	y	-	Leave an armoured lip on the base on the marina entrance
22		Dissolved metals	Basin water	Infiltration to groundwater	Dissolved metals	Groundwater	-	-	-	-	y	n	y	-	-
23	Georges River upstream of the site	Dissolved metals and particulate bound metals	River water												
24		Dissolved metals and particulate bound metals	River water	River flow	Dissolved metals and particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
25		Dissolved metals	River water	Absorption to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Lower risk than for dissolved metals	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable

Table A.1 Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
26		Particulate bound metals	River water	Particle settling	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
27	Georges River upstream of the site	Particulate bound metals	River sediment												
28		Particulate bound metals	River sediment	Movement of sediment along the river bed	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-		y	y	y	None	None (current boat use of river will continue).
29	Overland flow during flooding	Dissolved metals and particulate bound metals	River water												
30		Dissolved metals	River water	Absorption to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Lower risk than for dissolved metals	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
31		Particulate bound metals	River water	Particle settling	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	y	y	y	None	None (current boat use of river will continue).
Ammonia															
32	Surface water: urban runoff in unlined drain seeps to groundwater	Ammonia	Groundwater												
33		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Off-site source. Marina development will not change source or pathway.	y	y	y	None	None Note: lining the drain would change the pathway (less via groundwater, more via surface flow) but not the fate (discharge to river)
34		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and discharge to basin	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when basin is contiguous with river .	y	y	y	See basin water management	None
35		Dissolved ammonia	Basin water	Direct water flow to river	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	May occur when basin first opened to the river. Could be a ongoing pathway for movement of ammonia to the river.	n	y	y	See basin water management	Marina designed to promote frequent flushing, preventing ammonia accumulation increasing concentrations.
36		Organic matter	Basin sediment	Formation of ammonia in the sediments from organic matter and diffusion to overlying water column	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	Minimise input of solid organic matter to the basin by directly flow though treatment wetland.
37	Surface water: urban runoff in unlined drain - surface flow discharges directly to river	Ammonia	Groundwater												
38		Dissolved ammonia	Groundwater	Direct surface water discharge to river when drain is flowing	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Historic discharge. Drain and discharge point to river off-site	y	n	y	None	None
39	Leachate from landfills to north and/or south of the site	Dissolved ammonia	Groundwater												
40		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	-	y	n	y	None	Needs to be managed at the source. Measures on site could only redirect flows. Contamination assessment for area north of the site are underway.
41		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and discharge to basin.	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	Ongoing chemical treatment of basin/river water is not viable None as part of this development
42	Process water/surface water runoff from north of the site	Dissolved ammonia	Surface water												

Table A.1 Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
43		Dissolved ammonia	Surface water	Direct surface water discharge to basin	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river Basin water will cease to be used for processing at the cessation of recycling facility activities north of the site.	y	n	y	See basin water management	Minimise input of ammonia to the basin by directly flow though treatment ponds.
44		Dissolved ammonia	Basin water	Direct water flow to river	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river	n	y	y	See basin water management	None
45		Dissolved ammonia	Basin water	Infiltration to groundwater	Dissolved ammonia	Groundwater	-	-	-	-	y	n	y	-	-
46	Georges River upstream of the site	Dissolved ammonia	River water												
47		Dissolved ammonia	River water	River flow	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	-	y	n	y	None	None Current process unrelated to operation of the site
48	Georges River upstream of the site	Dissolved ammonia	River sediment												
49		Organic matter	River sediment	Formation of ammonia in the sediments from organic matter and diffusion to overlying water column	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	-	y	n	y	None	None Current process unrelated to operation of the site
50	Overland flow during flooding	Dissolved ammonia	River water												
51		Dissolved ammonia	River water	River flow	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	High organic loads may occur due to flooding and overflow of upstream sewage treatment plants	y	n	y	None	None Current process unrelated to operation of the site
Nutrients															
52	Surface water: urban runoff in unlined drain seeps to groundwater	Nutrients	Groundwater												
53		Nutrients	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Nutrients	River water	-	Eutrophication risk.	-	Off-site source. Marina development will not change source or pathway.	y	y	y	None	None
54		Nutrients	Groundwater	Seepage to groundwater (offsite) and discharge to basin	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when basin is contiguous with river .	y	y	y	See basin water management	None
55		Nutrients	Basin water	Direct water flow to river	Nutrients	River water	-	Eutrophication risk.	-	May occur when basin first opened to the river. Could be a ongoing pathway for movement of nutirents to the river.	n	y	y	See basin water management	Marina designed to promote frequent flushing, preventing nutrient accumulation and increasing concentrations.
56		Nutrients	Basin sediment	Release of nutrients from the sediments from organic matter and diffusion to overlying water column	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	Minimise input of solid organic matter to the basin by directly flow though treatment ponds.
57	Surface water: urban runoff in unlined drain - surface flow discharges directly to river	Nutrients	Groundwater												
58		Nutrients	Groundwater	Direct surface water discharge to river when drain is flowing	Nutrients	River water	-	Eutrophication risk.	-	Historic discharge. Drain and discharge point to river off-site	y	n	y	None	None
59	Leachate from landfills to north and/or south of the site	Nutrients	Groundwater												
60		Nutrients	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Nutrients	River water	-	Eutrophication risk.	-	-	y	n	y	None	Needs to be managed at the source. Measures on site could only redirect flows. Contamination assessment for area north of the site are underway.

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
61		Nutrients	Groundwater	Seepage to groundwater (offsite) and discharge to basin.	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	None
62	Process water/surface water runoff from north of the site	Nutrients	Surface water												
63		Nutrients	Surface water	Direct surface water discharge to basin	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when contiguous with river - see river row Basin water will cease to be used for processing at the cessation of recycling facility activities north of the site.	y	n	y	See basin water management	Minimise input of ammonia to the basin by directly flow though treatment ponds.
64		Nutrients	Basin water	Direct water flow to river	Nutrients	River water	-	Eutrophication risk.	-	Risk only when contiguous with river	n	y	y	See basin water management	None
65		Nutrients	Basin water	Infiltration to groundwater	Nutrients	Groundwater	-	-	-	-	y	n	y	-	None
66	Georges River upstream of the site	Nutrients	River water												
67		Nutrients	River water	River flow	Nutrients	River water	-	Eutrophication risk.	-	-	y	n	y	-	None Current process unrelated to operation of the site
68	Georges River upstream of the site	Nutrients	River sediment												
69		Nutrients	River sediment	Formation of ammonia in the sediments from organic matter and diffusion to overlying water column	Nutrients	River water	-	Eutrophication risk.	-	-	y	n	y	-	None Current process unrelated to operation of the site
70	Overland flow during flooding	Dissolved metals and particulate bound metals	River water												
71		Nutrients	River water	River flow	Nutrients	River water	-	Eutrophication risk.	-	High organic loads may occur due to flooding and overflow of upstream sewage treatment plants	y	n	y	-	None Current process unrelated to operation of the site

1. Metals of concern:
   High risk: lead in sediment (high risk), total mercury in basin water (high risk)
   Medium risk: aluminium (groundwater), cadmium (groundwater), mercury (basin sediment), nickel (groundwater), zinc (basin water and groundwater)
   Low risk: aluminium (basin water), copper (basin sediment, basin water and groundwater), manganese (groundwater), zinc (basin water)
2. It is assumed that ammonia will occur predominantly as dissolved ammonia.
3. Nutrients measured as total nitrogen and total phosphorus.
4. PAH are expected to partition between the dissolved and particulate phases and are a toxicity risk. The same pathways and mechanisms are expected to occur as for metals. Measures to manage metals will also manage PAHs.

Appendix E. Site Audit Correspondence

Ian Swane

From: Phil Towler <ptowler@emmconsulting.com.au>
Sent: Wednesday, 14 November 2018 10:16 AM
To: iswane@bigpond.com
Cc: Ernest Dupere
Subject: Georges Cove Marina - site audit
Attachments: Environmental Health Comments.pdf; AMMONIUM NITROGEN SPREADHSEET_Restored_21Jun18.xlsx

Hi Ian

Please find the comments from Environmental Health, Liverpool City Council attached. As discussed, \wWe propose to go down the path described in the last paragraph of the Site Audit Statement and Site Audit Report section.

We understand that a Section B site audit (B5?) would address this requirement. However, please let us know if you see any issues with this approach.

I understand that John Russell has sent you all of the relevant Douglas Partners information.

I previously sent you the relevant reports prepared by EMM.

I have attached ammonia monitoring results for the pond (from June) – I will ask Benedict for the most recent results. The only additional information that I think that we have are water quality monitoring in Georges River – let me know if you want this.

Best regards

Phil

Philip Towler | Associate Director

T 02 9493 9500 | **D** 02 9493 9518 | M 0409 702 050

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From: Boris Santana <SantanaB@liverpool.nsw.gov.au>
Sent: Thursday, 25 October 2018 6:15 PM
To: Phil Towler <ptowler@emmconsulting.com.au>
Cc: Lina Kakish <KakishL@liverpool.nsw.gov.au>; Susan May-Raynes <smayraynes@emmconsulting.com.au>; Nelson

Mu <MuN@liverpool.nsw.gov.au>; Ernest Dupere <Ernest@benedict.com.au>
Subject: RE: Georges Cove Marina consultation with RMS

Hi Philip,

Thanks for your time over the phone on Wednesday.

The DA proposes to construct and operate a marina and related facilities on the southern portion of 146 Newbridge Road, Moorebank.

DA-781/2015 for the marina was approved by the Sydney West Joint Regional Planning Panel at its meeting on 29 September 2016. A third party appeal was made to the NSW Land and Environment Court by Moorebank Recyclers Pty Ltd. The Court orders delivered on 28 February 2018 upheld the appeal and refused DA-781/2015.

An Environmental Impact Statement (EIS), including appendices, was prepared by EMM to support the application for DA-781/2015. The EIS was prepared in accordance with Secretary's Environmental Assessment Requirements (SEAR 912) that were issued for the project on 19 March 2015.

Council notes that the EIS submitted in support of the 2015 DA has also been submitted with the current DA. Also, given the circumstances with the application, an EIS addendum has been submitted with this application that provides additional information in response to the Court judgement.

A preliminary assessment of the application revealed that the SEARs that the original EIS was predicated on was outdated. An email was sent on 28 August 2018 requesting that the applicant consults with the Secretary in relation to any further requirements. Council has received a copy of an updated SEARs 912 that were issued on 9 October 2018.

During our telephone discussion, you advised that the submitted addendum would be revised to address the additional requirements of the updated SEARs. Council does not endorse this approach. An EIS should be prepared that reflects the updated SEARs requirements, and addresses any matters arising from the Court judgement, to ensure an orderly and informed decision can be made by Council and the Sydney Western City Planning Panel.

In addition, the updated SEARs state that the applicant is to re-consult with various internal and external stakeholders and address any issues they may raise in the EIS. During our discussion you advised that the applicant is in the process of consulting with these stakeholders. I note that applicant is also required to consult with Liverpool City Council. Please note that comments have been received from internal departments that raise issues pertinent to the proposed development and shall be addressed in the EIS. These comments are as follows:

<u>Environmental Health Section</u>

- The EIS must require preparation and submission of information to address matters concerning contamination, site audit statement and site audit report, long-term environmental management plan, potential water quality impacts, air quality assessment, sewage pumping station and acoustic assessment. This information is attached to the email.

<u>Strategic Planning</u>

- A voluntary planning agreement (VPA) was prepared for the site in 2008. There is an item in the VPA that requires the construction and dedication of a road bridge to Brickmakers Drive before this first subdivision certificate for the R3 zoned land to the north. Access to the Marina relies on the construction of this road bridge. Delivery/completion of items in the VPA are largely dependent on the staging of development for the R3 zoned land to the north (i.e. Mirvac Site – DA-24/2017, DA-519/2017, DA-758/2017, DA-319/2018). It appears that progress for the R3 zoned land to the north has stalled due to outstanding environmental issues. Consideration needs to be given to this issue.

- The aforementioned DAs have been lodged with Council seeking to subdivide the R3 zoned land to the north of the proposed Marina and construct residential dwellings. In this regard, the EIS, including appendices, is required to consider the potential amenity impacts of the proposed construction and operation of a Marina on the residential dwellings proposed in the R3 zoned land with these DAs.

  Natural Environment Landscape

- To adequately assess the landscaping proposal, a detailed landscaping plan which includes proposed species, quantities, planting sizes and other relevant landscaping details and specifications are required.

  Heritage

- The submitted information is insufficient for assessment and does not comply with the current Aboriginal Due Diligence Code of Conduct Guidelines. An Aboriginal Due Diligence Assessment, prepared in accordance with the Due Diligence Code of Conduct is to be submitted for review.

A submission was also received from Canterbury Bankstown Council during the notification period that raised concerns with the proposed development (see attached). Given that updated SEARs requires the applicant to consult with the surrounding landowners and occupiers that are likely to be impacted by the proposal, it is recommended that you consult with Canterbury Bankstown Council regarding these concerns and address these concerns in the EIS.

Given the above, it appears that the scale of tasks required for the preparation of an EIS is substantial. Rather than resuming with the current application it is recommended that the application is withdrawn, which will entitle you to a full refund of the development application fees. An application should be lodged once the EIS has been prepared so that the assessment of the application can be undertaken in an orderly and efficient manner.

Please advise how you wish to proceed with the application. You can contact me on 8711 7683 if you wish to discuss further.

Kind regards,

Boris Santana
Senior Development Planner

LIVERPOOL CITY COUNCIL
LIVERPOOL THE GREAT SOUTH WEST

33 Moore Street, Liverpool NSW 2170
P: 1300 36 2170 || **E:** SantanaB@liverpool.nsw.gov.au | **W:** www.liverpool.nsw.gov.au

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ENVIRONMENTAL HEALTH REQUIREMENTS

Council's Environmental Health Section was previously involved in the assessment of DA-781/2015 which was approved by the Sydney West Joint Regional Planning Panel at its meeting on 29th September 2016.

DA-781/2015 was later subject to a third party appeal under Section 79(5) of the *Environmental Planning and Assessment Act 1979.* The Orders of the Court were that the appeal was upheld, resulting in DA-781/2015 being refused. In summary, the Commissioner found that the previous contaminated land investigation reports and Remediation Action Plan for the marina site were deficient and did not provide sufficient information to enable the consent authority to undertake its planning functions in accordance with Clause 7 of *State Environmental Planning Policy (SEPP) No. 55- Remediation of Land.*

Furthermore, the Commissioner was not satisfied that Clause 7.9(3)(c)(i) of the *Liverpool Local Environmental Plan 2008* had been addressed in relation to the potential environmental impacts of the development. Concerns regarding water quality impacts associated with the opening of the marina basin were also raised. However, the Commissioner confirmed that the NSW EPA was responsible for ensuring that the water quality of the Georges River would not be adversely impacted when the marina basin was opened.

The EIS should be revised to ensure that the following deficiencies previously identified by the Court regarding site contamination and potential impacts on aquatic ecology and water quality are addressed as part of the most recent Application:

Contamination

On 28th February 2018, Commissioner Brown from the NSW Land and Environment Court reported that the previously submitted contamination investigation reports and Remediation Action Plan did not satisfactorily address the contaminated land planning guidelines. More specifically, it was indicated that the preliminary investigation did not include a detailed appraisal of the site's history including the northern part of the land. Based upon the experts' joint report dated 7th November 2017, Commissioner Brown believed that *SEPP No 55- Remediation of Land* had not been addressed satisfactorily.

Given the site's history, the absence of a landfill gas assessment was identified as a significant omission. The experts agreed that further monitoring was required including gas monitoring of the marina site at locations where structures are proposed and on the northern-western boundary between the marina and northern section of the site. Landfill gas monitoring wells (MW101, MW102 and MW103) detailed within the Douglas Partners Pty Ltd's Preliminary Site Investigation were primarily located near the western boundary of Area 2 and it appears that the extent of landfill gas monitoring may not address the deficiencies identified by Dr Woods and Dr Jorstad.

Commissioner Brown also concluded that earlier dredge pond sampling was inadequate. The Preliminary Site Investigation completed by Douglas Partners Pty Ltd related specifically to Area 2 and the residential use envelope. It is believed that insufficient investigations were completed to resolve the inadequacies of the dredge pond sampling program and asbestos assessment identified by Dr Woods. This is consistent with Douglas Partners Pty Ltd's recommendation for a full asbestos investigation to quantify the concentration of bonded asbestos containing materials, fibrous asbestos and asbestos fines against relevant Tier 1 screening criteria.

The issues highlighted by Commissioner Brown were not resolved by the submitted contamination investigation reports and Remediation Action Plan supporting this Application. To satisfy the requirements of *SEPP No. 55- Remediation of Land*, Commissioner Brown confirmed that the results of the Landfill Gas Assessment and Asbestos Management Plan must form part of the Preliminary Site Investigation. Furthermore, the Court's findings highlighted that both experts agreed the marina Remediation Action Plan did not sufficiently identify all key potential risks to the health and environment or provide adequate details on the management of contamination.

Despite these deficiencies, the latest Application appears to be supported by the same preliminary investigation of contamination report, supplementary investigation report and Remediation Action Plan Proposed Georges Cove Marina (Report J14149RP1, Version V2, Final) prepared by EMM Consulting dated 11th March 2016. It is also unclear whether the more recent Preliminary Site Investigation report prepared by Douglas Partners Pty Ltd addressed the Court's findings.

For these reasons, it is considered that any submitted EIS must require the preparation and submission of a Stage 1 Preliminary Site Investigation report, Stage 2 Detailed Site Investigation report and Remediation Action Plan prepared by a suitably qualified contaminated land consultant to address the matters detailed within the Land and Environment Court findings dated 28th February 2018 and recommendations made by Douglas Partners Pty Ltd in their Preliminary Site Investigation dated 28th May 2018.

Site Audit Statement and Site Audit Report

The EIS shall require the Remediation Action Plan (RAP) to be accompanied by a Section B Site Audit Statement and Site Audit Report prepared by a NSW EPA Accredited Site Auditor confirming that:

- The nature and extent of contamination has been appropriately determined at the proposed development site;

- The investigation, remediation or management plan is appropriate for the intended purpose; and

- The site can be made suitable for the proposed land use in accordance with the submitted Remediation Action Plan (Report J14149RP1, Version V2, Final) prepared by EMM Consulting dated 11th March 2016 or any modified Remediation Action Plan as required.

The Site Audit Statement shall also confirm that the matters detailed in the Land and Environment Court's findings dated 28th February 2018 and recommendations made by Douglas Partners Pty Ltd in their Preliminary Site Investigation dated 28th May 2018 have been addressed satisfactorily.

The Contaminated Land Planning Guidelines specify that a Stage 2 Detailed Site Investigation is only necessary when a preliminary investigation indicates that the land is contaminated or that it is, or was, formally used for an activity listed in Table 1 and a land use change is proposed that has the potential to increase the risk of exposure to contamination. More specifically, Section 3.4.1 of the Contaminated Land Planning Guidelines stipulate that a detailed investigation will also need to be conducted as part of a remediation proposal.

DA-611/2018 was not supported by a Stage 2 Detailed Site Investigation and only comprises the following documentation: a Preliminary Investigation of Contamination (Report J14149RP1, Version 1, Final) prepared by EMGA Mitchell McLennan Pty Limited dated 28th July 2015; Supplementary Preliminary Investigation (Report J14149RP1, Version V3, Final) prepared by EMM Consulting dated

11th March 2016; Remediation Action Plan (Report J14149RP1, Version V2, Final) prepared by EMM Consulting dated 11th March 2016; and Preliminary Site Investigation (Project 71459.10, Document No. R.001.Rev1, File name 71459.10.R.001.Rev1.PSI, Revision 1) prepared by Douglas Partners Pty Ltd dated 28th May 2018.

