NEPEAN HOSPITAL CAMPUS SERVICES INFRASTRUCTURE REPORT

ELECTRICAL, MECHANICAL AND MEDICAL GAS SERVICES

INCORPORATING HYDRAULICS INPUT FROM CONNELL WAGNER

STEENSEN VARMING

SYDNEY CANBERRA BRISBANE MELBOURNE

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1 INTRODUCTION

Penrith is in a growth area of Metropolitan Sydney. Nepean Hospital is the major Hospital for the region and has received a number of building additions and extensions over the past 20 years and further redevelopment is proposed to cater for the increasing health needs of the region. A redevelopment master plan has been prepared by Aurora Projects.

This report is the result of site investigations of systems compliance and capacities, considered in conjunction with the current Hospital requirements and the requirements of short and long term redevelopments identified as part of the master planning process.

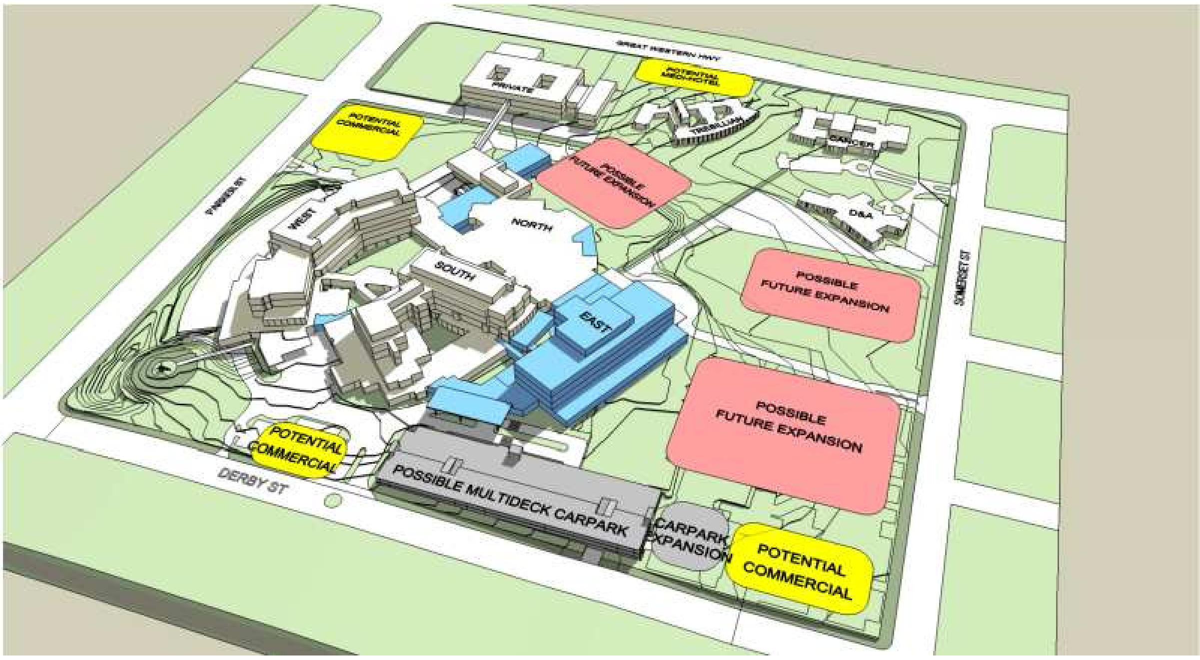
An earlier report was prepared by Donnelley Simpson Cleary which undertook a review of all services on the site and this information has been used to confirm our findings and in part to assist in the preparation of our report.

This report makes recommendations for adjustments and upgrades of systems where needed to support both the current hospital needs and the needs of the master planning proposal.

It is recommended that the strategies in this report form the basis of future designs for implementation of the master plan.

2 MASTER PLAN

A master plan has been prepared by Aurora Projects which identifies short and long term requirements of Nepean Hospital. The initial expansion of the hospital will account for approximately 7500m2 of new build with an overall long term expansion new build of approximately 20,000m2.



Implementation of the master plan will be staged.

The sequence of implementing the recommendations in this report should be carried out in parallel and under constant review to ensure that any adjustments in the building needs and legislature are addressed.

3 ELECTRICAL SERVICES

3.1 DESCRIPTION OF SERVICES

The Nepean Hospital Electrical services infrastructure can be divided into High voltage, Low voltage and Standby generator services.

The Hospital is a High Voltage customer with two incoming high voltage feeds into the site, one 11kV feed from Derby Street and the other from Parker Street. These incoming high voltage feeders serve a high voltage switch board which in turn serves a number of distribution sub-station transformers. Each transformer serves a low voltage main switch board some of which have BCA essential and or standby essential sections.

BCA essential includes lifts, fire fighting and detection services and smoke management services. Standby services are those services deemed to be critical Hospital services. The minimum requirements are listed in TS-11.

A diesel generator room is located adjacent to the loading dock. Two standby generators are installed within this room, which support the BCA essential as well as Hospital essential electrical services. The generators are rated at 680 kVA and 262 kVA respectively. They are synchronised and support the essential distribution boards. These are described in more detail in section 3.4.

3.2 HIGH VOLTAGE SERVICES

The electrical site infrastructure comprises two high voltage incoming mains from two separate Integral Energy zone sub-stations. These terminate onto a high voltage switchboard with high voltage outgoing switch fuses and mains that radially serve ten distribution sub-stations located around the site. The incoming authority mains enter the site from two different directions which provides increased reliability in supply and reduces the risk of completely losing the supply to the site due to incoming cable failure.

The High Voltage network is configured in a basic arrangement with switch fuse protection and radial outgoing circuits.

Both incoming high voltage feeds and outgoing radial feeds are installed underground as opposed to overhead. This is the recommended method of serving hospital premises as it is more reliable and less likely to be damaged due to storms and vandalism.

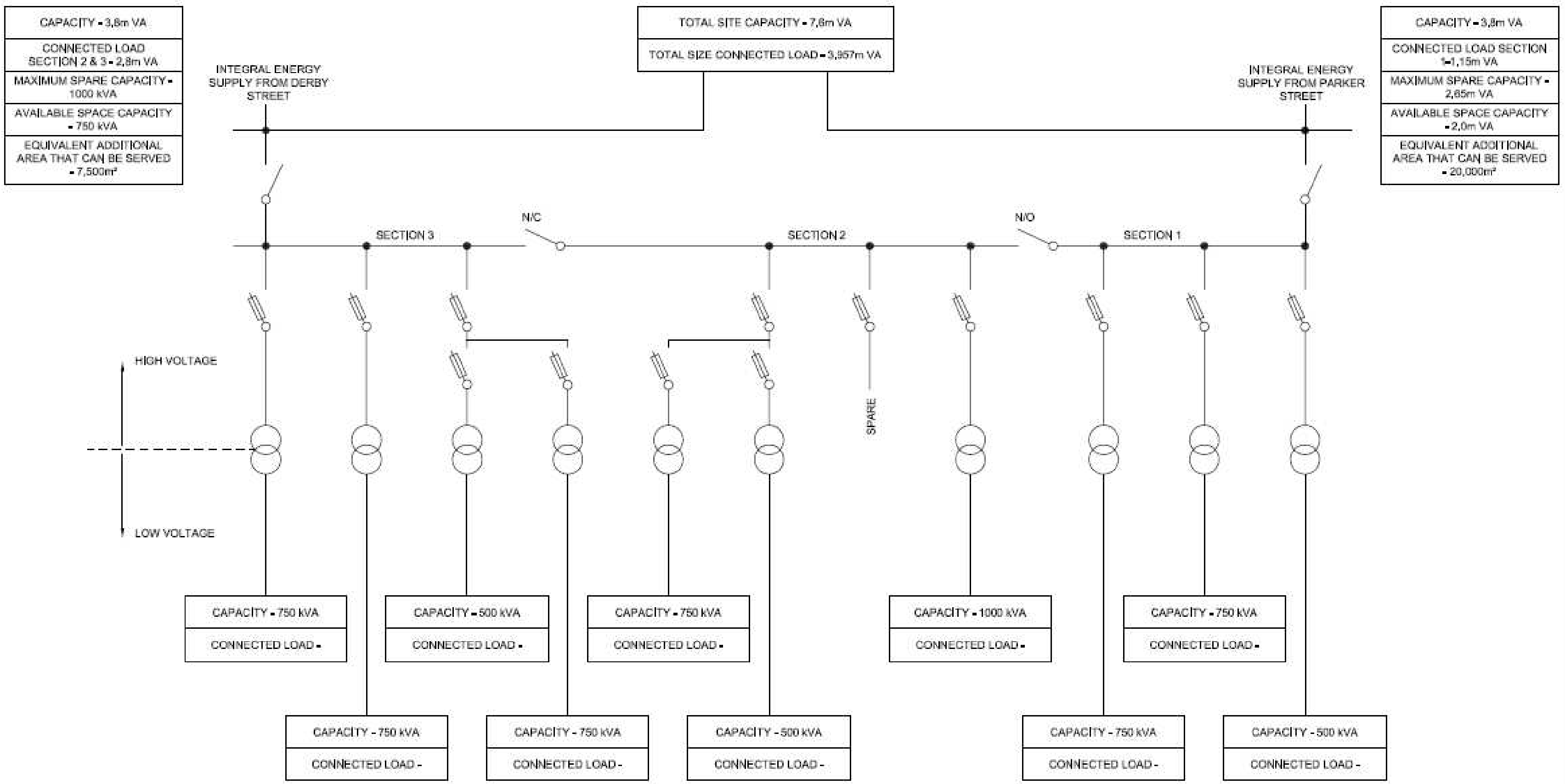
The high voltage switchboard is divided into three sections (1,2 and 3). The authority incoming mains are connected onto sections 1 and 3 with section 2 being served from either section 1 or 3. A table of each service that is connected onto each section of the high voltage switch board is given below.

Section 1	**HV Fuse protection**	**Sub-station capacity**	**Areas served**
Sub-station 'D'	100A	750kVA	Mechanical Plant Medical air compressors
Sub-station 'E'	100A	750kVA	Old and new operating theatres North block mechanical plant Intensive Care Unit Pharmacy Admin Pathology Theatre service lift Car park
Sub-Station 'J'	100A	500kVA	Human resources Staff education Staff accommodation Dental clinic air compressor Clinical services Medical education Maintenance workshops Communications room

Section 2	**HV Fuse Protection**	**Sub-station capacity**	**Areas served**
Sub-station 'C'	100A	1000kVA	Linen store Biomedical Service block ICU conference area PABX Disaster recovery room Kiosk Mechanical plant level 1
Sub-station 'F'	100A and 63A	500kVA	Tresillian block Psychiatric Centre Occupation therapy
Sub-station 'I'	100A and 63A	750kVA	Cancer care building
Spare space	100A	-	-

Section 3	**HV Fuse protection**	**Sub-station capacity**	**Areas served**
Sub-station 'B'	125A and 80A	750kVA	Women and children's unit
Sub-station 'G'	125A and 63A	750kVA	West block
Sub-station 'H'	80A	750kVA	Mechanical plant
Sub-station 'K'	80A	500kVA	Kitchen Women and childrens wards Security

The High Voltage switchboard has been modified at some stage to include the newer current section 3 of the switchboard. The switch board appears to have originally comprised sections 1 and 2, these being the older style of high voltage equipment. The arrangement of the current high voltage switchboard is shown on drawing E1000.



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DRAWING TITLE

Penrith Hospital
Electrical Services
Existing Distribution Arrangement and Capacity

DATE	DRAWN	DESIGNED	CHECKED	SCALE
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08718	E1000	02

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The capacity of the incoming high voltage feeders is approximately 3.8mVA (200A at 11Kv) each but due to the arrangement of the switch board and the need to serve the centre section (Section 2) of the switchboard from either incoming feed both feeds need to allow for the connected load of section 2 (2250 kVA). If this arrangement is changed by providing a different form of standby supply, then the normal capacity can be increased by 2250 kVA.

