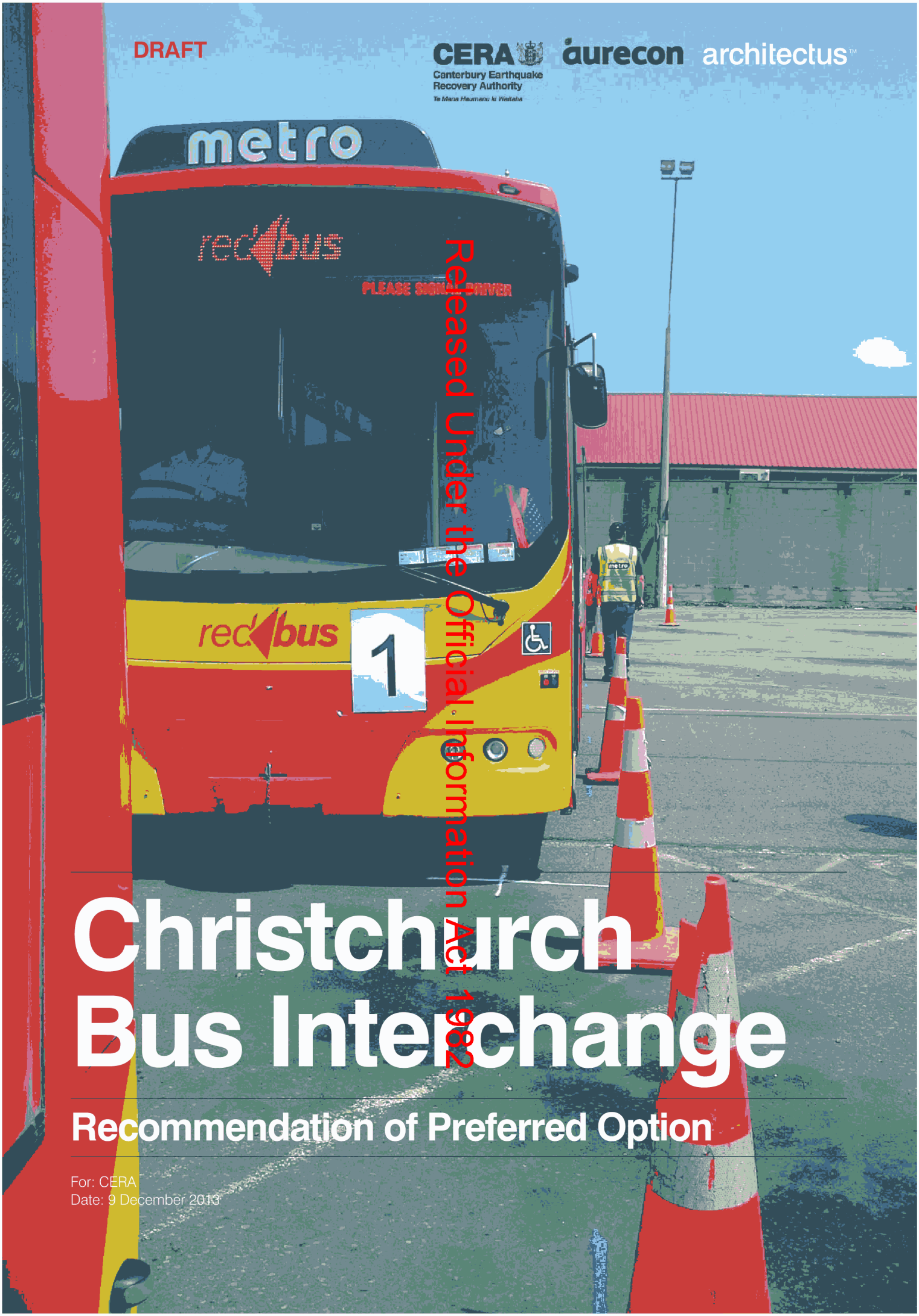
DRAFT

CERA Canterbury Earthquake Recovery Authority
Te Mana Haumanu ki Waitaha

aurecon architectus™



Christchurch Bus Interchange

Recommendation of Preferred Option

For: CERA
Date: 9 December 2013

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1. Brief Development Process

