Form A (version 2)

INDIVIDUAL EXPERT REPORT OF DR PETER REDMAN

19 JULY 2016

COURT DETAILS	
Court	Land and Environment Court of New South Wales
Class	1
Case number	2016/159652 (Formerly 2015/10898)
TITLE OF PROCEEDINGS	
PROCEEDINGS 2016/159652 (Formerly 2015/10898)	
Applicant	**Liverpool City Council**
First Respondent	**Moorebank Recyclers Pty Limited**
Second respondent	**Minister for Planning**
PROCEEDINGS 2016/157848 (Formerly 2015/10951)	
First applicant	**Benedict Industries Pty Limited**
Second applicant	**Tanlane Pty Limited**
First Respondent	**Minister for Planning**
Second respondent	**Moorebank Recyclers Pty Limited**
PREPARATION DETAILS	
Prepared for	**Liverpool City Council**, applicant
Legal representative	Chris Shaw, Swaab Attorneys
Legal representative reference	151403:CHS:TMS
Contact name and telephone	Theresa Sukkar, (02) 9777 8316
Contact email	tms@swaab.com.au

Peter Redman
Geotechnical Consultant

Swaab Attorneys
Liverpool City Council

Liverpool City Council v Moorebank Recyclers Pty Ltd
Moorebank Material Recycling Facility Project

Report PR214/1-AB
19 July 2016

Peter Redman
Geotechnical Consultant

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Our Ref: PR214/1-AB

Date: 19 July 2016

Ms Theresa Sukkar
Swaab Attorneys
Level 1, 20 Hunter Street
SYDNEY NSW 2000

Dear Ms Sukkar

RE: Liverpool City Council v Moorebank Recyclers Pty Ltd
Moorebank Waste Recycling Facility Project

Private and Confidential – Subject to Legal Privilege

Please find attached the report providing my opinion on geotechnical issues related to the Moorebank Waste Recycling Facility Project.

Do not hesitate to call if you have any queries or require any further information.

Yours faithfully

Dr Peter Redman FIEAust, CPEng

Member of:
CONSULT AUSTRALIA

TABLE OF CONTENTS

1 Introduction

1.1 General

1. I have been asked by Swaab Attorneys to provide my opinion on geotechnical issues in relation to the Moorebank Waster Recycling Facility Project (**the Project**) at Newbridge Road, Moorebank (**the Site**). A copy of the "brief to experts" document provided by Swaab Attorneys is included in Attachment A.

2. I note that I met with Mr Andrew Jackaman of JK Geotechnics on 4 July 2016 for the purpose of discussing our views on the geotechnical issues.

1.2 Qualifications and Expert Witness Code of Conduct

3. A copy of my curriculum vitae is included in Attachment B. This identifies my qualifications and summarises my overall geotechnical experience. It also provides examples of my involvement in geotechnical aspects of excavation and earthworks.

4. I confirm that I have read the Expert Witness Code of Conduct set out in Schedule 7 of the Uniform Civil Procedures Rules 2005 and agree to be bound by it. I acknowledge that I have made all the inquiries which I believe are desirable and appropriate and that no matters of significance which I regard as relevant have, to my knowledge, been withheld from the Court.

1.3 Information Supplied

5. The information provided to me that I rely upon are the geotechnical investigation reports in relation to the Site. The reports that I refer to are:

   (a) Report of Jeffrey and Katauskas to Concrete Recyclers titled *Geotechnical Investigation for Proposed Earthworks for New Development at Lot 6, DP1065574 Newbridge Road, Moorebank, NSW* and dated 15 October 2010 (**the J&K 2010 Report**);

   (b) Report of Jeffrey and Katauskas to Concrete Recyclers titled *Geotechnical Issues for Part 3A Planning Application (05_1576) for Material Recycling Facility at Lot 6, DP1065574 Newbridge Road, Moorebank, NSW* and dated 8 November 2012 (**the J&K 2012 Report**).

6. Other information supplied has included the Evans & Peck reports dated 2 August 2005 and 3 March 2006, the EIS report dated June 2009 and site plans.

1.4 Background and Assumptions

1.4.1 The Project

7. The background to the approval process, the environmental assessment and the planning assessments are summarised in the "brief to experts" from Swaab Attorneys included in Attachment A.

1.4.2 The Site and the Proposed Development

8. It is understood that the Site is a former landfill which ceased operating in 1979.

9. The Site occupies approximately 20.5 hectares and is bound by the following:

   (a) West – former Boral quarry, now the Georges Fair residential development;

   (b) Southwest – vegetated land;

   (c) South – the New Brighton Golf Course;

   (d) East – the Georges River and its floodplain areas;

   (e) North – former sand and gravel facility operated by Benedict Industries.

10. The proposed development of the Site is understood to involve establishing a material recycling facility in the northern part of the Site.

11. The overall site plan and the proposed facility are shown in Figure 1 which is a copy of the Lyle Marshall & Associates drawing titled *Proposed Overall Site Plan* dated 27.11.12. A detailed section of the plan was included at Appendix A of the J&K 2012 Report.