The high voltage switch board is located adjacent to the loading dock midway between North block and West block. This is an ideal location being close to the centre of the site load and adjacent the highest loads being the chiller sets. The high voltage switchboard incorporates nine outgoing fused switches eight of which are being used. There is only one spare fused switch available for adding more sub-stations which is the major factor limiting the ability for new loads to be added onto the system. To install further spare switch fuses directly onto the high voltage switch board would require major re-building of the high voltage switch board. The down time required to do this work would not be acceptable to the Hospital and therefore an alternative strategy is recommended (discussed further in the report).

The high voltage switch room has two exits which meets code requirements. Framed drawings of the switch board and the high voltage network are mounted on the switch room walls. The original sections 1 and 2 are arranged in an 'L' form around the perimeter of the room with the newer section 3 located towards the centre of the room. The room has no space to accommodate additional switchgear or equipment.

The majority of the local sub-stations are kiosk pad mount type, typically of 500, 750 or 1000kVA capacity each or multiples of these sizes.

Pad mounted types of substations have been installed into the chamber type of enclosure adjacent North block. It is not usual to have pad mounted substations installed inside a building. Pad mounts require good natural ventilation to perform satisfactory and are therefore usually installed outside in the open. The resulting ventilation in this installation may be less than satisfactory. The pad mounted substations being weatherproof may have been utilised within the chamber enclosure due to wet services being installed above them. The ventilation to this chamber substation comprises natural ventilation openings in opposite walls of the adjacent corridor and the loading dock together with exhaust fans located in the Western end wall. This chamber substation serves many of the critical areas of the Hospital, ie Medical air compressors, Chillers, Operating theatres, and although during our visits the temperature within the substation has been acceptable, during extreme weather conditions when the chillers are operating at peak load, then the room temperature will rise. It is recommended that a room temperature monitor and alarm system be introduced to ensure that any early warning is addressed.

Any redevelopment within the area of this chamber sub-station will need to ensure that the ventilation intakes and fan discharges are maintained.

One of the chamber distribution sub-stations, sub-station 'C', is of the open type, This is a newer transformer of 1000kVA capacity and replaced a 750kVA pad mount type in the year 2000. This type of transformer is more suited to the chamber installation due to the exposed cooling fins that are provided. See attached photograph below (transformer behind the orange switch board).

A capacity table is shown below which forms the basis of our assessment to accommodate future service growth at Nepean Hospital.

Development	High Voltage	Low Voltage	Generators
Existing 3.9 MVA	Adequate	Adequate but too few spare spaces	Not adequate
Existing plus East Block (Additional 750 kVA)	Just adequate	Adequate but too few spare spaces	Not adequate
Existing plus total proposed development (Additional 2000 kVA)	Not adequate	Not adequate	Not adequate

With the current arrangement of the high voltage switchboard (having a common section that can be served from either incomer and only one spare outgoing switch fuse which is located on the common section) the overall usable spare capacity on the high voltage system is approximately 750kVA which represents approximately 7500m2 of additional development. This equates to the size of the proposed East Block development. The existing high voltage switchboard could therefore serve East Block by utilising the spare switch fuse with no upgrade or alterations required, this switch is however reserved for the co-generator plant and hence with the current high voltage switchboard arrangement there is no provision for adding loads.
The additional buildings within the overall master plan will have a maximum demand of approximately 2000kVA. To accommodate any of this additional demand some upgrading of the existing high voltage main switch board will be required to allow better utilisation of the incoming high voltage Integral Energy supplies. It is recommended that as a minimum the supply capacity of the high voltage switchboard is increased to serve the redevelopment proposals as set out in the master plan.

By implementing this recommendation adequate normal supply capacity will be released to cater for the needs of the master plan. This will also allow two 750Kva sub-stations to be added onto section 1 of the high voltage switch board. **The recommended arrangement is shown in the attached drawing E1003.**

An alternative strategy could be to completely replace the switchboard with two new evenly loaded sections with no commonly served section thus allowing the full capacity of the authority supplies to be utilised. This arrangement would however require the existing high voltage switchboard to be completely rebuilt and to be shut down for an extended period of time. It is assumed that this would not be acceptable to the hospital and thus not recommended.

Four pad mounted distribution sub-stations are located outside South Block, two of these sub-stations are disused. The labelling of these suggests that one of the disused sub-stations is the unit that was originally located with the North block chamber sub-station and replaced with a larger unit. The disused sub-stations may not be connected but may have been placed there for storage. If these are in an acceptable condition, they could be used in the re-development.

Each of the distribution sub-stations include power factor correction equipment. This equipment is automatic in operation and is used to maintain a healthy acceptable power factor. This arrangement will ensure that the Integral Energy power factor requirements are met.

North Block Chamber Sub-station with Chamber and Pad Mounted Transformers

In summary the recommendations for the High Voltage Services are:

- Consider an alternative adequately sized standby supply to release 2250 kVA of normal supply.
- Common up two existing high voltage radial feeders to release one space on the high voltage switchboard to serve the redevelopment.
- Monitor North Block Chamber Substation to ensure that there are no temperature problems.

3.3 LOW VOLTAGE SERVICES

The low voltage service comprises eleven main switch boards which in turn serve distribution boards or motor control centres. Two of the main switch boards are dedicated to mechanical services each with their own independent distribution sub-station. These serve the heavier loads such as the chiller sets (Chiller sets and their associated equipment such as pumps and cooling towers can account for 40% of the total Hospital electrical load).

Main switch boards that have standby services connected onto them include an automatic transfer switch which switches the critical services from mains onto the standby generator in the event of a mains failure. These automatic transfer switches will operate whether it be an Integral Energy supply failure or a local Hospital high voltage network failure.

The main switch boards incorporate moulded case circuit beakers protecting the outgoing sub main cables. The low voltage switchboards that were inspected appear to be in good condition.

Many of the existing floor distribution boards are at full capacity with no ability to add circuits. It is recommended that all future distribution boards should have at least 30% spare capacity and spaces with a minimum of 12 spare spaces being made available on each board.

To future proof the site it is recommended that existing distribution boards be replaced with new boards (with a greater number of spare spaces) in each building refurbishment / redevelopment.

3.4 GENERATOR SERVICES

The existing generator room is located adjacent the loading dock. This accommodates two diesel standby generators with a total capacity of 942kVA (one generator is a 680kVA set and the other a 262kVA set). The output of each generator is connected into the generator switchboard which in turn has four outgoing sub-mains that serve standby switchboards around the site. The areas served are :

1. Pathology
2. Lifts and fire detection services
3. Computer room, ICU, PABX
4. Operating theatres, wards, medical air etc

Based on advice from the Sydney West Area Health Service it is understood that there have previously been issues with synchronising the two generator sets. This can occur where two dissimilar sized generators are installed to run in parallel with each other. A day diesel fuel tank is provided to serve the two generators which is supplied from the bulk storage tank.

The generators automatically start when a supply fails at any of the four loads served. The loss of supply is detected via phase failure relays which signal to the generator sets to start. Once the generator sets are up to speed and ready to take load the automatic transfer switch disconnect the mains supply side from the main switch board and connects the generator supply side of the transfer switch to the main switchboard.

Our assessment of current and future standby loads are:

Development	**Standby loads**
Existing	1300 kVA (942 kVA currently provided but which is not sufficient to meet existing demands. The current high voltage incoming supply switching arrangement provides some standby cover as well)
Existing plus East Block	1500kVA (200 kVA additional load)
Existing plus total revdevelopment	1900kVA (600 kVA additional load)

To cater for the new East Block, it is recommended that two 750kVA generators (providing a total of 1500kVA) be installed in place of the existing generators. These generators will operate in parallel as synchronised sets. Consideration should be given to these sets being capable of operating on bio-fuel as well as diesel. The increased size of generators can be accommodated in the existing generator room. The generator switch board will also need to be replaced with a higher capacity board with sufficient outgoing circuits to feed the existing

and future loads. **This is the recommended arrangement to achieve the construction of East Block.**
Planning to meet the generator needs of the full master plan would need to consider whether the existing generator room needs to be demolished to accommodate new buildings. If this is required a new generator room will need to be established with new mains provided to serve each of the existing standby essential services main switch boards. The new generator room should have space to accommodate a future third generator set with the generator switchboard also sized for three generators.

If the overall development did allow for the existing generator room to be retained, two options are available to accommodate the third generator :

1. Reconfigure and extend the current room
2. Build a separate room to accommodate the switch board.

Option 2 is the recommended option since it allows for a new switch board to be established in advance ready to accept the new generators and also places it in an acoustically separated space. **This is the recommended solution for three generators.**

Existing Standby Generators

An important consideration for future design is that by connecting several large generator sets onto a common switchboard the resulting fault level can become higher than that of the normal supply network. An audit of the current system fault level protection and limiting devices would be necessary to ensure that the generator plant fault level can be accommodated. Fault limiting protection devices can be provided to assist in ensuring that the down stream equipment fault levels are not exceeded.

The new standby generator installation should be arranged so that generators are tested using the site load. To achieve this will require either the generator sets to synchronise onto the authority supply for a short period before taking up the site load or arranged planned minor interruptions, which usually can be accommodated.

3.5 CONDITION OF THE ELECTRICAL SERVICES

The table below gives an indication of the condition and life expectancy of the existing electrical services

System Condition Table

Service	Condition	Equipment age	Life expectancy
High voltage	Good	10 – 30 years	20 years plus
Low voltage	Fair	5 – 25 years	10 – 25 years
Generators	Good	15 years	10 years

3.6 REQUIREMENT OF TS-11

TS-11 sets the guidelines for electrical services within Hospitals in NSW.

TS-11 recommends the use of pad mounted sub-stations over chamber type. The majority of sub-stations at Nepean Hospital are pad mounted. Pad mounted substations are much more economical to provide than the chamber type. Given the available land around the site, Nepean Hospital is well positioned for the provision of pad mounted sub-stations.

The requirement of TS-11 for ensuring a satisfactory and reliable electricity supply is to have either :

- Two independent high voltage feeds from two zone substations with automatic changeover between supplies.
- Standby generators operating as a back up supply in the event the authority supply failing.

Nepean Hospital has two independent authority feeders but no automatic changeover switch between them. It does however have automatic standby generators although not adequately sized. This is a reflection of how the system has evolved over time.

Previous sections of this report have articulated how adequate capacities of both normal and standby supply can be provided.

TS-11 recommends that the quantity of diesel fuel stored is dependant on the availability to be re-fuelled. We would generally design for at least 12 hours of fuel stored to operate the standby generators for that period at full load. The current bulk fuel store has a capacity of 20,000 litres which at full load for two 750kVA generator sets represents approximately 60 hours operation.
The proposed upgrade of the generator sets, will not require the fuel storage capacity to be increased.