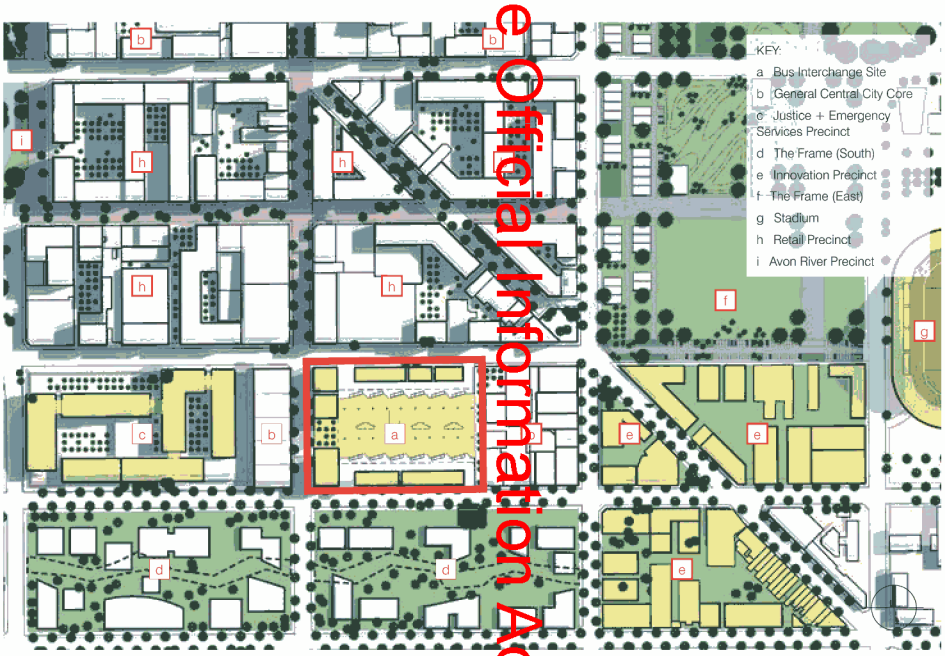
1.1 Background

Architectus and Aurecon were engaged by CERA in June 2013 to develop the Detailed Design Brief (DDB) for the Christchurch Bus Interchange. The purpose of the DDB is to establish the technical, functional and urban requirements for the Bus Interchange Anchor Project and to assist the associated Business Case.

1.2 Key Assumptions

The Detailed Design Brief is based on

- The Christchurch Central Recovery Plan (CCRP) / Blueprint and the 'Accessible City Chapter'
- The designated site for the Bus Interchange being the eastern part of the urban block bound by Colombo Street, Lichfield Street, Tuam Street and S.O.L Square/Manchester Street.
- The adoption of Environment Canterbury (ECan) 'Hubs and Spokes' model
- ECan's modelling for patronage demand in 2041:
  7 core bus routes leading to 14 stops with 2 spare requiring a total of 16 stops;
  weekday peak hour bus flow 72 buses per hour



Christchurch Central Recovery Plan (CCRP) Blueprint in area surrounding the site

1.3 Stakeholder Consultation

The DDB has been developed in consultation with the primary stakeholders

- CERA
- CCC
- ECan
- NZTA
- Te Rūnanga o Ngāi Tahu.
  Other key stakeholders that have been consulted are Christchurch Metro Bus Operators
- Taxi Association
- Christchurch Youth Community
- Inter-city Coach operators Association
- Passenger Transport Advisory Group
- Private Sector developers/neighbours

2. Design Principles and Requirements

The Detailed Design Brief establishes Principles and Requirements for a successful Bus Interchange that will be able to

- support the configuration of the wider public transport network
- provide passengers with safe, efficient and convenient access to public transport as well as
- become a facility that catalyses and connects with the surroundings, supports the ongoing recovery of Central Christchurch and encourages the use of Public Transport in its function as an important civic building
- add value to the adjacent precincts and the Central City, be effective, efficient and sustainable

The Principles and Requirements were organised into four categories with specific focus, which were consistent with those used for the 'Multi Criteria Analysis' (MCA) which was part of the Business Case.

Customer Focus

- Understanding the facility
- Movement and Circulation
- Comfort and Attractiveness
- Safety and Security
- Accessability and Inclusiveness

Urban Focus

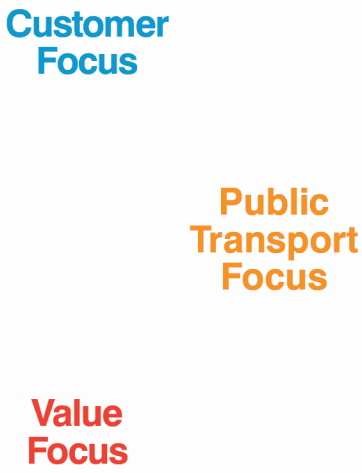
- Integration with context
- Design Quality
- Sense of Place

Public Transport Focus

- Modal Strategies
- Bus Operations
- Management and Maintenance
- Adaptability, Flexibility and Scalability

Value Focus

- Four Pillar Model of Sustainability
- Design for Change



Interchange principles and requirements

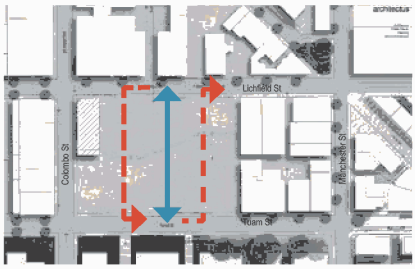
As part of the DDB establishment the Design Team also reviewed International Best Practice Examples and Documents.

The Brief also established a spatial programme for the Bus Interchange with an accommodation schedule requiring an area of a minimum of 1880m^2 for the Bus Interchange Building.

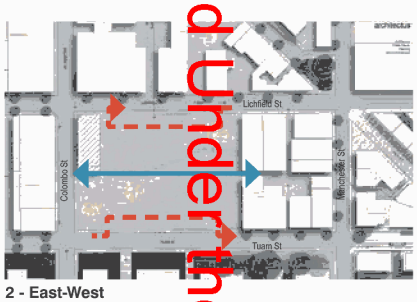
3. The 3 Concept Layouts

Concept Approaches

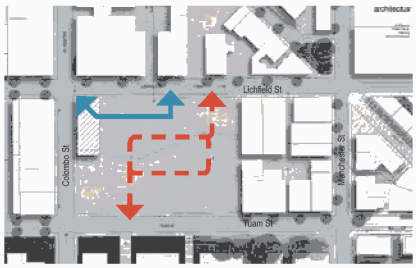
As part of the Detailed Design Brief Development a number of Concept Approaches have been explored. The drivers for these approaches were customer experience, urban integration and PT requirements The Multi Criteria Analysis (MCA) led to 3 options, which were then developed as the Concept Layouts.



