Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Targeted Site Investigation for Contamination

Part of Fairways North, Bingara Gorge Estate
Fairway Drive, Wilton

Prepared for
Lendlease Communities (Wilton) Pty Limited

Project 43677.47
December 2017

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	43677.47	Document No.	R.002.Rev0
Document title	Report on Targeted Site Investigation for Contamination Part of Fairways North, Bingara Gorge Estate Fairway Drive, Wilton		
Site address	Fairway Drive, Wilton		
Report prepared for	Lendlease Communities (Wilton) Pty Limited		
File name	43677.47.R.002.Rev0		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	David Walker	Paul Gorman	6 December 2017

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Rob Curlewis

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		6 December 2017
Reviewer		6 December 2017

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Table of Contents

Appendices

Report on Targeted Site Investigation for Contamination
Part of Fairways North, Bingara Gorge Estate
Fairway Drive, Wilton

1. Introduction

This report presents the results of a targeted site investigation for contamination undertaken for part of the Fairways North development area of Bingara Gorge at Fairway Drive, Wilton. It is understood that the proposed development will include construction of several new roads, approximately 200 new residential lots and installation of associated services. The investigation was commissioned by Lendlease Communities (Wilton) Pty Limited.

A preliminary investigation for contamination for proposed development areas at Bingara Gorge Estate was reported in:

- In Douglas Partners Pty Ltd (DP), *Report on Preliminary Site Investigation for Contamination, Future Development Areas & Associated Trails, Bingara Gorge Estate, Wilton*, March 2016, Project 43677.40.R.003.Rev1 (PSI).

From a review of historical information and site observations (in May 2015), it was concluded in the PSI that there was generally a low potential for contamination. It was recommended that some soil sampling should be undertaken from around the cottage and nearby sheds and remnants of previous structures to confirm (or otherwise) that the soil has not been impacted by possible spills or leaks of oil or fuel or by hazardous building materials. Therefore, the objectives of the targeted site investigation were to undertake soil sampling to assess the contamination status at the cottage and remnant structures (within the subject development area) and to provide an opinion on the suitability of the site for the proposed development.

2. Scope of Work

The scope of work for the investigation was as follows:

- Review information presented in the PSI;
- Collect soil samples using a hand auger from eight test locations;
- Screen samples for volatile compounds using a photo-ionisation detector (PID);
- Laboratory analysis on selected samples for the following:
  - Priority metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc);
  - Total recoverable hydrocarbons (TRH);
  - Benzene, toluene, ethylbenzene and xylene (BTEX);
  - Polycyclic aromatic hydrocarbons (PAH);
  - Polychlorinated biphenyls (PCB);

- Organochlorine pesticides (OCP);
- Total phenols;
- Asbestos;
- Cation exchange capacity (CEC);
- pH;
- TRH >C_{10}-C_{40} with silica gel cleanup;
- Toxicity characteristic leaching procedure (TCLP) for lead and zinc; and
- Australian standard leaching procedure (ASLP) for lead and zinc.

- Provision of this targeted site investigation report.

3. Site Identification and Description

The part of the Fairways North development area that comprises 'the site' for this investigation includes:

- Part of Lot 26 Deposited Plan 270536. The site approximately covers the southern two-thirds of this Lot which is a (proposed) road reserve; and
- Part of Lot 31 Deposited Plan 270536. The site covers approximately two-thirds of this Lot (at the southern and eastern parts of the Lot).

The site covers approximately 31 ha and is shown in Drawing 8, Appendix A.

At the time of field work (1 August 2017), the site was observed to be similar to that observed in May 2015 for the PSI. The majority of the site was grassed with some clusters of mature trees and was accessible by dirt roads. Much of the site area was used for horse grazing.

A sandstone brick cottage was located at the south of the site. A derelict (unused) tank (for possible previous fuel storage) was present at the rear of the cottage (Photograph 1, Appendix B). Rainwater tanks were also present around the cottage. Remnants of (unknown) structures and old animal pens were in close proximity of the cottage. An old small timber gazebo with a circular concrete floor and an old sandstone outhouse were also present. A small dam was located to the north of the cottage (and is on the site boundary).

The southernmost part of the site is filled as part of dam wall and provides vehicle access.

At the eastern part of the site, a relatively elevated area had been disturbed (scraped) and subject to removal of soil, leaving exposed soil and pools of turbid water. Some piles of soil were present surrounding this area and were presumed to have been sourced from this disturbed area. A small dam was located to the south of the disturbed area. Another dam is located at the northern part of the site.

Presumed asbestos containing fibre-cement pieces were used as (makeshift) support for the timber decking of the cottage (see Photographs 2 and 3, Appendix B).

Surrounding land uses include bushland to the north and east; a golf course, a large dam and undeveloped land to the south; and undeveloped land to the west. It is noted that an old shed and remnant structures (associated with the old cottage property) are located on the adjacent land to the west of the site.

4. Topography, Geology and Hydrogeology

The Wollongong-Port Hacking 1:100 000 Geology Sheet indicates that part of the site is underlain by Hawkesbury Sandstone which comprises medium to coarse-grained quartz sandstone, very minor shale and laminate lenses; and part of the site is underlain by Ashfield Shale which comprises laminite and dark-grey siltstone.

The Wollongong-Port Hacking 1:100,000 Soils Landscape Sheet indicates that the site has natural soils formed by residual processes.

The site has undulating topography with the majority of slopes down towards the large dam (south), Stringybark Creek (east) and Allens Creek (north). The majority of stormwater at the site is expected to infiltrate the permeable surfaces or run-off towards the dams and creeks. Groundwater is expected to migrate towards the large dam, Stringy Bark Creek or Allens Creek.

The geotechnical investigation, reported in DP, *Report on Phase 2 Salinity Assessment, Bingara Gorge, Fairways North, Pembroke Parade, Wilton,* December 2017 (Project 43677.47), comprised soil sampling from 70 test pits across the site (refer Drawing 8, Appendix A). The encountered soil profile typically comprised a surface layer of topsoil; underlain by silty sand, sandy clay, silty clay, gravelly sand or clay; underlain by sandstone or (occasional) shale/siltstone. Filling was infrequently encountered (although some soil layers were noted as possible filling) and was described as not having anthropogenic materials (i.e. the filling was described to comprise soil and rock including silt, sand, clay, shale and sandstone). Signs of contamination (such as odours, staining or building rubble) were not observed.

5. Site History Summary

The following site history summary is summarised from the PSI.

According to information sourced from Johnstone Environmental Technology Pty Ltd's preliminary contamination assessment in 1999, the Wilton area was used during World War II as a RAAF High Explosive bombing and gunnery range. The earliest available aerial photograph images, from 1956 and 1966, do not provide any evidence (e.g. bunkers) to suggest that the site was used for this purpose; however, a wartime aerial photograph was not available.

The site and surrounding areas appear to have been bushland and then used for grazing up until recently when the site and surrounding areas had been subject to changes as a result of developments for Bingara Gorge Estate. Aerial photographs indicate that the existing cottage was the only cottage that has been present at the site. Sheds (and possibly other small structures) surrounded

the cottage and were probably used to store farming equipment. Fuel (diesel) was likely stored somewhere close to the sheds, as old, disused tanks were observed near the uninhabited cottage. The exact location of where fuel was kept whilst the cottage was occupied is unknown. A number of (farm) dams had been constructed.

6. Potential Contamination Sources and Preliminary Conceptual Site Model

6.1 Potential Contamination Sources

The potential sources of contamination for this investigation, based on the findings of the PSI, are summarised as follows:

- Soil impacted from possible spills or leaks from previous fuel (diesel) and oil storage near the cottage. Potential contaminants include total petroleum hydrocarbons (TPH), BTEX, metals, PAH and (to a lesser extent) phenols; and
- Soil impacted from hazardous building materials from the cottage and surrounding structures. Potential contaminants include asbestos, PCB, lead and zinc.

Other possible contamination sources were listed in the PSI as fly tipping, imported contaminated filling, and possible RAAF use during World War II. As specific locations of these potential sources have not been identified within the subject site boundary, these potential sources have not been investigated.

6.2 Potential Receptors

Potential receptors to potential contamination from sources include:

- Future site users (primarily residential occupants but also visitors and pedestrians);
- Adjacent site uses (primarily the golf course users, pedestrians and future neighbouring residential occupants);
- Construction workers (for the proposed development) and maintenance workers;
- Surface water bodies;
- Groundwater;
- Terrestrial ecological receptors; and
- In ground building structures.

6.3 Potential Pathways

Possible transport pathways for contamination to impact receptors include the following:

- Ingestion and dermal contact with soil;
- Inhalation of dust or vapours;

- Surface water runoff;
- Leaching of contaminants and vertical migration into groundwater;
- Lateral migration of groundwater; and
- Direct contact of contaminated ground.

6.4 Preliminary Conceptual Site Model

A 'source-pathway-receptor' approach has been used to assess the potential risks of harm being caused to human or environmental receptors from contamination sources on or in the vicinity of the site, via exposure pathways (complete pathways). Table 1 shows the preliminary conceptual site model for this investigation and has the possible source-pathway-receptor linkages.

Table 1: Preliminary Conceptual Site Model

Source	Transport Pathway	Receptor
Soil impacted from possible spills or leaks from previous fuel and oil storage or from hazardous building materials	• Ingestion and dermal contact • Inhalation of dust or vapours	• Future site users • Construction workers and maintenance workers
	• Inhalation of dust or vapours	• Adjacent site users
	• Surface water runoff • Lateral migration of groundwater	• Surface water bodies
	• Leaching and vertical migration into groundwater	• Groundwater
	• Direct contact	• Terrestrial ecology • In ground building structures

7. Field Work, Analysis and QA/QC

7.1 Sample Locations and Rationale

As per the recommendations made in the PSI, eight sample locations (Bores 101 – 108) were positioned in the vicinity of the cottage and surrounding structures to target potential sources identified in Section 6. In particular:

- Bore 101 was positioned next to the derelict tank;
- Bores 102 and 106 were positioned next to remnant structures at the west of the cottage;
- Bores 103 and 105 was positioned close to the cottage;

- Bore 104 was positioned close the cottage, immediately next to where presumed asbestos containing materials were used for (makeshift) support for the timber decking;
- Bore 107 was positioned close to an off-site remnant structure; and
- Bore 108 was positioned next to an old timber gazebo.

Bore locations are shown on Drawing A, Appendix A.

7.2 Soil Sampling Procedures

Soil samples were collected from hand auger returns. Soil samples were collected at regular depth intervals and from different stratum. All sampling data was recorded on DP's test bore logs (Appendix C). The general sampling procedure adopted for the collection of soil samples for chemical analysis was:

- Collect soil samples using disposable gloves;
- Transfer samples into laboratory-prepared glass jars, completely filled to minimise the headspace within the sample jar, and capping immediately to minimise loss of volatiles;
- Label sample containers with individual and unique identification, including project number, sample location and sample depth; and
- Place the glass jars, with Teflon lined lids, into a cooled, insulated and sealed container for transport to the laboratory.

Replicate samples were collected in zip-lock bags for volatile screening using a PID as well as for asbestos analysis.

