LEICHHARDT MUNICIPAL COUNCIL

PROPOSED CHILDCARE CENTRE

LEICHHARDT PARK, MARY STREET
LILYFIELD NSW

GEOTECHNICAL INVESTIGATION

REPORT G09/1296-A MAY 2014

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G09/1296-A DS:ds
7 May 2014

Leichhardt Municipal Council
7 - 15 Wetherill Street
LEICHHARDT NSW 2040

Attention: Julian Oon

Dear Sir

Re: Proposed Childcare Centre, Leichhardt Park, Mary Street, Lilyfield: Geotechnical Assessment.

Please find enclosed our report on geotechnical studies undertaken for the above site.

The report presents the results of site observations and describes surface and subsurface conditions and recommendations in relation to foundation conditions, footing options, and advice on vibration, dilapidation, groundwater and excavation support.

This report should be read with the attached General Notes. Please contact the undersigned if you require further assistance.

For and on behalf of
Network Geotechnics Pty Ltd

David Smith *BEng(Civil), MIE Aust*
Geotechnical Engineer

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1.0 INTRODUCTION

1.1 General

Network Geotechnics Pty Ltd (NG) has conducted geotechnical studies at Leichhardt Park, Mary Street, Lilyfield, in order to provide geotechnical advice for a proposed Childcare Centre. The investigation was commissioned on 26th March, 2014 by Julian Oon of Leichhardt Municipal Council. The work was carried out in accordance with proposal by Network Geotechnics Pty Ltd dated 7th March, 2014 (Ref G09/1296).

1.2 Scope of Works

The scope of works for the current investigation included the following:

- Visual observations of surface features and within the proposed building envelopes;
- Geotechnical investigation comprising four boreholes drilled to 6m to 8m depth or prior to T-Bit refusal within the building footprint and fill pad;
- Standard Penetration Testing (SPT) at 1.5m depth intervals to assess the consistency/density of insitu soils to aid in the assessment of foundation conditions;
- Geotechnical report addressing site preparation, footings and other relevant issues including vibration, dilapidation, excavation support and groundwater.

2.0 FIELDWORK

Fieldwork carried out on 4th April, 2014 comprised drilling of four boreholes (BH1 to BH4) to refusal depths ranging from 5.7m to 9.45m.

The Boreholes were drilled using a 20t truck mounted 'EDSON 3000' drilling rig using a 100mm diameter auger attached with Tungsten Carbide (TC) bit. Standard Penetration Tests were carried out at 1.5m depth intervals to assess the consistency/strength of in-situ soils. Recovered samples were transported to NG Mount Kuring-Gai Laboratory for subsequent laboratory testing.

The field investigation was carried out by a Geotechnical Engineer from NG who selected borehole locations, carried out sampling and prepared borehole logs. Appropriate borehole locations are shown on the attached drawing (G09/1296-1) and the borehole logs are included in Appendix A.

3.0 LABORATORY TESTING

Laboratory testing on samples recovered during the field investigation comprised the following:

- One Atterberg Limit test and Linear Shrinkage test to aid assessment of soil classification, plasticity characteristics, soil reactivity and re-use potential;
- One Particle Size Distribution test to aid in soil classification, and;
- Natural Field Moisture Content tests on ten samples for assessment of soil classification;

Laboratory reports are included in Appendix B and are discussed in Section 5.0.

4.0 SITE CONDITIONS

4.1 Surface

The site is located within the Leichhardt Park precinct at the north western end of Mary Street, Lilyfield. The proposed childcare centre will be located on an irregular shaped parcel of land adjacent to an exiting playground and carpark. Based on concept plans the building footprint will be about 624m^2. The proposed site is bounded by:

- Car parking to the north;
- Fill embankment and Residential development to the south;
- Residential development and entrance to Mary Street to the south east;
- Playground to the east within the park area, and
- Steep fill embankment, Iron Cove, landscaped bushland and public reserves to the west.

The site is located on relatively undulating terrain sloping west toward public reserve adjacent to Iron Cove waterways. Locally, the proposed site has been subject to fill and is generally flat before falling steeply west and south to the naturally sloping ground.

The filled surface had shallow depressions probably as a result of settlement of dumped fill mainly comprising Sandy Gravelly/Gravelly SAND fill. Fill batters were relatively steep with slopes exceeding about 1H to 1V. The filled surface was covered with grass. The surface soil was found to be a grey brown Silty SAND/Sandy SILT topsoil fill of low plasticity with evidence of gravel and organic matter. The embankment contained various large trees and small shrubs.

The proposed development site consists of an irregular shaped area which extends about 35m long (east-west direction from playground) and about 40m long (north–south from existing carpark). The western and southern boundary was fenced at the top of the embankment forming the shape of a semicircle with about 35-40m radius.

Reference concept plans indicate the top of the embankment was about RL19.5m AHD in the north-western corner and to RL20.8m AHD at the start of the embankment in the south-eastern corner of the site. The survey plan indicates various underground services including two sewer mains across the site.

