Crozier Geotechnical Consultants
Unit 12/ 42-46 Wattle Road
Brookvale NSW 2100
Crozier Geotechnical Consultants a division of PJC Geo-Engineering Pty Ltd
ABN: 96 113 453 624
Phone: (02) 9939 1882
Fax :(02) 9939 1883

REPORT ON GEOTECHNICAL ASSESSMENT

for

PROPOSED HOTEL DEVELOPMENT

at

548 – 552 PACIFIC HIGHWAY, ST. LEONARDS, NSW

Prepared For

Magnificent Investments Pty. Ltd.

Project No.: 2016-109

June, 2016

Document Revision Record

Issue No	Date	Details of Revisions
0	16th June 2016	Original issue

TABLE OF CONTENTS

CROZIER
GEOTECHNICAL CONSULTANTS

Crozier Geotechnical Consultants ABN: 96 113 453 624
Unit 12/ 42-46 Wattle Road Phone: (02) 9939 1882
Brookvale NSW 2100 Fax :(02) 9939 1883
Crozier Geotechnical Consultants a division of PJC Geo-Engineering Pty Ltd

Date: 8th June 2016
Report No: 2016-109

GEOTECHNICAL REPORT FOR PROPOSED DEVELOPMENT
548 – 552 PACIFIC HIGHWAY, ST. LEONARDS, NSW

1. INTRODUCTION:

This report details the results of a geotechnical assessment carried out for a proposed residential unit development at 548 ï 552 Pacific Highway, St Leonards, NSW. The investigation was undertaken by Crozier Geotechnical Consultants at the request of the developer Magnificent Investments Pty. Ltd.

The site is situated on the low southern side of Pacific Highway within gently south and west sloping topography. It is bounded by Christie Lane along the rear. The site consists of two buildings which contain commercial and retail premises.

It is proposed to demolish the existing structures and construct a new hotel development. The new building will be 14 storey with 6 basement car park levels. The basement car park will require excavation below existing ground levels of at least 20.00m depth.

This report is provided for assessment of the site conditions with respect to the proposed development as part of a Development Application submission to North Sydney Council.

North Sydney Councils general Conditions of Consent - Section C6 requires geotechnical reporting to address the proposed development and construction works. To satisfy these conditions requires deep boreholes, cored through bedrock, to 1.00m below the proposed basement level to provide accurate information. However access to the site is very limited due to the siteĝs setting and existing structures, therefore this report incorporates visual inspection and assessment using previous experience within the area only. Further geotechnical investigation will be required once access to the site for a drill rig is possible.

A review of recent development applications nearby the site identified past geotechnical investigation and reporting carried out by Hyder/Jeffrey and Katauskas (J&K) Pty. Ltd. at No. 88 Christie Street opposite the rear of the site. We contacted J&K regarding use of their database information which is included herein with their consent.

Our geotechnical investigation comprised:

- Submission of a Dial Before You Dig enquiry with review of underground services within the vicinity of the site.
- A detailed geotechnical inspection and mapping of the site and adjacent land by a Senior Geotechnical Engineer including a photographic record of site conditions.
- A review of nearby development application submissions and related geotechnical investigations.

The following plans and diagrams were supplied for this work;

- Architectural Drawings by MD+A Architects, Project: Proposed Hotel 548-552 Pacific Highway, St. Leonards, Drawings: DA-01 to DA-04, DA-06 to DA-21, All Revision: A, Dated: 04.05.2016, Development Submission.

2. SITE FEATURES:

2.1. Description:

The site is located within gently south and west sloping topography with a natural ridge upslope to the north-east of the site. The surrounding topography becomes steeper to the south and west of the site. It consists of two adjoining buildings which contain No. 548-550 and No. 552 Pacific Highway.

No. 548-550 consists of a two storey brick building with a lower level basement car park on its southern side. The basement appears partially excavated below the natural ground surface which is sloping away towards the rear. The building is estimated to be at least 80 years old. The lower level of the building contains a restaurant whilst the upper level appears to be commercial offices.

No. 552 consists of a two storey brick building which is occupied by a medical commercial tenant. The building is estimated to be at least 80 years old. At the rear of the building a basement car park is apparent which fronts on to Christie Lane. The basement appears partially excavated below the natural ground surface which is sloping away towards the rear.

The neighbouring property to the west (No. 554) consists of an old (>100 years) two and three storey brick building at ground surface levels. The building adjoins No. 552 along the common boundary with the site. At the rear of the building some vertical and diagonal cracking was noted in the southern building wall.

The neighbouring property to the east (No. 544-546) consists of a two storey brick building which is occupied by a convenience store at the lower level. The building is estimated to be about 60 years old. At the rear is a small open asphalt parking area at a similar level and accessed off Christie Lane.

The North Shore Railway Line is located close to the site passing in a north-south direction with an underpass for the Pacific Highway approximately 60m to the west. Within the western embankment of the underpass, bedrock was visible with interbedded sandstone and shale present approximately 5m below the Pacific Highway road pavement level. This appears to be related to the Mittagong Formation rocks.

Extensive underground service pits were identified along Pacific Highway, Christie Street and Lithgow Street within the footpath reserves. A Dial Before You Dig enquiry indicates numerous services including fibre optics at the front of the site as well as mains gas and sewer within the rear laneway.

The assessments were based on limited visual inspections of the external aspects of neighbouring properties, carried out from the road reserves along with literature review, no sub-surface investigation was completed.

2.2. Geology:

Reference to the Sydney 1: 100,000 Geological Series sheet (9130) indicates that the site is underlain by Ashfield Shale (Rwa) however it is situated close to the contact boundary between the underlying Hawkesbury Sandstone (Rh) bedrock (see Figure: 1 below). The Mittagong Formation rocks can also be encountered at this interface. Mittagong Formation rocks are typically a discontinuous rock unit across Sydney that typically contains interbedded sandstones and shales with clay lenses and moderate levels of groundwater which can result in stability issues in excavtions.

Ashfield Shale is Triassic aged and from the Wianamatta Group of rocks. This unit generally comprises an inter-bedded sequence of shale and laminite which are prone to deep weathering at the surface to clays of medium to high plasticity.

Hawkesbury Sandstone is of Triassic Age. The sandstone rock unit typically comprises of medium to coarse grained quartz sandstone with minor lenses of shale and laminate. Major joint orientations identified within the Hawkesbury Sandstone typically strike north-east to south-west and south-east to north-west.

Figure: 1 ï Sydney 1: 100,000 Geological Series sheet (9130) ï Excerpt (Herbert C., 1983)

2.3. Past Investigations and Ground Conditions

Review of nearby development application submissions through Lane Cove Council identified a recent submission (DA11 224) for No. 88 Christie Street, just across Christie Lane from the rear of the site. This submission includes a Hyder Consulting Desktop Report with a J&K letter which details a database review of past investigations at nearby sites (Ref: 24004WNlet). J&K were approached to request access to their database information including ground testing at 4 nearby sites within 300m of the site. The J&K letter is included within Appendix: 1. Based on the J&K letter and the site inspection the following ground conditions are expected at the site:

FILL: Expected to consist of varying material and depth although generally expected to be in the order of 1.0m to 2.0m depth.

RESIDUAL SOIL ï CLAY and Silty CLAY: Very Stiff to Hard Consistency, expected to be intersected from approximately 1.0m depth up to 4.0m depth.

SHALE ï Of varying strength and weathering overlying the Hawkesbury Sandstone. Expected to be intersected below 2.0m to 4.0m depth.

SANDSTONE ï Varying strength up to very high strength and weathering. This unit was intersected below approximate R.L. 73.50 to R.L. 75.00 in nearby sites.

3. COMMENTS:

3.1. Geotechnical Assessment and Recommendations:

The site inspection identified that the site and adjoining properties contain buildings of significant age. The site is adjoined by existing roads on the north and southern sides whilst the footpath and road reserves contain significant underground service networks.

Based on investigation works undertaken in properties nearby it is expected that the site is underlain by shallow fill and residual clay soils over weathered shale and sandstone bedrock. The weathered rock will contain rock defects and low strength areas with continuous medium to high strength bedrock expected for the lower portion of the proposed excavation. This higher strength sandstone bedrock is expected to contain some jointing/defects.

No existing hazards were identified at the site or surrounding areas, which consists of gently sloping topography. However based on the expected geological and geotechnical conditions it is expected that the upper 5 ï 10m of the excavation will require installation of support measures prior to excavation (i.e. soldier pile walls). At depth the mmedium to high strength bedrock will generally be self supporting however excavation walls are expected to intersect joint defects in the sandstone bedrock which will require installation of rock support (i.e. rock bolts). The significant road and extensive underground services infrastructure adjoining the site could be susceptible to the proposed works within the site either through ground vibrations or movement in the excavation support walls, therefore the design proposal will require consultation with service providers prior to commencement of any works. The upper excavation support walls are likely to require temporary anchoring to reduce lateral deflection and movement in surficial soils/rock supporting adjacent structures, the road reserve and services.

Based on the proximity of the cuts to the side boundaries any excavation support (i.e. rock bolts) may need to extend across into the neighbouring properties or the Council reserve, principally along the southern boundary. Design for the rock support structures will be on an individual basis as identified during inspections and should be undertaken by a geotechnical engineer to limit potential exposure across property boundaries. If required bolts should be based on temporary anchoring with full time support implemented as part of the development. Rock bolting across property boundaries will require approval from neighbouring property and utility owners and relevant stakeholders.

