APPENDIX P

Structural Report (including Geotechnical Report)

KEMPSEY DISTRICT HOSPITAL REDEVELOPMENT

SCHEMATIC DESIGN REPORT - STRUCTURAL

Prepared for: **Health Infrastructure NSW**
By: **Enstruct Group**
Revision: **C**
April 2013

ISSUE AUTHORISATION

PROJECT:
Project No:

Rev	Date	Purpose of Issue /Nature of Revision	Prepared by	Reviewed by	Issue Authorised by
A	31/01/13	Draft Issue	JB	TBB	TBB
B	1/03/13	Final Schematic Design Report	JB	TBB	TBB
C	16/04/13	Final Schematic Design Report	JB	TBB	TBB

Enstruct group P/L
Level 4 – 2 Glen St
Milsons Point
Sydney NSW 2061
Australia.
Telephone (02) 8904-1444
Facsimile (02) 8904-1555

This Report is given for the benefit of:

a) NSW Health and Health Infrastructure (ABN 89 600 377 397); and
b) Any Tenderer (meaning any tenderer whether as an individual, and entity, a joint venture, a partnership or a consortium) to NSW Health or Health Infrastructure for the provision of works or services in any way in connection with the Project.

Executive Summary

This report describes the proposed structural engineering strategy to meet the requirements of the master plan strategy and is a continuation of the structural scheme developed during the master plan and feasibility phases of the project covering the following:

- Condition of existing structures and suitability for re-use.
- Structural engineering options for the proposed new buildings identified in the master plan.
- Key structural engineering issues and risks.

This Schematic Design Report has been prepared to set the basis for delivery phases of the structural engineering requirements for the proposed Stage 1 development of the Kempsey District Hospital site.

The report has been produced to summarise the process and findings to date in relation to the structural engineering for the Kempsey District Hospital redevelopment project.

The report discusses the due diligence process undertaken by enstruct to ascertain the existing site conditions and probable risks associated with the development of the site.

The report then continues to summarise the options available for the Stage 1 development of the site by discussing the following:

- Condition of existing structures and suitability for re-use.
- Structural engineering options for the proposed new buildings identified in the master plan.
- Key structural engineering issues and risks.

The structural schemes developed during the Schematic Design phase specifically address issues including:

- The new structures will generally utilise the HI systemised design approach.
- Design in accordance with HI floor vibration requirements.
- Careful selections of appropriate foundations – raft slabs or piles – for buildings on steep cut and fill sections of the site.
- More detailed assessment of existing structures to be retained at interfaces with new buildings.

The proposed structural system for the development is as follows:

- Piled foundation system.
- Concrete framed building.
- Hybrid shear wall and sway frame lateral system.
- On grade structure in the undercroft area;
- Post tensioned flat plate with drop panel suspended floor plate.

The report outlines Green Star credits in the Mat-5 Concrete and Mat-6 Steel criteria that can be readily achieved for the project with negligible or nil cost to the building structure to assist the project in targeting a 4 Green Star rating as requested by Kempsey Shire Council.

The project includes a level of refurbishment and re-use of some of the existing building stock on site. For the works to date detailed investigation of these structures have been undertaken to confirm their suitability for re-use and refurbishment, however it is noted that as is the case with all works on existing structures until construction works are commenced and the existing structure fully exposed there remains a risk of additional structural works being required due to unexpected deterioration or arrangement of existing structure. To minimise this risk significant investigation of the existing structure has been undertaken however the risk cannot be eliminated until such time as the structure is completed exposed during construction works.

For future stages of the Hospital redevelopment the Masterplan provides additional stage expansion and redevelopment to occur horizontally and as such no allowance for vertical expansion has been made in the Stage 1 Main Building.

TABLE OF CONTENTS

1 Project Description

1.1 Overview

Kempsey District Hospital is a 66 bed facility providing level 3 services including emergency, high dependency and coronary care, general medicine, general surgery, rehabilitation, maternity, mental health, renal dialysis, and a broad range of primary health care services.

The Hospital predominantly services the Kempsey Local Government Area (approximately 29,000 residents) and is located in West Kempsey, a short distance from the Kempsey Central Business District.

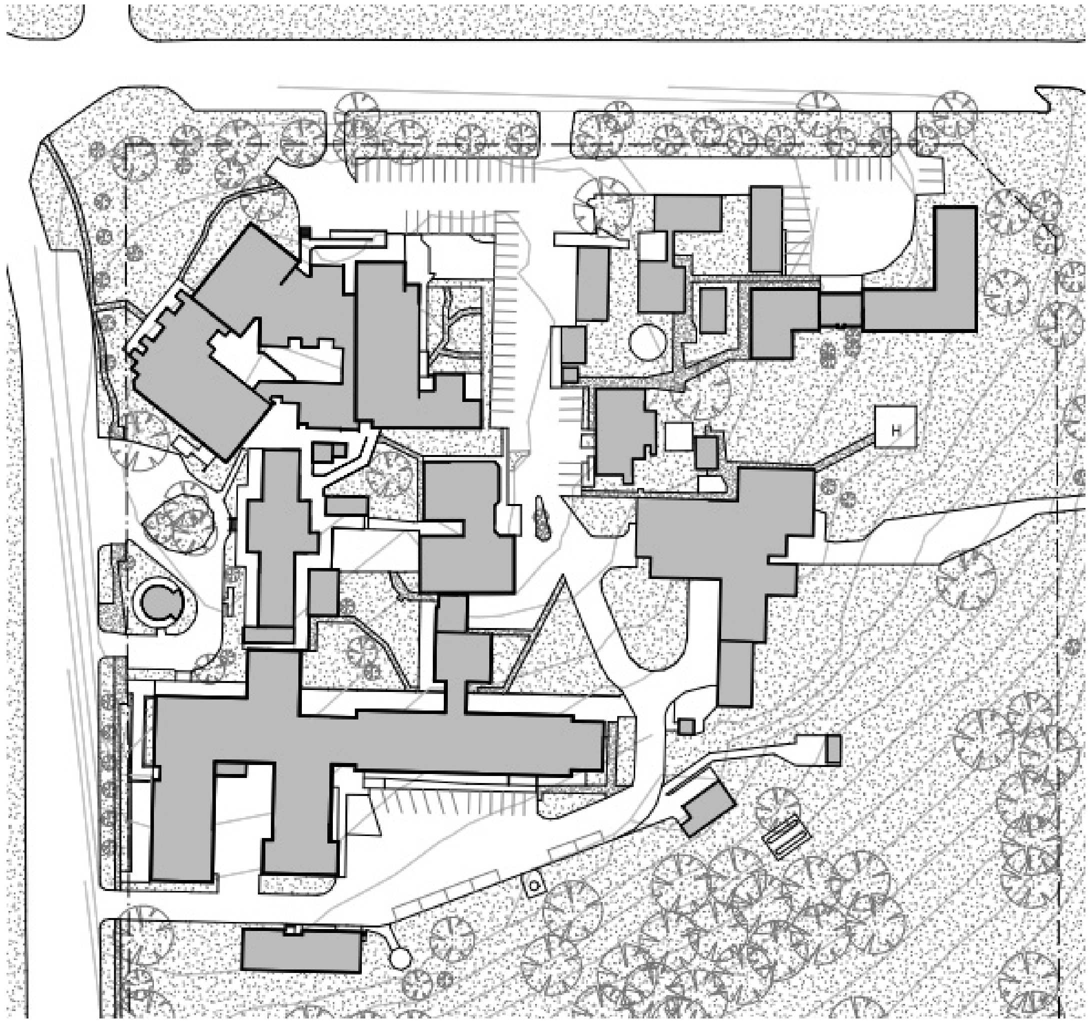


Fig 1 Kempsey Hospital site

Kempsey District Hospital is located within the Mid North Coast Local Health District, which also comprises facilities at Bellingen, Coffs Harbour, Dorrigo, Kempsey, Macksville, and Port Macquarie.

Fig 2 Mid North Coast Local Health District

Kempsey District Hospital is part of the Hastings Macleay Clinical Network, which also includes Port Macquarie Base Hospital and Wauchope District Memorial Hospital.

1.2 Project Background

In 2011, the NSW Government submitted an application to the Health and Hospital Fund for the Kempsey District Hospital Redevelopment.

In May 2012, the NSW Government and the Australian Government announced a major capital investment of $80 million for the Kempsey District Hospital Redevelopment Stage 1. The NSW Government will provide $40 million and the Australian Government will provide $40 million through the Health and Hospital Fund.

1.3 Project Overview

The Kempsey District Hospital Redevelopment represents a strategic capital investment in the health infrastructure of the Mid North Coast Local Health District and for rural services more generally across NSW. The broad objectives of the Redevelopment are to:

- Invest in increase clinical service capacity and address clinical service priority areas.
- Implement new models of care which better meet the health care needs of the community.
- Deliver culturally appropriate services which meet the needs of the high proportion of Aboriginal people in the Kempsey Local Government Area.
- Deliver new and contemporary health care facilities which support sustainable, safe, quality health care service delivery into the future.
- Support education and training of the health workforce, and workforce recruitment and retention strategies.
- Set up a strategic longer term development framework (master plan) for the site. This includes considering opportunities for future vertical expansion above the new hospital building.

1.4 Project Description

1.4.1 Service Profile

The Kempsey District Hospital Redevelopment Stage 1 will provide increased service capacity and contemporary models of care to meet the changing and unique health care needs of the community. The Redevelopment will provide the following:

- New main entrance and front of house services.
- New emergency department (with 2 resuscitation bays, 10 adult acute bays, 2 fast track bays, 4 paediatric bays, and associated consultation rooms and support areas).
- New 6 bed emergency medical unit.
- Establishment of an integrated community care centre.
- New medical imaging department with CT, general x-ray, ultrasound and OPG.
- New 4 space medical day procedures unit.
- New 32 bed acute inpatient unit with an additional 8 shell beds.
- New 8 bed high dependency and coronary care unit.
- New operating theatre suite with two operating theatres, one shell operating theatre, Stage 1 recovery, and 9 space day surgery unit.
- Expansion of renal dialysis services from 5 to 10 chairs, and the establishment of a renal dialysis training unit.
- Expansion of oral health from 2 to 4 chairs.
- Relocation and or expansion of several primary health care, community, and ambulatory services.

In addition to this, the Stage 1 Redevelopment will also comprise:

- Connections between Stage 1 new facilities and the existing facilities to achieve good connectivity and operational efficiency across the site.
- External site works such as landscaping, pathways etc.
- Reconfiguration of car parking provision for patients, visitors, and staff.
- Engineering services reconfiguration / upgrade to meet the future needs of the hospital.

2 Process for Developing the Schematic Design Report

This section of the report discusses the process undertaken to date culminating in the preparation of the schematic design report for the project.

2.1 Due Diligence

An initial due diligence process was undertaken in regards to the existing site conditions and possible constraints which would apply to the development works.

A report was prepared by enstruct which discussed both the civil and structural components of the existing site investigation. This report, the “Site Condition and Risk Analysis Report”, was completed following a number of visits to the site during which non-intrusive investigation were undertaken as to the existing condition of the site infrastructure.

In addition to the site investigations enstruct reviewed the existing documentation available for the site which provided information on existing in ground services. The findings of this review were also discussed in the above mentioned report.

2.2 Option Reporting

Following the release of the existing site conditions report enstruct were able to use the information gained during the due diligence process to provide the design team with likely impacts and possible options for the structural engineering requirements for the options proposed by the architect.

Common across all options is the proposed implementation of the systemised design (8.4m x 8.4m) grid with the vibration performance parameters outlined in previous enstruct reports for the project. A key element of options review going forward will be the consideration of foundation and ground floor options with the civil works for the site to minimise cost and target cut/fill balance.

The provision of this information assisted the design team in reducing the available options closing in on a preferred option.

2.3 Alignment with Master Plan and Concept Report Intent

The Master Planning, Feasibility/Concept Phases are a key component to the development of the schematic design report for the project with the concepts and structural systems developed during the early phases of the project refined and further developed during the Schematic Design Phase of the project. The structural concepts put forward in the master plan and concept design report remain valid at this schematic phase of the project with further development to continue into the delivery phases of the project.

2.4 HI ERG Review

The structural options and parameters for the project have been presented to the HI ERG and continues a refinement of structural options for health projects that enstruct has undertaken on a number of HI projects. The ERG raised no objection to the structural options for the project or the structural design parameters proposed.

2.5 Authority Consultation

Structural consultation for the project has been limited to the ERG as there are is no structural authority consultation required.

3 Existing Site Conditions

As discussed in previous sections of this report enstruct has prepared a report discussing the existing site conditions and constraints.

This section of the report aims to summarise the findings of the investigation and reporting works undertaken up to this point in the project.

3.1 Geotechnical Conditions and Site Contamination

To provide a detailed understanding of the geotechnical profile in the area identified for the proposed redevelopment a detailed geotechnical investigation will be carried out. A detailed tender process has been undertaken for these and the site contamination investigation services which has resulted in the engagement of Coffey Geotechnics to undertake these works. Coffey have now completed the following:

- Desktop review of the site geotechnical conditions (refer to Appendix D1-A);
- Detailed Geotechnical Report and Investigation for the site (refer to Appendix D1-B);
- Phase 1 Contamination Site Investigation (Appendix D1-C);
- Phase 2 Contamination Site Investigations (Appendix D1-D).

3.1.1 Geotechnical Investigation and Reports

3.1.1.1 Subsurface Conditions

This detailed investigation has found the subsurface conditions to be broadly in agreement with the previous assessment and can be summarised as follows from the Coffey Geotechnical Report:

- FILL: comprising a clay with low to high plasticity, some sand, some gravel. Variable consistency. In borehole BH6, a thicker sequence of fill material was encountered (2.6m) with some suspected fly ash. Older topsoil may be present under the fill.
- RESIDUAL SOIL: comprising high plasticity clay with some sand, generally Very Stiff to Hard.
- EXTREMELY WEATHERED SILTSTONE: comprising low to high plasticity clay with a gradational contact with bedrock. Generally very stiff to Hard and friable consistency.
- HIGHLY WEATHERED SILTSTONE: Generally low rock strength with variable RQD (between 0 and 88%) and fracture spacing. Some zones of core loss and very low strength siltstone.
- MODERATELY WEATHERED SILTSTONE: Generally medium to high rock strength with variable RQD, generally exceeding 70%.

3.1.1.2 Foundations

The Coffey report advises that shallow foundations founded at least 1.5m below the existing ground into residual soil or extremely weathered siltstone can be designed for an allowable bearing pressure of 200kPa.

Pile design parameters for the project are as follows:

Unit	Ultimate Bearing Resistance (MPa)	Ultimate Shaft Adhesion (kPa)	Young's Moduli (Vertical) (MPa)
Uncontrolled Fill	-	-	-
Very Stiff to Hard Residual Soil and XW Siltstone	1.5	30	60
HW Siltstone	6	100	200
MW Siltstone	10	450	600

It is recommended that ultimate strength testing of the piles is specified and undertaken to allow an efficient foundation solution to be developed with Coffey recommended a basic geotechnical strength reduction factor (ϕ_g) as follows:

- 3% of piles tested – $\phi_g = 0.61$;
- 10% of piles tested – $\phi_g = 0.7$.

3.1.1.3 Earthquake Design Parameters

Coffey have classified the site as a Class C_e – Shallow Soil Site in accordance with section 4.2 of AS1170.4 – 2007 Structural Design Actions in Australia Part 4: Earthquake Actions.

3.1.1.4 Site Classification to AS2870

Provided that any foundations are founded below any fill on the site Coffey have classified the site as being equivalent to a Class M site in accordance with AS2870 – 2011 Residential Slabs and Footings.

3.1.1.5 Soil Aggressively for Foundations

Coffey have found the site conditions to be "non-aggressive" to buried concrete elements in accordance with AS2159 – 2009 Piling Design and Installation.

3.1.1.6 Batter Slopes

The Coffey report has found that the following temporary and permanent batter slopes are appropriate for the site conditions:

Unit	Permanent Slopes		Temporary Slopes	
	Maximum Angle	Maximum Height (m)	Maximum Angle	Maximum Height (m)
Uncontrolled Fill	4H:1V	2m	2H:1V	2m
Very Stiff to Hard Residual Soil	3H:1V	3m	1.5H:1V	2m
Very Stiff to Hard Clay (XW Siltstone)	2.5H:1V	3m	1H:1V	3m
HW Siltstone or better	1.5H:1V	3m	0.75H:1V	3m

Temporary slopes are for up to 3 months duration and exposed permanent slopes are to be vegetated, provided with soil erosion protection measures or shotcreted, refer to Coffey report for limitations and requirements of batter slopes.

