REPORT

SOUTHERN CROSS HEALTH TRUST

Geotechnical Assessment Southern Cross Hospital Extension-Wellington

Report prepared for:

SOUTHERN CROSS HEALTH TRUST

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1 General

1.1 Introduction

This report presents the results of an assessment of the geotechnical conditions for the proposed extension of the Southern Cross Hospital, Hanson Street, Wellington. The study was carried out by Tonkin & Taylor Ltd (T&T) at the request of Holmes Consulting Group (HCG) acting on behalf of Southern Cross Health Trust (SCHT).

The conditions of engagement are detailed in our proposal dated 19 May 2008 (Ref. 84528). This report presents the results and conclusions of the investigations.

1.2 Scope of Work

The scope of work carried out for this study comprised the following:

1.2.1 Geotechnical Assessment,

- Collation and review geotechnical data available to us relevant to the site.
- On the basis of the previous information, development of an appropriate scope of site investigation work
- Supervision and logging of subsurface investigations including drilling and trench excavation.
- Preparation of investigation logs, location plan and relevant cross sections.
- Interpretation and analysis of the site data, including assessment of the following:
  - Description of the inferred subsurface conditions at the site, including groundwater levels, site soil classification
  - Bearing capacity and settlement potential for different foundation options and between existing and proposed buildings.
  - Lateral earth pressure coefficient and design parameters for retaining wall.
  - Expected groundwater levels and outline likely subsoil drainage requirements.
  - Seismic subsoil class.
  - Assessment of the geotechnical issues associated with earthworks and foundation construction, including the effects of noise and vibration from earthworks activities on adjoining occupied buildings.
  - Determine design parameters for the existing crib wall (including seismic) based on investigation of founding and retained material/height.

1.2.2 Environmental Investigation and Assessment

- Review historical certificates of title and available aerial photographs for the site.
- Request records of historical pollution incidents from Greater Wellington Regional Council (GWRC), and whether the site is listed on the Selected Land Use Register of contaminated sites.
- Undertake a review of historical files held at Wellington City Council (WCC) archives.

- Test selected soil samples collected from test pits performed during the geotechnical site investigation in a laboratory for contaminants to determine if soil can be managed as clean fill.

This report outlines our assessment and provides recommendations relating to geotechnical/environmental issues of site development.

2 Site Description & Proposed Development

2.1 Site Description

The site comprises land to the west of the existing Southern Cross Hospital on Hanson Street, Newtown. Figure 1 shows the proposed building locations relative to the location of the existing Hospital building and property boundaries. Beyond the western property boundary is the Wellington Indoor Sports Centre. This neighbouring property is owned by WCC and leased to third parties. A small area of land within the property boundary of Southern Cross Hospital is used by the neighbouring lessees as car-parking.

The site has been occupied since the late 1800's. The site has been redeveloped on many occasions and as such, the natural ground surface is now highly modified. A number of significant structures were demolished on the site as part of construction of the adjacent hospital building in 1990/91. In general, the ground surface within the site boundary slopes gently from the western side (RL 131 to 129m)[1] towards the south-eastern corner. The north-western corner rises to the platform level of the upslope property at approximately RL 137m.

The majority of the site comprises grass areas and gardens. A concrete crib retaining wall has been constructed at the toe of the slope adjacent to the north-western corner of the existing building.

2.2 Proposed Development

The proposed extension to the Southern Cross Hospital will comprise a two-storey structure without a basement. Construction will be staged over an undetermined period. Initial development is likely to include the bulk of the main structure.

We understand that the ground floor of this extension will be constructed with a partially suspended floor slab at RL 130m. The extension will be connected to the existing building by way of two walkways. The extension will be seismically separated from the existing hospital building which is founded on shallow foundations.

The north-west corner of the site is to be retained as the proposed extension will require a cut of up to 4.5m height. We understand that the preferred option is to retain this cutting with a crib wall with battering of the slope above extending to the property boundary.

[1] All Reduced Levels (RL) are given in relation to mean sea level as supplied on drawings by Holmes Consulting Group

3 Scope of Investigations

3.1 Existing Data

T & T have previously carried out a Foundation Investigation for HCG as part of the 1990 redevelopment of the site where the existing two storey hospital building to the east of the proposed extension was constructed. The 1990 investigations comprised:

- Drilling of six boreholes across the site with in-situ testing and sampling. Borehole depths ranged from 5.23m to 9.45m below the ground level at that time.
- Excavation of seven testpits across the site to depths of between 1.2m and 2.9m.

The 1990 investigations identified an in-filled stream channel with a south-west to north-east orientation. This channel is overlain with intermixed layers of potentially compressible silty clays and sandy gravels of colluvial/alluvial origin.

The site has been significantly modified since this initial investigation with the removal of a number of structures and re-profiling of the ground surface.

3.2 Current Investigation

Three additional boreholes were drilled within the site boundaries. The locations of the boreholes were chosen to provide clarification of the earlier investigation as well as provide information in the more critical areas of the proposed development, in particular the cuts proposed on the north-west side of the site.

Borehole locations are shown on Figure 1 (Appendix A). Field supervision was undertaken by T&T. Logs of the field investigations are provided in Appendix C.

The boreholes were advanced using a wash-boring technique with standard penetrometer testing (SPT) at 1.0m centres. The boreholes were drilled until either weathered rock was encountered or SPT (N) blow counts were consistently above 50 over several metres. Borehole depths range from approximately 4.1m in BH03 on the north-western side of the site to 10m in BH01 on the south-eastern edge of the proposed building.

Three test pits were excavated for the geotechnical investigation within the site boundaries. The locations of the test pits were chosen to provide clarification of the earlier investigation and confirmation of surface materials following earlier development.

The test pits were excavated using a 12 tonne tracked excavator. In locations where concrete floor slabs from previous buildings on the site where encountered, the test pits were extended to clarify the extent of these.

The interpreted subsurface profile is provided in Section 4.2.1 following.

4 Engineering Geology

4.1 Geological Setting

The Wellington region is situated within folded and faulted sandstone, siltstone and mudstone of the Triassic age (approx 250 to 204 million years) Rakaia Subterrane (Begg & Mazengarb, 1996). The Rakaia Subterrane is part of the Torlesse Supergroup. Commonly termed 'Greywacke' the Torlesse Supergroup forms the basement rock over much of the South Island and lower part of the North Island.

In the area of the site, greywacke rock is overlain by a sequence of sediments that are variably composed of colluvium and alluvium. Greywacke rock below the sediments is typically deeply weathered. Large cuts in rock are apparent to the west of the development above the Indoor Sports Centre. Fill from these previous large scale excavations has been pushed out to form the platform for the Indoor Sports Centre. This fill forms the batter on and above the western site boundary.

The seismically active Wellington Fault is located approximately 2.7km to the west of the site. The secondary, Lambton Fault is located approximately 150m to the southwest of the site. Stirling et al (2002) indicate that the Wellington Fault has a maximum credible earthquake event of magnitude 7.3 with a recurrence interval of 600 years.

4.2 Interpreted Site Conditions

4.2.1 Soil Profile

The subsurface materials and units that were encountered are summarised in Table 1.

Table 1: Summary of Soil Profile Encountered

Layer No.	Description	Depth of Top of layer (m)	Approx. Layer Thick. (m)	SPT Blow count (Blows/ 300mm)
1	<u>Topsoil grass/vegetation</u> The site has a largely grassed surface with areas of garden.	Surface	0.1-0.2m thick	N/A
2	<u>Fill(clean)</u> Typically composed of Orange brown Loose to Very Loose Sandy GRAVEL with minor silt. Traces of red brick and concrete.	0.0-2.0m In north west corner of site	At least 4m thick in north west at cest of slope, decresing to 0m thick at toe of slope	1-6
3	<u>Fill (construction)</u> The site has significant volumes of demolition waste left on site with remnant concrete floor slabs underlying. Waste consists of concrete, timber, roofing iron, probable asbestos etc. Waste un-compacted with often open framework.	0.2m along western side of site	Approximately 2.0m thick along western extent of site reducing to 0m in the east	N/A
4	<u>Fine Grained Cohesive Alluvium</u> Variably composed of light brown SILT and; Greenish grey Silty CLAY. Very stiff.	1.0m on south east corner of the site.	0m thick in northwest side of site increasing to 6m thick (intermixed with gravel layers) in south east corner of site.	20-22
5	<u>Coarse Grained Alluvium/Colluvium</u> Variably composed of silty GRAVEL; sandy GRAVEL; silty SAND. Medium dense with occasional organics (rootlets).	1.0m on south east corner of the site.	0m thick in northwest side of site increasing to 6m thick (intermixed with gravel layers) in south east corner of site.	11-30
6	<u>Greywacke</u> CW-HW Greywacke Sandstone. Orange Brown. Weak.	2.0-6m across site with general trend of rock head sloping upwards towards the west north-west (WNW).	Indefinate.	25-50+

Figures 2 to 5 (Appendix A) show interpreted cross sections through the site based on geotechnical investigation results. Figure 1 shows the inferred rock head contours across the site.

The existing ground profile across the site (building footprint) drops to the east below the proposed floor slab level (RL 30m). The building will found on or slightly above the rock interface in the north west corner and will found over 6-7m of variable alluvium/colluvium deposits in the south eastern corner.

4.2.2 Groundwater

Groundwater levels were measured in boreholes following drilling and prior to backfilling. The ground conditions were damp at the surface. Investigations followed a period of rainfall.

Groundwater levels were recorded at 0.5m in BH01 and 1.0m in BH02. Significant seepage was observed at 1.6m depth in TP02. Given the low lying nature of the site and soft surface conditions, ground water is likely to rise to the ground surface during periods of prolonged rain.

5 Engineering Discussion

Recommendations and opinions in this report are based on data from discrete investigation locations including boreholes and test pits. The nature and continuity of subsoil away from the test locations are inferred and it must be appreciated that actual conditions could vary from the assumed model.

Holmes Consulting Group have advised that the building is intended to be designed and built in two stages. Foundation loads are likely to be in the order of 7700kN. The floor slab will be at approximately RL 30m.

5.1 Founding Materials & Implications

5.1.1 Fill

The site has a variable thickness of fill containing demolition waste overlying the natural ground. In places buried concrete floor slabs remain immediately underlying the demolition waste. It is assumed that the presence of these slabs will be wide spread along the western side of the building site.

