Appendix I – Access Strategy

Land Development Agency

City to the Lake

West Basin Access Strategy

CttL-S1AW1-TTM-RPT-0002

Draft 1 | 28 April 2015

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This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Contents

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Glossary of Abbreviations

Abbreviation	Meaning
ACT	Australian Capital Territory
ANU	Australian National University
CLRMP	Canberra Light Rail Master Plan
CttL	City to the Lake development
EDD	Economic Development Directorate
GFA	Gross Floor Area
GLFA	Gross Leasable Floor Area
GTGD	*Guide to Traffic Generating Developments*, an RMS-produced document
NCP	National Capital Plan
NMA	National Museum of Australia
NSW	New South Wales
PWD	Persons with Disabilities
RMS	Roads and Maritime Services (NSW Government Department)
TAMS	Territory and Municipal Services
vpd	Vehicles per day

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1 Introduction

1.1 Background

The City to the Lake (CttL) development is proposed to introduce a mix of land uses to the area between Civic (the “City”) and Lake Burley Griffin (the “Lake”). The development is intended to promote increased connectivity and public usage of the area, with the first stages of development (Stages 1A, 1B and 2) focussed in the West Basin area:

- Stage 1A refers to the development of the West Basin foreshore from Commonwealth Avenue bridge to Edinburgh Avenue;
- Stage 1B refers to the development of the West Basin foreshore from Edinburgh Avenue to the National Museum of Australia; and
- Stage 2 refers to further residential and commercial development of the West Basin area.

The study area, which currently consists mainly of open air at-grade car parks and parkland, is bounded by:

- Lake Burley Griffith to the south and west;
- Parkes Way to the north; and
- Commonwealth Avenue to the east.

The study area is presented in Figure 1, showing Stages 1A, 1B and 2. A comparison of the scope of CttL development in the short term (Stage 1A), in the interim (Stages 1A, 1B and 2) and ultimately is presented in Figure 2. Note that this staging is indicative at present, and will be developed in more detail as the project progresses.

This access strategy primarily focusses on the West Basin area (including the Aquatics Centre shown in Figure 1), as documented in the Illustrative Masterplans (drawings CttL-SWP-LLU-DRG-0005 to 0007). It also considers the interface with adjacent key uses, including:

- Lawson Crescent;
- The National Museum of Australia (NMA); and
- The Australian National University (ANU).

This strategy has been developed to review and provide recommendations regarding the access and parking requirements for the development in the West Basin. This strategy considers the requirements for the site in the short, medium and long terms. For the purposes of this access strategy, these timeframes have been assigned to the various stages of CttL development as follows:

- Short term: Following the completion of Stage 1A (West Basin Foreshore);
- Medium term: Following the completion of Stage 1B; and
- Long term: Following the completion of Stage 2 (West Basin development).

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1.2 Objective of this Access Strategy

This report is intended to outline a strategy to provide safe and efficient access to and from the West Basin area, ensuring that movement routes are legible for all potential visitors to the site.

This access strategy aims to support the commercial viability of the development within the West Basin in the short, medium and long term. It considers access to and from the site using all modes including active transport, public transport and private vehicles.

This report has been structured into the following sections:

- Section 1 – Introduction (this section). This section summarises the background to the City to the Lake project, and in particular, the West Basin works. It also outlines the purpose of the access strategy.
- Section 2 – Planning and Policy Context. This section provides a summary of the planning and policy documents that influence development in the West Basin area. Particular focus is given how these documents affect access to and through the West Basin site, and the requirements for connectivity to the wider region.
- Section 3 – Proposed Development. This section summarises the currently assumed elements of development within the West Basin, and current and proposed transport networks in the region.
- Section 4 – Access Strategy. This section summarises the objectives for access in the West Basin, and presents a methodology for achieving these objectives. This section is separated into a number of sub-sections, each focussing on particular access modes:
  - Section 4.1 – Active Transport. This section explores the potential routes for pedestrians and cyclists to, from and through the West Basin in the short, medium and long term. It suggests a potential path treatment for higher-order routes, and outlines where these routes would lead. This section also explores the requirements for end-of-trip facilities for cyclists to assist in achieving the desired active transport mode share targets.
  - Section 4.2 – Road. This section provides advice regarding individual lot access to the internal road network. It also presents an assessment into the potential traffic generation, distribution and assignment on the internal and external road network. This section also presents a potential internal road hierarchy for the West Basin.
  - Section 4.3 – Parking. This section presents a potential parking management strategy to support the commercial viability of the West Basin area in the short, medium and long term. This includes a discussion on the parking supply within the West Basin, both in terms of location and quantum. An investigation into potential methods of managing car parking demand during a typical day and during an event is also summarised.
  - Section 4.4 – Bus. This section presents an assessment into integration with the current and potential bus network around the West Basin.
  - Section 4.5 – Light Rail. This section presents an assessment into integration with the potential light rail network around the West Basin.

- Section 4.6 – Ferry. This section presents an assessment into integration with potential ferry services around Lake Burley Griffin.
- Section 5 – Summary of Recommendations.

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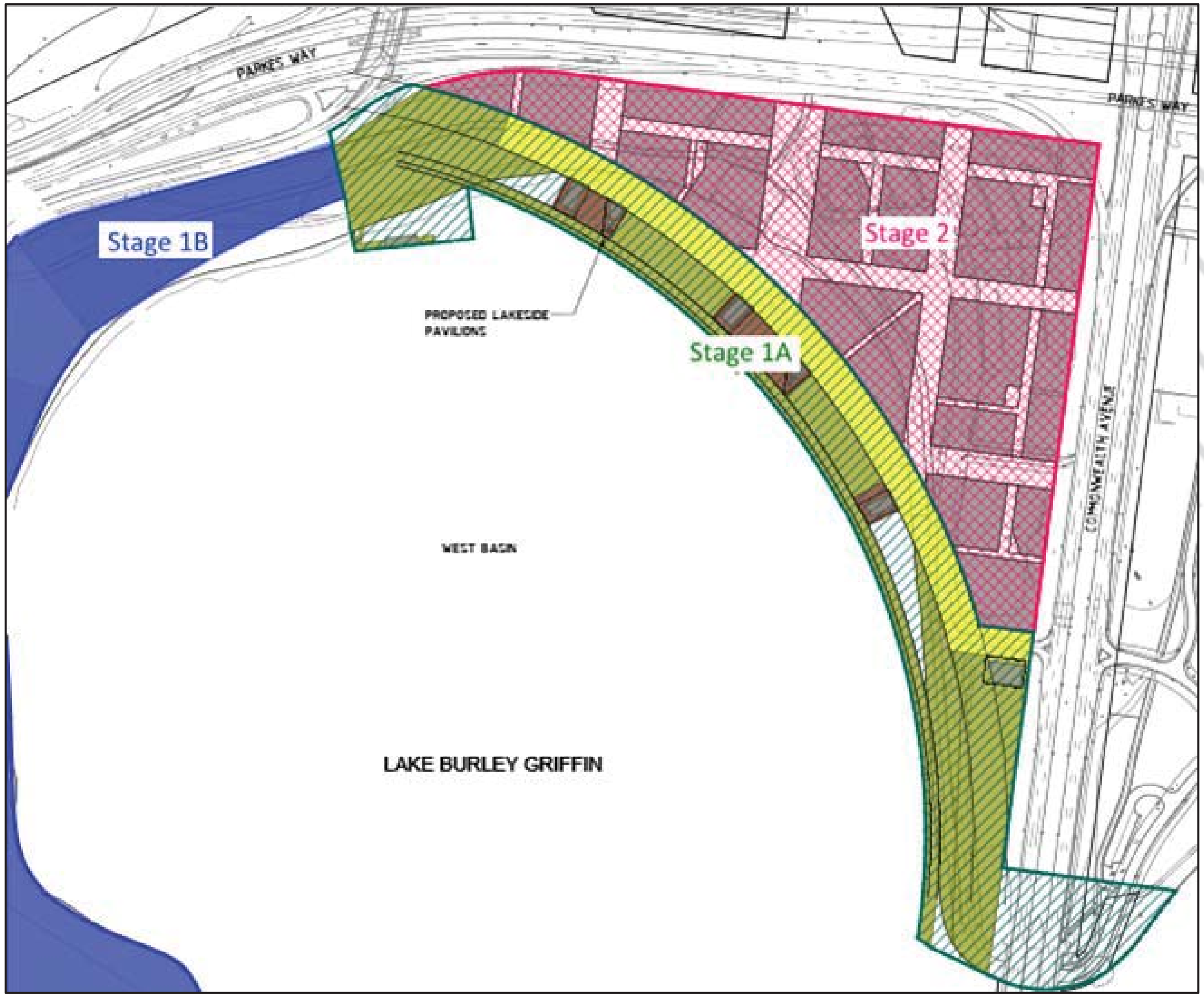

Figure 1 City to the Lake study area

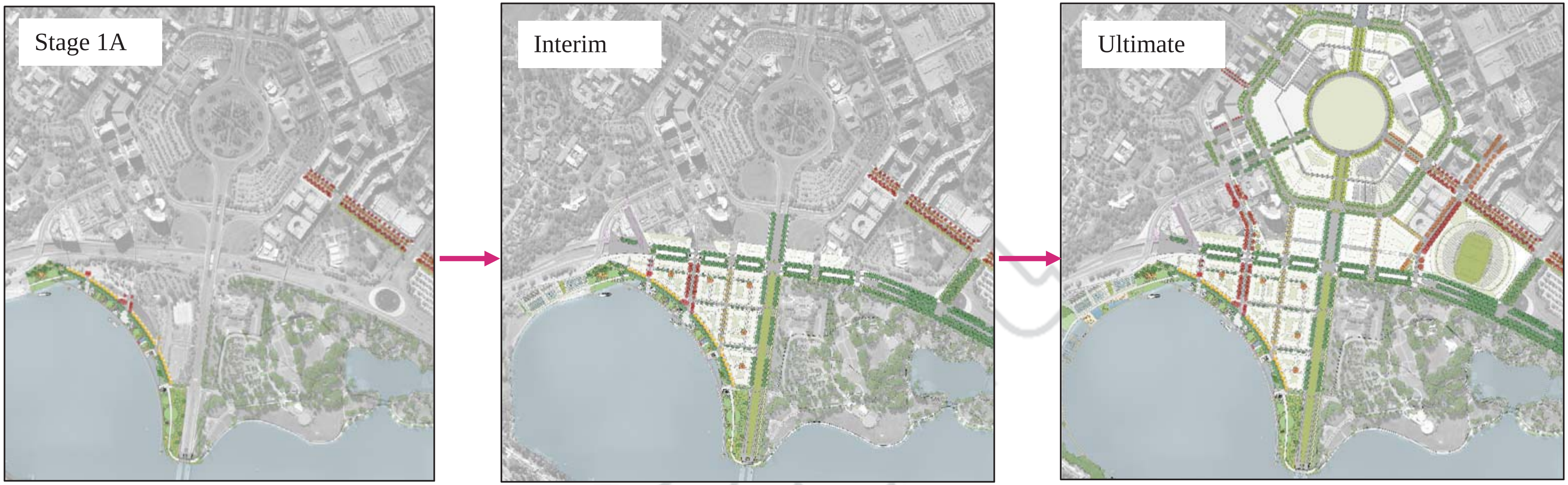

Figure 2 Staging of the City to the Lake development

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2 Planning and Policy Context

2.1 Transport for Canberra

The Transport for Canberra policy was released in March 2012, and forms the ACT Government’s foundation for transport planning in the next 20 years. It sets out policy directions to ensure that transport in Canberra is:

- Safe;
- Active;
- Integrated with land use planning;
- Accessible and socially inclusive;
- Sustainable; and
- Efficient and cost effective.

The policy is cognisant of the fact that the average car mode share within Canberra is higher than other Australian capitals at the expense of public transport mode share, as shown in Figure 3.

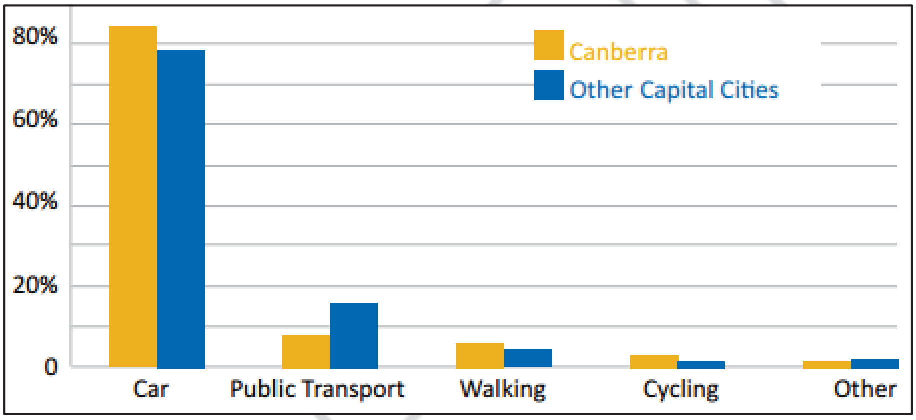

Figure 3 Canberra Journey to Work Mode Share in 2006 (source: ABS via ACT Government)

It also notes that although walking and cycling mode share is higher in Canberra compared to other capitals, the goal should still be to achieve higher mode shares for public transport, cycling and walking in the future. The Transport for Canberra policy targets a combined 30% mode share for public transport, walking and cycling by 2026 for the Canberra region. Trends in Canberra and other cities suggest that the mode share of cars is higher in areas further away from the Central Business District. As such, in order to achieve the 2026 targets, the actual active and public transport mode share in the vicinity of the city must be higher than 30%.

With respect to the West Basin, the key outcomes sought from this document are:

- Ensure that people who wish to utilise active modes of transport (walking, cycling) can easily do so around the site;

- Provide a safe means of moving to/from and around the site, whether it be by car, on foot, cycling or via public transport; and
- Ensure that the development is near and is integrated with the frequent public transport network.

2.2 Canberra Light Rail Master Plan

The Canberra Light Rail Master Plan (CLRMP) is a document that sets out the objectives for light rail in Canberra to 2031 and beyond. Amongst other priorities, the CLRMP is focussed on improving mobility and accessibility for Canberrans, encouraging the use of sustainable transport modes and stimulating development along transport corridors.

Stage 1 of the Canberra Metro project is proposed to run from Gungahlin to the City. The CLRMP explores multiple potential opportunities for extending the network through the City to other parts of Canberra. The investigations presented in the CLRMP include potential future extensions of the network, with one particular investigation focussing on routes through the Parliamentary precinct. One option is to extend the light rail network via Commonwealth Avenue to the Parliamentary precinct and beyond.

It is considered important that the layout of the West Basin roads and paths be responsive to the future light rail corridor to the east of the development.

2.3 National Capital Plan

The National Capital Plan (NCP) is a strategic plan that guides the development of Canberra and the Australian Capital Territory to ensure that the region is “planned and developed in accordance with their national significance” (National Capital Authority 2015).

The most important region falling within the NCP is the Central National Area, which encompasses the area around Lake Burley Griffin, as shown in Figure 4.

