APPENDIX L SITE AUDIT STATEMENTS

Site Audit Report
Stage 1 & 2, Little Bay Cove Development, Anzac Parade, Little Bay

Prepared for:

CHOF5 Little Bay Pty Ltd

Prepared by:
ENVIRON Australia Pty Ltd

Date:
September 2012

Project Number:
AS120833

Audit Number:
GN 388-1

ENVIRON

11 September 2012 Our Ref: AS120833

CHOF5 Little Bay Pty Ltd
c/o Charter Hall
Attn: Rajeev Sharma
GPO Box 2704
Sydney NSW 2001

Dear Rajeev

Re: Site Audit Report – Stage 1 & 2, Little Bay Cove Development, Anzac Parade, Little Bay

I have pleasure in submitting the Site Audit Report for the subject site. The Site Audit Statement, produced in accordance with the NSW Contaminated Land Management Act 1997, follows this letter. The Audit was commissioned by CHOF5 Little Bay Pty Ltd to assess the suitability of the site for its intended residential use.

The Audit was initiated to comply with terms of judgment of the Land and Environment Court, Appeal No. 10672 of 2009, dated 23 December 2009 and is therefore a statutory audit.

Thank you for giving me the opportunity to conduct this Audit. Please call me on 9954 8100 if you have any questions.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

Cc: EPA (Statement only)
Randwick City Council

ENVIRON Australia Pty Ltd, Level 3, 100 Pacific Highway, PO Box 560, North Sydney, NSW 2060, Australia
Tel: +61 2 9954 8100 Fax: +61 2 9954 8150

ACN 095 437 442
ABN 49 095 437 442

www.environcorp.com

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 May 2011. For more information about completing this form, go to Part IV.

PART I: Site audit identification

Site audit statement no. **GN 388-1**

This site audit is a **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: Graeme Nyland Company: ENVIRON Australia Pty Ltd

Address: Level 3, 100 Pacific Highway (PO Box 560)

North Sydney NSW Postcode: 2060

Phone: 02 9954 8100 Fax: 02 9954 8150

Site details

Address: 1406 – 1408 Anzac Parade, Little Bay, NSW

Postcode: 2036

Property description *(attach a list if several properties are included in the site audit)*

Part Lot 10 DP1127719 (excludes access road on northern boundary)

Proposed Lots 2-17, 45 and 46 (see attachment 1 included at end of Part 1 of Statement)

Local Government Area: Randwick City Council

Area of site (e.g. hectares): Approximately 5.9 ha

Current zoning: Zone 5 Special Uses

To the best of my knowledge, the site **is not** the subject of a declaration, order, agreement or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

Declaration/Order/Agreement/Proposal/Notice* no(s): N/A

Select as appropriate

Site audit commissioned by

Name: Mark Jacobs Company: CHOF5 Little Bay Pty Ltd

Address: GPO Box 2704, Sydney

Postcode: 2001

Phone: 8908 4060 Fax: 8908 4040

Name and phone number of contact person (if different from above)

Scott Stumbles T: +61 2 8908 4046 F: +61 2 8908 4040

Purpose of site audit

☒ A. To determine land use suitability *(please specify intended use[s])*

Mix of single dwelling houses, townhouses, apartments, public open space and roadways.

~~**OR**~~

~~☐ B(i) To determine the nature and extent of contamination, and/or~~

~~☐ B(ii) To determine the appropriateness of an **investigation/remedial action/management plan***, and/or~~

~~☐ B(iii) To determine if the land can be made suitable for a particular use or uses by implementation of a specified **remedial action plan/management plan*** *(please specify intended use[s])*~~

.....

Information sources for site audit

Consultancy(ies) which conducted the site investigation(s) and/or remediation

- Environmental Investigation Services (EIS).
- ENSR Australia Pty Ltd (ENSR now AECOM).
- AECOM Australia Pty Ltd (AECOM)
- Compaction & Soil Testing Services Pty Limited (CSTS)

Title(s) of report(s) reviewed:

- 'Report to University of NSW on Stage 1 Environmental Site Assessment for Proposed Site Redevelopment at 1408 Anzac Parade, Little Bay, NSW', dated December 2006 by Environmental Investigation Services (EIS).
- 'Report to University of NSW on Stage 2 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW', Draft dated February 2007 by EIS.
- 'Remediation Works Plan. 1406-1408 Anzac Parade, Little Bay NSW 2036', dated 2 February 2009 by ENSR Australia Pty Ltd (ENSR now AECOM).
- Letter Report '1406-1408 Anzac Pde Little Bay: Importation of Fill from UTS Broadway – Source Site Review', dated 2 August 2011 by AECOM.

Select as appropriate

- Letter Report '1406-1408 Anzac Pde Little Bay: Validation of Western Playing Fields' dated 9 August 2011 by AECOM.
- 'Virgin Excavated Natural Material (VENM) Classification Report University of Technology Sydney, ULTIMO NSW' dated 11 August 2011 by CSTS.
- 'Virgin Excavated Natural Material (VENM) Classification Report University of Technology Sydney, ULTIMO NSW' dated 15 August 2011 by CSTS.
- 'Stage 2 Environmental Site Assessment for Proposed New Broadway Building at Corner of Jones Street and Broadway, Ultimo, NSW' dated September 2011 by EIS
- Letter Report 'Supplementary Information: 1406-1408 Anzac Pde Little Bay: Validation of Western Playing Fields', dated 19 October 2011by AECOM.
- Letter Report 'Letter 05 – Post-Excavation Former Solarch Area Wall Validation – 1408 Anzac Parade, Little Bay NSW. Results from Inspection and Sampling Conducted along the Southern Wall of the Former Solarch Area on 6 October 2011', dated 20 October 2011 by AECOM.
- Letter Report 'Supplementary Information: 1406-1408 Anzac Pde Little Bay: Validation of Western Playing Fields', dated 12 January 2012 by AECOM.
- 'Supplementary Information: 1406-1408 Anzac Pde Little Bay: Validation of Marketing Suite and Associated Car Park Area' dated 16 January 2011 [sic 2012] by AECOM.
- 'Former Solarch Area Remediation and Base of Excavation Bedrock Validation and Validation Sampling – 1408 Anzac Parade, Little Bay NSW. Results from works conducted on 30 January 2012' dated 12 March 2012 by AECOM.
- 'Former Amenities Buildings, Beneath Building Footprint, Characterisation and Validation Sampling – 1408 Anzac Parade, Little Bay NSW. Results from works conducted on 29 and 31 March 2012' dated 24 April 2012 by AECOM.
- 'Letter 02 Former Solarch Stockpile Characterisation and Validation - 1408 Anzac Parade, Little Bay NSW. Results from Inspection and Sampling Conducted within former Solarch Area on 13 April 2012' dated 1 May 2012 by AECOM.
- 'Former Caretaker's Cottage Beneath Building Footprint Characterisation and Validation Sampling – 1408 Anzac Parade, Little Bay NSW. Results from Works Conducted on 16 March 2012', dated 1 May 2012 by AECOM.
- 'Little Bay Western Portion of Site – Stage 1 and 2 Summary of Works' dated 11 July 2012 by AECOM.
- 'Letter 03 – Former Solarach and Solarch Access Road Validation – 1408 Anzac Parade, Little Bay NSW. Results from Inspection and Sampling Conducted within former Solarch Area (Proposed Lot 7) on 27 and 29 June 2012', dated 16 July 2012.
- 'Letter 04 - Imported Topsoil Characterisation and Validation. Marketing Suite Proposed Lot 6 - 1408 Anzac Parade, Little Bay NSW', dated 27 August 2012 by AECOM.

Other information reviewed (including previous site audit reports and statements relating to the site)

- 'Site Audit Report - UNSW Little Bay', and Site Audit Statement GN336 (Section B) dated 6 July 2007, ENVIRON Australia (ENVIRON).
- 'Interim Advice Letter – Remedial Action Plan – Little Bay' dated 5 February 2009 by ENVIRON.
- 'Interim Advice Letter No. 2 – Western Playing Fields, 1406-1408 Anzac Parade, Little Bay' dated 9 February 2012 by ENVIRON.

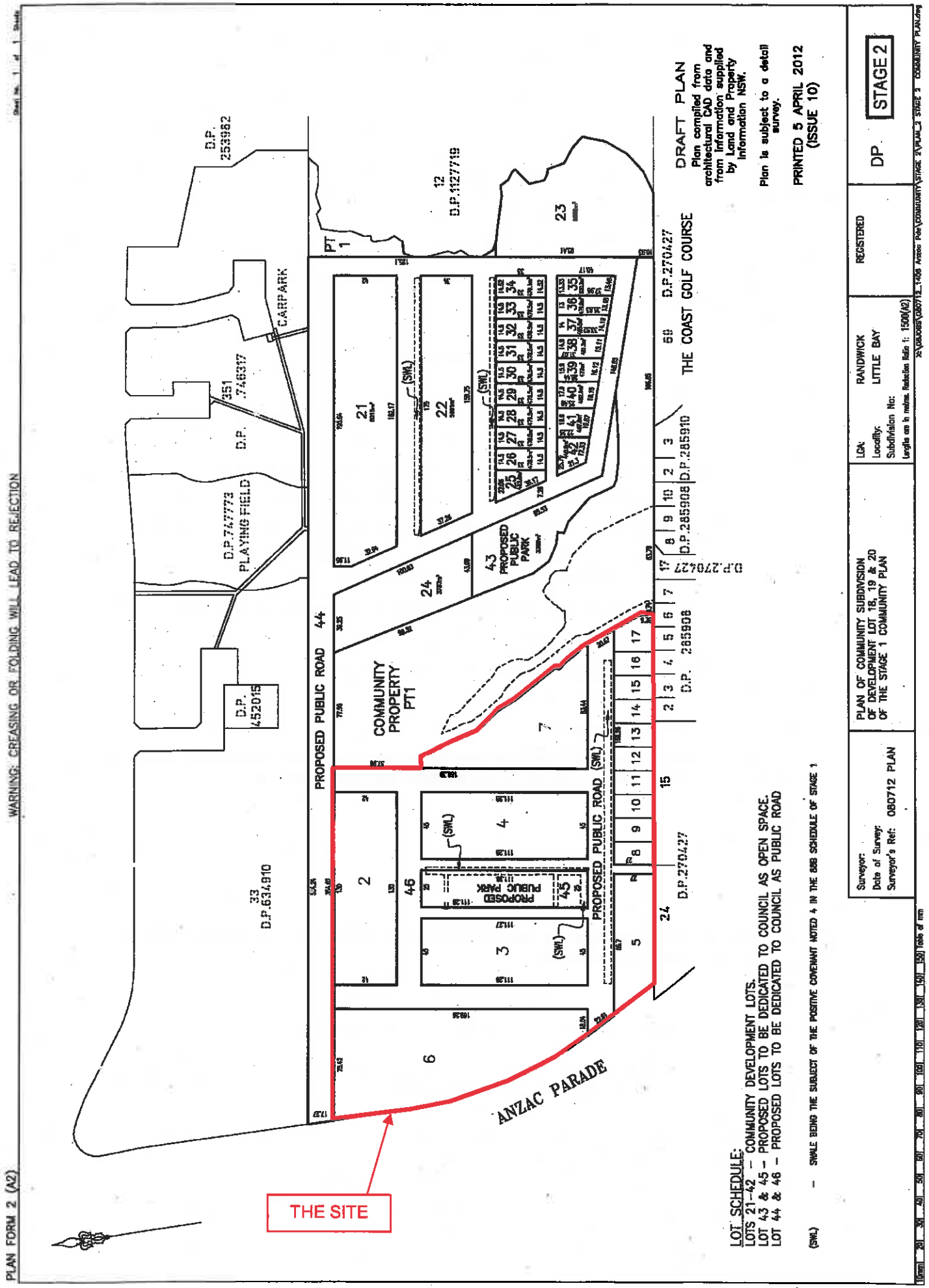
Select as appropriate

Site audit report

Title:... Site Audit Report – Stage 1 and 2, Little Bay Cove Development, Anzac Parade, Little Bay

Report no. GN 388-1 (ENVIRON Ref: AS120833) Date: September 2012

Select as appropriate


PLAN FORM 2 (A2)
WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION
DRAFT PLAN
Plan compiled from architectural CAD data and from information supplied by Land and Property Information NSW.
Plan is subject to a detail survey.
PRINTED 5 APRIL 2012 (ISSUE 10)
PLAN OF COMMUNITY SUBDIVISION OF DEVELOPMENT LOT 18, 19 & 20 OF THE STAGE 1 COMMUNITY PLAN
DP STAGE 2
REGISTERED
LGA: RANDWICK
Locality: LITTLE BAY
Subdivision No:
Surveyor:
Date of Survey:
Surveyor's Ref: 080712 PLAN
THE COAST GOLF COURSE
D.P.270427
D.P.285908
D.P.285910
D.P.747773 PLAYING FIELD
D.P. 746317
D.P. 253982
D.P. 452015
D.P.634910
D.P.1127719
CARPARK
PROPOSED PUBLIC ROAD
PROPOSED PUBLIC ROAD
COMMUNITY PROPERTY PT1
PROPOSED PUBLIC PARK
ANZAC PARADE
THE SITE
LOT SCHEDULE:
LOTS 21-42 - COMMUNITY DEVELOPMENT LOTS.
LOT 43 & 45 - PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS OPEN SPACE.
LOT 44 & 46 - PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS PUBLIC ROAD
(SWL) - SWALE BEING THE SUBJECT OF THE POSITIVE COVENANT NOTED 4 IN THE 88B SCHEDULE OF STAGE 1

PART II: Auditor's findings

Please complete either Section A or Section B, **not** both. *(Strike out the irrelevant section.)*

Use Section A where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land use(s).

Use Section B where the audit is to determine the nature and extent of contamination and/or the appropriateness of an investigation or remedial action or management plan and/or whether the site can be made suitable for a specified land use or uses subject to the successful implementation of a remedial action or management plan.

Section A

☒ **I certify that, in my opinion, the site is SUITABLE for the following use(s)** *(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)* .....~~

~~**subject to compliance with the following environmental management plan** *(insert title, date and author of plan)* **in light of contamination remaining on the site: ...**~~

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...

The site is the western portion of the Little Bay Cove development.

The Audit was initiated to comply with terms of judgment of the Land and Environment Court, Appeal No. 10672 of 2009, dated 23 December 2009.

Condition 77 of the judgment requires the remediation and validation works to be carried out in accordance with "Interim Advice Letter – Remedial Action Plan – Little Bay" dated 5 February 2009 prepared by the Auditor. In the Auditor's opinion, remediation and validation works were undertaken in accordance with the remedial action plan.

Condition 79 of the judgment requires the Site Audit Statement to clearly state the source of the standard adopted where no guideline made or approved under the NSW Contaminated Land Management Act is available. This does not apply to this site.

~~Section B~~

Purpose of the plan[1] which is the subject of the audit ...

I certify that, in my opinion:

- ☐ **the nature and extent of the contamination HAS/HAS NOT* been appropriately determined**

AND/OR

- ☐ **the investigation/remedial action plan/management plan* IS/IS NOT* appropriate for the purpose stated above**

AND/OR

- ☐ **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)* .....

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if the site is remediated/managed* in accordance with the following remedial action plan/management plan* *(insert title, date and author of plan)*

...

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subject to compliance with the following condition(s):

...

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[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

Select as appropriate

~~**Overall comments**~~

...

PART III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority under the *Contaminated Land Management Act 1997* (Accreditation No. 9808).

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... 11/9/2012

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 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 contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remedial action or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use(s) of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A or Section B of Part II, **not** both.

In **Section A** the auditor may conclude that the land is *suitable* for a specified use(s) 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 remediation or investigation of the site was needed to render the site fit for the specified use(s). Any **condition** imposed should be limited to implementation of an environmental management plan to help ensure the site remains safe for the specified use(s). The plan should be legally enforceable: for example a requirement of a notice under the *Contaminated Land Management Act 1997* (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*.

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.

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 whether land can be made suitable for a particular land use or uses upon implementation of a remedial action or management 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.

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.

In **Part III** the auditor certifies his/her 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:

Environment Protection Authority
Contaminated Sites Section
PO Box A290, SYDNEY SOUTH NSW 1232
Email: nswauditors@environment.nsw.gov.au

AND

the **local council** for the land which is the subject of the audit.

Contents

List of Tables and Figures

List of Appendices

List of Abbreviations

AECOM	AECOM Australia Pty Ltd
AHD	Australian Height Datum
ALS	Australian Laboratory Services
ASET	Australian Safer Environment and Technology Pty Ltd. (Laboratory)
ANZECC	Australian and New Zealand Environment and Conservation Council
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes (Monocyclic Aromatic Hydrocarbons)
CN	Cyanide (total or free)
DP	Deposited Plan
DQO	Data Quality Objectives
EIS	Environmental Investigation Services
ENSR	ENSR Australia Pty Ltd (now AECOM)
EPA	Environment Protection Authority (NSW)
ESA	Environmental Site Assessment report
ESBS	Eastern Suburbs Coastal Banksia Scrub
ha	Hectare
km	Kilometres
LOR	Limit of Reporting
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Fe: Iron, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury, Se: Selenium
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
mbgl	Metres below ground level
µg/L	Micrograms per Litre
NATA	National Association of Testing Authorities
NA	Not Analysed or Not Available
NC	Not Calculated
ND	Not Detected
ng/L	Nanograms per Litre
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
n	Number of Samples
OCPs	Organochlorine Pesticides
OH&S	Occupational Health & Safety
OPPs	Organophosphorus Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PID	Photoionisation Detector
PQL	Practical Quantitation Limit
pH	a measure of acidity, hydrogen ion activity
QA/QC	Quality Assurance/Quality Control
RAP	Remediation Action Plan
RPD	Relative Percent Difference
RWP	Remedial Work Plan
SILs	Soil Investigation Levels
TPHs	Total Petroleum Hydrocarbons
TV	Trigger Value
UCL	Upper Confidence Limit
UNSW	University of New South Wales
VENM	virgin excavated natural material
VOCs	Volatile Organic Compounds
-	On tables is "not calculated", "no criteria" or "not applicable"

1 Introduction

A site contamination audit has been conducted in relation to the redevelopment of a property at 1406-1408 Anzac Parade, Little Bay, NSW (Attachment 1, Appendix A). This audit report relates to Stages 1 and 2 of the Little Bay Cove development in the western portion of the property.

The audit was conducted to provide an independent review by an EPA Accredited Auditor of whether the land is suitable for any specified use or range of uses i.e. a "Site Audit" as defined in Section 4 (1) (b) (iii) of the NSW *Contaminated Land Management Act 1997* (the CLM Act).

Details of the audit are:

Requested by:	Mark Jacobs on behalf of CHOF5 Little Bay Pty Ltd
Request/Commencement Date:	28 March 2008
Auditor:	Graeme Nyland
Accreditation No.:	9808

The scope of the audit included:

- Review of the following reports:
  - 'Report to University of NSW on Stage 1 Environmental Site Assessment for Proposed Site Redevelopment at 1408 Anzac Parade, Little Bay, NSW', dated December 2006 by Environmental Investigation Services (EIS).
  - 'Report to University of NSW on Stage 2 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW', Draft dated February 2007 by EIS.
  - 'Remediation Works Plan. 1406-1408 Anzac Parade, Little Bay NSW 2036', dated 2 February 2009 by ENSR Australia Pty Ltd (ENSR now AECOM).
  - Letter Report '1406-1408 Anzac Pde Little Bay: Importation of Fill from UTS Broadway – Source Site Review', dated 2 August 2011(a) by AECOM.
  - Letter Report '1406-1408 Anzac Pde Little Bay: Validation of Western Playing Fields' dated 9 August 2011(b) by AECOM.
  - 'Virgin Excavated Natural Material (VENM) Classification Report University of Technology Sydney, ULTIMO NSW' dated 11 August 2011 by CSTS.
  - 'Virgin Excavated Natural Material (VENM) Classification Report University of Technology Sydney, ULTIMO NSW' dated 15 August 2011 by Compaction and Soil Testing Services (CSTS).

– 'Stage 2 Environmental Site Assessment for Proposed New Broadway Building at Corner of Jones Street and Broadway, Ultimo, NSW' dated September 2011 by EIS.

– Letter Report 'Supplementary Information: 1406-1408 Anzac Pde Little Bay: Validation of Western Playing Fields', dated 19 October 2011(c) by AECOM.

– Letter Report 'Letter 05 – Post-Excavation Former Solarch Area Wall Validation – 1408 Anzac Parade, Little Bay NSW. Results from Inspection and Sampling Conducted along the Southern Wall of the Former Solarch Area on 6 October 2011', dated 20 October 2011(d) by AECOM.

– Letter Report 'Supplementary Information: 1406-1408 Anzac Pde Little Bay: Validation of Western Playing Fields', dated 12 January 2012 by AECOM.

– 'Supplementary Information: 1406-1408 Anzac Pde Little Bay: Validation of Marketing Suite and Associated Car Park Area' dated 16 January 2011 [sic 2012] by AECOM.

– 'Former Solarch Area Remediation and Base of Excavation Bedrock Validation and Validation Sampling – 1408 Anzac Parade, Little Bay NSW. Results from works conducted on 30 January 2012' dated 12 March 2012 by AECOM.

– 'Former Amenities Buildings, Beneath Building Footprint, Characterisation and Validation Sampling – 1408 Anzac Parade, Little Bay NSW. Results from works conducted on 29 and 31 March 2012' dated 24 April 2012 by AECOM.

– 'Letter 02 Former Solarch Stockpile Characterisation and Validation - 1408 Anzac Parade, Little Bay NSW. Results from Inspection and Sampling Conducted within former Solarch Area on 13 April 2012' dated 1 May 2012 by AECOM.

– 'Former Caretaker's Cottage Beneath Building Footprint Characterisation and Validation Sampling – 1408 Anzac Parade, Little Bay NSW. Results from Works Conducted on 16 March 2012', dated 1 May 2012 by AECOM.

– 'Little Bay Western Portion of Site – Stage 1 and 2 Summary of Works' dated 11 July 2012 by AECOM.

– 'Letter 03 – Former Solarach and Solarch Access Road Validation – 1408 Anzac Parade, Little Bay NSW. Results from Inspection and Sampling Conducted within former Solarch Area (Proposed Lot 7) on 27 and 29 June 2012', dated 16 July 2012 by AECOM.

– 'Letter 02 – Post-Remediation Base of Excavation Validation Stage 2, Proposed View Street (Former Solarch Access Road)- 1408 Anzac parade, Little Bay NSW. Results from Validation Inspection and Sampling Conducted on 17 July 2012', dated 09 August 2012 by AECOM.

– 'Letter 03 – Post Remediation base of Excavation Validation Stage 3 Miocene Protected Area – 1408 Anzac parade, Little Bay NSW', dated 9 August 2012 by AECOM.

  - 'Letter 04 - Imported Topsoil Characterisation and Validation. Marketing Suite Proposed Lot 6 - 1408 Anzac Parade, Little Bay NSW', dated 27 August 2012 by AECOM.

- A review of monthly reports prepared by AECOM.
- Site visits on 27 March 2008, 7 July 2011, 1 September 2011, 6 June 2012 and 28 August 2012.
- Discussions with ENSR/AECOM who undertook the investigations and remediation.

Separate Site Audit Reports (SAR) and Site Audit Statements (SAS) are to be prepared for the eastern and western portions of the site. The area considered in this SAR is shown as Stages 1 and 2 in Attachment 2, Appendix A.

The Auditor previously prepared 'Site Audit Report UNSW, Little Bay' and a Section B SAS (GN 336 dated 6 July 2007) for the entire site. Following receipt of a remedial action plan (RAP), the Auditor prepared 'Interim Advice Letter – Remedial Action Plan – Little Bay' dated 5 February 2009 and concluded that "...implementation of the RWP [remedial work plan] would render the site suitable for residential development subject to suitable and successful validation of the excavation base and imported material..." and a number of other measures. The Interim Advice Letter (IAL) is attached as Appendix D. The development was approved by a land and Environment Court order. Conducting of remediation and validation works in accordance with the Interim Advice Letter was a condition of the judgment.

Following bulk earthworks in the western playing fields (removal of grass and topsoil from the fields, and removal of the synthetic hockey pitch) an IAL dated 9 February 2012 concluded that '…no further remedial works are required in the validated areas (which excludes the former Solarch compound and existing buildings) to ensure that the site is suitable for the proposed residential and open space uses'. Relevant information from that IAL which was essentially a progress report is included in this SAR.

The remedial works proposed in the RAP for the Solarch area and validation of the building footprints have now been implemented.

2 Site Details

2.1 Location

The site locality is shown on Attachment 1, Appendix A.

The site details are as follows:

Street address:	1406-1408 Anzac Parade, Little Bay, NSW, 2036
Identifier:	Part Lot 10 DP1127719. The draft lot and DP numbers include development lots 2 to 17, the 'Proposed Public Park (Lot 45) and proposed roadways (Lot 46)' (Attachment 3, Appendix A)
Local Government:	Randwick City Council
Owner:	CHOF5 Little Bay Pty Ltd
Site Area:	Approximately 5.9 ha

2.2 Zoning

The current zoning of the site is Zone 5 Special Uses under the Randwick Local Environmental Plan 1998. It is understood that this zoning allows for residential uses.

2.3 Adjacent Uses

The site is located within an area of residential and open space uses. The surrounding land uses include:

- North - Medium density housing development, beyond which is the Long Bay Correctional Facility.
- East – The eastern portion of 1406-1408 Anzac Parade, consisting of a drainage channel with two dams, an Aboriginal and geological heritage area, a former landfill and former University facility (UNSW Biological Services Compound). Beyond this, is area of protected Eastern Suburbs Coastal Banksia Scrub (ESBS) consisting of 1 to 3 m tall vegetation and The Coast Golf Course, beyond which is Little Bay and the Pacific Ocean.
- South - A low to high density residential subdivision that was formerly the Prince Henry Hospital. The hospital site was remediated for the presence of asbestos as fibres within the sands.
- West - Anzac Parade, beyond which is residential housing.

The area to the east of the site (i.e. the eastern portion of 1406-1408 Anzac Parade) was previously used as a landfill. The area is a potential source of contamination, however is currently undergoing remediation.

Nearby sensitive receptors include:

- Residential properties to the north, south and west.

- A drainage channel with two dams located to the east of the site.
- The Aboriginal and geological heritage area to the east of the site.
- Little Bay and the Pacific Ocean to the east of the site.

2.4 Site Condition

The site extends from Anzac Parade in the west to the former UNSW Solarch compound in the east. A sandstone plateau extends from Anzac Parade along the eastern edge of the former UNSW Solarch compound and the eastern edge of the Western Playing Fields. A sandstone ridgeline was present in the west of the site.

Prior to demolition and remediation works, the site was described by EIS (2006) as follows:

- A landscaped area was present along the western boundary.
- An asphalt paved car park, single storey office, club house and amenities buildings were located in the west of the site.
- Caretakers brick cottage was present in the north western corner.
- A synthetic surfaced hockey field and sports fields in the centre of the site.

During the site visit by the Auditor on 1 September 2011, the following was noted:

- The synthetic surfacing had been removed and top soil stripped from the sports fields.
- The buildings and asphalt car park had been retained.

During the site visit on 6 June 2012, the following was noted:

- The asphalt paved car park was still present however all other buildings and surfaces had been removed. Concrete had also been broken up and the topsoil stripped and placed in stockpiles for future use. Asphalt material sourced from under the hockey fields was stockpiled on-site and is understood to be used under the road surfaces.
- Most fill material had been removed and either disposed off-site or transported to the east for further remediation. A buffer zone adjacent along the eastern boundary had been retained. Fill extended approximately 5 m onto the site under this proposed pathway. A section of the adjoining site is raised above the current site and contained pieces of loose asbestos.
- VENM had been imported and spread over the surface of the former Western Playing Fields with the depth decreasing from west (approximately 2.5 m) to east (0 m). VENM was not placed in areas designated for future buildings and basement car parking. A stockpile of sandstone boulders sourced from the VENM was stockpiled on-site.
- A marketing suite has been erected within the western boundary, to the south of the former amenities building.

During the site visit on 28 August 2012, it was noted:

- The site was active. Some subsurface services had been installed and trenching was being conducted. Concrete parking bay slabs had been laid along the sides of some of the proposed roads.

- Roads had been formed and compacted. Pavement material had not been placed.
- Development lots were generally near their finished levels, in some places lower than the roads to allow for basement construction. Surfaces were uncompacted soil or covered with mulch. There were a number of stockpiles of topsoil, aggregate and sand.
- No indications of contamination were seen, but the surface in places contained discarded construction material, pieces of debris such as steel, pipe, brick, and some general litter such as drink cans and bottles.
- Fill material had been removed from the eastern boundary. Fill material had also been removed from the adjoining central corridor area, which was at a lower elevation than the site.
- The north eastern corner had been filled with VENM.

2.5 Proposed Development

It is understood that the site is to be redeveloped with a mix of single dwelling houses, townhouses, apartments, open space and roadways.

For the purposes of this audit, the 'residential with soil access' land use scenario will be assumed.

3 Site History

EIS (2006) provided a site history based on aerial photographs, Council Records, Certificates of Title, WorkCover Database Records and NSW EPA records. The site history is summarised in Table 3.1. The site layout prior to the commencement of development is shown on Attachment 4.

Table 3.1: Site History

Date	Activity
1881 - 1940	Hospital uses however the aerial photographs do not indicate that any buildings were located on the site and indicate that the site was used for paddocks and cultivated land for the hospital.
1940 - 1959	Sand mining 'in the vicinity of the hospital site'.
1959 - 1960	Site subdivided and granted to UNSW.
1960 - 1979	Some land filling conducted on the site and adjacent areas. The site is listed under Randwick Council Unhealthy Building Land Policy Golf tee and green facilities constructed to the east.
1979 - 1992	The UNSW developed sport field facilities in 1979. The caretakers cottage and office/amenities building were constructed in 1987.
1992 - 2007	The sport fields were redesigned and the synthetic hockey pitch installed in 1992. The Solarch building was constructed in 1992/1993.
2007 - 2011	The Solarch building was demolished in 2007 Demolition of the hockey field was undertaken in June 2011. The caretakers cottage and office/amenities building were demolished in 2012.

EIS (2006) provided a brief history of the adjoining Prince Henry Hospital on the southern side of the site, indicating that it was assigned for hospital uses in 1881. Hospital buildings and a cemetery were constructed over the 10 years from 1881 to 1891.

Correspondence with Council indicates that the landfill to the east of the site was filled with non-putrescible waste however detailed records were not kept and the EPA sent a contradictory letter. The consistency and sources of these wastes is also unknown. The lack of available detail has been considered in the review of sample density and the results of the intrusive investigations.

The topography of the site indicates that some filling has occurred to level and build up some minor sections of the site.

The summary of the site history provided by EIS indicates that the site has been used by UNSW for the past 50 years, prior to which it was used for cultivation.

In the Auditor's opinion, the site history provides an adequate indication of past activities to determine potentially contaminating activities. There are inherent uncertainties in the contents of the landfill.

4 Contaminants Of Concern

EIS provided a discussion on the general contamination processes in Sydney and the potential site specific contamination. These have been tabulated in Table 4.1.

Table 4.1: Contaminants of Concern

Area	Activity	Potential Contaminants
Whole site	General history of contamination in Sydney	Lead, copper and zinc
	Filling	Unknown however could include metals, petroleum hydrocarbons, PAHs and asbestos.
Playing Fields	Spraying of pesticides	OCPs

The Auditor considers that the analyte list used by EIS and AECOM is adequately reflected in the analytical suite used.

ENSR (2009) also note that fill has been contaminated by heavy metals, petroleum hydrocarbons, PAHs, asbestos containing materials, methane gas and general waste and demolition materials.

5 Stratigraphy and Hydrogeology

Following a review of the referenced reports, a summary of the site stratigraphy and hydrogeology was compiled as follows.

5.1 Stratigraphy

EIS (2006) indicated that the 1:100,000 geological map of Sydney (Map 9130) indicated that the site is underlain by Triassic Hawkesbury Sandstone and Quaternary deposits of sand, gravel, silt and clay.

Initial characterisation of the stratigraphy of the site by EIS, especially with respect to fill composition, was limited as augers and SPTs were used to investigate the site. The stratigraphy of the site prior to remediation is summarised in Table 5.1.

Table 5.1: Stratigraphy

Depth (mbgl)	Stratigraphy
0 to 1.0	Fill: Silty sand with some sandstone gravel and root fibres, ranging in depth from 0.1 mbgl to 3.2 mbgl. Fill material beneath the playing fields was typically thin (<1 m) and did not contain anthropogenic material. Fill material beneath the synthetic hockey pitch consisted of gravel fill containing sandstone boulders and sandstone. Fill material at the western boundary consisted mainly of silty sand fill (to approximately 0.3 m) over natural sands and sandstone.
1.0 - depth	Sandstone. The depth to sandstone was typically approximately 1 mbgl, however ranged between 0.05 m and greater than 4.5 mbgl.

5.2 Hydrogeology

EIS (2006) identified one registered groundwater bore within 500 m of the site. The bore was used for domestic purposes and located approximately 400 m to the south of the site. A search of registered groundwater bores within 500 m of the site by the Auditor identified 4 registered bores for domestic use. One bore installed to 6 mbgl was located 400 m to the south of the site (SWL not provided). Three bores were located 300 to 400 m to the west of the site. They were installed to between 4 and 6.1 mbgl. The SWL was provided for only one bore (2.8 mbgl).

EIS estimate that the groundwater is perched within the fill and joints in the sandstone rather than being a ‘significant water bearing aquifer’. Water was not encountered during borehole drilling by EIS (2006 & 2007).

EIS installed 3 groundwater monitoring wells (MW357, MW361 and MW366) near the eastern boundary of the site (Attachment 5, Appendix 1) and undertook a monitoring round in February 2007. The hydrogeology is summarised in Table 5.2.

Table 5.2: Site-Specific Hydrogeology	
Aspect	**Details**
Depth to Water	The standing water level (SWL) was 3.6 mbgl in MW357, 5.3 mbgl in MW361 and 2.9 mbgl in MW366. The SWLs indicate that groundwater was present in sandstone. The groundwater elevation was 34.6 m Australian Height Datum (AHD) in MW357, 32.5 mAHD in MW361 and 32.5 mAHD in MW366.
Phase Separated Hydrocarbon (presence and thickness)	Not identified.
Hydraulic Parameters (gradient, conductivity, porosity, seepage velocity)	Not determined due to the limited monitoring well coverage on the site. Monitoring wells were purged dry and groundwater recharge was observed to be slow.
Interpreted Flow Direction	Not determined due to the limited monitoring well coverage on the site. Estimated by EIS (2007) to be to the east towards the dams and Little Bay.
Groundwater Quality (redox, EC, pH and DO)	Groundwater was typically slightly acidic (pH 4.2-5.4), low conductivity (450-754 µS/cm) and anaerobic (DO 0.5-2.5 ppm).

6 Evaluation of Quality Assurance and Quality Control

The Auditor has assessed the overall quality of the investigation data by review of the information presented in the referenced reports, supplemented by field observations. Remediation and validation data quality is discussed in Section 10.

The Auditor's assessment follows in Tables 6.1 and 6.2.

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
Data Quality Objectives	EIS (2007) defined specific DQOs in accordance with the seven step process outlined in DEC (2006). These were considered appropriate for the investigations conducted. The Stage 1 investigation by EIS (2006) defined DQOs, however they were not in accordance with DEC (2006).
Sampling Pattern and Locations	**Soil:** Investigation locations were spaced to gain coverage of the majority of the site. The various fill materials at the site were targeted for sampling. In the Auditor's opinion these investigation locations adequately target the main areas of concern. **Groundwater:** Monitoring wells were concentrated in the eastern portion of the site. The wells are on the down gradient boundary of the site. No up gradient well was installed.
Sampling Density	**Soil:** The sampling density was approximately the minimum recommended by EPA (1995) 'Sampling Design Guidelines'. Over most the site the spacing was approximately 30-40 m. The hockey field was excluded. The hotspot diameter is large; however, the heterogeneous nature of the fill material is unlikely to be better characterised by a higher sampling density. **Groundwater:** Three groundwater wells were installed at the site. The density is low, however the wells were installed on the down gradient boundary of the playing fields and did not identify significant groundwater contamination. The groundwater monitoring well density is therefore considered adequate.
Sample depths	Soil samples were collected and analysed from a range of depths depending on the stratigraphy. The primary intervals being surface (0-0.1 m), shallow fill (0.3-0.5 mbgl) and natural material (around 1 mbgl). In the Auditor's opinion, this sampling strategy was appropriate and adequate to identify the primary material and contaminant types present on site.
Well construction	The groundwater monitoring wells (MW357, MW361 and MW366) were completed at between 6 and 7 m depth, and were constructed of 55 mm diameter PVC tubing. The screen intervals were 3 m long over sandstone and placed in a sand filter pack. The Auditor considers this to be adequate.

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
Sample Collection Method	**Soil**: The soil investigation was undertaken using a drill rig, hand auger or excavator. EIS noted that sample collection during drilling was via SPT split spoon or directly from solid stem augers when conditions did not allow use of the SPT sampler. Samples were collected directly from hand augers or the excavator bucket during test pitting. Collecting samples directly from augers is not ideal as it can result in loss of volatiles and sample cross contamination. Given the key contaminants at the site are generally not volatile, this deficiency is not considered to be of great significance. **Groundwater**: Wells were installed by solid stem augers, developed with a submersible pump and samples were collected by low flow pump with dedicated sample tubing. This is considered by the Auditor to be adequate.
Decontamination Procedures	**Soil**: Sampling equipment was cleaned with a solution of potable water and detergent, followed by a rinse in potable water prior to sampling and between sampling events to prevent cross contamination. New gloves were reportedly used for each new sample. **Groundwater**: The submersible pump used to develop the wells was reportedly decontaminated between locations. Dedicated sampling equipment was used for each well. New gloves were reportedly used for each new sample.
Sample handling and containers	Samples were placed into prepared and preserved sampling bottles provided by the laboratory and chilled during storage and subsequent transport to the labs.
Chain of Custody	Completed chain of custody forms were provided in the reports and appeared to be complete.
Detailed description of field screening protocols	Field screening for volatiles was undertaken using a PID. PID screening involved partly filling a glass jar with a soil sample and measuring VOCs in the headspace after allowing time for equilibration. PID readings are provided on borehole logs or in the text. Readings were generally 0 ppm. The highest PID concentration recorded was 0.7 ppm. Groundwater field parameters were measured during well sampling and development.
Calibration of field equipment	The reports indicated that calibration of the PID had been undertaken prior to use. Calibration certificates were provided for the Stage 2 investigation (EIS, 2007), however were not provided for the Stage 1 investigation (EIS, 2006). Given that PID readings were consistently low during both investigations, this is considered adequate. Groundwater quality meters were reported to have been calibrated prior to the start of each day. Field sheets were

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	provided.
Sampling Logs	Soil logs are provided within the report, indicating sample depth, PID readings and lithology. Groundwater field sampling records showing field parameters and standing water level were provided.

Table 6.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Auditor Comments**
Field quality control samples	During the EIS (2006) Stage 1 investigation only intra-laboratory duplicates were undertaken. During the Stage 2 investigation field quality control samples including trip spikes, rinsate blanks, field blanks, intra-laboratory and inter-laboratory duplicates were undertaken. Trip blanks were not analysed during either investigation. This was not considered to affect the usability of the data since no volatile compounds (including BTEX and TPH C_6-C_9) were detected in the soil samples analysed.
Field quality control results	The results from field quality control samples were generally within appropriate limits. RPDs for the intra- and inter- (Stage 2 only) laboratory soil duplicate samples were outside of the control limits for analytes detected significantly above the PQL (metals and PAHs). EIS attributed this to the heterogeneous nature of the fill material. Benzo(a)pyrene and chrysene were detected in a sand field blank. EIS (2007) indicated the detections may be a result of the source of the sand (building materials supplier). Zinc was detected in a water field blank. The soil rinsate blank concentrations were less than the PQL. Low level metals concentrations (zinc and copper) were found in the water rinsate blanks, however were not considered significant by EIS. The trip spike recovery was within the control limits. The Auditor considers the results of field quality control samples to be acceptable.
NATA registered laboratory and NATA endorsed methods	Laboratories used included: Envirolab Service Pty ltd (Envirolab) and SGS Australia Pty Ltd (SGS). Laboratory certificates were NATA stamped.
Analytical methods	Analytical methods were included in the laboratory test certificates.
Holding times	Review of the COCs and laboratory certificates indicate that the holding times had been met by the primary laboratory. EIS

Table 6.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Auditor Comments**
	(2006 and 2007) also reported that holding times have been met.
Practical Quantitation Limits (PQLs)	PQLs were less than the threshold criteria for the contaminants of concern.
Laboratory quality control samples	Laboratory quality control samples including laboratory control samples, matrix spikes, surrogate spikes, blanks and duplicates were undertaken by the laboratory at appropriate frequencies.
Laboratory quality control results	The recovery of one surrogate spike for TPH/PAHs/zinc/ammonia for one sample each was 'not available due to significant background levels of analyte in the sample'. A high spike recovery of lead (162%) was reported. The laboratory notes that this is due to the non homogeneous nature of the sample for this particular element. The laboratory duplicates were elevated for metals (maximum of 58% for copper) and PAHs (maximum of 120%). Low concentrations were reported in the primary and duplicate samples. EIS noted that RPDs for copper and PAH in separate samples were higher than generally accepted. Envirolab noted that the elevated RPDs were accepted due to non-homogeneous nature of the sample. The Auditor notes that results for PAHs and duplicates and descriptions of tar residues do indicate that the soils are non-homogeneous. There were no tar residues in site soils and the QA/QC was undertaken for the larger site that included a landfill. The results from all other laboratory quality control samples were within appropriate limits.
Data Quality Indicators and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	EIS did not define DQIs and did not undertake a formal QA/QC data evaluation against the five category areas. They did, however, conclude that "the QA/QC data including the RPD results are considered to meet the Data Quality Objectives developed for this project".

In considering the data as a whole the Auditor concludes that:

- The data is considered to be complete.
- There is a high degree of confidence that data is comparable for each sampling and analytical event. The consultant and laboratory were consistent between the Stage 1 and Stage 2 investigations.
- The data is considered to be representative of the fill and natural material on the site.
- The primary laboratory provided sufficient information to conclude that data is of sufficient precision.
- The data is considered to be accurate.

7 Environmental Quality Criteria

7.1 Soil

The Auditor has assessed the soil data provided by EIS and AECOM in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW (SIL Column 1 – 'residential with gardens and accessible soil' and the Column 5 'provisional phytotoxicity') in DEC *Guidelines for the NSW Site Auditor Scheme* (2006). EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing TPH and BTEX results.

The ENSR (2009) RWP references SIL Column 3 – 'recreational open space' for open spaces including the central corridor sensitive areas, Column 5 'provisional phytotoxicity' for surface soils only, Column 4 – 'commercial industrial' for roadway areas and SIL Column 1 'residential with access to soil' and Column 2 'residential with minimal access to soil' for the relevant residential developments.

Imported fill has been assessed in relation to attributes expected of virgin excavated natural material (VENM). The NSW DECC (July 2009) *Waste Classification Guidelines, Part 1: Classifying Waste* classifies VENM as "…natural material

- 'that has been excavated or quarried from areas that are not contaminated with manufactured chemicals or process residues, as a result of industrial, commercial, mining or agricultural activities, and
- 'that does not contain sulphidic ores or soils, and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA gazettal notice."

On this basis, the Auditor considers that for soil to be classified as VENM, the following criteria generally apply:

- Organic compounds (including petroleum hydrocarbons, PAHs, OCPs, PCBs, Phenols) should be less than the LORs; and
- Inorganic compounds should be consistent with background concentrations.

The Auditor has considered the need for remediation based on the 'aesthetic' contamination as outlined in the NEPM (1999) Schedule B(1) *Guideline on the Investigation Levels for Soil and Groundwater* that states that 'there are no numeric Aesthetic Guidelines but the fundamental principle is that the soils should not be discoloured, malodorous (including when dug over or wet) nor of abnormal consistency. The natural state of the soil should be considered'.

There are no national or EPA approved guidelines for asbestos in soil relating to human health. DEC (2006) state that Auditors must exercise their professional judgement when assessing whether a site is suitable for a specific use. The DEC states that the position of the Health Department is that there should be no asbestos in surface soil.

7.2 Groundwater

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for marine waters. Trigger values (TVs) provided are concentrations that, if exceeded, indicate a potential environmental problem and 'trigger' further investigation. It is not clear whether groundwater flows to the dams to be used as irrigation water over the golf course or to Little Bay. For the purpose of assessing groundwater analytical results the marine TVs were adopted.

Low reliability ANZECC (2000) TVs have been used where they exist for the individual PAHs (Appendix B). However, a trigger level for total PAHs within groundwater is not provided within the ANZECC (2000) guidelines. As such, the threshold level of 3 µg/L from the EPA (1994) *Guidelines for Assessing Service Station Sites* has been adopted.

There are no reliable Australian criteria for TPH in groundwater. The current NSW EPA position is that there should be no free phase product in groundwater, and that the aromatic components of dissolved-phase TPH in groundwater should be assessed using the ANZECC (2000) TVs where available. These guidelines include criteria for some BTEX compounds and for some polycyclic aromatic hydrocarbons.

8 Evaluation of Soil Analytical Results

The results below only include those obtained by EIS during the Stage 1 and Stage 2 Investigations.

Soil samples were analysed for a variety of contaminants including asbestos, hydrocarbons, pesticides, herbicides and heavy metals. The results have been assessed against the environmental quality criteria. Soil sampling locations are shown as Attachment 5, Appendix A.

Table 8.1: Evaluation of Soil Analytical Results – Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > SIL Column 5 (DEC 2006)
Asbestos	56	**2**	ACM	-	-	-
Arsenic	62	28	35	-	0	**3**
Cadmium	62	0	<PQL	-	0	0
Total Chromium	62	60	27	-	0	0
Copper	62	59	70	-	0	0
Lead	62	61	85	0	0	0
Mercury	62	11	0.49	-	0	0
Nickel	62	55	170	-	0	**2**
Zinc	62	59	110	-	0	0
TPH (C_6-C_9)	62	0	<PQL	0	-	-
TPH (C_{10}-C_{36})	62	0	<PQL	0	-	-
BTEX	62	0	<PQL	0	-	-
Benzo(a)pyrene	62	10	1	-	0	-
Total PAHs	62	14	9	-	0	-
PCBs	59	0	<PQL	-	0	-
Chlordane	59	2	0.4	-	0	-
DDT + DDD + DDE	59	2	0.3	-	0	-
Other OCP	59	0	<PQL	-	-	-
OPP	15	0	<PQL	-	-	-

n number of samples
- No criteria available/used

The analytical results summary presented above indicates that concentrations of hydrocarbons, pesticides, herbicides and heavy metals were less than the human health criteria.

Four samples of fill material contained metals concentrations above the provisional phytotoxicity criteria. Three samples contained arsenic concentrations (22 mg/kg, 24 mg/kg and 35 mg/kg) marginally above the provisional phytotoxicity criteria (20 mg/kg), with only two samples containing a nickel concentration (170 mg/kg and 110 mg/kg) above the criteria (60 mg/kg). Placement of 1.5 m of VENM on the site is proposed, so these marginal exceedances of the criteria are unlikely to pose a phytotoxic risk.

Asbestos was identified in a plaster fragment (1 x 1 x 2 mm) recovered from a shallow sample of fill material (BH378). Asbestos was also detected in a sample of fill material from 1.3 mbgl near the southern boundary of the site (TP112). No asbestos fibres were detected in either sample.

It is noted that although ACM was identified in only one of the 43 boreholes undertaken by EIS in the western playing fields, the use of boreholes may have limited the visual observations of the fill. ACM may be more common in the fill material than indicated. This is supported by the observations made by AECOM during bulk earthworks in the western playing fields. Seven fragments of ACM were observed during systematic surface inspections. The observations are discussed in Section 10.

9 Evaluation of Groundwater Analytical Results

A limited groundwater investigation was undertaken by EIS (2007) in February 2007. Groundwater samples were collected from three groundwater monitoring wells (MW357, MW361 and MW366) installed in the eastern portion of the site (Attachment 5, Appendix A). Samples were submitted for metal, TPH, BTEX, VOC, OCP and naphthalene analysis.

The analytical results are summarised below in Table 9.1.

Table 9.1: Groundwater Analytical Results (µg/L)

Analyte		TVs	MW357	MW361	MW366
Date Sampled			9-Feb-07	9-Feb-07	9-Feb-07
Heavy Metals	Arsenic	2.3	1.1	<PQL	<PQL
	Cadmium	5.5	<PQL	0.4	0.1
	Total Chromium	27.4	<PQL	4.6	<PQL
	Copper	1.3	<PQL	**24**	<PQL
	Lead	4.4	<PQL	**24**	1.3
	Mercury (inorganic)	0.4	<PQL	<PQL	<PQL
	Nickel	70	**120**	**190**	**94**
	Zinc	15	**160**	**400**	**110**
TPH	C_6-C_9	-	<PQL	<PQL	<PQL
	C_{10}-C_{14}	-	<PQL	<PQL	<PQL
	C_{15}-C_{28}	-	<PQL	<PQL	<PQL
	C_{29}-C_{36}	-	<PQL	<PQL	<PQL
	Total TPH (C_{10}-C_{36})	-	<PQL	<PQL	<PQL
Monocyclic Aromatic Hydrocarbons	Benzene	700	<PQL	<PQL	<PQL
	Toluene	180	<PQL	<PQL	<PQL
	Ethylbenzene	5	<PQL	<PQL	<PQL
	Total Xylenes	-	<PQL	<PQL	<PQL
PAHs	Naphthalene	70	<PQL	<PQL	<PQL
Other VOCs		-	<PQL	<PQL	<PQL
OCPs		-	<PQL	<PQL	na

na not analysed
PQL Practical Quantitative Limits
TV Trigger value, marine adopted
4 Concentration exceeds TV

The main impacts were metals, with concentrations of copper, lead, nickel and zinc exceeding the TVs. The wells were located down gradient of the playing fields, which were filled and levelled with material from various sources. No groundwater monitoring wells were installed on the up gradient boundary of the site so it cannot be determined if the metal concentrations represent background concentrations or contamination from fill material. It is however noted that samples of fill material did not contain significantly elevated concentrations of metals.

TPH, BTEX, VOC, OCP and naphthalene were not detected in groundwater. It is noted that groundwater samples were not analysed for the full PAH suite. Soil samples did not contain significant PAH concentrations, therefore the risk of significant groundwater contamination from PAHs is considered to be low.

The Auditor considers it has been established that there is limited evidence of groundwater contamination as a result of landfilling on the site.

The groundwater receptors are not well defined. It is not clear if groundwater flows to the dams located to the east of the site or Little Bay. The presence and quality of perched groundwater was also not assessed, however perched groundwater was not encountered during borehole drilling and test pit excavation. It is likely to be present only intermittently following periods of heavy rainfall, if at all, and it is likely to flow across the sandstone bedrock to the dams to the east of the site.

The previous Site Audit Report and Section B Site Audit Statement (GN336) dated 6 July 2007 for the property noted that "*groundwater should not be abstracted for use on site*". Although the groundwater investigations to date have identified only limited evidence of potential contamination from metals, groundwater would need to be investigated to determine suitability for any proposed use, and abstraction permits obtained.

10 Evaluation of Remediation

10.1 Remediation Required

Remediation was considered necessary to make the development site (Stages 1 – 4, Attachment 2, Appendix A) suitable for residential development due to landfilling in the eastern portion of the site (i.e. to the east of the Western Playing Fields). Investigations indicated that the landfill material contained asbestos, heavy metals, PAHs and petroleum hydrocarbons.