The site is adjoined to the east by a two storey commercial building which contains a convenience store and to the west by two and three storey brick terrace style buildings occupied by commercial and retail tenants. These structures are expected to be founded at shallow depth. The existing site buildings are built right to the neighbouring structures to the east and west. The western neighbouring terrace buildings are old and No. 552 immediately to the west had visible vertical and diagonal cracking at the rear of the building. These structures will be at risk of vibrations and noise from the proposed excavation works as part of the proposed development. The excavation is expected to encounter bedrock of medium and high strength at depth and will therefore require the use of rock excavation equipment which can produce damaging ground vibrations. Prior to excavation commencement the proposed excavation equipment will require approval by the geotechnical engineer with vibration calibration carried out on site and full time vibration monitoring of neighbouring structures recommended during rock excavation works.

The proposed excavation is expected to intersect groundwater in the form of seepage below approximately 3.0m to 5.0m depth and may intersect a significant volume near the base of the proposed excavation. Seepage will occur over the bedrock surface and through rock defects and jointing. The proposed excavation and basement are expected to be waterproof/tanked as part of the final structure and therefore it is expected that only a temporary draw-down effect on existing groundwater levels may result. It is recommended that groundwater wells be installed as part of additional geotechnical investigation with monitoring of site groundwater levels over a minimum 6 month period. It is understood that nearby large basements extend to similar depths as the proposed development (St Leonards Forum) and therefore groundwater draw-down impacts may already be apparent in the vicinity of the site.

Due to the depth of the proposed excavation it should be expected that deformation of the excavated rock face from rock mass de-stressing will occur. The most significant deformation will occur at the crest of the excavation midway along the length of the longer east-west oriented excavation walls. The de-stressing and deformation will open up existing sub-vertical joints in the excavation walls, which would otherwise be stable. This deformation should also be allowed for in the design of the proposed development. During excavation works it is recommended that inclinometers be installed to record these types of movement.

Access to the site is very limited at present by existing structures, however it is recommended that a specialized drill rig for coring into the bedrock be engaged to provide greater detail on the subsurface conditions at depth, including rock strength, groundwater conditions and information on defects within the rock mass. This should be undertaken across the site with boreholes drilled to below basement level and can only be properly completed following demolition of existing structures. Based on previous investigations within similar geological and geotechnical conditions across Sydney the bedrock will be capable of supporting the loads required of the proposed development.

The recommendations and conclusions in this report are based on an investigation utilising only surface observations due to site access limitations. However, provided further geotechnical investigations are undertaken including cored boreholes to below excavation level and the recommendations of this report and future geotechnical reporting are implemented in the design and construction phases the proposed development can be carried out without adverse impact to the site or neighbouring areas.

3.2. Conditions Relating to Design and Construction Monitoring:

To allow Crozier Geotechnical to provide certification as part of construction, building and post-construction activity, it will be necessary for Crozier Geotechnical Consultants to:

1. Undertake additional investigation via cored boreholes to below excavation base to assess bedrock defect and strength characteristics for excavation stability and footing design assessment,
2. Review and approve the structural drawings for compliance with the recommendations of this and additional investigation geotechnical reports,
3. Inspect the installation of any excavation support measures,
4. Review Excavation Methodology and vibration calibration and monitoring of excavation,
5. Inspect excavation at regular intervals for assessment of conditions for stability,
6. Inspect all new footings to confirm compliance to design assumptions with respect to allowable bearing pressure, basal cleanness and the stability prior to the placement of steel or concrete.

The client and builder should make themselves familiar with the Councils Geotechnical Policy and the requirements spelled out in this report for further investigation, assessment, support design and inspections during the construction phase. Crozier Geotechnical Consultants cannot provide certification for the Occupation Certificate if these recommendations are not implemented.

4. CONCLUSION:

The site appears to be underlain by shallow fill and residual clay overlying weathered shale bedrock with sandstone bedrock expected below the shale. The inspection did not identify any obvious existing geotechnical hazards or issues at the site.

The proposed works involve a deep excavation which will extend through weathered shale bedrock within the upper portion with medium to high strength sandstone bedrock expected in the lower portion of the excavation. The excavation will extend right to site boundaries where public walkways/footpaths exist and adjoining buildings therefore excavation support is critical. There is also the potential for vibration damage to adjacent structures during excavation of bedrock. Therefore it is recommended that further geotechnical investigation, including a minimum of 4 cored boreholes be undertaken to below basement level to assess bedrock characteristics for excavation stability and footing design. Regular geotechnical inspection of the bedrock excavation is also required to assess bedrock conditions and allow installation of support as required.

Provided appropriate construction methods are used and the recommendations of this report are adhered to, as well as further geotechnical investigation being carried out prior to construction commencing, the development can be achieved without adverse impact on the site or surrounding areas. However, this will require vibration monitoring and/or onsite calibration as well as ongoing geotechnical supervision of the excavation works including regular site inspections to identify any concerns before problems develop.

Prepared By:	Reviewed By:
James Butcher	Troy Crozier
Senior Geotechnical Engineer	Principal Engineering Geologist
MIE (Aust) No. 3087084	MAIG. RPGeo; 10197

5.0. REFERENCES:

1. Herbert C., 1983, Sydney 1:100 000 Geological Sheet 9130, 1st edition. Geological Survey of New South Wales, Sydney
2. Pells et. al. Design loadings for foundations on shale and sandstone in the Sydney region. Australian Geomechanics Society Journal, 1978, updated 1998.

Appendix 1

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

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

Description and classification Methods

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

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. Sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12 - 25
Firm	25 – 50
Stiff	50 – 100
Very stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300mm)	CPT Cone Value (Qc – MPa)
Very loose	less than 5	less than 2
Loose	5 – 10	2 – 5
Medium dense	10 – 30	5 -15
Dense	30 – 50	15 – 25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

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

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

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

Details of the type and method of sampling are given in the report.

Drilling Methods

The following is a brief summary of drilling methods currently adopted by the company and some comments on their use and application.

Test Pits – these are excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descent into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) – the hole is advanced by a rotating plate or short spiral auger, generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling – the hole is advanced by pushing a 100mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers – the hole is advanced using 90 – 115mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPT's or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling – similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. From SPT).

Continuous Core Drilling – a continuous core sample is obtained using a diamond-tipped core barrel, usually 50mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedures is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test 6.3.1.

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

The test results are reported in the following form.

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

  as 4, 6, 7
  N = 13
- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm

  as 15, 30/40mm.

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50mm diameter thin wall sample tubes in clay. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch Cone – abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australia Standard 1289, Test 6.4.1.

In tests, a 35mm diameter rod with a cone-tipped end is pushed continually into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separte 130mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected buy electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) their information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: -

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0 – 5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0 – 50 MPa) is less sensitive and is shown as a full line. The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios 1% - 2% are commonly encountered in sands and very soft clays rising to 4% - 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range: -

Qc (MPa) = (0.4 to 0.6) N blows (blows per 300mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range: -

Qc = (12 to 18) Cu

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculations of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer – a 16mm diameter flattened rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test 6.3.2). The test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289, Test 6.3.2). The test was developed initially for pavement sub-grade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 “Methods of Testing Soil for Engineering Purposes”. Details of the test procedure used are given on the individual report forms.

Bore Logs

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

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

Ground Water

Where ground water levels are measured in boreholes there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made. More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. A three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. To a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

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

- unexpected variations in ground conditions – the potential for this will depend partly on bore spacing and sampling frequency,
- changes in policy or interpretation of policy by statutory authorities,
- the actions of contractors responding to commercial pressures,

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

Site Anomalies

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

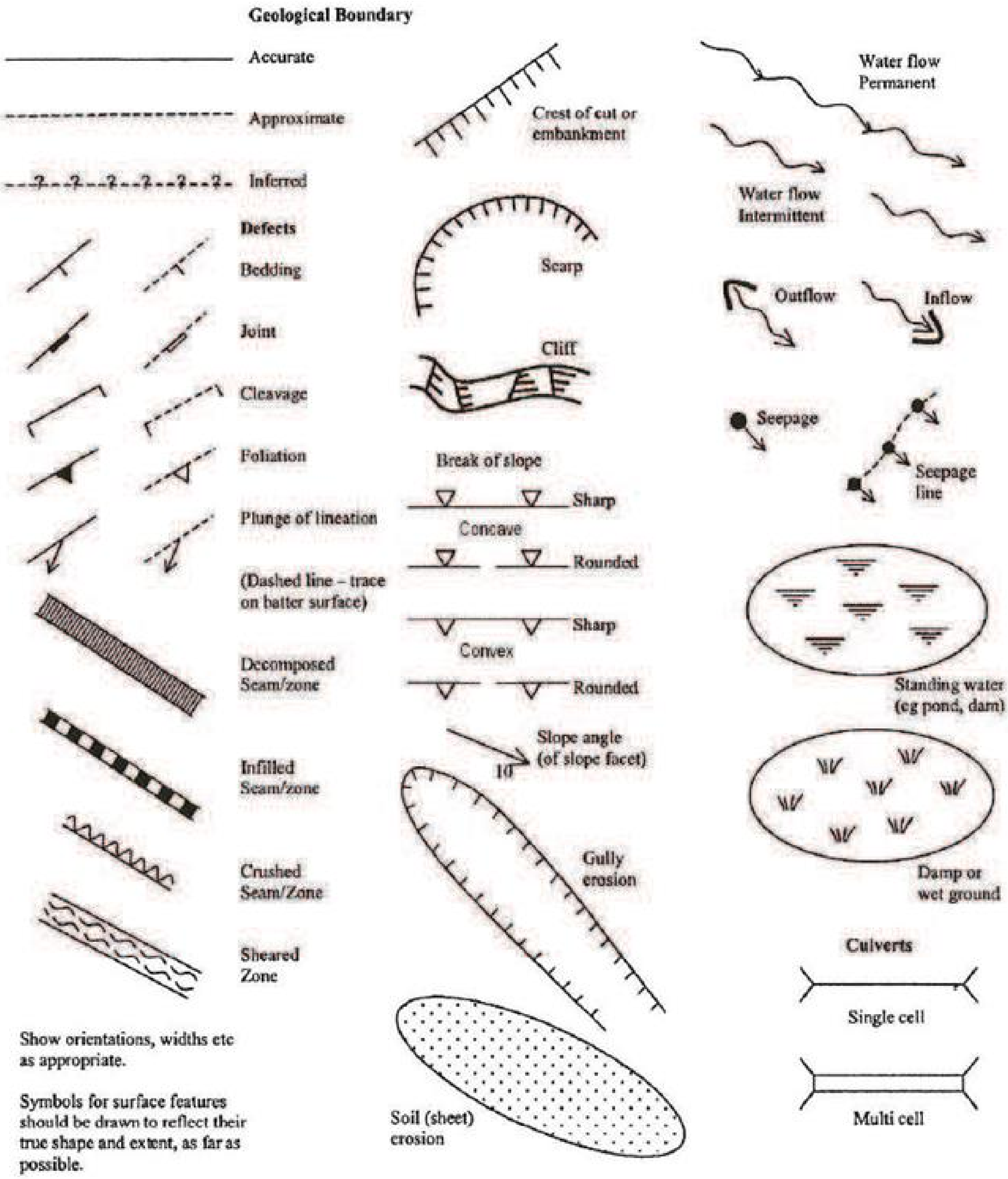
Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a special ally edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