The demolition waste was found to consist of mixed, non-compacted refuse including; concrete, timber, roofing iron, masonry blocks and other assorted construction materials.

The fill contains significant volumes of organic material in the form of untreated timber and displays an open framework in parts. This material is not suitable for founding on due to its variable and compressive properties.

All foundations will need to found below the fill material.

Temporary trenches through the fill material (for services and foundation construction) are likely to require heavy excavators (12 ton plus) to break through buried concrete. Trenches should be battered back to a stable grade. This may be as flat as 1.5H:1V in poor material.

5.1.2 Alluvial & Colluvial Soils

The site has a variable thickness of normally consolidated alluvial and colluvial soils with a deepening trend towards the south east. These soils consist of intermixed layers of fine and coarse grained deposits. Fine grained soils range from stiff to very stiff silts and clays, coarse grained soils range from medium dense to dense sands and gravels.

Heavy loads founded on these materials may induce consolidation. Design parameters for founding on the alluvial/colluvial soils are set out in Table 2 & 3.

Table 2: Material properties in typical shallow founding soils. (Based on soil layers 4 & 5 in Table 1)

Material Design Parameters		Value
Effective Cohesion	C′	2 kPa
Effective Friction Angle	Ø′	32°

Un-drained strength of soil	**Su**	80 kPa
Bulk density of soil	γ	19 kN/m^3

Table 3: Settlement parameters for alluvial soil layers

Material type	M_v (m^2/MN)
Silt	0.3
Silty Gravel	0.22
Silty Clay	0.25
Sandy Gravel	0.05
Silty Sand	0.1

5.1.3 Rock

Underlying rock consists of completely weathered to highly weatherd greywacke sandstone/siltstone. Inferred rock head elevations are shown on Figure 1. There is a general trend with increasing depth to rock moving from the north west to the south east. Over the majority of the site the rock is overlain with alluvial/colluvial soils. In the north west the rock is overlain with consolidated fill.

5.2 Foundation Design

We consider that the site is generally suitable for the proposed redevelopment. Elements of the structure that are lightly loaded and can tolerate small differential settlement may suit shallow foundations. Structural elements not tolerant of differential foundation movement should be piled. The floor slab is intended to be suspended and will be self supporting between piled foundations.

5.2.1 Shallow Foundations

5.2.1.1 Alluvial/Colluvial soils

Shallow foundations will need to found below the fill and soft surface sediments into stiff natural ground. Based on our investigations we expect that the optimum founding elevation will be below RL 27m. At this level, across most of the site, we expect to encounter stiff cohesive alluvial materials (silty SAND/GRAVEL) and medium dense to dense granular colluvial materials (sandy GRAVEL).

We expect Ultimate Geotechnical (UG) Bearing Capacities to be as set out in Table 4 (for 800mm) and graphically for other depths and widths in Figures 6/7 in Appendix B.

Values of UG bearing capacity should be reduced by a strength reduction factor of 0.5 to give the maximum Ultimate Limit State (ULS) design bearing capacity. Founding depth shall be taken as founding depth below finished ground level. The top 70% of this depth can consist of recompacted fill material. Foundations should found a minimum of 300mm into stiff natural ground or 450mm below finished ground level.

Table 4: Expected settlement and UG bearing capacity of shallow strip footings embedded 800mm below finished ground.

Shallow foundation dimensions	Long Duration (Working) Load on Foundations				[1]UG bearing capacity
	80KPa	100KPa	150kPa	200kPa	
1.0m x 1.0m square	0 to 10mm	0 to 10mm	0 to 20mm	0 to 25mm	370 KPa
1.5m x 1.5m square	0 to 15mm	0 to 15mm	0 to 25mm	0 to 35mm	380 KPa
2.0m x 2.0m square	0 to 15mm	0 to 20mm	0 to 35mm	0 to 45mm	410 KPa
600mm strip	0 to 5mm	0 to 5mm	0 to 10mm	0 to 15mm	280 KPa
1000mm strip	0 to 15mm	0 to 15mm	0 to 25mm	0 to 30mm	300kPa

In areas where loose and/or soft materials are encountered within the founding subgrade (in particular in the south and east of the proposed building). The soft layer shall be sub-excavated and replaced (to the satisfaction of Geotechnical Engineer) with compacted hardfill. The plan area of the zone of sub-excavation and replacement should exceed that of the footing by a distance of 2V:1H.

5.2.1.2 Greywacke Rock

Areas where Greywacke rock is encountered at shallower depths than RL 27m, the founding level may be raised to reduce the required excavation. This is likely in the north west corner of the building. In areas where the underlying rock is at, or close to, the founding level expected settlements will be negligible.

The Ultimate Geotechnical Bearing Capacity for rock on the site is 1.2 Mpa for shallow footings.

5.2.1.3 Expected Settlement

It is envisaged that foundation design will be governed by differential settlements rather than the expected UG bearing capacity. Design of shallow foundations for the site will be dependant on acceptable settlement for particular aspects of the building.

There is a potential for differential settlement due to variations in depth and composition of material across the site. The expected differential settlement over the building area is reflected in the range of maximum total predicted settlement for footing width/foundation loading combinations shown in Table 4 and Figures 8/9 in Appendix B. The calculated expected settlements are based on the ground conditions encountered in limited test locations. It is possible that there may be areas of soft compressible alluvial materials away from the test locations that would give rise to higher differential settlements without the previously detailed ground pre-treatment.

In calculating the expected total settlement, the maximum influence is where the depth of soft soils extend 1 to 2 times the footing width. In practice, at this site, where the rock head is at or below RL 25m (south east of site) larger settlements are likely. Where the rock head is at or above RL 27m (north west of site) the footings shall be founded on rock and settlement will be negligible. In the intermediate region the settlement will vary across the range provided in Table 4 dependant on the depth and consistency of the compressible soils. Figure 1 shows the inferred rock head elevations. Confirmation of these depths (particularly in the centre of the site where concrete floor slabs prevented test piting) will be required during construction with scala testing once surface material has been excavated in foundation positions.

Seasonal variations of up to 5mm vertical movement can be expected in the existing building based on shallow footings, underlying fined grained soil and high fluctuating ground water levels. Similar ongoing seasonal movement is likely for the proposed new building following initial consolidation settlement if found on shallow footings.

5.2.2 Piled Foundations

A number of pile options were considered for the site. Screw piles are not suitable as the colluvium material across the site is too variable and difficult to target and the pile type is not suitable for construction in rock. The noise and vibration associated with the construction of driven piles is unlikely to be acceptable at this site and was therefore not considered further.

Bored cast in-situ piles are likely to be the most practical solution for heavily loaded foundations. The piles will be required to be embedded at least three times the pile diameter into insitu HW rock. The piles will be up to approximately 9m total length (from the existing ground level) in the south east corner. The required depth will reduce from this maximum across the site. Figure 1 shows the inferred rock head elevations across the site.

For pile construction, temporary pre excavation is likely to be required in order to clear obstructions within the fill and casings may be required whilst boring in loose saturated alluvial materials. See comments in the environmental section for comments on off-site disposal of this material. The pre-existing floor slabs will require localised break out.

End bearing capacity (UG) of 5MPa can be assumed for design where piles found a minimum of 3 pile diameters into the highly weathered rock. This ultimate geotechnical capacity should be reduced by a SRF of 0.55 for ultimate limit state design.

5.2.3 Floor Slabs

It is our understanding that the floor slab will be self supporting between piles.

Should the option of floor slabs on grade with imported hardfill used to raise the platform to RL 30m be considered, the following should be considered;

- The complete removal and disposal of all demolition fill currently on site will be required.
- Consolidation settlement would be expected under the additional loading of compacted hardfill,

- Differential settlement will occur due to variable depths of compressible soils across the site.

The extent of this consolidation can be estimated if this option is to be considered.

5.3 Retaining Wall Design Parameters

A retaining wall will need to be constructed in the north west corner of the site. Based on our investigations, the retained slope comprises in-situ rock overlain by moderately dense colluvial/fill material with loose fill at the surface. The surface fill comprises loose hardfill with traces of construction materials (concrete, brick etc) extending to at least 4m depth at the crest of the slope. The toe of the slope comprises 2m of recent demolition waste over the in-situ rock.

Table 6 gives the material properties applicable for the design of the retaining wall.

Table 6: Soil properties for retaining wall stability analysis

Parameter	**Backfill**	**Consolidated Fill**	**Clayey Gravel**
Bulk Density γ (kN/m³)	20	18	18.5
Cohesion c′ (kPa)	0	3.0	5.0
Internal Friction Angle Ø (°)	32	30	32

A slope stability analysis was carried out to determine the stability and optimum height of the wall. Global slope stability will influence wall loading due to the required batter slope and the variable properties between soil layers on the slope.

Based on this analysis, a 1200mm deep concrete crib retaining wall (1H:4V), 2m in height with a 2H:1V batter slope behind is recommended. The wall footing should found onto underlying rock. This foooting will vary in depth along the length but is likely to have a maximum depth of 1m. The top of the battered slope will extend towards the western property boundary.

The existing crib retaining wall will need to be reduced in height by up to 2m at the northern end due to the proposed floor level of the hospital extension. All foundations imediatley behind the existing crib wall , will need to be bored piles founded on rock or strip piles founded on rock around the north west perimeter of the structure.

5.4 Seismic Considerations

5.4.1 Subsoil Class

The seismic subsoil category in accordance with NZS 1170.5:2004 Section 3.1.3 for the subject site is considered to be 'Class C - Shallow Soil'.

6 Environmental Report

6.1 Property History

The property history below focuses on the proposed building area (the 'site') located to the west of the present Southern Cross Hospital. Property history information has been established from a variety of sources including historical certificates of title, historical aerial photographs, Wellington City Council archive files, and Greater Wellington Regional Council records. All records are summarised below.

6.1.1 Certificates of Title

Current and historical certificates of title showed the following ownership records:

- Sec 911 Town of Wellington (northern half of site)
  - 1911-1949: Victoria Laundry Company
  - 1949-1966: Macduffs Storage Ltd
  - 1966-1981: Hanson Storage Ltd
  - 1981-1989: Britt Ryan
  - 1989-1989: Heldingham Investments Ltd
  - 1989-Present: Southern Cross Medical Society
- Sec 913 Town of Wellington (southern half of site)
  - 1911-1949: Victoria Laundry Company
  - 1949-1966: Macduffs Storage Ltd
  - 1966-1981: Rotowax Ltd
  - 1981-1989: Britt Ryan
  - 1989-1989: Heldingham Investments Ltd
  - 1989-Present: Southern Cross Medical Society

6.1.2 Aerial photographs

Historical aerial photographs of the site from 1970, 1980, and 2004 were reviewed.