According to the Contaminated Land Planning Guidelines, the objective of a detailed investigation is to obtain sufficient information to develop a Remedial Action Plan (RAP) if required. The marina site is known to be contaminated and requires remediation to be suitable for the proposed development. If a Stage 2 Detailed Site Investigation report is not submitted, it is requested that the NSW EPA Accredited Site Auditor confirms within the Site Audit Statement and Site Audit Report whether the Applicant is required to provide a report on a detailed investigation (as referred to in the contaminated land planning guidelines) to address potential data gaps between the submitted Stage 1 Preliminary Site Investigation reports and Remediation Action Plan.

Long-Term Environmental Management Plan

The Remediation Action Plan prepared by EMM Consulting dated 11th March 2016 indicated that affected areas of the site would be remediated through removal and disposal or covered with an impermeable surface. Similarly, the Preliminary Site Investigation prepared by Douglas Partners Pty Ltd dated 28th May 2018 suggested that the proposed development may incorporate a cap and contain strategy for asbestos contamination.

Douglas Partners Pty Ltd confirmed that this remediation strategy would require the preparation of a Long-Term Environmental Management Plan for the site. If remediation is to include a cap and contain strategy, it is requested that the EIS requires the preparation and submission of a Long-Term Environmental Management Plan for the ongoing management of the site.

Potential Water Quality Impacts

During the appeal, Commissioner Brown was not satisfied that Clause 7.9(3)(c)(i) of the *Liverpool Local Environmental Plan 2008* had been addressed in relation to the potential environmental impacts of the development. The consent authority still requires sufficient information to address the requirements of Clause 7.9(3)(c)(i) of the *Liverpool Local Environmental Plan 2008.* In this regard, it is requested that the EIS resolves the deficiencies identified by Commissioner Brown.

Acoustic Assessment

The most recent Application (DA-611/2018) for the proposed marina development was supported by a Noise Impact Assessment (Report_J14149RP2, Version V1, Final) prepared by EMGA Mitchell McLennan Pty Limited dated 21st July 2015. This acoustic assessment references the NSW Environment Protection Authority's (EPA) Industrial Noise Policy (2000). In October 2017, the NSW Industrial Noise Policy (2000) was withdrawn and replaced by the Noise Policy for Industry (2017) except as described in points 2, 3 and 8 of the implementation and transitional arrangements.

Point 3 of the implementation and transitional arrangements indicates that the Industrial Noise Policy (2000) may continue to apply if the proponent can demonstrate that the environmental assessment substantially commenced before release of the new policy. This report was prepared prior to the release of the Noise Policy for Industry (2017). However, planning and regulatory authorities may only determine applications based on the NSW Industrial Noise Policy (2000) for a period of up to one (1) year from the date of release of the Noise Policy for Industry (2017). As the Application is unable to be determined based upon the NSW Industrial Noise Policy (2000), it is requested that EIS requires

the preparation and submission of a revised acoustic report by a suitably qualified acoustic consultant in accordance with the NSW EPA's Noise Policy for Industry (2017) and other relevant standards.

Air Quality Assessment

The air quality assessment prepared by Todoroski Air Sciences dated 14th December 2011 referred to air quality criteria adopted from the 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales' prepared by the Department of Environment and Conservation NSW dated 2005. Minor revisions were made to this document in November 2016 which resulted in a more recent document titled 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales' being published by the NSW EPA in January 2017.

DA-611/2018 indicated that terrace houses and residential flat buildings were proposed in Area 2 of the marina site. The air quality assessment primarily considered off-site residential receivers rather than receptors inhabiting the marina site. Therefore, EIS shall be revised to require the preparation and submission of a comprehensive air quality assessment prepared by a suitably qualified air quality consultant comprising an appraisal of potential air quality impacts affecting all receptors in accordance with the more recent 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales' published by the NSW EPA in January 2017.

Sewage Pumping Station

The EIS shall require specific details for the sewage pump-out facilities to be detailed within the Application. Section 68 of the *Local Government Act 1993* indicates that approval is required to install, construct or alter a waste treatment device and operate a system of sewage management at the premises.

"Operate a system of sewage management" means hold or process, or re-use or discharge, sewage or by-products of sewage (whether or not the sewage is generated on the premises on which the system of sewage management is operated). Therefore, separate approval may be required under Section 68 of the *Local Government Act 1993* if the proposal includes sewage pump-out facilities or any other infrastructure to hold or process, or re-use or discharge, sewage or by-products of sewage. In these circumstances, the EIS shall require the Applicant to demonstrate that the system's design and capacity are adequate for its intended purpose taking into consideration maximum load requirements, unforeseen incidents and shutdown contingencies.

Ian Swane

From: Phil Towler <ptowler@emmconsulting.com.au>
Sent: Wednesday, 14 November 2018 10:16 AM
To: iswane@bigpond.com
Cc: Ernest Dupere
Subject: Georges Cove Marina - site audit
Attachments: Environmental Health Comments.pdf; AMMONIUM NITROGEN SPREADHSEET_Restored_21Jun18.xlsx

Hi Ian

Please find the comments from Environmental Health, Liverpool City Council attached. As discussed, \wWe propose to go down the path described in the last paragraph of the Site Audit Statement and Site Audit Report section.

We understand that a Section B site audit (B5?) would address this requirement. However, please let us know if you see any issues with this approach.

I understand that John Russell has sent you all of the relevant Douglas Partners information.

I previously sent you the relevant reports prepared by EMM.

I have attached ammonia monitoring results for the pond (from June) – I will ask Benedict for the most recent results. The only additional information that I think that we have are water quality monitoring in Georges River – let me know if you want this.

Best regards

Phil

Philip Towler | Associate Director

T 02 9493 9500 | **D** 02 9493 9518 | M 0409 702 050

Ground Floor, Suite 01, 20 Chandos Street, St Leonards NSW 2065

PO Box 21, St Leonards NSW 1590

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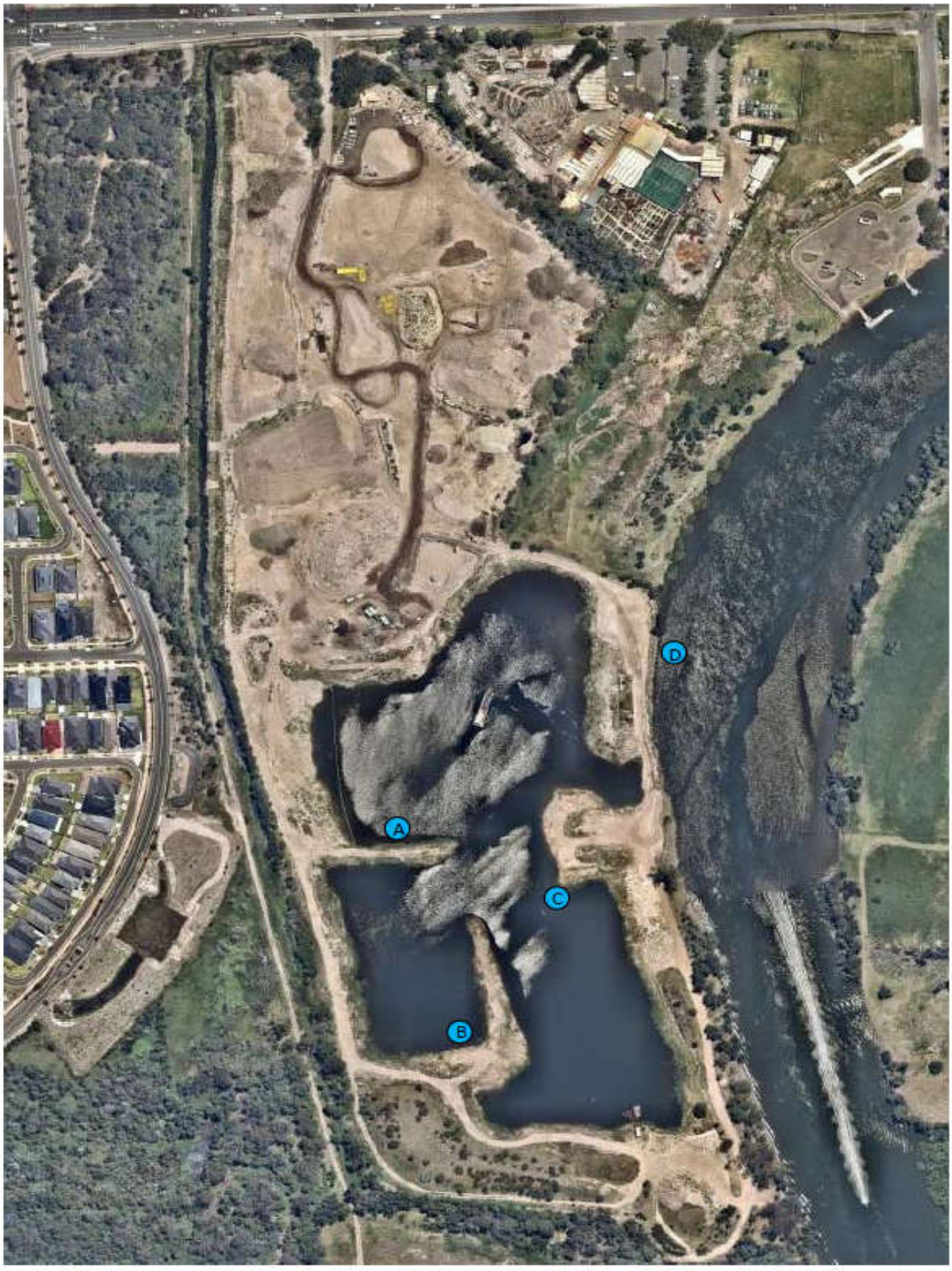
From: Boris Santana <SantanaB@liverpool.nsw.gov.au>
Sent: Thursday, 25 October 2018 6:15 PM
To: Phil Towler <ptowler@emmconsulting.com.au>
Cc: Lina Kakish <KakishL@liverpool.nsw.gov.au>; Susan May-Raynes <smayraynes@emmconsulting.com.au>; Nelson

AMMONIA WATER SAMPLING LOCATIONS



AMMONIUM N mg/L	Monitoring Points									Comments
	Mix A,B,C	A	A graph data	B	B graph data	C	C graph data	Georges River	Georges River graph data	
21/05/2018		0.1	0.1	0.2	0.2	0.2	0.2	<0.1	0.05	No dredging
14/05/2018		0.6	0.6	0.3	0.3	0.3	0.3	<0.1	0.05	No dredging
7/05/2018		0.1	0.1	0.2	0.2	0.1	0.1	<0.1	0.05	No dredging
30/04/2018		<0.1	0.05	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
23/04/2018		0.1	0.1	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
16/04/2018		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
9/04/2018		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
3/04/2018		0.1	0.1	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
26/03/2018		0.1	0.1	0.2	0.2	0.1	0.1	<0.1	0.05	No dredging
20/03/2018		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
6/03/2018		0.2	0.2	0.1	0.1	<0.1	0.05	0.1	0.1	No dredging
27/02/2018		0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.5	No dredging
19/02/2018		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
12/02/2018		<0.1	0.05	0.1	0.1	0.1	0.1	<0.1	0.05	No dredging
5/02/2018		<0.1	0.05	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
29/01/2018		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
24/01/2018		0.1	0.1	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
15/01/2018		<0.1	0.05	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
8/01/2018		0.1	0.1	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
2/01/2018		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
18/12/2017		<0.1	0.05	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
12/12/2017		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
5/12/2017		0.5	0.5	0.6	0.6	0.4	0.4	<0.1	0.05	No dredging
27/11/2017		0.2	0.2	0.2	0.2	0.3	0.3	<0.1	0.05	No dredging
20/11/2017		0.4	0.4	0.4	0.4	0.3	0.3	<0.1	0.05	No dredging
13/11/2017		0.3	0.3	0.3	0.3	0.3	0.3	<0.1	0.05	No dredging
6/11/2017		0.6	0.6	0.7	0.7	0.7	0.7	<0.1	0.05	No dredging
30/10/2017		0.5	0.5	0.4	0.4	0.4	0.4	0.1	0.1	No dredging

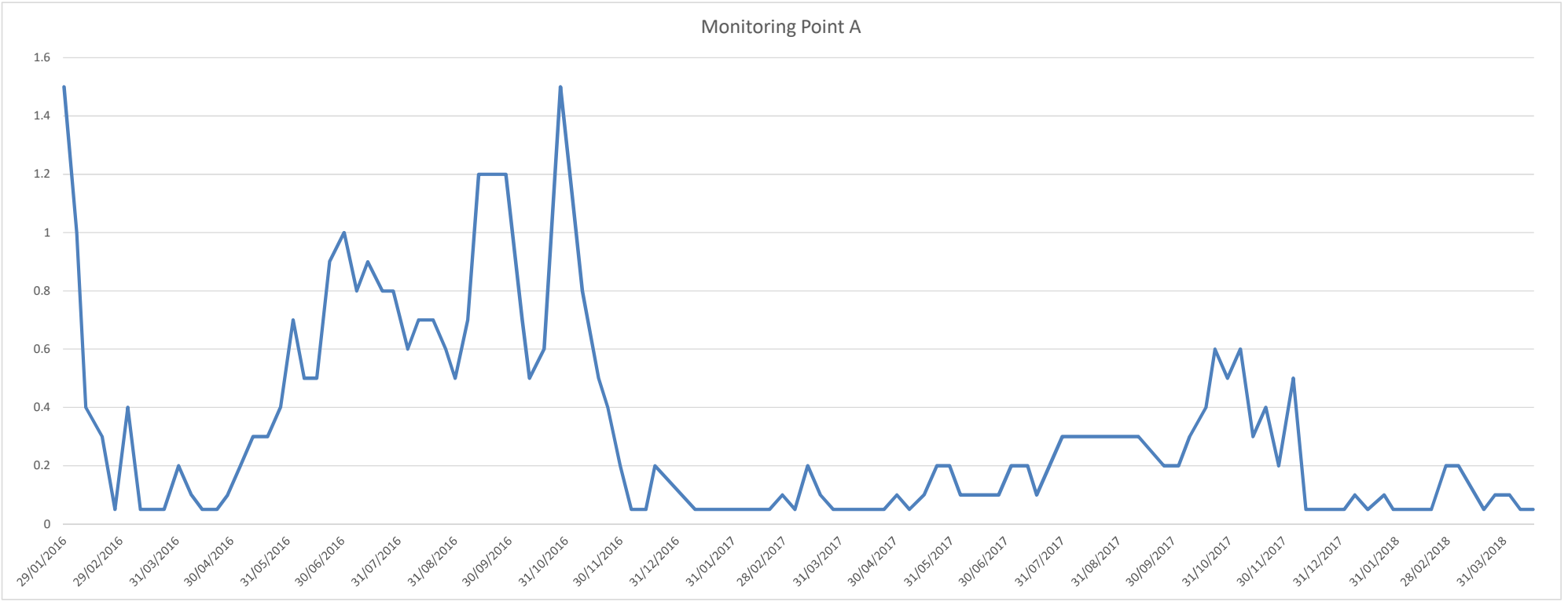
23/10/2017		0.6	0.6	0.6	0.6	0.6	0.6	<0.1	0.05	No dredging
18/10/2017		0.4	0.4	0.4	0.4	0.4	0.4	<0.1	0.05	No dredging
9/10/2017		0.3	0.3	0.5	0.5	0.3	0.3	<0.1	0.05	No dredging
3/10/2017		0.2	0.2	0.2	0.2	0.2	0.2	<0.1	0.05	No dredging
25/09/2017		0.2	0.2	0.3	0.3	0.2	0.2	<0.1	0.05	No dredging
11/09/2017		0.3	0.3	0.3	0.3	0.2	0.2	<0.1	0.05	No dredging
4/09/2017		0.3	0.3	0.4	0.4	0.3	0.3	<0.1	0.05	No dredging
28/08/2017		0.3	0.3	0.6	0.6	0.2	0.2	0.4	0.4	No dredging
21/08/2017		0.3	0.3	0.5	0.5	0.3	0.3	<0.1	0.05	No dredging
14/08/2017		0.3	0.3	0.4	0.4	0.4	0.4	0.2	0.2	No dredging
7/08/2017		0.3	0.3	0.5	0.5	0.4	0.4	<0.1	0.05	No dredging
31/07/2017		0.3	0.3	0.3	0.3	0.3	0.3	<0.1	0.05	No dredging
24/07/2017		0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.1	No dredging
17/07/2017		0.1	0.1	0.2	0.2	0.2	0.2	<0.1	0.05	No dredging
12/07/2017		0.2	0.2	0.2	0.2	0.2	0.2	<0.1	0.05	No dredging
3/07/2017		0.2	0.2	0.2	0.2	0.2	0.2	<0.1	0.05	No dredging
26/06/2017		0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	No dredging
21/06/2017		0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	No dredging
13/06/2017		0.1	0.1	<0.1	0.05	<0.1	0.05	0.6	0.6	No dredging
5/06/2017		0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.05	No dredging
30/05/2017		0.2	0.2	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
23/05/2017		0.2	0.2	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
16/05/2017		0.1	0.1	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
8/05/2017		<0.1	0.05	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
1/05/2017		0.1	0.1	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
24/04/2017		<0.1	0.05	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
20/04/2017		<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
10/04/2017		<0.1	0.05	<0.1	0.05	<0.1	0.05	0.3	0.3	No dredging
4/04/2017		<0.1	0.05	<0.1	0.05	<0.1	0.05	0.2	0.2	No dredging
27/03/2017		<0.1	0.05	<0.1	0.05	<0.1	0.05	0.4	0.4	No dredging
20/03/2017		0.1	0.1	<0.1	0.05	<0.1	0.05	0.3	0.3	No dredging
13/03/2017		0.2	0.2	<0.1	0.05	<0.1	0.05	0.5	0.5	No dredging
6/03/2017		<0.1	0.05	0.2	0.2	<0.1	0.05	0.5	0.5	No dredging
27/02/2017	N/T	0.1	0.1	0.2	0.2	<0.1	0.05	0.2	0.2	No dredging