7.3 Analytical Rationale

Samples for laboratory analysis were based on field observations as well as the potential contamination sources and the preliminary conceptual site model (see Section 6). In particular:

- Surface samples from each location were analysed for the primary potential contaminants associated with fuel and oil storage including TRH, BTEX, metals and PAH. The surficial soil sample from next to the derelict tank (Bore 101, depth 0-0.15) was also analysed for total phenols. A deeper soil sample from next to the derelict tank (Bore 101, depth 0.4-0.5 m) was also analysed for TRH, BTEX, metals and PAH;
- To test for possible contamination from hazardous building materials, a sample of surface soil from each location was analysed for asbestos, lead and zinc, and the majority of surface soil samples were analysed for PCB;
- Although pesticides were not considered to be a primary contaminant of concern, the majority of surface soil samples were analysed for OCP;
- An additional sample of the filling from Bore 103 (depth 0.3-0.4 m) was also analysed for TRH, BTEX, PAH and metals to test for possible contamination associated with the filling;

- The two samples with the highest lead and zinc concentrations were subject to TCLP and ASLP for zinc and lead analysis; and
- A sample with concentrations of TRH >C_{16}-C_{34} and TRH >C_{34}-C_{40} above the laboratory's limit of reporting was subject to TRH >C_{10}-C_{40} with silica gel cleanup analysis (TPH).

7.4 Quality Assurance and Quality Control

The field QC procedures for sampling were undertaken as prescribed in Douglas Partners' *Field Procedures Manual*. The results of field QA/QC procedures as well as a discussion of Data Quality Objectives (DQO) and Data Quality Indicators (DQI) for the assessment are provided in Appendix D.

The analytical laboratory, accredited by NATA, is required to conduct in-house QA/QC procedures. These are normally incorporated into every analytical run and include reagent blanks, spike recovery, surrogate recovery and duplicate samples. These results are included in the laboratory reports in Appendix E and discussed in Appendix D.

8. Site Assessment Criteria

The Site Assessment Criteria (SAC) applied in the current investigation is informed by the preliminary conceptual site model which identified receptors to potential contamination (refer to Section 6). Analytical results are assessed (as a Tier 1 assessment) against the SAC comprising investigation levels, screening levels and management limits of Schedule B1, *National Environment Protection (Assessment of Site Contamination) Measure* 1999, as amended 2013 (NEPC, 2013). The guidelines are endorsed by the NSW EPA under the *Contaminated Land Management Act 1997*.

The investigation levels, screening levels and management limits in NEPC (2013) are applicable to generic land use settings and include consideration of, where relevant, the soil type and the depth of contamination. The investigation levels, screening levels and management limits are not intended to be used as clean up levels. Rather, they establish concentrations above which further appropriate investigation (e.g. Tier 2 assessment) should be undertaken. They are intentionally conservative and are based on a reasonable worst-case scenario.

The majority of the site is proposed to be used for low-density residential purposes. Therefore, the SAC used for this investigation are investigation levels, screening levels and management limits for a generic residential land use that includes gardens or accessible soil (i.e. the 'Residential A' generic land use). It is noted that the site will also have public roads and the SAC are considered to be very conservative for this land use given that the potential for exposure to contaminants at a road reserve is lower than that for the Residential A land use scenario.

8.1 Health Investigation and Screening Levels

The Health Investigation Levels (HIL) and Health Screening Levels (HSL) are scientifically-based, generic assessment criteria designed to be used in the first stage (Tier 1) of an assessment of potential human health risk from chronic exposure to contaminants.

HIL are applicable to assessing health risk arising via all relevant pathways of exposure for a range of metals and organic substances. The HIL are generic to all soil types and apply generally to a depth of 3 m below the surface for residential use.

HSL are applicable to selected petroleum compounds and fractions to assess the risk to human health via the inhalation pathway. The HSL depend on the soil types and depths to contamination.

The generic HIL and HSL are considered to be appropriate for the assessment of contamination at the site. HIL A and HSL A have been adopted as the applicable Tier 1 criteria. As soils at the sample locations primarily comprise manly silt and clay, the most conservative HSL for silt and clay soil types have been adopted. HSL are for the top 1 m of the soil profile which are more conservative than those for greater depths.

The adopted HIL and HSL from NEPC (2013) are shown in Table 2.

It is noted that HSL for direct contact have not been listed given that these are significantly higher other screening levels and management limits and, therefore, are unlikely to become drivers for further investigation or site management.

Table 2: HIL and HSL for Soil Contaminants

Chemical	HIL A (mg/kg)	HSL A for vapour intrusion (mg/kg)
Metals and Inorganics		
Arsenic	100	-
Cadmium	20	-
Chromium (VI)	100	-
Copper	6000	
Lead	300	-
Mercury (inorganic)	40	-
Nickel	400	-
Zinc	7400	-
TRH		
$C_6 – C_{10}$ (less BTEX)	-	40
$>C_{10}$-C_{16} (less Naphthalene)	-	230
BTEX		
Benzene	-	0.6
Toluene	-	390
Ethylbenzene	-	NL
Xylenes	-	95
PAH		
Benzo(a)pyrene TEQ	3	-
Naphthalene	-	4
Total PAHs	300	-
Phenols		-
Phenol	3000	-
Pentachlorophenol	100	-
Cresols	400	-
OCP		
DDT+DDE+DDD	240	-
Aldrin + Dieldrin	6	-
Chlordane	50	-
Endosulfan (total)	270	-
Endrin	10	-
Heptachlor	6	-
HCB	10	-
Methoxychlor	300	-
Other Organics		
PCBs (non dioxin- like PCB only)	1	-

Notes: TEQ is Toxic Equivalency Quotient.

NL is 'Not Limiting'. If the derived soil HSL exceeds the soil saturation concentration, a soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario. For these scenarios, the HSL is given as NL.

8.2 Ecological Investigation and Screening Levels

Ecological Investigation Levels (EIL) have been derived for selected metals and organic compounds and are applicable for assessing risk to terrestrial ecosystems. EIL depend on specific soil physiochemical properties and land use scenarios and generally apply to the top 2 m of soil, which corresponds to the root zone and habitation zone of many species. The EIL is determined for a contaminant based on the sum of the ambient background concentration (ABC) and an added contaminant limit (ACL). The ABC of a contaminant is the soil concentration in a specific locality that is the sum of naturally occurring background levels and the contaminants levels that have been introduced from diffuse or non-point sources (e.g. motor vehicle emissions). The ACL is the added concentration (above the ABC) of a contaminant above which further appropriate investigation and evaluation of the impact on ecological values is required.

The EIL is calculated using the following formula:

EIL = ABC + ACL

The ABC is determined through direct measurement at an appropriate reference site (preferred) or through the use of methods defined by Olszowy et al *Trace element concentrations in soils from rural and urban areas of Australia*, Contaminated Sites monograph no. 4, South Australian Health Commission, Adelaide, Australia 1995 (Olszowy, 1995) or Hamon et al, *Geochemical indices allow estimation of heavy metal background concentrations in soils*, Global Biogeochemical Cycles, vol. 18, GB1014, (Hamon, 2004). ACL is based on soil characteristics including pH, CEC and clay content.

EIL (and ACLs where appropriate) have been derived in NEPC (2013) for only a short list of contaminants comprising arsenic, copper, chromium (III), DDT, naphthalene, nickel, lead and zinc. An *Interactive (Excel) Calculation Spreadsheet* may be used for calculating site-specific EIL for these contaminants, and has been provided in the ASC NEPM Toolbox available on the SCEW (Standing Council on Environment and Water) website (http://www.scew.gov.au/node/941).

The adopted EIL, from using the *Interactive (Excel) Calculation Spreadsheet,* are shown in Table 3. EIL for a residential land use scenario have been adopted. The following site specific data and assumptions have been used to determine the EILs:

- The EILs apply to the top 2 m of the soil profile;
- Given the likely source of soil contaminants (i.e. previous filling) the contamination is considered as “aged” (>2 years);
- ABCs have been derived using the *Interactive (Excel) Calculation Spreadsheet* using input parameters of NSW for the State in which the site is located, and low for traffic volumes;
- A pH of 6.85 has been used as an input value based on site specific data. This input value is the average of the two obtained pH values of 7.2 and 6.5 (see laboratory certificate 172580-, Appendix E);
- A CEC of 8.55 cmol/kg has been used as an input value based on site specific data. This input value is the average of the two obtained CEC values of 12 cmol/kg and 5.1 cmol/kg (see laboratory certificate 172580-, Appendix E); and
- In the absence of site specific data, a conservative clay content value of 10% and a conservative organic carbon content value of 0.5% have been used.

Ecological Screening Levels (ESL) are used to assess the risk of selected petroleum hydrocarbon compounds, BTEX and benzo(a)pyrene to terrestrial ecosystems. ESL apply to the top 2 m of the soil profile as for EIL.

ESL have been derived in NEPC (2013) for petroleum fractions as well as BTEX and benzo(a)pyrene. The adopted ESL are shown in Table 3 and are for an urban residential land use scenario. ESL for fine grained soils have been adopted as soils at the site are predominately fine grained (silts and clays).

Table 3: EIL and ESL for Soil Contaminants

Chemical	EIL – Urban Residential (mg/kg)	ESL – Urban Residential (mg/kg)
Metals and Inorganics		
Arsenic	100	-
Copper	180	-
Nickel	120	-
Chromium III	410	-
Lead	1100	-
Zinc	430	-
TRH		
$C_6 – C_{10}$ (less BTEX)	-	180*
$>C_{10}-C_{16}$	-	120*
$>C_{16}-C_{34}$	-	1300
$>C_{34}-C_{40}$	-	5600
BTEX		
Benzene	-	65
Toluene	-	105
Ethylbenzene	-	125
Xylenes	-	45
PAH		
Benzo(a)pyrene	-	0.7
Naphthalene	170	-
OCP		
DDT	180	-

Note: All ESL are low reliability apart from those marked with * which are moderate reliability

8.3 Management Limits for Petroleum Hydrocarbons

In addition to appropriate consideration and application of the HSLs and ESLs, there are additional considerations which reflect the nature and properties of petroleum hydrocarbons, including:

- Formation of observable light non-aqueous phase liquids (LNAPL);

- Fire and explosion hazards; and
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services.

Management Limits to avoid or minimise these potential effects have been adopted from NEPC (2013) as interim Tier 1 guidance. The adopted Management Limits are for a generic for residential land use scenario and apply to any depth within the soil profile. Table 4 shows the Management Limits which are for fine textured soils as the soil types encountered were primarily fine grained (silts and clays).

Table 4: Management Limits

TRH Fraction	Management Limit – Residential (mg/kg)
$C_6 – C_{10}$	800
$>C_{10}-C_{16}$	1000
$>C_{16}-C_{34}$	3500
$>C_{34}-C_{40}$	10 000

8.4 Asbestos in Soil

Bonded asbestos-containing material (ACM) is the most common form of asbestos contamination across Australia, generally arising from: inadequate removal and disposal practices during demolition of buildings containing asbestos products; dumping of asbestos products; and the use of filling containing unsorted demolition materials including asbestos products.

Mining, manufacturing or distribution of asbestos products may result in sites being contaminated by friable asbestos including free fibres. Severe weathering or damage to bonded ACM may also result in the formation of friable asbestos comprising fibrous asbestos (FA) and/or asbestos fines (AF).

Asbestos only poses a risk to human health when asbestos fibres are made airborne and inhaled. If asbestos is bound in a matrix such as cement or resin, it is not readily made airborne except through substantial physical damage. Bonded ACM in sound condition represents a low human health risk, whilst both FA and AF materials have the potential to generate, or be associated with, free asbestos fibres. Consequently, FA and AF must be carefully managed to prevent the release of asbestos fibres into the air.