1 - North-South



2 - East-West

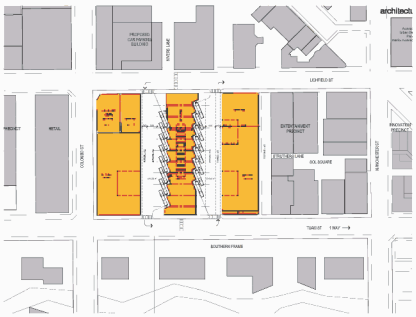


3 - Passenger Loung On Lichfield Street

Key: Pedestrians Buses

Concept Layouts

The Concept Layouts have undergone traffic analysis and Multi Criteria Analysis (MCA) which fed into the Business Case. The 3 Concept Layouts are summarised below and assessed in terms of their strengths and weaknesses on the following pages.

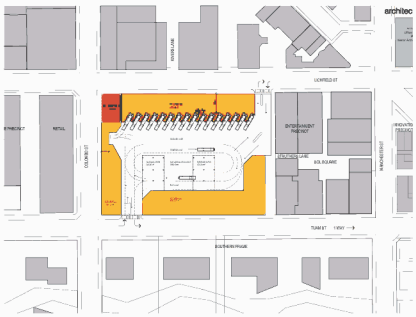


Option 1

The passenger lounge is orientated North-South - connecting Lichfield Street and Tuam Street - with eight bus bays in a relaxed saw tooth arrangement on either side.
Two building platforms - one along Colombo Street and the other on the eastern boundary towards S.O.L. Square are available for other development.

Option 2

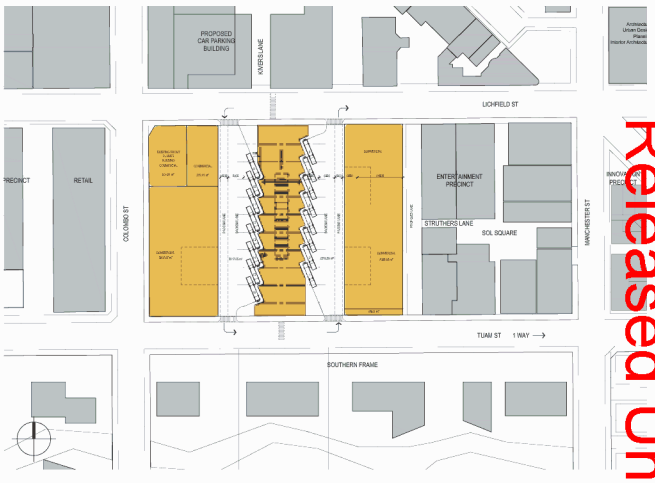
The passenger lounge is orientated East-West - connecting S.O.L. Square and Colombo Street - with eight bus bays in a relaxed saw tooth arrangement on either side.
Building platforms for other development are available along Lichfield and Tuam Street as well as on the balance of the Colombo Street frontage.

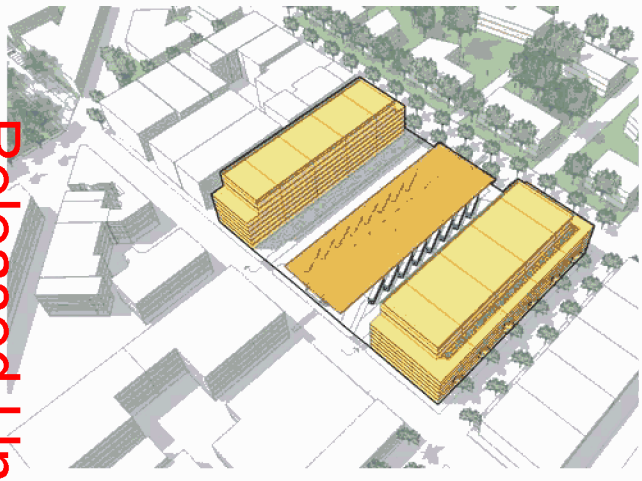


Option 3

This option locates the passenger lounge on the perimeter of the site facing Lichfield Street. All 16 bus bays are provided on the southern side of the lounge in a finger arrangement.
Building platforms for other development are available along Colombo Street, Tuam Street and on part of the eastern boundary.