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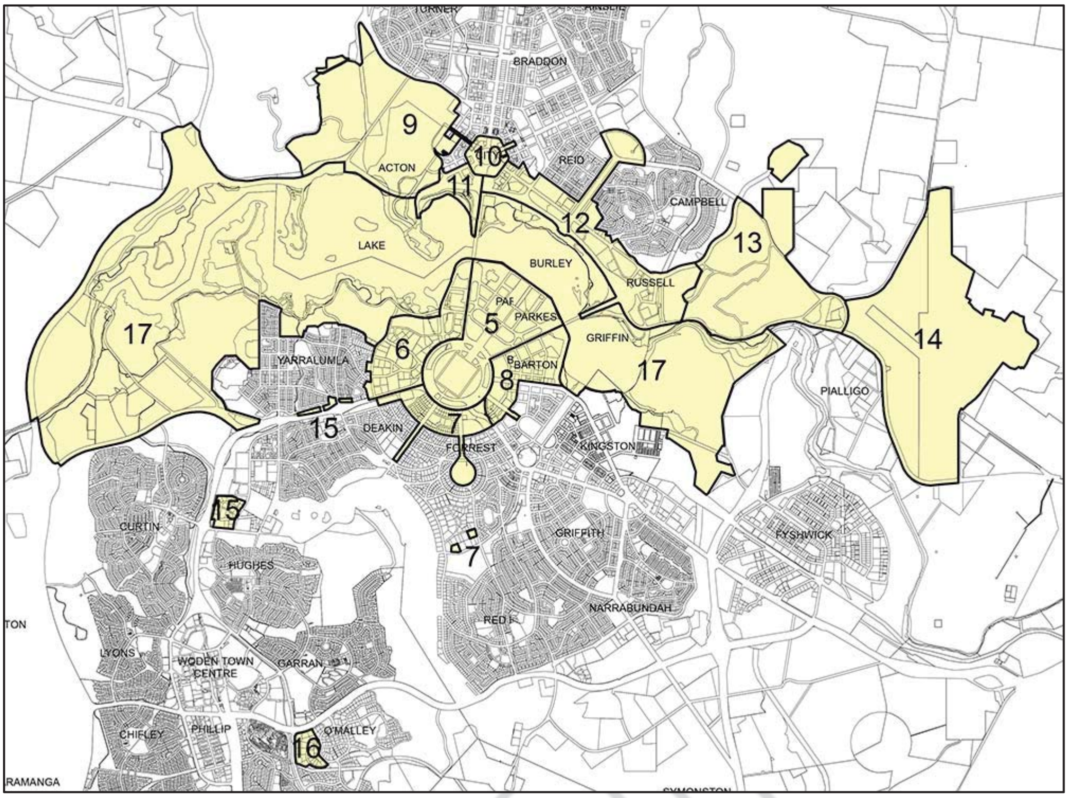

Figure 4 Central National Area (source: National Capital Authority)

The West Basin area, shown as region 11 in Figure 4, is a Designated Area under the NCP. The NCP's principles for the West Basin include:

- Create a legible network of paths and streets that extends the city to the lake;
- Create a vibrant public waterfront promenade in the Central National Area;
- Enhance the range of tourism and recreation experiences available on Lake Burley Griffin;
- Enhance continuous public access to the lake shore with links to the surrounding national attractions;
- Provide a mix of land uses;
- Realise key elements of the geometry and intent of the 1918 Griffin Plan at West Basin;
- Develop a built environment which demonstrates design excellence; and
- Achieve best practice environmentally sustainable development.

These principles will influence the preparation of the West Basin master plan. The National Capital Plan also defines a number of specific outcomes that should be achieved in the West Basin area, many of which have an impact on transport and access. The key implications of the National Capital Plan for the access strategy are:

- Provide a continuous public access route around West Basin linking the Parliamentary Zone and other national attractions;
- Extend the city grid of streets and paths to provide connectivity and accessibility between the city and the lake;

- Parking should be integrated with street tree planting to minimise visual impact;
- Provide a continuous pedestrian and cyclist network along the foreshore to link with the existing networks;
- Allow for ferry landing points;
- Avoid large permanent off-street car parking areas, with basement or above-ground structures obscured by facades preferred;
- Provide on-street parking along major streets to support retail uses, pedestrian amenity and after-hours activity; and
- Provide a road hierarchy consisting of major roads, major streets and minor streets with the flexibility to allow temporary closures of minor streets for significant pedestrian events.

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3 Proposed Development

3.1 Land Uses

Stage 1A of the City to the Lake development includes works along the lake foreshore area, with the majority of new land uses being recreational / parkland uses.

In the longer term following Stage 2, the proposed development in the West Basin area will consist of a number of land uses, including:

- Recreational / parkland uses along the foreshore (as per the interim stage), and at the aquatic centre to the west of the site;
- Residential;
- Commercial; and
- Retail.

The exact area of the residential, commercial and retail uses has not been confirmed at this stage. It is anticipated that those uses will be characterised by medium to high rise development in the West Basin.

3.2 Road Network

Following Stage 1A of the CttL development, the road network within the West Basin will be similar to the existing network. The exception is the replacement of Barrine Drive with the Waterfront Boulevard following the new lake shoreline. Access to and from Waterfront Boulevard is proposed to be via Commonwealth Avenue at the existing Albert Street intersection, as shown in Figure 5.

Figure 5 Stage 1A road network (indicative)

The construction of Stage 1A and Waterfront Boulevard will lead to a minor reduction in car parking supply in the area, from 805 car parking spaces currently to around 691 spaces following the development. An assessment of the parking figures indicates that the reduced car parking supply should still be able to accommodate the anticipated parking demand (refer to the Traffic Assessment Report – Stage 1A Works Package 2: CttL-S1AW2-TTM-RPT-0001).

The Waterfront Boulevard is intended to be a low traffic shared zone, with access for servicing and to a relatively small number of on-street parking bays only. Vehicle turn-around manoeuvres will be possible through a number of "hammerhead" style facilities located along the boulevard. The main access to the existing open-air car parking areas is proposed to be via a connection directly from Commonwealth Avenue (at the existing intersection with Corkhill Street).

The long term road network within the development is proposed to be a grid system bounded by Parkes Way to the north, Commonwealth Avenue to the east and the Waterfront Boulevard to the south. It is anticipated that the later stages of the West Basin development will be completed following the Parkes Way upgrade works. This Access Strategy was developed based on the following Parkes Way upgrade assumptions:

- A boulevard style carriageway constructed at/near the West Basin site level to cater for local traffic, with at-grade intersections with the West Basin access roads. The allowable movements at each intersection are dependent on the solution selected for the upgrade, as the presence of ramps may preclude the construction of all-movements intersections at some locations; and
- A tunnel to allow east-west through traffic to bypass the new intersections and the Commonwealth Avenue intersection.

Access to the West Basin in the ultimate development scenario will be possible via Commonwealth Avenue or Parkes Way. The longer term road network is illustrated in Figure 6.

Figure 6 Long term road network in the West Basin (indicative)

3.3 Public Transport Network

3.3.1 Bus

The existing bus network is not expected to change in the short term following Stage 1A of CttL. The existing bus network includes a number of bus routes running in the vicinity of the West Basin. However, the closest permanent bus stops are located on Edinburgh Avenue, which is over 400m walk from the Waterfront Boulevard. The existing bus routes in the area are shown in Figure 7.

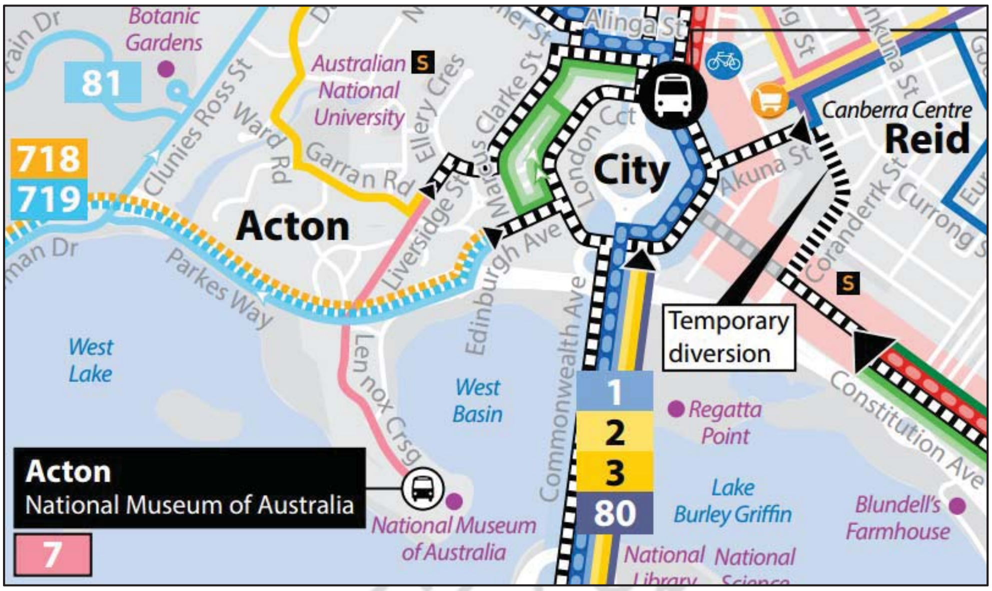

Figure 7 Bus routes near the West Basin (source: ACTION buses)

There may, however, be an opportunity to activate the existing stops on Commonwealth Avenue near Albert Street on a more permanent basis to improve coverage of the West Basin area.

Following the development of Stage 2, there may be an opportunity for buses to run along Parkes Way (boulevard level), providing better public transport coverage to the northern side of the site.

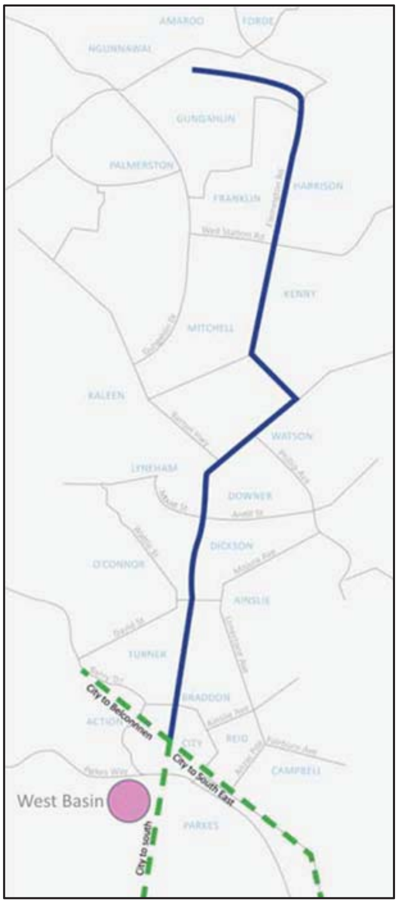

Figure 8 Indicative extensions to the Canberra Metro (source: ACT Government)

3.3.2 Light Rail

The Canberra Metro project aims to introduce light rail to Canberra, and is proposed to be delivered in multiple stages across the city.

Stage 1 of the Canberra Metro project is planned to link Gungahlin to the city along Flemington Road and Northbourne Avenue, and is expected to begin construction in 2016.

The first stage of the Canberra Metro is unlikely to have a major impact on development in the West Basin in the short term. As such, there is unlikely to be a significant level of Light Rail usage to or from the West Basin following the construction of CttL Stage 1A.

In the longer term, the Canberra Light Rail Master Plan (refer to Section 2.2) considers potential extensions of the network beyond the city.

One potential option is to extend the network to the Parliamentary precinct and Woden, via Commonwealth Avenue as shown in Figure 8.

If this extension proceeds, there is an opportunity to provide a light rail station on Commonwealth Avenue adjacent to the site.

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3.3.3 Ferry

According to the NCP, there are plans to introduce a ferry service around Lake Burley Griffin, with at least one terminal to be provided along the foreshore of the West Basin. Although a ferry terminal is proposed to be constructed as part of Stage 1A, a ferry service is not anticipated to begin service immediately at that point, and a service is more likely to be provided in the longer term. Similarly, water taxi services are not expected in the short term, however, they may be provided further in the future.

In the short and medium term, the ferry terminal is expected to be used by ad-hoc services and scheduled charters, such as cruise, sightseeing and other pleasure boats. It is assumed that these services will not be used to transport people between different terminals around the lake and will instead operate as 'loop' services. In the long term (following Stage 2), there may be the opportunity to introduce regular passenger ferry services from the ferry terminal.

4 Access Strategy

Following consideration of future planning for Canberra and the West Basin area, the CttL access strategy was developed around four main principles:

- **Active** and **Sustainable**: Provide opportunities for visitors to use active and public transport to travel to and through the site;
- **Safe**: Provide a safe means of entering, exiting and moving around the site;
- **Accessible**: Provide a means for all visitors to enjoy the site;
- **Efficient**: Efficiently cater for the demand for trips to and from the site, minimising the impact on the surrounding network.

These principles are largely based on the Transport for Canberra policy, and are consistent with the proposed nature of the CttL development.

These access principles have an impact on various elements of the CttL development, including:

- Road and intersection layout: The layout of the internal roadways within the site needs to be legible and safe. This can be achieved by defining a clear road hierarchy, and ensuring that the design of internal roadways and intersections complies with the relevant standards;
- Pedestrian and cycle path layout: The layout of pedestrian, cycle and shared paths within the site should follow desire lines, and provide sufficient width to accommodate the cyclist and pedestrian volumes;
- Positioning of future bus stops: The location of future bus stops should maximise the number of people who live or work within the stop catchment area; and
- Parking management strategy: On-site parking should include sufficient spaces for people with disabilities to enable equitable **access** to the development. Each of the residential / commercial / retail lots on site should be provided with adequate (but not excessive) off-street car parking for residents and staff to ensure that sufficient on-street car parking is available to visitors. Parking controls (such as access controls and time limited parking) should be considered to promote the **efficient** use of on-street parking, and to encourage greater use of **active** and **sustainable** modes of transport.

This access strategy also considers connections between West Basin and important adjoining attractions, including the National Museum of Australia and the Australian National University.

Further details of the access strategy for CttL development is presented in the below sub-sections.

4.1 Active Transport

One of the key aims of the proposed CttL development is to facilitate greater levels of active transport usage in the area. As the City to the Lake project name suggests, one key connection is between the City and the West Basin.

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The objective of the access strategy with respect to active transport is to maintain the existing strong active transport links around Lake Burley Griffin, while introducing a greater level of connectivity with the City and other nearby destinations.

In the short term, the main pedestrian and cyclist path will run parallel to the Waterfront Boulevard along the foreshore. Connections will be provided to:

- Civic and the Australian National University via the existing the footbridge at Marcus Clarke Street;
- Commonwealth Avenue at the end of the Waterfront Boulevard;
- Commonwealth Park via the underpass below Commonwealth Avenue bridge; and
- The National Museum of Australia via the existing pathway to the east.

This network is shown in Figure 9.

Figure 9 Short term pedestrian and cyclist network in West Basin

In the long term, the proposed grid layout of the road network within the West Basin offers an opportunity to provide multiple parallel pedestrian and cyclist routes. Allowing for efficient pedestrian and cyclist movement along each of the streets will make the West Basin area more **accessible** by ensuring that pedestrian and cyclist desire lines are not obstructed.

It is noted that in the long term, the construction of the Parkes Way upgrade is likely to lead to the removal of the existing pedestrian footbridge at Marcus Clarke Street. Connectivity between the West Basin and the areas to the north of Parkes Way (including Civic and the Australian National University) is critical in achieving the urban design goals of the West Basin, and is also consistent with the goals of the Transport for Canberra policy (refer to Section 2.1) and the National Capital Plan (refer to Section 2.3). As such, it is important to maintain connectivity across Parkes Way in the long term. This could be achieved through the provision of signalised pedestrian crossings across Parkes Way, particularly at proposed all-movements intersections. Further discussion on intersection form is provided in Section 4.2.4.

It is recommended that each of the future streets are provided with paths that are sufficiently wide to accommodate the high volumes of slow moving pedestrians walking between shops as well as cyclists. Consideration should also be given to areas that may be reserved for outdoor dining or for vegetation, which should be excluded from path width calculations.

The proximity of the West Basin to Civic and the Australian National University, combined with its connection to the wider cycle network around Lake Burley Griffin means that there are likely to be high volumes of pedestrians and cyclists in the West Basin. Modelling documented in the ACT's "Canberra Central 'City to the Lake' Masterplan Design Appraisal" report prepared by Atkins in 2014 (referred to from here on in as the "Atkins report") suggests that the anticipated number of pedestrians for the West Basin area will be in the order of 500 people per hour.

As such, separated cycle and pedestrian paths are preferred over shared paths to avoid collisions. Based on the anticipated pedestrian volumes, the minimum pedestrian path width is 2m. The minimum bicycle path width should be 2.5m for a separated two-way path, or 1.5m for on-road bicycle lanes (one in each direction). Separation is especially important for key commuter routes through and around the West Basin, as shown indicatively in Figure 10. This ensures that slower pedestrians visiting the active commercial frontages do not obstruct higher-speed commuter cyclists.