A detailed asbestos assessment (as described in NEPC, 2013) was not undertaken as part of this investigation. The presence of asbestos in analysed soil samples as well as a visual assessment for the presence of ACM has been adopted for this assessment as an initial screen.

9. Field Observations and Analytical Results

9.1 Field Observations and Results

Borehole logs are provided in Appendix C and should be referred to for detailed soil descriptions and notes about this report.

At Bores 101, 102, 104, 106 and 107, brown silty clay topsoil (approximately 0.2 m thick) was observed to be underlain by red-brown or brown silty clay (to depths of up to 0.5 m).

At Bores 103 and 105, brown silty clay filling with sandstone gravel was observed to a depth of 0.4 m. Filling was underlain by brown and red-brown silty clay to depth of 0.9 m and 0.65 m, respectively.

At Bore 108, brown silty clay topsoil (possible filling) was observed to a depth of 0.3 m. This bore was discontinued at a depth of 0.3 m due to refusal on a possible tree root.

PID results were all less than 1 ppm, which indicates a low potential for volatile contaminants.

9.2 Laboratory Results

The laboratory certificate of analysis is provided in Appendix E. A summary of results compared to the SAC is shown in the following Table 5.

Table 5: Summary of Results of Soil Analysis

Sample Location (Test Bore) or Sample Identification	Sample Depth (m)	Sample Type	Metals												Polycyclic Aromatic Hydrocarbons				Petroleum Hydrocarbons											Organochlorine Pesticides										PCBs (total)	Total Phenols	Asbestos
			Arsenic	Cadmium	Chromium (III + VI)	Copper	Lead	Lead in TCLP	Lead in ASLP	Mercury	Nickel	Zinc	Zinc in TCLP	Zinc in ASLP	Benzo(a)pyrene	Benzo(a)pyrene TEQ	Naphthalene	Total PAHs	TRH C6-C10 less BTEX	TRH >C10-C16 less Naphthalene	TRH C6-C10	TRH >C10-C16	TPH >C10-C16 (Silica)	TRH >C16-C34	TPH >C16-C34 (Silica)	TRH >C34-C40	TPH >C34-C40 (Silica)	Benzene	Toluene	Ethylbenzene	Total Xylene	DDT	DDT+DDE+DDD	Aldrin + Dieldrin	Chlordane	Endosulfan (total)	Endrin	Heptachlor	HCB	Methoxychlor			
			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	-
101	0-0.15	topsoil	7	<0.4	16	12	140	-	-	0.1	9	280	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<5	NAD
101	0.4-0.5	natural	11	<0.4	24	16	24	-	-	<0.1	13	66	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
102	0-0.15	topsoil	7	<0.4	19	11	66	-	-	<0.1	11	130	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	NAD
BD1-010817	0-0.15	topsoil	6	<0.4	17	9	47	-	-	<0.1	10	89	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
103	0-0.2	filling	9	<0.4	20	23	56	-	-	<0.1	12	240	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	NAD
103	0.3-0.4	filling	5	<0.4	12	16	72	-	-	<0.1	6	170	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
104	0-0.2	topsoil	8	<0.4	15	15	550	0.07	0.069	<0.1	7	420	1.5	0.073	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	NAD
105	0-0.2	filling	6	1	14	20	200	0.05	0.025	<0.1	9	880	7.8	0.25	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	<50	580 & 130	<100	280 & 120	<100	<0.2	<0.5	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	NAD
106	0-0.2	topsoil	6	<0.4	15	8	72	-	-	<0.1	7	110	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	-	-	-	-	-	-	-	-	-	-	-	NAD
107	0-0.1	topsoil	8	<0.4	22	12	36	-	-	0.2	11	74	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	NAD
108	0-0.1	topsoil	6	<0.4	16	8	24	-	-	<0.1	8	57	-	-	<0.05	<0.5	<0.1	<0.05	<25	<50	<25	<50	-	<100	-	<100	-	<0.2	<0.5	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	NAD
Site Assessment Criteria (NEPC, 2013)																																										
Health Investigation Levels (HIL A)			100	20	100 for Cr (VI)	6000	300	-	-	40	400	7400	-	-	-	3	-	300	-	-	-	-	-	-	-	-	-	-	-	-	-	240	6	50	270	10	6	10	300	1	100*	-
Health Screening Levels for Vapour Intrusion (HSL A)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	40	230	-	-	-	-	-	-	-	0.6	390	NL	95	-	-	-	-	-	-	-	-	-	-	-
Ecological Investigation Levels (EIL - Residential)			100	-	410 for Cr (III)	180	1100	-	-	-	120	430	-	-	-	-	170	-	-	-	-	-	-	-	-	-	-	-	-	-	180	-	-	-	-	-	-	-	-	-	-	-
Ecological Screening Levels (ESL - Residential)			-	-	-	-	-	-	-	-	-	-	-	-	0.7	-	-	-	180	-	-	120	120	1300	1300	5600	5600	65	105	125	45	-	-	-	-	-	-	-	-	-	-	-
Management Limit			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	800	1000	1000	3500	3500	10000	10000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes

BD1-010817	Blind replicate of 102 / 0-0.15 m
NAD	No asbestos detected
-	Not tested / Not applicable
TEQ	Toxicity Equivalent Quotient

10. Discussion

10.1 Discussion of Analytical Results

Concentrations of arsenic, cadmium, chromium, copper, mercury and nickel were low and within the respective HIL and EIL.

Concentrations of lead were within the HIL (300 mg/kg) and EIL (1100 mg/kg) except for the sample from Bore 104, depth 0-0.2 m (550 mg/kg), which had a concentration above the HIL and less than the EIL. It is noted that a somewhat elevated lead concentration (of more than half the HIL) was recorded for the sample from Bore 105, depth 0-0.2 m (200 mg/kg). Statistical analysis (using Pro UCL 5.0) of lead concentrations in primary samples collected from surface soils (i.e. within the top 0.2 m of the soil profile) indicates that the lead concentration for the sample from Bore 104, depth 0-0.2 m, is significant with respect to the HIL given that the standard deviation (174.5 mg/kg) is more than half the HIL.

Concentrations of zinc were within the HIL (7400 mg/kg) and EIL (430 mg/kg) except for the sample from Bore 105, depth 0-0.2 m (880 mg/kg) which had a concentration above the EIL but not the HIL. It is noted that a somewhat elevated zinc concentrations (of more than half the EIL) were recorded for the samples from Bore 101, depth 0-0.15 m (280 mg/kg); Bore 103, depth 0-0.2 m (240 mg/kg); and Bore 104, depth 0-0.2 m (420 mg/kg). Statistical analysis (using Pro UCL 5.0) of zinc concentrations in primary samples collected from surface soils (i.e. within the top 0.2 m of the soil profile) indicates that the zinc concentration for the sample from Bore 105, depth 0-0.2 m, is significant with respect to the EIL given that the standard deviation (273.7 mg/kg) is more than half the EIL and the 95% Student's-t upper confidence level (457.2 mg/kg) is more than the EIL.

The most elevated recorded concentrations of lead and zinc were from surface soil samples in close proximity to the cottage (Bores 104 and 105). It is, therefore, considered likely that the lead and zinc in the surface soil at Bores 104 and 105 is sourced from the cottage building materials (such as lead-based paint and zinc roofing). Contamination from such sources is likely to be localised to the footprint and/or peripheries of the cottage. The TCLP and ASLP results for the samples with the highest lead and zinc concentrations indicate that the lead and zinc in soil has low leachability.

Concentrations of PAH were below the laboratory's limit of reporting for all analysed samples and, hence, within the respective HIL, HSL, EIL and ESL.

Concentrations of TRH C_6-C_{10}, TRH >C_{10}-C_{16} and BTEX were below the laboratory's limit of reporting for all analysed samples and, hence, within the respective HSL, ESL and Management Limits. Concentrations of TRH >C_{16}-C_{34} and TRH >C_{34}-C_{40} were below the laboratory's limit of reporting except for the sample from Bore 105, depth 0-0.2 m. All samples had concentrations of TRH >C_{16}-C_{34} and TRH >C_{34}-C_{40} within the HSL, ESL and Management Limits. Concentrations of TPH >C_{10}-C_{16}, TPH >C_{16}-C_{34} and TPH >C_{34}-C_{40} (i.e. TRH >C_{10}-C_{40} with silica gel cleanup) in the sample from Bore 105, depth 0-0.2 m, were below the laboratory's limit of reporting which suggests that the detected TRH in this sample was not associated with a petroleum product.

Concentrations of OCP, PCB and total phenols were less than the laboratory's limit of reporting and, hence, within the respective EIL and HIL.

No asbestos was detected above the reporting limit (0.1g/kg) or in trace analysis.

10.2 Recommendations

Based on the results, it should be assumed that the surface soil (i.e. topsoil of filling) in close proximity (i.e. within 2 m) of the cottage structure is contaminated with lead and zinc unless shown otherwise by further testing. It is noted that the highest recorded concentrations of zinc and lead are not more than 2.5 times the investigation or screening levels (i.e. not at 'hotspot' concentrations), and further testing (to obtain a larger dataset) and statistical analysis may determine that these concentrations are not significant. The options to address the zinc and lead impacted soil, therefore, are to:

- Conduct additional testing to better understand the significance and distribution of the lead and zinc in soil around the cottage structure, and subsequently determine if remediation is required. If remediation is required, then the extent of remediation should be able to be well defined from the additional test results; and
- Undertake remediation on the surface soils in close proximity (i.e. within 2 m) of the cottage (based on the assumption that all surface soils in close proximity to the cottage are lead and zinc contaminated). Remediation is likely to involve excavation and off-site disposal (to a licenced landfill) of the surface soils.

Remediation works should be validated by an environmental consultant (by inspection of the remediation works and validation testing). Soils designated for off-site disposal will need to be classified in accordance with NSW EPA, *Waste Classification Guidelines*, 2014.

Given the presence of observed fibre-cement pieces used as support for the timber decking, and the elevated lead concentrations in soil in close proximity to the cottage, it is recommended that a hazardous building materials survey be conducted for the demolition or refurbishment of the cottage.

As recommended in the PSI, an Unexpected Finds Protocol should be adopted for development of the site whereby, if signs of contamination are encountered (in stockpiles, filling or natural soil), an environmental consultant should be engaged to investigate and assess the potential contamination.

11. Conclusion

Targeted soil sampling at the site has revealed zinc and lead impacted surface soils in close proximity of the cottage. Based on the results, it should be assumed that the surface soil in close proximity (i.e. within 2 m) of the cottage structure is contaminated with lead and zinc unless shown otherwise by further testing.

It is recommended that either additional testing be undertaken to better understand the significance and distribution of the lead and zinc in soil around the cottage structure and subsequently determine if remediation is required; or, if additional testing is not undertaken, remediation be undertaken on the surface soils in close proximity of the cottage. Remediation works should be validated by an environmental consultant. Soils designated for off-site disposal will need to be classified in accordance with NSW EPA, *Waste Classification Guidelines*, 2014.

Based on the results and above recommendations, it is considered that the site can be made suitable (or possibly shown to be suitable through additional testing) for the proposed development from a contamination standpoint.