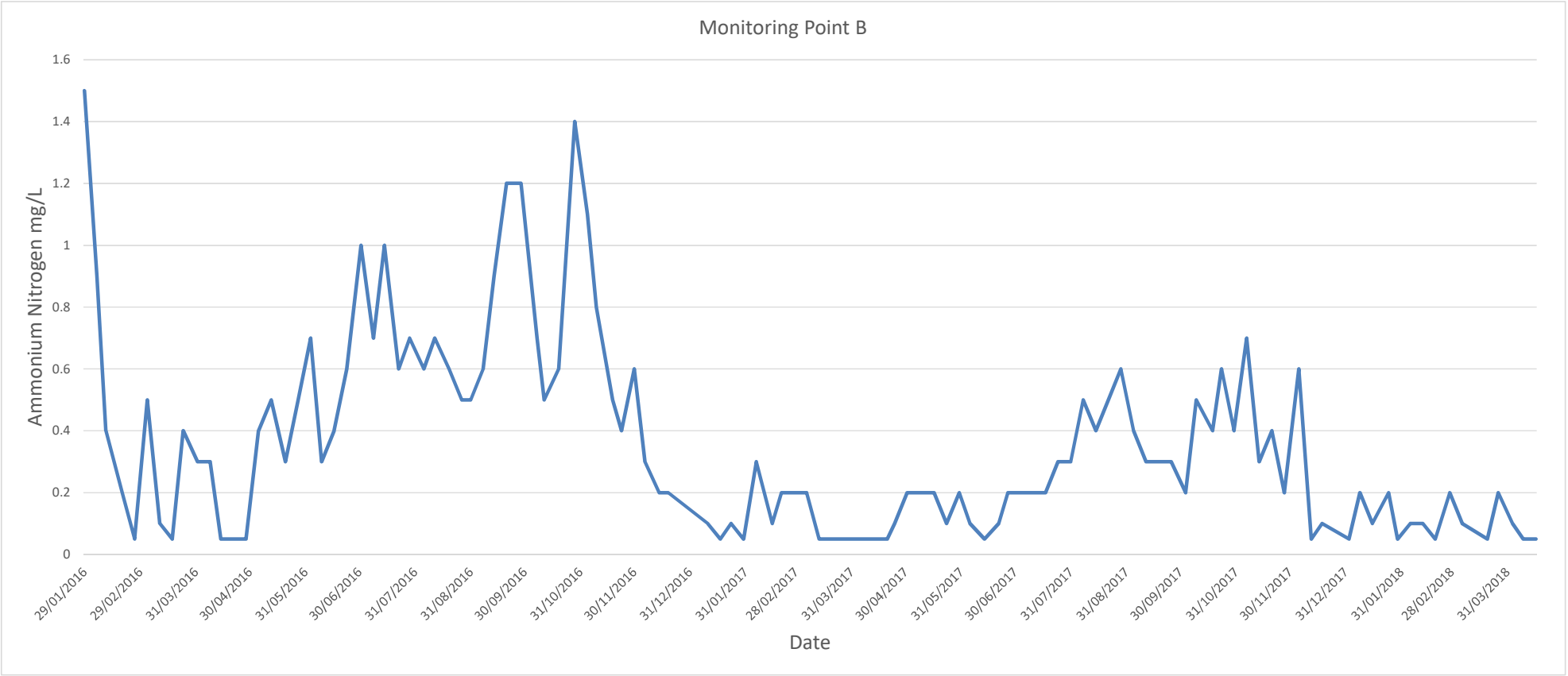
20/02/2017	N/T	<0.1	0.05	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
15/02/2017	N/T	<0.1	0.05	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
6/02/2017	N/T	<0.1	0.05	0.3	0.3	<0.1	0.05	<0.1	0.05	No dredging
30/01/2017	N/T	<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
23/01/2017	N/T	<0.1	0.05	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
17/01/2017	N/T	<0.1	0.05	<0.1	0.05	<0.1	0.05	<0.1	0.05	No dredging
10/01/2017	N/T	<0.1	0.05	0.1	0.1	<0.1	0.05	<0.1	0.05	No dredging
19/12/2016	N/T	0.2	0.2	0.2	0.2	0.1	0.1	0.4	0.4	No dredging
14/12/2016	N/T	<0.1	0.05	0.2	0.2	<0.1	0.05	<0.1	0.05	No dredging
6/12/2016	N/T	<0.1	0.05	0.3	0.3	0.2	0.2	<0.1	0.05	No dredging
30/11/2016	N/T	0.2	0.2	0.6	0.6	0.2	0.2	<0.1	0.05	No dredging
23/11/2016	N/T	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1	No dredging
18/11/2016	N/T	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.3	No dredging
9/11/2016	N/T	0.8	0.8	0.8	0.8	0.8	0.8	<0.1	0.05	No dredging
4/11/2016	N/T	1.1	1.1	1.1	1.1	1.1	1.1	0.3	0.3	No dredging
28/10/2016	N/T	1.5	1.5	1.4	1.4	1.4	1.4	<0.1	0.05	No dredging
19/10/2016	N/T	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	Dredging
11/10/2016	N/T	0.5	0.5	0.5	0.5	0.5	0.5	<0.1	0.05	No dredging
7/10/2016	N/T	0.7	0.7	0.7	0.7	0.7	0.7	<0.1	0.05	No dredging
28/09/2016	N/T	1.2	1.2	1.2	1.2	1.2	1.2	<0.1	0.05	No dredging
20/09/2016	N/T	1.2	1.2	1.2	1.2	1.1	1.1	0.2	0.2	No dredging
13/09/2016	N/T	1.2	1.2	0.9	0.9	1.0	1.0	0.2	0.2	No dredging
7/09/2016	N/T	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7	Dredging
31/08/2016	N/T	0.5	0.5	0.5	0.5	0.7	0.7	0.4	0.4	No dredging
26/08/2016	N/T	0.6	0.6	0.5	0.5	0.6	0.6	0.4	0.4	No dredging
19/08/2016	N/T	0.7	0.7	0.6	0.6	0.7	0.7	0.1	0.1	No dredging
11/08/2016	N/T	0.7	0.7	0.7	0.7	0.7	0.7	0.3	0.3	No dredging
5/08/2016	N/T	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	No dredging
28/07/2016	N/T	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6	No dredging
22/07/2016	N/T	0.8	0.8	0.6	0.6	0.9	0.9	0.6	0.6	No dredging
14/07/2016	N/T	0.9	0.9	1	1	0.8	0.8	0.4	0.4	No dredging
8/07/2016	N/T	0.8	0.8	0.7	0.7	0.7	0.7	N/T	N/T	No dredging
1/07/2016	N/T	1.0	1.0	1.0	1.0	0.9	0.9	0.4	0.4	No dredging
23/06/2016	N/T	0.9	0.9	0.6	0.6	0.9	0.9	N/T	N/T	No dredging

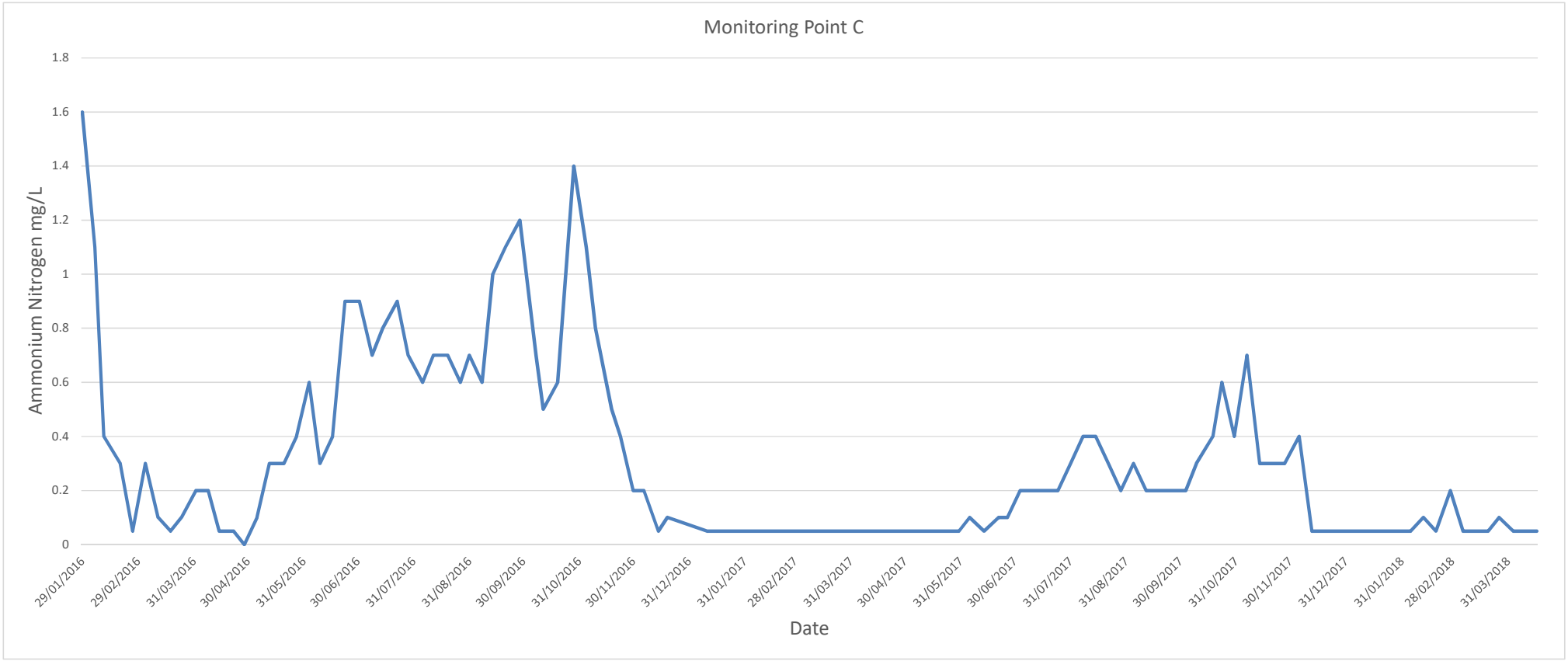
16/06/2016	N/T	0.5	0.5	0.4	0.4	0.4	0.4	N/T	N/T	No dredging
9/06/2016	N/T	0.5	0.5	0.3	0.3	0.3	0.3	N/T	N/T	No dredging
3/06/2016	N/T	0.7	0.7	0.7	0.7	0.6	0.6	N/T	N/T	No dredging
27/05/2016	N/T	0.4	0.4	0.5	0.5	0.4	0.4	N/T	N/T	No dredging
20/05/2016	N/T	0.3	0.3	0.3	0.3	0.3	0.3	N/T	N/T	No dredging
12/05/2016	N/T	0.3	0.3	0.5	0.5	0.3	0.3	N/T	N/T	No dredging
5/05/2016	N/T	0.2	0.2	0.4	0.4	0.1	0.1	N/T	N/T	No dredging
28/04/2016	N/T	0.1	0.1	<0.1	0.05	<0.1	0	N/T	N/T	No dredging
22/04/2016	N/T	<0.1	0.05	<0.1	0.05	<0.1	0.05	N/T	N/T	No dredging
14/04/2016	N/T	<0.1	0.05	<0.1	0.05	<0.1	0.05	N/T	N/T	No dredging
8/04/2016	N/T	0.1	0.1	0.3	0.3	0.2	0.2	N/T	N/T	No dredging
1/04/2016	N/T	0.2	0.2	0.3	0.3	0.2	0.2	N/T	N/T	No dredging
24/03/2016	N/T	<0.1	0.05	0.4	0.4	0.1	0.1	N/T	N/T	No dredging
18/03/2016	N/T	<0.1	0.05	<0.1	0.05	<0.1	0.05	N/T	N/T	No dredging
11/03/2016	N/T	<0.1	0.05	0.1	0.1	0.1	0.1	N/T	N/T	No dredging
4/03/2016	N/T	0.4	0.4	0.5	0.5	0.3	0.3	N/T	N/T	No dredging
26/02/2016	N/T	<0.1	0.05	<0.1	0.05	<0.1	0.05	N/T	N/T	No dredging
19/02/2016	N/T	0.3	0.3	0.2	0.2	0.3	0.3	N/T	N/T	No dredging
10/02/2016	N/T	0.4	0.4	0.4	0.4	0.4	0.4	N/T	N/T	No dredging
5/02/2016	N/T	1.0	1.0	0.9	0.9	1.1	1.1	N/T	N/T	No dredging
29/01/2016	N/T	1.5	1.5	1.5	1.5	1.6	1.6	N/T	N/T	No dredging
22/01/2016	1.3							N/T		No dredging
15/01/2016	0.5							N/T		No dredging
8/01/2016	1.7							N/T		No dredging
18/12/2015	5.6							N/T		No dredging - 23/12/15 - 5/1/16
11/12/2015	2.9							N/T		
4/12/2015	3.3							N/T		
27/11/2015	3.5							N/T		
20/11/2015	3.3							N/T		
13/11/2015	6.0							N/T		
6/11/2015	6.9							N/T		
30/10/2015	10							N/T		
23/10/2015	11							N/T		

16/10/2015	12							N/T		
12/10/2015	N/T							N/T		
8/10/2015	6.3							N/T		
1/10/2015	9.5	10		9.4		9.2		0.2		
25/09/2015	9.4							<0.1		
18/09/2015	3.5									
6/07/2015										
10/04/2015										
19/01/2015										
13/10/2014										
14/07/2014										
15/04/2014										
16/01/2014										
18/10/2013										
24/07/2013										
15/04/2013										
11/01/2013										
17/10/2012										
9/07/2012										
20/04/2012										
11/01/2012										
17/10/2011										
13/07/2011										
8/04/2011										
10/01/2011										
11/10/2010										
15/07/2010										
19/05/2010										
20/01/2010										

Note: Value for the samples less than LOR (Limit of Repeating) have been halved for the purpose of graphical representation


Monitoring Point A
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
29/01/2016
29/02/2016
31/03/2016
30/04/2016
31/05/2016
30/06/2016
31/07/2016
31/08/2016
30/09/2016
31/10/2016
30/11/2016
31/12/2016
31/01/2017
28/02/2017
31/03/2017
30/04/2017
31/05/2017
30/06/2017
31/07/2017
31/08/2017
30/09/2017
31/10/2017
30/11/2017
31/12/2017
31/01/2018
28/02/2018
31/03/2018


Monitoring Point B
Ammonium Nitrogen mg/L
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
29/01/2016
29/02/2016
31/03/2016
30/04/2016
31/05/2016
30/06/2016
31/07/2016
31/08/2016
30/09/2016
31/10/2016
30/11/2016
31/12/2016
31/01/2017
28/02/2017
31/03/2017
30/04/2017
31/05/2017
30/06/2017
31/07/2017
31/08/2017
30/09/2017
31/10/2017
30/11/2017
31/12/2017
31/01/2018
28/02/2018
31/03/2018
Date


Monitoring Point C
Ammonium Nitrogen mg/L
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
29/01/2016
29/02/2016
31/03/2016
30/04/2016
31/05/2016
30/06/2016
31/07/2016
31/08/2016
30/09/2016
31/10/2016
30/11/2016
31/12/2016
31/01/2017
28/02/2017
31/03/2017
30/04/2017
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30/06/2017
31/07/2017
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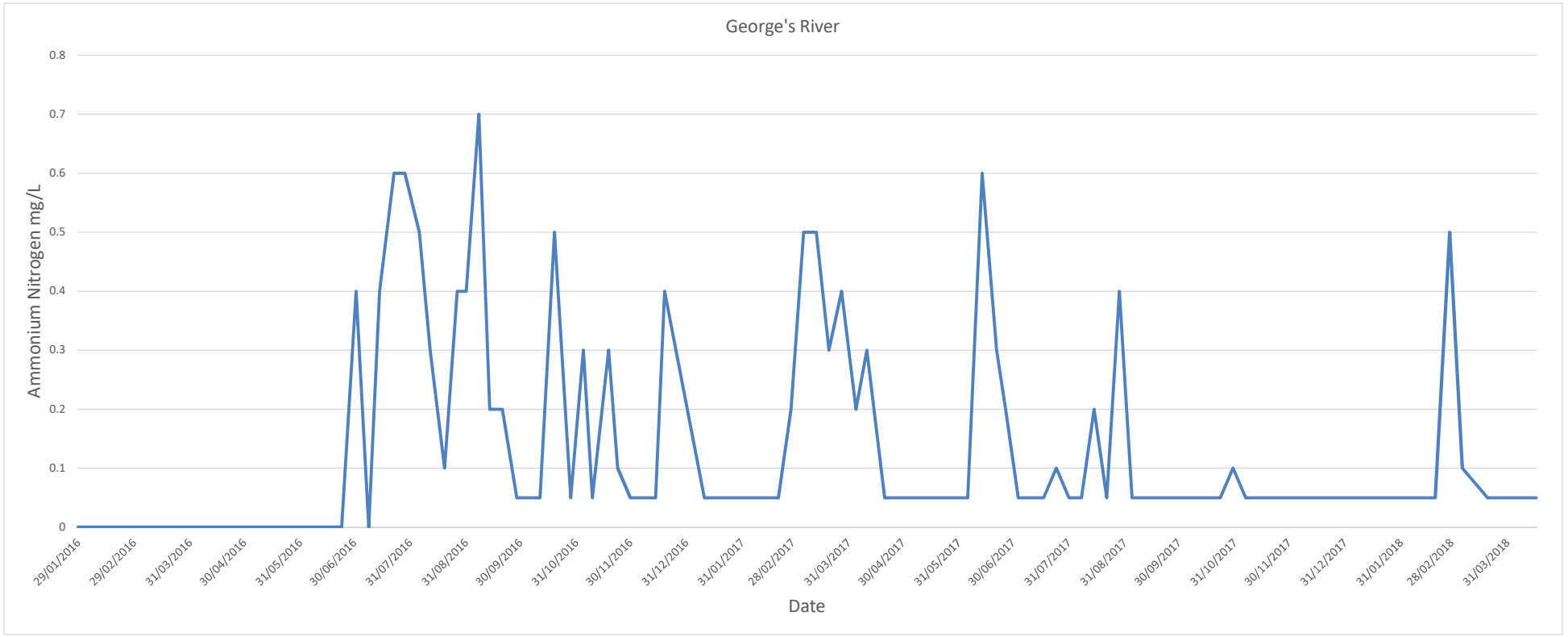
31/12/2017
31/01/2018
28/02/2018
31/03/2018
Date


George's River
Ammonium Nitrogen mg/L
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
29/01/2016
29/02/2016
31/03/2016
30/04/2016
31/05/2016
30/06/2016
31/07/2016
31/08/2016
30/09/2016
31/10/2016
30/11/2016
31/12/2016
31/01/2017
28/02/2017
31/03/2017
30/04/2017
31/05/2017
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31/12/2017
31/01/2018
28/02/2018
31/03/2018
Date

Appendix F. Site Auditor Photographs

Photo 1: Site view from southern boundary looking north

Photo 2: Close-up view of central spit

Photo 3: Distant view of northern part of Benedict site

Appendix G. Site Audit Statement

NSW Site Auditor Scheme

Site Audit Statement

A site audit statement summarises the findings of a site audit. For full details of the site auditor's findings, evaluations and conclusions, refer to the associated site audit report.

This form was approved under the *Contaminated Land Management Act 1997* on 12 October 2017.

For information about completing this form, go to Part IV.

Part I: Site audit identification

Site audit statement no. **282**

This site audit is a:

☑ **statutory audit**

~~☐ non-statutory audit~~

within the meaning of the *Contaminated Land Management Act 1997*.

Site auditor details

(As accredited under the *Contaminated Land Management Act 1997*)

Name **Dr Ian C Swane**

Company **Ian Swane & Associates**

Address **PO Box 359, Mortdale NSW**

Postcode **2223**

Phone **0418 867 112**

Email **iswane@bigpond.com**

Site details

Address **Georges Cove Marina site, 146 Newbridge Road, Moorebank (Figure 2)**

Postcode **2170**

Property description

(Attach a separate list if several properties are included in the site audit.)

The Georges Cove Marina site is to occupy the southern part of the Benedict Sand & Gravel Moorebank site (Benedict Site), which is legally defined as Lot 7 in DP1065574 with an area of 222,740 m^2 (22.274 ha) and is shown in Figures 1 & 2.

Local government area **Liverpool City Council**

Area of site (include units, e.g. hectares) **13 ha**

Current zoning **RE1 – Public recreation, RE2 – Private recreation and SP2 – Infrastructure Drainage**

Regulation and notification

To the best of my knowledge:

☐ ~~**the site is** the subject of a declaration, order, agreement, proposal or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*, as follows: (provide the no. if applicable)~~

~~☐ Declaration no.~~

~~☐ Order no.~~

~~☐ Proposal no.~~

~~☐ Notice no.~~

☑ **the site is not** the subject of a declaration, order, proposal or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

To the best of my knowledge:

☑ the site **has** been notified to the EPA under section 60 of the *Contaminated Land Management Act 1997*

☐ ~~the site **has not** been notified to the EPA under section 60 of the *Contaminated Land Management Act 1997*.~~

Site audit commissioned by

Name **Ernest Dupere**

Company **Benedict Industries Pty Ltd**

Address **PO Box 431, Frenchs Forest NSW**

Postcode **1640**

Phone **(02) 9986 3500**

Email **ernest@benedict.com.au**

Contact details for contact person (if different from above)

Name

Phone

Email

Nature of statutory requirements (not applicable for non-statutory audits)

☐ Requirements under the *Contaminated Land Management Act* 1997 (e.g. management order; please specify, including date of issue)

☐ Requirements imposed by an environmental planning instrument (please specify, including date of issue)

☑ Development consent requirements under the *Environmental Planning and Assessment Act 1979* (please specify consent authority and date of issue)

Council required this site audit statement (SAS) as a pre-condition of approving a Development Application for the proposed marina development.