The 1970 photograph shows the proposed building area is developed with low level warehousing. Photographs of the site held in WCC archive files indicate the buildings were mainly one storied and were constructed out of timber. The warehouses appear to be surrounded by paved areas. There is an unpaved area on the northwest corner of the site that appears to be used as a rubble or timber yard.

The 1980 photograph shows little change on the site compared to 1970. The unpaved area on the northwest corner of the site had been developed into low lying warehouse store. A small building on the southwest corner of the site had been demolished and developed into a vehicle yard.

The current site layout, as shown in 2004, shows the low level warehouses in the 1970 and 1980 photographs have been removed and/or demolished. The site has been redeveloped into Southern Cross Hospital. The main hospital building is a north to south elongated rectangle located in the centre of the property. The proposed building area to the west of the hospital consists of a grass lawn that slopes gently to the east.

6.1.3 Wellington City Council files

Building plans and City Engineer's files held at WCC Archives were reviewed on 3 June 2008. Table 6.1 below contains a summary of property development gathered from WCC files.

Table 6.1: Summary of WCC archive files

Date	Activity
1923	Brick warehouse constructed on 100 Hanson Street.
1937	File note for S. Ivory Ltd had an approved application to install a 750 gallon diesel underground fuel tank at 114 Hanson Street. The reason was that the property was used for carrier goods. Note the tank is unlikely to have been located near the proposed building area.
1943	Addition to building on 90-100 Hanson Street. Building plan shows timber floors and piles and asbestos roofing.
1958	Erect freezing room and offices at 90-100 Hanson Street. Building plan shows asbestos roof to be constructed and concrete flooring.
1965	Council approval notice for use of 98 Hanson Street by Wellington Fishing Boat Owners Association for storage and processing of fish.
1972	Store building constructed at 90-100 Hanson Street
1974	Dangerous good store constructed at 90-100 Hanson Street for Rotowax Ltd. Store had masonry walls and concrete floor.
1966-1990	Large file titled Rotowax Ltd. Rotowax owned and operated at 90-94 Hanson Street until 1981 when it went into receivership. Rotowax specialised in printing, cellophane printing, and cardboard manufacturing. The Rotowax buildings were demolished in the early 1990s. The adjacent property at 112-114 Hanson Street was owner by Martin Ginty Ltd. A council note indicated that the buildings owned by Martin Ginty Ltd were in very poor condition.
1988	A council plan shows major drains run under the old Rotowax complex. A council note suggests future developers should take note of the drains.
1991	Demolition 90 Hanson Street
1991-1995	Southern Cross Hospital construction

6.1.4 Greater Wellington Regional Council files

GWRC selected land use register was queried on 28 May 2008 to determine whether the site is listed as a contaminated site. The site (Lot 1 DP 75743) did not appear on the GWRC selected land use register as a site that has used, stored, or disposed of hazardous substances.

6.1.5 Summary of Property History

The proposed building site (Sections 911 and 913) has been used for industrial purposes since approximately 1911. The site was used by Victoria Laundry Company until 1949 and later by Macduffs and Hanson Storage Ltd until 1966. Between 1966 and 1981 the site was owned by Rotowax Ltd, a printing company. Southern Cross Health Trust has owned the site since 1989.

Council records indicate that many of the old warehouse buildings contained asbestos roofing. The printing practices of Rotowax Ltd had the potential to cause soil contamination.

6.2 Potential for contamination

Historical property information indicates that some past activities on the site had the potential to have caused ground contamination of surface soil. Table 6.2 contains a summary of the potential contamination on the proposed building development area.

Table 6.2: Summary of potentially contaminating activities

Activity	Potential Contaminants	Potential Location and extent
Macduffs and later Hanson Storage Ltd - Freeze rooms and store	Asbestos in roofing materials.	Sections 911 and 913 between 1949-1966. Buildings may have stayed on site until 1991 when the site was demolished for the new hospital. Asbestos may not have been disposed properly after demolition.
Rotowax Ltd - Printing industry	Hydrocarbons/ metals	Section 913 between 1966-1981.

The proposed site use, which comprises a commercial building with suspended concrete slab floor, will minimise exposure of site users to contaminated soil.

6.3 Results of limited site soil testing

A soil sample was collected from a TP 01 on 4 June 2008. The sample was collected using clean latex gloves, a clean trenching spade, and was stored in a clean glass jar.

The sample was sent to Hill Laboratories under chain of custody documentation and was tested for metals and polycyclic aromatic hydrocarbons (PAH).

The test results are provided in Tables 6.3 and 6.4 below. The laboratory report is provided in Appendix D. Results are compared with expected background concentrations for soil in the Wellington region, guideline values for commercial/industrial land use, excavation and maintenance worker protection, and acceptance criteria for disposal to a consented landfill.

6.3.1 Metals

Metal concentrations were well below guidelines for commercial land use and the excavation worker protection. All of the metal concentrations exceeded background levels for typical Wellington soils. Concentrations of lead and zinc also exceeded landfill acceptance criteria.

Table 6.3: Metals (mg/kg)

Sample ID	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
T&T 84528/1	**12**	**0.32**	**29**	**73**	**280**	**18**	**280**
Guidelines							
Commercial[1,2]	500 [1]	100 [2]	360 [1]	5,000 [2]	1,500 [2]	3,000 [2]	35,000 [2]
Excavation worker[1,2]	1,200 [1]	-	520 [1]	-	-	-	-
Background[3]	<2-7	<0.1-0.1	7-12	4-10	4.5-180	4-9	28-79
Landfill [4]	100	20	100	100	100	200	200

Bold cells exceed normal background levels. Shaded cells exceed landfill acceptance criteria. - = no limit established for this exposure pathway.

1Health and Environmental Guidelines for Selected Timber Treatment Chemicals (MfE and MoH, 1997), unpaved industrial land

2 National Environmental Protection (Assessment of Site Contamination) Measure (NEPC 1999), commercial

3 Determination of Common Pollutant Background Soil Concentrations for Wellington Region (URS 2003), sand

4 Hazardous Waste Guidelines: Landfill Waste Acceptance Criteria and Landfill Classification (MfE 2004)

6.3.2 Polycyclic aromatic hydrocarbons

PAH were present in low concentrations and were below the guideline for commercial land use. The presence of PAH indicates the soil exceeds normal background levels for typical Wellington soils and can not be regarded as clean fill.

Table 6.4: PAH (mg/kg)

PAH	T&T 84528/1	Background[1]	Commercial guideline [2]
Acenaphthene	< 0.030	-	-
Acenaphthylene	< 0.030	-	-
Anthracene	0.073	<0.002-0.01	-
Benzo[a]anthracene	0.17	-	-
Benzo[a]pyrene (BAP)	0.14	<0.002-0.08	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	0.23	-	-
Benzo[g,h,i]perylene	0.1	-	-
Benzo[k]fluoranthene	0.13	-	-
Chrysene	0.29	-	-
Dibenzo[a,h]anthracene	< 0.030	-	-
Fluoranthene	0.58	<0.002-0.14	-
Fluorene	0.038	-	-
Indeno(1,2,3-c,d)pyrene	0.06	-	-

Naphthalene	0.44	<0.002-0.01	210 270 [2]
Phenanthrene	0.38	<0.002-0.07	-
Pyrene	0.59	<0.002-0.12	-
BaP equivalents	0.23	<0.002-0.08	11 25 [2]

Bold exceeds background values, shaded cells exceed commercial or hospital site guideline values.

1 Determination of Common Pollutant Background Soil Concentrations for Wellington Region (URS, 2003), sand

2 Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE 1999), sand, surface soil. Criteria are for shallow soil (<1m depth) and deeper soil (1-4m depth).

6.4 Environmental Conclusions

Former site buildings were demolished in the 1990s to make way for Southern Cross Hospital. It is not know if the soil was investigated or cleaned up during the demolition. Construction debris was encountered at shallow depths in geotechnical test pits. It is possible that asbestos containing building materials and chemical residues may be present.

The single sample tested did not indicate the presence of significant contamination that is unsuitable for the proposed commercial site use. However, if fill material has to be removed for geotechnical purposes and cannot be reused on the site (or if fill is elected to be disposed off site as part of landscaping), the soil may need to be disposed at a consented landfill. Extra testing may be requested by the landfill to see if it is suitable for disposal (i.e. Toxicity Characteristic Leaching Procedure). Based on the single sample tested, soil would not be suitable for disposal at a clean fill. Additional testing would be required to determine if any soil can be disposed of as clean fill.

If asbestos containing material is to be disposed off site, this will need to be properly handled and disposed appropriately.

Based on the limited extent of this investigation, we cannot rule out the possibility that higher levels of contamination may be present elsewhere on the site. Based on the proposed construction of future buildings (concrete slab floor), there is minimal opportunity for exposure of site users to potential contamination. The desk top study did identify potential ground for contamination in the buildings history and therefore contamination of the natural ground could not be ruled out without further sampling beneath the demolition waste.

We understand that it is your preference to leave the existing demolition material on site if possible. We would advise that further testing should be undertaken to rule out the possibility of contaminants that may conflict with the proposed development. These tests should be undertaken prior to construction so that if unacceptable levels of contaminants were detected, arrangements could be made for disposal.

7 Applicability

This report has been prepared for the benefit of Southern Cross Health Trust with respect to the particular brief given to us by Holmes Consulting Group and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

TONKIN & TAYLOR LTD
Environmental and Engineering Consultants

Report prepared by:

....
Stuart Farrant
Natural Resources Engineer

Authorised for Tonkin & Taylor by:

....
Bruce Symmans
Senior Geotechnical Engineer

sjef
2 July 2008
P:\84528\WorkingMaterial\Rpt_drf_Jun 08.doc

8 References

Begg, J. G and Mazengarb, C (1996): Geology of the Wellington Area. IGNS 1:50 000 geological map.