12. The proposed development involves the earthworks to construct a floodway in the southern part of the Site and a platform over the north half of the Site to accommodate plant, equipment, building and material stockpiles associated with the materials recycling facility.

1.4.3 The Geotechnical Aspects

13. The geotechnical aspects of the proposed development relate to the earthworks and the foundation requirements for proposed structures.

14. Based on the J&K 2010 and 2012 Reports and the discussions from the meeting held with Mr Jackaman of JK Geotechnics the geotechnical aspects of the works can be summarised as follows:

   (a) The excavation of existing landfill materials from the south of the Site to be placed as compacted fill over the northern half of the Site and capped. This will include the construction of sheet pile walls and associated groundwater pumping;

   (b) The construction of containment bund walls to supplement existing bund walls;

   (c) The use of driven piles to support the proposed plant, equipment and structures installed as part of the materials recycling facility;

   (d) The construction of 8m high bunds as noise walls.

2 The Geotechnical Issues

2.1 The Range of Issues

15. The J&K 2012 Report sets out a number of geotechnical issues in relation to the Project. Based on that report and the discussions with Mr Jackaman my summary of the scope of the geotechnical issues is as follows:

(a) Excavations at the Southern part of the Site;

i. Sheet pile wall cut off construction and excavation dewatering;

ii. Extent to which groundwater/leachate can be contained;

iii. Temporary and permanent batter slopes in landfill.

(b) Earthworks at the Northern end of the Site;

i. Screening of landfill materials;

ii. Strength and stiffness characteristics of compacted landfill materials;

iii. The concept of 'heavy compaction' to achieve ground improvement including the relationship of ground improvement measures to the type of materials present, groundwater levels and moisture conditions.

(c) Buildings and Stockpiles;

i. Requirements to deal with gas in the structural design of buildings;

ii. Settlement and bearing capacity of stockpiles;

iii. Differential settlement of ground surrounding piled structures.

(d) Bund walls;

i. Use of landfill materials and the extent to which strength and stiffness parameters can be assessed for design;

ii. Batter slopes for bund walls;

iii. Extent to which landfill would need to be removed from under bund walls.

(e) Other Aspects;

i. Overall sequencing of the various steps in the works;

ii. Acid Sulphate soils – their occurrence and control;

iii. Structures for containment of pumped groundwater during the earthworks;

iv. OH&S issues with use of landfill materials (contaminated) in earthworks.

16. I comment further on these issues below.

2.2 Comments

2.2.1 Excavations Southern end of the Site

2.2.1.1 The proposed works

17. The works at the southern end of the Site are understood to be required so as to construct a floodway.[1]

18. Earthworks are proposed involving excavation of existing landfill and the subsequent placement of engineered fill to create a permanent southern fill batter slope. An indicative batter slope design geometry is given in Figure 19 of the J&K 2010 Report. Temporary and permanent batter slopes are shown as a minimum of 1(V): 2(H).

19. The J&K 2010 Report also refers to the concept of a sheet pile wall installed across the southern part of the Site so at to control groundwater and leachate inflows into the excavation.

2.2.1.2 The sheet pile wall

20. The proposed sheet pile wall will need to act as a cut off if it is to control inflows into the excavation. An issue will be how effective a limited length run sheet pile wall, with partial penetration into the fluvial soils will be.

21. Whilst clay soils have been identified in the J&K investigations, questions could arise about the continuity of such layers over the proposed extent of the sheet pile wall. A further issue would be the effectiveness of the existing bund walls in containing groundwater/leachate.[2]

2.2.1.3 Temporary batter slopes

22. The temporary cut batter slopes will be in materials that will be existing capping layer fill and landfill materials. The landfill materials are described in the investigations referred to in the J&K 2010 Report variously as:

(a) Clays and sands and plastic bags;[3]

(b) A strong hydrogen sulphide odour in test pits and the test pit sides were unstable, continually collapsing during excavation;[4]

(c) Predominantly plastic bags, clays and sands with the materials assessed as poorly compacted.[5]

23. Based on discussion with Mr Jackaman it is understood that plastic bags can, at times, be full of discarded syringes.

24. Clearly the temporary batter slopes need to be designed. Decisions will need to be made about appropriate strength parameters to adopt for the landfill materials. Whilst there is a significant

[1] See for example reports of Evans & Peck dated 2 August 2005 and 3 March 2006.
[2] See Figures 3 to 7 in the J&K 2010 Report.
[3] The J&K 2010 Report section 3.2.1, p10 based on boreholes JK1, JK2 and JK3 located near the southern end of the Site.
[4] The J&K 2010 Report section 3.2.2, p12 referring to test pit investigations involving test pits JK101 to JK114 located throughout the Site.
[5] The J&K 2010 Report section 3.2.3, p14 referring to BH/EFCP212 to BH/EFCP217 located in the northern part of the Site.

amount of published information on the characterisation of domestic landfill materials, there may be greater difficulty in characterising the medical and other industrial wastes. The minimum 1(V):2(H) batter slopes may need to be flatter or, in the absence of a rational basis to assess parameters, may be difficult to adequately design.