4.2 Subsurface

Reference to 1:100000 Sydney Landscape Series sheet and a previous investigation within the site indicates the site is to comprise up to about 5m depth of disturbed (xx) fill underlain by the Gymea (gy) erosional landscape comprising rolling rises and low hills on Hawkesbury Sandstone (Rh) consisting of medium to coarse grained quartz, sandstone and very minor shale and laminate lenses.

The subsurface profile encountered in BH1 to BH4 is summarised in Table 1 as follows:

Table 1 - Subsurface Lithology Encountered at BH1 to BH4

Layer	Description	Depth to Base of Layer (m)
FILL:	Gravelly/Clayey SAND/Sandy GRAVEL, fine to coarse grained, grey/brown, fine to coarse gravel, low to medium plasticity, bitumen, brick, metals, glass, cloth	5.0 – 8.5
RESIDUAL:	Clayey SAND, fine to coarse grained, pale yellow white, low to medium plasticity (BH2 and BH4 only)	6.15 - 9.0
WEATHERED ROCK:	SANDSTONE, extremely to moderately weathered, fine to coarse grained, white	>5.7 - >9.45m

4.3 Groundwater

Groundwater was not encountered in Boreholes BH1 to BH4 during the investigation drilling. However, it should be noted that groundwater levels may fluctuate with changes in environmental factors.

5.0 GEOTECHNICAL DISCUSSION & RECOMMENDATIONS

5.1 General

The subsurface conditions encountered at the site included variable fill with thicknesses ranging from 5.0m to 8.5m. Residual clays were encountered in BH2 and BH4 to depths of 9.0m and 6.15m respectively. Weathered rock was encountered beneath fill and residual soils. Refusal depths ranged from 5.7m to 9.45m.

Laboratory moisture content tests of ten samples were taken from fill, residual soils and weathered rock samples. Results indicated field moisture content values of fill soils ranged from 6.8% to 17.6% and a residual soil sample recorded 12.9%. The laboratory results are summarised in Table 6.1 below:

Table 5.1 – Summary of Laboratory Test Results

Borehole No.	Depth	Description	LL %	PL %	PI %	FMC %
BH1	0.5 – 0.95	FILL: Sandy Gravel	29	15	14	11.0
BH1	1.5 – 1.95	FILL: Sandy Gravel	-	-	-	6.8
BH1	4.5 – 4.95	FILL: Gravelly SAND	-	-	-	6.9
BH2	4.5 – 4.95	FILL: Sandy GRAVEL	-	-	-	8.2
BH2	7.5 – 7.95	FILL: Sandy GRAVEL	-	-	-	12.7
BH2	9.0 – 9.45	SANDSTONE: moderately weathered	-	-	-	11.5
BH3	0.5 – 0.95	FILL: Sandy Gravel/Gravelly SAND	-	-	-	11.8
BH3	1.5 – 1.95	FILL: Sandy Gravel/Gravelly SAND	-	-	-	17.6
BH4	4.5 – 4.95	FILL: Sandy CLAY	-	-	-	14.2
BH4	6.0 – 6.28	RESIDUAL: Clayey SAND	-	-	-	12.9

Note: LL (Liquid Limit), PL (Plastic Limit), PI (Plastic Index), Ls (Linear Shrinkage), FMC (Field Moisture Contents), Iss (Shrink-Swell Value)

Standard Penetrometer testing (SPT) carried out on fill soils recorded <1 to 30 blows per 300mm penetration indicating the density of fills soils to be variable. SPT testing carried out on stratum encountered below fill recorded 44 blows (BH2) per blows per 300mm penetration indicating very dense soils or was refused on weathered rock.

5.2 Site Constraints

5.2.1 Uncontrolled Fill

The site is assessed as class P in accordance with AS2870-2011 Residential Slabs and Footings on account of the fill (possible landfill) present within the building envelope and on the site.

The fill depths encountered within the proposed building envelope in Boreholes BH1 to BH4 ranged from 5.0m to 8.5m (about RL 16.5m to RL11.5m AHD). Standard Penetrometer testing (SPT) carried out on fill soils recorded <1 to 30 blows per 300mm penetration indicating the density of fills soils to be variable.

Observations during drilling indicated the fill to be highly variable and probably contain putrescrible materials or large voids. The consequence of the presence of uncontrolled fill includes the following:

- There may be large and uneven settlement of footings placed on fill;
- Excavations for footings and piers would require disposal of excess materials that may be contaminated. Excavated spoil should be tested in accordance with NSW Waste Guidelines prior to disposal, and;

- Any deep excavations within the fill should be supported to prevent collapse.

5.2.2 Settlement

The long term settlement of fill would be difficult to assess as the fill compaction and quality are variable. A rule of thumb the creep settlement of landfill containing putrescible material could range from 2% to 5% of the fill depth. Assuming that the fill depth ranges from 5m to 8m, the total settlement would be about 100mm to 400mm. This settlement may take 100 years to complete and is proportional to logarithm of time. The settlement reactivates with any new loading such as construction of a building or placing new fill. Assuming that the fill would have been present in place more than 50 years the new settlement would likely be about 1.5% of fill height per log cycle. Therefore for a long term settlement in the range of 100mm to 200mm should be allowed. The elastic settlement of the fill with a load of 100kPa would be less than 10mm.