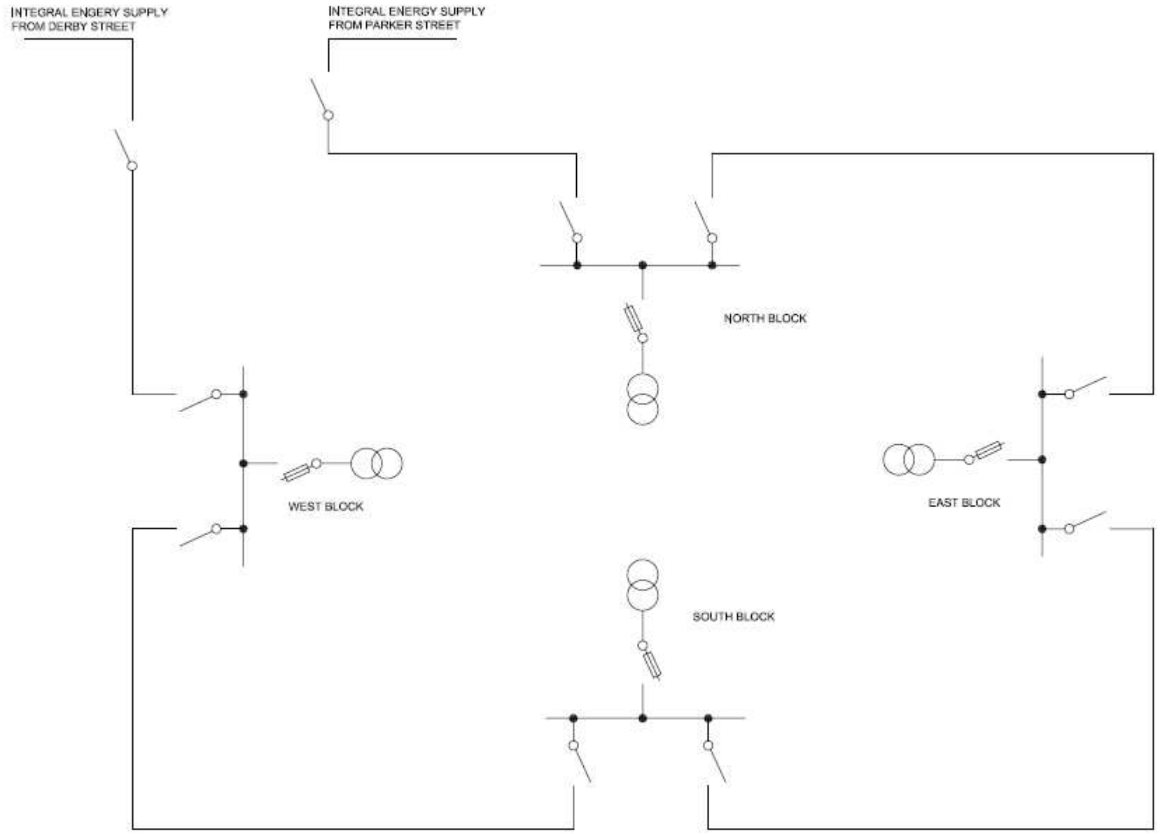
3.7 STRATEGIES FOR THE FUTURE

Three options are available to ensure that the high voltage network can meet the demands of the master plan.

Option 1
If this was a new hospital the best distribution arrangement for the electrical services would be to have the two high voltage incoming feeders serving a ring arrangement of high voltage network on the site. To achieve this for Nepean Hospital would require the existing arrangement to be abandoned and a completely new site network installed. The high voltage ring would serve distribution sub-stations within each load centre, ie each block, with main switch board provided within each block. This arrangement would provide flexibility, reliability and redundancy. The high voltage ring network could either be arranged as an open ring with switch fuse protection provided at each distribution transformer or a closed ring which would require more expensive high voltage circuit breakers and a relay protection system to be installed. The cost and disruption in providing this would be high. This arrangement is shown on drawing E1001. The closed ring arrangement with circuit breakers and protection relays has the ability to isolate faulty sections automatically whilst keeping other healthy section on line, this arrangement can be quite sophisticated and requires a high level of user knowledge.

Option 2
Alternatively the two existing incoming high voltage feeders could each serve a section of high voltage switchboard, ie the high voltage switch board could have two sections only. This will allow the full capacity of the incoming feeders to be utilised. Radial feeders would then serve the distribution sub-stations around the site. Each of the critical low voltage switch boards would have two transformers each transformer served off a different high voltage incomer with a low voltage switch board manual bus tie included. Each section of the low voltage switch board would be served by the standby generators to support BCA essential and Hospital essential services. All of the existing radial feeders would be re-used. To provide this arrangement would require an extensive shut down of the supply to the hospital. This arrangement is shown on drawing E1002.

Option 3
As discussed earlier our recommended approach is shown in drawing E1003



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DRAWING TITLE

Penrith Hospital
High Voltage Network Ring
Main Arrangement
(IDEAL) Arrangement

0 50mm A3

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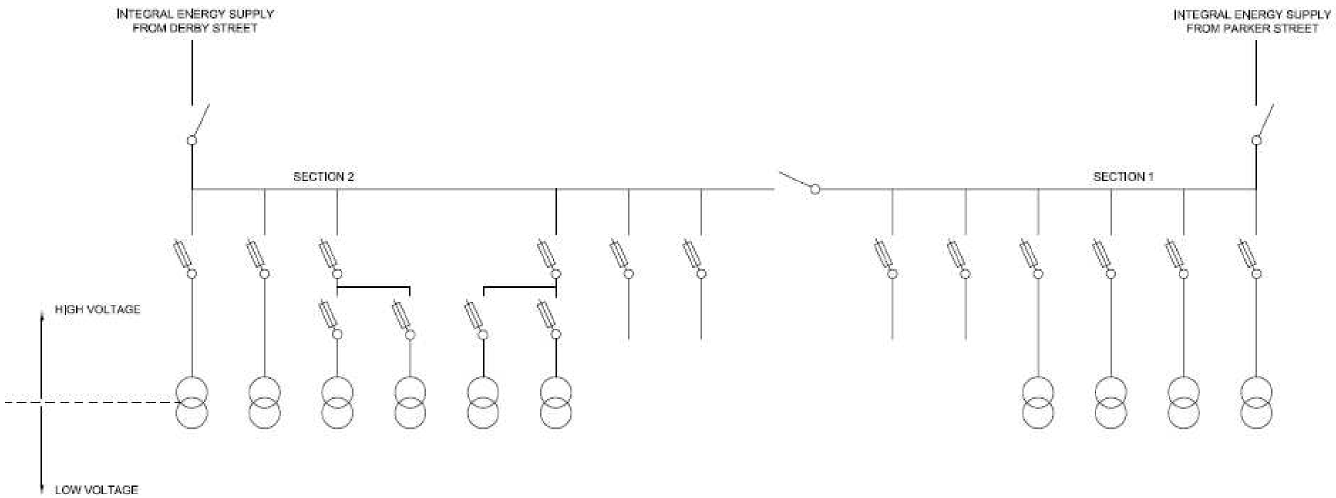

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DRAWING TITLE

Penrith Hospital
Electrical Services
Proposed Alteration to The Electrical Distribution Arrangement

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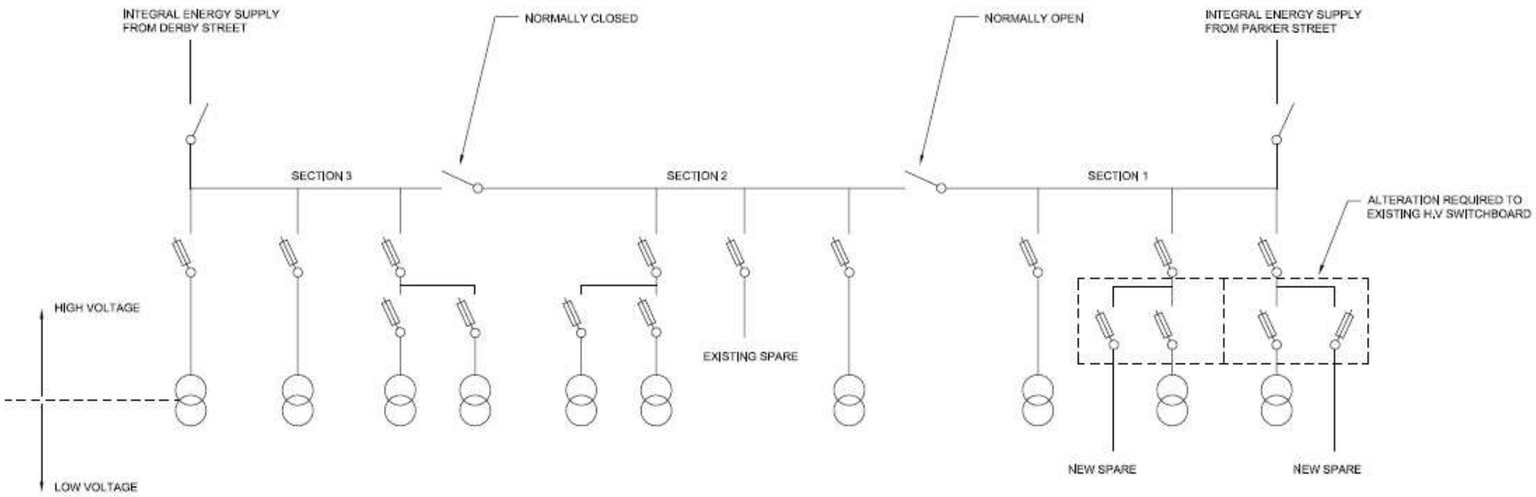

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DRAWING TITLE

Penrith Hospital
Electrical Services
Existing Distribution Arrangement

ALTERED TO ACCOMMODATE THE OVERALL REDEVELOPMENT

0 50mm A3

DATE	DRAWN	DESIGNED	CHECKED	SCALE
APR'08	SB	BC	RT	N.T.S

PROJECT No.	DRAWING No.	REVISION
08718	E1003	01

3.8 PROPOSED DEVELOPMENT

For this proposed development the following work will need to be undertaken

- **New SWAHS Executive**. This would be served off an existing low voltage main switchboard.

- **New Mental Health building.** The estimated maximum demand for this building is 400kVA, a 500kVA sub-station would therefore be required. We would expect this to be a pad mounted sub-station located adjacent to the building and close to the building main switch board. The building may have a small requirement for standby services.

- **New Engineering building**. The maximum demand for this building will be in the order of 100kVA, there will be no requirement for standby services within this building.

- **New East Block**. The maximum demand of this building with chiller plant to support the full redevelopment would be in the order of 1500kVA.

- **Car park.** The load of this is expected to be in the order of 60kVA and should be served from the existing 500kVA J substation. No standby services will be required.

3.9 CONCLUSIONS

The current arrangement of the electrical high voltage infrastructure does not allow the full capacity of the authority supplies to be utilised.

The standby generator capacity is not sufficient to meet the site standby requirements and is below the capacity recommended in TS-11 to meet the current site maximum demand.

The outgoing circuits of local distribution boards are in many cases fully utilised with no spare spaces for adding local circuits.

An overall redevelopment proposal has been identified for the site but the current high voltage arrangement and standby generator capacity are not able to fully support this development. East block has been identified as the initial new building for the site, the current high voltage arrangement will just be able to meet the requirements of this building but the standby generators cannot support it.

3.10 RECOMMENDATIONS

Alterations to the high voltage switch board is recommended to allow better utilisation of the incoming authority supplies. The recommended proposed arrangement is shown in drawing E1003.

The installation of two larger 750kVA generator sets is recommended to meet the current and initial site re-development requirements with a further increase in capacity by adding a third generator as the site moves towards the overall identified site master plan re-development.

The replacement of existing distribution boards is recommended as buildings are refurbished, replacement distribution boards should have at least 30% spare capacity.

4 MECHANICAL SERVICES

4.1 DESCRIPTION OF SERVICES

The mechanical services comprises central chillers, central heating hot water boilers (HHW) , central steam boilers, air handling plant and ventilation fans.

The chillers are located in the lower level of North Block and are accessible from the loading dock. The HHW boilers and Steam boilers are located within the lower level of North Block, heating hot water boilers are also located within the roof plant room of West block.

Air handling plant is generally located within the roof top plant rooms local to each block.

4.2 CHILLED WATER SERVICES

The chiller plant comprises four water cooled chilled water chillers. Two of the chillers are new, one chiller was installed in 2000 and one chiller is reaching the end of its economical and reliable life.