It is recommended that a hazardous building materials survey be conducted for the demolition or refurbishment of the cottage

12. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at Bingara Gorge Estate in accordance with DP's email's dated 27 June 2017 and 25 July 2017 and email acceptance received from Mr Rob Curlewis of Lendlease Communities (Wilton) Pty Limited dated 25 July 2017. The work was carried out under a Professional Services Agreement. This report is provided for the exclusive use of Lendlease Communities (Wilton) Pty Limited for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

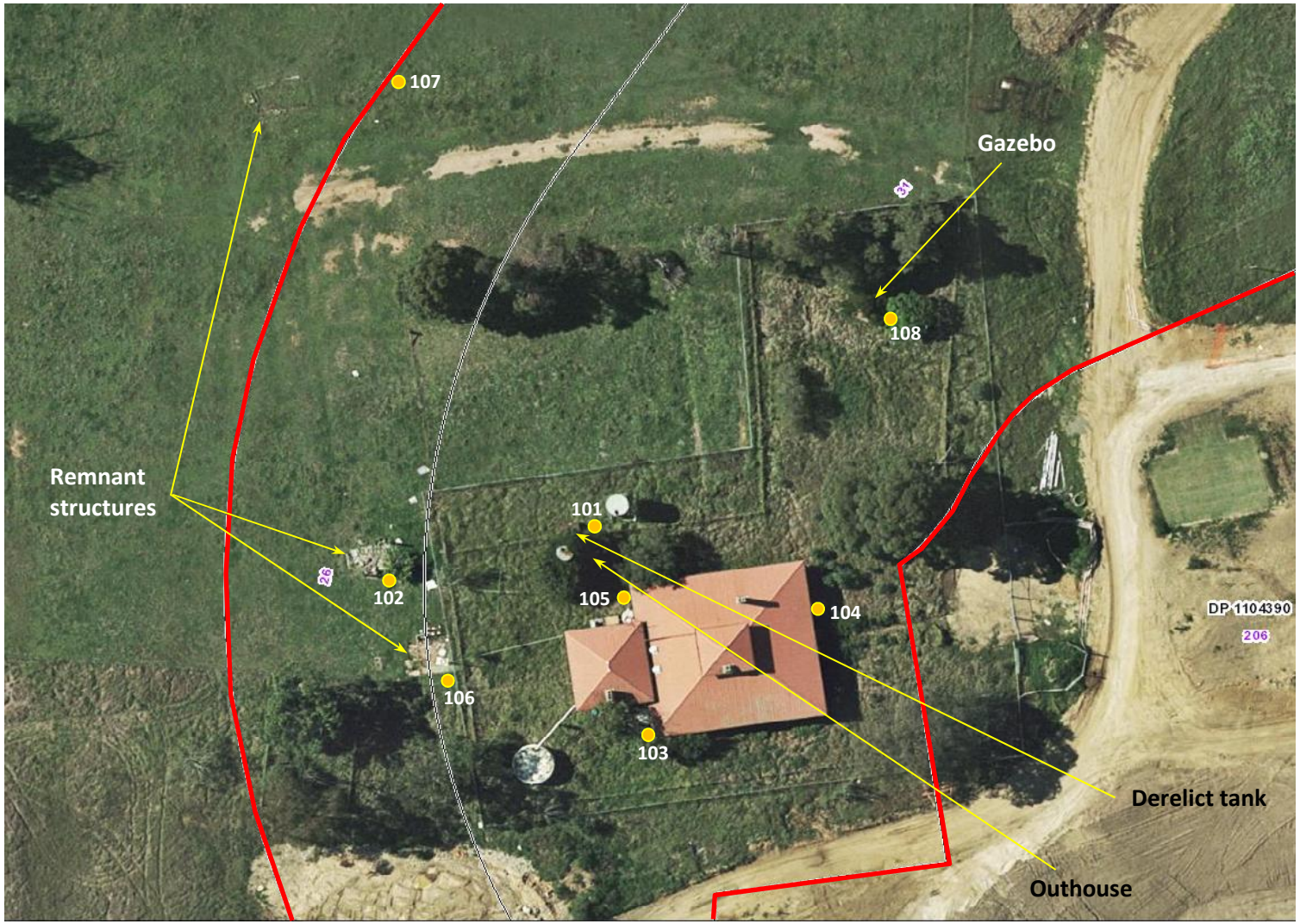
The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical /

environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

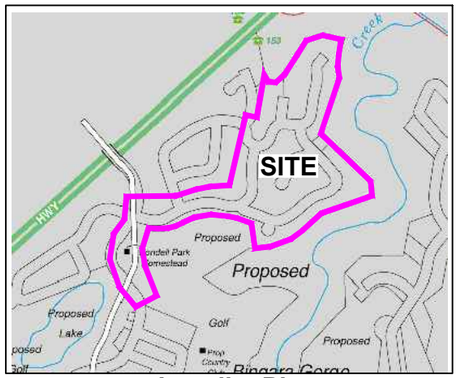
Appendix A

Drawings



Base image from SIX Maps, NSW Spatial Services

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Lendlease Communities (Wilton) Pty Limited	**Site Features and Location of Boreholes**	PROJECT No: 43677.47
	OFFICE: SYD	**Part of Fairways North, Bingara Gorge**	DWG No: A
	DATE: 23 Aug 2017	**Fairway Drive**	REVISION: 0



Locality Plan

NOTE:
1: Base drawing supplied by Cardno (NSW/ACT) Pty Ltd (Dwg. XR-NA82013043-D1-Base)
2: Test locations are approximate only and are shown with reference to existing features.

LEGEND

- Test pit location for geotechnical investigation
- Archaeological exclusion zone
- Aboriginal exclusion zone

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Lend Lease Communities (Wilton) Pty Ltd		TITLE: **Site Location** **Bingara Gorge - Fairways North** **Fairway Drive, WILTON**
OFFICE: Sydney	DRAWN BY: PSCH	
SCALE:1:4000 @ A3 approx.	DATE: 3.12.2017	

N

PROJECT No:	43677.47
DRAWING No:	8
REVISION:	0

Appendix B

Site Photographs

Photograph 1 - Derelict tank

Photograph 2 - Presumed asbestos containing fibre-cement

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Fairways North, Bingara Gorge Estate** **Fairway Drive, Wilton**	PROJECT: 43677.47 PLATE No: B1 REV: 0
	CLIENT: Lendlease Communities (Wilton) Pty Ltd	DATE: 2-Aug-17

Photograph 3 - Presumed asbestos containing fibre-cement

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Fairways North, Bingara Gorge Estate** **Fairway Drive, Wilton**	PROJECT: 43677.47 PLATE No: B2 REV: 0
	CLIENT: Lendlease Communities (Wilton) Pty Ltd	DATE: 2-Aug-17

Appendix C

Test Bore Logs

& Notes About this Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

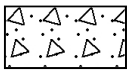
Symbols & Abbreviations

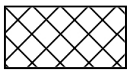
Graphic Symbols for Soil and Rock

General

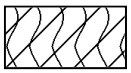

Asphalt

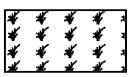

Road base

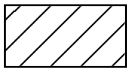

Concrete

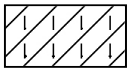

Filling

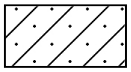
Soils


Topsoil

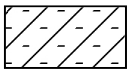

Peat

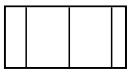

Clay

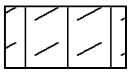

Silty clay

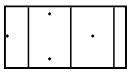

Sandy clay

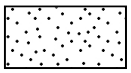

Gravelly clay

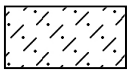

Shaly clay

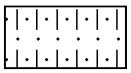

Silt


Clayey silt


Sandy silt

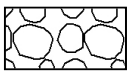

Sand

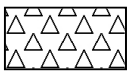

Clayey sand


Silty sand


Gravel

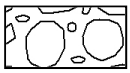

Sandy gravel


Cobbles, boulders

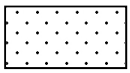

Talus

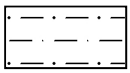
Sedimentary Rocks

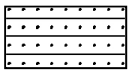

Boulder conglomerate

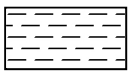

Conglomerate


Conglomeratic sandstone

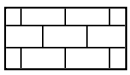

Sandstone


Siltstone

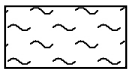

Laminite

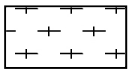

Mudstone, claystone, shale

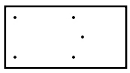

Coal


Limestone

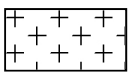
Metamorphic Rocks

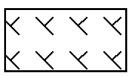

Slate, phyllite, schist

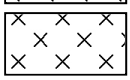

Gneiss

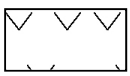

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286626
NORTHING: 6211135
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - brown silty clay topsoil with a trace of rootlets, moist		E	0.0		PID<1		
					0.15				
	0.2	SILTY CLAY - stiff to very stiff, red-brown silty clay with a trace of ironstone gravel, moist		E	0.2		PID<1		
					0.3				
				E	0.4		PID<1		
	0.5	Bore discontinued at 0.5m - target depth reached			0.5				
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286607
NORTHING: 6211128
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - brown silty clay topsoil with a trace of sandstone gravel and rootlets, damp (possible filling)		E*	0.0		PID<1		
	0.2	SILTY CLAY - stiff to very stiff, red-brown silty clay, damp		E	0.15 0.2		PID<1		
	0.5	Bore discontinued at 0.5m - target depth reached			0.4				
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: *BD1-010817 is blind replicate sample from 0.0-0.15m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286634
NORTHING: 6211108
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - brown silty clay filling with a trace of fine sand and gravel, moist			0.0				
		- trace of rootlets to 0.1m		E			PID<1		
					0.2				
		- some sandstone gravel at 0.3m to 0.4m			0.3				
				E			PID<1		
	0.4	SILTY CLAY - firm, brown mottled grey silty clay with some fine sand and a trace of organic matter and ironstone gravel, moist			0.4				
					0.5				
				E			PID<1		
					0.8				
	0.9	Bore discontinued at 0.9m - target depth reached							
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286655
NORTHING: 6211127
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - brown silty clay topsoil with a trace of fine sand and rootlets, damp		E*	0.0		PID<1		
	0.25	SILTY CLAY - very stiff, brown and red-brown silty clay, damp			0.2				
				E	0.3		PID<1		
	0.5	Bore discontinued at 0.5m - target depth reached			0.5				
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS: *BD2-010817 is blind replicate sample from 0.0-0.2m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286632
NORTHING: 6211125
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - brown silty clay filling with a trace of sand, sandstone gravel and rootlets, moist		E	0.0		PID<1		
					0.2				
	0.4	SILTY CLAY - stiff to very stiff, red-brown silty clay with a trace of ironstone gravel, moist		E	0.4		PID<1		
					0.6				
	0.65	Bore discontinued at 0.65m - refusal in very stiff silty clay							
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286613
NORTHING: 6211116
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - brown silty clay topsoil with a trace of rootlets, damp		E	0.0		PID<1		
	0.2	SILTY CLAY - very stiff, brown silty clay with a trace of fine sand and ironstone gravel, humid		E	0.2 0.3		PID<1		
	0.35	Bore discontinued at 0.35m - refusal in very stiff silty clay							
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286606
NORTHING: 6211185
DIP/AZIMUTH: 90°/--

BORE No: 107
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - brown silty clay topsoil with a trace of rootlets, damp		E	0.0		PID<1		
	0.15	SILTY CLAY - stiff to very stiff, brown silty clay, moist - trace of carbonaceous material from 0.15m to 0.25m			0.1				
				E	0.3		PID<1		
	0.5	Bore discontinued at 0.5m - target depth reached			0.4				
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Lend Lease Communities (Wilton) Pty Ltd
PROJECT: Bingara Gorge, Fairways North
LOCATION: Pembroke Parade, Wilton

SURFACE LEVEL: --
EASTING: 286658
NORTHING: 6211159
DIP/AZIMUTH: 90°/--

BORE No: 108
PROJECT No: 43677.47
DATE: 1/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL - brown silty clay topsoil with a trace of fine sand, gravel and rootlets, damp (possible filling)		E	0.0 0.1		PID<1		
	0.3	Bore discontinued at 0.3m - refusal on possible tree root							
	1								1

RIG: Hand tools **DRILLER:** DW **LOGGED:** DW **CASING:** Uncased
TYPE OF BORING: Hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix D

QA/QC Report

QA/QC PROCEDURES AND RESULTS

Q1. DATA QUALITY OBJECTIVES

The Preliminary Site Investigation has been devised broadly in accordance with the seven step data quality objective (DQO) process which is provided in Appendix B, Schedule B2 of the National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended 2013 (NEPC 2013). The DQO process is outlined as follows:

- Stating the Problem;
- Identifying the Decision;
- Identifying Inputs to the Decision;
- Defining the Boundary of the Assessment;
- Developing a Decision Rule;
- Specifying Acceptable Limits on Decision Errors; and
- Optimising the Design for Obtaining Data.