Option 1





Strengths

PT

- Simple and direct bus movements
- Bus routes can be permanently allocated to stops
- Compatible with dynamic stop allocation - buses can circulate freely and access any stop - resilient to problems in interchange
- Relaxed sawtooth requires less reversing to clear compared with full sawtooth, simultaneous passenger loading and unloading (shorter dwell)
- Bus movement in each lane limited to 8 stops in normal operation (36/hr)
- Flexible layout (approach/depart routes)
- System efficiency: greater adaptability to be reliable

Passenger

- Good for transfer customers

Urban Design

- Good N-S precinct connectivity
- Good street edge onto Colombo
- Good frontage onto Struthers Lane
- Passenger lounge has some potential to activate Lichfield and Tuam Street
- Passenger lounge opposite Kivers Lane allows for direct connection to Retail Precinct
- Interchange visible on Lichfield and Tuam Street

Value

- Compact facility

Safety

- Lane along eastern boundary is screened from bus area by a building

Weaknesses

PT

- Buses cross over at entrance and exit but with wide separation of entrances impact should be low
- Reversing buses - weaves required for 'front' buses near exits, potential for delay to get to exit - though wide exit helps
- Pedestrians cross a bus roadway to access any stop in the interchange
- Tuam exit is close to Colombo Street

Passenger

- Less suitable for terminal passengers
- Limited quality of user experience

Urban Design

- Poor E-W precinct connectivity
- Doesn't address the corner Colombo/Lichfield Street
- Difficult to achieve good street edge onto Lichfield and Tuam St.

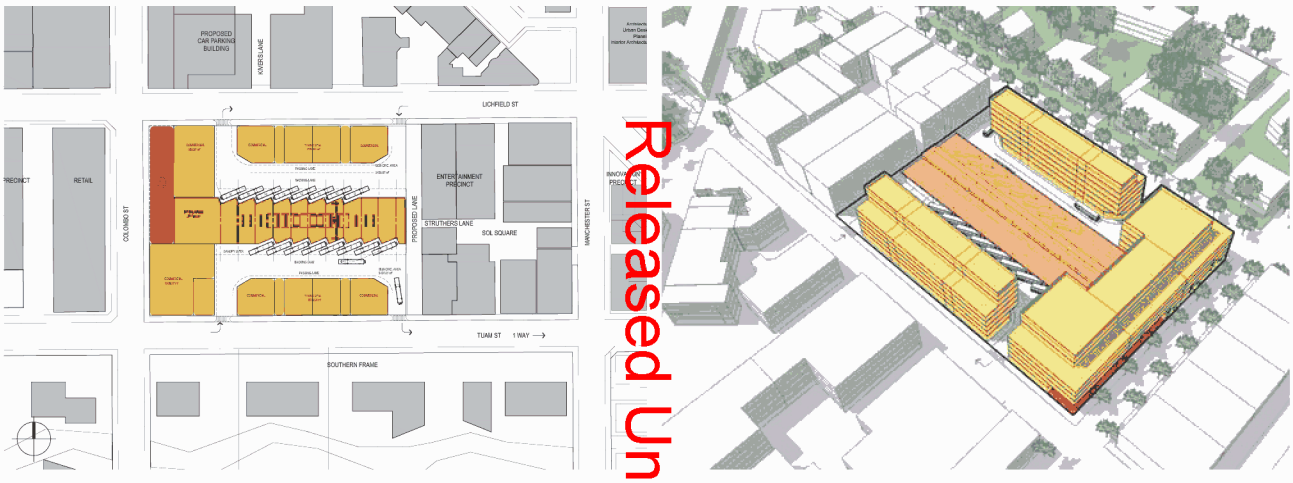
Value

- Limited opportunity for retail to support lounge
- Less attractive to private sector investors
- Building footprint on eastern boundary has limited street frontage

Safety

- Increased conflict of station buses interacting on Lichfield and Tuam Street
- Significant increase in pedestrian bus conflicts (Pedestrians have to cross a bus roadway to access any stop in the interchange)
- Pedestrians on Lichfield and Tuam Street footpaths encounter 2 bus crossings within short distance

Option 2



Strengths

PT

- Self-contained bus zones - no conflict between entering and exiting buses
- Bus routes can be permanently allocated to stops
- Semi-dynamic bus stop allocation possible (within two zones)
- Relaxed sawtooth requires less reversing to clear compared with full sawtooth, simultaneous passenger loading and unloading (shorter dwell)
- Bus movement in each lane limited to 8 stops in normal operation (36/hr)
- Good pedestrian-vehicle separation - less likelihood pedestrians will enter from roadway
- System efficiency: least adaptable to be reliable, inability to connect northern and southern bus areas

Customer

- Good for transfer and terminal customers
- Passenger lounge can be directly accessed from Colombo Street and S.O.L. Square without crossing bus ways

Urban Design

- Good E-W precinct connectivity
- Potential to address corner Colombo/Lichfield Street
- Strong street edges onto Colombo, Lichfield and Tuam Street
- Good frontage onto Struthers Lane
- Interchange visible on Colombo Street

Value

- Long street frontage available for private sector investors
- Potential for retail to support lounge (on Colombo Street side)

Safety

- Entry to passenger lounge from Colombo Street and S.O.L. Square doesn't require passengers to cross bus entry and exit ways

Weaknesses

PT

- Requires additional bus movement on street due to two separate areas
- Not as flexible in dynamic stop allocation potential without connection between two sides of interchange
- More manoeuvring needed than in Option 1
- Delays to exit onto Tuam or Lichfield can lead to congestion in facility

Customer

- Passenger lounge is 'site internal' and has limited visual connection to surrounding public realm

Urban Design

- Limited N-S precinct connectivity
- Poor connection between passenger lounge and Kivers Lane / Retail precinct
- Passenger lounge has limited potential to activate streets