- Chiller No 1 – Trane helical rotary chiller – 1500Kwr – installed 2000
- Chiller No 2 – trane centrifugal chiller – 1000Kwr – installed 1979
- Chiller No 3 – Carrier centrifugal chiller – 1800Kwr- installed 2007
- Chiller No 4 – Carrier centrifugal chiller – 1800Kwr – installed 2007

The oldest chiller (No2) operates on refrigerant R113 which is no longer available. The two new chillers are of a lesser capacity than the units they replaced (originally 2000kW units) but have been able to cope with the site load. If chiller No 2 became unavailable due to loss of refrigerant the remaining chillers may not be able to meet the site chilled water demands. Due to its age and the type of refridgerant used, the number 2 chiller will require replacement in the near future.

Since the installation of the new chillers, the Sydney region has not experienced extreme hot weather conditions and hence the current installation has not been subjected to a real test.

The total current chiller capacities represent approximately 51,000m2 of building area being air conditioned. It is understand that the current total building area is in the order of 54,000m2, and therefore at times the total installed chiller capacity is required to meet the site demands.

To meet the chilled water requirements of the master plan a further 2600kW of chiller capacity is required. The new additional chillers would ideally be located within the basement of the new East block close to the existing chiller plant room in order that the two systems can be married into one large central chilled water system. This would allow for better redundancy and reliability. If possible the new chillers should be served from a different high voltage incomer to that of the existing chillers.

To summarize the above discussion, additional chillers are required at a capacity of 2650 KW and number 2 chiller (1000 kw) replacement is recommended to handle to current and future loads.

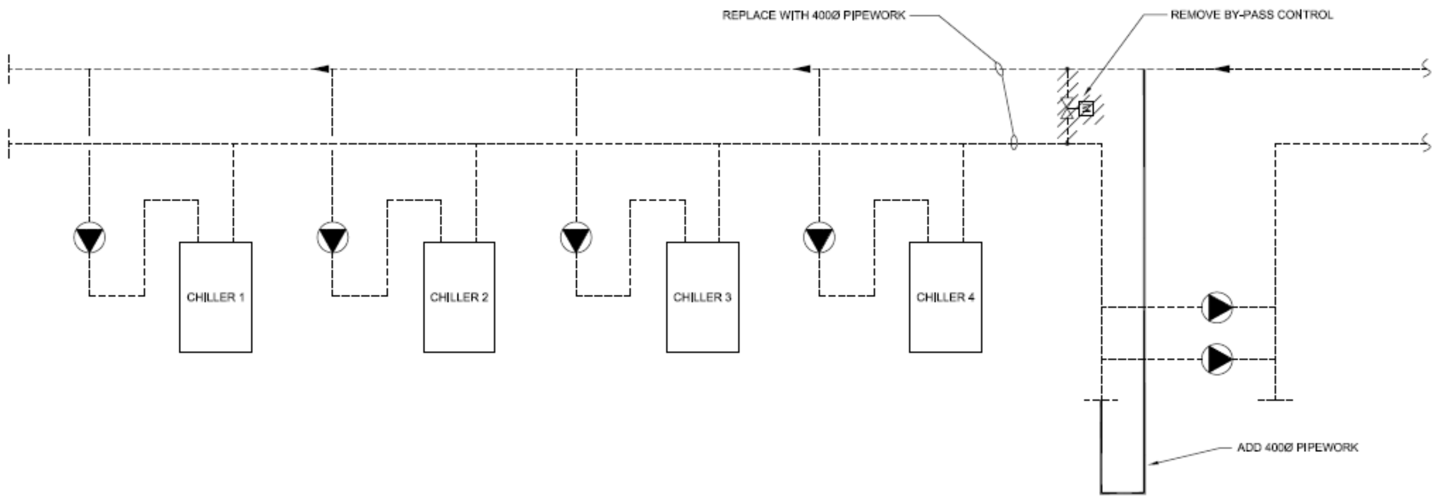
This additional chiller capacity will initially serve the new East Block with other new buildings being connected into this system as they come on line.

The existing system of chilled water pumping is a primary / secondary system with the primary pumps circulating chilled water through the chillers and large header and the secondary pumps pumping chilled water to the buildings. The primary pumps are constant flow whereas the secondary pumps are variable flow with variable speed drives to the motors to allow them to match the system demands. This arrangement is usually provided in the form of a combined flow and return low loss header such that the primary and secondary circuits are de-coupled. The current arrangement includes separate flow and return headers with a by-pass connection installed between the primary flow and return headers. This current arrangement relies on the motorised by-pass valve responding to system pressure fluctuations as well as ensuring that adequate chilled water flow is maintained through each on line chiller. A simplified schematic diagram of this current arrangement is shown on drawing M1000.

A more stable arrangement is to have a common flow and return low loss header with secondary pumps drawing off this header. The alterations required to achieve this arrangement is also shown on schematic drawing M1000. Due to the pipe size and space required to achieve this, demolition/modification to the existing equipment layout will be required. For long term stability, it is recommended that this modification is completed with the redevelopment.

We have been advised that the two secondary chilled water pumps struggle at times to meet the site demands, the option of changing these to larger capacity pumps of adding a third pump should be considered.

Existing Chillers



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REV	DESCRIPTION	DATE	APP'D
01	PRELIMINARY ISSUE	11.04.08	RT

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DRAWING TITLE

PENRITH HOSPITAL
MECHANICAL SERVICES
CHILLED WATER PIPEWORK
PROPOSED ALTERATIONS

0 50mm A3

DATE	DRAWN	DESIGNED	CHECKED	SCALE
APR'08	SB	BC	RT	N.T.S

PROJECT No.	DRAWING No.	REVISION
08718	M1000	01

4.3 COOLING TOWERS

The existing cooling towers are adequately sized to meet the condenser water requirements of the current chilled water plant. The capacity of the cooling towers has been calculated from the flow rate of 179.5 l/s (given in as installed drawings of the installation) with a condenser water temperature differential of 5.5 degree C which is standard for cooling towers. This gives a maximum cooling capacity for 6.2MW of refrigeration against the current installed capacity of 6.1MW of refrigeration. From these calculations it is evident that there is no spare capacity in the condenser water system. The current cooling towers also take all of the space available on the supporting roof structure and gantry, therefore there is no space for additional chillers.

The cooling towers do not meet current code requirements with regards to drift losses and ability to clean the fill material. For long term planning, it is recommended that these are replaced with compliant units and additional cooling tower capacity provided to meet the re-development needs. The existing steel gantry should be retained to accommodate the new replacement cooling towers.

It is recommended that additional system drain points are introduced to enable half of the system to be completely drained for cleaning.

The introduction of side stream filtration is recommended for the new cooling towers to assist in the removal of solid matter from the condenser water and hence improve the overall condition of the water. The side stream filtration would include automatic back flushing of the filter to provide a fully automated system of filtration. Given the Hospital site is a leafy area which could also be quite dusty during times of drought provision of side stream filtration will assist in the removal of plant matter and dust that enters the towers.

Due to the lack of spare space on the existing platform, the additional cooling tower capacity for the redevelopment should be located on the top of the new East block building (local to the new chillers).

Variable speed drives will be provided to the towers to optimise fan power to water temperature thus saving electrical energy and ensuring minimum evaporation of condenser water.

As a water saving initiative the use of harvested rain water is recommended to replenish the cooling towers. This would be used in conjunction with the mains water during times of drought. This ESD initiative is worth considering.

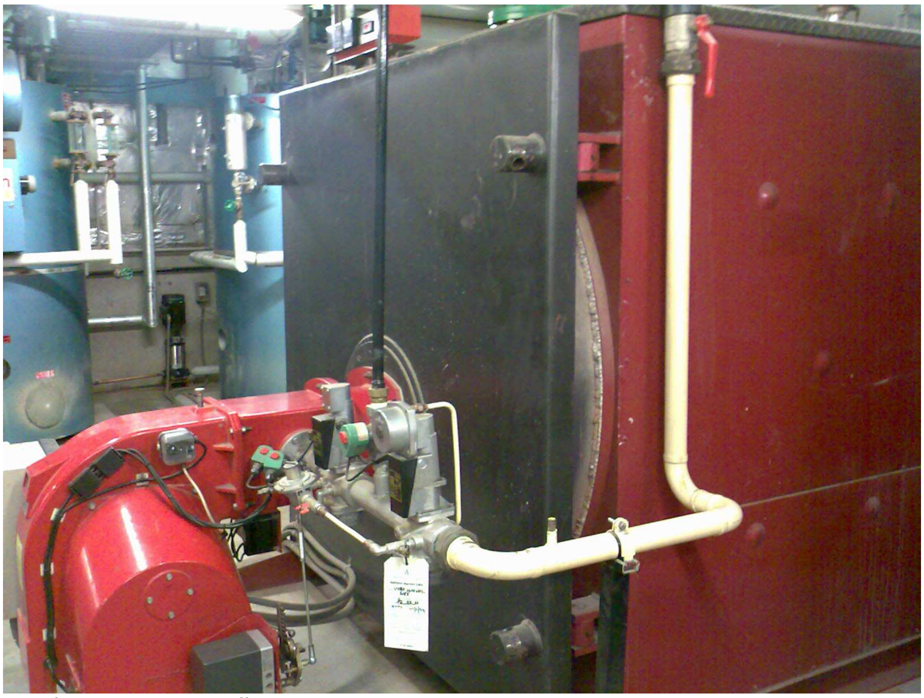

Cooling Towers

4.4 HEATING HOT WATER SERVICES

Two 1650kW pressure jet gas fired Thomlinson heating hot water boilers are installed within the basement plant room of North block. These boilers are traditional mild steel, fully welded, three pass, fire tube, induced draught boilers. The boilers serve both domestic and heating hot water. The boilers were installed in 1993 and appear to be in good condition and in normal circumstances will have a further 5-10 design life. Despite this it will not provide the redevelopment with a new lift cycle. It is therefore recommended that these be replaced as part of the redevelopment.

Two 625kW boilers are also located within West Block. These were also installed in 1993 and have a life expectancy of between 5 – 10 years. These boilers are of a similar construction and operation to that of the North block boilers. And for the same rationale as above, these are recommended to be replaced.

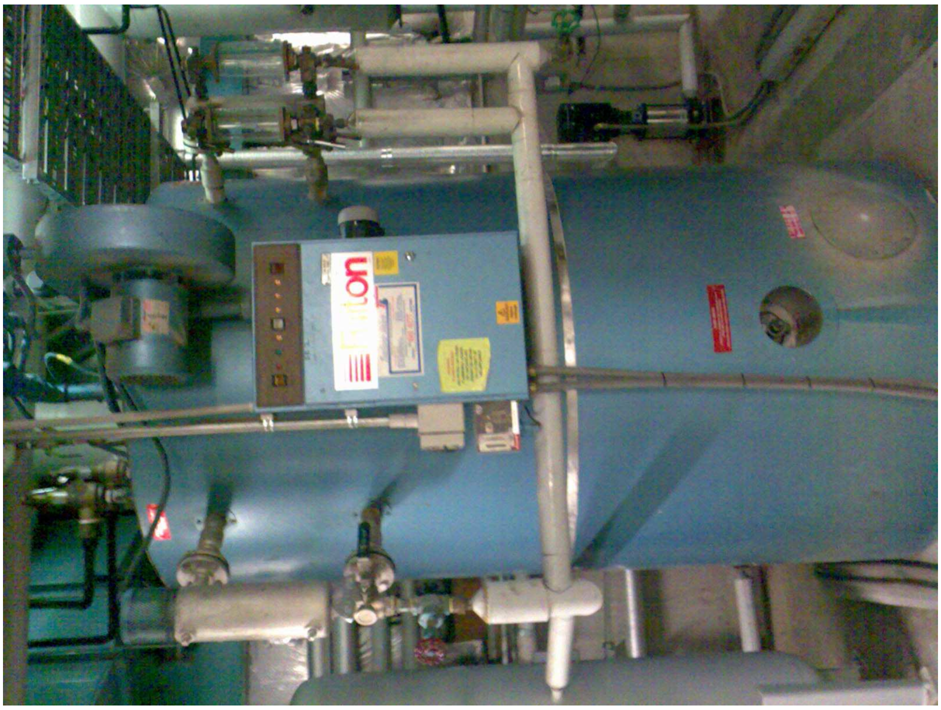
The new East Block building should be provided with new boilers to serve it and any other adjacent new buildings that come on line. These boilers would be horizontal gas fired pressure jet units fitted with boiler flue condenser recovery systems to be used for pre-heating the potable domestic hot water. East block should be connected into the co-generator hot water circuit and this should be treated as the priority heating hot water source with the boilers operating as back up plant.


