Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Fill Management Protocol

Proposed Residential Subdivision
16 Chapman Street, Werrington, NSW

Prepared for
Lendlease Communities Pty Ltd c/- GLN Planning

Project 94571.00
October 2019

Douglas Partners
Geotechnics / Environment / Groundwater

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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
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Reviewer		1 October 2019

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Report on Fill Management Protocol
Proposed Residential Subdivision
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1. Introduction

Douglas Partners Pty Ltd (DP) was commissioned by GLN Planning on behalf of Lendlease Communities Pty Ltd ('Lendlease') to prepare this Fill Management Protocol (FMP) for the proposed residential subdivision of Lot 1 on Deposited Plan 1226122, 16 Chapman Street, Werrington. The site location and layout is provided in Drawing 1, Appendix E.

The FMP details the requirements for the assessment of fill, prior to importation to the site, with respect to contamination, salinity and geotechnical requirements. DP understands that the FMP is required to facilitate the import of an (currently) undefined volume of soils and rock for the proposed development.

Application of this FMP to all soil and rock to be imported onto the site will provide a consistent approach to the management of fill materials with respect to their suitability for use as part of the site development from the perspective of contamination and salinity.

The following should be considered with respect to the implementation of the FMP:

- The FMP is only for materials imported for bulk earthworks and does not apply to other materials imported to the site for the purpose of road construction or drainage works etc.;
- It is the responsibility of Lendlease and their nominated qualified Environmental Consultant to assess compliance with the FMP; and
- The fill suppliers are required to provide supporting documentation to verify that the subject material complies with the FMP. It is the suppliers' responsibility to ensure the supporting documentation is complete and correct. In this regard, the fill suppliers must be issued with a copy of the FMP.

1.1 Site Background

1.1.1 Site Description

The site is approximately 28 hectares in size and is located in the local government area of Penrith City Council.

The site is currently unoccupied and comprises cleared bushland in the east and west and low lying bush/mature trees in the centre and northern portion.

1.1.2 Soils and Geology

Reference to the Soils Landscape 1:100,000 *Penrith Sheet* indicates that the northern part of the site is located on the erosional Luddenham soil landscape and the southern part by alluvial South Creek podzolic soils/solodic soils and clays.

Reference to the Geological Series 1:100,000 *Penrith Sheet 9030* (1991) indicates that the site is underlain by Wianamatta Group Bringelly Shales of Triassic Age. This formation consists of shale, claystone, laminate and minor coal bands which are typically overlain by stiff residual clay soil.

2. Contamination

2.1 Relevant Legislation and Guidelines

Importation of materials onto the site must fully abide by the provisions of relevant NSW environmental legislation, including, *inter alia*, the *Contaminated Land Management Act* (1997) (CLM Act) and the *Protection of the Environment Operations Act* (1997) (POEO Act) and associated exemptions (e.g. excavated natural materials (ENM)). The following guidelines are considered to be relevant:

- NSW EPA (2014) *Waste Classification Guidelines*;
- NSW EPA Resource Recovery Orders under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014;
- National Environment Protection Council (2013) *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM, 1999 - amended 2013); and
- ANZECC/NHMRC (1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, Environmental Soil Quality Guidelines Background A [ANZECC A].

2.2 Imported Material Acceptance Criteria

Materials imported to the site must satisfy the minimum requirements detailed below. All materials to be imported must be accompanied by appropriate reports from qualified environmental or geotechnical consultants confirming the status of the material with respect to contamination, salinity and relevant geotechnical parameters. Prior to acceptance of imported material onto the site, all waste classification reports must be reviewed by a qualified Environmental Consultant nominated by Lendlease.

The Environmental Consultant must provide feedback on the suitability of the material based on the provided documentation, the apparent reliability, or otherwise, of the documentation and its conformance with this protocol. If the material is found suitable for import, the Environmental Consultant must provide written approval prior to its importation.