The DQOs have been addressed within the report as shown in Table Q1.

Table Q1: Data Quality Objectives

Data Quality Objective	Report Section Where Addressed
State the Problem	S1 Introduction
Identify the Decision	S10 Discussion of Results S11 Conclusion
Identify Inputs to the Decision	S1 Introduction S3 Site Identification and Description S5 Site History Summary S6 Potential Contamination Sources and Preliminary Conceptual Site Model S8 Site Assessment Criteria S9 Fieldwork Observation and Analytical Results
Define the Boundary of the Assessment	S3 Site Identification and Description
Develop a Decision Rule	S8 Site Assessment Criteria
Specify Acceptable Limits on Decision Errors	S7 Fieldwork, Analysis and QA/QC
Optimise the Design for Obtaining Data	S2 Scope of Works S7 Fieldwork, Analysis and QA/QC

Q2. FIELD QUALITY ASSURANCE AND QUALITY CONTROL

The field QC procedures for sampling as prescribed in Douglas Partners' *Field Procedures Manual* were followed at all times during the assessment.

Q2.1 Sampling Team

Field sampling was undertaken by a DP Environmental Engineer, David Walker. Sampling was undertaken on 1 August 2018. Sampling was undertaken during cool to warm and mostly sunny weather conditions.

Q2.2 Sample Collection

Soil samples were collected from hand auger returns using disposal nitrile gloves between collection of each sample. Further details of the sampling methodology is presented in Section 7 of the report.

Q2.3 Logs

Logs for each soil sampling location were recorded in the field. The individual samples were recorded on the field logs along with the sample identity, location, depth, initials of sampler and replicate locations.

Q2.4 Chain of Custody

Chain of custody information was recorded on the Chain-of-Custody (COC) sheets and accompanied samples to the analytical laboratory.

Q2.5 Replicate Samples

Replicate samples were collected in the field as a measure of accuracy, precision and repeatability of the results.

Field replicate samples for soil were collected from the same location and an identical depth to the primary sample. Equal portions of the primary sample were placed into the sampling jars and sealed. The sample was split to prevent the loss of volatiles from the soil but not homogenised in a bowl. Replicate samples were labelled with a DP identification number, recorded on DP's test bore logs, so as to conceal their relationship to their primary sample from the analytical laboratory.

A measure of the consistency of results for field samples is derived by the calculation of relative percentage differences (RPDs) for replicate samples. A RPD of 30% is generally considered typically acceptable for inorganic analytes by NSW EPA, although in general a wider RPD range (50%) may be

acceptable for organic analytes. RPDs have only been considered where a concentration is greater than five times the PQL.

Replicate samples were collected at a rate of at least one replicate sample for every ten original samples collected.

An intra-laboratory replicate was analysed as an internal check of the reproducibility within the primary laboratory (Envirolab Pty Ltd) and as a measure of consistency of sampling techniques.

The comparative results of analysis between original and replicate sample is summarised in Table Q2.

Table Q2: Intra-laboratory Results

Analyte	Primary Sample [102 / 0-0.15 m] Concentration (mg/kg)	Replicate Sample [BD1-010817] Concentration (mg/kg)	Difference (mg/kg)	RPD (%)
Arsenic	7	6	1	15
Cadmium	<0.4	<0.4	0	0
Chromium	19	17	2	11
Copper	11	9	2	20
Lead	66	47	19	**34**
Mercury	<0.1	<0.1	0	0
Nickel	11	10	1	10
Zinc	130	89	41	**37**
Total PAH	<0.05	<0.05	0	0
TRH C_6-C_{10}	<25	<25	0	0
TRH >C_{10}-C_{16}	<50	<50	0	0
TRH >C_{16}-C_{34}	<100	<100	0	0
TRH >C_{34}-C_{40}	<100	<100	0	0
Benzene	<0.2	<0.2	0	0
Toluene	<0.5	<0.5	0	0
Ethlybenzene	<1	<1	0	0
Total Xylene	<1	<1	0	0

The calculated RPD values were within the acceptable range except for those shown in bold. The results in bold are not of concern given that the RPD results were marginally outside the acceptable range and the actual differences in concentrations is low. Overall, the intra-laboratory comparisons

indicate that the sampling technique was consistent and repeatable and therefore the results are useable and representative of the conditions encountered.

Q2.6 Field Instrument Calibration

The photoionisation detector (PID) was calibrated prior to fieldwork using with isobutylene gas.

Q3. LABORATORY QUALITY ASSURANCE AND QUALITY CONTROL

Q3.1 Holding Times

A review of the laboratory certificates of analysis and chain-of-custody documentation indicated that holding times were met as summarised in Table Q3.

Table Q3: Holding Times for Soil Samples

Analyte	Recommended holding time	Holding time met
Metals	6 months	Yes
TRH C_6-C_9	14 days	Yes
TRH C_{10}-C_{36}	14 days	Yes
BTEX	14 days	Yes
PAH	14 days	Yes
OCP	14 days	Yes
PCB	14 days	Yes
pH	7 days	Yes
CEC	28 days	Yes

Q3.2 Analytical Laboratories

Samples were submitted to Envirolab Pty Ltd which is NATA accredited for the analysis undertaken.

Q3.3 Analytical Methods

The laboratory analytical methods are provided on the laboratory certificates of analysis.

Q3.4 Results of Laboratory QA/QC Procedures

The following QA/QC procedures were conducted by the laboratories. The results are included in the laboratory certificates of analysis.

Q3.4.1 Surrogate Spike

This sample is prepared by adding a known amount of surrogate, which behaves similarly to the analyte, prior to analysis of each sample. The recovery result indicates the proportion of the known concentration of the surrogate that is detected during analysis. These results are within acceptance limits as specified by the laboratories indicating that the extraction technique was effective.

Q3.4.2 Practical Quantitation Limits (PQL)

The PQL is the lowest quantity of an analyte which can be measured with a high degree of confidence that the analyte is present at or above that concentration. PQL at different analytical laboratories can differ based on the analytical techniques.

Q3.4.3 Reference and Daily Check Sample Results – Laboratory Control Sample (LCS)

This sample comprises spiking either a standard reference material or a control matrix (such as a blank of sand or water) with a known concentration of specific analytes. The LCS is then analysed and the results are compared against each other to determine how the laboratory has performed with regard to sample preparation and analytical procedure. LCS are analysed at a frequency of 1 in 20, with a minimum of one analysed per batch. The laboratory QC for LCS was within the acceptance standards.

Q3.4.4 Laboratory Replicate Results

These are additional portions of a sample which are analysed in exactly the same manner as all other samples. The laboratory acceptance criteria for replicate samples is: in cases where the level is <5xPQL – any RPD is acceptable; and in cases where the level is >5xPQL – a 30% or 50% RPD is acceptable depending on the analyte. RPDs were within the acceptance standards.

Q3.4.5 Laboratory Blank Results

The laboratory blank, sometimes referred to as the method blank or reagent blank is the sample prepared and analysed at the beginning of every analytical run, following calibration of the analytical apparatus. This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, it can be determined by processing solvents and reagents in exactly the same manner as for samples. Laboratory blanks are typically analysed at a frequency of 1 in 20, with a minimum of one per batch. The laboratory QC for method blanks was within the acceptance standards.

Q3.4.6 Matrix Spike

This is a sample replicate prepared by adding a known amount of analyte prior to analysis, and then treated exactly the same as all other samples. The recovery result indicates the proportion of the known concentration of the analyte that is detected during analysis. The laboratory acceptance criteria for matrix spike samples is generally 70-130% for inorganic/metals and 60-140% for organics. Recorded matrix spike results were within the acceptance standards.

Q3.4.7 Overall Laboratory QA/QC

It is considered that an acceptable level of laboratory precision and consistency was achieved and that surrogate spikes, LCS, laboratory replicate results, method blanks and matrix spike results were of an

acceptable level overall. On the basis of this assessment, the laboratory data sets are considered to be reliable and useable for this assessment.

Q4. QA/QC DATA EVALUATION

Field and laboratory procedures were assessed against the following data quality indicators (DQIs):

- Completeness – a measure of the amount of usable data from a data collection activity;
- Comparability – the confidence (qualitative) that data may be considered to be equivalent for each sampling and analytical event;
- Representativeness – the confidence (qualitative) of data representativeness of media present on-site;
- Precision – a measure of variability or reproducibility of data; and
- Accuracy – a measure of closeness of the data to the 'true' value.

The DQIs were assessed as outlined in Table Q4.

Table Q4: DQI Assessment

DQI	Considerations as specified in NEPM Schedule B2	Comment
Completeness		
Field Considerations	All critical locations sampled	All critical locations sampled in accordance with the proposal and PSI.
	All samples collected.	The sampling density is considered appropriate for a targeted investigation.
	Standard operating practices (SOPs) appropriate and complied with	Field staff followed SOPs as defined in the DP *Field Procedures Manual.*
	Experienced sampler	DP environmental engineer with more than 8 years experience undertook the sampling.
	Documentation correct	Field staff followed SOPs as defined in the DP *Field Procedures Manual.* Documentation reviewed and signed off by project reviewer.
Laboratory	All critical samples analysed according	All critical samples analysed

DQI	Considerations as specified in NEPM Schedule B2	Comment
Considerations	to the proposal and PSI.	according to the proposal and site information
	All analytes analysed according to proposal	All analytes analysed according to the proposal. Any variation has been recorded in the report.
	Appropriate methods and PQLs/LOR	NATA approved methods have been adopted. Limits of reporting (LORs) and practical quantitation limits (PQLs) in accordance with the method have been used by the contract laboratory.
	Sample Documentation complete	Chain-of-custody (CoC) maintained and appended to the Certificates of Analysis. All Certificates of Analysis are complete and appended to the report.
	Sample holding times complied with	Sample holding times complied with the NATA accredited Laboratory.
Comparability		
Field Considerations	Same SOPs used on each occasion	Field staff followed SOPs sampling as defined in the DP *Field Procedures Manual*
	Experienced sampler	DP environmental engineer with more than 8 years experience undertook the sampling.
	Climatic conditions	Field staff recorded the climatic conditions at the time of sampling
	Same types of samples collected	Field staff followed SOPs as defined in the DP *Field Procedures Manual* and sampling regime defined in the proposal.