☐ Requirements under other legislation (please specify, including date of issue)

Purpose of site audit

☐ **A1** To determine land use suitability

Intended uses of the land:

OR

A2 To determine land use suitability subject to compliance with either an active or passive environmental management plan

Intended uses of the land:

OR

(Tick all that apply)

☑ **B1 To determine the nature and extent of contamination**

☑ **B2 To determine the appropriateness of:**

☐ an investigation plan

☑ **a remediation plan**

☐ a management plan

☐ **B3** To determine the appropriateness of a **site testing plan** to determine if groundwater is safe and suitable for its intended use as required by the *Temporary Water Restrictions Order for the Botany Sands Groundwater Resource 2017*

☐ ~~**B4** To determine the compliance with an approved:~~

~~☐ **voluntary management proposal** or~~

~~☐ **management order** under the *Contaminated Land Management Act 1997*~~

☑ **B5 To determine if the land can be made suitable for a particular use (or uses) if the site is remediated or managed in accordance with a specified plan.**

Intended uses of the land: **NEPM (2013) Commercial / Industrial D, Recreational C and Residential B land uses (refer Figure 3)**

Information sources for site audit

Consultancies which conducted the site investigations and/or remediation:

Douglas Partners (DP), EIS, J&K Geotechnics (J&K) and EMM

Titles of reports reviewed:

1. Douglas Partners (24 June 1999) "*Proposed Environmental Monitoring Program, Sorting, Recovery and Transfer (SRT) Facility, 146 Newbridge Road, Moorebank*". Document No: 27879 prepared for Benedict Reclamations
2. Douglas Partners (May 2002) "*Report on Preliminary Contamination Assessment, Proposed Residential Development,146 Newbridge Road, Moorebank*". Document No: 43479 prepared for Benedict Sand and Gravel
3. EIS (June 2009) "*Environmental Site Assessment for Proposed Earthworks at Lot 6 DP1065574 Newbridge Road, Moorebank*". Document E22833K-GWRPT prepared for Concrete Recyclers Pty Ltd
4. EIS (July 2010) "*Groundwater Assessment for Proposed Earthworks for New Concrete Recycling Plant at Lot 6 DP1065574 Newbridge Road, Moorebank*". Document E22833K rpt3 prepared for Concrete Recyclers
5. EIS (19 December 2013) "*Report to Benedict Industries Pty Ltd on Stage 1 Environmental Site Assessment for Proposed Residential Development at 146 Newbridge Road, Moorebank, NSW*". Document No: E26930KBrpt
6. EMM (28 July 2015) "*Preliminary Investigation of Contamination, Proposed Georges Cove Marina*". Document No: J14149RP1 prepared for Benedict Industries
7. EMM (11 March 2016) "*Supplementary Preliminary Investigation, Proposed Georges Cove Marina*". Document No: J14149RP1 prepared for Benedict Industries
8. EMM (11 March 2016b) "*Remediation Action Plan, Proposed Georges Cove Marina*". Document No: J14149RP1 prepared for Benedict Industries
9. Douglas Partners (2 September 2016) "*Detailed Site Investigation, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.03 prepared for Benedict Industries
10. Douglas Partners (17 March 2017) "*Groundwater Data Review, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.06 prepared for Benedict Industries, 22 pages

11. Douglas Partners (15 December 2017) "*Remedial Action Plan, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.06 (Revision 5) prepared for Benedict Industries Pty Ltd

12. Douglas Partners (28 May 2018) "*Preliminary Site Investigation, Proposed Rezoning (Area 1) and Georges Cove Marina (Area 2), 146 Newbridge Road, Moorebank*". Document 71459.10 prepared for Mirvac Homes NSW Pty Ltd and Tanlane Pty Ltd

13. EMM (4 July 2018) '*Environmental Impact Statement Addendum, Georges Cove Marina, Volume 1 – Main report'*. Prepared for Benedict Industries Pty Ltd

14. Douglas Partners (31 August 2018) "*Landfill Gas Monitoring Events, Oct & Dec 2017, Feb, Apr & Aug 2018, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.09.R.011.Rev0 prepared for Benedict Industries Pty Ltd

15. Douglas Partners (6 September 2018) "*Surface Water Sampling, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.09.R.014.Rev1 prepared for Benedict Industries Pty Ltd

16. Douglas Partners (17 September 2018) "*Data Summary Report, Proposed Residential Development, 146 Newbridge Road, Moorebank*". Document No: 71459.09 prepared for Benedict Industries Pty Ltd

17. EMM (14 November 2018) Email providing ammonia monitoring results for dredge pond

Other information reviewed, including previous site audit reports and statements relating to the site:

70. Liverpool City Council (29 August 2008) "*Liverpool Local Environmental Plan 2008, Acid sulfate soil map – sheet ASS-014 and sheet ASS-015*"

71. Liverpool City Council (29 August 2008) "*Liverpool Local Environmental Plan 2008, Urban release area map – sheet URA-014 and sheet URA-015*"

72. Liverpool City Council (1 September 2017 & 19 April 2013) "*Liverpool Local Environmental Plan 2008, Land zoning map – sheet LZN-014 and sheet LZN-015*"

73. Liverpool City Council (17 August 2012 & 19 April 2013) "*Liverpool Local Environmental Plan 2008, Environmentally significant land map – sheet ESL-014 and sheet ESL-015*"

74. Liverpool City Council (11 June 2015) "*Liverpool Local Environmental Plan 2008, Flood planning area map – sheet FLD-014 and sheet FLD-015*"

75. Matthew Freeburn (22 August 2013) "*Plan Showing Levels, Contours and Stockpile Volumes as at 20-08-13, 146 Newbridge Road, Moorebank*". Drawing No: CC6-SURVEY4-32825 EPA 20-08-13 (provided in Appendix C1, Ref [11])

76. JMD Development Consultants (24 January 2017) Drawing "*Plan of Existing Features Over Stage 1, Moorebank Cove – Stage 2, Newbridge Road, Moorebank*". Drawing No: 14005-DS1 prepared for Mirvac Homes (provided in Appendix B, Ref [32])

77. Ian Swane & Associates (23 January 2018) "*Site Audit Report, Site Audit 264B by Dr Ian Swane, Review of Remediation Strategy for Residential Development at 146 Newbridge Road, Moorebank NSW 2170*" (includes site audit statement)

78. Alyazichi Y.M., Jones B.G., McLean E.J., Pease J and Brown H (2017) '*Geochemical assessment of trace element pollution in surface sediments from the Georges River, Southern Sydney, Australia*'. Archives of Environmental Contamination and Toxicology, 72 (2), 247-259

79. Liverpool City Council (25 October 2018) Email from Boris Santana, Senior Development Planner, titled '*Georges Cove Marina consultation with RMS*' including a copy of updated SEAR 912

Site audit report details

Title **Site Audit Report, Site Audit 282 by Dr Ian Swane, Remediation Strategy for Proposed Georges Cove Marina Development at 146 Newbridge Road, Moorebank NSW 2170**

Report no**. 282** Date **27 April 2019**

Part II: Auditor's findings

Please complete either Section A1, Section A2 or Section B, not more than one section. (Strike out the irrelevant sections.)

- Use **Section A1** where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land uses **without the implementation** of an environmental management plan.
- Use **Section A2** where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land uses **with the implementation** of an active or passive environmental management plan.
- Use **Section B** where the audit is to determine:
  - (B1) the nature and extent of contamination, and/or
  - (B2) the appropriateness of an investigation, remediation or management plan[1], and/or
  - (B3) the appropriateness of a site testing plan in accordance with the *Temporary Water Restrictions Order for the Botany Sands Groundwater Source 2017*, and/or
  - (B4) whether the terms of the approved voluntary management proposal or management order have been complied with, and/or
  - (B5) whether the site can be made suitable for a specified land use (or uses) if the site is remediated or managed in accordance with the implementation of a specified plan.

[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

Section A1

I certify that, in my opinion:

The **site is suitable** for the following uses:

(Tick all appropriate uses and strike out those not applicable.)

☐ Residential, including substantial vegetable garden and poultry

☐ Residential, including substantial vegetable garden, excluding poultry

☐ Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry

☐ Day care centre, preschool, primary school

☐ Residential with minimal opportunity for soil access, including units

☐ Secondary school

☐ Park, recreational open space, playing field

☐ Commercial/industrial

☐ Other (please specify):

OR

☐ I certify that, in my opinion, the **site is not suitable** for any use due to the risk of harm from contamination.

Overall comments:

Section A2

I certify that, in my opinion:

Subject to compliance with the **attached** environmental management plan[2] (EMP), the site is suitable for the following uses:

(Tick all appropriate uses and strike out those not applicable.)

☐ Residential, including substantial vegetable garden and poultry

☐ Residential, including substantial vegetable garden, excluding poultry

☐ Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry

☐ Day care centre, preschool, primary school

☐ Residential with minimal opportunity for soil access, including units

☐ Secondary school

☐ Park, recreational open space, playing field

☐ Commercial/industrial

[2] Refer to Part IV for an explanation of an environmental management plan.

☐ Other (please specify):

EMP details

Title

Author

Date No. of pages

EMP summary

This EMP (attached) is required to be implemented to address residual contamination on the site.

The EMP: (Tick appropriate box and strike out the other option.)

☐ requires operation and/or maintenance of **active** control systems[3]

☐ requires maintenance of **passive** control systems only[3].

Purpose of the EMP:

Description of the nature of the residual contamination:

Summary of the actions required by the EMP:

How the EMP can reasonably be made to be legally enforceable:

How there will be appropriate public notification:

Overall comments:

Section B

Purpose of the plan[4] which is the subject of this audit:

To remediate the site and make it suitable for the proposed Georges Cove Marina development

[3] Refer to Part IV for definitions of active and passive control systems.
[4] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

I certify that, in my opinion:

(B1)

☐ ~~The nature and extent of the contamination has been appropriately determined~~

☐ ~~The nature and extent of the contamination **has not** been appropriately determined~~

~~AND/OR (B2)~~

☐ ~~The investigation, remediation or management plan is appropriate for the purpose stated above~~

☐ ~~The investigation, remediation or management plan **is not** appropriate for the purpose stated above~~

~~AND/OR (B3)~~

☐ ~~The site testing plan:~~

- ☐ ~~**is** appropriate to determine~~
- ☐ ~~**is not** appropriate to determine~~

~~if groundwater is safe and suitable for its intended use as required by the *Temporary Water Restrictions Order for the Botany Sands Groundwater Resource 2017*~~

~~AND/OR (B4)~~

☐ ~~The terms of the approved voluntary management proposal* or management order** (strike out as appropriate):~~

- ☐ ~~**have** been complied with~~
- ☐ ~~**have not** been complied with.~~

~~*voluntary management proposal no.~~

~~**management order no.~~

~~AND/~~OR (B5)

☑ **The site can be made suitable for the following uses:**

(Tick all appropriate uses and strike out those not applicable.)

- ☐ ~~Residential, including substantial vegetable garden and poultry~~
- ☐ ~~Residential, including substantial vegetable garden, excluding poultry~~
- ☐ ~~Residential with accessible soil, including garden (minimal home-grown produce contributing less than 10% fruit and vegetable intake), excluding poultry~~
- ☐ ~~Day care centre, preschool, primary school~~
- ☑ **Residential with minimal opportunity for soil access, including units**
- ☐ ~~Secondary school~~
- ☑ **Park, recreational open space, playing field**
- ☑ **Commercial/industrial**
- ☐ ~~Other (please specify):~~

IF the site is remediated/~~managed~~* in accordance with the following plan (**attached**):

*Strike out as appropriate

Plan title	**Remedial Action Plan, Proposed Georges Cove Marina (Ref [8])**
Plan author	**EMM**
Plan date	**11 March 2016** No. of pages **52**

SUBJECT to compliance with the following condition(s):

1. **Prior to the commencement of remediation work, a detailed design program is completed involving:**

   a) **A building design for the proposed development. Elements of the design relevant to the remediation of the site include, among other things, site layout plans, elevations and plan views, cross-sections, foundation design, use of suspended slabs and natural ventilation under buildings, areas to be sealed by pavement and building slabs, and buried service corridors.**

   b) **An earthworks plan for the proposed development. Elements of this plan relevant to the remediation of the site include, among other things, a detailed earthworks design, plans showing the areas of the site to be excavated and filled, the types of fill needing to be imported to the site, construction strategies, material management procedures, and accurate surveys of the existing and final ground surface.**

   c) **Data gap investigations for Area 2 and other fill areas at the site based on the needs of the project design in 1(a) and the earthworks plan in 1(b). The investigations are to involve asbestos in soil, groundwater quality along southern boundary and soil gas monitoring. The quality of existing fill that is to remain at the site also needs to be assessed in accordance with EPA guidance. The data obtained by these investigations is to be documented in a detailed site investigation (DSI) report.**

   d) **Preparation of a RAP Addendum that is to include documentation that address the data gaps identified in the SAR. This should include, among other things, environmental criteria, an Asbestos Management Plan, an acid sulphate soil management plan, an environmental management plan, protocols for opening the pond to the Georges River, material tracking from cradle-to-grave, contingency planning, validation and monitoring program.**

   e) **A Long-Term Environmental Management Plan (LTEMP) for the ongoing management of contamination that is to remain at the site.**

2. **No remediation work is to commence until a Section B SAS has been issued by the Site Auditor concluding that the DSI report, the detailed plans and strategies provided by the RAP Addendum, and the draft LTEMP meet NSW EPA guidance and address the Secretary's Environmental Assessment Requirements (SEAR 912) issued to Council on 9/10/18.**

3. **If a LTEMP is required by the adopted remediation strategy, no remediation work is to commence until written in-principal approval of the draft LTEMP is provided by the Site Auditor and Council.**

4. **Any modification to the RAP Addendum should not be implemented without prior written approval of the Site Auditor and Council.**

5. **Following the completion of remediation work at the site, a Section A SAS is issued by the Site Auditor confirming that the site is suitable for its intended land uses prior to commencement of the built form in that area. If a LTEMP is required by the remediated site, the Section A SAS can only be issued following the Site Auditor's receipt of written approval of the final version of the LTEMP.**

Overall comments:

1. **This SAS should be read in conjunction with the site audit report (SAR).**

2. **As required by SEAR 912, the Site Auditor confirms that a DSI report needs to be provided to address potential data gaps between the submitted PSI reports and the RAP.**

Part III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority (EPA) under the *Contaminated Land Management Act 1997.*

Accreditation no. **9821**

I certify that:

- I have completed the site audit free of any conflicts of interest as defined in the *Contaminated Land Management Act 1997,* and
- with due regard to relevant laws and guidelines, I have examined and am familiar with the reports and information referred to in Part I of this site audit, and
- on the basis of inquiries I have made of those individuals immediately responsible for making those reports and obtaining the information referred to in this statement, those reports and that information are, to the best of my knowledge, true, accurate and complete, and
- this statement is, to the best of my knowledge, true, accurate and complete.

I am aware that there are penalties under the *Contaminated Land Management Act 1997* for wilfully making false or misleading statements.

Signed Date **27 April 2019**

Part IV: Explanatory notes

To be complete, a site audit statement form must be issued with all four parts.

How to complete this form

Part I

Part I identifies the auditor, the site, the purpose of the audit and the information used by the auditor in making the site audit findings.

Part II

Part II contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remediation plan or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use or uses of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A1 or Section A2 or Section B of Part II, **not** more than one section.

Section A1

In Section A1 the auditor may conclude that the land is *suitable* for a specified use or uses OR *not suitable* for any beneficial use due to the risk of harm from contamination.

By certifying that the site is *suitable*, an auditor declares that, at the time of completion of the site audit, no further investigation or remediation or management of the site was needed to render the site fit for the specified use(s). **Conditions must not be** imposed on a Section A1 site audit statement. Auditors may include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

Section A2

In Section A2 the auditor may conclude that the land is *suitable* for a specified use(s) subject to a condition for implementation of an environmental management plan (EMP).

Environmental management plan

Within the context of contaminated sites management, an EMP (sometimes also called a 'site management plan') means a plan which addresses the integration of environmental mitigation and monitoring measures for soil, groundwater and/or hazardous ground gases throughout an existing or proposed land use. An EMP succinctly describes the nature and location of contamination remaining on site and states what the objectives of the plan are, how contaminants will be managed, who will be responsible for the plan's implementation and over what time frame actions specified in the plan will take place.

By certifying that the site is suitable subject to implementation of an EMP, an auditor declares that, at the time of completion of the site audit, there was sufficient information satisfying guidelines made or approved under the *Contaminated Land Management Act 1997*

(CLM Act) to determine that implementation of the EMP was feasible and would enable the specified use(s) of the site and no further investigation or remediation of the site was needed to render the site fit for the specified use(s).

Implementation of an EMP is required to ensure the site remains suitable for the specified use(s). The plan should be legally enforceable: for example, a requirement of a notice under the CLM Act or a development consent condition issued by a planning authority. There should also be appropriate public notification of the plan, e.g. on a certificate issued under s.149 of *the Environmental Planning and Assessment Act 1979*.

Active or passive control systems

Auditors must specify whether the EMP requires operation and/or maintenance of active control systems or requires maintenance of passive control systems only. Active management systems usually incorporate mechanical components and/or require monitoring and, because of this, regular maintenance and inspection are necessary. Most active management systems are applied at sites where if the systems are not implemented an unacceptable risk may occur. Passive management systems usually require minimal management and maintenance and do not usually incorporate mechanical components.

Auditor's comments

Auditors may also include **comments** which are key observations in light of the audit which are not directly related to the suitability of the site for the use(s). These observations may cover aspects relating to the broader environmental context to aid decision-making in relation to the site.

Section B

In Section B the auditor draws conclusions on the nature and extent of contamination, and/or suitability of plans relating to the investigation, remediation or management of the land, and/or the appropriateness of a site testing plan in accordance with the *Temporary Water Restrictions Order for the Botany Sands Groundwater Source 2017*, and/or whether the terms of an approved voluntary management proposal or management order made under the CLM Act have been complied with, and/or whether the site can be made suitable for a specified land use or uses if the site is remediated or managed in accordance with the implementation of a specified plan.

By certifying that a site *can be made suitable* for a use or uses if remediated or managed in accordance with a specified plan, the auditor declares that, at the time the audit was completed, there was sufficient information satisfying guidelines made or approved under the CLM Act to determine that implementation of the plan was feasible and would enable the specified use(s) of the site in the future.

For a site that *can be made suitable*, any **conditions** specified by the auditor in Section B should be limited to minor modifications or additions to the specified plan. However, if the auditor considers that further audits of the site (e.g. to validate remediation) are required, the auditor must note this as a condition in the site audit statement. The condition must not specify an individual auditor, only that further audits are required.

Auditors may also include **comments** which are observations in light of the audit which provide a more complete understanding of the environmental context to aid decision-making in relation to the site.

Part III

In **Part III** the auditor certifies their standing as an accredited auditor under the CLM Act and makes other relevant declarations.

Where to send completed forms

In addition to furnishing a copy of the audit statement to the person(s) who commissioned the site audit, statutory site audit statements must be sent to

- the **NSW Environment Protection Authority**: nswauditors@epa.nsw.gov.au or as specified by the EPA

  AND

- the **local council** for the land which is the subject of the audit.