Heating Hot Water Boilers

4.5 STEAM BOILER PLANT

Two vertical steam generators are provided to serve the CSSD. These steam generators are Fulton pressure jet, gas fired, fully welded units of approx 300kW (480kg/hr) capacity each. The steam generators were installed in 1993, they appear to be in good condition but as with the HW Boilers we again recommend their replacement to provide a new life cycle of services. These boilers do however have some 5 – 10 years further life if adequately maintained.

No new steam users have been identified so far within the Master plan. The CSSD is however being refurbished but not increased in size. Although we would not expect the steam capacity to require increasing, any new equipment loads should be checked against the current steam plant capacity.



Steam Boilers

4.6 CONDITION AND CAPACITY OF EXISTING SYSTEMS

System condition table

Service	**Condition**	**Life expectancy**	**TS-11 / Code compliant**
Chillers	Fair to Good	5 – 20 years	Compliant
Cooling towers	Fair	10 years	Not compliant
HHW Boilers	Good	5 – 10 years	Compliant
Steam Boilers	Good	5 – 10 years	Compliant

System capacity table

.Development	**Chilled water**	**Cooling Towers**	**HHW Boilers**	**Steam Boilers**
Existing	Adequate	Adequate	Adequate	Adequate
East Block Added	Not adequate	Not Adequate	Adequate	Adequate
Total proposed development	Not adequate	Not adequate	Not Adequate	Adequate

4.7 BUILDING MANAGEMENT CONTROL SYSTEM

The site has two Building Management Control Systems.

1. Honeywell System – this BMCS serves the older part of the Hospital and the majority of the plant, the system is obsolete and should be phased out.
2. TAC – this BMCS is the newer system and serves the majority of the site, the preference is for new systems to be connected onto this system with a gradual

transfer of all current systems onto this BMCS.

Each of these control systems has a head end computer located within the maintenance department.
These BMCS companies should tender for the redevelopment work with an option from each to replace current systems and hence to serve the entire site. This will allow the Hospital to determine if it is financially worthwhile converting over to one system.

4.8 STRATEGIES FOR THE FUTURE

Central chilled water systems similar to the current arrangement is the best means of meeting the cooling demands within a large hospital campus. The central chillers allow for overall system diversities to be accounted for in plant sizing and allow for central redundancies to be accommodated. It also provides a central point for the maintenance and servicing of some of the most complex plant installed into a hospital site.

The physical arrangement of the existing buildings and proposed developments (all being interlinked and in close proximity) promote the central chilled water plant solution.

Ideally the existing and new plant would be linked into a common header arrangement or if this is found to be too difficult to achieve then the systems should be interlinked such that if one system fails chilled water can be re-directed from the other operating system into the system that failed. This has been achieved in many hospitals as a back up to the air conditioning of operating suites.

As energy saving and chiller capacity mitigation measures the following should be considered

1. Provide shading to the Western Facade we estimate that this could save 80kW in cooling demand.
2. Provide cold water storage to widen the band of peak chilled water demand.

4.9 PROPOSED DEVELOPMENT

For this proposed development the following work will need to be undertaken :

- **New SWAHS Executive.** This building is a stand alone small building which will require ventilation and some air conditioning. The cooling and heating requirements would be best achieved through local air conditioning systems.

- **New Mental Health building.** The requirement for chilled water and heating hot water should be derived from the central East Block systems. The chilled and heating hot water should be reticulated via either underground service ducts or permanent covered walk ways. Local air handling plant will provide air conditioning to this building. This building will be a stand alone building less than three stories high, the smoke management system will therefore require the air handling plant to shut down upon a fire alarm with no zone smoke control required.

- **New Engineering building**. This building is a stand alone small building which will require ventilation and some air conditioning. The cooling and heating requirements would be best achieved through local air conditioning systems.

- **New East Block.** The requirement for chilled water and heating hot water will be met from central systems installed within this building. The systems should be linked into the current systems under North block. Local air handling plant will provide air conditioning to the building. Smoke management will be required in the form of either a sprinkler system installation or a zone smoke control system.

4.10 CONCLUSION AND RECOMMENDATIONS

The reliability of the No 2 chiller set is questionable due to its age and the unavailability of the refrigerant that it operates on. **This chiller should be replaced.**

To make the chilled water distribution arrangement more stable, a low loss header should be introduced.

Chillers should be provided within the new East block and these should be linked into the existing chilled water system to provide redundancy within the systems.

The existing cooling towers need to be replaced and new cooling towers provided to serve East block. If space and planning permits the newer generation of hybrid towers should be considered.

The existing Heating Hot Water and stream boilers should be replaced in order to provide a new life cycle for this equipment. The capacity and arrangement of the heating hot water boilers should account for the new co-generator plant. (This plant currently has technical difficulties and is not operational).

5 MEDICAL GASES

5.1 DESCRIPTION OF SERVICES

The medical gases services comprises –

- Oxygen served from a bulk vessel compound as well as a smaller cylinder compound
- Medical air produced via reciprocating compressors as well as cylinders
- Nitrous oxide gas via cylinders
- Suction vacuum plant located local to the buildings served
- Tool air via cylinders

.
These services appear to be AS2896 compliant.

5.2 OXYGEN SERVICES

Oxygen is supplied to the site via a 10,000 litre nominal capacity duty bulk oxygen vertical storage tank with a second 2000 litre nominal capacity vertical vessel acting as a standby oxygen supply. These vessels are located within a fenced compound towards the Northern end of the site. The current oxygen supplier is Air Liquide.

The smaller 2000 litre vessel is dated 1965 and although some 43 years old, these vessels are inspected each year and is therefore considered to be in an acceptable condition. The larger 10,000 litre vessel has no manufacture date on its identification plate.

SWAHS advised that the bulk vessel is filled every few days. Given this short time frame it is recommended that as part of the redevelopment work the vessel is replaced with one of at least 15,000 litre nominal capacity.

It should be possible to install the larger vessel within the current compound. The current arrangement and location requires the oxygen delivery tanker to turn after completing the delivery. Many delivery companies now demand a drive through arrangement such that the tanker vehicle does not have to turn and this may need to be reviewed as part of the overall master plan.

A temporary bulk oxygen vessel may need to be provided during the disconnection and replacement of the existing vessel. This temporary vessel would require a concrete hard standing adjacent the existing compound. Alternatively a new bulk oxygen compound could be provided at a location that improves tanker delivery and upon completion of the new compound and bulk vessel the existing compound would be de-commissioned.

Two oxygen distribution mains exit the compound underground and head South towards the North block building. As the bulk oxygen vessel serves both the Private and Public hospitals we would expect that one main serves the Private and the other serves the Public hospital. The size of the mains pipework leaving the bulk oxygen compound are adequate for serving the current hospital and proposed redevelopment.

Bulk Oxygen Store

A separate oxygen cylinder compound is provided to serve the Cancer Care building. This compound comprises two groups of six G sized oxygen cylinders linked via a manifold with automatic changeover from duty to standby. This arrangement is satisfactory and is typical of the installations used within smaller hospital sites. The cancer care unit could be linked into the main bulk oxygen store but at the moment the oxygen demand in this unit is probably small and the distance to connect into the bulk store is considerable. If the redevelopment places other oxygen demands within the vicinity of this cancer care unit then a connection into the bulk oxygen network would become viable and would be recommended.
This cancer care unit compound is adjacent a road way which allows for easy delivery of the replacement cylinders.

5.3 MEDICAL AIR SERVICES

The medical air plant comprises three Broomwade reciprocating compressors V200DN units with two separate refrigerant drier units and two vertical compressed air storage cylinders. These compressors are located within the lower level of North block. The plant room is of a generous size with space for additional medical air compressors if required. The reciprocating compressors are considerably noisier than the modern rotary types of compressors however the plant room is provided with sound proofing which ameliorates this.

The existing compressors are the older style reciprocating type and appear to be in good condition. These compressors have a further life expectancy of between 8 and 12 years. The compressors include a water cooled heat exchanger between compression stages 1 and 2. The air passes through a further water cooled vessel before entering the two storage vessels.

The medical air storage vessels are 5600 litres each which is considered to be adequate capacity.

The driers are Fridgematic units and appear to be operating satisfactory.

There are two final filters and pressure regulating stations allowing for maintenance of one station whilst the other is being maintained. The pipework size leaving the regulating stations is 80mm diameter which is considered to be adequate.

For the redevelopment documentation, the capacity of these existing compressors will need to be checked against the increased demand for medical air and if necessary additional or larger more efficient compressors installed.

Any increase in capacity would be achieved by installing oil free variable speed rotary machines with built in drier equipment. These would operate much more efficiently than the current compressors and hence would reduce the hospital energy consumption.

During each of three visits to the site we visited the medical air compressor plant room and in each case have found only one compressor to be operating. During each inspection the operating machine unloaded indicating that with less than one full machine operating the demand for medical breathing air was being met. This would suggest that at the most two machines would be called upon to meet the hospital demands leaving the third machine as a standby unit.

Medical air compressors

A separate medical breathing air cylinder compound is provided to serve the Cancer Care building, this compound comprises two groups of six G sized oxygen cylinders linked via a manifold with automatic changeover from duty to standby. This arrangement is satisfactory and is typical of the installations used within smaller hospital sites. The cancer care unit could be linked into the main reticulated medical air network but at the moment the medical air demand in this units is probably small and the distance to connect into the medical air network is considerable. If the redevelopment places other medical air demands within the vicinity of this cancer care unit then a connection into the main network would become viable and would be recommended.
This cancer care unit compound is adjacent a road way which allows for easy delivery of the

replacement cylinders.

5.4 NITROUS OXIDE

Nitrous Oxide is provided as a single central supply via cylinders located adjacent to the loading dock. The installation is typical of all hospitals and complies with current standards.

The installation comprises a duty / standby manifold with eight G sized cylinders operating as duty and a further eight operating as standby.

This current arrangement should be retained but adjusted as necessary to suit the revised loading dock arrangement. The capacity of the installation can if necessary be increased by installing larger cylinder packs.

Delivery and removal access for cylinder packs is considered to be satisfactory.

5.5 VACUUM SUCTION

Vacuum suction pumps are installed within each building. The installations are package units with vacuum pumps mounted on top of horizontal cylinders. These installations should be retained with new vacuum sets added into the new buildings as necessary.
The existing vacuum plant has a life expectancy of between 8 and 12 years.

5.6 TOOL AIR

Tool air is provided as a single central supply via cylinders located adjacent the loading dock. The installation is typical of all hospitals and complies with current standards. Tool air is generally only used within operating theatres and the demand would therefore currently be mainly from North block.

The installation comprises a duty / standby manifold with eight G sized cylinders operating as duty and a further eight operating as standby.

This current arrangement should be retained but adjusted as necessary to suit the revised loading dock arrangement.

With the addition of more operating theatres within the East block development the number of cylinders connected into the system may need to be increased with an additional separate branch line installed to serve the East block theatres. The capacity of the installation can if necessary be easily increased by adding larger cylinder packs.