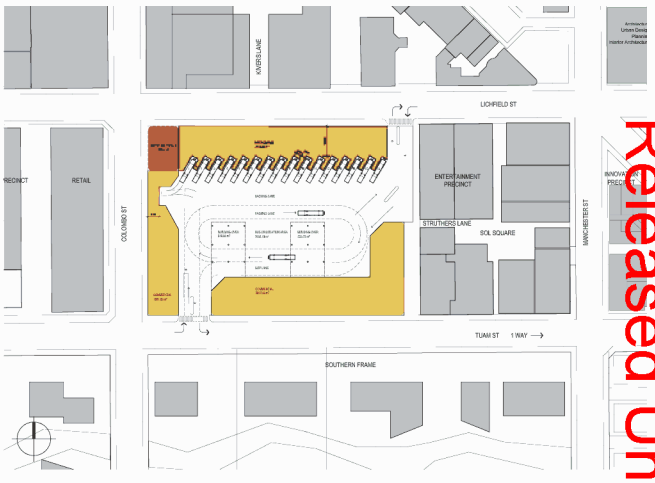
Value

- Larger footprint of facility due to required presence of waiting lounge on Colombo Street

Safety

- North side bus operation increased pedestrian conflict on Lichfield Street (buses coming back on themselves)
- Passengers arriving from Kivers Lane have to cross bus way to access lounge
- Lane along eastern boundary is in parts directly adjacent bus area

Option 3



Strengths

PT

- Consolidated stops in single facility allows better management of stops (higher efficiency potential)
- Compatible with through bus routes with north-south connection
- Compatible with dynamic stop allocation - buses can circulate between stops
- System efficiency: high level of adaptability to improve reliability, however internal bus/bus movements reduce its ability to deliver

Passenger

- Good for transfer and terminal customers
- Passenger lounge visually connected to surrounding public realm

Urban Design

- Addresses corner Colombo/Lichfield Street
- Good Street edge onto Colombo, Lichfield and Tuam Street
- Good frontage onto Struthers Lane
- Passenger lounge activates Lichfield frontage
- Passenger lounge opposite Kivers Lane allows for direct connection to Retail Precinct
- High visibility of PT interchange within the urban fabric

Value

- Compact passenger lounge

Safety

- Passenger from Kivers lane have direct access to lounge

Weaknesses

PT

- All buses share circulation roadways - 72 buses per hour in short roads - risk of congestion
- Potential for conflicts between buses near exit
- All buses share same access/egress roadway for bus stops - greater potential for delays compared with other options due to interaction between buses at stops?
- Steeper sawtooth may require longer dwell times as simultaneous passenger loading/unloading not possible
- Close proximity of entrance/exit to Tuam /Colombo intersection - very close.
- Access/egress for stop 1 - needs to be confirmed in trials
- Access and egress for stop 16 - close proximity to exit, potential conflict with exiting buses
- Capacity - a lot of circulation and requirements for buses to join and leave flows - possible issues with ability to accommodate flows approach 100 buses (or indeed almost 200)
- Increased risk of internal congestion with this option

Passenger

- Poor linkage to S.O.L. Square
- Entry predominantly from Lichfield Street side

Urban Design

- Limited E-W / N-S precinct connectivity

Value

- Limited opportunity for retail to support passenger lounge

Safety

- Passengers from S.O.L. Square have to cross a bus entry/exit way to access waiting lounge
- Lane along eastern boundary is in parts directly adjacent bus area

4. Design Team Appointment and Concept Review

The Design Team (Architectus/Aurecon) for the Bus Interchange were appointed by CERA in November 2013.
The team reviewed key design assumptions for the three concept options, including bus routes and frequencies, the street network, urban integration and bus operational and manoeuvring assumptions. The benefits of Option 3 led to this option being the preferred layout but weak areas had to be addressed.

Revision of Design Assumptions

Updated bus network and service levels information supplied by Environment Canterbury (ECan) had substantial implications for the concept options.
Latest bus network planning for the 'Hubs and Spokes' network increases both the number of bus routes and peak bus flows to be accommodated in the Bus Interchange.
The number of individual bus routes to be accommodated increases from 7 (September 2012 advice) to up to 14, with weekday peak hour bus flows increasing from 72 to up to 97 buses per hour.
The combination of increase in bus routes to be accommodated (which has customer legibility implications) and increased peak period bus flows, necessitates use of a bus management system with semi-dynamic bus stop allocation in the interchange.

- Options 1 and 3 are compatible with semi-dynamic bus stop allocation.
- Option 2, because it lacks provision for internal bus circulation, is less compatible with semi-dynamic stop allocation and is considered to have insufficient bus capacity in light of latest bus network and service level projections.
- The review of design assumptions concluded that Option 1 had relatively poor urban integration potential, while Option 3 is considered to have excellent urban integration potential, but needed some improvement.