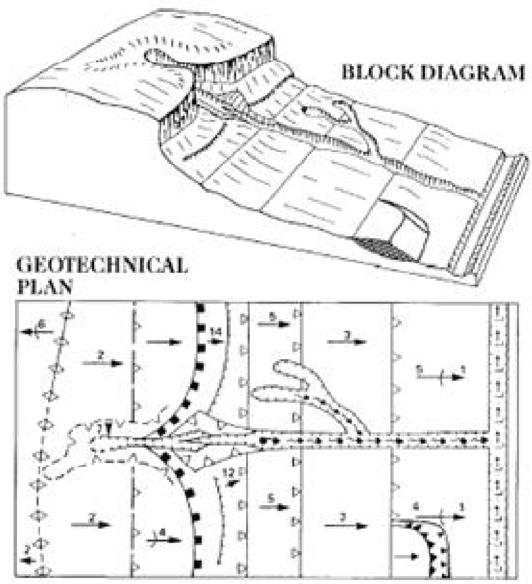
Site Inspection

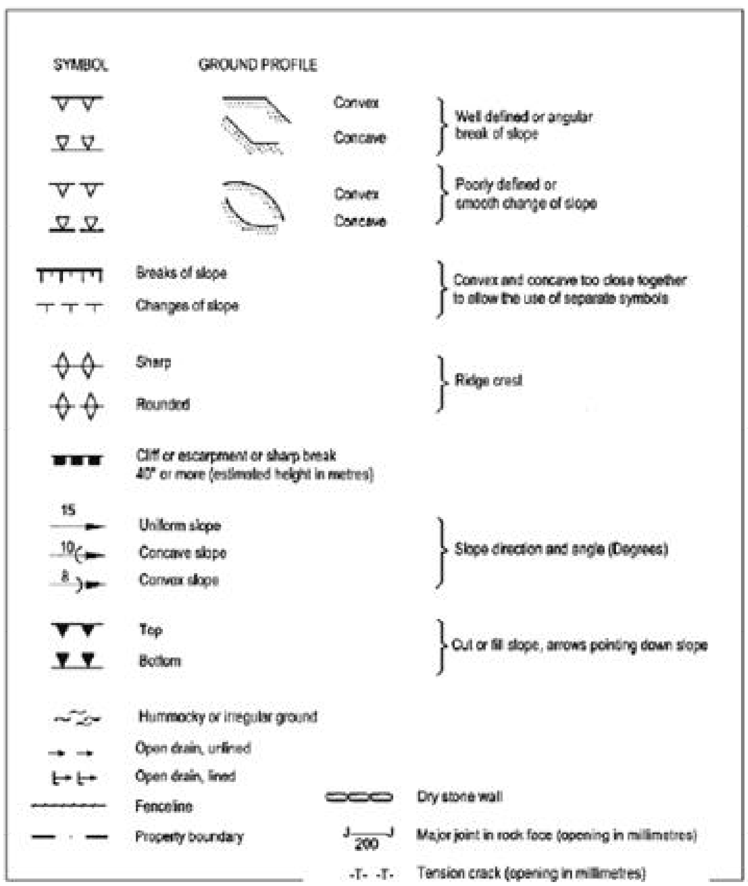
The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

APPENDIX E - GEOLOGICAL AND GEOMORPHOLOGICAL MAPPING SYMBOLS AND TERMINOLOGY



Examples of Mapping Symbols (after Guide to Slope Risk Analysis Version 3.1 November 2001, Roads and Traffic Authority of New South Wales).





Example of Mapping Symbols
(after V Gardiner & R V Dackombe (1983).Geomorphological Field Manual. George Allen & Unwin).

CROZIER
GEOTECHNICAL CONSULTANTS

Appendix 2

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
ABN 17 003 550 801

AS/NZS ISO 9001
Certified
Davis Langdon Certification Services

PO BOX 976, NORTH RYDE BC NSW 1670
Tel: 02 9888 5000 • Fax: 02 9888 5001
Email: engineers@jkgroup.net.au

11 May, 2010
Ref: 24004WNlet

Hyder Consulting Pty Ltd
Level 45, 141 Walker Street
NORTH SYDNEY NSW 2060

ATTENTION: Dr Jim Yang

Dear Sir

DESKTOP STUDY
PROPOSED DEVELOPMENT
88 CHRISTIE STREET, ST LEONARDS, NSW

This letter reports the results of a desktop study for the proposed development at 88 Christie Street St Leonards, NSW. The study was commissioned by Dr Jim Young of Hyder Consulting Pty Ltd by email dated 6 May 2010 and was carried out as outlined in our email dated 5 May 2010.

From email correspondence with Dr Jim Young of Hyder consulting Pty Ltd, we understand that a Part 3 application is being made for a proposed development at the above address. For this application, information is required on anticipated subsurface conditions, both geotechnical and hydrogeological.

The scope of this study was limited to providing existing subsurface information from previous investigations completed on nearby sites.

NEARBY SITES IDENTIFIED

The following nearby sites were identified from our database as having relevant subsurface information obtained during previous geotechnical investigations:

Site 1: Albany Street – approximately 300m to the east of the site.

Site 2: Pacific Highway – approximately 200m to the east of the site.

Site 3: Lithgow Street – approximately 50m to the south of the site.

Site 4: Forum Development, north side of Pacific Highway – approximately 150m north of the site.

Details of the investigations carried out and the subsurface conditions encountered are discussed below. A selection of borehole logs for the above sites have also been included with this letter. The approximate location of the subject site and the nearby sites is shown on the attached Figure 1.

INVESTIGATION DETAILS AND SUBSURFACE CONDITIONS

Site 1

The elevation of site 1 is significantly higher than the subject site, being located uphill towards crows nest.

Two boreholes (BH1 and BH2) were drilled on this site to a maximum depth of 18m. BH2 was diamond cored from a depth of 7.5m and a copy of the borehole log is attached.

Fill was encountered in both boreholes to a maximum depth of 1.2m

Residual silty clay was encountered from beneath the fill to depths of 2.8m and 4m.

Interbedded weathered shale and sandstone bedrock was encountered from beneath the residual silty clay in both boreholes. The bedrock was generally extremely weathered and of extremely low strength, or distinctly weathered and of very low strength. Some higher strength (typically very low to low strength) bands were encountered within the poorer quality bedrock profile.

Minor seepage was encountered at a depth of 10.5m in BH1, however, both boreholes were 'dry' on completion of augering. No piezometers were installed to allow for ongoing groundwater monitoring.

Site 2

Three boreholes (BH1, BH2 and BH3) were drilled to depths between 14.65m and 24.20m using spiral augering and diamond coring techniques. Borehole logs for BH1 and BH3 are attached.

Surficial fill was encountered in all of the boreholes to depths between 0.4m and 0.8m.

Residual silty clay was encountered from beneath the fill to depths between 1.7m and 2.5m.

Deeply weathered shale of extremely low and very low strength was encountered in all of the boreholes to depths between 9.4m and 16.0m. The deeper shale in one of the boreholes was interbedded with silty clays of hard strength.

In BH1, medium strength shale was encountered below a depth of 11.5m, and high strength shale below a depth of 12.4m. Core loss was experienced in this hole between 11.8m and 12.4m depth.

In BH2, the shale was of extremely low and very low strength to the depth of termination at 14.65m.

In BH3, extremely low strength sandstone was encountered from a depth of 16.0m and sandstone bedrock of high strength from a depth of 21.1m to termination at 24.2m depth.

Groundwater seepage was encountered in BH3 at a depth of 7.2m during augering. BH1 and BH2 were 'dry' during augering. No piezometers were installed to allow for ongoing groundwater monitoring.

Site 3

Five boreholes (BH1 to BH5) were drilled to depths between 9.0m and 11.5m. Three boreholes (BH6 to BH8) were subsequently drilled to a depth of 4.5m. All of the boreholes were drilled using spiral augering techniques only. Borehole logs for BH1 and BH4 are attached.

The five initial boreholes disclosed the following profile:

- Fill to depths between 0.3m and 2.2m.
- Residual clays to between 1.1m and 4.2m depth.
- Sandstone bedrock below this. The upper approximately 3m were generally highly weathered and of very low strength, with medium strength sandstone below this. Shale bands were encountered in some of the sandstone bedrock.
- Groundwater was present at depths between 3.6m and 6.6m on completion of the fieldwork.

The three subsequent boreholes disclosed the following subsurface profile:

- Surficial fill to a maximum depth of 0.4m.
- Residual clays to a depths between 1.8m and 1.8m
- Sandstone bedrock below the residual clays. The upper 0.4m to 0.6m was extremely weathered and of extremely low strength, with less weathered and higher strength sandstone bedrock encountered below this.