DQI	Considerations as specified in NEPM Schedule B2	Comment
Laboratory Considerations	Sample analytical methods used	Laboratories used are accredited by NATA for the analyses undertaken. Laboratory methods are as stated on the Certificates of Analysis
	Sample PQLs / LORs	PQL or LOR set by the laboratories are below the adopted site criteria or indicate across-the-board lack of detection.
	Same laboratories	Envirolab Pty Ltd was used for all sample analysis.
	Same units	All laboratory results are expressed in consistent units for each media type.
Representativeness		
Field Considerations	Appropriate media sampled according to the proposal	Appropriate media were sampled in accordance with the proposal
	All media identified in proposal sampled	All media identified in proposal were sampled.
Laboratory Considerations	All samples analysed according to the proposal	All samples analysed according to proposal
Precision		
Field Considerations	SOPs appropriate and complied with	Field staff followed SOPs as defined in the DP *Field Procedures Manual*
Laboratory Considerations	Analysis of: 1) intra-laboratory replicates 2) field duplicates	Laboratory acceptance limits are: 1) Average relative percentage difference (RPD) result <5 times PQL/LOR, no limit; results >5 times PQL/LOR, 30% or 50% depending on analyte 2) Average relative percentage difference (RPD) result <5 times PQL/LOR, no limit; results >5 times PQL/LOR, 30% or 50% depending on analyte

DQI	Considerations as specified in NEPM Schedule B2	Comment
Accuracy (bias)		
Field Considerations	SOPs Appropriate and complied with	Field staff to follow SOPs as defined in the DP *Field Procedures Manual*
Laboratory Considerations	Analysis of: 1) field blanks 2) reagent blank/method blank 3) matrix spike 4) surrogate spike 5) reference material 6) laboratory control sample	Laboratory acceptance limits are 1) Concentrations of analytes are <PQL/LOR 2) Results are within acceptance limits as specified by the laboratory *(recovery usually within 60-140%).* 3) Results are within acceptance limits as specified by the laboratory *(recovery within 70-130% for inorganics and 60-140% for organics).* 4) Results are within acceptance limits as specified by the laboratory (recovery within 70-130% for inorganics and 60-140% for organics). 5) Analysis within the acceptable limits of the Certificate of Analysis for the reference material. These results are generally not contained in the Certificate of Analysis. 6) Results are within acceptance limits as specified by the laboratory (recovery within 70-130% for inorganics and 60-140% for organics).

Appendix E

Laboratory Certificates

& Chain of Custody

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 172580

Client Details

Client	Douglas Partners Pty Ltd
Attention	David Walker
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**43677.47, Bingara Gorge, Fairways North**
Number of Samples	11 soils
Date samples received	02/08/2017
Date completed instructions received	02/08/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	09/08/2017
Date of Issue	08/08/2017

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lucy Zhu
Authorised by Asbestos Approved Signatory: Lulu Scott

Results Approved By
Jeremy Faircloth, Organics Supervisor
Long Pham, Team Leader, Metals
Lulu Scott, Asbestos Supervisor
Nick Sarlamis, Inorganics Supervisor
Steven Luong, Chemist

Authorised By

David Springer, General Manager

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		172580-1	172580-2	172580-3	172580-4	172580-5
Your Reference	UNITS	101	101	102	103	103
Depth		0-0.15	0.4-0.5	0-0.15	0-0.2	0.3-0.4
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	107	124	128	122	123

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		172580-6	172580-7	172580-8	172580-9	172580-10
Your Reference	UNITS	104	105	106	107	108
Depth		0-0.2	0-0.2	0-0.2	0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	127	115	126	112	123

vTRH(C6-C10)/BTEXN in Soil		
Our Reference		172580-11
Your Reference	UNITS	BD1-010817
Depth		-
Date Sampled		01/08/2017
Type of sample		Soil
Date extracted	-	03/08/2017
Date analysed	-	04/08/2017
TRH C_6 - C_9	mg/kg	<25
TRH C_6 - C_{10}	mg/kg	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25
Benzene	mg/kg	<0.2
Toluene	mg/kg	<0.5
Ethylbenzene	mg/kg	<1
m+p-xylene	mg/kg	<2
o-Xylene	mg/kg	<1
Total +ve Xylenes	mg/kg	<1
naphthalene	mg/kg	<1
Surrogate aaa-Trifluorotoluene	%	131

svTRH (C10-C40) in Soil						
Our Reference		172580-1	172580-2	172580-3	172580-4	172580-5
Your Reference	UNITS	101	101	102	103	103
Depth		0-0.15	0.4-0.5	0-0.15	0-0.2	0.3-0.4
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100	<100	<100	<100
TRH C_{29} - C_{36}	mg/kg	<100	<100	<100	<100	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	<100	<100	<100	<100
TRH >C_{34} -C_{40}	mg/kg	<100	<100	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50	<50	<50
Surrogate o-Terphenyl	%	93	91	93	91	93

svTRH (C10-C40) in Soil						
Our Reference		172580-6	172580-7	172580-8	172580-9	172580-10
Your Reference	UNITS	104	105	106	107	108
Depth		0-0.2	0-0.2	0-0.2	0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	240	<100	<100	<100
TRH C_{29} - C_{36}	mg/kg	<100	450	<100	<100	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	580	<100	<100	<100
TRH >C_{34} -C_{40}	mg/kg	<100	280	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	850	<50	<50	<50
Surrogate o-Terphenyl	%	88	92	89	88	86

svTRH (C10-C40) in Soil		
Our Reference		172580-11
Your Reference	UNITS	BD1-010817
Depth		-
Date Sampled		01/08/2017
Type of sample		Soil
Date extracted	-	03/08/2017
Date analysed	-	04/08/2017
TRH C_{10} - C_{14}	mg/kg	<50
TRH C_{15} - C_{28}	mg/kg	<100
TRH C_{29} - C_{36}	mg/kg	<100
TRH >C_{10} -C_{16}	mg/kg	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50
TRH >C_{16} -C_{34}	mg/kg	<100
TRH >C_{34} -C_{40}	mg/kg	<100
Total +ve TRH (>C10-C40)	mg/kg	<50
Surrogate o-Terphenyl	%	83

PAHs in Soil						
Our Reference		172580-1	172580-2	172580-3	172580-4	172580-5
Your Reference	UNITS	101	101	102	103	103
Depth		0-0.15	0.4-0.5	0-0.15	0-0.2	0.3-0.4
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Total +ve PAH's	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Surrogate p-Terphenyl-d14	%	95	112	110	113	103

PAHs in Soil						
Our Reference		172580-6	172580-7	172580-8	172580-9	172580-10
Your Reference	UNITS	104	105	106	107	108
Depth		0-0.2	0-0.2	0-0.2	0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Total +ve PAH's	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Surrogate p-Terphenyl-d14	%	109	108	108	102	105

PAHs in Soil		
Our Reference		172580-11
Your Reference	UNITS	BD1-010817
Depth		-
Date Sampled		01/08/2017
Type of sample		Soil
Date extracted	-	03/08/2017
Date analysed	-	04/08/2017
Naphthalene	mg/kg	<0.1
Acenaphthylene	mg/kg	<0.1
Acenaphthene	mg/kg	<0.1
Fluorene	mg/kg	<0.1
Phenanthrene	mg/kg	<0.1
Anthracene	mg/kg	<0.1
Fluoranthene	mg/kg	<0.1
Pyrene	mg/kg	<0.1
Benzo(a)anthracene	mg/kg	<0.1
Chrysene	mg/kg	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2
Benzo(a)pyrene	mg/kg	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5
Total +ve PAH's	mg/kg	<0.05
Surrogate p-Terphenyl-d14	%	108

Organochlorine Pesticides in soil						
Our Reference		172580-1	172580-3	172580-4	172580-6	172580-7
Your Reference	UNITS	101	102	103	104	105
Depth		0-0.15	0-0.15	0-0.2	0-0.2	0-0.2
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	93	92	94	95	95

Organochlorine Pesticides in soil			
Our Reference		172580-9	172580-10
Your Reference	UNITS	107	108
Depth		0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017
Type of sample		Soil	Soil
Date extracted	-	03/08/2017	03/08/2017
Date analysed	-	03/08/2017	03/08/2017
HCB	mg/kg	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1
Surrogate TCMX	%	95	93

PCBs in Soil						
Our Reference		172580-1	172580-3	172580-4	172580-6	172580-7
Your Reference	UNITS	101	102	103	104	105
Depth		0-0.15	0-0.15	0-0.2	0-0.2	0-0.2
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Aroclor 1016	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCLMX	%	93	92	94	95	95

PCBs in Soil			
Our Reference		172580-9	172580-10
Your Reference	UNITS	107	108
Depth		0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017
Type of sample		Soil	Soil
Date extracted	-	03/08/2017	03/08/2017
Date analysed	-	03/08/2017	03/08/2017
Aroclor 1016	mg/kg	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1
Surrogate TCLMX	%	95	93

Acid Extractable metals in soil						
Our Reference		172580-1	172580-2	172580-3	172580-4	172580-5
Your Reference	UNITS	101	101	102	103	103
Depth		0-0.15	0.4-0.5	0-0.15	0-0.2	0.3-0.4
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Arsenic	mg/kg	7	11	7	9	5
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	16	24	19	20	12
Copper	mg/kg	12	16	11	23	16
Lead	mg/kg	140	24	66	56	72
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	9	13	11	12	6
Zinc	mg/kg	280	66	130	240	170

Acid Extractable metals in soil						
Our Reference		172580-6	172580-7	172580-8	172580-9	172580-10
Your Reference	UNITS	104	105	106	107	108
Depth		0-0.2	0-0.2	0-0.2	0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Arsenic	mg/kg	8	6	6	8	6
Cadmium	mg/kg	<0.4	1	<0.4	<0.4	<0.4
Chromium	mg/kg	15	14	15	22	16
Copper	mg/kg	15	20	8	12	8
Lead	mg/kg	550	200	72	36	24
Mercury	mg/kg	<0.1	<0.1	<0.1	0.2	<0.1
Nickel	mg/kg	7	9	7	11	8
Zinc	mg/kg	420	880	110	74	57

Acid Extractable metals in soil		
Our Reference		172580-11
Your Reference	UNITS	BD1-010817
Depth		-
Date Sampled		01/08/2017
Type of sample		Soil
Date prepared	-	03/08/2017
Date analysed	-	03/08/2017
Arsenic	mg/kg	6
Cadmium	mg/kg	<0.4
Chromium	mg/kg	17
Copper	mg/kg	9
Lead	mg/kg	47
Mercury	mg/kg	<0.1
Nickel	mg/kg	10
Zinc	mg/kg	89

Misc Soil - Inorg		
Our Reference		172580-1
Your Reference	UNITS	101
Depth		0-0.15
Date Sampled		01/08/2017
Type of sample		Soil
Date prepared	-	03/08/2017
Date analysed	-	03/08/2017
Total Phenolics (as Phenol)	mg/kg	<5

Misc Inorg - Soil			
Our Reference		172580-6	172580-7
Your Reference	UNITS	104	105
Depth		0-0.2	0-0.2
Date Sampled		01/08/2017	01/08/2017
Type of sample		Soil	Soil
Date prepared	-	04/08/2017	04/08/2017
Date analysed	-	04/08/2017	04/08/2017
pH 1:5 soil:water	pH Units	7.2	6.5