Evolved Option 3*

An evolved Option - named 3* for the purpose of this report - has been produced to

a) overcome the weaknesses of Option 3

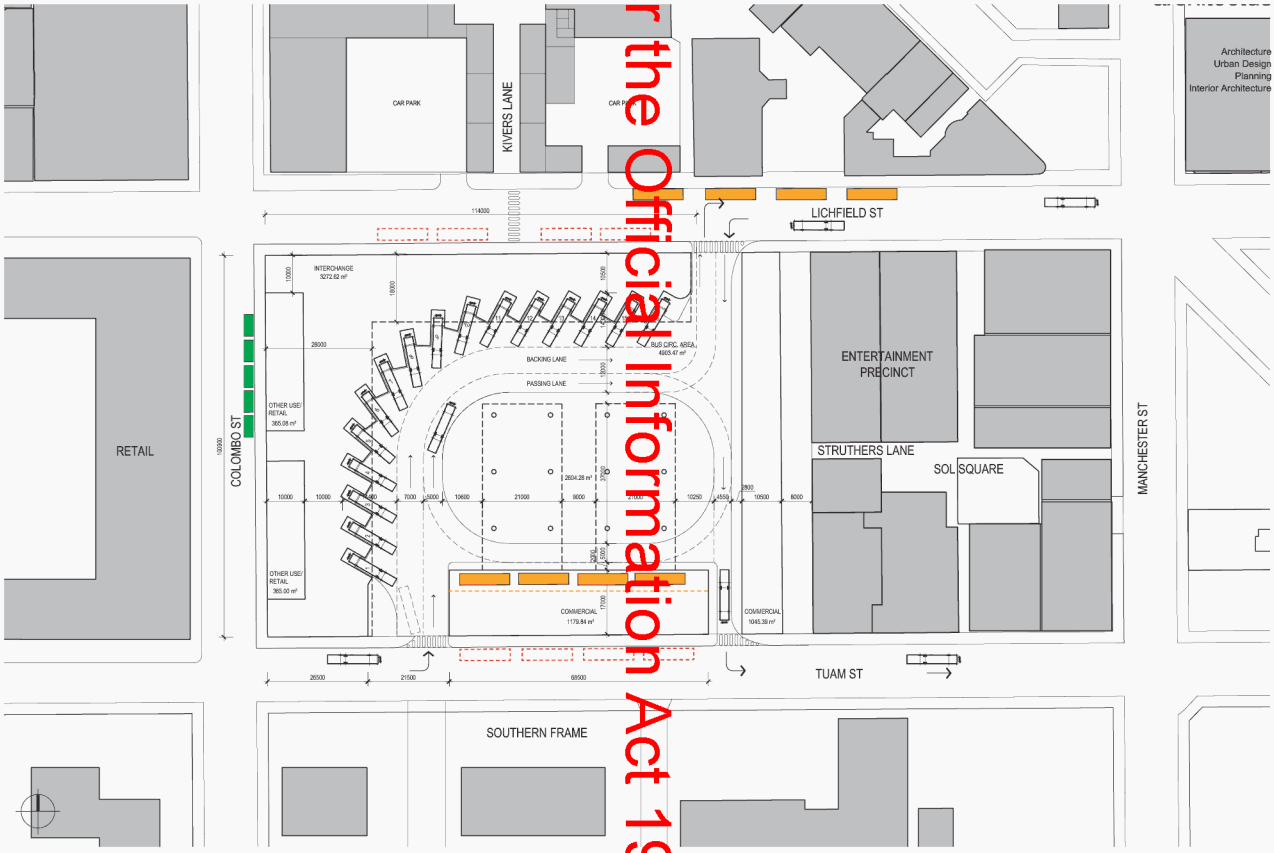
b) deal with the revised network and service levels

Option 3* has the following improvements:

- More generous bus stands and increased finger widths
- Bus circulation area has a dedicated entry and exit on Tuam Street, which reduces risk of internal congestion
- L-shaped passenger lounge extending south along Colombo Street allows entry also from Tuam Street
- Colombo Street frontage has the possibility of 'blended/integrated' retail (flexible space to cater for change in patronage)
- The bus interchange building alone has the potential to repair the street frontages on Colombo Street and Lichfield Street; i.e. these two street frontages don't rely on private development
- A better interface to S.O.L. Square and Struthers Lane by introduction of a narrow building running north-south along the eastern end of the Bus Interchange

4. Design Team Appointment and Concept Review

Plan Layout and analysis of Option 3* follow below:



Option 3* with possible coach and taxi locations

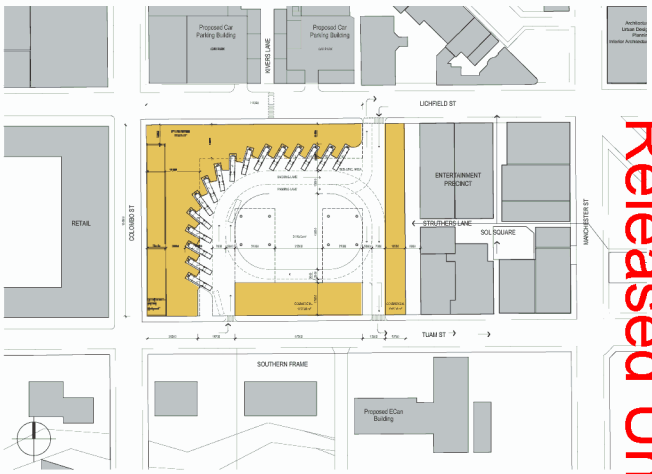
Coach locations:

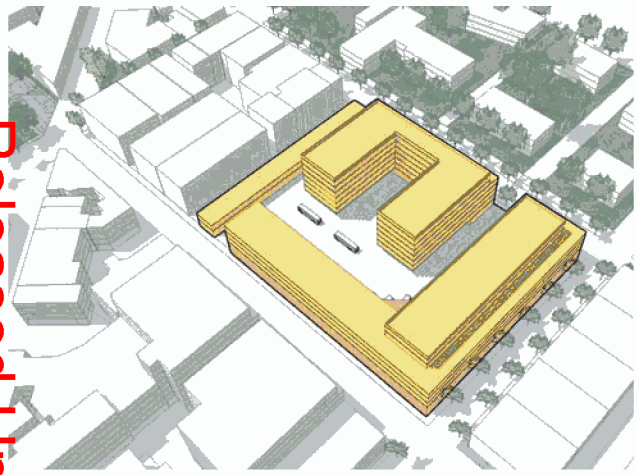
Opposite side of street:	possible on Lichfield St
Perimeter of site:	possible on Lichfield St and Tuam St
On site:	potential to implement a dedicated lane

Taxi location:

Colombo Street

Option 3*





Strengths

PT

- Compatible with through bus routes with north-south connection
- Compatible with dynamic stop allocation - buses can circulate between stops
- Compared to Option 3 bus stands are more generous which reduces risk for interaction between buses at stops compared to option 3
- Compared to Option 3 additional exit onto Tuam has been added, which reduces risk of internal congestion and conflict between buses at exits

Passenger

- Good for terminal customers
- Majority of passenger lounge visually connected to surrounding public realm
- Access to lounge from Colombo, Lichfield and Tuam Street

Urban Design

- Good N-S precinct connectivity
- Addresses corner Colombo/Lichfield Street
- Good street edge onto Colombo, Lichfield and Tuam Street
- Good frontage onto Struthers Lane
- Passenger lounge activates Colombo and Lichfield frontage
- Passenger lounge opposite Kivers Lane allows for direct connection to Retail Precinct
- High visibility of PT interchange within the urban fabric

Value

- good opportunity for retail to support lounge
- flexibility for passenger growth and demand (retail as buffer)

Safety

- Lane along eastern boundary is screened from bus area by a building

Weaknesses

PT

- Steeper sawtooth may require longer dwell times as simultaneous passenger loading/unloading not possible

Passenger

- Increased distance for transfer passengers

Urban Design

- Limited E-W precinct connectivity

Value

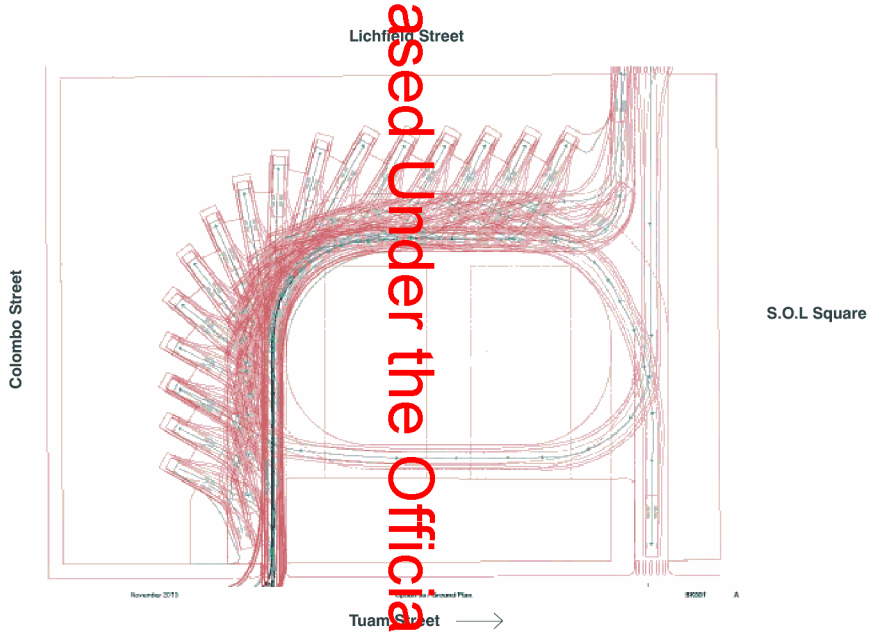
- Increased footprint of facility

Safety

- Passengers from S.O.L. Square have to cross a bus entry/exit way to access waiting lounge

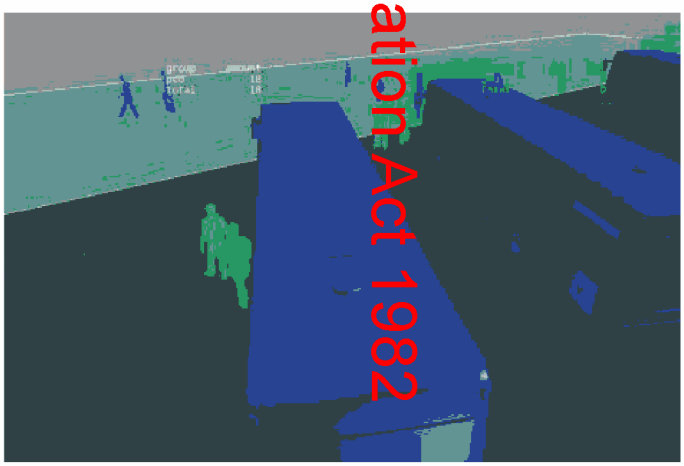
5. Transport Modelling

Tracking analysis of the preferred option 3* has been carried out. The image below shows a screen shot of the analysis.