Stirling, M. W, McVerry, G H and Berryman, K R (2002). A New Seismic Hazard Model for New Zealand. Bull. Seism. Soc. of America June 2002

Appendix A: Figures

- Figure 1 Location Plan
- Figure 2 Cross Section 1
- Figure 3 Cross Section 2
- Figure 4 Cross Section 3
- Figure 5 Cross Section 4

Legend

Inferred rock contours	--26--
Property boundary	
Test pit	
Borehole test location (1990)	BH4
Borehole test location (2008)	BH 1

SCALE 1:500

0 5 10 15 20 25 (m)

Reference: Image Terraview 2006
Cadastral: Terraview 2006

Tonkin & Taylor
Environmental & Engineering Consultants

☐Auckland ■Wellington ☐Christchurch
☐Hamilton ☐Nelson ☐Whangarei

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APPROVED		7/8

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SCALES (AT A3 SIZE) 1:500

PROJECT No. 84528

SOUTHERN CROSS HEALTH TRUST

HOSPITAL EXTENSION

HANSON STREET – NEWTOWN

Plan

FIG. No. Figure 1

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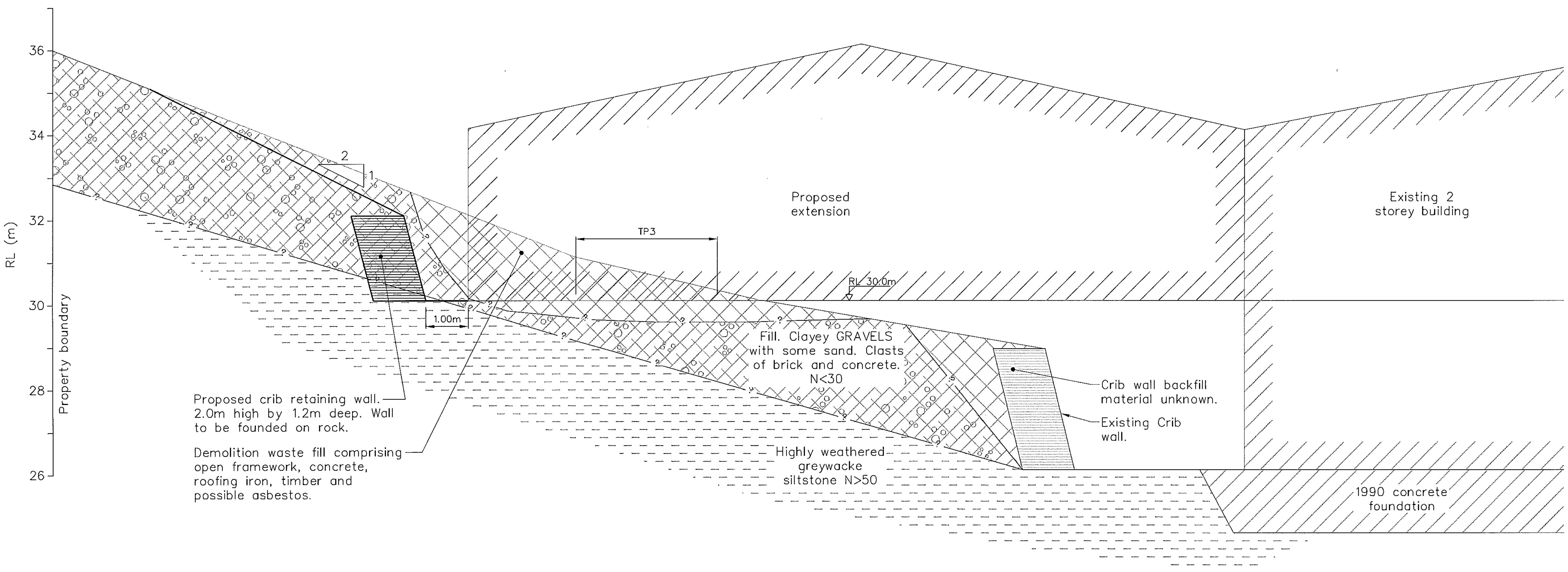

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SCALE 1: 100
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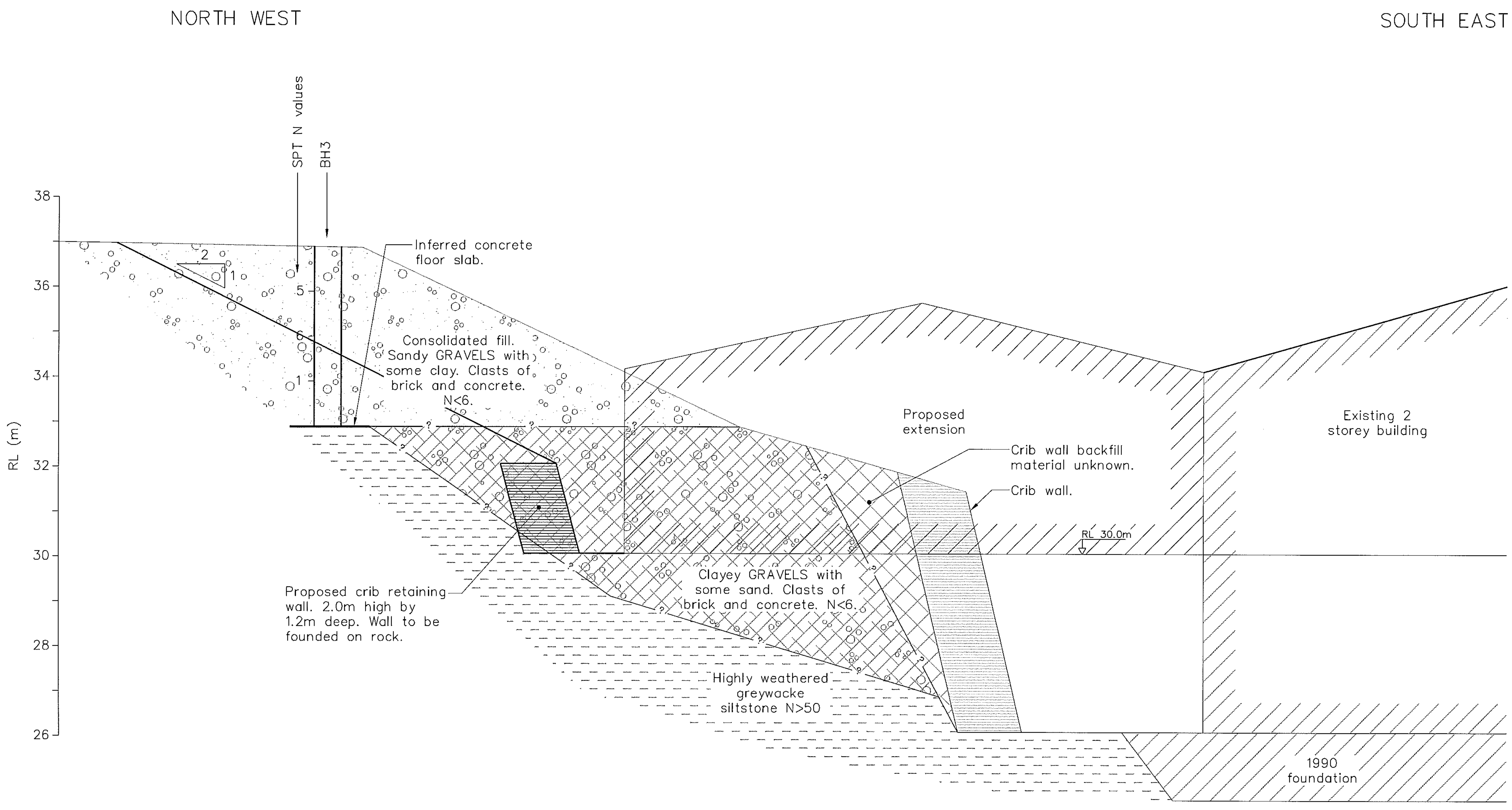
PROJECT No. 84528		

SOUTHERN CROSS HEALTH TRUST
HOSPITAL EXTENSION
HANSON ST – NEWTOWN
Sections – Sheet 1 of 4

FIG. No. Figure 2 REV. 0



SECTION 2/01
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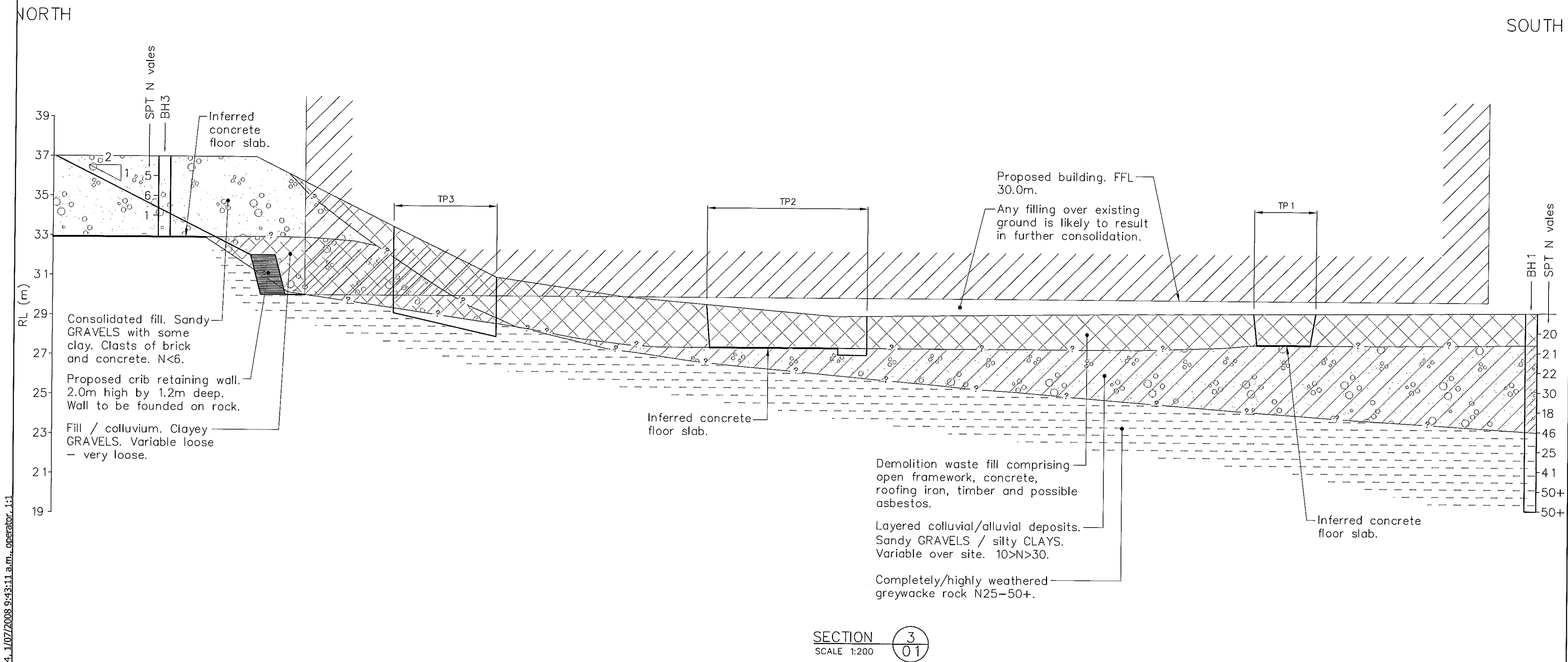
Tonkin & Taylor Environmental & Engineering Consultants ☐ Auckland ■ Wellington ☐ Christchurch ☐ Hamilton ☐ Nelson ☐ Whangarei	DRAWN MBG Jun.08 DRAFTING CHECKED 7/8 APPROVED BS 3/8 CADFILE : \\Figures 2-5.dwg SCALES (AT A3 SIZE) 1: 100 PROJECT No. 84528	SOUTHERN CROSS HEALTH TRUST HOSPITAL EXTENSION HANSON ST – NEWTOWN Sections – Sheet 2 of 4 FIG. No. Figure 3 REV. 0