3.1.1.7 Retaining Walls

The Coffey report nominates that for gravity and simple anchored retaining walls with a maximum of one row of anchors can be designed using a triangular stress distribution with the design to ensure that the rear of the wall is appropriately drained with allowance in the wall design made for potential water pressure build-up equivalent to 1/3 of the wall height. The nominated retaining wall geotechnical design parameters are as follows:

Unit	Bulk Density γ_b (kN/m^3)	Effective Cohesion c` (kPa)	Effective Friction Angle ϕ`
Very Stiff to Hard Residual Soil	21	10	25°
Very Stiff to Hard Clay (XW Siltstone)	22	10	25°
Low Strength Siltstone	23	25	30°

3.1.2 Phase 1 Environmental Site Assessment

The following extract is from the executive summary of the Coffey Geotechnics Phase 1 Environmental Site Assessment report which provides a summary of the contamination findings in this initial investigation and report.

In summary, the site history prepared for the Stage 1 and Civil Work Zones redevelopment areas within the Kempsey District Hospital grounds shows that the hospital was constructed in the early 1940's. A review of the earliest available historical 1957 aerial photographs shows original hospital buildings within the northern portion of the Stage 1 area, which included the former nurse quarters. The aerial photographs indicate that the former boiler and laundry buildings and the fumigation building were constructed sometime between 1957 and 1967 and the incinerator and coke storage buildings were constructed between 1967 and 1979.

Interviews with Kempsey District Hospitals Acting Assistant Engineer suggests that the fill embankment observed to the southeast of the boiler and laundry building was filled during construction of the boiler and laundry building in the early 1960's. Observations made by Coffey during our site walkover found no visual evidence of contamination including surface staining observed around the perimeter of the buildings within Stage 1.

A review of NSW WorkCover records found no evidence of underground storage tanks (USTs) being present within the hospital grounds. A review of the limited records held by Kempsey Shire Council for the period 1991 to 2002 included hospital plans identifying the small building to the southwest of the boiler and laundry building as the coal (coke) storage building. The former incinerator was once located in a building to the south of the boiler and laundry buildings at the base of the embankment within the Stage 1 area. This building is now used for waste storage and cleaning of bins.

The findings from the site history assessment and site walkover identified four (4) areas of environmental concern (AECs). These AECs were associated with the former activities and current landuses of the site, they included the former laundry and boiler room, incinerator, fumigation and coke storage buildings, the existing diesel AST, former nurse quarters building, and the fill embankments constructed of unknown material within the site.

Based on the findings of the Phase 1 ESA a more detailed investigation (Phase 2 ESA) is recommended.

3.1.3 Phase 2 Environmental Site Assessment

The following extract is from the executive summary of the Coffey Geotechnics Phase 2 Environmental Site Assessment report which provides a summary of the contamination findings for the site.

Coffey Geotechnics Pty Ltd (Coffey) was engaged by the enstruct Group Pty Ltd to undertake a Phase 2 Environmental Site Assessment (Phase 2 ESA) for the Stage 1 and Civil Works Zone redevelopment Kempsey District Hospital located at 119 River Street, West Kempsey NSW, see Figure 1.

Coffey Geotechnics have previously completed a Phase 1 ESA (see report GEOTCOFH03037AA-AD), dated 16 November 2012. The Phase 1 ESA identified four (4) areas of environmental concern (AECs), including:

- *AEC 1 – Embankments (suspected fill) (southeast of boiler and laundry building and associated with the helipad).*
- *AEC 2 – Boiler Room, Incinerator, Coke Storage and Fumigation buildings, and the diesel above ground storage tank.*

- *AEC 3 – Former Nurse Quarters Building.*
- *AEC 4 – Broad screening over the balance of the site.*

The field investigation program was design to assess the potential contamination present in each of the AECs. The Phase 2 ESA including the drilling of five (5) boreholes within the fill embankments (AEC1) to the east of the boiler room building and associated with the construction of the helipad. Surface soil sampling and one borehole were undertaken within the remaining three (3) AECs. During the field investigation no signs of surface staining or hydrocarbon odours were observed. Minor coal and ash fragments were identified in BH6 (0.5 – 1.4m) and BH14 (0.6 – 1.3m) and in surface soils during collection of sample SS10.

The lab results indicated that 41 of the 42 samples analysed reported levels of potential contaminates of concern below adopted investigation criteria. The exception was surface sample SS10 reporting concentration of lead (960mg/kg) above the adopted SIL of 600mg/kg. Surface sample SS10 was collected from adjacent to the eastern wall of the boiler room building. The source of the elevated levels of lead is flaking paint (potential lead based paint) observed on the eves around this building.

During the previous site walkover and this current field investigation asbestos containing materials (ACM) including fibro cement sheeting and potential lead based paint, on buildings timber eves, was observed within the site. The ACM appeared to be in relatively good condition and no asbestos was detected in the surface soil samples analysed. Several of the buildings proposed to be demolished within the Stage 1 area contain ACM and potential lead based paint coatings. Coffey recommends that prior to redevelopment of the Stage 1 area that a detailed HAZMAT survey is undertaken to identify and quantify the amount of asbestos and potential lead based paint materials present.

The findings from the field investigation and laboratory results indicated that the elevated lead concentrations within AEC2 and the presence of ACM and potential lead based paint within the hospital buildings in Stage 1 warrant further investigation and remediation. Implementation of these recommendations will allow for this site to be made suitable for its intended future redevelopment.

3.1.4 Existing Building Foundations

Available drawings of existing structures show high level pad footings and integral raft footings for the smaller buildings, and a mixture of pad and undercut pier foundation on clay for the main ward building.

3.2 Existing Buildings

The following is a summary of the structure of the existing buildings identified at the time of site inspections as possibly being impacted by proposed works.

The inspection of the existing buildings was limited to a walk through site inspection and review of structural drawings available (note not all buildings had structural drawings available) and was not a detailed or invasive inspection.

The level of inspection undertaken to date is appropriate for scheme design with more detailed investigations, such as timber inspections and grading, being undertaken in areas identified as requiring further investigation that can be accessed at this stage. It is highlighted that as is the nature of re-suing and refurbishing existing buildings until such time as construction commences and the building structure is fully exposed the risk of unexpected levels of structural deterioration or unexpected structural arrangements remains. All appropriate investigations have been undertaken at this stage of the project to minimise these risks however they cannot be eliminated until such time as construction works are progressed.

Refer to Figure 1 (following) for a key plan showing locations and layout of existing buildings.

For details of buildings to be retained, refurbished or demolished refer to architectural schematic design report and drawings.

3.2.1 Buildings 3, 5A & 5B: Emergency & Main Ward

Description:
- 2 to 5 level ward & theatre building.

Structural System:
- Reinforced concrete frame and slab with infill masonry internal and external walls, with steel framed roof which appears to be supported on the exterior brick walls.

Foundation System:
- High level pad and undercut bored pier foundation on clay with an allowable bearing intensity of 2 tons per square foot (approximately 214 kPa)

Date of Construction:
- Approximately 1962.

Condition:
- Structure found to be in generally satisfactory condition with no obvious signs of significant structural distress.
- There is some deterioration of the white painted external concrete sun shades, mostly on the southern side. We understand that this is being investigated and dealt with by the Local Health District.

Structural Comments on Building Re-Use:
- As most walls are infill this will allow modification to the wall layout with no impact on the building structure. The existing structural drawings that have been accessed for the buildings show the roof framing independent of the internal walls, however there remains a minor risk that some framing may be have been propped to the internal walls which it will need to be monitored during construction works and if found to be the case localised reframing may be required. Modification to any internal non-load bearing walls will not affect the vertical capacity of the existing structure however it is likely that they participate in the lateral capacity of the building which will allow a number of the walls

to be removed without structural impact provided that an appropriate number remain to provide the required lateral capacity. Determination of the impact of wall removal will need to be undertaken on a case by case basis reviewing schemes as they are provided;
- Vibration performance of existing floor plates unlikely to comply with current HI guidelines.

3.2.2 Buildings 6, 7 & 8: Mortuary and Garbage

Description:
- Single level minor structures

Assumed Structural System:
- Load bearing masonry internal and external walls timber framed roof.

Assumed Foundation System:
- Strip footings or concrete raft.

Date of Construction:
- Unconfirmed. Most likely more recent.

Condition:
- Structure observed to be in generally satisfactory condition with no obvious signs of structural distress.

Structural Comments on Building Re-Use:
- As all walls are assumed load bearing any modification to layout of the walls would require insertion of some transfer beams with possible new columns.

Building 8 is a minor brick ‘shed’ beside the workshop currently used as a store.

3.2.3 Buildings 9A, 9B & 10: Linen Service and Boiler plus Workshop

Description:
- Industrial type building which housed the laundry service and boilers, which are now disused, and with current sub-station and switch room. The workshop appears to be a later addition to the southern end.

Structural System:
- External load bearing masonry;
- Slab on grade ground floor structure in part, timber in part;
- Steel framed roof with some timber elements seated on external walls and some interior columns.

Foundation System:
- Assumed slab on grade with high level strip foundations

Date of Construction:
- Estimated to be circa 1960’s. The workshop appears to be a later addition.

Condition:
- Structure appears to have been modified in a random way and looks ‘scrappy’ and ill maintained. Floor slabs cracked and broken in places.

Structural Comments on Building Re-Use:
- Timber floor structures are inappropriate for future re-use as boiler room. Load capacity of existing concrete floor slabs for heavy equipment loads unknown and questionable given history of patching.
- It is understood that the substation and switch room will be re-located as part of the redevelopment.
- New lightweight metal deck roof system would need to be provided to replace old fibre cement sheeting.

Building 10 is a small ‘Helicopter Fuel Transfer Station’ added at a later date to the rear of Building 9B.

3.2.4 Buildings 11A to D:

These comprise a number of small ancillary facilities alongside the Linen Service building including a disused water tower and a garden store building.

3.2.5 Building 12: Blood Bank

Description:
- Single level original structure with ‘veranda’ wings added at later date.

Structural System:
- Original building: solid load bearing brick walls with timber floor and roof. Internal cross walls are timber infill
- Verandas: timber framed with brick pier foundations.

Foundation System:
- Assumed minor strip footings; possibly through belling of brick walls.

Date of Construction:
- Understood to be around 1919.

Condition:
- Structure found to be in generally satisfactory condition with no obvious signs of significant structural distress.

Structural Comments on Building Re-Use:
- Use will be limited by the narrow width between the original external load bearing walls.

3.2.6 Buildings 13A to D: Community Health

Building 13A – Former Nurses Quarters

Description:
- Double and single level accommodation buildings.

Structural System:
- Original two storey building: solid load bearing brick walls with timber floors and roof. Single level extension at rear appears to be similar construction.

Foundation System:
- Assumed minor strip footings; possibly through belling of brick walls.

Date of Construction:

- Décor suggests original building circa early 1900s.

Condition:

- Structure found to be in generally satisfactory condition with no obvious signs of significant structural distress.

Structural Comments on Building Re-Use:

- Use will be limited by the load bearing walls which limit the opportunity for re-planning. Removal of any internal load bearing walls will require the provision of underpinning steelwork and analysis to determine the impact on the building lateral capacity.

Forestry Corporation of NSW has undertaken a timber inspection of this building (see Appendix D1-I for report) and found the timber to be generally of good quality with no noticeable degradation since construction with a limited number of members identified as requiring replacement, refer to the report in Appendix D1-I for full details.

Building 13B – Computer Training Room

This is a simple pre-fabricated building with channel floor rails supported on brick piers.

The structure appears to be in satisfactory condition with no obvious signs of structural distress.

It will be quite simple to remove or re-use these buildings elsewhere on the site. As the building is of demountable construction relocation of the building would only require removal of internal and external wall and floor coverings at the joint between the two sections that make up the building and the sections of the building can then be craned into a new position or onto a truck for relocation. At the new location for the building new foundations in the form of brick piers on high level pad footings would need to be provided to support the building and then the internal and external wall and floor coverings at the joint location reinstated.

Building 13C – Dental Service and Community Health Meeting Room

These two small buildings are of simple timber and lightweight steel section construction. The structure appears to be in satisfactory condition with no obvious signs of structural distress.

The structural support system seen beneath the northern wing (Dental Service), suggests this was either constructed on site or as a transportable timber framed building with a timber framed floor with the main underfloor bearers seated onto brick piers. Through the use of a specialised building relocation firm it is expected that these buildings could be quite readily relocated on the hospital site and re-used if required. Specialist advice will need to be sought as to whether the building needs to be split to be relocated however even if splitting of the buildings is required this would only require removal of internal and external wall and floor coverings at any joint locations between the sections and the sections of the building can then be relocated into a new position. At the new location for the building new foundations in the form of brick piers on high level pad footings would need to be provided to support the building and then the internal and external wall and floor coverings at any joint locations reinstated. All services currently entering the building would need to be terminated at floor level and then be reconnected once in new location, details of this would need to be developed by the appropriate services consultant.

The central and southern section of this building (entry area and Community Health Meeting Rooms) appear to have been constructed on site. From inspection of the underfloor framing, wall cladding and roof construction of this section of the building these areas are not suitable for relocation due to the age and construction arrangement of this area.

All structures appear to be in satisfactory condition with no obvious signs of structural distress.

Building 13D – Drug and Alcohol Offices

This building has a simple timber framed construction on brick piers, and appears to have been constructed either on site or as a transportable timber framed building with a timber framed floor with the main underfloor bearers seated onto brick piers. Through the use of a specialised building relocation firm it is expected that these buildings could be quite readily relocated on the hospital site and re-used if required. Specialist advice will need to be sought as to whether the building needs to be split to be relocated however even if splitting of the buildings is required this would only require removal of internal and external wall and floor coverings at any joint locations between the sections and the sections of the building can then be relocated into a new position. At the new location for the building new foundations in the form of brick piers on high level pad footings would need to be provided to support the building and then the internal and external wall and floor coverings at any joint locations reinstated. All services currently entering the building would need to be terminated at floor level and then be reconnected once in new location, details of this would need to be developed by the appropriate services consultant.

The structure appears to be in satisfactory condition with no obvious signs of structural distress.

Forestry Corporation of NSW has undertaken a timber inspection of this building (see Appendix D1-I for report) and found the timber to be generally of good quality with no noticeable degradation since construction with a limited number of members identified as requiring replacement, refer to the report in Appendix D1-I for full details.

3.2.7 Building 14: Aboriginal Health

This building has a simple timber framed construction on brick piers, and appears to have been either constructed on site or as a transportable timber framed building with a timber framed floor with the main underfloor bearers seated onto brick piers. Through the use of a specialised building relocation firm it is expected that these buildings could be quite readily relocated on the hospital site and re-used if required. Specialist advice will need to be sought as to whether the building needs to be split to be relocated however even if splitting of the buildings is required this would only require removal of internal and external wall and floor coverings at any joint locations between the sections and the sections of the building can then be relocated into a new position. At the new location for the building new foundations in the form of brick piers on high level pad footings would need to be provided to support the building and then the internal and external wall and floor coverings at any joint locations reinstated. All services currently entering the building would need to be terminated at floor level and then be reconnected once in new location, details of this would need to be developed by the appropriate services consultant.

The structure appears to be in satisfactory condition with no obvious signs of structural distress.

Forestry Corporation of NSW has undertaken a timber inspection of this building (see Appendix D1-I for report) and found the timber to be generally of good quality with no noticeable degradation since construction with a limited number of members identified as requiring replacement, refer to the report in Appendix D1-I for full details.

3.2.8 Buildings 15A & 15B: Garden Shed

These are two minor structures – one out of brick and the other in a lightweight form of construction, that we understand are used for the storage of garden equipment. The roof sheeting appears deteriorated in both cases.

3.2.9 Building 18: Hydrotherapy and Day Hospital

Description:
- Single level building with hydrotherapy pool and day hospital facilities.

Structural System:
- Perimeter brick walls and steel posts supporting mixed steelwork and timber truss roof system.
- Timber ground floor on brick piers for Day Hospital. Shaped concrete slab on ground for pool area. Foundation System:
- High level pad and strip footings.

Date of Construction:
- Approximately 1987 – sequence unconfirmed.

Condition:
- Structure found to be in generally satisfactory condition with no obvious signs of significant structural distress. No sign of any major corrosion (corrosion that would currently require repair or rectification) in pool area was evident.

Structural Comments on Building Re-Use:
- Satisfactory for current or similar uses.

3.2.10 Main Ward Block Building 5A Link to Building 5B

Description:
- High level two storey link between Main Ward block and Building 5B.

Structural System:
- Steel framed primary building structure.
- Reinforced concrete floor slabs supported on steel framing.
- Piled foundations.

Date of Construction:
- Approximately late 1960’s.

Condition:
- Structure found to be in generally satisfactory condition with no obvious signs of significant structural distress.

Structural Comments on Building Re-Use:
- Satisfactory for current or similar uses.