EIS prepared '*Report to University of NSW on Remedial Action Plan for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW*' (RAP), dated May 2007, which detailed the proposed remedial strategy for the site. The RAP was the subject of a previous site audit (GN336) by the current Site Auditor. The site audit statement (SAS), dated 6 July 2007, concluded that the site can be made suitable for the purposes of 'residential with gardens and accessible soil' if the site is remediated/managed in accordance with several options presented in the RAP, subject to compliance with a number of conditions.

Following the sale of the site by UNSW to CHOF5 Little Bay Pty Ltd, ENSR prepared a Remediation Works Plan (RWP), dated 2 February 2009. The RWP identified the preferred remediation option for the site and detailed the remediation methodology. Remediation was proposed for the eastern portion of the site and the former Solarch compound in the western portion of the site (Attachment 4, Appendix A).

Bulk earthworks were required in the western playing fields, however remediation of the western playing fields was not considered necessary. ENSR (2009) noted that "*in the event that unexpected areas of contamination are identified during the earthworks in this area, the same remediation process to be followed in the Remediation Area would be applied*".

10.2 Remediation Works

10.2.1 Western Playing Fields – Bulk Earthworks

Bulk earthworks were undertaken in the western playing fields, resulting in the removal of grass and topsoil from the fields, and removal of the synthetic hockey pitch.

Prior to the commencement of the bulk earthworks, AECOM undertook two test pits (TP1 and TP2) at locations where ACM had previously been observed by EIS (Attachment 5, Appendix A). Additional ACM was observed in TP1, which targeted BH378.

Following removal of the synthetic hockey pitch, AECOM undertook two test pits (also termed TP1 and TP2) (Attachment 5, Appendix A). The stratigraphy was described as gravel fill and no ACM was observed. Samples were not collected for analyses.

Following removal of grass and topsoil, a number of site walkovers and inspections (10 m transect spacing) of the ground surface for the presence of ACM were undertaken. "*Occasional fragments*" of ACM were observed, which were removed from the site. A total of

7 fragments were encountered, with four fragments encountered during targeted test pitting in the locations of previous detections.

There is a potential for some fragments of ACM to remain in the former western playing fields area. Given the relatively low number of detections over this large area, it is however considered that the amount is trivial. The potential for exposure of future residents to any residual asbestos fragments is considered to be negligible as VENM has been placed over most the area. Many of the areas that are not covered with VENM are to be used for basement excavations.

Although there is a potential for the stripped topsoil to contain fragments of ACM, the risk is considered to be sufficiently low such that further validation is not required. The material should be inspected during placement to further reduce this low risk.

The Auditor agrees that the observations made and the results obtained by AECOM during surface stripping and bulk earthworks are consistent with those presented by EIS. The Auditor agrees that no further remedial works are required in the validated areas to ensure that the site is suitable for the proposed residential and open space uses.

10.2.2 Solarch Compound and Eastern Boundary – Remediation and Validation

The following remedial works were undertaken over the former Solarch Compound:

- Fill containing building rubble, demolition waste and ACM was excavated from the footprint of the former Solarch Building.
- The excavations extended to natural sands or sandstone bedrock
- The excavations extended to the southern boundary with the adjoining residential properties and to the eastern boundary (fenced due to sandstone outcrops that are on the Register of the National Estate for its Geological Significance).
- Fill containing ACM (approximately 276 tonnes) was disposed off-site to a landfill and remaining fill (4840 m^3) was transferred to the adjoining site formerly part of the larger site where ongoing remediation of fill material is occurring.
- Fill was removed from the proposed View St adjacent to the Stage 3 area, and also from the adjoining central corridor (Stage 3) area.
- Over-excavation of the sandstone was undertaken to facilitate design levels. The material was re-used on-site.

Validation of the works included:

- Inspection and sampling of natural material over the base of the excavation and from the over-excavated sandstone.
- Inspection and sampling of fill retained in the excavation walls along the southern boundary.
- Testing of the over-excavated sandstone to demonstrate suitability for on-site use.

Fill containing rubble including asbestos was removed from the central corridor (Stage 3 area) adjoining the site boundary to prevent recontamination of the remediated area.

10.2.3 Former Buildings at Western Boundary – Validation of Building Footprints

The former amenities building and caretaker's cottage were demolished. Following this, validation of the suitability of the underlying material was verified by undertaking the following:

- Inspection of the base of the excavation
- Test pitting and sampling of soil in the building footprint

Intrusive investigations were not undertaken prior to the erection of the Marketing Suite however consideration was given to previous investigation results obtained around and in the vicinity of the building.

Topsoil was imported and placed around the marketing suite. As the source of the material could not be confirmed, AECOM analysed three samples representing 45 m^3.

10.3 Quality Assurance and Quality Control

The Auditor's assessment of investigations at the Former Amenities Building, the Former Caretaker's Cottage and former Solarch Area follows in Tables 10.1 and 10.2.

Table 10.1: QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Works Undertaken
Sampling Pattern, Locations, Density and Depth	Former Amenities Building, the Former Caretaker's Cottage: Test pits were excavated between 10 and 15 m apart (RWP specified 1 per 50 m^3) over the former building footprints (amenities and caretaker's cottage) with the test pits terminated at between 0.3 and 0.4 m on sandstone (amenities) and 0.5 and 0.7 m on sandstone. Samples were collected within the fill. Former Solarch Compound and access road: Surface samples from the natural residual material and from a stockpile of over-excavated sandstone were collected at 1 per 100 m^2 as per the RWP. Wall samples were collected from three locations spaced at 20 m apart as per the RWP.
Sample Collection Method	Samples were collected directly from the base of the excavations and from the walls.
Decontamination Procedures	New gloves were reportedly used for each new sample.
Sample handling and containers	Samples were placed into prepared and preserved sampling bottles provided by the laboratory and chilled during storage and subsequent transport to the labs.
Chain of Custody	Completed chain of custody forms were provided in the reports and appeared to be complete.
Detailed description of field screening protocols	Field screening for volatiles was undertaken using a PID. PID screening methodology was not discussed. PID readings were generally discussed in the text. Readings

Table 10.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Works Undertaken**
	were generally 0 ppm. The highest PID concentration was 0.3 ppm for the building footprints and up to 2.1 ppm on the southern wall of the Solarch excavation.
Calibration of field equipment	The reports indicated that calibration of the PID had been undertaken prior to delivery and prior to use each day. Calibration certificates were provided.
Sampling Logs	Soil logs are provided within the report, indicating sample depth, PID readings and lithology. Logs were not provided for some base validation samples. Photographs were provided.

Table 10.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Works Undertaken**
Field quality control samples	Field quality control samples including intra-laboratory and inter-laboratory duplicates, trip spikes and trip blanks were undertaken
Field quality control results	The results from field quality control samples were generally within appropriate limits.
NATA registered laboratory and NATA endorsed methods	Laboratories used included: Envirolab and MGT. Laboratory certificates were NATA stamped.
Analytical methods	Analytical methods were included in the laboratory test certificates.
Holding times	Review of the COCs and laboratory certificates indicate that the holding times had been met.
Practical Quantitation Limits (PQLs)	PQLs were less than the threshold criteria for the contaminants of concern.
Laboratory quality control samples	Laboratory quality control samples including laboratory control samples, matrix spikes, surrogate spikes, blanks and duplicates were undertaken by the laboratory at appropriate frequencies.
Laboratory quality control results	Elevated RPDs were reported for lead and zinc (maximum of 67%). The results reported were low and close to the PQLs. The Auditor does not consider that these discrepancies affect the conclusions. The results from other laboratory quality control samples were within appropriate limits.
Data Quality Indicators and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	DQIs were set in the RWP by AECOM. Formal QA/QC data evaluation against the five category areas was not undertaken however a discussion was provided which concluded that 'the reported analytical results are representative of soil/fill conditions' and that the 'overall quality of the analytical data produced is acceptably reliable for the purpose of the validation works'.

In considering the data as a whole the Auditor concludes that:

- The data is considered to be complete.
- There is a high degree of confidence that data is comparable for each sampling and analytical event.
- The data is considered to be representative material on the site.
- The primary laboratory provided sufficient information to conclude that data is of sufficient precision.
- The data is considered to be accurate.

10.4 Validation Results

10.4.1 Solarch Compound and Access Road

Validation works over the base confirmed that:

- The base of the excavation consists of natural sands and sandstone bedrock (photographs and descriptions provided following the inspection). Some fill was retained at the northern end of the access road (proposed View Street).
- Consistent with the field observations, the residual material reported only low concentrations of metals with nearly all organics reported below the PQLs. There was a minor detection of PAHs in one sample from the northern end of the access road.
- The over-excavated sandstone from the former building location at the southern end is suitable for use on-site given the field observations and as the analytical results are consistent with the attributes expected of VENM i.e. only low concentrations of metals with all organics reported below the PQLs.
- The southern wall consisted of fill (gravelly sand, clay and clayey sand) with no inclusions or indications of impact noted. A thin layer of black fill at 0.4 – 0.5 m was encountered at one location. Only low concentrations of metals and non-detects for organics were reported in all samples. Given these results, the Auditor considers that placement of remediated and validated material up against the validated wall is acceptable.

Invoices from the waste transporter were provided indicating that the material was disposed off-site as asbestos contaminated waste to Enviroguard. Waste disposal dockets from Enviroguard were provided.

10.4.2 Former Amenities Building

The material exposed following removal of the building consists of a silty sand fill over sandstone bedrock (encountered at 0.4 m bgl). Only low concentrations of metals were reported and organics (PAHs and petroleum hydrocarbons) were not reported above the PQLs.

10.4.3 Former Caretaker's Cottage

The material exposed following removal of the building consists of sandy fill with silt, clay or gravelly clay that extend to natural sand or sandstone bedrock. Fill thickness ranged from 0.2 m to 0.6 m. Generally, only low concentrations of metals were reported and organics were not reported above the PQLs. Lead was reported at 680 mg/kg in one sample above the SIL of 300 mg/kg. The gravelly clayey sand fill is not consistent with the dark silty sand encountered by AECOM and EIS in the overlying soil and in surrounding locations. All other fill reported lead at less than 78 mg/kg. Given the limited thickness of the fill (0.1 m) and extent (based on surrounding excavations) the risk to human health is considered to be low.

10.4.4 Marketing Suite

The material beneath the newly constructed Marketing Suite consists of a silty sand fill. Only low concentrations of metals were reported and organics were not reported above the PQLs. Observations of the surface by AECOM following removal of vegetation were consistent with those made by EIS with no asbestos fragments noted.

Gravel for the car park and mulch and topsoil from Building & Landscape Supplies were imported to facilitate development.

AECOM analysed three samples representing 45m^3 of imported topsoil. The results contained minor PAHs but were otherwise indicative of natural material.

10.4.5 VENM

Material sourced from UTS Broadway consisted of sandstone. Potential previous sources of contamination identified by EIS (September 2010) included two underground storage tanks, asbestos contamination associated with demolition of buildings and chemicals from dry-cleaning and steel and newspaper production and the use of unknown fill.

It is understood that remediation and validation of the site was undertaken. Compaction & Soil Testing Services Pty Limits (CSTS) provided validation reports for the base of the tanks; spoil classification reports and two VENM certificates. CSTS concluded that:

- The red-brown and light grey clay retained at the base of the tank pits, following the removal of the tanks and associated spoil, could be classified as VENM (not imported to this site). The results were non-detect for organics and low for metals.
- The light grey and orange sandstone bedrock, exposed following removal of the fill and clay, could be classified as VENM. The results of the 6 randomly selected samples were non-detect for organics and low for metals. These results confirmed the field observations.

AECOM undertook an inspection of the source site on 9 August 2011 and noted that fill material had been removed and there was no evidence of the UST's. Removal of the residual clay was still in progress over a portion of the site with the underlying sandstone exposed. This is consistent with observations made during an audit site inspection of the source site. AECOM undertook a final inspection at the source site on 26 August 2011 and confirmed that the clay overburden had been removed.

Given the field observations and review of the information supplied by EIS and CSTS, AECOM conclude that the material is suitable for importation.

The Auditor concludes that imported material is considered to be VENM.

11 Contamination Migration Potential

No significant levels of contaminants were detected over the site and therefore there is little or no potential for migration of contamination from the site or vertically to groundwater.

12 Assessment of Risk

Based on assessment of results against relevant guidelines and consideration of the overall investigation and removal and validation of impacted fill, it is the Auditor's opinion that there are no indications of contamination that would pose a risk to human health if used for residential purposes.

13 Compliance with Regulatory Guidelines And Directions

Guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997* are listed in Appendix C. The Auditor has used these guidelines.

The investigation was generally conducted in accordance with SEPP 55 Planning Guidelines and reported in accordance with the EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*. The EPA's *Checklist for Site Auditors using the EPA Guidelines for the NSW Site Auditor Scheme 1998 (December 1999)* has been completed and is kept on file.

The Audit was initiated to comply with terms of judgment of the Land and Environment Court, Appeal No. 10672 of 2009, dated 23 December 2009.

Condition 77 requires the remediation and validation works to be carried out in accordance with "Interim Advice Letter – Remedial Action Plan – Little Bay" dated 5 February 2009 prepared by the Auditor. The IAL is included in Appendix D. In the Auditor's opinion, remediation works undertaken were appropriate and in accordance with the RAP and IAL. Validation results and testing are discussed in Section 10.4.

Conditions 78 a) to c) require a Site Audit Statement and Site Audit Report to be prepared to verify that the land is suitable for the intended use. This SAR and accompanying SAS will be submitted to Council to comply with those conditions.

The remediation strategy has not included 'capping' or 'containment' of contamination, and the SAS is not conditional on conformance to an Environmental Management Plan (EMP). The subsections of Condition 78 that refer to these issues therefore do not apply.

Condition 78 g) requires fill imported to the site to be VENM or ENM. As discussed in Section 10.4.5, the Auditor concludes that imported fill is considered to be VENM.

Condition 79 requires the SAS to clearly state the source of the standard adopted where no guideline made or approved under the NSW Contaminated Land Management Act is available. This does not apply to this site. Environmental quality criteria used are discussed in Section 7.

14 Conclusions and Recommendations

AECOM (11 July 2012) concludes that the site 'is suitable for the proposed land use – residential (with accessible soil), recreation/open space and roads'. Based on the information presented in the reports prepared by EIS, ENSR and AECOM and observations made on site, and following the Decision Process for Assessing Urban Redevelopment Sites in DEC (2006) Guidelines for the NSW Site Auditor Scheme, the Auditor concludes that the site is suitable for the purposes of "residential with gardens and accessible soil" and other less sensitive land uses including recreational open space.

15 Other Relevant Information

This Audit was conducted on the behalf of Client for the purpose of assessing whether the land is suitable for the proposed residential uses i.e. a “Site Audit” as defined in Section 4 (1) (b) (iii) of the CLM Act.

This summary report may not be suitable for other uses. EIS, ENSR and AECOM included limitations in their report. The audit must also be subject to those limitations. The Auditor has prepared this document in good faith, but is unable to provide certification outside of areas over which he had some control or is reasonably able to check.

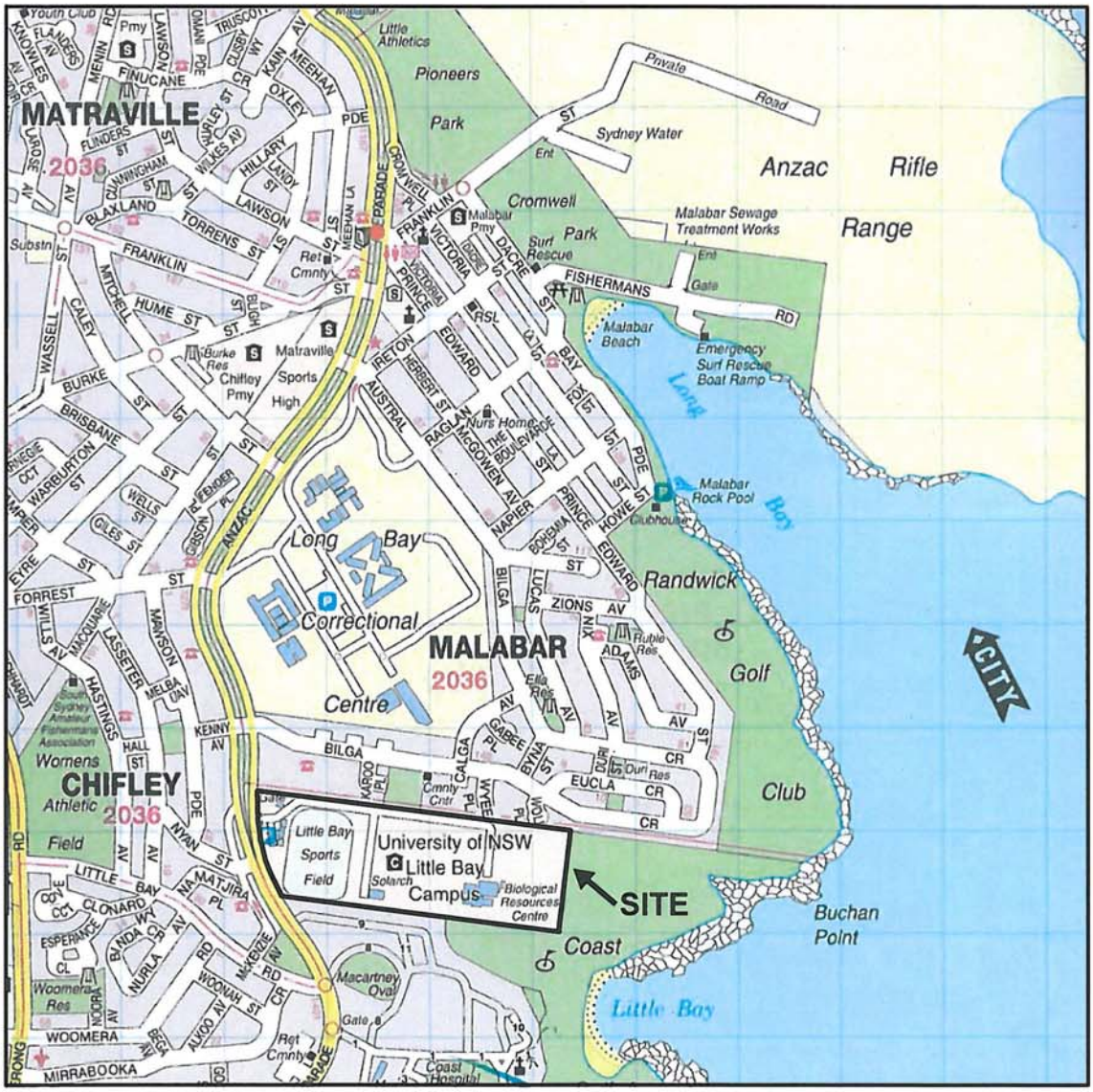
The Auditor has relied on the documents referenced in Section 1 of the Site Audit Report in preparing his opinion. If the Auditor is unable to rely on any of those documents, the conclusions of the audit could change.

It is not possible in a Site Audit Report to present all data which could be of interest to all readers of this report. Readers are referred to the referenced reports for further data. Users of this document should satisfy themselves concerning its application to, and where necessary seek expert advice in respect to, their situation.

Appendix A: Attachments

Attachment 1: Site Location
Attachment 2: Staging Plan
Attachment 3: Proposed Lot Numbers and Survey Boundaries
Attachment 4: Former Site Layout
Attachment 5: Investigation Sample Locations

Attachment 1: Site Location



SYDNEY UBD 2007 EDITION

SITE LOCATION PLAN

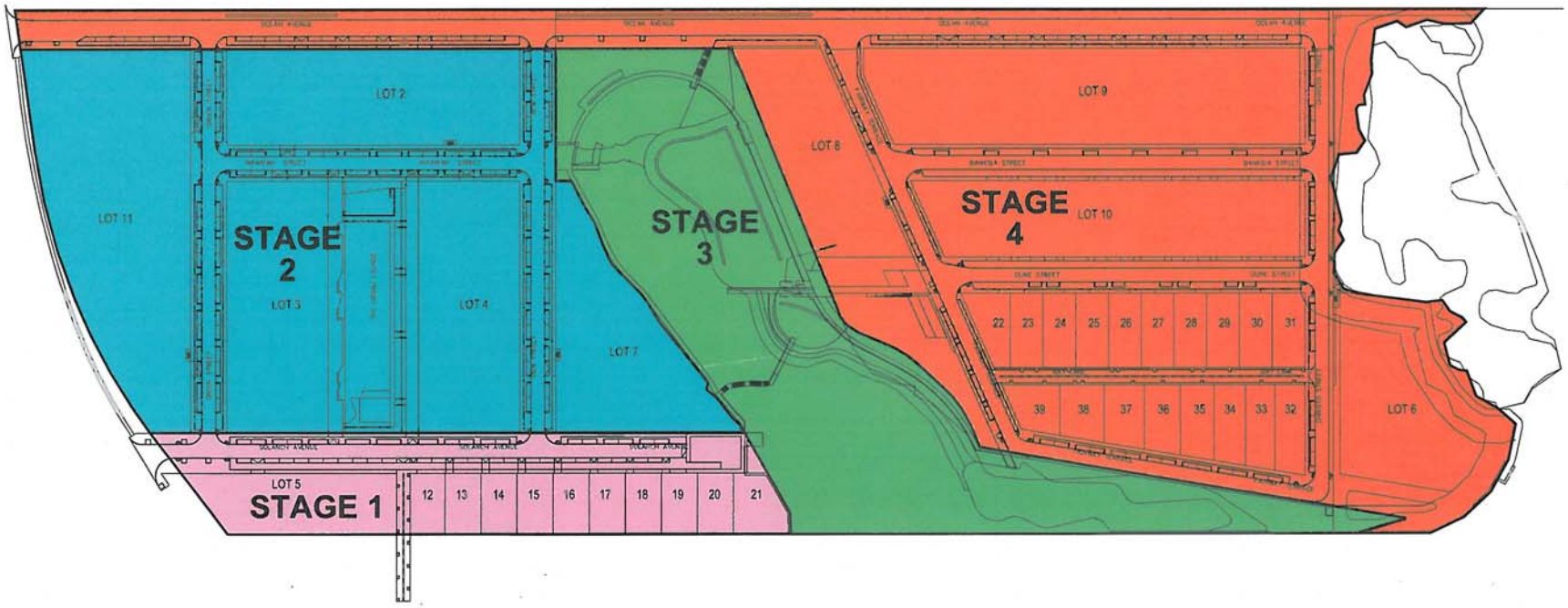
1408 Anzac Parade, Little Bay, NSW

EIS
ENVIRONMENTAL
INVESTIGATION
SERVICES

Job No: E20167FJ-rpt2
Figure: 1

LITTLE BAY STAGING PLAN

Developing Relationships
Building Success



NOTE:-

- LOT 7 MAY BE HANDED OVER WITH STAGE 2 OR STAGE 3 DEPENDANT ON PROGRESS OF THE WORKS.
- LOT 8 MAY BE HANDED OVER WITH STAGE 3 OR STAGE 4 DEPENDANT ON PROGRESS OF THE WORKS

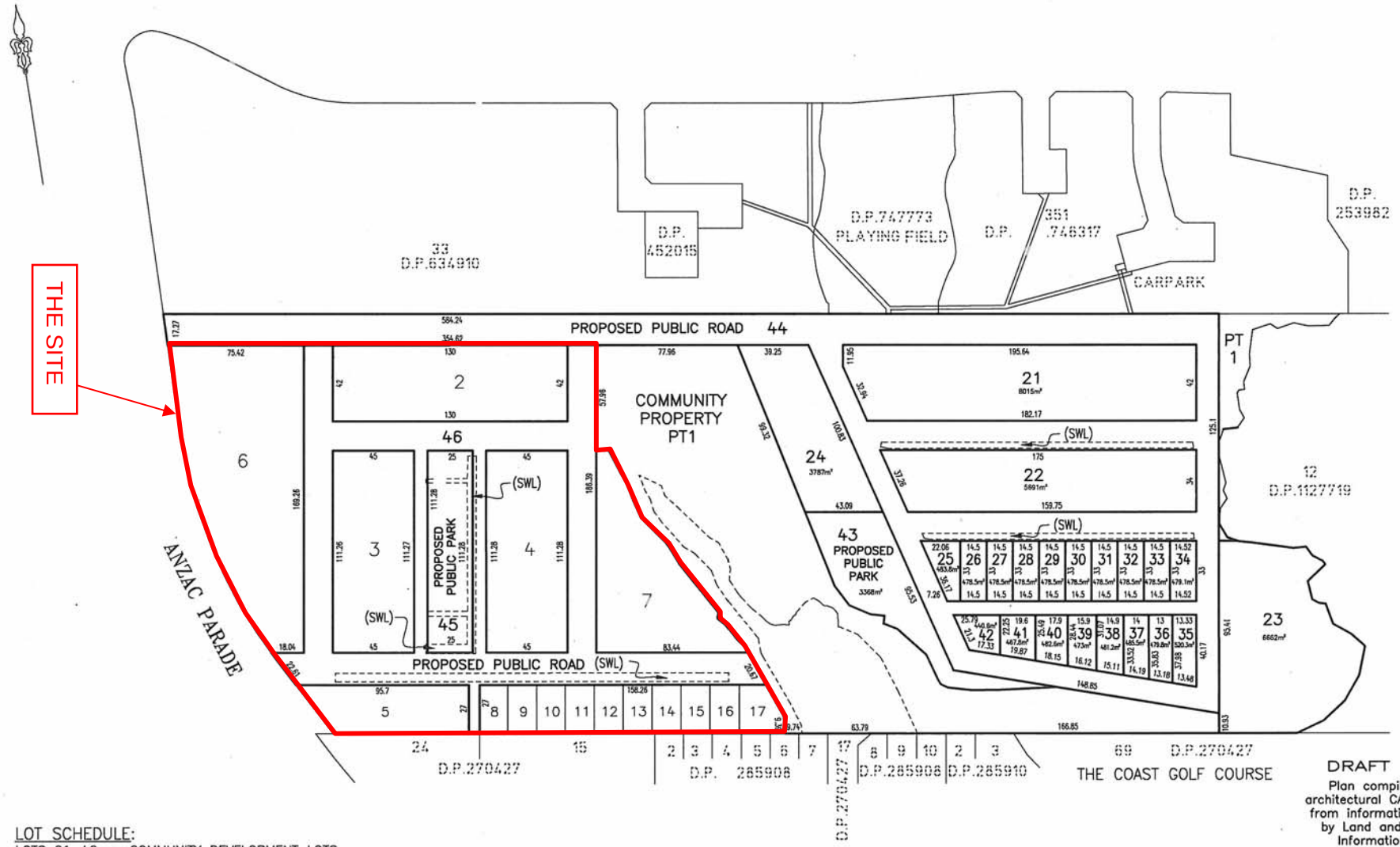
Scale
0 10 20 30 40 50 100m

Attachment 2: Staging Plan

PLAN FORM 2 (A2)

WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION

Sheet No. 1 of 1 Sheets



LOT SCHEDULE:
LOTS 21–42 – COMMUNITY DEVELOPMENT LOTS.
LOT 43 & 45 – PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS OPEN SPACE.
LOT 44 & 46 – PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS PUBLIC ROAD

(SWL) – SWALE BEING THE SUBJECT OF THE POSITIVE COVENANT NOTED 4 IN THE 88B SCHEDULE OF STAGE 1

DRAFT PLAN

Plan compiled from architectural CAD data and from information supplied by Land and Property Information NSW.

Plan is subject to a detail survey.

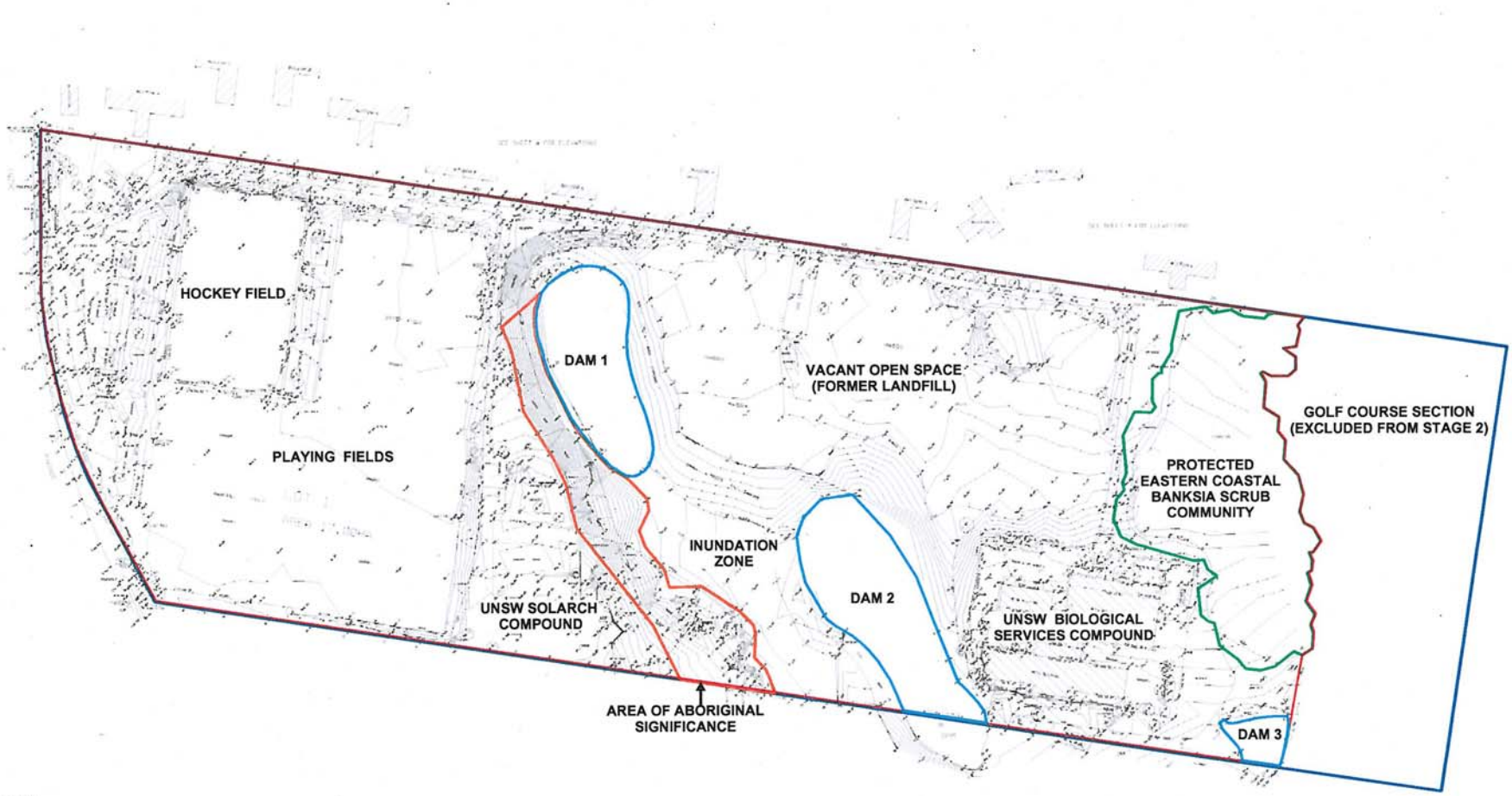
PRINTED 5 APRIL 2012
(ISSUE 10)

Surveyor: Date of Survey: Surveyor's Ref: 080712 PLAN	PLAN OF COMMUNITY SUBDIVISION OF DEVELOPMENT LOT 18, 19 & 20 OF THE STAGE 1 COMMUNITY PLAN	LGA: RANDWICK Locality: LITTLE BAY Subdivision No: Lengths are in metres. Reduction Ratio 1: 1500(A2)	REGISTERED	DP STAGE 2

10mm 20 30 40 50 60 70 80 90 100 110 120 130 140 150 Table of mm

X:\08JOBS\080712_1408 Anzac Pde\COMMUNITY\STAGE 2\PLAN_2 STAGE 2 COMMUNITY PLAN.dwg

Attachment 3: Proposed Lot Numbers and Survey Boundaries



LEGEND:

- Lot Boundary
- Site Investigation Area Boundary
- Area of Aboriginal Significance
- Area of Ecological Significance for Banksia Community
- Dams

SCALE (m)

0 20 40 60 80 100

Note: Reference should be made to the text for a full understanding of this plan.

SITE LAYOUT PLAN

UNSW Campus, 1408 Anzac Parade, Little Bay

EIS
ENVIRONMENTAL
INVESTIGATION
SERVICES

Job No: E20167FJrpt
Figure: 2

Attachment 4: Former Site Layout


OCEAN AVENUE
RIPARIAN STREET
GREEN STREET
VIEW STREET
SOLARCH AVENUE
ANZAC AVENUE
FAIRWAY TERRACE
Lot 2
Lot 3
Lot 4
Lot 5
Lot 6
Lot 7
Lot 19
PROJECT ID: 60212824
CREATED BY: TO
LAST MODIFIED: TO 06 07 2012
AECOM
www.aecom.com
0
50m
Site boundary
Development stage 1
Development stage 2
Development stage 4
Proposed development (Charter Hall, McGregor and Partners, 2008)
(N & S) Test pit sampled on both northern and southern walls
(E & W) Test pit sampled on both eastern and western walls
EIS, 2006 Stage 1 sample location
EIS, 2007 Stage 2 sample location
AECOM, 2011 Hockey field test pit location
AECOM, 2011 Hotspot test pit location
AECOM, 2011 Marketing suite surface sample location
AECOM, 2011 Validation wall sample location
AECOM, 2012 Caretakers Cottage test pit location (no survey data provided by CIP)
AECOM, 2012 Amenities building test pit location (no survey data provided by CIP)
Base of excavation validation sample location - residual material
Indicative base of excavation validation sample location - residual material (no survey data provided by CIP)
Bedrock validation sample location
Potential asbestos in soil sample location
Stage 1 and 2 Sample Location Plan
Commercial & Industrial Property Pty Ltd (CIP)
Remediation and Validation
1406 - 1408 Anzac Parade,
Little Bay NSW
Figure
F1
A3 Size
Map Document: G:\Projects\602\60212824 Little Bay\FIGURES\60212824 F1 Stage 1 and 2 Sample Location Plan

Appendix B:
Soil and Groundwater Criteria

Soil investigation levels for urban development sites
Department of Environment and Conservation NSW (April 2006)

Substance	Health-based investigation levels[1] (mg/kg)				Provisional phytotoxicity-based investigation levels[2] (mg/kg)
	Residential with gardens and accessible soil (home-grown produce contributing < 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools, primary schools, townhouses, villas (NEHF A)[3]	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space, playing fields including secondary schools (NEHF E)	Commercial or industrial (NEHF F)	
	Column 1	Column 2	Column 3	Column 4	Column 5
Metals and metaloids					
Arsenic (total)	100	400	200	500	20
Beryllium	20	80	40	100	–
Cadmium	20	80	40	100	3
Chromium (III)[4]	12%	48%	24%	60%	400
Chromium (VI)	100	400	200	500	1
Cobalt	100	400	200	500	–
Copper	1,000	4,000	2,000	5,000	100
Lead	300	1,200	600	1,500	600
Manganese	1,500	6,000	3,000	7,500	500
Methyl mercury	10	40	20	50	–
Mercury (inorganic)	15	60	30	75	1[5]
Nickel	600	2,400	600	3,000	60
Zinc	7,000	28,000	14,000	35,000	200
Organics					
Aldrin + dieldrin	10	40	20	50	–
Chlordane	50	200	100	250	–
DDT + DDD + DDE	200	800	400	1,000	–
Heptachlor	10	40	20	50	–
PAHs (total)	20	80	40	100	–
Benzo(a)pyrene	1	4	2	5	–
Phenol[6]	8,500	34,000	17,000	42,500	–
PCBs (total)	10	40	20	50	–
Petroleum hydrocarbon components[7]					
> C16–C35 (aromatics)	90	360	180	450	–
> C16–C35	5,600	22,400	11,200	28,000	–
> C35 (aliphatics)	56,000	224,000	112,000	280,000	–
Other					
Boron	3,000	12,000	6,000	15,000	–[8]
Cyanides (complex)	500	2,000	1,000	2,500	–
Cyanides (free)	250	1,000	500	1,250	–

1 The limitations of health-based soil investigation levels are discussed in Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater and Schedule B(7a) Guidelines on Health-based Investigation Levels, *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999)
2 The provisional phytotoxicity-based investigation levels proposed in this document are single number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. They are intended for use as a screening guide and may be assumed to apply to sandy loam soils or soils of a closely similar texture for pH 6–8.
3 National Environmental Health Forum (NEHF) is now known as enHealth.
4 Soil discolouration may occur at these concentrations.
5 Total mercury
6 Odours may occur at these concentrations.
7 The carbon number is an 'equivalent carbon number' based on a method that standardises according to boiling point. It is a method used by some analytical laboratories to report carbon numbers for chemicals evaluated on a boiling point GC column.
8 Boron is phytotoxic at low concentrations. A provisional phytotoxicity-based investigation level is not yet available.

Notes:

This table is adapted from Table 5-A in Schedule B(1): Guidelines on Investigation Levels for Soil and Groundwater to the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC 1999).

Soil investigation levels (SILs) may not be appropriate for the protection of ground water and surface water. They also do not apply to land being, or proposed to be, used for agricultural purposes. (Consult NSW Agriculture and NSW Health for the appropriate criteria for agricultural land.)

SILs do not take into account all environmental concerns (for example, the potential effects on wildlife). Where relevant, these would require further consideration.

Impacts of contaminants on building structures should also be considered.

For assessment of hydrocarbon contamination for residential land use, refer to the Guidelines for Assessing Service Station Sites (EPA 1994).

Threshold Concentrations for Sensitive Land Use – Soils Guidelines for Assessing Service Station Sites (NSW EPA 1994)	
Contaminant	**Threshold Concentration (mg/kg)**
TPH (C_6-C_9)	65
TPH (C_{10}-C_{36})	1,000
Benzene	1
Toluene	1.4
Ethylbenzene	3.1
Xylenes (total)	14

Trigger Values (TV) for Screening Marine Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Metals and Metalloids		
Arsenic – As (III/V)	2.3/4.5	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Cadmium – Cd	0.7	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Mercury – Hg	0.1	
Nickel – Ni	7	ANZECC (2000) 99% protection level due to potential for toxicity.
Manganese – Mn	80	Low reliability trigger values (derived from the mollusc figure) from Volume 2 of ANZECC (2000)
Chromium – Cr (III/VI)	27.4/4.4	ANZECC (2000) 95% protection levels.
Copper – Cu	1.3	
Cobalt – Co	1	
Lead – Pb	4.4	
Zinc – Zn	15	
Aromatic Hydrocarbons		
Benzene	700	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	
Ethylbenzene	5	
o-xylene	350	
m-xylene	75	
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	50	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000) ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Phenanthrene	0.6	
Fluoranthene	1	
Benzo(a)pyrene	0.1	
Chlorinated Alkanes and Alkenes		
Tetrachloroethene (PCE)	70	Low reliability trigger values (95% level of protection)
1,1,2-Trichloroethene (TCE)	330	
Vinyl chloride (chloroethene)	100	
1,1,1-Trichloroethane (1,1,1-TCA)	270	
1,1-Dichloroethene	700	
1,1-Dichloroethane	250	
1,2-Dichloroethane	1900	
1,1,2-Trichloroethane	1900	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chloroform	370	Low reliability trigger value (95% level of protection)
Non-Metallic Inorganics		
Ammonia Total – NH_3 (at pH of 8)	910	ANZECC (2000) 95% protection levels.
Cyanide (Free or unionised HCN)	4	

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Metals and Metalloids		
Arsenic – As (III/V)	24/13	ANZECC (2000) 95% protection levels.
Boron - B	370	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Cadmium – Cd	0.2	ANZECC (2000) 95% protection levels.
Nickel – Ni	11	
Manganese – Mn	1900	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Mercury – Hg	0.06	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Chromium – Cr (III/VI)	3.3/1.0	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000) for Cr (III) and Co
Cobalt – Co	2.8	
Copper – Cu	1.4	ANZECC (2000) 95% protection levels.
Lead – Pb	3.4	
Zinc – Zn	8.0	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Aromatic Hydrocarbons		
Benzene	950	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Ethylbenzene	80	
m-xylene	75	
o-xylene	350	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	16	ANZECC (2000) 95% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000)
Phenanthrene	0.6	
Fluoranthene	1	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Benzo(a)pyrene	0.1	
Organochlorine Pesticides		
Aldrin	0.001	Low reliability trigger values from Volume 2 of ANZECC (2000)
DDE	0.03	
Dieldrin	0.01	
Endosulfan α	0.0002	
Endosulfan β	0.007	
Chlordane	0.03	ANZECC (2000) 95% protection levels
DDT	0.006	
Lindane	0.2	
Endosulfan	0.03	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Endrin	0.01	
Heptachlor	0.01	
Organophosphorus Pesticides		
Azinphos methyl	0.01	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
		toxicity to particular species.
Methoxychlor	0.005	Low reliability trigger values from Volume 2 of ANZECC (2000)
Dementon-S-methyl	4	
Chloropyrifos	0.01	ANZECC (2000) 95% protection levels
Diazinon	0.01	ANZECC (2000) 95% protection levels
Dimethoate	0.15	
Fenitrothion	0.2	
Malathion	0.05	
Parathion	0.004	
Non-Metallic Inorganics		
Total Ammonia as N (pH of 8)	900	ANZECC (2000) 95% protection levels
Cyanide (Free or unionised)	7	
Nitrate	700	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
NO_x	40	ANZECC (2000) Default trigger values for physical and chemical stressors for slightly disturbed ecosystems in lowland rivers of South-east Australia. The trigger values for TP and TN are 25 µg/L and 350 µg/L, respectively, for east flowing coastal rivers in NSW.
Total Nitrogen	500	
Total Phosphorous	50	
Ammonium ($NH4^+$)	20	
Chlorine	3	ANZECC (2000) 95% protection levels.
Phenols		
Phenol	320	ANZECC (2000) 95% protection levels
2,4-dimethylphenol	2	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Alkanes and Alkenes		
Tetrachloroethene (PCE)	70	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,1,2-Trichloroethene (TCE)	330	
Vinyl chloride (chloroethene)	100	
1,1,1-Trichloroethane (1,1,1-TCA)	270	
1,1-Dichloroethene	700	
1,1-Dichloroethane	90	
1,2-Dichloroethane	1900	
Chloroform	370	
1,1,2-Trichloroethane	6500	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Aromatic Hydrocarbons		
1,3-dichlorobenzene	260	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,4-dichlorobenzene	60	
1,2,4-trichlorobenzene	85	
Hexachlorobenzene	0.05	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000). (QSAR derived)
Miscellaneous Industrial Chemicals		
Hexachlorobutadiene	0.04	Environmental Concern Level from Volume 2 of ANZECC (2000)

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

Appendix C:
EPA Approved Guidelines

Guidelines made or approved by the EPA under section 105 of the *Contaminated Land Management Act 1997*

(*as of 3 July 2009*)

Guidelines made by the EPA

- *Contaminated Sites: Guidelines for Assessing Service Station Sites*, December 1994 - servicestnsites.pdf, 1.3Mb
- *Contaminated Sites: Guidelines for the vertical mixing of soil on former broad-acre agricultural land*, January 1995 - *vertmix.pdf*, 149kb
- *Contaminated Sites: Sampling Design Guidelines*, September 1995
- *Contaminated Sites: Guidelines for Assessing Banana Plantation Sites*, October 1997 - bananaplantsite.pdf, 586 kb
- *Guidelines for Consultants Reporting on Contaminated Sites* (97104consultantsglines.pdf; 209 KB), September 2000
- *Contaminated Sites: Guidelines for Assessing Former Orchards and Market Gardens,* June 2005 - orchardgdlne05195.pdf, 172 kb
- *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd edition)*, April 2006 - auditorglines06121.pdf, 510kb
- *Guidelines for the Assessment and Management of Groundwater Contamination*, March 2007 - groundwaterguidelines07144.pdf 604 kb
- *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*, June 2009 - 09438gldutycontclma.pdf, 1 Mb

Note: All references in the EPA's contaminated sites guidelines to the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, November 1992) are replaced as of 6 September 2001 by references to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, October 2000), subject to the same terms.

Guidelines approved by the EPA

ANZECC publications

- *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites,* published by Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC), January 1992
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Paper No 4, October 2000

EnHealth publications (formerly National Environmental Health Forum monographs)

- *Composite Sampling, by Lock, W. H., National Environmental Health Forum Monographs, Soil Series No.3, 1996, SA Health Commission, Adelaide*
- *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards, Department of Health and Ageing and EnHealth Council, Commonwealth of Australia, June 2002*

National Environment Protection Council publications

- National Environment Protection (Assessment of Site Contamination) Measure 1999

The Measure consists of a policy framework for the assessment of site contamination, Schedule A (Recommended General Process for the Assessment of Site Contamination) and Schedule B (Guidelines). Schedule B guidelines include:

B(1) Guideline on Investigation Levels for Soil and Groundwater

B(2) Guideline on Data Collection, Sample Design and Reporting

B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils

B(4) Guideline on Health Risk Assessment Methodology

B(5) Guideline on Ecological Risk Assessment

B(6) Guideline on Risk Based Assessment of Groundwater Contamination

B(7a) Guideline on Health-Based Investigation Levels

B(7b) Guideline on Exposure Scenarios and Exposure Settings

B(8) Guideline on Community Consultation and Risk Communication

B(9) Guideline on Protection of Health and the Environment During the Assessment of Site Contamination

B(10) Guideline on Competencies & Acceptance of Environmental Auditors and Related Professionals

Other documents

- Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential *Purposes*, NSW Agriculture and CMPS&F Environmental, February 1996
- *Australian Drinking Water Guidelines*, NHMRC & Natural Resource Management Ministerial Council of Australia and New Zealand, 2004

Appendix D:
Interim Advice Letter

ENVIRON

5 February 2009 Our Ref: AS120833

CHOF5 Little Bay Pty Ltd
c/o Charter Hall
Attn: Mark Jacobs
GPO Box 2704
Sydney NSW 2001

Dear Mark

Interim Advice Letter – Remedial Action Plan - Little Bay

1. INTRODUCTION

As a NSW EPA Accredited Auditor I have been engaged by CHOF5 Little Bay Pty Ltd to conduct a site audit for 1408 Anzac Parade, Little Bay, NSW. This interim advice has been provided with regard to the suitability of a Remedial Action Plan

Details of the audit are:

Requested by:	Mark Jacobs on behalf of CHOF5 Little Bay Pty Ltd
Request/Commencement Date:	28 March 2008
Auditor:	Graeme Nyland
Accreditation No.:	9808

This interim advice letter has been prepared based on the following:

- Review of the following reports:
  - 'Report to University of NSW on Stage 1 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW' Draft dated December 2006 by Environmental Investigation Services (EIS).
  - 'Report to University of NSW on Stage 2 Environmental Investigation Work Plan for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW' Draft dated December 2006 by EIS.
  - 'Report to University of NSW on Stage 2 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW' Draft dated February 2007 by EIS.
  - 'Little Bay, Trenching Works. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 23 April 2008 by ENSR Australia Pty Ltd (ENSR).

- 'Stage 1 Environmental Site Assessment Biological Resources Centre (BRC) 1406-1408 Anzac Parade Little Bay NSW 2036' dated 28 July 2008 by ENSR.
- Draft 'Remediation Works Plan. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 26 September 2008 by ENSR.
- Final 'Remediation Works Plan. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 7 October 2008 by ENSR.
- Final 'Remediation Works Plan. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 2 February 2009 (RWP)

- A site visit by the Auditor, 27 March 2008
- Discussions with ENSR who undertook the investigations.

EIS referred to previous investigation reports (see Section 8). These were not provided to the auditor.

The Auditor previously prepared a Site Audit Report and a Section B Site Audit Statement (GN336) on 6 July 2007 which concluded that the site could be made suitable for the proposed landuses subject to a RAP prepared by EIS in May 2007. The EIS RAP presented three options while the current RWP provides details for a preferred approach.

The RWP and this Interim Advice Letter will be submitted to provide elarification to Randwick City Council on the preferred remediation approach.

2. SITE DETAILS

2.1. Location

The site details are as follows:

Street address:	1408 Anzac Parade, Little Bay, NSW, 2036
Identifier:	Lot 10 and 11, DP 1127716
Local Government:	Randwick City Council
Site Area:	approximately 13.6 ha

The boundaries of the site are well defined by fence lines for most of the site however the eastern boundary is not marked.

2.2. Zoning

The current zoning of the site is Zone 5 Special Uses. It is understood that this zoning allows for residential uses.

2.3. Adjacent Uses

The site is located within an area of residential and open space uses. The surrounding land uses include:

- Medium density housing development to the north beyond which is the Long Bay Correctional Facility.

- An area of protected Eastern Suburbs Banksia Scrub (ESBS) consisting of 1 to 3m tall vegetation and The Coast Golf Course to the east which includes a fairway beyond which is Little Bay and the Pacific Ocean.

- A residential subdivision to the south that was formerly the Prince Henry Hospital to the south. The hospital site was remediated for the presence of asbestos as fibres within the sands and at the time of the site visit construction of houses was being undertaken.

- Anzac Parade to the west, beyond which is residential housing.

2.4. Site Condition

The site as shown as Attachment 1 consists of the following current land uses extending from Anzac Parade towards the coast:

- UNSW playing fields including synthetic hockey field, baseball diamond, football fields, office, caretakers brick cottage and car park area (approximately 4.5 ha) are located in the western section of the site adjacent to Anzac Parade. The hockey field had been cut into the sandstone with a bank separating this field from the football field. A bank sloped up towards the office from the western edge of the hockey field.

- UNSW Solarch compound (approximately 0.7 ha) to the south-east of the playing fields (towards the coast) which consists of a building previously used by for solar research and for the construction of solar vehicles.

- Dams extend north-south across the site with the southern-most dam extending to the south over the adjacent site.

- Vacant grassed area (approximately 3 ha) over the north-east section of the site on which there are large fill mounds, shipping containers, mounds of organic material and other surficial dumped rubbish. This area was previously a landfill area.

- UNSW Biological Services Compound (0.9 ha) included a complex of car parks and buildings of brick and iron/steel construction. Two electrical substations are located in this area.

The major topography of the site is varied. The site covers 17 hectares and extends 250 metres from Anzac Parade towards the coast. The site is characterised by:

- Sandstone plateau that extends from Anzac Parade to the eastern edge of the Solarch Compound and the eastern edge of the Soccer Field. The area below the sandstone plateau at the Solarch Compound consists of sandstone outcrops that are on the Register of the National Estate for its Geological Significance.

- The land falls steeply away from the sandstone ridge to the drainage channel that consists of two man-made dams that are aligned from north to south bisecting the site with seasonal inundation in between. A levee bank has been built up along the western extent of the second dam.

- Land filling in the western section has built up this area which still slopes down towards the coast.

- The UNSW Biological Services Compound is located on a slightly lower level.

2.5. Proposed Development

A development application (DA) is to be submitted for Stage 1 of works to facilitate the ultimate development of a mix of single dwelling houses, townhouses, apartments, open space and roadways over Lot 10.

The central corridor (Lot 11) would be retained and preserved as open space. This riparian corridor includes open space, two large dams and inundation area and the area of geological and aboriginal significance (ENSR indicate this is approximately 2.2 hectares).

For the purposes of this audit the 'residential with soil access' land use scenario will be assumed.