Moisture						
Our Reference		172580-1	172580-2	172580-3	172580-4	172580-5
Your Reference	UNITS	101	101	102	103	103
Depth		0-0.15	0.4-0.5	0-0.15	0-0.2	0.3-0.4
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
Moisture	%	18	18	17	18	16

Moisture						
Our Reference		172580-6	172580-7	172580-8	172580-9	172580-10
Your Reference	UNITS	104	105	106	107	108
Depth		0-0.2	0-0.2	0-0.2	0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	03/08/2017	03/08/2017	03/08/2017	03/08/2017	03/08/2017
Date analysed	-	04/08/2017	04/08/2017	04/08/2017	04/08/2017	04/08/2017
Moisture	%	13	15	19	20	12

Moisture		
Our Reference		172580-11
Your Reference	UNITS	BD1-010817
Depth		-
Date Sampled		01/08/2017
Type of sample		Soil
Date prepared	-	03/08/2017
Date analysed	-	04/08/2017
Moisture	%	8.5

Asbestos ID - soils						
Our Reference		172580-1	172580-3	172580-4	172580-6	172580-7
Your Reference	UNITS	101	102	103	104	105
Depth		0-0.15	0-0.15	0-0.2	0-0.2	0-0.2
Date Sampled		01/08/2017	01/08/2017	01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date analysed	-	07/08/2017	07/08/2017	07/08/2017	07/08/2017	07/08/2017
Sample mass tested	g	Approx. 35g	Approx. 25g	Approx. 35g	Approx. 25g	Approx. 35g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected

Asbestos ID - soils				
Our Reference		172580-8	172580-9	172580-10
Your Reference	UNITS	106	107	108
Depth		0-0.2	0-0.1	0-0.1
Date Sampled		01/08/2017	01/08/2017	01/08/2017
Type of sample		Soil	Soil	Soil
Date analysed	-	07/08/2017	07/08/2017	07/08/2017
Sample mass tested	g	Approx. 30g	Approx. 25g	Approx. 25g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected

CEC			
Our Reference		172580-6	172580-7
Your Reference	UNITS	104	105
Depth		0-0.2	0-0.2
Date Sampled		01/08/2017	01/08/2017
Type of sample		Soil	Soil
Date prepared	-	04/08/2017	04/08/2017
Date analysed	-	04/08/2017	04/08/2017
Exchangeable Ca	meq/100g	9.8	4.4
Exchangeable K	meq/100g	0.1	<0.1
Exchangeable Mg	meq/100g	1.5	0.57
Exchangeable Na	meq/100g	<0.1	<0.1
Cation Exchange Capacity	meq/100g	12	5.1

Method ID	Methodology Summary
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Inorg-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Metals-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'EQ PQL'values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'EQ zero'values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'EQ half PQL'values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Date analysed	-			04/08/2017	1	04/08/2017	04/08/2017		04/08/2017	[NT]
TRH C_6 - C_9	mg/kg	25	Org-016	<25	1	<25	<25	0	118	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	1	<25	<25	0	118	[NT]
Benzene	mg/kg	0.2	Org-016	<0.2	1	<0.2	<0.2	0	118	[NT]
Toluene	mg/kg	0.5	Org-016	<0.5	1	<0.5	<0.5	0	118	[NT]
Ethylbenzene	mg/kg	1	Org-016	<1	1	<1	<1	0	117	[NT]
m+p-xylene	mg/kg	2	Org-016	<2	1	<2	<2	0	119	[NT]
o-Xylene	mg/kg	1	Org-016	<1	1	<1	<1	0	118	[NT]
naphthalene	mg/kg	1	Org-014	<1	1	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	120	1	107	119	11	127	[NT]

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	8	03/08/2017	03/08/2017		[NT]	[NT]
Date analysed	-			[NT]	8	04/08/2017	04/08/2017		[NT]	[NT]
TRH C_6 - C_9	mg/kg	25	Org-016	[NT]	8	<25	<25	0	[NT]	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-016	[NT]	8	<25	<25	0	[NT]	[NT]
Benzene	mg/kg	0.2	Org-016	[NT]	8	<0.2	<0.2	0	[NT]	[NT]
Toluene	mg/kg	0.5	Org-016	[NT]	8	<0.5	<0.5	0	[NT]	[NT]
Ethylbenzene	mg/kg	1	Org-016	[NT]	8	<1	<1	0	[NT]	[NT]
m+p-xylene	mg/kg	2	Org-016	[NT]	8	<2	<2	0	[NT]	[NT]
o-Xylene	mg/kg	1	Org-016	[NT]	8	<1	<1	0	[NT]	[NT]
naphthalene	mg/kg	1	Org-014	[NT]	8	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	[NT]	8	126	126	0	[NT]	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date extracted	-			04/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Date analysed	-			04/08/2017	1	04/08/2017	04/08/2017		04/08/2017	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	1	<50	<50	0	111	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	1	<100	<100	0	105	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	1	<100	<100	0	106	[NT]
TRH >C_{10} -C_{16}	mg/kg	50	Org-003	<50	1	<50	<50	0	111	[NT]
TRH >C_{16} -C_{34}	mg/kg	100	Org-003	<100	1	<100	<100	0	105	[NT]
TRH >C_{34} -C_{40}	mg/kg	100	Org-003	<100	1	<100	<100	0	106	[NT]
Surrogate o-Terphenyl	%		Org-003	91	1	93	99	6	96	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	8	03/08/2017	03/08/2017		[NT]	[NT]
Date analysed	-			[NT]	8	04/08/2017	04/08/2017		[NT]	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	[NT]	8	<50	<50	0	[NT]	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	[NT]	8	<100	<100	0	[NT]	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	[NT]	8	<100	<100	0	[NT]	[NT]
TRH >C_{10} -C_{16}	mg/kg	50	Org-003	[NT]	8	<50	<50	0	[NT]	[NT]
TRH >C_{16} -C_{34}	mg/kg	100	Org-003	[NT]	8	<100	<100	0	[NT]	[NT]
TRH >C_{34} -C_{40}	mg/kg	100	Org-003	[NT]	8	<100	<100	0	[NT]	[NT]
Surrogate o-Terphenyl	%		Org-003	[NT]	8	89	89	0	[NT]	[NT]

QUALITY CONTROL: PAHs in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date extracted	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Date analysed	-			04/08/2017	1	04/08/2017	04/08/2017		04/08/2017	[NT]
Naphthalene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	94	[NT]
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	109	[NT]
Phenanthrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	108	[NT]
Anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	103	[NT]
Pyrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	104	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	104	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	1	<0.05	<0.05	0	88	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	117	1	95	120	23	93	[NT]

QUALITY CONTROL: PAHs in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	8	03/08/2017	03/08/2017		[NT]	[NT]
Date analysed	-			[NT]	8	04/08/2017	04/08/2017		[NT]	[NT]
Naphthalene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Acenaphthylene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Phenanthrene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Anthracene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Pyrene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	[NT]	8	<0.2	<0.2	0	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	[NT]	8	<0.05	<0.05	0	[NT]	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	[NT]	8	108	109	1	[NT]	[NT]

QUALITY CONTROL: Organochlorine Pesticides in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date extracted	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Date analysed	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
HCB	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	85	[NT]
gamma-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	97	[NT]
Heptachlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	94	[NT]
delta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	95	[NT]
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	90	[NT]
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	96	[NT]
Dieldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	99	[NT]
Endrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	90	[NT]
pp-DDD	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	96	[NT]
Endosulfan II	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	95	[NT]
Methoxychlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-005	95	1	93	94	1	110	[NT]

QUALITY CONTROL: PCBs in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date extracted	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Date analysed	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	104	[NT]
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCLMX	%		Org-006	95	1	93	94	1	90	[NT]

QUALITY CONTROL: Acid Extractable metals in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date prepared	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Date analysed	-			03/08/2017	1	03/08/2017	03/08/2017		03/08/2017	[NT]
Arsenic	mg/kg	4	Metals-020	<4	1	7	7	0	104	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	1	<0.4	<0.4	0	99	[NT]
Chromium	mg/kg	1	Metals-020	<1	1	16	15	6	105	[NT]
Copper	mg/kg	1	Metals-020	<1	1	12	12	0	102	[NT]
Lead	mg/kg	1	Metals-020	<1	1	140	150	7	97	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	1	0.1	0.1	0	106	[NT]
Nickel	mg/kg	1	Metals-020	<1	1	9	8	12	99	[NT]
Zinc	mg/kg	1	Metals-020	<1	1	280	290	4	102	[NT]

QUALITY CONTROL: Acid Extractable metals in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	8	03/08/2017	03/08/2017		[NT]	[NT]
Date analysed	-			[NT]	8	03/08/2017	03/08/2017		[NT]	[NT]
Arsenic	mg/kg	4	Metals-020	[NT]	8	6	6	0	[NT]	[NT]
Cadmium	mg/kg	0.4	Metals-020	[NT]	8	<0.4	<0.4	0	[NT]	[NT]
Chromium	mg/kg	1	Metals-020	[NT]	8	15	16	6	[NT]	[NT]
Copper	mg/kg	1	Metals-020	[NT]	8	8	8	0	[NT]	[NT]
Lead	mg/kg	1	Metals-020	[NT]	8	72	77	7	[NT]	[NT]
Mercury	mg/kg	0.1	Metals-021	[NT]	8	<0.1	<0.1	0	[NT]	[NT]
Nickel	mg/kg	1	Metals-020	[NT]	8	7	8	13	[NT]	[NT]
Zinc	mg/kg	1	Metals-020	[NT]	8	110	130	17	[NT]	[NT]

QUALITY CONTROL: Misc Soil - Inorg						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date prepared	-			03/08/2017	[NT]	[NT]	[NT]	[NT]	03/08/2017	[NT]
Date analysed	-			03/08/2017	[NT]	[NT]	[NT]	[NT]	03/08/2017	[NT]
Total Phenolics (as Phenol)	mg/kg	5	Inorg-031	<5	[NT]	[NT]	[NT]	[NT]	101	[NT]

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date prepared	-			04/08/2017	[NT]	[NT]	[NT]	[NT]	04/08/2017	[NT]
Date analysed	-			04/08/2017	[NT]	[NT]	[NT]	[NT]	04/08/2017	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]

QUALITY CONTROL: CEC						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-3	[NT]
Date prepared	-			04/08/2017	6	04/08/2017	04/08/2017		04/08/2017	[NT]
Date analysed	-			04/08/2017	6	04/08/2017	04/08/2017		04/08/2017	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	6	9.8	10	2	99	[NT]
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	6	0.1	0.1	0	113	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	6	1.5	1.5	0	98	[NT]
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	6	<0.1	<0.1	0	121	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No: 43677.47	**Suburb:** Wilton	**To:**	Envirolab Services
Project Name: Bingara Gorge, Fairways North	**Order Number**		12 Ashley Street, Chatswood NSW 2067
Project Manager: R. Blinman / D. Walker	**Sampler:** D. Walker	**Attn:**	Aileen
Emails: david.walker@douglaspartners.com.au		**Phone:**	02 9910 6200
Date Required: Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ☑		**Email:**	sydney@envirolab.com.au
Prior Storage: ☐ Esky ☑ Fridge ☐ Shelved	Do samples contain 'potential' HBM? Yes ☐ No ☑ (If YES, then handle, transport and store in accordance with FPM HAZID)		