Fig. 3 Site Plan showing arrangement of Existing Hospital Buildings

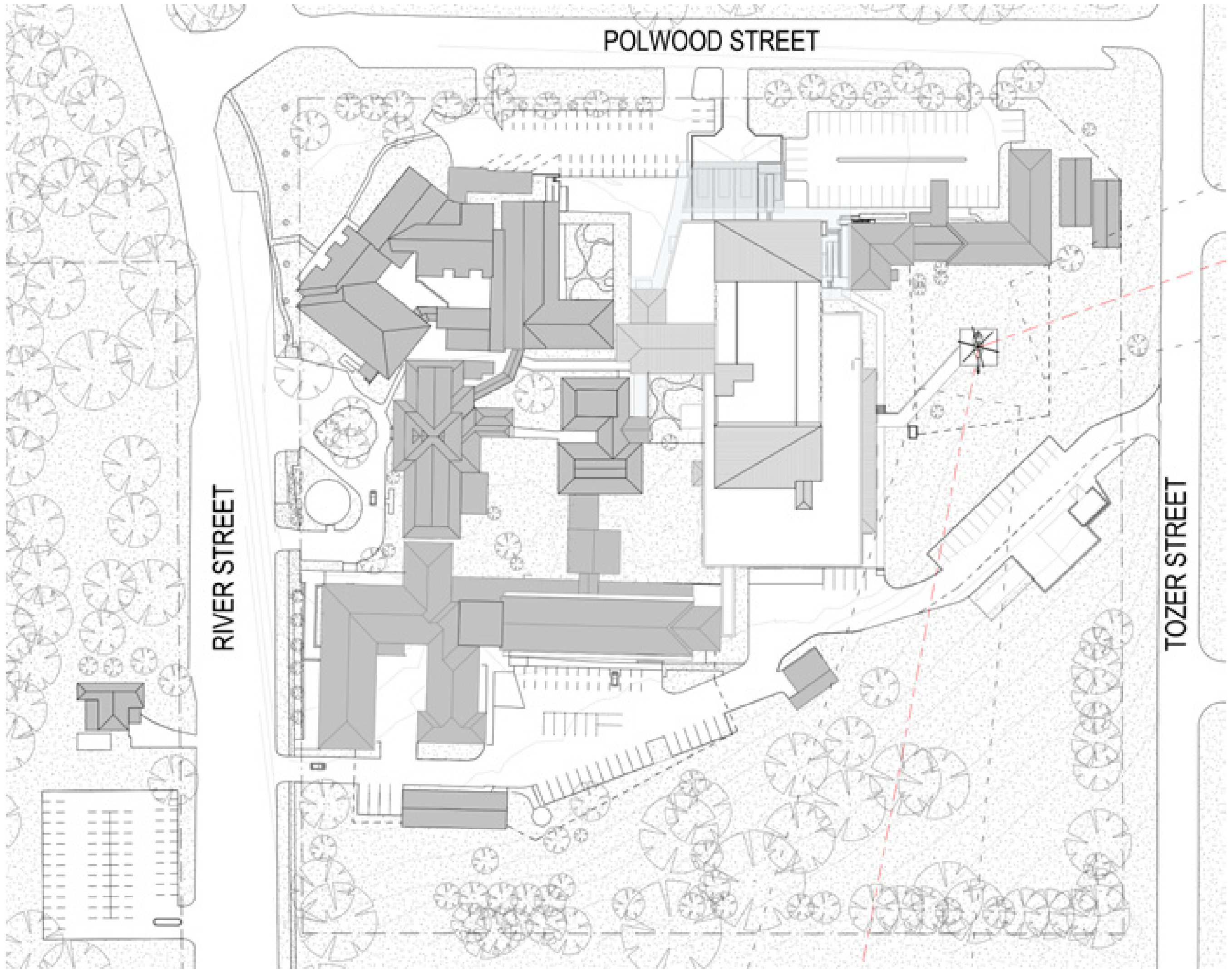
3.3 Key Issues & Risks

The key risks in relation to structure for the redevelopment are identified in the table below:

Risk	Risk Strategy	Risk Rating	Risk Value
Variability in ground conditions for foundations	Detailed geotechnical investigation of works area has been undertaken in initial phases of the project to ensure detailed understanding of the subsoil conditions is in place	Low	APK to advise
Structural condition of existing buildings intended for re-use/refurbishment.	Increasing level of investigation of existing structures will be undertaken to determine suitability of areas proposed for re-use as concepts develop. Investigations to date have identified issues with the existing southern sunshade on the main ward building. Timber frame inspection and grading of the existing Community Health, Aboriginal Health and Drug and Alcohol buildings has been undertaken to confirm the structural adequacy and remaining life of the timber members in these buildings.	Low	APK to advise
Hazardous materials within existing buildings	Detailed hazardous materials assessment of these areas has been engaged by a specialist sub-contractor	Medium	APK to advise
Site Contamination	Both Phase 1 and Phase 2 Environmental Site Assessments have been undertaken for the development site to identify possible site contamination to allow a strategy for dealing with any contamination to be put in place prior to works commencing.	Low	APK to advise
Connections between new and existing structures	All new structures will be designed to be self supporting to ensure that there is no reliance on existing buildings for structural capacity and the new construction does not modify the existing building structures. Movement joints at these interfaces will be design to allow existing and new buildings to act independently	Low	APK to advise
Ongoing maintenance	Possible higher levels of ongoing maintenance for structures that are re-used with aging infrastructure.	Low	APK to advise
HI Standards	Existing structures that are re-used may not satisfy current HI standards for a modern hospital facility. In particular the vibration sensitivity of the floor structures of the current ward building. Planning will need to ensure that appropriate uses are allocated to existing building stock that is to be re-used that is compatible with the performance characteristics of these buildings.	Low/Medium - Subject to Appropriate Planning	APK to advise

4 Schematic Design Response

A number of master planning options were initially produced by the design team which were then reduced to a preferred option as shown in Figure 4. Enstruct provided general advice during the master planning process in relation to options for structures of this scale and height at the site.



Fig,4 Master Plan Layout

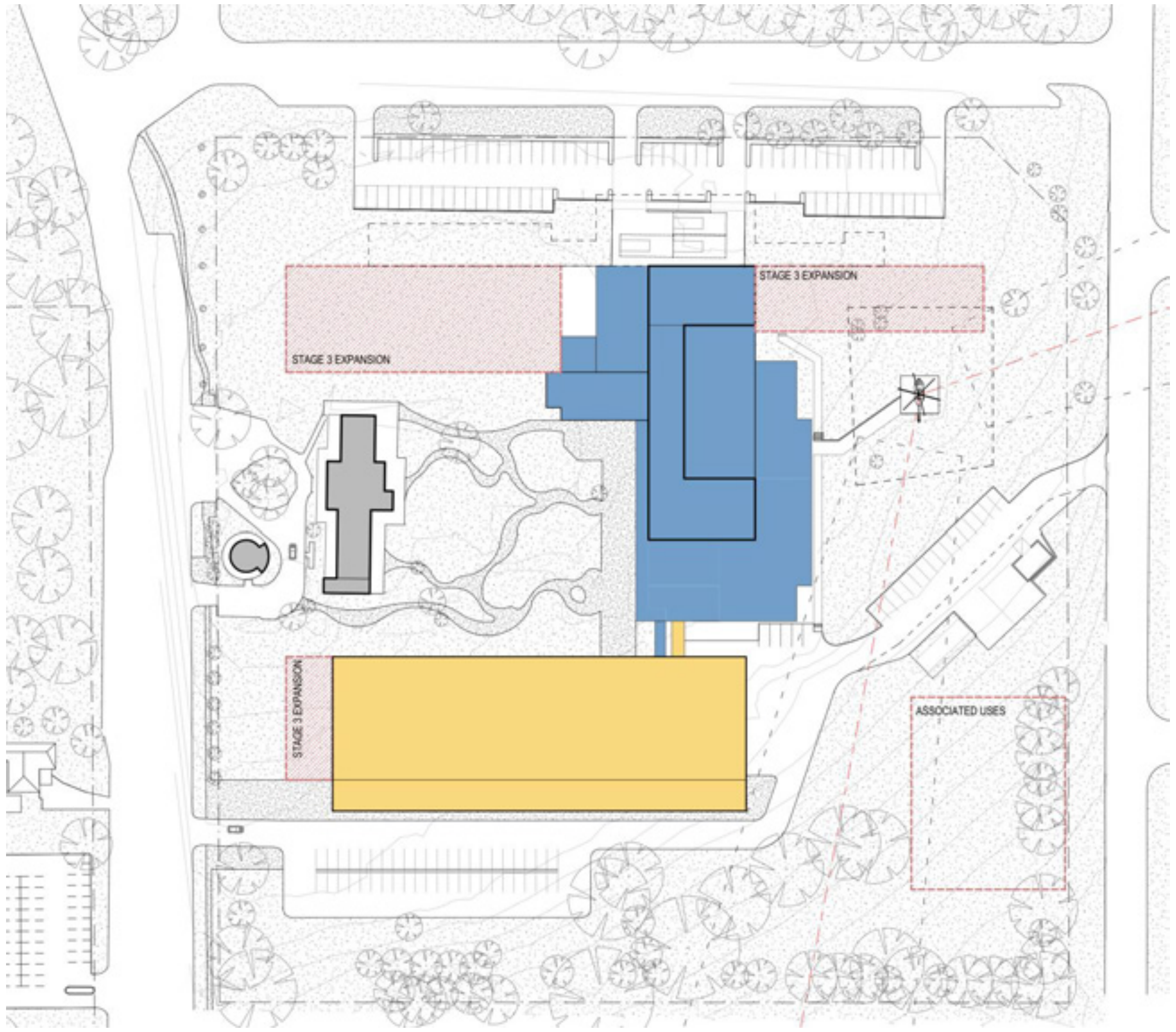


Fig. 5 Potential Master Plan Staging

4.1 Master Plan Staging

The figure above indicates the potential future staging of the master plan (not in the scope of these works) with the blue building being Stage 1, the yellow Stage 2 and the red Stage 3.

The section in Figure 6 indicates the proposed Stage 1 building arrangement in relation to the existing ground level which shows the excavation required for the undercroft area and filling required at the northern end of the building to meet the ground floor level.

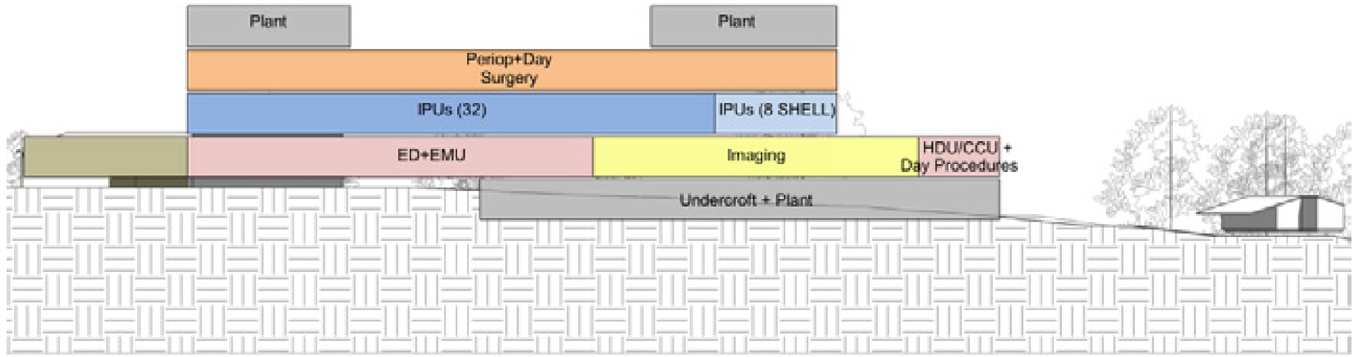


Fig. 6 Section

The structural engineering options for the new structures have been provided in recognition of the proposed multi story construction to satisfy the space requirements of the redevelopment on the site.

4.2 Structural Engineering

The new structures will generally utilise the HI systemised design approach.

4.2.1 Design Standards

The structural design shall be in accordance with the latest issue of all relevant structural Australian Standards, relevant structural sections of the BCA and other statutory requirements.

In particular the structural design will be in accordance with the following relevant Australian Standards:

- AS/NZS 1170.0 (2002) – Structural Design Actions Part 0 General Principles
- AS/NZS 1170.1 (2002) – Structural Design Actions Part 1 Permanent, Imposed and Other Actions
- AS/NZS 1170.2 (2011) – Structural Design Actions Part 2 Wind Loads
- AS 1170.4 (2007) – Structural Design Actions Part 4 Earthquake Actions in Australia
- AS 2159 (2009) – Piling – Design and Installation
- AS 2670.1 (2001) – Evaluation of Human Exposure to Whole-Body Vibration – General Requirements
- AS 2670.2 (1990) – Evaluation of Human Exposure to Whole-Body Vibration – Continuous and Shock-Induced Vibration in Buildings (1 to 80Hz)
- AS 3600 (2009) – Concrete Structures
- AS 3700 (2011) – Masonry Code
- AS 4100(1998) – Steel Structures
- AS 4678 (2002) – Earth Retaining Structures

4.2.2 Design Life

The building structure will be designed to provide adequate performance for a minimum period of 50 years with a typical structural maintenance system.

4.2.3 Materials

The following structural materials are proposed to be used in the works. Typical values for the properties of these materials are listed. These values are to be adjusted where appropriate.

4.2.3.1 Concrete

4.2.3.1.1 Properties

Co-efficient of thermal expansion	12×10^{-6} per ^{0}C
Basic shrinkage strain	In accordance with AS 3600 Clause 3.1.7
Basic creep factor	In accordance with AS 3600 Clause 3.1.8
Poisson's ratio	0.2
Density	24 kN/m^{3}

4.2.3.1.2 Proposed Concrete Grades

Footings	40MPa
Suspended Slabs and Beam	40MPa
Columns	40 to 50MPa
Walls	40 to 50MPa
Other areas (UNO)	40MPa

4.2.3.2 Reinforcement

4.2.3.2.1 Properties

Plain bars (R)	fsy = 250 MPa
Deformed bars (N)	fsy = 500 MPa
Welded wire fabric (L)	fsy = 500 Mpa
Young's modulus	200 x 10^{3} MPa

4.2.3.3 Structural steel

4.2.3.3.1 Properties

Grade (UNO)	300MPa
Steelwork density:	7850 kg/m^{3}
Young's modulus:	2.05 x 10^{5} MPa
Poisson's ratio:	0.3
Coefficient of thermal expansion:	12 x 10^{-6}

4.2.3.4 Blockwork

4.2.3.4.1 Properties

Characteristic Strength	15 MPa.	
Mortar mix (cement:lime:sand)	1 : 1 : 6	Unreinforced Blockwork
	1 :0.5: 4.5	Reinforced Blockwork
Core fill grout	20 MPa	

4.2.4 Loading

4.2.5 Vertical

- Typical Floor Areas:
  - SDL = 1.8kPa;
  - LL = 3.0kPa;
- Plantrooms:
  - SDL = 2.5kPa;
  - LL = 7.5kPa;
- Stairs
  - SDL = 0kPa;
  - LL = 4.0kPa;
- Toilets/Bathrooms/Kitchens:
  - SDL = 1.8kPa;
  - LL = 2.0kPa;
- Non-Trafficable Metal Deck Roof Areas:
  - SDL = 0.5kPa;
  - LL = 0.25kPa;
- Trafficable Concrete Roof Areas:
  - SDL = 2.5kPa;
  - LL = 4.0kPa

4.2.6 Wind

Wind loading is in accordance with AS/NZS 1170.2 – Structural Design Actions – Wind Actions with the following parameters;

- Annual probability of exceedance – 1:2000;
- Region A2;
- V_{2000} – 48m/s;
- Terrain Category 2.5;

4.2.7 Robustness

Robustness loading in accordance with AS/NZS 1170.0 – Structural Design Actions General Principles with the following parameters:

- 1.0% of (G + ψcQ) load case;

4.2.8 Earthquake

Earthquake loading in accordance with AS 1170.4 – Structural Design Actions – Earthquake Actions for Australia with the following parameters:

- Annual probability of exceedance – 1:1500;
- kp = 1.5;
- Z = 0.06;
- Class Ce – Shallow Soil Site;
- Earthquake Design Category III;
- Dynamic Analysis.

4.2.9 Serviceability

4.2.9.1 Deflection limits

4.2.10 Vertical

Maximum vertical deflections shall be in accordance with Table 2.3.2 of AS 3600 – 2009.

4.2.11 Lateral

The lateral drift of the building will be limited to the following:

- Under Serviceability Wind Actions – Height/500
- Under Earthquake Actions (AS 1170.4 clause 7.5) – Height/67

4.2.12 Floor Vibrations

The design of the floor structure will ensure that vibration due to footfall excitation is kept within acceptable limits. These limits will be based on Health Infrastructure Design Guidance Note 1 – Structural Design Criteria Guidelines and the recommendations of AS 2670.2 adjusted for the intended occupancy and approximate duration of vibration. The vibration design parameters for the project will be as follows:

Area	Damping	Footfall Frequency (Hz)	Sacrificial Topping Considered Structurally	Response Factor
Clinical Areas	2.5%	2.1Hz Typically 2.5Hz Corridors	Yes	1
	2.5%	2.1Hz Typically 2.5Hz Corridors	No	2
Operating Theatres	2.5%	2.1Hz	No	1
Plantrooms and External Areas	Not Considered			

All equipment which may be a possible source of vibration will be isolated from the structure through the provision of isolation mounts.