All imported soil/rock material must be either:

- **Virgin Excavated Natural Material (VENM)** as defined under NSW EPA *Waste Classification Guidelines* (EPA, 2014);
    - VENM proposed to be imported must include analyses of samples at the appropriate density specified in Table C1, Appendix C. As the NSW EPA has no specific VENM assessment criteria (in terms of contaminant thresholds), VENM should be reviewed on the basis of the source site history and observations of the material. Assessment of inorganic contaminants should be conducted with reference to the published background ranges for typical Australian soils in Berkman (1989) *Field Geologists Manual* and/or ANZECC (1992) (see extract in Table B1, Appendix B). Assessment of organic contaminants should be conducted with reference to their analytical practical quantitation limits (i.e.: no detections exceeding these limits);
    - Table C1, Appendix C includes sampling densities for:
        - Source sites where VENM comprising of soil is intended to be exported; and
        - Large deep excavation source sites where VENM comprising bedrock is intended to be exported. These sites include road tunnel infrastructure sites (tunnel spoil sites) where spoil is not classified under a Resource Recovery Exemption.

      A reduced sampling density is applicable for bedrock VENM, which is considered as having a lower potential for contamination than overlying soil (subject to the source site conditions and history). If material other than excavated bedrock is to be exported from these sites (i.e.: soil overlying bedrock), the density for soil VENM will apply for the soil portion of the import (refer Table C1, Appendix C); and
    - VENM must be accompanied by a VENM validation report from a suitably qualified environmental consultant, or alternatively the Lendlease appointed environmental consultant can undertake the VENM validation.
- **Excavated Natural Material (ENM)** as defined under the NSW EPA Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014, *The excavated natural material order 2014* (the ENM Order):
    - ENM must be verified in accordance with the ENM Order and should include analyses of samples at the appropriate density specified in Table C1, Appendix C. In addition, the relevant "chemical and other attributes" in the ENM Order (including EC parameters) must be verified to comply with the concentration threshold values specified in Table 4 of the ENM Order. These concentrations are reproduced in Table B2, Appendix B;
    - ENM must be accompanied by an ENM validation report from a suitably qualified environmental consultant, or alternatively the Lendlease appointed environmental consultant can undertake the ENM validation; and
    - The recipient of materials classified under the ENM Order must abide by the conditions of the corresponding NSW EPA Resource Recovery Order under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014, The excavated natural material exemption 2014 (the ENM Exemption).

- Material which complies with an appropriate general Resource Recovery Order (RRO) which allows application to land (e.g.: recovered aggregate, recovered fines). The RRO may include specifications, record-keeping, reporting and other requirements which need to be met in order to comply. All RROs are made under clause 93 of the *Environmental Operations (Waste) Regulation 2014*;
- A specific waste exemption as may be granted by the NSW EPA. The EPA grants resource recovery orders and resource recovery exemptions where the application of a waste material to land is a bona-fide, fit-for-purpose, re-use opportunity rather than a means of waste disposal. A specific application would need to be made in this case;
- Material classified under the NSW EPA Resource Recovery Order Under Part 9, Clause 93 (and the Resource Recovery Exemption Part 9, Clauses 91 and 92) of the Environmental Operations (Waste) Regulation 2014 (Tunnel Spoil Exemptions) as outlined below:
    - Tunnel spoil exemptions where that material is excavated bedrock (i.e.: from Road Infrastructure Project Sites). Samples of bedrock material classified under a tunnel spoil exemption should be analysed at the frequency provided for bedrock VENM sites specified in Table C1, Appendix C;
    - Laboratory reported concentrations of chemical analytes shall be compared against the criteria detailed in Table B2 of the FMP; and
    - Other Resource Recover Exempt material (excluding tunnel spoil exemptions) subject to written approval from Council.

In addition to the above requirement:

- All materials must be validated to be suitable, from a contamination standpoint, for use on residential sites. In this regard, contaminant concentrations must not exceed the health-based investigation levels for 'Residential A' and health screening levels '(HSL) A assessment criteria specified in Table 1A(1) and Table 1A(3), respectively within Schedule B1 of the NEPC (2013), shown in Table A1, Appendix A;
- For fill to be used in the top 2.0 m of site soils, the material must comply with the Urban Residential and Public Open Space Ecological Investigation Levels (pH and cation exchange capacity (CEC) dependent) and Ecological Screening Levels within Schedule B1 of the NEPC (2013). The screening criteria is provided in Table A1, Appendix A;
- If the review of the waste classification report indicates that analyte concentrations are greater than the screening EIL criteria, a material specific EIL (based on pH and cation exchange capacity (CEC) of the material to be imported) should be developed to determine suitability; and
- With regard to the assessment testing, all laboratory analysis must be conducted by a laboratory that holds National Association of Testing Authorities (NATA) accreditation for the test methods performed.