25. A standard geotechnical approach to characterising the strength parameters of materials is to sample the materials and carry out appropriate laboratory tests. Such an approach may not be available in circumstances where the landfill materials are contaminated medical wastes. The problem of relying on field trials to assess parameters would be the variability of the landfill materials.

2.2.1.4 Permanent southern batter slope

26. The concept of a "new" southern batter slope involves placement of a geosynthetic clay liner (**GCL**) on the temporary fill batter slope, a sand/recycled concrete lower fill layer and an engineered fill consisting of imported clayey soils or well graded crushed sandstone.[6]

27. Although Figure 19 of the J&K 2010 Report shows a minimum batter of 1(V):2(H), the text refers to a preferable batter slope of 1(V) :3(H) in order to facilitate establishing a protective vegetative cover to the batter.[7]

28. Issues arise about the long-term functioning of the GCL if there is any continuing settlement of the underlying materials (landfill or fluvial clays). Also an issue would be whether the presence of landfill materials would impact on the ability to adequately compact any overlying engineered fill.

2.2.2 Earthworks Northern end of the Site

2.2.2.1 The sequence of works

29. The J&K 2010 Report identified a number of steps in the earthworks at the northern end of the Site. They include, but are not necessarily limited to, the following;

(a) Lowering the groundwater level where it is currently mounded above the levels outside of the Site with associated groundwater/leachate control and construction of a drainage trench;

(b) Reconstruction of the western bund wall (see Figure 20 of the J&K 2010 Report);

(c) Ground improvement of the existing landfill material using 'heavy compaction';

(d) Backfilling of landfill materials with compaction using large static roller;

(e) Reconstruction of the capping layer over the landfill materials.[8]

2.2.2.2 Western bund wall

30. Comment in section 2.2.1 above on the design and construction of temporary batters in landfill materials are also applicable to the works proposed for the western bund reconstruction.

[6] The J&K 2010 Report section 4.1.3, p21.
[7] The J&K 2010 Report section 4.1.3, p22.
[8] The J&K 2010 Report section 4.2, p23-33.

2.2.2.3 Heavy compaction

31. The proposed 'heavy compaction' is to be carried out after stripping of ground to expose the existing capping layer. Impact rolling is referred to as the method of 'heavy compaction'. It is likely that there would be a reduction in ground levels with compaction of the capping and some of the landfill underlying the capping.

32. However, in my experience, the effectiveness of impact rolling as a ground improvement measure is sensitive to the particular characteristics of the materials at a site. In my opinion it would be unlikely that depths of improvement would be greater than 1.5-2m. The effectiveness would usually be assessed by trial compactions. These may indicate that irrespective of how many passes are used, the depth of ground improvement is less than assumed in the design.

33. In such circumstances the issue arises as to the capacity of the existing landfill materials to adequately support developments in the northern part of the Site. The developments would include bunds and stockpiles.

2.2.2.4 Landfill materials as fill

34. Based on the descriptions of the landfill materials in the J&K 2010 Report screening of materials excavated from the southern part of the Site would be required. The objective would be to limit the fill to those materials likely to be improved by the proposed use of a large static roller and which are also amenable to characterisation in terms of strength and deformation properties.

35. Blending of landfill with other fill materials (for example off site sourced VENM) may be required.

36. Related issues would be the engineering criteria used and the OH&S requirements for the screening.

2.2.3 Buildings and Stockpiles

37. I would expect that buildings could be supported on piled footings with piles taken to suitable materials in the natural fluvial soils.

38. It is understood that all buildings would be designed to have suspended slabs with gas drainage blankets.

39. Stockpiles are understood to be up to about 10m high. Issues will exist about the bearing capacity of the ground made up of the capping layer and landfill materials with varying composition and varying degrees of improvement from any 'heavy compaction'. The potential would exist for global stability issues requiring specific ground improvement under the stockpiles. Further measures could include additional piling and/or excavate and replacement of fill.

2.2.4 Bund Walls

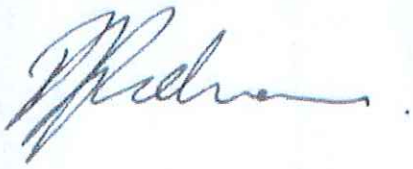
40. It is understood that 8m high bund walls are proposed around some of the perimeter of the Site. The fill materials proposed for the bund walls are understood to include a landfill core overlain by imported fill. There are a number of issues that arise with such a structure.

41. As a guess batter slopes for local stability of fill that includes a landfill material core could be of the order of 1(V):3(H). Allowing for a 2m wide crest, the overall footprint of an 8m high bund would be of the order of 50m. This would be expected to have a significant impact on the space available as part of the development. Such site constraints do not appear to be reflected in the geometries shown in drawings such as that included in Figure 1.