5.7 CONDITION OF EXSITING SERVICES

System condition table

Service	Condition	Life expectancy	Code compliant
Oxygen	Good	15 – 20 years	Complies
Medical air	Fair to good	5 – 10 years	Complies
Tool air	Good	15 – 20 years	Complies
Nitrous Oxide	Good	15 – 20 years	Complies
Vacuum	Good	10 – 15 years	Complies

System capacity table

.Development	Oxygen	Medical air	Tool air	Nitrous Oxide	Vacuum
Existing	Adequate	Adequate	Adequate	Adequate	Adequate
East Block Added	Bulk vessel not adequate due to delivery periods	Adequate	May need to add cylinders onto existing arrangement	Adequate	Add new local plant
Total proposed development	Not adequate	Not adequate	May need to add cylinders onto the existing arrangement	Adequate	Add new local plant

5.8 STRATEGIES FOR THE FUTURE

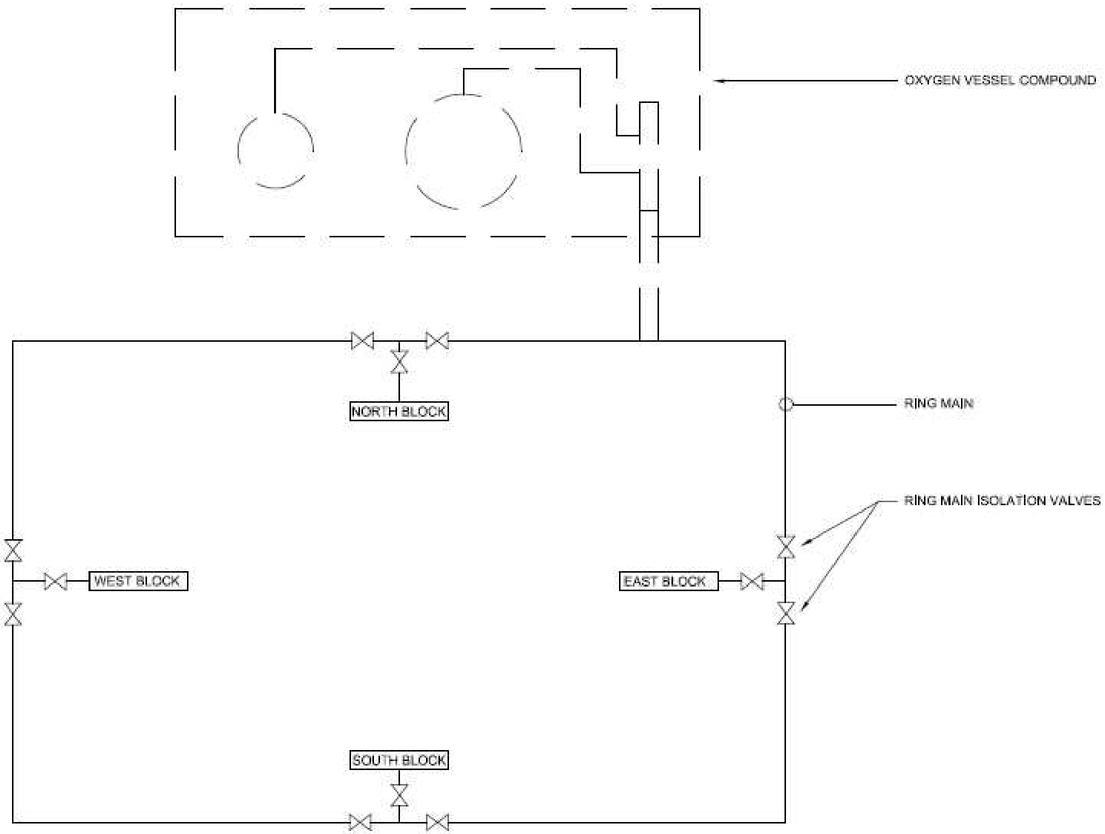
If this was a new hospital the best distribution arrangement for both oxygen and medical air would be to provide a ring main with valved tee off connections to serve each load centre. This arrangement allows for maximum flexibility for future expansion and also provides maximum reliability of the distribution network.

The physical locations of the existing and proposed new building lend themselves to a ring main arrangement of pipework and if not fully implemented during the new East Block project, the oxygen and medical air pipework within this new building should be arranged such that a ring main system can be achieved at a later date.

These ring main arrangements are shown in drawings:

08718 MG2000 01 Oxygen services

08718 MG2001 01 Medical air services



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01	PRELIMINARY ISSUE	11.04.08	APP

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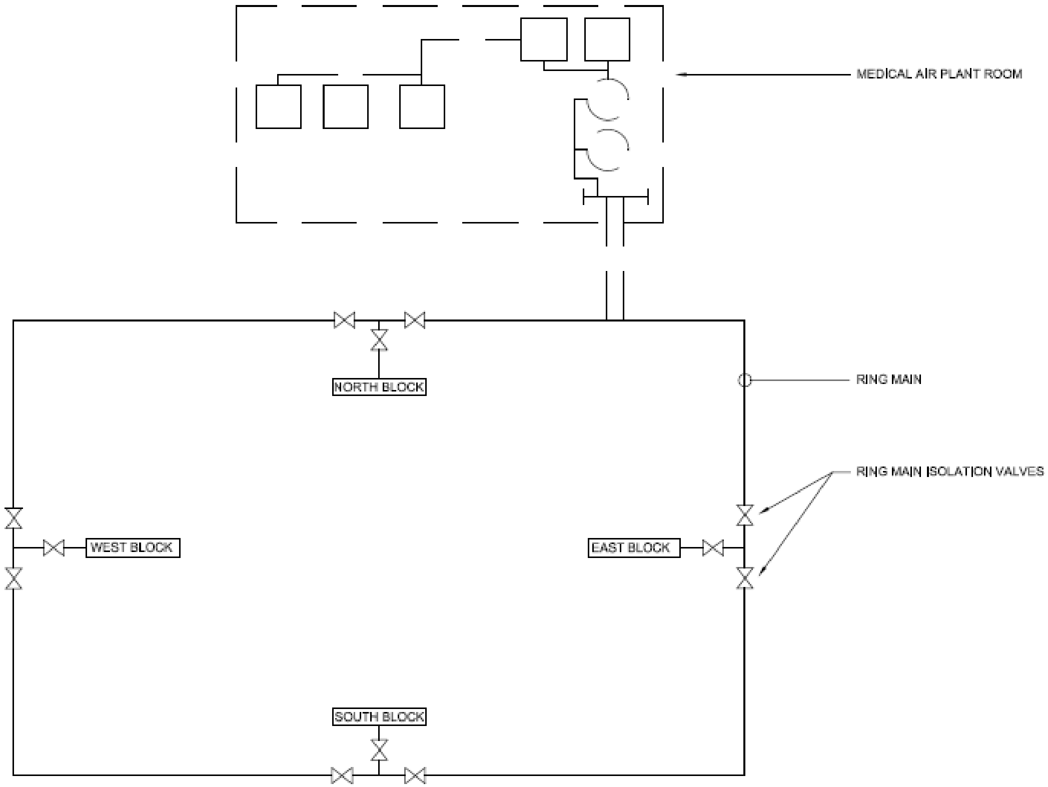
DRAWING TITLE

PENRITH HOSPITAL
MEDICAL GASES - OXYGEN SERVICES
PROPOSED UPGRADE

0 50mm A3

DATE	DRAWN	DESIGNED	CHECKED	SCALE
APR'08	SB	BC	RT	N.T.S

PROJECT No.	DRAWING No.	REVISION
08718	MG2000	01



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DRAWING TITLE

PENRITH HOSPITAL MEDICAL GASES - MEDICAL AIR SERVICES PROPOSED UPGRADE

0 50mm A3

DATE	DRAWN	DESIGNED	CHECKED	SCALE
APR'08	SB	BC	RT	N.T.S

PROJECT No.	DRAWING No.	REVISION
08718	MG2001	01

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5.9 PROPOSED DEVELOPMENT

For this proposed development the following work will need to be undertaken

- **New SWAHS Executive**. There will be no medical gases requirement in this building.

- **New Mental Health building**. The requirement for medical gases within this building will be minimal, in mental health facilities any gases requirement is often dealt with by the use of local cylinders.

- **New Engineering building**. The will be no requirement for medical gases within this building.

- **New East Block**. The requirement for medical gases within this building will be high. We propose that the medical gases and oxygen services pipework is extended into this building at basement level sized and arranged in readiness for a future ring main arrangement of pipework.

5.10 CONCLUSION AND RECOMMENDATIONS

The medical gas services are in fair to good condition and are considered to be code compliant.

With any major development on the site the bulk oxygen vessel will need to be changed to a larger vessel, a 15,000 litre vessel should be adequate. We understand that a 18,000 litre vessel is currently being considered.

New oxygen and medical air main distribution pipework runs should be arranged such that a ring main network arrangement can be achieved at a later date.

Any increase in medical air capacity should be achieved using variable speed rotary compressor sets with integral driers.

Vacuum suction shall continue to be provided as localised plant.

6 COMMUNICATIONS

6.1 DESCRIPTION OF SERVICES

The lead in services comprises copper and optical fibre cabling installed into the site inside conduits.

The main communication rooms are located within North Block and South Block. Copper and Optical fibre cabling is provided to link these main communication rooms to the floor communication rooms. The cabling onto the floors serving RJ45 outlets is four pair UTP category 5 cabling terminating onto passive patch panels located within the floor communication rooms.

The new East block development communication rooms will need to be connected into the North Block main communication room.

6.2 PABX ROOM

The PABX is located within the North block main communication room, this room is at ground level and is ideally located for the distribution of telephone services around the site.

6.3 OPTICAL FIBRE CABLING

Multi mode and single mode optical fibre cabling is installed between the main communication rooms and the floor communication rooms.
New optical fibre cabling will need to be installed between the main communication room and the new communication rooms.

6.4 MULTI CORE COPPER CABLING

Multi core copper cabling is installed between the PABX frame and the communication rooms, this provides the voice telephone services cabling.
New multi core copper cabling will be required to be installed between the PABX frame and the new communication rooms.

6.5 CONCLUSION AND RECOMMENDATIONS

The current communications arrangement is considered to be satisfactory and will need to be extended as necessary to serve the areas of new development. New developments will need to comply with latest trends and developments in communications. Wireless capabilities and increased cable speeds such as category 6 UTP cabling to work station outlets.

7 HYDRAULICS

Connell Wagner has been commissioned by Aurora Projects to undertake a high level review of the Nepean Hospital Campus hydraulic services infrastructure. This review assesses the impact of the future redevelopment master plan and forecast population growth in order to formulate a future strategy for the hydraulic services to the Nepean Hospital Campus.

The objective of this report is to identify authority supply and on site hydraulic services infrastructure that will require amplification and or diversion, and nominate additional plant and systems to cater for the proposed master plan.

This report is based in the following inputs:

- Site inspection,18 February 2008
- Aurora Projects - Site Wide Master Plan (Option 2A from March 2008)
- Existing Site Plan – Rice Daubney
- Sydney Water Corporation - Sewer and water diagram
- Alinta - Natural gas network diagram
- Nepean Hospital Master Plan Report – Thinc Projects 9 October 2006

In preparation of this report, we have relied on the findings of Thinc Projects ‘Nepean Hospital Master Plan Report’ Appendix 6 - ‘Building Services Reports - Donnelley Simpson Cleary’.

7.1 DOMESTIC WATER

7.1.1 Description of Existing Services

Sydney Water domestic water mains are located in each of the four streets surrounding the Hospital site. All authority services are interconnected as a ring main which provides the Hospital with a high level of domestic water supply redundancy.