All source sites are subject to approval by Lendlease and their nominated Environmental Consultant on a case by case basis.

3. Geotechnical

The materials to be imported to the site should have the following geotechnical characteristics:

- Materials should not contain particle sizes larger than 150 mm. If the materials contain particle sizes larger than 150 mm such materials should be breakable under the normal compaction conditions;
- Materials are not overly wet (greater than +4% of optimum moisture content) upon visual assessment; and
- Materials should be free of topsoil, organic material, fill, refuse, building rubble, anthropogenic inclusions and other material indicated in Appendix D.

4. Salinity

4.1 Relevant Guidelines

The DLWC (2002) Site Investigations for Urban Salinity guidelines are considered relevant to the assessment of the suitability of the imported materials with respect to their salinity-related (and geotechnical) properties:

4.2 Salinity Acceptance Criteria

The site is in an area with soils classified as non to slightly saline (Refer to DP *Report on Land Capability Assessment, South Werrington Sub-Precinct, Werrington,* Project 43739 Rev 1 dated July 2007). The aggressivity of soil conditions (to concrete and steel) will be investigated prior to bulk earthworks and are assumed to likely comprise non to mildly aggressive soil conditions to both concrete and steel.

The salinity testing and selection criteria for imported fill are as follows:

- Soil and bedrock VENM, and ENM must be tested for salinity characteristics at the rates provided in Table C2, Appendix C;
- Imported materials should have a maximum classification of moderately saline (though preferably slightly saline), based on ECe, the electrical conductivity of saturated pore water (refer to Table B3, Appendix B for salinity scale); and
- Materials should be non-aggressive to mildly aggressive to both concrete and steel based on the scale given in Table B4 and B5, respectively.

NOTE:

Materials of higher salinity and aggressivity may be accepted if they can be demonstrated to be consistent with the local background conditions at the site or an area within the site or if appropriate salinity management procedures or appropriate engineering practices are in place to handle such materials. Such materials will only be accepted at the discretion of the Environmental Consultant and Lendlease.

5. Implementation of the Fill Management Protocol

This section outlines the general steps in implementing this FMP once a potential source of imported material is identified:

1. Supplier of the material to provide information on the source address, type of material and available volume of material.
2. Supplier of the material to provide all supporting documentation (e.g.: VENM report, geotechnical/salinity assessment reports) conducted by a suitably qualified Environmental Consultant, confirming compliance with the FMP.
3. Review of documentation provided in points 1 and 2 by the Lendlease appointed Environmental Consultant, providing written confirmation of one of the following:
    - approval if the material is deemed suitable for import under this protocol; or
    - rejection if the material is deemed unsuitable for import under this protocol; or
    - requirements for further information to be provided in order to make a decision;
4. If approved, provision of notice to Council of the intention to commence the import of materials by Lendlease.
5. If approved, collation of trucking records by the environmental consultant's gate keeper (refer Section 6.2).
6. If approved, recording of the location of materials imported onto the site including photographs and drawings (or volumes if the material is stockpiled) by the gate Keeper.
7. Provision of monthly summary to Lendlease and a final report (Section 8) to Lendlease by the Environmental Consultant.

All documentation should be supplied to the Lendlease appointed Environmental Consultant for approval. All records will be kept by Lendlease for future reference.

6. Approval / Assessment

Prior to acceptance of material from an external source site, assessment of the source site will be undertaken to determine the general acceptability of material from that site. In addition, material tracking records and inspection of the materials imported to the site should be undertaken to assess that the materials being imported are consistent with those approved for importation.

6.1 Assessment / Approval of Source Site

Materials will be judged as suitable, or otherwise, by the Environmental Consultant based on the provided documentation, the apparent reliability, or otherwise, of the documentation and its conformance with this FMP.

No material is to be imported to site that has not had prior written approval from the Environmental Consultant.

6.2 Gate Records and Check Sampling

The Environmental Consultant will provide a gate keeper to oversee the importing of materials to the site.

A record of truck movements must be maintained by a gate keeper for trucks carrying material imported to the site, providing the following information:

- The date and time of truck arrival;
- The source location of the material;
- The truck registration details;
- Material type;
- The approximate volume of material per load;
- Visual assessment of material at gate;
- Record of load acceptance/rejection;
- The approximate location of material placement (on a daily basis not per truck load); and
- The amount of material remaining to be imported based on the volume supplied in the original assessment report.