3. SITE HISTORY

EIS provided a site history based on aerial photographs, Council Records, Certificates of Title, WorkCover Database Records and NSW EPA Records and is summarised in Table 3.1.

Table 3.1 – Site History

Date	Activity
1881 - 1940	Hospital uses however the aerial photographs do not indicate that any buildings were located on the site and indicate that the site was used for paddocks and cultivated land for the hospital.
1940 – 1959	Sand mining 'in the vicinity of the hospital site'
1959 - 1960	Site subdivided and granted to UNSW
1960- - 1970	Aerial photographs indicated that an active quarry extended over the central section of the site which then operated as a non-putrescible landfill. Golf tee and green facilities constructed to the east.
1970 - 1987 -	Land filling in the west completed in approximately 1987. This site is listed under Randwick Council Unhealthy Building Land Policy. From the early 1980s the west was developed as sporting facilities with removal of landfill material in this area. The site was filled and levelled for the playing fields in 1981.
1987 - 1993	UNSW developed the current buildings on-site in 1984 to 1987 and in 1992 the sports fields and the Solarch building were constructed. It is understood that in 1991 the Biological services compound was excavated such that deep fill was removed.
1993 - 2007	The Solarch building is no longer used. The sports fields and biological services compound are still in use.

EIS provided a brief history of the adjoining Prince Henry Hospital site that indicated that the Prince Henry site was assigned for hospital uses in 1881. Hospital buildings and a cemetery were constructed over the 10 years from 1881 to 1891.

Based on Council correspondence summarised in the EIS Stage 2 Report, land filling at the site proceeded as follows:

- An application to fill the subject site with putrescible garbage was refused in March 1970. Council offered to fill the area with materials collected from clean up campaigns and other non-putrescible materials.

- The site was filled in by Randwick City Council as a weekend tip site (27 October 1976)

- UNSW gave approval for a company to apply for a licence to place 'clean fill' (natural excavated materials and selected demolition rubble subject to conditions of the Waste Control Authority) at the site. Tipping commenced in December 1981 and was to be closed in March 1987.

- NSW EPA correspondence on 25 February 2000 indicated that the landfill previously over the area of the Biological Services Building was 'a former putrescible garbage landfill'. Requirements for building included provisions for settlement, landfill gas accumulation under buildings, potential groundwater contamination with landfill leachate and off-site migration issues and potential risk of human exposure to contaminated landfill materials. Staged development approval was obtained in 2001. No validation sampling and analysis was undertaken prior to the construction of the buildings and the nature of materials below the buildings can not be verified.

Correspondence with Council indicates that the landfill was filled with non-putrescible waste however detailed records were not kept and the EPA sent a contradictory letter. The consistency and sources of these wastes is also unknown. The lack of available detail has been considered in the review of sample density and the results of the intrusive investigations.

The topography of the site indicates that some filling has occurred to level and build up some minor sections of the site.

The summary of the site history provided by EIS indicates that the site has been used by UNSW for the past 50 years, prior to which it was used for cultivation.

In the Auditor's opinion, the site history provides an adequate indication of past activities to determine potentially contaminating activities. There are inherent uncertainties in the contents of the landfill.

4. CONTAMINANTS OF CONCERN

EIS provided a discussion on the general contamination processes in Sydney and the potential site specific contamination. These have been tabulated in Table 4.1.

Table 4.1 – Contaminants of Concern (excluding BRC)

Area	Activity	Potential Contaminants
Adjacent to the adjoining former hospital site	Contamination is known to have been targeted for remediation.	PAHs and asbestos
Landfill area	Placement of organic material in the landfill and subsequent decomposition.	Landfill gas including methane
	Landfill material including demolition rubble.	Metals, PAHs, petroleum hydrocarbons, OCPs, PCBs and asbestos
Whole site	General history of contamination in Sydney	Lead, copper and zinc
	Filling	Unknown however could include metals, petroleum hydrocarbons, PAHs and asbestos.
Playing Fields	Spraying of pesticides	OCPs
Geologically significant area	Human disturbance in non-vegetated areas including dumped household rubbish and campfire sites noted by Douglas in 2003.	Douglas (2003) (see Section 8) submitted samples for a generic suite of analytes (metals, PAHs and petroleum hydrocarbons).

EIS did not undertake any intrusive investigations in the geologically significant area. Management of this area is discussed in Section 11.

The Auditor considers that the analyte list used by EIS is adequately reflected in the analytical suite used.

ENSR also note that fill has been contaminated by heavy metals, petroleum hydrocarbons, PAHs, asbestos containing materials, methane gas and general waste and demolition materials. Following a Stage 1 Assessment of the Biological Resources Centre (BRC) ENSR noted the additional chemicals of concern shown in Table 4.2.

Table 4.2 – Contaminants of Concern (BRC)

Activity	Potential Contaminants
Landfill materials	As for Table 4.1
Potential hazardous materials during building construction and electrical transformers	Metals (mainly zinc and lead), PCBs and asbestos
Potential use of solvents	Volatile organic compounds (VOCs) including chlorinated hydrocarbons and BTEX
Storage of oil and lubricants	Petroleum hydrocarbons and PAHs
Spraying of pesticides/termicides under and around residence	OCPs and metals

ENSR noted that contaminants of potential concern also included radioactive materials due to the use of radioisotopes and/or x-ray equipment. ENSR note that that it is 'unlikely that the activities conducted at the biological resources centre would have resulted in contamination beneath buildings'. A summary of the findings and recommendations of an earlier investigation is provided however future actions are not discussed in the RWP. It is understood that validation works are proposed following demolition of the building are proposed. This has been included as a recommendation in Section12.

5. STRATIGRAPHY AND HYDROGEOLOGY

Following a review of the referenced reports, a summary of the site stratigraphy and hydrogeology was compiled as follows.

5.1. Stratigraphy

Initial characterisation of the stratigraphy of the site by EIS, especially with respect to fill composition, was limited as augers and SPTs were used to investigate the site. Trenching undertaken by ENSR over the former landfill found that the depth of the fill was variable with fill extending to 9.7 m in one location. Fibre cement fragments were common with most encountered below 1.0 m and occasionally in the upper 1m. ENSR concluded that there is the potential for 'unidentified pockets of deep fill'.

The stratigraphy of the landfill is summarised in Table 5.1.

Table 5.1 – Stratigraphy (Landfill)

Depth	Stratigraphy
0 – 3/10 m	Fill: Silty sand with some sandstone gravel and root fibres and trace of coal and cloth fibres. Similar to this description the fill also contains sandstone, gravels, concrete, cobbles, rubber, glass, coal, ash and slag in places.
3.0 m	Sandstone

The stratigraphy of the Remainder of the Site is summarised in Table 5.2.

Table 5.2 – Stratigraphy (Remainder of the Site)

Depth	Stratigraphy
0 – 2.0	Fill: Silty sand with some sandstone gravel and root fibres The fill also contained clay and gravels and other inclusions such as cobbles, wire and brick. In some locations where fill was shallow (< 1m), a layer of silty sand (natural) was encountered (< 0.5 m thickness) over the sandstone bedrock.
2.0 - continues	Sandstone:

5.2. Hydrogeology

EIS estimate that the groundwater is perched within the fill and joints in the sandstone rather than being a 'significant water bearing aquifer'. A review of the Groundwater Monitoring Reports and the well construction descriptions on the logs indicates that groundwater was encountered as follows:

- Inflow of water was noted on the borehole logs at or just above the base of the fill in the landfill area. However 3 of the 4 wells screened in fill in landfill were dry on completion. (MW326A (borehole logs indicate that the well had inflow at 0.5 m), MW333A (no inflow noticed) and MW335A).

- The standing water levels in the landfill area varied from 2.7 m to 4.2 m BGL in the wells screened in sandstone and at 2.5 m in wells screened in the fill.

- Up-gradient groundwater varied from 3 m to 5 m BGL and down-gradient from 1 m to 3 m. The variations also indicate that groundwater is located within sandstone fractures.

- EIS has indicated that the apparent flow direction, based on the SWLs, is towards the dams to the west and south-west. However, EIS estimate that the higher elevation of sandstone to the east of the landfill may form a natural control structure causing artificial mounding leading to the apparent flow direction i.e. the true groundwater flow is to the east towards Little Bay. EIS concluded that 'further monitoring of groundwater conditions would be necessary to confirm the groundwater flow patterns within this section of the site'. The Auditor agrees that the flow directions of groundwater are not well known which has implications for the assessment criteria as the end point could be Little Bay or use for irrigation at the adjoining golf course.

6. EVALUATION OF QUALITY ASSURANCE AND QUALITY CONTROL

The Auditor has assessed the overall quality of the data by review of the information presented in the referenced reports, supplemented by field observations.

The Auditor's assessment follows in Tables 6.1 and 6.2.

Table 6.1 – QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
Sampling Density, Pattern, Location and Depth	In total, there are 137 soil sampling locations over 11.9 hectares. Buildings and the synthetic hockey field have been excluded. The appropriateness of the density of sampling (given that the site is so large) will depend on the consistency of results and the field observations. All samples were submitted for the common suite of analyses (TPH, BTEX, PAHs, metals) with slightly less for asbestos, OCPs and PCBs. Only samples collected from the playing fields were submitted for OPPs and acid herbicides. **Landfill**: 40 boreholes on a grid pattern over 3 hectares with an approximate distance of < 50 m between the boreholes. The boreholes confirm that the material consists of uncontrolled fill. The density allows the general nature of the contaminants to be determined. **Remainder of the site**: Boreholes were placed such that the density was less than 30m distance. This is equivalent to the minimum sampling density required for hot spot detection by EPA (1995) Sampling Design Guidelines for a 2 hectare site. Given the proposed use is for residential development the logs and analytical results will need to confirm the consistency of the materials. Fill used in the embankment to the west of the hockey field consists of a silty sand with concrete and gravel that was not targeted during the investigations. All other fill types appear to have been targeted for analysis. No point sources of potential contamination were identified that required targeted sampling. Two samples from each borehole were submitted for analysis. Surface samples (0-0.1m) were submitted for analysis. In the Auditor's opinion, this sampling strategy was appropriate and adequate to characterise the primary material types present on site. **Dam Sediments**: Five locations were sampled from the three dams. The samples were collected at 1 and 2 m depth. **Groundwater** monitoring wells were concentrated in the landfill (5 wells with 4 bundled), three located on the up-gradient side of the dams and three down-gradient within the Biological Services Building. The Auditor considers the density to be adequate to gain an overall impression of the risk of impacts in groundwater.
Well construction	Groundwater wells were installed with a solid flight auger. Four wells were screened over fill material with the remaining 10 wells excavated to 7m and screened over the final 3 metres in sandstone. Wells were constructed of 50 mm casing. The annulus was backfilled with 2mm graded sand to 0.5 to 1 m above the screen, a bentonite seal and then a concrete grout was used to seal the top. EIS indicate that all wells were fitted with and Ex-cap self sealing vapour sampling cap however the groundwater log sheets indicate

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	that not all of these were in place at that time. The wells were allowed to stand for one week prior to vapour measurements. For wells screened in fill, the standing water level was either encountered at the base or the wells were dry. Wells were developed with a pump with water parameters stabilised and visual monitoring indicating fines had been flushed or the well was dry.
Sample Collection Method	**Soil**: Sample collection was via a standard penetration test (SPT) split spoon which is considered adequate for this stage of the project but has deficiencies in assessing landfill contents. Some samples were collected directly from the solid stem auger and a hand auger (access restrictions adjacent to the dam). EIS did not indicate whether the external material was removed prior to collecting the sample. This method is not ideal as it can result in loss of volatiles and sample cross contamination. Most samples were collected with the SPT. Where odours were reported and the one elevated PID reading, SPTs were used. **Groundwater**: sampling was undertaken using low flow/micro purge and the water quality parameters were monitoring such that steady state conditions were achieved. **Landfill Gas:** EIS indicate that the wells were fitted with gas caps (except MW319A, MW312 and MW366) and a landfill gas analyser was used. No further details were provided**.**
Decontamination Procedures	**Soil**: The SPT was cleaned with detergent and rinsed following each event. The augers were also scrubbed with water and detergent followed by rising with potable water. New gloves were reportedly used for each new sample. **Groundwater**: The pump was cleaned between each well with dedicated bladders and tubing used for each new well.
Sample handling and containers	All samples were placed into prepared and preserved sampling bottles provided by the laboratory and chilled during storage and subsequent transport to the labs. Water samples to be analysed for heavy metals were field filtered. Correspondence between EIS and the laboratory indicate that two samples that were missing according to the chain of custody were sent to the laboratory 6 days after sampling for asbestos and TPH/BTEX analysis.
Chain of Custody	Completed chain of custody forms were provided in the report. It appears that these were faxed with a Sample Receipt Advice indicating that they were received on the same day. The date of sampling is not included in all report photocopied versions. The first page of 17 pages of chain of custody forms was not provided.
Detailed description of field screening protocols	A PID was used to screen the soil samples with results presented in the report. The maximum concentration was 247 ppm (eastern edge of the landfill) with all others less than 33 ppm. A sample

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	within 0.1m of the maximum PID reading was submitted for analysis. EIS indicate that the PID was calibrated prior to use. EIS indicate that VOC data was obtained from a partly filled glass jar following equilibrium. An LFGA2000 gas detector was used to detect methane, oxygen, hydrogen sulphide and carbon monoxide. Groundwater field parameters were measured during well sampling and development. Meters were calibrated prior to the start of each day. Calibration certificates were provided.
Calibration of field equipment	The reports indicated that calibration had been undertaken prior to leaving the office. Calibration certificates were provided to the Auditor. Groundwater meters were reported to have been calibrated prior to the start of each day. Field sheets were provided
Sampling Logs	Soil logs are provided within the report, indicating sample depth, PID readings and lithology. Landfill logs lack detail because of the limitations of the method used. Groundwater field sampling records were provided.

Table 6.2 – QA/QC – Field and Lab Quality Assurance and Quality Control

Field and Lab QA/QC	Auditor Comments
Field quality control samples	Field quality control samples including inter and intra laboratory duplicates, field blanks, rinsate blanks and a trip spike (water) were undertaken at appropriate frequencies.
Field quality control results	RPDs for the inter-laboratory (15) and intra-laboratory (11) duplicates were elevated for metals (lead, zinc, copper, nickel), PAHs, and for TPHs (only 2) as results were close to PQLs. Some detections in rinsate blanks, one detection in a soil blank of chrysene and benzo(a)pyrene and detection of zinc in two groundwater field blanks. Given the detections in the rinsate blanks and those in the primary samples, the risk of cross-contamination affecting the conclusions is considered to be minor. The results from all other field quality control samples were within appropriate limits.
NATA registered laboratory and NATA endorsed methods	Laboratories used included: Envirolab and SGS. All laboratory certificates were NATA stamped.
Analytical methods	A methodology summary was provided with the Envirolab and SGS laboratory certificates.
Holding times	Review of the COCs and laboratory certificates indicate that the holding times had been met. EIS also reported that holding times have been met.

Field and Lab QA/QC	Auditor Comments
Practical Quantitation Limits (PQLs)	PQLs were all less than the threshold criteria for the contaminants of concern.
Laboratory quality control samples	Laboratory quality control samples including laboratory duplicates, matrix spikes, laboratory blanks and surrogate spikes were undertaken by the laboratory at appropriate frequencies.
Laboratory quality control results	The recovery of one surrogate spike for TPH/PAHs/zinc/ammonia (acceptable levels were reported in the laboratory control sample) for one sample each was 'not available due to significant background levels of analyte in the sample'. A high spike recovery of lead (162%) was reported. The laboratory notes that this is due to the non homogenous nature of the sample for this particular element. The laboratory duplicates were elevated for metals (maximum of 58% for copper) and PAHs (maximum of 120%). Low concentrations were reported in the primary and duplicate samples. EIS noted that RPDs for copper and PAH in separate samples were higher than generally accepted. Envirolab noted that the elevated RPDs were accepted due to non-homogenous nature of the sample. The Auditor notes that results for PAHs and duplicates and descriptions of tar residues do indicate that the soils are non-homogenous. The results from all other laboratory quality control samples were within appropriate limits.
Data Quality Objectives and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	Predetermined data quality objectives (DQOs) were set for laboratory analyses including blanks, replicates, duplicates, laboratory control samples, matrix spikes, surrogate spikes and internal standards. These were discussed with regard to the five category areas. There was limited discussion regarding actions required if data do not meet the expected objectives. DQOs were also provided for the overall project which the Auditor considers to be appropriate. A QA/QC narrative describing all information relevant to the site assessment was included and concluded that the QA/QC data is of sufficient quality to be considered acceptable and meet the DQOs of the report.

The Auditor notes that some of the results reported in the laboratory certificates were not discussed in the report or tabulated. This was limited to the retesting of one sample for chromium VI and three for PAHs. One of three samples submitted in a separate sample batch reported a detection of asbestos that was not included in the tables or text of the report.

In considering the data as a whole the Auditor concludes that:

- The data are likely to be representative of the overall conditions at the site. Given the historical waste disposal by landfilling at the site, there are inherent uncertainties in the landfill content. This is discussed further during the assessment of remedial options.

- The data are complete.
- There is a high degree of confidence that the data are comparable for each sampling and analytical event.
- The primary laboratory provided sufficient information to conclude that the data are of sufficient precision.
- The data are likely to be accurate.

7. ENVIRONMENTAL QUALITY CRITERIA

The Auditor has assessed the soil and sediment data provided by EIS in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW (SIL Column 1 – 'residential with access to soil' and Column 5 'provisional phytotoxicity') in DEC *Guidelines for the NSW Site Auditor Scheme* (2006).

The RWP references SIL Column 3 – 'recreational open space' for open spaces including the central corridor sensitive areas, Column 5 'provisional phytotoxicity' for surface soils only, Column 4 – 'commercial industrial' for roadway areas and SIL Column 1 'residential with access to soil' and Column 2 'residential with minimal access to soil' for the relevant residential developments.

EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing TPH and BTEX results.

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for marine waters. As flow directions have not been clearly established it is not clear whether groundwater flows to the dams to be used as irrigation water over the golf course or to Little Bay.

The Auditor has considered the need for remediation based on the 'aesthetic' contamination as outlined in the NEPM (1999) Schedule B(1) *Guideline on the Investigation Levels for Soil and Groundwater* that states that 'there are no numeric Aesthetic Guidelines but the fundamental principle is that the soils should not be discoloured, malodorous (including when dug over or wet) nor of abnormal consistency. The natural state of the soil should be considered'.

Imported fill has been assessed in relation to attributes expected of virgin excavated natural material (VENM) or excavated natural material (ENM).

There are no national or EPA endorsed guidelines for asbestos in soil relating to human health. DEC (2006) state that Auditors must exercise their professional judgement when assessing whether a site is suitable for a specific use. The EPA states that the position of the Health Department is that there should be no asbestos in surface soil.

There are no criteria produced by the EPA for landfill gas specific to the assessment of contaminated sites. Guidelines are provided, however, in the EPA (January 1996) *"Environmental Guidelines: Solid Waste Landfills"*. The following requirements for monitoring of landfill gas are specified:

- Action level for subsurface gas monitoring to detect off-site migration is 1.25% methane by volume (v/v). This is equivalent to 25% of the Lower Explosive Limit (LEL) of methane. This action level relates to purged measurements, following flushing of one probe casing volume.

- Action level for gas accumulation in buildings within 250 m of deposited waste is 1.25% methane (v/v);

- Action level for surface gas emission monitoring is 500ppm (v/v) of methane at any point on the landfill surface (5cm above the ground surface on a calm day); and

- In addition to monitoring for methane, monitoring for hydrogen sulfide (H2S) may be required if landfill gas odours are of concern.

8. EVALUATION OF SOIL AND SEDIMENT ANALYTICAL RESULTS

Previous investigations were undertaken by Environmental and Earth Sciences in 1999 (15 test pits and groundwater assessment) and 2001 (landfill gas monitoring and groundwater assessment). Douglas Partners also undertook investigations in 2006. These reports were not provided to the Auditor.

The results below only include those obtained by EIS during the Stage 1 and Stage 2 Investigations. EIS provided a summary of works undertaken by Douglas Partners (2003) 'Report on Due Diligence Study, Little Bay Playing Fields and Biological Science Site, 1408 Anzac Parade, Little Bay' for the coastal vegetation area and the area of geologic significance which is also discussed below.

ENSR undertook trenching as outlined in ENSR (2008a) that provided clarification on the depths of fill in the landfill and the contaminant status.

8.1. Landfill

The fill within the former landfill area has been logged from auger holes as consisting of silty sand with inclusions varying from sandstone, gravels, concrete, cobbles, rubber, glass, coal, ash to slag. Fill depth is variable. Trenching by ENSR (23 April 2009) confirmed that fill was variable and reflective of the undulating bedrock topography.

Soil samples were analysed by EIS for a variety of contaminants including petroleum hydrocarbons, PAHs, asbestos and heavy metals, the results of which are summarised in Table 8.1. The results have been assessed against the environmental quality criteria.

Table 8.1 – Evaluation of Soil Analytical Results – Former Landfill - Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Asbestos	82	13	NA	NA	NA	NA
Arsenic	87	8	8.8	NA	0	0
Cadmium	87	8	2.2	NA	0	0

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Total Chromium	87	85	3300	NA	0	**1**
Chromium VI	1	0	-	NA	0	NA
Copper	87	79	15000	NA	0	**1**
Lead	87	87	290	NA	0	0
Nickel	87	73	79	NA	0	**2**
Zinc	87	87	2500	NA	0	**19**
Mercury (inorganic)	87	35	51	NA	0	**2**
PCBs	73	0	-	NA	0	NA
OCPs	73	0	-	NA	0	NA
TPH (C_6-C_9)	88	0	-	0	NA	NA
TPH (C_{10}-C_{36})	88	3	230	0	NA	NA
BTEX	88	0	-	0	NA	NA
Total PAHs	86	46	1200	NA	**5**	NA
Benzo(a)Pyrene	86	40	54	NA	**6**	NA

The results tabulated in Table 8.1 include results for BH340 as logs and site plan indicate that this borehole is consistent with the landfill. materials
n number of samples
NA No criteria available/used

The main impacts were found to consist of asbestos, tars and some metal and fuel impacts.

Asbestos fibres were detected in 12 of 81 (approximately 15%) samples collected from the landfill. The descriptions given by the laboratory included:

- fibres embedded in fibre cement sheet fragments with total weights ranging from 0.8 mg to 2.2 g
- fibres embedded in fibre cement sheet/small plaster fragments
- loose bundles from 3 to 4 mm long
- one fibre was embedded in a tarry residue.
- All detections were reported as ‘non-respirable fibres’.

Discussions with the laboratory indicate that this is based on the observation of asbestos fibres less than 3 micrometres in width, and greater than 5 micrometres in length, and with a length to width ratio greater than 3:1. EnHealth (2005) ‘Management of Asbestos in a Non-occupational Environment’ note that ‘fibres greater than 100 µm are not respirable unless first

broken down into smaller fibres' and that 'fibres less than 5 µm do not appear to cause, or at least, are much less likely to cause, asbestos related disease'. The laboratory reports the asbestos as observed and do not attempt to determine the friability of the materials.

The distribution of asbestos did not appear to be associated with other contaminants, fill type or location within the landfill. No visual indications of asbestos were noted in any of the EIS borehole logs. ENSR (23 April 2008) noted that fibre cement fragments were common, with most reported at greater than 1m depth, although occasionally at less than 1m depth. Concentrated areas of asbestos were not identified and there was no apparent pattern of distribution. ENSR note that 'fragments are visually identifiable once exposed'.

PAHs were detected above the PQLs in half of all samples with PAH concentrations above the site criteria in fill materials at five locations. The maximum benzo(a)pyrene concentration was 54 mg/kg and total PAHs at 1200 mg/kg in a sample from 3 metres depth. A sample at 1.7 to 1.95m in the same borehole also reported PAHs at 79.5 mg/kg and benzo(a)pyrene at 2.8 mg/kg. There were no visual indications noted in the borehole logs and the elevated concentrations did not appear to be associated with any particular fill type. The Auditor notes that the most elevated concentrations of PAHs were associated with a tarry residue noted by the laboratory during asbestos analysis. Two other samples within the landfill (and one within the playing fields adjacent to the main road) were reported by Envirolab during asbestos analysis as having either a 'plastic tarry disk' or 'tar fragments'. ENSR (23 April 2008) expect that small areas of ash/hydrocarbon impacted material are likely to be readily identifiable once exposed. Vertically adjacent samples did not report detections of PAHs above the PQLs.

Some fuel impacts associated with the fill materials were noted with 'hydrocarbons/oil waste' noted on borehole logs at two locations. Detections of ethylbenzene, xylene, naphthalene and trimethylbenzene were reported at one location. TPH C15-C28 was detected at three locations by EIS at low concentrations. A strong hydrocarbon odour was noted in the south-east corner at 1.4m where water was encountered. Odours nor water were encountered at any nearby boreholes. The most elevated PID reading of 247 ppm was encountered to the immediate north of the detection of the strong hydrocarbon odour.

Based on a strong hydrocarbon odour, distinct grey staining and a PID reading of 10 ppm, one sample was collected from 1.8 m and submitted for analysis. The material was encountered in trench No. 4 in the central northern portion of the site. The sample reported TPH C10-C36 at 65,440 mg/kg.

On review of the results and field observations ENSR consider that there is no apparent trend in the datea which is consistent with the variable fill that was observed.

Slightly elevated concentrations of metals were also reported across the landfill with mercury (50 times the PIL), chromium, copper (all in one sample only), nickel and zinc, exceeding the PILs. Copper was detected at an elevated concentration of 15,000 mg/kg well above the PIL of 100 g/kg and the SIL of 1000 mg/kg in one sample. Most other detections were less than 70 mg/kg. EIS submitted the sample with elevated chromium for chromium VI analysis. Chromium VI was not reported above the PQLs.

A broad sampling grid was implemented by EIS using augers and SPTs rather than test pits such that the ability to visually characterise the materials is limited. In addition, the history of the disposal of the landfill materials was not recorded. While a pattern of impact cannot be determined, the results indicate that the material contains at least some asbestos, heavy

metals, PAHs and petroleum hydrocarbons. EIS refer to the elevated concentrations as hotspots. Remedial options were presented in a RAP which is discussed in Section 11.

8.2. Geological/Aboriginal Heritage

Douglas Partners Pty Ltd (Douglas) undertook intrusive investigations in the geological and aboriginal heritage area in 2003. Fill consisting of sand to 0.4m was encountered adjacent to the access road in the geological area. Some dumped household rubbish and campfire sites were encountered. Petroleum hydrocarbons and PAHs were not reported above the PQLs and only low concentrations of metals were reported.

In the geological and aboriginal heritage area alluvial silty clays to 0.3 m were found to overlie sandstone. Some silty sand fill with cobbles, plant material and building rubble (roof tiles, concrete and wood pieces) was also encountered from 0.6 to 2.0 m depth. One sample was collected from the fill material which did not report TPH or PAHs above the PQLs and only low concentrations of metals.

The RAP indicates that a site management plan will be prepared for this area during rehabilitation and landscaping works for the geologically significant area. Given that limited information was provided to the Auditor, the Auditor considers that management e.g.limited access, is required until these areas are validated. This is discussed in Section 11.

8.3. Remainder of the Site

Soil samples were analysed for a variety of contaminants including asbestos, hydrocarbons, pesticides, herbicides (playing fields only) and heavy metals. The results have been assessed against the environmental quality criteria and are summarised in Table 8.2.

Table 8.2 – Evaluation of Soil Analytical Results – Remainder of the Site - Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Asbestos	105	**4**	NA	NA	NA	NA
Arsenic	127	34	35	NA	0	**3**
Cadmium	127	2	3	NA	0	0
Total Chromium	127	123	32	NA	0	0
Copper	127	119	110	NA	0	**1**
Lead	127	125	280	NA	0	0
Mercury (inorganic)	127	33	2	NA	0	**1**
Nickel	127	105	170	NA	0	**1**
Zinc	127	118	680	NA	0	**7**
PCBs	119	0	-	NA	0	NA
Chlordane	119	4	0.4	NA	0	NA

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
DDT, DDE and DDD	119	5	0.4	NA	0	NA
Other OCPs	119	0	-	NA	0	NA
OPPs	17	0	-	NA	0	NA
Total Acid Herbicides	15	0	-	NA	NA	NA
TPH (C_6-C_9)	127	0	-	0	NA	NA
TPH (C_{10}-C_{36})	127	3	230	0	NA	NA
BTEX	127	0	-	0	NA	NA
Total PAHs	127	33	15.8	NA	0	NA
Benzo(a)Pyrene	127	27	1	NA	0	NA

n *number of samples*
NA *No criteria available/used*

Asbestos fibres were detected in 4 of 105 (approximately 4%) samples collected from the remainder of the site. The likely source of the asbestos is estimated by EIS to be fill material and asbestos containing building materials (sourced from Sydney in general). The descriptions given by the laboratory were similar to that in the landfill. The locations and types found were as follows:

- The detections were within the football field (two at a distance of 150 m from each other) and on the edges of the Biological Services Compound (two at a distance of 100 m from each other).
- Two positive detections were reported in surface soils (0-0.2m), one in near surface soils (0.2-0.5m) and one at depth. No asbestos was observed visually in the field.
- fibres embedded in plaster fragment or fibre cement and one as a ‘loose fibre bundle 4mm long’ at the southern boundary with the Prince Henry site.
- All detections were reported by the laboratory as ‘non-respirable fibres’. The Auditor notes that the laboratory reports the asbestos as presented at the time and do not attempt to determine the friability of the materials.

These results indicate that the vertical and horizontal distribution is not known. There is a risk that the asbestos containing materials, particularly the loose fibre bundles, are friable and could become loose fibres if disturbed.

All other organics including chlordane, DDT/DDE/DDD and PAHs that were detected were reported at low concentrations well below the SILs.

One sample was collected adjacent to the electrical transformers however was collected at 0.6 to 0.8 m depth in fill located below a concrete base. PCBs were not detected above the PQLs. Further validation is proposed following removal of the substations as detailed in Section 11.

8.4. Sediments

Sediment samples were collected from the three dams and analysed for a variety of contaminants including hydrocarbons, pesticides, herbicides and heavy metals. The results have been assessed against the environmental quality criteria and are summarised in Table 8.3.

Table 8.3 – Evaluation of Sediment Analytical Results – Dams-Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Arsenic	5	4	22	NA	0	**1**
Cadmium	5	1	1.8	NA	0	0
Total Chromium	5	5	28	NA	0	0
Copper	5	5	49	NA	0	0
Lead	5	5	64	NA	0	0
Mercury (inorganic)	5	5	0.33	NA	0	0
Nickel	5	5	21	NA	0	0
Zinc	5	5	1000	NA	0	**2**
PCBs	5	0	-	NA	0	NA
OCPs	5	0	-	NA	0	NA
OPPs	5	0	-	NA	0	NA
Total Acid Herbicides	5	0	-	NA	NA	NA
TPH (C_6-C_9)	5	0	-	0	NA	NA
TPH (C_{10}-C_{36})	5	0	-	0	NA	NA
BTEX	5	0	-	0	NA	NA
Total PAHs	5	0	-	NA	0	NA
Benzo(a)Pyrene	5	0	-	NA	0	NA

n *number of samples*
- *No criteria available/used*

Only metals were reported above the PQLs with elevated zinc, consistent with other elevated concentrations on-site, reported above the PIL in two samples. All results were reported at less than the SIL. The Auditor concludes that the results adequately characterise the sediments at the site with regard to the risk to human health. The status of the dams with respect to aquatic ecosystems is not known or discussed.

9. EVALUATION OF LANDFILL GAS ANALYTICAL RESULTS

Landfill gas was measured in the former landfill area during EIS soil investigations. Landfill gas was also measured at eleven monitoring wells. Methane was detected at most locations. Methane was reported above the threshold of 1.25% v/v at 6 of the 25 drilling locations and 10 of 11 monitoring wells. Some more elevated concentrations reported in an additional two drilling locations were greater than 5% v/v at the eastern end of the landfill.

Although limited organic material was encountered during the intrusive investigations the results indicate that there is some decomposition of organic matter that is resulting in the generation of methane.

Methane gas was not encountered by ENSR, including in areas where methane has previously been detected. ENSR concluded that the excavation and removal of fill materials will remove the source of the methane.

Remedial works to address the generation of methane gas and other constituents of landfill gas i.e., hydrogen sulphide, which has a disagreeable odour, are discussed in Section 11.

10. EVALUATION OF SURFACE WATER AND GROUNDWATER ANALYTICAL RESULTS

Groundwater samples were collected from 10 wells in February 2007. Two additional shallow landfill wells and one up-gradient well were found to be dry. Samples were submitted for metal, hydrocarbons, VOC, OCP and nutrient analyses. Samples were submitted for naphthalene analysis rather than a suite of PAHs. The analytical results are summarised below in Table 10.1.

Table 10.1 – Evaluation of Groundwater Analytical Results – Summary Table (µg/L)

Analyte	Immediately Up-gradient of Landfill		Landfill		Biological Services Building		Dams (Surface Water)	
	Detections (n = 3)	Max	Detections (n = 5 including 319A)	Max	Detections (n = 2)	Max	Detections (n = 3)	Max
Arsenic	0	-	5	6	1	1	1	1.1
Cadmium	2	0.4	1	0.8	1	0.5	0	-
Total Chromium	1	**4.6**	5	**3.5**	0	-	2	**1.4**
Copper	1	**24**	1	**9.4**	0	-	2	**2.1**
Lead	2	**24**	1	**82**	2	**18**	**0**	**-**
Mercury (inorganic)	0	-	1	**39**	0	-	0	-
Nickel	3	**190**	5	**110**	2	**130**	0	16
Zinc	3	**400**	5	**300**	2	**200**	3	**13**
Ammonia-Nitrogen	NA	NA	3	**34000**	NA	NA	0	-

Analyte	Immediately Up-gradient of Landfill		Landfill		Biological Services Building		Dams (Surface Water)	
	Detections (n = 3)	Max	Detections (n = 5 including 319A)	Max	Detections (n = 2)	Max	Detections (n = 3)	Max
			(n = 3)					
OCPs	NA	NA	0	-	NA	NA	NA	NA
TPH (C_6-C_9)	0	-	0	-	1	150	0	-
TPH (C_{10}-C_{36})	0	-	5	590	2	270	0	-
Benzene	0	-	0	-	0	-	0	-
Toluene	0	-	0	-	0	-	0	-
Ethylbenzene	0	-	1	2.7	0	-	0	-
Total xylene	0	-	1	190	0	-	0	-
Naphthalene	0	-	2	10	0	-	0	-
Chloroform	0	-	1	1.8	1	360	0	-
Chlorobenzene	0	-	2	5.8	0	-	0	-
Isopropylbenzene	0	-	2	3.7	0	-	0	-
n-propyl benzene	0	-	2	6.1	0	-	0	-
1,3,5 – trimethyl benzene	0	-	1	**22**	0	-	0	-
1,2,4 – trimethyl benzene	0	-	1	**100**	0	-	0	-
Other VOCs	0	-	0	-	0	-	0	-

n *number of samples*
NA *not analysed*
- *Maximum less than the PQLs*
Bold *Concentrations exceed the ANZECC (2000) Trigger Values for Marine Waters*

The main impacts detected include ammonia, metals, TPH and associated fuel products such as trimethylbenzene.

Ammonia was found to dominate the nitrogen compounds in landfill groundwater which EIS considers to be associated with the anaerobic decomposition of organic matter including timber and other waste within the landfill. Groundwater outside the landfill was not submitted for analysis so a comparison of concentrations can not be made.

Organics were detected above the PQLs in groundwater sampled from the landfill and to a lesser extent at the Biological Services Building (which EIS estimates is affected by the landfill) indicating that landfill materials have had an impact on groundwater quality.

Groundwater wells were not located to the east of the landfill (towards Little Bay) with most detections reported in MW319 and MW319A (water perched in the fill) at the eastern edge of the landfill. The standing water levels and known relief of the site indicate that groundwater mounding occurs at this location behind the in-cut sandstone.

Chloroform and TPH C6-C9 were detected at low concentrations in the Biological Services Compound. EIS conclude that the likely source is the landfill rather than the biological services compound as there was no evidence of any sources at this location. The Auditor notes that as only low concentrations were reported no further action is required at this stage. During demolition of the biological services building observations of any odours or visual impacts should be noted and addressed. This is discussed in Section 11.

Three samples were collected from the three dams. The results indicate that only low concentrations of metals were reported. EIS conclude that the 'results do not indicate that the dams have been significantly impacted by contaminant leachate from the adjoining land filled area'. The Auditor agrees with regard to those contaminants submitted for analysis however samples were not analysed for ammonia.

Environmental and Earth Sciences (EES) undertook groundwater, soil and methane gas sampling in 2001. EIS provided a summary of the report however tabulated results and the report have not been provided to the Auditor. EIS indicate that petroleum hydrocarbons reported at < 10mg/L were encountered in all three wells that were screened in the fill material (sandstone aquifer was not assessed). The water was also characterised by low concentrations of metals and PAHs. EES discussed the possibility that detections of TPH were a result of breakdown of natural organic compounds in soil. These results are consistent with the current results. Relatively low concentrations of petroleum hydrocarbons were detected in soil at limited locations.

EIS concluded that slightly elevated concentrations of metals and petroleum hydrocarbons were of anthropogenic origin and likely to be associated with contaminated material within the landfill. Measures to address groundwater impacts are discussed in Section 11.

EIS concluded that 'contamination issues at the site are considered to be related to the presence of land filled material at the site. Additional groundwater monitoring may be necessary to confirm perched water conditions within the landfill with variation in climatic conditions'.

The Auditor considers that it has been established that there is contamination of groundwater principally by ammonia because of the presence of the landfill. It is not clear whether groundwater flows to the dams or via the subsurface to Little Bay. Groundwater is further discussed in the context of proposed site remediation in Section 11.

11. EVALUATION OF REMEDIATION

11.1. Remediation Strategy

Remediation is required for residential use due to the presence and potential presence of asbestos and other potential contamination pockets in fill materials. The presence of landfill gas and groundwater contamination indicates that putrescible materials such as green wastes may also be present in the landfill.

The 'Remediation Area' includes the following due to fill materials:

- Landfill and surrounds
- Former Solarch Compound
- The former Biological Resources Compound and surrounds
- Area surrounding two dams/water bodies in the central corridor.

A remedial strategy has been selected by ENSR as documented in the Remedial Works Plan (RWP). The remediation strategy is aimed at source removal and containment of residual fill materials.

Remediation is not required in the western portion (playing fields) of the site. ENSR indicate that bulk earthworks will be undertaken in this area and if contaminants are found the contingency would be to follow the remediation process outlined for other fill materials. Remedial works in this area are likely to be relatively minor compared to the remediation and/or management of the former landfill in rendering the site suitable for residential use.

The areas of geological, Aboriginal and ecological significance will be managed under an EMP. The boundaries will be delineated with fences and barriers. As limited information is available on these areas the Auditor considers that management is required until validated.

The Stage 1 report for the former Biological Resources Compound (BRC) and surrounds recommends that a hazardous materials assessment be undertaken prior to demolition, that validation sampling be undertaken following removal of fill 'prior to the broader remediation programme' as the contaminants of concern are different.

11.2. Evaluation of Remedial Action Plan

The Auditor has assessed the RWP by comparison with the checklist included in "Guidelines for Consultants Reporting on Contaminated Sites". As summarised in Table 11.1 the RWP was found to address the required remaining information for most items.

Table 11.1 – Evaluation of Remedial Works Plan

Remedial Action Pan	Comments
Remedial Goal	The purpose of the plan is to 'remove all accessible fill materials'. This includes removal of materials that generate methane, wastes un-suitable for re-use and contaminated materials such that the risks to human health and the environment are reduced. Broader objectives to minimise risks to human health and the environment are considered to be adequate.
Discussion of the extent of remediation required.	Landfill – to base of the landfill and edges as defined by the topography of the site which is to address associated groundwater and gas contamination. Fill – Solarch, former Biological Resources Compound and area surrounding the two dams/water bodies in the central corridor. These areas are defined by local topography and the depth of the materials. The extent of the Remediation Area adjacent to the dams and the geologically significant area will be surveyed prior to remedial works. The vertical extent of the remedial works will be 'either bedrock or natural residual material, if present'. While the aim is to target all accessible fill materials the horizontal extent may be limited to areas of restricted access. This includes protection of the integrity and stability of embankments adjacent to the geologically signficiant area, (fence lines and buildings) at the northern property boundary and at the dams. The extent of landfill material will terminate at the boundary between the site and the ESBS. If further excavation is required due to putrescible material off-site then arrangements would be made with the property owner and appropriate approvals obtained. The Auditor notes that where materials are retained, a discussion of risk and extent should be provided.
Remedial Options	A number of options considered for the landfill by the EIS RAP were previously assessed by the Auditor (SAS GN 336). ENSR also presented five options for the landfill in accordance with the remediation hierarchy (DEC 2006). Remainder of the Site: Limited discussion.
Selected Preferred Option	Excavation and removal of contaminated soils and unsuitable waste and off-site disposal and re-use of suitable materials. The Auditor considers that the landfill has been sufficiently characterised to implement this preferred option. Other than removal of unsuitable materials, no direct remediation of groundwater or landfill gas is proposed in the RWP. The Auditor agrees

Remedial Action Pan	Comments
	that groundwater and landfill gas can be addressed through soil remediation.
Rationale	Justification based on reduction of mass of contaminants, reduction or elimination of landfill gas and removal of source for groundwater contamination. The strategy limits the off-site disposal of suitable materials and is more cost-effective and environmentally sustainable than removing all fill. ENSR anticipate that following successful validation of the remedial works that 'ongoing and long-term management of the site will not be required'. The feasibility of this option is discussed in Section 11.3.
Proposed Validation Testing	Discussed in Section 11.3 The statistical basis for validation results was provided.
Interim Site Management Plan (before remediation)	It is understood that the development process could take some time given the staged development applications. It is understood that the site is fenced and grassed that will restrict access. There was evidence on-site of access (car dumping, rubbish dumping and graffiti). Additional fencing and signage may be required.
Site Management Plan (operation phase) including stormwater, soil, noise, dust, odour and OH&S	The Auditor considers that the RWP provides a basis on which contractors can prepare specific management plans i.e. Soil and Water Management Plan, Acid Sulphate Soil Management Plan, Health and Safety Plan.
Contingency Plan if Selected Remedial Strategy Fails	The Auditor considers that the RWP provides a basis on which contractor can prepare a Contingency Plan. If 'unacceptable conditions remain at the boundary (e.g. fill/waste with leachate or gas generating potential) then further remediation would be undertaken such as excavation, barrier or treatment.
Contingency Plans to Respond to site Incidents.	Provides management and contingency plans that are directly applicable.
Remediation Schedule and Hours of Operation	To be in accordance with the development consent once issued.
Licences and Approvals	It is understood that as the remediation and bulk earthworks are to be undertaken ancillary to a development application for the subdivision and are conditions of consent that the works are Category 2 under SEPP55. The Randwick City Council Contaminated Land Policy was not discussed. The land is located within a Heritage conservation area under the provisions of the Randwick LEP 1998 however the site is not a heritage item. RWP notes that materials would be disposed of in accordance with DECC (2008) Waste Classification Guidelines, transported by licensed contractors and be disposed of at an appropriately licensed waste facility.

Remedial Action Pan	Comments
	The POEO Act indicates that a licence is required where an area of more than 3 hectares of contaminated soil (material that presents a risk of harm) is disturbed or where more than 30,000 m^3 of contaminated soil is treated. The RWP notes that an environmental protection licence will be required prior to commencement of the works. RWP indicates that acid sulphate soils would be managed in accordance with the ASSMAC (1998) Acid Sulphate Manual, Acid Sulphate Soil Management Advisory Committee.
Contacts/Community Relations/	A sign displaying contact details of the contractor and project manager will be displayed during remediation works. RWP recommends that neighbours be informed of the works.
Staged Progress Reporting	Not indicated.
Long term site management plan	RWP notes that the remedial works proposed 'may remove the requirement for a long term EMP or implementation of a leachate or landfill gas management system'. ENSR essentially anticipate that a long term EMP will not be required. Given this assumption, no further details on management were provided. Long term management plans are proposed for areas of geological, Aboriginal and ecological significance. No details were provided.

11.3. Remediation Methodology and Validation

Remediation will involve the excavation of materials followed by screening, sorting and classification to determine whether the materials can be re-used or will be disposed off-site.

Essentially the process involves visual classification of materials based on the amount of waste, odours, the nature and type of inclusions and inert materials.

Materials with a 'significant proportion of general or demolition waste' will be disposed off-site. Other materials will be stockpiled and screened for visual and olfactory indications of contamination. If there are indications of contamination (excluding asbestos containing materials (ACM)), sampling and laboratory analysis will be undertaken to determine the suitability of the materials. Where ACM are observed, further investigations will be required. Inert materials such as bricks, sandstone and concrete will separated, crushed and re-used on-site.

Acid Sulphate Soil (ASS), if present beneath fill in the landfill areas and excavated, will be managed by containment dosing with lime.

Suitable materials will be placed and compacted prior to placement of a 1.5 m layer of VENM/ENM 'to meet the shortfall of the final design levels (if any) and to provide an additional layer between the final surface and the validated material'. It is understood that at least 1.5 m of VENM or ENM would be placed over the entire remediation area.

ENSR have considered the likely sources and volumes of materials to be excavated and screened.

To ensure that this process is successful the RWP indicates that 'caution will be exercised as the exact composition and depth of the subsurface fill materials is unknown', there will be a staged approach, the fill will be closely observed and a PID will be used to screen samples.

Validation works proposed are outlined in Table 11.2

Table 11.2 – Evaluation of Validation Plan

Classification	Nature	Validation – Visual and Analytical	Auditor Comments
Screening, Sorting and Classification Works			
Significant proportion of general or demolition waste	Heterogeneous fill material. No quantitative indication provided.	Once removed off-site, further bulk earthworks including screening and sorting would be undertaken.	Material will need to be adequately classified for off-site disposal.
Visual/olfactory indications of contamination	Hydrocarbon odours, ash, etc	A PID will be used and careful observation for visual and olfactory indications of contamination undertaken essentially on a bucket by bucket basis. Given the initial screen and the estimated small volumes of materials likely to be suitable for re-use, ENSR indicate confirmation analytical testing would be undertaken following the placement of materials at a rate of 1 per 500 m^3. If there is some evidence of impact then materials would be sampled at 1 per 120 m^3 and analysed for metals, petroleum hydrocarbons and PAHs. This density was selected as little chemical contamination has been detected in the past.	As sampling, for materials to be re-used, is proposed following placement of materials, there is a risk that re-excavation may be required depending on the results. The sampling densities are considered adequate as contamination has previously been shown to be associated with visual indications.
Visual indications of ACM	Low ACM risk – no apparent inclusions Medium ACM risk – moderate ACM inclusions	ACM Validation Process -hand picked -placed in 20 m x 20 m x 300 mm beds for visual inspection and hand picking -validation sampling over 5m by 5m grid creating composites to be assessed and screened in the field Repeat until satisfactory.	It is understood that all materials to be re-used will be screened for asbestos.

Classification	Nature	Validation – Visual and Analytical	Auditor Comments
	High ACM risk – significant ACM content	Dispose off-site and validate remaining materials as per low and medium ACM risk materials.	Adequate
Following Excavation			
Excavation	Base: Natural bedrock or natural residual soil Wall – aim is to 'remove all accessible fill materials' so validation limited to areas where access is limited.	Base Bedrock – visual validation including photographs Natural Residual Soil - Base (floor) samples at 1 per 100 m^2. If fill is retained (> 10m or where excavation to depth is not feasible) validation samples will still be collected (1 per 50 m^2). Wall: Fill retained horizontally in areas of restricted access will be targeted at 1 per 20 lineal metres. This also includes where fill is retained at the site boundaries i.e. between the site and the ESBS. If fill is retained in the dam embankments samples would be collected at 0.5 m depth prior to placement of VENM/ENM.	It is understood that the aim is to remove all fill materials. ENSR provide an estimate of areas where residual materials may be retained.
Surface	Not discussed	Surface samples (0-0.1 m) on a 40 m grid in the ecologically sensitive area and the dam area. Additional samples will be collected from 0.5 m in the dam area.	Given that sampling has already been undertaken the additional density if considered to be adequate.
Groundwater and Gas	Contaminants sourced from fill	Removal of fill. The RWP proposes validation monitoring at the completion of the remedial works. The number of wells, locations and period of monitoring would be agreed prior to completion of the soil remediation programme.	A discussion of any residual fill retained on-site and the potential risk to groundwater and gas should be discussed at the completion of the works. In principal this should be adequate however will depend on validation of fill removal and the proposed sampling regime.

Classification	Nature	Validation – Visual and Analytical	Auditor Comments
		ENSR note that the duration is unlikely to extend beyond 3 months given the low likelihood of groundwater and gas impacts post-remediation.	
Imported Materials	VENM /ENM	Documentation. If documentation satisfactory, sample rate of 1 per 100 m^3 of imported fill for TPH, BTEX, metals, OCPs, PCBs and PAHs.	Ensure that visual verification of the material is also provided and an acceptance process is implemented.

The Auditor considers that implementation of this remedial option would render the site suitable for residential development subject to suitable and successful validation of the excavation base and imported material and the other measures discussed for the remainder of the site in Section 11.1.

An EMP may still be required, depending on the level of validation and validation results obtained.

It is considered that these further actions can be adequately mandated and controlled as part of the development application process.

12. CONCLUSIONS AND RECOMMENDATIONS

It is the Auditors opinion that implementation of the RWP would render the site suitable for residential development subject to suitable and successful validation of the excavation base and imported material and the other measures discussed for the remainder of the site in Section 11.

It is the Auditor's opinion that:

- investigations undertaken by EIS and ENSR have adequately characterised the nature and extent of contaminants in fill to formulate a plan of remediation or management
- the site could be made suitable for residential uses if the site were remediated and validated in accordance with the RWP
- an EMP may be required depending on the level of validation and validation results obtained.

The Auditor recommends that:

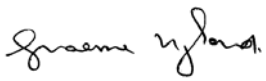
- Following demolition of the buildings and associated infrastructure in the Biological Resource Centre, that the surface be validated.

* * *

Consistent with Department of Environment and Climate Change (DECC and formerly NSW EPA) requirement for staged "signoff" of sites that are the subject of progressive assessment, remediation and validation, I advise that:

- This advice letter does not constitute a Site Audit Report or Site Audit Statement.
- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation.
- This interim advice will be documented in the Site Audit Report.