	Sample ID	(m) depth	Lab ID	Date Sampled	Sample Type: S - soil, W - water	Container Type: G - glass, P - plastic	Analytes: Combo 7a	CEC, pH	Combo 5a	Combo 3	Combo 3a					Notes/preservation
1	101	0-0.15		1/8/17	S	G bag	✓									
2	101	0.4-0.5								✓						
3	102	0-0.15				bag			✓							
4	103	0-0.2				bag			✓							
5	103	0.3-0.4								✓						
6	104	0-0.2				bag		✓	✓							
7	105	0-0.2				bag		✓	✓							
8	106	0-0.2				bag					✓					
9	107	0-0.1				bag			✓							
10	108	0-0.1				bag			✓							
11	BD1-01	0817								✓						
	PQL (S) mg/kg															ANZECC PQLs req'd for all water analytes ☐

ENVIROLAB GROUP
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 172580
Date Received: 2/8/17
Time Received: 12:00
Received by: A
Temp: Cool/Ambient 10.8°C
Cooling: Ice/Icepack
Security: Intact/Broken/None

PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit

Metals to Analyse: 8HM unless specified here:

Lab Report/Reference No:

Total number of samples in container: 11 **Relinquished by:** DW **Transported to laboratory by:** Courier

Send Results to: Douglas Partners Pty Ltd **Address** 96 Hermitage Road, West Ryde **Phone:** 98090666 **Fax:** 98094095

Signed: **Received by:** A ELS **Date & Time:** 2/8/17 12:00

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Pty Ltd
Attention	David Walker

Sample Login Details

Your reference	43677.47, Bingara Gorge, Fairways North
Envirolab Reference	172580
Date Sample Received	02/08/2017
Date Instructions Received	02/08/2017
Date Results Expected to be Reported	09/08/2017

Sample Condition

Samples received in appropriate condition for analysis	YES
No. of Samples Provided	11 soils
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	10.8
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	vTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	PAHs in Soil	Organochlorine Pesticidesin soil	PCBsin Soil	Acid Extractable metalsin soil	Misc Soil - Inorg	Misc Inorg - Soil	Asbestos ID - soils	CEC
101-0-0.15	✓	✓	✓	✓	✓	✓	✓		✓	
101-0.4-0.5	✓	✓	✓			✓				
102-0-0.15	✓	✓	✓	✓	✓	✓			✓	
103-0-0.2	✓	✓	✓	✓	✓	✓			✓	
103-0.3-0.4	✓	✓	✓			✓				
104-0-0.2	✓	✓	✓	✓	✓	✓		✓	✓	✓
105-0-0.2	✓	✓	✓	✓	✓	✓		✓	✓	✓
106-0-0.2	✓	✓	✓			✓			✓	
107-0-0.1	✓	✓	✓	✓	✓	✓			✓	
108-0-0.1	✓	✓	✓	✓	✓	✓			✓	
BD1-010817	✓	✓	✓			✓				

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 172580-A

Client Details

Client	Douglas Partners Pty Ltd
Attention	David Walker
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**43677.47, Bingara Gorge, Fairways North**
Number of Samples	Additional Testing on 2 Soils
Date samples received	02/08/2017
Date completed instructions received	09/08/2017

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	16/08/2017
Date of Issue	16/08/2017

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lucy Zhu
Authorised by Asbestos Approved Signatory: Lulu Scott

Results Approved By
Jeremy Faircloth, Organics Supervisor
Long Pham, Team Leader, Metals

Authorised By

David Springer, General Manager

svTRH (C10-C40) in Soil		
Our Reference		172580-A-7
Your Reference	UNITS	105
Depth		0-0.2
Date Sampled		01/08/2017
Type of sample		Soil
Date extracted	-	10/08/2017
Date analysed	-	11/08/2017
TRH C_{10} - C_{14}	mg/kg	<50
TRH C_{15} - C_{28}	mg/kg	<100
TRH C_{29} - C_{36}	mg/kg	160
TRH >C_{10} -C_{16}	mg/kg	<50
TRH >C_{16} -C_{34}	mg/kg	130
TRH >C_{34} -C_{40}	mg/kg	120
Total +ve TRH (>C10-C40)	mg/kg	250
Surrogate o-Terphenyl	%	88

sTPH in Soil (C10-C40)-Silica		
Our Reference		172580-A-7
Your Reference	UNITS	105
Depth		0-0.2
Date Sampled		01/08/2017
Type of sample		Soil
Date extracted	-	10/08/2017
Date analysed	-	11/08/2017
TPH C_{10} - C_{14}	mg/kg	<50
TPH C_{15} - C_{28}	mg/kg	<100
TPH C_{29} - C_{36}	mg/kg	<100
TPH >C_{10} -C_{16}	mg/kg	<50
TPH >C_{16} -C_{34}	mg/kg	<100
TPH >C_{34} -C_{40}	mg/kg	<100
Surrogate o-Terphenyl	%	86

Metals in TCLP USEPA1311			
Our Reference		172580-A-6	172580-A-7
Your Reference	UNITS	104	105
Depth		0-0.2	0-0.2
Date Sampled		01/08/2017	01/08/2017
Type of sample		Soil	Soil
Date extracted	-	10/08/2017	10/08/2017
Date analysed	-	10/08/2017	10/08/2017
pH of soil for fluid# determ.	pH units	6.6	6.7
pH of soil TCLP (after HCl)	pH units	1.6	1.6
Extraction fluid used	-	1	1
pH of final Leachate	pH units	5.0	5.0
Lead in TCLP	mg/L	0.07	0.05
Zinc in TCLP	mg/L	1.5	7.8

Metals-ASLP Neutral (ICP-MS)			
Our Reference		172580-A-6	172580-A-7
Your Reference	UNITS	104	105
Depth		0-0.2	0-0.2
Date Sampled		01/08/2017	01/08/2017
Type of sample		Soil	Soil
Date extracted	-	10/08/2017	10/08/2017
Date analysed	-	10/08/2017	10/08/2017
pH of final Leachate	pH units	7.3	7.1
Lead in ASLP	µg/L	69	25
Zinc in ASLP	µg/L	73	250

Method ID	Methodology Summary
EXTRACT.7	Toxicity Characteristic Leaching Procedure (TCLP) using Zero Headspace Extraction (zHE) using AS4439 and USEPA 1311.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-004	Toxicity Characteristic Leaching Procedure (TCLP) using in house method INORG-004.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-022	Determination of various metals by ICP-MS following leaching using neutralised deionised water by AS 4439.3 - 1997.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).

QUALITY CONTROL: svTRH (C10-C40) in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	
Date extracted	-			10/08/2017	[NT]	[NT]	[NT]	[NT]	10/08/2017	[NT]
Date analysed	-			11/08/2017	[NT]	[NT]	[NT]	[NT]	11/08/2017	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	103	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	107	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	121	[NT]
TRH >C_{10} -C_{16}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	103	[NT]
TRH >C_{16} -C_{34}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	107	[NT]
TRH >C_{34} -C_{40}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	121	[NT]
Surrogate o-Terphenyl	%		Org-003	100	[NT]	[NT]	[NT]	[NT]	88	[NT]

QUALITY CONTROL: sTPH in Soil (C10-C40)-Silica						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-4	[NT]
Date extracted	-			10/08/2017	[NT]	[NT]	[NT]	[NT]	10/08/2017	[NT]
Date analysed	-			11/08/2017	[NT]	[NT]	[NT]	[NT]	10/08/2017	[NT]
TPH C_{10} - C_{14}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	103	[NT]
TPH C_{15} - C_{28}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	107	[NT]
TPH C_{29} - C_{36}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	121	[NT]
TPH >C_{10} -C_{16}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	103	[NT]
TPH >C_{16} -C_{34}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	107	[NT]
TPH >C_{34} -C_{40}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	121	[NT]
Surrogate o-Terphenyl	%		Org-003	100	[NT]	[NT]	[NT]	[NT]	88	[NT]

QUALITY CONTROL: Metals in TCLP USEPA1311					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			10/08/2017	[NT]	[NT]	[NT]	[NT]	10/08/2017	[NT]
Date analysed	-			10/08/2017	[NT]	[NT]	[NT]	[NT]	10/08/2017	[NT]
Lead in TCLP	mg/L	0.03	Metals-020 ICP-AES	<0.03	[NT]	[NT]	[NT]	[NT]	89	[NT]
Zinc in TCLP	mg/L	0.02	Metals-020 ICP-AES	<0.02	[NT]	[NT]	[NT]	[NT]	93	[NT]

QUALITY CONTROL: Metals-ASLP Neutral (ICP-MS)						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			10/08/2017	[NT]	[NT]	[NT]	[NT]	10/08/2017	[NT]
Date analysed	-			10/08/2017	[NT]	[NT]	[NT]	[NT]	10/08/2017	[NT]
Lead in ASLP	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Zinc in ASLP	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	89	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Aileen Hie

From: David Walker <David.Walker@douglaspartners.com.au>
Sent: Wednesday, 9 August 2017 8:16 AM
To: Aileen Hie
Cc: Ken Nguyen
Subject: FW: Results for Registration 172580 43677.47, Bingara Gorge, Fairways North

Aileen,

Please go ahead with:

- Sample 6, 104 /0-0.2, TCLP and ASLP for lead and zinc;
- Sample 7, 105 /0-0.2, TCLP and ASLP for lead and zinc, & TRH C10-C36 with silica gel clean up.

Standard turnaround is fine.

Regards

David Walker | Associate / Environmental Engineer
Douglas Partners Pty Ltd | ABN 75 053 980 117 | www.douglaspartners.com.au
96 Hermitage Road West Ryde NSW 2114 | PO Box 472 West Ryde NSW 1685
P: 02 9809 0666 | F: 02 9809 4095 | M: 0407 540 537 | E: David.Walker@douglaspartners.com.au

From: Ken Nguyen [mailto:KNguyen@envirolab.com.au]
Sent: Tuesday, 8 August 2017 8:57 PM
To: David Walker
Subject: Results for Registration 172580 43677.47, Bingara Gorge, Fairways North

Please refer to attached for:
a copy of the Certificate of Analysis
a copy of the COC/paperwork received from you
ESDAT Extracts
an Excel or .csv file containing the results
Please note that a hard copy will not be posted.

Envirolab Ref: 172580 A
DJe: 16/8/17
Std +1A.

Enquiries should be made directly to:
customerservice@envirolab.com.au

Regards

Envirolab Services
12 Ashley St Chatswood NSW 2067

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details

Client	Douglas Partners Pty Ltd
Attention	David Walker

Sample Login Details

Your reference	43677.47, Bingara Gorge, Fairways North
Envirolab Reference	172580-A
Date Sample Received	02/08/2017
Date Instructions Received	09/08/2017
Date Results Expected to be Reported	16/08/2017

Sample Condition

Samples received in appropriate condition for analysis	YES
No. of Samples Provided	Additional Testing on 2 Soils
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	10.8
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments

Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	sTPH in Soil (C10-C40)-Silica	Metals in TCLP USEPA1311	Metals-ASLP Neutral (ICP-MS)	On Hold
101-0-0.15				✓
101-0.4-0.5				✓
102-0-0.15				✓
103-0-0.2				✓
103-0.3-0.4				✓
104-0-0.2		✓	✓	
105-0-0.2	✓	✓	✓	
106-0-0.2				✓
107-0-0.1				✓
108-0-0.1				✓
BD1-010817				✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info

Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.

Requests for longer term sample storage must be received in writing.