It is noted that one of the north-south streets within the West Basin has been nominated as a commuter route towards Civic. The exact route will, however, depend on the design of Parkes Way. It is anticipated that at least one pedestrian/cyclist crossing will be provided over the Parkes Way lower motorway level, and the active transport infrastructure within the West Basin should integrate with this crossing. This is consistent with the Atkins report, which suggests that one of the two north-south streets going through the West Basin should be prioritised "to have a high density of active frontages and create a strong and attractive route for pedestrians".

The layout of the Aquatics Centre site is currently unknown, however, it is recommended that pedestrian and cyclist access be provided to the site from both Lawson Crescent and the Waterfront Boulevard. It is noted that there is a significant level difference between the two sides of the site. As such, consideration should be given to providing access on different levels of the Aquatics Centre facility to facilitate equitable access.

Provision of access to the Aquatics Centre from both sides ensures that the key future pedestrian and cyclist desire lines from the north (Civic and the Australian National University) and the West Basin are addressed. There is an opportunity to increase the visibility of the West Basin from surrounding areas (including Civic and the Australian National University) through appropriate signage and other wayfinding devices.

An indicative diagram showing the potential long term pedestrian and cyclist network in the West Basin is presented in Figure 10 for commuters and Figure 11 for non-commuters.

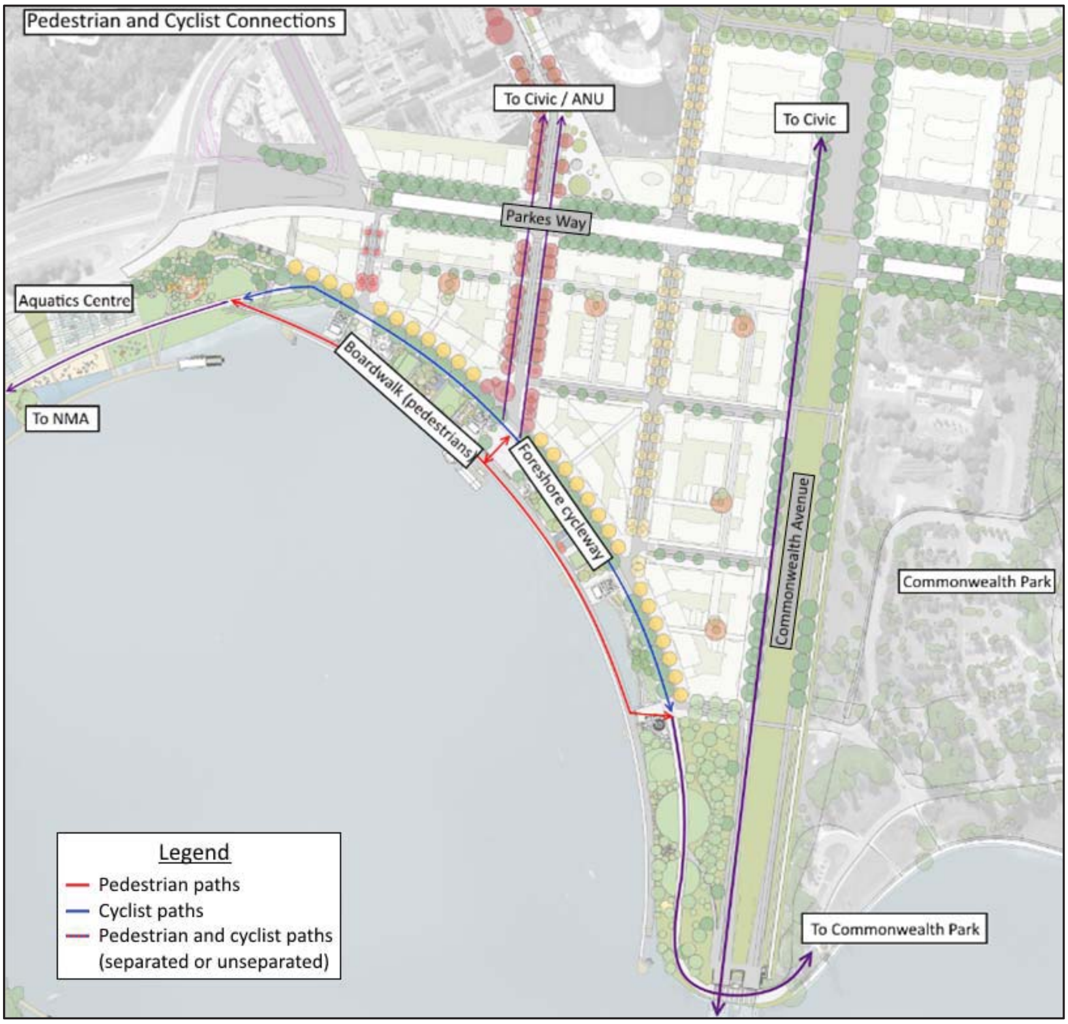

Figure 10 Long term pedestrian and cyclist network in West Basin (commuter)

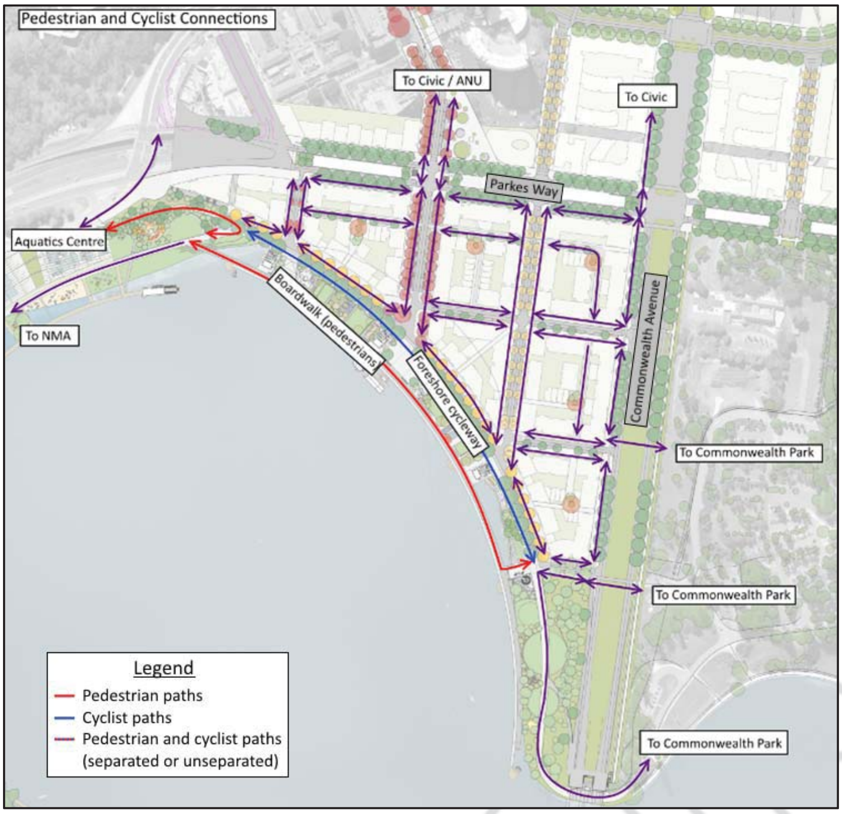

Figure 11 Long term pedestrian and cyclist network in West Basin (non-commuter)

In order to facilitate and encourage cycling within the West Basin area, end-of-trip facilities such as bicycle racks/lockers and shower facilities should be provided. It is recommended as a minimum that cyclist end-of-trip facilities should be provided based on the requirements in the Territory Plan's Bicycle Parking General Code. The locations of these parking areas should be signposted to ensure that potential users are aware of their existence.

A summary of the bicycle parking requirements (mostly by Gross Floor Area (GFA)) for potential uses within the West Basin is provided in Table 1.

Table 1 Bicycle Parking Requirements (source: Territory Plan)

Land Use	Bicycle Parking Required for Staff / Residents (spaces)	Bicycle Parking Required for Visitors (spaces)
Apartment / Multi-unit housing	1 per apartment	1 per 12 apartments after the first 12 apartments
Drink establishment	1 per 100m^2 bar floor area after the first 100m^2 bar floor area, plus 1 per 400m^2 of lounge and beer garden after the first 400m^2 of lounge and beer garden	1 per 25m^2 bar floor area after the first 25m^2 bar floor area, plus 1 per 100m^2 of lounge and beer garden after the first 100m^2 of lounge and beer garden (minimum 2)

Land Use	Bicycle Parking Required for Staff / Residents (spaces)	Bicycle Parking Required for Visitors (spaces)
Hotel	As per drink establishment, plus: 1 per 80 guest bedrooms after the first 50 bedrooms	As per drink establishment, plus: 1 per 30 guest bedrooms after the first 30 bedrooms (minimum 2)
Office	1 per 250m^2 GFA after the first 250m^2 GFA	1 per 950m^2 GFA after the first 400m^2 GFA
Restaurant	1 per 400m^2 GFA after the first 400m^2 GFA	1 per 200m^2 GFA after the first 200m^2 GFA (minimum 2)
Shop (other than Department Stores)	1 per 500m^2 GFA after the first 500m^2 GFA	1 per 300m^2 GFA (minimum 2)
Supermarket	1 per 750m^2 GFA after the first 750m^2 GFA	1 per 300m^2 GFA (minimum 2)
Take-away food shop	1 per 250m^2 GFA after the first 250m^2 GFA	1 per 100m^2 GFA (minimum 2)

It should be noted that the above bicycle parking requirements relate only to the commercial areas of the West Basin development. Bicycle parking for staff and residents should be provided in a secure location, such as individual lockers or a secured storage space. Bicycle parking for visitors should be provided in a more accessible location which can be easily provided with casual surveillance, such as bicycle racks or rails located near building access points.

Additional bicycle parking spaces (in the form of bicycle rails or racks) for visitors to the cultural and recreational uses within the West Basin should also be provided. It is suggested that these be dispersed through the West Basin area to ensure that visitors cycling to the area can easily find a bicycle parking space.

With respect to provision for employee cyclists, showers should be provided in addition to bicycle parking spaces. The number of showers should be in proportion to the number of bicycle parking spaces. The ACT Territory Plan suggests the following provision:

- 5 to 9 bicycle parking spaces: 1 shower;
- 10 to 24 bicycle parking spaces: 2 showers; and
- 25 or more bicycle parking spaces: 2 showers, plus 2 per 20 employee bicycle parking spaces after the first 24 spaces, rounded up to the nearest even number.

These showers should be provided with lockers for storing a change of clothes for cyclists as required.

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4.2 Road

The proposed road hierarchy within the West Basin area was developed using a four-step methodology, which traces the access requirements from the individual lots through the internal road network to the external road network:

- Consideration of vehicular access to lots (Section 4.2.1);
- Estimation of trip generation (Section 4.2.2);
- Assignment of trips on the external road network (Section 4.2.3); and
- Development of a potential internal road hierarchy to facilitate the access strategy (Section 4.2.4).

It was assumed that development of the majority of lots within the West Basin will require the future grid street network within the West Basin to be built, as well as the upgrade to Parkes Way. As such, an interim development stage with partial development on site being accessed solely from Commonwealth Avenue has not been considered.

4.2.1 Vehicular access to Lots

Vehicular access to West Basin lots should be provided on the access lanes and minor streets, where possible.

Direct property access from shared zones should be discouraged to minimise vehicle volumes and improve the environment for pedestrians and cyclists and to reduce the number of potential conflict points.

In relation to the Aquatics Centre, two potential access options were considered:

- Option 1: Access via Lawson Crescent only; or
- Option 2: Access via Lawson Crescent and Waterfront Boulevard.

These options are presented in Figure 12.

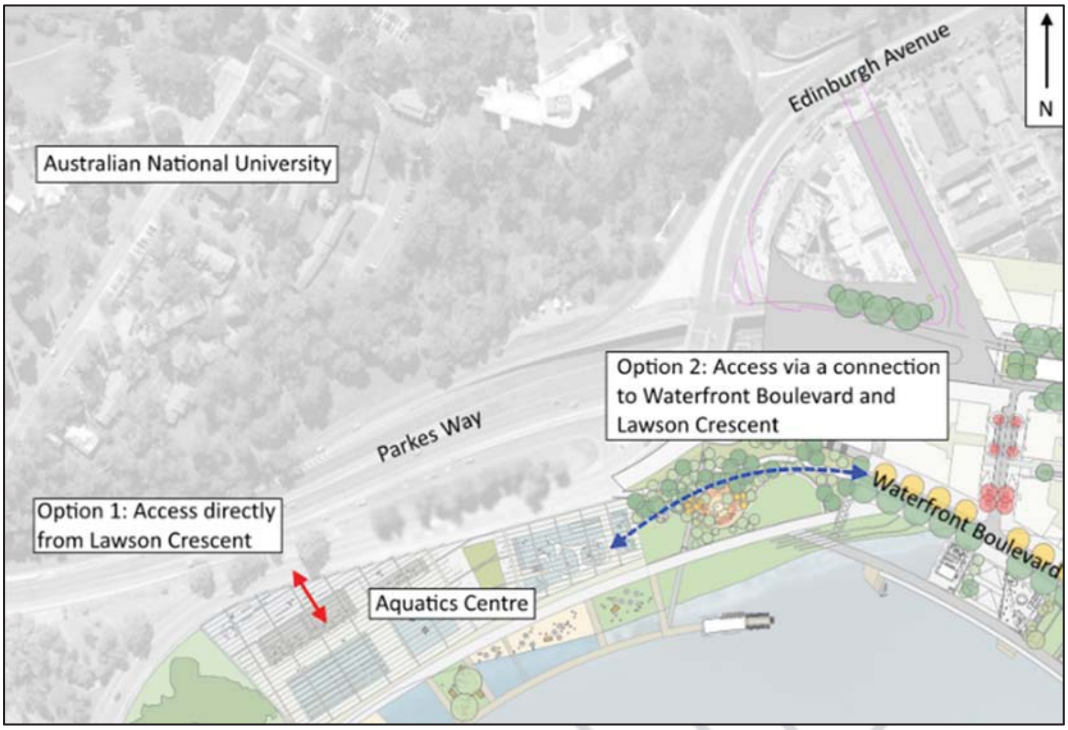

Figure 12 Aquatics Centre access options

Option 1 is the preferred access option, as it preserves the low-traffic environment of the Waterfront Boulevard. Providing vehicular access to the Aquatics Centre from Waterfront Boulevard is likely to lead to more vehicles driving along the Waterfront Boulevard, which would be contrary to its status as a low traffic shared zone.

4.2.2 Trip Generation (Residential, Retail, Commercial)

Current forecasts of development within the West Basin indicate that the majority of development will be residential or retail in nature, with a small proportion of commercial (office) development. The trip generation for the adjacent Aquatics Centre was not considered, as access to that site is proposed to be from Lawson Crescent only, and as such, will not directly affect the road hierarchy within the main portion of the West Basin development.

The proposed development lots and currently anticipated site yields are presented in Figure 13 and Table 2.

Figure 13 West Basin Development Lot Naming

Table 2 Forecast Development Yield

Block	Commercial GFA (m^2)	Retail GFA (m^2)	Apartment #
F	0	902	143
U	0	3,657	274
V	0	2,133	338
W	4,455	4,455	297
X	0	2,682	201
Y	0	4,050	304
Z	0	3,110	233

Estimates of vehicle trip generation from the proposed uses within the West Basin were made using data from the NSW Roads and Maritime Services (RMS) *Guide to Traffic Generating Developments* (GTGD) and updated data in the latest RMS technical direction TDT 2013/04a.

Due to the proximity of the West Basin to Civic and the Australian National University, adoption of residential vehicle trip generation rates associated with high-density residential development in city areas was considered:

- 1.52 vehicle trips per unit per day;
- 0.19 vehicle trips per unit per hour during the AM peak hour; and
- 0.15 vehicle trips per unit per hour during the PM peak hour.

These vehicle trip generation rates take into account the high expected levels of active and public transport usage in the area. In particular, the proximity of the Australian National University increases the likelihood of a student population in the West Basin walking to and from the university. The West Basin is also within walking and cycling distance of a large portion of Civic, which would further increase the potential level of active transport usage in the area.

The adopted vehicle trip generation rates are based on a car (driver) mode share of between 20% and 30%.