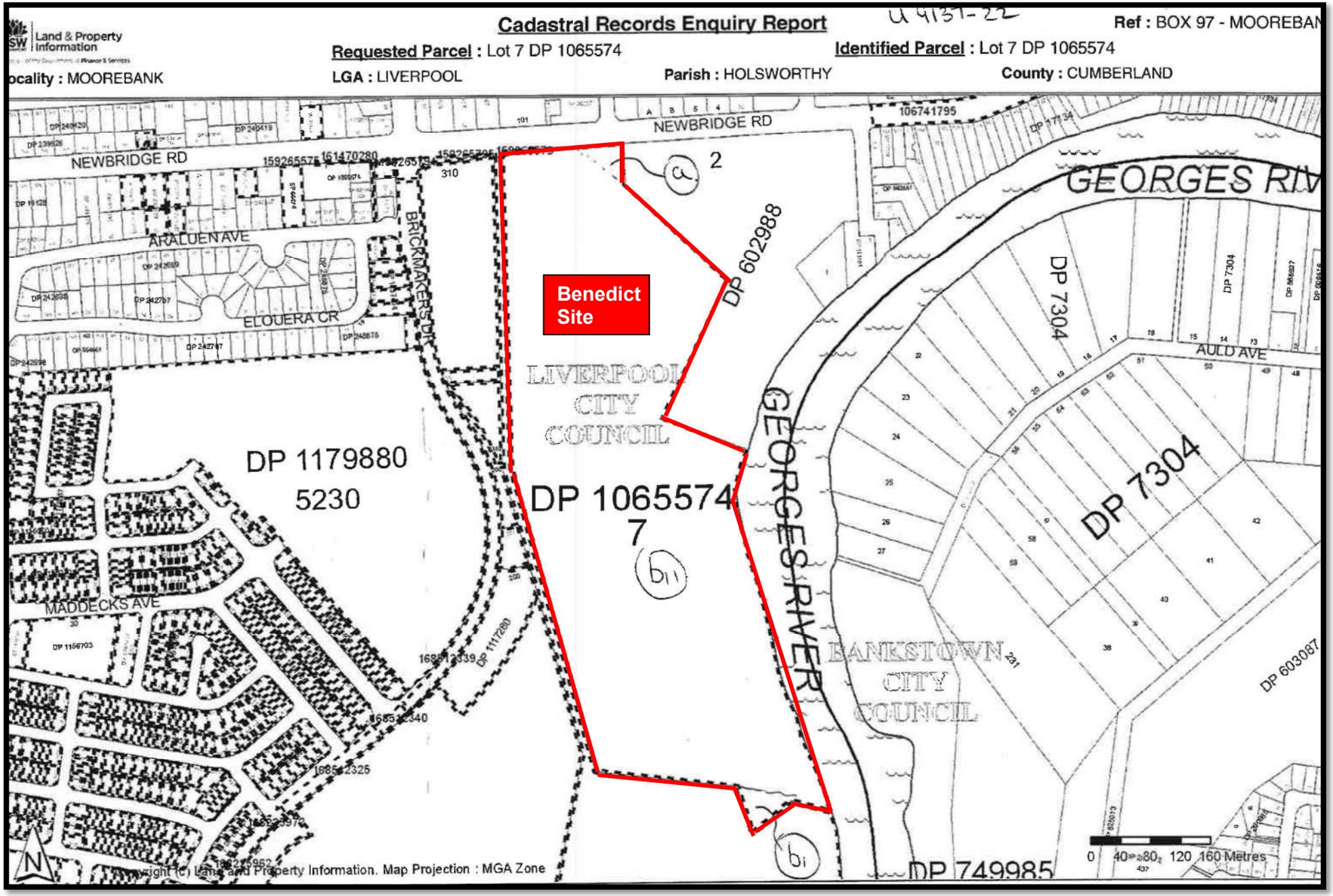

Figure 1 Subdivision Plan of Benedict Site & Surrounding Area (Source: Appendix C7, Ref [11])

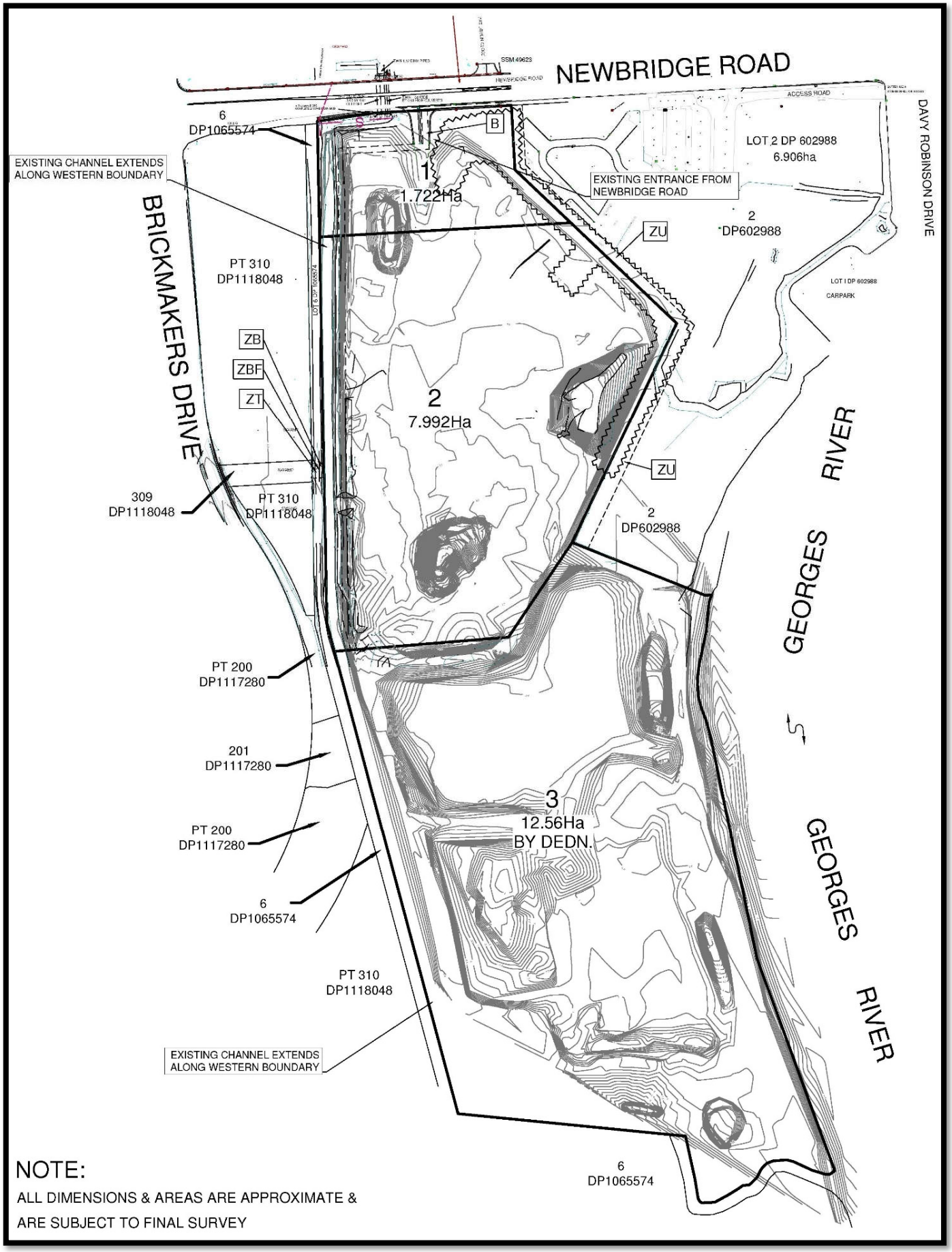

Figure 2 January 2017 Survey Plan of Benedict Site (Source: Ref [80])

Figure 3 Proposed Layout of Georges Cove Marina (Source: Figure 1.2, Ref [13])

Remediation Action Plan

Proposed Georges Cove Marina

Prepared for Benedict Industries Pty Ltd | 11 March 2016

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Proposed Georges Cove Marina

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Remediation Action Plan

Final

Report J14149RP1 | Prepared for Benedict Industries Pty Ltd | 11 March 2016

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1 Introduction

1.1 Proposed Georges Cove Marina

Benedict Industries Pty Ltd (Benedict Industries) (who are acting for the landowner, Tanlane Pty Ltd (Tanlane)) propose to construct and operate a marina and related facilities on part of Lot 7 in DP 1065574 (referred to as "Lot 7" hereafter), 146 Newbridge Road, Moorebank, in the Liverpool City Council Local Government Area (LGA). The marina is proposed to be developed on the southern portion (approximately 13 ha) of Lot 7 (which is approximately 22 ha in total). Lot 7 (ie the combined northern section and marina site) has historically been used for sand extraction, dredging and recycling operations.

As referenced in this report, the 'site' only refers to the southern portion of Lot 7 (see Figure 1.1) on which is proposed to develop the marina.

The marina site comprises a dredge pond created by the existing extractive operations and surrounding banks that accommodate access roads and stockpiles.

During construction of the marina, a channel will be excavated through the bank of the Georges River, connecting the dredge pond/marina basin to the adjacent Georges River.

1.2 Contamination overview

Preliminary contamination investigations were undertaken in 2015 and 2016. These included analyses of historic information and specific sampling and analysis programs. The results are presented in the *Preliminary Investigation* report (EMM 2015a) and the *Supplementary Preliminary Investigation* report (EMM 2016). These preliminary contamination investigations identified varying degrees of soil, dredge pond sediment, dredge pond water and groundwater contamination. This contamination was related to the concentrations of some metals, polycyclic aromatic hydrocarbons (PAHs), ammonia and nutrients.

1.2.1 Land based risks

The benzo(a)pyrene (a PAH), copper and zinc concentrations measured in a small number of soil samples exceeded the applicable ecological guidelines. However based on the concentrations measured in the soils, these contaminants are considered to present a low and acceptable risk in the context of the operation of a commercial marina and for the potential residential uses associated with the marina development (EMM 2016).

1.2.2 Aquatic environment risks

Some metals, PAHs and ammonia concentrations in the groundwater, dredge pond water and dredge pond sediment present a potential ecotoxicological risk to the aquatic receiving environment, the Georges River. High nutrient concentrations in the groundwater, dredge pond water and dredge pond sediment present a potential eutrophication risk.

EMM

Marina site location and boundary

Georges Cove Marina Development
Remediation action plan

Figure 1.1

1.3 Regulatory framework

State Environmental Planning Policy No 55 – Remediation of Land (2014) (SEPP 55) provides a state-wide planning approach to the remediation of contaminated land, and aims to promote the remediation of contaminated land for the purpose of reducing the risk of harm to human and environmental health. Clause 7 of SEPP 55 requires contamination and remediation to be considered in determining development applications. Clause 7(4) of SEPP 55 specifies categories of land that have the potential to be contaminated via reference to Table 1 of the contaminated land planning guideline, *Managing Land Contamination Planning Guidelines: SEPP 55 – Remediation of Land* (DUAP and EPA 1998).

Two known potentially contaminating activities have been undertaken at the site: extractive industries and landfilling. Landfilling has occurred at the marina site and on the northern portion of Lot 7 immediately to the north. Other potentially contaminating activities undertaken at the site, but not listed in the *Managing Land Contamination Planning Guidelines*, include: historic land use as a dairy and the introduction of fill to assist in landform restoration (source and quantity is unknown). There is also evidence to suggest that parts of the site were used as a landfill between 1972 and 1993, most likely for construction and demolition waste.

The applicant is therefore required to carry out an investigation where the objective of the investigation is to provide a preliminary assessment of site contamination. If the land is contaminated it must be shown that the land is, or can be made, suitable in its contaminated or remediated state for the proposed development. A contamination investigation provides the planning authority with the information it needs to carry out its planning functions and the investigation is required to be undertaken in accordance with the contaminated land planning guidelines (DUAP and EPA 1998). The PI and SPI reports were prepared to satisfy the requirements of Clause 7 of SEPP 55.

1.4 Objectives

This remediation action plan (RAP) has been prepared to:

- outline the site-specific remediation goals;
- determine the extent to which remediation is required; and
- identify management and remediation actions.

1.5 Contamination assessment method

The contamination assessment and remediation program is in two parts, the preliminary contamination investigations (PI and SPI) and this RAP.

The PI and SPI (EMM 2015a and 2016) characterised the site, identifying:

- potential contaminants of concern in each medium based on:
    - *National Environment Protection (Assessment of Contamination) Measures* (ASC NEPM) (NEPC 2013) risk-based Health Investigation Levels (HIL);
    - ASC NEPM Health Screening Levels (HSL);
    - ASC NEPM Ecological Investigation Levels (EIL);

- ASC NEPM Ecological Screening Levels (ESL);
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Water Quality Guidelines) (ANZECC and ARMCANZ 2000) water quality guidelines for the protection of freshwater and marine ecosystems;
- ANZECC and ARMCANZ (2000) sediment quality guidelines;
- *Guidelines for Managing Risks in Recreational Water* (NHMRC 2008);

- potential offsite and onsite sources of contamination;
- human health risks and ecological risks;
- management and further assessment recommendations; and
- the suitability of the site for the proposed uses.

The SPI confirmed the original conclusions of the PI, that contamination issues would not preclude the proposed future land use as a proposed marina development as well as for high-density residential dwellings with minimal opportunities for soil access.

The preliminary investigations found there is a risk that metals, ammonia and nutrients in the dredge pond water, and these contaminants plus PAHs in the sediment, may impact ecological values in the Georges River when the marina basin is first opened to the river (acute impacts) and/or during of marina operations (chronic impacts).

This RAP identifies actions to minimise risks to human health or ecology and provides the following:

- a summary of the PI and SPI findings (Chapter 2);
- development of a conceptual site model (CSM) (Chapter 3);
- identification of remediation goals (Chapter 4);
- examination of each feasible contaminant source, each pathways/mechanisms in the environment, the contaminant's fate and potentially exposed populations (Chapter 5);
- identification of remediation options to reduce the exposure of populations, generally through interrupting the exposure pathways/mechanisms in the environment (Chapter 5);
- consolidation of the proposed remediation options into a RAP (Chapter 6); and
- identification of monitoring requirements (Chapter 6).

The implementation of the remediation actions will ensure that:

- risks to human health and ecology from onsite contaminant sources are reduced to an acceptable level;
- the site is suitable for the proposed uses; and

2 Overview of site contamination

2.1 Investigations

Historic, preliminary investigations (EMM 2015a and 2016) have assessed the contamination status of soil, dredge pond sediment, dredge pond water and groundwater within the site. Historic sampling, focusing on groundwater and surface water, commenced in 2002. Detailed site investigations undertaken in 2015, in support of the marina site development application, comprised sampling of site soil, dredge pond water and dredge pond sediment (PI), and groundwater (SPI).

The PI was submitted to Liverpool City Council (the Council) for review, with a follow up meeting held with the Council and the Environment Protection Authority (EPA) on 30 October 2015. It was agreed that further investigation should be undertaken to evaluate the nature and potential risk of ammonia in the dredge pond sediment and water. In addition, a higher sampling density for all mediums (soil, groundwater, dredge pond water and dredge pond sediment) was requested to definitively determine the sites suitability for its proposed use. The SPI reports the results of additional sampling to provide improved spatial and statistical confidence in the levels and distribution of potential contaminants on the site.

2.2 Contaminants and areas of potential concern

An overview of the contaminants of potential concern at the site and the mediums where contamination is observed is provided in the SPI and reproduced in Table 2.1 below. The table has been colour coded to identify the contaminants of highest concern in red; moderate concern in orange; and lowest concern in green.

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Metals*				
Aluminium	-	-	Freshwater TV exceeded in 6 samples. Exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L).	Freshwater TV exceeded by a factor of up to about 140 with the highest concentration in groundwater west of the basin. Low concentrations in groundwater adjacent to the Georges River.
Cadmium	-	-	-	Freshwater TV exceeded by a factor of about 20 and the marine TV (for protection of 99% if species) exceeded by a factor of about 6 in one sample from west of the basin. Lower concentrations in groundwater adjacent to the Georges River.
Copper	EIL exceeded in 2 samples by a factor of up to about 2.2.	ISQG-low exceeded in 10 samples but concentrations within range reported for the Georges River.	Freshwater and marine TVs exceeded in 1 sample.	Freshwater and marine TV exceeded by a factor of up to about 5 with the highest concentration in groundwater east of the basin. The highest concentration (0.005 mg/L) in groundwater is lower than the mean concentration in Georges River water (0.006 mg/L) (Marine Pollution Research 2010).
Lead	-	ISQG-low exceeded in 12 samples and the ISQG-high exceeded in 7 samples. Concentrations higher than in the main channel of the Georges River but within the range measured in bays and tributaries, where flow is lower and where there are historic contamination sources.	-	-

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Manganese	-	-	-	Freshwater TV exceeded in one sample by a factor of about 1.4 with the highest concentration in groundwater west of the basin. Low concentrations (below Freshwater TV) in groundwater adjacent to the Georges River.
Nickel	-	-	-	Freshwater TV exceeded in one sample by a factor of about 5 with the highest concentration in groundwater west of the basin. Marine TV (for protection of 99% if species) exceeded by a factor of up to about 85 in one sample from west of the basin. Lower concentrations in groundwater adjacent to the Georges River.
Zinc	EIL exceeded in 3 samples by a factor of about 2.	ISQG-low exceeded in 10 samples but concentrations within range reported for the Georges River.	Freshwater and marine TVs exceeded. Concentrations correlated with TSS concentrations. Some exceedances (by a factor of about 2) in samples with low TSS concentrations (<1 g/L). However, these levels are similar to the mean concentration in the Georges River (Marine Pollution Research 2010).	Freshwater and marine TV exceeded by a factor of up to about 115 with the highest concentration in groundwater west of the basin.

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Mercury (total)	-	ISQG-low exceeded in 12 samples.	Freshwater and marine TVs exceeded by total mercury concentrations in 6 samples. All exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L). Recreational guideline exceeded in 2 samples, both with high TSS concentrations (>58 g/L).	-
Nutrients				
Nitrate	-	-	Mean concentration exceeds TV for Lowland Rivers in 7 samples, by a factor of about 2.5.	-
Ammonia	-	-	Mean concentration exceeds TV for Lowland Rivers by a factor of about 400. Mean concentration exceeds freshwater and marine TVs by a factor of about 9.	Mean concentration exceeds TV for Lowland Rivers by a factor of about 120. Mean concentration exceeds freshwater and marine TVs by a factor of about 3. Lower concentrations in groundwater adjacent to the Georges River but still high.
Total nitrogen	-	Potential release of nutrients to water column and eutrophication risk.	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 95. Eutrophication risk.	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 10. Eutrophication risk.

Table 2.1 Contaminants of potential concern

Contaminant	Soil	Dredge pond sediment	Dredge pond water	Groundwater
		Assessment criteria/guideline exceedances		
Total phosphorus	-	-	Mean concentration exceeds trigger value for Lowland Rivers by a factor of about 370. Eutrophication risk	-
PAH				
Benzo(a) pyrene	ESL exceeded in two samples by a factor of about 1.6.	ISQG-low exceeded in 5 samples.	Recreational guideline value exceeded Exceedances correlated with high TSS concentrations (>1 g/L). No exceedances in samples with low TSS concentrations (<1 g/L).	-
Chrysene	-	ISQG-low exceeded in 3 samples.	-	-
Phenanthrene	-	Concentrations below the LOR in all but one sample. ISQG-low and -high exceeded in 1 sample.	-	-
Pyrene	-	ISQG-low exceeded in 8 samples and the ISQG-high exceeded in 1 sample.	-	-
Benzo(a) anthracene	-	ISQG-low exceeded in 4 samples.	-	-

Notes: ** Dissolved.*

EIL: environmental investigation level, and ESL: environmental screen level (NEPC 2013).

ISQG: interim sediment quality guidelines, high and low trigger values: (ANZECC and ARMCANZ 2000).

Freshwater & marine TVs: freshwater and marine trigger values for slightly to moderately disturbed ecosystems, generally for the protection of 95% of freshwater/marine species (ANZECC and ARMCANZ 2000).

River: default trigger values for South-east Australia Lowland Rivers (ANZECC and ARMCANZ 2000).

Recreational: recreational guideline (NHMRC 2008).

Eutrophication, no assessment criteria exceedance, but concentration high enough to consider a potential eutrophication risk.