The gate keeper will reject any materials entering the site when:

- The material is deemed to not be consistent based on a visual assessment of the material at the gate with that described in supporting documentation approved by the Environmental Consultant; and
- Supporting documentation has not been previously supplied and accepted.

Similarly the gate keeper will reject materials from source sites from which more material has been delivered than has been allowed for in the original assessment. A supplementary assessment may be made by the source site's consultant to allow for the additional assessment, but this must be submitted for review and approval by the Lendlease appointed Environmental Consultant.

As an additional level of control, check samples should be collected at the gate for imported ENM and bedrock material for large deep excavation sites only. Check samples for VENM will be collected only if considered necessary during the course of import. Sampling rates and analytical scope for check samples are provided in Table C3, Appendix C. If check samples indicate non-conformance with this protocol then further review/assessment of the source site may be required.

7. Non-Compliance

Any material imported to site that is found to be non-compliant (discovered during check testing or during general site activities) will be isolated and assessed by the Environmental Consultant. If the non-compliant material is found to be incompatible with the site requirements it will be tested and removed at the cost of the source site supplier. A bond system is recommended to address such matters. The cost of remediation and validation will be borne by the source supplier.

8. Final Validation of Imported Fill

At the completion of importation of the materials to the site and prior to the commencement of construction a validation report will be prepared by the Environmental Consultant. The validation report should include the following:

- A review of source site documentation;
- A review of gate keeping records;
- A review of site drawings/surveys identifying where imported materials were placed within the site;
- A review of and discussion of check sampling undertaken at the gate in accordance with Section 6.2;
- Records of non-conformances with this FMP; and
- Assessment of the overall compliance with the FMP.

If there are data gaps or incomplete records of gate keeping, then additional check sampling of the imported materials may be required. The scope of such work would need to be determined at the time by a suitably qualified consultant.

A summary report shall be provided to Council on an annual basis (or as required) detailing both accepted and rejected sites. The final validation report will also be submitted to Council to demonstrate adherence to the FMP.

9. References

1. ANZECC/NHMRC (1992) Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites.
2. Berkman (1989) Field Geologist's Manual.
3. DP (2007) Report on Land Capability Assessment, South Werrington Sub-Precinct, Werrington, Project 43739 Rev 1 dated July 2007.
4. DECCW (2009) Waste Classification Guidelines.
5. EPA (2014) Excavated Natural Material Order.
6. Martens Consulting Engineers (2015) Detailed Site Investigation: South Werrington Urban Village Precinct, Lot 102 DP 1140594, 16 Chapman Street, Werrington, NSW.
7. McNally, GH (2005) Investigation of Urban Salinity – Case Studies from Western Sydney. UrbanSalt 2005 Conference Paper, Parramatta.
8. McNally, GH (2004) Shale, Salinity and Groundwater in Western Sydney, Australian Geomechanics 39(3), pp 109 - 123.
9. McNally, GH (2009) Soil and Groundwater Salinity in the Shales of Western Sydney, Groundwater in the Sydney Basin Symposium, International Association of Hydrogeologists, pp 228 - 235.

10. National Environment Protection Council (2013) National Environment Protection (Assessment of Site Contamination) Measure (NEPM, 1999 - amended 2013).

11. Old, AN (1942) The Wianamatta Shale Waters of the Sydney District, NSW Agricultural Gazette, pp 215 - 221.

12. Russell G, McKibbin D, Williams J and Gates G A (2009) Groundwater Resource Assessment of the Triassic rocks of the Sydney Basin, Groundwater in the Sydney Basin Symposium, International Association of Hydrogeologists, pp 312 - 328.

13. Wooley D (1991) Groundwater in Jones DC and Clark NR (editors) Geology of the Penrith 1:100,000 sheet, pp 119 - 121. NSW Geological Survey, Sydney, 202p.