4.2.13 Fire resistance levels for structural elements

Fire resistance levels for structural elements will be in accordance with the structural requirements of the BCA and will developed with the project BCA consultant. Design of individual structural elements to achieve the required FRL will be in accordance with the appropriate materials design code.

4.2.14 Foundations

Foundations for new structures are dependent on size of building. Several foundation systems have been considered for the new building:

- Foundations integral with ground floor raft slab founded on similar material to surrounding buildings. Due to the level change between ground floor and the undercroft area within the footprint of the building and the high levels of cut and fill required to create the building platform this is not considered appropriate for this building.
- High level pad foundations founded in the very stiff to hard residual soils. With the limited bearing pressure available for high level pad foundations it was found that pad footing sizes up to 5m x 5m would be required which would have high levels of settlement and large depths to achieve required founding material in filled areas this foundation system is not considered appropriate for this building.
- Piled foundations founding in XW/HW Siltstone as shown in the sketch provided in Appendix D1-E. Piled foundation system provides a foundation system that is suitable for the building and cost effective to construct.

The foundation design has been based on the design parameters provided in the Coffey Geotechnical Report (refer section 3.1.1.2 of this report for summary details) allowing for 3% of the piles to be ultimate strength tested resulting in a basic geotechnical reduction factor ϕ_g = 0.61.

4.2.15 Retaining Walls

The structural and civil design is focused on minimising retaining walls for the project. The areas that require retaining and the solutions that are proposed to be implemented are outlined as follows:

- West of the Undercroft Area:
  - Varying retained height up to a maximum height of approximately 4m;
  - Provide permanent batter slope beneath the footprint of the ground floor slab with the lift shaft in the north west corner of the undercroft space utilised for retaining due to limit batter zone;
- North of the Undercroft Area:
  - Retained height up to a maximum height of approximately 4.5m;
  - Provide permanent batter slope beneath the footprint of the ground floor slab;
- East of the Undercroft Area:
  - Varying retained height up to a maximum height of approximately 1.5m;
  - Provide permanent batter slope adjacent to the building;
- Surrounding the Northern Section of the Ground Floor:
  - Varying retained height up to a maximum height of approximately 2m;
  - Due to limited zone for batter slopes and the need to provide accessible ramp access into the building in this area retaining in this area is proposed to be undertaken by cantilevered reinforced blockwork retaining walls founding on high level concrete strip foundations.

Design parameters for retaining walls and batter slopes is outlined in the Coffey Geotechnical Report (refer section 3.1.1.6 and 3.1.1.7 of this report for summary details).

4.2.16 Lateral System

Lateral structure for the new buildings is a hybrid system of the reinforced concrete shear walls utilising stair and lift shafts required by planning and the sway frame structure utilising the stiffness of the floor plate and building columns.

4.2.17 Vertical Structure

All columns for the primary building structure are to be construction from reinforced concrete with columns for lightweight structures (i.e. plantroom roofs etc.) to be steel columns.

4.2.18 On Grade Floor Plate

There are two areas within the project where the floor plate is on grade, the undercroft area and the northern section of the ground floor. The structural arrangements for each of these areas are varied and have been designed as follows.

The on grade slab for the undercroft area is located within a cut zone of the site and as such will found on very stiff to hard residual soil or better. Given this founding material this section of on grade slab has been designed as a stiffened on grade raft slab.

The on grade section of the ground floor slab to the north is either located over void space or on filled ground. Given the potential differential settlements between the remainder of the ground floor suspended structure and filled ground the entire ground floor slab has been designed as a suspended floor plate as outlined in section 4.2.18. The area below this slab will still be filled to minimise the fill that will be required to be disposed of off-site and providing a formwork platform for the ground floor slab.

4.2.19 Suspended Floor Plate

It is proposed that post tensioned concrete floor plates designed to achieve vibration performance of response factor 2.0 be used as the structural system for the floor plates, which aligns with current HI guidelines for structural systems. With strengthening at areas requiring increased vibration performance via serviceability posts connecting to vertically adjacent floor plates to mobilise increased stiffness and mass to improve vibration performance. Areas which will require increased vibration performance are those which either house sensitive equipment, ie areas medical imaging and areas in which invasive procedures are undertaken, ie operating theatres.

Enstruct provided the project team with several floor plate options for comparison for the project, refer to Appendix D1-F for details of refined options provided. Based on costing advice from APK that there was no cost differential between all three of the final options presented the project team selected the flat plate with drop panel option due to the services reticulation space provided across the floor plate which assisted with lowering the building floor to floor height to 4.2m with the exception of Lower Ground and Level 3 Plantroom.

The floor to floor height has been developed with the entire project team and to satisfy the required services and future flexibility requirements a typical floor to floor height of 4.2m is proposed increasing to 4.5m on the Lower Ground and Level 3 Plantroom.

Floor plates will be designed to accommodate an integral 50mm non-structural screed throughout.

Floor plate will be designed to allow for future penetrations to maintain the future flexibility of the structure in accordance with Health Infrastructure Design Guidance Note 1 – Structural Design Criteria Guidelines.

Movement joints will be provided in all locations where the new and existing facilities interconnect, and these will allow for earthquake framing movements. These are not anticipated to be significant with all existing building being no greater than three stories in height with connection to the existing Ward Block readily achievable at any of the three levels of this building.

The proposed development includes a number of on grade links between the new and existing buildings. It is expected that the structural arrangement for these link elements will be a stiffened raft slab founded at high level with steel framed structure forming the enclosure structure to the link.

The structure for the multi-story link between the southern end of the proposed building and the eastern end of the existing ward block will form part of the new building structure and be isolated from the existing ward block. As such the structure for this link will match that of the new building with suspended post tensioned concrete floor plates and piled foundation system being a continuation of the main building system.

4.2.20 Main Ward Block Link to Building 5B

To accommodate planning requirements for the link to the north of the existing main ward block Building 5A the travel path width of the existing footpath to the north of the main ward block needs to be increased at the location of the columns supporting the link between Buildings 5A and 5B. Two options have been identified to provide this increased travel path width as follows:

- Relocate link structure columns;
- Demolish existing sunshade structure.

4.2.20.1 Relocate Existing Link Structure Columns

To accommodate a revised column location new steel columns and additional floor framing beams would need to be introduced and founded on new pile foundations (refer to sketch in Appendix D1-H). We note that the additional steel framing shown in blue may not be required which will require further invasive site inspections as the existing structural drawings for this building cannot be located.

To achieve this reframing it is expected that the following construction sequence would be required:

- Install new foundations. Note that these piles will have to be installed with a restricted access rig capable of working within 2400mm head height zone and will require some minor demolition/connection to the existing Main Ward Block foundations as it will be in the area of the sunshade foundations (see attached existing foundation drawing);
- Construct new steelwork;
- For external steelwork concrete encase and for internal steelwork fire spray/box out;
- Demolish existing column;
- Note that no backpropping or temporary support of the existing structure would be required with this option however the new steelwork would need to be constructed up through each of the existing internal levels;

4.2.20.2 Demolish Existing Sunshade Structure

Demolition of the existing sunshade structure would provide the required travel distance along this link. As the existing sunshade structure is a free standing concrete element with discreet props off the Main Ward block building for lateral support it can be demolished without impacting on other structures. If the existing sunshade structure is demolished it is anticipated that the following works will be required:

- Demolition of existing concrete structure;
- Relocation of mechanical condensers supported on the western end sunshade;
- Provision of new structural support for existing kitchen exhaust ductwork at the eastern end sunshade;
- Provision of new lightweight awning structure as the existing awning structure would be removed with the sunshade demolition;
- Confirmation that the existing fire stair at the western end of the sunshade is no longer required. If fire egress is required to be maintained at this point a new steel framed stair would be required at this location.

4.2.21 Green Star

Structural influence on Green Star targets for a building of this nature is limited to the following criteria:

- Mat-5 Concrete;
- Mat-6 Steel.

The points targeted for these items should be those which have nil or negligible impact on the project structural cost. Outlined below are the points that we would recommend be targeted for the project with nil or minimal cost impact on the project.

4.2.21.1 Mat-5 Concrete

For a building of this nature we would recommend that 2 Green Star points be targeted for the Mat-5 Concrete credit by requiring the following of the concrete for the project:

- Supplementary cementitious material used to replace 30% of the Portland cement content by mass across all concrete used for the project compared to the Geen Star reference case;
- All concrete for the project to contain 50% captured or reclaimed water and either:
  - 40% of coarse aggregate in the concrete to be either crushed slag or other alternate materials; or
  - 25% of fine aggregates in the concrete to be either manufactured sands or other alternate materials.

4.2.21.2 Mat-6 Steel

For a building of this nature we would recommend that 1 Green Star point be targeted for the Mat-6 Steel credit by requiring the following of the reinforcing used in the project;

- At least 95% of reinforcing is sourced from a responsible steel maker;
- At least 95% of all reinforcing bar and mesh meets or exceeds 500MPa strength grade, and at least 60% of all reinforcing steel is produced using energy-reducing processes in its manufacture.

4.2.22 Refurbishment

4.2.22.1 ICCC into Refurbished Existing Community Health Building 13A

The existing building consists of load bearing masonry with timber framed walls and floors with a tile roof.

Given the nature of the existing structure removal of any internal or external walls will require underpinning works to provided support to the floor/roof over. On this basis structural recommendation would be that all existing internal and external walls should be retained in current configuration. From the plans provided to date of the proposed refurbishment works it appears that only minor non-structural walls will be modified which will not require any structural works. If in development of the design load bearing walls are required to be removed these will require underpinning with secondary steelwork.

From our walk through inspection of the building it appears to be performing adequately from a structural viewpoint for the current usage which should be structurally similar to the proposed usage as ICCC. It is therefore expected that the existing structure will be satisfactory to accommodate the ICCC without structural upgrade/modifications. As the design progresses as detailed review of the existing floor framing will be undertaken to confirm the live load capacity of the existing floor structures so that a definitive value can be placed on the allowable live load for the building.

As the existing building is timber framed an inspection of all timber has been undertaken by Forestry Corporation of NSW to confirm condition, grade and remaining life of all existing timber members. The timber inspection has found the timber to be generally in good condition with no noticeable degradation since construction with only limited members identified as requiring replacement, refer to Appendix D1-I for full details.

Advice from the design team to date is that there are no vibration sensitive requirements for the ICCC so there would be no consideration of vibration in the refurbished use as an ICCC unless advised otherwise.

4.2.22.2 Primary and Community into Refurbished Existing Ward Block Level 1

The existing building consists of concrete framed structure with infill masonry walls.

A review of the available structural drawings for the existing ward block has been undertaken and from these drawings the lateral structure of the building appears to be provided via sway frame action of the floor plate and columns and shear capacity of the internal and external masonry walls. Removal of some existing masonry walls can be accommodated structurally without impact on floor capacity. The current proposed layout for the refurbished space shows minimal modifications to the existing masonry walls which can be accommodated with the existing structural system. If during design development the number of masonry walls to be removed is increased significantly a further lateral review of the existing building will need to be undertaken as these walls may contribute to the lateral capacity of the existing building with possible lateral strengthening of the building being required with this being readily provided through the provision of new internal braced or masonry walls replacing those removed which would only be required if the masonry walls are found to form part of the lateral system for the building, however for the current proposed modifications this will not be required.

Floor live loads for use as a P & C function are compatible with original building design as an inpatient ward.

Advice from all parties to date is that there are no vibration sensitive requirements for the P & C so there would be no consideration of vibration in the refurbished area to be used for P & C unless advised otherwise.

4.2.22.3 Renal and Oral Health into Existing ED & Theatres

The existing building consists of concrete framed structure with infill masonry.

A review of the available structural drawings for the existing ward block has been undertaken and from these drawings the lateral structure of the building appears to be provided via sway frame action of the floor plate and columns and shear capacity of the internal and external masonry walls. Removal of some existing masonry walls can be accommodated structurally without impact on floor capacity.

The current proposed layout for the refurbished space is only to occur in the top level of this area of the building which only has lightweight steel framed roof structure over. As there is reasonable level of modification to internal walls proposed in the current refurbishment arrangement and due to the limited cross bracing in the existing roof structure some additional internal bracing walls will be required. These additional internal bracing walls can be readily achieved by having all new walls which abut the external walls of the building being constructed from lightweight framing with either metal strap cross bracing or plywood bracing as per standard residential bracing wall construction, which will provide lateral support to the external perimeter walls. These braced walls will still be able to constructed as standard lightweight walls however they will require the addition of metal strap cross bracing or plywood fixed in accordance with the residential timber framing code

Floor live loads for use as a P & C function are compatible with original building design as an inpatient ward.

Advice from all parties to date is that there are no vibration sensitive requirements for the Renal and Oral Health so there would be no consideration of vibration in the refurbished areas to be used for Renal and Oral Health unless advised otherwise.

4.2.23 Future Expansion

Structurally we recommend that allowances for future expansion be made for horizontal expansion with vertical expansion allowance avoided if possible.

Vertical expansion over existing structures typically causes unavoidable disruptions to operating facilities below and with the sensitive nature of facilities that would be impacted by any future expansion of the building it further reinforces the recommendation to avoid this otherwise compromise in service for these areas is likely.

No matter the function of the floor below an vertical expansion zone significant additional cost to the initial stage of the project is required to provide a working platform for construction of the vertical expansion and despite the provision of this the floor below will require access for services installations and is likely to be impacted by construction noise and vibration.

With the Master Planning for the site demonstrating sufficient development area to accommodate all services via maximum of 3 storey buildings across the site it further highlights that horizontal expansion is the appropriate solution for this hospital site. Given this the only allowance for vertical expansion that has been allowed in the new building design is provision for vertical expansion at the Southern end of the Stage 1 development to allow connection of a link to the future Stage 2 development.

4.2.24 Early Works Demolition

To assist with program requirements for the project investigation of buildings on the site which require demolition has been undertaken to identify which buildings could be demolished prior to the early works on the site. The drawing mark-up in Appendix D1-J shows the outcomes of this investigation. The buildings identified that can be demolished as part of the early works are:

- Building 7 Garbage Building;
- Building 8 Store Building;
- Building 9A Workshop;
- Building 9B Laundry Building:
    - As this building houses the existing substation, switchboard and generator for the hospital site the western portion of this building must be retained until the early works is completed. We have inspected this building and found that the western portion of this building which houses these services can be retained as a free standing structure allowing demolition of the remainder of the building. To allow demolition of the remainder of the building an LPG service will require termination and an electrical service will require relocation;
- Buildings 11A to 11D Water Tower and other Ancillary Buildings:

- Provided that the wind sock and lighting for the helipad are relocated these buildings can be demolished prior to the early works.

4.2.25 Preferred Strategy

Refer to Appendix D1-G for current details of the schematic structural design for the development. The structural schemes will be developed in more detail during the Design Development stages. Particular issues to be addressed as part of the design strategy will include:

- The new structures will generally utilise the HI systemised design approach.
- Design in accordance with HI floor vibration requirements.
- Continued development of foundations system.
- Ongoing detailed assessment of existing structures to be retained at interfaces with new buildings.

Appendix D1-A – Desktop Geotechnical Investigation

25 October 2012

Enstruct Group Pty Ltd
Level 4, No 2 Glen Street
Milsons Point, NSW, 2061

Delivered by email to: Tim.Boulton@enstruct.com.au

Attention: Tim Boulton

RE: Kempsey District Hospital - Desktop Geotechnical Assessment and Preliminary Design Parameters

1 INTRODUCTION

Enstruct Group Pty Ltd (Enstruct) has engaged Coffey Geotechnics Pty Ltd (Coffey) to provide Geotechnical and Environmental consulting services for the Kempsey District Hospital (KDH) Redevelopment.

The scope of work included the requirement for Coffey undertake a desktop study on the site geology and to provide a letter report on the expected foundation design parameters and retaining wall design parameters. The desk top study was generally conducted in accordance with Coffey's Proposal GEOTCOFH03037AA-AB dated 20 September 2012.

Following site investigation fieldwork we will be preparing a geotechnical site investigation report that will update and/or supersede the preliminary geotechnical model and recommendations presented in this preliminary report.

2 AVAILABLE GEOLOGICAL INFORMATION

The site of the KDH is located at the corner of River Street and Polwood Street, Kempsey.

Regionally the site is located above, and set back from, the incised outer bank of the Macleay River. The site elevation is about 25 m AHD. River Street runs along the western boundary of the site and the distance between the crest of the incised bank to the hospital's western boundary is about 40 m.