- All of the boreholes were 'dry' during and on completion of drilling.

No piezometers were installed to allow for ongoing groundwater monitoring.

Inspections of the cut faces during excavation showed the subsurface profile to be highly variable, with numerous extremely weathered bands and clay bands within the sandstone bedrock strata. The cut faces required significant stabilisation treatment in some areas. Some record photographs of the excavation faces are attached.

Site 4

Twenty two boreholes (BH1 to BH22) were drilled by others to depths between 1.4m and 5.0m using spiral augering techniques. A number of the boreholes were extended to a maximum depth of 23.1m using diamond coring techniques. The surface RL of the boreholes varied between 74.4m and 79.9m, datum unknown.

Fill and residual silty clay was encountered in all of the boreholes to RLs between 69.4m and 78.6m.

Highly weathered shale with variable strength sandstone bands was encountered in two of the boreholes to RLs of 72.5m and 72.0m.

Variable strength sandstone was encountered across the site to RLs between 58.6m and 70.5m. The sandstone generally comprised interbedded layers of extremely low to very low strength and medium to high strength sandstone. Some extremely weathered shale bands were also present within this sandstone.

Better quality sandstone bedrock of medium o high strength was encountered below the variable quality sandstone bedrock. Some minor extremely low strength shale lenses were present within he better quality sandstone.

Groundwater was encountered in two of the boreholes at depths between 4.1m and 6.0m. No piezometers were installed to allow for ongoing groundwater monitoring.

OVERVIEW

The 1:100,000 Geological Map of Sydney indicates that the site lies close to or on the interface between Ashfield Shale and the underlying Hawkesbury Sandstone. At this interfaces the Mittagong formation is also encountered and is characterised by interbedded sandstones and shales.

The upper profile encountered was variable with residual clays over weathered shale and interbedded sandstone and shale with fragmented zones and joints. At depth, good quality sandstone bedrock is generally anticipated though some clay and shale seams will likely be present within the better quality sandstone.

Seepage would be expected from the upper profile, say about 3m to 5m depth.

GENERAL COMMENTS

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. Copyright in this report is the property of Jeffery and Katauskas Pty Ltd. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

Should you require any further information regarding the above please do not hesitate to contact the undersigned.

Yours faithfully
For and on behalf of
JEFFERY AND KATAUSKAS PTY LTD

Nicholas Smith
Geotechnical Engineer

Bruce F.L. Walker

Bruce Walker
Principal.

Encl: Borehole Logs from Nearby Sites (5 boreholes)
Figure 1: Sketch Plan Showing Approximate Location of Subject Site and Nearby Sites
Record Photographs from Site 3

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **2** 1/4

Client:
Project: PROPOSED DEVELOPMENT
Location: SITE 1

Job No. 16186W
Date: 29-7-02
Method: SPIRAL AUGER JK250
Logged/Checked by: A.M./
R.L. Surface: ≈ 85.0m
Datum: AHD

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			FILL: Silty clay, low plasticity, dark brown, with a trace of sand.	D			
						CONCRETE: 60mm.t.				50mm DIAMETER REINFORCEMENT AT 40mm TOP COVER
						FILL: Silty clay, low plasticity, brown, with a trace of sandstone and ironstone gravel.	MC>PL			
			1		CH	SILTY CLAY: high plasticity, light grey mottled red brown.	MC>PL	VSt	-	RESIDUAL
		N = 16 4,7,9							380 310 280	
			2					H	>600 >600	
			3		-	SHALE: light grey and grey brown.	DW	L		LOW 'TC' BIT RESISTANCE
			4			as above, but with occasional ironstone bands.				
			5			as above, but dark grey.				
			6					L-VL		LOW TO VERY LOW RESISTANCE
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
2 2/4

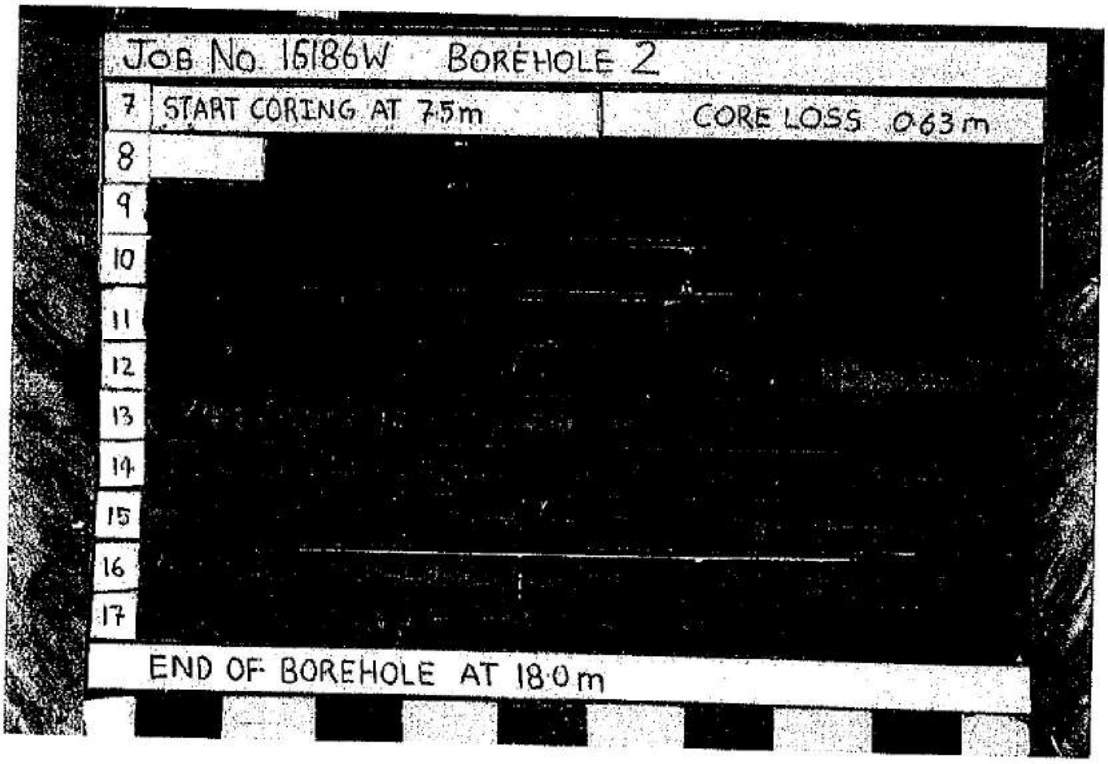
BOREHOLE LOG

Client:
Project: PROPOSED DEVELOPMENT
Location: SITE 1

Job No. 16186W
Date: 29-7-02
Method: SPIRAL AUGER JK250
Logged/Checked by: A.M./ BPW
R.L. Surface: ≃ 85.0m
Datum: AHD

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									SHALE: dark grey.	DW	L-VL		VERY LOW TO LOW RESISTANCE
									REFER TO CORED BOREHOLE LOG				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

SITE 1



JOB No. 16186W BOREHOLE 2
7
START CORING AT 7.5m
CORE LOSS 0.63m
8
9
10
11
12
13
14
15
16
17
END OF BOREHOLE AT 18.0m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No. **2** 3/4

Client:
Project: PROPOSED DEVELOPMENT
Location: SITE 1

Job No. 16186W **Core Size:** NMLC **R.L. Surface:** ≈ 85.0m
Date: 29-7-02 **Inclination:** VERTICAL **Datum:** AHD
Drill Type: JK250 **Bearing:** - **Logged/Checked by:** A.M./BLO.

Water Loss/Level	Depth (m)	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating)
	7	START CORING AT 7.5m			
		CORE LOSS: 0.63m			
	8	SHALE: dark grey.	XW	EL	
			DW	VL	
			XW	EL	
	9	SILTY CLAY: high plasticity, light brown.			HP READINGS:- 480, 440, 500
		as above, but grey.			
		SHALE: dark grey.	DW	VL	
		SHALE: light grey.	XW	EL-VL	
	10				
		INTERBEDDED SANDSTONE: fine grained, light grey, and SHALE: grey.			
	11				
	12				
FULL RETURN	13				
		as above, but with occasional bands of very low strength sandstone, 30-100mm.t.			

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **2** 4/4

CORED BOREHOLE LOG

Client:
Project: PROPOSED DEVELOPMENT
Location: SITE 1

Job No. 16186W	Core Size: NMLC	R.L. Surface: ≈ 85.0m
Date: 29-7-02	Inclination: VERTICAL	Datum: AHD
Drill Type: JK250	Bearing: -	Logged/Checked by: A.M.