Currently the Hospital Campus features three independent domestic water connections from the Sydney Water mains:

1. 1 x 150mm connection to 225mm Sydney Water main located in Barber Avenue. This 150 service branches into 1 x 150mm fire hydrant system supply, and 1 x 100mm diameter domestic water supply, which extends to South, North blocks, Cancer Centre and most low level buildings on site
2. 1 x 65mm connection to 150mm Sydney Water main located in the Parker Street. This connection provides domestic water to the West block and Pialla building
3. 1 x 32mm connection to 100mm Sydney Water main located in Somerset Street. This connection provides domestic water to the Child Care Centre.

The low level buildings are typically supplied by pipework of various sizes at mains pressure via inground reticulation. The North, South and West block fixtures are supplied from water storage tanks located at high level within plant rooms. Within these blocks the domestic water supply is reticulated to all sanitary fixtures and fittings via pressure pumps located adjacent to storage tanks. Booster pumps are located at ground level for each tank infill supply.

Non potable water tanks provide storage for 8 to 12 hours in various tanks installed usually in the building they serve. The current non potable water storage capacity can accommodate future redevelopment to these buildings.

The North Block features four flusherette tanks, in various locations for the purpose of sanitary flushing. These tanks will be suitable for future reuse.

7.1.2 Issues with Current Service Configuration

The current cold water service configuration is acceptable as it is supplied from a ring main in the surrounding streets. Ideally the street connections would form another ring main within the site, for further redundancy. Presently all buildings are served directly from one mains connection, with no secondary source of supply downstream of the meter. If a break in supply occurred between the meter and the building the water supply to the building would be lost.

7.1.3 Strategies for the future

Recommendation is made to upsize the water supply from Somerset Street to 65mm, and interconnect each of the three independent water supplies within the Hospital Campus to form a ring main. This will provide a further level of redundancy and ensure the site water supply meets the full recommendation of TS11 guidelines. Water storage tanks are recommended to all buildings

Calculations using predicted population growth suggest that that the current domestic water storage capacity will accommodate the future redevelopment to existing blocks.

7.1.4 Recommendations

- New Child Care Centre (old Pialla building) - Reuse existing cold water supply and modify existing pipework reticulation within the building

- New SWAHS Prefab – Extend cold water supply from existing SWAHS building reticulation system

- New Mental Health building – Amplify existing Somerset St mains connection and meter assembly from 32mm to 65mm. Extend supply to interconnect with other site domestic supplies. Provide new reticulation to Mental Health building

- New Engineering building – Extend cold water supply from the North Block and reticulate throughout new building

- New East Block – New cold water tank, booster pumps and filters on roof. Extension to the inground pipework reticulation system will be required to supply domestic cold water to the proposed new buildings.

- South Block – Modify existing pipework reticulation to suit new refurbishment.

- North Block – Modify and extend existing reticulation and pipework distribution to suit new Pathology and ICU extensions, new loading dock, and refurbishment of existing areas.

7.2 DOMESTIC HOT WATER SUPPLY

7.2.1 Description of Existing Services

Hot water is supplied to each building via localised central hot water plants located in plant areas. Hot water systems to buildings with large demands feature storage tanks, boosters and circulating pumps supplying insulated flow and return pipe networks.

Areas with smaller demand feature small electric hot water units, varying in size from 50 – 315 litres, and are located near to the point of use. Pipework to all hot water systems is generally insulated.

The central hot water plants to the North Block, Kitchen, and Pialla Building have recently been upgraded from large gas boilers, and have been replaced with Rotex heat exchangers, which use heat rejected from the mechanical heating system to heat the domestic hot water. This is considered to be an efficient plant and is not likely to need replacement in the next 20 years.

The South Block hot water plant features 4 large hot water heaters connected in a manifold arrangement, generating high temperature hot water (85°-90°C) for use in the utility room and laundry. A warm water system featuring two heat exchange tanks is provided with hot water from the main hot water plant. The warm water plant supplies amenities throughout the South Block.

The West block hot water plant features 3 hot water heaters and 2 large hot water storage vessels.

7.2.2 Issues with Current Service Configuration

The Rotex heat exchanger type hot water plants that have recently been upgraded to are considered to be efficient to operate and are not likely to need replacement in the next 20 years.

The existing warm water plant located in the roof of South Block does not have UV system or other treatment to prevent any Legionella outbreak. It is recommended that a UV treatment system is immediately installed to this system.

The existing hot water boilers in the South Block and storage vessels in the West Block plant rooms are nearing the end of their operational life. These boilers have recently stripped and re-welded to prevent leaks. It is recommended that these systems are replaced with new plants. Further investigation will be required to determine the most appropriate source of heating fro the plant.

7.2.3 Strategies for the future

The current configuration of water heating plants is suitable for the hospital campus at present; however, the capacities of the existing hot and warm water plants would be insufficient to accommodate the proposed redevelopment. Hot water to new and refurbished areas will be provided by additional hot water plants or by expanding existing plants where practical.

Local electric hot water units will be provided to isolated points of use where it would be inefficient to extend flow and return pipe reticulation.

It is recommended that where possible, waste heat from mechanical services should be used to pre heat or fully heat domestic hot water, as per the recent conversion in the North Block.

Warm water supplies to fixtures in all new and refurbished areas are to be supplied via thermostatic mixing valves located near to point of use in accordance with TS11 guidelines. Investigate the option of installing drain points on the dead legs to each TMV.

7.2.4 Recommendations

- New Child Care Centre (old Pialla building) – Modify existing flow and return to suit new refurbishment. Re-use existing Rotex heat exchangers. New reticulation to fixtures and thermostatic mixing valves to be installed at ablutionary fixtures.

- New SWAHS Prefab – Extend from existing SWAHS building reticulation system if required.

- New Mental Health building – New flow and return hot water system with circulating pumps from Rotex heat exchangers supplied with mechanical waste heat. If waste heat is unavailable, instantaneous gas fired hot water units should be used for generating domestic hot water. Plant room space will be required for pumps and hot water system. Thermostatic mixing valves to be installed at ablutionary fixtures.

- New Engineering building – New localised gas fired hot water storage system and pipework reticulation.

- New East Block – New flow and return hot water system with circulating pumps from Rotex heat exchangers supplied with mechanical waste heat. If waste heat is unavailable, instantaneous gas fired hot water units should be used for generating domestic hot water. Plant room space will be required for pumps and hot water system. Thermostatic mixing valves to be installed at ablutionary fixtures.

- Refurbished West Block – Existing flow and return reticulation to be modified to suit new redevelopment. Thermostatic mixing valves to be installed at ablutionary fixtures

- South Block – Modify existing flow and return reticulation to suit new refurbishment. We recommend that a UV disinfection system is provided to the existing warm water system.

- North Block – Modify and extend existing hot water plant, reticulation and pipework distribution to suit new Pathology and ICU extensions, loading dock and refurbishment of existing areas. Replace electric hot water units with natural gas supplied hot water units and where feasible with Rotex heat exchangers running off mechanical heat waste. Thermostatic mixing valves to be installed at ablutionary fixtures.

7.3 NATURAL GAS SUPPLY

7.3.1 Description of Existing Services

Agility owned natural gas mains are located in Derby and Parker Streets. The Hospital site gas connection is from the 100mm secondary (high pressure) main in Parker Street. The authority 'secondary main' carries a considerable volume of gas past the site. Gas supply from this main will cater for the proposed development. The master meter and regulator are located in an enclosure near the Ambulance entrance. The service pressure drops from 1050kPa to 7kPa and then reticulates in ground throughout the hospital serving several gas appliances. Pressure is then further regulated to 2.75 kPa at each building or appliance. This is an efficient method of gas distribution, a higher volume of gas can be distributed through a pipe at a higher pressure.

Calculations based on expected future gas demands suggest that the current natural gas connection will accommodate the proposed redevelopment. The calculations allow for predicted additional gas loads for mechanical boilers and gas hot water plants. Further analysis will be required for onerous additional gas demands, such as gas fired cogeneration plants, if proposed.

7.3.2 Issues with Current Service Configuration

The existing pipework reticulation is inground throughout the site. 150mm copper pipe is installed between the meter assembly, adjacent to the main connection in Parker Street, and the South Block. 40mm pipe then reticulates to the Cancer Care building, Detox Centre and Women and Children's Health Centre. The current service configuration is considered to be suitable for the existing campus arrangement.

The visible elements of the system, such and the boundary regulator, building and plant regulators, and pipework within buildings appear to be in good condition.

7.3.3 Strategies for the future

The current configuration provides a large volume of gas to the main blocks. This is expected to cater fro the increased demand to these areas. Further assessment will be requires regarding the gas demands for satellite buildings as there is a limited supply available in existing inground pipework, however from preliminary assessments the existing pipework will be suitable for appliances such as hot water units.

7.3.4 Recommendations

- New Mental Health building – New natural gas supply for domestic heating and hot water units to be extended from existing system.

- New East Block – New natural gas supply for domestic heating and hot water units to be extended from existing system.

- North Block – Modify and extend existing reticulation and pipework distribution to suit new extensions.

7.4 SANITARY PLUMBING AND DRAINAGE

7.4.1 Description of Existing Services

There are three Sydney Water owned manholes within the site for connection, all currently receiving sewer discharge from the existing hospital buildings, as follows;

1 x 150mm on Parker Street

1 x 300mm on Parker Street (in northern corner of site)

1 x 225mm on Somerset Street

Sewer Drainage
Sewer drainage throughout the hospital campus generally reticulates via gravity to the three authority connection points, with the exception of sewer drainage from the Risk Management building, Court building and part of the Tresillian building. These buildings gravitate to sumps from which sewer drainage is pumped to the gravity sewer drainage network. Sump pumps are required to these building as gravity connections are not achievable.

The sanitary drainage system is partially elevated under the buildings, and partially buried in ground and reticulates by gravity in sizes from 100mm to 225mm.

Sanitary Plumbing
Existing sanitary plumbing within multi level buildings is typically installed as 100mm diameter, fully vented modified waste stacks. This type of system is flexible and will have sufficient capacity for the proposed redevelopment. Plumbing stacks are generally in good condition and will be suitable for use over the next 20 years.

7.4.2 Issues with Current Service Configuration

The existing sewer drainage system is sized adequately for the hospital campus. The condition of the system is by all reports good generally, with the exception of parts of the inground drainage under the North Block which has collapsed due to building settlement. This is presently being rectified in concurrence with refurbishment works within this building.

7.4.3 Strategies for the future

Sanitary plumbing stacks within buildings are expected to be suitable for future upgrade within buildings. Calculations based on predicted fixture unit loadings suggest that there is sufficient capacity in the existing sanitary plumbing reticulation for the proposed development.

Further detailed study of additional building and refurbishment to the main multi storey buildings may reveal that some low level aerial or inground drainage will require amplification to accommodate extra stack work.

The capacity of the existing sewer connections to authority mains are expected to accommodate the proposed development.

7.4.4 Recommendations

Detailed investigation is to be undertaken at the site of each new building and refurbishment to identify sewer diversions. It is recommended that sewer drains located under the footprint of new buildings are diverted to maintain clear access for maintenance.

7.5 TRADE AND GREASE WASTE DRAINAGE

7.5.1 Description of Existing Services

Existing on site trade waste treatment systems are as follows:

- 1000 litre dilution holding tank located above ground at low level in West Block
- Dilution pit located inground, north east corner of Pathology building
- 5000 litre inground grease arrestor collecting grease waste from the hospital kitchen and cafeteria

7.5.2 Issues with Current Service Configuration

The existing grease arrestor is currently at full capacity; therefore an increase to the population of the hospital will require an additional grease arrestor. Suggestion has been made that cooking will be moved off site. This will significantly reduce the volume of greasy drainage produced by the kitchen, reducing the required capacity of the grease arrestor.

7.5.3 Strategies for the future

Additional pre-treatment for trade waste discharges will be required to serve the proposed redevelopment. Pre treatment is required for the following applications:

- Holding tank for nuclear medicine trade waste discharge
- Silver recovery from medical imaging processes
- Plaster traps for mortuary and laboratories
- Dilution pit for the pathology unit drainage

Pre treatment equipment should be accessible for waste removal and be located externally or in service areas.