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0 2 4 6 8 10 (m)

I:\WELLINGTON-MG\84528\CAD\Figures 2-5.dwg, F.04, 1/07/2008 9:43:11 a.m., operator: 1:1

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APPROVED		7/08
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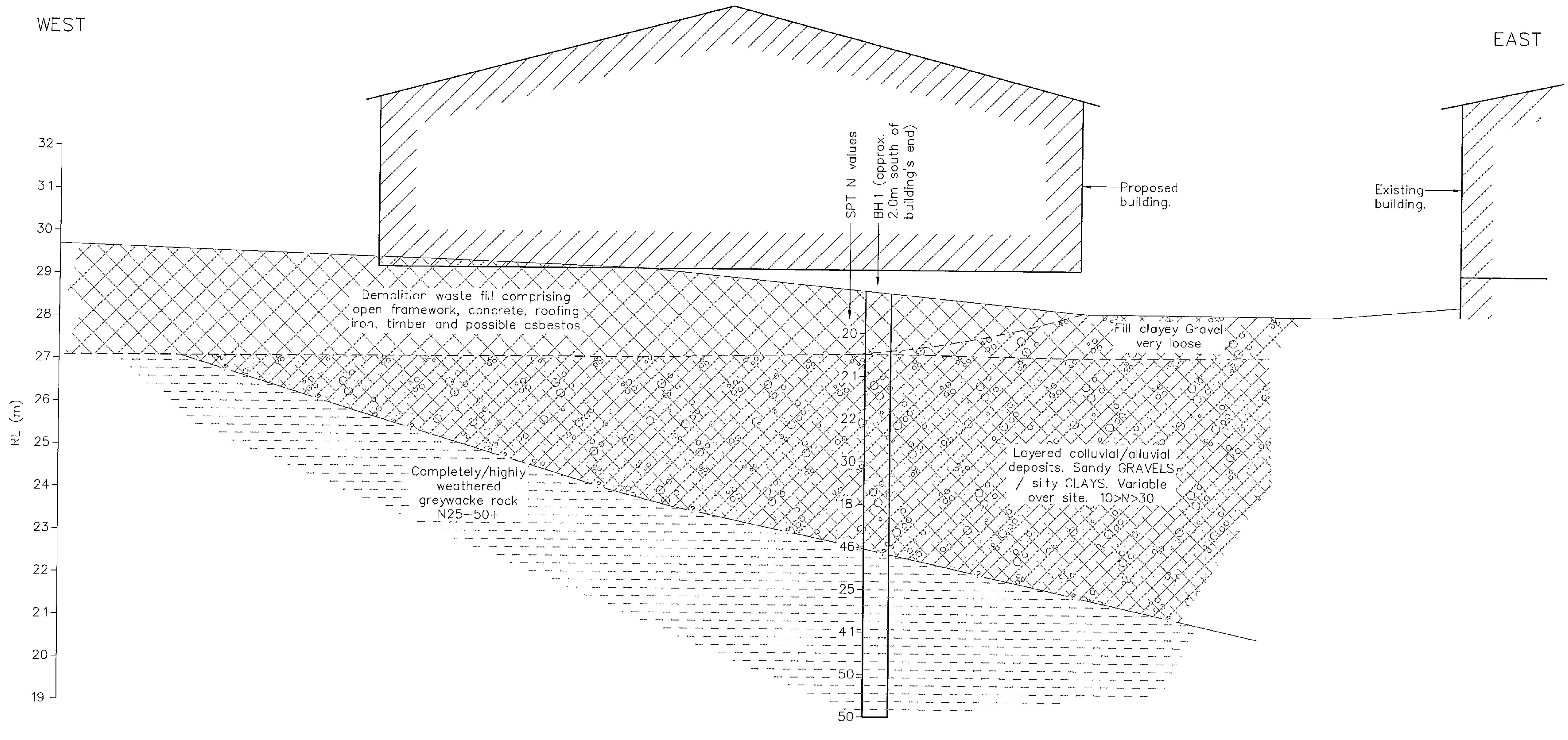
SCALES (AT A3 SIZE) 1:200		
PROJECT No. 84528		

SOUTHERN CROSS HEALTH TRUST
HOSPITAL EXTENSION
HANSON ST – NEWTOWN
Sections – Sheet 3 of 4

FIG. No. Figure 4 REV. 0



SECTION 4/01
SCALE 1: 100

SCALE 1: 100
0 1 2 3 4 5 (m)

Tonkin & Taylor Environmental & Engineering Consultants ☐ Auckland ■ Wellington ☐ Christchurch ☐ Hamilton ☐ Nelson ☐ Whangarei	DRAWN	MBG	Jun,08
	DRAFTING CHECKED		7/08
	APPROVED		7/08
	CADFILE : \\Figures 2-5.dwg		
	SCALES (AT A3 SIZE) 1: 100		
	PROJECT No. 84528		