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 600 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
				INTERBEDDED SANDSTONE AND SHALE: as above	XW	EL-VL				
		15								
		16								
				SANDSTONE: fine grained, light grey with dark grey laminae at 5-10mm spacings.	DW	VL / L			XWS, 90mm.t.	
		17		INTERBEDDED SANDSTONE: fine grained, light grey, and SHALE: grey.	XW	EL-VL				
		18		END OF BOREHOLE AT 18.0m						
		19								
		20								

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 1 1/3

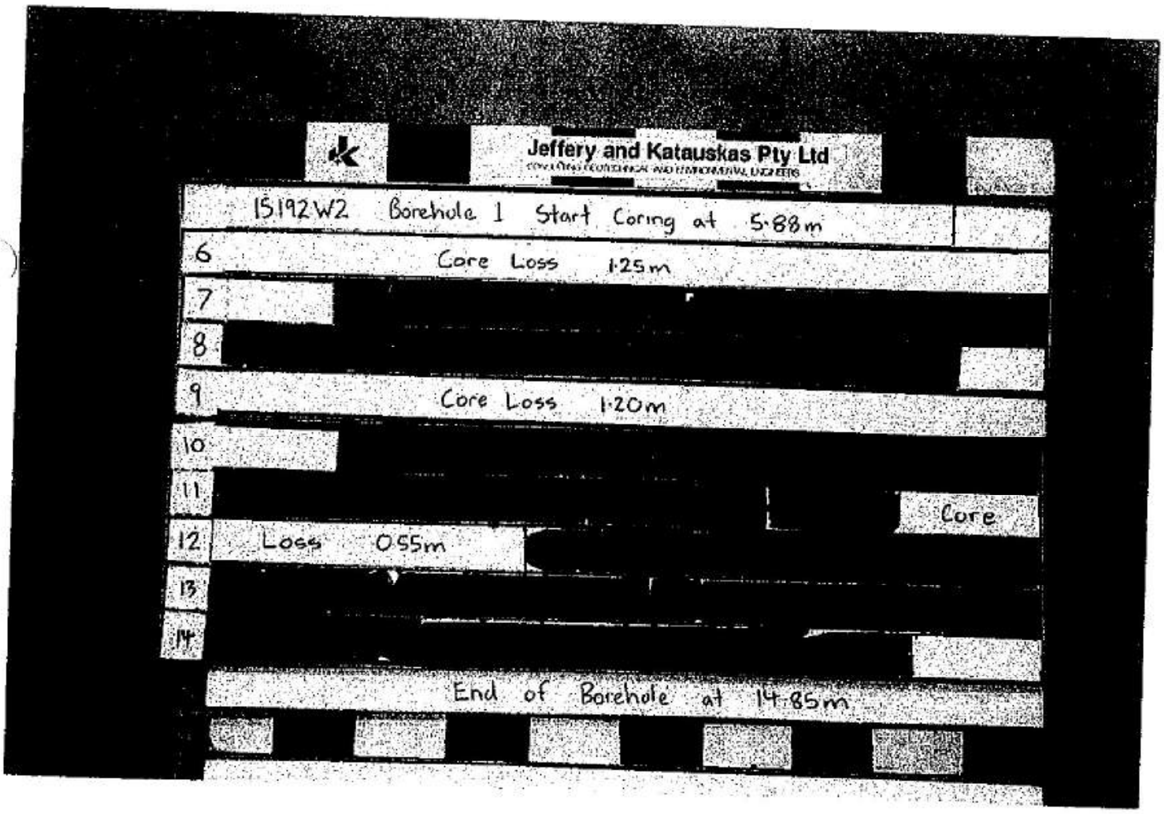
BOREHOLE LOG

Client:
Project: PROPOSED COMMERCIAL/RESIDENTIAL DEVELOPMENT
Location: SITE 2

Job No. 15192WZ
Date: 10-6-00
Method: SPIRAL AUGER INTERTECH 550
Logged/Checked by: S.P./
R.L. Surface: ~93.3m
Datum: ASSUMED

Groundwater Record	Samples	Field Tests	Depth (m)	Unified Classification	Description	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING	ES	PID=0.0	0	–	ASPHALTIC CONCRETE: 30mm.t	MC<PL	(H)	–	–
					FILL: Gravelly silty clay, low plasticity, mottled red brown and dark grey, with a trace of sand.				
	ES, DS	N = 11 4,4,7 PID=0.0		CH	SILTY CLAY: high plasticity, red brown.	MC>PL	VSt–H	250 310 480	RESIDUAL
	DS	N = 19 6,8,11	1		as above, but pale grey mottled red brown, with a trace of medium grained ironstone gravel.	MC<PL	H	>600 510 >600	
	DS	SPT 3/10mm R	2	–	SHALE: brown and grey.	XW	EL–VL	–	VERY LOW 'TC' BIT RESISTANCE
			3						LOW RESISTANCE
	DS				as above, but dark grey, with pale grey laminae.				
	DS		4 5						
			6		REFER TO CORED BOREHOLE LOG				
			7						

SITE 2


Jeffery and Katauskas Pty Ltd
15192W2 Borehole 1 Start Coring at 5.88m
6
Core Loss 1.25m
7
8
9
Core Loss 1.20m
10
11
Core
12
Loss 0.55m
13
14
End of Borehole at 14.85m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **1**

CORED BOREHOLE LOG

Client:
Project: PROPOSED COMMERCIAL/RESIDENTIAL DEVELOPMENT
Location: SITE 2

Job No. 15192WZ **Core Size:** NMLC **R.L. Surface:** ~93.3m
Date: 10-6-00 **Inclination:** VERTICAL **Datum:** ASSUMED
Drill Type: INTERTECH 550 **Bearing:** – **Logged/Checked by:** S.P./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DESCRIPTION: Type, inclination, thickness, planarity, roughness, coating. Specific / General
		5		START CORING AT 5.88m					
FULL RETURN		6		CORE LOSS 1.25m					
		7		SHALE: dark grey with pale grey laminae bedded at 0°.	XW	EL-VL	× × ×		- Be, 0°, IS - Be, 0°, IS - Be, 0°, IS - Be, 0°, IS
		8							
		9		CORE LOSS 1.20m					
		10		SHALE: dark grey, bedded at 0°.	DW	VL-L	×		- J, 40°, P, S - J, 70-90°, P, S - CS, 0°, 30mm.t - CS, 0°, 10mm.t - CS, 0°, 20mm.t - CS, 0°, 20mm.t
		11			XW	EL			
					DW-SW	M	×		
		12		CORE LOSS 0.55m					

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
1
3/3

CORED BOREHOLE LOG

Client:
Project: PROPOSED COMMERCIAL/RESIDENTIAL DEVELOPMENT
Location: SITE Z

Job No. 15192WZ	**Core Size:** NMLC	**R.L. Surface:** ~93.3m
Date: 10-6-00	**Inclination:** VERTICAL	**Datum:** ASSUMED
Drill Type: INTERTECH 550	**Bearing:** -	**Logged/Checked by:** S.P./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		12		CORE LOSS						
FULL RETURN		13		SHALE: dark grey.	DW-SW	H	× × × ×		J, 60°, P, S J, 75°, P, S XWS, 0°, 20mm.t. J, 45°-90°, P, S J, 75°, P, S	
		14								
		15		END OF BOREHOLE AT 14.85m						
		16								
		17								
		18								

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **3** 1/4

Client:
Project: PROPOSED COMMERCIAL/RESIDENTIAL DEVELOPMENT
Location: SITE 2

Job No. 15192WZ
Date: 12-6-00
Method: SPIRAL AUGER INTERTECH 550
R.L. Surface: ~91.3m
Datum: ASSUMED
Logged/Checked by: P.R./

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0		CONCRETE: 100mm.t				
	PID=0.0		-	FILL: Silty clay, medium plasticity, brown and grey, with fine to medium grained igneous and shale gravel.	MC=PL	-	-	-
	N = 7 3,3,4 PID=0.0	1	CH	SILTY CLAY: high plasticity, brown and red brown, with a trace of fine to medium grained sub-rounded shale and ironstone gravel.	MC<PL	VSt-H	400 340 220	RESIDUAL
	N > 10 10,10/ 40mm R			as above, but mottled grey with friable bands.		H	450 440	
		2	-	SHALE: grey, with thin high strength ironstone bands.	XW-DW	L		LOW 'TC' BIT RESISTANCE
		3		SHALE: grey and brown, with thin bands of silty clay of high plasticity, and brown mottling.		VL		
		4						
		5						
AFTER PULLING ROTARY CASING ▼		6		as above, but with extremely strength low bands.	XW			VERY LOW TO LOW RESISTANCE
		7						

SAMPLES: ES, U50, DB, DS

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **3** 2/4

Client:
Project: PROPOSED COMMERCIAL/RESIDENTIAL DEVELOPMENT
Location: SITE 2

Job No. 15192WZ
Date: 12-6-00
Method: SPIRAL AUGER INTERTECH 550
R.L. Surface: ~91.3m
Datum: ASSUMED
Logged/Checked by: P.R./

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/Weathering	Strength/Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
▼			7			SHALE: as above.	XW	VL		
			8		CH	SILTY CLAY: high plasticity, dark grey, with a trace of thin bands of extremely weathered, extremely low strength shale.	MC<PL	(VSt-H)		NO DRILLING RESISTANCE
		SPT 20/150mm R	9		-	SHALE/SILTY CLAY: dark grey, high plasticity.	MC<PL/XW	H/EL	>600 >600	OCCASIONAL BANDS OF VERY LOW RESISTANCE
			10							
		N > 14 15,14/100mm R							>600 >600 >600	
			11							
		N > 37 10,17,20/100mm R	12						>600 >600 >600	WITH THIN FRIABLE BANDS
			13							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