5.2.3 Vibration and Dilapidation

Earthworks involving compaction machines and driving piles would contribute to ground vibration. It is assessed that unless earthworks are to be carried out within the proposed site along the fill embankment and no driven piles are used then vibration will be minimal. Light plant can be used to minimise the impact of vibration with the site and its surrounds. To reduce the effect of vibration and dilapidation during earthworks it is recommended footings be founded on bored piers or grout injected (CFA) piles to weathered rock or shallow foundations with rigid raft construction with flexible super structure. It is recommended that a dilapidation survey be carried out on adjoining properties to assess any possible impact of construction work.

5.3 Footings Options

The site is assessed as class P in accordance with AS2870-2011 Residential Slabs and Footings on account of the fill present within the building envelope and surrounding site.

At the time of preparation of this report no structural details for the proposed development had been provided. Footings should be carried out based on the following:

5.3.1 Option One

It is recommended shallow foundation design should comprise of a rigid raft with flexible super structure. Edge footings and other ground beams on fill material may be proportioned for an allowable bearing pressure of 100kPa. Finishings should be designed to tolerate settlement. The design should recognise P classification and should allow for a differential settlement of 100mm.

Design of slabs in contact with the ground may be carried out assuming a surface movement up to 40mm as per Class M (Moderately Reactive) sites in accordance with AS2870-2011.

Footings should be inspected and approved by a geotechnical consultant prior to concreting.

Parts of the slab over the existing sewer should be piered to below the invert level.

5.3.2 Option Two

Footings embedded in weathered rock should be proportioned for an allowable end bearing pressure of 700kPa. Bored Piers and Grout injected (CFA) piles may be suitable. Screw piles may not be feasible as the piles may not penetrate in to weathered rock to achieve suitable bearing.

Slabs supported on filled ground may be designed based on a surface movement up to 40mm similar to Class M Site in accordance with AS2870-2011.

The footing systems should be designed with generous provision for structural articulation to reduce potential effects of differential movement between areas of varying soil thickness.

The classifications and recommendations presented in this report are provided on the basis that the performance expectations set out in Appendix B of AS2870-1996 are acceptable and that future site maintenance complies with CSIRO Sheet BTF-18, a copy of which is attached. In particular, the site should be maintained in stable moisture conditions by providing adequate drainage.

5.4. Retaining Walls

Retaining walls should be supported by bored piers or CFA piles bearing on weathered rock. Piers bearing weathered rock can be proportioned for an allowable bearing pressure of 700kPa. Earth pressure coefficients for retaining walls are presented in the table below:

Table 5.2 Earth Pressure Co-efficient for Retaining Wall Design

Material	**Unit Weight (kN/m^{3-})**	**φ'**	**Ka**	**Kp**
Fill: Gravelly SAND	18	32	0.3	3.3
Sandstone: Extremely to moderately weathered	21	40	0.2	4.0

Permanent and temporary batters in fill soils should be proportioned for 3H:1V.

Excavation conditions would have to take into consideration the environmental impact of the existing trees.

6.0 LIMITATIONS

This report has been prepared for Leichhardt Municipal Council in accordance with NG's proposal G09/1296 dated March, 2014.

The report is provided for the exclusive use of Leichhardt Municipal Council for the specific development and purpose as described in the report. The report may not contain sufficient information for developments or purposes other than that described in the report or for parties other than Leichhardt Municipal Council.

The information in this report is considered accurate at the date of issue with regard to the current conditions of the site. The conclusions drawn in the report are based on interpolation between boreholes or test pits. Conditions can vary between test locations that cannot be explicitly defined or inferred by investigation.

The report, or sections of the report, should not be used as part of a specification for a project, without review and agreement by NG, as the report has been written as advice and opinion rather than instructions for construction.

The report must be read in conjunction with the attached General Notes and should be kept in its entirety without separation of individual pages or sections. NG cannot be held responsible for interpretations or conclusions from review by others of this report or test data, which are not otherwise supported by an expressed statement, interpretation, outcome or conclusion stated in this report. In preparing the report NG has necessarily relied upon information provided by the client and/or their agents.

For and on behalf of
Network Geotechnics Pty Ltd

D Smith *BEng (Civil)*
Geotechnical Engineer

Reviewed by

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Principal Geotechnical Engineer

Network Geotechnics

GENERAL NOTES

GENERAL

Geotechnical reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report may not be relevant for other phases of the project (e.g. construction), or where project details change.

SOIL AND ROCK DESCRIPTIONS

Soil and rock descriptions are based on AS 1726 – 1993, using visual and tactile assessment except at discrete locations where field and / or laboratory tests have been carried out. Refer to the terms and symbols sheet for definitions.