SOUTHERN CROSS HEALTH TRUST
HOSPITAL EXTENSION
HANSON ST – NEWTOWN
Sections – Sheet 4 of 4

FIG. No. Figure 5
REV. 0

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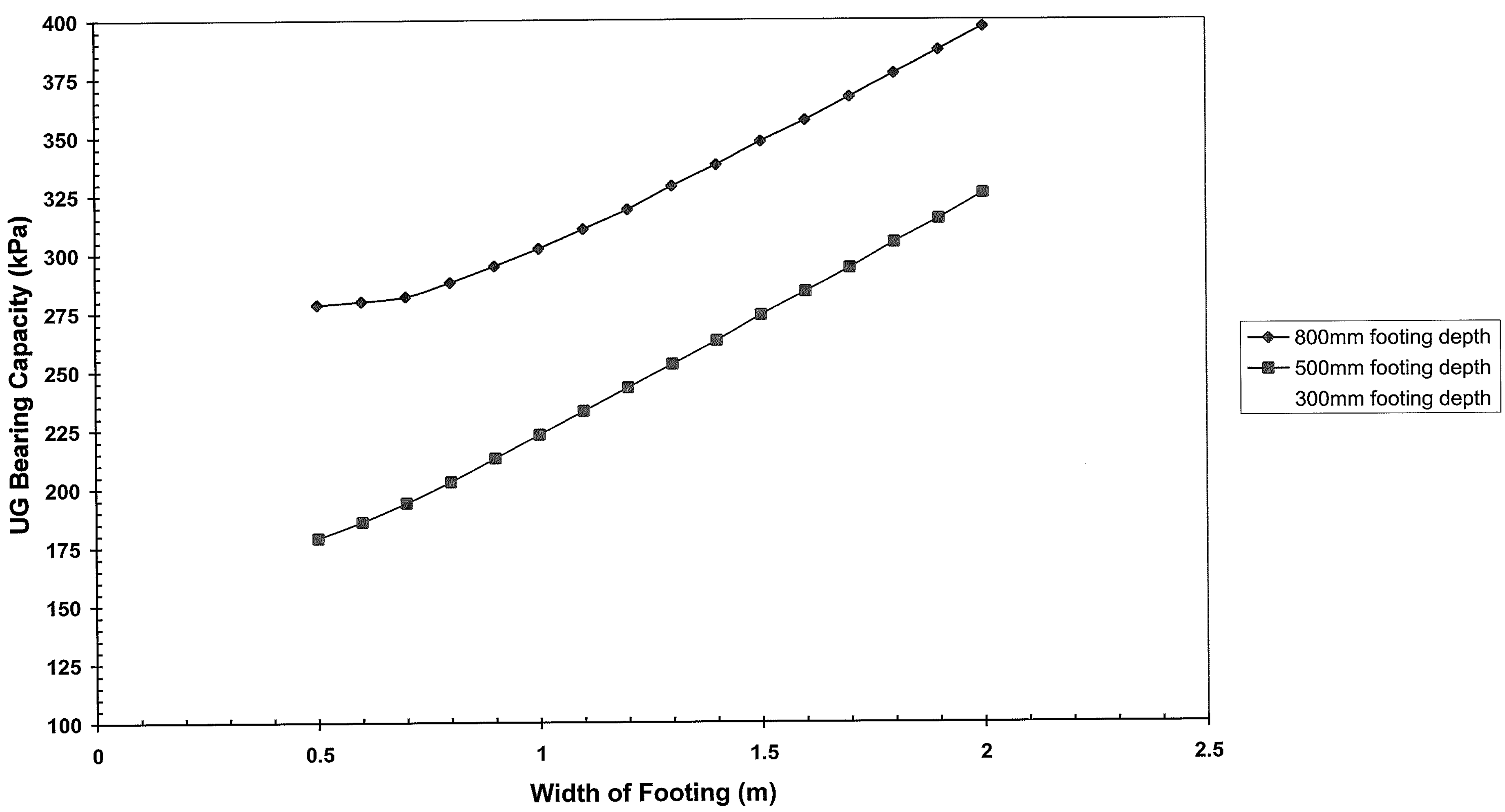
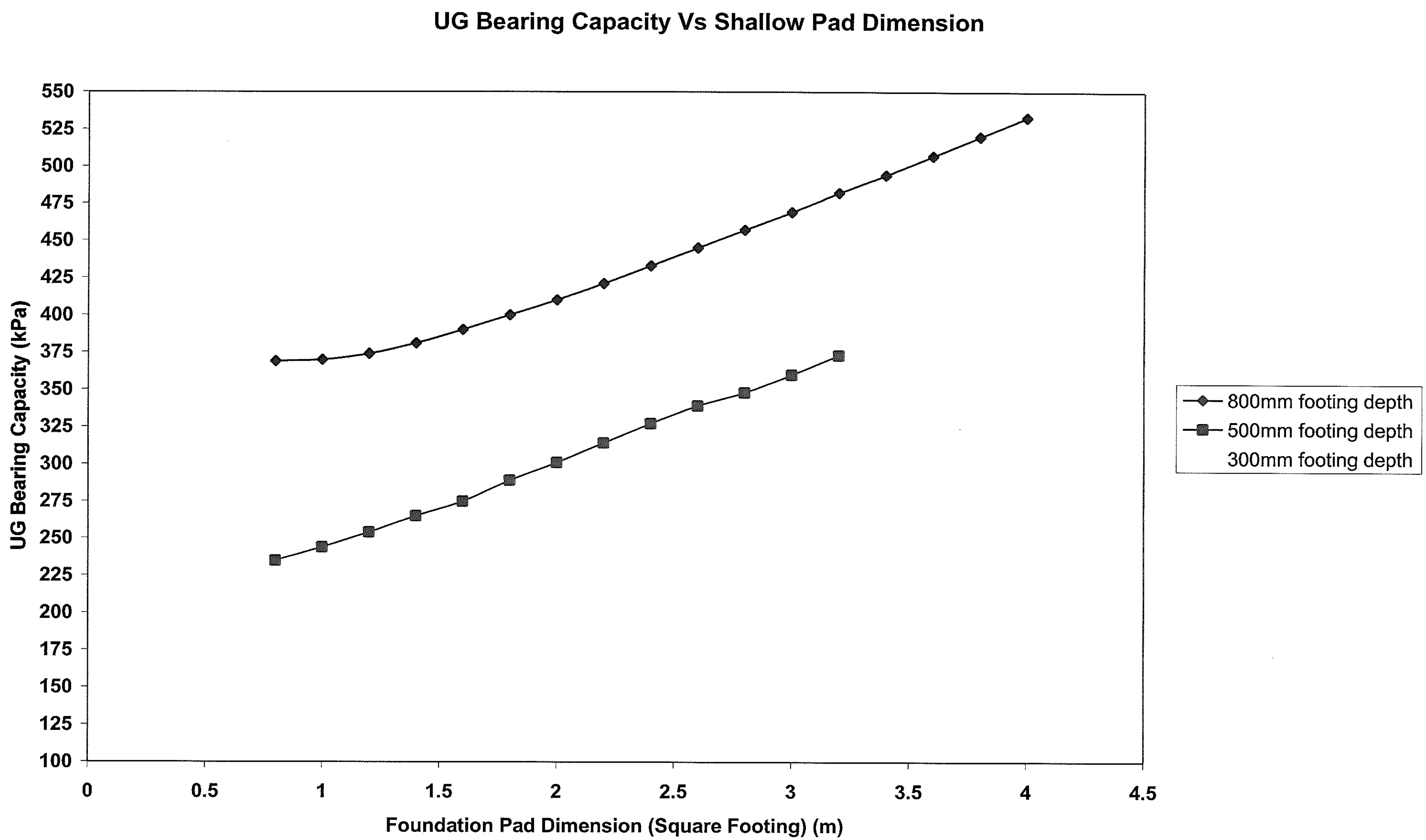
Appendix B: Shallow Foundation Plots

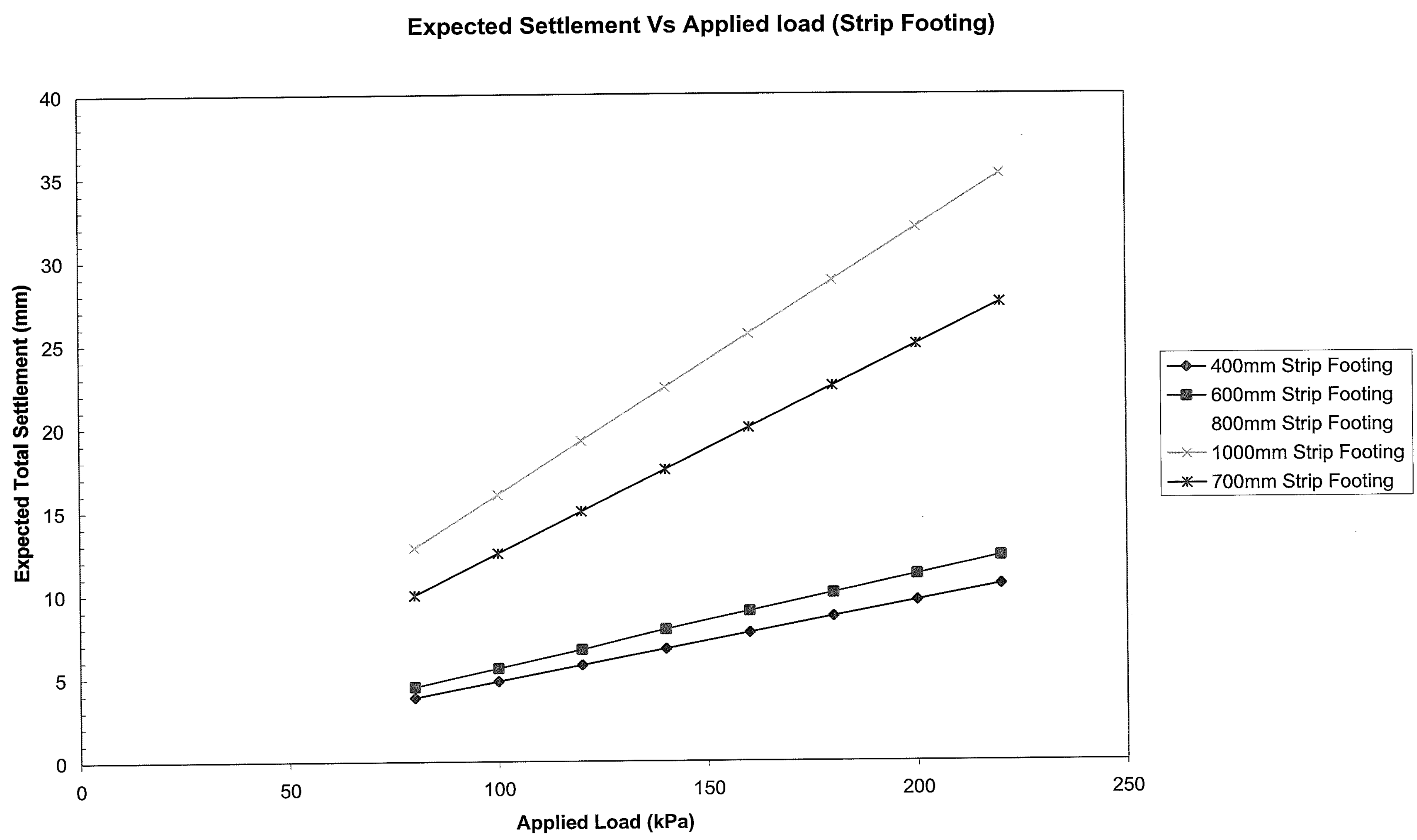
- **Figure 6 Ultimate Geotechnical Bearing Capacity (Strip Footing)**
- **Figure 7 Ultimate Geotechnical Bearing Capacity (Pad Footing)**
- **Figure 8 Maximum Expected Settlement (Strip Footing)**
- **Figure 9 Maximum Expected Settlement (Pad Footing)**

