C. BUILDING FACADE CALCULATION METHODOLOGY

C.1 Calculation Principles

Noise data obtained during the documented survey period and presented herein will provide the basis against which predicted internal noise levels can be calculated and compared against the referenced Australian Standard *AS2107:2000* criteria to assess internal noise amenity and compliance. The process of this evaluation assesses the composite acoustic performance of each façade element (e.g. glazing/frame, building envelope, ventilation opening etc) is calculated and the measured external sound field is said to impinge upon it as direct sound. As all measured noise levels were recorded under 'free-field' conditions, a correction of 2.5dB is applied to linear spectral noise levels when calculating façade performance to account for the façade incidence effect.

From the layouts and elevation drawings the building envelope there are typically two materials capable of transmitting sound into the internal space; Concrete, masonry or other main building structure construction, and a range of framed and sliding glazing elements. Airborne sound transmission through the building structural element is less critical than sound transmission through glazed panels, therefore various acoustic performances of glazing types and thicknesses will be assessed and adjusted in design calculation to effect the most cost-effective design solution, whilst ensuring design compliance is demonstrated.

Corresponding internal noise levels are then predicted using these detailed sound transmission loss calculations through the calculated composite façade performance, with resultant internal levels corrected for radiating (exposed) façade area and internal energy 'losses' associated with transmitted sound undergoing absorption from (proposed) internal room finishes. This assessment is generally conservative to allow for unforeseen variation in eventual performance.

Each façade is also assessed for flanking transmission paths. This includes, but is not limited to, transmission through junctions between structural elements, aperture seals, and transmission through inter-connected elements such as mechanical systems.

In order that an acoustically-robust façade design is achieved, building façade assessment calculations are undertaken using 'worst case' (i.e. highest measured) external noise levels, unless otherwise noted. Calculations are carried out on the most sensitive internal spaces – generally those with the largest glazed area and a low internal absorptive area. This methodology provides an efficient review ensuring all spaces meet or exceed the required standard.

All façade ingress calculations are carried out in accordance with the relevant parts of British and European Standard *BS EN 12354:2000 Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements Part 3: Airborne sound insulation against outdoor sound*, which is the most prevalent calculation methodology in the absence of an equivalent Australian Standard.

D. CALCULATION OF NOISE EMISSIONS LIMITS

An Assigned Noise Level is calculated for each noise sensitive receiver using a combination of environmental factors local to the receiver. A standard set of ANL's exist to provide a base level of acoustic amenity, as shown in the Table below. These levels are modified by an Influencing Factor (IF) to reflect noise sensitivity in the specific environment relative to the subject development.

To calculate the additional Influencing Factor (IF), concentric circles are drawn around the nearest noise-sensitive reception point; one at 450m radius and one at 100m radius. Percentages are calculated for the amount of land area within the circles used for noise emitting purposes (e.g. industrial or commercial uses) which are compared to the total area encompassed by the concentric circles.

Traffic volume is taken into account in order to reach an acceptable ANL, or noise reception level, appropriate for the area in which the receiver is to be situated.

Part of Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises at locations within 15m of a building directly associated with a noise sensitive use	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sundays and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises at locations further than 15m of a building directly associated with a noise sensitive use	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and Utility premises	All hours	65	80	90

Calculation of Influencing Factor (IF)

The Influencing Factor (IF) is calculated using the following equation:

Influencing Factor (IF) = I + C + TF

Where;

I = (% of industrial land usage within 100m + %industrial land usage within 450m) x 1 / 10

C = (% of commercial land usage within 100m + %commercial land usage within 450m) x 1 / 20

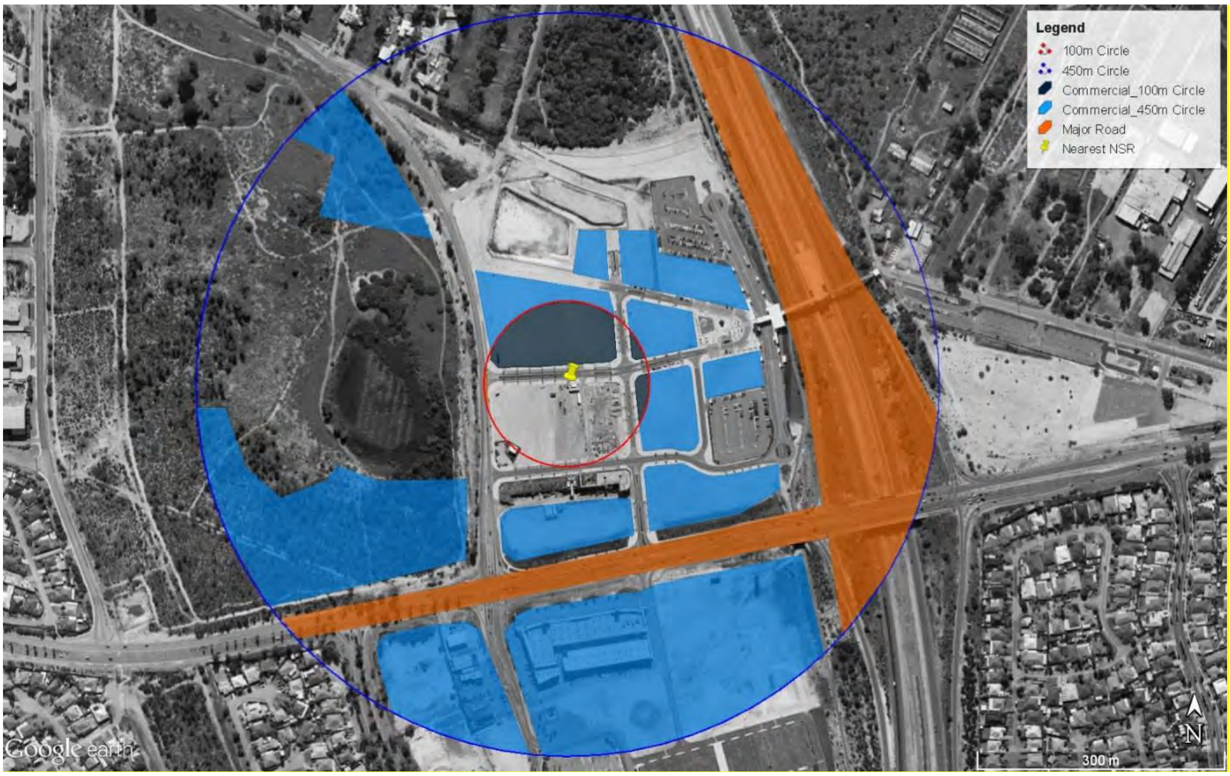
TF = +6 if there is a major road within 100m of the development
+2 if there is a major road within 450 m of the development
+ 2 if there is a secondary road within 100m of the development

The maximum value the transport factor (TF) can reach is 6;

A major road is defined as having Annual Average Weekday Traffic (AAWT) flows in excess of 15,000 vehicle movements per day. A secondary road is defined as having Annual Average Weekday Traffic (AAWT) flows in excess of 6,000 vehicle movements per day.

Identification of Land Use

The image below shows our calculation of Commercial (C) and Industrial (I) land use in inner (100 m) and outer circle (450m) radii centred on nearest NSR, identified as the adjacent Lot 08, 1m from the property boundary, 15m south of the Stage 1 Lot 5 development facade. Commercial land use is shown light blue outer circle, and dark blue in inner circle. Industrial land use is shown red in the outer circle. Yellow indicates "Secondary" road transport infrastructure in the outer circle.



ASSIGNED NOISE LEVEL LIMTS – SUMMARY CALCULATION TABLE

Land Use Type & IF Calculation					
Industrial					"I"
% Area in Inner Circle	0%				+0
% Area in Outer Circle	0%				
Commercial					"C"
% Area in Inner Circle	34%				+3.16
% Area in Outer Circle	30%				
Roads	Location	Estimated vehicle Movements per day	Classification	Result	"TF"
North Lake Rd (N of Beeliar Drv)	INNER CIRCLE	15,180	Major	+6	6
Beeliar Drv (W of Kwinana Freeway)	OUTER CIRCLE	35,540	Major	+2	
Kwinana Freeway	OUTER CIRCLE	>100,000	Major	+2	
INFLUENCING FACTOR					+9.16

The resultant IF therefore equals 9, determining the applicable Assigned Noise Level limits at the NSR.

E. EQUIPMENT CALIBRATION CERTIFICATES

Certificate of Calibration

Certificate No.: 473692023

Object: Sound Analyser Nor140

Supplier: Norsonic AS

Type: Nor140

Serial number: 1406036

Client: Sealhurst Pty Ltd , Perth ,WEST AUSTRALIA

Calibration complies with the following standard(s)

IEC 61672-1:2002 class 1
IEC 60651 type 1
IEC 60804 type 1
IEC 61260 class 1
ANSI S1.4-1983 (R2001) with amd. S1.4A-1985 class 1
ANSI S1.43-1997 (R2002) class 1
ANSI S1.11-2004 class 1
DIN 45 657, Applicable parts
Norsonic production standard set for the Nor140

Instrumentation used for calibration traceable to:

Electrical Parameters: MT, Norway
Acoustical Parameters: PTB, Germany
Environmental Parameters: IKM, Norway. Justervesenet. Norway

Adjustments: None

Comments: None

Date of calibration: 2014-08-14

Calibration interval recommended 2 years

The environmental parameters applicable to this calibration are kept well within limits ensuring negligible deviation on obtained measurement results.

Calibrated by:

Sign.

Norsonic
P.O. BOX 24, N-3420 LIERSKOGEN, NORWAY
TEL: +47 32 85 89 00

Norsonic AS, P.B 24, 3421 Lierskogen. Visitor address: Gunnersbråtan 2, Tranby, Norway.
Phone +47 32858900 Fax.: +47 32852208. email: info@norsonic.com

Norsonic

Certificate of Calibration

Certificate No.: CAL 022-2014-4735

NORWEGIAN ACCREDITATION CAL 022

Test object:	Sound Calibrator
Manufacturer:	Norsonic
Type:	1251
Serial no:	34172

Customer:

	Level	Level Stability	Frequency	Frequency Stability	Distortion
Measurement Results:	114,00 dB	0,05 dB	1000,34 Hz	0,00 %	0,41 %
Expanded Uncertainty:	0.11 dB	0.02 dB	1.0 Hz	0.1 %	0.2 %

The stated level is relative to 20µPa.
The stated level is valid at reference conditions.The following correction factors have been applied during the measurement:
Pressure: 0,0005 dB/kPa Temperature: 0,000 dB/°C Relative humidity: 0,000 dB/%RH Load volume : 0,0003 dB/mm3
The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, which for a t-distribution with the reported effective degree of freedom corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA publication EA-4/02.

Records: L:\PROJECTS\CALLAB\PROGRAM\Cal\2014\NOR1251_34172_M1.nmf

Environmental conditions:	Pressure:	Temperature:	Relative humidity:
Reference conditions:	101,325 kPa	23,0 °C	50 %RH
Measurement conditions:	97,030 ± 0,010 kPa	23,8 ± 0,2 °C	48,1 ± 1,0 %RH

Date received for calibration:	
Date of calibration:	2014-08-13
Date of issue:	2014-08-13
Engineer	Terje Hansen
Supervisor	

Terje Hansen

Preconditioning
The equipment was preconditioned for more than 12 hours at the specified calibration temperature and humidity.

Calibration and verification performed
The performed tests refer to the sections 5.2, 5.3 and 5.5 in IEC 60942 (1997-11): Electro-acoustics - Sound Calibrators. The calibrator has been tested as described in Annex B of the same standard described in the sections B.3.3 for the sound level, B.3.4 for Sound pressure level stability - short-term fluctuations, B.3.5 for frequency and in B.3.6 for total distortion.

Method of Calibration
A detailed description of the calibration procedure is available separately from the calibration laboratory.

Instruments and Program
A complete list of instruments, hardware and software, that has been used for this calibration is separately available from the calibration laboratory.

Traceability
The measured values are traceable to the following laboratories:
Sound Pressure Level: PTB, Germany
Voltage: IKM Laboratorium Norway
Frequency: IKM Laboratorium Norway
Ambient Pressure: Justervesenet, Norway
Temperature: Justervesenet, Norway
Relative Humidity: Justervesenet, Norway

Statement of Conformity
The tested Sound Calibrator has shown to conform with the requirements for periodic tests as described in IEC 60942 (1997-11) Annex B. All required tests have been performed and have demonstrated measurement values, extended by the uncertainty of the measurements, to be within the required range for a Class 1 sound calibrator.