GROUNDWATER

The water levels indicated on the logs are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specific locations. Also, groundwater levels can vary with time due to seasonal or tidal fluctuations and construction activities.

INTERPRETATION OF RESULTS

The discussion and recommendations in the accompanying report are based on extrapolation / interpolation from data obtained at discrete locations. The actual interface between the materials may be far more gradual or abrupt than indicated. Also, actual conditions in areas not sampled may differ from those predicted.

CHANGE IN CONDITIONS

Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

REPRODUCTION OF REPORTS

This report is the subject of copyright and shall not be reproduced either totally or in part without the express permission of this firm. Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimise the likelihood of misinterpretation from logs.

FURTHER ADVICE

Network Geotechnics would be pleased to further discuss how any of the above issues could affect your specific project. We would also be pleased to provide further advice or assistance including:

- assessment of suitability of designs and construction techniques;
- contract documentation and specification;
- construction control testing (earthworks, pavement materials, concrete);
- construction advice (foundation assessments, excavation support).

Foundation Maintenance and Footing Performance: A Homeowner's Guide

CSIRO

BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

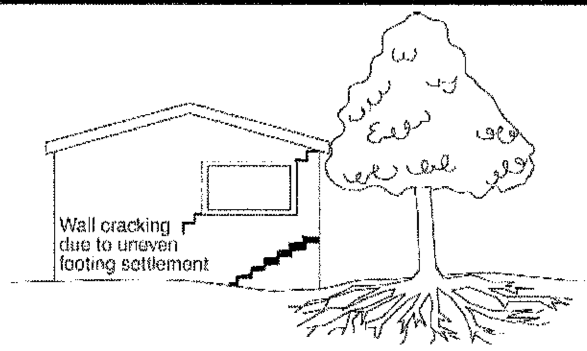
Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures

Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures

Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing

Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage

In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

Protection of the building perimeter

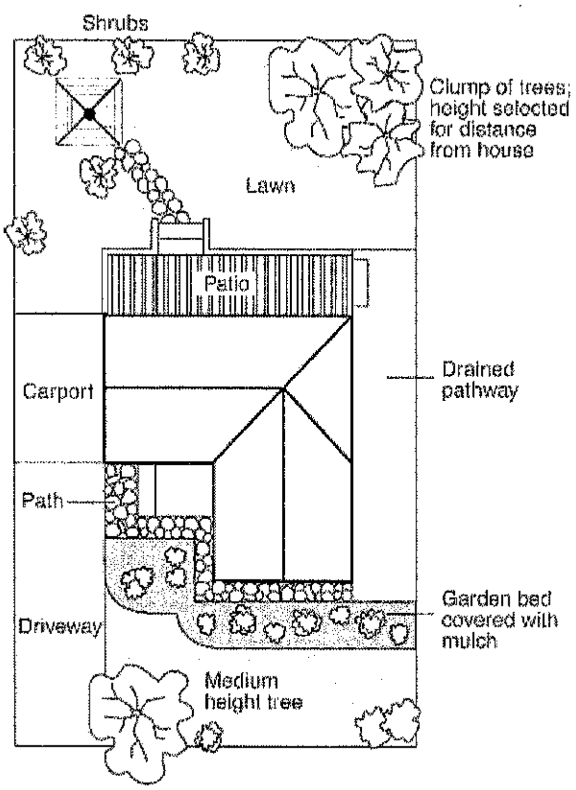
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

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APPENDIX A

Borehole Logs (BH1 to BH4)
Terms & Symbols

BOREHOLE LOG

Network Geotechnics
ACN 069 211 561
12/9-15 Gundah Road
Mount Kuring-gai NSW 2080
(02) 8438 0300
(02) 8438 0310

Job No:	G09/1296
Hole No:	**BH1**
Sheet:	PAGE 1 / 1
Started:	04/04/14
Finished:	04/04/14
Logged:	DS
Checked:	VdS
RL Surface:	
Datum:	

Client: Leichardt Council

Project: Proposed Child Care Centre

Location: Leichardt Park, Mary Street, Lilyfield
GPS

Equipment Type: Truck Mounted Drilling Rig

Borehole Diameter: Inclination: -90 deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments: notes, structure, and additional observations
ADT						SM	Silty SAND fine to medium grained, grey brown, low plasticity, grass roots	M		TOPSOIL FILL
						SM	Silty SAND with Clay, fine to medium grained, dark brown, some medium to high plasticity	D		FILL
SPT		11, 5, 6 N=11				GP	Sandy GRAVEL fine to coarse grained, dark brown, some low to medium plasticity clays at about 2.5m depth, crushed sandstone at the base of the SPT sample	M		Bitumen encountered at 0.25m depth Brick, glass, roadbase, cloth, steel pin, fence wire encountered throughout depth of fill
ADT				1.0						
SPT		4, 4, 8 N=12								
ADT				2.0						
SPT		2, 1, 4 N=5		3.0						
ADT				4.0		SC	Clayey SAND fine to coarse grained, dark grey, medium plasticity	M-W		
SPT		1, 5, 6 N=11				SP	Gravelly SAND fine to coarse grained, grey brown, fine to medium gravel	M-W		Glass encountered
ADT				5.0		GC	SANDSTONE extremely to highly weathered, fine to coarse grained, mottled pale red white	-		WEATHERED ROCK 5.5m depth: very slow drilling progress
		NR		6.0			BH1 Terminated at 5.8 m			5.8m depth: ADT Refusal