UG Bearing Capacity Vs Width of Strip Footing



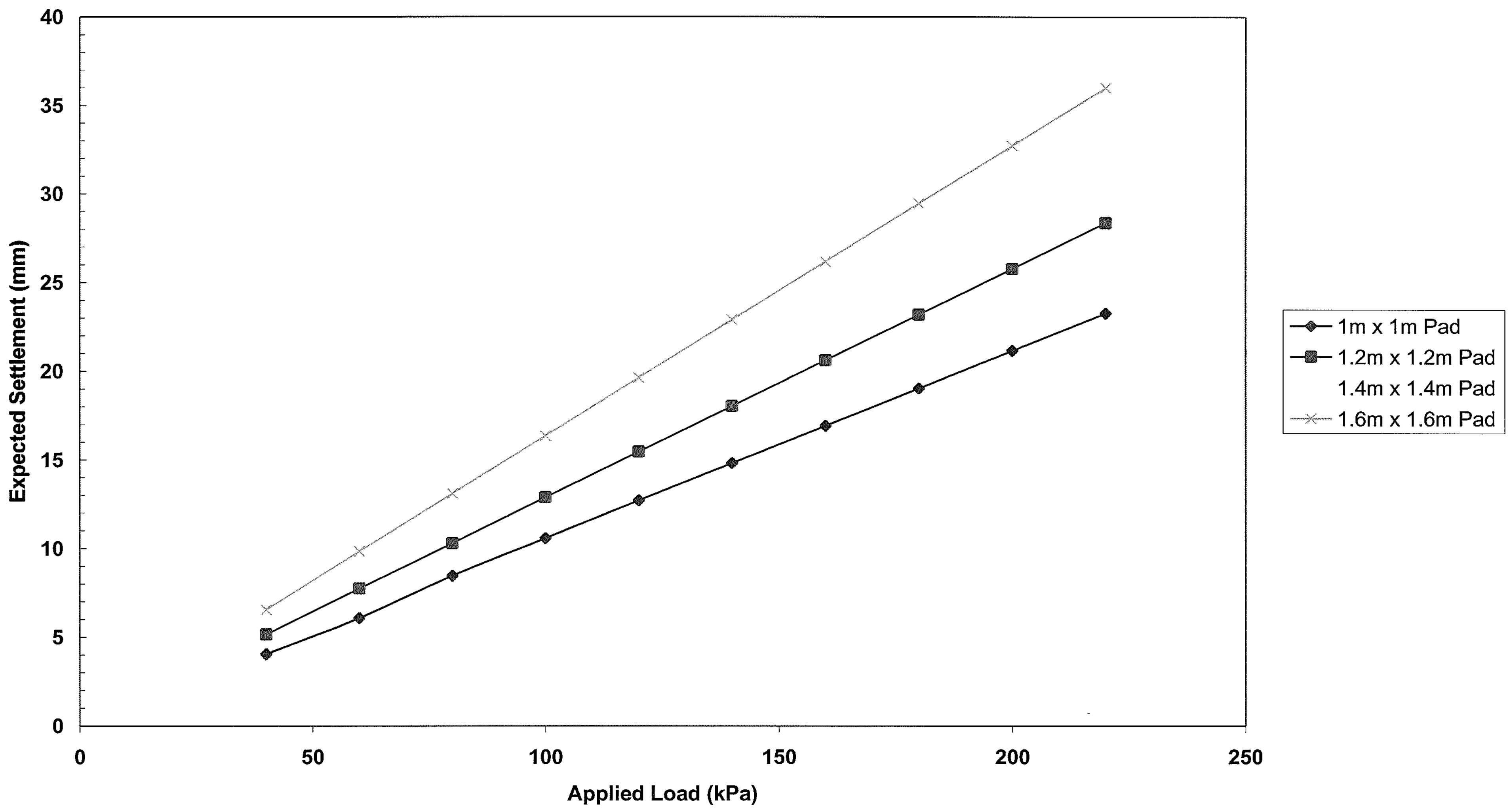


UG Bearing Capacity Vs Shallow Pad Dimension
UG Bearing Capacity (kPa)
550
525
500
475
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Foundation Pad Dimension (Square Footing) (m)
800mm footing depth
500mm footing depth
300mm footing depth



Expected Settlement Vs Applied load (Strip Footing)
Expected Total Settlement (mm)
40
35
30
25
20
15
10
5
0
0
50
100
150
200
250
Applied Load (kPa)
400mm Strip Footing
600mm Strip Footing
800mm Strip Footing
1000mm Strip Footing
700mm Strip Footing

Expected Settlement Vs Applied Load (Pad Footing)



Appendix C: Investigation Logs

TONKIN & TAYLOR LTD.

EXCAVATION LOG

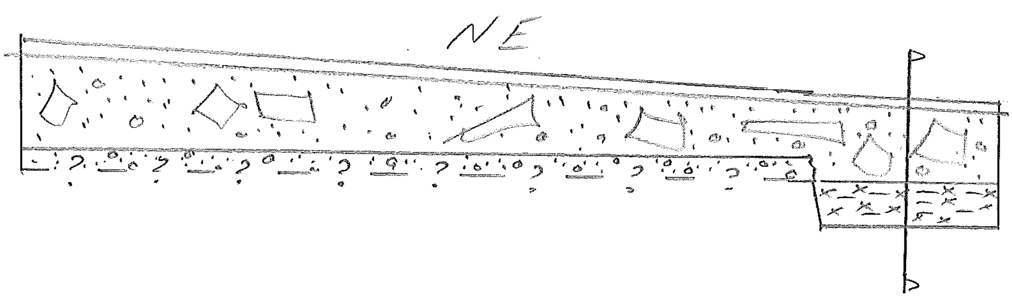
EXCAVATION NO: TP1
SHEET 1 OF 1

PROJECT: SOUTHERN CROSS EXTN
LOCATION: HANSON ST
JOB NO: 84528
CO-ORDINATES:
EXPOSURE TYPE: TEST PIT
HOLE STARTED: 4/06/2008 2:15pm
EQUIPMENT: 12 T EXCAVATOR
HOLE FINISHED: 3:30pm.
RL: 29m.
OPERATOR: B. BELLAMY
LOGGED BY: S JER.
DATUM:
EXCAVATION DIMENSIONS:
CHECKED BY:

EXCAVATION AND TESTS: | ENGINEERING DESCRIPTION: | GEOLOGICAL:

PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
								Silty CLAY with organics	M	S		Topsoil / Fill	
	N/A	NA			1			Construction waste - Timber/concrete/iron etc - Loose - Intermixed with silty CLAY	M	VL		Demolition waste	
								Clayey SILT, Greenish Grey Firm.	M	St		Alluvium.	
					2			TESTPIT TERMINATED AT					
					3								

SKETCH



SCALE 1:100

TONKIN & TAYLOR LTD.

EXCAVATION LOG

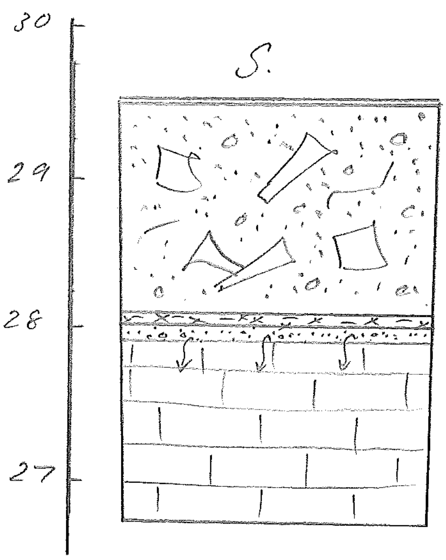
EXCAVATION NO: TP2
SHEET OF

PROJECT: SOUTHERN CROSS EXTN	LOCATION: HANSON ST	JOB NO: 84528.
CO-ORDINATES:	EXPOSURE TYPE: TEST PIT	HOLE STARTED: 4/06/2008 12am
	EQUIPMENT: 12 T EXCAVATOR	HOLE FINISHED: 2pm
RL: 29.5m.	OPERATOR: B. BELLAMY.	LOGGED BY: SJER
DATUM:	EXCAVATION DIMENSIONS: 2.1m x 1m.	CHECKED BY:

EXCAVATION AND TESTS: | ENGINEERING DESCRIPTION: | GEOLOGICAL:

PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa (10 25 50 100 200)	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
								Topsoil				Topsoil	
	N/A							Construction waste -Timber/concrete/iron etc -Loose -Intermixed with silty CLAY; Sandy GRAVEL	M	VL		Demolition waste	
					1				M				
		Seepage.						Silty CLAY Grey, Firm Coarse SAND, Black, Wet				Fill	
	N/A				2			Greywacke Sandstone. Orange Brown, Weak	W			Greywacke sandstone	
									M				
					3			TEST PIT TERMINATED AT 2.8m					

SKETCH



SCALE 1:50.

TONKIN & TAYLOR LTD.

EXCAVATION LOG

EXCAVATION NO: TP3

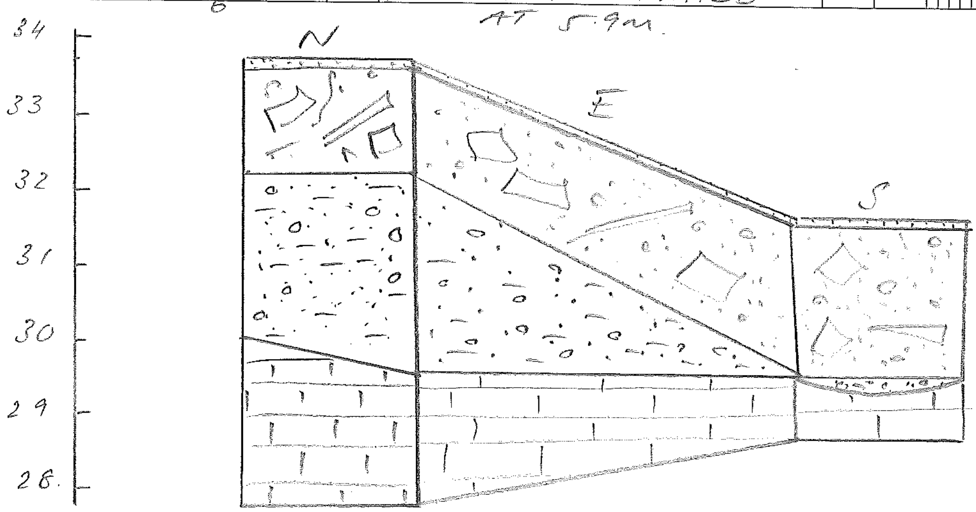
SHEET 1 OF 1

PROJECT: SOUTHERN CROSS EXTN	LOCATION: HANSON ST		JOB NO: 86528.
CO-ORDINATES:	EXPOSURE TYPE: TEST PIT	HOLE STARTED: 4/06/2008 10am	
	EQUIPMENT: 12 T EXCAVATOR	HOLE FINISHED: 11:45am	
RL: ~34-31	OPERATOR: B. BELLAMY	LOGGED BY: SJEF	
DATUM:	EXCAVATION DIMENSIONS: 2.3m x 5m.	CHECKED BY:	

EXCAVATION AND TESTS: / ENGINEERING DESCRIPTION: / GEOLOGICAL:

PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa (10 25 50 100 200)	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
	N/A		NORTH FACE.		1			Sandy loam with organics. Construction waste - Timber/concrete/iron etc. - loose - Intermixed with silty CLAY; Organic loams.	M	VL		Topsoil Demolition waste	
	N/A				2, 3			Sandy CLAY with some gravels. Orange brown, medium dense	M, M	St		Colluvium/ Fill	
	N/A				4, 5, 6			Siltstone Highly fractured with iron staining on defects. Orange Brown Weak. TEST PIT TERMINATED AT 5.9m.	M			Greywacke siltstone.	

SKETCH



R.L. (m)

SCALE 1:100

TONKIN & TAYLOR LTD.