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report (or services) for this project at 16 Chapman Street, Werrington in accordance with DP's proposal MAC190239 dated 14 August 2019 and acceptance received from Peter McManus from GLN Planning on behalf of Lendlease dated 16 September 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of 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

NEPC (2013) Health-Based Investigation Levels, Health Screening Levels and Ecological Investigation Limits

Given the site is a proposed residential development, the adopted screening criteria comprised the:

- **Health Investigation Levels (HIL) A** – The health investigation levels (HILs) are scientifically based, generic assessment criteria designed to be used in the first stage (Tier 1) of an assessment of potential risks to human health from chronic exposure to contaminants. Given the proposed land use is residential, the HIL (A) guideline values have been adopted which are for sites that are residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry)), and also includes childcare centres, preschools and primary schools.
- **Health Screening Levels (HSL) A & B (low – high density residential sites)** - Health Screening Levels (HSLs) are used to assess selected petroleum compounds and fractions to assess the risk to human health via inhalation and direct contact with affected soils and groundwater. The HSLs were developed by the Co-operative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) and were derived through the consideration of health effects only, with particular emphasis on the vapour exposure pathway. Other considerations such as ecological risk, aesthetics, the presence of free phase product and explosive/fire risk are not addressed by the HSLs. As such the HSLs should be used similarly to the HILs, i.e. as a screening tool. Given the proposed land use at the destination sites is residential and silty clays are dominant within the site, the HSL A & B (low - high density residential sites) for depths to contamination of 0 m to 1 m has been adopted for silt soil types as a screening criteria;
- **Ecological Investigation Levels (EIL)** – Ecological Investigation Levels (EILs) have been developed and discussed in NEPC (2013) for selected metals and organic compounds and are applicable for assessing risk to terrestrial ecosystems. EILs depend on specific soil physiochemical properties and land use scenarios and generally apply to the top 2 m of soil, which essentially corresponds to the root zone and habitation zone of many species. The EIL is determined for a contaminant using the following formula:

  EIL = ABC + ACL, where

  ABC = Ambient Background Concentration

  ACL = Added Contaminant Limit
- 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 (eg: motor vehicle emissions). The ABC was determined through the use of methods defined by Olszowy et al. (1995).
- EIL (and ACLs where appropriate) have been derived in NEPC (2013) for only a short list of contaminants comprising As, Cu, Cr (III), DDT, naphthalene, Ni, Pb and Zn. An Interactive (Excel) Calculation Spreadsheet was 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).
- Given the material is proposed to be imported to a residential development, a conservative ACL for a residential land use has been adopted as a screening level. Site specific pH and CEC values obtained as part of the salinity investigation have been used as input parameters in the Interactive (Excel) Calculation Spreadsheet. The mean pH and CEC values reported in the Salinity Investigation (Project 76644.00) have been used as an initial screening. The pH and CEC values adopted are a pH of 6 and CEC of 14 cmolc/kg, and have been used as input parameters in the Interactive (Excel) Calculation Spreadsheet.

- **Ecological Screening Levels (ESL) – ESLs** are used to assess the risk of selected petroleum hydrocarbon compounds, BTEX and benzo(a)pyrene to terrestrial ecosystems. ESLs apply to the top 2 m of the soil profile, which essentially corresponds to the root zone and habitation zone of many species. Given the proposed land use is residential and silty clays were encountered, the ESLs for Urban Residential/public open space sites and for fine soil texture have been adopted.
- **Management Limits –** 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 the formation of observable light non-aqueous phase liquids (LNAPL), fire and explosion hazards; and effects on buried infrastructure eg: penetration of, or damage to, in-ground services. Management Limits to avoid or minimise these potential effects have been adopted in NEPC (2013) as interim Tier 1 guidance. Given the proposed land use at the destination sites is residential and silty clays were encountered (refer to the test pit logs attached); the management limits for residential, parkland and public open spaces for fine soils have been adopted.

Table A1 - NEPC (2013) Health-Based Investigation Levels (HIL), Health Screening Levels (HSL) and Ecological Investigation Limits (EIL).