In order to assess the reasonableness of the assumed car mode share, consideration was given to the *Linking City Centre to the Lake Urban Strategy* document, which was prepared on behalf of the ACT Office of the Coordinator General, Economic Development Directorate (EDD) by Hill Thalis Architecture + Urban Projects with Jane Irwin Landscape Architecture and SMEC. This document suggested that there would be high active transport usage in the area, point to existing low car mode shares (~20%) for journeys to work from Turner and Braddon to Civic. Turner and Braddon, however, are located closer to the main commercial centres of Civic than the West Basin and are therefore more likely to have a higher proportion of people walking to work. It should also be noted that employment in Canberra is distributed in areas other than Civic, and it is likely that these trips would have a greater car mode share.

Consideration was also given to the city-wide 2026 mode share targets presented in the Transport for Canberra policy (refer to Section 2.1), which targeted a 30% mode share for the ACT for public and active transport by 2026. This equates to approximately 60% car (driver) mode share, after accounting for people riding as passengers. It was noted, however, that areas closer to Civic will be required to achieve a lower car mode share in order to account for higher car usage in outer areas.

As such, a sensitivity test using a 50% loading on top of the vehicle trip generation rates was conducted, which effectively assumed a car (driver) mode share of between 30% and 45%. Assuming a 10% car (passenger) mode share, this equates to a requirement for 45% to 60% active and public transport mode share. This is considered to be reasonable given that the active and public transport mode share near Civic is required to be higher to achieve the Territory-wide goal of 30% active and public transport mode share.

The higher vehicle trip generation rates were used in this analysis to provide robustness to the traffic estimate, considering that the existing high car mode share in Canberra. The adopted residential vehicle trip generation rates were:

- 2.28 vehicle trips per unit per day;
- 0.285 vehicle trips per unit per hour during the AM peak hour; and
- 0.25 vehicle trips per unit per hour during the PM peak hour.

The trip generation from the proposed retail development was calculated using the retail trip rate, accounting for some reduction in trip rate due to the scale of retail development within West Basin.

Assuming that the Gross Leasable Floor Area (GLFA) is 75% of the Gross Floor Area (GFA) as per the guidance from the GTGD, the total proposed retail GLFA within the West Basin is 15,741m^2. The evening peak hour trip rate was therefore estimated to be 10.42 person trips per 100m^2 GLFA per hour, and 6.7 vehicle trips per 100m^2 GLFA per hour. The retail trip generation during the morning peak hour was assumed to be small compared to the evening peak hour, and an allowance for 25% of the evening peak hour trip generation was assumed. The daily trip generation was estimated at eight (8) times the evening peak hour trip generation, based on assessment of RMS data.

Allowance was also made for linked trips made by West Basin residents (i.e. people living in West Basin who visit a shop on their way home).

The trip generation from commercial development was calculated using the trip rates presented in the RMS technical direction:

- 11 trips per $100m^2$ GFA per day;
- 1.6 trips per $100m^2$ GFA per hour during the morning peak hour; and
- 1.2 trips per $100m^2$ GFA per hour during the evening peak hour.

The trip generation calculations for each land use are summarised in the tables below and overleaf.

Table 3 Residential Trip Generation Calculation

Block	Apartments	Vehicle Trips Per Day	Vehicle Trips during AM peak hour	Vehicle Trips during PM peak hour
F	143	325	41	32
U	274	625	78	62
V	338	770	96	76
W	297	677	85	67
X	201	459	57	45
Y	304	692	87	68
Z	233	532	66	52
Total	**1,790**	**4,081**	**510**	**403**

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Table 4 Retail Trip Generation Calculation (evening peak hour)

A: Total Retail GLFA (m^2)	15,741
B: Total Evening Peak Hour Person Trips (A * 10.42 / 100)	1,640
C: Linked trips due to residents (assume 1 in 10 units makes a trip to and from the retail area during the PM peak hour)	358
D: Total External Evening Peak Hour Person Trips (B – C)	1,282
E: Total External Vehicle Trips (D * 6.7 / 10.42)	824

Table 5 Retail Trip Generation – distribution between lots

Block	Retail GFA (m^2)	Retail GLFA (m^2)	Vehicle Trips Per Day	Vehicle Trips during AM peak hour	Vehicle Trips during PM peak hour
F	901.5	676.1	283	9	35
U	3656.5	2742.4	1,149	36	144

Block	Retail GFA (m^2)	Retail GLFA (m^2)	Vehicle Trips Per Day	Vehicle Trips during AM peak hour	Vehicle Trips during PM peak hour
V	2132.7	1599.5	670	21	84
W	4455.3	3341.5	1,400	44	175
X	2682.2	2011.7	843	26	105
Y	4049.7	3037.3	1,273	40	159
Z	3110.3	2332.7	977	31	122
Total		**15,741**	**6,596**	**206**	**824**

Note: The totals may be slightly different from the sum of the individual numbers due to rounding

Table 6 Commercial Trip Generation calculation

Block	GFA (m^2)	Vehicle Trips Per Day	Vehicle Trips during AM peak hour	Vehicle Trips during PM peak hour
W	4,455	490	71	53

The distribution of trips into and out of the West Basin was estimated using data from the Institute of Transportation Engineers' Trip Generation manual. The assumed trip distribution is summarised in Table 7.

Table 7 Trip Distribution Figures

Land Use	AM In	AM Out	PM In	PM Out
Residential	25%	75%	61%	39%
Retail	61%	39%	50%	50%
Commercial	88%	12%	17%	83%

The results of the overall trip generation calculations are presented in Table 8.

Table 8 West Basin Peak Hour Vehicle Trip Generation Summary

Land Use	AM Trips In	AM Trips Out	PM Trips In	PM Trips Out
Residential	128	383	246	157
Retail	126	80	412	412
Commercial	63	9	9	44
Subtotal	**316**	**472**	**667**	**614**
Add trips for foreshore	75	75	150	150
Total Vehicle Trips to West Basin	**391**	**547**	**817**	**764**

4.2.3 Trip Assignment

Based on a review of the location of the West Basin in relation to the external road network and areas of development within Canberra, the assignment of vehicle trips to/from the West Basin was completed using the following assumptions:

- 35% to/from the north;
- 35% to/from the south;
- 15% to/from the east; and
- 15% to/from the west.

This is illustrated in Figure 14.

Figure 14 Assumed directional assignment of vehicular traffic from the West Basin

4.2.4 Road Hierarchy

In order to provide an **efficient** and **safe** street network within the West Basin area, a sensible road hierarchy is required. The indicative road hierarchy within the West Basin was developed based on guidance from the National Capital Plan (refer to Section 2.3):

- Major streets;
- Minor streets;
- Access lanes; and
- Shared zones.

It should be noted that the classification names above differ from the typical road hierarchy naming system presented by the Territory and Municipal Services (TAMS) authority in the “Trunk Road Infrastructure Standard No. 1”. In particular, reference to major and minor collector roads are replaced with major and minor streets.

Shared zone areas are those designed to encourage low vehicle speeds, and to provide greater levels of priority and safety for pedestrians and cyclists. These zones work best with lower traffic volumes, and as such, they should not be used for direct property access or provide an attractive route for through traffic.

Within the West Basin, the key shared zone is the Waterfront Boulevard. The Waterfront Boulevard is intended to be a pedestrian-friendly area, and act as a destination rather than a through route. It is noted that there will inevitably be some usage of the Waterfront Boulevard as a through route, however, the street design will aim to minimise this. This will include:

- Usage of different paving materials to indicate to drivers that they are not driving on a standard roadway and that they ought to be aware of other road users;
- Traffic calming through constrained road geometry; and
- Low posted speed limits to provide more time for road users to perceive each other, to reduce the severity of any collisions, and to encourage use of other routes where possible.

Following the shared zone, the lowest proposed level in the hierarchy is the access lane. These lanes can provide vehicular access and servicing to individual lots to minimise traffic conflicts on the higher-order streets.

The access lanes are intended to connect to minor and major streets within the West Basin, which then provide access to the wider road network.

The classification of streets within the West Basin will drive elements of the road design, including lane width and on-street parking provision.

In the short term, the two main routes within the West Basin are the Waterfront Boulevard and the access to the existing open-air car parks. As discussed above, the Waterfront Boulevard will be classified as a shared zone. The car park access street will be considered as a minor street.

A potential road hierarchy for the long term was developed using the traffic volumes estimated in Section 4.2.3.

It is important to note that at the time of preparation of this document, the final treatment of Parkes Way including the treatment of intersections adjacent to the West Basin is still to be determined. Depending on the proposed treatment (all movements allowed, left-in left-out, left in only, or cul-de-sac), this has an impact on the potential traffic volumes to be expected on the north-south roads within the West Basin.

For this access strategy document, it has been assumed that:

- The western-most street (between lots F and U on Figure 13) will have either a left-in, left-out arrangement at the intersection with Parkes Way or be a cul-de-sac. This is due to the proximity to the nearby Parkes Way / Edinburgh Avenue intersection. In addition, the proposed lot layout is such that this street only services lots F and U, and there would be less demand for an all-movements intersection at this location. A mid-block pedestrian crossing may be appropriate at this location in order to provide a more direct connection to the Australian National University;

- Marcus Clarke Street (between lots U and V on Figure 13) will have an all-movements or a left-in, left-out intersection with Parkes Way, depending on the design of the Parkes Way upgrade. This intersection offers the best opportunity for providing a signalised pedestrian crossing of Parkes Way, as it provides good connectivity to the Australian National University and parts of the city;
- The eastern north-south street (between lots V and W on Figure 13) will have a left-in, left-out intersection with Parkes Way. This is due to the proximity to the nearby proposed Parkes Way / Commonwealth Avenue intersection, which is expected to generate queues that extend to the Parkes Way / Marcus Clarke Street intersection. In addition to less efficient operation due to queuing, some of the potential Parkes Way upgrade options include ramps approaching the Parkes Way / Commonwealth Avenue intersection. As such, it is considered less likely that an all-movements intersection will be provided at this location;
- The northern-most cross street (between lots W and Y on Figure 13) will have a left-in, left-out intersection with Commonwealth Avenue. This is due to the proximity to the nearby proposed Parkes Way / Commonwealth Avenue intersection. Similar the Parkes Way / Marcus Clarke Street intersection, some of the potential Parkes Way upgrade options include ramps approaching the Parkes Way / Commonwealth Avenue intersection. As such, it is considered less likely that an all-movements intersection will be provided at this location;
- Corkhill Street (between lots Y and Z on Figure 13) will have an all-movements intersection with Commonwealth Avenue in the long term; and
- The Waterfront Boulevard will have a left-in, left-out intersection with Commonwealth Avenue in the short term. It is noted that an all-movements intersection may be provided in the short term. However, following the construction of further development in the West Basin, this may encourage increased through-traffic volumes along the Waterfront Boulevard contrary to the goal of a low-traffic shared zone environment.

The allowed movements assumed at each intersection are illustrated in Figure 15.

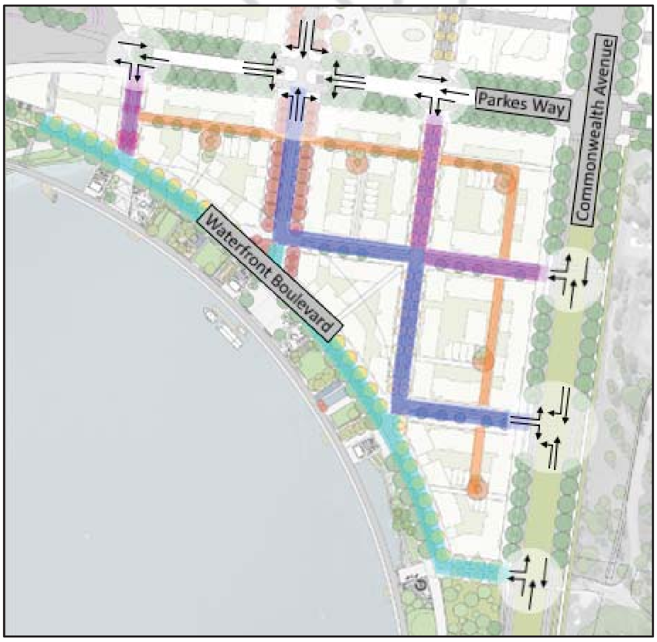

Figure 15 Assumed turning movements within the West Basin

A potential road hierarchy was developed based on the assumed external intersection layouts, and is presented in Figure 16. It consists of major streets feeding into the West Basin from the nominated all-movements intersections along Commonwealth Avenue and Parkes Way, with minor streets branching off to provide access to the other development lots.

It should be noted that this hierarchy is based on the assumptions regarding possible intersection layouts along Commonwealth Avenue and Parkes Way, as well as the assumed development yields. These assumptions (and the resultant road hierarchy) are dependent on future decisions to be made regarding the Parkes Way upgrade and future economic assessment regarding West Basin development. As such, the illustrated road hierarchy is indicative only and subject to change.

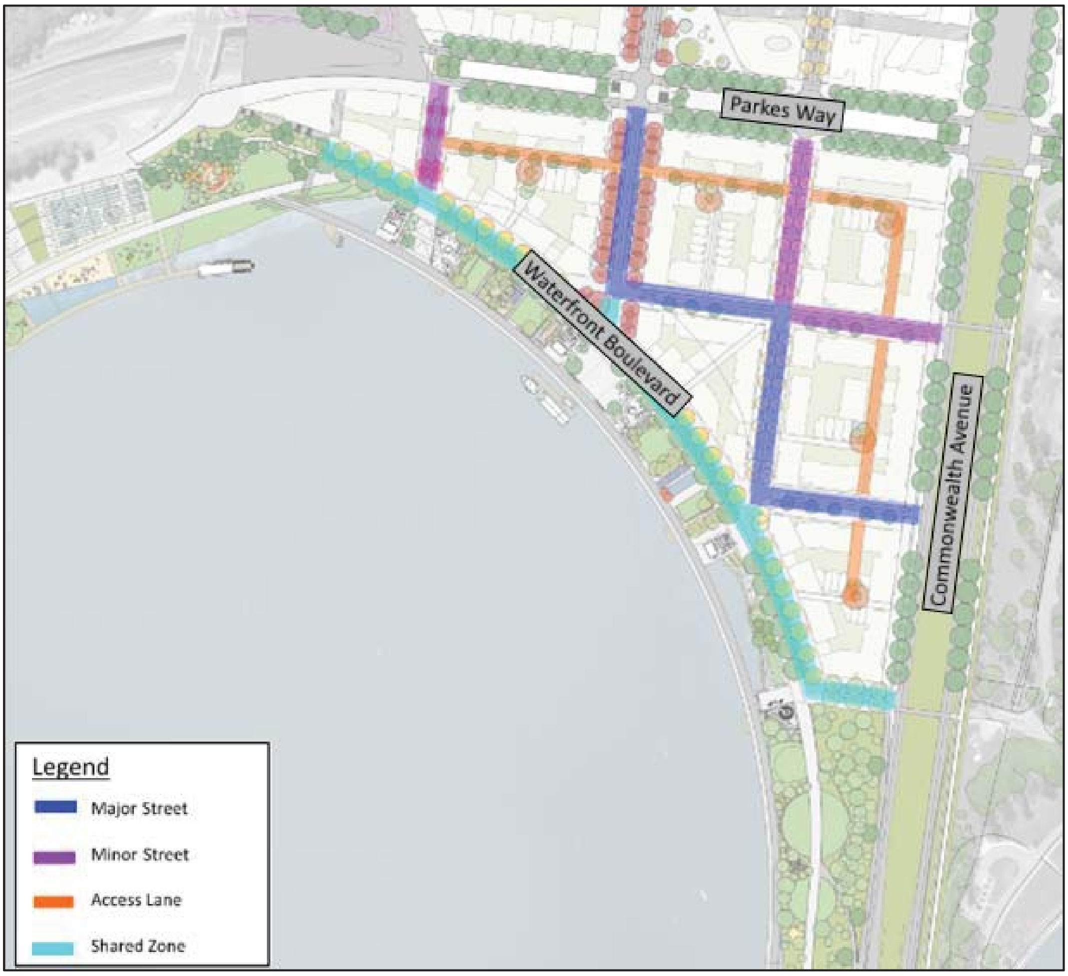

Figure 16 Indicative road hierarchy within the West Basin

Based on the trip generation and assignment figures presented in Sections 4.2.2 and 4.2.3, the daily traffic volumes along each of the street segments was estimated. The volumes are presented in Figure 17. Traffic volumes along the Waterfront Boulevard have been nominally assumed as 1,500vpd-2,000vpd (vehicles per day), which includes:

- An allowance for each on-street car park along the Waterfront Boulevard to turn over every hour for 12 hours;

- An additional allowance of 50% to account for some people driving along the Waterfront Boulevard who are unable to find a parking space; and
- An additional allowance for vehicles using the Waterfront Boulevard as a through route.