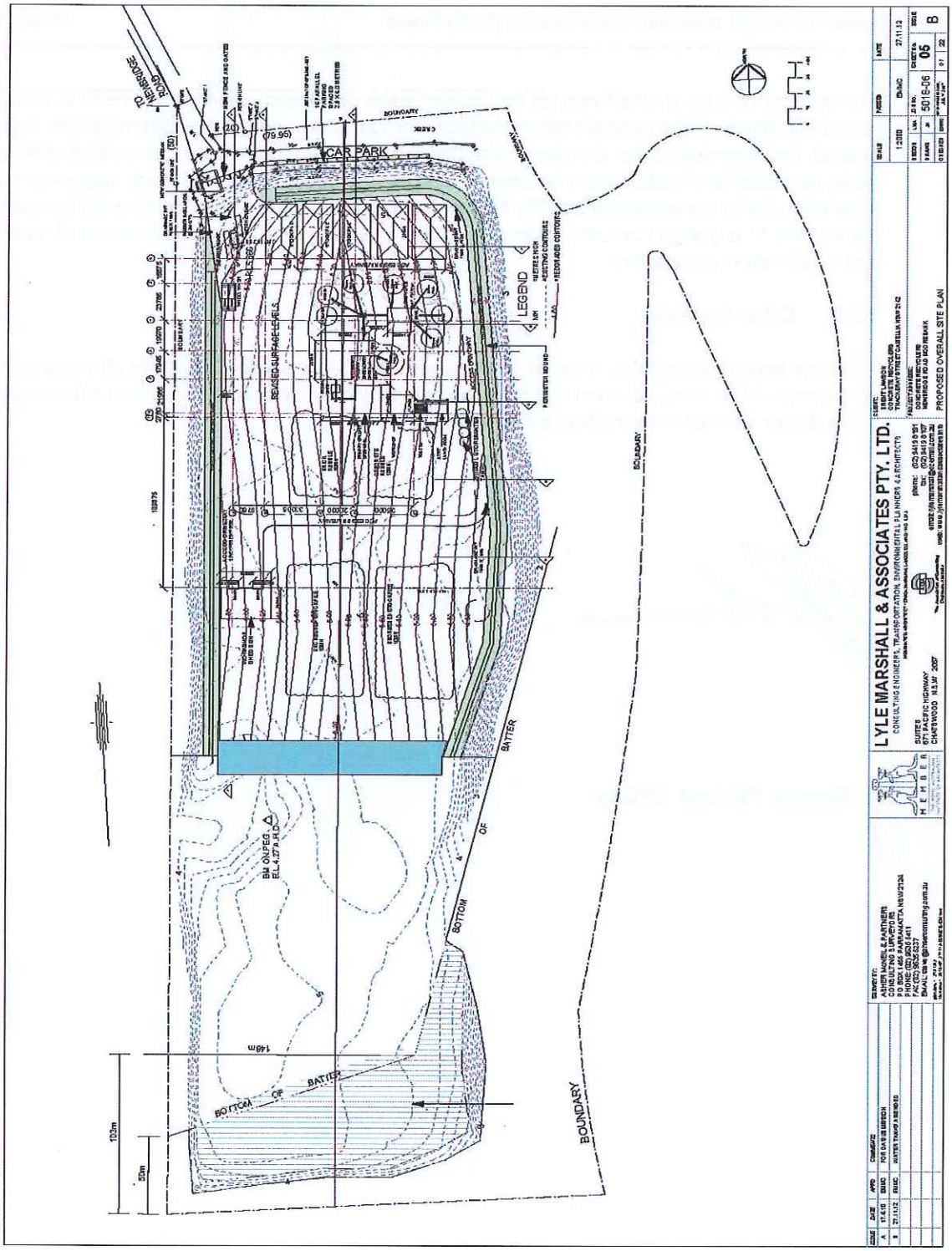
42. The design of the bund structures (as for the stockpiles discussed above) would need to consider global stability involving possible failure surfaces through the underlying landfill materials. Further ground improvement under the bund footprint might be required and could involve extensive piling, excavate and replacement or other ground improvement measures. Such measures could arise because of the assessed stability for the assumed fill parameters or could arise because of the inability in a design context to adequately characterise the fill materials in terms of strength and deformation parameters.

2.2.5 Other Aspects

43. The other aspects referred to in the range of issues identified in section 2.1 above all would require consideration in a design context and have the potential to require particular actions to be included in the design and /or work method statements.