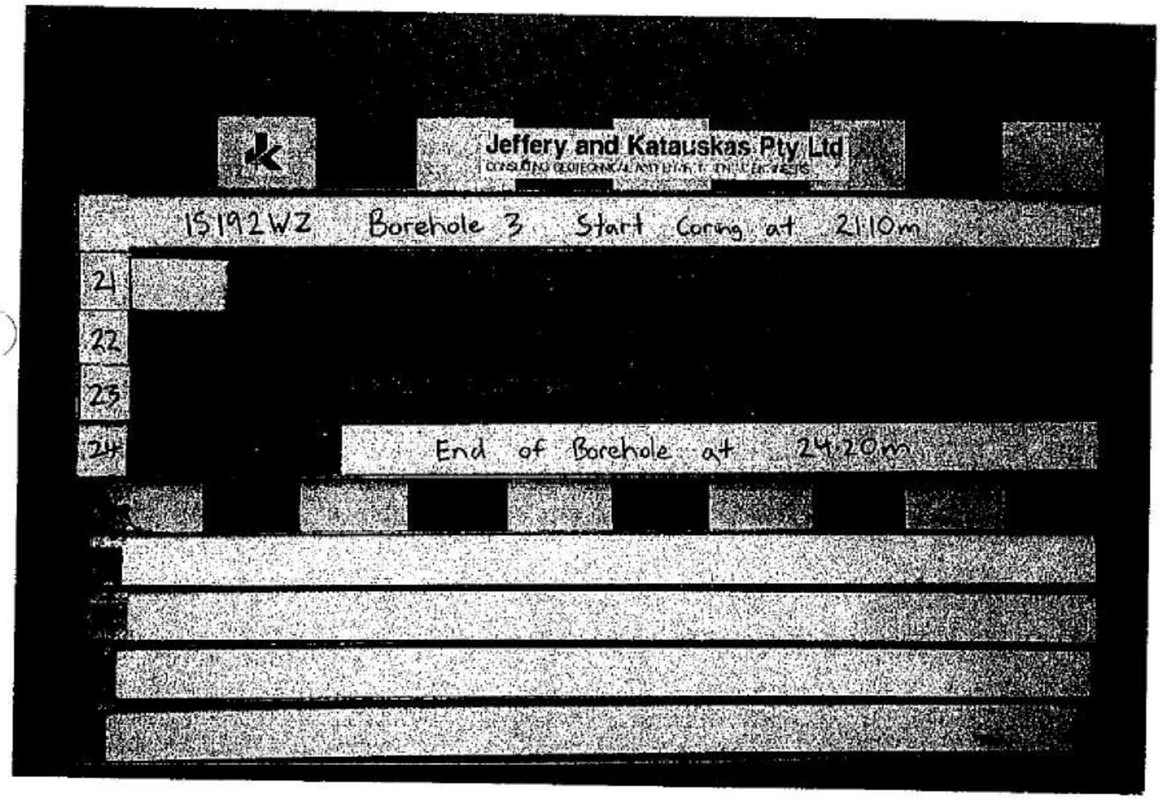
Borehole No. **3** 3/4

Client:)
Project: PROPOSED COMMERCIAL/RESIDENTIAL DEVELOPMENT
Location: SITE 2

Job No. 15192WZ **Method:** SPIRAL AUGER INTERTECH 550 **R.L. Surface:** ~91.3m
Date: 12-6-00 **Datum:** ASSUMED
Logged/Checked by: P.R./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						14			SHALE/SILTY CLAY: dark grey, high plasticity.	MC<PL/ XW	H/ EL		
						15							
					SPT 23/ 100mm R	16		-	SANDSTONE: fine grained, light grey.	XW	EL	-	-
						17							THIN BANDS OF LOW RESISTANCE
						18				XW-DW	L-M		BANDS OF LOW TO MODERATE RESISTANCE
						19							
						20				XW	EL		VERY LOW RESISTANCE
									REFER TO CORED BOREHOLE LOG				

SITE 2


Jeffery and Katauskas Pty Ltd
15192WZ Borehole 3 Start Coring at 21.10m
21
22
23
24
End of Borehole at 24.20m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **3** 4/4

CORED BOREHOLE LOG

Client:
Project: PROPOSED COMMERCIAL/RESIDENTIAL DEVELOPMENT
Location: SITE 2

Job No. 15192WZ **Core Size:** NMLC **R.L. Surface:** ~91.3m
Date: 12-6-00 **Inclination:** VERTICAL **Datum:** ASSUMED
Drill Type: INTERTECH 550 **Bearing:** - **Logged/Checked by:** P.R./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD INDEX STRENGTH $I_s(50)$	DEFECT SPACING (mm)	DEFECT DETAILS DESCRIPTION: Type, inclination, thickness, planarity, roughness, coating. Specific / General
		20							
		21		START CORING AT 21.1m					
FULL RETURN				SANDSTONE: fine grained, light grey, bedded at 0° to 10°.	DW	H	x		- CS, 0°, 8mm.t
									- LAMINATED BAND, 0°, 25mm.t
		22							- 2 J, 55°, P, R, 25mm SPACING
							x		- CS, 0°, 55mm.t, HP = >600kPa
							x		- Cr, 10°, 10mm.t
		23							
							x		- XW BAND, 10°, 5mm.t
		24							- J, 70°, P, R
				END OF BOREHOLE AT 24.2m					
		25							
		26							
		27							

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 1 1/2.

Client:
Project: 729 CLUB DEVELOPMENT
Location: SITE 3

Job No. 5120 JW
Date: 11·6·87

Method: SPIRAL AUGER HYDRAPOWER RIG

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						FILL: sandy clay, low plasticity, yellowish brown and brown, fine to medium grained sand with a trace of gravels, root fibres and charcoal fragments	MC≤PL	V.St		
	D.S.	N=11 4,5,6	1						360 370 350 370	
			2							
	D.S.	N=8 4,4,4			CL-CH	CLAY: medium-high plasticity, orange brown and yellow brown with some fine grained sand and trace of root fibres	MC>PL	V.St / H	320 380 390 540 540	
			3		CL	SILTY SANDY CLAY: low plasticity, whitish brown fine to medium grained sand.				RESIDUAL
	D.S.	N=28 4,18,10/100mm	4			as above, but with some ironstone bands.			320 300 350 320 330	ESTIMATED 'V' BIT REFUSAL
AFTER 4½ hrs	D.S.					SANDSTONE: fine to medium grained, whitish brown, highly weathered, weak, some ironstone bands.				MODERATE 'TC' BIT RESISTANCE WITH SOME WEAK BANDS
			5			as above, but grayish white, moderately weathered, weak-medium strong				MODERATE TO HIGH 'TC' BIT RESISTANCE
			6			as above, but medium strong, occasional interbedded weak shale bands				HIGH 'TC' BIT RESISTANCE WITH SOME MODERATE BANDS.
			7							

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 1. 2/2

Client:
Project: 729 CLUB DEVELOPMENT
Location: SITE 3

Job No. 5120 JW
Date: 11·6·87

Method: SPIRAL AUGER
HYDRAPOWER RIG

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
	D.S.		7–9			SANDSTONE: fine to medium grained, greyish white, moderately weathered, medium strong, occasional weak shale bands				HIGH 'TC' BIT RESISTANCE WITH OCCASIONAL MODERATE BANDS.
	D.S.		9–11.5m			as above, but greyish white, moderately weathered, medium strong.				HIGH 'TC' BIT RESISTANCE
			11.5–13			END OF BOREHOLE				

JEFFERY AND KATAUSKAS PTY. LTD.

BOREHOLE LOG

Borehole No. 4 1/2

Client:
Project: 729 CLUB DEVELOPMENT
Location: SITE 3

Job No. 5120 JW
Date: 11·6·87

Method: SPIRAL AUGER HYDRAPOWER RIG

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
						BITUMEN LAYER				
						FILL: sandy clay, low plasticity, dark brown				
	D.S.	N=26 11,12,14	1		CL	SANDY CLAY: low to medium plasticity, yellowish brown and orange brown, fine to medium grained sand, with some ironstone gravels	MC<PL	H	400 420 >600 >600 >600	ESTIMATED 'Y' BIT REFUSAL
						SANDSTONE: fine grained, whitish grey and light grey, extremely weathered, very weak with interbedded ironstone bands.				MODERATE 'TC' BIT RESISTANCE WITH HIGH BANDS
	D.S.		2, 3							
			4, 5			as above, but fine to medium grained, light grey, highly weathered, weak to medium strong with some ironstone bands.				HIGH 'TC' BIT RESISTANCE WITH MODERATE BANDS
AFTER 1 hour	D.S.		6, 7			as above, but medium strong with occasional shale bands.				HIGH 'TC' BIT RESISTANCE WITH OCCASIONAL MODERATE BANDS

JEFFERY AND KATAUSKAS PTY. LTD.