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics
ACN 069 211 561
12/9-15 Gundah Road
Mount Kuring-gai NSW 2080
(02) 8438 0300
(02) 8438 0310

Job No:	G09/1296
Hole No:	**BH2**
Sheet:	PAGE 1 / 2
Started:	04/04/14
Finished:	04/04/14
Logged:	DS
Checked:	VdS
RL Surface:	
Datum:	

Client:	Leichardt Council
Project:	Proposed Child Care Centre
Location:	Leichardt Park, Mary Street, Lilyfield GPS
Equipment Type:	Truck Mounted Drilling Rig
Borehole Diameter:	Inclination: -90 deg; Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments — notes, structure, and additional observations
ADT						ML	Sandy SILT low plasticity, dark brown, grass roots, fine to medium sand	M		TOPSOIL FILL
						GP/SP	Sandy GRAVEL fine to medium grained, grey brown, fine to coarse sand, low plasticity, crushed sandstone enconutered at the base of the SPT samples	>Wp		FILL 0.2m depth: glass and concrete encontered
SPT		0, 0, 1 N=1								
				1.0						
ADT										
SPT		2, 5, 6 N=11								
				2.0						
ADT										
				3.0						
SPT		3, 10, 10 N=20								
ADT										
				4.0						
SPT		0, 0, 1 N=1								
				5.0						
ADT										
				6.0						
SPT		1, 5, 5 N=10								

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

ACN 069 211 561
12/9-15 Gundah Road
Mount Kuring-gai NSW 2080
(02) 8438 0300
(02) 8438 0310

Job No:	G09/1296
Hole No:	**BH2**
Sheet:	PAGE 2 / 2
Started:	04/04/14
Finished:	04/04/14
Logged:	DS
Checked:	VdS
RL Surface:	
Datum:	

Client: Leichardt Council

Project: Proposed Child Care Centre

Location: Leichardt Park, Mary Street, Lilyfield
GPS

Equipment Type: Truck Mounted Drilling Rig

Borehole Diameter: Inclination: -90 deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments notes, structure, and additional observations
ADT				7.0		GP/SP	Sandy GRAVEL fine to medium grained, grey brown, fine to coarse sand, low plasticity, crushed sandstone enconutered at the base of the SPT samples *(continued)*			
SPT		2, 2, 0 N=2								
ADT				8.0						8.1m depth: slow drilling progress to 8.5m
						SC	Clayey SAND fine to coarse grained, pale yellow white, medium plasticity	D-M		RESIDUAL
SPT		4, 17, 27 N=44		9.0		GC	SANDSTONE moderately weathered, fine to coarse grained, white	-		WEATHERED ROCK
				10.0			BH2 Terminated at 9.45 m			
				11.0						
				12.0						

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics
ACN 069 211 561
12/9-15 Gundah Road
Mount Kuring-gai NSW 2080
(02) 8438 0300
(02) 8438 0310

Job No:	G09/1296
Hole No:	**BH3**
Sheet:	PAGE 1 / 1
Started:	04/04/14
Finished:	04/04/14
Logged:	DS
Checked:	VdS
RL Surface:	
Datum:	

Client: Leichardt Council

Project: Proposed Child Care Centre

Location: Leichardt Park, Mary Street, Lilyfield
GPS

Equipment Type: Truck Mounted Drilling Rig

Borehole Diameter: Inclination: -90 deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments: notes, structure, and additional observations
ADT						ML	Sandy SILT low plasticity, dark brown, fine to medium sand, grass roots	>Wp		TOPSOIL FILL
						GP/SP	Sandy GRAVEL/Gravelly SAND, fine to coarse gravel, grey, fine to medium sand, some low plasticity clays	D		FILL
SPT		1, 3, 2 N=5								
ADT				1.0						
SPT		3, 3, 5 N=8								
ADT				2.0						
SPT		9, 15, 15 N=30		3.0						
ADT				4.0						
SPT		3, 9, 11 N=20								
ADT				5.0						
						SC	SANDSTONE moderately weathered, white, fine to coarse grained	-		WEATHERED ROCK 5.5m depth: very slow drilling progress
		NR					BH3 Terminated at 5.7 m			5.7m depth: ADT Refusal
				6.0						

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics
ACN 069 211 561
12/9-15 Gundah Road
Mount Kuring-gai NSW 2080
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Job No:	G09/1296
Hole No:	**BH4**
Sheet:	PAGE 1 / 1
Started:	04/04/14
Finished:	04/04/14
Logged:	DS
Checked:	VdS
RL Surface:	
Datum:	