Dr Peter Redman FIEAust, CPEng



Copy of Lyle Marshall & Associates drawing titled 'Proposed Overall Site Plan' dated 27.11.12

Peter Redman Geotechnical Consultant	Swaab Attorneys Liverpool City Council v Moorebank Recyclers Moorebank Waste Recyling Facility Project Proposed Overall Site Plan	**Figure 1**
		Ref. PR214/1-AB / Scale: N/A

C:\\PR214\Figures-214

Attachment A

Brief Letter

30 June 2016

SWAAB

Dr Peter Redman
Geotechnical Consultant
PO Box 84
BALMAIN NSW 2041

SWAAB Attorneys

ABN 71 028 846 652

Level 1, 20 Hunter Street
SYDNEY NSW 2000

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Dear Dr Redman,

Liverpool City Council v Moorebank Recyclers Pty Limited and Minister for Planning
NSWLEC 2016/157848 (formerly 2015/10898)

We act for Liverpool City Council in the above proceedings.

Instructions

We are instructed by our client to engage you as a waste management expert to provide advice in relation to this matter and to provide evidence in court, if required. Specifically, we would like you:

- to prepare an initial report addressed to us with respect to the waste management related matters which arise from:
  - the proposed excavation of areas of landfill
  - the proposed bulk earthworks
  - the impact of proposed piles through former landfill and the landfill liner system upon groundwater and landfill gases;
  - the geotechnical risk of differential settlement caused by placement of the proposed bunds, various site working stockpiles and structures;
  - the geotechnical risks that may arise from the proposed buildings and stockpiles;
  - the geotechnical risks associated with the proposed bund walls; and
  - any other matters that you consider relevant;
- to confer with Council's other experts with respect to the matter;
- to attend a site inspection and discuss the matter with Council's legal advisors;
- to confer with the respondent's expert

We note that Council, who are an objector in the proceedings, do not have access to the site and therefore we are happy for a desktop assessment of these issues to be undertaken. We can provide you with access to Council's relevant records.

Expert witness obligations

As an expert witness in the Land and Environment Court, you are required to comply with Division 2 of Part 31 of the *Uniform Civil Procedure Rules 2005* and the Expert Witness Code of Conduct in Schedule 7 of the *Uniform Civil Procedure Rules 2005*. Copies of the rules are **enclosed**.

Partner
Chris Shaw

Contact
Theresa Sukkar
Senior Associate
+61 2 9777 8321
tms@swaab.com.au

Our ref
151403

By email
p_redman@bigpond.com

Privileged and confidential communication

All communications from you concerning this matter will be with Swaab Attorneys. These communications are privileged and confidential and are subject to legal professional privilege. All written communications should be marked "*Privileged and confidential*" except for your expert report to be filed in the proceedings.

Estimate

While you are engaged by Swaab Attorneys, the cost of your services will be covered by Liverpool City Council.

Please provide us with your fee estimate. We note the following:

1 we will be relying on your estimate to meet our disclosure obligations to the client under the Legal Profession Uniform Law (NSW). Accordingly, please provide:

   (a) an estimate of your total costs

   (b) a single figure for your estimate (not a range of costs)

   (c) an explanation of the basis on which your costs will be calculated (eg applicable hourly rates and relevant units of time, or fixed fee)

   (d) a single figure estimate of all disbursements and, where applicable, how they will be calculated; and

2 we are unable to pay any fees or expenses significantly above those stated in your estimate unless you have notified us promptly after you become aware that your estimate should be revised, giving reasons for the change.

Licence

We ask that, by accepting these instructions, you grant to Swaab Attorneys a non-exclusive, royalty free, perpetual licence to reproduce, adapt and communicate any advice you provide in connection with the instructions for the purposes of the matter and for precedent, knowledge management and training and development purposes.

We will not provide the advice to any client other than the client on whose behalf you are currently briefed without your express permission, and then only subject to any conditions you may require. If this is not acceptable, please let us know immediately.

Timing

1. The matter is listed for hearing for three weeks commencing on 10 October 2016.
2. The experts are required to confer on a preliminary basis by 4 July 2016.
3. The Council is required to file and serve its individual expert reports other than planning and urban design by 15 July 2016.
4. The experts grouped in areas of expertise are to confer in accordance with the UCPR Rules and the Expert Witness Code of Conduct and are to file and serve their joint report by 15 September 2016.

Yours sincerely,

Chris Shaw

Theresa Sukkar

Attachment B

CV Dr Peter Redman

Curriculum Vitae

Dr Peter Redman

Nationality	Australian
Qualifications	BE, Sydney, 1975 PHD, Sydney, 1980 Professional Certificate in Arbitration, Adelaide, 2005 Grade 3 Arbitrator BA (Hons), Macquarie, 2006
Membership	Fellow, Institute of Engineers, Australia Chartered Professional Engineer Registered Professional Engineer, QLD (RPEQ 02411)

Summary

Dr Redman practices as a consultant providing specialist geotechnical services. He has a background of over 35 years of experience and has consulted widely in geotechnical engineering in Australia and overseas. He established his own practice in 1999 and has provided input at senior levels in design development, design review and construction aspects of major infrastructure projects as well as the preparation of expert reports in relation to project claims.

His particular fields of expertise include forensic geotechnical studies, foundation engineering, slope stability studies, earthworks design and construction, numerical analysis, soft ground engineering, and deep excavations. He has experience in most states of Australia and in south-east Asia.