At the scheme design stage of planning, it is recommended that written statements are obtained from users regarding the frequency, quality and strength of liquid trade waste which may be generated for consultation with Sydney Water for direction regarding appropriate method of treatment.

7.5.4 Recommendations

- Trade waste service requirements to each area of the proposed master plan are as follows:

- New Central Block – New grease waste drainage and grease arrestor to be installed for proposed new kitchen and cafe

- West Block – New pre-treatment trade waste plants are recommended for the discharge from nuclear medicine and medical imaging. Alternatively existing pre treatment trade waste plant to be expanded and modified to accommodate additional discharge.

- South Block – Remove existing grease waste system.

- North Block –New trade waste drainage to be installed for proposed extensions to be connected to existing system. Existing trade waste pre treatment system to be modified to accommodate additional discharge

7.6 STORMWATER DRAINAGE

7.6.1 Description of Existing Services

Council Stormwater system

The council stormwater network installed in the surrounding streets conveys all hospital campus drainage by gravity system.

The Main Hospital Campus is drained via a 910 mm diameter RCP culvert on Parker Street. The Council flood way drains via a 1200 mm diameter RCP culvert on Somerset Street.

Site Stormwater system and detention basins

The current stormwater management infrastructure of the hospital campus incorporates:

- On site detention storage basin located behind the West block
- On site detention storage basin located behind the Pialla building

- On site detention storage basin located near Cancer Care building
- "V" drain along Parker Street and grated surface pits connected to underground stormwater network
- Council Flood way around Cancer Care building
- Site floodway following the Sydney Water services easement crossing the site in an east / west direction from the end of Barber Avenue
- The site stormwater network varies in size from 100mm diameter to 525mm diameter.

<u>Roof Rainwater system</u>
The existing roof rainwater system discharges via gutters and downpipes into the site stormwater system.

7.6.2 Issues with Current Service Configuration

The site slopes away in all directions from the highest point located at the new Women and Children's Building, gradually to the east towards Somerset Street, with steeper sections to the north gradually leveling out towards the north east corner of the Great Western Highway and Somerset Street, 12 meters lower than the high point of the site.

Parts of the overland drainage system are prone to litter with leaves and mud. The ground around the detention basin becomes saturated after rain events, residual ponding can occur and ground becomes soft under foot.

Down pipes serving building roof drainage are typically visible however the location of inground services to the main stormwater drains could not be tracked. It is difficult to assess the condition of inground pipe however no known problems were reported.

7.6.3 Strategies for the future

An increase to the total rainwater catchment area resulting from the proposed redevelopment will require a higher volume of on site detention. This is a council stormwater policy prerequisite, determined by the total impervious area of the additional development. It is recommended, where possible, to consolidate additional on site detention with existing basins.

7.6.4 Recommendations

Stormwater service requirements to each area of the proposed master plan are as follows:

- New SWAHS Prefab – New rainwater drainage to be connected to existing infrastructure.

- New Mental Health building – New rainwater and stormwater drainage required. Install new rainwater harvesting tank for capture and reuse of rainwater. New stormwater drainage to connect to existing infrastructure. Existing services diversions required. On site detention tank or basin required.

- New Engineering building – New rainwater drainage to be connected to existing infrastructure.

- New East Block – New rainwater and stormwater drainage required. Install new rainwater harvesting tank for capture and reuse of rainwater. New stormwater drainage to connect to existing infrastructure. Existing services diversions required. On site detention tank or basin required.

- North Block – New rainwater and stormwater drainage required for new extensions, connected to existing stormwater system. Existing services diversions required. Increase capacity of existing on site detention

- New On Grade Carpark – New stormwater drainage required. Existing services diversions required. On site detention tank or basin required.

- New Multi Level Carpark – New rainwater and stormwater drainage required. Install new rainwater harvesting tank for capture and reuse of rainwater. New stormwater drainage to connect to existing infrastructure. Existing services diversions required. On site detention tank or basin required.

7.7 FIRE HYDRANT

7.7.1 Description of Existing Services

The fire hydrant system is connected to the 225mm Sydney Water main located in Barber Avenue. The service entering the site is 150mm and it is boosted by a diesel pump located near the North block building. There are two fire brigade booster valves assemblies on site:

- 1 x 150mm assembly with four booster inlets and four suction outlets located outside the North block
- 1 x 100mm diameter with two booster inlets and two suction outlets located in front of the workshops building

The current fire hydrant system is a ring main consisting of 150mm and 100mm pipe size diameters. The existing system features three capped ends for future extension, located:

- Between CSID and WALHALA
- WAHS carpark - south east corner
- Dental Clinic

Existing documentation also indicates that the Pathology building is fed from existing town's main connection. The fire hydrant pipework reticulates as a ring main and interconnects with the Campus ring main. This pathology building ring main is boosted by an electric pump located in the service tunnel.

7.7.2 Issues with Current Service Configuration

It is assumed that the existing fire hydrant system complies with the AS2419-1995 (assumption based on an upgrade to the ring main being carried out in 1999 & 2000).

Due to the recent amplification of the ring main, we expect that the pipework capacity will sufficiently provide for the future redevelopment. Extensions to the existing ring main will be required to provide hydrant protection to the new areas of the proposed development.

7.7.3 Strategies for the future

Guidance will be sought from the NSWFB to determine if the existing hydrant system will need to be upgraded to the current standard (AS2419-2005). The main difference being minimum supply pressure to attack hydrants has increased from 250 kPa – 700 kPa. If required, this will result in the replacement of all hydrant system pumps. During the initial stages of the master plan it is likely that the NSWFB will approve hydrant works to be an extension of the existing system. At some stage of the master plan we expect the system will require upgrade to current code requirements.

No buildings in the master plan are proposed to have effective height of 25 meters or greater. Therefore no on site storage will be required for the hydrant system.

There are several drencher risers interconnected to the hydrant system. New buildings will need to be individually assessed for future drencher requirements. Drenchers or other means of protection to openings will be required where a potential fire source is located within 6 meters of the far side of a road or near point of a building on the same allotment, or where exposure between fire compartments within a building is present via external openings.

It is recommended that the existing fire brigade booster valve assemblies are upgraded and fire hydrant block plan be provided to comply with the NSW Fire Brigade, Sydney Water backflow requirements and latest Australian Codes. It is likely that this will be a requirement of the NSWFB Section 188 exemption to extend to the system in compliance with AS2419-2004.

7.7.4 Recommendations

Hydrant service requirements to each area of the proposed master plan are as follows:

- New Child Care Centre (old Pialla Building) – No internal hydrants. External Fire Hydrants to be provided to achieve full coverage.

- New SWAHS Prefab – No internal hydrants. External Fire Hydrants to be provided to achieve full coverage.

- New Mental Health building – No internal hydrants. External Fire Hydrants to be provided to achieve full coverage.

- New Engineering building – No internal hydrants. External Fire Hydrants to be provided to achieve full coverage.

- New East Block – New fire hydrant system will be required. Connect and extend from the existing ring main system.

- South Block – Modify and extend fire hydrant system to provide coverage for redevelopment.

- North Block – Modify and extend fire hydrant system to provide coverage for redevelopment and new extensions.

- West Block – Modify and extend fire hydrant system to provide coverage for redevelopment and new extensions.

- New On Grade Carpark – Extend fire hydrant system to provide coverage for new carpark.

- New Multi Level Carpark – Provide new internal fire hydrant system and connect to existing site system.

7.8 FIRE HOSE REELS

7.8.1 Description of Existing Services

The fire hose reel system is generally fed from the domestic cold water service in each building. Fire Hose Reel service pumps are provided to achieve required pressures. The existing fire hose reels pumps are located at ground level in the following locations:

- Visitors carpark behind West Block
- Pialla building
- West Block – Block A

- South Block
- North Block
- Tresillian building
- Cancer Care Building
- Detox Centre
- Child Care Centre

7.8.2 Issues with Current Service Configuration

The capacity of the existing fire hose reel system is adequate for the existing buildings.

7.8.3 Strategies for the future

Each new building is to be provided with a fire hose reel system including pumps, dedicated pipework reticulation and hose reels, supplied from the cold water system.

7.8.4 Recommendations

Fire hose reel service requirements to each area of the proposed master plan are as follows:

- New Child Care Centre (old Pialla Building) – Reuse existing fire hose reel system and modify existing pipework reticulation within the building. The existing pump requires replacement.
- New SWAHS Prefab – Extend from existing SWAHS building fire hose reel system
- New Mental Health building – New fire hose reel system including pump required.
- New Engineering building – New fire hose reel system including pump required.
- New East Block – New fire hose reel system including pump required.
- South Block – Modify existing reticulation and pipework distribution to suit new refurbishment.
- North Block – Modify and extend existing fire hose reel system to suit new Pathology & ICU extensions, new loading dock and refurbishment.
- New On Grade Carpark – New fire hose reel system including pump required.
- New Multi Level Carpark – New fire hose reel system including pump required.

7.9 RECYCLED WATER

7.9.1 Description of Existing Services

An existing 50m³ rainwater harvesting tank incorporating a first flush system is located near the south end of the carpark, in the vicinity of the helicopter pad. This system is to supply recycled water to the cooling towers

7.9.2 Issues with Current Service Configuration

The above mentioned rainwater harvesting system is currently not in operation due to failed pumps and float valves. Maintenance personnel indicate that the problem will be rectified in the near future.

7.9.3 Strategies for the future

Installation of rainwater harvesting tanks is recommended to reduce potable water consumption. It is important to note that the capital cost of installing a rainwater harvesting tank is likely to incur a long payback period; however it is a simple and relatively inexpensive sustainability measure which is easily identifiable by the public.

7.9.4 Recommendations

To reduce the overall domestic cold water consumption in the future we recommend that rainwater harvesting tanks be installed for new East Block, Mental health building and Multi level carpark. Recycled water can be used for various applications such as WC flushing, irrigation system or for mechanical services.

7.10 SPRINKLER SYSTEM

No fire sprinkler services are installed in the hospital campus, with the exception of deluge systems as discussed in the hydrant section (as these are fed from the hydrant system). It is assumed that any required future drencher systems will also be fed from the hydrant system.

No buildings in the master plan are proposed to have effective height of 25 meters or greater. Therefore no dedicated sprinkler system will be required.

7.11 ESD INITIATIVES

There are various energy efficient initiatives that can be can implemented into the future hospital campus redevelopment. These initatives are as follows:

- Replacement of existing WC cisterns / flush valves with efficient dual flushing valves
- Replacement of existing Tapware and fixtures with low flow equivalent, or installation of flow restrictors to existing Tapware
- Replacing all existing main cold water booster pumps with variable speed, electronically controlled pumps to obtain better water flow and pressure adjustment and prolong the life span of the pump
- Pipe material selection, such as avoiding uPVC and copper by using products such as polypropylene and polyethylene for water supply and drainage systems
- Installation of water meters at all major water use points, and monitoring meters via leak detection software
- Reclaiming heat waste from mechanical hot water system. Currently several buildings on hospital campus already use this technology. The reduced energy consumption offers significant cost savings.
- Solar Hot Water Preheating – Consideration should be made to use Solar Panels for domestic hot water preheats in conjunction with above initiative.
- Rainwater Harvesting – The current cost of water is relatively inexpensive, which equates to a long pay back period on the life cycle cost analysis of rainwater harvesting. However, the price of water is predicted to rise in the near future therefore the payback period for a rainwater harvesting system is expected to decrease

7.12 CONCLUSION

Connell Wagner's investigation reveals most of the existing site hydraulic services are of sufficient capacity to be upgraded or extended to meet the future redevelopment demands. The existing various authority mains also have sufficient spare capacity to accommodate the proposed redevelopment and extensions.