SOIL LOG

BOREHOLE NO: BH1

SHEET 1 OF 1

PROJECT: SOUTHERN CROSS EXTN | LOCATION: HANSON ST. | JOB NO: 86528
CO-ORDINATES: | DRILL TYPE: 100mm | HOLE STARTED: 3/06/2008 10am
| DRILL METHOD: TRACK MOUNTED ROTARY/WASH DRILL | HOLE FINISHED: 2 30pm
RL: 29·5 | | DRILLED BY: J CROFT
DATUM: | DRILL FLUID: REHOPOL/WATER | LOGGED BY: SJEF CHECKED BY:

DRILLING AND TESTS: | ENGINEERING DESCRIPTION: | GEOLOGICAL:

FLUID LOSS	WATER	SAMPLING METHOD	METHOD/CASING	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa (10 25 50 100 200)	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
									Silty GRAVEL LOOSE DARK BROWN.	M / S			FILL/(HARD)FILL	
				20		1			SILT, LIGHT BROWN. Sandy GRAVEL with some silt. MEDIUM DENSE.	W			FILL.	
				21		2			Silty GRAVELS MEDIUM DENSE.	W			INTERMIXED ALLUVIAL/ COLLUVIAL DEPOSITS.	
				22		3			Silty CLAY. GREENISH GREY Sandy GRAVEL SOME SUB ANGULAR CLASTS. MEDIUM DENSE ORANGEY BROWN.					
				30		4			Sandy GRAVEL with some silt MEDIUM DENSE ORANGEY BROWN SOME ORGANICS (ROOTLETS)	W				
				18		5			Silty SAND with some gravels FIRM. LIGHT GREY.	W				
				46		6								
				25		7			SANDSTONE. ORANGEY BROWN VERY WEAK. CW.	W			IN-SITU GREYWACKE ROCK.	
				41		8			SANDSTONE. ORANGEY BROWN WEAK. HW.	W				
				50+ @ 60mm		9								
				50+		10			BOREHOLE TERMINATED AT 10m.					

TONKIN & TAYLOR LTD.

SOIL LOG

BOREHOLE NO: BH2.
SHEET 1 OF 1

PROJECT: SOUTHERN CROSS EXTN
LOCATION: HANSON ST, NEWTOWN
JOB NO: 84528

CO-ORDINATES:
DRILL TYPE: 100mm
DRILL METHOD: TRACK MOUNTED ROTARY WASH DRILL
DRILL FLUID: REHOPOL/WATER
RL: 29m.
DATUM:
HOLE STARTED: 3/06/2008 3:15pm
HOLE FINISHED: 4:45pm
DRILLED BY: J CROFT
LOGGED BY: STEF
CHECKED BY:

DRILLING AND TESTS:							ENGINEERING DESCRIPTION:						GEOLOGICAL:	
FLUID LOSS	WATER	SAMPLING METHOD	METHOD/CASING	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa (10 25 50 100 200)	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				JET VAC EXCAVATED TO 2m.		0–2			Silty GRAVEL. LOOSE - VERY LOOSE BROWN.	M / W			FILL.	
				41 (2m); 50+ (3m); 50+ @ 140mm (4m); 50+ (5m)		2–5			SANDSTONE. (CW - HW), DENSE - VERY DENSE. ORANGEY BROWN.	W			IN-SITU GREYWACKE ROCK.	
						5			BOREHOLE TERMINATED AT 5m.					

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TONKIN & TAYLOR LTD.

SOIL LOG

BOREHOLE NO: BH 3.
SHEET / OF /

PROJECT: SOUTHERN CROSS EXT. LOCATION: HANSON ST. JOB NO: 84528
CO-ORDINATES:
DRILL TYPE: 100mm - CASING TO 3.9m. HOLE STARTED: 4/06/2008 9:30am
DRILL METHOD: TRACK MOUNTED ROTARY WASH DRILL HOLE FINISHED: 3pm.
RL: 37.10m. DRILLED BY: J CROFT
DATUM:
DRILL FLUID: REMOPOL/WATER LOGGED BY: STEF CHECKED BY:

FLUID LOSS	WATER	SAMPLING METHOD	METHOD/CASING	SAMPLES, TESTS	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa (10 25 50 100 200)	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				5		1			Sandy GRAVEL with some silt. VERY LOOSE. ORANGEY BROWN. ANGULAR & SUB-ANGULAR GRAVELS. FRAGMENTS OF BRICK.	M / ? ; W			FILL.	
				6		2				W				
				1		3				W				
										W				
				REFUSAL; BOUNCING FOR 90mm.		4			CONCRETE, BRICKWORK, TRACES OF STEEL				CONCRETE. FLOOR SLAB.	
									BOREHOLE TERMINATED AT 4.09m.					

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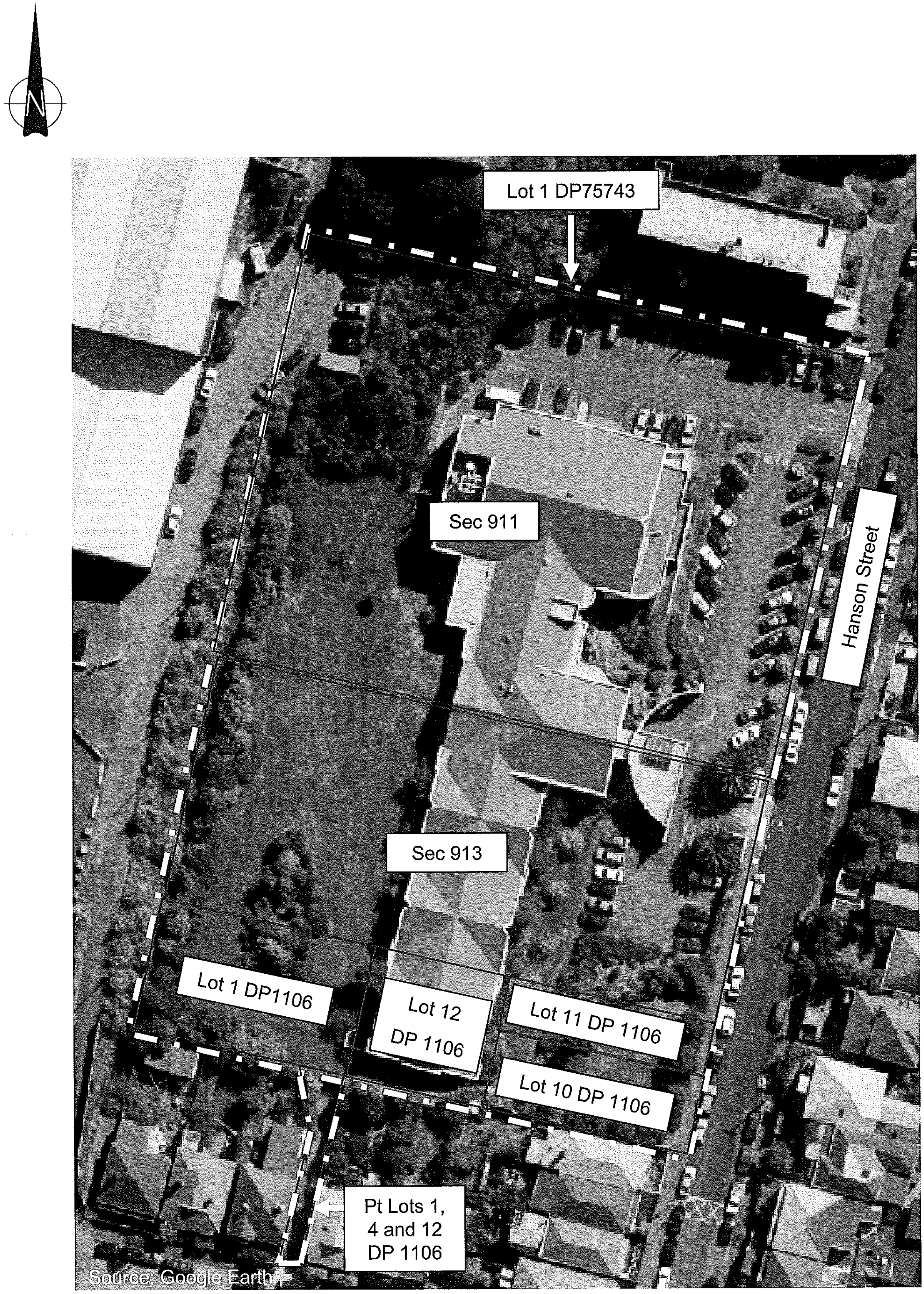
Appendix D: Historical Property Boundaries/Lab Report



Tonkin & Taylor
Environmental & Engineering Consultants

☐ Hamilton ■ Wellington ☐ Dunedin
☐ Nelson ☐ Christchurch ☐ Tauranga
☐ Auckland

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DRAFTING CHECKED	
APPROVED	
CADFILE:	Figures.ppt
SCALES (AT A4 SIZE)	1:1,000
PROJECT No.	84528

Geotechnical Site Investigation and Historical Property Review

90-114 Hanson Street, Newtown, Wellington

FIG. No. Figure 2 **Historical Property Boundaries**

REV. 0

Hill Laboratories
A WORLD LEADER IN ANALYTICAL SERVICES

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	645009 SPv1
Contact:	Hughes, Glen	**Date Registered:**	06-Jun-2008
	c/o Tonkin & Taylor	**Date Reported:**	12-Jun-2008
	P O Box 2083	**Quote No:**	
	WELLINGTON	**Order No:**	84528
		Client Reference:	84528
		Submitted By:	Hughes, Glen

RECEIVED
16 JUN 2008
BY: GRH

Sample Type: Soil

Sample Name:		T&T 84528/1				
Lab Number:		645009.1				
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	12	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.32	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	29	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	73	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	280	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	18	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	280	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Dry Matter	g/100g as rcvd	82	-	-	-	-
Acenaphthene	mg/kg dry wt	< 0.030	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.030	-	-	-	-
Anthracene	mg/kg dry wt	0.073	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	0.17	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.14	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.23	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.10	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	0.13	-	-	-	-
Chrysene	mg/kg dry wt	0.29	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.030	-	-	-	-
Fluoranthene	mg/kg dry wt	0.58	-	-	-	-
Fluorene	mg/kg dry wt	0.038	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.060	-	-	-	-
Naphthalene	mg/kg dry wt	0.44	-	-	-	-
Phenanthrene	mg/kg dry wt	0.38	-	-	-	-
Pyrene	mg/kg dry wt	0.59	-	-	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation*	Air dried at 35°C and sieved, <2mm fraction.	-	1
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis	-	1
Dry Matter (Org)	Dried at 103°C (removes 3-5% more water than air dry), gravimetry.	0.10 g/100g as rcvd	1
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2	-	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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