The NSW Geological Map of Hastings (1:250,000) shows that the hospital site is located on the geological unit entitled the "Kempsey Beds", comprising mudstone and sandstone.

Coffey observed an exposed cutting on the site. The cutting was about 2.5m high and battered at about 1V:1.5H. Residual soil was observed in the cutting face, comprising medium to high plasticity cohesive soil.

Coffey has provided geotechnical consulting services to the Roads and Maritime Services for the Kempsey Bypass Section of the Pacific Highway Upgrade. Sections of this upgrade to the south of Kempsey are located in the same geological unit as the hospital. From our experience on the bypass, the weathering of the unit is relatively deep. In general, soil strength cohesive material was encountered in the upper 3m, with highly weathered sedimentary rock observed for significant depths below the soil mantle.

Based on discussions with hospital site staff, the main hospital building (general wards) and pathology building (each four storeys in height) were constructed in the 1960's and may have been founded on belled-out piers. If this is the case then end bearing piles on relatively high quality rock is likely to be supporting the existing hospital buildings.

3 ANTICIPATED GEOTECHNICAL UNITS

Based on our review of geological mapping and our involvement with other projects in the same geological unit, we have assessed that it is likely that the following units will be encountered on the site:

- **Fill.** Given the long history of site development and staged development, filling conditions may be complex and fill properties may be variable. Compaction records are understood to be unavailable, and therefore fill should be considered to be uncontrolled fill per AS3798-2009.
- **Residual Soil.** The residual soil on the site is expected to comprise medium to high plasticity cohesive soil (i.e. clay and silty clay). The residual soil is likely to be at least stiff, unless heavy saturation has caused softening. The thickness of the residual soil may be in the order of 3 m.
- **Sedimentary Rock.** The rock strength material on the site is expected to comprise highly weathered , low strength sedimentary rock. The bedding orientation may be variable but indications from the Kempsey Bypass are that the bedding may be inclined to near vertical. The rock would likely comprise interbedded silt- and sandstones with bedding intervals in the range of 0.3m to 1m.

The contacts between geotechnical units may not be distinct, and may vary significantly across the site. Other geotechnical units such as less weathered rock may also be encountered.

4 PRELIMINARY SHALLOW FOOTING DESIGN PARAMETERS

Shallow footings such as pad or strip footings bearing on the anticipated cohesive, stiff residual soil may be designed on the basis of the following preliminary parameters:

- Allowable bearing pressure: 150 kPa.
- Young's Modulus: 10 MPa.

Uncontrolled fill or other deleterious materials should not be considered as a bearing stratum for shallow footings

It is envisaged that rock will occur at shallow enough depths to allow strip or pad footings supported on rock to be practicable (i.e. less than 1.5m below ground).

If cuts are proposed in excess of 3m vertical height, then rock may become exposed allowing shallow footings to be adopted. In the event that shallow footings bearing on rock are considered an allowable bearing pressure up to 700 kPa and Young's Modulus of 100 MPa may be adopted for rock that is at least very low strength.

5 PRELIMINARY PILE DESIGN PARAMETERS

In order to allow for the preparation of preliminary pile designs, geotechnical design parameters for bored piles are presented in Table 1. Bored piles may comprise CFA or open bored piles (cased or uncased).

A geotechnical reduction factor from AS2159-2011 will need to be applied to the ultimate values shown in the table. For this stage of the project the use of ϕ_g = 0.4 is recommended. The guidelines of the standard may be used to assess the efficacy of including pile testing in the design. A minimum level of pile testing will be required if a higher value of ϕ_g is to be adopted or required to achieve a desired design. Significant increases in the reduction factor may be possible following the geotechnical investigation if site conditions are favourable and testing of piles are specified in the contract.

The parameters apply for pile sections greater than 4 pile diameters below the finished ground surface.

6 PRELIMINARY RETAINING WALL DESIGN PARAMETERS

Geotechnical parameters and lateral earth pressure parameters have been assessed and are summarised in Table 2.

7 CLOSING COMMENTS

The anticipated geotechnical units have been based on Coffey's past experience in similar geological units, limited site observations, and geological mapping. Variations from this assessment are likely to be observed when the geotechnical investigation is undertaken and again during construction.

The design parameters will be revised following the site investigation and will be included in the geotechnical investigation report. A geotechnical engineer should be engaged to review preliminary and detailed designs, and to undertake verification of ground conditions during construction.

The attached document entitled "Important Information about Your Coffey Report" presents additional information regarding the uses and limitations of this report and should be read by all parties seeking to use this report. If you have any questions regarding our report please contact the undersigned in our Alstonville office.

For and on behalf of Coffey Geotechnics Pty Ltd

Rian Vleggaar

Geotechnical Engineer

Attachments: Site Plan showing Staged Development and Civil Works Zones

Important Information about Your Coffey Report

Distribution: 1 Electronic Copy - Enstruct Group Pty Ltd

Original held by Coffey Geotechnics Pty Ltd

Table 1: Preliminary Geotechnical Design Parameters – Bored Piles

Unit	Ultimate End Bearing Pressure (MPa)	Ultimate Shaft Adhesion (kPa)	Ultimate Lateral Yielding Profile (kPa)	Young's Moduli (Vertical) (MPa) Note 3	Subgrade Reaction Modulus, k_s for Laterally Loaded Piles (MPa/m) Note 4
Uncontrolled fill, organic soil, otherwise deleterious soil	Ignore Contribution to Pile support				
Stiff Residual Soil	0.5	35	0.5	10	5
Low Strength Rock or better	6 Note 1	300	1.5 Note 2	200	125

Notes to Table 1:

1. If preliminary design based on working stress is preferred we recommend that for piles taken into low strength rock be designed assuming an allowable end bearing pressure of 1000kPa and allowable shaft adhesion of 100kPa. Settlements where these parameters are adopted should be less than 1% of the pile diameter.

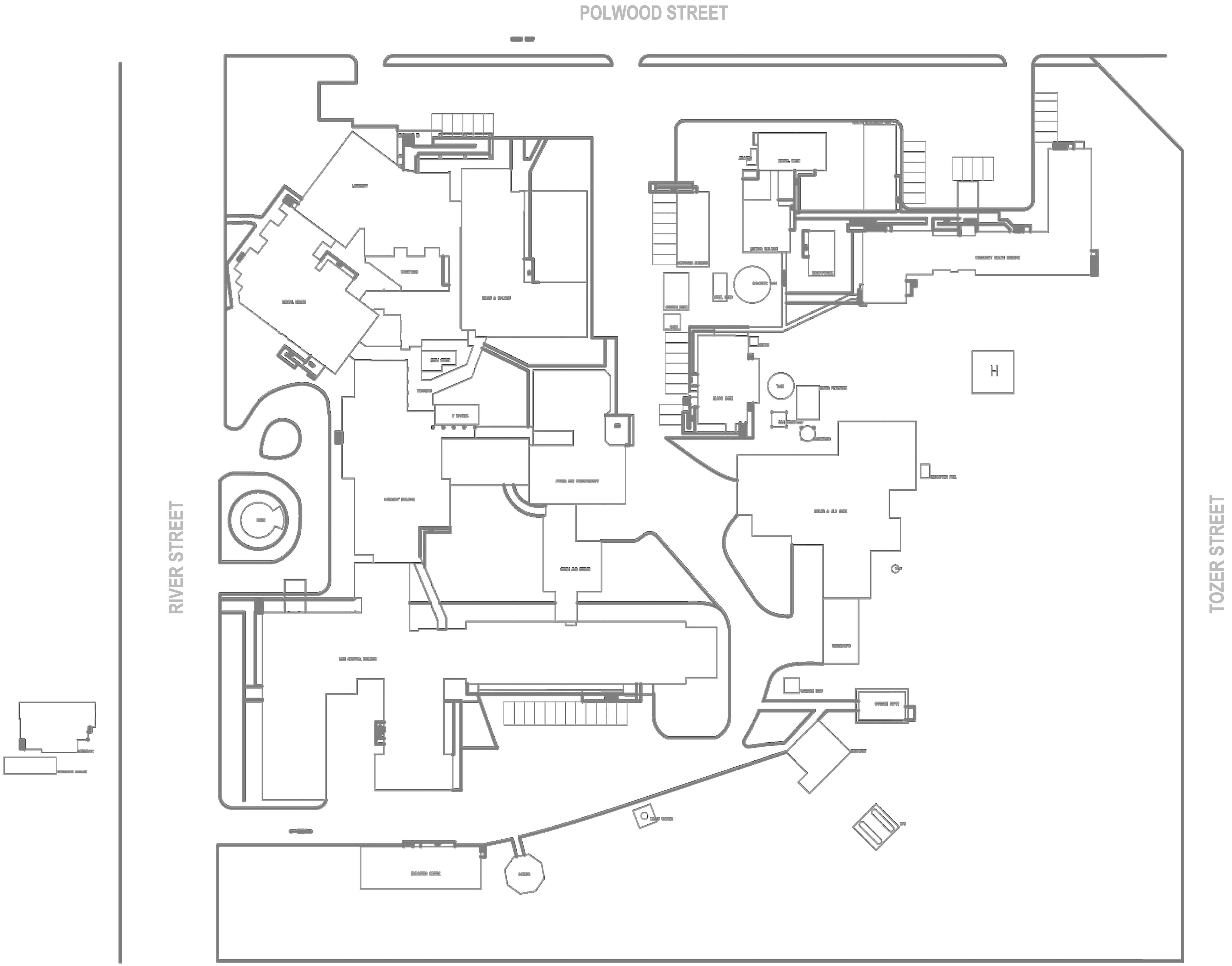
2. This value may be doubled for the zone of the pile at least 1m or 1 pile diameter (whichever is the greatest) below the top of rock.

3. Young's Modulus under lateral loads may be taken as 75% of the vertical values.

4. Assumes a pile size (d) of 900mm and pile concrete modulus of 30 GPa. Note $k'_s = k_s$ d. (Vesic, 1961). Local spring stiffnesses (force per distance) may be estimated by using the product of k's and the spring spacing in the structural model.

Table 2: Preliminary Geotechnical and Lateral Earth Pressure Parameters

Unit	Bulk Density, γ_b (kN/m^3)	Design Undrained Shear Strength (kPa), S_u	Effective Cohesion (kPa), c'	Effective Friction Angle ϕ'	Lateral Earth Pressure Parameters			Anchor/Soil Nail Ultimate Bond Stress, kPa
					K_a	K_0	K_p	
Uncontrolled fill, organic soil, otherwise deleterious soil	18	--	--	24°	0.42	0.59	2.4	--
Stiff Residual Soil	18	50	5	25°	0.41	0.58	2.4	35
Low Strength Rock	20	--	20	35°	0.27	0.43	3.6	200



SITE PLAN
KEMPSEY HOSPITAL

rev	date	description	drn	ch'k
01	01.08.12	FOR INFORMATION	J.D.B.	T.B.B.

enstruct group pty ltd
Level 4, 2 Glen Street
Milsons Point NSW 2061
Australia

Telephone (02) 8904 1444
Facsimile (02) 8904 1555
http: // www.enstruct.com.au

enstruct

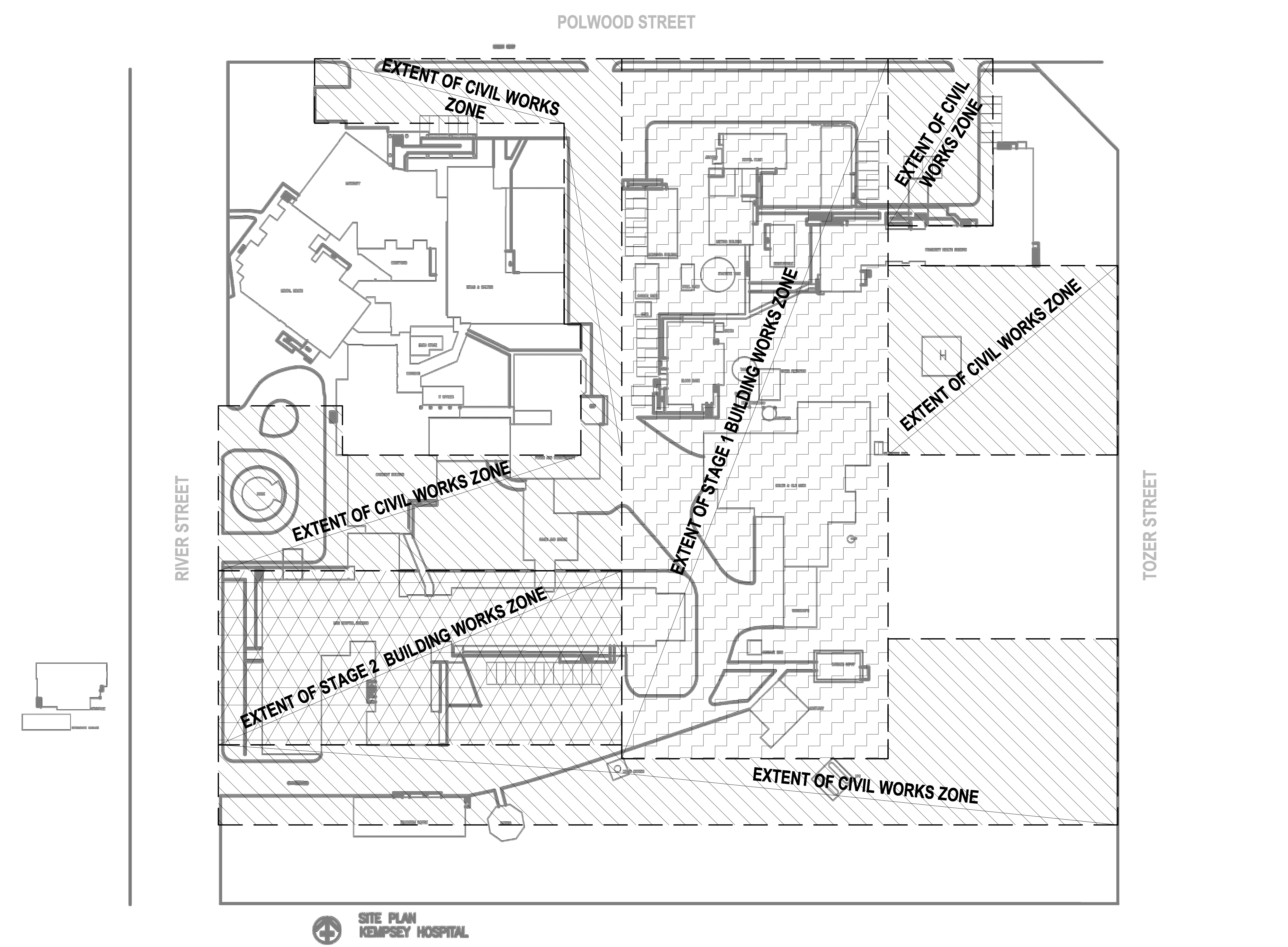
project
KEMPSEY DISTRICT HOSPITAL
REDEVELOPMENT STAGE 1

drawing title
SITE PLAN

status
FOR INFORMATION ONLY

scale at A1	drawn by	checked	date
1:500	J.D.B.	T.B.B.	AUG 12'

project no.	drawing no.	rev.
4463	SK-001	01



rev	date	description	drn	ch'k
02	08.08.12	FOR INFORMATION	J.D.B.	T.B.B.
01	01.08.12	FOR INFORMATION	J.D.B.	T.B.B.