Borehole No.
4 2/2

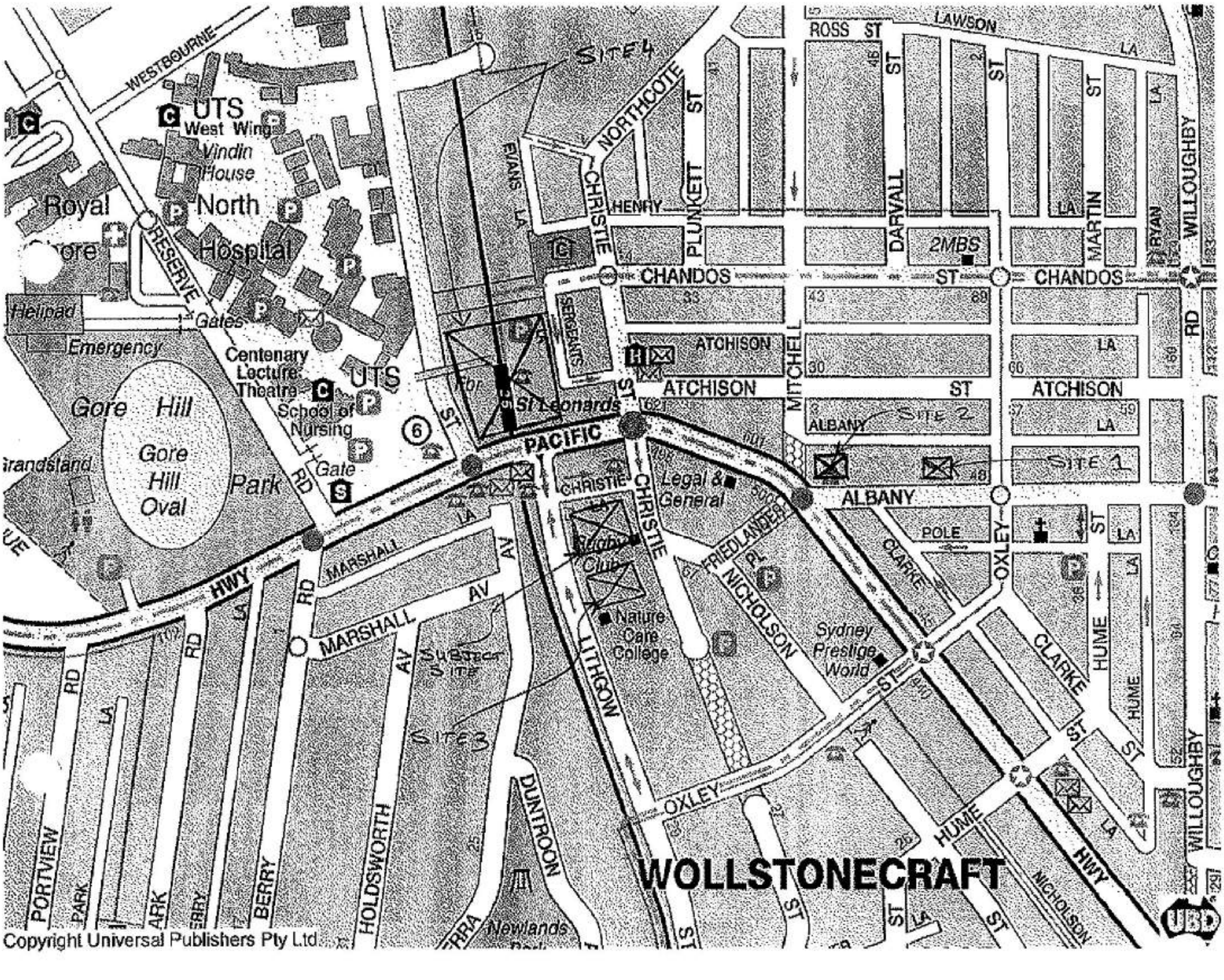
BOREHOLE LOG

Client:
Project: 729 CLUB DEVELOPMENT
Location: SITE 3

Job No. 5120 JW
Date: 11·6·87

Method: SPIRAL AUGER HYDRAPOWER RIG

Groundwater record	Samples	FIELD TESTS	Depth (m.)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition	Consistency/ Rel. Density	Hand Penetrometer Readings kPa.	Remarks
			7			SANDSTONE : as above				HIGH 'TC' BIT RESISTANCE WITH OCCASIONAL MODERATE BANDS
			8							
	D.S.		9.0m							
			9			END OF BOREHOLE				
			10							
			11							
			12							
			13							

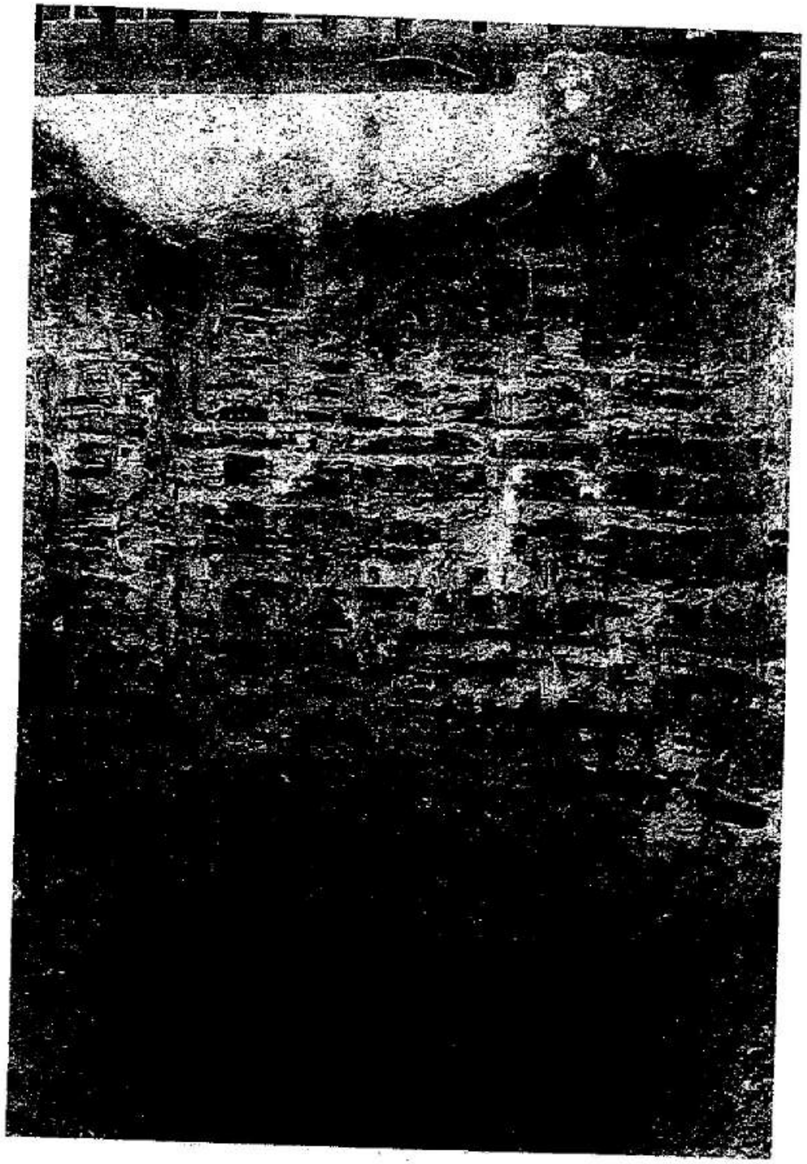


SKETCH PLAN SHOWING APPROXIMATE LOCATION OF SUBJECT SITE AND NEARBY SITES.