Street address: Gunnersbråtan 2, N-3421 Tranby, Norway
Tel.: +47 32858900 Fax.: +47 32852208 email: ncl@norsonic.com

F. NOISE DURING CONSTRUCTION PHASE

F.1 Extract from Appendix D AS 2436 - Section 4.6

AS2436:2010 Appendix D

Section 4.6

In demolition work alongside occupied premises there should, if possible, be a break in solid connections, e.g. concrete paving, between the working area and the adjoining buildings. This will reduce the transmission of vibration and structure-borne noise. Care should be taken that any such break is of no structural significance in relation to the planned system of demolition. The break could result in premature collapse due to lack of continuity or restraint. Care should be taken not to drop materials from a height either into or out of trucks. The surfaces on to which the materials are being moved should be covered by some resilient material. Particular care should be taken during the loading and unloading of scaffolding. Where material cannot be lowered in skips or by other means, it is recommended that properly constructed and damped chutes be used. The effectiveness of noise enclosures and screens can be partially lost if they are used incorrectly. For example, the noise being enclosed should be directed into and not out of the enclosure. There should also be no reflecting surfaces opposite the open side.

4.5.5 Maintenance of equipment Increases in plant noise are often indicative of future mechanical failure. Regular and effective maintenance of plant and equipment including vehicles is essential and will do much to maintain noise levels near to that of new plant. Maintenance should be carried out only by trained persons. Where maintenance work has to be done at night, precautions may be necessary to minimize any nuisance. Vibration from machinery with rotating parts can be reduced by attention to proper balancing. Frictional noise from the cutting action of tools and saws may be reduced if the tools are kept sharp. Other noises caused by friction in machines, conveyor rollers and trolleys can be reduced by proper lubrication.

4.6 CONTROLLING THE SPREAD OF NOISE

4.6.1 General

If noisy processes cannot be avoided, then the amount of noise reaching the receiver should be minimized. Two ways of doing this are either to increase the distance between the noise source and the receiver or to introduce noise reduction measures such as screens. Physical methods to reduce the transmission of noise between the site works and residences, or other sensitive land uses, are generally suited to works where there is longer-term exposure to the noise. Practices that will reduce noise from the site include: (a) Increasing the distance between noise sources and sensitive receivers. (b) Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office transportables can be effective barriers). (c) Constructing barriers that are part of the project design early in the project to afford mitigation against site noise. (d) Installing purpose built noise barriers, acoustic sheds and enclosures.

4.6.2 Distance

Increasing the distance is often the most effective method of controlling noise. This may not be possible where work takes place on fixed structures, e.g. railway tracks. The effect of distance on noise levels is explained in Appendix B. Stationary plant such as compressors and generators can be located away from the work area so as to avoid being close to any noise-sensitive area.

4.6.3 Screening

On sites where distance is limited, the screening of noise may be of benefit and this should be taken into account at the planning stages. Appendix B illustrates the effect of the screen in reducing the noise level and Appendix D describes the performance of different types of acoustic screens and enclosures and the materials they are made of. If structures such as stores, site offices and other temporary buildings are situated between the noisiest part of the site and the nearest dwellings, some of the noise emission from the site can be reduced. If these buildings are occupied, then sound insulation measures may be necessary to protect workers in them.

A hoarding that includes a site office on an elevated structure offers a superior noise reduction when compared with a standard (simple) hoarding. This performance is further enhanced when the hoarding is a continuous barrier. Storage of building materials or the placement of shipping containers between the noise source and any noise-sensitive area may also provide useful screening and the same is true of partially completed or demolished buildings.

Noisy stationary plant can be put in a basement, the shell of which has been completed, provided reverberant noise can be controlled. Where compressors or generators are used in closed areas, it is necessary to ensure that the exhaust gases are discharged directly to the outside air and that there is good cross-ventilation to prevent the build-up of poisonous carbon monoxide fumes and to allow an adequate air supply to maintain efficient running.

Where such noise barriers are not practicable, a worthwhile reduction in noise can be obtained by siting the plant behind and as close as possible to mounds of earth, which may effectively screen the plant from any noise-sensitive areas. These can often be designed into the construction schedule or site arrangement for future landscaping. Water pumps, fans and other plant and equipment that operate on a 24-hour basis may not be a source of noise nuisance by day but can create problems at night. They should therefore be effectively screened either by being sited behind a noise barrier or by being positioned in a trench or a hollow in the ground provided this does not generate reverberant noise. In such cases, however, adequate ventilation should also be ensured.

Long, temporary earth embankments can provide quite an effective noise screen for mobile equipment moving, for example, on a haulage road. When the earthworks are complete, the earth mounds should be removed if possible with smaller, quieter excavators. A noise barrier may be a more reliable method of noise control than the imposition of restrictions on throttle settings. In many cases it will not be practicable to screen earthmoving operations effectively, but it may be possible to partially shield construction plant or to build-in at the early stages protective features ultimately required to screen traffic noise. Where earth noise barriers are not a practical proposition because of lack of space, consideration should be given to the possibility of constructing temporary screens from wood or any of the materials suggested in Appendix D.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and to the listener, and the material from which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected to a distance of not less than ten times the shortest measurement from the property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend to a distance beyond the direct line between the noise source and the receiver to a distance equal to ten times the effective barrier height, which is the height above the direct line between source and receiver. If the works are predominately within nominally closed structures, careful consideration should be given to reducing noise breakout at any openings.

4.7 CONTROL OF NOISE AT THE RECEIVER

In cases where noise emissions cannot be adequately controlled at the source or by controlling the spread of noise, consideration should be given to control of noise received at nearby sensitive locations. Provision of treatments at the affected residence or other sensitive land use is normally only suited to addressing noise from longer term construction projects at a stationary site, or where the work site is relatively isolated, or where only a few residences or other sensitive land uses are affected.

Practices that will mitigate the impacts of noise include: (a) Providing localized noise barriers adjacent to the receiving location. (b) Providing acoustic insulation to reduce airborne noise entering buildings, for example, heavyweight glazing or double glazing. (c) Providing ventilation to enable windows and doors to remain closed. (d) Providing access to temporary relocation for noise-affected occupants for short periods, for example, when high noise levels from construction occur at night and there are no feasible and reasonable ways of reducing noise levels.

4.8 CONTROL OF VIBRATION

4.8.1 General

Vibration can be more difficult to control than noise, and there are few generalizations that can be made about its control. It should be kept in mind that vibration may cause disturbance by causing structures to vibrate and radiate noise in addition to perceptible movement. Impulsive vibration can, in some cases, provide a trigger mechanism that could result in the failure of some building component that had previously been in a stable state. It can also trigger annoyance being elevated into action by occupants of exposed buildings, and should therefore be included in planning of communication with impacted communities.

It should be remembered that failures, sometimes catastrophic, can occur as a result of conditions not directly connected with the transmission of vibrations, e.g. the removal of supports from retaining structures to facilitate site access. BS 7385-2 provides information on managing groundborne vibration and its potential effects on buildings.

Where site activities may affect existing structures, a thorough engineering appraisal should be made at the planning stage. General principles of seeking minimal vibration at receiving structures should be followed in the first instance. Predictions of vibration levels likely to occur at sensitive receivers is recommended when these are relatively close, depending on the magnitude of source of the vibration or the distance involved. Relatively simple prediction methods are available in texts, codes of practice or other standards, however it is preferable to measure and assess site transmission and propagation characteristics between source and receiver locations.

Comparison of predicted levels of vibration with preferred or regulatory levels will indicate when either more detailed predictions are required or mitigation of transmitted vibration is advisable or necessary. Guidance in measures available for mitigation of vibration transmitted can be sought in more detailed standards, such as BS 5228-2 or policy documents, such as the NSW DEC Assessing Vibration: A technical guideline.

Identifying the strategy best suited to controlling vibration follows a similar approach to that of noise—of avoidance, control at the source, control along the propagation path, control at the receiver, or a combination of these. It is noted that vibration sources can include stationary plant (pumps and compressors), portable plant (jackhammers and pavement vibrators), mobile plant, pile-drivers, tunnelling machines and activities, and blasting, amongst others. Unusual ground conditions, such as a high water-table, can also cause a difference to expected or predicted results, especially with piling.

G. ACOUSTIC GLOSSARY

Acoustic Measurement Parameter Definitions

dB

Decibel: a logarithmic scale applied to acoustic units such as sound pressure and sound power. Decibels are always the ratio between two numbers. Sound Pressure in Pascals becomes "Sound Pressure Level re $2x10^{-5}$ Pa" in decibels. Sound Power in watts becomes "Sound Power Level re 10^{-12} W" in decibels. It is

also used for sound reduction or sound insulation and is the ratio of the amount of sound energy incident upon a partition and the proportion of that energy which passes through the partition. The result is stated as a "decibel reduction".

dB(A)

A- weighting: This is an electronic filter which attenuates sound levels at some frequencies relative to the sound levels at other frequencies. The weighting is designed to produce the relative response of a human ear to sound at different frequencies. The A-weighted sound level is therefore a measure of the subjective loudness of sound rather than physical amplitude. A- weighting is used extensively and is denoted by the subscript A as in L_{A10}, L_{Aeq} etc. (Levels given without the subscript A are linear sound levels without the A- weighting applied, e. g. L_{10}, L_{eq} etc.).

$L_{Aeq,T}$

The "A" weighted equivalent continuous sound pressure level. This may be thought of as the "average" sound level over a given time "T". It is used for assessing noise from various sources: industrial and commercial premises, construction sites, railways and other intermittent noises.

$L_{A90,T}$

The "A" weighted sound pressure level that is exceeded for 90% of the time T. It reflects the quiet periods during that time and is often referred to as the "background noise level". It is used for setting noise emission limits for industrial and commercial premises.

L_{Amax}

The maximum "A" weighted sound pressure level during a given time on fast or slow response.

L_{pA}

The "A" weighted sound pressure Level. The sound pressure level is filtered through a standard frequency weighting known as A-weighting. This filter copies the frequency response of the human ear, so that the resulting sound level closely represents what people actually hear.

R

Is the sound reduction index of a construction element in octave or $^{1}/_{3}$ octaves and can only be measured in a laboratory. There must be no flanking transmission.

R'

Is the sound reduction index of a construction element in octave or $^{1}/_{3}$ octaves measured on site, and normally includes flanking transmission (ie where sound travels via paths other than straight through the element being tested, such as columns, ducts, along external walls, etc).

R_w

To get the weighted sound reduction index (R_w) of a construction, the R values are measured in octave or 1/3 octave bands covering the range of 100Hz to 3150Hz. The curve is adjusted so that the unfavourable deviation (or shortfall of the actual measurements below this standard curve) averaged over all the octave or 1/3 octave bands is not greater than 2dB. The value of the curve at 500Hz is the R_w.

R'_w

The apparent sound reduction index, which is determined in exactly the same way as the R_w but on site where there is likely to be some flanking transmission.

D

This is the "level difference". It is determined by placing a noise source in one room and measuring the noise levels in that room (the "source room") and an adjacent room (the "receiver room"). The level difference is calculated by simply deducting the "receiver" noise level (dB) from the "source" noise level (dB).

D_w

This is the weighted level difference. D is measured on site in octave or 1/3 octave bands covering the range of 100Hz to 3150Hz. The D values are compared to a standard weighting curve. The curve is adjusted so that the "unfavourable deviation" (or shortfall of the actual measurements below this standard curve) averaged over all the octave or 1/3 octave bands is not greater than 2dB. The D_w is then the value of the curve at 500Hz.

D_{nw}

This is the weighted normalised level difference. D is measured on site in octave or 1/3 octave bands covering the range of 100Hz to 3150Hz. As the level difference is affected by the area of the common wall/ floor and the volume of the receiving room, as well as the amount of absorption in the receiving room, in the case of the $D_{nT,w}$, the results are "normalised" by a mathematical correction to 10m2 of absorption (D_n). The same weighting curve as for D_w is used to obtain the single figure: D_{nw}.

Acoustic Performance Guide

$D_{nT,w}$

This is the weighted standardised level difference. D is measured on site in octave or 1/3 octave bands covering the range of 100Hz to 3150Hz. As the level difference is affected by the area of the common wall/ floor and the volume of the receiving room, as well as the amount of absorption in the receiving room, in the case of the $D_{nT,w}$, the results are "standardised" by a mathematical correction a reverberation time, usually 0.5 seconds (D_{nT}). The same weighting curve as for D_w is used to obtain a single figure "$D_{nT,w}$"

$D_{nT(Tmf,\ max),w}$

This is the weighted BB93 standardised level difference corresponding to a Building Bulletin 93 reference value reverberation time in a receiving room. It is measured on site in accordance with BS EN ISO 140- 4: 1998.