Experience

1999 - present	Peter Redman - Geotechnical Consultant
1993 - 1999	Coffey Partners International, Coffey Geosciences, - Senior Principal, Sydney
1990 - 1993	Coffey Partners International, Managing Director, Sydney
1986 - 1990	Coffey Partners International – Manager, South Australia, Queensland
1984 - 1985	Minister for Mineral Resources and Energy - Adviser
1982 - 1983	Coffey & Partners – Senior Engineer, Sydney
1980 - 1981	McMahon Burgess & Yeates – Engineer and Senior Engineer, Sydney
1976 - 1980	Post-graduate research in Geomechanics, University of Sydney
1975	Sir Alexander Gibb & Partners – Engineer, Canberra

EXAMPLES OF EXPERIENCE

Office Tower, George Street, Sydney
Assessment of impact of deep excavation adjacent to existing railway tunnels using elastic and non-linear finite element modelling to assess changes to in-situ stresses and expected deformation of tunnel lining.

Thomson Dam, Victoria
Over-core testing in adit to assess in-situ stress filed at dam abutment.

Mangrove Creek Dam, NSW
Analysis of dam instrumentation data that included horizontal and vertical displacements and earth pressures. Finite element analysis of the construction stages was carried out to derive deformation parameters by correlation with the field measurements. An incremental construction model was used to predict face displacement on first reservoir filling and future creep related displacements.

Tramway, Iron Monarch, South Australia
Investigation, materials search, materials testing and assessment for a 30km mine tramway.

Road Construction Claims, South Australia
Review of pavement materials test information, aggregate sampling protocols and test outcomes and assessment of the compaction testing information as part of Contractor's construction claims for various road projects (Port Augusta and South-east).

Paper Machine Foundation, Millicent, South Australia
Site investigation for a tissue paper machine involving pressuremeter testing, the testing and assessment of proposed fill materials and the assessment of collapse potential of calcareous sands.

Lochiel Coal Prospect, Lochiel, South Australia:
Geotechnical and hydrogeological studies for the Lochiel Trial Pit Project including design of dewatering system, design and monitoring of trial pit excavation, construction and testing of spoil dumps and induced slope failures. The project was the recipient of the 1987 South Australia Division Engineering Award.

Kanmantoo Mine, South Australia
Investigation of groundwater seepage from an old mine tailings dam. Design of evaporation pond to intercept long-term seepage flows.

Myer Centre, Adelaide
Finite element modelling of a deep excavation to assess potential ground movements and possible impacts on adjacent historical buildings.

Drayton Mine, NSW
Design stability analysis for mine runoff water dam consisting of earthfill and rockfill zones.

Sydney to Brisbane Railway
Investigation and assessment of embankment instability and requirements for earthworks associated with formation reconstruction and stabilisation at sites that included Acacia Ridge, Greenbank, Cougal, Loadstone, Macksville and Casino.

Kunwarara Magnesia Project, Queensland
Investigation and design recommendations for Rockhampton plant site. Fill compaction trials using mine overburden materials and the assessment of design requirements for embankment construction.

Currumbin Crest Development, Gold Coast, Qld
Geotechnical investigation for a hillside development involving treatment of existing landslides, design of retaining structures and construction liaison.

Denarau Island, Fiji
Assessment of offshore sand resources and reclamation strategies as part of a major dredge fill study for a hotel, marina and resort development.

Castle Hill, NSW:
Assessment of a major creep slide that impacted over a large area. Issues arose regarding the evidence for the presence of the slide and the relationship to constraints for nearby development. Involvement included presentations to Council and at public meetings.

Department of Defence, Cockatoo Island, Sydney
Project director for an environmental audit involving the assessment of soil and groundwater contamination at Cockatoo Island in Sydney Harbour. Involved development of a sampling plan based on a detailed historical survey and liaison with EPA. Remediation options were considered and costed in the context of possible development proposals.

Soil Nailed Embankment, Campbelltown, NSW
Design of soil nail remedial measures for an overpass embankment undergoing continuing movement.

Prospect Water Filtration Plant, NSW
Project manager for geotechnical design input and construction inspection for a major water treatment facility. Design aspects of deep excavations, clear water storage tanks with membrane cover and residuals/spoil disposal area. Use was made of large volumes of fill from the nearby Prospect quarry with consideration of material variability at the quarry source, compaction methodology and post-compaction settlement behaviour. Also involved design and construction of a cofferdam using site residual clays.

High-rise apartment building, Moore Park, Sydney
Design analysis of piles-raft foundations to optimize settlements and pile numbers in conjunction with the structural designer.

MFP site, Adelaide, SA
Review geotechnical consultant for investigation of low lying site underlain by soft clays. Included review of trial embankment design and performance, monitoring and construction strategies.

Kooragang Island, Newcastle, NSW
Project manager for geotechnical design input to ground improvement works for Stage 2 of Kooragang Island Coal Loader Facility for contractor client. Work included ground improvement using pre-loading and wick drains and assessment of pile design for associated wharf facilities.