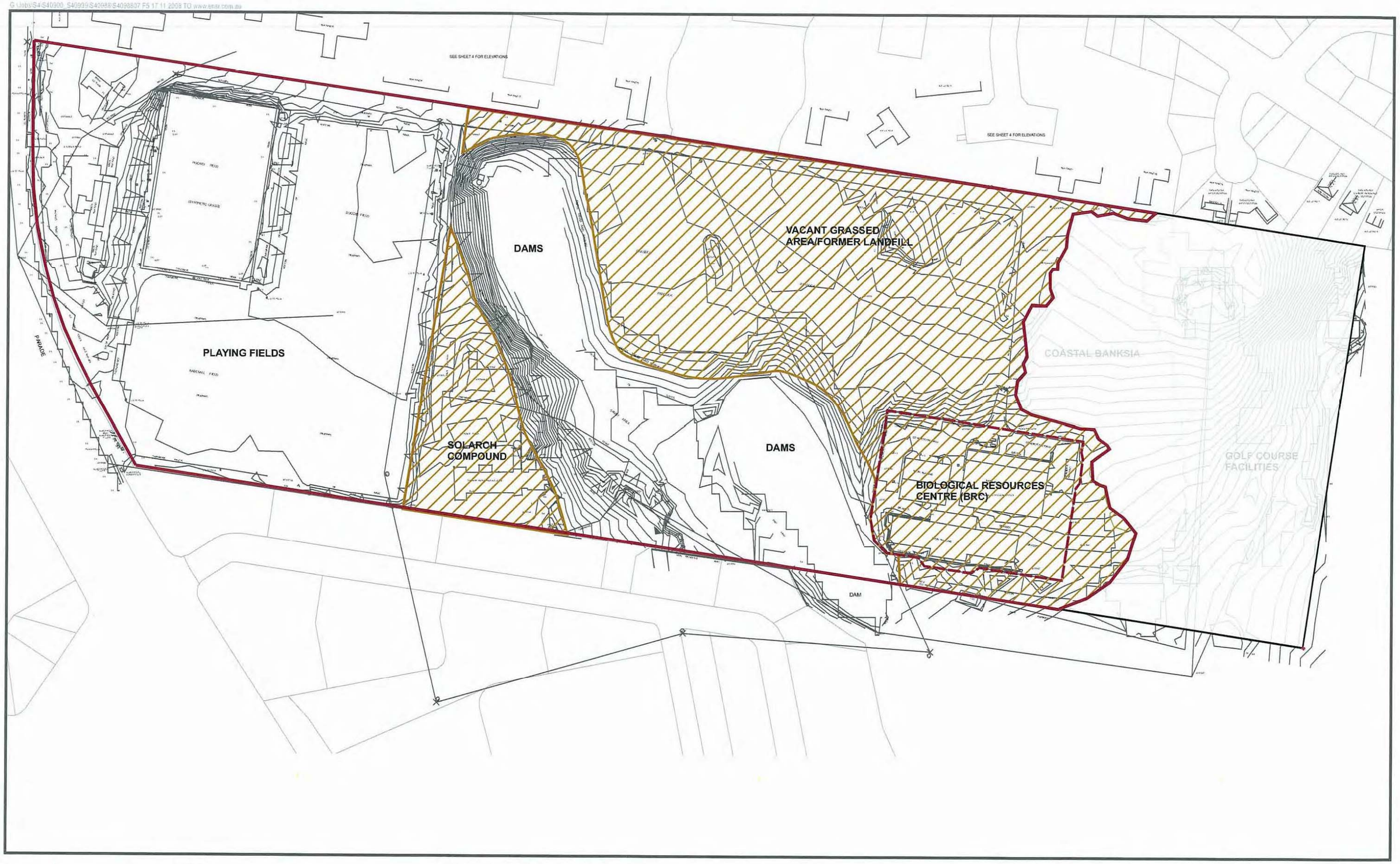
Yours faithfully
ENVIRON Australia Pty Ltd



Graeme Nyland
EPA Accredited Auditor 9808

Enc: Attachment 1

ATTACHMENT 1: Site Layout



ENSR | AECOM

0 50m

Little Bay Campus Boundary
Biological Resources Centre Boundary (BRC)
Remediation area

Figure 5 | **Remediation Area**

Charter Hall Pty Ltd

1406 - 1408 Anzac Parade,
Little Bay NSW

Site Audit Report
Stage 3 & 4, Little Bay Cove Development, Anzac Parade, Little Bay

Prepared for:

CHOF5 Little Bay Pty Ltd

Prepared by:
ENVIRON Australia Pty Ltd

Date:
May 2014

Project Number:
AS120833

Audit Number:
GN 388-2
GN 338-3

ENVIRON

26 May 2014 Our Ref: AS120833

CHOF5 Little Bay Pty Ltd
c/o Charter Hall
Attn: Simon Stockfeld
Level 20, No.1 Martin Place
Sydney, NSW, 2000

Dear Simon

Re: Site Audit Report – Stage 3 & 4, Little Bay Cove Development, Anzac Parade, Little Bay

I have pleasure in submitting the Site Audit Report for the subject site. Two Site Audit Statements, produced in accordance with the NSW Contaminated Land Management Act 1997, follow this letter. The Audit was commissioned by CHOF5 Little Bay Pty Ltd to assess the suitability of the site for its intended residential and recreational uses.

The Audit was initiated to comply with terms of judgment of the Land and Environment Court, Appeal No. 10672 of 2009, dated 23 December 2009 and is therefore a statutory audit.

Thank you for giving me the opportunity to conduct this Audit. Please call me on 9954 8100 if you have any questions.

Yours faithfully,
ENVIRON Australia Pty Ltd

Graeme Nyland
EPA Accredited Site Auditor 9808

Cc: EPA (Statement only)
Randwick City Council

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 31st October 2012. For more information about completing this form, go to Part IV.

PART I: Site audit identification

Site audit statement no. GN 388-2

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:	Graeme Nyland	Company:	ENVIRON Australia Pty Ltd
Address:	Level 3, 100 Pacific Highway (PO Box 560)		
	North Sydney NSW	Postcode:	2060
Phone:	02 9954 8100	Fax:	02 9954 8150

Site details

Address: 1406 – 1408 Anzac Parade, Little Bay, NSW

Postcode: 2036

Property description *(attach a list if several properties are included in the site audit)*

Part Lot 10 and Lot 11 DP 1127719 (See Stage 4 on attachment at end of Part I of this Statement)

Local Government Area: Randwick City Council

Area of site (e.g. hectares): 5.77 ha Current zoning: R1 General Residential

To the best of my knowledge, the site **~~is/~~is not*** the subject of a declaration, order, agreement or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

Declaration/Order/Agreement/Proposal/Notice* no(s): N/A

Strike out as appropriate

Site audit commissioned by

Name: Mark Jacobs Company: CHOF5 Little Bay Pty Ltd

Address: GPO Box 2704, Sydney

Postcode: 2001

Phone: 8908 4060 Fax: 8908 4040

Name and phone number of contact person (if different from above)

Geoff Warren, phone 9247 7999, fax 9247 4977

Purpose of site audit

☑ A. To determine land use suitability *(please specify intended use[s])*

Mix of single dwelling houses, townhouses, apartments, public open space and roadways

~~**OR**~~

☐ ~~B(i) To determine the nature and extent of contamination, and/or~~

☐ ~~B(ii) To determine the appropriateness of an **investigation/remedial action/management plan***, and/or~~

☐ ~~B(iii) To determine if the land can be made suitable for a particular use or uses by implementation of a specified **remedial action plan/management plan*** *(please specify intended use[s])*~~

……

Information sources for site audit

Consultancy(ies) which conducted the site investigation(s) and/or remediation

- Environmental Investigation Services (EIS).
- ENSR Australia Pty Ltd (ENSR now AECOM).
- AECOM Australia Pty Ltd (AECOM)
- Australian Nuclear Science and Technology Organisation (ANSTO)

Title(s) of report(s) reviewed:

- 'Report to University of NSW on Stage 1 Environmental Site Assessment for Proposed Site Redevelopment at 1408 Anzac Parade, Little Bay, NSW', dated December 2006 by EIS.
- 'Report to University of NSW on Stage 2 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW', Draft dated February 2007 by EIS.
- 'Stage 1 Environmental Site Assessment, Biological Resources Centre (BRC), 1406-1408 Anzac Parade Little Bay NSW 2036' dated 28 July 2008 by ENSR.
- 'Remediation Works Plan, 1406-1408 Anzac Parade, Little Bay NSW 2036', dated 2 February 2009 by ENSR.

Strike out as appropriate

- ‘Biological Resources Centre, Post-Demolition Validation Sampling Plan’, dated 23 November 2010 by AECOM.
- ‘In-situ Waste Classification, 1406 Anzac Parade Little Bay – Eastern Portion’, draft dated 20 May 2011 by AECOM.
- ‘Former Biological Resources Centre, Post-Demolition Validation’, draft dated 13 July 2011 by AECOM.
- ‘Work Method Statement – Little Bay Soil Validation Sampling (Draft)’, dated 3 August 2011 by AECOM.
- ‘Radiological Survey of Biological Resources Centre Land at Little Bay, NSW’, dated 6 January 2012 by ANSTO.
- ‘Landfill Gas and Groundwater Monitoring – 1408 Anzac Parade, Little Bay NSW’, dated 25 July 2013, AECOM.
- ‘Remediation and Validation Report, 1406-1408 Anzac Parade, Little Bay NSW’, dated 6 May 2014, by AECOM. Interim validation progress reports were attached as appendices.

Other information reviewed (including previous site audit reports and statements relating to the site)

- ‘Site Audit Report - UNSW Little Bay’, and Site Audit Statement GN336 (Section B) dated 6 July 2007, ENVIRON Australia (ENVIRON).
- ‘Interim Advice Letter – Remedial Action Plan – Little Bay’ dated 5 February 2009 by ENVIRON.

Site audit report

Title: Site Audit Report – Stage 3 & 4, Little Bay Cove Development, Anzac Parade, Little Bay

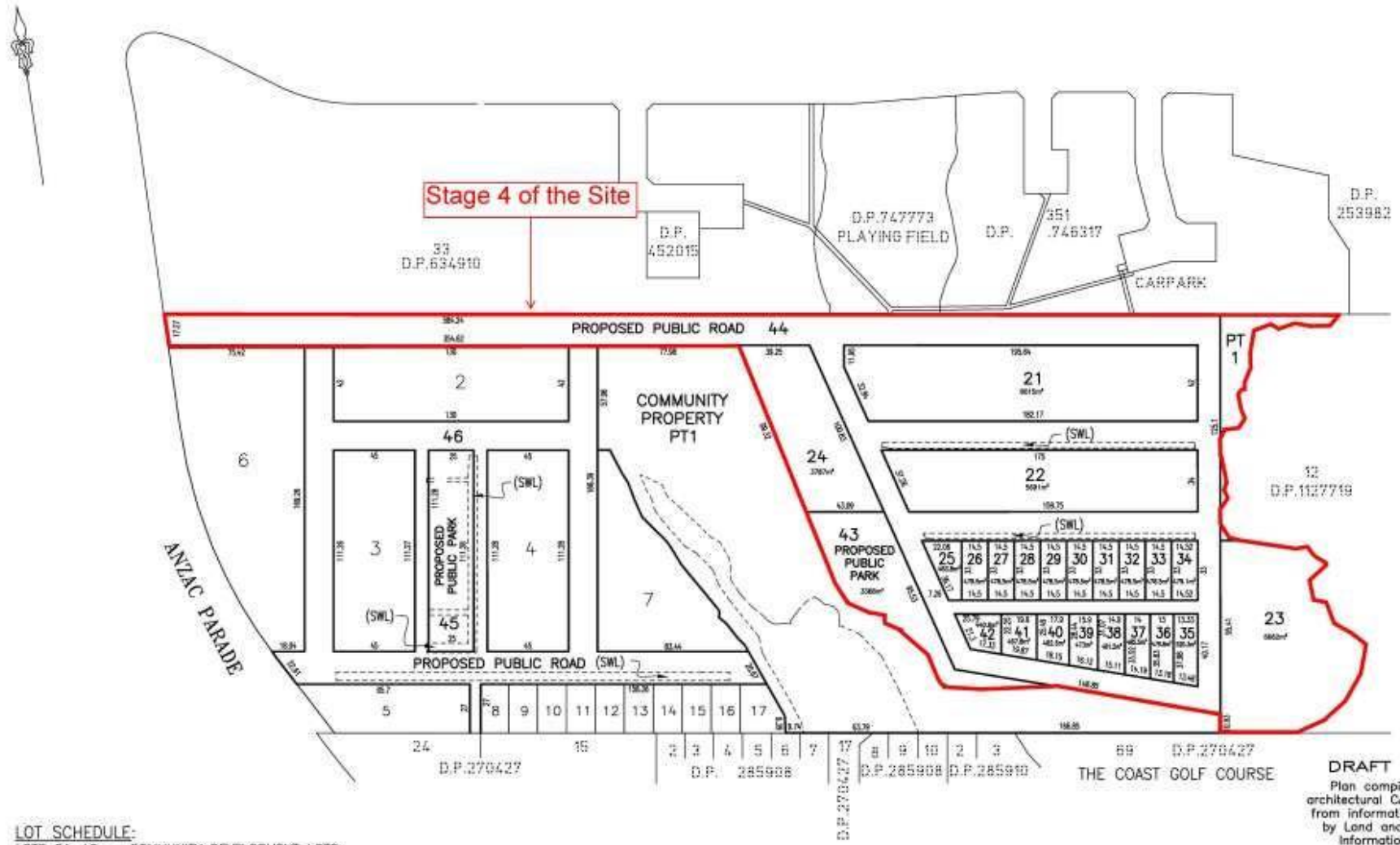
Report no. GN 388-2 (ENVIRON Ref: AS120833) Date: May 2014

Strike out as appropriate

PLAN FORM 2 (A2)

WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION

Sheet No. 1 of 1 Sheets



DRAFT PLAN

Plan compiled from architectural CAD data and from information supplied by Land and Property Information NSW.

Plan is subject to a detail survey.

PRINTED 5 APRIL 2012
(ISSUE 10)

LOT SCHEDULE:
LOTS 21–42 – COMMUNITY DEVELOPMENT LOTS.
LOT 43 & 45 – PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS OPEN SPACE.
LOT 44 & 46 – PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS PUBLIC ROAD

(SWL) – SWALE BEING THE SUBJECT OF THE POSITIVE COVENANT NOTED 4 IN THE 88B SCHEDULE OF STAGE 1

Surveyor: Date of Survey: Surveyor's Ref: 080712 PLAN	PLAN OF COMMUNITY SUBDIVISION OF DEVELOPMENT LOT 18, 19 & 20 OF THE STAGE 1 COMMUNITY PLAN	LGA: RANDWICK Locality: LITTLE BAY Subdivision No: Lengths are in metres Reduction Ratio 1: 1500(A2)	REGISTERED	DP STAGE 2

10mm 20 30 40 50 60 70 80 90 100 110 120 130 140 150 Table of mm

PART II: Auditor's findings

Please complete either Section A or Section B, **not** both. *(Strike out the irrelevant section.)*

Use Section A where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land use(s).

Use Section B where the audit is to determine the nature and extent of contamination and/or the appropriateness of an investigation or remedial action or management plan and/or whether the site can be made suitable for a specified land use or uses subject to the successful implementation of a remedial action or management plan.

Section A

☑ **I certify that, in my opinion, the site is SUITABLE for the following use(s)** *(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)* ……~~

~~**subject to compliance with the following environmental management plan** *(insert title, date and author of plan)* **in light of contamination remaining on the site:**~~

~~**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:

The site is the eastern portion of the Little Bay Cove development. Prior to remediation, the site contained a landfill and biological research centre.

Remediation of the site involved the excavation of fill material followed by validation of the resulting excavation. Material not suitable for reuse was disposed offsite. Fill material reused on the site was remediated by sieving and picking, and validated.

Low concentrations of contaminants and occasional fragments of asbestos sheeting may remain in remediated and validated fill material. A sandstone separation layer approximately 1 m thick was placed over the remediate fill material.

Section B

Purpose of the plan[1] which is the subject of the audit …

I certify that, in my opinion:

- ❑ **the nature and extent of the contamination HAS/HAS NOT* been appropriately determined**

AND/OR

- ❑ **the investigation/remedial action plan/management plan* IS/IS NOT* appropriate for the purpose stated above**

AND/OR

- ❑ **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 remedial action plan/management plan* *(insert title, date and author of plan)*

…

subject to compliance with the following condition(s):

…

[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

**** Strike out as appropriate***

~~**Overall comments**~~

...

PART III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority under the *Contaminated Land Management Act 1997* (Accreditation No. 9808).

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... 26/5/2014

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 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 contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remedial action or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use(s) of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A or Section B of Part II, **not** both.

In **Section A** the auditor may conclude that the land is *suitable* for a specified use(s) 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 remediation or investigation of the site was needed to render the site fit for the specified use(s). Any **condition** imposed should be limited to implementation of an environmental management plan to help ensure the site remains safe for the specified use(s). The plan should be legally enforceable: for example a requirement of a notice under the *Contaminated Land Management Act 1997* (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*.

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.

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 whether land can be made suitable for a particular land use or uses upon implementation of a remedial action or management 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.

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.

In **Part III** the auditor certifies his/her 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:

EPA (NSW)
Contaminated Sites Section
PO Box A290, SYDNEY SOUTH NSW 1232
nswauditors@epa.nsw.gov.au

AND

the **local council** for the land which is the subject of the audit.

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 31st October 2012. For more information about completing this form, go to Part IV.

PART I: Site audit identification

Site audit statement no. GN 388-3

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:	Graeme Nyland	Company:	ENVIRON Australia Pty Ltd
Address:	Level 3, 100 Pacific Highway (PO Box 560)		
	North Sydney NSW	Postcode:	2060
Phone:	02 9954 8100	Fax:	02 9954 8150

Site details

Address: 1406 – 1408 Anzac Parade, Little Bay, NSW

Postcode: 2036

Property description *(attach a list if several properties are included in the site audit)*

Part Lot 10 and Lot 11 DP 1127719 (See Stage 3 on attachment at end of Part I of this Statement).

Local Government Area: Randwick City Council

Area of site (e.g. hectares): 2.37 ha Current zoning: E2 Environmental Conservation

To the best of my knowledge, the site **~~is/~~is not*** the subject of a declaration, order, agreement or notice under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

Declaration/Order/Agreement/Proposal/Notice* no(s): N/A

Strike out as appropriate

Site audit commissioned by

Name: Mark Jacobs Company: CHOF5 Little Bay Pty Ltd

Address: GPO Box 2704, Sydney

Postcode: 2001

Phone: 8908 4060 Fax: 8908 4040

Name and phone number of contact person (if different from above)

Geoff Warren, phone 9247 7999, fax 9247 4977

Purpose of site audit

☑ A. To determine land use suitability *(please specify intended use[s])*

Public open space

~~**OR**~~

☐ ~~B(i) To determine the nature and extent of contamination, and/or~~

☐ ~~B(ii) To determine the appropriateness of an **investigation/remedial action/management plan***, and/or~~

☐ ~~B(iii) To determine if the land can be made suitable for a particular use or uses by implementation of a specified **remedial action plan/management plan*** *(please specify intended use[s])*~~

……

Information sources for site audit

Consultancy(ies) which conducted the site investigation(s) and/or remediation

- Environmental Investigation Services (EIS).
- ENSR Australia Pty Ltd (ENSR now AECOM).
- AECOM Australia Pty Ltd (AECOM)
- Australian Nuclear Science and Technology Organisation (ANSTO)

Title(s) of report(s) reviewed:

- 'Report to University of NSW on Stage 1 Environmental Site Assessment for Proposed Site Redevelopment at 1408 Anzac Parade, Little Bay, NSW', dated December 2006 by EIS.
- 'Report to University of NSW on Stage 2 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW', Draft dated February 2007 by EIS.
- 'Stage 1 Environmental Site Assessment, Biological Resources Centre (BRC), 1406-1408 Anzac Parade Little Bay NSW 2036' dated 28 July 2008 by ENSR.
- 'Remediation Works Plan, 1406-1408 Anzac Parade, Little Bay NSW 2036', dated 2 February 2009 by ENSR.
- 'Biological Resources Centre, Post-Demolition Validation Sampling Plan', dated 23 November 2010 by AECOM.

Strike out as appropriate

- ‘In-situ Waste Classification, 1406 Anzac Parade Little Bay – Eastern Portion’, draft dated 20 May 2011 by AECOM.
- ‘Former Biological Resources Centre, Post-Demolition Validation’, draft dated 13 July 2011 by AECOM.
- ‘Work Method Statement – Little Bay Soil Validation Sampling (Draft)’, dated 3 August 2011 by AECOM.
- ‘Radiological Survey of Biological Resources Centre Land at Little Bay, NSW’, dated 6 January 2012 by ANSTO.
- ‘Landfill Gas and Groundwater Monitoring – 1408 Anzac Parade, Little Bay NSW’, dated 25 July 2013, AECOM.
- ‘Remediation and Validation Report, 1406-1408 Anzac Parade, Little Bay NSW’, dated 6 May 2014, by AECOM. Interim validation progress reports were attached as appendices.

Other information reviewed (including previous site audit reports and statements relating to the site)

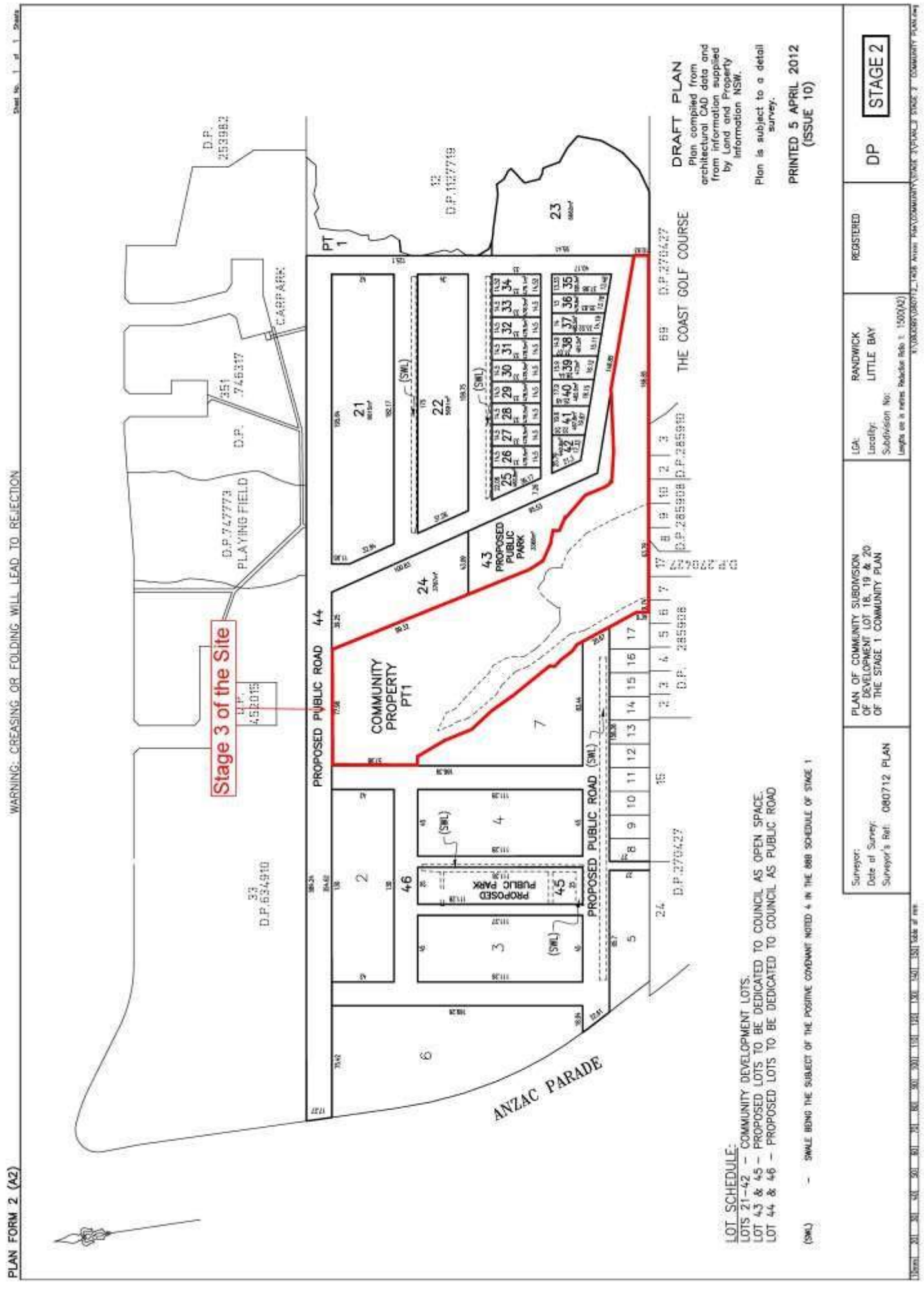
- ‘Site Audit Report - UNSW Little Bay’, and Site Audit Statement GN336 (Section B) dated 6 July 2007, ENVIRON Australia (ENVIRON).
- ‘Interim Advice Letter – Remedial Action Plan – Little Bay’ dated 5 February 2009 by ENVIRON.

Site audit report

Title: Site Audit Report – Stage 3 & 4, Little Bay Cove Development, Anzac Parade, Little Bay

Report no. GN 388-3 (ENVIRON Ref: AS120833) Date: May 2014

Strike out as appropriate


PLAN FORM 2 (A2)
WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION
Stage 3 of the Site
PROPOSED PUBLIC ROAD 44
COMMUNITY PROPERTY PT1
43 PROPOSED PUBLIC PARK
PROPOSED PUBLIC ROAD (SWL)
PROPOSED PUBLIC PARK
ANZAC PARADE
THE COAST GOLF COURSE
D.P.747773 PLAYING FIELD
CARP PARK
D.P. 253982
D.P. 746317
D.P.634910
D.P.1077719
D.P.270427
D.P. 285998
PT 1
DRAFT PLAN
Plan compiled from architectural CAD data and from information supplied by Land and Property Information NSW.
Plan is subject to a detail survey.
PRINTED 5 APRIL 2012 (ISSUE 10)
LOT SCHEDULE:
LOTS 21-42 - COMMUNITY DEVELOPMENT LOTS.
LOT 43 & 45 - PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS OPEN SPACE.
LOT 44 & 46 - PROPOSED LOTS TO BE DEDICATED TO COUNCIL AS PUBLIC ROAD
(SWL) - SWALE BEING THE SUBJECT OF THE POSITIVE COVENANT NOTED 4 IN THE 88B SCHEDULE OF STAGE 1
Surveyor:
Date of Survey:
Surveyor's Ref: 080712 PLAN
PLAN OF COMMUNITY SUBDIVISION OF DEVELOPMENT LOT 18, 19 & 20 OF THE STAGE 1 COMMUNITY PLAN
LGA: RANDWICK
Locality: LITTLE BAY
Subdivision No:
Lengths are in metres. Reduction Ratio 1: 1500(A2)
REGISTERED
DP
STAGE 2

PART II: Auditor's findings

Please complete either Section A or Section B, **not** both. *(Strike out the irrelevant section.)*

Use Section A where site investigation and/or remediation has been completed and a conclusion can be drawn on the suitability of land use(s).

Use Section B where the audit is to determine the nature and extent of contamination and/or the appropriateness of an investigation or remedial action or management plan and/or whether the site can be made suitable for a specified land use or uses subject to the successful implementation of a remedial action or management plan.

Section A

☑ **I certify that, in my opinion, the site is SUITABLE for the following use(s)** *(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)* ……~~

~~**subject to compliance with the following environmental management plan** *(insert title, date and author of plan)* **in light of contamination remaining on the site:**~~

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:

The site is the central portion of the Little Bay Cove development. Prior to remediation the site contained a drainage channel with two constructed wetlands.

Remediation of the site involved the excavation of fill material followed by validation of the resulting excavation. Material not suitable for reuse was disposed offsite. Fill material reused on the site was remediated by sieving and picking, and validated.

Low concentrations of contaminants and occasional fragments of asbestos sheeting may remain in remediated and validated fill material. A minimum of 300 mm of topsoil was placed over the remediated fill material.

Section B

Purpose of the plan[1] which is the subject of the audit …

I certify that, in my opinion:

- ❑ **the nature and extent of the contamination HAS/HAS NOT* been appropriately determined**

AND/OR

- ❑ **the investigation/remedial action plan/management plan* IS/IS NOT* appropriate for the purpose stated above**

AND/OR

- ❑ **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 remedial action plan/management plan* *(insert title, date and author of plan)*

…

subject to compliance with the following condition(s):

…

[1] For simplicity, this statement uses the term 'plan' to refer to both plans and reports.

**** Strike out as appropriate***

~~**Overall comments**~~

...

PART III: Auditor's declaration

I am accredited as a site auditor by the NSW Environment Protection Authority under the *Contaminated Land Management Act 1997* (Accreditation No. 9808).

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... 26/5/2014

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 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 contains the auditor's opinion of the suitability of the site for specified uses or of the appropriateness of an investigation, or remedial action or management plan which may enable a particular use. It sets out succinct and definitive information to assist decision-making about the use(s) of the site or a plan or proposal to manage or remediate the site.

The auditor is to complete either Section A or Section B of Part II, **not** both.

In **Section A** the auditor may conclude that the land is *suitable* for a specified use(s) 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 remediation or investigation of the site was needed to render the site fit for the specified use(s). Any **condition** imposed should be limited to implementation of an environmental management plan to help ensure the site remains safe for the specified use(s). The plan should be legally enforceable: for example a requirement of a notice under the *Contaminated Land Management Act 1997* (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*.

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.

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 whether land can be made suitable for a particular land use or uses upon implementation of a remedial action or management 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.

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.

In **Part III** the auditor certifies his/her 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:

EPA (NSW)
Contaminated Sites Section
PO Box A290, SYDNEY SOUTH NSW 1232
nswauditors@epa.nsw.gov.au

AND

the **local council** for the land which is the subject of the audit.

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List of Tables and Figures

List of Appendices

List of Abbreviations

ABS	Activity Based Sampling
ACM	Asbestos Containing Material
AECOM	AECOM Australia Pty Ltd
AHD	Australian Height Datum
ALS	Australian Laboratory Services
ANSTO	Australian Nuclear Science and Technology Organisation
ANZECC	Australian and New Zealand Environment and Conservation Council
ASET	Australian Safer Environment and Technology Pty Ltd. (Laboratory)
ASS	Acid Sulphate Soils
BSC	UNSW Biological Services Compound
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes (Monocyclic Aromatic Hydrocarbons)
CIP	CIP Constructions (NSW) Pty Ltd
COC	Chain of Custody
CSTS	Compaction & Soil Testing Services Pty Ltd
DP	Deposited Plan
DQO	Data Quality Objectives
EIS	Environmental Investigation Services
EMP	Environmental Management Plan
ENSR	ENSR Australia Pty Ltd (now AECOM)
Envirolab	Envirolab Services Pty Ltd
EPA	Environment Protection Authority (NSW)
EPL	Environment Protection Licence
ESA	Environmental Site Assessment report
ESBS	Eastern Suburbs Coastal Banksia Scrub
ha	Hectare
HIL	Health Investigation Level
IAL	Interim Advice Letter
km	Kilometres
LOR	Limit of Reporting
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
Mercury	Inorganic mercury unless noted otherwise
Metals	As: Arsenic, Cd: Cadmium, Cr: Chromium, Cu: Copper, Fe: Iron, Ni: Nickel, Pb: Lead, Zn: Zinc, Hg: Mercury, Se: Selenium
mbgl	Metres below ground level
MGT	MGT LabMark / Eurofins
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
µg/L	Micrograms per Litre
NATA	National Association of Testing Authorities
NA	Not Analysed or Not Available
NC	Not Calculated
ND	Not Detected
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
n	Number of Samples
OCPs	Organochlorine Pesticides
OH&S	Occupational Health & Safety
OPPs	Organophosphorus Pesticides
PAHs	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulphate Soils
PCBs	Polychlorinated Biphenyls
PID	Photoionisation Detector
PQL	Practical Quantitation Limit
pH	a measure of acidity, hydrogen ion activity

QA/QC	Quality Assurance/Quality Control
RAP	Remediation Action Plan
RPD	Relative Percent Difference
RWP	Remediation Works Plan
SAR	Site Audit Report
SAS	Site Audit Statement
SWL	Standing Water Level
TPHs	Total Petroleum Hydrocarbons
TV	Trigger Value
UCL	Upper Confidence Limit
UNSW	University of New South Wales
UTS	University of Technology
VENM	virgin excavated natural material
VOCs	Volatile Organic Compounds
-	On tables is "not calculated", "no criteria" or "not applicable"

1 Introduction

1.1 Audit Details

A site contamination audit has been conducted in relation to the redevelopment of a property at 1406-1408 Anzac Parade, Little Bay, NSW (Attachment 1, Appendix A). This audit report relates to Stages 3 and 4 of the Little Bay Cove development in the eastern portion of the property.

The audit was conducted to provide an independent review by an EPA Accredited Auditor of whether the land is suitable for any specified use or range of uses i.e. a "Site Audit" as defined in Section 4 (1) (b) (iii) of the NSW *Contaminated Land Management Act 1997* (the CLM Act).

Details of the audit are:

Requested by:	Mark Jacobs on behalf of CHOF5 Little Bay Pty Ltd
Request/Commencement Date:	28 March 2008
Auditor:	Graeme Nyland
Accreditation No.:	9808

1.2 Scope of the Audit

The scope of the audit included:

- Review of the following reports:
  - 'Report to University of NSW on Stage 1 Environmental Site Assessment for Proposed Site Redevelopment at 1408 Anzac Parade, Little Bay, NSW', dated December 2006 by Environmental Investigation Services (EIS).
  - 'Report to University of NSW on Stage 2 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW', Draft dated February 2007 by EIS.
  - 'Little Bay, Trenching Works, 1406-1408 Anzac Parade Little Bay NSW 2036' dated 23 April 2008(a) by ENSR Australia Pty Ltd (ENSR, now AECOM).
  - 'Stage 1 Environmental Site Assessment, Biological Resources Centre (BRC), 1406-1408 Anzac Parade Little Bay NSW 2036' dated 28 July 2008(b) by ENSR.
  - 'Remediation Works Plan, 1406-1408 Anzac Parade, Little Bay NSW 2036', dated 2 February 2009 by ENSR.
  - 'Biological Resources Centre, Post-Demolition Validation Sampling Plan', dated 23 November 2010 by AECOM Australia Pty Ltd (AECOM).
  - 'In-situ Waste Classification, 1406 Anzac Parade Little Bay – Eastern Portion', draft dated 20 May 2011(a) by AECOM.

  - 'Former Biological Resources Centre, Post-Demolition Validation', draft dated 13 July 2011(b) by AECOM.
  - 'Work Method Statement – Little Bay Soil Validation Sampling (Draft)', dated 3 August 2011(c) by AECOM.
  - 'Radiological Survey of Biological Resources Centre Land at Little Bay, NSW', dated 6 January 2012 by Australian Nuclear Science and Technology Organisation (ANSTO).
  - 'Landfill Gas and Groundwater Monitoring – 1408 Anzac Parade, Little Bay NSW', dated 25 July 2013, AECOM.
  - 'Remediation and Validation Report, 1406-1408 Anzac Parade, Little Bay NSW', dated 6 May 2014, by AECOM. Interim validation progress reports were attached as appendices.
- A review of monthly reports prepared by AECOM.
- Site visits on 27 March 2008, 7 July 2011, 1 September 2011, 21 December 2011, 8 February 2012, 6 June 2012, 28 August 2012, 29 October 2012, 14 December 2012 and 15 May 2014.
- Discussions with ENSR/AECOM who undertook the investigations and validation.

1.3 Audit Stages

The Auditor previously prepared 'Site Audit Report UNSW, Little Bay' and a Section B Site Audit Statement (SAS) (GN 336 dated 6 July 2007) base on a review of a Remedial Action Plan (RAP) prepared by EIS (the RAP was subsequently superseded by the Remediation Works Plan). The SAS concluded that the site could be made suitable for residential use and less sensitive land uses if remediated in accordance with the RAP, subject to compliance with a number of conditions.

ENSR (2009) prepared a Remediation Works Plan (RWP), which identified the preferred remediation option for the site and detailed the remediation methodology. The Auditor prepared 'Interim Advice Letter – Remedial Action Plan – Little Bay' dated 5 February 2009 and concluded that "*...implementation of the RWP would render the site suitable for residential development subject to suitable and successful validation of the excavation base and imported material...*" and a number of other measures. The Interim Advice Letter (IAL) is attached as Appendix D. The development was approved by a Land and Environment Court order. Conducting remediation and validation works in accordance with the Interim Advice Letter was a condition of the judgment.

Separate Site Audit Reports (SAR) and Site Audit Statements (SAS) were to be prepared for the eastern and western portions of the greater development area. The area considered in this SAR is shown as Stages 3 and 4 in Attachment 2, Appendix A ('the site').

The Auditor previously prepared 'Site Audit Report – Stage 1 & 2, Little Bay Cove Development, Anzac Parade, Little Bay' and a Section A SAS (GN 388-1 dated 11 September 2012) for Stage 1 and 2 in the west of the greater development area.

1.4 Development Process

The greater development area is being remediated and redeveloped for mixed residential and open space use (Attachment 2, Appendix A). The east and west of the greater development area is to be developed for low to high density residential use with associated roadways and other infrastructure. The central portion is to be retained for open space use. This SAR and accompanying SAS relates to the eastern portion of the development area, the central open space area and the access road along the north of the site (Ocean Avenue), referred to as 'Stage 3 and 4' (the site).

Remediation of the site included demolition of the UNSW Biological Services Compound (BSC), validation of the BSC, excavation of fill material, validation of resulting excavations, offsite disposal of unsuitable fill material, reuse of remediated and validated fill material, and monitoring of groundwater and landfill gas.

Remediation of fill material containing waste material was undertaken in conjunction with the development. Fill material was excavated and disposed offsite or re-used onsite following sieving to remove items larger than 75 x 150 mm diameter. The excavation base and walls were validated prior to placement of sieved waste material. The sifted material was laid in 20 m by 20 m by 0.3 m layers (120 m^3 uncompacted). Each layer was inspected and any asbestos containing material (ACM) or other unsuitable material removed. A soil sample was collected from every fourth layer to validate the material. Approximately 1 m of imported sandstone VENM was placed over the residential portions of the site. A 0.3 m topsoil layer was placed in open space areas.

2 Site Details

2.1 Location

The site locality is shown on Attachment 1, Appendix A.

The site details are as follows:

Street address:	1406-1408 Anzac Parade, Little Bay, NSW, 2036
Identifier:	Part Lot 10 and Lot 11 DP 1127719 (Attachment 3, Appendix A, which includes an incorrect DP number). Proposed lot and DP numbers include development Lots 21-42 and the open space Lot 1 (Attachment 2, Appendix A)
Local Government:	Randwick City Council
Owner:	CHOF5 Little Bay Pty Ltd
Site Area:	Approximately 8.15 ha (Stage 3 is 2.37 ha and Stage 4 is 5.77 ha)

2.2 Zoning

The current zoning of the site is Zone R1 General Residential (Stage 4) and Zone E2 Environmental Conservation (Stage 3) under the Randwick Local Environmental Plan 2012. It is understood that this zoning allows for residential uses in Zone R1.

2.3 Adjacent Uses

The site is located within an area of residential and open space uses. The surrounding land uses include:

- North - Medium density housing development, beyond which is the Long Bay Correctional Facility.
- East - An area of protected Eastern Suburbs Coastal Banksia Scrub (ESBS) consisting of 1 to 3 m tall vegetation, a dam and The Coast Golf Course, beyond which is Little Bay and the Pacific Ocean.
- South - A low to high density residential subdivision that was formerly the Prince Henry Hospital. The hospital site was remediated for the presence of asbestos as fibres within the sands.
- West - The western portion of 1406-1408 Anzac Parade, which is being developed for residential land use. Beyond which is Anzac Parade and residential housing.

Nearby sensitive receptors include:

- Residential properties to the north, south and west.
- Little Bay and the Pacific Ocean to the east of the site.
- The ESBS area to the east of the site.
- A drainage channel with two man-made dams located in the west of the site.

- An Aboriginal and geological heritage area in the west of the site.

2.4 Site Condition Prior to Remediation and Development

Prior to demolition and remediation works, the site was described by EIS (2006) as follows. The former site features are shown in Attachment 3, Appendix A.

- A drainage channel with two constructed wetlands was present in the west of the site. The wetlands were surrounded by dense vegetation and steep slopes. The area between the two dams appeared to be periodically inundated following heavy rain. Geological features described as "*critical exposure area*" and "*potential Ochre site*" were present near the centre of this area ('the central corridor').
- The University of NSW (UNSW) Biological Services Compound (BSC) was present in the southeast of the site (also referred to as the Biological Resources Centre). It comprised three brick buildings, an asphalt paved carpark, sheep holding paddock, and two electrical substations to the west of the entry driveway. The buildings included an office, laboratory, laundry, animal holding areas, UV water treatment room, chemical and equipment storerooms, warehouse storage, delivery dock and plant room.
- A vacant grassed area was present in the northeast of the site. This area was previously used for sand mining and subsequently used as an uncontrolled landfill. Several large fill mounds, dumped rubbish, shipping containers, organic material and concrete screens were present.
- An asphalt paved access road servicing the UNSW facility ran along the northern boundary of the greater development site and through the vacant grassed area.

2.5 Site Condition During Remediation

Site visits were undertaken over the course of remediation between 2011 and 2014. During the site visits the Auditor observed the excavation, sieving and remediation of fill material. The processes described by AECOM (2014) in the Remediation and Validation Report are consistent with the observations made by the Auditor and the Auditor's assistants.

2.6 Current Site Condition

The Auditor undertook a site visit on 15 May 2014 following completion of remediation and civil works. The site was described as follows:

- The northern and eastern boundaries of the site were fenced with chain link fencing. The southern boundary was a concrete/brick retaining wall.
- Asphalt sealed roads with concrete curb and guttering were present at the site. Grass verge, garden beds and concrete footpaths were present adjacent to the roads.
- Residential areas were surfaced with crushed sandstone and sand. Some scattered rubbish was present on the surface (hard and soft plastic, steel, bottles, timber, conduit, wire). No development had commenced.
- Stockpiles of sandstone were present on residential lots in the southeast of the site. It is understood that this material is to be used to complete a dam located offsite to the south.

- An electrical substation was present on the eastern side of Fairway Terrace, between Ocean Avenue and Banksia Street.
- A park was present in the western portion of Stage 4 (west of Dune Street). The park was sealed with grass and contained garden beds with trees and small plants. Footpaths were sealed with sandstone pavers or sand. Facilities included benches, picnic tables, barbeques and bins.
- The open space area comprised a series of dams, weirs and connecting streams. The surrounding area sloped down to the dams, and comprised garden beds containing immature trees, small plants and woodchip. Footpaths sealed with sandstone pavers, sand or concrete transverse the area.
- The protected areas in the west of the site comprised exposed rock and soil with established trees.

2.7 Proposed Development

It is understood that the site is to be redeveloped with a mix of single dwelling houses, townhouses, apartments, open space and roadways.

The open space area in the central corridor is to include a pool and riffle system comprising reconstructed dams, three weir walls and a wetland area.

For the purposes of this audit, the land use scenario will be assumed to be ‘parks and recreational open space’ for Stage 3 and ‘residential with soil access’ for Stage 4.

3 Site History

EIS (2006) provided a history of the greater development area based on historical aerial photographs, Council records, Certificates of Title, WorkCover database records and NSW EPA records. The site history is summarised in Table 3.1. The site layout prior to the commencement of remediation and development is shown on Attachment 3, Appendix A.

Table 3.1: Site History

Date	Activity
1881 - 1940	Hospital uses however the aerial photographs do not indicate that any buildings were located on the greater development area and indicate that it was used for paddocks and cultivated land for the hospital.
1940 - 1959	Sand mining "*in the vicinity of the hospital site*". Aerial photographs indicate that hospital buildings were present in the south of the central and east sections of the greater development area. The greater development area was subdivided from the former hospital and granted to UNSW in 1959.
1960 - 1969	Some land filling conducted on the site and adjacent areas. The 1961 aerial photograph appears to show disturbed ground in the northeast of the site, which extends offsite to the north and east. Fenced paddocks also appeared to be present in the east of the site. Areas offsite to the north and east were being used as a residents tip in 1969.
1970 - 1979	An application to fill the site with putrescible garbage was refused by the Department of Health on 27 March 1970. Council subsequently offered to fill the area with material collected from clean-up campaigns and other non-putrescible materials. The site was declared 'Unhealthy Building Land' by a notice dated 8 July 1977 due to former use as a putrescible garbage landfill. The western portion of the greater development appeared to be an active quarry site in the 1970 aerial photograph. Golf tee and green facilities constructed to the east.

1980 - 1989	Initial construction of the UNSW BSC and the access road was approved in 1984 and was evident in the 1986 aerial photograph. Excavation of fill material from the BSC footprint and disposal onsite occurred prior to construction of the buildings. Correspondence from UNSW dated 18 March 1987 indicated that a waste disposal depot on university land was to be closed as of 30 March 1987. It is not clear where on the site the disposal occurred. A pump house was constructed on the bank adjacent to the dam in the central section of the site. The water was used to irrigate the playing fields within the western portion of the greater development area. Filling of the western portion of the greater development area with “clean fill” described as natural excavated materials and selected demolition rubble was undertaken in 1981. The area was to be filled and levelled for construction of playing fields. The caretaker’s cottage and office/amenities building were constructed prior to 1986.
1990 - 2000	Development applications were submitted to Council in 1991 for the construction of additional buildings in the UNSW BSC. It is unclear when or if the construction was undertaken. The second of the two electrical substations as installed in 1992. The BSC was vacated in June 2008. Approximately 6 ha of the central corridor was listed on the National Estate by the Australian Heritage Commission for its Geological Significance in 1991. The area is shown in Attachment 4, Appendix A. The sport fields in the western portion of the greater development area were redesigned and the synthetic hockey pitch installed in 1992. The Solarch building, also located in Stage 1 and 2 of the greater development area (west), was constructed in 1992/1993.
2000 - 2014	Charter Hall purchased the site from UNSW in 2008. Remediation of the site commenced in 2011 and was completed in February 2014. The Solarch building was demolished in 2007. Demolition of the hockey field was undertaken in June 2011. The caretaker’s cottage and office/amenities building were demolished in 2012. Remediation of Stage 1 and 2 of the greater development area was completed in 2012. Remediation of Stage 3 and 4 was completed in February 2014.

EIS (2006) provided a brief history of the adjoining Prince Henry Hospital on the southern side of the site, indicating that it was assigned for hospital uses in 1881. Hospital buildings and a cemetery were constructed over the 10 years from 1881 to 1891.

Based on Council correspondence summarised in the EIS Stage 2 Report, land filling at the site proceeded as follows:

- An application to fill the subject site with putrescible garbage was refused in March 1970. Council offered to fill the area with materials collected from clean up campaigns and other non-putrescible materials.
- The site was filled in by Randwick City Council as a weekend tip site (27 October 1976)
- UNSW gave approval for a company to apply for a licence to place ‘clean fill’ (natural excavated materials and selected demolition rubble subject to conditions of the Waste

Control Authority) at the site. Tipping commenced in December 1981 and was to be closed in March 1987.

- NSW EPA correspondence on 25 February 2000 indicated that the landfill previously over the area of the BSC building was ‘a former putrescible garbage landfill’. Requirements for building included provisions for settlement, landfill gas accumulation under buildings, potential groundwater contamination with landfill leachate and offsite migration issues and potential risk of human exposure to contaminated landfill materials. Staged development approval was obtained in 2001. No validation sampling and analysis was undertaken prior to the construction of the buildings.

Correspondence with Council indicates that the landfill was filled with non-putrescible waste however detailed records were not kept and the EPA sent a contradictory letter. The consistency and sources of these wastes is also unknown. Remediation undertaken in the landfill is considered by the Auditor to have addressed the lack of available detail.

The summary of the site history provided by EIS indicates that the site has been used by UNSW for the past 50 years, prior to which it was used for cultivation.

In the Auditor’s opinion, the site history provides an adequate indication of past activities to determine potentially contaminating activities. There are inherent uncertainties in the contents of the landfill.

4 Contaminants Of Concern

EIS (2006) provided a discussion on the potential site specific contaminants of concern. These have been tabulated in Table 4.1.

Table 4.1: Contaminants of Concern

Area	Activity	Potential Contaminants
Whole site	Filling	Unknown however could include metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), pesticides, polychlorinated biphenyls (PCB) and asbestos
Landfill area	Placement of organic material and subsequent decomposition	Landfill gas, including methane, hydrogen sulphide, carbon dioxide and carbon monoxide
	Landfill material	Metals, PAHs, petroleum hydrocarbons, pesticides, PCBs and asbestos
UNSW Biological Service Compound	Hazardous building materials	Metals (zinc and lead), PCBs and asbestos
	Potential use of solvents	Volatile organic compounds (VOCs) including chlorinated hydrocarbons
	Storage of oil and lubricants	Petroleum hydrocarbons and PAHs
	Spraying of pesticides/ termicides under and around buildings	Organochlorine pesticides (OCPs) and metals
	Use of radioisotopes and/or x-ray equipment	Radioactive materials

The Auditor considers the analyte list used by AECOM during remediation and validation of the site to be adequate.

5 Stratigraphy and Hydrogeology

Following a review of the referenced reports, a summary of the site stratigraphy and hydrogeology was compiled as follows.

5.1 Stratigraphy

EIS (2006) stated that the 1:100,000 geological map of Sydney (Map 9130) indicated that the site is underlain by Triassic Hawkesbury Sandstone and Quaternary deposits of sand, gravel, silt and clay.

A sandstone plateau extends from the western boundary of the greater development area to the central corridor. The central corridor is an ancient stream valley running through the site. Sand mining exposed Miocene sediments and ochre deposits of Aboriginal significance.

5.1.1 Pre-Remediation

Initial characterisation of the stratigraphy of the site by EIS, especially with respect to fill composition, was limited as augers and SPTs were used to investigate the site. Trenching undertaken by ENSR over the former landfill found that the depth of the fill was variable with fill extending to 9.7 m in one location. Fibre cement fragments were common, with most encountered below 1.0 m. ENSR concluded that there is the potential for *"unidentified pockets of deep fill"*.

The stratigraphy of the site prior to remediation is summarised in Table 5.1.

Table 5.1: Stratigraphy

Depth (mbgl)	Stratigraphy
0 to 2.0	Fill: Silty sand with some sandstone gravel and root fibres. The fill also contained clay and gravels and other inclusions such as cobbles, wire and brick. Fill thickness ranged in depth from 0.1 mbgl to 3.2 mbgl. Fill material in the landfill ranged from 3 to 10 m in thickness over sandstone bedrock. The fill material consisted of silty sand with some sandstone gravel, root fibres, concrete, cobbles, rubber, glass, cloth, coal, ash and slag in places. Fill material in the central corridor ranged between approximately 0.3 to 12 m in thickness. The fill consisted of clayey sand with some gravel, concrete, brick, timber, plastic, coal, glass and sandstone.
2.0 - depth	Sandstone. The depth to sandstone was typically approximately 1 mbgl, however ranged between 0.05 m and greater than 4.5 mbgl.

5.1.2 Post-Remediation

Bulk excavation during remediation resulted in changes to the stratigraphy of the site. Fill material was generally excavated to sandstone bedrock or natural soil and re-laid in 0.3 m thick layers, which were compacted to a thickness of 0.2 m. Approximately 1 m of imported sandstone VENM was placed over the residential portions of the site to an elevation of 28-33

m Australian Height Datum (AHD) (Attachment 4, Appendix A). A 0.3 m thick topsoil layer was placed in open space areas. Remediation undertaken at the site is discussed in Section 11.

Actual and potential acid sulphate soils (ASS/PASS) were identified in the central corridor during remediation. Disturbance of the ASS/PASS was minimised during remediation and development of the site.

5.2 Hydrogeology

EIS (2006) identified one registered groundwater bore within 500 m of the site. The bore was used for domestic purposes and located approximately 400 m to the south of the site. A search of registered groundwater bores within 500 m of the site by the Auditor (undertaken on 8 January 2014) identified five registered bores for domestic or industrial use. One bore installed to 6 mbgl in sand was located 400 m to the south of the site (SWL not provided). One bore installed to 200 m in sandstone and shale was located approximately 500 m to the southeast on the golf course (SWL not provided). Three bores located 300 to 400 m to the west of the site were installed to between 4 and 6.1 mbgl in sand. The SWL was provided for only one bore (2.8 mbgl).