$D_{n,c}$

Suspended ceiling normalised level difference. This is the sound level difference between two rooms, separated by a suspended ceiling, normalised to a reference value of absorption in the receiving room (10m2 for the Laboratory as specified in ISO 140- 9 : 1985). It is measured in 1/3 octave or octave frequency bands.

$D_{n,c,w}$

Weighted suspended ceiling normalised level difference. This is a single number quantity representing the sound reduction between two rooms separated a suspended ceiling. It is obtained by applying specified weightings to the 1/3 octave band suspended ceiling normalised level differences in the frequency range 100Hz to 3150Hz.

C_{tr}

Spectrum adaptation term: Value, in decibels, to be added to a single- number rating (e. g. Rw) to take account of the characteristics of particular sound spectra. Ctr is calculated using an A- weighted urban traffic noise spectrum as defined in BS EN ISO 717- 1 : 1997.

NR

Stands for Noise Rating. (It is NOT noise reduction). It is (e. g. NR30, NR35 etc.) a single number, which represents the sound level in a room and takes account of the frequency content of the noise. The lower the NR value, the quieter the room will be. It is mainly used for assessing noise from mechanical services systems. In leisure developments it is used as a standard for noise break- in to rooms from external noise sources such as traffic.

NC

Stands for Noise Criteria. It is very similar to NR but (e.g. NC30, NC35 etc.) uses slightly different frequency weightings.

NRC

Stands for Noise Reduction Coefficient. The noise reduction coefficient of a material is the average, to the nearest multiple of 0.05, of the absorption coefficients at 250Hz, 500Hz, 1kHz and 2kHz.

α

Stands for Absorption Coefficient, which represents the proportion of incident sound energy arriving from all directions that is not reflected back into the room. It ranges between 0 and 1, where 0 is reflective and 1 is totally absorptive.

α_w

Stands for Weighted Absorption Coefficient. Single- number frequency dependent value which equals the value of the reference curve at 500Hz after shifting it as specified in EN ISO 11654 :1997.

α_p

Stands for practical absorption factor. It is a frequency dependent value of sound absorption coefficient which is based on measurements in one- third- octave bands in accordance with ISO 354 and which is calculated in octave bands in accordance with EN ISO 11654 : 1997. It is the arithmetic mean of the three 1/3 octave sound absorption coefficients within the octave being considered. The mean value is calculated to the second decimal place and rounded in steps of 0.05 up to a value of 1.0.

Class X

Stands for the Absorption Class between 250 and 4kHz, as defined by EN ISO 11654. Class A is the best classification representing the highest level of absorption, and Class E offers to lowest classification.

RT or T_{60}

Reverberation Time is a measure of the echoic nature of a room. It is normally measured in 1/3 octave or 1/1 octave bands by creating a loud noise and measuring the time it takes for that noise to decay by 60dB. The longer the reverberation time, the more 'echoey' a room sounds. For dwellings, a reverberation time of 0.5 seconds or less is normal. Cinema auditoria will have reverberation times of 1.0 second or below when fitted out, but up to 9 seconds at shell completion.

When designing acoustically sensitive areas such as concert halls or lecture theatres, it is necessary to design the room finishes to achieve optimum reverberation times. These will vary depending on the type of activity in the room and the room volume.

T_{mf}

Stands for the arithmetic average of the reverberation times in the 500Hz, 1kHz and 2kHz octave bands, for the type of receiving room, as defined in UK Schools design manual, Building Bulletin 93.

Sealhurst
Acoustic Design
& Engineering

Lot 5 Signal Terrace, Cockburn Central

Transport Assessment

CW932300

Prepared for
Fraser Property Australia

06 November 2015

Cardno®
Shaping the Future

Document Information

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Document Control

Version	Date	Author	Author Initials	Reviewer	Reviewer Initials
A	05/11/2015	Mina Bayat Mokhtari	MBM	Ray Cook	RJC
B	06/11/2015	Mina Bayat Mokhtari	MBM	Ray Cook	RJC

Table of Contents

Tables

Figures

Appendices

1 Introduction

1.1 Introduction

Cardno has been commissioned by Fraser Property Australia to prepare a Transport Assessment for the proposed mixed used development located at lot 5 Signal Terrace, Cockburn Central Town Centre. The development full build out is planned to be in 4 stages and this report will review the transport aspects of the proposed development for the full build out but with special focus on Stage 1 which is the subject of the current Development Application (DA).

The development plan is provided is enclosed in **Appendix A**.

This report has been prepared in accordance with the Western Australian Planning Commission (WAPC) *Transport Assessment Guidelines for Developments: Volume 4 – Individual Developments (2006)* and the related checklist is included at **Appendix B**.

This report will specifically focus on traffic access, circulation, and safety. Discussion regarding pedestrian, cycle and public transport considerations is also provided.

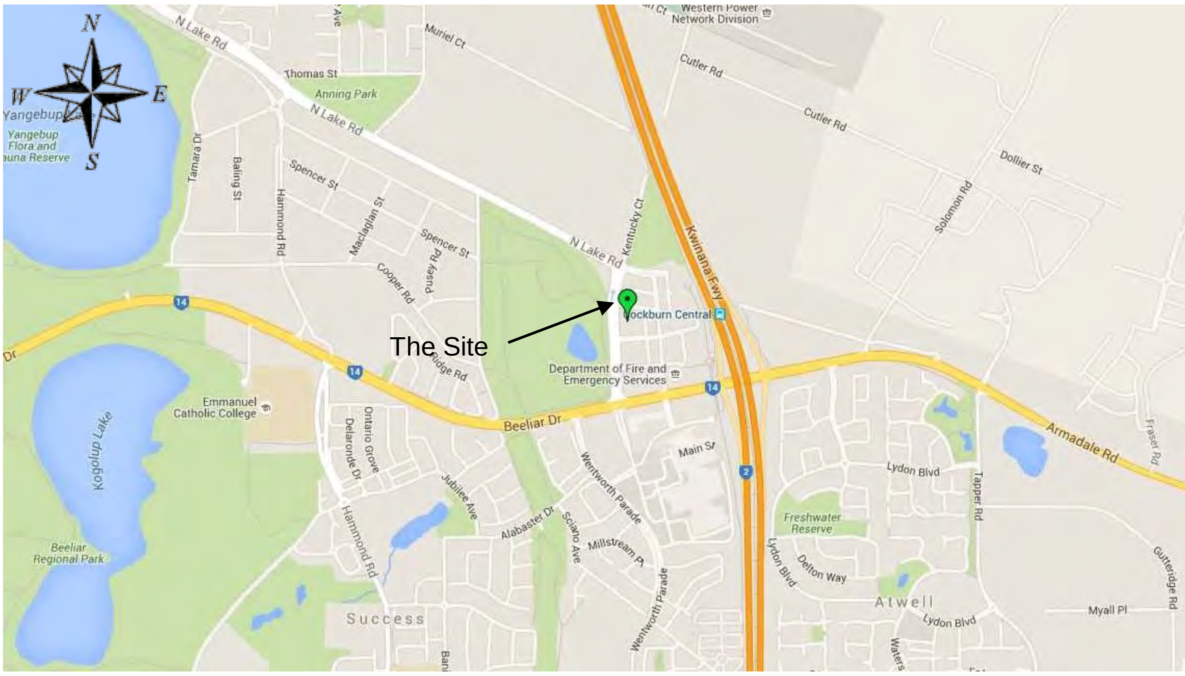
2 Existing Situation

2.1 Existing Site Context

The proposed development site (the Site) is located in Cockburn Central Town Centre and is bounded by Junction Boulevard to the north, Midgegooroo Avenue to the west, Signal Terrace to the south and Sleeper Lane to the east.

The location of the Site is illustrated in **Figure 2-1**.

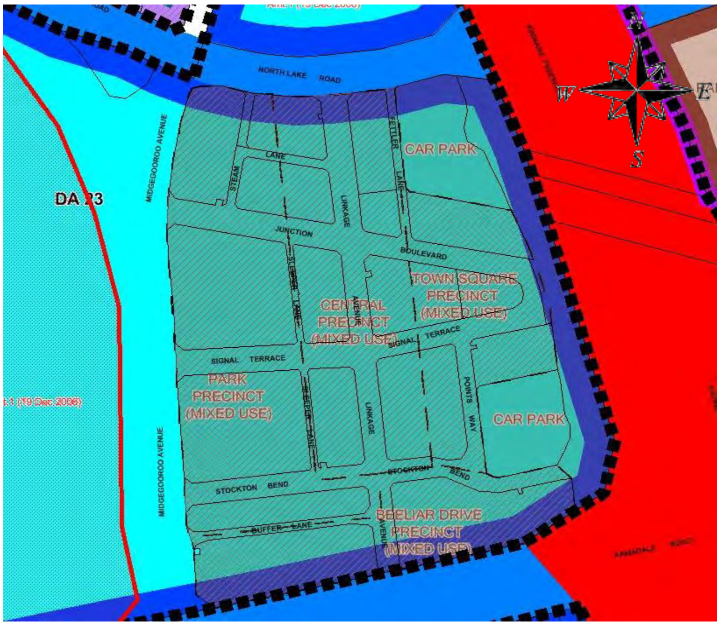
Figure 2-1 The Site Locality



Source: Nearmap 2015

As shown in **Figure** 2-2, the surrounding area of the Site is also zoned as "Mixed Use".

Figure 2-2 Land uses adjacent to the Site



Source: City of Cockburn Mapping Tool, October 2015

The Site is currently a vacant land. Apart from the developed land to the east and south of the Site the area to the north and west of the Site is mainly undeveloped.

The close-up image of the site is shown in **Figure 2-3** below

Figure 2-3 The Close-up Image of the Development Site

Source: Nearmap 2015

2.2 Existing Road Network

Figure 2-4 shows the layout and classification of the roads surrounding the Site.

Road classifications are defined in the Main Roads Functional Hierarchy as follows:

Primary Distributors (light blue): Form the regional and inter-regional grid of MRWA traffic routes and carry large volumes of fast-moving traffic. Some are strategic freight routes, and all are National or State roads. They are managed by Main Roads.

District Distributor A (green): These carry traffic between industrial, commercial and residential areas and connect to Primary Distributors. These are likely to be truck routes and provide only limited access to adjoining property. They are managed by Local Government.

District Distributor B (dark blue): Perform a similar function to District Distributor A but with reduced capacity due to flow restrictions from access to and roadside parking alongside adjoining property. These are often older roads with traffic demand in excess of that originally intended. District Distributor A and B roads run between land-use cells and not through them, forming a grid that would ideally be around 1.5 kilometres apart. They are managed by Local Government.

Local Distributors (orange): Carry traffic within a cell and link District Distributors at the boundary to access roads. The route of the Local Distributor discourages through traffic so that the cell formed by the grid of District Distributors only carries traffic belonging to or serving the area. These roads should accommodate buses but discourage trucks. They are managed by Local government.

Access Roads (grey): Provide access to abutting properties with amenity, safety and aesthetic aspects having priority over the vehicle movement function. These roads are bicycle and pedestrian friendly. They are managed by Local government.

Figure 2-4 The existing road network surrounding the Shopping Centre

Source: Main Roads Mapping Information Centre 2015

The characteristics of the surrounding road network are discussed as follows:

> **Midgegooroo Avenue**: located on the western boundary of the Site. Consists of a four-lane two-way median-divided carriageway. Midgegooroo Avenue connects to Junction Boulevard and Signal Terrace to the north-west and south-west of the Site respectively. Midgegooroo Avenue is a District Distributor A in the MRWA Metropolitan Functional Road Hierarchy (MFRH). Midgegooroo Avenue functions as continuation to North Lakes Road that serves as the main connection between the residential areas to the north-west and Cockburn Town Centre. Midgegooroo Avenue has a posted speed limit of 70 km/h, on-street parking is currently not feasible along both sides of Midgegooroo Avenue adjacent to the Site.

> **Signal Terrace**: located on the southern boundary of the Site. Consists of a two-lane two-way median-divided carriageway. Signal Terrace connects to Midgegooroo Avenue and Sleeper Lane to the south-west and south-east of the Site respectively. Signal Terrace is an Access Road in the MFRH WA, with a posted speed limit of 50 km/h. Indented parking is provided on both sides of Signal Terrace adjacent to the Site.

> **Junction Boulevard**: located on the northern boundary of the Development. Consists of a two-lane two-way median-divided carriageway. Junction Boulevard connects to Midgegooroo Avenue and Sleeper Lane to the north-west and north-east of the site, respectively. Junction Boulevard is an Access Road in the MFRH WA, with a posted speed limit of 50 km/h. Indented parking is provided on both sides of junction Boulevard adjacent to the Site.