Contaminants		NEPC (2013) HIL and HSL (Residential[1] A)	NEPC (2013) HIL and HSL (Residential[1] B)	NEPC (2013) Management Limit (Residential)	NEPC (2013) EIL or ESL (Urban Residential and Open Public Spaces[1])
Heavy Metals	Arsenic	100	500	-	100
	Cadmium	20	150	-	
	Chromium (III + IV)	100	500	-	410
	Copper	6000	30 000	-	210
	Lead	300	1 200	-	1 100
	Mercury	40	120	-	
	Nickel	400	1 200	-	210
	Zinc	7 400	60 000	-	480
	Manganese	3 800	14 000	-	
PAHs	Benzo(a)pyrene TEQ	3	4	-	-
	Benzo(a)pyrene	-	-	-	0.7
	Naphthalene	4	4	-	170
	Total PAHs	300	400	-	-
TRH	F1 TRH C6-C10 less BTEX	40	40	-	180
	F2 TRH >C10-C16 less Napthalene	230	230	-	120
	F3 TRH >C16-C34	-	-	3 500	1 300
	F4 TRH >C34-C40	-	-	10 000	5 600
	TRH C6-C10	-	-	800	-
	TRH >C10-C16	-	-	1 000	-
BTEX	Benzene	0.6	0.6	-	65
	Toluene	390	390	-	105
	Ethylbenzene	-	-	-	125
	Total Xylene	95	95	-	45
PCB	PCB	1	1	-	-
OPP	Chlorpyrifos	160	340	-	-
Organochlorine Pesticides (OCP)	DDT+DDE+DDD	240	600	-	180
	Aldrin and dieldrin	6	10	-	-
	Chlordane	50	90	-	-
	Endosulfan	270	400	-	-
	Endrin	10	20	-	-
	Heptachlor	6	10	-	-
	HCB	10	15	-	-
	Methoxychlor	300	500	-	-
Asbestos	Asbestos	NAD	NAD	NAD	NAD

[1] Generic land uses are described in detail in NEPC (2013) Schedule B7 Section 3

Appendix B

Threshold Values

Table B1 – Reference Contaminant Values for Virgin Excavated Natural Material (VENM)
Apply to Imported Natural Materials

Contaminant [1]	Berkman (1989) [2]	ANZECC [3]
Metals		
Arsenic (total)	1-50	0.2-30
Cadmium	1	0.04-2
Chromium (III)	5-1000	0.5-110
Copper	2-100	1-190
Lead	2-200	<2-200
Mercury	0.03	0.001-0.1
Nickel	5-500	2-400
Zinc	10-300	2-180
TRH $C_6 – C_{10}$ $C_{10} – C_{16}$ $C_{16} – C_{34}$ $C_{34} – C_{40}$	For all organic analytes, the analytical practical quantitation limits are used as the reference levels for VENM assessment. Special consideration may be given to low levels of naturally occurring TRH or PAH in shale.	
BTEX Benzene Toluene Ethyl Benzene Xylene		
Total Phenols		
PAH Total Benzo(a)Pyrene		
PCB		
OPP		
OCP aldrin dieldrin aldrin + dieldrin chlordane DDT (including DDD, DDE, DDT) Heptachlor		
Asbestos	No asbestos present	

Notes:

1. Contaminant concentrations must also be evaluated against NEPC (2013)
2. Berkman (1989) Field Geologists Manual
3. Australian and New Zealand Environment and Conservation Council/National Health and Medical Research Council (ANZECC/NHMRC): Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (1992), Environmental Soil Quality Guidelines Background A [ANZECC A];

Table B2 – Threshold Contaminant Values for ENM

Chemicals and other attributes	Maximum average concentration for characterisation (mg/kg 'dry weight' unless otherwise specified)	Absolute maximum concentration (mg/kg 'dry weight' unless otherwise specified)
Mercury	0.5	1
Cadmium	0.5	1
Lead	50	100
Arsenic	20	40
Chromium (total)	75	150
Copper	100	200
Nickel	30	60
Zinc	150	300
Electrical Conductivity	1.5 ds/m	3 ds/m
pH	5 to 9	4.5 to 10
Total PAH	20	40
Benzo(a)pyrene	0.5	1
Benzene	NA	0.5
Toluene	NA	65
Ethyl-benzene	NA	25
Xylene	NA	15
Total Petroleum Hydrocarbons	250	500
Rubber, plastic, bitumen, paper, cloth, paint and wood	0.05%	0.1%

Table B3 – Salinity Scale

Salinity	Electrical conductivity (ECe)
Non Saline	<2 dS/m
Slightly Saline	2 – 4 dS/m
Moderately Saline	4 – 8 dS/m
Highly Saline	8 – 16 dS/m

Table B4 – Criteria for Soil Aggressivity for Concrete

Sulphate as SO3* (mg/kg)	pH	Aggressivity To Concrete	
		High Permeability Soils Below Groundwater	Low Permeability Soils / All Soils Above Groundwater
<5,000	>5.5	Non-Aggressive	Non-Aggressive
5,000 – 10,000	4.5 – 5.5	Mild	Mild
10,000 – 20,000	4 – 4.5	Severe	Moderate
>20,000	<4	Very Severe	Severe