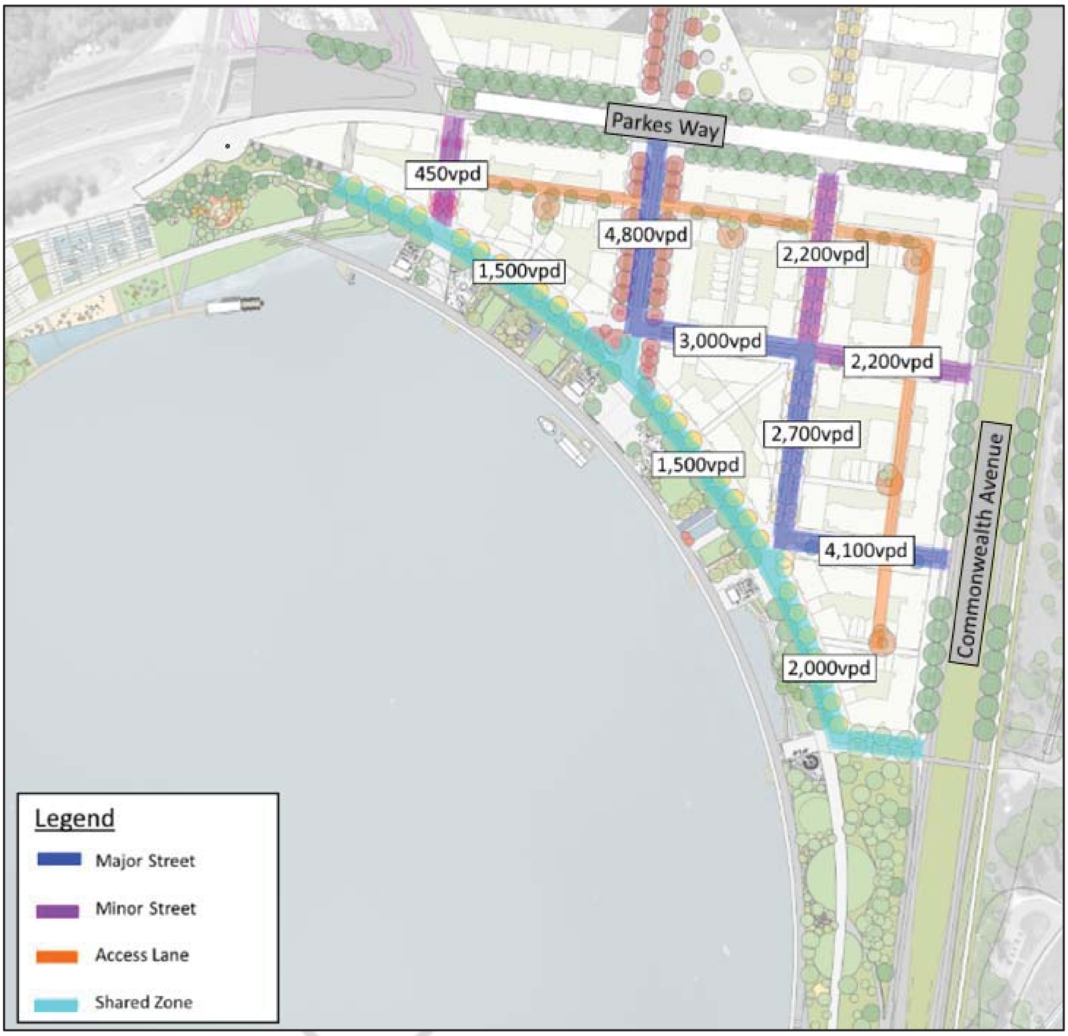

Figure 17 Estimated daily traffic volumes on West Basin internal road network

4.3 Parking

A management strategy for parking on site is an important part of ensuring that the site is **accessible**, both from an equitable access point of view (refer to Section 4.3.1) and from a utilisation point of view (refer to Section 4.3.2).

4.3.1 Parking for People with Disabilities

In order to ensure that access to the site is equitable, it is recommended that sufficient parking designed for people with disabilities be provided across the site. These parking spaces should be located near key uses within the site, including:

- The boardwalk area;
- The ferry terminal;

- Near retail uses; and
- The aquatics centre.

These parking spaces should be designed to be compliant with AS2890.6. Example layouts of these parking spaces are shown in Figure 18 and Figure 19.

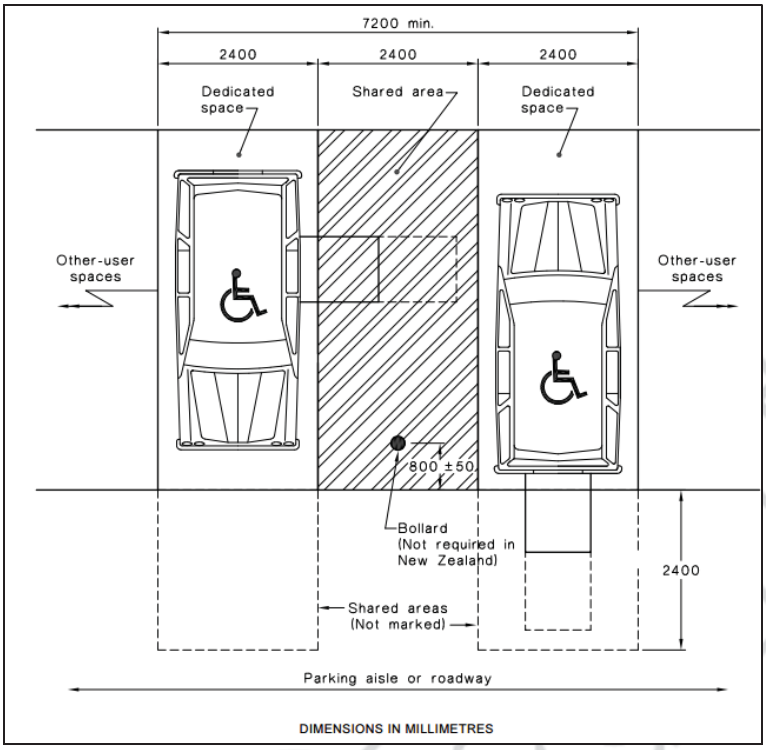

Figure 18 Example PWD angle parking space layout (source: Australian Standards)

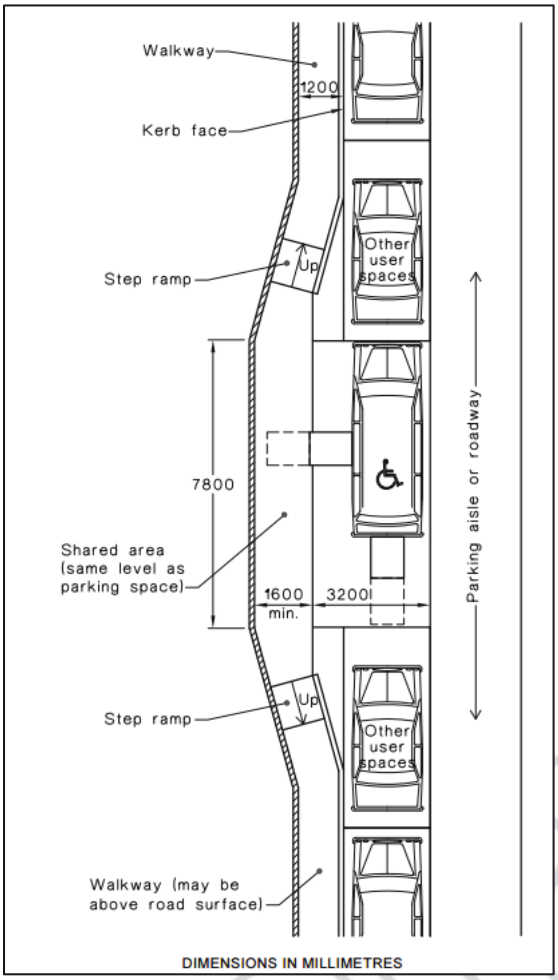

Figure 19 Example PWD parallel parking space layout (source: Australian Standards)

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4.3.2 Parking Management Strategy

In order to support the commercial viability of development within West Basin, it is important to ensure that the on-site parking is managed appropriately to ensure that the supply is utilised efficiently. This sub-section explores potential components of a parking strategy for the short, medium and long term to promote efficient utilisation. In particular, a parking management strategy for the area helps mitigate two main risks:

- Reduced available parking supply due to workers from Civic parking in the area and walking to work; and
- Insufficient parking for workers and residents in the area.

These issues may lead to short-term visitors to the site being unable to find a parking space due to excessive long-term parking demand due to staff or commuter parking, which could affect the commercial viability of development on site. The solution to this issue is not simply to provide more parking spaces, as this will lead to unsightly empty paved areas and potentially personal safety issues during times of lower demand.

A more effective means of controlling parking is through the use of parking restrictions. These restrictions would not inconvenience the majority of genuine visitors to the West Basin, while simultaneously discouraging parking by others. Depending on the type of parking concerned, these restrictions could include boom gates to physically isolate areas of car parking, the imposition of time limits on parking to promote turnover and/or the imposition of parking fees.

It should be noted that paid parking has already been introduced to the existing open-air car parks in the West Basin, as well as in the Parliamentary Triangle, the National Museum of Australia and in Civic. The introduction of unrestricted parking is likely to undermine the existing parking restrictions in the areas adjoining the West Basin, and would lead to the car parking within the West Basin being increasingly utilised by visitors to other areas. As such, the system of parking restrictions within the West Basin should be complementary to those adopted in adjoining areas.

This does not necessarily mean that paid parking is the ideal method of parking control within the West Basin. For example, parking for visitors to retail areas may be better controlled through time-limited parking (e.g. 30 minutes or 1 hour limited parking) for free, with longer-term parking for a fee. It is considered that people wishing to visit the West Basin for a short period with a specific purpose (e.g. to pick up a coffee and some snacks) would be discouraged more by having to organise payment than the cost of the parking fee itself. Time limited parking may therefore have a lower discouraging effect on potential visitors. In addition, time limited parking would tend to increase turnover of parking spaces, increasing the number of unique visitors to each shop.

With respect to visitors to residential areas, it is considered that people would be less willing to live in an area where visitors would have to pay to visit them. This issue is usually resolved by specially designating visitor parking areas behind gates, with access controlled by tenants. As such, consideration should be given to parking control measures other than simply levying a parking fee in order to maximise the overall economic and social benefits.

In order to facilitate the change in parking paradigm from the existing “excessive supply” scenario to a more efficient car parking management strategy, use of parking technologies such as real time parking information systems should be considered. These systems use detectors to determine the number and location of parking spaces that are utilised at any given time, and can be linked to dynamic signage systems that direct drivers to unused parking spaces. More advanced applications of these systems could also be used to:

- Support enforcement of parking restrictions; or
- Establish a “dynamic parking charge” system, similar to the SFpark system in Downtown San Francisco. This system dynamically adjusts parking charges in different areas based on the real-time parking demand and supply information. In addition to encouraging parking turnover and more economically efficient land usage, this system helps ensure that unoccupied car parking spaces are more evenly distributed throughout the area. This in turn reduces the number of vehicles “cruising” to find parking spaces or double parking, which improves safety and reduces environmental impacts.

The parking management strategy for the West Basin should consider the purpose of parking located at various locations around the site. Key parking elements on site are expected to include:

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- On-street parking. This is anticipated to be parallel parking along the Waterfront Boulevard and along the main streets in the West Basin; and
- Off-street parking lots. This is expected to consist of basement parking provided within each lot, as well as within the aquatics centre. Off-street at-grade parking, while cheaper than basement parking, would not be consistent with the principles of the National Capital Plan for the West Basin (refer to Section 2.3). The layout of off-street car parking areas should be such that vehicles can enter and exit the road network in forward gear.

Demand for parking on site is typically expected to come from six main sources. In approximate order of required parking duration, these are:

- Visitors to the West Basin Foreshore (boardwalk and park);
- Visitors to the aquatics centre;
- Visitors to retail / commercial areas in the West Basin;
- Visitors to residential areas in the West Basin;
- Workers in the West Basin; and
- Residents living the West Basin.

Each of the above groups would prefer to park closer to their destinations, for example, residents would prefer to park underneath or adjacent to their building, and visitors to the boardwalk area would prefer to park near the boardwalk. Potential methods for managing this parking is presented in Table 9.

Table 9 Potential Parking Management Strategy

User Group	**Preferred Location**	**Potential Treatment – Short Term (Stage 1A)**	**Potential Treatment – Medium Term (Stage 1B)**	**Potential Treatment – Longer Term (Stage 2)**
Boardwalk visitors Park visitors (Stage 1A)	On Waterfront Boulevard On surrounding streets In open air car park (short to medium term)	Time limited (potentially paid) parking	Time limited (potentially paid) parking	Time limited (potentially paid) parking
Aquatics visitors	Within aquatics centre car park	n/a	Time limited parking	Time limited parking

User Group	Preferred Location	Potential Treatment – Short Term (Stage 1A)	Potential Treatment – Medium Term (Stage 1B)	Potential Treatment – Longer Term (Stage 2)
Retail / commercial visitors	Parking on street frontage	Visitors to park in spaces on boulevard, or within the existing open air car parks. The existing paid parking provisions should be retained.	Visitors to park in spaces on boulevard, or within the existing open air car parks. The existing paid parking provisions should be retained.	Time limited (potentially paid) parking
Residential visitors	Within off-street car park in building or Parking on street frontage	n/a	n/a	Designated visitor bays in off-street car park. Potentially time limited parking Time limited parking on street
Employees	In open air parking In staff car parking spaces in building (longer term)	Continue to allow paid commuter / employee parking on site in the short term. Employees working at the boardwalk businesses should park at the retained open air car parks, to allow boardwalk visitors to park closer.	Continue to allow paid commuter / employee parking at the existing open air car parks in the medium term. Designated aquatics centre staff car parking spaces should be provided in the off-street car park. Potentially isolate using boom gates or similar.	Designated staff car parking spaces in off-street car park. Potentially isolate using boom gates or similar. Do not provide excessive staff car parking in order to encourage active and public transport usage.

User Group	Preferred Location	Potential Treatment – Short Term (Stage 1A)	Potential Treatment – Medium Term (Stage 1B)	Potential Treatment – Longer Term (Stage 2)
Residents	In resident car parking spaces in building	n/a	n/a	Designated residential car parking spaces in off-street car park. Potentially isolate using boom gates or similar.

In addition to the uses listed in Table 9, it is recognised that the West Basin foreshore may also attract atypical levels of parking demand due to events held in the area. The parking requirements associated with these events will depend on the event characteristics, and as such, an accurate estimate of event parking requirements is not possible at this stage. It is considered, however, that provision of additional car parking spaces within the West Basin to solely cater for atypical peak parking demands would not be an efficient use of resources.

Parking demands associated with large events near the city centre are typically addressed through operational management plans. Depending on the scale of the event, actions included in these plans could include:

- Scheduling larger events outside typical peak hours for the West Basin where possible;
- Use of parking areas around West Basin, for example, the existing parking areas in Civic or proposed parking areas to the north of Parkes Way;
- The introduction of “Park n Ride” bus services, which shuttle visitors between the West Basin and major centres and/or parking areas; and
- For ticketed events, including the price of the public transport fare in the event admission cost.

4.3.3 Parking Supply Provision

In the short term, it is considered that the existing open air car parking areas should be retained, with the exception of some car parking areas that will be closed to allow for the foreshore to be constructed.

In the medium and longer term, it is recommended that a sustainable level of car parking be provided on site.

The number of parking spaces required for each use can be estimated using the proposed development areas and typical parking rates for those uses adopted in other jurisdictions.