> **Sleeper Lane:** located on the eastern side of the Site is an un-marked two-way carriageway. Sleeper Lane connects to Signal Terrace and Junction Boulevard to the north east and south east of the Site respectively. Sleeper Lane is an Access Road in the MFRH with a posted speed limit of 50 km/h, on-street parking is currently not feasible along both sides of the Site. Sleeper Lane is currently about 6 m wide and also has a mainly red asphalt pavement which combined with its narrowness will encourage drivers to drive slowly. Therefore it is expected that its operation is as a lane way and the operational speed in Sleeper Lane will be about 30 km/h.

2.3 Existing Intersections

Sleeper Lane / Junction Boulevard Intersection (**Figure 2-5**) located at the north eastern corner of the Site is a full movement T-intersection.

Figure 2-5 Existing intersection of Junction Boulevard/Sleeper Lane

Source: Nearmap 2015

Signal Terrace/ Sleeper Lane (**Figure 2-6**) located at the south western corner of the site is a four-way priority intersection.

Figure 2-6 Existing intersection of Signal Terrace/ Sleeper Lane

Source: Nearmap 2015

2.4 Existing Site Traffic Generation and Land Uses

Currently the Site is a vacant land and there is no trip to/from the Site.

2.5 Existing Road Network Performance

Existing traffic volumes of the surrounding road network were sourced from traffic count data undertaken by Cardno in November 2015. Details are summarised in **Table 2-1**.

Table 2-1 Existing mid-block traffic volumes (two-way)

	Date	Average Two-way Weekday Traffic Volumes	
		Vehicles per AM Peak Hour	Vehicles per PM Peak Hour
Junction Boulevard	November 2015	40	180
Signal Terrace	November 2015	200	250
Sleeper Lane*	November 2015	-	-

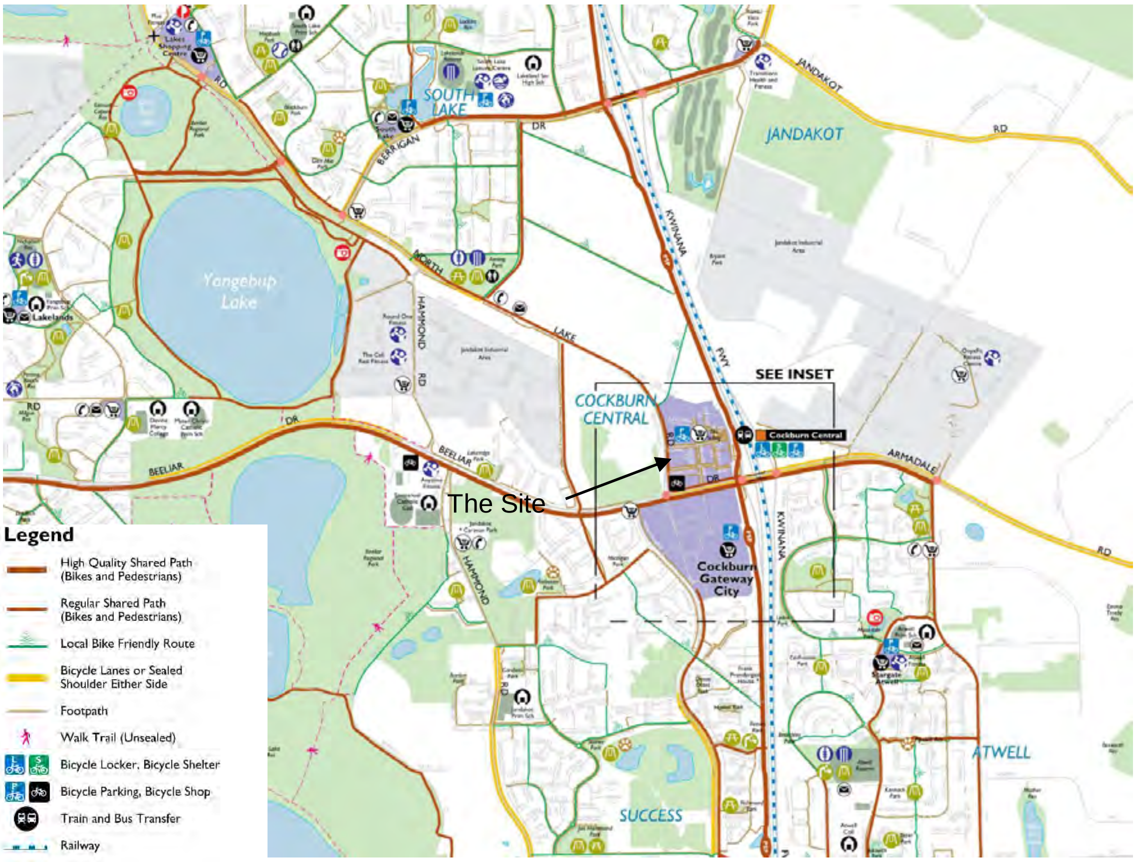
*No data was recorded for existing traffic movements along Sleeper Lane as it was closed for the purpose of construction

2.6 Existing Pedestrian/Cycle Networks

According to the map provided by Department of Transport, there is a shared path along Midgegooroo Avenue that continues to the north and south and connects to the shared path along Beeliar Drive, which continues toward east and connects to the shared path along Kwinana Freeway. There is no other dedicated on-road and limited off-road cyclist facilities in the close vicinity of the Site. Footpaths are provided on both sides of the roads surrounding the Site, the majority of paths exceed the 2.0m minimum and are generally considered suitable for slow-speed utility cycling access. Town Centre streets are also generally low speed, with capacity for mixed-traffic cycling for more confident riders. This suggests that there are reasonable existing links between the Site and the surrounding area.

The walk and cycle map is shown in **Figure 2-7**

Figure 2-7 Exisitng Pedestrian/Cycling Facilities in the Area Surrounding the Site



Source: Department of Transport, Walk & Cycle Information, July 2013

2.7 Existing Public Transport Facilities

Cockburn Central Train Station is located within 400m walkable catchment from the Site. Trains toward Mandurah/Perth stop at this station every 10 minutes. A number of buses provide services from this train station to the surrounding suburbs.

The local bus frequencies and information about bus routes within the Site surrounding area are shown in **Table 2-2** and **Figure 2-8**, respectively.

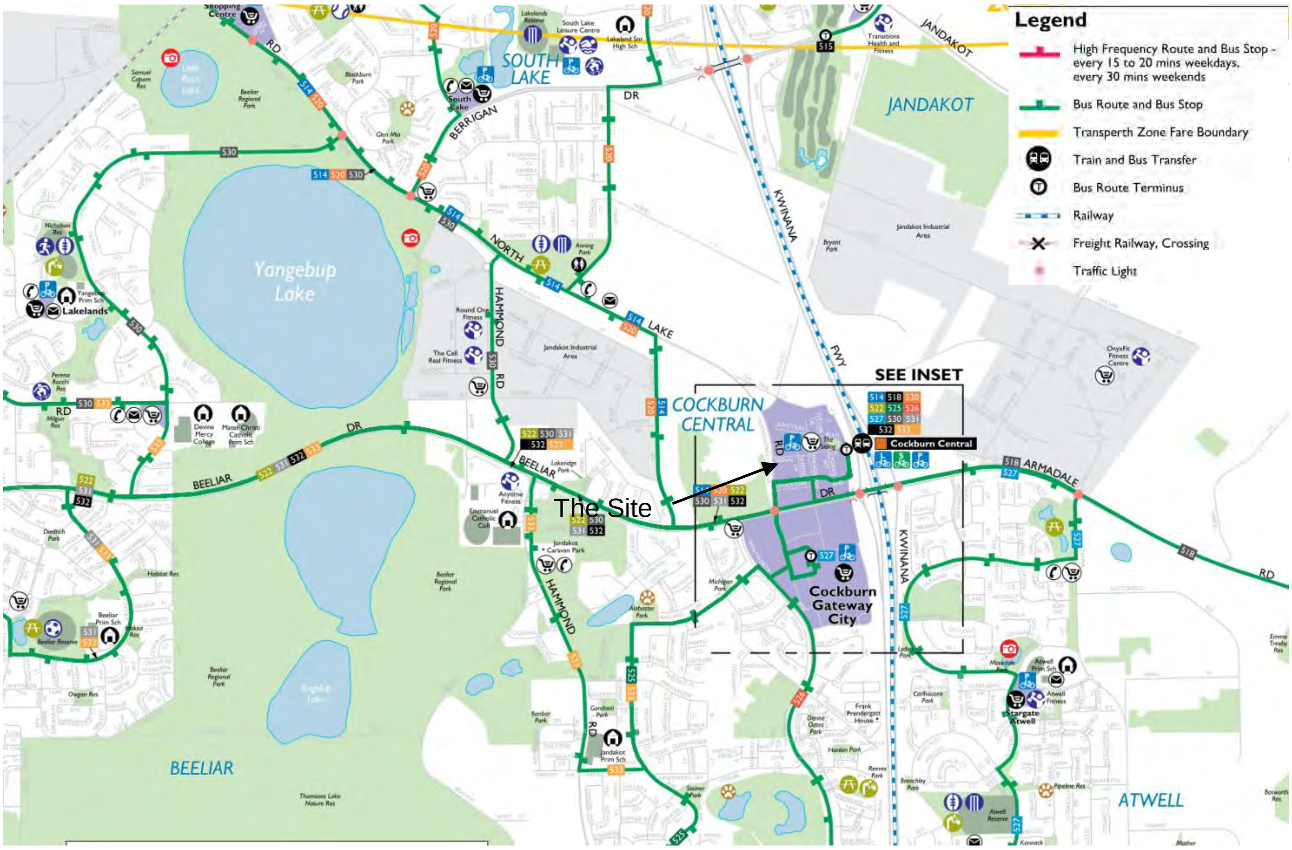
Table 2-2 Cockburn Central Bus Routes

Route No.	Route Description	Frequency per day	
		Weekdays	Saturday
514	Murdoch Stain - Cockburn Central Station	every 20 – 60 minutes	every 60 minutes
518	Murdock Station - Cockburn Central Station	every 20 – 30 minutes	every 60 minutes
525 & 526	Cockburn Central Station – Hammond Park	every 10 – 30 minutes	every 20 – 45 minutes
522	Cockburn Central Station - Spearwood	1 service per day	No service
532	Cockburn Central Station- Fremantle Station	every 10 – 30 minutes	every 60 minutes

Access to Cockburn Central Train Station is supported by footpaths along both sides of the roads in the area surrounding the Site.

Uncontrolled crossings are provided at all the intersections located between the Site and the train station to support access to public transport.

Figure 2-8 Existing Public Transport Services in the Area Surounding the Site



Source: Public Transport Authority

It can be stated that due to its proximity to the station, this Site has very good public transport connectivity.

2.8 Crash Assessment

A search of the Main Roads WA Reporting Centre for traffic accident data was made. This search covered all recorded accidents between 1 January 2010 and 31 December 2014 on the following sections of the roads:

> Intersection of Signal Terrace/Midgegooroo Avenue

It is understood that this intersection was upgraded in 2014 and MRWA Reporting Centre only provides data up to December 2014.

Records show that before the upgrade, ten crashes occurred at this intersection, of which nine happened between 2010 and 2012 and one in 2013.

> Intersection of Signal Terrace/Linkage Avenue

There is a record of 11 crashes occurred at this intersection. Right Angle crashes are the most common type of crashes at this intersection. 4 of the recorded crashes required medical attention.

It should be noted that 9 of the crashes were occurred between March 2010 and November 2012, at this time most of the roads and intersection in Cockburn Central Town Center were under construction.