5.2.1 Pre-Remediation

EIS (2007) estimate that the groundwater is perched within the fill and joints in the sandstone rather than being a 'significant water bearing aquifer'. A review of the groundwater monitoring reports and the well construction descriptions on the logs indicates that groundwater was encountered as follows:

- Inflow of water was noted on the borehole logs at or just above the base of the fill in the landfill area. However two of the four wells screened in fill in the landfill were dry (MW333A and MW335A). The standing water levels in the landfill area varied from 27.1 m to 30.1 mAHD in the wells screened in sandstone and at 29.5 m to 30.4 mAHD in wells screened in fill material.
- Up-gradient groundwater varied from 32.5 m to 34.6 mAHD and down-gradient from 25 m to 26.1 mAHD. The variations also indicate that groundwater is located within sandstone fractures.
- EIS indicated that the apparent flow direction, based on the SWLs, is towards the dams to the west and south-west. However, EIS estimate that the lower elevation of sandstone to the east of the landfill may form a natural control structure causing artificial mounding leading to the apparent flow direction i.e. the true groundwater flow is to the east towards Little Bay. EIS concluded that "*further monitoring of groundwater conditions would be necessary to confirm the groundwater flow patterns within this section of the site*". The Auditor agrees that the flow directions of groundwater are not well known which has implications for the assessment criteria as the end point could be Little Bay or the adjoining golf course, where it may be used for irrigation.

Monitoring wells screened across sandstone in the landfill may not have been constructed adequately to exclude perched groundwater in fill material, however there is likely to be some interconnection between the two aquifers. The standing water levels suggest that

groundwater in fill material and sandstone is at the same elevation, and analytical results were not significantly different.

5.2.2 Post-Remediation

Following remediation of the site, three groundwater monitoring wells were installed on the northern (MW01 and MW03) and southern (MW02) boundaries of the site (Attachment 5, Appendix A). The following was noted during installation and monitoring of the wells:

- The up-gradient groundwater elevation was 30.3 m and 32.0 mAHD and down-gradient was 26.5 mAHD. The elevations are consistent with those measured prior to remediation, indicating that groundwater may have re-established and stabilised.
- Groundwater is perched within the remediated fill material and joints in the sandstone.

6 Evaluation of Quality Assurance and Quality Control

Review of quality assurance and quality control relating to previous investigations of the site by EIS is provided in the IAL on the RWP (dated 5 February 2009), included in Appendix D. In reviewing the data, the Auditor concluded that the data is likely to be reliable and useable for the purpose of the Audit.

Investigation of the site undertaken by ENSR (2008a) and AECOM (2011a) prior to remediation has not been included in the review of quality assurance and quality control as it is not representative of the final site condition.

The Auditor has assessed the overall quality of the validation data by review of the information presented in the AECOM (2011b) BSC validation, ANSTO (2012) BSC survey, AECOM (2013) landfill gas and groundwater monitoring, and AECOM (2014) remediation and validation reports, supplemented by field observations. The Auditor's assessment follows in Tables 6.1 and 6.2.

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
Data Quality Objectives (DQO)	The reviewed reports defined specific DQOs in accordance with the seven step process outlined in DEC (2006). These were considered appropriate for the remediation and validation conducted.
Sampling Pattern and Locations	**Soil**: Validation sample locations were collected from remediated fill material, and the base and walls of excavations. In the Auditor's opinion the validation locations adequately target the remediated areas. **Groundwater**: Monitoring wells were located on the northern (MW01 and MW03) and southern (MW02) boundaries of the site. No monitoring wells were located within the site. **Landfill Gas**: landfill gas monitoring was undertaken from the groundwater monitoring wells discussed above.
Sampling Density	**Soil**: The sampling density for validation of the BSC exceeded the minimum recommended by EPA (1995) 'Sampling Design Guidelines'. 20 sample locations were spaced over approximately 4,000 m^2 in the BSC. The proposed sampling densities for remediated fill material (1/480 m^3), excavation walls (1/20 m) and excavation base (1/100 m^2 natural and 1/50 m^2 fill) were generally met. Field ACM validation was undertaken at a density of 1/120 m^3. The RWP proposed a sampling density of 1/100 m^3 for imported fill material. Sampling of imported fill was not undertaken as per the RWP following source site inspections and a review of source investigation reports. **Groundwater and Landfill Gas**: Three monitoring wells were installed at the site. The density is low, however the remediation and validation of the site indicate a low potential for groundwater

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	contamination. The wells were installed on the up and down gradient boundary of the site and did not identify significant groundwater contamination. The groundwater monitoring well density is therefore considered adequate.
Sample depths	Soil samples were collected and analysed from a range of depths depending on the material being sampled and the stratigraphy. Samples from the BSC were collected from the ground surface and from 0.5 mbgl. In the Auditor's opinion, this sampling strategy was appropriate and adequate to validate the material remaining on site.
Well construction	The groundwater monitoring wells (MW01-MW03) were constructed of 50 mm diameter Class 18 uPVC tubing. They were completed to a depth of between 3.2 and 5 m depending on the observed depth to groundwater and the stratigraphy. The standing water level intersected the screen interval, which was 1.5 to 2.5 m long. Screens were installed in a sand filter pack, with hydrated bentonite placed above the screen to the ground surface. The Auditor considers this to be adequate.
Sample Collection Method	**Soil**: Validation samples were collected using disposable nitrile gloves and hand tools. Samples from deeper excavations were collected from the excavator bucket. **Groundwater**: Wells were installed by solid stem augers, developed with a foot valve and purged/sampled by low flow (peristaltic) pump with dedicated sample tubing. This is considered by the Auditor to be adequate. **Landfill Gas**: Landfill gas was monitored with a GMF410 gas meter capable of measuring methane, carbon dioxide, oxygen and hydrogen sulphide. Gas monitoring of the wells was undertaken using a "*gas-accessible well cap*".
Decontamination Procedures	**Soil**: Sampling equipment was cleaned with a detergent solution followed by a rinse in potable and laboratory grade water prior to sampling and between sampling events to prevent cross contamination. New gloves were reportedly used for each new sample. **Groundwater**: The interface probe was decontaminated prior to use and between locations using a detergent solution and rinsed with potable and laboratory grade water. Dedicated sampling equipment was used for each well.
Sample handling and containers	Soil samples were placed in glass sample jars with Teflon lined lids provided by the laboratory. Jars were reportedly filled to ensure no headspace was present. Groundwater samples were placed into prepared and preserved sampling bottles provided by the laboratory. Samples were chilled during storage and subsequent transport to the laboratories. Soil samples from the BSC for radiological analysis were collected

Table 6.1: QA/QC – Sampling and Analysis Methodology Assessment	
Sampling and Analysis Plan and Sampling Methodology	**Auditor Comments**
	in 1 L plastic containers. Samples were homogenised during sampling.
Chain of Custody (COC)	Completed chain of custody forms were provided in the reports and appeared to be complete.
Detailed description of field screening protocols	Field screening of soil for volatiles was undertaken using a PID. PID screening involved partly filling a zip-lock plastic bag with a soil sample and measuring VOCs in the headspace after allowing time for equilibration. Field radiological monitoring of soil was undertaken using the following instrumentation: Eberline E-600; NE Electra/DP2R/4-A; Mini Instrument 6-80; Target Field spec; and Rotem RAM R-200. Groundwater field parameters (dissolved oxygen, temperature, redox potential, electrical conductivity and pH) were measured during well development and sampling with a water quality meter. Landfill gas was measured with a GMF410 gas meter.
Calibration of field equipment	The reports indicated that calibration of the PID had been undertaken prior to use. Calibration certificates were provided for the BSC validation (AECOM, 2011b) and Stage 3 and 4 validation (AECOM, 2014). Calibration of field radiological monitoring devices is undertaken annually with daily instrument response checks against natural background radiation. Field records of response checks were not provided. The groundwater quality meter was reported to have been calibrated prior to the start of each day. Field sheets were not provided. A calibration certificate was provided from the equipment supplier. Field sheets for the calibration of the landfill gas monitor were not provided. A calibration certificate was provided from the equipment supplier.
Sampling Logs	Tables were provided in the reports indicating sample depth, PID readings, lithology and observations. Logs were provided for wall validation, ACM validation and for test pits excavated in residual fill material. Photographs were provided of validation sample locations. Field records were not provided for the validation of BSC or for base of excavation validation. Groundwater field sampling records showing field parameters and standing water level were provided. Monitoring well construction logs were provided.

Table 6.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Auditor Comments**
Field quality control samples	During validation of the site, field quality control samples including trip spikes, trip blanks, rinsate blanks, intra-laboratory and inter-laboratory duplicates were submitted for analyses. During validation of remediated fill material, intra-laboratory duplicates were analysed at a rate of 1/5 primary samples. Inter-laboratory duplicates were analysed at a rate of 1/10 primary samples. During radiological assessments of the BSC, only intra-laboratory duplicates were collected. During groundwater monitoring, intra-laboratory and inter-laboratory duplicates, a rinsate blank, a trip blank and a trip spike were submitted for analyses.
Field quality control results	The results from field quality control samples were generally within appropriate limits. RPDs for the intra- and inter-laboratory soil duplicate samples were generally within the control limits. Occasional exceedances were reported, typically for metals and PAHs. This is likely to be attributed to the heterogeneous nature of the fill material. The Auditor has undertaken a spot check of the data and considers the results of field quality control samples to be acceptable.
NATA registered laboratory and NATA endorsed methods	Laboratories used for soil and water analyses included: ALS Environmental (ALS); Envirolab Services Pty Ltd (Envirolab); and MGT-LabMark/ Eurofins (MGT). Laboratory certificates were NATA stamped. Laboratories used for asbestos analyses included: Microanalysis Australia; SGS; and AEC Environmental. Samples for radiological analysis were analysed at ANSTO laboratories.
Analytical methods	Analytical methods were included in the laboratory test certificates.
Holding times	A spot-check review of the COCs and laboratory certificates indicate that the holding times had been met by the primary laboratory. AECOM reported that holding times have been met.
Practical Quantitation Limits (PQLs)	PQLs were less than the threshold criteria for the contaminants of concern.
Laboratory quality control samples	Laboratory quality control samples including laboratory control samples, matrix spikes, surrogate spikes, blanks and duplicates were undertaken by the laboratory at appropriate frequencies. No quality control samples were undertaken during asbestos analyses. Samples were analysed in accordance with Australian Standard 4964-2004. No quality control samples were reported for radiological analyses. ANSTO report that instruments were calibrated against reference standards, and the gamma ray spectrometer has undergone

Table 6.2: QA/QC – Field and Lab Quality Assurance and Quality Control	
Field and Lab QA/QC	**Auditor Comments**
	external proficiency testing.
Laboratory quality control results	AECOM report that laboratory quality control results were generally with the control limits. A number of exceedances of the criteria were reported. The Auditor has undertaken a spot check of approximately 20% of the laboratory data to confirm the results and conclusions of the AECOM data validation.
Data Quality Indicators and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	For the validation of the BSC, AECOM (2011b) concluded that "…the *reported analytical results are representative of soil conditions at the sample locations, and that the overall quality of the analytical data produced is acceptably reliable for the purpose of the validation works".* With regards to groundwater monitoring, AECOM (2013) concluded that *"…the overall quality of the analytical data produced is acceptably reliable for the purpose of this monitoring event"*. AECOM (2014) assessed the data against the five category areas, concluding that "*…the reported analytical results are representative of soil and water conditions at the sample locations, and that the overall quality of the analytical data produced is acceptably reliable for the purpose of the in-situ waste classification, soil validation, and water monitoring works*".

In considering the data as a whole the Auditor concludes that:

- The data is considered to be accurate.
- The data is considered representative of site conditions.
- The validation data are complete.
- The primary laboratory provided sufficient information to conclude that data is of sufficient precision. Field and laboratory duplicates and triplicates had elevated RPD values for metals and PAHs, which are considered an indication of sample heterogeneity rather than poor sample handling.
- There is a high degree of confidence that data is comparable, as consistent sampling protocols and field scientists were employed throughout the duration of the remediation and analysis was undertaken by NATA accredited laboratory methods.

In considering the data obtained by AECOM, the Auditor concludes that it is likely to be reliable and is useable for the purpose of this audit.

7 Environmental Quality Criteria

The environmental quality criteria adopted by the Auditor to assess soil and groundwater data provided by AECOM is provided in Appendix B and discussed below.

7.1 Soil

The Auditor has assessed the soil data provided by EIS and AECOM in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW in DEC (2006) *Guidelines for the NSW Site Auditor Scheme*. Soils in the proposed residential portion of the site were assessed with reference to HIL Column 1 – 'residential with gardens and accessible soil'. Soils in the central corridor open space area of the site were assessed with reference to HIL Column 3 'recreational open space'. Soil from the site was also assessed against HIL Column 5 'provisional phytotoxicity'.

The ENSR (2009) RWP references HIL Column 3 – 'recreational open space' for open spaces including the central corridor sensitive areas, Column 5 'provisional phytotoxicity' for surface soils only, Column 4 – 'commercial industrial' for roadway areas and HIL Column 1 'residential with access to soil' and Column 2 'residential with minimal access to soil' for the relevant residential developments.

EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing TPH and BTEX results.

Imported fill has been assessed in relation to attributes expected of virgin excavated natural material (VENM). The NSW DECC (July 2009) *Waste Classification Guidelines, Part 1: Classifying Waste* classifies VENM as *"…natural material*

- *'that has been excavated or quarried from areas that are not contaminated with manufactured chemicals or process residues, as a result of industrial, commercial, mining or agricultural activities, and*
- *'that does not contain sulphidic ores or soils, and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA gazettal notice."*

On this basis, the Auditor considers that for soil to be classified as VENM, the following criteria generally apply:

- Organic compounds (including petroleum hydrocarbons, PAHs, OCPs, PCBs, Phenols) should be less than the PQLs; and
- Inorganic compounds should be consistent with background concentrations.

The Auditor has considered the need for remediation based on the 'aesthetic' contamination as outlined in the National Environment Protection (Assessment of Site Contamination) Measure (NEPM) (1999) Schedule B(1) *Guideline on the Investigation Levels for Soil and Groundwater* that states that *"there are no numeric Aesthetic Guidelines but the fundamental principle is that the soils should not be discoloured, malodorous (including when dug over or wet) nor of abnormal consistency. The natural state of the soil should be considered"*.

AECOM (2014) report that waste material was removed to the extent possible or feasible. Excavated and stockpiled fill material intended for reuse was sieved using a 75 x 150 mm mesh excavator bucket. Waste material was also removed from remediation beds by hand picking.

Criteria for asbestos are provided in the National Environment Protection Council (NEPC) NEPM (amended 2013). Criteria considered by the Auditor are summarised as follows:

- Less than 0.01% (residential), 0.02% (open space) and 0.05% (commercial) asbestos as ACM.
- Less than 0.001% asbestos as asbestos fines (AF) or fibrous asbestos (FA).
- No visible asbestos on the surface (defined as the top 10 cm).

AECOM (2009) adopted 0.01% as the criteria for ACM from the 2008 draft WA Department of Health *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia*. Remediation of the site was initially undertaken to a level below 0.01% w/w, which was later changed to 'no visible asbestos present' following commencement of the Work Health and Safety Act and Regulation 2011. Remediation of the site was also to ensure no visible asbestos on the surface by placement of a separation layer of 1 m (residential) or 0.3 m (open space).

The Auditor notes that the criteria adopted by AECOM is more conservative than WA DoH (2009) and NEPM (2013), and is therefore acceptable.

7.2 Groundwater

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for marine waters. Trigger values (TVs) provided are concentrations that, if exceeded, indicate a potential environmental problem and 'trigger' further investigation. The marine 95% level of protection has been adopted.

Low reliability ANZECC (2000) TVs have been used where they exist for the individual PAHs (Appendix B). However, a trigger level for total PAHs within groundwater is not provided within the ANZECC (2000) guidelines. As such, the threshold level of 3 µg/L from the EPA (1994) *Guidelines for Assessing Service Station Sites* has been adopted.

At the time of the groundwater investigation there were no reliable Australian criteria for TPH in groundwater. The NSW EPA position is that there should be no free phase product in groundwater, and that the aromatic components of dissolved-phase TPH in groundwater should be assessed using the ANZECC (2000) TVs where available. These guidelines include criteria for some BTEX compounds and for some PAHs.

7.3 Landfill Gas

In considering landfill gas, the Auditor has referred to the NSW EPA (2012) *Guidelines for the Assessment and Management of Site Impacted by Hazardous Ground Gases*.

7.4 NEPM (2013)

The investigations and the majority of the remediation were completed prior to the revision of the NEPM (2013). Validation of the site by AECOM was undertaken referencing the NEPM (1999) criteria. AECOM (2014) reported that the NEPM (1999) criteria for residential and recreational open space land use are generally more conservative than the NEPM (2013) criteria. The NEPM (1999) criteria were therefore used throughout the project.

The Auditor considers application of the amended NEPM is unlikely to significantly change the conclusions of this audit. Adoption of the NEPM (1999) criteria is therefore considered acceptable.

7.5 Radiological Survey

The investigation and validation of the BSC by ANSTO (2012) adopted the DECC *Waste Classification Guideline, Part 1: Classifying Waste (2009)* and *Part 3: Waste Containing Radioactive Material (2008)* as the criteria. ANSTO report that "*these levels will also meet other requirements for any material that remains on the site*".

8 Evaluation of Soil Analytical Results

Previous investigations were undertaken by Environmental and Earth Sciences in 1999 (15 test pits and groundwater assessment) and 2001 (landfill gas monitoring and groundwater assessment). Douglas Partners also undertook investigations in 2003. These reports were not provided to the Auditor and are therefore not discussed.

The results below include those obtained by EIS during the Stage 1 and Stage 2 Investigations (prior to remediation) for the whole of the greater development area, as well as investigations of the former landfill area by ENSR (2008a) and AECOM (2011a). EIS provided a summary of works undertaken by Douglas Partners (2003) 'Report on Due Diligence Study, Little Bay Playing Fields and Biological Science Site, 1408 Anzac Parade, Little Bay' for the coastal vegetation area and the area of geologic significance which is also discussed below.

The results from these investigations were summarised and discussed further in the IAL on the RWP, which is provided in Appendix D.

8.1 Landfill

The fill within the former landfill area was logged from auger holes as consisting of silty sand with inclusions varying from sandstone, gravels, concrete, bricks, timber, steel, cobbles, rubber, glass, coal, ash to slag. Fill depth was variable. Trenching by ENSR (2008a) and test pits by AECOM (2011a) confirmed that the fill contents were variable and the depth was reflective of the undulating sandstone bedrock topography.

Soil samples were analysed by EIS for a variety of contaminants including petroleum hydrocarbons, PAHs, asbestos and heavy metals, the results of which are summarised in the IAL in Appendix D.

The main impacts were found to consist of asbestos, tars and some metal and fuel impacts.

Asbestos was observed in fill material and detected in approximately 15% of samples collected from the landfill by EIS. The laboratory described asbestos observations as ACM and loose bundles from 3 to 4 mm long.

The distribution of asbestos did not appear to be associated with other contaminants, fill type or location within the landfill. No visual indications of asbestos were noted in any of the EIS borehole logs. ENSR (2008a) noted that fibre cement fragments were common, with most reported at greater than 1 m depth, although occasionally at less than 1 m depth. AECOM observed ACM in eight locations in the landfill. Concentrated areas of asbestos were not identified and there was no apparent pattern of distribution. ENSR noted that "*fragments are visually identifiable once exposed*".

PAHs were detected above the PQLs in approximately a third of the samples, with PAH concentrations above the site criteria in fill materials at eight locations. The maximum benzo(a)pyrene concentration was 54 mg/kg and total PAHs at 1,200 mg/kg in a sample from 3 metres depth (BH327 in Attachment 17, Appendix A). A sample at 1.7 to 1.95 m in the same borehole also reported total PAHs at 79.5 mg/kg and benzo(a)pyrene at 2.8 mg/kg.

There were no visual indications noted in the borehole logs and the elevated concentrations did not appear to be associated with any particular fill type. The Auditor notes that the most elevated concentrations of PAHs were associated with a tarry residue noted by the laboratory during asbestos analysis. Two other samples within the landfill (and one within the playing fields adjacent to the main road) were reported by Envirolab during asbestos analysis as having either a "*plastic tarry disk*" or "*tar fragments"*. ENSR (2008a) expected that small areas of ash/hydrocarbon impacted material were likely to be readily identifiable once exposed. Vertically adjacent samples did not report detections of PAHs above the PQLs.

Some fuel impacts associated with the fill materials were noted by EIS (2006 and 2007), with hydrocarbon odour noted on borehole logs at two locations (BH9 and BH313). Concentrations of volatile petroleum hydrocarbons (BTEX, TPH C_6-C_{14}) were generally less than the PQL in soil samples, with minor detections in the landfill by AECOM (2011a). The most elevated PID reading of 247 ppm was encountered to the immediate north of the detection of the strong hydrocarbon odour (BH314, no odour reported).

During trenching works by ENSR (2008a), one soil sample was collected from Trench 04 (TR04) in Attachment 8, Appendix A) for laboratory analyses due to a strong hydrocarbon odour, dark grey staining and a PID reading of 10 ppm. The sample was collected from 1.8 mbgl and submitted for analysis. The sample reported TPH C_{10}-C_{36} at 65,440 mg/kg, TPH C_6-C_9 of 30 mg/kg and toluene of 0.8 mg/kg.

Slightly elevated concentrations of metals were also reported across the landfill with mercury (50 times the HIL 5), chromium, copper (all in one sample), nickel and zinc, exceeding the HILs. Copper was detected at an elevated concentration of 15,000 mg/kg well above the HIL of 100 mg/kg and the HIL of 1,000 mg/kg in one sample. Most other detections were less than 70 mg/kg. EIS submitted the sample with elevated chromium for chromium VI analysis, which was not reported above the PQL.

A broad sampling grid was implemented by EIS using augers and SPTs rather than test pits, such that the ability to visually characterise the materials was limited. In addition, the history of the disposal of the landfill materials was not recorded. Test pits undertaken by AECOM adequately characterised the extent and contents of the landfill for the purposes of developing a remedial approach. The analytical results indicate that the material contains at least some asbestos, heavy metals, PAHs and petroleum hydrocarbons.

8.2 Geological/Aboriginal Heritage

Douglas Partners Pty Ltd (Douglas) undertook intrusive investigations in the geological and aboriginal heritage area in 2003. Fill consisting of sand to 0.4 m was encountered adjacent to the access road in the geological area. Some dumped household rubbish and campfire sites were encountered. Petroleum hydrocarbons and PAHs were not reported above the PQLs and only low concentrations of metals were reported.

In the geological and aboriginal heritage area, alluvial silty clays to 0.3 m were found to overlie sandstone. Some silty sand fill with cobbles, plant material and building rubble (roof tiles, concrete and wood pieces) was also encountered from 0.6 to 2.0 m depth. One sample

was collected from the fill material which did not report TPH or PAHs above the PQLs and only low concentrations of metals.

8.3 Remainder of the Greater Development Area

Soil samples collected from the remainder of the greater development area were analysed for a variety of contaminants including asbestos, hydrocarbons, pesticides, herbicides (playing fields only) and heavy metals. The results are summarised in the IAL in Appendix D.

Asbestos was detected in approximately 4% of samples collected from the remainder of the site. The likely source of the asbestos was estimated by EIS to be fill material and asbestos containing building materials (sourced from Sydney in general). The descriptions given by the laboratory were similar to that in the landfill. These results indicate that the vertical and horizontal distribution is not known. There is a risk that the asbestos containing materials, particularly the loose fibre bundles, are friable and could become loose fibres if disturbed.

All other organics including chlordane, DDT/DDE/DDD and PAHs that were detected were reported at low concentrations below the HILs.

8.4 Dam Sediments

Dam sediment samples collected from the two dams located on the site were analysed for a variety of contaminants including hydrocarbons, pesticides, herbicides and heavy metals. The analytical results are summarised in the IAL in Appendix D.

Only metals were reported above the PQLs. Elevated zinc, consistent with other elevated concentrations onsite, was reported above the phytotoxicity criteria (HIL 5) in one sample from the southern dam. Arsenic in the northern dam exceeded the HIL 5 in one sample. Results were reported at less than the HIL 1 (residential with gardens).

The Auditor concludes that the results adequately characterise the sediments at the site with regard to the risk to human health and the environment. Remediation of the dam sediments was not considered to be required, however re-engineering of the dams in the central corridor was undertaken as part of the development of the site.

9 Evaluation of Groundwater and Surface Water Analytical Results

Groundwater samples were collected from ten wells by EIS in February 2007 (prior to remediation) (Attachment 6, Appendix A). The results of groundwater monitoring undertaken following remediation are discussed in Section 11.

Groundwater samples were collected from three locations in the west of the site (MW357, MW361, MW366), five in the former landfill (MW319, MW319A, MW326, MW333, MW335) and two around the BSC (MW306, MW312). Three shallow landfill wells (MW326A, MW333A and MW335A) and one down-gradient well (MW302) were found to be dry. Surface water samples were collected from two dams in the central corridor. A surface water sample was also collected from a dam located offsite to the east, which has not been considered further.

Samples were submitted for metal, hydrocarbons, VOC, OCP and nutrient analyses. Samples were submitted for naphthalene analysis rather than a suite of PAHs. The analytical results are summarised in Table 9.1.

Table 9.1: Evaluation of Groundwater Analytical Results – Summary Table (µg/L)

Analyte	Up-gradient of Landfill		Landfill		BSC		Dams (Surface Water)	
	Detections (n = 3)	Max	Detections (n = 5 including 319A)	Max	Detections (n = 2)	Max	Detections (n = 2)	Max
Arsenic	1	1.1	5	6.2	0	0	1	1.1
Cadmium	2	0.4	1	0.8	2	0.5	0	-
Total Chromium	1	4.6	5	3.5	0	-	2	1.4
Copper	1	**24**	1	**9.4**	0	-	1	**1.9**
Lead	2	**24**	1	**82**	2	**18**	0	-
Mercury (inorganic)	0	-	1	**39**	0	-	0	-
Nickel	3	**190**	5	**110**	2	**130**	0	1.6
Zinc	3	**400**	5	**300**	2	**200**	2	8.3
Ammonia-Nitrogen	NA	NA	3 (n = 3)	**34,000**	NA	NA	0	-
OCPs	NA	NA	0	-	NA	NA	NA	NA
TPH (C_6-C_9)	0	-	0	-	1	150	0	-
TPH (C_{10}-C_{36})	0	-	5	590	2	270	0	-

Table 9.1: Evaluation of Groundwater Analytical Results – Summary Table (µg/L)

Analyte	Up-gradient of Landfill		Landfill		BSC		Dams (Surface Water)	
	Detections (n = 3)	Max	Detections (n = 5 including 319A)	Max	Detections (n = 2)	Max	Detections (n = 2)	Max
Benzene	0	-	0	-	0	-	0	-
Toluene	0	-	0	-	0	-	0	-
Ethylbenzene	0	-	1	2.7	0	-	0	-
Total xylene	0	-	1	37	0	-	0	-
Naphthalene	0	-	2	10	0	-	0	-
Chloroform	0	-	1	1.8	1	360	0	-
Chlorobenzene	0	-	2	5.8	0	-	0	-
Isopropylbenzene	0	-	2	3.7	0	-	0	-
n-propyl benzene	0	-	2	6.1	0	-	0	-
1,3,5 – trimethylbenzene	0	-	1	**22**	0	-	0	-
1,2,4 – trimethylbenzene	0	-	1	**100**	0	-	0	-
Other VOCs	0	-	0	-	0	-	0	-

n number of samples
NA not analysed
- Maximum less than the PQL
Bold Concentrations exceed the ANZECC (2000) Trigger Values for Marine Waters

The main impacts detected include ammonia, metals, TPH and associated fuel products such as ethylbenzene, xylene and trimethylbenzene.

Ammonia was found to dominate the nitrogen compounds in landfill groundwater which EIS considers to be associated with the anaerobic decomposition of organic matter including timber and other waste within the landfill. Groundwater outside the landfill was not submitted for analysis so a comparison of concentrations cannot be made.

Organics were detected above the PQLs in groundwater sampled from the landfill and to a lesser extent at the BSC (which EIS estimates is affected by the landfill) indicating that landfill materials have had an impact on groundwater quality.

Groundwater wells were not located to the east of the landfill (towards Little Bay), with most detections reported in MW319 and MW319A (water perched in the fill) at the eastern edge of

the landfill. The standing water levels and known relief of the site indicate that groundwater mounding occurs at this location behind the in-cut sandstone.

Chloroform and TPH C_6-C_9 were detected at low concentrations in the BSC. EIS conclude that the likely source is the landfill rather than the BSC as there was no evidence of any sources at this location. The Auditor notes that only low concentrations were reported and no odours or visual evidence of impacts were noted following demolition of the buildings (Section 11).

Two samples were collected from the two dams. The results indicate that only low concentrations of metals were reported. EIS conclude that the "*results do not indicate that the dams have been significantly impacted by contaminant leachate from the adjoining land filled area*". The Auditor agrees with regard to those contaminants submitted for analysis, however samples were not analysed for ammonia.

EIS concluded that *"groundwater contamination issues at the site are considered to be related to the presence of landfilled material at the site. Additional groundwater monitoring may be necessary to confirm perched water conditions within the landfill with variation in climatic conditions"*.

The Auditor considers that it was established that there was contamination of groundwater principally by ammonia because of the presence of the landfill. Remediation of the site has involved the excavation and offsite disposal of material not suitable to remain. Post-remediation groundwater monitoring has been undertaken (Section 11.3.4), which has demonstrated that remediation of the site has removed the source of contamination.

10 Evaluation of Landfill Gas Analytical Results

Landfill gas was measured at eleven monitoring wells and during drilling of boreholes into the former landfill area during EIS soil investigations undertaken prior to remediation.

Methane was detected at six borehole locations and in all monitoring wells. Methane concentrations in monitoring wells ranged from 1.2% by volume (v/v) to 4.8% v/v. Two boreholes in the east of the landfill (BH318 and BH318) had methane concentrations of 6.2% v/v and 9.2% v/v.

Flow rates were not provided for boreholes or monitoring wells. An assessment of the analytical results with reference to the NSW EPA (2012) *Guidelines for the Assessment and Management of Site Impacted by Hazardous Ground Gases* is therefore not possible.

EIS (2007) referred to the EPA (1996) *Environmental Guidelines: Solid Waste Landfills.* These guidelines apply to licensed landfills and are therefore not applicable to the site. The guidelines include a methane action level for subsurface gas monitoring of 1.25% v/v to detect offsite migration. Methane concentrations exceeded the threshold in ten of eleven monitoring wells and six of twenty five boreholes.

ENSR (2008a) undertook landfill gas monitoring during trenching works in the landfill area of the site. Methane and carbon dioxide were not detected, including in areas where methane has previously been detected.

Remedial works undertaken to address the generation of landfill gas and the results of monitoring undertaken following remediation are discussed in Section 11.

11 Evaluation of Remediation

11.1 Remediation Required

Remediation was considered necessary to make the development site (Stages 1 – 4, Attachment 2, Appendix A) suitable for residential development due to landfilling in the eastern portion of the site. Investigations indicated that the landfill material contained asbestos, heavy metals, PAHs, petroleum hydrocarbons and methane.

EIS prepared 'Report to University of NSW on Remedial Action Plan for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW' (RAP), dated May 2007, which detailed the proposed remedial strategy for the site. The RAP was the subject of a previous site audit (GN336) by the current Site Auditor. The site audit statement (SAS), dated 6 July 2007, concluded that the site can be made suitable for the purposes of 'residential with gardens and accessible soil' if the site is remediated/managed in accordance with several options presented in the RAP, subject to compliance with a number of conditions.

Following the sale of the site by UNSW to CHOF5 Little Bay Pty Ltd, ENSR prepared a Remediation Works Plan (RWP), dated 2 February 2009. The RWP identified the preferred remediation option for the site and detailed the remediation methodology. The RWP was reviewed by the Auditor in the IAL provided in Appendix D.

AECOM subsequently prepared a Work Method Statement (2011c) for the validation of the site. The Work Method Statement was prepared to provide further guidance for the validation of the site, and to bring the RWP in line with WA DoH (2009).

Civil works were undertaken by CIP Constructions (NSW) Pty Ltd (CIP), with monitoring and validation undertaken by AECOM. Works were largely undertaken between June 2011 and February 2014.

The remediation and validation undertaken is discussed in the following sections.

11.2 Remediation Works

11.2.1 UNSW Biological Service Compound

ANSTO (2012) undertook a radiological survey inside the BSC prior to demolition. Following demolition of the buildings and associated infrastructure in the BSC, the ground surface was validated by AECOM (2011b) and ANSTO (2012).

No evidence of radiological material or other sources of contamination were observed inside the buildings prior to demolition. The remediation and validation of the site therefore did not target specific sources of contamination. However ANSTO reported that anecdotal evidence and comparison to similar research facilities indicated that radioactive material may have been used. Validation of the BSC following demolition was therefore considered necessary.

The objective of the validation works undertaken by ANSTO and AECOM was to determine if historical activities had resulted in contamination of the site warranting remediation. The results of the validation sampling are discussed in Section 11.3.

11.2.2 Landfill and Central Corridor

Investigation of the landfill by AECOM (2011a and 2014) for waste classification purposes was undertaken prior to remediation. AECOM identified that fill material generally occurred in layers, which varied in content, moisture and colour. The upper layers were considered suitable for re-use onsite following sieving, sorting and validation. The lower layer of fill material was not suitable for re-use onsite and was disposed of as general solid waste (64,372.19 tonnes), asbestos waste (1737.26 tonnes) or restricted solid waste (625 tonnes).

AECOM (2014) report that the following scope of works was undertaken during remediation of the landfill:

- Excavation of fill material present in the former landfill area. Material suitable for re-use on the site was stockpiled prior to remediation (discussed below). Material not suitable for re-use was disposed directly offsite. Excavation of the western portion of Ocean Avenue was not considered to be required as landfill material was not present.
- Validation of sandstone bedrock (Attachment 7, Appendix A) or natural material (Attachment 9, Appendix A) at the base of the excavation at a density of 1/100 m^2. Residual fill material was present in the base of the excavation at locations of ASS and inundation of surface water and groundwater. Where fill was present, validation samples were collected from natural material by test pitting through the residual fill material, or the fill material was validated at a higher density (1/50 m^2 or 1/60 m^2).
- Validation samples of walls along the northern, eastern and southern boundaries of the site at 20 m intervals (Attachment 9, Appendix A). Samples were not collected from the western wall as the excavation did not terminate at a wall.
- Stockpiled fill material was sieved to remove bulk materials using a 75 x 150 mm mesh excavator bucket. The removed material was disposed offsite. The sieved material was laid in 20 m x 20 m x 300 mm remediation beds (120 m^3) (Attachment 10, Appendix A). In the later stages of remedial works, the beds were not placed in 20 m x 20 m grids due to access and other restrictions (Attachment 11, Appendix A). The remediation beds were therefore sized to meet the 120 m^3 volume.
- Hand picking of ACM in conjunction with tilling/turning of material laid in remediation beds. Hand picking was continued until the bed was visually clear of ACM and other waste. If friable asbestos was discovered, the bed was disposed of offsite as asbestos waste. Photographs were taken of the bed prior to and during validation sampling, including images of suspect materials.
- Validation of each bed for ACM was undertaken onsite against the validation criteria of <0.01% w/w initially and no visible asbestos after 30 June 2012. Ten soil samples of approximately 1 kg were collected from the four equally divided portions of the 20 m x 20 m remediation bed (approximately 5 m x 5 m grids) and combined to achieve a total composite sample mass of 10 kg (minimum). Samples were distributed both horizontally and vertically to be representative of materials contained within the bed.

The sample was sieved using a 6.7 mm aperture woven mesh test sieve, and the ACM retained on the sieve weighed to determine the total ACM weight and percentage of asbestos.

- If validation failed, the bed was re-tilled by an excavator, hand-picked until no visible ACM remained, and re-validated.
- Following validation of the bed for ACM, the material was compacted prior to placement of the next bed. Samples were collected approximately every fourth bed (i.e. approximately every 480 m^3) for PID screening and laboratory analysis for metals, TPH, BTEX and PAHs (Attachments 12 and 13, Appendix A).
- ACM removed from the material was disposed offsite as asbestos waste.
- Following compaction of the final bed of fill material, approximately 1 m of validated imported VENM/ENM was placed on the fill material in residential areas of the site (Attachment 4, Appendix A). The site was surveyed prior to and following material placement to confirm the thickness achieved. In open space areas of the site, 300 mm of topsoil was placed on the fill material.

Departures from the scope of work described above included the following:

- During excavation of the southern dam in the central corridor, significant water seepage occurred upon penetration of a clay layer that precluded the removal of all fill material. Test pits were excavated through the remaining fill material, which logged anthropogenic material and decomposing organic matter. The modified scope involved retaining up to 700 mm of fill material, with the top 300 mm tilled and picked as per the RWP. The material would remain below approximately 3 m of remediated fill material and a separation layer.
- The northern dam in the central corridor was not excavated as a result of the significant seepage experienced in the southern dam. The modified scope involved retaining 300 mm of fill material above the clay layer, which was tilled and picked as per the RWP. Test pits were excavated through the fill material at a density of 1/50 m^2 to confirm the thickness and to collect validation samples from the underlying material.
- Approximately 2 to 7 m of residual fill material remained in the northern portion of the central corridor and beneath Ocean Avenue (Lot 52 and 53 in Attachment 8, Appendix A). Removal of the material was not considered feasible due to the depth of the fill material and the potential instability of the excavation. Seven trenches (CS01-CS07) were excavated in the material and samples collected for characterisation of the fill. The material was overlain with 4 metres of remediated fill material and a separation layer. The material is in the proposed open space area of the site.
- Residual fill material remained in the central corridor to avoid exposing the underlying PASS. The modified scope involved retaining 500 mm of fill material, which was tilled and picked as per the RWP. Test pits were excavated through the fill material to confirm the thickness and to collect validation samples from the underlying material.

Analytical results for validation samples of fill material and imported VENM/ENM are discussed in Section 11.3.

Daily air monitoring for airborne asbestos fibres was conducted during the remediation works for health and safety. Asbestos fibre concentrations greater than the detection limit of 0.01 f/mL were detected on 65 occasions. AECOM undertook activity based sampling (ABS) for asbestos fibres during remediation and validation of the site in response to the detections. ABS was implemented to assess the potential risk posed by future excavation beneath the VENM separation layer and exposure to the remediated fill material.

The exposure scenarios monitored during ABS included controlled and uncontrolled excavation of fill material using an excavator, and a child playing in fill material at the ground surface. Controlled excavation involved the use of a garden hose to apply water at the point of excavation. Air monitoring for asbestos fibres was undertaken in the breathing zone and immediate surrounding area while the activities were being undertaken.

The ABS was undertaken at 14 trenches excavated through remediated fill material to bedrock (Attachment 14, Appendix A). The trenches were undertaken in areas of the site where fill material had been placed at the time. Excavation was undertaken for approximately 1-2 hours. Three small stockpiles were set aside from the trench for the child playing ABS. Each stockpile was dug/scraped using a trowel and bucket for 1 hour.

The results of the ABS indicated no asbestos fibre detections. AECOM therefore concluded that *"…the material in the investigated area of the site did not pose an unacceptable risk from airborne asbestos for the proposed land use"*.

AECOM also undertook interim ABS to assess unremediated fill material remaining stockpiled on the site (in lieu of further ABS following placement of material). Interim ABS involved air monitoring immediately surrounding the remediation beds, personal monitoring on an ACM removalist and simulation of a child playing scenario on every eighth bed. Interim ABS was undertaken between September 2012 and February 2014.

Interim ABS concentrations exceeded 0.01 f/mL on five occasions (Attachment 15, Appendix A). Three instances were marginally above the detection limit (0.02 f/mL) and no further action was considered to be required. Two instances were significantly elevated (0.42 and 0.5 f/mL) so the material being handled at the time was excavated and disposed offsite. The Auditor notes that the five elevated asbestos fibre concentrations reported during the Interim ABS represent less than 1% of the samples collected between September 2012 and February 2014.

In response to occasional elevated asbestos fibre concentrations in air monitors, AECOM investigated potential sources of asbestos fibres. Samples were collected from soils being handled at the time for laboratory analysis.

The sampling by AECOM, along with samples collected by EIS, resulted in approximately 765 samples being analysed for asbestos. Approximately 75 contained ACM (10%) and 3 contained respirable fibres below the detection limit (0.4%).

The investigations and ABS have demonstrated that there is a low potential for asbestos fibre generation during future occupation of the site.

11.3 Validation Results

11.3.1 UNSW Biological Services Compound

ANSTO (2012) undertook a radiological survey of the building pre-demolition, which did not identify evidence of radioactivity above background radiation levels. Following demolition of the building, ANSTO conducted a continuous walk-over survey on a 1 m transect spacing, which indicated a relatively uniform distribution of radioactivity across the entire area consistent with typical background levels.

Instrumentation used during the pre and post demolition surveys included 2 inch NaI detectors, thin end window scintillation detectors and Geiger-Muller detectors. ANSTO reported that "*All instruments used performed satisfactorily during the survey*".

Following building demolition works, validation samples were collected from BSC by AECOM (2011b) and ANTSO (2012) on a grid basis beneath building footprints (Attachment 16, Appendix A). Test pit excavations at twenty locations were extended to bedrock, with samples collected from the ground surface and 0.5 mbgl. Collected samples were analysed for metals, TPH, BTEX and PAH, with selected samples also analysed for asbestos, OCP, OPP, PCB and VOC. Soil samples collected as part of the radiological investigation were analysed by ANSTO for low energy beta emitting radionuclides, gamma radionuclides and tritium.

Fill material primarily consisted of sand and gravel overlying sandstone bedrock. The fill material thickness ranged from 0.2 to 0.7 m, with no visual or olfactory signs of contamination noted. Following validation, the fill material was excavated and remediated with the remainder of the site.

Concentrations of contaminants of concern were less than the PQL or less than the adopted criteria. AECOM concluded that the material *"…is considered suitable for the proposed residential land use"*, however noted that fragments of ACM were observed in areas surrounding the BSC during previous investigations. ANSTO report that gamma and beta results for soil samples collected for radiological analyses were less than the detection limit.

11.3.2 Landfill and Central Corridor

Excavation Validation

Following excavation of fill material, validation samples were collected from the base and walls of excavations, and residual fill material remaining in-situ. The validation sample locations are shown in Attachment 7 (bedrock base), Attachment 8 (soil base) and Attachment 9 (wall) in Appendix A.

The analytical results for base validation samples are summarised in Table 11.1.

Table 11.1: Evaluation of Base Validation Results – Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > HIL 1 (DEC 2006)
Arsenic	338	49	24	-	0

Table 11.1: Evaluation of Base Validation Results – Summary Table (mg/kg)					
Analyte	**n**	**Detections**	**Maximum**	**n > EPA (1994)**	**n > HIL 1 (DEC 2006)**
Cadmium	338	16	3	-	0
Total Chromium	338	328	32	-	0
Copper	338	257	90	-	0
Lead	338	319	**1,800**	-	**3**
Mercury (inorganic)	338	56	0.3	-	0
Nickel	338	187	42	-	0
Zinc	338	298	470	-	0
BTEX	337	0	<PQL	0	-
TPH (C_6-C_9)	337	0	<PQL	0	-
TPH (C_{10}-C_{36})	337	28	**1,740**	**3**	-
Total PAHs	345	76	**33.6**	-	**1**
Benzo(a)pyrene	345	71	**3.2**	-	**2**

n number of samples
- No criteria available/used

Validation samples collected from natural material at the base of the excavation following fill material removal generally contained contaminant concentrations less than the adopted criteria. Approximately 1% of samples contained concentrations of TPH, benzo(a)pyrene, total PAH and lead concentrations exceeding the adopted criteria.

Three samples (SV342, SV348 and SV355) contained elevated TPH C_{10}-C_{36} concentrations. Additional analysis for SVOCs and a scan for unknowns were undertaken on the two samples with the highest TPH concentrations. SVOC concentrations were less than the PQL and the scan for unknowns showed no matches. AECOM report that the samples were collected from natural material. The Auditor therefore considers it likely that the TPH concentrations represent naturally occurring hydrocarbons.

Two of the lead exceedances were within the statistical acceptance criteria. The third elevated lead concentration (SV356) was collected from the central corridor. AECOM report that SV356 and three samples with elevated TPH concentrations (SV342, SV348 and SV355) will be located below the clay liner of the northern dam. The potential for exposure to the elevated contaminant concentrations is therefore considered to be low.

Elevated PAH concentrations were reported in a validation sample collected from the stormwater infrastructure excavation in Ocean Avenue to the west of View Street (Attachment 8, Appendix A). The analytical laboratory undertook additional analyses of the primary sample and field duplicate. The average benzo(a)pyrene concentration of the additional analysis was reported by AECOM to be 1.2 mg/kg, which marginally exceeds the criteria. AECOM considered that further remediation or assessment was not warranted as

the sample location will be located beneath a roadway and at a depth of over 1.5 mbgl. The Auditor agrees that there will be a low potential for exposure to the residual material given its location and depth below ground level.

At the 367 locations where bedrock was present a visual inspection was conducted to confirm fill material had been removed and no evidence of contamination remained. Samples of bedrock were not collected for laboratory analyses.

Remediation and validation of the western portion of Ocean Avenue was not undertaken. Validation samples (SV186-SV206) and visual observations from a stormwater service excavation undertaken within Ocean Avenue confirm that landfill materials were not present in the area. AECOM report that "*as landfill materials were not present remediation and validation works were not required in this area*".

The Auditor has undertaken a review of previous investigations undertaken by EIS (2006 and 2007), which included seven boreholes drilled within the footprint of Ocean Avenue to the west of View Street (Attachment 17, Appendix A). Borehole logs indicate that fill material comprising silt, sand, clay and gravel to depths of 3 mbgl in the east and 0.3 mbgl in the west. No landfill material was noted. Soil samples collected from fill material contained contaminant concentrations less than the adopted criteria. Remediation of Ocean Avenue to the west of View Street is therefore not considered to be required.

The analytical results for wall validation samples are summarised in Table 11.2.

Table 11.2: Evaluation of Wall Validation Results – Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > HIL 1 (DEC 2006)
Arsenic	137	8	24	-	0
Cadmium	137	11	5.1	-	0
Total Chromium	137	131	82	-	0
Copper	137	99	240	-	0
Lead	137	135	**810**	-	**2**
Mercury (inorganic)	137	33	1.6	-	0
Nickel	137	107	79	-	0
Zinc	137	131	500	-	0
BTEX	135	0	<PQL	0	-
TPH (C_6-C_9)	105	0	<PQL	0	-
TPH (C_{10}-C_{36})	117	9	350	0	-
Total PAHs	137	46	14.6	-	0
Benzo(a)pyrene	137	43	**1.5**	-	**3**

n number of samples

- No criteria available/used

Four wall validation samples contained benzo(a)pyrene and lead concentrations exceeding the adopted criteria. AECOM considered the exceedances acceptable based on statistical interpretation of the analytical results: 95% UCL concentrations less than the criteria; concentrations were less than 250% of the criteria; and the standard deviation was less than 50% of the criteria.

The samples along the northern boundary are to be located beneath a roadway. The Auditor therefore considers the potential for exposure to the residual material to be low.

Waste material was observed in the wall of the southern boundary. Waste material comprised approximately 10% of the soil matrix and included slag, brick, tile, plastic and rubber. ACM and organic material were not noted on the field logs.

The western boundary of the site largely comprised the protected Miocene sediments. Validation of the base of this area (SV085-SV100) was undertaken following removal of the majority of the waste material. The validation samples were collected adjacent to the western boundary of the site and did not contain contaminant concentrations exceeding the adopted criteria.

Bedrock and soil validation were not undertaken in the northwest of the site. Correspondence from AECOM (email 29/4/14) reported that validation of Lot 53 and Lot 54 was undertaken. Validation samples SV019-SV020 (Attachment 8, Appendix A), shown on the western side of View Street, were apparently collected from the eastern side of View Street and validate this portion of the site.

Remediation Bed Asbestos Validation

Following validation of the excavation, fill material was replaced in remediation beds. Asbestos quantification was undertaken on 10 kg samples collected from each remediation bed. Remediation bed locations for which asbestos quantification was undertaken are shown in Attachments 10 and 11, Appendix A.

AECOM (2014) report that a total of 1,002 remediation beds were placed on the site (approximately 80,160 m^3 compacted). 79% of remediation beds passed on the first round of ACM validation, with 95% passing after three rounds of validation.

38 remediation beds (4%) contained visible asbestos ranging from 0.0005% to 0.0096% w/w. The concentrations are less than the adopted criteria (0.01%) and are located at depths of 1.4 m to 4.8 mbgl. The remaining 964 remediation beds (96%) did not contain visible asbestos.

It is not possible to remove 100% of the ACM present in the fill material. Fragments of material may therefore be present, however at concentrations less than the residential and open space criteria (0.01% and 0.02% respectively), and at depths of greater than approximately 1 mbgl. The risk-based assessment of the remediated material has not demonstrated unacceptable exposure levels from residual asbestos.

Remediation Bed Laboratory Validation

Validation samples were collected every fourth remediation bed for laboratory analyses. Remediation bed validation sample locations for laboratory analyses are shown in Attachments 12 and 13, Appendix A. The analytical results are summarised in Table 11.3.

Table 11.3: Evaluation of Remediation Bed Validation Results – Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > HIL 1 (DEC 2006)
Arsenic	270	19	8	-	0
Cadmium	270	39	3.9	-	0
Total Chromium	270	265	32	-	0
Copper	270	270	370	-	0
Lead	270	270	**310**	-	**1**
Mercury (inorganic)	270	210	5	-	0
Nickel	270	263	240	-	0
Zinc	270	270	460	-	0
BTEX	269	1*	0.6	0	-
TPH (C_6-C_9)	269	0	<PQL	0	-
TPH (C_{10}-C_{36})	269	42	**1,300**	**1**	-
Total PAHs	274	255	**81.5**	-	**4**
Benzo(a)pyrene	274	252	**6.9**	-	**4**

n number of samples
- No criteria available/used
* BTEX detection was toluene

274 validation samples were collected from the remediation beds for laboratory analyses for metals, TPH, BTEX and PAHs. Six samples (2.2%) contained contaminant concentrations exceeding the adopted criteria.

AECOM considered the exceedances acceptable based on statistical interpretation of the analytical results. The exceptions were two samples (VB010 and VB088), which contained benzo(a)pyrene and total PAH concentrations that failed the statistical parameters.

The intra-laboratory duplicate (QC506) of VB010 has PAH concentrations less than the PQL. Reanalyses of four duplicates of VB010 and QC506 by the laboratory did not identify elevated PAH concentrations. The laboratory considered the original results for VB010 to be a "*statistical anomaly*" and recommended that it be excluded from the data set. AECOM considered that the material therefore met the validation criteria and was suitable to be retained on the site.

Further analysis of five laboratory duplicate samples of VB088 did not identify concentrations exceeding the criteria. AECOM considered the elevated PAH concentrations in the primary sample to not be representative of the sampled material, and therefore concluded that the material could be retained on the site.

The Auditor considers the fill material to be adequately validated for use on the site. The exceedances of the criteria are not considered significant enough to warrant further remediation or offsite disposal of the material. In most instances, the exceedances were within statistical parameters and the material represented by the exceedances will be at least one metre below the final ground level (below 1 m of VENM). There would therefore be a low potential for exposure to the fill material.