Client: Leichardt Council

Project: Proposed Child Care Centre

Location: Leichardt Park, Mary Street, Lilyfield
GPS

Equipment Type: Truck Mounted Drilling Rig

Borehole Diameter: Inclination: -90 deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments: notes, structure, and additional observations
ADT						GC	Crushed Sandstone, acts as a Gravelly SAND with Clay, fine to coarse grained, fine to medium sandstone gravel, some low to medium plastic fines, pale white pale orange, grass cover, grass roots	M		FILL wire and cloth encountered throughout depth of fill
SPT		11, 5, 6 N=11								
ADT				1.0						
SPT		4, 4, 8 N=12								
ADT				2.0		CI	Sandy Gravelly CLAY medium plasticity, mottled pale red pale yellow, fine to coarse sand, fine to coarse gravel	<Wp		
						GP	Sandy GRAVEL fine to medium grained, brown, fine to coarse sand, some medium plasticity clays	D-M		2.7m depth: Auger drop to 2.9m depth
SPT		2, 1, 4 N=5		3.0		CI	Sandy CLAY medium to high plasticity, pale yellow brown, fine to coarse grained sand	<Wp		
ADT				4.0						4.2m depth: Auger drop to 5.0m depth
SPT		1, 5, 6 N=11								
ADT				5.0		SC	Clayey SAND fine to coarse grained, mottled red white, medium to high plasticity	M-W		RESIDUAL
SPT		6, R		6.0		GC	SANDSTONE moderately weathered, white, fine to coarse grained	-		WEATHERED ROCK
							BH4 Terminated at 6.28 m			6.28m depth: ADT Refusal

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

Network Geotechnics

TERMS AND SYMBOLS

SOIL DESCRIPTIONS

Moisture Condition

D	Dry
M	Moist
W	Wet
Wp	Plastic Limit
Wl	Liquid Limit
MC	Moisture Content

Consistency

		Qu (kPa)
VS	Very Soft	<25
S	Soft	25 – 50
F	Firm	50 – 100
St	Stiff	100 – 200
VSt	Very Stiff	200 – 400
H	Hard	>400
Fb	Friable	

Density Index

		I_D (%)
VL	Very Loose	< 15
L	Loose	15 – 35
MD	Medium Dense	35 – 65
D	Dense	65 – 85
VD	Very Dense	> 85

ROCK DESCRIPTIONS

Weathering

Rs	Residual Soil
XW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
DW	Distinctly Weathered
SW	Slightly Weathered
FR	Fresh

(DW covers both HW & MW)

Strength

		Is (50) MPa
EL	Extremely Low	< 0.03
VL	Very Low	0.03 – 0.1
L	Low	0.1 – 0.3
M	Medium	0.3 – 1
H	High	1 – 3
VH	Very High	3 – 10
EH	Extremely High	> 10

Structure

	Spacing
Thinly Laminated	< 6mm
Laminated	6 – 20mm
Very thinly bedded	20 – 60mm
Thinly bedded	60 – 200mm
Medium bedded	0.2 – 0.6m
Thickly bedded	0.6 – 2.0m
Very thickly bedded	> 2.0m

NOTE: Soil And rock descriptions are based on AS 1726 - 1993

Natural Fractures

Type		Shape	
JT	Joint	pl	Planar
BP	Bedding plane	cu	Curved
SM	Seam	un	Undulose
FZ	Fractured zone	st	Stepped
SZ	Shear zone	ir	Irregular
VN	Vein		

Infill or Coating		Roughness	
Cn	Clean	pol	Polished
Cl	Clay	slk	Slickensided
Ca	Calcite	smo	Smooth
Fe	Iron oxide	rou	Rough
Mi	Micaceous	vro	Very rough
Qz	Quartz		

EXCAVATION/DRILLING METHOD & CASING

BH	Backhoe/excavator bucket
NE	Natural exposure
HE	Hand excavation
AS	Auger Screwing *
AD	Auger Drilling *
R	Roller/Tricone
W	Washbore

** denotes bit shown by suffix*

B	Blank Bit
V	"V" Shaped Bit
T	Tungsten Carbide Bit
LB	Large Bore Push Tube Drilling
MC	Macro Core Push Tube Drilling
DT	Dual Push Tube Drilling
NMLC	NMLC Core Drilling
NQ/HQ	Wireline Core Drilling
C	Casing
M	Mud

SAMPLES/TESTS

B	Bulk sample
D	Disturbed sample
U50	Thin-walled tube sample (50mm diameter)
PP	Pocket penetrometer (kPa)
N*	SPT (blows per 300mm) **denotes sample taken*
Nc	SPT with solid cone
R	SPT refusal

VANE SHEAR TESTS

s_U	Vane shear strength Peak/residual (kPa) and Vane size (mm)

WATER MEASUREMENTS

▼	Water level at the time of drilling
▽	Water level after drilling
▲—	Water inflow
—▲	Water outflow

PUSH TUBE DRILLING

Degree of Resistance	Factor
No percussion	0
Fast push with percussion	1
Medium push with percussion	2
Slow push with percussion	3
Very slow - nearing refusal	4