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Table 10 Parking Requirements

Land Use	Parking Rate / Requirement	Notes
Residential	0.4-0.9 spaces per 1 bedroom unit 0.7-1.3 spaces per 2 bedroom unit 1.2-1.8 spaces per 3 bedroom unit 0.15 visitor spaces per unit	Based on requirements published by RMS, Brisbane City Council and the Territory Plan for developments in the fringe of city centres. The Territory Plan proposes higher parking provision on site, which is not consistent with the intent for greater active and public transport usage in this area.
Commercial (office)	1 space per 100m^2 GFA	Based on requirements for the CZ1 zone in the Territory Plan, which is consistent with parking rates for office uses in other city centre regions in Australia
Retail	1 space per 20m^2 to 33m^2 GFA	Based on requirements in the Territory Plan
Boardwalk	Refer to discussion below	
Aquatics Centre	Refer to discussion below	

The resultant parking requirements based on the above parking rates and the currently assumed development yields is presented in Table 11. The figures in the table assume that the average rate for retail parking applies (1 space per 25m^2), and that the lower rates for residential parking apply (to assist in achieving the low car mode share target for the area).

The residential development has been assumed to consist of:

- 30% one bedroom units;
- 40% two bedroom units; and
- 30% three bedroom units.

Table 11 Estimated parking requirements

Block	GFA (m^2) / Unit #			Estimated Parking Requirement			
	Commercial / Office	Retail	Res. (#)	Office	Retail	Res	Total
F	0	902	143	0	37	131	**168**
U	0	3,657	274	0	147	250	**397**
V	0	2,133	338	0	86	308	**394**
W	4,455	4,455	297	45	179	271	**495**
X	0	2,682	201	0	108	183	**291**
Y	0	4,050	304	0	162	277	**439**
Z	0	3,110	233	0	125	213	**338**
Total	**4,455**	**20,989**	**1,790**	**45**	**844**	**1,633**	**2,522**

It should be noted that the estimated parking requirements do not consider any reductions due to potential linked trips. Further discussion of linked trips is provided in the discussion of Boardwalk Visitor Parking below.

Boardwalk Visitor Parking

The traffic assessment for Stage 1A of the CttL project considered that the parking demand generated by visitors to the boardwalk could be accommodated within the existing open-air car parks.

Following the development of CttL Stage 2, however, these open-air car parks will be replaced with residential/retail/commercial development. One potential method of addressing the foreshore parking demand would be to provide additional car parking above the number required to service the residential, retail and commercial development within the West Basin. This would likely be a costly solution, as additional basement car parks would be required to be constructed. Providing more parking in the West Basin would also lead to an undesirable outcome of more vehicular traffic in the area.

A more cost-effective solution could be achieved by considering the different temporal profiles of parking demand associated with the different uses on site. In particular, it is considered that the peak commercial (office) parking demand would not coincide with the peak parking demand for visitors to the foreshore area. There is an opportunity to use the commercial parking areas for boardwalk visitors during off-peak periods. This system is already used in commercial developments in other locations around the country. This could be supplemented by additional basement car parking if an economic need can be demonstrated.

In addition, it is considered that the nature of the West Basin development means that there will be a high level of linked trips going to the boardwalk as well as to the retail developments, with visitors staying to complete secondary activities once they have arrived and completed their initial primary activity in the West Basin area. Initial strategy advice from MacroPlan Dimasi for the West Basin boardwalk retail development suggests that "*Secondary activities are where 80% of all visitor spending takes place*", indicating a significant opportunity for linked trips. As such, there would be less demand for additional car parking for foreshore/boardwalk activities once the future retail precincts are developed.

Consideration should also be given to potential car parking to be provided on the northern side of Parkes Way, which is under 300m walk from the boardwalk. It is noted that a site north of Parkes Way to the west of Marcus Clarke Street has been provisionally identified for a multi-storey car park.

The level of additional parking to be provided for boardwalk visitors will ultimately be an economic decision, balancing the cost of providing additional car parking spaces with the benefits associated with allowing more visitors to drive to the area.

Aquatics Centre Parking

The parking requirements for an aquatics centre depends on the scale and type of uses within the centre, for example, the number and type of pools, whether the centre will include a gym, and whether there will be a café on site. Parking provided for an existing development from the Gold Coast is discussed below as an example of the level of parking required.

It is understood that the proposed Aquatics Centre will have a similar number of pools as the Gold Coast Aquatics Centre, although the pools may be more geared towards leisure uses (i.e. with fewer squads and more general purpose swimmers). Although a higher number of visitors may be expected in a leisure scenario, they are more likely to arrive as groups of family and friends together in the same vehicle. As such, provision of a similar level of parking supply for the pools (approximately 150 spaces) may be considered reasonable as an initial estimate. A more accurate estimate of the actual parking requirements will require consideration of the proposed patronage at the different parts of the complex during peak times.

It is also understood that the Aquatics Centre will include additional uses. Some of the potential uses include a café, a restaurant and a gym. It is unclear how large these proposed uses are, which precludes an accurate estimation of their parking demand. In the case of the Gold Coast Aquatics Centre, the proposed gym had a GFA of 1,000m^2 and the café had a GFA of 155m^2. The gym required 28 car parking spaces (assuming 42 patrons – equivalent to around 1 per 24m^2, and an average car occupancy of 1.2 persons per vehicle) and the café required 6 spaces. Given the larger scale of the facilities within the West Basin Aquatics Centre, a greater number of parking spaces for these facilities may be required.

Gold Coast Aquatics Centre

A similar aquatics centre development in Gold Coast City (Queensland) included:

- Six (6) pools, including a play pool, an outdoor 25m pool, an outdoor 50m pool, a program pool, a competition pool and a learn to swim pool;
- A café (180m^2 GFA);
- A crèche;
- A dry dive facility;
- A function area; and
- A gym / fitness centre (1,000m^2 GFA).

The Gold Coast Aquatics Centre has a provision of 154 on-site parking spaces. Analysis indicated the peak parking demand occurred on the weekend, during which there would be a demand for 150 parking spaces for pool staff and visitors (i.e. excluding demand and potential for linked trips associated with the gym, café etc.). This was based on a future scenario which included 20 staff on site, two classes of 20 students learning to swim, two squads of 70 swimmers training and 40 general purpose swimmers. This includes an allowance for an overlap of parking demand from swimming classes in adjacent hours, and assumed an average car occupancy of 2 persons/vehicle (1 per vehicle for staff).

Some reduction in parking requirements for the Gold Coast Aquatics Centre was allowed for due to the proximity to a commercial centre. A reduction in parking may be possible for the West Basin Aquatics Centre due to the proximity to ANU, which does not currently have a pool on-site.

4.3.4 Location of On-Street Parking

The provision of on-street parking can assist in activating street frontages within the development.

On-street parking is currently proposed along most of the streets except where safety considerations preclude this provision (for example, near intersections, and along the southern side of the Waterfront Boulevard due to interaction with high numbers of cyclists).

The design and placement of on-street parking spaces should consider interaction with pedestrian and cycle paths to minimise conflicts and potential safety issues. For example, on-street parking spaces placed adjacent to cycle lanes should be provided with a buffer (typically 0.5m for lower speed roads) to reduce the risk of cyclists colliding with open car doors

4.3.5 Location of Off-Street Parking

It is recommended that off-street parking be provided within each of the development lots in sufficient numbers to service the on-site development mix. Residents in particular are less likely to accept parking in a different building to where they live. In addition, visitors to the Aquatics Centre would expect to be able to park within the Aquatics Centre. As such, where possible, the car parking for the residential development and the Aquatics Centre should be provided in the same lot as the use.

There may, however, be some opportunity to consolidate the parking requirements for commercial and retail areas into a number of larger parking areas. Access to these car parking areas should be provided from major streets.

4.4 Bus

The CttL site is bounded by Parkes Way and Commonwealth Avenue. A number of bus routes travel along Commonwealth Avenue to travel between Civic and the southern side of the lake, including the high frequency “blue rapid” route between Belconnen and Tuggeranong. There is a bus stop located on Commonwealth Avenue north of Albert Street, however, this stop is currently only observed during events. This is considered to be appropriate due to the limited level of commuter demand at this stop.

To the north of the site, the closest existing bus stops are located on Edinburgh Avenue near London Circuit (limited services, mostly from Tuggeranong and Black Mountain), and London Circuit at the Metropolitan Building (more services, but no high frequency routes). These stops are located between 350m and 500m from the site, and can currently be accessed via the Marcus Clarke Street pedestrian bridge.

In the longer term, the construction of the Parkes Way boulevard is expected to include provision for new bus stops and bus services running along Parkes Way.

4.4.1 Short Term (Stage 1A)

In the short term, it is considered that there may be an increased level of public transport demand due to new facilities along the foreshore.

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In order to promote more **sustainable** modes of access to the area, it is recommended that the existing bus stops along Commonwealth Avenue at Albert Street be activated on a more permanent basis to allow visitors to catch buses to and from the area. The proposed route for pedestrians from the Albert Street bus stops is shown in Figure 20. The figure shows that the majority of the site is within a 400m radius from the bus stops, but only a third of the site is within a 200m radius of the stops.

In order to facilitate groups of visitors, for example tourist or school groups, visiting the foreshore area, provision for coach parking should be considered. Due to the limited width along the Waterfront Boulevard, the coach parking area should be located within the open-air car parking area.

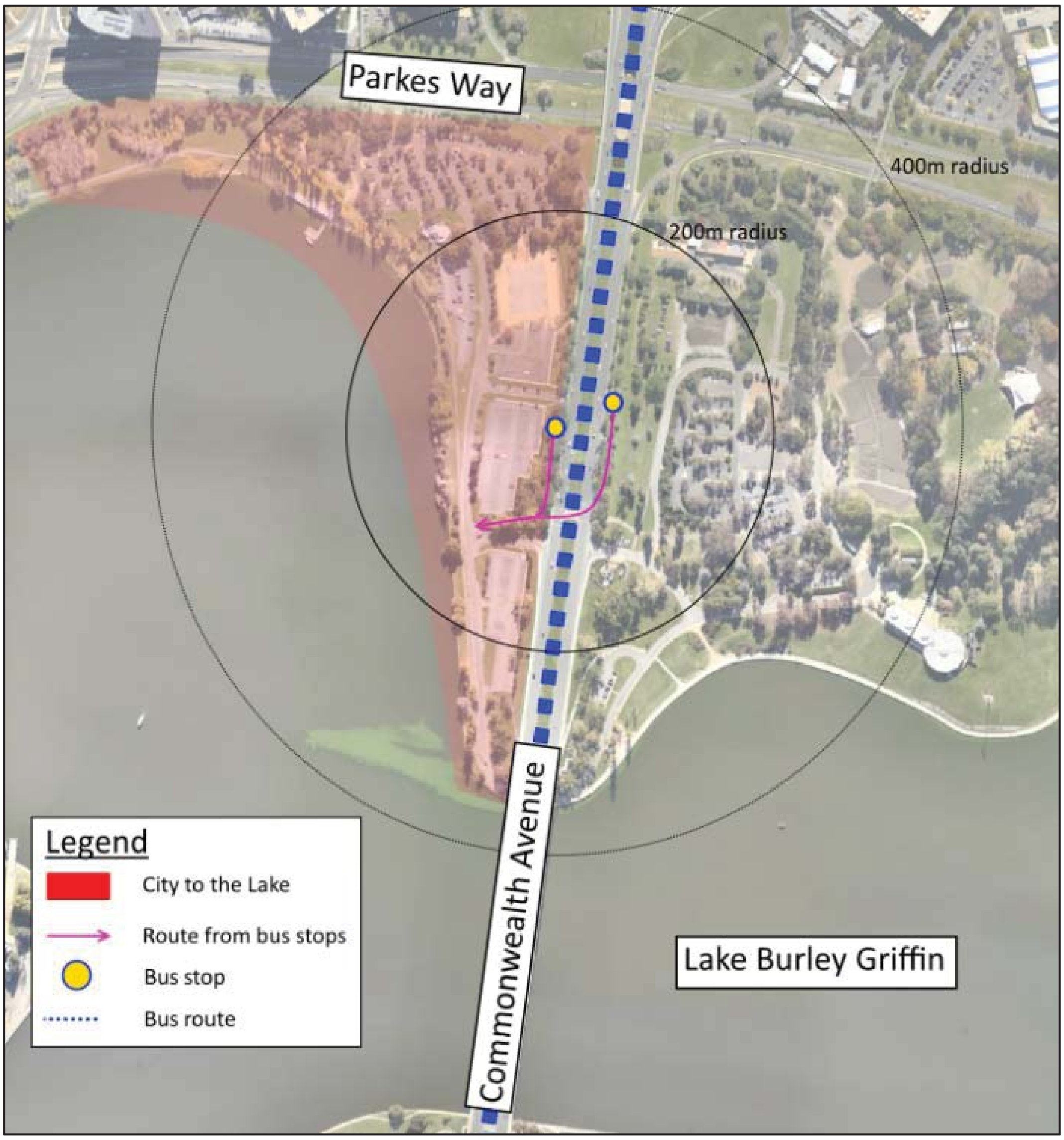

Figure 20 Site access plan for bus passengers - short term

4.4.2 Long Term (Stage 2)

In the longer term, there is an opportunity to provide additional bus stops on Parkes Way to increase public transport coverage within the site, and encourage more **sustainable** transport to the site. These stops will allow for the introduction of future bus routes running along the boulevard level of Parkes Way. In order to maximise **efficiency**, the stops should be located on Parkes Way near Marcus Clarke Street.

An option to allow buses to run through the CttL site was also considered, however, the proposed street cross sections are designed to reduce vehicle speeds and promote pedestrian **safety**. Furthermore, the proposed road access strategy (refer to Section 4.2) is designed to limit rat-running through a combination of restricted movements at intersections and traffic calming within the site. These treatments are not conducive to bus routes. In addition, it was observed that the majority of the site will be within 200m of a bus stop, and additional bus connectivity would provide limited benefit.

The proposed route for pedestrians from the bus stops around the site is shown in Figure 21.

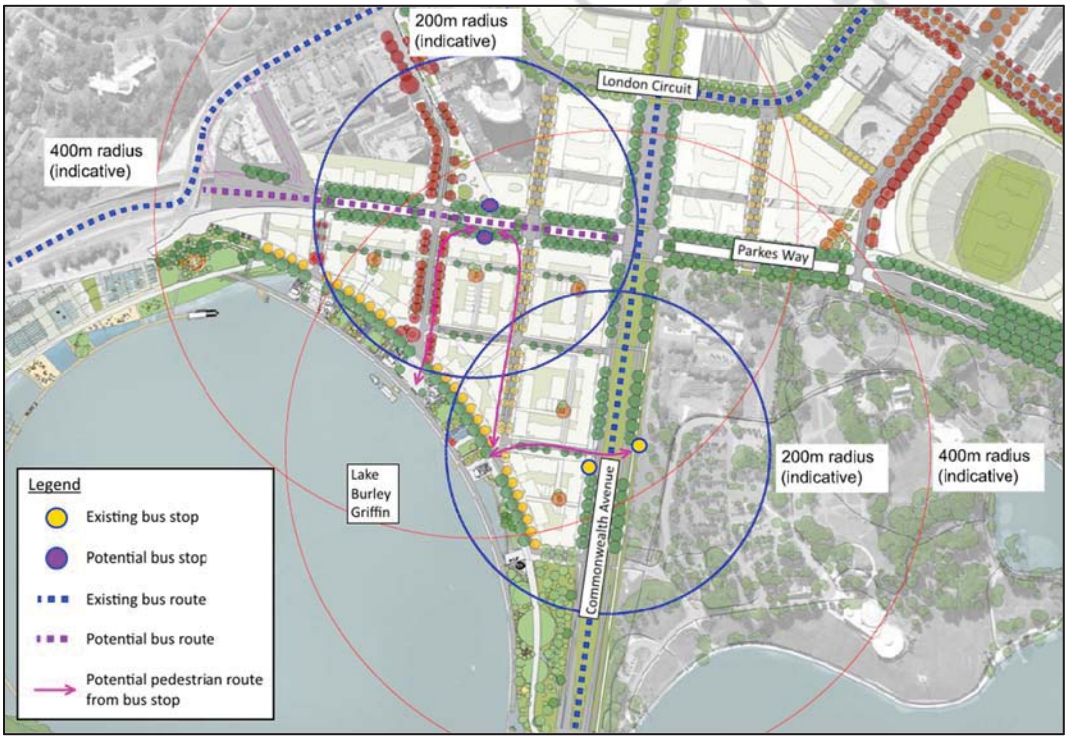

Figure 21 Site access plan for bus passengers - long term

In the long term, coach parking should be provided to allow for large groups of visitors. These parking areas should be provided:

- Along Lawson Crescent near the Aquatics Centre. This will facilitate events such as school swimming carnivals; and
- Along the Parkes Way (boulevard level). This will allow for general visitors to the West Basin area.