enstruct group pty ltd
Level 4, 2 Glen Street
Milsons Point NSW 2061
Australia

Telephone (02) 8904 1444
Facsimile (02) 8904 1555
http: // www.enstruct.com.au

enstruct

project
KEMPSEY DISTRICT HOSPITAL
REDEVELOPMENT STAGE 1

drawing title
EXTENT OF
GEOTECHNICAL INVESTIGATION

status
FOR INFORMATION ONLY

scale at A1	drawn by	checked	date
1:500	J.D.B.	T.B.B.	AUG 12'

project no.	drawing no.	rev.
4463	SK-002	02

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

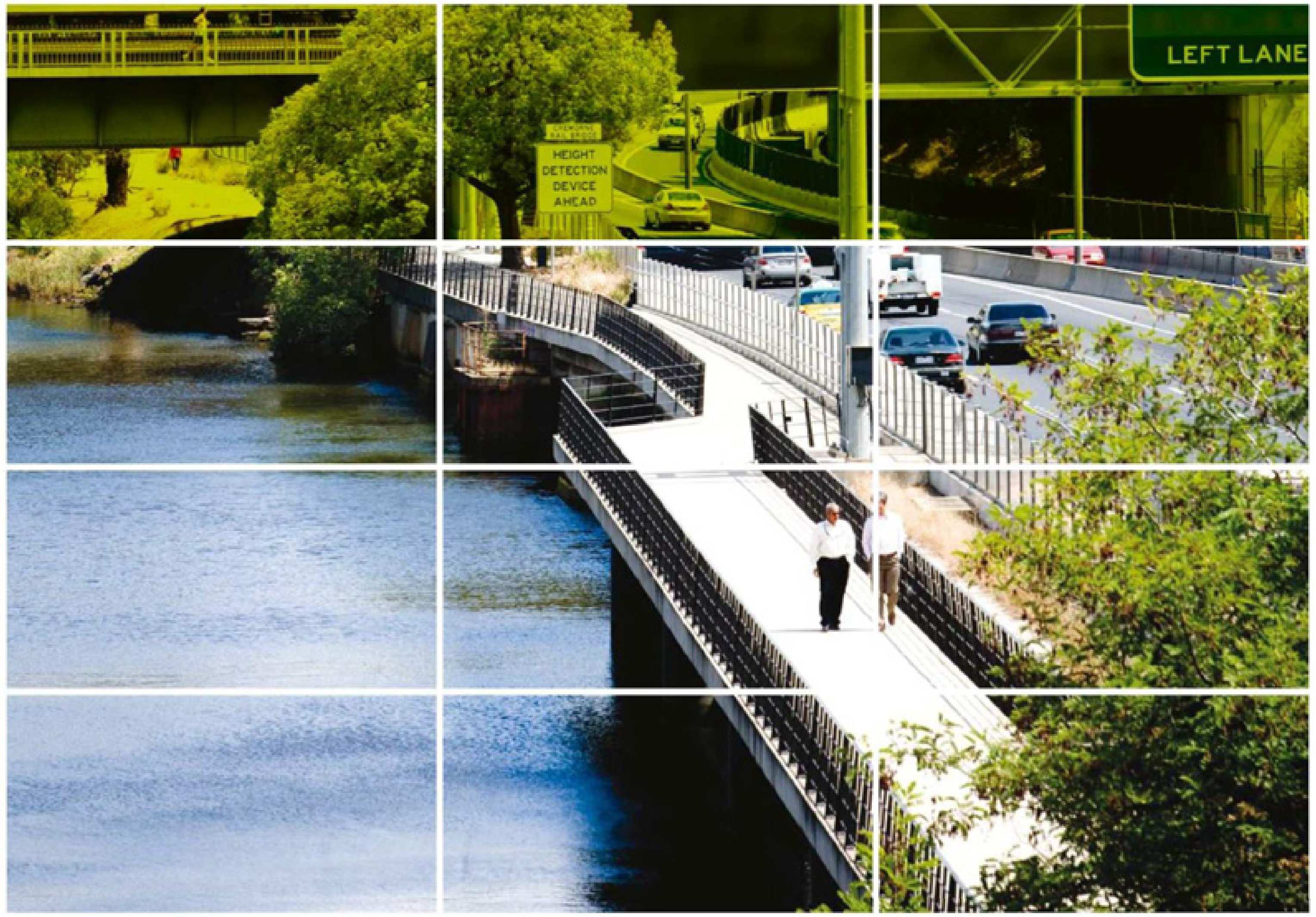
Appendix D1-B – Detailed Geotechnical Investigation and Report

KEMPSEY DISTRICT HOSPITAL - GEOTECHNICAL INVESTIGATION

Kempsey

Enstruct

GEOTCOFH03037AA-AG Rev 2
8 March 2013



8 March 2013

Enstruct
Level 4, No 2 Glen Street
MILSONS POINT NSW 2061

Delivered by email to: Tim.Boulton@enstruct.com.au

Attention: Tim Boulton

RE: KEMPSEY DISTRICT HOSPITAL

GEOTECHNICAL INVESTIGATION

Coffey Geotechnics is pleased to present our report on the geotechnical investigation at the above site.

We draw your attention to the attached sheet entitled “Important Information about Your Coffey Report” which should be read in conjunction with this report.

We trust that this report meets your requirements. If you require further information please contact the undersigned in our Coffs Harbour office.

For and on behalf of Coffey Geotechnics Pty Ltd

Tom Nicholson

Associate

Distribution: 1 Electronic Copy – Enstruct
Original – Coffey Geotechnics (Coffs Harbour Office)

CONTENTS

CONTENTS

1 INTRODUCTION

Enstruct Group Pty Ltd (Enstruct) has engaged Coffey Geotechnics Pty Ltd (Coffey) to undertake a geotechnical investigation for the Kempsey District Hospital Redevelopment Stage1, comprising the Stage 1 redevelopment area and the Civil Works areas.

Coffey conducted the work in general accordance with proposal no. GEOTCOFH03037AA-AB, dated 20th September 2012. This report presents the results of the site investigation and makes recommendations for the following:

- Foundation design;
- Pavement design;
- Temporary and permanent slopes;
- Retaining wall design;
- Earthwork preparation and excavatability;
- Soil aggressivity.

2 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site of the Kempsey District Hospital is located at the corner of River Street and Polwood Street, Kempsey. The site locality is shown in Figure 1. The site comprises of eleven (11) separate lots and occupies an area of approximately 4.1 ha. The Stage 1 and Civil Works Zones included in this investigation have been highlighted in the attached Figure 2, which also shows the location of the existing facilities on the site.

Within the Stage 1 area the proposed development comprises demolition of existing structures and construction of a 4/5 storey hospital building. Parking and roadways may be developed within the Civil Works Zones.

Regionally the site is located above, and set back from, the incised outer bank of the Macleay River. The site elevation is about 25 m AHD. River Street runs along the western boundary of the site and the distance between the crest of the incised bank to the hospital's western boundary is about 40 m.

The hospital is situated within an area of undulating topography and is located on the upper south and southeast slopes of a low hill. The site was made relatively level in the northern portion through previous earthworks for the construction of hospital buildings and associated parking areas. Towards the south of the site the land slopes down to the south east. A cemetery is located east of the site and residential houses are located east of Tozer St which bounds the hospitals eastern boundary.

Based on the topography of the site and surrounding area it appears that drainage is by way of overland flow to the southeast across the natural contours of the land.

There were various buildings observed during the site walkover within the Stage 1 and Civil Works Zones. These building have been predominately identified and highlighted in the attached Figure 2. Vegetation onsite includes areas of landscaped gardens, cleared grass areas and scattered large trees in the southern and southeast portion of the hospital grounds.

3 SCOPE OF WORK

3.1 Fieldwork

Fieldwork was carried out between 19 and 27 November 2012. The fieldwork comprised:

- 7 boreholes to 10 m depth or TC bit refusal, with coring of 5 holes for up to a further 4 m in depth beyond TC bit refusal depth;
- 6 shallow boreholes to 1.5 m depth for CBR sample collection;
- 2 boreholes to 2.5 m depth to assess fill near the workshop;
- The installation of a temporary standpipe piezometer in borehole BH6 to allow monitoring of groundwater levels during the fieldwork.

The location of the investigations is shown on Figure 3. Surface levels of boreholes have been estimated from survey data provided by Enstruct.

Undisturbed U50 tube samples, SPT samples and disturbed samples were collected from the boreholes for subsequent laboratory testing.

Fieldwork was conducted in the full-time presence of a geotechnical professional from Coffey who logged the materials observed, collected samples and recorded results of in-situ testing.

3.2 Laboratory Testing

Samples for geotechnical testing were submitted to our NATA-accredited Coffs Harbour laboratory and Aggressivity suite testing samples were submitted to the NATA-accredited MGT-Labmark laboratory in Sydney.

The following testing was undertaken:

- 6 Atterberg Limits tests;
- 3 shrink swell tests;
- 3 California Bearing Ratio (CBR) tests;
- 2 Aggressivity suites for buried structural elements (pH, conductivity, chlorides and sulphates);
- 26 point load tests.

Laboratory Test results are summarised in Section 4.3 and test results are included in Appendix B.

4 SUBSURFACE CONDITIONS

4.1 Stratigraphy

The NSW Geological Map of Hastings (1:250,000) shows that the hospital site is located on the geological unit known as the "Kempsey Beds", comprising Permian aged mudstone and sandstone.

Previously, Coffey carried out a desktop Geotechnical Assessment report, reference GEOTCOFH03037AA-AE. The drilling investigation reported in this document encountered conditions broadly in agreement with the desktop study.

BH8 to BH13 were drilled to 1m depth for CBR sample recovery and encountered fill overlying residual soil.

The geotechnical model of the site considered in this report is:

- **FILL:** comprising clay with low to high plasticity, some sand, some gravel. Variable consistency. In borehole BH6, a thicker sequence of fill material was encountered (2.6m) with some suspected fly ash. Older topsoil may be present under the fill;
- **RESIDUAL SOIL:** comprising high plasticity clay with some sand, generally Very Stiff to Hard;
- **EXTREMELY WEATHERED SILTSTONE:** comprising low to high plasticity clay with a gradational contact with bedrock. Generally Very Stiff to Hard and friable consistency;
- **HIGHLY WEATHERED SILTSTONE:** Generally low rock strength with variable RQD (between 0 and 70%) and fracture spacing. Some zones of core loss and very low strength siltstone;
- **MODERATELY WEATHERED SILTSTONE:** Generally medium to high rock strength with variable RQD, generally exceeding 70%.

The materials observed in the deeper boreholes (BH1 to BH7, BH14 and BH15) are summarised in Table 1 along with the depth to the base of each material type. Further details of the materials encountered in the boreholes are provided on the Engineering Logs in Appendix A.

TABLE 1 - DEPTH TO BASE OF MATERIAL LAYER (M)

MATERIAL	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH14	BH15
FILL: variable plasticity clay, some sand and gravel, fly ash at BH6 and BH14. Variable consistency.	0.7	0.2	0.4	1.2	0.9	2.6	1.2	1.25	1.25
RESIDUAL SOIL: High plasticity clay, very stiff to hard.	1.3	2.5	1.3	1.8	1.4	3.5	2.5	>2.5 (2)	>2.5
XW SILTSTONE: Medium plasticity silty clay, very stiff to hard with some very low to low rock strength layers.	6.8	9.25	6.25	8.5	>5.2	11.0	8.0	-	-
HW SILTSTONE: low to medium rock strength, with some high strength zones.	>9.1	10.5	9.25	11.6 (1)	-	12.25	12.0	-	-
MW SILTSTONE: Medium to high rock strength.	-	>13.75	>11.6	>14.6 (1)	-	>16.0	>14	-	-

Notes: (1) BH4 includes core loss (10.8m to 11.6m) below moderately weathered high strength siltstone, and zones of variable weathering ranging from HW to MW siltstone of medium to high strength.

(2) Possible slopewash soils in BH14.

4.2 Groundwater

Groundwater was not observed in the boreholes during the investigation, although water was used to lubricate drilling of cored boreholes. Groundwater was measured in the BH6 piezometer at a depth of 9.06m on 21 December 2012, approximately one month since the drilling of the borehole. Groundwater conditions may fluctuate seasonally due to variations in rainfall distribution and river water levels. Should further information be required on groundwater levels, Coffey recommends installation of a data logger and interpretation of results with respect to rainfall and river levels.

4.3 Laboratory Test Results

4.3.1 Classification Testing

Atterberg Limits tests with natural moisture contents were undertaken on six samples of fine grained residual and stiff clay for classification assessment. Three shrink swell tests were undertaken to assist with assessment of the near surface soil reactivity.

Material classification and shrink swell tests are summarised in Table 2 and Table 3 respectively.

The results presented in Table 2 show that the cohesive soil is of low to intermediate plasticity, though when assessed in the field were generally described as medium to high plasticity.

Laboratory test results are provided in Appendix B.

TABLE 2 - MATERIAL CLASSIFICATION TEST RESULTS SUMMARY

SAMPLE	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX
BH1 1.5-1.95	54	30	30
BH1 3.0-3.45	37	23	14
BH1 5.7-6.15	45	24	21
BH4 1.5-1.95	53	23	30
BH7 1.5-1.95	61	26	35
BH7 7.5-7.78	32	21	11

TABLE 3 - SHRINK SWELL TEST RESULTS SUMMARY

SAMPLE	FIELD MOISTURE CONTENT (%)	SHRINK SWELL (%)
BH3 0.5-0.95	29.3	2
BH7 0.5-0.95	27.6	1.6
BH5 1.0-1.28	26.0	2.3

4.3.2 Aggressivity Testing

Two soil samples were tested for aggressivity to buried concrete elements. The results are presented in Table 4 below.

TABLE 4 - AGGRESSIVITY TEST RESULTS SUMMARY– REFERENCED TO TABLE 6.4.2(C) AS2159-2009

SAMPLE LOCATION (DEPTH)	CHLORIDE (ppm)	CONDUCTIVITY (uS/cm)	SULFATES (ppm)	pH	EXPOSURE CLASSIFICATION (SOIL CONDITIONS B)
BH6 (5.5m)	18	34	<10	5.7	Non-aggressive to buried concrete elements
BH14 (2.5m)	<10	57	39	5.4	

4.3.3 CBR Testing

Three samples were submitted for California Bearing Ratio (CBR) testing. CBR results are shown in Table 5.

The sample from BH12 0.4-0.8m reported a particularly high swell percentage and low CBR value.

TABLE 5 - CBR TEST RESULTS SUMMARY

SAMPLE	CBR (%)	MAXIMUM DRY DENSITY (t/m3)	OPTIMUM MOISTURE CONTENT (%)	SWELL (%)
BH8 0.4-0.8m	3.5	1.44	28.0	2
BH10 0.4-0.8m	2	1.45	27.0	0.5
BH12 0.4-0.8m	1	1.48	23.5	5.5

4.3.4 Point Load Testing

Point load tests were undertaken on suitable sizes of rock core recovered from rotary coring in Boreholes BH2, BH3, BH4, BH6 and BH7. The results from axial testing are summarised below in Table 6. The tests indicate that the intact rock strength ranges from “extremely low”, generally increasing to “high” (with the majority between low and medium) with increasing depth although the data set is insufficient to define a trend.

TABLE 6 - AXIAL POINT LOAD TEST RESULTS

SAMPLE LOCATION	SAMPLE DEPTH (m)	$I_{s(50)}$	STRENGTH CLASS
BH2	9.95	<0.1	Very Low
BH2	10.65	0.5	Medium
BH2	11.90	1.8	High
BH2	12.95	0.5	Medium
BH2	13.65	1.2	High
BH3	6.66	1.1	High
BH3	7.43	2.0	High
BH3	8.54	0.8	Medium
BH3	9.4	1.3	High
BH3	10.16	2.3	High
BH4	9.05	1.3	High
BH4	10.47	1.4	High
BH4	11.79	0.9	Medium
BH4	12.4	0.9	Medium
BH6	11.95	0.5	Medium
BH6	12.75	0.2	Low
BH6	13.75	0.7	Medium
BH6	14.25	0.1	Low
BH6	15.25	0.9	Medium
BH7	8.95	0.3	Low
BH7	9.95	0	Very Low
BH7	10.80	0.3	Medium

SAMPLE LOCATION	SAMPLE DEPTH (m)	$I_{s(50)}$	STRENGTH CLASS
BH7	11.45	0.1	Low
BH7	12.92	0.9	Medium
BH7	13.14	0.9	Medium

5 GEOTECHNICAL ASSESSMENT

Within the Stage 1 area the proposed development comprises demolition of existing structures and construction of a 4/5 storey hospital building. Parking and roadways may be developed within the Civil Works Zones.

5.1 Foundations

Based on the site investigation we expect up to 2.6m of fill overlying stiff to hard residual clay. Based on the general soil profile, imposed loads, constructability, the proposed development may be founded on shallow or deep foundations. It is expected that the column loads from the 4/5 storey building will need to be transferred to the rock below the structure by piles. Driven piles are not recommended for use given the proximity of sensitive hospital equipment and the likely variable strength of the extremely weathered siltstone unit may result in early refusal. A half basement or full basement level may be constructed below the ground floor of the building to provide storage and facilities and services access. Smaller ancillary structures on the site may be founded on strip or pad footings in residual soil or weathered rock.

5.1.1 Bored Piles

We recommend the following Geotechnical Design Parameters presented in Table 7 for bored piles.

TABLE 7 - PRELIMINARY GEOTECHNICAL DESIGN PARAMETERS – Bored Piles

FOUNDING MATERIAL	ULTIMATE END BEARING PRESSURE[1] (MPa)	SERVICEABILITY END BEARING PRESSURE[2] (kPa)	PILE ULTIMATE SHAFT ADHESION[3] (kPa)	ULTIMATE LATERAL YIELD STRESS (MPa)	HORIZONTAL ELASTIC MODULUS (MPa)	VERTICAL ELASTIC MODULUS (MPa)
Uncontrolled Fill	NA	NA	NA	NA	NA	NA
Very Stiff to Hard Residual Soil and XW Siltstone	1.5	600	30	0.7	45	60
HW Siltstone	6	2400	100	1.0	150	200
MW Siltstone	10	4000	450	1.0	450	600

NOTES:

1. *Ultimate values occur at large settlements (>5% of pile diameter);*
2. *End bearing pressure to cause settlement of <1% of pile diameter;*
3. *Design values are estimated based on assessed subsurface profile across the Site and that piles are embedded minimum 4 times the nominal pile diameter;*

The above parameters are for geotechnical design aspects only. Structural design and static must be considered separately.