Source: AS 2159 2009

* Approximate 100 mg/kg of SO_4 = 80 mg/kg of SO_3

Table B5 – Criteria for Soil Aggressivity for Steel

Chloride in Soil (mg/kg)	pH	Aggressivity To Steel	
		High Permeability Soils Below Groundwater	Low Permeability Soils / All Soils Above Groundwater
<5,000	>5	Non-Aggressive	Non-Aggressive
5,000 – 20,000	4 – 5	Mild	Non-Aggressive
20,000 – 50,000	3 – 4	Moderate	Mild
>50,000	<3	Severe	Moderate

Source: AS 2159 2009

Appendix C

Sampling Densities

Table C1 – Sampling and Analytical Requirements for VENM and ENM

Filling/ Natural	Material Quantity (m^3)	Minimum Sample number/ Frequency[4, 5]	Minimum Analyte suite to include[1, 2]	Additional analysis as required[3]
Soil VENM	<5000	1 per 2,000 m^3, with a minimum of three samples	- heavy metals - PAH - TRH - BTEX - phenol - PCB - OCP - asbestos	- Any contaminant considered potentially present in the material based on site information
	5000-50,000	1 per 2,000 m^3, with a minimum of five samples		
Bedrock VENM5	NA	1 per 50,000 m^3, with a minimum of five samples		
Excavated Natural Material	Any volume	Based on the ENM Order 2014 issued by NSW EPA	Mercury, cadmium, lead, arsenic, chromium (total), copper, nickel, zinc, electrical conductivity, pH, PAH, TPH, BTEX, rubber, plastic, bitumen, paper, cloth, paint and wood.	- Asbestos/OCP plus any contaminant considered potentially present in the material based on site information

Notes:

1. Not all samples necessarily require testing for all analytes (not relevant for ENM).
2. Heavy metals = arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. BTEX = benzene, toluene, ethyl benzene, total xylenes OCP = Organochlorine Pesticides (a scheduled chemical). PAH = Polycyclic Aromatic Hydrocarbons.PCB = Polychlorinated Biphenyls.TRH = Total Recoverable Hydrocarbons (including Total Petroleum Hydrocarbons). SPOCAS = Suspension Peroxide Oxidation Combined Acidity and Sulphate method.
3. Based on advice from a qualified consultant.
4. Including exempt and non-exempt tunnel spoil sites. A reduced sampling density is applicable for VENM bedrock source sites based on the material comprising excavated bedrock, which is considered as having a lower potential for contamination than overlying soil.
5. Higher frequency of testing should be adopted in area of higher contamination potential (such as service stations).

Table C2 – Sampling and Analytical Requirements for Salinity

Assessment type	Minimum Sample Frequency	Minimum analyte suite
Soil VENM and ENM	1 sample per 2,000 m^3	ECe, pH, sulphates, chlorides, textural classification
Bedrock VENM	1 per 50,000 m^3, with a minimum of five samples	

Table C3 – Sampling Requirements for Check Samples at Gate

Material	Minimum Sampling Frequency*	Analytical Requirement
Natural (VENM)	Not Required#	-
ENM	1 per 2,500 m^3	**Contamination** - heavy metals, PAH, TRH, BTEX, phenol, PCB, OCP, and asbestos **Salinity** – EC, pH, Chloride and sulphate
Bedrock VENM	1 per 10,000 m^3	

* Sampling frequency may be increased based on visual assessment at gate.

\# To be collected randomly if contamination is suspected in the imported material or material imported does not match its documented description.