NOT TO SCALE

Jeffery and Katauskas Pty Ltd

Report No. 24004WN Figure No. 1

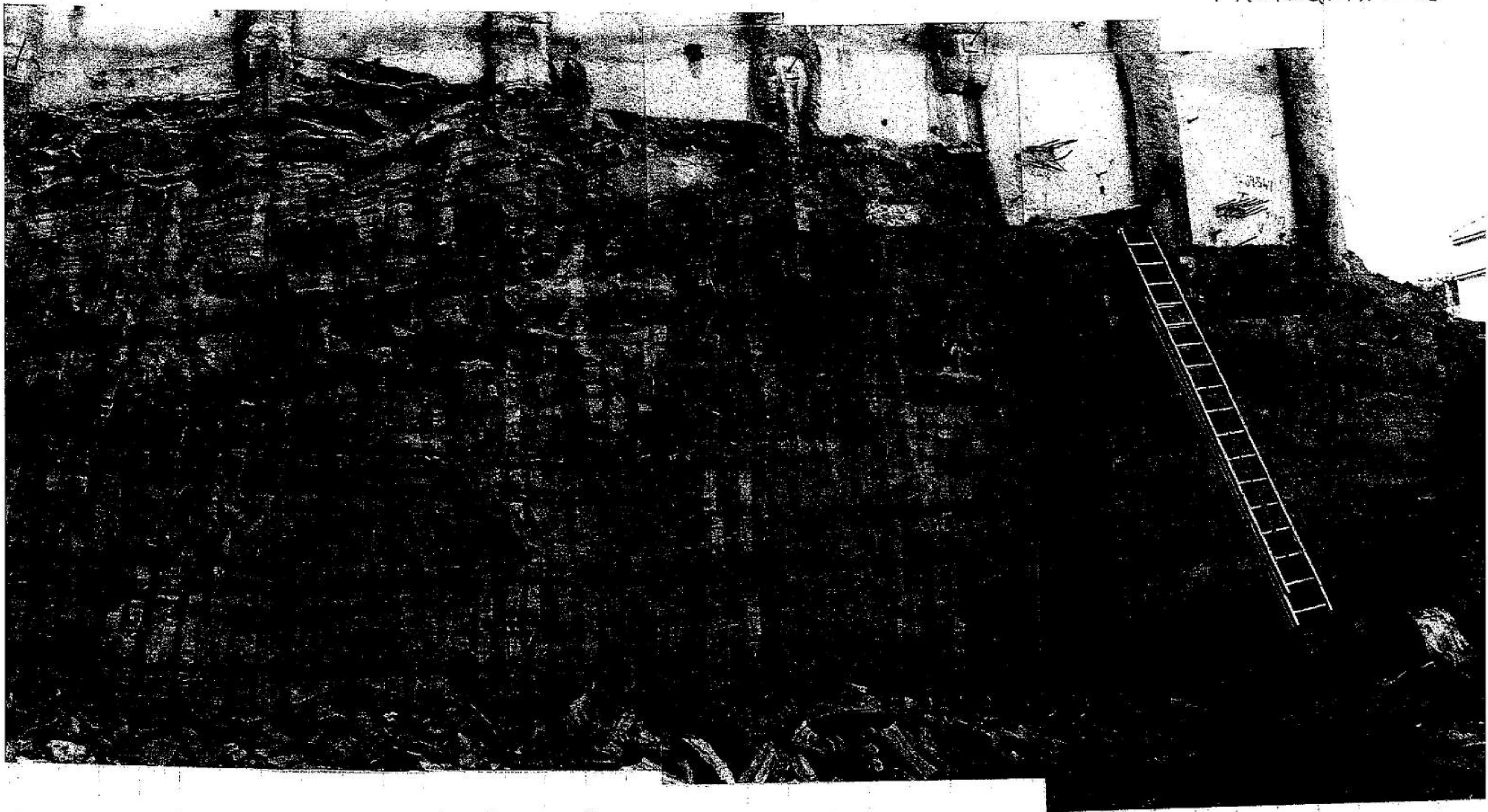


Initial Excav. for underpinning rear corner

26/2/88

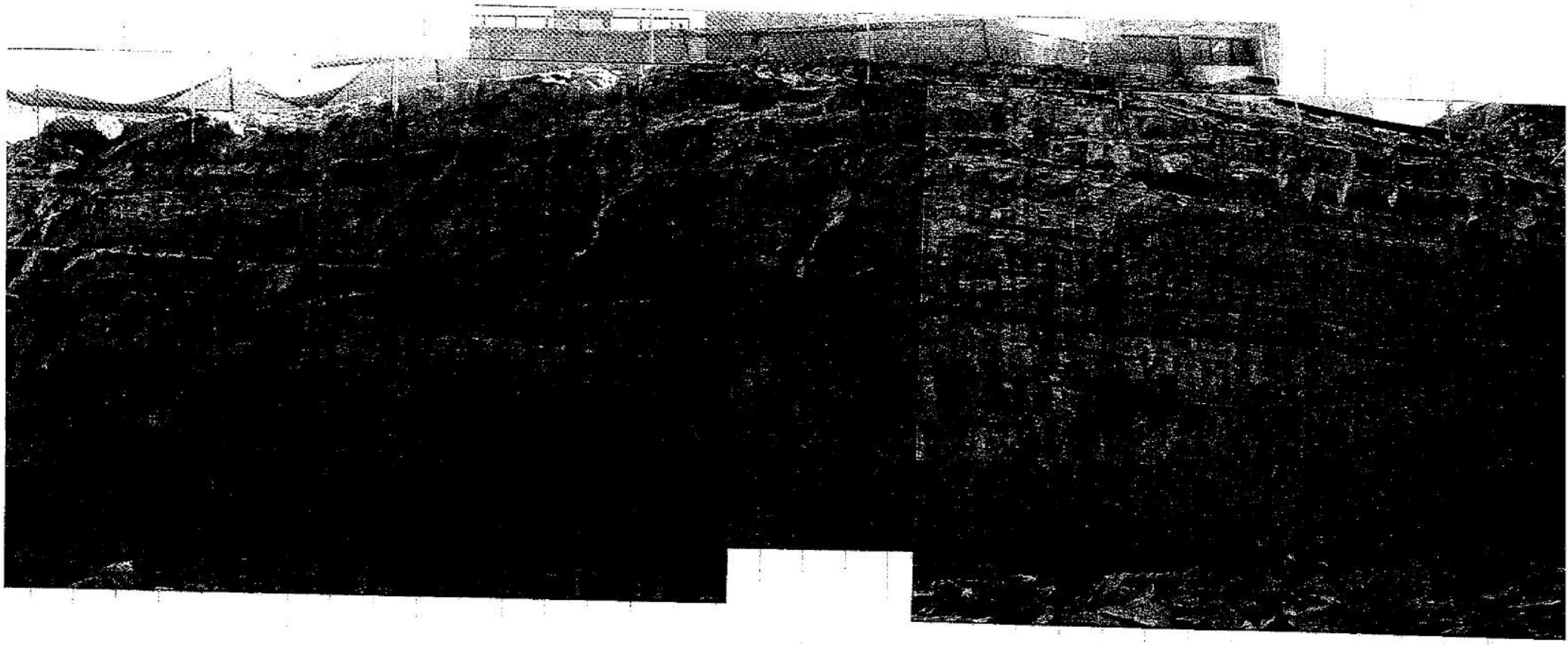
SITE 3
RECORD
PHOTOGRAPH 1

SITE 3
RECORD
PHOTOGRAPH 2



West Side of 729 Club - detailed view

14/9/88.



North Side with adjacent site.

14/4/88

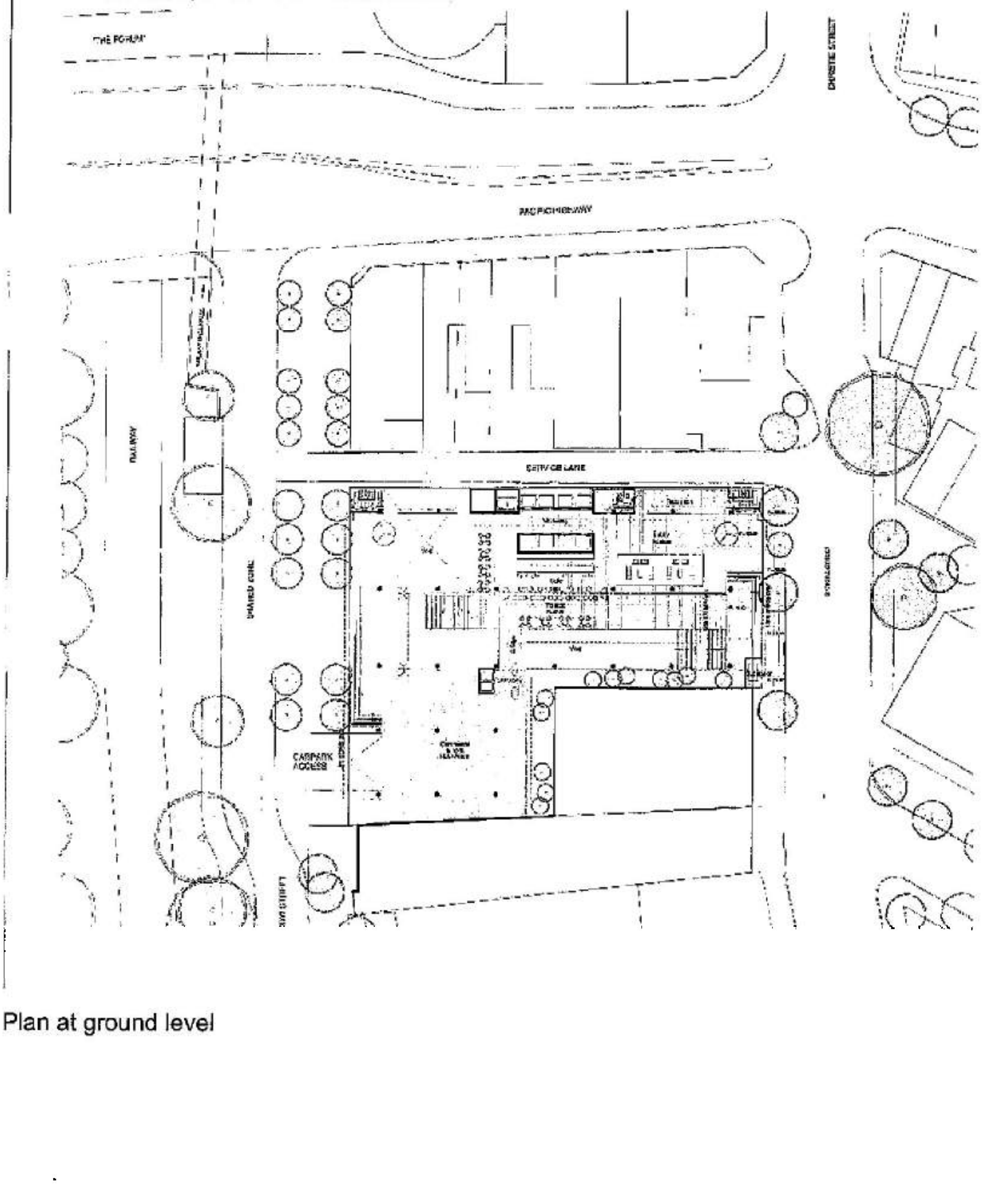
SITE 3
RECORD
PHOTOGRAPH 3

Appendix B

Architectural Plan and Sections

BATESSMART

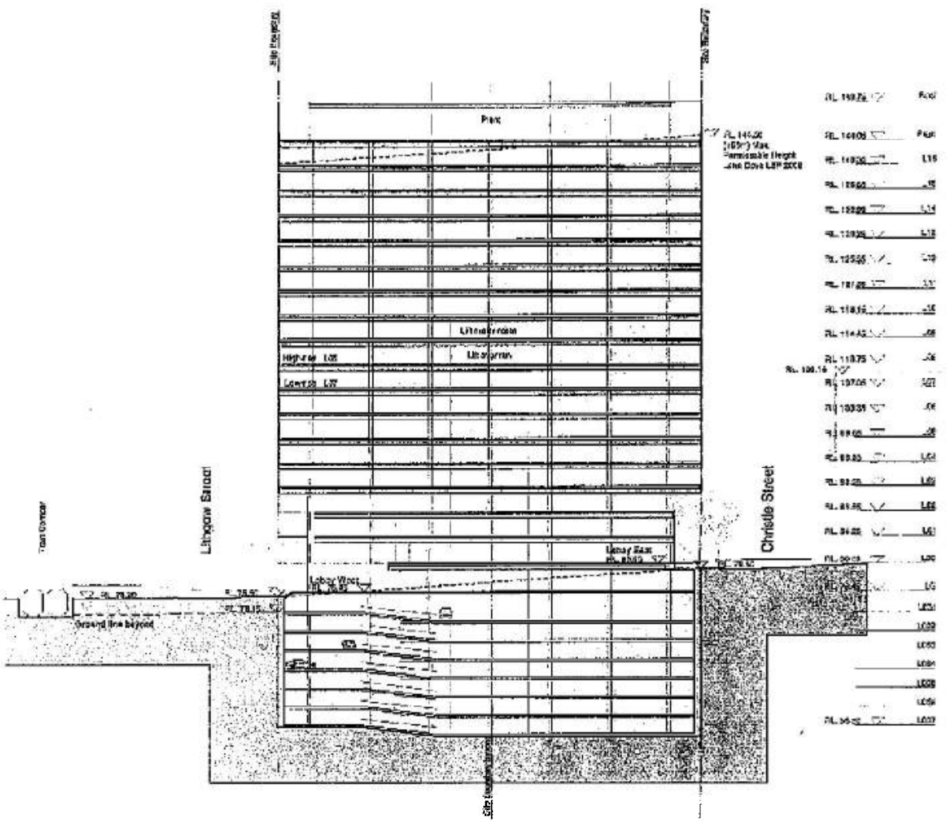
Christie Street, St Leonards Plan Ground 1:500



Plan at ground level

BATESSMART

Christie Street, St Leonards Section 1:500



Typical Cross-Section