Turning track analysis of option 3*

The internal bus operation has been modelled and analysed with 'AureALIS' software. A screenshot of the agent based modelling is shown below.



AureALIS modelling of the bus bays and passengers off loading

Withheld under sections 9(2)(b)(ii), 9(2)(f)(iv), 9(2)(i) and 9(2)(j) of the OIA 1982

6. Field Trials

6.1 Previous Field Trials

Previous Bus Interchange field trials in Christchurch in 2009 confirmed that the relaxed sawtooth bus bay layouts in Options 1 and 2 were feasible.

2009 Interchange Bus Trials Wigram – testing of relaxed saw tooth layout

2009 Interchange Bus Trials Wigram – testing of relaxed saw tooth layout with bike rack

6.2 Further Trials

On the 5th December, field testing of option 3* took place. A number of tests were directed by Aurecon, and performed within the Redbus yard. The event was well attended, with representatives from CERA, CCC, ECAN, NZTA, GoBus and Redbus present.

The purpose of the testing was largely to validate the modelling which Aurecon have been conducting on the layout. The tests identified by Aurecon were specifically designed to identify areas of concern, conflict and to test performance of the layout. In summary, the tests validated the modelling and the layout performed well, some minor tweaks to the layout were identified and have subsequently been incorporated in the layout.

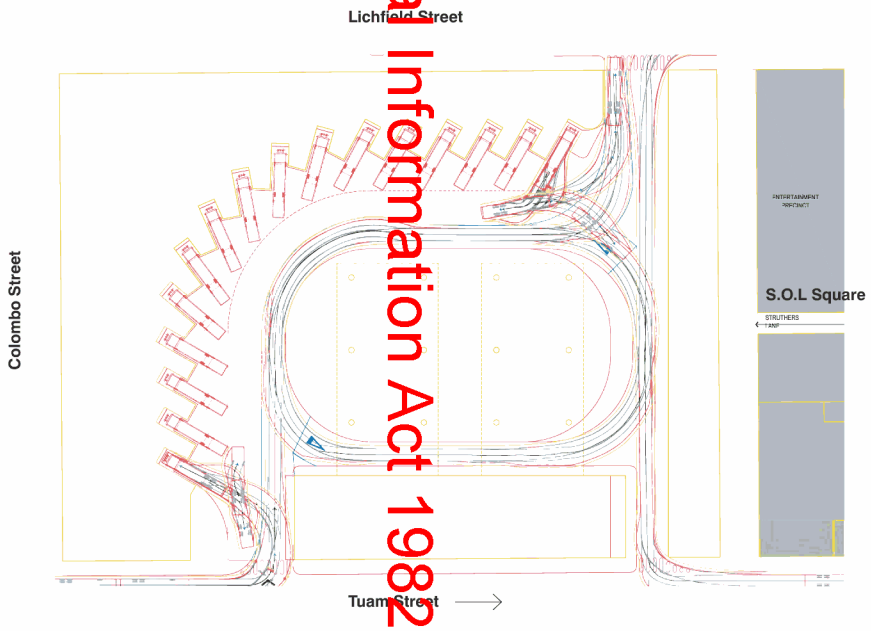
2013 Field Trials Red Bus depot - testing of reversing bus in bay 1 with circulating bus

2013 Field Trials Red Bus depot - Cycle access briefing assessing depth of access area

6. Field Trials contd.

Aurecon have revised kerb and building footprint layout that reflects the results of the bus field trial conducted on the 5th December 2013. The following provide some insight into the proposed changes.

- Easing of Lichfield and Tuam entry drive ways for buses (as a direct result of field trial and driver feedback)
- Please note that the configuration of Lichfield and Tuam cross sections will determine the final entry design. THIS WOULD REQUIRE INPUT FROM CERA.
- Some minor adjustments to kerbs supporting bay 1
- Refining the widths of circulating and reversing lanes particularly towards the north west of the bus operation area
- Refinement of internal circulation roadway which increases the island (surrounded by the circulating lane)
- Lengthened all bays to facilitate access to bikes on buses (confirm 1 metre required between deployed bike rack and end wall of bay) and to accommodate rear door locations. In this drawing we have identified front and rear lounge door locations. We are assuming an additional door would provide access to the bike rack (to be defined how we manage that – thoughts welcomed from the true designers)
- Shown 30 cm wide footpath to form bay wheel stop plus footfall location at bus doors



Turning track analysis of option 3* incorporating refinements post field trial

7. Design Team Recommendation

Having considered all investigated Options on their merits the Design Team recommends Option 3* to be progressed further as it appears to best meet the aspirations and requirements set out in the Detailed Design Brief.

The above massing studies illustrate a fully developed site with other uses above the Bus Interchange, up to the maximum height limit.
The site plan below locates the Bus Interchange in the context of the 'Blueprint' and other developments as currently known.