Coach parking could also be provided along the streets within the West Basin, however, these areas may be better reserved for on-street general parking.

4.5 Light Rail

In the short term (following Stage 1A), the proposed Canberra Metro is expected to run between Gungahlin and Civic. It is anticipated that the impact of the light rail system on the CttL development will be limited in the near term.

In the longer term, the Canberra Light Rail Master Plan (refer to Section 2.2) considers potential extensions to the Canberra Metro system. One of the potential extensions is proposed to connect Civic to the parliamentary precinct via London Circuit and Commonwealth Avenue, running adjacent to the West Basin.

The potential future light rail extension provides an opportunity to further integrate the West Basin with the Canberra public transport system. Although the light rail extensions are not confirmed, the layout of the West Basin development should be designed so that future connectivity with an extension to the light rail system is not precluded.

To this end, the West Basin site layout should consider:

- Providing opportunities for pedestrians and cyclists to **efficiently** and **safely** cross Commonwealth Avenue to/from the light rail station; and
- Providing paths in an east-west direction to allow **active** modes of transport (walking and cycling) to **efficiently** traverse the site.

These elements are consistent with the providing access by bus via Commonwealth Avenue, as discussed in Section 4.4.

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4.6 Ferry

As described in Section 3.3.1, there are no plans to provide access to the West Basin from other parts of Canberra via ferry in the short or medium term.

In the longer term, the ferry terminal provides an opportunity to introduce regular passenger ferry services from other locations around Lake Burley Griffin. This could:

- Allow residents in the West Basin to travel to other parts of the lake;
- Provide other residents of Canberra an alternative method to access the West Basin for work or recreation; and
- Provide connectivity to the National Museum of Australia.

It is considered that provision of a Park n Ride facility for the West Basin ferry terminal is not necessary, as it is unlikely that commuters will drive to the West Basin to catch the ferry to another location around Lake Burley Griffin.

5 Conclusion

This report presented a potential strategy to provide access to and from the West Basin area. Five key considerations included:

- Existing planning in the area;
- The requirements of different modes of transport;
- Connections to key attractions in the area, including the National Museum of Australia, the Australian National Museum and Civic;
- The likely treatment of intersections along Parkes Way and Commonwealth Avenue; and
- Methodologies for managing parking within the West Basin.

During the development of this access strategy, a number of planning documents with the potential to affect development within the West Basin were reviewed to ensure that the strategy is consistent with and supports the intent for the region. Key documents reviewed included the Transport for Canberra policy document, the National Capital Plan and the Canberra Light Rail Master Plan.

Key principles for the access strategy were developed with consideration of the existing planning in the area:

- **Active** and **Sustainable**: Provide opportunities for visitors to use active and public transport to travel to and through the site;
- **Safe**: Provide a safe means of entering, exiting and moving around the site;
- **Accessible**: Provide a means for all visitors to enjoy the site;
- **Efficient**: Efficiently cater for the demand for trips to and from the site, minimising the impact on the surrounding network.

An access strategy was developed following the key principles for the West Basin for the short term (following Stage 1A of CttL) and the long term (following Stage 2 of CttL). The key recommendations for each of the access modes considered are presented in the following sub-sections.

5.1 Active Transport

The key recommendations for active transport within the West Basin are:

- Provide separated pedestrian and cyclist paths to allow cyclists to **safely** pass by slow moving pedestrians visiting active commercial frontages:
    - Minimum pedestrian path width is 2m;
    - Minimum cycle path width is 2.5m (two-way path) or 1.5m per one-way cycle lane.
- Path widths greater than the minima should be provided along nominated commuter routes to ensure that these routes can **efficiently** accommodate commuters using **active** transport;
- Pedestrian and cyclist access to the Aquatics Centre should be provided from both Lawson Parade and the Waterfront Boulevard. This will facilitate equitable access;

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- Ensure sufficient wayfinding devices are placed within and surrounding the West Basin to ensure that key routes into and through the area are visible and legible; and
- Ensure that sufficient cyclist end-of-use facilities (including cycle parking spaces, showers and lockers) are provided at each proposed use, and sufficient cycle parking is provided along the foreshore. This will maximise **accessibility** for cyclists to the site.

5.2 Road (Private Transport)

The key recommendations for private road transport within the West Basin are:

- Vehicular access to the Aquatics Centre should be provided from Lawson Crescent only. This will minimise traffic volumes along Waterfront Boulevard, reducing potential conflicts and improving **safety**;
- A coherent road hierarchy should be implemented for the West Basin to ensure that the road network is legible, **efficient** and **safe**. A suggested hierarchy based on the currently assumed development yields has been developed, which includes:
  - A shared zone along the Waterfront Boulevard to promote **safety** for the higher volumes of pedestrians and cyclists in the area;
  - A network of access lanes, minor streets and major streets within the West Basin based on the allowable movements at external intersections and key routes to Civic and ANU.

5.3 Parking

The key recommendations for parking within the West Basin are:

- Ensure that sufficient parking spaces for people with disabilities are provided. These spaces should be spread throughout the West Basin to maximise **accessibility** between parking spaces and key attractors;
- On-street parking should be provided to activate commercial frontages. However, the placement and design of these spaces should consider adjacent pedestrian and cyclist paths to minimise the risk of injury;
- Ensure that the parking management strategy for the West Basin is complementary with that used in the surrounding area. This could include a combination of:
  - Paid parking;
  - Physical parking access controls (boom gates);
  - Time limited parking;
  - Intelligent Parking Systems.
- The provision of on-site car parking should consider whether sharing of spaces due to different parking demand peak periods can occur. For example, office car parking spaces may be shared with retail car parking spaces;

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- It may not be considered economical to provide sufficient parking supply to cater for peak parking demands during events. Event parking demands should be managed through a combination of:
  - Scheduling outside of peak hours;
  - Consideration of parking supply in areas adjacent to West Basin;
  - Introduction of "Park and Ride" services from suburban areas; and
  - Including the public transport fare in event admission costs.

5.4 Public Transport (Bus, Light Rail, Ferry)

The key recommendations for public transport within the West Basin are:

- Consider activating the event bus stop along Commonwealth Avenue on a more permanent basis to encourage more **sustainable** modes of transport;
- Consider provision of new bus stops along Parkes Way boulevard in the longer term to serve potential new routes and to maximise penetration of the West Basin site;
- Coach parking within the site should be considered to facilitate **access** by larger groups of visitors. Key locations include the Aquatics Centre and near the Waterfront Boulevard;
- Pedestrian connectivity along the east-west streets should be provided to link into a potential future light rail network along Commonwealth Avenue;
- Ensure that sufficient pedestrian and cyclist connectivity is provided to the ferry terminal to facilitate future ferry services around Lake Burley Griffin.

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Appendix J – Not used

Appendix K – Geothermal Report (Geoexchange)

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GEOEXCHANGE PRE-FEASIBILITY AND CONCEPT DESIGN:
CITY TO THE LAKE
CANBERRA ACT

PREPARED FOR THE LAND DEVELOPMENT AGENCY

GeoExchange Project ID: GXA14-ACT-07

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GEOEXCHANGE PRE-FEASIBILITY AND CONCEPT DESIGN: CITY TO THE LAKE, CANBERRA ACT PREPARED FOR THE LAND DEVELOPMENT AGENCY

Project ID: GXA14-ACT-07

EXECUTIVE SUMMARY

GeoExchange Australia Pty Ltd (GXA) was requested by the Land Development Agency (LDA) to prepare a Pre-feasibility and Concept Design for the incorporation of a geoexchange district heating and cooling system for the City to the Lake Development in Canberra ACT. In discussion with the LDA, the Aquatic Centre, Hotel and Public Waterfront Pavilions have been selected as the focus for this assessment. Additional comment is also provided for future stages.

Please note that this Report is of a preliminary nature only and that a detailed design is required prior to finalising any component of the geoexchange system.

The scope of works for this assessment included the following:

- Review of the current Master Plan and other available planning documents;
- Review of existing reports on the project;
- Review heating and cooling loads of the Aquatic Centre, Hotel and Public Waterfront Pavilions;
- Preliminary selection of Ground Source Heat Pumps (GSHPs) to provide required heating and cooling for various requirements across the site;
- Preliminary assessment of Ground Heat Exchanger (GHX) options with respect to the available heat source/ sink options;
- Concept drawings of GHX options;
- Comparative analysis with proposed alternative systems, including energy and CO_2 emissions. This will include systems proposed in existing site assessments as well as other approaches that may be identified by this assessment;
- Comments on staging of works with respect to the multiple buildings on site; and
- Report summarizing the above.

Detailed design and drawings have been omitted from this assessment due to the early phase of the overall planning process.

Conclusions

The key conclusions of the pre-feasibility and concept design were as follows:

- The heating, cooling and hot water loads across the Stage 1 buildings are approximately balanced and provide opportunity for heat transfer both simultaneously and across the annual cycle. For example, heat rejected from the ice rink can be used to heat the adjacent outdoor pool, while

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heat rejected while air conditioning the hotel in summer can be used to heat the main Aquatic Centre;

- A closed water loop heat exchanger using stainless steel plates located in the West Basin of Lake Burley Griffin is the most suitable GHX for the site due to the availability of the high yielding lake and to eliminate maintenance associated with open loop systems. It would be preferred to locate the plates beneath boardwalk areas;
- A distributed GSHP approach was considered the optimal approach with respect to the building distribution due to higher efficiencies, higher redundancy, lower installation cost and simplified controls;
- The closed loop and the distributed GSHP approach also provide a staged approach across the 3 building types that enables the LDA to stage works and not overcapitalise on infrastructure unnecessarily in Stage 1;
- This staged and modular approach also enables simple augmentation for future stages of the project;
- The additional capital cost for the closed water loop geoexchange system was approximately $4.2 million more than the conventional system and the financial breakeven point in terms of operational and maintenance savings was 5.2 years;
- An assessment of a nominal ten year financed option indicates that energy savings exceed finance costs and thus a financed purchase, possibly in accordance with a service level agreement, has merits for the installation and ongoing operation of the system;
- The future addition of on-site renewable energy (*ie* solar PV) will further improve the operating cost of the system. The reduced electrical usage, and in particular peak load, of the geoexchange system will reduce the investment required in solar PV to power the site; and
- In addition to the economic analysis, the geoexchange system will also:
  - Reduce peak loads by approximately 25 to 40 %;
  - Free up roof space for future installation of solar PV;
  - Free up plant room space for greater storage;
  - Have quieter operation;
  - Improved comfort levels with individual temperature and humidity control in each zone;
  - Reduced maintenance as reflected in operating costs;
  - Eliminate requirement for gas at the site as proposed to provide heating;
  - Potentially provide hot water for ‘domestic’ use in the building; and
  - Be a genuine and proven energy efficient solution.

Recommendations

Based upon the results of this report, the geoexchange approach presents a strong energy and economic case. In order to progress to the next stage the following is recommended:

- Conduct of detailed design of geoexchange system, including detailed energy modelling of the buildings to be incorporated into Stage 1 and detailed design of the closed water loop heat exchanger; and
- Investigation of project delivery methods to assess the method best suited to the ongoing role of the LDA and the ACT Territory Government with respect to the provision of utility services across the development.

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GEOEXCHANGE PRE-FEASIBILITY AND CONCEPT DESIGN:
CITY TO THE LAKE, CANBERRA ACT
PREPARED FOR THE LAND DEVELOPMENT AGENCY

Project ID: GXA14-ACT-07

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GEOEXCHANGE PRE-FEASIBILITY AND CONCEPT DESIGN:
CITY TO THE LAKE, CANBERRA ACT
PREPARED FOR THE LAND DEVELOPMENT AGENCY

Project ID: GXA14-ACT-07

1. INTRODUCTION

GeoExchange Australia Pty Ltd (GXA) was requested by the Land Development Agency (LDA) to prepare a Pre-feasibility and Concept Design for the incorporation of a geoexchange district heating and cooling system for the City to the Lake Development in Canberra ACT. In discussion with the LDA, the Aquatic Centre, Hotel and Public Waterfront Pavilions have been selected as the focus for this assessment. Additional comment is also provided for future stages.

Please note that this Report is of a preliminary nature only and that a detailed design is required prior to finalising any component of the geoexchange system.

1.1 Structure of this Report

This report commences with an outline of the City to the Lake Development and Geoexchange systems before focusing on the application of Geoexchange systems within the development.

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2. SCOPE OF WORKS

The scope of works for this assessment included the following:

- Review of the current Master Plan and other available planning documents;
- Review of existing reports on the project;
- Review heating and cooling loads of the Aquatic Centre, Hotel and Public Waterfront Pavilions;
- Preliminary selection of Ground Source Heat Pumps (GSHPs) to provide required heating and cooling for various requirements across the site;
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3. THE CITY TO THE LAKE DEVELOPMENT

3.1 Introduction

The City to the Lake Development is centralised on the suburb of Canberra encompassing London Circuit, the West Basin lakeside portion of Acton and adjacent portions of City East and Parkes. Significant structures proposed as part of the development include an Aquatic Centre, Public Waterfront Facilities, Convention and Exhibition Centre, Stadium and Urban Community Precinct.

The aim of this report is to focus on the Aquatic Centre and the adjacent Hotel/ Apartment Complex as well as the lake front pavilions.

3.2 Lake Burley Griffin

In accordance with a review of the Lake Burley Griffin Water Quality Management Plan (National Capital Authority, 2011), the West Basin encompassing the proposed Public Waterfront Development is ideally suited to direct or indirect heat exchange for the City to the Lake.

Based on average ambient air temperatures, the water temperature range at depth within the lake is expected to be between 12^{o}C and 22^{o}C over the annual cycle.

3.3 Geology

The topography of the site consisted of open areas that lead slope down to the Lake Burley Griffin.

The 1:100 000 Geology Map of the Australian Capital Territory (2007) indicates that the site is underlain by the Canberra Formation of the Early Silurian period comprising shale and siltstone.

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4. GEOEXCHANGE HEATING AND COOLING SYSTEMS

4.1 Introduction to Geoexchange

Geoexchange systems are also referred to as geothermal, ground source and/or ground coupled systems. The term Geoexchange has been adopted more recently as it more accurately describes the heat exchange process with the ground, whereas geothermal is typically associated with geothermal energy or 'hot rocks'. With respect to geothermal energy, Geoexchange could most accurately be described as low temperature geothermal as it works within the top 100 to 200 m of the earth's surface where temperatures are similar to the annual average air temperature for a given geographic location.

Geoexchange is a high efficiency heating and cooling system that uses solar energy stored in the ground or a body of water. The high efficiencies are achieved by transferring heat from the ground into the building in winter (earth as heat source) and transferring heat from the building into the ground in summer (earth as heat sink). Geoexchange systems are equally as efficient in heating water bodies such as spas and swimming pools as well as industrial process waters.

Large buildings using GSHPs have multiple heat pump units, located around the building, transferring heat to and from a common building loop. This arrangement is very beneficial. First, large buildings often have simultaneous heating and cooling loads: for example, the retail areas may need cooling while residential dwellings need heating. The common building loop can transfer heat from cooling loads to heating loads, reducing the demand on the GHX and improving efficiency. Second, climate control is simplified and occupant comfort is improved, since each GSHP affects only its localised zone. Controls can be local, rather than part of a complex building-wide system. Third, the common building loop transfers heat using a liquid, which permits it to be much more compact than the ducting required by air distribution systems tied to conventional central air handling plants; space is freed up for more productive uses.