For piles founded on rock, the minimum center-to-center spacing is 3 times the average pile diameter, or 2.75 times the diagonal dimension of the pile cross section, but not less than 0.6m.

The design should be undertaken according to the provisions of AS2159-2009: *Piling - Design and Construction*. When considering the ultimate limit state the use of the geotechnical strength reduction factor (ϕ_g) is required. As per AS2159-2009 the factor is a function of the basic geotechnical strength reduction factor (ϕ_{gb}) and the degree of testing undertaken. The basic factor is a function of a subjective consideration of the risk at the site posed by the site conditions, design process, and installation quality control of the piles.

The assessment requires assignment of an Average Risk Rating (ARR) which is then used to determine a geotechnical strength reduction factor taking into account the redundancy of the pile system and quantity and type of pile testing to calculate geotechnical strength reduction factor. This process necessarily requires consideration of a number of factors which are beyond the direct control of the geotechnical consultant.

In order for a recommendation to be made the following assumptions have been made about decisions that will be made by the structural designer. The terms used in AS2159 have been used. In the event that these assumptions change, the design geotechnical strength reduction factor would need to be modified in accordance with the requirements of AS2159-2009 Clause 4.3.

- The pile designer has more than limited experience with similar foundations in similar geological conditions;

- Design method adopted will be based on simplified methods with well-established basis, the methods recommended in this report or other mutually agreed methods;
- A limited degree of professional geotechnical involvement in supervision will be undertaken (or specified) and conventional construction techniques would be used;
- No monitoring of the level of performance of the supported structures during or after construction.

Coffey has undertaken an assessment of the risks based on the above assumptions and the available information at the time of the investigation and considers that an ARR of 3.5 to 4.0 (moderate to high risk) is appropriate for the site. Accordingly a basic geotechnical reduction factor (ϕ_{gb}) of 0.45 to 0.53 is considered to be appropriate for the site, based on current information available, for low and high redundancy piling systems respectively.

Coffey notes that basic pile testing is required by AS2159 if a reduction factor of greater than 0.4 is to be used. If no testing is undertaken, a geotechnical reduction actor of 0.4 shall be used. Per Section 8.2.4 of the standard, the minimum requirement is for serviceability and integrity testing on 3% of the installed piles to be undertaken if no further strength testing is undertaken and the above basic geotechnical reduction factor ($\phi_g = \phi_{gb} = 0.45$) is to be used.

If ultimate strength testing is undertaken, the benefit from testing may be incorporated into an increased value for (ϕ_g). As an example, using dynamic load testing of other than preformed piles, and the guidelines of Clause 4.3.1 of the standard, the following geotechnical reduction factors may be used:

- 3% of piles tested: ϕg= 0.61;
- 10% of piles tested: ϕg= 0.70.

The parameters in Table 7 do not take into account slope instability. For footings in slopes or near the crest of slopes, additional consideration should be given to the effect of the slope on vertical and lateral bearing capacity.

5.1.2 Shallow Footings

High level footings such as pad or strip footings founded at least 1.5m below the existing ground surface into the residual soil or soil strength XW material may be designed. Due to variable nature of fill on site, the depth of embedment may vary depending on the extent of fill.

For assessment of potential settlements under load, other than movements associated with the site reactivity, Young's Modulus given in Table 8 may be used. The incorporation of articulation joints beyond typical allowances for residential dwellings is recommended to allow for variability in foundation layer composition.

Coffey recommends that an experienced geotechnical engineer observe the footing excavations prior to construction. This is particularly important on this site due to the potentially varying subsurface conditions.

Shallow foundations may be designed for Geotechnical Design Parameters given in Table 8.

TABLE 8 - PRELIMINARY GEOTECHNICAL DESIGN PARAMETERS – Shallow Footings

FOUNDING MATERIAL	ULTIMATE END BEARING PRESSURE[1] (kPa)	SERVICEABILITY END BEARING PRESSURE[2] (kPa)	VERTICAL ELASTIC MODULUS (MPa)
Uncontrolled Fill	NA	NA	NA
Very Stiff to Hard Residual Soil and XW Siltstone	600	200	30
HW Siltstone	1200	400	200
MW Siltstone	3000	1000	600

NOTES:

1. *Ultimate values occur at large settlements (>5% of shallow footing width);*
2. *End bearing pressure to cause settlement of <1% of shallow footing width;*
3. *Design values are estimated based on assessed subsurface profile across the Site;*
4. *A square footing 1m x 1m at a minimum depth of 1.5m below existing ground surface was assumed.*

The above parameters are for geotechnical design aspects only. Structural design and static must be considered separately.

Please note that the extent of testing associated with this assessment is limited to discrete locations and variations in ground conditions can occur between and away from such locations. If conditions other than those described in this report are encountered during construction, further advice should be sought without delay.

Coffey recommends that a geotechnical professional observe the footing excavations prior to construction for confirmation of the design intent. This is important on this site due to the potentially varying foundation materials.

5.2 Earthquake Design Parameters

The site has been classified as Class C_e – Shallow Soil Site in accordance with section 4.2 of AS1170.4 - 2007 Earthquake Actions in Australia, given the presence of very stiff to hard clay soils shallower than 60m depth.

5.3 Site Classification to AS2870-2011

The classification of a site in accordance with AS2870-2011 Residential Slabs and Footings is not appropriate for an 4/5 storey building however this information may be appropriate for other developments on this site.

The characteristic surface movement (Y_s) of the site has been estimated based on AS2870-2011. This takes into consideration laboratory testing, profiles encountered and site features such as the climatic zone and depth of influence. Our assessment has been based on a climatic region of 1 (Wet Coastal) for Kempsey, depth of moisture change (H_s) of 1.8m, Δu = 1.5 pF (Smith, 2004) and crack depth of 50% of H_s.

Laboratory testing indicates Iss(%) values up to 2.3%. CBR testing indicates that swelling of re-compacted soils may be as high was 5.5%.

Our estimate for Y_s is 40mm (based on I_{ss} = 2.3%).

The site is classified as a Class P site due to the presence of greater than 400mm of predominantly cohesive fill in the slopes near the helipad and workshop. Other parts of the site may include filling also.

However for the purposes of design of shallow footings founded below any fill on the site, an allowance for estimated characteristic surface movements equivalent to a Class M site may be made.

The classification does not allow for ground moisture changes due to leaking services or surface infiltration/ponding. Roof and site runoff must be channelled/piped away from the ground surrounding the structures to reduce the likelihood of infiltration affecting the ground moisture.

5.3.1 Effect of Trees

Our assessment of the site classification does not consider tree root effects. Planting of trees for landscaping around the structures is also not known at this stage.

The structural designer must add an allowance (if any) to the value of Y_s to allow for the presence of any trees that may be planted on the site by calculating the design tree effect, Y_t, as presented in the guidelines in AS2870-2011. The appendices and commentary to AS2870-2011 include guidelines on planting distances that should be considered when considering tree effects. Special consideration will need to be given by the footing design to the presence of trees or landscaping which may give rise to variations in moisture conditions beneath the footings beyond that which is normally expected for a site without trees.

5.4 Soil Aggressivity to Buried Structural Elements

Based on the test results, the soil conditions were found to be 'non-aggressive' to buried concrete elements in accordance with Table 6.4.2(C) of AS2159-2009.

5.5 Pavement Design

5.5.1 Design Parameters

The CBR results reported for the three samples ranged from 1% to 3.5%. Two of the samples exhibited considerable swell on soaking. The values reported are relatively low for soils derived from siltstone. The lowest CBR value coupled with high swell percentage taken from BH12 is at odds with the shrink swell samples from similar soil types at the site. While the materials intersected BH12 were observed to be Fill, this test result indicates the possibility that the soils near BH12 have been reworked or are fill of a more reactive nature than the remainder of the site.

We recommend a design CBR value of 1% though further testing following stripping of the subgrade may allow for a reduction of the pavement thickness where CBR values in excess of 2% are found. If this is to occur then anomalously low CBR values must be explained by way of geological characterisation of the area to aid prediction of other isolated areas of low CBR/high reactivity clay on the site.

Long term elastic modulus of 5MPa and short term elastic modulus of 10MPa are recommended based on CBR test results. However as discussed above, upon stripping of low strength (CBR = 1) material to higher strength (>CBR = 2), a higher elastic modulus can be used. For higher strength material (CBR =>2) a long term modulus of 10MPa and short term modulus of 20MPa may be used. A site visit by an experienced geotechnical engineer to confirm the subgrade is recommended.

In areas where the subgrade consists of uncontrolled fill, we recommend this be either removed and/or replaced in accordance with the recommendations in section 5.8.1 or proof rolled prior to pavement construction. For proof rolling, we recommend using a 9 tonne or greater smooth drum roller in the presence of an experienced Geotechnical Engineer. Should excessive deflection be observed, soft spots will need to be removed and replaced with imported granular fill.

5.5.2 Flexible Pavement Designs

Enstruct propose that for simplicity only two different flexible pavement types will be specified for the project:

1. Heavier duty asphalt pavement to service road and delivery/collection areas (principally in the south of the site). Traffic loading to not exceed 8×10^4 ESA (Equivalent Standard Axles)
2. Lighter duty asphalt pavement to car parks and light vehicle access (principally in the north of the site). Traffic loading to not exceed 2×10^4 ESA

Two corresponding flexible pavement thickness design summaries are presented in Appendix C.

The pavement thickness design was based on the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design and Kempsey Shire Council Development Design Specification D2.

The pavement design is based on the provision of good drainage and water-shedding of the pavement layers. The pavement may be built proud of the surrounding ground if the site is flat, to reduce moisture ingress into the pavement layers.

Prior to construction of the pavement confirmatory testing of the pavement subgrade should be undertaken. The aim of the testing is to confirm that the foundation is of appropriate compaction and CBR value, and is of uniform material type. We recommend that:

- Compaction testing should be undertaken at an interval of 1 test per 5000 square metres with a minimum of 6 tests per lot as per Kempsey Shire Council Development Construction Specification C242 Flexible pavements section C242.18;
- CBR testing be undertaken on subgrade materials at an interval of one test every 50m of pavement;
- An appropriately qualified and experienced geotechnical professional should observe the subgrade to confirm that the materials are uniform and meet the requirements of the design.

5.6 Temporary and Permanent Slopes

5.6.1 General

Proposed cut section details provided indicate that the cut areas will be within the fill, residual soil and extremely weathered siltstone layers.

Temporary slopes (up to 3 month duration) above groundwater level should be limited to the angles in Table 9. Temporary slopes should be observed daily for deterioration, covered with an impermeable membrane, have surface waters directed away from the crest and toe of the slope and should be maintained during exposure. Coffey understand that maximum temporary batter heights will be 5m.

Where temporary slopes are required above the proposed maximum height geotechnical slope stability analysis is recommended to assess the stability.

Permanent slopes above groundwater level should be limited to the slopes angles shown in Table 9 and designed with appropriate drainage conditions and erosion protection depending on their location. Coffey understands that maximum permanent batter heights will be up to 5m. Where a combination of geological layers is encountered the recommended slope batters may be applied to each layer.

The adopted angle of protected slopes should be as shown for all permenant slopes in Table 9. If steeper batter angles are required, Coffey would need to carry out additional laboratory testing (such as triaxial testing) and slope stability assessments beyond the scope of work in this commission. Coffey does not recommend stockpiling above slopes nor placement of structural footings on or near the crest of batters without further detailed geotechnical assessment.

We recommend exposed permanent batters be vegetated as fast as practicable or other erosion protection measures implemented. We recommend on site mapping of defects be carried out for batters in siltstone and consideration be given to erosion protection measures such as shotcreting of defects and soil strength seams if found.

TABLE 9 - PERMANENT AND TEMPORARY SLOPES

UNIT	PERMANENT SLOPES	TEMPORARY SLOPES
	MAXIMUM ANGLE	MAXIMUM ANGLE
Uncontrolled Fill	3H:1V	2H:1V
Very Stiff to Hard Residual Soil	2H:1V	1.5H:1V
Very Stiff to Hard clay (XW Siltstone)	1.75H:1V	1H:1V

5.7 Retaining Wall Design

Based on maximum height of excavation, depth to bedrock, and nearby buildings with sensitive equipment, the following retaining wall system may be considered:

1. Gravity Retaining Wall;
2. Contiguous Bored Pile Wall;
3. Simple Anchored Retaining Wall – Sheet piles may be pinned at the top and bottom anchored into soil/rock. The wall may be embedded at the base into the bedrock and tied to a slab at the top or to a “dead-man anchor”.

Please note that the above options are concept in nature and detailed design needs to be carried out upon selection of a preferred option. The identified retaining wall systems provide a starting point for Enstruct and other retaining wall systems may also be considered.

Simple anchored retaining walls may be designed on the basis of a triangular stress distribution where up to one row of lateral anchors are considered.

Design of the walls must take into account any surcharge from sloping ground or other loadings behind the wall (e.g. vehicle movements or footings). Global failure of the structure should also be checked for acceptable factors of safety. Parameters required for design of retaining walls are provided in Table 10.

Adequate drainage should be provided for all slopes and retaining walls. Surface water should be directed away from the crest and toe of slopes in lined drainage channels. A drainage zone behind the wall should be incorporated for all retaining structures. This drainage zone should be hydraulically connected to porous drains, wrapped in geofabric, on the rear surface of the wall which should be linked to a geofabric wrapped perimeter drain provided at the toe of the final excavation. The perimeter drain should discharge to the site stormwater system to provide long term drainage behind excavation walls. Flushing points should be incorporated into the design of the perimeter drain and periodic maintenance should be incorporated into the management plan of the proposed development.

Drainage measures as described above, if properly maintained, should reduce the risk of elevated pore pressures at the back of the wall, however pore pressures may still be generated at other points behind the wall due to drain failure or lack of maintenance over long periods of time. The design should incorporate an allowance for such pressures. A typical allowance of potential water pressure build-up equivalent to 1/3 of the wall height is considered to be reasonable with such drainage measures installed and maintained over the life of the structure.

Under no circumstances should walls be founded on topsoil, colluvium, uncontrolled fill or other deleterious materials.

Retaining wall design should incorporate checks on the following modes of failure:

- Global slope failure;
- Overturning of the wall;
- Sliding of the wall;
- Internal component rupture (e.g. sliding of the blocks which form the wall);
- Bearing failure due to self-weight and overturning moments.

Retaining walls should be designed by a qualified engineer according to the provisions of AS4678-2002: Earth-retaining Structures.

TABLE 10 - RETAINING WALL GEOTECHNICAL PARAMETERS

UNIT	BULK DENSITY, γ_B (KN/M^3)	EFFECTIVE COHESION (KPA), C’	EFFECTIVE FRICTION ANGLE ϕ’	ACTIVE EARTH PRESSURE COEFFICIENT, KA	PASSIVE EARTH PRESSURE COEFFICIENT, KP	AT REST EARTH PRESSURE COEFFICIENT, KO
VERY STIFF TO HARD RESIDUAL SOIL	21	10	25°	0.4	2.5	0.5

UNIT	BULK DENSITY, γ_B (KN/M^3)	EFFECTIVE COHESION (KPA), C'	EFFECTIVE FRICTION ANGLE ϕ'	ACTIVE EARTH PRESSURE COEFFICIENT, KA	PASSIVE EARTH PRESSURE COEFFICIENT, KP	AT REST EARTH PRESSURE COEFFICIENT, KO
VERY STIFF TO HARD XW SILTSTONE	22	10	25°	0.4	2.5	0.5
LOW STRENGTH SILTSTONE	23	25	30°	0.33	3.0	0.5

5.8 Earthwork Site Preparation

5.8.1 Site Preparation

The following general comments and recommendations are provided for site preparation beneath structures and pavements:

- Following excavation to design level, the exposed subgrade materials should be proof rolled to identify any wet, excessively deflecting or other deleterious material. Any such areas should be over-excavated and backfilled with a clean select material. All topsoil should be stripped and stockpiled for re-use as landscaping materials only;
- Approved fill beneath roads should be placed in layers not exceeding 300mm loose thickness and be compacted to a minimum dry density ratio of 95% Standard Compaction. Clay fill should be placed and maintained at 60% to 90% of Standard OMC;
- The top 300mm of natural subgrade or subgrade fill below pavements should be compacted to a minimum dry density ratio of 100% Standard Compaction;
- All pavement materials should be placed and maintained at 60% to 90% of Standard OMC;
- Approved fill beneath structures should be placed in layers not exceeding 300mm loose thickness and be compacted to a minimum dry density ratio of 98% Standard Compaction. Clay fill should be placed and maintained at 60% to 90% of Standard OMC. All filling beneath structures should be carried out under Level 1 construction monitoring and testing as defined in AS3798-1996.

Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007, '*Guidelines for Earthworks for Commercial and Residential Developments*'.

KEMPSEY DISTRICT HOSPITAL - GEOTECHNICAL INVESTIGATION

5.8.2 Excavation Conditions

Discussions with the project team indicate that a partial basement or void area of about 1 to 2m depth is proposed below the structure. At this depth, excavations are likely to be within the very stiff to hard residual clay materials, and will need to progress through fill materials in some areas.

Based on experience with similar conditions, economic excavation in soil strength materials such as the very stiff to hard clay could be conducted using backhoes or tracked, hydraulic excavators. It is possible excavation may encounter zones of rock that are stronger, iron cemented or less jointed than that intersected in the boreholes. Such zones may require ripping or preliminary loosening with a hydraulic rock breaker.

It is likely that detailed excavation of footings could be conducted using the excavator bucket.

It is important that contractors should inspect the rock cores and do their own assessment on excavatability or drillability in relation to the type of equipment and cutting tools they intend using for the project. It is also essential that a good engineering geologist be engaged to make appropriate assessment of the geological conditions and features that may influence productivity.

Unless significant use of heavy hydraulic rock breakers is found to be necessary, the excavation methods suggested above should not create vibrations which would adversely affect adjacent buildings. If other methods involving higher energy input into the ground are employed, vibration monitoring may be required at the commencement of excavation and throughout the work to assess whether levels generated are in excess of the damage thresholds for the adjacent buildings.

Groundwater was not encountered within the depth of proposed excavation at the time of the investigation, though groundwater conditions may change if rainfall is experienced prior to or during construction. A test pit could be excavated to the depth of the proposed basement prior to bulk excavation to further assess the likelihood of water inflow.

6 FURTHER GEOTECHNICAL WORK REQUIRED

Further geotechnical assistance is expected to be required for progression of a development of this nature. The ongoing involvement will provide additional benefit through adjustment of the design assumptions to the conditions through detailed analysis or further investigation and testing of options prior to construction.

During design phase Coffey should be involved with the assessment of the final foundation design for proposed structures. Coffey can assist with review of design once preliminary analysis has been undertaken.

Following design completion but prior to construction we recommend that consideration be given to more detailed investigation of pavement design parameters along the actual routes of the proposed pavements. This may allow reduction of pavement thickness in areas where higher CBR subgrade is present.

During construction Coffey can assist with construction stage engineering. Coffey should be engaged to confirm that the ground conditions anticipated in this report are generally consistent and that the design conditions have been met.

Coffey can also assist with testing of the subgrade of pavements, materials assessment and assessment of foundation conditions during construction works.

7 LIMITATIONS

The findings in this report are the result of observations made at discrete intrusive investigation locations, and observation of the surface conditions. Subsurface conditions may vary from those encountered within the boreholes when moving away from the boreholes. Should different subsurface conditions to those expected be encountered during construction, Coffey should be contacted immediately.

Your attention is drawn to the document 'Important Information about Your Coffey Report', which is attached and should be read in conjunction with this report.

Please do not hesitate to contact the undersigned if you require further information with respect to this report.

For and on behalf of Coffey Geotechnics Pty Ltd

Tom Nicholson

Associate

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

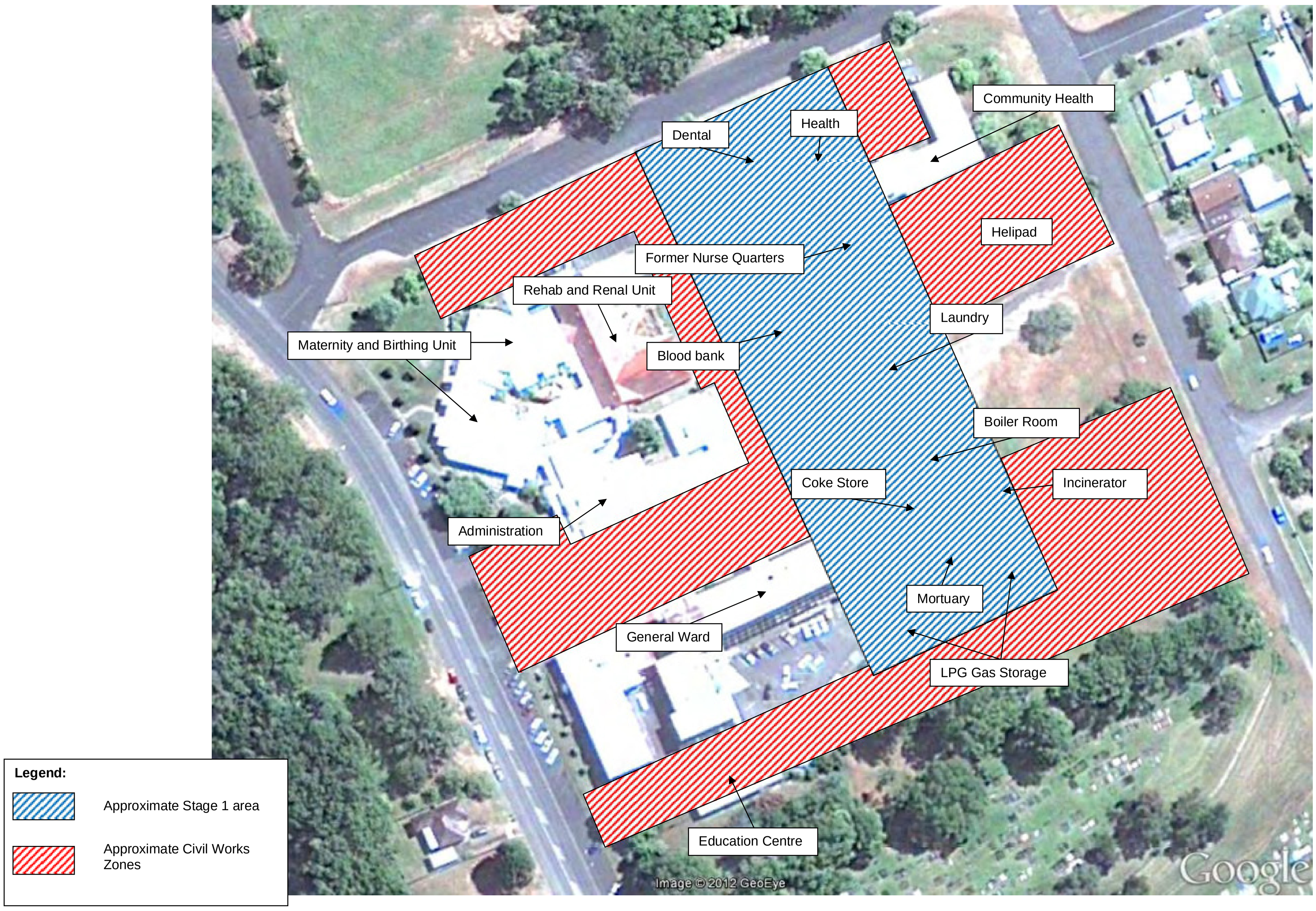
Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

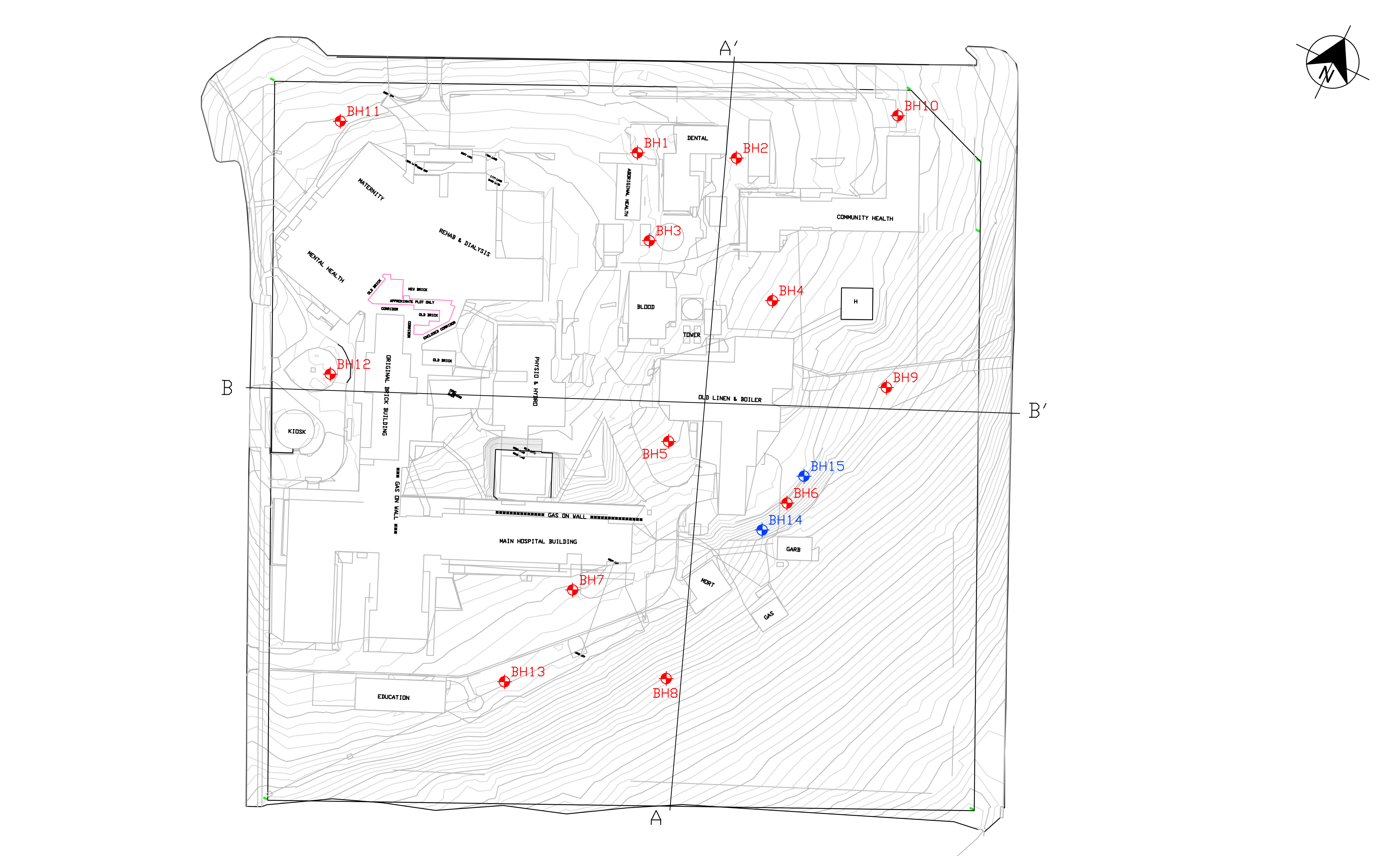
Figures

drawn	JP	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	enstruct Group Pty Ltd	
approved	TGN		project:	Geotechnical Assessment for the Stage 1 and Civil Works Zones Redevelopment Kempsey District Hospital, Kempsey NSW	
date	16-Nov-12		title:	Site Locality Plan	
scale	NTS				
original size	A4		project no:	GEOTCOFH03037AA-AG	figure no: Figure 1



revision	description	drawn	approved	date
	Image sourced from Google Earth 2012			

drawn	JP	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	enstruct Group Pty Ltd	
approved	TGN		project:	Geotechnical Assessment for the Stage 1 and Civil Works Zones Redevelopment Kempsey District Hospital, Kempsey NSW	
date	16-Nov-12		title:	Site Layout Plan	
scale	NTS				
original size	A3		project no:	GEOTCOFH03037AA-AG	figure no: Figure 2



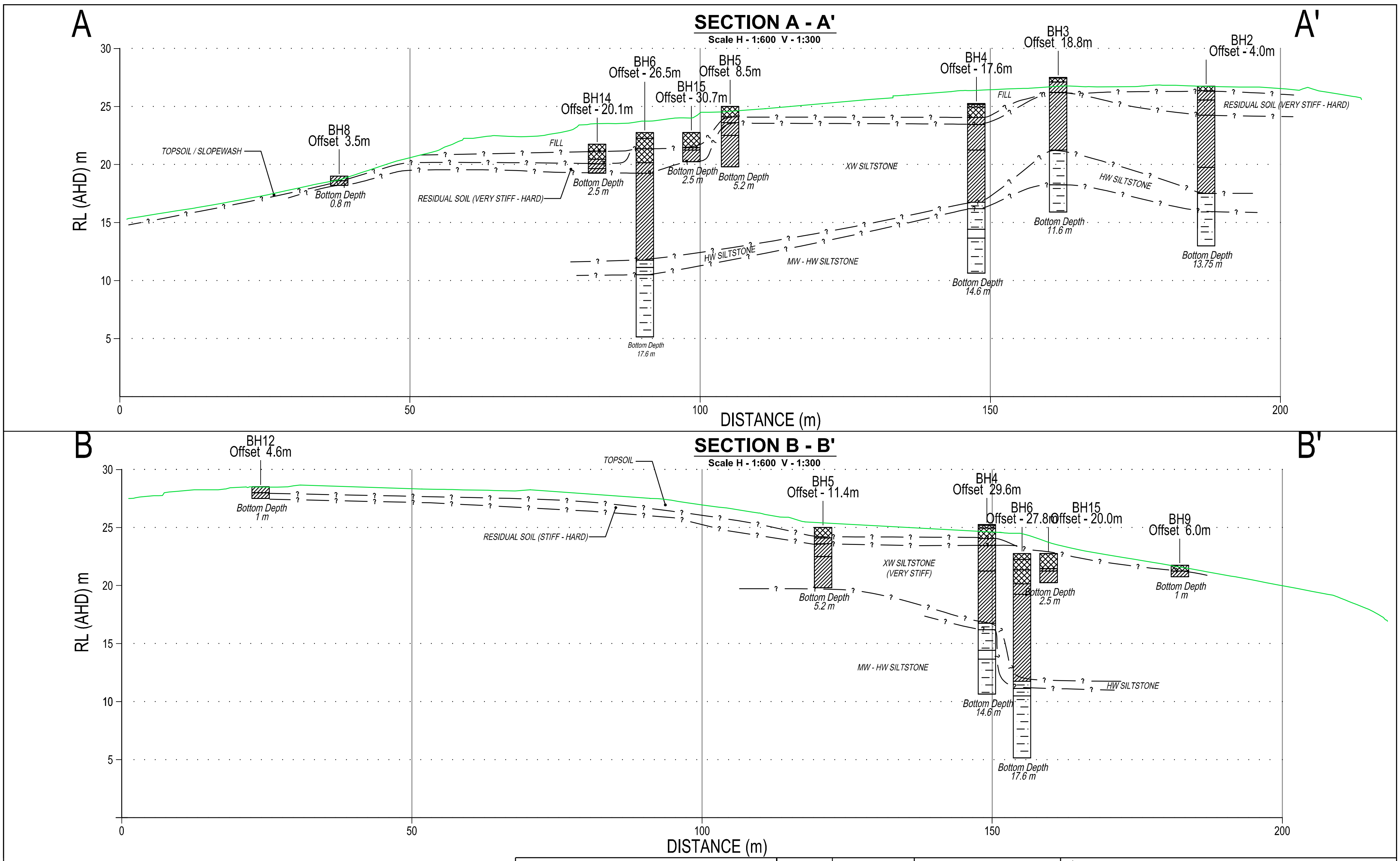
LEGEND

GEOTECHNICAL BOREHOLE LOCATION

ENVIRONMENTAL BOREHOLE LOCATION

Scale (metres): 0, 20, 40, 60

drawn	NLS	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client: ENSTRUCT GROUP PTY LTD
approved	SB		project: GEOTECHNICAL ASSESSMENT FOR THE STAGE AND CIVIL WORKS ZONES REDEVELOPMENT KEMPSEY DISTRICT HOSPITAL KEMPSEY NSW
date	06-03-13		title: SITE PLAN AND INVESTIGATION LOCATIONS
scale	1:1000		project no: GEOTCOFH03037AA
original size	A3		figure no: FIGURE 3



LEGEND

CLAY

FILL

SILTSTONE

Horizontal Scale (metres): 0, 6, 12, 24, 36

Vertical Scale (metres): 0, 6, 12, 18

drawn	NLS	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client: ENSTRUCT GROUP PTY LTD
approved	SB		project: GEOTECHNICAL ASSESSMENT FOR THE STAGE AND CIVIL WORKS ZONES REDEVELOPMENT KEMPSEY DISTRICT HOSPITAL KEMPSEY NSW
date	06-03-13		title: GEOTECHNICAL SECTIONS A - A' & B - B'
scale	AS SHOWN		project no: GEOTCOFH03037AA
original size	A3		figure no: FIGURE 4