Appendix D

Materials Given Rise to Load Rejection

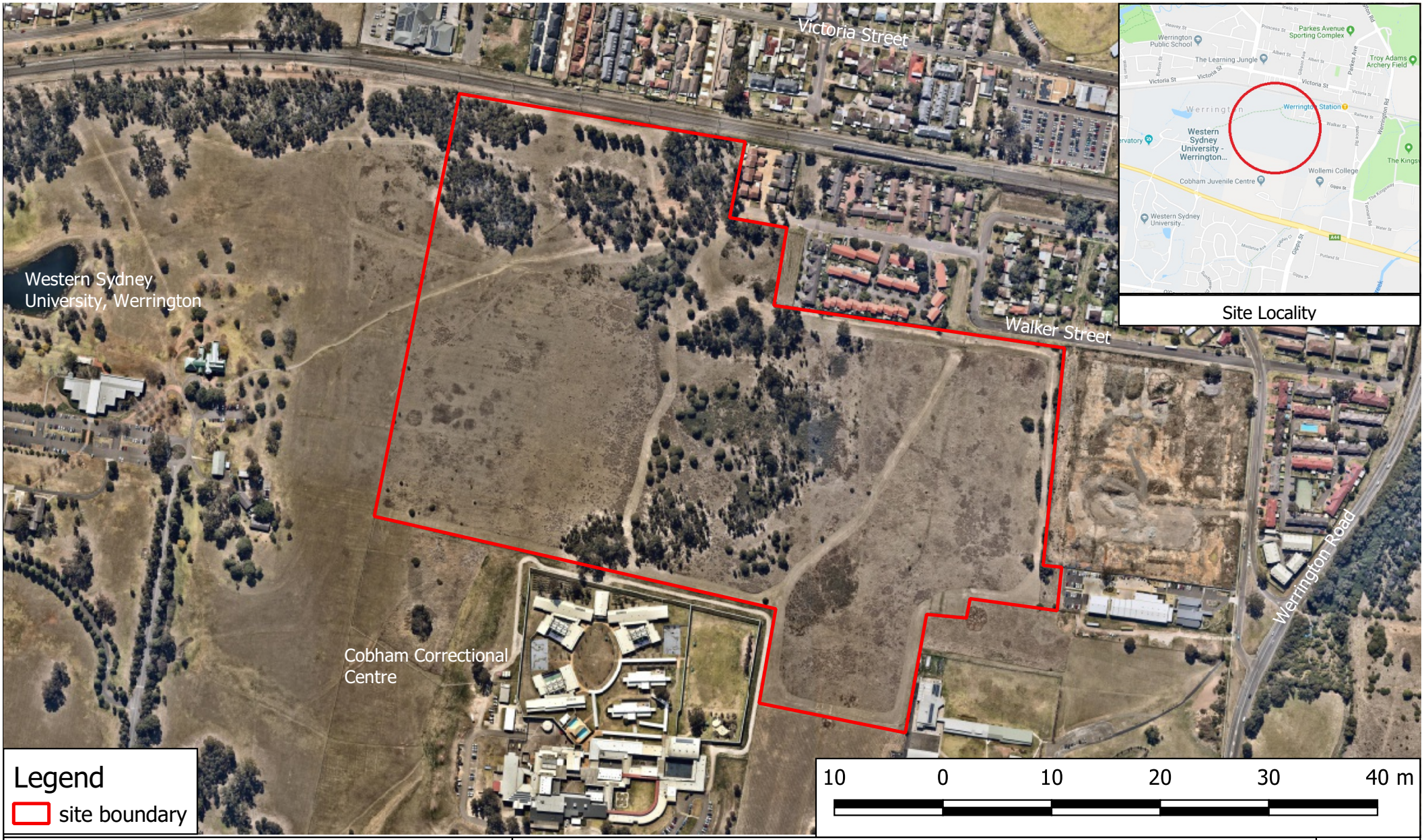
Unsuitable Materials List

The following list contains materials that are unsuitable for use as fill. Any materials containing the following will be rejected. The list is not exhaustive.

- Acid sulphate soils;
- Asbestos (fibre and bonded);
- Biocides;
- Chemical storage containers;
- Contaminated material;
- Excessively wet soils (greater than 3% of optimal moisture content);
- Explosives;
- Fibro;
- Food waste;
- Fungicides;
- Herbicides;
- Household domestic waste;
- Liquid waste;
- Non-validated materials;
- Oil filters and rags;
- Paint;
- Pesticides;
- Radioactive waste;
- Sanitary waste;
- Tyres;
- Vegetative waste; and
- All other potentially contaminating materials.

Appendix E

Drawing 1



Site Locality

Douglas Partners
Geotechnics / Environment / Groundwater

TITLE: **Site Layout**
Fill Managment Protocol
16 Chapman Street, Werrington

CLIENT: Lendlease Communities Pty Ltd	PROJECT No.: 94571.00	SCALE: As shown	DRAWING No: 1
OFFICE: Macarthur	DRAWN BY: EMG	DATE: 25 September 2019	REVISION: 1

Appendix F

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.