APPENDIX B

Laboratory Test Results

Network Geotechnics
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TEST REPORT

Client:	Leichardt Council	Job No:	G09/1296	Sheet:	1 of 1
Client Address:	Leichardt NSW	Report No:	4		
Principal:					
Project:	Leichardt Childcare Centre	Tested By:	Cathy McDonald	Date:	7/04/2014
Location:	Leichardt Park, Mary Street, Lilyfield				

Sample Procedure: AS1289.1.2.1 (Clause 6.5.3 - Power Auger Drilling)

MOISTURE CONTENT - AS1289.2.1.1

Sample Number	Test Pit or Borehole	Depth	Test Results
G36997	Test Pit or Borehole: BH1	Depth: 4.5-4.95m	11.0
G36998	Test Pit or Borehole: BH1	Depth: 0.5-0.95m	6.8
G36999	Test Pit or Borehole: BH1	Depth: 1.5-1.95m	6.9
G37000	Test Pit or Borehole: BH2	Depth: 4.5-4.95m	8.2
G37001	Test Pit or Borehole: BH2	Depth: 7.5-7.95m	12.7
G37002	Test Pit or Borehole: BH2	Depth: 9.0-9.45m	11.5
G37003	Test Pit or Borehole: BH3	Depth: 0.5-0.95m	11.8
G37004	Test Pit or Borehole: BH3	Depth: 1.5-1.95m	17.6
G37005	Test Pit or Borehole: BH4	Depth: 4.5-4.95m	14.2
G37006	Test Pit or Borehole: BH4	Depth: 6.0-6.28m	12.9

REMARKS:

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Mt Kuring-Gai Laboratory 1318

APPROVED SIGNATORY: Steven Waugh
DATE: 1/05/2014

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Unit 12, 9-15 Gundah Road
Mt Kuring-Gai,NSW,2080,AUSTRALIA
(02) 8438 0300
(02) 8438 0310
laboratory@netgeo.com.au

TEST REPORT

Client:	Leichardt Council	**Job Number:**	G09/1296
Project:	Leichardt Childcare Centre	**Report Number:**	2
Location:		**Report Date:**	15/04/2014
GTR Number :		**Tested By:**	Craig Giblett

Lot Number :		Lab Number:	G36998
Lot Description :		Date Sampled:	4/04/2014
Test Pit or Borehole: BH1		Sampling Procedure:	AS1289.1.2.1 (Clause 6.4b - Compacted Layers)
Depth: 0.5-0.95m			

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
Liquid Limit (W_L) AS1289.3.1.1	%	29
Plastic Limit (W_P) AS1289.3.2.1	%	15
Plasticity Index (I_P) AS1289.3.3.1	%	14
Linear Shrinkage AS1289.3.4.1	%	-
LS Comments		-
Sample History:		Oven Dried
Preparation Method:		Dry
Shrinkage Mould Length(mm)		

REMARKS:

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

Mt Kuring-Gai Laboratory 1318

APPROVED SIGNATORY
Adam Wallace

DATE
15/04/2014

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Mt Kuring-Gai,NSW,2080,AUSTRALIA
(02) 8438 0300
(02) 8438 0310
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TEST REPORT

Client:	Leichardt Council	**Job Number:**	G09/1296
Project:	Leichardt Childcare Centre	**Report Number:**	3
Location:	LEICHARDT	**Report Date:**	15/04/2014
GTR Number :		**Tested By:**	Cathy McDonald

Lot Number :	Lab Number:	G36997
Lot Description :	Date Sampled:	4/04/2014
Test Pit or Borehole: BH1	Sampling Procedure:	AS1289.1.2.1 (Clause 6.4b - Compacted Layers)
Depth: 4.5-4.95m		

Sample Description:
Gravelly SAND, dark brown

GRADING ANALYSIS - AS1289.3.6.1 (WASHED)

TEST PROCEDURE		TEST RESULTS	SPECIFICATION
Percentage (%) Passing	200 mm sieve		
Percentage (%) Passing	150 mm sieve		
Percentage (%) Passing	125 mm sieve		
Percentage (%) Passing	100 mm sieve		
Percentage (%) Passing	90 mm sieve		
Percentage (%) Passing	75 mm sieve		
Percentage (%) Passing	63 mm sieve		
Percentage (%) Passing	53 mm sieve		
Percentage (%) Passing	37.5 mm sieve		
Percentage (%) Passing	26.5 mm sieve		
Percentage (%) Passing	19.0 mm sieve	100	
Percentage (%) Passing	13.2 mm sieve	96	
Percentage (%) Passing	9.5 mm sieve	95	
Percentage (%) Passing	6.7 mm sieve	93	
Percentage (%) Passing	4.75 mm sieve	90	
Percentage (%) Passing	2.36 mm sieve	87	
Percentage (%) Passing	1.18 mm sieve	83	
Percentage (%) Passing	600 µm sieve	77	
Percentage (%) Passing	425 µm sieve	66	
Percentage (%) Passing	300 µm sieve	51	
Percentage (%) Passing	150 µm sieve	35	
Percentage (%) Passing	75 µm sieve	24	
Coefficient of Uniformity			