3 Proposed Redevelopment

3.1 Development Yields

As stated earlier the Site is a mixed used development and is planned to be developed in 4 different stages. Stage 1-4 consists of the followings:

> 332 Multiple Dwellings

> 743 sq.m Commercial Units

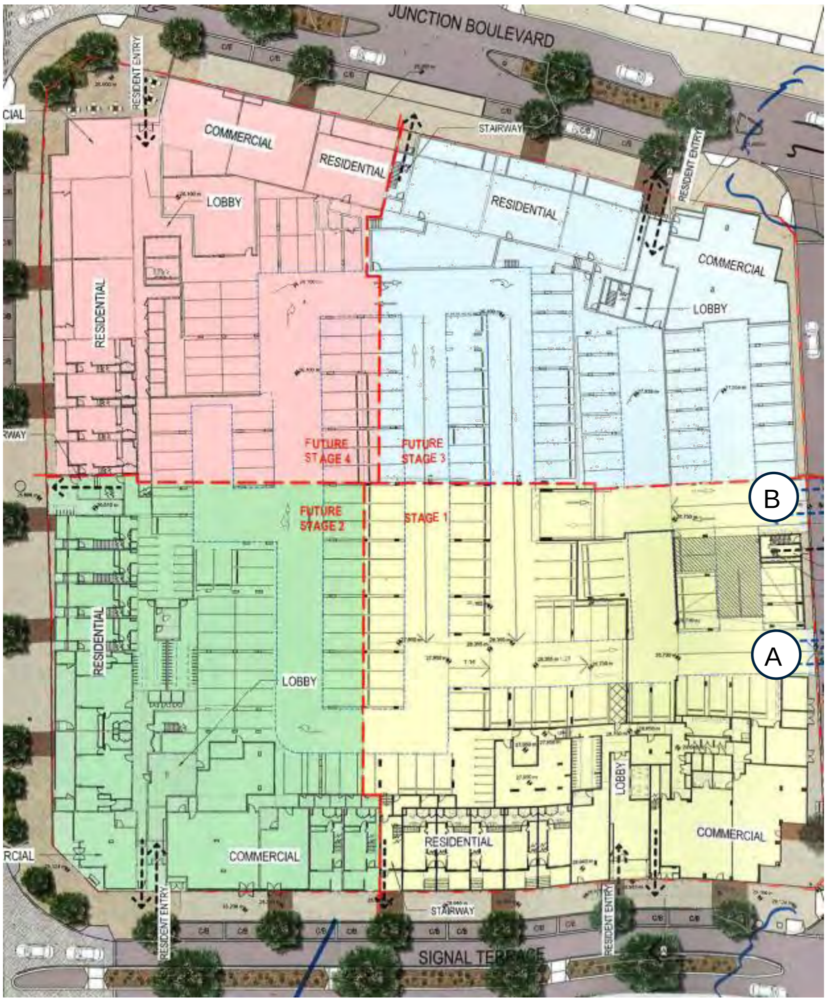
> 307.5 sq.m Café

The proposed plans of the Site is provided in **Appendix B**.

3.2 Access Arrangements

As shown in **Figure 3-1** the Site provides 2 access points (A and B) for cars and both are located on Sleeper Lane.

Figure 3-1 Access arrangements for the Site



Source: Cameron Chisholm Nicol

Entry/exit to the Site for pedestrian is provided at 4 different locations. (Each Stage will provide a separate access for residents).

3.3 Service Vehicle Provision

As per information provided in the waste management plan prepared by Bowman Associates Pty Ltd, once construction of all stages is complete, the waste collection will be from the ground floor. The truck will always travel in forward direction.

4 Analysis of Transport Network

4.1 Transport Assessment

Future traffic conditions have been analysed for the year 2021. The assessment quantifies the effect that the Site (Stage 1-4) will have on the road network.

Given that currently much of the land in the area surrounding the Site is undeveloped, for the purpose of the traffic analysis only the future scenario has been considered.

As per the information provided in the ABS website, the population growth in the City of Cockburn is about 4.5% per annum. As a conservative estimate, the existing background traffic was increased by 5% per annum to project the background traffic for 2021.

Conservatively, for the purpose of this assessment, traffic generated by the undeveloped, planned, developments in the area has also been added the existing background traffic and then increased by the growth factor of 5% per annum.

4.2 Development Traffic Generation

Trip generation rates for the residential dwellings have been sourced from Institute of *Transport Engineer's Trip Generation Handbook 7th Edition.*

Trips to the Site for the Commercial area and the Café have been based on the number of car bays provided on-site and trips made by the customers will be considered to be as part of the background growth.

Table 4-1 summaries the ITE rates for AM and PM peak periods.

Table 4-1 ITE Trip Generation Rates

Land Use	ITE Code	Weekday Peak hours	
		AM Peak Hour	PM Peak Hour
Mid-rise apartments	223	0.35 per dwelling	0.44 per dwelling
Commercial and Café	-	1 per 1 car bay	1 per 1 car bay

Trip directionality proportions for the stated land uses have been also sourced from the *ITE Trip Generation Handbook 7th edition* and are shown in **Table 4-2.**

Table 4-2 Generated traffic directional proportions

Land Use	AM Peak hour		PM Peak Hour	
	IN	OUT	IN	OUT
Mid-rise apartments	29%	71%	59%	41%
Commercial and Café	88%	12%	17%	83%

Table 4-3 shows the total number of trips estimated to be generated by the Site after the application of above trip and direction rates.

Table 4-3 Trip Generation (Stage 1-4)

Land Use	AM Peak hour		PM Peak Hour	
	IN	OUT	IN	OUT
Mid-rise apartments	34	83	86	60
Commercial and Café	18	3	4	17

Due to the land uses, above trip generation are likely to be generated by vehicles such as private cars, mainly by residents. It is noted that the trip generation is very conservative and it will most likely be much lower as future residents will utilise the excellent public transport services.

4.3 Development Traffic Distribution and Assignment

As a result of having a train station and high frequency bus services in the close vicinity of the Site, it is expected that a high proportion of home-based work and home-based education trips will be by using public transport services.

Cockburn Central Station is approximately 19.4km south of Perth CBD and the travel time by train to Perth Station is approximately 20 minutes. The cost of parking in the City can be prohibitive and as such, travelling by train is an attractive mode of transport for commuters traveling to the Perth CBD in peak periods. Travel time on the train is significantly faster when compared to travelling via private vehicle in peak periods

The ABS Census data for 2011 has been used to allocate residential trips to work to different modes.

Information about the modes used by the residents of Cockburn Central, is summarised in **Table 4-4**.

Table 4-4 Modes used by Cockburn Central Residents for Home-based Work Trips

Travel to work	%
People who travelled to work by public transport	13.60
People who travelled to work by car as driver or passenger	67.80

Source: ABS Census Data, 2011

Shown in **Table 4-4**, approximately 14% of employed people living in the Cockburn Central travel to work by use of public transport services. It is noted that this proportion has not been applied to the number of trips generated by the Site in the intersection performance assessment presented in **Section 4.10** and the assessment is therefore considered a very conservative assessment.

A common behavioural assumption in the study of transport networks is that travellers will gradually choose routes that they identify as being the shortest under the traffic conditions. For the purpose of this report, it has therefore been assumed that when the Site opens, drivers may be more inclined to turn right at the intersection of Sleeper Lane/Signal Terrace and then turn right or left at the intersection of Midgegooroo Avenue/Signal Terrace, As drivers will gradually start to experience delays, especially if they want to merge into traffic in Signal Terrace, due to the volume of the through movement on Signal Terrace, they will decide to reduce their travel time by choosing a different route. As a result, a proportion of traffic intending to go north is therefore expected to go via Sleeper Lane and then via Linkage Avenue. It is also expected that people intending to access Kwinana Freeway, will turn left at the intersection of Sleeper Lane /Signal Terrace and go south via Linkage Avenue, and will merge into Beeliar Drive through the left in, left out intersection of Linkage Avenue and Beelliar Drive as they do not need to go through the signalised intersection at Midgegooroo Avenue and Beeliar Drive.

The results of above assumptions are shown in **Figure 4-1** and **Figure 4-2**.

Figure 4-1 and **Figure 4-2** show the turning movements at the intersections of Sleeper Lane/Junction Boulevard and Sleeper Lane/Signal Terrace in 2021 including background 2021 traffic and all traffic due to the developments planned in the area including The Site.

Figure 4-1 Turning movement diagram for 2021- AM Peak Hour

Source: Nearmap 2015

Figure 4-2 Turning movement diagram for 2021- PM Peak Hour

Source: Nearmap 2015

4.4 Car Parking Provision

The car parking provision required to service the proposed residential dwellings is set out in the Residential Design Codes (R-Codes) and City of Cockburn Town Planning Scheme No.3. The applicable land uses and their car parking requirements are set out in **Table 4-5.**

Table 4-5 Car Parking Requirements

Use	Car Parking Requirements
Multi-Unit Residential (Location A)*	> 1 car parking space per Less than 110m2 and/or 1 or 2 bedrooms > 1.25 car parking space per 110m2 or greater and/or 3 or more bedrooms > 0.25 visitor car parking space per residential dwelling unit (according to the agreement with the City of Cockburn, the number of visitor car parking bays can be limited to 10% of the total number of residential dwellings)
Commercial (Office) & Café **	> 1 per 50 sq.m GLA

Source: * R-Codes

Location A is within:

- 800m of a train station on a high frequency rail route, measured in a straight line from the pedestrian entry to the train station platform to any part of a lot; or
- 250m of a high frequency bus route, measured in a straight line from along any part of the route to any part of a lot.

** City of Cockburn Town Planning Scheme No.3

Table 4-6 shows these requirements applied to the Site.

Table 4-6 Proposed Land Uses and Parking Bays, Stage 1-4

Use	Proposed No. of Car Bays		Requirement	Compliant
Multi-Unit Residential – 332 Units (42 x 3 bedrooms and the rest less than 3 bedrooms)	For residents	369 car bays for residents (see comment below)	343	Yes
	For visitors	34 visitor spaces	34 (as per agreement with the City)	Yes
Commercial (Office) and Café	for staff	21 car bays (including 1 ACROD bay)	21	Yes

It is noted that currently only Stage 1 of the 4 stages is part of this DA submission. As part of Stage 1, 121 car bays will be provided for 87 dwellings and 307.5 sq.m café and with following allocation:

> 98 car bays for residents (including 18 tandem bays)

> 6 car bays for commercial tenancies (including 1 ACROD)

> 17 car bays for visitors (8 bays will be allocated to Stage 2)

The overall provision of visitor bays is subject to change as the plans for the other stages has not been finalised and Stage 1 provides sufficient visitor parking and also will provide extra visitor bays for the use of Stage 2 when it is developed.

As part of the agreement with the City of Cockburn some of the dwellings that are provided for affordable apartment living, will not have an allocated car parking bay and the Site will provide a motorcycle bay for each of these dwellings. Therefore, 29 motorcycle bays (5% of the total bays provided for residents) of which 16 will be provided as part of Stage 1 will provided on-site.

4.5 Bicycle Parking Provision

The bicycle parking requirement for the proposed development is also provided in City of Cockburn Town Planning Scheme No.3. It is shown in **Table 4-7** below.

Table 4-7 Bicycle Parking Requirements

Use	Bicycle Parking Requirements
Multi-Unit Residential – 332 Units*	> 1 bicycle rack per each 4 dwellings for residents > 1 bicycle rack per each 16 dwellings for visitors
Commercial (Office) and Café **	> 1 bicycle rack per 200sq.m GLA for employees > 1 bicycle rack per 750sq.m GLA for visitors

Source: * City of Cockburn Town Planning Scheme No.3
** According to the agreement with the City of Cockburn, the total number of bicycle racks can be limited to 10% of the total number of commercial car parking bays provided

As per above requirement, 71 bike racks will be provided as part of Stage 1 and 108 as part of Stage 2,3 and 4.

4.6 End of Trip Facilities

A unisex shower and 2 lockers will be provided at the ground floor for the use of commercial staff.

4.7 Car Park Layout

The car park layout of Stage 1, including the dimension of car parking bays, circulation roadways, aisles and sight line clearance at the access driveways, drawings No. A03-01 to A03-04 dated to 04/11/2015, have been checked for compliance with AS 2890.1 requirements.

4.8 Proposed Pedestrian/Cycle Facilities

In the study undertaken by Cardno for the Department of Transport “Cycling and Walking Routes to Stations”, December 2014, new connections and some improvement in the existing paths were suggested, including the following:

- Line marking and bicycle symbols for all existing shared paths
- New Connection between the shared path along North Lake Road and the shared path along Kwinana Freeway
- Improvement in the exiting path at the intersection of Beeliar Drive and Midgegooroo Avenue
- Improvement in the connectivity between the shared path along Kwinana Freeway and the Cockburn Gateway Shopping Centre

It is also understood that City of Cockburn bike plan will also be updated in 2015-16 financial year.

4.9 Proposed Public Transport Facilities

According to the advice obtained from PTA, no major changes are proposed to the public transport services for the road network surrounding the Site.

4.10 Intersection Performance

Analysis of the 2021 performance has been undertaken for the following access intersections:

> Sleeper Lane / Junction Boulevard
> Sleeper Lane / Signal Terrace

These identified intersections have been analysed for each scenario using the SIDRA v5.1 analysis program. This program calculates the performance of intersections based on input parameters, including geometry and traffic volumes. As an output SIDRA v5.1 provides values for the Degree of Saturation (DOS), queue lengths, and delays. The generally accepted upper limits for the DOS (where it is considered that the operation of the intersection is constrained) are:

> 0.80 for unsignalised intersections
> 0.85 for roundabouts
> 0.95 for signalised intersections

A DOS exceeding these values indicates that the intersection may exceed its practical capacity. Above these values, users of the intersection are likely to experience unsatisfactory queuing and delays during peak hour periods.