M4 Upgrade, Sydney
Project manager for the investigation and assessment of a major road reconstruction. Included assessment of subgrade and fill materials and advice on embankment extension and further cuts for pavement widening.

Thredbo Landslide, NSW
Involvement in the investigations, Coronial Inquiry and civil proceedings following the Thredbo Landslide. This included participation in expert conclaves and preparation of an expert report for the civil proceedings. Related investigations were carried out for Kosciusko Thredbo Pty Ltd including slope stability risk assessments for Thredbo Alpine Village following the July 1997 landslide. This included review of hazards, assessment of available historical data, field mapping, public liaison and development of risk management strategies and implementation of management measures.

Reinforced Soil Wall Overpass, Silverwater, NSW
Expert report in relation to excessive movement of a reinforced soil wall embankment. Investigations into continuing movement considered the marginal nature of the fill, the records of fill compaction, testing of fill strength and degradation of the fill with time.

Sydney Aquatic Centre, Homebush Bay, NSW
Assessment of probable cause of movement of a reinforced soil wall, including assessment of stability and deformation behaviour. Involved assessment of a range of soil compaction test data and FLAC computer analysis of the reinforced soil wall with overlying fill embankment.

Landslide damage to houses at Newport, NSW
Preparation of an expert report in relation to landslide damage to two houses. Issues related to the history of the site development, the role of shallow fill, the hydrogeology and drainage measures.

South East Transit Way, Brisbane, Qld
Independent third party reviewer of issues between the road authority and contractor in relation to the stability and performance of a number of reinforced soil structures. Assessment of fill materials, quarry sources and construction outcomes.

Penrith Lakes, NSW
Provided technical direction to a major study of the settlement characteristics of deep poorly compacted fills ranging from clayey sands to sandy clays. Fill placement had varied from scraper to truck dumped. Laboratory and field investigations were carried out in relation to fill collapse potential and the efficacy of ground improvement measures. Full scale Dynamic compaction trials were carried out in conjunction with detailed heave testing regimes, soil movement monitoring and deep test pits. Computer Plaxis modelling was carried out in conjunction with empirical methods of assessing the relationship between ground surface movement profiles with collapse behaviour in deeper fill overlain by an engineered fill.

Southern Expressway, Adelaide
Independent third party reviewer of on-going movement problems with the approach and abutment at the Young Street Bridge. Involved FLAC modelling of reinforced soil structures and review of fill material and compaction data. Facilitated on-going technical discussions between Transport SA and the contractor leading to the development and implementation of remedial measures.

Coal UnLoader Facility, Hunter Valley
Preparation of expert report in relation to latent conditions claims by a Contractor. Issues related to the excavation of a dump station, ground characterisation for the rail loop and for conveyor structures.

Orange, NSW
Preparation of an expert report assessing design and construction issues related to erosion and leakage from an earthfill/rockfill dam. Included review of material testing, assessment of earth and rock fill materials, compaction records and test pit investigation of the embankment.

Saigon Premier Container Terminal, Vietnam
Review of soft ground treatment and wharf stability for a green field container terminal development located on the banks of the Soai Rap River near Ho Chi Minh City. Treatments reviewed included pre-loading with wick drains and deep soil mixing. Involvement included assessing the progress of pre-loading and predicted long-term settlement behaviours.

Remediation of Site, Hoxton Park, Sydney
Preparation of expert report in relation to issues raised about the adequacy of fill placed as part of the backfilling of a deep excavation and the cause of surface subsidence following construction. This involved consideration of the specification requirements, the information from several suites of compaction testing, the methods used for fill compaction and the roles of various parties.

Kingsgrove to Revesby Quadruplication (K2RQ), Sydney, NSW
Independent verifier for geotechnical works associated with a major rail upgrade to the existing metropolitan rail network. Included review of geotechnical models, assessment of excavation and fill support designs including reinforced soil walls and contiguous bored piles.

Port Botany Expansion Project, Sydney
Independent geotechnical reviewer of tenders and design development by the successful contractor for a major port expansion project involving 1.2km of counterfort wall with dredged fill reclamation. The sub-surface conditions included fissured clays with issues regarding the strength assessment of the range of materials expected, ground movements with placement and vibro-compaction of the hydraulically placed dredged fill and potential impacts of vibro-compaction on the counterfort structures.

Senoko Tunnel, Singapore
Forensic assessment of third party damage allegedly related to a TBM, shaft and adit works. Issues arose related to loss of ground, groundwater inflows and depressurisation impacts from the works on residual soils and recent sediments.

Domestic houses, various sites, soil reactivity
Preparation of expert reports over approximately a 25 year period in relation to the cracking of domestic houses involving issues of shrink swell behaviour of reactive clays. Sites have included

Adelaide, Armidale, Balgownie, Bourke, Moree, Mullaley, Rutherford, Tapitallee, Werai and various suburban Sydney sites including Bankstown, Strathfield, Terry Hills and Thornleigh.