Based on the results of the remediation bed validation and ABS, the Auditor considers the site to be suitable for the proposed use.

11.3.3 Imported VENM

Approximately 45,000 m^3 of sandstone VENM was imported to the site for use as a separation layer. VENM was imported from the following sources:

- University of Technology (UTS) at the corner of Jones Street and Broadway, Ultimo
- UTS at the corner of Thomas Street and Jones Street, Ultimo
- 100 Glover Street, Mosman

UTS Broadway

Previous investigations of the source site identified potential sources of contamination, including two underground storage tanks, asbestos contamination associated with demolition of buildings and chemicals from dry-cleaning and steel and newspaper production and the use of unknown fill.

It is understood that remediation and validation of the site was undertaken. Compaction & Soil Testing Services Pty Ltd (CSTS) provided validation reports for the base of the tanks; spoil classification reports and two VENM certificates. CSTS concluded that:

- The red-brown and light grey clay retained at the base of the tank pits, following the removal of the tanks and associated spoil, could be classified as VENM (not imported to this site). The results were non-detect for organics and low for metals.
- The light grey and orange sandstone bedrock, exposed following removal of the fill and clay, could be classified as VENM. The results of the 6 randomly selected samples were non-detect for organics and low for metals. These results confirmed the field observations.

AECOM undertook an inspection of the source site on 9 August 2011 and noted that fill material had been removed and there was no evidence of the USTs. Removal of the residual clay was still in progress over a portion of the site with the underlying sandstone exposed. This is consistent with observations made during an audit site inspection of the source site. AECOM undertook a final inspection at the source site on 26 August 2011 and confirmed that the clay overburden had been removed.

UTS Thomas Street

AECOM reviewed previous site investigation reports, which included a review of the site history, drilling of 11 boreholes, excavation of 9 test pits, and collection of fill (7 samples), natural soil (13 samples) and groundwater (2 samples) for laboratory analysis. Shale and sandstone bedrock was encountered underlying fill (silt, sand and clay containing brick and ash) and natural soil (silty clay). Laboratory analyses of natural soil and groundwater samples did not identify elevated contaminant concentrations. The silty clay and sandstone material was classified as VENM.

AECOM undertook an inspection of the source site on 21 June 2012 and noted that fill and silty clay material had been removed. No ACM fragments, anthropogenic material, odour or staining was observed. AECOM concluded that the material was VENM and suitable for importation to the site subject to implementation of a material tracking protocol.

100 Glover Street, Mosman

AECOM reviewed previous site investigation reports, which included excavation of six test pits into fill and sandstone. Laboratory analyses of two fill and four soil samples did not identify elevated contaminant concentrations. The sandstone material was classified as VENM.

AECOM undertook an inspection of the source site on 3 April 2012 and noted that fill material had been removed and sandstone material was present. No odour, staining or ACM was noted. Although information on the historical use of the site was lacking, the sandstone material was considered to be VENM.

Conclusion

Given the field observations and review of the information supplied, AECOM concluded that the material from each source site was suitable for importation.

A material tracking protocol was prepared and implemented by CIP for the importation of VENM. AECOM periodically inspected the material upon importation to the site to confirm the material type and identify unexpected inclusions. AECOM report that inclusions, staining and odours were not observed.

The RWP (AECOM, 2009) required sampling and analyses of imported material at a rate of 1/100 m^3 for TPH, BTEX, metals, OCPs, PCBs and PAHs. Samples were not collected for analysis upon importation due to the adequacy of the source site investigations and the large volume of material imported.

Sampling and laboratory analysis of the imported material was undertaken for asbestos in soil. A total of 59 primary samples, five duplicates and five triplicates were collected. Asbestos fibres were identified in two triplicate samples below the reporting limit (0.002 g) and less than the guideline (0.001%). Reanalysis of samples by the triplicate laboratory did not identify asbestos. AECOM considered that the detections may represent cross contamination during the stockpiling process. AECOM concluded that the materials are suitable for capping.

The Auditor concludes that imported material is considered to be VENM.

11.3.4 Topsoil

Topsoil used to complete open space areas in the central corridor was sourced from Stages 1 and 2 (the western portion of the greater development area). The material was stripped from former playing fields following removal of grass, and stockpiled in Stages 1 and 2 until used on the site.

Analytical results for soil samples collected from the surface of the western playing fields during investigation of the site by EIS (2007) are summarised in Table 11.4. The sample locations are shown on Attachment 17, Appendix A.

Table 11.4: Topsoil Analytical Results – Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > HIL 3 (DEC 2006)
Arsenic	32	19	24	-	0
Cadmium	32	0	<PQL	-	0
Total Chromium	32	32	23	-	0
Copper	32	32	70	-	0
Lead	32	32	49	-	0
Mercury (inorganic)	32	6	0.49	-	0
Nickel	32	32	170	-	0
Zinc	32	32	86	-	0
BTEX	32	0	<PQL	0	-
TPH (C_6-C_9)	32	0	<PQL	0	-
TPH (C_{10}-C_{36})	32	0	<PQL	0	-
Total PAHs	32	8	9	-	-
Benzo(a)pyrene	32	5	1	-	-
OCP	32	1	0.4*	-	-
OPP / Herbicides	15	0	<PQL	-	-
PCB	32	0	<PQL	-	-
Asbestos	33	1	ACM fragment 1x1x2 mm	-	-

n number of samples
- No criteria available/used
* OCP detections were chlordane and DDT/DDD/DDE in BH380 at 0-0.1 mbgl

The analytical results for surface soil samples collected from the playing fields in the western portion of the greater development area contained contaminant concentrations that were

less than the HIL for open space land use. Concentrations of arsenic and nickel exceeded the provisional phytotoxicity based criteria (HIL 5), however the exceedances were considered marginal (arsenic maximum of 24 mg/kg versus HIL 5 of 20 mg/kg, nickel maximum of 170 mg/kg versus HIL 5 of 60 mg/kg).

ACM was identified in one surface soil sample from the western playing field. The SAR for Stages 1 and 2 concluded that "*Although there is a potential for the stripped topsoil to contain fragments of ACM, the risk is considered to be sufficiently low such that further validation is not required. The material should be inspected during placement to further reduce this low risk*".

AECOM inspected the material as it was stripped and stockpiled in Stages 1 and 2. Records of inspection of the material as it was placed on the site were not provided by AECOM.

During the site visit by the Auditor on 15 May 2014, a site walkover observed woodchip placed over the topsoil in the central corridor.

The Auditor considers the material suitable for use based on the results of previous investigations and observations by AECOM during stripping and stockpiling of the material.

11.3.5 Groundwater

Groundwater monitoring wells sampled prior to remediation were destroyed during excavation of the site (Attachment 6, Appendix A). The results of groundwater monitoring undertaken prior to remediation of the site are discussed in Section 9.

At the completion of the majority of the remediation, AECOM installed three new groundwater monitoring wells on the site (MW01-MW03) (Attachment 5, Appendix A). Two wells were located adjacent to the northern boundary (up gradient) and one was located in the southeast of the site (down gradient).

No wells were installed within the former landfill area of the site. AECOM had proposed to install one well within the landfill, however report that it could not be undertaken due to access constraints.

Groundwater samples collected from the wells were analysed for TPH, BTEX, PAHs and metals. The groundwater analytical results are summarised in Table 11.4.

Table 11.4: Groundwater Analytical Results (µg/L)

Analyte	TVs	MW01	MW02	MW03
Date Sampled		25 Jun 2013	25 June 2013	25June 2013
Arsenic	2.3	<PQL	2	<PQL
Cadmium	0.7	0.7	<PQL	0.3
Total Chromium	27.4	<PQL	2	<PQL
Copper	1.3	**4**	<PQL	1
Lead	4.4	<PQL	<PQL	<PQL
Mercury (inorganic)	0.1	<PQL	<PQL	<PQL

Table 11.4: Groundwater Analytical Results (µg/L)				
Analyte	**TVs**	**MW01**	**MW02**	**MW03**
Date Sampled		**25 Jun 2013**	**25 June 2013**	**25June 2013**
Nickel	7	**20**	<PQL	2
Zinc	15	**71**	5	**93**
TPH C_6-C_9	-	<PQL	<PQL	<PQL
TPH C_{10}-C_{36}	-	<PQL	<PQL	<PQL
BTEX	-	<PQL	<PQL	<PQL
Total PAHs	3	<PQL	<PQL	<PQL

- TV not available
Bold Concentration exceeds the ANZECC (2000) Trigger Value for Marine Waters

Concentrations of TPH, BTEX and PAHs were less than the PQL. Concentrations of selected metals exceeded the adopted criteria in MW01 and MW03 installed on the up gradient boundary of the site.

AECOM considered the metals results to be representative of background concentrations or surface water in the water retention basin in the central corridor.

The Auditor does not consider the metals results to be significantly elevated and further investigation or remediation is not considered warranted.

11.3.6 Landfill Gas

Monitoring of landfill gas within the former landfill portion of the site prior to remediation identified elevated concentrations of methane (Section 10). Towards the completion of remedial works, assessment of landfill gas was undertaken by AECOM.

AECOM considered that landfill gas monitoring was not required as fill material was excavated to bedrock or natural material across the majority of the site, offsite disposal of waste material occurred, and putrescible waste was not identified in residual fill material.

AECOM measured landfill gas concentrations (methane, carbon dioxide, oxygen and hydrogen sulphide) in the three groundwater monitoring wells (MW01-MW03) installed adjacent to the northern and southern boundaries of the site (Attachment 5, Appendix A).

The landfill gas concentrations are summarised as follows:

- Methane was not detected in the wells.
- Low concentrations of carbon dioxide (up to 7.1%) and hydrogen sulphide (up to 1 ppm) were reported.
- Oxygen concentrations were roughly equivalent of atmospheric conditions (20.4-20.9%).

AECOM considered that no further monitoring was required. The Auditor considers that, the likelihood of landfill gas being present post-remediation is low.

11.3.7 Auditor's Opinion

Remediation of the site has involved the excavation and sorting of the majority of waste material on the site. The remediation undertaken is considered to have adequately addressed groundwater and landfill gas such that further monitoring is not required.

12 Contamination Migration Potential

Following remediation of the site, remediated fill material is present beneath a separation layer. Low concentrations of contaminants may remain. The contaminants of concern (metals, TPH, PAHs and asbestos) are not volatile and have low mobility. Validation samples collected from the remediation beds did not identify significantly elevated concentrations of contaminants and asbestos was removed to <0.01% w/w (prior 30 June 2012) or no visible asbestos (after 30 June 2012).

A separation layer of imported sandstone VENM was placed over remediation beds in the eastern portion of the site where residential land use is anticipated. The thickness of the separation layer ranged from 0.95 to 1.1 m (Attachment 4, Appendix A).

A separation layer of imported topsoil was placed over remediation beds in the proposed open space areas in the central corridor. The topsoil separation layer is approximately 0.3 m thick.

With respect to groundwater, monitoring undertaken towards the completion of remediation did not identify elevated contaminant concentrations requiring further investigation or remediation.

There is therefore limited potential for migration of contamination from the site in dust or surface water runoff, or vertically to groundwater.

The observation of fill material on the site boundaries indicates the material may be present at offsite adjoining locations.

In the Auditor’s opinion, there is little potential for future migration.

13 Assessment of Risk

Based on assessment of validation sample analytical results against relevant guidelines and consideration of the overall remediation, it is the Auditor's opinion that there are no indications of contamination that would pose a risk to human health if used for residential and open space purposes.

If future works on the site result in excavation through the separation layer, site users may be exposed to remediated fill material. Validation samples collected from the remediated fill material during placement and compaction identified contaminant concentrations exceeding the criteria in 6 of 274 (2%) samples. Following further laboratory analyses and statistical analyses of the analytical results, AECOM concluded that the material was suitable to be retained onsite.

The Auditor therefore considers there to be a low risk to future site users from remediated fill material present on the site below the separation layer.

14 Compliance with Regulatory Guidelines And Directions

Guidelines currently approved by the EPA under section 105 of the NSW *Contaminated Land Management Act 1997* are listed in Appendix C. The Auditor has used these guidelines.

The investigations and remediation were generally conducted in accordance with SEPP 55 Planning Guidelines and reported in accordance with the OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*. The checklist included in that document has been referred to. The EPA's *Checklist for Site Auditors using the EPA Guidelines for the NSW Site Auditor Scheme 1998 (December 1999)* has also been referred to.

The Audit was initiated to comply with terms of judgment of the Land and Environment Court, Appeal No. 10672 of 2009, dated 23 December 2009.

Condition 77 requires the remediation and validation works to be carried out in accordance with "Interim Advice Letter – Remedial Action Plan – Little Bay" dated 5 February 2009 prepared by the Auditor. The IAL is included in Appendix D. In the Auditor's opinion, remediation works undertaken were appropriate and in accordance with the RWP and IAL. Validation results and testing are discussed in Section 11.3.

Conditions 78 a) to c) require a Site Audit Statement and Site Audit Report to be prepared to verify that the land is suitable for the intended use. This SAR and accompanying SAS have been prepared to comply with those conditions.

The remediation strategy has not included 'capping' or 'containment' of contamination, and the SAS is not conditional on conformance to an Environmental Management Plan (EMP). The subsections of Condition 78 that refer to these issues therefore do not apply.

Condition 78 g) requires fill imported to the site to be VENM or ENM. As discussed in Section 11.3.3, the Auditor concludes that imported fill is considered to be VENM.

Condition 79 requires the SAS to clearly state the source of the standard adopted where no guideline made or approved under the NSW Contaminated Land Management Act is available. This does not apply to this site. Environmental quality criteria used are discussed in Section 7.

The NSW EPA issued an environment protection licence (EPL) number 13282 on 26 May 2011, which was varied on 9 July 2012. The EPL and variation relate to discharge of surface water from sedimentation basins present on the site during civil works. Section 19.2 of AECOM (2014) *Remediation and Validation Report* discusses monitoring undertaken to comply with the EPL.

Disposal documentation for contaminated soil was provided. Waste disposal dockets indicate 1,737 tonnes of special asbestos general solid waste was disposed offsite to Enviroguard, Elizabeth Drive Landfill Kemps Creek and Blacktown Waste Services. 6,023 tonnes of green waste was disposed to Botany Building Recyclers. 64,372 tonnes of general solid waste was disposed to Benedict Recycling, Kurnell Land Fill Company and Botany Building Recyclers. 625 tonnes of restricted solid waste was disposed to Enviroguard.

15 Conclusions and Recommendations

AECOM (2014) concludes "*based on the results of the remediation and validation works conducted at the site… the site is considered to be suitable for the following land uses:*

- *Residential with accessible soil including garden (minimal homegrown produce contributing less than 10% of 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.*

Based on the information presented in the reports prepared by AECOM and ANSTO, observations made on the site, and following the Decision Process for Assessing Urban Redevelopment Sites in DEC (2006) *Guidelines for the NSW Site Auditor Scheme*, the Auditor concludes that:

- Stage 3 of the site is suitable for the purposes of 'open space' use.
- Stage 4 of the site is suitable for the purposes of 'residential with gardens and accessible soil' and other less sensitive land uses including recreational open space.

16 Other Relevant Information

This Audit was conducted on the behalf of CHOF5 Little Bay Pty Ltd for the purpose of assessing whether the land is suitable for the proposed residential uses i.e. a “Site Audit” as defined in Section 4 (1) (b) (iii) of the CLM Act.

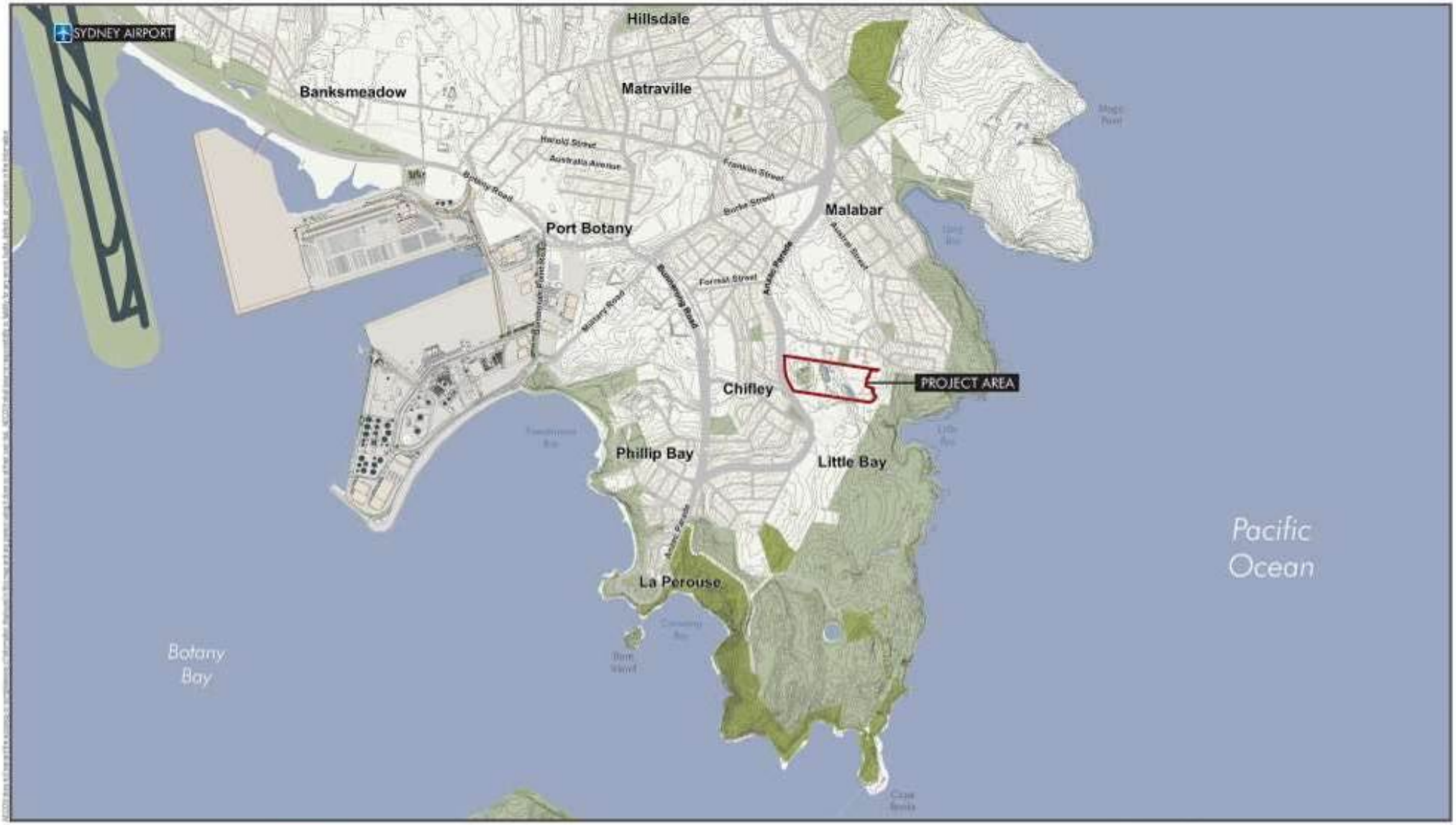
This summary report may not be suitable for other uses. EIS, ENSR, ANSTO and AECOM included limitations in their reports. The audit must also be subject to those limitations. The Auditor has prepared this document in good faith, but is unable to provide certification outside of areas over which he had some control or is reasonably able to check.

The Auditor has relied on the documents referenced in Section 1 of the Site Audit Report in preparing his opinion. If the Auditor is unable to rely on any of those documents, the conclusions of the audit could change.

It is not possible in a Site Audit Report to present all data which could be of interest to all readers of this report. Readers are referred to the referenced reports for further data. Users of this document should satisfy themselves concerning its application to, and where necessary seek expert advice in respect to, their situation.

Appendix A: Attachments

Attachment 1: Site Location
Attachment 2: Staging Plan and Proposed Lots
Attachment 3: Former Site Layout
Attachment 4: VENM Separation Layer
Attachment 5: Groundwater Monitoring Well Locations
Attachment 6: Former Groundwater Monitoring Well Locations
Attachment 7: Bedrock Validation Locations
Attachment 8: Soil Validation Locations
Attachment 9: Wall Validation Locations
Attachment 10: Eastern Remediation Beds
Attachment 11: Western Remediation Beds
Attachment 12: Eastern Bed Validation Samples
Attachment 13: Western Bed Validation Samples
Attachment 14: ABS Locations
Attachment 15: Interim ABS Exceedances
Attachment 16: BSC Validation Locations
Attachment 17: Stage 1 & 2 Investigation Locations



AECOM
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Site boundary
NPWS estate
Parks and reserves

Site Location

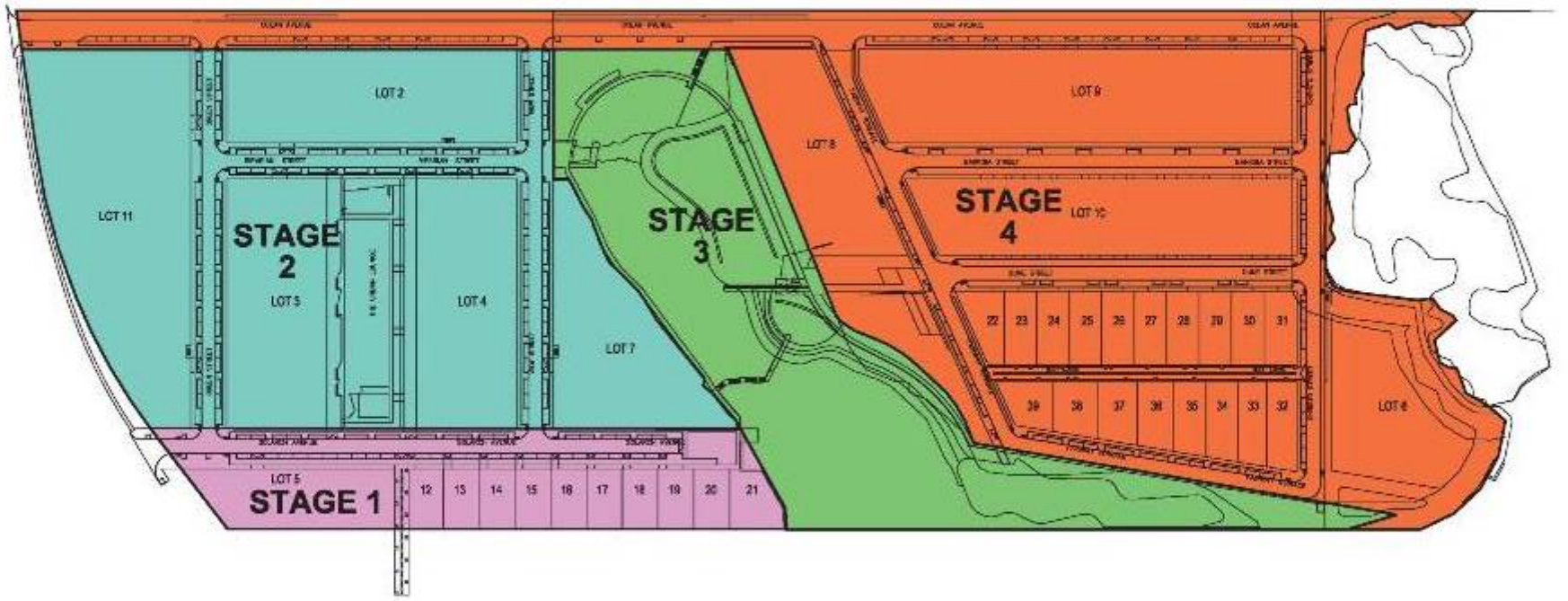
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F1

Attachment 1: Site Location

LITTLE BAY STAGING PLAN

Developing Relationships
Building Success

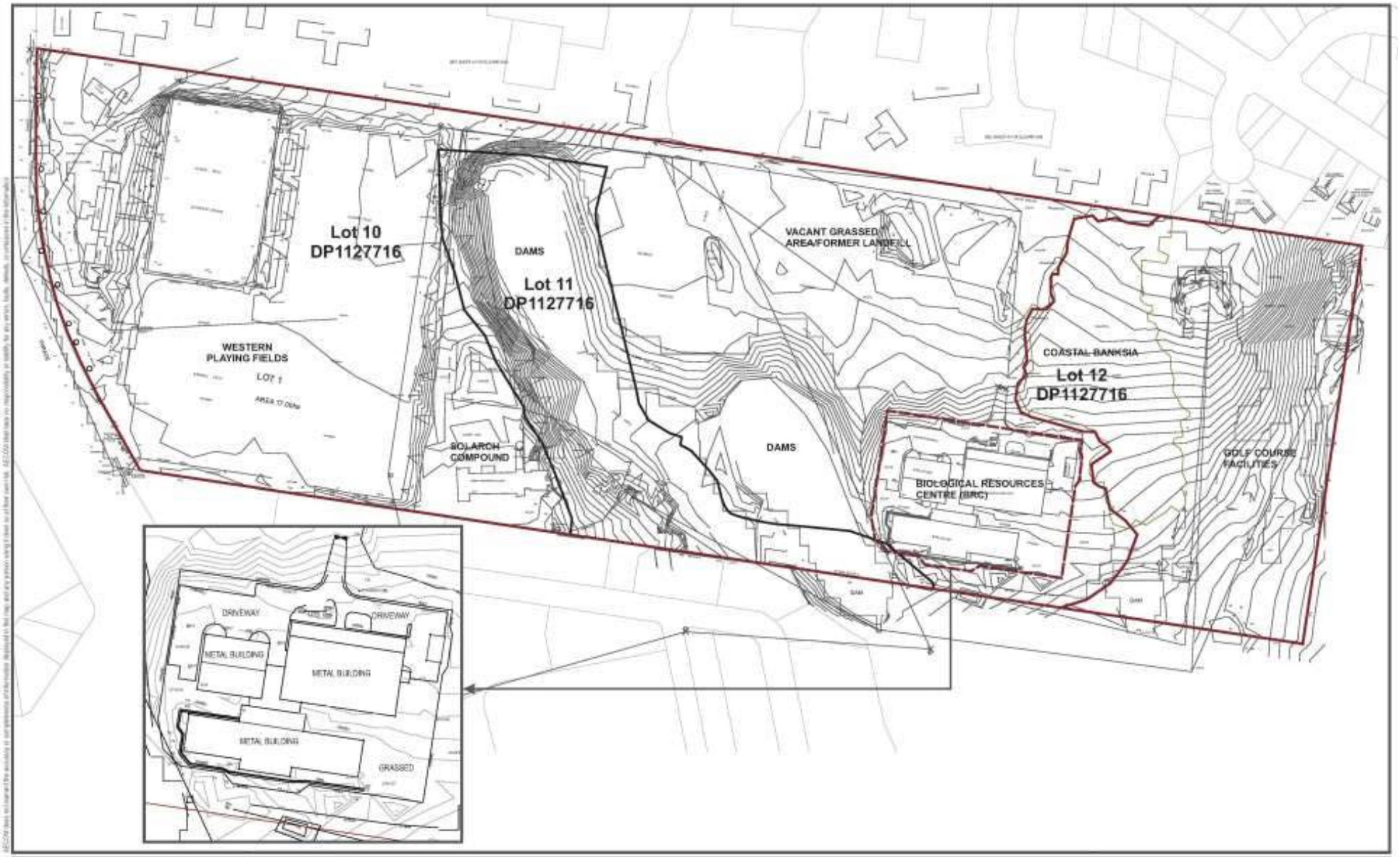


NOTE:-

- LOT 7 MAY BE HANDED OVER WITH STAGE 2 OR STAGE 3 DEPENDANT ON PROGRESS OF THE WORKS.
- LOT 8 MAY BE HANDED OVER WITH STAGE 3 OR STAGE 4 DEPENDANT ON PROGRESS OF THE WORKS

Scale
0 10 20 30 40 50 100m

Attachment 2: Staging Plan and Proposed Lots



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AECOM
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0 100m

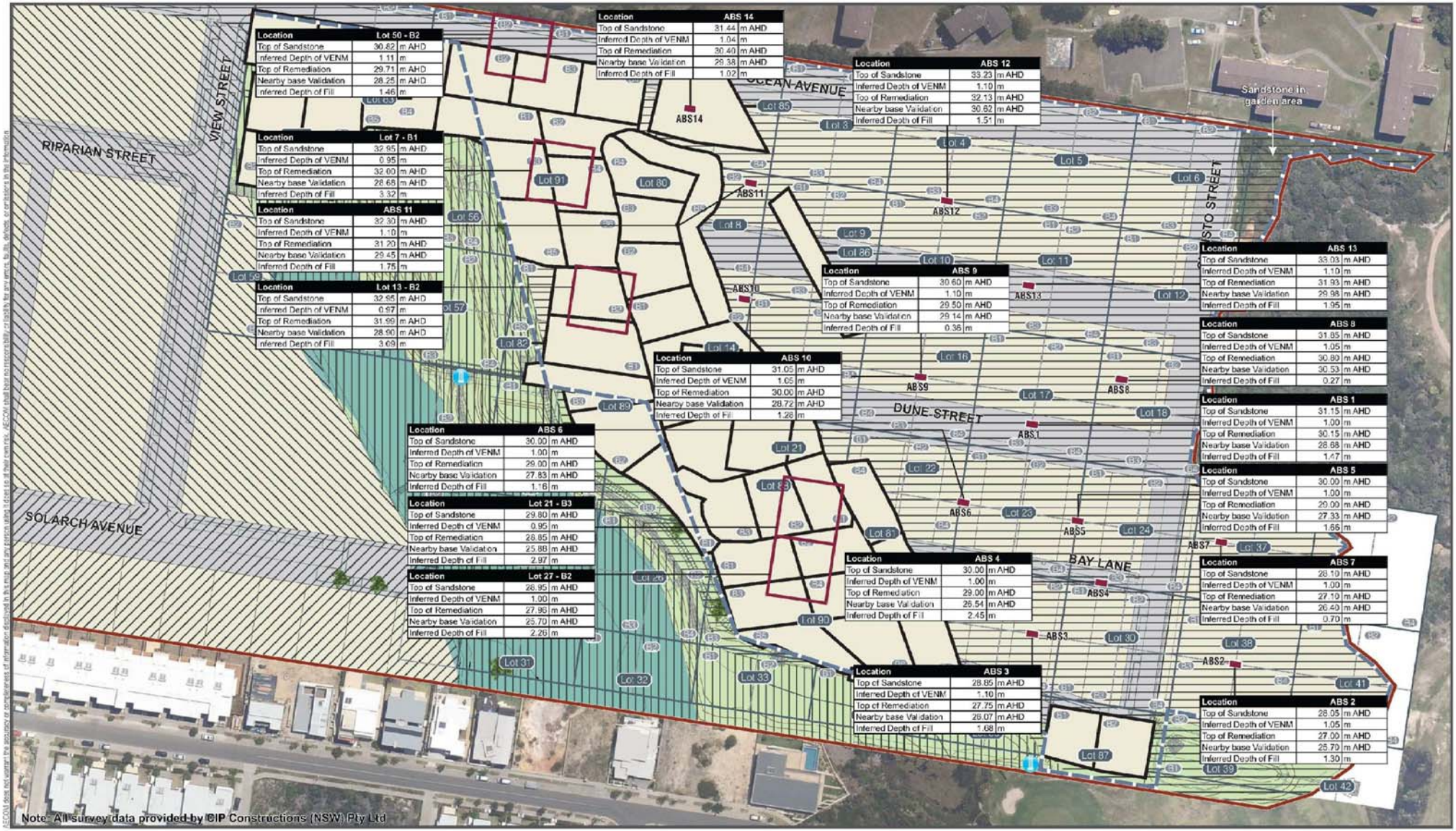
LEGEND
Little Bay Campus Boundary
Biological Resources Centre Boundary (BRC)

Original Site Layout and Previous Land Use

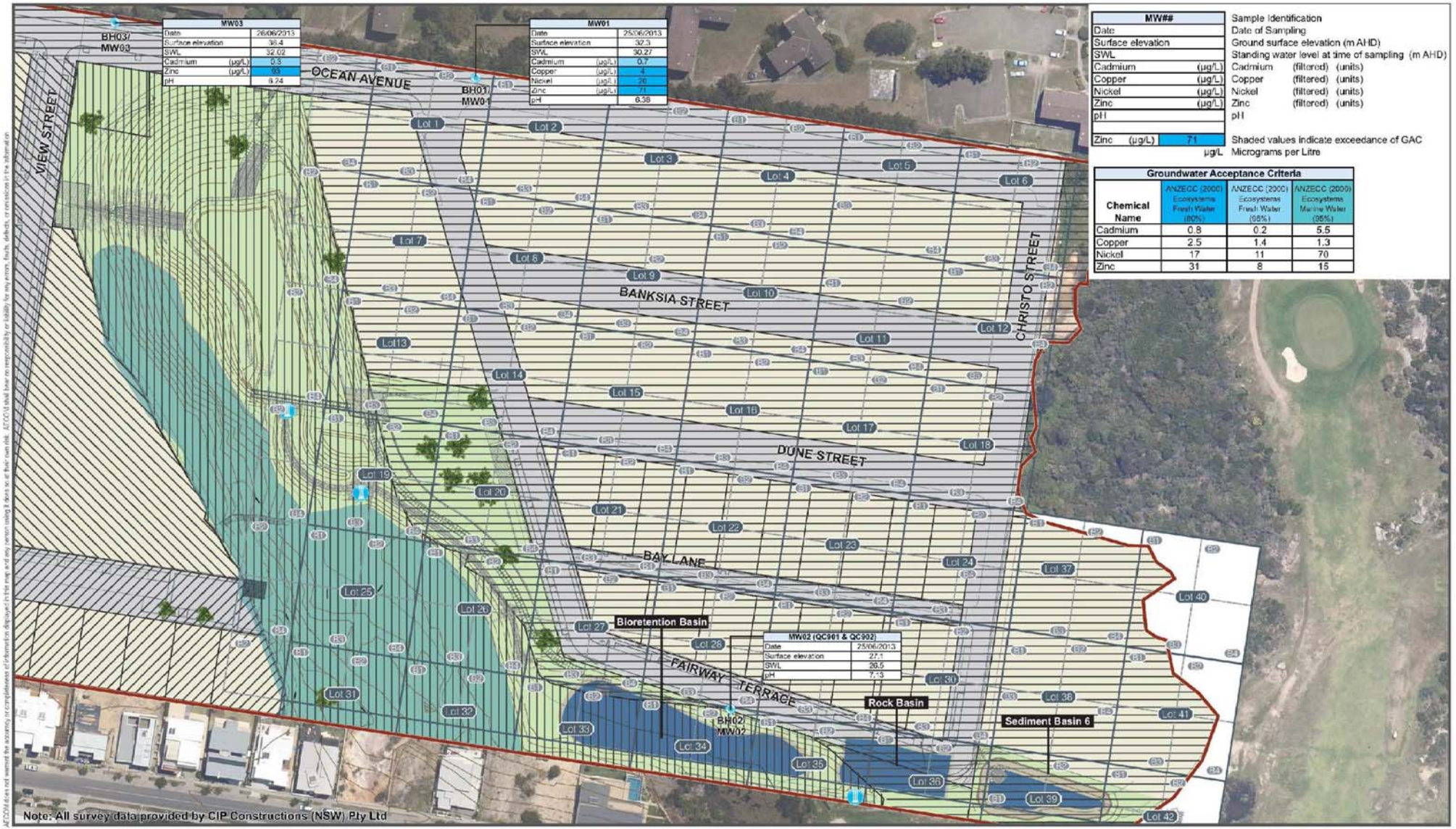
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F2

Attachment 3: Former Site Layout



Attachment 4: VENM Separation



MW##	
Date	Sample Identification
Surface elevation	Date of Sampling
SWL	Ground surface elevation (m AHD)
Cadmium (µg/L)	Standing water level at time of sampling (m AHD)
Copper (µg/L)	Cadmium (filtered) (units)
Nickel (µg/L)	Copper (filtered) (units)
Zinc (µg/L)	Nickel (filtered) (units)
pH	Zinc (filtered) (units)
	pH
Zinc (µg/L) 71	Shaded values indicate exceedance of GAC
µg/L	Micrograms per Litre

Groundwater Acceptance Criteria			
Chemical Name	ANZECC (2000) Ecosystems Fresh Water (80%)	ANZECC (2000) Ecosystems Fresh Water (95%)	ANZECC (2000) Ecosystems Marine Water (95%)
Cadmium	0.8	0.2	5.5
Copper	2.5	1.4	1.3
Nickel	17	11	70
Zinc	31	8	15

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LAST MODIFIED: TO 01 05 2014

AECOM
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0 50m

- Site boundary
- Miocene protected area boundary
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Groundwater monitoring well location (AECOM, 2013)
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- A - H Completed remediation bed layers
- Lot 32 Remediation bed validation lot reference
- 61 Remediation bed validation reference

Groundwater Investigation Summary

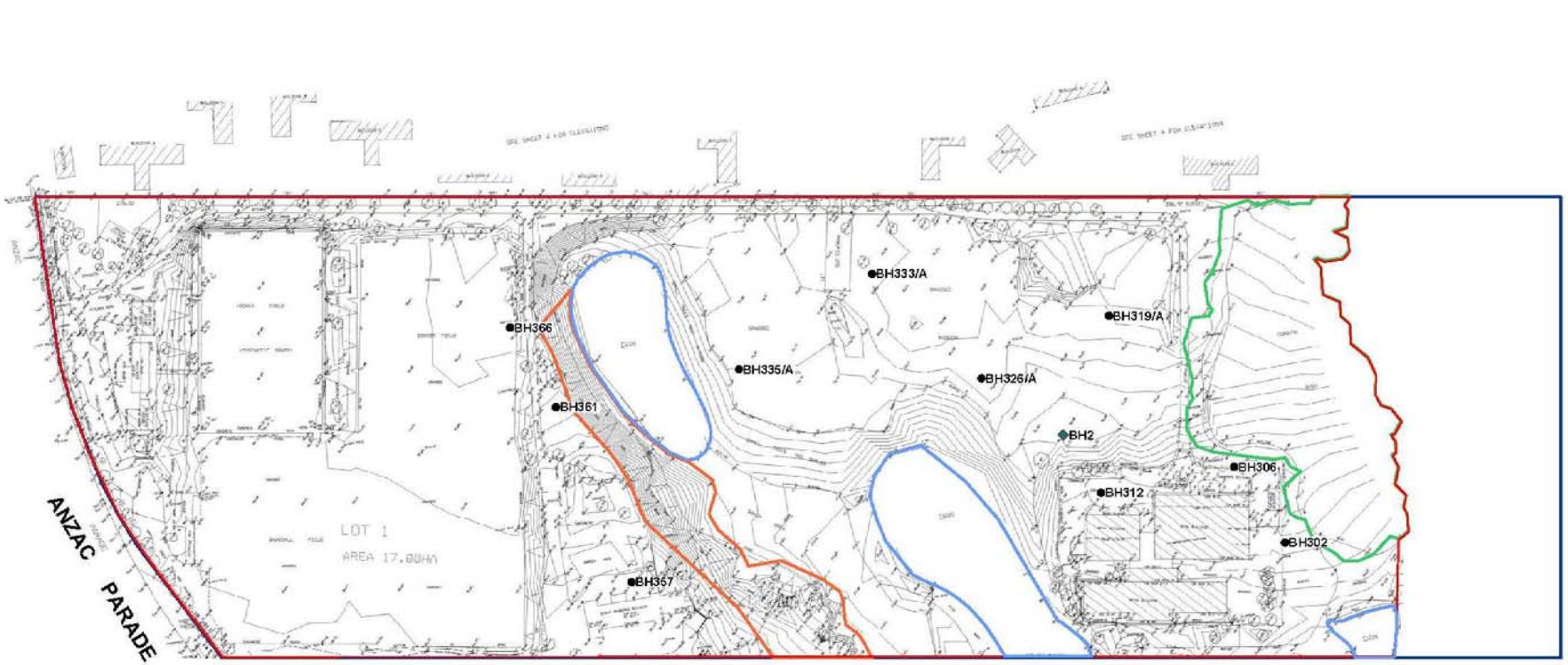
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F12

Map Document: G:\Projects\60\60212824\ Little Bay\FIGURES\Post Remediation Summary Report\60212824 F12 Groundwater Exceedances Rev B

A3 Size

Attachment 5: Groundwater Monitoring Well Locations



LEGEND:

- ● BH300 EIS STAGE 2 MONITORING WELL LOCATION, NUMBER (2007)
- ◆ BH2 E&ES MONITORING WELL LOCATION, NUMBER (2001)

SCALE (m)

0 20 40 60 80 100

Note: Reference should be made to the text for a full understanding of this plan. The E&ES investigation locations are based upon field measurements undertaken by EIS during the Stage 2 investigation.

MONITORING WELL LOCATION PLAN

UNSW Campus, 1408 Anzac Parade, Little Bay

EIS ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E20167FJrpt2
Figure: 5

Attachment 6: Former Groundwater Monitoring Well Locations

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AECOM
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0 50m

- Site boundary
- Micocene protected area boundary
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Bedrock validation location
- Test pit location
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- Lot 32 Remediation bed validation lot reference
- B1 Remediation bed validation reference

Base of Excavation Validation - Bedrock

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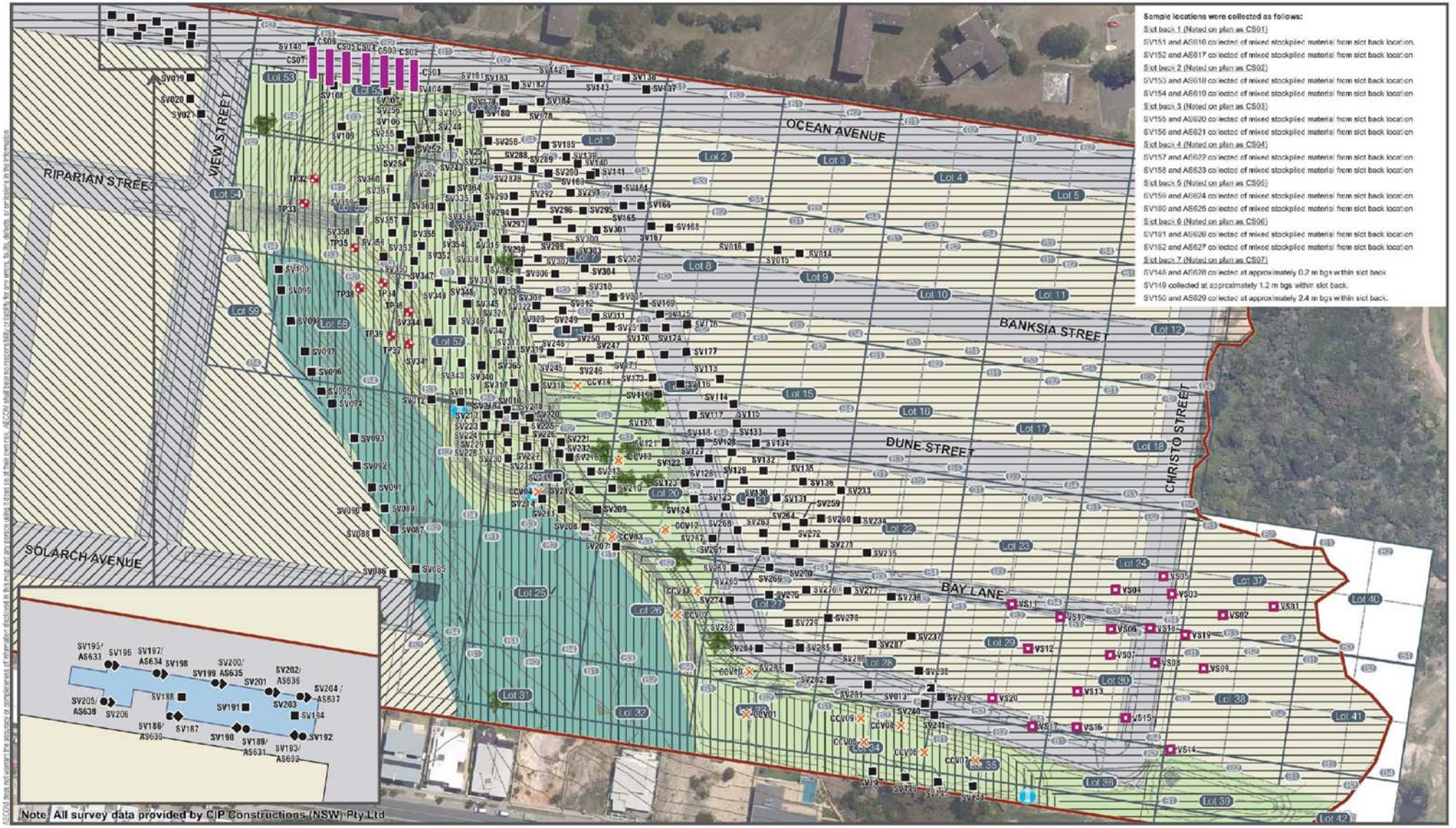
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F5

Map Document: G:\Projects\60\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F5 Base of Excavation Validation - Bedrock Rev E

A3 Size

Attachment 7: Bedrock Validation Locations



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LAST MODIFIED: TO 01 05 2014

AECOM
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0 60m

- Site boundary
- Micoocere protected area boundary
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- Lot 32 Remediation bed valication lot reference
- 31 Remediation bed valication reference
- Base of excavation soil validation sample location
- Top of wall soil validation sample location
- Bottom of wall soil validation sample location
- Central corridor validation sample location
- Former BRC soil validation sample location
- Test pit location
- Characterisation slot back

Base of Excavation Validation - Soil

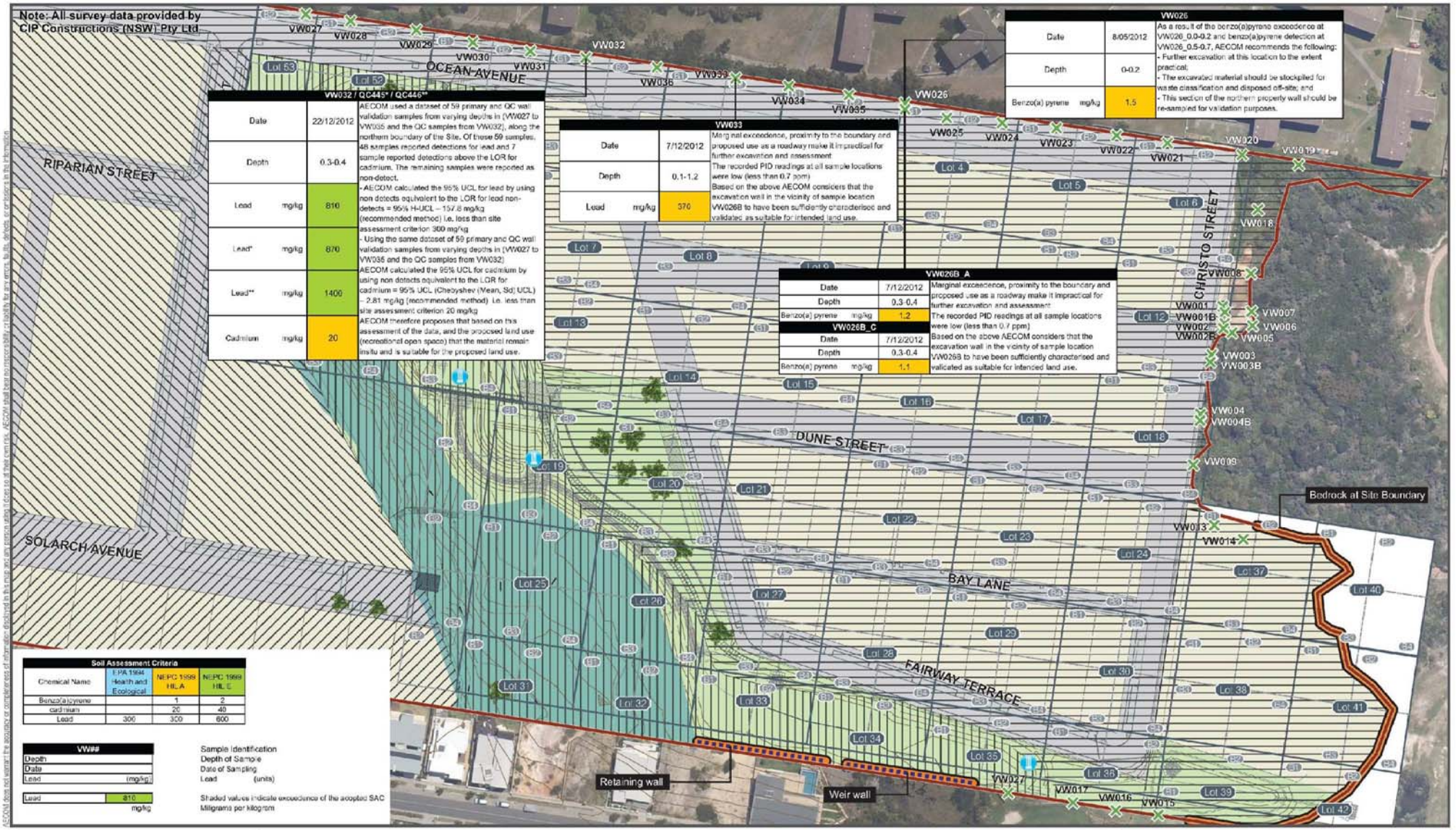
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F6

Map Document: G:\Projects\62\60212824 Little Bay\IT\GIS\Post Remediation Summary Report\60212824 F6 Base of Excavation Validation - Soil Rev C

A3 Size

Attachment 8: Soil Validation Locations



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Wall Validation Sampling Summary

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Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F7

Map Document: G:\Projects\60\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F7 Wall Validation Sampling Summary Rev E

A3 Size

Attachment 9: Wall Validation Locations

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0 50m

- Site boundary
- Miocoene protected area boundary
- Puzzle bed extent
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- A-H Completed remediation bed layers
- Lot 32 Remediation bed validation lot reference
- B1 Remediation bed validation reference