4.10.1 Sleeper Lane / Junction Boulevard Intersection

The analysis of the Sleeper Lane / Junction Boulevard intersection for the weekday peak hour is discussed below. **Figure 4-3** is a SIDRA layout representation of the intersection.

Figure 4-3 SIDRA Layout for Sleeper Lane / Junction Boulevard Intersection

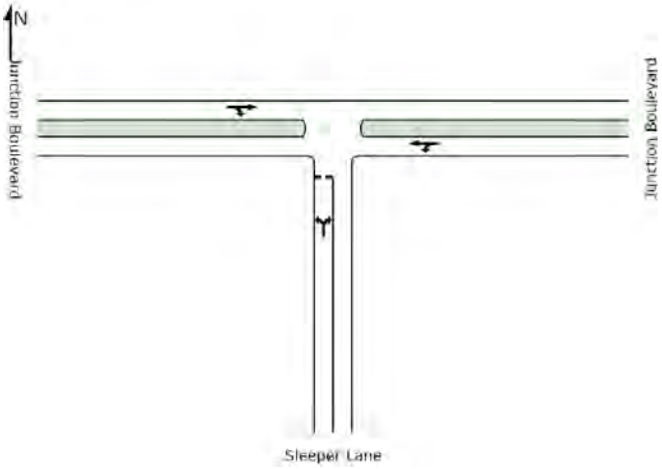


Table 4-8 Sleeper Lane / Junction Boulevard Intersection Performance for 2021 AM Peak Hour

Intersection Approach		Background 2021 without Development				Background 2021 with Development			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
Sleeper Lane (S)	L	0.06	4	A	2	0.066	4	A	2
	R	0.06	4	A	2	0.06	4	A	2
Junction Boulevard (E)	L	0.11	1	A	0	0.11	1	A	0
	T	0.11	0	A	0	0.11	0	A	0
Junction Boulevard (W)	T	0.05	1	A	2	0.06	1	A	2
	R	0.05	2	A	2	0.06	2	A	2
All vehicles		0.11	1	NA	2	0.11	1	NA	2

Table 4-9 Sleeper Lane / Junction Boulevard Intersection Performance for 2021 PM Peak Hour

Intersection Approach		Background 2021 without Development				Background 2021 with Development			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
Sleeper Lane (S)	L	0.01	4	A	0	0.05	6	A	1
	R	0.01	4	A	0	0.05	6	A	1
Junction Boulevard (E)	L	0.07	1	A	0	0.11	1	A	0
	T	0.07	0	A	0	0.11	0	A	0
Junction Boulevard (W)	T	0.08	1	A	3	0.16	1	A	7
	R	0.08	2	A	3	0.16	2	A	7
All vehicles		0.08	0	NA	3	0.16	1	NA	7

As indicated in **Table 4-8**, the proposed intersection configuration has sufficient capacity for all approaches under the background 2021 plus development.

The geometry of the existing intersection is considered sufficient for both operation and safety.

4.10.2 Sleeper Lane / Signal Terrace Intersection

The analysis of the Sleeper Lane / Signal Terrace intersection for the weekday peak hour is discussed below. **Figure 4-4** is a SIDRA layout representation of the intersection.

Figure 4-4 SIDRA Layout for Sleeper Lane / Signal Terrace Intersection

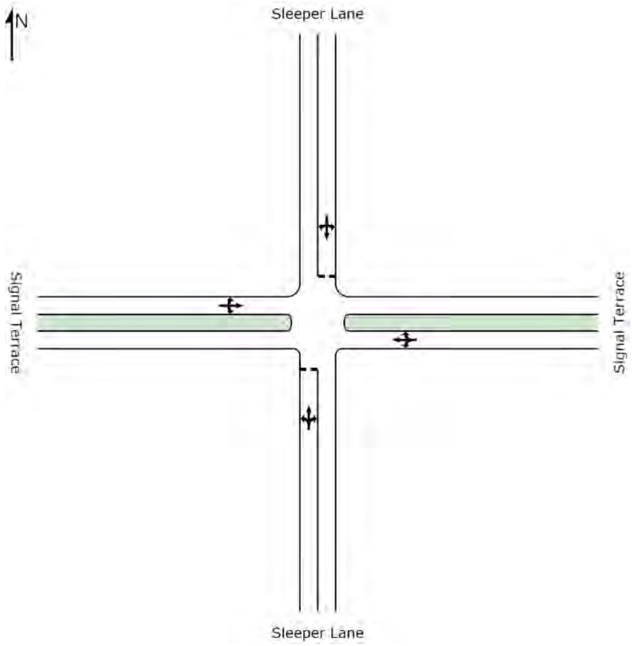


Table 4-10 Sleeper Lane / Signal Terrace Intersection Performance for 2021 AM Peak Hour

Intersection Approach		Background 2021 without Development				Background 2021 with Development			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
Sleeper Lane (S)	L	0.03	3	A	1	0.04	5	A	1
	T	0.03	3	A	1	0.04	4	A	1
	R	0.03	3	A	1	0.04	4	A	1
Signal Terrace (E)	L	0.05	3	A	2	0.08	3	A	5
	T	0.05	1	A	2	0.08	2	A	5
	R	0.05	3	A	2	0.08	3	A	5
Sleeper Lane (N)	L	0.05	5	A	1	0.20	8	A	6
	T	0.05	5	A	1	0.20	7	A	6
	R	0.05	5	A	1	0.20	8	A	6
Signal Terrace (W)	L	0.18	2	A	8	0.23	2	A	11
	T	0.18	0	A	8	0.23	1	A	11
	R	0.18	1	A	8	0.23	2	A	11
All vehicles		0.18	1	NA	8	0.23	2	NA	11

Table 4-11 Sleeper Lane / Signal Terrace Intersection Performance for 2021 PM Peak Hour

Intersection Approach		Background 2021 without Development				Background 2021 with Development			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
Sleeper Lane (S)	L	0.02	5	A	0	0.03	7	A	1
	T	0.02	4	A	0	0.03	7	A	1
	R	0.02	5	A	0	0.03	7	A	1
Signal Terrace (E)	L	0.10	2	A	5	0.11	3	A	7
	T	0.10	1	A	5	0.11	2	A	7
	R	0.10	2	A	5	0.11	3	A	7
Sleeper Lane (N)	L	0.06	5	A	2	0.21	7	A	6
	T	0.06	4	A	2	0.21	7	A	6
	R	0.06	5	A	2	0.21	7	A	6
Signal Terrace (W)	L	0.14	2	A	7	0.19	2	A	11
	T	0.14	1	A	7	0.19	1	A	11
	R	0.14	2	A	7	0.19	2	A	11
All vehicles		0.14	1	NA	7	0.21	2	NA	11

As indicated in **Table 4-10**, the existing intersection configuration has sufficient capacity for all the approaches under the background 2021 plus development.

The geometry of the existing intersection is considered sufficient for both operation and safety.

4.11 Safe Walk/Cycle to School

There is no school located within 800m radius of the Site and it is expected that students living in the area will utilise public transport.

5 Site Specific Issues

5.1 Site Specific Transport Issues

The Site is expected to have minimal adverse impact on the surrounding area in terms of traffic generation or safety.

5.2 Operation of Sleeper Lane

Sleeper Lane is 6 m wide, quite narrow and will mainly serve as the access for lots 5 and 6. As defined in Liveable Neighbourhoods a narrow local access street with the width of 6m located along the rear /side of the property boundary that is provided for vehicular access to higher density or missed used developments, operates as a laneway. Therefore, it is expected that Sleeper Lane will operate as a low speed environment (30km/h) due to its appearance as a lane way.

6 Conclusions

This Transport Assessment outlines the transport aspects of the proposed redevelopment focusing on traffic operations, access, and car parking. Discussion regarding pedestrian, cycle parking and public transport considerations are also provided.

This statement has been prepared in accordance with the WAPC Transport Assessment Guidelines for Developments: Volume 4 – Individual Developments (2006) for lodgement with the development application for the City of Cockburn.

The following conclusions have been made in regards to the proposed development:

> All 4 Stages are expected to generate relatively low traffic volumes of approximately 137 vehicle trips in the AM peak hour and 167 vehicle trips in the PM peak hour which will have minimal impact on the surrounding road network

> The surrounding area has good pedestrian and cyclist provision

> The Site has excellent public transport connectivity due to its close proximity to the Cockburn Central Station

Accordingly, it is considered that the proposed development will have minimal impact in transport terms.

APPENDIX A
CONCEPT DEVELOPMENT PLANS

Cardno
Shaping the Future

HARD LANDSCAPE NOTES

*RL 29.000 — LEVELS MARKED WITH AN ASTERISK ARE LEVELS TAKEN FROM THE SURVEY DRAWINGS.

NOTE A — EXPOSED AGGREGATE SLAB LAID ON GROUND 100mm THICK (MIN.) WITH L11 TM REINFORCING MESH

FINISH TO EXPOSED AGGREGATE SLAB TO BE HOLCIM WATTLE 32MPA
AGGREGATE - 100% QUARTZ 7mm - 10mm
MAX SLUMP - 80mm

FOAM EXPANSION JOINT TO BE APPLIED BETWEEN WINDOW FRAME AND SLAB.
CONTROL JOINT TO BE APPLIED BETWEEN NOW AND OLD SLABS.
CONTROL JOINTS TO BE INSTALLED AT 4.0M CTS MAX.
SEE DRAWINGS A03-01 FOR SET-OUT OF CONTROL JOINTS.

NOTE B — EXPOSED AGGREGATE SLAB LAID ON GROUND 100mm THICK (MIN.) WITH L11 TM REINFORCING MESH

FINISH TO EXPOSED AGGREGATE SLAB TO BE HOLCIM SPINIFEX 32MPA WITH CCS MUDPACK
AGGREGATE - 100% QUARTZ 7mm - 10mm
MAX SLUMP - 80mm

FOAM EXPANSION JOINT TO BE APPLIED BETWEEN WINDOW FRAME AND SLAB.
CONTROL JOINT TO BE APPLIED BETWEEN NOW AND OLD SLABS.
CONTROL JOINTS TO BE INSTALLED AT 4.0M CTS MAX.
SEE DRAWINGS A03-01 FOR SET-OUT OF CONTROL JOINTS.

NOTE 1 — REMOVE EXISTING AGGREGATE AND REPLACE WITH NEW.

NOTE 2 — ALL WORK ALONG SLEEPER LANE BETWEEN GRID LANES A & THE CAR PARK ENTRANCES, & BETWEEN THE TWO CAR PARK ENTRANCES ARE NEW WORKS.

NOTE 3 — ALL WORKS ALONG SIGNAL TERRACE ARE WORKS TO EXISTING PAVEMENT.