Domestic houses, various sites, excavation vibration
Preparation of expert reports in relation to alleged damage to domestic houses generally involving issues of possible impacts from vibrations generated by adjacent excavation of rock. Sites have generally been in Sydney and have involved the excavation of Hawkesbury sandstone at locations the have included Bondi, Double Bay, Pennant Hills, Vaucluse and Woollahra.

Material assessment for use of Bottom Ash, Wyong, NSW
Sat with the Judge in the NSW Supreme Court as a court appointed expert in a case involving a proposal to use bottom ash as a drainage layer in the rehabilitation of an old landfill site as a sports field. Issues related to the material durability and permeability and the relationship between the specification requirements and the interpretation of test data.

Moura Rail Upgrade, Qld
Independent geotechnical review of the detailed design investigation for a proposed rail duplication of the Moura line, inland of Gladstone. Included assessment of cuts, fills, bridge foundations and rail formation requirements in a range of geological settings.

Ravensworth North Mine, Hunter Valley, NSW
Design reviewer for a major coal development involving the relocation of a major road, multi-span bridge structures, coal stockpile areas, mine infrastructure buildings and conveyors.

Deep Excavations, various sites
The assessment and preparation of expert reports in a number of matters involving deep excavation support and impacts on third party infrastructure. Site locations in Sydney include Alexandria, Dee Why, Dover Heights, Maroubra and Vaucluse. Other locations include Port Stephens, Adelaide and Canberra. Issues have ranged from vibration impacts, adequacy of the ground support design, loss of ground due to pile defects and loss of ground due to anchor installation.

Port of Brisbane Motorway Upgrade, Brisbane
Independent geotechnical reviewer of investigations and geotechnical design assessment for a motorway construction over soft ground.

Brisbane Airport – New Parallel Runway
Independent geotechnical reviewer of design development of ground improvement strategies for construction over soft ground with time and settlement constraints.

Kooragang Island Emplacement Cell, Newcastle
Geotechnical design input to the design and construction of containment bunds for a contamination fill emplacement over soft ground. Included pre-loading strategies, the assessment of site investigation data and stability analyses.

EastLink Embankment, Melbourne
Independent geotechnical review of on-going settlement of a motorway embankment. Included review of investigation and monitoring data including settlement points, extensometers, inclinometers and piezometers. Input was provided to continuing monitoring programmes. As part of

the assessment of possible remedial measures trails were carried out of cementitous and chemical grouting measures with associated monitoring of impacts on settlement.

Enfield Intermodal Terminal, Sydney
Investigation, design and assessment of earthworks and ground improvement options for the development of an old industrial site as an Intermodal Terminal Facility. Included review of field compaction trials involving heavy rollers and impact rollers with a range of fill thickness.

West Camden Sewage Treatment Plant, Sydney
Expert report in relation to design and construction issues for an STP. Issues involved fill compaction, control of groundwater, the function of clay liners, the characterisation of ground conditions and slope stability.

Townhouse development, Thornleigh, NSW
Expert report in relation to design and construction issues in a multi-unit townhouse development. Issues raised included hydroconsolidation settlement of loose fill, shrink-swell behaviour, the effect of trees and possible remedial measures.

LNG Facility, Darwin, NT
Expert report for contractor involved in a major green-fields LNG facility. Advice was in relation to the available tender geotechnical information compared to conditions subsequently encountered and the scope of the ground improvement required to address soft ground conditions.

Rail Maintenance Facility, Auburn, Sydney
Advice in relation to the collapse of a geo-cell detention basin underlying a car park. Issues involved included the characteristics of the geo-cells, and the use of chemical grouting to stabilise on-going problems with ground movement.

LNG Facility, Gladstone, Qld
Expert report for contractor involved in dredging for LNG pipelines. Advice was in relation to the dredged materials, the dredged geometries and the relationship to the design requirements.

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Small, J.C., Booker, J.R., and Redman, P.G., (1980) The Behaviour of Circular Tanks on Deep Elastic Foundations, *Third ANZ Conference on Geomechanics*, Wellington, pp 2-215 to 2-220.

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O'Brien, M.D., Sullivan, T.D., and Redman, P.G. (1988) Design and Operation of the Dewatering System for the Lochiel Trial Pit, *Third International Mine Water Congress*, Melbourne.

Hacker, J.L.F. and Redman, P.G. (1990) Recent Coastal Sediments and Climatic Variation in South East Queensland, *Proceedings Queensland Division of Institution of Engineers*.

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Moyle, R., Hackney, G. and Redman P. G. (2009) Mechanism and magnitude of collapse settlement in sands and clays, *4th Asia Pacific Conf. on unsaturated soils*, Singapore.

Moyle, R., Redman, P. G. and Hackney, G. (2010) Assessment of ground surface profile resulting from collapsing soils, *3rd International Conf. on Problematic Soils*, Adelaide.