Bed Remediation and Validation
31 August 2011 to 10 September 2012

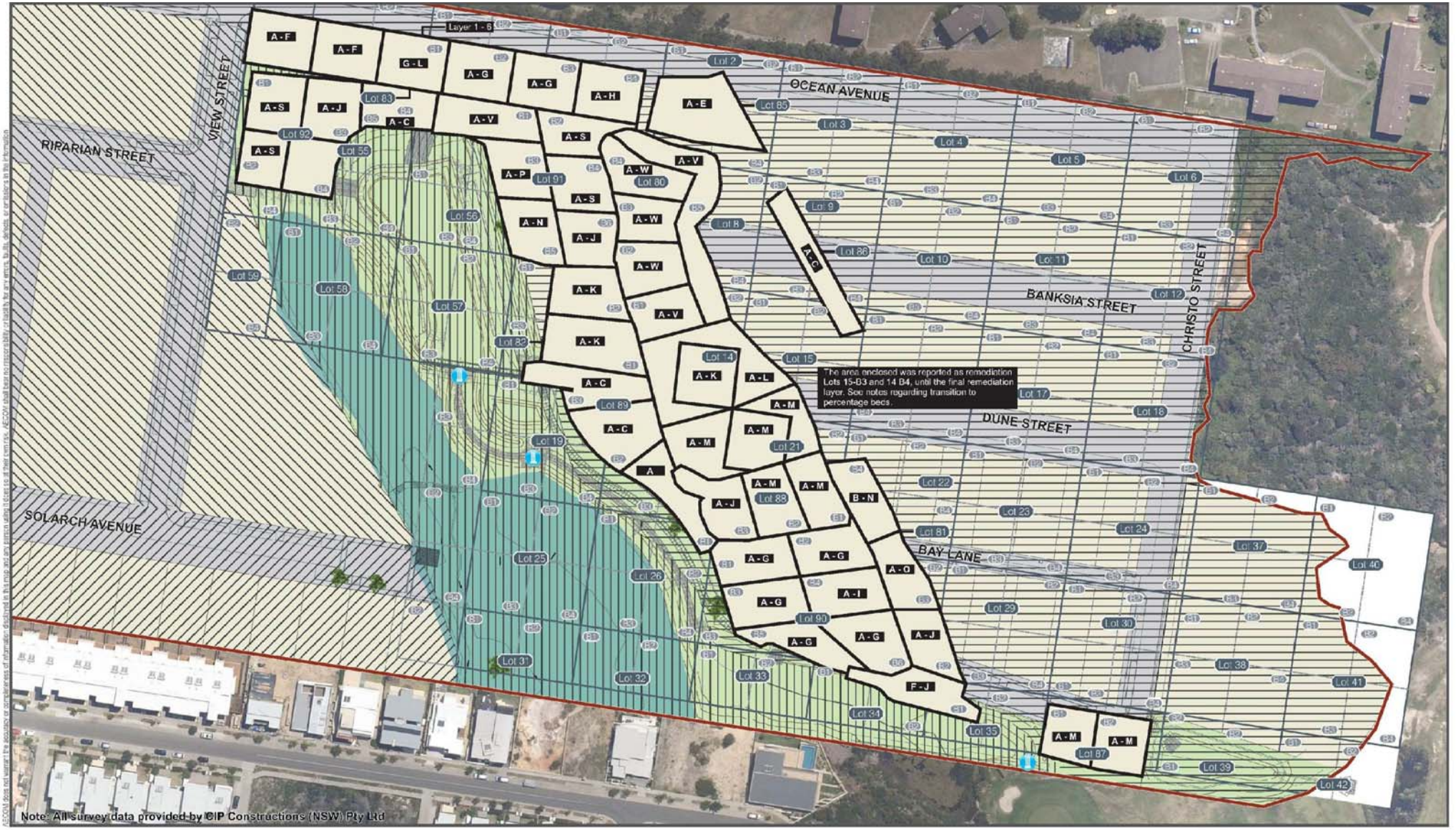
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F8a

Map Document: G:\Projects\60\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F8a Bed Remediation and Validation Rev C

A3 Size

Attachment 10: Eastern Remediation Beds



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0 50m

- Site boundary
- Micocene protected area boundary
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- A-H Completed remediation bed layers
- Lot 32 Remediation bed validation lot reference
- B1 Remediation bed validation reference

Bed Remediation and Validation
11 September 2012 to 7 February 2014

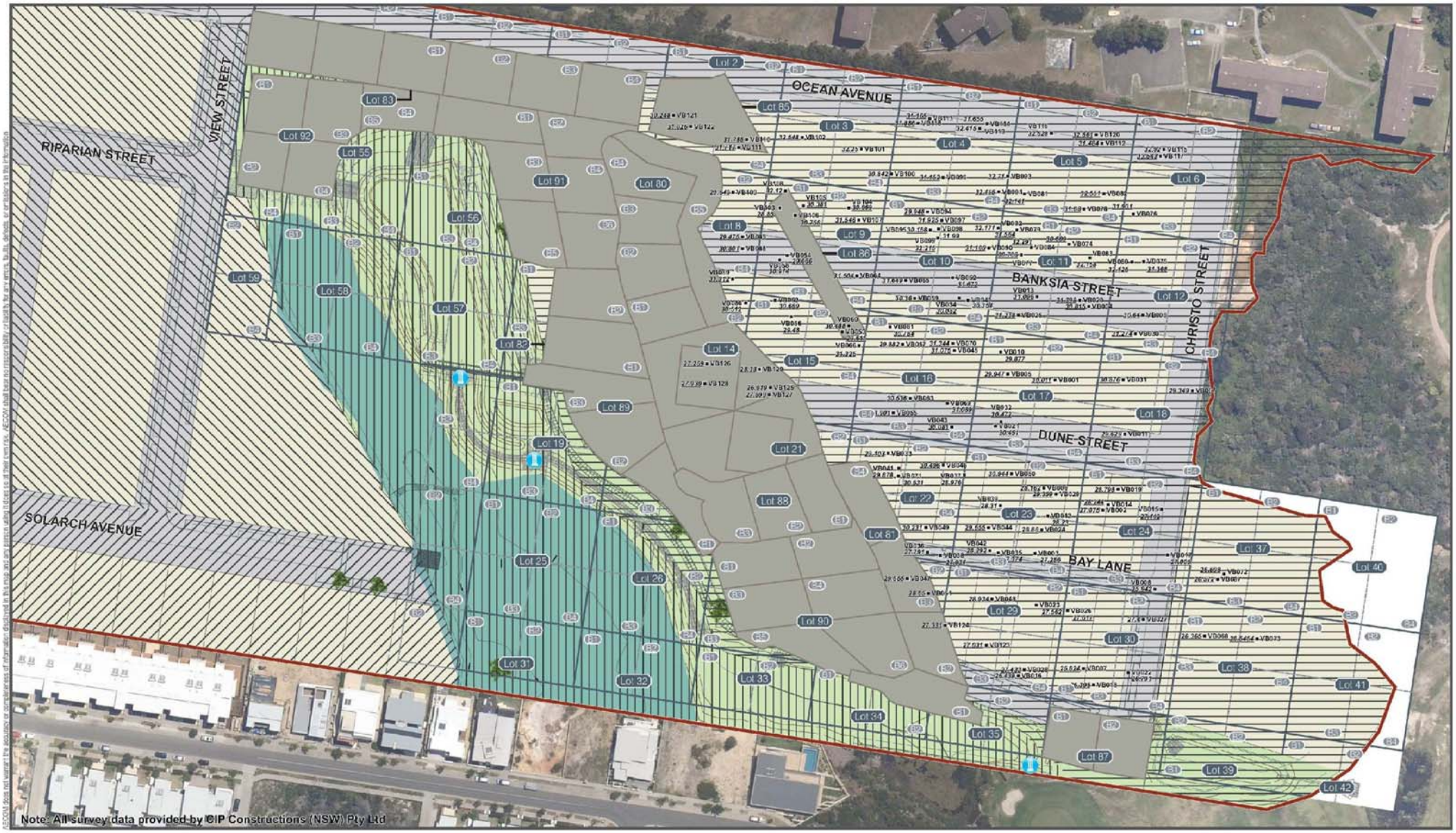
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F8b

Map Document: G:\Projects\60\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F8b Bed Remediation and Validation 11 September 2012 to 7 February 2014 Rev D

A3 Size

Attachment 11: Western Remediation Beds



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LAST MODIFIED: TO 01 05 2014

AECOM
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0 50m

- Site boundary
- Micocene protected area boundary
- Puzzle bed extent
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- A - H — Completed remediation bed layers
- Lot 32 — Remediation bed validation lot reference
- B1 — Remediation bed validation reference
- 24.594 — Sample elevation (mAHD)

Bed Remediation and Validation
31 August 2011 to 10 September 2012

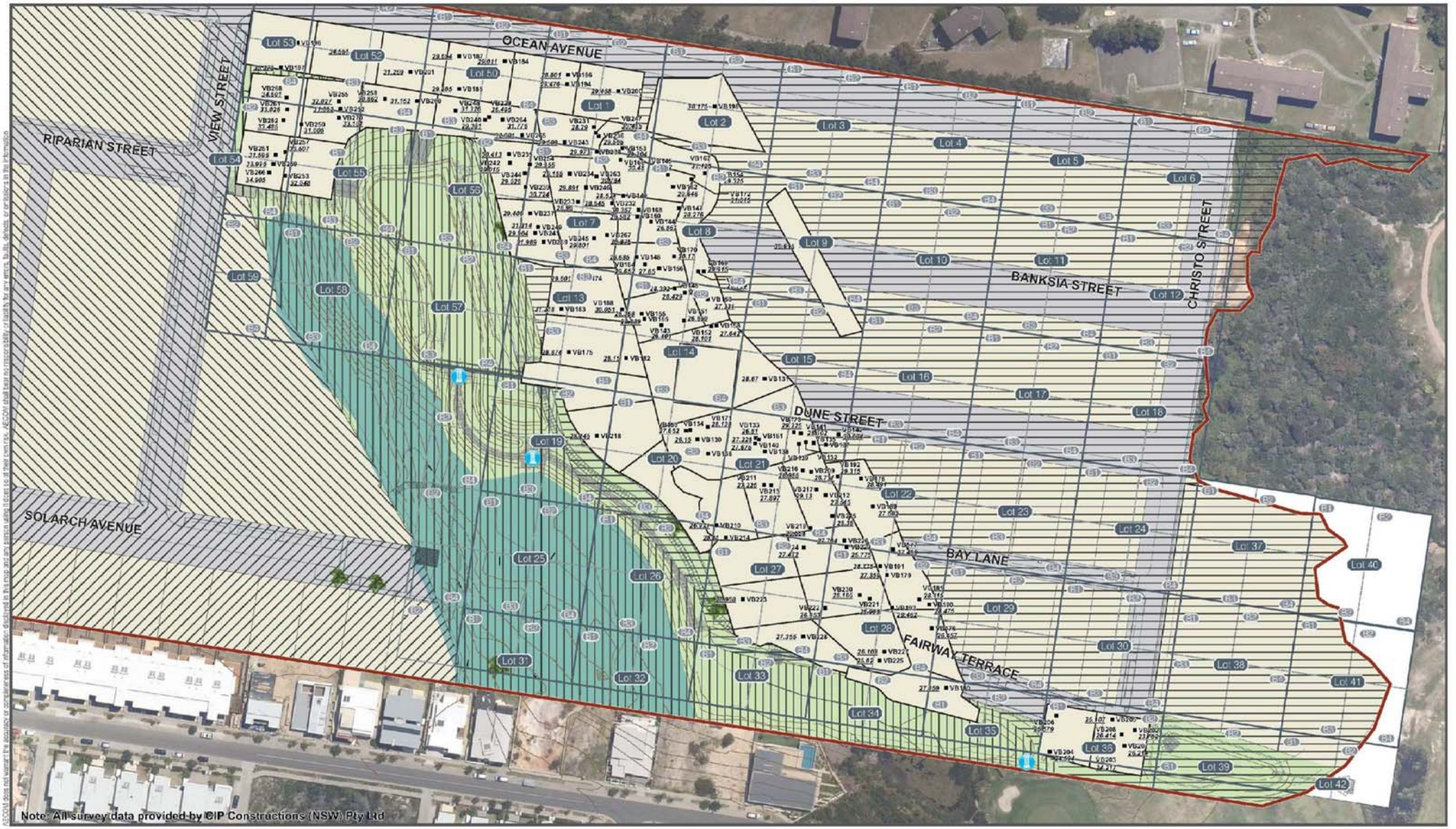
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F8c

Map Document: G:\Projects\60\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F8c Bed Remediation and Validation 31 August 2011 to 10 September 2012 Rev B

A3 Size

Attachment 12: Eastern Bed Validation Samples



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0 50m

- Site boundary
- Miocoere protected area boundary
- Puzzle bed extent
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- A - H — Completed remediation bed layers
- Lot 32 — Remediation bed validation lot reference
- B1 — Remediation bed validation reference
- 24.594 — Sample elevation 9mAHD)

Bed Remediation and Validation
12 September 2012 to 7 February 2014

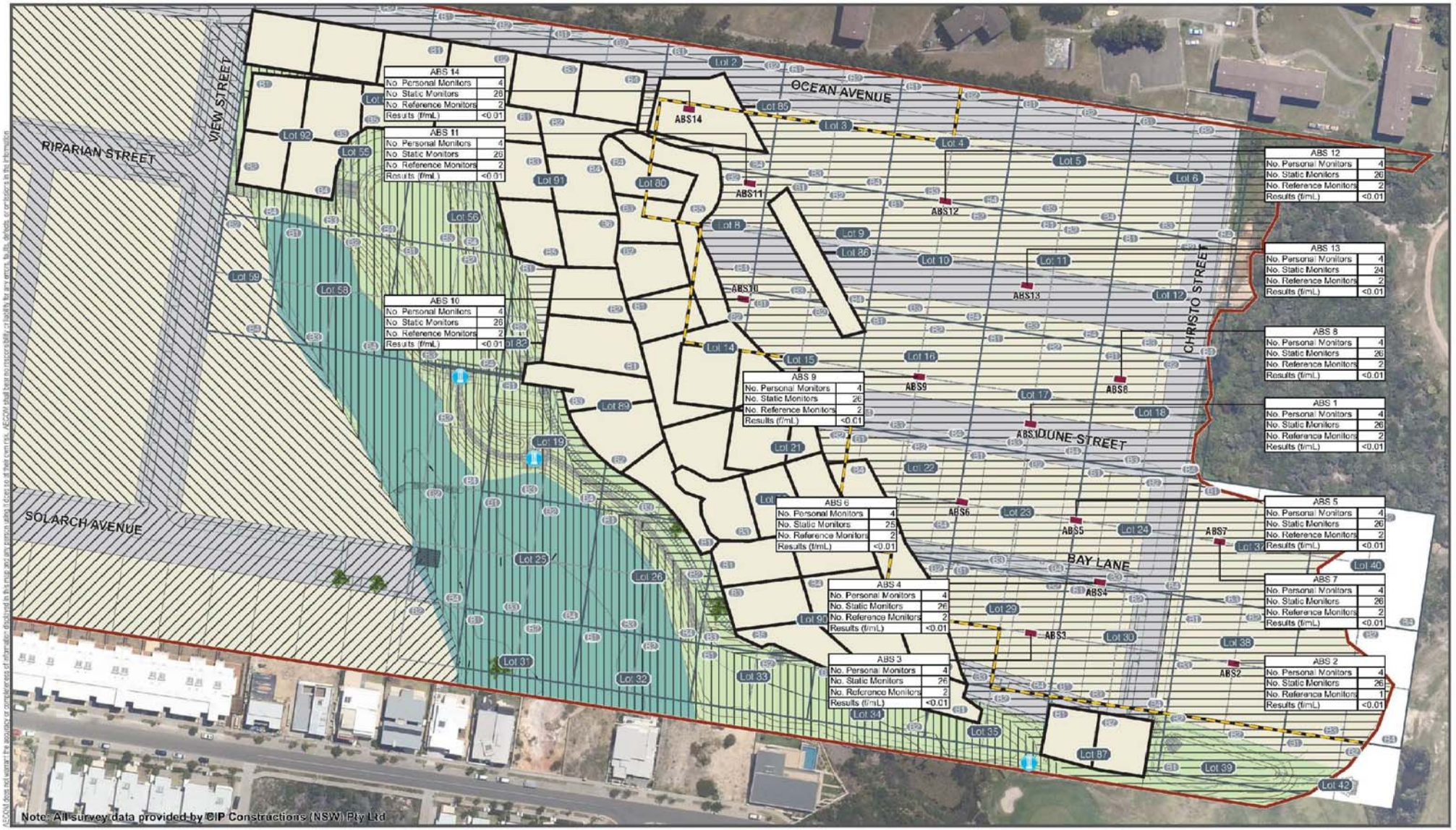
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F8d

Map Document: G:\Projects\60\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F8b Bed Remediation and Validation 12 September 2012 to 7 February 2014 Rev 3

A3 Size

Attachment 13: Western Bed Validation Samples



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LAST MODIFIED: TO 01 05 2014

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0 50m

- Site boundary
- Extent of capping
- Micocene protected area boundary
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- Trench location (ABS, December 2012)
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- A - H Completed remediation bed layers
- Lot 32 Remediation bed validation lot reference
- 81 Remediation bed validation reference

Note: For additional ABS remediation bed sampling please refer to figure F10

Activity Based Sampling and Air Monitoring Summary of Trenching Works December 2012

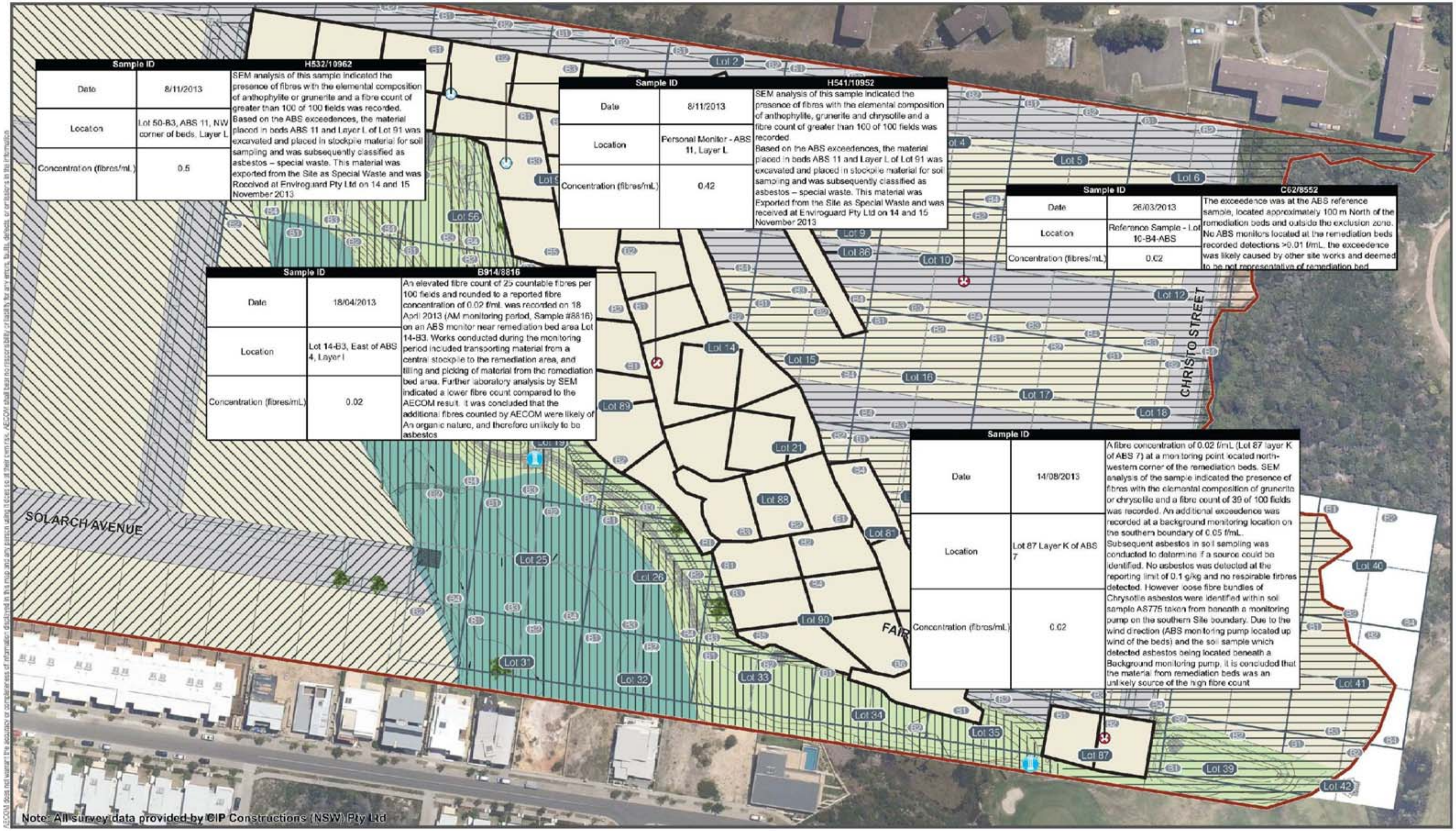
CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure F10

Map Document: G:\Projects\60\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F10 Activity Based Sampling and Air Monitoring Summary Rev B

A3 Size

Attachment 14: ABS Locations



Sample ID	H532/10962	
Date	8/11/2013	SEM analysis of this sample indicated the presence of fibres with the elemental composition of anthophyllite or grunerite and a fibre count of greater than 100 of 100 fields was recorded. Based on the ABS exceedences, the material placed in beds ABS 11 and Layer L of Lot 91 was excavated and placed in stockpile material for soil sampling and was subsequently classified as asbestos – special waste. This material was exported from the Site as Special Waste and was Received at Enviroguard Pty Ltd on 14 and 15 November 2013
Location	Lot 50-B3, ABS 11, NW corner of beds, Layer L	
Concentration (fibres/mL)	0.5	

Sample ID	H541/10952	
Date	8/11/2013	SEM analysis of this sample indicated the presence of fibres with the elemental composition of anthophylite, grunerite and chrysotile and a fibre count of greater than 100 of 100 fields was recorded. Based on the ABS exceedences, the material placed in beds ABS 11 and Layer L of Lot 91 was excavated and placed in stockpile material for soil sampling and was subsequently classified as asbestos – special waste. This material was Exported from the Site as Special Waste and was received at Enviroguard Pty Ltd on 14 and 15 November 2013
Location	Personal Monitor - ABS 11, Layer L	
Concentration (fibres/mL)	0.42	

Sample ID	C62/8552	
Date	26/03/2013	The exceedence was at the ABS reference sample, located approximately 100 m North of the remediation beds and outside the exclusion zone. No ABS monitors located at the remediation beds recorded detections >0.01 f/mL. the exceedence was likely caused by other site works and deemed to be not representative of remediation bed
Location	Reference Sample - Lot 10-B4-ABS	
Concentration (fibres/mL)	0.02	

Sample ID	B914/8816	
Date	18/04/2013	An elevated fibre count of 25 countable fibres per 100 fields and rounded to a reported fibre concentration of 0.02 f/mL was recorded on 18 April 2013 (AM monitoring period, Sample #8816) on an ABS monitor near remediation bed area Lot 14-B3. Works conducted during the monitoring period included transporting material from a central stockpile to the remediation area, and tilling and picking of material from the remediation bed area. Further laboratory analysis by SEM indicated a lower fibre count compared to the AECOM result. It was concluded that the additional fibres counted by AECOM were likely of An organic nature, and therefore unlikely to be asbestos
Location	Lot 14-B3, East of ABS 4, Layer I	
Concentration (fibres/mL)	0.02	

Sample ID		
Date	14/08/2013	A fibre concentration of 0.02 f/mL (Lot 87 layer K of ABS 7) at a monitoring point located north-western corner of the remediation beds. SEM analysis of the sample indicated the presence of fibres with the elemental composition of grunerite or chrysotile and a fibre count of 39 of 100 fields was recorded. An additional exceedence was recorded at a background monitoring location on the southern boundary of 0.05 f/mL. Subsequent asbestos in soil sampling was conducted to determine if a source could be identified. No asbestos was detected at the reporting limit of 0.1 g/kg and no respirable fibres detected. However loose fibre bundles of Chrysotile asbestos were identified within soil sample AS775 taken from beneath a monitoring pump on the southern Site boundary. Due to the wind direction (ABS monitoring pump located up wind of the beds) and the soil sample which detected asbestos being located beneath a Background monitoring pump, it is concluded that the material from remediation beds was an unlikely source of the high fibre count
Location	Lot 87 Layer K of ABS 7	
Concentration (fibres/mL)	0.02	

PROJECT ID: 60212824
CREATED BY: TO
LAST MODIFIED: TO 01 05 2014

AECOM
www.aecom.com

0 — 50m

Legend

- Site boundary
- Miocoene protected area boundary
- Development stage 1
- Development stage 2
- Development stage 3
- Development stage 4
- EB Exclusion zone boundary
- Weir location
- Proposed development (Charter Hall, McGregor and Partners, 2008)
- Proposed recreational and open space land use
- Proposed roadway land use
- Proposed residential land use
- Lot 32 Remediation bed validation lot reference
- B1 Remediation bed validation reference
- Inferred location of air monitoring exceedance

Airborne Asbestos Concentration (fibres/ML)	Control/ Action
> 0.02	Stop removal work and find the cause
≥ 0.1	Exceedance of exposure standard

Interim Activity Based Sampling Exceedances Summary 11 September 2012 - 7 February 2014

CIP Constructions (NSW) Pty Limited
Remediation and Validation Report
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F11

Map Document: G:\Projects\60212824 Little Bay\FIGURES\Post Remediation Summary Report\60212824 F11 Interim Activity Based Sampling Exceedances Summary Rev B

A3 Size

PROJECT ID: 60212824
CREATED BY: TO
LAST MODIFIED: TO 12 07 2011

AECOM
www.aecom.com

0 20m

LEGEND

Indicative soil sample location

(0.1) Depths to sandstone bedrock m bgs

Validation Sample Locations

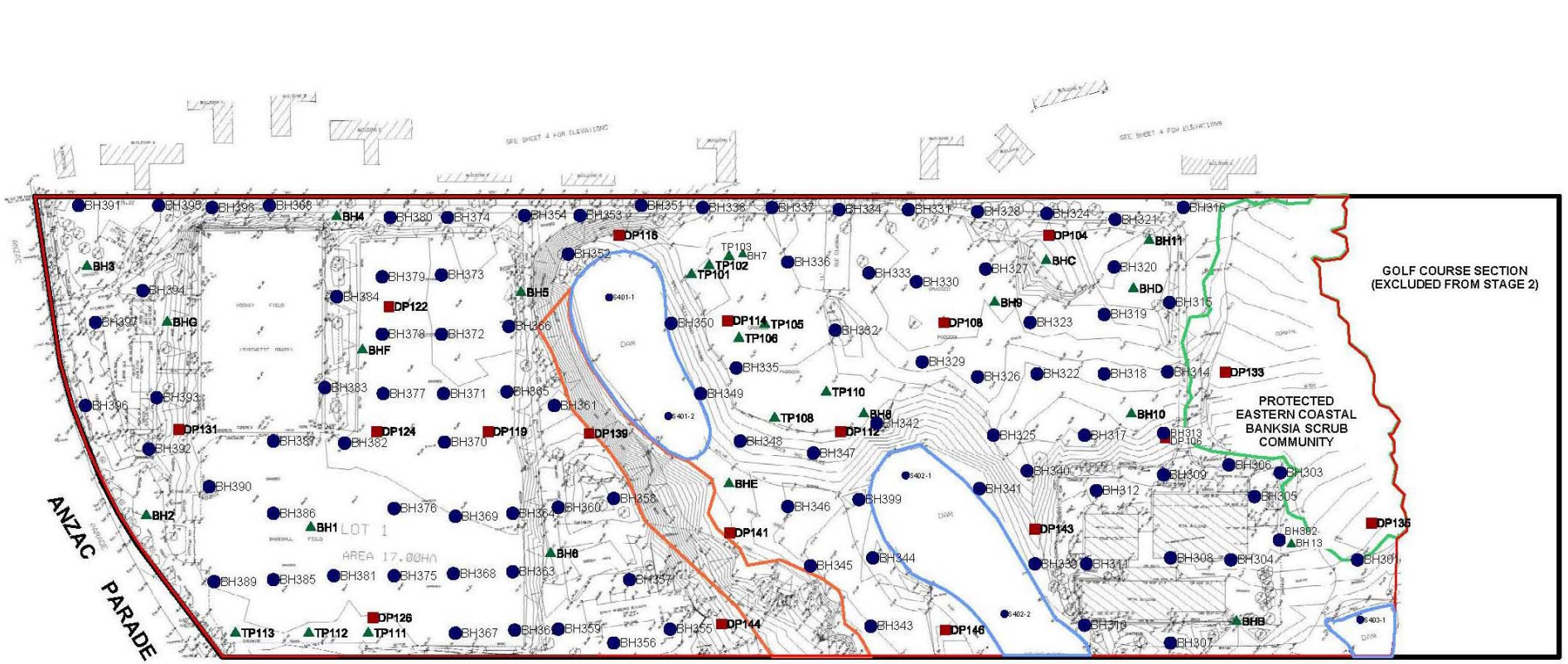
Charter Hall Pty Ltd
Biological Resource Centre Post-Demolition
1406 - 1408 Anzac Parade,
Little Bay NSW

Figure
F3

Map Document: G:\Projects\602\60212824 Little Bay\FIGURES\Former Biological Resources Centre Post Demolition\60212824 F3 Rev A

A4 Size

Attachment 16: BSC Validation Locations



LEGEND:

- ■ DP100 DOUGLAS PARTNERS SAMPLING LOCATION, NUMBER (2005)
- ▲ BH1 EIS STAGE 1 SAMPLING LOCATION, NUMBER (2006)
- ● BH300 EIS STAGE 2 SAMPLING LOCATION, NUMBER (2007)

SCALE (m)

0 20 40 60 80 100

Note: Reference should be made to the text for a full understanding of this plan.
The 2005 and 2006 investigation locations are based upon plans included in the previous reports rather than on-site measurements and so are considered approximate only.

SAMPLE LOCATION PLAN

UNSW Campus, 1408 Anzac Parade, Little Bay

ENVIRONMENTAL INVESTIGATION SERVICES

Job No: E20167F Jrpt2
Figure: 3

Attachment 17: Stage 1 & 2 Investigation Locations

Appendix B:
Soil and Groundwater Criteria

Soil investigation levels for urban development sites
Department of Environment and Conservation NSW (April 2006)

Substance	Health-based investigation levels[1] (mg/kg)				Provisional phytotoxicity-based investigation levels[2] (mg/kg)
	Residential with gardens and accessible soil (home-grown produce contributing < 10% fruit and vegetable intake; no poultry), including children's day-care centres, preschools, primary schools, townhouses, villas (NEHF A)[3]	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space, playing fields including secondary schools (NEHF E)	Commercial or industrial (NEHF F)	
	Column 1	Column 2	Column 3	Column 4	Column 5
Metals and metaloids					
Arsenic (total)	100	400	200	500	20
Beryllium	20	80	40	100	–
Cadmium	20	80	40	100	3
Chromium (III)[4]	12%	48%	24%	60%	400
Chromium (VI)	100	400	200	500	1
Cobalt	100	400	200	500	–
Copper	1,000	4,000	2,000	5,000	100
Lead	300	1,200	600	1,500	600
Manganese	1,500	6,000	3,000	7,500	500
Methyl mercury	10	40	20	50	–
Mercury (inorganic)	15	60	30	75	1[5]
Nickel	600	2,400	600	3,000	60
Zinc	7,000	28,000	14,000	35,000	200
Organics					
Aldrin + dieldrin	10	40	20	50	–
Chlordane	50	200	100	250	–
DDT + DDD + DDE	200	800	400	1,000	–
Heptachlor	10	40	20	50	–
PAHs (total)	20	80	40	100	–
Benzo(a)pyrene	1	4	2	5	–
Phenol[6]	8,500	34,000	17,000	42,500	–
PCBs (total)	10	40	20	50	–
Petroleum hydrocarbon components[7]					
> C16–C35 (aromatics)	90	360	180	450	–
> C16–C35	5,600	22,400	11,200	28,000	–
> C35 (aliphatics)	56,000	224,000	112,000	280,000	–
Other					
Boron	3,000	12,000	6,000	15,000	–[8]
Cyanides (complex)	500	2,000	1,000	2,500	–
Cyanides (free)	250	1,000	500	1,250	–

1 The limitations of health-based soil investigation levels are discussed in Schedule B(1) Guidelines on the Investigation Levels for Soil and Groundwater and Schedule B(7a) Guidelines on Health-based Investigation Levels, *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 1999)

2 The provisional phytotoxicity-based investigation levels proposed in this document are single number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. They are intended for use as a screening guide and may be assumed to apply to sandy loam soils or soils of a closely similar texture for pH 6–8.

3 National Environmental Health Forum (NEHF) is now known as enHealth.

4 Soil discolouration may occur at these concentrations.

5 Total mercury

6 Odours may occur at these concentrations.

7 The carbon number is an 'equivalent carbon number' based on a method that standardises according to boiling point. It is a method used by some analytical laboratories to report carbon numbers for chemicals evaluated on a boiling point GC column.

8 Boron is phytotoxic at low concentrations. A provisional phytotoxicity-based investigation level is not yet available.

Notes:

This table is adapted from Table 5-A in Schedule B(1): Guidelines on Investigation Levels for Soil and Groundwater to the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC 1999).

Soil investigation levels (SILs) may not be appropriate for the protection of ground water and surface water. They also do not apply to land being, or proposed to be, used for agricultural purposes. (Consult NSW Agriculture and NSW Health for the appropriate criteria for agricultural land.)

SILs do not take into account all environmental concerns (for example, the potential effects on wildlife). Where relevant, these would require further consideration.

Impacts of contaminants on building structures should also be considered.

For assessment of hydrocarbon contamination for residential land use, refer to the Guidelines for Assessing Service Station Sites (EPA 1994).

Threshold Concentrations for Sensitive Land Use – Soils Guidelines for Assessing Service Station Sites (NSW EPA 1994)	
Contaminant	**Threshold Concentration (mg/kg)**
TPH (C_6-C_9)	65
TPH (C_{10}-C_{36})	1,000
Benzene	1
Toluene	1.4
Ethylbenzene	3.1
Xylenes (total)	14

Trigger Values (TV) for Screening Marine Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Metals and Metalloids		
Arsenic – As (III/V)	2.3/4.5	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Cadmium – Cd	0.7	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Mercury – Hg	0.1	
Nickel – Ni	7	ANZECC (2000) 99% protection level due to potential for toxicity.
Manganese – Mn	80	Low reliability trigger values (derived from the mollusc figure) from Volume 2 of ANZECC (2000)
Chromium – Cr (III/VI)	27.4/4.4	ANZECC (2000) 95% protection levels.
Copper – Cu	1.3	
Cobalt – Co	1	
Lead – Pb	4.4	
Zinc – Zn	15	
Aromatic Hydrocarbons		
Benzene	700	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	
Ethylbenzene	5	
o-xylene	350	
m-xylene	75	
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	50	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000) ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Phenanthrene	0.6	
Fluoranthene	1	
Benzo(a)pyrene	0.1	
Chlorinated Alkanes and Alkenes		
Tetrachloroethene (PCE)	70	Low reliability trigger values (95% level of protection)
1,1,2-Trichloroethene (TCE)	330	
Vinyl chloride (chloroethene)	100	
1,1,1-Trichloroethane (1,1,1-TCA)	270	
1,1-Dichloroethene	700	
1,1-Dichloroethane	250	
1,2-Dichloroethane	1900	
1,1,2-Trichloroethane	1900	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chloroform	370	Low reliability trigger value (95% level of protection)
Non-Metallic Inorganics		
Ammonia Total – NH_3 (at pH of 8)	910	ANZECC (2000) 95% protection levels.
Cyanide (Free or unionised HCN)	4	

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
Metals and Metalloids		
Arsenic – As (III/V)	24/13	ANZECC (2000) 95% protection levels.
Boron - B	370	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Cadmium – Cd	0.2	ANZECC (2000) 95% protection levels.
Nickel – Ni	11	
Manganese – Mn	1900	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Mercury – Hg	0.06	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Chromium – Cr (III/VI)	3.3/1.0	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000) for Cr (III) and Co
Cobalt – Co	2.8	
Copper – Cu	1.4	ANZECC (2000) 95% protection levels.
Lead – Pb	3.4	
Zinc – Zn	8.0	ANZECC (2000) 95% protection levels (figure may not protect key test species from chronic toxicity)
Aromatic Hydrocarbons		
Benzene	950	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Toluene	180	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Ethylbenzene	80	
m-xylene	75	
o-xylene	350	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
p-xylene	200	
Polycyclic Aromatic Hydrocarbons		
Naphthalene	16	ANZECC (2000) 95% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Anthracene	0.01	Low reliability trigger values from Volume 2 of ANZECC (2000)
Phenanthrene	0.6	
Fluoranthene	1	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Benzo(a)pyrene	0.1	
Organochlorine Pesticides		
Aldrin	0.001	Low reliability trigger values from Volume 2 of ANZECC (2000)
DDE	0.03	
Dieldrin	0.01	
Endosulfan α	0.0002	
Endosulfan β	0.007	
Chlordane	0.03	ANZECC (2000) 95% protection levels
DDT	0.006	
Lindane	0.2	
Endosulfan	0.03	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute toxicity to particular species.
Endrin	0.01	
Heptachlor	0.01	
Organophosphorus Pesticides		
Azinphos methyl	0.01	ANZECC (2000) 99% protection level due to potential for bio-accumulation or acute

Trigger Values (TV) for Screening Fresh Water Quality Data (µg/L) for Slightly to Moderately Disturbed Ecosystems (ANZECC 2000)		
Contaminant	**Threshold Concentration (µg/L)**	**Guideline Source**
		toxicity to particular species.
Methoxychlor	0.005	Low reliability trigger values from Volume 2 of ANZECC (2000)
Dementon-S-methyl	4	
Chloropyrifos	0.01	ANZECC (2000) 95% protection levels
Diazinon	0.01	ANZECC (2000) 95% protection levels
Dimethoate	0.15	
Fenitrothion	0.2	
Malathion	0.05	
Parathion	0.004	
Non-Metallic Inorganics		
Total Ammonia as N (pH of 8)	900	ANZECC (2000) 95% protection levels
Cyanide (Free or unionised)	7	
Nitrate	700	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
NO_x	40	ANZECC (2000) Default trigger values for physical and chemical stressors for slightly disturbed ecosystems in lowland rivers of South-east Australia. The trigger values for TP and TN are 25 µg/L and 350 µg/L, respectively, for east flowing coastal rivers in NSW.
Total Nitrogen	500	
Total Phosphorous	50	
Ammonium ($NH4^+$)	20	
Chlorine	3	ANZECC (2000) 95% protection levels.
Phenols		
Phenol	320	ANZECC (2000) 95% protection levels
2,4-dimethylphenol	2	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Alkanes and Alkenes		
Tetrachloroethene (PCE)	70	Low reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,1,2-Trichloroethene (TCE)	330	
Vinyl chloride (chloroethene)	100	
1,1,1-Trichloroethane (1,1,1-TCA)	270	
1,1-Dichloroethene	700	
1,1-Dichloroethane	90	
1,2-Dichloroethane	1900	
Chloroform	370	
1,1,2-Trichloroethane	6500	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
Chlorinated Aromatic Hydrocarbons		
1,3-dichlorobenzene	260	Moderate reliability trigger values (95% level of protection) from Volume 2 of ANZECC (2000)
1,4-dichlorobenzene	60	
1,2,4-trichlorobenzene	85	
Hexachlorobenzene	0.05	Low reliability values (95% level of protection) from Volume 2 of ANZECC (2000). (QSAR derived)
Miscellaneous Industrial Chemicals		
Hexachlorobutadiene	0.04	Environmental Concern Level from Volume 2 of ANZECC (2000)

While the low reliability figures should not be used as default guidelines they will be useful for indicating the quality of groundwater migrating off-site.

Appendix C:
EPA Approved Guidelines

Guidelines made or approved by the EPA under section 105 of the *Contaminated Land Management Act 1997*

(*as of 13 February 2014*)

Section 105 of the Contaminated Land Management Act 1997 (CLM Act) allows the Environment Protection Authority (EPA) to make or approve guidelines for purposes connected with the objects of the Act. These guidelines must be taken into consideration by the EPA whenever they are relevant and by accredited site auditors when conducting a site audit. They are also used by contaminated land consultants in undertaking investigation, remediation, validation and reporting on contaminated sites.

Guidelines made by the EPA

- Guidelines for Assessing Service Station Sites (94119ServiceStnGuidelines.pdf, 1.2MB) (December 1994)
- Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land(2003028VerticalMixGuidelines.pdf, 148KB) (January 1995)
- Sampling Design Guidelines (9559sampgdlne.pdf, 2MB) (September 1995)
- Guidelines for Assessing Banana Plantation Sites (bananaplantsite.pdf; 586KB) (October 1997)
- Guidelines for Consultants Reporting on Contaminated Sites (20110650consultantsglines.pdf; 428KB) (reprinted August 2011)
- Guidelines for Assessing Former Orchards and Market Gardens (orchardgdlne.pdf; 172KB) (June 2005)
- Guidelines for the NSW Site Auditor Scheme, 2nd edition (auditorglines06121.pdf; 510KB) (April 2006)
- Guidelines for the Assessment and Management of Groundwater Contamination (groundwaterguidelines07144.pdf; 604KB) (March 2007)
- Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 (09438gldutycontclma.pdf; 1MB) (June 2009)

Note: All references in the EPA's contaminated sites guidelines to:

- the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, November 1992) are replaced as of 6 September 2001 by references to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, October 2000)
- the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC 1999) are replaced as of 16 May 2013 by references to the National Environment Protection (Assessment of Site Contamination) Measure 1999 (April 2013)

subject to the same terms.

Guidelines approved by the EPA

ANZECC publications

- Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, published by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) (January 1992)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, published by ANZECC and the Agriculture and Resource Management Council of Australia and New Zealand, Paper No. 4 (October 2000)

EnHealth publications (formerly National Environmental Health Forum monographs)

- Composite Sampling, Lock, W. H., National Environmental Health Forum Monographs, Soil Series No.3, 1996, SA Health Commission, Adelaide
- 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)

National Environment Protection Council publications

- National Environment Protection (Assessment of Site Contamination) Measure 1999 (April 2013)

The NEPM consists of a policy framework for the assessment of site contamination, Schedule A (Recommended General Process for the Assessment of Site Contamination) and Schedule B (Guidelines).

Schedule B guidelines include:
Guideline on Investigation Levels for Soil and Groundwater
Guideline on Site Characterisation
Guideline on Laboratory Analysis of Potentially Contaminated Soils
Guideline on Site-specific Health Risk Assessment Methodology
Guideline on Ecological Risk Assessment
Guideline on Methodology to Derive Ecological Investigation Levels in Contaminated Soils
Guideline on Ecological Investigation Levels for Arsenic, Chromium(III), Copper, DDT, Lead, Naphthalene, Nickel and Zinc
Guideline on the Framework for Risk-based Assessment of Groundwater Contamination
Guideline on Derivation of Health-based Investigation Levels
Guideline on Community Engagement and Risk Communication
Guideline on Competencies and Acceptance of Environmental Auditors and Related Professionals

Other documents

- Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential Purposes, NSW Agriculture and CMPS&F Environmental (February 1996)
- Australian Drinking Water Guidelines, NHMRC and Natural Resource Management Ministerial Council of Australia and New Zealand (2011)

Appendix D:
Interim Advice Letter

ENVIRON

5 February 2009 Our Ref: AS120833

CHOF5 Little Bay Pty Ltd
c/o Charter Hall
Attn: Mark Jacobs
GPO Box 2704
Sydney NSW 2001

Dear Mark

Interim Advice Letter – Remedial Action Plan - Little Bay

1. INTRODUCTION

As a NSW EPA Accredited Auditor I have been engaged by CHOF5 Little Bay Pty Ltd to conduct a site audit for 1408 Anzac Parade, Little Bay, NSW. This interim advice has been provided with regard to the suitability of a Remedial Action Plan

Details of the audit are:

Requested by:	Mark Jacobs on behalf of CHOF5 Little Bay Pty Ltd
Request/Commencement Date:	28 March 2008
Auditor:	Graeme Nyland
Accreditation No.:	9808

This interim advice letter has been prepared based on the following:

- Review of the following reports:
  - 'Report to University of NSW on Stage 1 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW' Draft dated December 2006 by Environmental Investigation Services (EIS).
  - 'Report to University of NSW on Stage 2 Environmental Investigation Work Plan for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW' Draft dated December 2006 by EIS.
  - 'Report to University of NSW on Stage 2 Environmental Site Assessment for Proposed Residential Subdivision Development at 1408 Anzac Parade, Little Bay, NSW' Draft dated February 2007 by EIS.
  - 'Little Bay, Trenching Works. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 23 April 2008 by ENSR Australia Pty Ltd (ENSR).

- 'Stage 1 Environmental Site Assessment Biological Resources Centre (BRC) 1406-1408 Anzac Parade Little Bay NSW 2036' dated 28 July 2008 by ENSR.
- Draft 'Remediation Works Plan. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 26 September 2008 by ENSR.
- Final 'Remediation Works Plan. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 7 October 2008 by ENSR.
- Final 'Remediation Works Plan. 1406-1408 Anzac Parade Little Bay NSW 2036' dated 2 February 2009 (RWP)

- A site visit by the Auditor, 27 March 2008
- Discussions with ENSR who undertook the investigations.

EIS referred to previous investigation reports (see Section 8). These were not provided to the auditor.

The Auditor previously prepared a Site Audit Report and a Section B Site Audit Statement (GN336) on 6 July 2007 which concluded that the site could be made suitable for the proposed landuses subject to a RAP prepared by EIS in May 2007. The EIS RAP presented three options while the current RWP provides details for a preferred approach.

The RWP and this Interim Advice Letter will be submitted to provide clarification to Randwick City Council on the preferred remediation approach.

2. SITE DETAILS

2.1. Location

The site details are as follows:

Street address:	1408 Anzac Parade, Little Bay, NSW, 2036
Identifier:	Lot 10 and 11, DP 1127716
Local Government:	Randwick City Council
Site Area:	approximately 13.6 ha

The boundaries of the site are well defined by fence lines for most of the site however the eastern boundary is not marked.

2.2. Zoning

The current zoning of the site is Zone 5 Special Uses. It is understood that this zoning allows for residential uses.

2.3. Adjacent Uses

The site is located within an area of residential and open space uses. The surrounding land uses include:

- Medium density housing development to the north beyond which is the Long Bay Correctional Facility.

- An area of protected Eastern Suburbs Banksia Scrub (ESBS) consisting of 1 to 3m tall vegetation and The Coast Golf Course to the east which includes a fairway beyond which is Little Bay and the Pacific Ocean.

- A residential subdivision to the south that was formerly the Prince Henry Hospital to the south. The hospital site was remediated for the presence of asbestos as fibres within the sands and at the time of the site visit construction of houses was being undertaken.

- Anzac Parade to the west, beyond which is residential housing.

2.4. Site Condition

The site as shown as Attachment 1 consists of the following current land uses extending from Anzac Parade towards the coast:

- UNSW playing fields including synthetic hockey field, baseball diamond, football fields, office, caretakers brick cottage and car park area (approximately 4.5 ha) are located in the western section of the site adjacent to Anzac Parade. The hockey field had been cut into the sandstone with a bank separating this field from the football field. A bank sloped up towards the office from the western edge of the hockey field.

- UNSW Solarch compound (approximately 0.7 ha) to the south-east of the playing fields (towards the coast) which consists of a building previously used by for solar research and for the construction of solar vehicles.

- Dams extend north-south across the site with the southern-most dam extending to the south over the adjacent site.

- Vacant grassed area (approximately 3 ha) over the north-east section of the site on which there are large fill mounds, shipping containers, mounds of organic material and other surficial dumped rubbish. This area was previously a landfill area.

- UNSW Biological Services Compound (0.9 ha) included a complex of car parks and buildings of brick and iron/steel construction. Two electrical substations are located in this area.

The major topography of the site is varied. The site covers 17 hectares and extends 250 metres from Anzac Parade towards the coast. The site is characterised by:

- Sandstone plateau that extends from Anzac Parade to the eastern edge of the Solarch Compound and the eastern edge of the Soccer Field. The area below the sandstone plateau at the Solarch Compound consists of sandstone outcrops that are on the Register of the National Estate for its Geological Significance.

- The land falls steeply away from the sandstone ridge to the drainage channel that consists of two man-made dams that are aligned from north to south bisecting the site with seasonal inundation in between. A levee bank has been built up along the western extent of the second dam.

- Land filling in the western section has built up this area which still slopes down towards the coast.

- The UNSW Biological Services Compound is located on a slightly lower level.

2.5. Proposed Development

A development application (DA) is to be submitted for Stage 1 of works to facilitate the ultimate development of a mix of single dwelling houses, townhouses, apartments, open space and roadways over Lot 10.

The central corridor (Lot 11) would be retained and preserved as open space. This riparian corridor includes open space, two large dams and inundation area and the area of geological and aboriginal significance (ENSR indicate this is approximately 2.2 hectares).

For the purposes of this audit the 'residential with soil access' land use scenario will be assumed.

3. SITE HISTORY

EIS provided a site history based on aerial photographs, Council Records, Certificates of Title, WorkCover Database Records and NSW EPA Records and is summarised in Table 3.1.

Table 3.1 – Site History

Date	Activity
1881 - 1940	Hospital uses however the aerial photographs do not indicate that any buildings were located on the site and indicate that the site was used for paddocks and cultivated land for the hospital.
1940 – 1959	Sand mining 'in the vicinity of the hospital site'
1959 - 1960	Site subdivided and granted to UNSW
1960- - 1970	Aerial photographs indicated that an active quarry extended over the central section of the site which then operated as a non-putrescible landfill. Golf tee and green facilities constructed to the east.
1970 - 1987 -	Land filling in the west completed in approximately 1987. This site is listed under Randwick Council Unhealthy Building Land Policy. From the early 1980s the west was developed as sporting facilities with removal of landfill material in this area. The site was filled and levelled for the playing fields in 1981.
1987 - 1993	UNSW developed the current buildings on-site in 1984 to 1987 and in 1992 the sports fields and the Solarch building were constructed. It is understood that in 1991 the Biological services compound was excavated such that deep fill was removed.
1993 - 2007	The Solarch building is no longer used. The sports fields and biological services compound are still in use.

EIS provided a brief history of the adjoining Prince Henry Hospital site that indicated that the Prince Henry site was assigned for hospital uses in 1881. Hospital buildings and a cemetery were constructed over the 10 years from 1881 to 1891.

Based on Council correspondence summarised in the EIS Stage 2 Report, land filling at the site proceeded as follows:

- An application to fill the subject site with putrescible garbage was refused in March 1970. Council offered to fill the area with materials collected from clean up campaigns and other non-putrescible materials.

- The site was filled in by Randwick City Council as a weekend tip site (27 October 1976)

- UNSW gave approval for a company to apply for a licence to place 'clean fill' (natural excavated materials and selected demolition rubble subject to conditions of the Waste Control Authority) at the site. Tipping commenced in December 1981 and was to be closed in March 1987.

- NSW EPA correspondence on 25 February 2000 indicated that the landfill previously over the area of the Biological Services Building was 'a former putrescible garbage landfill'. Requirements for building included provisions for settlement, landfill gas accumulation under buildings, potential groundwater contamination with landfill leachate and off-site migration issues and potential risk of human exposure to contaminated landfill materials. Staged development approval was obtained in 2001. No validation sampling and analysis was undertaken prior to the construction of the buildings and the nature of materials below the buildings can not be verified.

Correspondence with Council indicates that the landfill was filled with non-putrescible waste however detailed records were not kept and the EPA sent a contradictory letter. The consistency and sources of these wastes is also unknown. The lack of available detail has been considered in the review of sample density and the results of the intrusive investigations.

The topography of the site indicates that some filling has occurred to level and build up some minor sections of the site.

The summary of the site history provided by EIS indicates that the site has been used by UNSW for the past 50 years, prior to which it was used for cultivation.

In the Auditor's opinion, the site history provides an adequate indication of past activities to determine potentially contaminating activities. There are inherent uncertainties in the contents of the landfill.

4. CONTAMINANTS OF CONCERN

EIS provided a discussion on the general contamination processes in Sydney and the potential site specific contamination. These have been tabulated in Table 4.1.

Table 4.1 – Contaminants of Concern (excluding BRC)

Area	Activity	Potential Contaminants
Adjacent to the adjoining former hospital site	Contamination is known to have been targeted for remediation.	PAHs and asbestos
Landfill area	Placement of organic material in the landfill and subsequent decomposition.	Landfill gas including methane
	Landfill material including demolition rubble.	Metals, PAHs, petroleum hydrocarbons, OCPs, PCBs and asbestos
Whole site	General history of contamination in Sydney	Lead, copper and zinc
	Filling	Unknown however could include metals, petroleum hydrocarbons, PAHs and asbestos.
Playing Fields	Spraying of pesticides	OCPs
Geologically significant area	Human disturbance in non-vegetated areas including dumped household rubbish and campfire sites noted by Douglas in 2003.	Douglas (2003) (see Section 8) submitted samples for a generic suite of analytes (metals, PAHs and petroleum hydrocarbons).