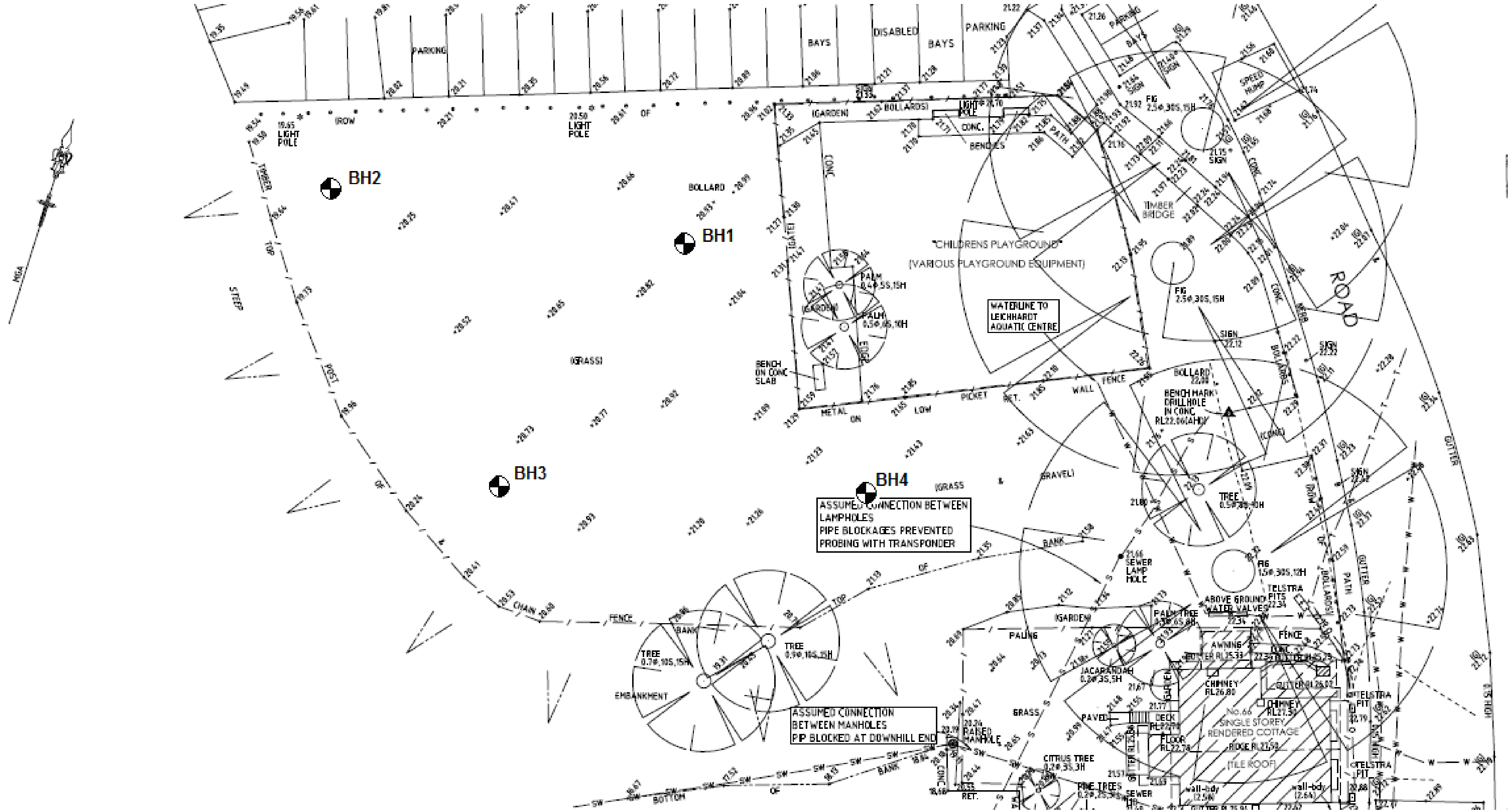
REMARKS:

Accredited for compliance with ISO/IEC 17025.

Mt Kuring-Gai Laboratory 1318

APPROVED SIGNATORY
Adam Wallace

DATE
15/04/2014



	LEGEND:
◑	APPROXIMATE BOREHOLE LOCTIONS

Network Geotechnics Pty Ltd

12/9-15 Gundah Road,
MT KURING-GAI NSW 2080
Tel: (02) 8438 0300
Fax: (02) 8438 0310
Email: engineering@netgeo.com.au

Scale: A4 - NOT TO SCALE	Client: LEICHARDT CITY COUNCIL
Date: 29/04/2014	Project: PROPOSED CHILDCARE CENTRE
Drawing: DS	Location: LEICHARDT PARK, MARY STREET, LILYFIELD
Drawing No: G09-1296-1	Sheet: 1 OF 1 — **BOREHOLE LOCATION PLAN**

Document No. R21.0