2.2.1 Human health risks

The SPI (EMM 2016) found the following in relation to human health risks at the site:

> The SPI and PI did not identify soil contamination issues that are considered to present an unacceptable risk to human health in the context of the proposed future land uses.
>
> The elevated nutrient concentrations in the dredge pond water and the groundwater are not considered to represent a risk to human health as swimming in the pond water (leading to potential ingestion of pond water/groundwater) is unlikely in the context of a commercial marina.
>
> The elevated benzo(a)pyrene and total mercury concentrations measured in the dredge pond water were associated with very high TSS concentrations. The concentrations measured in the samples with low TSS concentrations are not considered to represent an unacceptable risk to human health. Therefore, these contaminants are not considered to represent an unacceptable risk to human health if sediment remains on the base of the marina and are not resuspended into the water column.

2.2.2 Ecological risks

The SPI (EMM 2016) found the following in relation to ecological risks at the site:

> While the ecological assessment criteria for benzo(a)pyrene, zinc and copper were exceeded in five soil samples, the exceedances are considered to present a low and acceptable risk in the context of the operation of a commercial marina. The marina design (ie locations of car parks, roads and buildings) will contribute to further reductions in the current risk level. No other ecological criteria applicable to soils were exceeded.
>
> The highest ecological toxicant risks contaminants in the groundwater, dredge pond water, dredge pond sediments are a result of:
>
> - lead and pyrene in the dredge pond sediment;
> - ammonia in the groundwater when the groundwater is discharging to the Georges River; and
> - total mercury and ammonia in the dredge pond water.
>
> The highest eutrophication risks are a result of:
>
> - ammonia in the groundwater; and
> - ammonia, total nitrogen and total phosphorus concentrations in the dredge pond water.

3 Conceptual site model

3.1 Approach to land based risks

Soil in the site contains fill which includes anthropogenic debris. Some locations have elevated benzo(a)pyrene, copper and zinc concentrations. Soil remediation will be relatively straight forward with contaminated soils removed or covered by impermeable surfaces. These will be managed through the remediation actions described in Section 6.1, including implementation of an unexpected finds protocol (see Section 6.1.2). Given the relative simplicity of the soil contamination, it has not been extensively considered in the CSM other than as a potential source of contamination to the aquatic environment.

3.2 Approach to aquatic environment risks

3.2.1 Conceptual site model overview

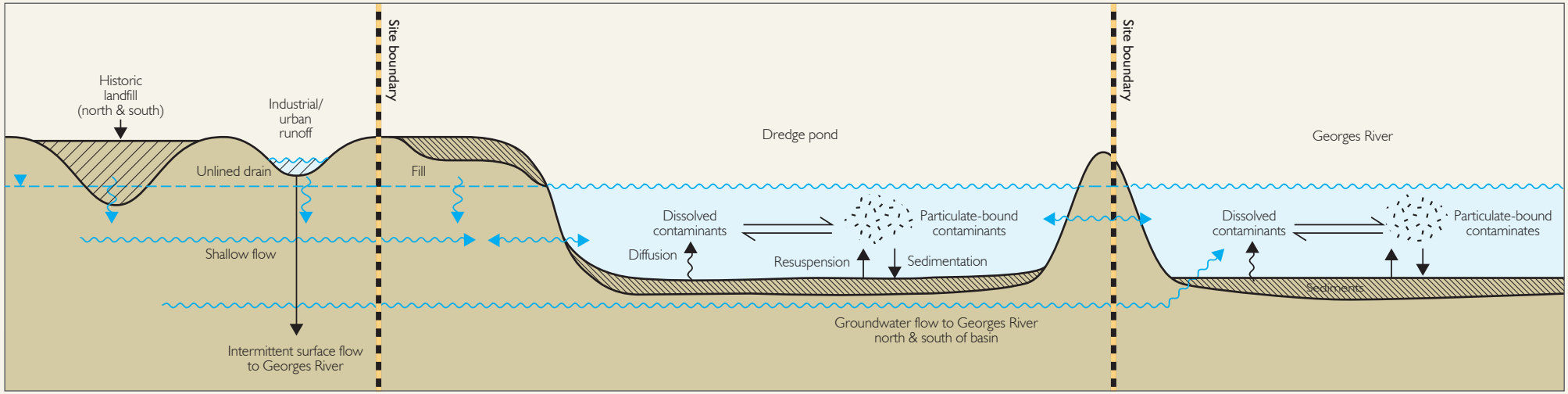
A CSM was developed to understand the potential contamination sources, the exposed populations and the pathways between these. The CSM reflects the complexity of the site and surrounding environment and includes:

- onsite and offsite environmental media;
- potential onsite and offsite contaminants sources;
- groups of contaminants with different chemical behaviour and partitioning;
- a range of potential physical and chemical transport mechanisms; and
- potentially exposed populations.

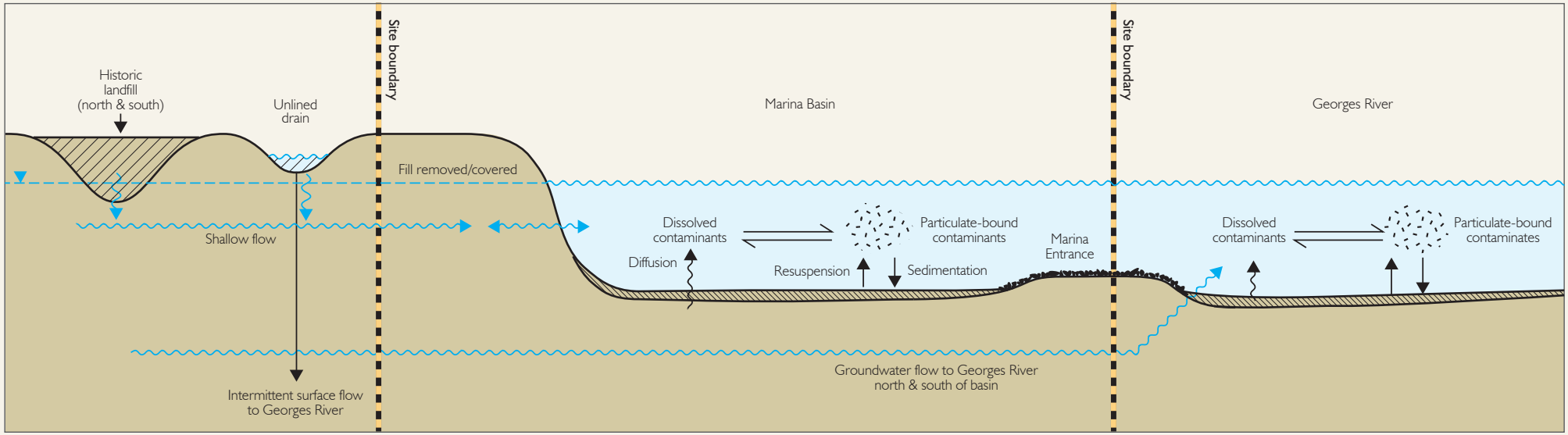
Some of the pathways will change when the use of the land is changed from a sand extraction operation to a marina. There are acute (ie short-term) risks when the marina basin is first opened to the Georges River and chronic (ie long-term) risks when the site operating as a marina.

The CSM is illustrated in Figure 3.1 and is described below.

Conceptual site model - sand extraction (current)



Conceptual site model - marina (future)



EMM

Conceptual site model
Remediation action plan
Georges Core Marina Development
Figure 3.1

3.2.2 Environmental media

The CSM includes the following environmental media:

- Groundwater: generally from offsite and moving through the site towards the Georges River. The groundwater flow is expected to be influenced by surface water inputs and the Georges River water level that changes due to river flow and tides (depending on the distance from the river).

- Surface water:

    - largely from offsite but particularly the unlined stormwater drain running along the western boundary of the site that drains stormwater from the Chipping Norton industrial area to the north of Newbridge Road. It is separated from the site by a levee running from Newbridge Road to the southern end of the site. This water discharges to the un-named creek the Georges River immediately south of the site. As the drain is unlined adjacent to the site, there is expected to be some seepage to groundwater. Contaminant concentrations is this drain will be highly variable and will depend on many factors including flow, period since last rain, rainfall intensity, and rainfall duration. It would be extremely difficult to characterise the average concentrations (or loads) in such a highly variable system.

    - Basin (dredge pond) water is currently used as part of processing operations to the north of the site (see Section 3.2.3). This flow has been considered in the surface water compartment. Process water is sourced from the basin and is returned to the basin after use. The water is used to wash concrete, bricks, glass and excavated geological materials, including soils with a high organic fraction.

    - Surface water runoff from north of the site drains to the basin. This includes water that has been in contact with stockpiled materials.

- Basin water: the dredge pond is currently about 6 ha and about 2.9 m deep. A cutter suction dredge is used to recover material from the basin as part of the sand extraction operations. Presently, there is no opening between the dredge pond and the Georges River. The water in the dredge pond is brackish with a mean salinity of 8.7 g/L (salinity of seawater is 35 g/L) and is generally well mixed (Marine Pollution Research 2010). The dredge pond will form the marina basin which will open to the river. It is estimated that up to 40 to 60% of the water in the marina basin will be exchanged between each peak and trough of a tidal cycle (Worley Parsons 2010).

- Basin sediments: the base of the basin is covered by fine sediments. The operating dredge resuspends these sediments into the water column. When the marina is opened, the basin sediments will be contiguous with Georges River sediments.

- Georges Cove River water: the site is toward the top of the estuarine section of the Georges River. The river adjacent to the site carries stormwater runoff from highly urbanised sub catchments upstream, including wet weather sewage discharges from three Sewage Treatment Plants (STPs): Glenfield, Liverpool and Fairfield. The *Georges River Catchment Built Environment and Foreshore Access Study* (DIPNR 2004) states that in the section of the river between Liverpool Weir and Sandy Point Bridge "Water quality is generally poor and affected by urban influences including discharge from sewage treatment plants, sewage overflows, discharge from industrial activities and contaminated run-off." River ecosystems include mangroves, benthos (ie organisms living in or on the sediment in the base of the river) and nekton/plankton (ie free-swimming/drifting organisms within the water column).

- Georges Cove River sediment: as described in the SPI, Georges River sediments have elevated copper, lead and zinc concentrations. As reported in Marine Pollution Research (2015):

  > Ecological Risk Assessment for the estuarine section of the Georges River downstream of Chipping Norton sewerage overflow [upsteam of the site] showed that there was potential risk to aquatic life from exposure to chemicals in sewer overflow and stormwater. Twenty-five chemicals were identified as COPCs [chemicals of potential concern] following chronic exposures and 5 COPCs were identified for acute exposures. Detailed risk evaluation indicated that processes such as degradation and the settling of particle bound chemicals reduced the number of chemicals of potential concern. However risks were still predicted from 3 acute COPCs and 9 chronic COPCs.
  >
  > In practice, Sydney Water (1998) found that whilst preliminary sampling of sediments undertaken in 1996 identified arsenic, cadmium, chromium, copper, iron, nickel, lead, zinc, a & b-BHC, endosulphan, DDT, Chlordane, chloropyrifos as chemicals of potential concern, no toxicity was found in a sediment bioassay taken downstream of the overflow.

- Site soils: the site soils contain fill, some of which extends at least 4 m below ground level. This is primarily construction and demolition waste (SPI Table 4.1). There is the potential that the dredge pond contains some of this fill as a result of the excavation of the pond.

The dredge pond, stormwater drain and un-named creek and the Georges River adjacent to the site are described in detail in Marine Pollution Research (2010), with an update provided in Marine Pollution Research (2015).

3.2.3 Contaminant sources

The CSM includes the following potential contaminant sources:

- Urban runoff: largely in the unlined stormwater drain west of the site that is expected to contain metals, ammonia, nutrients and PAHs with some seepage to groundwater.

- Fill to the north of the site: an old landfill that may contribute metals, ammonia, nutrients and PAHs to the basin and Georges River through groundwater seepage.

- Fill to the south of the site: an old landfill to the immediate south of the site that is a potential source of contamination (metals, ammonia, nutrients and PAHs), contributing to contamination of groundwater and the dredge pond sediments at the site (see SPI Section 5.5.2 for further details).

- Fill on the site: generally inert fill (bricks, rubble, etc. but with some anthropogenic debris such as plastics) may generate some leachate or may have been introduced to the dredge pond as the pond was excavated. Therefore the fill may have contributed metals, nutrients and PAHs to the groundwater and dredge pond.

- Runoff and process water from north of the site: materials such as concrete, bricks and glass are recycled in the area north of the site. This includes sorting, crushing, washing and stockpiling. Material is washed using pond water that is returned to the pond while runoff from the site also reports to the pond. Given that the waste materials are inspected prior to being accepted by the recycling facility, there is a low risk of these activities being a source of metal or organic chemical contaminants. However, these activities have the potential to introduce ammonia and nutrients to the dredge pond.

- Georges River Water, suspended sediment, and bed sediment: as described in Section 3.2.2.

3.2.4 Transport mechanisms

The CSM includes the following physical and chemical transport mechanisms:

- seepage of surface water containing dissolved contaminants to groundwater (onsite and offsite);
- groundwater flow containing dissolved contaminants with discharge to the basin (onsite);
- groundwater flow containing dissolved contaminants with discharge to the Georges River (onsite and offsite);
- seepage of basin water containing dissolved contaminants to groundwater (onsite);
- suspended particles with adsorbed contaminants settling to the sediments on the base of the basin or the Georges River (onsite and offsite);
- resuspension of sediments into the water column (onsite and offsite);
- adsorption of contaminants onto particles suspended in the water column (onsite and offsite);
- desorption of contaminants from suspended particles to the dissolved phase in the water column (onsite and offsite);
- direct discharge of stormwater in the unlined drain containing dissolved and particulate contaminants to the Georges River (offsite);
- formation of ammonia from organic matter in sediments (onsite and offsite);
- diffusion of contaminants from the bed sediment (onsite and offsite);
- Georges River water flow (offsite);
- sediment movement along the bed of the river (offsite); and
- overland flow during floods (offsite).

3.3 Existing arrangement, construction and operations

The CSM considers three periods:

- Existing arrangement: sand extraction on the site using the dredge. The basin is not connected directly to the Georges River but there is groundwater flow between the basin and the river.
- Marina construction, in particular opening the marina basin to the Georges River (acute risks): the marina basin will be completed to the greatest possible extent with the marine entrance channel partially excavated. The bank will only be opened if the water quality in the basin is similar to, or better than, that in the Georges River (based on the site-specific water quality assessment criteria described in Section 6.2.2).
- Marina operations (chronic risks): once the access channel is constructed, the marina will remain open for the foreseeable future with 40 to 60% of the water within the basin exchanged every tidal cycle (Worley Parsons 2010).

3.4 Chemical behaviour

The chemical behaviour of a contaminant will determine the pathways it will follow in the environment and the potential toxicity to biological receptors. The CSM considers the following chemical behaviours:

- Dissolved metals and PAHs concentrations measured in the dredge pond water as part of the SPI were generally correlated with TSS concentrations, with low metal and PAH concentrations in samples that had a low TSS concentration. Adsorption of these contaminants onto suspended particles followed by settling of the particles is expected to decrease the concentration of these contaminants in the water column. The contaminants remaining in the water column will be partitioned between the dissolved and particulate phases. Dissolved contaminants are generally considered to be more bioavailable, and hence of greater toxicity risk, than particulate-bound contaminants.

- Ammonia is highly soluble and predominantly occurs in the dissolved phase. In the SPI dredge pond water results, there was little correlation between TSS and ammonia concentrations at lower TSS concentrations. This is consistent with ongoing elevated ammonia concentrations across the dredge pond (see Section 6.2.2i). The samples with the highest TSS concentrations and had the highest ammonia concentrations suggesting that mobilisation of dredge pond sediments adds additional ammonia to the water column. Most of the ammonia in the environment comes from the natural breakdown of manure and dead plants and animals. Anthropogenic sources include fertiliser, sewage, breakdown of waste.

- Nutrients (measured as total nitrogen and total phosphorus in unfiltered samples) are generally associated with organic matter and may be transported as solids or in the dissolved phase. There was a good correlation between TSS and nutrient concentrations in the SPI dredge pond water results indicating that nutrients are being remobilised with the sediment by dredging.

3.5 Exposed population

Three exposed populations have been considered in the CSM:

- Humans: the Georges River adjacent to the site is used for recreational boating, including power boats, jet skis and kayaks. The recreational contact guidelines are calculated by multiplying the *Australian Drinking Water Guidelines* criterion by 10, assuming that water ingested during recreational activity is approximately 10% (200 mL) of that assumed for daily drinking water intake (2 L). Ingestion of 200 mL of water is far more likely when swimming than boating.

- Nekton and plankton: nekton are actively swimming aquatic organisms (eg fish) while plankton are passive organisms carried along by the current. The risk to these organisms has primarily been considered using the ANZECC and ARMCANZ (2000) water quality guidelines for slightly to moderately disturbed ecosystems.

- Benthos: the benthos is the community of organisms living in or on the bed sediment. The risk to these organisms has primarily been considered using the ANZECC and ARMCANZ (2000) sediment quality guidelines.

4 Remediation goal

The remediation goal is to ensure that:

- the site is suitable, from a contamination perspective, for the proposed uses — this will be achieved through the remediation of contaminated soil of the site, including unexpected finds (see Section 6.1.2);
- the risks to human health and ecology from onsite contaminant sources are reduced to an acceptable level — this will be achieved through the management and remediation actions during construction and operation of the marina basin (see Section 6.2); and
- the marina development does not increase the risks to the environment from offsite contaminant sources — this will be achieved through management and remediation actions during construction of the marina (see Section 6.2).

5 Potential pathways from sources to populations

The CSM was used to identify each feasible pathway between contaminant sources and exposed receptors. Each of these pathways is presented in Table A.1 in Appendix A.

High metals, PAHs and nutrients concentrations present ecotoxicity risks, while high nutrient concentrations present eutrophication risks. The Georges River is the main receptor of mobile onsite and offsite contaminants. The CSM focuses on pathways to the Georges River where there are ecotoxicity or eutrophication risks.

Generally, the exposure pathways from the primary source to the receptors include secondary sources. The form of the contaminant (eg dissolved or particulate) and the media (eg basin water or river water) for each secondary source are identified in Table A.1. The fate of the contaminant (form and medium) is identified based on the available transport mechanisms. Each fate may form a further secondary source, may result in exposure to a receptor, or both. Table A.1 lists whether each pathway is existing and whether the pathway needs to be considered when the marina channel between the basin and the Georges River is first opened and/or needs to be considered as part of ongoing marina operations.

Remediation options to reduce the exposure of populations, generally through interrupting the pathways/mechanisms in the environment, are listed for each pathway.

6 Remediation actions

6.1 Land based remediation

The general sequence for land based remediation works will comprise:

1. Prior to commencing any remediation works the dredge infrastructure will be removed. Any signs of contamination (notably staining and petroleum odours) observed during this process will be recorded. If unexpected areas of potential contamination are identified, the unexpected finds protocol (Section 6.1.2) will be implemented.

2. The need for excavation and/or the introduction of fill for the site will be determined prior to the start of construction.

3. The existing soil stockpiles in the north of the site and the soil mound in the south of the site will be removed with validation soil samples taken from the stockpile footprints. As described in the SPI, it is considered unlikely that gross contamination would be encountered within or under the mound or stockpiles that would render the site unsuitable for the proposed uses. The unexpected finds protocol (Section 6.1.2) will be implemented if required.

4. Areas where soil has been identified as having exceedances of the soil acceptance criteria will be:

    a) remediated through the removal and appropriate disposal of soil and fill; or

    b) will be covered with an impermeable surface.

5. Any material proposed for offsite disposal or reuse will be characterised for waste classification in accordance with the NSW EPA (2014) *Waste Classification Guidelines, Part 1: Classifying Waste*, or with regard to a relevant resource recovery order and exemption issued under the *Protection of the Environment Operations Act 1997* (POEO Act).

6. A validation survey of areas where soils will remain exposed will be conducted by a qualified environmental consultant following the completion of the landform. This will determine if contamination has been adequately removed, remediated and/or managed and no longer presents an unacceptable risk to human or environmental health.