HARD LANDSCAPE - LEGEND

EXPOSED WASHED AGGREGATE FINISH
COLOUR - WATTLE

EXPOSED WASHED AGGREGATE FINISH
COLOUR - SPINIFEX WITH CCS MUDPACK

SETOUT SYMBOLS LEGEND

WINDOW / CURTAIN WALL / LOUVRE TAG
W01 101 — TYPE / NUMBER — W01 101 HIGH LEVEL

DOOR / TEMPORY DOOR / GATE / LOUVRE DOOR
ROLLER SHUTTER TAG
D01 101 — TYPE / NUMBER

MJ — STRUCTURAL MOVEMENT JOINT LOCATION - INSTALL TO AFS PANEL MANUFACTURER'S SPECIFICATION

NOTE: INSTALL SURFACE JOINTS AS REQUIRED IN LINE WITH AFS PANEL MANUFACTURER'S RECOMMENDATION

CR — CARD READER

DR — DOOR RELEASE

FIRE DOOR LEGEND

FD1 — FRL - /60/30 SELF CLOSING FIRE DOOR

FD2 — FRL - /120/30 SELF CLOSING FIRE DOOR

SMD — SMOKE DOOR - HOT AND COLD SMOKE SEALS

LEGEND AND GENERAL NOTES

- REFER TO ARCHITECTURAL DRAWINGS SHEET A-00-03 FOR ARCHTECTURAL LEGEND AND GENERAL NOTES
- REFER TO A50 SERIES DRAWINGS FOR DETAILED ELECTRICAL AND CEILING INFORMATION
- REFER TO A13 SERIES DRAWINGS FOR DETAILED WET AREA LAYOUTS

NOTES:
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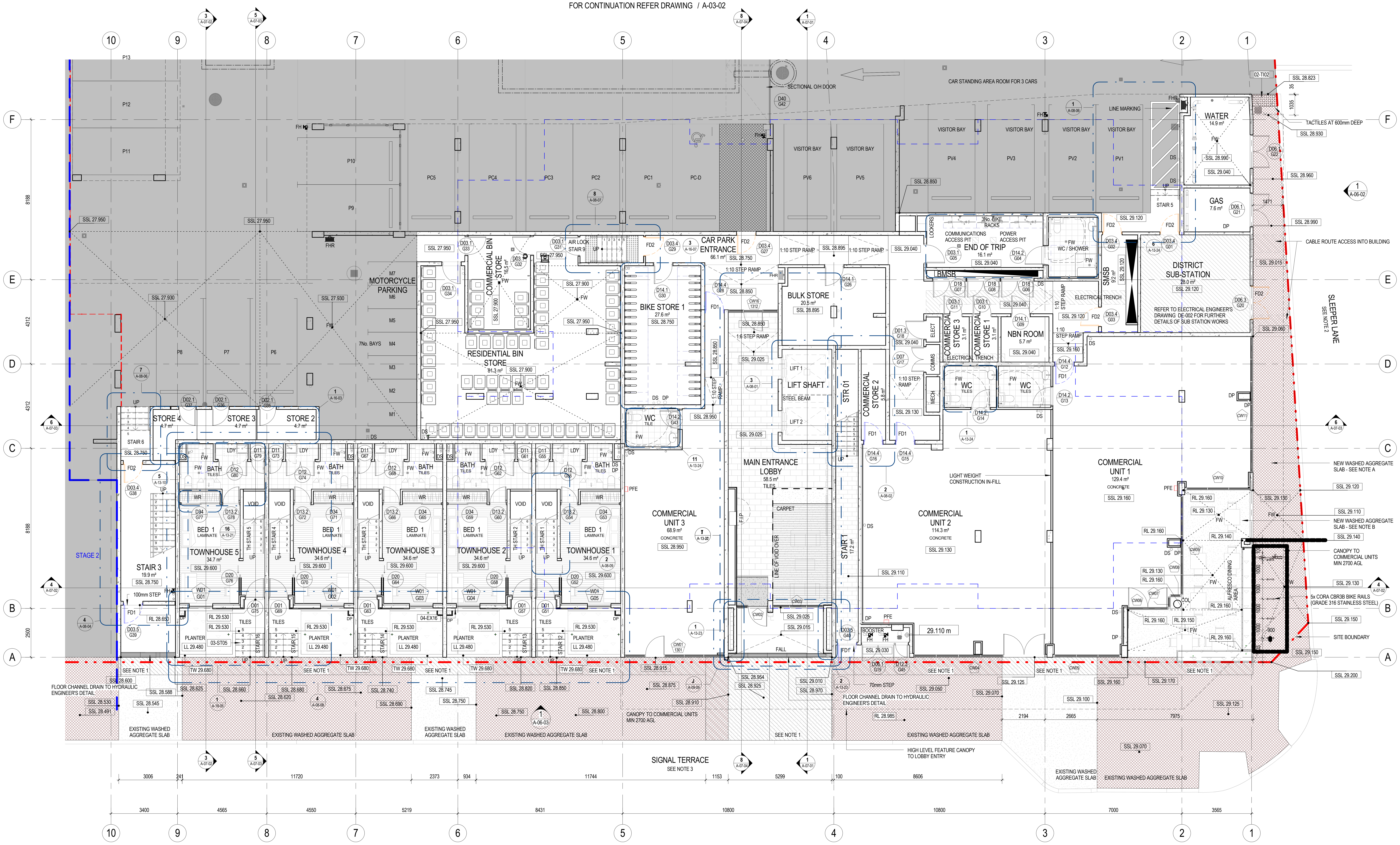
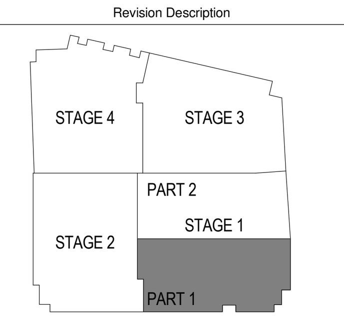
FOR CONTINUATION REFER DRAWING / A-03-02



1 GROUND LEVEL - GA PLAN - PART 1
1 : 100
A-06-01

Date	No.	Revision Description	Drawn
30/09/2015	B	ISSUE FOR REVIEW	
31/07/2015	A	ISSUE FOR REVIEW	

KEY PLAN



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CAMERON CHISHOLM NICOL

CLIENT

FRASERS PROPERTY

PROJECT
COCKBURN CENTRAL - LOT 5 - STAGE 1
SIGNAL TERRACE, WA 6164

TITLE
GENERAL ARRANGEMENT PLAN GROUND FLOOR - PART 1

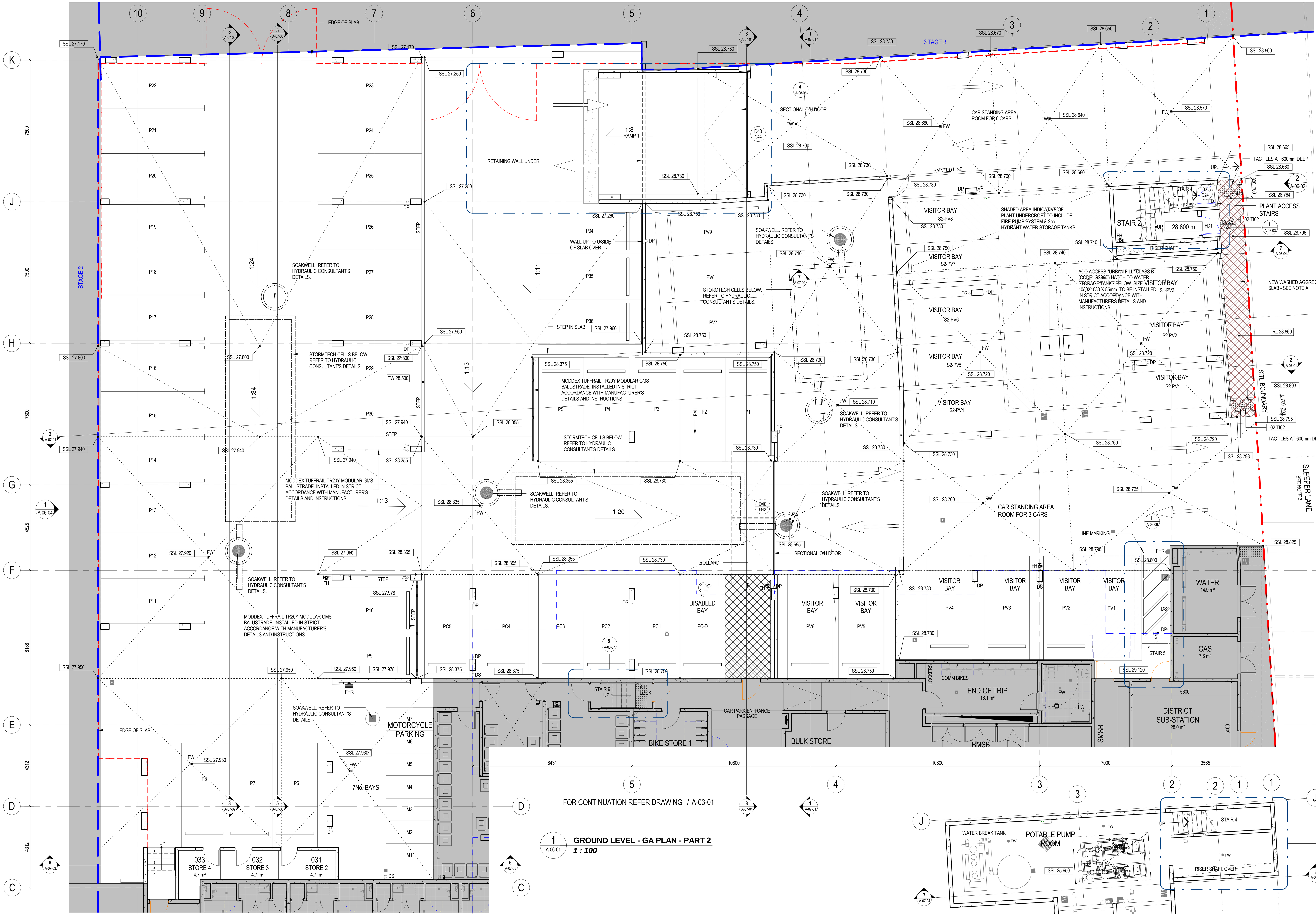
TENDER DOCUMENTATION
NOT FOR CONSTRUCTION

DATE DRAWN: PLOT DATE: *5/11/2015 5:33:25 PM*

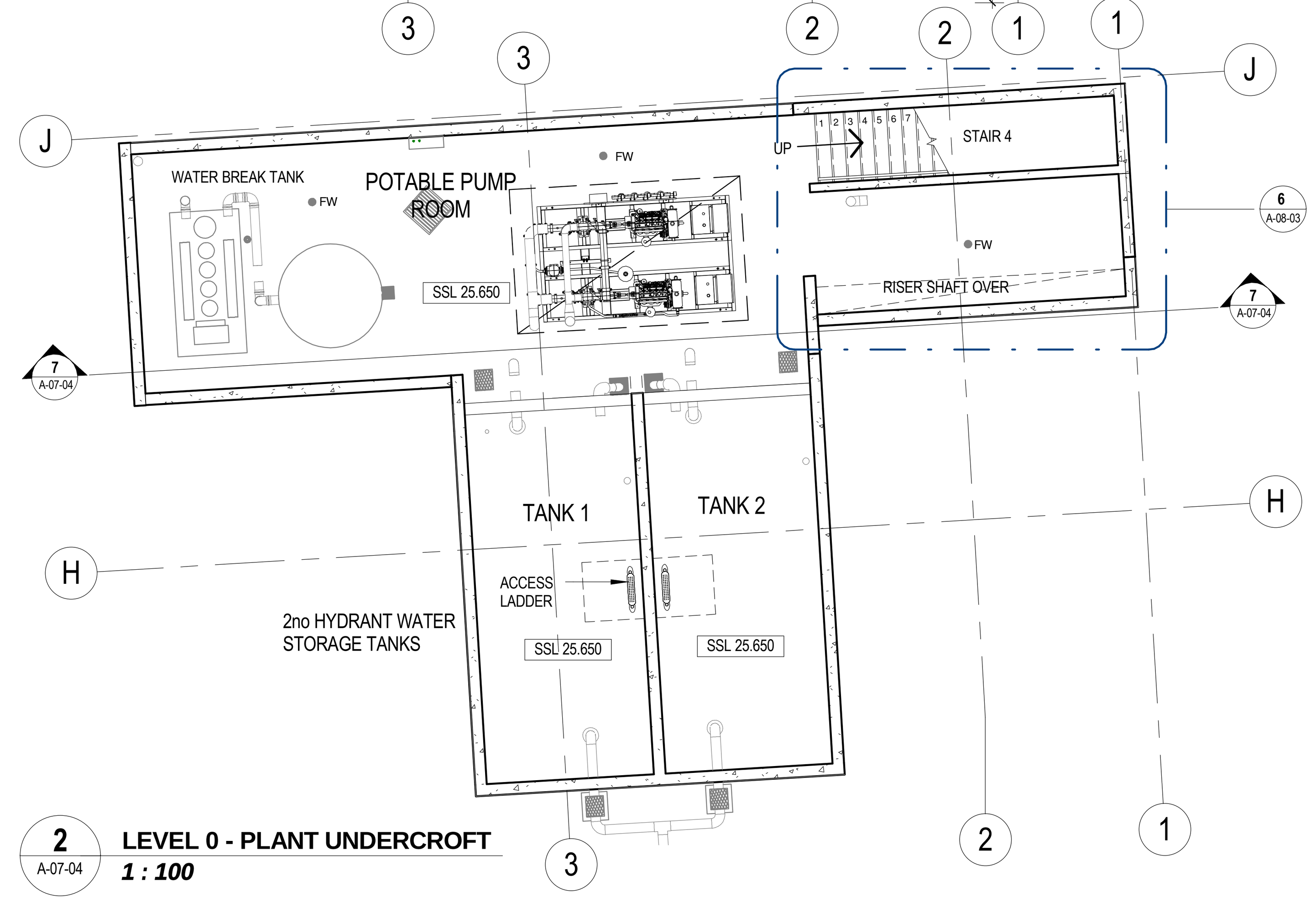
DRAWN: **HL** CHECKED: **RM** APPROVED: **Approver**