EIS did not undertake any intrusive investigations in the geologically significant area. Management of this area is discussed in Section 11.

The Auditor considers that the analyte list used by EIS is adequately reflected in the analytical suite used.

ENSR also note that fill has been contaminated by heavy metals, petroleum hydrocarbons, PAHs, asbestos containing materials, methane gas and general waste and demolition materials. Following a Stage 1 Assessment of the Biological Resources Centre (BRC) ENSR noted the additional chemicals of concern shown in Table 4.2.

Table 4.2 – Contaminants of Concern (BRC)

Activity	Potential Contaminants
Landfill materials	As for Table 4.1
Potential hazardous materials during building construction and electrical transformers	Metals (mainly zinc and lead), PCBs and asbestos
Potential use of solvents	Volatile organic compounds (VOCs) including chlorinated hydrocarbons and BTEX
Storage of oil and lubricants	Petroleum hydrocarbons and PAHs
Spraying of pesticides/termicides under and around residence	OCPs and metals

ENSR noted that contaminants of potential concern also included radioactive materials due to the use of radioisotopes and/or x-ray equipment. ENSR note that that it is 'unlikely that the activities conducted at the biological resources centre would have resulted in contamination beneath buildings'. A summary of the findings and recommendations of an earlier investigation is provided however future actions are not discussed in the RWP. It is understood that validation works are proposed following demolition of the building are proposed. This has been included as a recommendation in Section12.

5. STRATIGRAPHY AND HYDROGEOLOGY

Following a review of the referenced reports, a summary of the site stratigraphy and hydrogeology was compiled as follows.

5.1. Stratigraphy

Initial characterisation of the stratigraphy of the site by EIS, especially with respect to fill composition, was limited as augers and SPTs were used to investigate the site. Trenching undertaken by ENSR over the former landfill found that the depth of the fill was variable with fill extending to 9.7 m in one location. Fibre cement fragments were common with most encountered below 1.0 m and occasionally in the upper 1m. ENSR concluded that there is the potential for 'unidentified pockets of deep fill'.

The stratigraphy of the landfill is summarised in Table 5.1.

Table 5.1 – Stratigraphy (Landfill)

Depth	Stratigraphy
0 – 3/10 m	Fill: Silty sand with some sandstone gravel and root fibres and trace of coal and cloth fibres. Similar to this description the fill also contains sandstone, gravels, concrete, cobbles, rubber, glass, coal, ash and slag in places.
3.0 m	Sandstone

The stratigraphy of the Remainder of the Site is summarised in Table 5.2.

Table 5.2 – Stratigraphy (Remainder of the Site)

Depth	Stratigraphy
0 – 2.0	Fill: Silty sand with some sandstone gravel and root fibres The fill also contained clay and gravels and other inclusions such as cobbles, wire and brick. In some locations where fill was shallow (< 1m), a layer of silty sand (natural) was encountered (< 0.5 m thickness) over the sandstone bedrock.
2.0 - continues	Sandstone:

5.2. Hydrogeology

EIS estimate that the groundwater is perched within the fill and joints in the sandstone rather than being a 'significant water bearing aquifer'. A review of the Groundwater Monitoring Reports and the well construction descriptions on the logs indicates that groundwater was encountered as follows:

- Inflow of water was noted on the borehole logs at or just above the base of the fill in the landfill area. However 3 of the 4 wells screened in fill in landfill were dry on completion. (MW326A (borehole logs indicate that the well had inflow at 0.5 m), MW333A (no inflow noticed) and MW335A).

- The standing water levels in the landfill area varied from 2.7 m to 4.2 m BGL in the wells screened in sandstone and at 2.5 m in wells screened in the fill.

- Up-gradient groundwater varied from 3 m to 5 m BGL and down-gradient from 1 m to 3 m. The variations also indicate that groundwater is located within sandstone fractures.

- EIS has indicated that the apparent flow direction, based on the SWLs, is towards the dams to the west and south-west. However, EIS estimate that the higher elevation of sandstone to the east of the landfill may form a natural control structure causing artificial mounding leading to the apparent flow direction i.e. the true groundwater flow is to the east towards Little Bay. EIS concluded that 'further monitoring of groundwater conditions would be necessary to confirm the groundwater flow patterns within this section of the site'. The Auditor agrees that the flow directions of groundwater are not well known which has implications for the assessment criteria as the end point could be Little Bay or use for irrigation at the adjoining golf course.

6. EVALUATION OF QUALITY ASSURANCE AND QUALITY CONTROL

The Auditor has assessed the overall quality of the data by review of the information presented in the referenced reports, supplemented by field observations.

The Auditor's assessment follows in Tables 6.1 and 6.2.

Table 6.1 – QA/QC – Sampling and Analysis Methodology Assessment

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
Sampling Density, Pattern, Location and Depth	In total, there are 137 soil sampling locations over 11.9 hectares. Buildings and the synthetic hockey field have been excluded. The appropriateness of the density of sampling (given that the site is so large) will depend on the consistency of results and the field observations. All samples were submitted for the common suite of analyses (TPH, BTEX, PAHs, metals) with slightly less for asbestos, OCPs and PCBs. Only samples collected from the playing fields were submitted for OPPs and acid herbicides. **Landfill**: 40 boreholes on a grid pattern over 3 hectares with an approximate distance of < 50 m between the boreholes. The boreholes confirm that the material consists of uncontrolled fill. The density allows the general nature of the contaminants to be determined. **Remainder of the site**: Boreholes were placed such that the density was less than 30m distance. This is equivalent to the minimum sampling density required for hot spot detection by EPA (1995) Sampling Design Guidelines for a 2 hectare site. Given the proposed use is for residential development the logs and analytical results will need to confirm the consistency of the materials. Fill used in the embankment to the west of the hockey field consists of a silty sand with concrete and gravel that was not targeted during the investigations. All other fill types appear to have been targeted for analysis. No point sources of potential contamination were identified that required targeted sampling. Two samples from each borehole were submitted for analysis. Surface samples (0-0.1m) were submitted for analysis. In the Auditor's opinion, this sampling strategy was appropriate and adequate to characterise the primary material types present on site. **Dam Sediments**: Five locations were sampled from the three dams. The samples were collected at 1 and 2 m depth. **Groundwater** monitoring wells were concentrated in the landfill (5 wells with 4 bundled), three located on the up-gradient side of the dams and three down-gradient within the Biological Services Building. The Auditor considers the density to be adequate to gain an overall impression of the risk of impacts in groundwater.
Well construction	Groundwater wells were installed with a solid flight auger. Four wells were screened over fill material with the remaining 10 wells excavated to 7m and screened over the final 3 metres in sandstone. Wells were constructed of 50 mm casing. The annulus was backfilled with 2mm graded sand to 0.5 to 1 m above the screen, a bentonite seal and then a concrete grout was used to seal the top. EIS indicate that all wells were fitted with and Ex-cap self sealing vapour sampling cap however the groundwater log sheets indicate

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	that not all of these were in place at that time. The wells were allowed to stand for one week prior to vapour measurements. For wells screened in fill, the standing water level was either encountered at the base or the wells were dry. Wells were developed with a pump with water parameters stabilised and visual monitoring indicating fines had been flushed or the well was dry.
Sample Collection Method	**Soil**: Sample collection was via a standard penetration test (SPT) split spoon which is considered adequate for this stage of the project but has deficiencies in assessing landfill contents. Some samples were collected directly from the solid stem auger and a hand auger (access restrictions adjacent to the dam). EIS did not indicate whether the external material was removed prior to collecting the sample. This method is not ideal as it can result in loss of volatiles and sample cross contamination. Most samples were collected with the SPT. Where odours were reported and the one elevated PID reading, SPTs were used. **Groundwater**: sampling was undertaken using low flow/micro purge and the water quality parameters were monitoring such that steady state conditions were achieved. **Landfill Gas:** EIS indicate that the wells were fitted with gas caps (except MW319A, MW312 and MW366) and a landfill gas analyser was used. No further details were provided**.**
Decontamination Procedures	**Soil**: The SPT was cleaned with detergent and rinsed following each event. The augers were also scrubbed with water and detergent followed by rising with potable water. New gloves were reportedly used for each new sample. **Groundwater**: The pump was cleaned between each well with dedicated bladders and tubing used for each new well.
Sample handling and containers	All samples were placed into prepared and preserved sampling bottles provided by the laboratory and chilled during storage and subsequent transport to the labs. Water samples to be analysed for heavy metals were field filtered. Correspondence between EIS and the laboratory indicate that two samples that were missing according to the chain of custody were sent to the laboratory 6 days after sampling for asbestos and TPH/BTEX analysis.
Chain of Custody	Completed chain of custody forms were provided in the report. It appears that these were faxed with a Sample Receipt Advice indicating that they were received on the same day. The date of sampling is not included in all report photocopied versions. The first page of 17 pages of chain of custody forms was not provided.
Detailed description of field screening protocols	A PID was used to screen the soil samples with results presented in the report. The maximum concentration was 247 ppm (eastern edge of the landfill) with all others less than 33 ppm. A sample

Sampling and Analysis Plan and Sampling Methodology	Auditor Comments
	within 0.1m of the maximum PID reading was submitted for analysis. EIS indicate that the PID was calibrated prior to use. EIS indicate that VOC data was obtained from a partly filled glass jar following equilibrium. An LFGA2000 gas detector was used to detect methane, oxygen, hydrogen sulphide and carbon monoxide. Groundwater field parameters were measured during well sampling and development. Meters were calibrated prior to the start of each day. Calibration certificates were provided.
Calibration of field equipment	The reports indicated that calibration had been undertaken prior to leaving the office. Calibration certificates were provided to the Auditor. Groundwater meters were reported to have been calibrated prior to the start of each day. Field sheets were provided
Sampling Logs	Soil logs are provided within the report, indicating sample depth, PID readings and lithology. Landfill logs lack detail because of the limitations of the method used. Groundwater field sampling records were provided.

Table 6.2 – QA/QC – Field and Lab Quality Assurance and Quality Control

Field and Lab QA/QC	Auditor Comments
Field quality control samples	Field quality control samples including inter and intra laboratory duplicates, field blanks, rinsate blanks and a trip spike (water) were undertaken at appropriate frequencies.
Field quality control results	RPDs for the inter-laboratory (15) and intra-laboratory (11) duplicates were elevated for metals (lead, zinc, copper, nickel), PAHs, and for TPHs (only 2) as results were close to PQLs. Some detections in rinsate blanks, one detection in a soil blank of chrysene and benzo(a)pyrene and detection of zinc in two groundwater field blanks. Given the detections in the rinsate blanks and those in the primary samples, the risk of cross-contamination affecting the conclusions is considered to be minor. The results from all other field quality control samples were within appropriate limits.
NATA registered laboratory and NATA endorsed methods	Laboratories used included: Envirolab and SGS. All laboratory certificates were NATA stamped.
Analytical methods	A methodology summary was provided with the Envirolab and SGS laboratory certificates.
Holding times	Review of the COCs and laboratory certificates indicate that the holding times had been met. EIS also reported that holding times have been met.

Field and Lab QA/QC	Auditor Comments
Practical Quantitation Limits (PQLs)	PQLs were all less than the threshold criteria for the contaminants of concern.
Laboratory quality control samples	Laboratory quality control samples including laboratory duplicates, matrix spikes, laboratory blanks and surrogate spikes were undertaken by the laboratory at appropriate frequencies.
Laboratory quality control results	The recovery of one surrogate spike for TPH/PAHs/zinc/ammonia (acceptable levels were reported in the laboratory control sample) for one sample each was 'not available due to significant background levels of analyte in the sample'. A high spike recovery of lead (162%) was reported. The laboratory notes that this is due to the non homogenous nature of the sample for this particular element. The laboratory duplicates were elevated for metals (maximum of 58% for copper) and PAHs (maximum of 120%). Low concentrations were reported in the primary and duplicate samples. EIS noted that RPDs for copper and PAH in separate samples were higher than generally accepted. Envirolab noted that the elevated RPDs were accepted due to non-homogenous nature of the sample. The Auditor notes that results for PAHs and duplicates and descriptions of tar residues do indicate that the soils are non-homogenous. The results from all other laboratory quality control samples were within appropriate limits.
Data Quality Objectives and Data Evaluation (completeness, comparability, representativeness, precision, accuracy)	Predetermined data quality objectives (DQOs) were set for laboratory analyses including blanks, replicates, duplicates, laboratory control samples, matrix spikes, surrogate spikes and internal standards. These were discussed with regard to the five category areas. There was limited discussion regarding actions required if data do not meet the expected objectives. DQOs were also provided for the overall project which the Auditor considers to be appropriate. A QA/QC narrative describing all information relevant to the site assessment was included and concluded that the QA/QC data is of sufficient quality to be considered acceptable and meet the DQOs of the report.

The Auditor notes that some of the results reported in the laboratory certificates were not discussed in the report or tabulated. This was limited to the retesting of one sample for chromium VI and three for PAHs. One of three samples submitted in a separate sample batch reported a detection of asbestos that was not included in the tables or text of the report.

In considering the data as a whole the Auditor concludes that:

- The data are likely to be representative of the overall conditions at the site. Given the historical waste disposal by landfilling at the site, there are inherent uncertainties in the landfill content. This is discussed further during the assessment of remedial options.

- The data are complete.
- There is a high degree of confidence that the data are comparable for each sampling and analytical event.
- The primary laboratory provided sufficient information to conclude that the data are of sufficient precision.
- The data are likely to be accurate.

7. ENVIRONMENTAL QUALITY CRITERIA

The Auditor has assessed the soil and sediment data provided by EIS in reference to Soil Investigation Levels for Urban Redevelopment Sites in NSW (SIL Column 1 – 'residential with access to soil' and Column 5 'provisional phytotoxicity') in DEC *Guidelines for the NSW Site Auditor Scheme* (2006).

The RWP references SIL Column 3 – 'recreational open space' for open spaces including the central corridor sensitive areas, Column 5 'provisional phytotoxicity' for surface soils only, Column 4 – 'commercial industrial' for roadway areas and SIL Column 1 'residential with access to soil' and Column 2 'residential with minimal access to soil' for the relevant residential developments.

EPA (1994) *Guidelines for Assessing Service Station Sites* have also been referred to for assessing TPH and BTEX results.

The Auditor has assessed the groundwater data in reference to ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for marine waters. As flow directions have not been clearly established it is not clear whether groundwater flows to the dams to be used as irrigation water over the golf course or to Little Bay.

The Auditor has considered the need for remediation based on the 'aesthetic' contamination as outlined in the NEPM (1999) Schedule B(1) *Guideline on the Investigation Levels for Soil and Groundwater* that states that 'there are no numeric Aesthetic Guidelines but the fundamental principle is that the soils should not be discoloured, malodorous (including when dug over or wet) nor of abnormal consistency. The natural state of the soil should be considered'.

Imported fill has been assessed in relation to attributes expected of virgin excavated natural material (VENM) or excavated natural material (ENM).

There are no national or EPA endorsed guidelines for asbestos in soil relating to human health. DEC (2006) state that Auditors must exercise their professional judgement when assessing whether a site is suitable for a specific use. The EPA states that the position of the Health Department is that there should be no asbestos in surface soil.

There are no criteria produced by the EPA for landfill gas specific to the assessment of contaminated sites. Guidelines are provided, however, in the EPA (January 1996) *"Environmental Guidelines: Solid Waste Landfills"*. The following requirements for monitoring of landfill gas are specified:

- Action level for subsurface gas monitoring to detect off-site migration is 1.25% methane by volume (v/v). This is equivalent to 25% of the Lower Explosive Limit (LEL) of methane. This action level relates to purged measurements, following flushing of one probe casing volume.

- Action level for gas accumulation in buildings within 250 m of deposited waste is 1.25% methane (v/v);

- Action level for surface gas emission monitoring is 500ppm (v/v) of methane at any point on the landfill surface (5cm above the ground surface on a calm day); and

- In addition to monitoring for methane, monitoring for hydrogen sulfide (H2S) may be required if landfill gas odours are of concern.

8. EVALUATION OF SOIL AND SEDIMENT ANALYTICAL RESULTS

Previous investigations were undertaken by Environmental and Earth Sciences in 1999 (15 test pits and groundwater assessment) and 2001 (landfill gas monitoring and groundwater assessment). Douglas Partners also undertook investigations in 2006. These reports were not provided to the Auditor.

The results below only include those obtained by EIS during the Stage 1 and Stage 2 Investigations. EIS provided a summary of works undertaken by Douglas Partners (2003) 'Report on Due Diligence Study, Little Bay Playing Fields and Biological Science Site, 1408 Anzac Parade, Little Bay' for the coastal vegetation area and the area of geologic significance which is also discussed below.

ENSR undertook trenching as outlined in ENSR (2008a) that provided clarification on the depths of fill in the landfill and the contaminant status.

8.1. Landfill

The fill within the former landfill area has been logged from auger holes as consisting of silty sand with inclusions varying from sandstone, gravels, concrete, cobbles, rubber, glass, coal, ash to slag. Fill depth is variable. Trenching by ENSR (23 April 2009) confirmed that fill was variable and reflective of the undulating bedrock topography.

Soil samples were analysed by EIS for a variety of contaminants including petroleum hydrocarbons, PAHs, asbestos and heavy metals, the results of which are summarised in Table 8.1. The results have been assessed against the environmental quality criteria.

Table 8.1 – Evaluation of Soil Analytical Results – Former Landfill - Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Asbestos	82	13	NA	NA	NA	NA
Arsenic	87	8	8.8	NA	0	0
Cadmium	87	8	2.2	NA	0	0

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Total Chromium	87	85	3300	NA	0	**1**
Chromium VI	1	0	-	NA	0	NA
Copper	87	79	15000	NA	0	**1**
Lead	87	87	290	NA	0	0
Nickel	87	73	79	NA	0	**2**
Zinc	87	87	2500	NA	0	**19**
Mercury (inorganic)	87	35	51	NA	0	**2**
PCBs	73	0	-	NA	0	NA
OCPs	73	0	-	NA	0	NA
TPH (C_6-C_9)	88	0	-	0	NA	NA
TPH (C_{10}-C_{36})	88	3	230	0	NA	NA
BTEX	88	0	-	0	NA	NA
Total PAHs	86	46	1200	NA	**5**	NA
Benzo(a)Pyrene	86	40	54	NA	**6**	NA

The results tabulated in Table 8.1 include results for BH340 as logs and site plan indicate that this borehole is consistent with the landfill. materials
n number of samples
NA No criteria available/used

The main impacts were found to consist of asbestos, tars and some metal and fuel impacts.

Asbestos fibres were detected in 12 of 81 (approximately 15%) samples collected from the landfill. The descriptions given by the laboratory included:

- fibres embedded in fibre cement sheet fragments with total weights ranging from 0.8 mg to 2.2 g
- fibres embedded in fibre cement sheet/small plaster fragments
- loose bundles from 3 to 4 mm long
- one fibre was embedded in a tarry residue.
- All detections were reported as ‘non-respirable fibres’.

Discussions with the laboratory indicate that this is based on the observation of asbestos fibres less than 3 micrometres in width, and greater than 5 micrometres in length, and with a length to width ratio greater than 3:1. EnHealth (2005) ‘Management of Asbestos in a Non-occupational Environment’ note that ‘fibres greater than 100 µm are not respirable unless first

broken down into smaller fibres' and that 'fibres less than 5 µm do not appear to cause, or at least, are much less likely to cause, asbestos related disease'. The laboratory reports the asbestos as observed and do not attempt to determine the friability of the materials.

The distribution of asbestos did not appear to be associated with other contaminants, fill type or location within the landfill. No visual indications of asbestos were noted in any of the EIS borehole logs. ENSR (23 April 2008) noted that fibre cement fragments were common, with most reported at greater than 1m depth, although occasionally at less than 1m depth. Concentrated areas of asbestos were not identified and there was no apparent pattern of distribution. ENSR note that 'fragments are visually identifiable once exposed'.

PAHs were detected above the PQLs in half of all samples with PAH concentrations above the site criteria in fill materials at five locations. The maximum benzo(a)pyrene concentration was 54 mg/kg and total PAHs at 1200 mg/kg in a sample from 3 metres depth. A sample at 1.7 to 1.95m in the same borehole also reported PAHs at 79.5 mg/kg and benzo(a)pyrene at 2.8 mg/kg. There were no visual indications noted in the borehole logs and the elevated concentrations did not appear to be associated with any particular fill type. The Auditor notes that the most elevated concentrations of PAHs were associated with a tarry residue noted by the laboratory during asbestos analysis. Two other samples within the landfill (and one within the playing fields adjacent to the main road) were reported by Envirolab during asbestos analysis as having either a 'plastic tarry disk' or 'tar fragments'. ENSR (23 April 2008) expect that small areas of ash/hydrocarbon impacted material are likely to be readily identifiable once exposed. Vertically adjacent samples did not report detections of PAHs above the PQLs.

Some fuel impacts associated with the fill materials were noted with 'hydrocarbons/oil waste' noted on borehole logs at two locations. Detections of ethylbenzene, xylene, naphthalene and trimethylbenzene were reported at one location. TPH C15-C28 was detected at three locations by EIS at low concentrations. A strong hydrocarbon odour was noted in the south-east corner at 1.4m where water was encountered. Odours nor water were encountered at any nearby boreholes. The most elevated PID reading of 247 ppm was encountered to the immediate north of the detection of the strong hydrocarbon odour.

Based on a strong hydrocarbon odour, distinct grey staining and a PID reading of 10 ppm, one sample was collected from 1.8 m and submitted for analysis. The material was encountered in trench No. 4 in the central northern portion of the site. The sample reported TPH C10-C36 at 65,440 mg/kg.

On review of the results and field observations ENSR consider that there is no apparent trend in the datea which is consistent with the variable fill that was observed.

Slightly elevated concentrations of metals were also reported across the landfill with mercury (50 times the PIL), chromium, copper (all in one sample only), nickel and zinc, exceeding the PILs. Copper was detected at an elevated concentration of 15,000 mg/kg well above the PIL of 100 g/kg and the SIL of 1000 mg/kg in one sample. Most other detections were less than 70 mg/kg. EIS submitted the sample with elevated chromium for chromium VI analysis. Chromium VI was not reported above the PQLs.

A broad sampling grid was implemented by EIS using augers and SPTs rather than test pits such that the ability to visually characterise the materials is limited. In addition, the history of the disposal of the landfill materials was not recorded. While a pattern of impact cannot be determined, the results indicate that the material contains at least some asbestos, heavy

metals, PAHs and petroleum hydrocarbons. EIS refer to the elevated concentrations as hotspots. Remedial options were presented in a RAP which is discussed in Section 11.

8.2. Geological/Aboriginal Heritage

Douglas Partners Pty Ltd (Douglas) undertook intrusive investigations in the geological and aboriginal heritage area in 2003. Fill consisting of sand to 0.4m was encountered adjacent to the access road in the geological area. Some dumped household rubbish and campfire sites were encountered. Petroleum hydrocarbons and PAHs were not reported above the PQLs and only low concentrations of metals were reported.

In the geological and aboriginal heritage area alluvial silty clays to 0.3 m were found to overlie sandstone. Some silty sand fill with cobbles, plant material and building rubble (roof tiles, concrete and wood pieces) was also encountered from 0.6 to 2.0 m depth. One sample was collected from the fill material which did not report TPH or PAHs above the PQLs and only low concentrations of metals.

The RAP indicates that a site management plan will be prepared for this area during rehabilitation and landscaping works for the geologically significant area. Given that limited information was provided to the Auditor, the Auditor considers that management e.g.limited access, is required until these areas are validated. This is discussed in Section 11.

8.3. Remainder of the Site

Soil samples were analysed for a variety of contaminants including asbestos, hydrocarbons, pesticides, herbicides (playing fields only) and heavy metals. The results have been assessed against the environmental quality criteria and are summarised in Table 8.2.

Table 8.2 – Evaluation of Soil Analytical Results – Remainder of the Site - Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Asbestos	105	**4**	NA	NA	NA	NA
Arsenic	127	34	35	NA	0	**3**
Cadmium	127	2	3	NA	0	0
Total Chromium	127	123	32	NA	0	0
Copper	127	119	110	NA	0	**1**
Lead	127	125	280	NA	0	0
Mercury (inorganic)	127	33	2	NA	0	**1**
Nickel	127	105	170	NA	0	**1**
Zinc	127	118	680	NA	0	**7**
PCBs	119	0	-	NA	0	NA
Chlordane	119	4	0.4	NA	0	NA

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
DDT, DDE and DDD	119	5	0.4	NA	0	NA
Other OCPs	119	0	-	NA	0	NA
OPPs	17	0	-	NA	0	NA
Total Acid Herbicides	15	0	-	NA	NA	NA
TPH (C_6-C_9)	127	0	-	0	NA	NA
TPH (C_{10}-C_{36})	127	3	230	0	NA	NA
BTEX	127	0	-	0	NA	NA
Total PAHs	127	33	15.8	NA	0	NA
Benzo(a)Pyrene	127	27	1	NA	0	NA

n *number of samples*
NA *No criteria available/used*

Asbestos fibres were detected in 4 of 105 (approximately 4%) samples collected from the remainder of the site. The likely source of the asbestos is estimated by EIS to be fill material and asbestos containing building materials (sourced from Sydney in general). The descriptions given by the laboratory were similar to that in the landfill. The locations and types found were as follows:

- The detections were within the football field (two at a distance of 150 m from each other) and on the edges of the Biological Services Compound (two at a distance of 100 m from each other).
- Two positive detections were reported in surface soils (0-0.2m), one in near surface soils (0.2-0.5m) and one at depth. No asbestos was observed visually in the field.
- fibres embedded in plaster fragment or fibre cement and one as a ‘loose fibre bundle 4mm long’ at the southern boundary with the Prince Henry site.
- All detections were reported by the laboratory as ‘non-respirable fibres’. The Auditor notes that the laboratory reports the asbestos as presented at the time and do not attempt to determine the friability of the materials.

These results indicate that the vertical and horizontal distribution is not known. There is a risk that the asbestos containing materials, particularly the loose fibre bundles, are friable and could become loose fibres if disturbed.

All other organics including chlordane, DDT/DDE/DDD and PAHs that were detected were reported at low concentrations well below the SILs.

One sample was collected adjacent to the electrical transformers however was collected at 0.6 to 0.8 m depth in fill located below a concrete base. PCBs were not detected above the PQLs. Further validation is proposed following removal of the substations as detailed in Section 11.

8.4. Sediments

Sediment samples were collected from the three dams and analysed for a variety of contaminants including hydrocarbons, pesticides, herbicides and heavy metals. The results have been assessed against the environmental quality criteria and are summarised in Table 8.3.

Table 8.3 – Evaluation of Sediment Analytical Results – Dams-Summary Table (mg/kg)

Analyte	n	Detections	Maximum	n > EPA (1994)	n > SIL Column 1 (DEC 2006)	n > PIL Column 5 (DEC 2006)
Arsenic	5	4	22	NA	0	**1**
Cadmium	5	1	1.8	NA	0	0
Total Chromium	5	5	28	NA	0	0
Copper	5	5	49	NA	0	0
Lead	5	5	64	NA	0	0
Mercury (inorganic)	5	5	0.33	NA	0	0
Nickel	5	5	21	NA	0	0
Zinc	5	5	1000	NA	0	**2**
PCBs	5	0	-	NA	0	NA
OCPs	5	0	-	NA	0	NA
OPPs	5	0	-	NA	0	NA
Total Acid Herbicides	5	0	-	NA	NA	NA
TPH (C_6-C_9)	5	0	-	0	NA	NA
TPH (C_{10}-C_{36})	5	0	-	0	NA	NA
BTEX	5	0	-	0	NA	NA
Total PAHs	5	0	-	NA	0	NA
Benzo(a)Pyrene	5	0	-	NA	0	NA

n *number of samples*
- *No criteria available/used*

Only metals were reported above the PQLs with elevated zinc, consistent with other elevated concentrations on-site, reported above the PIL in two samples. All results were reported at less than the SIL. The Auditor concludes that the results adequately characterise the sediments at the site with regard to the risk to human health. The status of the dams with respect to aquatic ecosystems is not known or discussed.

9. EVALUATION OF LANDFILL GAS ANALYTICAL RESULTS

Landfill gas was measured in the former landfill area during EIS soil investigations. Landfill gas was also measured at eleven monitoring wells. Methane was detected at most locations. Methane was reported above the threshold of 1.25% v/v at 6 of the 25 drilling locations and 10 of 11 monitoring wells. Some more elevated concentrations reported in an additional two drilling locations were greater than 5% v/v at the eastern end of the landfill.

Although limited organic material was encountered during the intrusive investigations the results indicate that there is some decomposition of organic matter that is resulting in the generation of methane.

Methane gas was not encountered by ENSR, including in areas where methane has previously been detected. ENSR concluded that the excavation and removal of fill materials will remove the source of the methane.

Remedial works to address the generation of methane gas and other constituents of landfill gas i.e., hydrogen sulphide, which has a disagreeable odour, are discussed in Section 11.

10. EVALUATION OF SURFACE WATER AND GROUNDWATER ANALYTICAL RESULTS

Groundwater samples were collected from 10 wells in February 2007. Two additional shallow landfill wells and one up-gradient well were found to be dry. Samples were submitted for metal, hydrocarbons, VOC, OCP and nutrient analyses. Samples were submitted for naphthalene analysis rather than a suite of PAHs. The analytical results are summarised below in Table 10.1.

Table 10.1 – Evaluation of Groundwater Analytical Results – Summary Table (µg/L)

Analyte	Immediately Up-gradient of Landfill		Landfill		Biological Services Building		Dams (Surface Water)	
	Detections (n = 3)	Max	Detections (n = 5 including 319A)	Max	Detections (n = 2)	Max	Detections (n = 3)	Max
Arsenic	0	-	5	6	1	1	1	1.1
Cadmium	2	0.4	1	0.8	1	0.5	0	-
Total Chromium	1	**4.6**	5	**3.5**	0	-	2	**1.4**
Copper	1	**24**	1	**9.4**	0	-	2	**2.1**
Lead	2	**24**	1	**82**	2	**18**	**0**	**-**
Mercury (inorganic)	0	-	1	**39**	0	-	0	-
Nickel	3	**190**	5	**110**	2	**130**	0	16
Zinc	3	**400**	5	**300**	2	**200**	3	**13**
Ammonia-Nitrogen	NA	NA	3	**34000**	NA	NA	0	-

Analyte	Immediately Up-gradient of Landfill		Landfill		Biological Services Building		Dams (Surface Water)	
	Detections (n = 3)	Max	Detections (n = 5 including 319A)	Max	Detections (n = 2)	Max	Detections (n = 3)	Max
			(n = 3)					
OCPs	NA	NA	0	-	NA	NA	NA	NA
TPH (C_6-C_9)	0	-	0	-	1	150	0	-
TPH (C_{10}-C_{36})	0	-	5	590	2	270	0	-
Benzene	0	-	0	-	0	-	0	-
Toluene	0	-	0	-	0	-	0	-
Ethylbenzene	0	-	1	2.7	0	-	0	-
Total xylene	0	-	1	190	0	-	0	-
Naphthalene	0	-	2	10	0	-	0	-
Chloroform	0	-	1	1.8	1	360	0	-
Chlorobenzene	0	-	2	5.8	0	-	0	-
Isopropylbenzene	0	-	2	3.7	0	-	0	-
n-propyl benzene	0	-	2	6.1	0	-	0	-
1,3,5 – trimethyl benzene	0	-	1	**22**	0	-	0	-
1,2,4 – trimethyl benzene	0	-	1	**100**	0	-	0	-
Other VOCs	0	-	0	-	0	-	0	-

n *number of samples*
NA *not analysed*
- *Maximum less than the PQLs*
Bold *Concentrations exceed the ANZECC (2000) Trigger Values for Marine Waters*

The main impacts detected include ammonia, metals, TPH and associated fuel products such as trimethylbenzene.

Ammonia was found to dominate the nitrogen compounds in landfill groundwater which EIS considers to be associated with the anaerobic decomposition of organic matter including timber and other waste within the landfill. Groundwater outside the landfill was not submitted for analysis so a comparison of concentrations can not be made.

Organics were detected above the PQLs in groundwater sampled from the landfill and to a lesser extent at the Biological Services Building (which EIS estimates is affected by the landfill) indicating that landfill materials have had an impact on groundwater quality.

Groundwater wells were not located to the east of the landfill (towards Little Bay) with most detections reported in MW319 and MW319A (water perched in the fill) at the eastern edge of the landfill. The standing water levels and known relief of the site indicate that groundwater mounding occurs at this location behind the in-cut sandstone.

Chloroform and TPH C6-C9 were detected at low concentrations in the Biological Services Compound. EIS conclude that the likely source is the landfill rather than the biological services compound as there was no evidence of any sources at this location. The Auditor notes that as only low concentrations were reported no further action is required at this stage. During demolition of the biological services building observations of any odours or visual impacts should be noted and addressed. This is discussed in Section 11.

Three samples were collected from the three dams. The results indicate that only low concentrations of metals were reported. EIS conclude that the 'results do not indicate that the dams have been significantly impacted by contaminant leachate from the adjoining land filled area'. The Auditor agrees with regard to those contaminants submitted for analysis however samples were not analysed for ammonia.

Environmental and Earth Sciences (EES) undertook groundwater, soil and methane gas sampling in 2001. EIS provided a summary of the report however tabulated results and the report have not been provided to the Auditor. EIS indicate that petroleum hydrocarbons reported at < 10mg/L were encountered in all three wells that were screened in the fill material (sandstone aquifer was not assessed). The water was also characterised by low concentrations of metals and PAHs. EES discussed the possibility that detections of TPH were a result of breakdown of natural organic compounds in soil. These results are consistent with the current results. Relatively low concentrations of petroleum hydrocarbons were detected in soil at limited locations.

EIS concluded that slightly elevated concentrations of metals and petroleum hydrocarbons were of anthropogenic origin and likely to be associated with contaminated material within the landfill. Measures to address groundwater impacts are discussed in Section 11.

EIS concluded that 'contamination issues at the site are considered to be related to the presence of land filled material at the site. Additional groundwater monitoring may be necessary to confirm perched water conditions within the landfill with variation in climatic conditions'.

The Auditor considers that it has been established that there is contamination of groundwater principally by ammonia because of the presence of the landfill. It is not clear whether groundwater flows to the dams or via the subsurface to Little Bay. Groundwater is further discussed in the context of proposed site remediation in Section 11.

11. EVALUATION OF REMEDIATION

11.1. Remediation Strategy

Remediation is required for residential use due to the presence and potential presence of asbestos and other potential contamination pockets in fill materials. The presence of landfill gas and groundwater contamination indicates that putrescible materials such as green wastes may also be present in the landfill.

The 'Remediation Area' includes the following due to fill materials:

- Landfill and surrounds
- Former Solarch Compound
- The former Biological Resources Compound and surrounds
- Area surrounding two dams/water bodies in the central corridor.

A remedial strategy has been selected by ENSR as documented in the Remedial Works Plan (RWP). The remediation strategy is aimed at source removal and containment of residual fill materials.

Remediation is not required in the western portion (playing fields) of the site. ENSR indicate that bulk earthworks will be undertaken in this area and if contaminants are found the contingency would be to follow the remediation process outlined for other fill materials. Remedial works in this area are likely to be relatively minor compared to the remediation and/or management of the former landfill in rendering the site suitable for residential use.

The areas of geological, Aboriginal and ecological significance will be managed under an EMP. The boundaries will be delineated with fences and barriers. As limited information is available on these areas the Auditor considers that management is required until validated.

The Stage 1 report for the former Biological Resources Compound (BRC) and surrounds recommends that a hazardous materials assessment be undertaken prior to demolition, that validation sampling be undertaken following removal of fill 'prior to the broader remediation programme' as the contaminants of concern are different.

11.2. Evaluation of Remedial Action Plan

The Auditor has assessed the RWP by comparison with the checklist included in "Guidelines for Consultants Reporting on Contaminated Sites". As summarised in Table 11.1 the RWP was found to address the required remaining information for most items.

Table 11.1 – Evaluation of Remedial Works Plan

Remedial Action Pan	Comments
Remedial Goal	The purpose of the plan is to 'remove all accessible fill materials'. This includes removal of materials that generate methane, wastes un-suitable for re-use and contaminated materials such that the risks to human health and the environment are reduced. Broader objectives to minimise risks to human health and the environment are considered to be adequate.
Discussion of the extent of remediation required.	Landfill – to base of the landfill and edges as defined by the topography of the site which is to address associated groundwater and gas contamination. Fill – Solarch, former Biological Resources Compound and area surrounding the two dams/water bodies in the central corridor. These areas are defined by local topography and the depth of the materials. The extent of the Remediation Area adjacent to the dams and the geologically significant area will be surveyed prior to remedial works. The vertical extent of the remedial works will be 'either bedrock or natural residual material, if present'. While the aim is to target all accessible fill materials the horizontal extent may be limited to areas of restricted access. This includes protection of the integrity and stability of embankments adjacent to the geologically signficiant area, (fence lines and buildings) at the northern property boundary and at the dams. The extent of landfill material will terminate at the boundary between the site and the ESBS. If further excavation is required due to putrescible material off-site then arrangements would be made with the property owner and appropriate approvals obtained. The Auditor notes that where materials are retained, a discussion of risk and extent should be provided.
Remedial Options	A number of options considered for the landfill by the EIS RAP were previously assessed by the Auditor (SAS GN 336). ENSR also presented five options for the landfill in accordance with the remediation hierarchy (DEC 2006). Remainder of the Site: Limited discussion.
Selected Preferred Option	Excavation and removal of contaminated soils and unsuitable waste and off-site disposal and re-use of suitable materials. The Auditor considers that the landfill has been sufficiently characterised to implement this preferred option. Other than removal of unsuitable materials, no direct remediation of groundwater or landfill gas is proposed in the RWP. The Auditor agrees

Remedial Action Pan	Comments
	that groundwater and landfill gas can be addressed through soil remediation.
Rationale	Justification based on reduction of mass of contaminants, reduction or elimination of landfill gas and removal of source for groundwater contamination. The strategy limits the off-site disposal of suitable materials and is more cost-effective and environmentally sustainable than removing all fill. ENSR anticipate that following successful validation of the remedial works that 'ongoing and long-term management of the site will not be required'. The feasibility of this option is discussed in Section 11.3.
Proposed Validation Testing	Discussed in Section 11.3 The statistical basis for validation results was provided.
Interim Site Management Plan (before remediation)	It is understood that the development process could take some time given the staged development applications. It is understood that the site is fenced and grassed that will restrict access. There was evidence on-site of access (car dumping, rubbish dumping and graffiti). Additional fencing and signage may be required.
Site Management Plan (operation phase) including stormwater, soil, noise, dust, odour and OH&S	The Auditor considers that the RWP provides a basis on which contractors can prepare specific management plans i.e. Soil and Water Management Plan, Acid Sulphate Soil Management Plan, Health and Safety Plan.
Contingency Plan if Selected Remedial Strategy Fails	The Auditor considers that the RWP provides a basis on which contractor can prepare a Contingency Plan. If 'unacceptable conditions remain at the boundary (e.g. fill/waste with leachate or gas generating potential) then further remediation would be undertaken such as excavation, barrier or treatment.
Contingency Plans to Respond to site Incidents.	Provides management and contingency plans that are directly applicable.
Remediation Schedule and Hours of Operation	To be in accordance with the development consent once issued.
Licences and Approvals	It is understood that as the remediation and bulk earthworks are to be undertaken ancillary to a development application for the subdivision and are conditions of consent that the works are Category 2 under SEPP55. The Randwick City Council Contaminated Land Policy was not discussed. The land is located within a Heritage conservation area under the provisions of the Randwick LEP 1998 however the site is not a heritage item. RWP notes that materials would be disposed of in accordance with DECC (2008) Waste Classification Guidelines, transported by licensed contractors and be disposed of at an appropriately licensed waste facility.

Remedial Action Pan	Comments
	The POEO Act indicates that a licence is required where an area of more than 3 hectares of contaminated soil (material that presents a risk of harm) is disturbed or where more than 30,000 m^3 of contaminated soil is treated. The RWP notes that an environmental protection licence will be required prior to commencement of the works. RWP indicates that acid sulphate soils would be managed in accordance with the ASSMAC (1998) Acid Sulphate Manual, Acid Sulphate Soil Management Advisory Committee.
Contacts/Community Relations/	A sign displaying contact details of the contractor and project manager will be displayed during remediation works. RWP recommends that neighbours be informed of the works.
Staged Progress Reporting	Not indicated.
Long term site management plan	RWP notes that the remedial works proposed 'may remove the requirement for a long term EMP or implementation of a leachate or landfill gas management system'. ENSR essentially anticipate that a long term EMP will not be required. Given this assumption, no further details on management were provided. Long term management plans are proposed for areas of geological, Aboriginal and ecological significance. No details were provided.

11.3. Remediation Methodology and Validation

Remediation will involve the excavation of materials followed by screening, sorting and classification to determine whether the materials can be re-used or will be disposed off-site.

Essentially the process involves visual classification of materials based on the amount of waste, odours, the nature and type of inclusions and inert materials.

Materials with a 'significant proportion of general or demolition waste' will be disposed off-site. Other materials will be stockpiled and screened for visual and olfactory indications of contamination. If there are indications of contamination (excluding asbestos containing materials (ACM)), sampling and laboratory analysis will be undertaken to determine the suitability of the materials. Where ACM are observed, further investigations will be required. Inert materials such as bricks, sandstone and concrete will separated, crushed and re-used on-site.

Acid Sulphate Soil (ASS), if present beneath fill in the landfill areas and excavated, will be managed by containment dosing with lime.

Suitable materials will be placed and compacted prior to placement of a 1.5 m layer of VENM/ENM 'to meet the shortfall of the final design levels (if any) and to provide an additional layer between the final surface and the validated material'. It is understood that at least 1.5 m of VENM or ENM would be placed over the entire remediation area.

ENSR have considered the likely sources and volumes of materials to be excavated and screened.

To ensure that this process is successful the RWP indicates that 'caution will be exercised as the exact composition and depth of the subsurface fill materials is unknown', there will be a staged approach, the fill will be closely observed and a PID will be used to screen samples.

Validation works proposed are outlined in Table 11.2

Table 11.2 – Evaluation of Validation Plan

Classification	Nature	Validation – Visual and Analytical	Auditor Comments
Screening, Sorting and Classification Works			
Significant proportion of general or demolition waste	Heterogeneous fill material. No quantitative indication provided.	Once removed off-site, further bulk earthworks including screening and sorting would be undertaken.	Material will need to be adequately classified for off-site disposal.
Visual/olfactory indications of contamination	Hydrocarbon odours, ash, etc	A PID will be used and careful observation for visual and olfactory indications of contamination undertaken essentially on a bucket by bucket basis. Given the initial screen and the estimated small volumes of materials likely to be suitable for re-use, ENSR indicate confirmation analytical testing would be undertaken following the placement of materials at a rate of 1 per 500 m^3. If there is some evidence of impact then materials would be sampled at 1 per 120 m^3 and analysed for metals, petroleum hydrocarbons and PAHs. This density was selected as little chemical contamination has been detected in the past.	As sampling, for materials to be re-used, is proposed following placement of materials, there is a risk that re-excavation may be required depending on the results. The sampling densities are considered adequate as contamination has previously been shown to be associated with visual indications.
Visual indications of ACM	Low ACM risk – no apparent inclusions Medium ACM risk – moderate ACM inclusions	ACM Validation Process -hand picked -placed in 20 m x 20 m x 300 mm beds for visual inspection and hand picking -validation sampling over 5m by 5m grid creating composites to be assessed and screened in the field Repeat until satisfactory.	It is understood that all materials to be re-used will be screened for asbestos.

Classification	Nature	Validation – Visual and Analytical	Auditor Comments
	High ACM risk – significant ACM content	Dispose off-site and validate remaining materials as per low and medium ACM risk materials.	Adequate
Following Excavation			
Excavation	Base: Natural bedrock or natural residual soil Wall – aim is to 'remove all accessible fill materials' so validation limited to areas where access is limited.	Base Bedrock – visual validation including photographs Natural Residual Soil - Base (floor) samples at 1 per 100 m^2. If fill is retained (> 10m or where excavation to depth is not feasible) validation samples will still be collected (1 per 50 m^2). Wall: Fill retained horizontally in areas of restricted access will be targeted at 1 per 20 lineal metres. This also includes where fill is retained at the site boundaries i.e. between the site and the ESBS. If fill is retained in the dam embankments samples would be collected at 0.5 m depth prior to placement of VENM/ENM.	It is understood that the aim is to remove all fill materials. ENSR provide an estimate of areas where residual materials may be retained.
Surface	Not discussed	Surface samples (0-0.1 m) on a 40 m grid in the ecologically sensitive area and the dam area. Additional samples will be collected from 0.5 m in the dam area.	Given that sampling has already been undertaken the additional density if considered to be adequate.
Groundwater and Gas	Contaminants sourced from fill	Removal of fill. The RWP proposes validation monitoring at the completion of the remedial works. The number of wells, locations and period of monitoring would be agreed prior to completion of the soil remediation programme.	A discussion of any residual fill retained on-site and the potential risk to groundwater and gas should be discussed at the completion of the works. In principal this should be adequate however will depend on validation of fill removal and the proposed sampling regime.

Classification	Nature	Validation – Visual and Analytical	Auditor Comments
		ENSR note that the duration is unlikely to extend beyond 3 months given the low likelihood of groundwater and gas impacts post-remediation.	
Imported Materials	VENM /ENM	Documentation. If documentation satisfactory, sample rate of 1 per 100 m^3 of imported fill for TPH, BTEX, metals, OCPs, PCBs and PAHs.	Ensure that visual verification of the material is also provided and an acceptance process is implemented.

The Auditor considers that implementation of this remedial option would render the site suitable for residential development subject to suitable and successful validation of the excavation base and imported material and the other measures discussed for the remainder of the site in Section 11.1.

An EMP may still be required, depending on the level of validation and validation results obtained.

It is considered that these further actions can be adequately mandated and controlled as part of the development application process.

12. CONCLUSIONS AND RECOMMENDATIONS

It is the Auditors opinion that implementation of the RWP would render the site suitable for residential development subject to suitable and successful validation of the excavation base and imported material and the other measures discussed for the remainder of the site in Section 11.

It is the Auditor's opinion that:

- investigations undertaken by EIS and ENSR have adequately characterised the nature and extent of contaminants in fill to formulate a plan of remediation or management
- the site could be made suitable for residential uses if the site were remediated and validated in accordance with the RWP
- an EMP may be required depending on the level of validation and validation results obtained.

The Auditor recommends that:

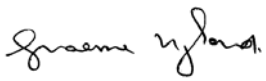
- Following demolition of the buildings and associated infrastructure in the Biological Resource Centre, that the surface be validated.

* * *

Consistent with Department of Environment and Climate Change (DECC and formerly NSW EPA) requirement for staged "signoff" of sites that are the subject of progressive assessment, remediation and validation, I advise that:

- This advice letter does not constitute a Site Audit Report or Site Audit Statement.
- At the completion of the remediation and validation I will provide a Site Audit Statement and supporting documentation.
- This interim advice will be documented in the Site Audit Report.

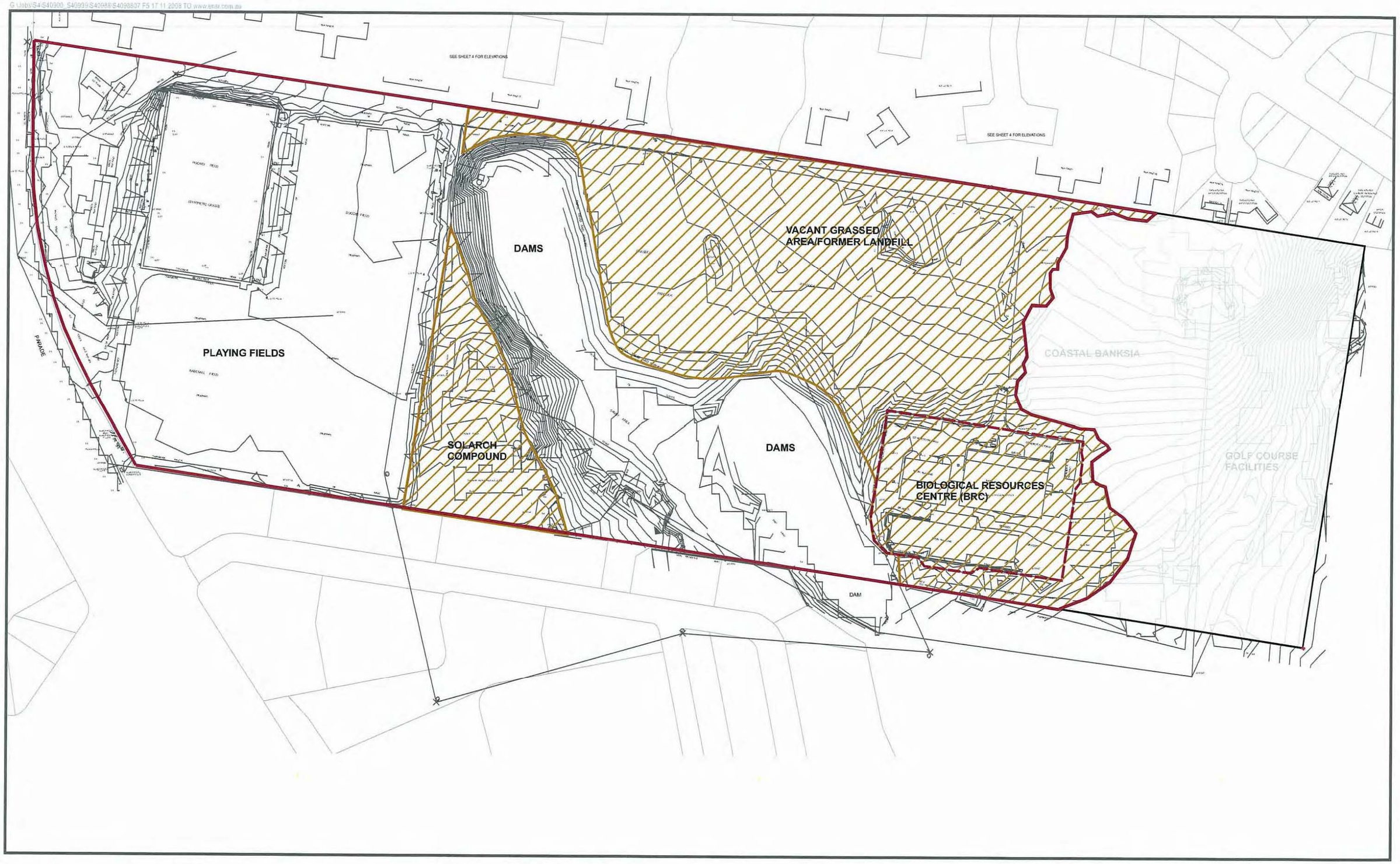
Yours faithfully
ENVIRON Australia Pty Ltd



Graeme Nyland
EPA Accredited Auditor 9808

Enc: Attachment 1

ATTACHMENT 1: Site Layout



ENSR | AECOM

0 50m

Little Bay Campus Boundary
Biological Resources Centre Boundary (BRC)
Remediation area

Figure 5 | **Remediation Area**

Charter Hall Pty Ltd

1406 - 1408 Anzac Parade,
Little Bay NSW