6.1.1 Materials used for construction fill

Soils from the site or imported materials may be used as fill during construction.

Any material from the site that is proposed for reuse and that will not be covered by an impermeable surface will need to meet the ASC NEPM *Schedule B1: Guideline on Investigation Levels for Soil and Groundwater* (NEPC 2013) health-based and ecological investigation and screening levels for soil and soil vapour.

Any fill imported onto the site will need to be validated by a qualified environmental consultant, or certified by the supplier, as being suitable for the proposed land use. Virgin excavated natural material (VENM), with an appropriate VENM validation certificate, will be assumed to be suitable for importation without further assessment.

There must be no aesthetic issues associated with any fill (eg visible debris, staining or odours) that may be exposed when the marina site is operating.

6.1.2 Unexpected finds protocol

Given the inherent heterogeneity of fill material present at the marina site, an unexpected finds protocol with clear instructions for identifying and managing potential undiscovered contamination issues during development is required.

The appropriate management of unexpected finds will minimise human health and environmental risk from the disturbance of potential contaminated materials, and will ensure the material is managed in accordance with the *Contaminated Land Management Act 1997*.

Unexpected finds at the site could relate to buried finds and/or volatile contaminants, including (but not limited to):

- oil/diesel/tar/petrol sheens, free product, odours or impacted soils;
- buried structures, such as storage tanks, drums, disused pipe work, tyres or waste;
- asbestos pieces, fibre cement sheets, fibres (although this is considered highly unlikely due to the lack of development at the site);
- discoloured or odorous soil; and
- acid sulfate soils (ASS) or potential ASS, appearing as grey, gluggy soils with rotten egg smell.

The following procedures will be implemented if suspected contamination is discovered during construction:

1. Upon discovery of suspected contamination, all construction works in the vicinity are to cease, the site foreman is to be notified and the area barricaded.
2. The potentially contaminated material is to be removed and disposed of in accordance with the Waste Classification Guidelines. This may include removal of a buffer zone around the potentially contaminated material, based on field observations or volatile detections with a photoionization detector. The notification and engagement of a qualified environmental consultant will be required to assess the nature and degree of potential contamination and classification.
3. If the find is suspected to be asbestos material, the area is to be kept wet and management practices implemented in accordance with the NSW *WorkCover How to Manage and Control Asbestos in the Workplace, Code of Practice* (WorkCover 2011). If appropriate, the material will be covered to prevent dust generation, pending final management.
4. If the find is actual ASS or potential ASS, a suitably qualified consultant is to be engaged to manage the ASS in accordance with the *National Guidance for the Management of Acid Sulfate Soils in Inland Aquatic Ecosystems* (EPHC and NRMMC 2011).
5. If there is large scale exceedance of the assessment criteria it may be more practical to remediate the contamination rather than remove the source. An environmental consultant will establish and document a tailored remediation process, and will likely undertake sampling to confirm the type and extent of contamination. This is most likely for instances of potential and actual ASS.

6. Unexpected finds will be documented throughout the unexpected finds process. This will include: date(s), location(s), persons involved and remedial actions.

7. Once the site is remediated and validated, construction works will recommence.

Any required remediation will be directed by the Site Manager with supervision from a qualified Environmental Consultant depending on the type and extent of contamination.

6.2 Aquatic environment remediation

6.2.1 Consolidated management actions

The actions identified for each pathway in Table A.1 have been consolidated into management and remediation actions that will address the range of contaminants and pathways related to the marina basin and the aquatic environment.

The actions and monitoring to manage marina construction risks are described in Section 6.2.2 and those to manage marina operations risks are described in Section 6.2.3.

6.2.2 Marina basin construction

The marina construction management actions and monitoring are provided in Table 6.1 and described in further detail below. These will be implemented up to the time that the marina basin is opened to the Georges River.

Table 6.1 Management and remediation actions - construction

Potential source and mechanism	Construction actions	Construction monitoring
Direct water flow of water containing elevated metals, ammonia, nutrients and PAHs from secondary contaminant sources (groundwater, surface flows to basin and basin sediments) from the basin to the river.	Actions: • Cease dredging. • Complete all marina construction activities that may result in sediment resuspension and then allow time for metals to be adsorbed and for particles in the water column to settle to the bed sediments. • Monitoring of basin water prior to opening basin - only open basin once concentrations in the basin are in the range occurring in the river as determined by site-specific water quality assessment criteria. • Use silt curtains to minimise high TSS water entering the river surface water discharge from marina basin to river. Contingencies: • If required, treatment to remove ammonia and nutrients from the water column, eg flocculent addition.	Basin (prior to opening to the river): • pH, temperature, EC, DO and turbidity • TSS • Dissolved Al, Cd, Cu, Ni, Pb and Zn • Total and dissolved Hg • PAHs • Ammonia, total P and total N • BOD and COD River upstream/downstream of the site to provide a contemporary baseline: • pH, temperature, EC, DO and turbidity • TSS • Dissolved Al, Cd, Cu, Ni, Pb and Zn • Total and dissolved Hg • PAHs • Ammonia, total P and total N • BOD and COD

Table 6.1 Management and remediation actions - construction

Potential source and mechanism	Construction actions	Construction monitoring
Seepage of water containing elevated metals, ammonia and nutrients from the offsite unlined stormwater drain to groundwater followed by groundwater flow discharge to basin. Ongoing offsite source that has contributed contaminants to the basin.	Management through managing water quality in the basin prior to opening it to the river. Slow process - source will not contribute significant contaminants to the basin over the period which the basin will be opened to the river.	See basin/river water construction monitoring above.
Seepage from historic landfills north and south of the site to groundwater followed by groundwater flow discharge to basin. Ongoing offsite sources that may have contributed contaminants to the basin.	Management through managing water quality in the basin prior to opening the basin to the river. Slow process - sources will not contribute significant contaminants to the basin over the period which the basin will be opened to the river.	See basin/river water construction monitoring above.
Direct surface water discharge to the basin from north of the site. Historic offsite source that has contributed contaminants to the basin.	Cease processing to north of site. Prevent surface water runoff from offsite running directly into the basin.	See basin/river water construction monitoring above.

EC: electrical conductivity, DO: dissolved oxygen, TSS: total dissolved solids, Al: aluminium, Cd: cadmium, Cu: copper, Ni: nickel, Pb: lead, Zn: zinc, Hg: mercury, PAHs: polycyclic aromatic hydrocarbons, total P: total phosphorus, total N: total nitrogen, BOD: biological oxygen demand, COD: chemical oxygen demand.

i Cease dredging

The ammonia concentration in the dredge pond water generally decreased between September 2015 and January 2016 (Figure 6.1).

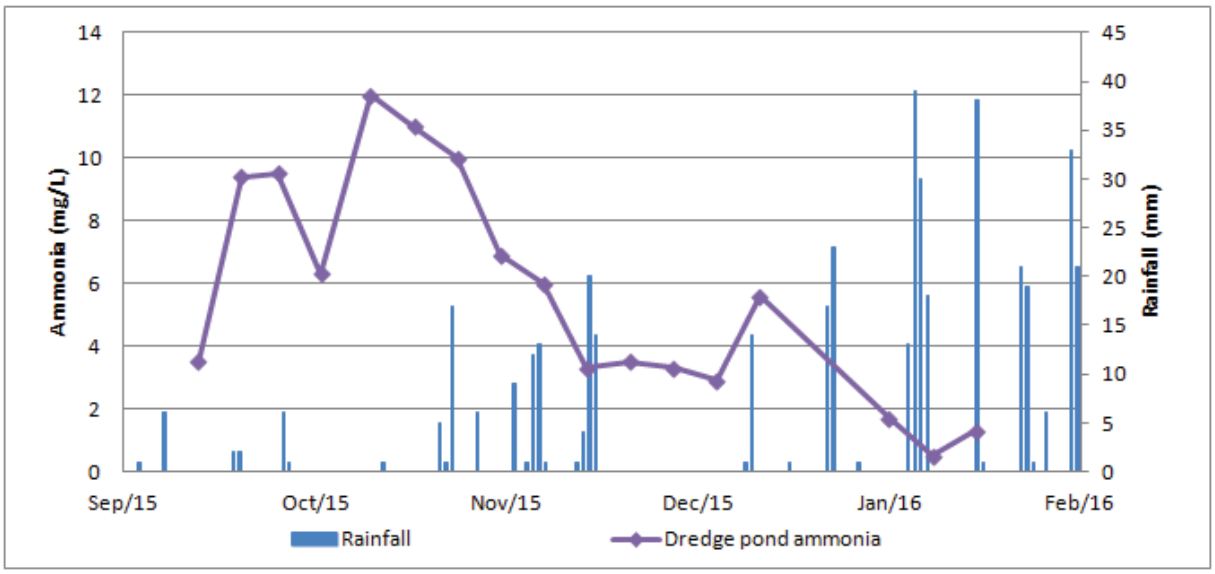


Figure 6.1 Ammonia results in the dredge pond water

The decreasing ammonia concentration has coincided with decreasing dredging activity in the pond. It may have also been reduced by dilution following rainfall. However, the decrease from October 2015 started before there was any appreciable rainfall.

Dredging within the pond as part of sand extraction activities was completed in February 2016. This has allowed suspended particles to settle. Since the completion of dredging, preliminary results indicate that the ammonia concentration in the pond has been measured to be 0.1 mg NH_3-N mg/L. There was little rainfall in this period. This preliminary concentration is below the ANZECC and ARMCANZ (2000) freshwater/marine trigger values for the protection of slightly to moderately disturbed ecosystems (0.90 NH_3-N mg/L / 0.91 NH_3-N mg/L). Monitoring is continuing.

It is anticipated that metals, PAHs and nutrient concentrations in the dredge pond water will also decrease as particulates in the water column settle and the bed sediments are no longer resuspended. Water sampling and analyses are underway to test this.

Ammonia concentrations below 0.90 NH_3-N mg/L will not result in an unacceptable ecotoxicologial risk. On the basis that metals and PAHs concentrations in pond water with low TSS concentrations were below trigger values (see Section 3.4), these contaminants are not expected to result in an ecotoxicologial risk to nekton/plankton or a recreational risk to humans when TSS levels are low as will be the case once particle settling is complete.

Given that dredging is believed to mobilising nutrients from the sediments into the dredge pond water (see Section 3.4), the risk of eutrophication is expected to reduce by orders of magnitude now that dredging has ceased. This would be further reduced as basin water is diluted with the far great volume of water in the Georges River.

While risks are expected to be reduced to acceptable levels, monitoring is required (see below) to confirm that metals, PAHs, ammonia and nutrient concentrations will not result in ecotoxicologial or eutrophication impacts. As the basin will not be opened to the river until assessment criteria are met, there is no change of an unacceptable risk to environment from water quality during construction.

ii Preventing surface flow to basin

The use of basin water for washing material to the north of the site will start prior to the start of marina construction. This will remove a historic contamination source.

Drains will be constructed at the start of the marina construction phase that prevent surface water runoff from the area north of the site running directly into the basin.

iii Marina basin and entrance construction

The *Georges Cove Marina, Moorebank, Environmental Impact Statement* (EMM 2015b) describes construction of the marina basin (EIS Section 2.10.3):

> The marina basin will be formed by filling parts of the existing quarry basin to shape it to the final landform using the existing quarry dredge and land-based earth moving machinery. This has been largely completed as part of recent quarry operations although final rehabilitation of the basin has not yet started.
>
> Excavated sand and other suitable materials will be used to form the entrance channel and associated land areas required for the marina. As described in Section 1.3 [of the EIS], some VENM (but no other waste materials) and rock will be imported to assist with shaping the marina basin.

Modification of the quarry basin to form the marina basin and entrance channel will commence on the landward (eastern) side of the basin wall prior to breaking through the banks to the river. The breakthrough to the river will be undertaken as the last activity in the construction of the marina basin after the water quality in the basin has stabilised and is suitable for discharge to the river. In this way, works in the basin will not impact on river water quality.

This sequencing will allow sediments that have been resuspended during construction to settle to the bed sediments and allow time for the majority of dissolved metals in the water column to be adsorbed onto these settling particles. Absorption of dissolved metals in the basin water onto suspended particulates followed by sediment deposition will reduce concentrations in the water column and reduce contaminant mobility.

As for the cessation of dredging, allowing any suspended particulates to settle is expected reduce contaminant concentrations in basin water to levels where risks are acceptable. While risks are expected to be reduced to acceptable levels, monitoring is required (see below) to confirm that metals, PAHs, ammonia and nutrient concentrations will not result in ecotoxicologial or eutrophication impacts.

iv Silt curtains

Silt curtains are required in the river when the basin entrance is opened. These will prevent visible surface silt plumes entering the Georges River and will assist any suspended particles to settle to the bed of the Georges River by reducing the current and turbulence at the marina entrance.

v Water quality monitoring

A water quality monitoring program is required to confirm that the water from the basin is suitable for discharge when the marina channel is opened. The following parameters need to be measured in the basin (prior to opening to the river):

- pH, temperature, EC, DO and turbidity;
- TSS;
- dissolved Al, Cd, Cu, Ni, Pb and Zn;
- total and dissolved Hg;
- PAHs;
- ammonia, total P and total N; and
- BOD and COD.

Approximately five samples could be taken one to two days apart following the completion of construction activities that may disturb the water in the basin. Samples will take three to five days to analyse. Therefore this program should commence approximately two weeks before it is planned to complete the channel. Real-time measurements (pH, temperature, EC, DO and turbidity) could be used as an indicator that the water quality was stable immediately prior to commencing works to open the marina to the river.

The same parameters would be measured in the river upstream and downstream of the site to provide a contemporary baseline of river water quality. Up to ten weekly samples should be collected during marina construction.

vi Assessment criteria

The basin should not be opened unless the site-specific water quality assessment criteria are achieved.

Water quality in the Georges River varies according to rainfall events in the catchment and flow. The basin will be flushed with approximately 40 to 60% of the water exchanged each tide. Therefore when the basin is first opened, the majority of water in the basin will be flushed into the river by the first two tides. This is a short-duration event and assessment criteria for determining whether the basin can be opened to the river should reflect this.

The ANZECC and ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* recommend the use of site-specific water quality data where possible when developing trigger values. Single trigger values should be derived statistically from a site-specific water quality dataset.

The site-specific Georges River water quality data collected prior to determining whether to open the basin would be used to determine site-specific assessment criteria. Given that the opening of the basin, and the subsequent flushing of the basin will occur within about 24 hours, it is appropriate that the assessment criteria reflect conditions that occur in the river frequently but not all of the time. The use of the 90th-percentile of the baseline data as the assessment criteria would achieve this goal. Assuming that the baseline data are reasonably representative of daily water quality over a year, the assessment criteria levels would be expected to be exceeded on 35 days per year regardless of marina construction. In reality, it is unlikely that the baseline sampling would capture the days when the water quality in the river was poorest so use of the 90th-percentile values for assessment criteria would be conservative.

vii Validation monitoring

Validation monitoring upstream and downstream in the river 24 hours after the basin is first opened is required. The same parameters should be measured as prior to opening the basin.

viii Contingencies

The management measures described above are expected to reduce the risks to exposed nekton/plankton and human populations to acceptable levels during construction. However, chemical treatment options are available as a contingency should contaminant concentrations not reduce to below the assessment criteria over an acceptable period to allow the marina basin to be opened to the river.

As described above, sufficient time will be allowed for suspended sediments in the basin water to settle to the basin bed sediments prior to opening the marina basin to the river. This will reduce the concentrations of metals and PAHs in the water column. If required, a non-toxic flocculent may be added to increase settling rates of fine particles (ie clay-sized particles). The capacity of a particle to adsorb contaminants increases with increasing particle surface area. The smallest particles have the highest surface area to mass ratio so addition of a flocculent is likely to further decrease contaminant concentrations if the water is turbid. Alternatively or in combination, the addition of coagulants (clarifying agents) can cause colloids to come out of suspension in the form of flocs or flakes.

Another option, if necessary, would be the use of in-situ biological reactors within the pond that promote the growth of ammonia oxidising bacteria (AOB). This is accomplished through the installation of high surface area fixed growth media that allow for water flow through the media (essentially, a metal frame structure wrapped with a material similar to a fine fish net). The system includes air diffusers which provide the oxygen required for AOB growth and for the nitrification of dissolved ammonia. These systems are suitable for reducing a one-off nutrient load in a pond, as well as managing continuous loading if relevant.

Water treatments options are also available using external fixed bed reactors to remove nutrients if required.

There will be no risk from the development of the marina before the basin is opened. Benedict Industries has committed to only opening the marina basin to the Georges River once the water quality is similar to the Georges River. The contingency measures outlined above are unlikely to be required to achieve this goal. However, there are a range of options available to reduce contaminant concentrations if required to meet the water quality assessment criteria prior to opening the pond. There will be as much time as needed to investigate and implement contingency actions if they are required.

6.2.3 Marina operations

The marina operations management actions and monitoring are provided in Table 6.2 and described in further detail below.

Table 6.2 Remediation options - operations

Potential source and mechanism	Operations remediation options	Operations monitoring

Direct water flow of water containing elevated metals, ammonia, nutrients and PAHs from secondary contaminant sources (groundwater, surface flows to basin and basin sediments) from the basin to the river.	• The marina basin is designed to promote frequent flushing (40–60% per tidal cycle), preventing contaminant accumulation in the water column and increasing contaminant concentrations.
	• Prevent basin sediment resuspension from propeller wash by:
	  ○ providing adequate under keel clearance; and
	  ○ enforcing speed limit (4 knots).
	• Ongoing chemical treatment of basin/river water is not viable.
		River upstream/downstream of the site to provide a contemporary baseline:
		• pH, temperature, EC, DO and turbidity
		• TSS
		• Dissolved Al, Cd, Cu, Ni, Pb and Zn
		• Total and dissolved Hg
		• PAHs
		• Ammonia, total P and total N
		• BOD and COD

Seepage of water containing elevated metals, ammonia and nutrients from the offsite unlined stormwater drain to groundwater followed by groundwater flow discharge to basin. Ongoing offsite source that will continue to contribute contaminants to the basin.	No viable remediation options. Unlined stormwater drain transports runoff from the industrial area north of Newbridge Road to the Georges River. It is likely that the majority of the contaminant load from the drain is delivered to the Georges River by direct surface water discharged through the un-named creek south of the site rather than through groundwater seepage to the basin. Lining the drain would change the pathway (less flow/contaminant movement via groundwater and more via surface flow) but not the fate of contaminants in drain (discharge to river).	See basin/river water operations monitoring.

Table 6.2 Remediation options - operations

Potential source and mechanism	Operations remediation options	Operations monitoring
Seepage from historic landfills north and south of the site to groundwater followed by groundwater flow discharge to basin. Ongoing offsite sources that will continue to contribute contaminants to the basin.	Contaminants need to be managed at the source. The marina development will not change the contribution of contaminants from the historic land fill to the north of the site to the river. The land fill to the north is an offsite source that cannot be rectified as part of the marina development. However, this area will be remediated to the required standard as part of developing the Georges Cove residential estate. The marina development will not change the contribution of contaminants from the historic land fill to the south of the site to the river. There is no known proposal to remediate this area as it is currently approved to be used as a recycling facility for which no remediation works were required. Any measures to redirect this groundwater around the site would not reduce the total contaminant loads to the river.	See basin/river water operations monitoring.
Direct surface water discharge to basin from north of the site. Historical source that has contributed contaminants to the basin.	Cease processing to the north of site. Prevent surface water runoff from offsite running directly into the basin. Direct surface runoff to treatment area in north-west of basin to minimise solids, organic matter and nutrients entering the basin.	See basin/river water operations monitoring.
Movement of sediment along the bed of the basin to the river.	The marina entrance will be excavated to a depth that leaves a 'lip' at the entrance that extends above the base of the basin and river. The lip will be armoured with rock to prevent erosion by water moving into and out of the basin.	Upstream and downstream river sediment survey: • Fraction <63 µm • Cd, Cu, Hg, Ni, Pb and Zn concentrations • PAHs concentrations.
Desorption of metals or PAH from bed sediment and diffusion to overlying water column.	Ongoing chemical treatment of basin/river water is not viable.	See basin/river water operations monitoring.
Formation of ammonia in the sediments from organic matter and/or release of nutrients and diffusion to overlying water column.	Minimise input of solid organic matter to the basin by directly flow though treatment ponds.	See basin/river water operations monitoring.

i Marina flushing

The marina basin has been designed to promote frequent flushing (40–60% per tidal cycle), preventing contaminant accumulation in the water column and increasing contaminant concentrations.

ii Sediment resuspension prevention

The management described in Section 6.2 aim to ensure that there no unacceptable risks from water quality in the basin. In general, contaminants in the water column will be carried to the sediments. Given that the resuspension of sediments are believed to be a source of contaminants in water column, the settling of particles is not expected to increase contaminant levels in the sediment. Conversely, resuspension of contaminated sediments in the basin and subsequent transport to the Georges River is a potential long-term risk.