SCALE 1:200 (A3) As indicated (A1)

PROJ N°	STAGE	ZONE	DISC./ DWG N°	REV
P05161	1	5	A-03-01	B



1
A-06-01
GROUND LEVEL - GA PLAN - PART 2
1 : 100



2
A-07-04
LEVEL 0 - PLANT UNDERCROFT
1 : 100

LEGEND AND GENERAL NOTES

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- REFER TO A13 SERIES DRAWINGS FOR DETAILED WET AREA LAYOUTS

HARD LANDSCAPE - LEGEND

(hatch)	EXPOSED WASHED AGGREGATE FINISH COLOUR - WATTLE
(hatch)	EXPOSED WASHED AGGREGATE FINISH COLOUR - SPINIFEX WITH CCS MUDPACK

FIRE DOOR LEGEND

FD1	FRL - /60/30 SELF CLOSING FIRE DOOR
FD2	FRL - /120/30 SELF CLOSING FIRE DOOR
SMD	SMOKE DOOR - HOT AND COLD SMOKE SEALS

SETOUT SYMBOLS LEGEND

WINDOW / CURTAIN WALL / LOUVRE TAG

W01 101 — TYPE / NUMBER; W01 101 — HIGH LEVEL

DOOR / TEMPORY DOOR / GATE / LOUVRE DOOR ROLLER SHUTTER TAG

D01 101 — TYPE / NUMBER

MJ	STRUCTURAL MOVEMENT JOINT LOCATION - INSTALL TO AFS PANEL MANUFACTURER'S SPECIFICATION
NOTE:	INSTALL SURFACE JOINTS AS REQUIRED IN LINE WITH AFS PANEL MANUFACTURER'S RECOMMENDATION
CR	CARD READER
DR	DOOR RELEASE

HARD LANDSCAPE NOTES

*RL 29.000	LEVELS MARKED WITH AN ASTERISK ARE LEVELS TAKEN FROM THE SURVEY DRAWINGS.
NOTE A	EXPOSED AGGREGATE SLAB LAID ON GROUND 100mm THICK (MIN.) WITH L11 TM REINFORCING MESH FINISH TO EXPOSED AGGREGATE SLAB TO BE HOLCIM WATTLE 32MPA AGGREGATE - 100% QUARTZ 7mm - 10mm MAX SLUMP - 80mm FOAM EXPANSION JOINT TO BE APPLIED BETWEEN WINDOW FRAME AND SLAB. CONTROL JOINT TO BE APPLIED BETWEEN NOW AND OLD SLABS. CONTROL JOINTS TO BE INSTALLED AT 4.0M CTS MAX. SEE DRAWINGS A03-01 FOR SET-OUT OF CONTROL JOINTS.
NOTE 3	ALL WORK ALONG SLEEPER LANE BETWEEN GRID LANES A AND THE CAR PARK ENTRANCES, AND BETWEEN THE TWO CAR PARK ENTRANCES ARE NEW WORKS.

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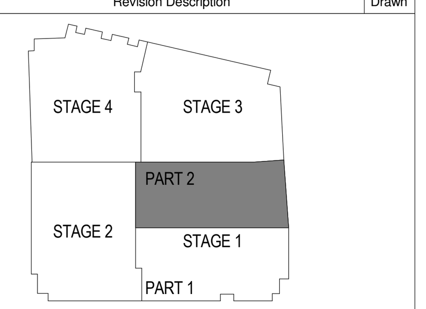
31/07/2015	A	ISSUE FOR REVIEW	

KEY PLAN



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PROJECT

COCKBURN CENTRAL - LOT 5 - STAGE 1
SIGNAL TERRACE, WA 6164

TITLE

GENERAL ARRANGEMENT PLAN GROUND FLOOR - PART 2

TENDER DOCUMENTATION

NOT FOR CONSTRUCTION

DATE DRAWN:	PLOT DATE: *5/11/2015 5:34:44 PM*	
DRAWN: **HL**	CHECKED: **RM**	APPROVED: **Approver**
SCALE	As indicated (A1)	M

PROJ N°	STAGE	ZONE	DISC./ DWG N°	REV
P05161			A-03-02	B

FIRE DOOR LEGEND

FD1	FRL - /60/30 SELF CLOSING FIRE DOOR
FD2	FRL - /120/30 SELF CLOSING FIRE DOOR
SMD	SMOKE DOOR - HOT AND COLD SMOKE SEALS

SETOUT SYMBOLS LEGEND

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W01 101 — TYPE / NUMBER; W01 101 — HIGH LEVEL

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LEGEND AND GENERAL NOTES

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1 LEVEL 1 - GA PLAN - PART 1
A-06-01
1 : 100

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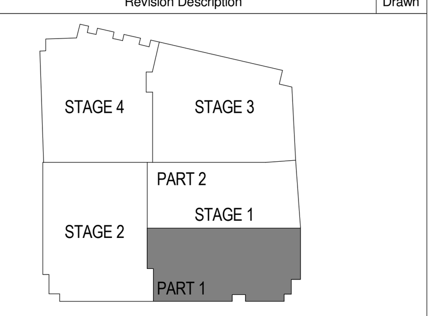
30/09/2015	B	ISSUE FOR REVIEW	
31/07/2015	A	ISSUE FOR REVIEW	

KEY PLAN



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SIGNAL TERRACE, WA 6164

TITLE
GENERAL ARRANGEMENT PLAN LEVEL 1 - PART 1

TENDER DOCUMENTATION
NOT FOR CONSTRUCTION

DATE DRAWN:	PLOT DATE: *5/11/2015 5:35:52 PM*	
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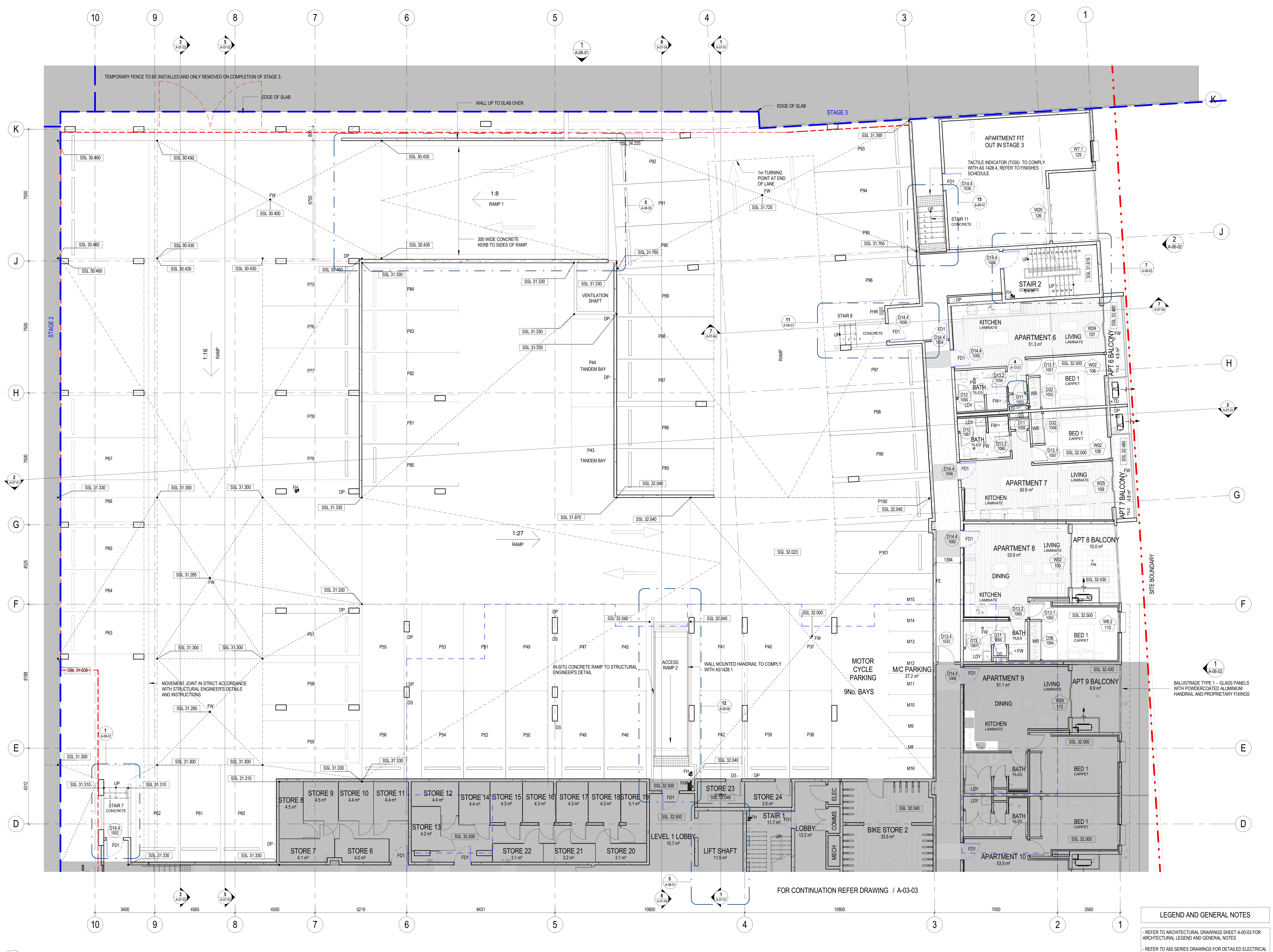
SCALE	As indicated (A1)	M

PROJ N°	STAGE	ZONE	DISC./ DWG N°	REV
P05161			A-03-03	B



1 LEVEL 1 - GA PLAN - PART 2
1 : 100

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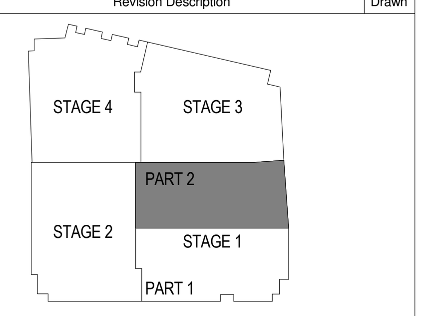
KEY PLAN



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GENERAL ARRANGEMENT PLAN LEVEL 1 - PART 2

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DATE DRAWN: PLOT DATE: 5/11/2015 5:37:35 PM
DRAWN: HL CHECKED: RM APPROVED: Approver
SCALE As indicated (A1)

PROJ N°	STAGE	ZONE	DISC./ DWG N°	REV
P05161			A-03-04	B

Transport Assessment

APPENDIX B
WAPC CHECKLIST

Cardno
Shaping the Future

Item	Status	Comments/Proposals
Proposed development		
▪ proposed land use	Included	Discussed in Section 3
▪ existing land uses	Included	Discussed in Section 2
▪ context with surrounds	Included	Discussed in Section 2.1
Vehicular access and parking		
▪ access arrangements	Included	Discussed in Section 3.2
▪ public, private, disabled parking set down / pick up	Included	Discussed in Section 4.4
Service vehicles (non-residential)		
▪ access arrangements	Included	Discussed in Section 3.3
▪ on/off-site loading facilities	Included	Discussed in Section 3.3
Service vehicles (residential)		
Rubbish collection and emergency vehicle access	N/A	
Traffic volumes		
▪ daily or peak traffic volumes	Included	Discussed in Section 2.5
▪ type of vehicles (e.g. cars, trucks)	Included	Discussed in Section 4.2
Traffic management on frontage streets	Included	Discussed in Sections 2.2 & 2.3
Public transport access		
▪ nearest bus/train routes	Included	Discussed in Sections 2.7
▪ nearest bus stops/train stations	Included	Discussed in Sections 2.7
▪ pedestrian/cycle links to bus stops/train station	Included	Discussed in Section 2.7
Pedestrian access/facilities		
▪ existing pedestrian facilities within the development (if any)	Included	Discussed in Section 2.6
▪ proposed pedestrian facilities within development	Included	Discussed in Section 4.8
▪ existing pedestrian facilities on surrounding roads	Included	Discussed in Section 2.6
▪ proposals to improve pedestrian access	Included	Discussed in Section 5.1
Cycle access/facilities		
▪ existing cycle facilities within the development (if any)	N/A	
▪ proposed cycle facilities within the development	N/A	
▪ existing cycle facilities on surrounding roads	Included	Discussed in Section 2.6
▪ proposals to improve cycle access	N/A	
Site specific issues		
Safety issues		
▪ identify issues	Included	Discussed in Section 5.1
▪ remedial measures	N/A	