The marina will be a relatively low energy environment compared to the Georges River channel so particulates are more likely to settle in the basin than in the marina. Over the very long-term this will cap, or at least dilute, contaminants in the basin sediments.

The majority of the boats using the marina will be less than 15 m long. There will be four berths for boats between 15 m and 20 m long and no berths for boats more than 20 m long. Power boats 15 to 20 m long have draughts of up to 2.0 m (JBA Planning 2008). An under keel clearance of 0.3 m plus half the significant wave height is required to allow safe boat movement (JBA Planning 2012) where the bed is soft sediment. The marina basin will be 2.92 m deep at low tide and there will be no waves. Therefore there will be 0.92 m clearance for the longest boats using the marina at low tide. A speed limit of 4 knots will be enforces and significant propeller induced sediment resuspension is unlikely.

iii Treatment of surface flow to basin

The marina will be constructed to prevent uncontrolled surface run-off to the marina basin except from the immediately adjacent areas, eg walk ways and landscaped areas. Most storm water runoff from the marina site will be directed to the stormwater drain along the western boundary of the site.

As described in EIS Sections 3.4.6 and 6.1.7, the marina basin will incorporate a large constructed wetland to the north-west of the marina basin for polishing and treatment of storm water runoff from the development. The wetland will minimise solids (and associated contaminants such as metals), organic matter and nutrients from entering the basin.

iv Lip on floor of basin opening

There will be the potential for sediment to move horizontally between the base of the basin (2.92 m below the low tide level) and the base of the Georges River if the bottom basin entrance is at the same level. Rather, a ‘lip’ will be left at the base of the entrance. This will minimise the horizontal movement of basin sediment. The lip will be covered by rock armouring to prevent it being eroded by the overlying water movement in and out of the marina.

Over time, sediments in the basin are expected to further consolidate following the completion of dredging and become less mobile.

Monitoring of sediments in the Georges River prior to opening the basin (as a baseline) and quarterly for a year and then annual for five years is required. Sediments should be analysed for:

- fraction <63 µm;
- Cd, Cu, Hg, Ni, Pb and Zn concentrations; and
- PAHs concentrations.

The concentrations of contaminants in the sediments, most notably lead and pyrene (see Table 2.1), are elevated to levels where there are ecotoxicological risks to the benthos. However, these risks will be largely confined to the marina basin.

v Offsite contaminant sources

It is not proposed to implement management measures to control the following offsite contaminant sources identified in the CSM as the proponent will not be taking actions that will alter these sources and the project will not exacerbate the risks to receptors as a result of these sources:

- seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin;
- offsite urban runoff discharge directly to river from the unlined storm water drain;
- leachate from landfills to north and/or south of the site entering the groundwater and direct discharge to Georges River north and south of basin;
- dissolved and particulate contaminants in the Georges River upstream of the site;
- dissolved and particulate contaminants in overland flow during flooding of the Georges River of the site; or
- contaminants in the Georges River sediments upstream of the site Georges River upstream of the site.

7 Conclusions and recommendations

7.1 Site suitability

A marina development is proposed on the site. The PI and SPI (EMM 2015a and 2016) characterised the site. These preliminary investigations found there is a risk that metals, ammonia and nutrients in the dredge pond water, and these contaminants plus PAHs in the sediment, may impact ecological values in the Georges River when the marina basin is first opened to the river (acute impacts) and/or during of marina operations (chronic impacts).

This RAP identifies a range of actions to minimise risks to human health or ecology within the marina basin and adjoining George River (see Section 7.2).

The land is suitable in its contaminated state (or will be suitable, after remediation) for the proposed future land use as a proposed marina development as well as for high-density residential dwellings with minimal opportunities for soil access.

7.2 Management actions

This RAP identifies the following management actions to ensure that the risks to human health or ecology within the marina basin and adjoining George River are minimised:

- During marina construction:
    - Cease dredging to allow suspended particulates in the dredge pond to settle. (Dredging ceased in February 2016).
    - Complete all marina construction activities that may result in sediment resuspension and then allow time for metals to be adsorbed and for particles in the water column to settle to the bed sediment.
    - Monitor basin water prior to opening basin. Only open basin once concentrations in the basin are in the range occurring in the river.
    - Monitor Georges River water quality to establish a contemporary baseline and establish site-specific water quality assessment criteria.
    - Use silt curtains to minimise water with high TSS concentrations entering the river surface water from the marina basin.
    - If required, investigate contingencies to reduce contaminant concentrations in the basin to meet site-specific water quality assessment criteria.
- During marina operations:
    - The marina basin is designed to promote frequent flushing, preventing contaminant accumulation in the water column and increasing contaminant concentrations.
    - Prevent basin sediment resuspension from propeller wash by: providing adequate under keel clearance (2.9 m low tide water depth) and enforcing the speed limit within the marina basin (4 knots).

- Cease processing to the north of site.

- Prevent surface water runoff from offsite running directly into the basin.

- Direct surface runoff to the treatment area in north-west of the basin to minimise solids, organic matter and nutrients entering the basin.

- Excavate the marina entrance to a depth that leaves a 'lip' at the entrance that extends above the base of the basin and river. Armour the lip with rock to prevent erosion by water moving into and out of the basin.

- Monitor Georges River water quality and sediment quality for five years to validate that marina operations are not an unacceptable risk to the ecology of river or to recreational users.

7.3 Conclusion

There are a range of offsite sources contributing contaminants to the Georges River in the vicinity of the site. These contaminants enter the river directly though surface water flow (eg urban runoff) and indirectly through seepage to groundwater followed be discharge of groundwater to the river. Development of the marina would not materially change these inputs.

The identified contamination on the site is largely associated with the basin, particularly bed sediments and suspended particulate matter.

There will be no ecological or recreational contact risk from the development of the marina before the basin is opened. There are a range of active and passive management measures that will reduce contaminant concentrations in the basin water before it is opened to the river. Benedict Industries has committed to only opening the marina basin to the Georges River once the water quality is similar to the Georges River.

Ecological or recreational contact risks in the river during marina operations will be generally associated with the movement of sediment along the bed or as a result of sediment resuspension. There are a range of management measures that will reduce these risks to acceptable levels.

Monitoring during marina construction, following opening the marina basin and during marina operations will be required to confirm that risks are acceptable based on established and site-specific criteria.

References

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Appendix A

Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
Metals															
1	Surface water: urban runoff in unlined drain seeps to groundwater	Dissolved metals	Groundwater												
2		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Off-site source. Marina development will not change source or pathway. Lining the drain would change the pathway (less via groundwater, more via surface flow) but not the fate (discharge to river)	y	y	y	None	None
3		Dissolved metals	River water	Absorption to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
4		Particulate bound metals	River water	Particle settling	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	y	y	y	None	None
5	Surface water: urban runoff in unlined drain seeps to groundwater	Dissolved metals	Groundwater												
6		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and discharge to basin.	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Off-site source. Marina development will not change source or pathway. Ongoing input so redirection (eg in-ground barriers) would not change fate (flow to Georges River).	y	n	y	See basin water management	None
7		Dissolved metals	Basin water	Absorption of metals to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	y	y	y	Basin water management: - allow time for metals to be adsorbed. - basin water monitoring of prior to opening basin - open basin only when site-specific water quality assessment criteria acheived - contingency water treatment if required (eg flocculent)	None Ongoing chemical treatment of basin/river water is not viable
8		Particulate bound metals	Basin water	Particle settling	Particulate bound metals	Basin sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	Risk only when basin is contiguous with river Metals most immobile and generally lowest risk when associated with the sediment	y	n	y	None	None
9		Particulate bound metals	Basin sediment	Resuspension of sediments by dredge or propellers	Particulate bound metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Small number of boats 15-20 m long and no boats more than 20 m long	y	n	y	See basin water management	Prevent sediment resuspension from prop wash by providing adequate clearance and enforcing speed limit (4 knots)
10		Particulate bound metals	Basin water	Desorption of metals from suspended particulates	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	y	y	y	See basin water management	Prevent sediment resuspension
11		Particulate bound metals	Basin sediment	Desorption of metals from sediment and diffusion to overlying water column	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Slow chemical processes that may be accelerated by bioturbation. Metals likely to remain largely adsorbed on particles	y	n	y	See basin water management	None
12	Surface water: urban runoff in unlined drain - surface flow discharges directly to river	Dissolved metals and particulate bound metals	River water												

Table A.1 Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
13		Dissolved metals and particulate bound metals	River water	Direct surface water discharge to river when drain is flowing	Dissolved metals and particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Historic discharge. Drain and discharge point to river off-site.	y	n	y	None	None
14	Leachate from landfills to north and/or south of the site	Dissolved metals	Groundwater												
15		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved metals	River water	-	Levels above baseline/ANZECC WQTVs - potential toxicity	Levels exceed recreational guidelines	Need to be managed at the source. Measures on site could only redirect flows. A contamination assessment for area north of the site is underway. No remediation was required during recent approcal of site to the south	y	n	y	None	None
16		Dissolved metals	Groundwater	Seepage to groundwater (offsite) and discharge to basin	Dissolved metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	y	n	y	See basin water management	None. Ongoing chemical treatment of basin/river water is not viable
17	Process water/surface water runoff from north of the site	Dissolved metals and particulate bound metals	Surface water												
18		Dissolved metals and particulate bound metals	Surface water	Direct surface water discharge to basin	Dissolved metals and particulate bound metals	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river Basin water will cease to be used for processing at the cessation of recycling facility activities north of the site.	y	y	y	Cease processing to north of site Prevent surface water runoff from offsite running directly into basin Direct surface runoff to treatment area in north-west of basin See basin water management	Prevent surface water runoff from offsite running directly into basin Direct surface runoff to treatment area in north-west of basin
19		Dissolved metals	Basin water	Direct water flow to river	Dissolved metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	n	y	y	See basin water management	Marina designed to promote frequent flushing (40-60% per tidal cycle), preventing dissolved and particulate metal accumulation and increasing concentrations.
20		Particulate bound metals	Basin water	Direct water flow to river	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Risk lower than for dissolved metals	Levels exceed recreational guidelines	Risk only when basin is contiguous with river	n	y	y	See basin water management	None
21		Particulate bound metals	Basin sediment	Movement of sediment along bed to river	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	n	n	y	-	Leave an armoured lip on the base on the marina entrance
22		Dissolved metals	Basin water	Infiltration to groundwater	Dissolved metals	Groundwater	-	-	-	-	y	n	y	-	-
23	Georges River upstream of the site	Dissolved metals and particulate bound metals	River water												
24		Dissolved metals and particulate bound metals	River water	River flow	Dissolved metals and particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
25		Dissolved metals	River water	Absorption to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Lower risk than for dissolved metals	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable

Table A.1 Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
26		Particulate bound metals	River water	Particle settling	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
27	Georges River upstream of the site	Particulate bound metals	River sediment												
28		Particulate bound metals	River sediment	Movement of sediment along the river bed	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-		y	y	y	None	None (current boat use of river will continue).
29	Overland flow during flooding	Dissolved metals and particulate bound metals	River water												
30		Dissolved metals	River water	Absorption to suspended particulates	Particulate bound metals	River water	-	Levels above baseline/ANZECC TVs - potential toxicity Lower risk than for dissolved metals	Levels exceed recreational guidelines	-	y	y	y	None	None Ongoing chemical treatment of basin/river water is not viable
31		Particulate bound metals	River water	Particle settling	Particulate bound metals	River sediment	Levels above baseline/ANZECC ISQGs - potential toxicity	-	-	-	y	y	y	None	None (current boat use of river will continue).
Ammonia															
32	Surface water: urban runoff in unlined drain seeps to groundwater	Ammonia	Groundwater												
33		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Off-site source. Marina development will not change source or pathway.	y	y	y	None	None Note: lining the drain would change the pathway (less via groundwater, more via surface flow) but not the fate (discharge to river)
34		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and discharge to basin	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when basin is contiguous with river .	y	y	y	See basin water management	None
35		Dissolved ammonia	Basin water	Direct water flow to river	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	May occur when basin first opened to the river. Could be a ongoing pathway for movement of ammonia to the river.	n	y	y	See basin water management	Marina designed to promote frequent flushing, preventing ammonia accumulation increasing concentrations.
36		Organic matter	Basin sediment	Formation of ammonia in the sediments from organic matter and diffusion to overlying water column	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	Minimise input of solid organic matter to the basin by directly flow though treatment wetland.
37	Surface water: urban runoff in unlined drain - surface flow discharges directly to river	Ammonia	Groundwater												
38		Dissolved ammonia	Groundwater	Direct surface water discharge to river when drain is flowing	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Historic discharge. Drain and discharge point to river off-site	y	n	y	None	None
39	Leachate from landfills to north and/or south of the site	Dissolved ammonia	Groundwater												
40		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	-	y	n	y	None	Needs to be managed at the source. Measures on site could only redirect flows. Contamination assessment for area north of the site are underway.
41		Dissolved ammonia	Groundwater	Seepage to groundwater (offsite) and discharge to basin.	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	Ongoing chemical treatment of basin/river water is not viable None as part of this development
42	Process water/surface water runoff from north of the site	Dissolved ammonia	Surface water												

Table A.1 Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
43		Dissolved ammonia	Surface water	Direct surface water discharge to basin	Dissolved ammonia	Basin water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river Basin water will cease to be used for processing at the cessation of recycling facility activities north of the site.	y	n	y	See basin water management	Minimise input of ammonia to the basin by directly flow though treatment ponds.
44		Dissolved ammonia	Basin water	Direct water flow to river	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	Risk only when contiguous with river	n	y	y	See basin water management	None
45		Dissolved ammonia	Basin water	Infiltration to groundwater	Dissolved ammonia	Groundwater	-	-	-	-	y	n	y	-	-
46	Georges River upstream of the site	Dissolved ammonia	River water												
47		Dissolved ammonia	River water	River flow	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	-	y	n	y	None	None Current process unrelated to operation of the site
48	Georges River upstream of the site	Dissolved ammonia	River sediment												
49		Organic matter	River sediment	Formation of ammonia in the sediments from organic matter and diffusion to overlying water column	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	-	y	n	y	None	None Current process unrelated to operation of the site
50	Overland flow during flooding	Dissolved ammonia	River water												
51		Dissolved ammonia	River water	River flow	Dissolved ammonia	River water	-	Levels above baseline/ANZECC TVs - potential toxicity. Eutrophication risk.	-	High organic loads may occur due to flooding and overflow of upstream sewage treatment plants	y	n	y	None	None Current process unrelated to operation of the site
Nutrients															
52	Surface water: urban runoff in unlined drain seeps to groundwater	Nutrients	Groundwater												
53		Nutrients	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Nutrients	River water	-	Eutrophication risk.	-	Off-site source. Marina development will not change source or pathway.	y	y	y	None	None
54		Nutrients	Groundwater	Seepage to groundwater (offsite) and discharge to basin	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when basin is contiguous with river .	y	y	y	See basin water management	None
55		Nutrients	Basin water	Direct water flow to river	Nutrients	River water	-	Eutrophication risk.	-	May occur when basin first opened to the river. Could be a ongoing pathway for movement of nutirents to the river.	n	y	y	See basin water management	Marina designed to promote frequent flushing, preventing nutrient accumulation and increasing concentrations.
56		Nutrients	Basin sediment	Release of nutrients from the sediments from organic matter and diffusion to overlying water column	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	Minimise input of solid organic matter to the basin by directly flow though treatment ponds.
57	Surface water: urban runoff in unlined drain - surface flow discharges directly to river	Nutrients	Groundwater												
58		Nutrients	Groundwater	Direct surface water discharge to river when drain is flowing	Nutrients	River water	-	Eutrophication risk.	-	Historic discharge. Drain and discharge point to river off-site	y	n	y	None	None
59	Leachate from landfills to north and/or south of the site	Nutrients	Groundwater												
60		Nutrients	Groundwater	Seepage to groundwater (offsite) and direct discharge to Georges River north and south of basin	Nutrients	River water	-	Eutrophication risk.	-	-	y	n	y	None	Needs to be managed at the source. Measures on site could only redirect flows. Contamination assessment for area north of the site are underway.

Table A.1 Contaminant pathways and management

ID	Primary source	Secondary source		Mechanism	Fate		Risk to potential receptors			Notes	Existing?	Future?		Management options	
		Form	Media		Form	Media	Benthos (including bottom feeding nekton)	Nekton/plankton	Humans (recreational contact)			Acute	Chronic	Maqrina construction (acute risk)	Marina operations (chronic risk)
61		Nutrients	Groundwater	Seepage to groundwater (offsite) and discharge to basin.	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when contiguous with river	y	n	y	See basin water management	None
62	Process water/surface water runoff from north of the site	Nutrients	Surface water												
63		Nutrients	Surface water	Direct surface water discharge to basin	Nutrients	Basin water	-	Eutrophication risk.	-	Risk only when contiguous with river - see river row Basin water will cease to be used for processing at the cessation of recycling facility activities north of the site.	y	n	y	See basin water management	Minimise input of ammonia to the basin by directly flow though treatment ponds.
64		Nutrients	Basin water	Direct water flow to river	Nutrients	River water	-	Eutrophication risk.	-	Risk only when contiguous with river	n	y	y	See basin water management	None
65		Nutrients	Basin water	Infiltration to groundwater	Nutrients	Groundwater	-	-	-	-	y	n	y	-	None
66	Georges River upstream of the site	Nutrients	River water												
67		Nutrients	River water	River flow	Nutrients	River water	-	Eutrophication risk.	-	-	y	n	y	-	None Current process unrelated to operation of the site
68	Georges River upstream of the site	Nutrients	River sediment												
69		Nutrients	River sediment	Formation of ammonia in the sediments from organic matter and diffusion to overlying water column	Nutrients	River water	-	Eutrophication risk.	-	-	y	n	y	-	None Current process unrelated to operation of the site
70	Overland flow during flooding	Dissolved metals and particulate bound metals	River water												
71		Nutrients	River water	River flow	Nutrients	River water	-	Eutrophication risk.	-	High organic loads may occur due to flooding and overflow of upstream sewage treatment plants	y	n	y	-	None Current process unrelated to operation of the site

1. Metals of concern:
   High risk: lead in sediment (high risk), total mercury in basin water (high risk)
   Medium risk: aluminium (groundwater), cadmium (groundwater), mercury (basin sediment), nickel (groundwater), zinc (basin water and groundwater)
   Low risk: aluminium (basin water), copper (basin sediment, basin water and groundwater), manganese (groundwater), zinc (basin water)
2. It is assumed that ammonia will occur predominantly as dissolved ammonia.
3. Nutrients measured as total nitrogen and total phosphorus.
4. PAH are expected to partition between the dissolved and particulate phases and are a toxicity risk. The same pathways and mechanisms are expected to occur as for metals. Measures to manage metals will also manage PAHs.

Table A.1 Contaminant pathways and management

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