The technology has been applied at scales ranging from single residential buildings to the district scale in applications as wide ranging as residential sub-divisions, university campuses and business parks.

Geoexchange systems consist of two components, the Ground Heat Exchanger (GHX) and the Ground Source Heat Pump (GSHP) which is installed inside the building. The GHX can be vertical or horizontal. It can also be located within a water body and can be open or closed. Hybrid systems are also available for commercial installations which work with conventional boilers and cooling towers for either partial or full loads.

Figure 1 shows a typical schematic of a Geoexchange system integrated with the internal building services.

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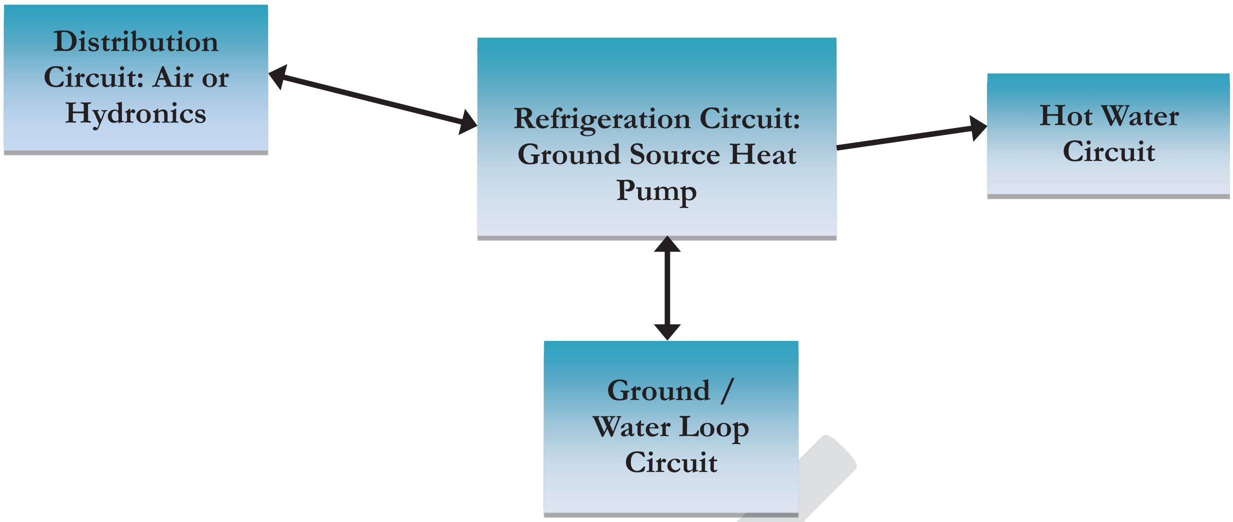

Figure 1: Components of a Geoexchange System, including building services.

4.2 History of Geoexchange

The first recorded Geoexchange system was a 1912 Swiss Patent with practical applications first appearing in the 1930s. Although the concept proved to be effective, the technology was not widely utilized as the steel pipe available would fail through either corrosion or cracking under the temperature fluctuations experienced within the GHX.

The advent of plastic pipe (polybutylene and polyethylene) in the 1970s provided a durability and flexibility previously absent with steel pipe. High Density Polyethylene (HDPE) pipe is now the most commonly used pipe material and has been installed in Geoexchange systems around the world over the past forty years.

4.3 The Ground Heat Exchanger

Geoexchange systems are flexible by nature and can access the renewable solar energy (indirect solar energy) available in the earth or a water body in a variety of ways. Part of the design process is ensuring that the most appropriate GHX is selected for any given site. Factors to consider when selecting a loop field include its cost effectiveness, operating efficiencies and whether it is environmentally friendly and sustainable over the long term. The possible options include:

- Closed Vertical Ground Loop;
- Closed Horizontal Ground Loop;
- Closed Water Loop;
- Open Surface Water Loop;
- Open Groundwater Loop; and
- Hybrid Systems.

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4.3.1 Closed Vertical Ground Loop

Closed vertical ground loops (Figure 2) are the most common type of GHX due to their suitability to a diverse range of sites and comparatively minimal land area requirements. They are installed by drilling to an average depth of 100 m and connecting sets of six to eight boreholes in a reverse return header configuration. The typical rule of thumb for loop capacity is 5-6 kW per 100 m deep borehole on an 8 metre grid spacing. Vertical ground loops can be installed in most soil/rock types and can be located either underneath or beside a building. Due to the drilling requirement, closed vertical ground loops are typically the most capital intensive loop field option.

Figure 2: Closed Vertical Loop.

4.3.2 Closed Horizontal Ground Loop

Closed horizontal ground loops (Figure 3) are common where the relationship between building load and land area is small. For example, a rural residential system is more suitable to a closed horizontal ground loop than an inner city commercial system. Closed horizontal ground loops require a typical soil depth of two metres and operate more effectively when the soil has a high clay and high moisture content. They should not be located underneath a sealed surface as this prevents appropriate heat exchange.

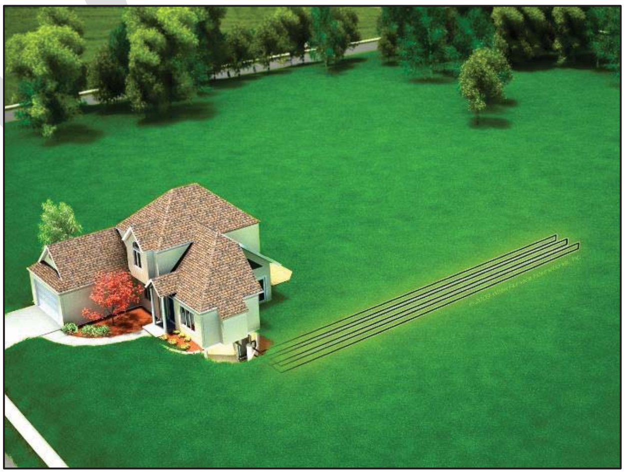

Figure 3: Closed Horizontal Loop.

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4.3.3 Closed Water Loop

A closed water loop (Figure 4) is an option when a suitable water body is located nearby. The minimum requirements for a suitable water body are a minimum water depth of two metres and sufficient water volume to accommodate the load to be applied. Open or flowing water bodies such as harbours and estuaries provide a greater capacity than a closed water body such as a farm dam or lake. It is possible to use water fountains / sprinklers to increase the capacity of a water body as they increase the heat rejection process.

It is important that a closed water loop has adequate protection from external influences such as boat anchors and motors, floods and storms. Location beneath a jetty or wharf is the most common application of a closed water loop, although successful installations have occurred in areas where boating and other activities are not permitted.

Figure 4: Closed Water Loop.

Further to the use of conventional Polyethylene (PE) coils, stainless steel lake plate heat exchangers may be an option if fresh water is present in the wetland. However, if the water body is saline, then the additional cost of titanium heat exchangers may not be cost effective.

4.3.4 Open Surface Water Loop

Open surface water loops are commonly used in waterside locations and typically require a secondary heat exchanger. Their advantage over a closed water loop is that they are not limited by the requirement for a 'protected area', although ongoing maintenance associated with water quality such as scaling and clogging of filters is an issue in most applications.

4.3.5 Open Groundwater Loop

Open groundwater loops (Figure 5) require the presence of a reliable, high volume and high quality groundwater source. The three main requirements associated with open groundwater loops are water quantity, water quality and disposal. Water quantity is important in ensuring the sustainability of the aquifer and the proper ongoing function of the system. Water quality is important with respect to the ongoing operational and maintenance costs of the system. Water disposal is important as all water extracted from the ground must be disposed of appropriately, which is typically through reinjection back into the aquifer.

Open water loops are also possible utilising water sources such as rivers, treated effluent, process waters etc.

Figure 5: Open Groundwater Loop.

4.3.6 Hybrid Systems

Hybrid systems (Figure 6) are adopted when a full capacity GHX is not practical due to either area or financial considerations. They are thus a hybrid of geoexchange and conventional systems. In general, the conventional component consists of a boiler (if supplementary heating required), a fluid or adiabatic cooler (if supplementary cooling required) or both. Two types of hybrid Geoexchange systems are available.

The first type utilizes the efficiencies of the Geoexchange system to provide baseload heating/cooling to a building or site. This provides a high efficiency system for the majority of the operating time. Peak periods are supplemented by a lower efficiency conventional system. The benefits of this system are that it provides a high efficiency system for typically > 90 % of the year, without the additional capital cost implications of the additional loop field requirements.

The second type of hybrid system utilises the inherent efficiencies of a GSHP with a conventional boiler / cooling tower arrangement only (*ie* no GHX). The benefits of this system are savings in operating costs and installation available due to the higher efficiencies of the GSHPs over a wider range of operating temperatures.

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Figure 6: Vertical ground loop with 'fluid cooler' hybrid.

4.4 Ground Source Heat Pumps

Ground source heat pump (GSHP) types include water to air GSHPs for ducted air systems and water to water GSHP for chilled water, hydronics and heating of other water bodies such as pools and spas or industrial process waters.

The main difference between a GSHP and a conventional heat pump or water packaged unit is that a GSHP has been designed to operate in the wider range of temperatures associated with Geoexchange loop fields. GSHPs typically operate with a Coefficient of Performance (COP) greater than 4 (*ie* 400 % efficiency) and in many instances can achieve higher COPs than this.

4.5 District Geoexchange Systems

A district geoexchange system is a geoexchange heating, cooling and hot water system that is applied over multiple buildings at scales ranging from a school campus to business parks and sub divisions. District systems can use either individual GHXs for each building / lot or common GHXs that are shared across multiple buildings / lots.

District geoexchange systems are typically installed and managed as project infrastructure in the same way as water, sewerage, power etc. Ongoing management of the system is of paramount importance and a number of project delivery models can be adopted (GXA, 2010) that range from individual ownership to the formation of utility style companies that provide ongoing management and service.

The two main benefits of a District Geoexchange system are load diversity and load sharing, with both resulting in the potential for shorter ground loops and a more efficient system.

The concept of load diversity is commonly applied across the air conditioning industry to commercial premises and is similar to the zoning concept within a home. Diversity factors of 5% to 30% are fairly typical. That is, as the system is being shared across multiple users, the capacity of the system (number of boreholes) can be reduced in size as it is unlikely that all users will require the full capacity of the system at any given time.

The concept of load sharing is one of the strengths of the geoexchange technology. It applies when mixed heating and cooling loads occur either concurrently or over the course of a given period such as a day, season or year. Concurrent load sharing occurs when different zones and different heating and cooling requirements enable the heat rejected from one area of the system that is in cooling mode to be immediately transferred to an area requiring heating. System efficiencies over 600 % are not uncommon in such instances as the requirement for both a heating and a cooling system has been replaced by the single geoexchange system.

The most common application and simplest example of load sharing is where the heat rejected from building air conditioning is transferred into a local hot water service or swimming pool. Load sharing can also occur annually, whereby heat rejected into the ground in summer is used to warm the building in winter. Underground Thermal Energy Storage (UTES) is a term commonly applied to these applications.

Figure 7 is a schematic of the system at Ball State University in Indiana, USA. This system replaces a ~100 year old centrally located coal-fired boiler and uses the existing reticulation infrastructure.

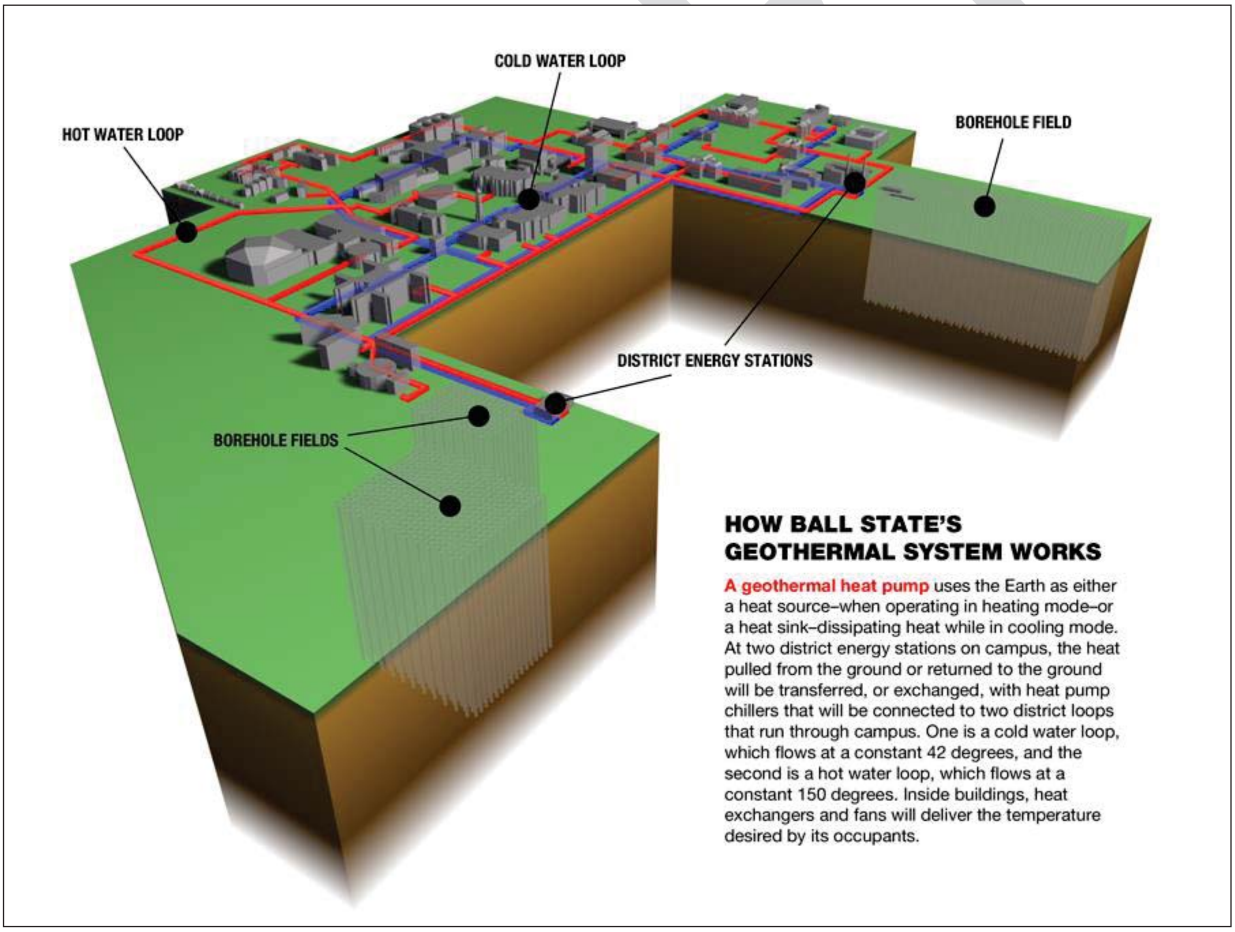

Figure 7: Schematic showing the Ball State University district system.

4.6 Geoexchange in Australia

Geoexchange systems have been present in Australia since approximately 1990. In this period, over 3000 GSHPs have been installed into dozens of commercial and government applications and hundreds of residential homes across all states and territories.

The largest closed loop Geoexchange system in Australia is the Geoscience Australia installation located in Jerrabomberra in the ACT. This installation has a capacity of 2.5 MW and consists of 350 boreholes in a closed vertical ground loop and approximately 200 GSHPs.

In Australia, district-style Geoexchange systems have been installed in a selection of schools, nursing homes and business parks.

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5. RESULTS AND DISCUSSION

In accordance with the scope of works, this section addresses the adoption of a geoexchange system for the City to the Lake development. It discusses the system capacity requirements and the recommended GHX and GSHPs.

As identified in the Scope of Works, a Stage 1 installation for the Aquatic Centre, Hotel and Pavilions forms the basis of this analysis. Additional commentary will be provided with respect to future stages of the development.

Budgets presented below are based upon a combination of supplied data, industry experience on similar projects and an understanding of regional contracting rates in conjunction with reference to the Rawlinson's Australian Construction Handbook. Design fees are included.

5.1 Aquatic Centre, Hotel and Pavilions Peak Loads

A summary of the heating and cooling load estimates for the Aquatic Centre, Hotel and Pavilions is summarised in Table 1.

Table 1: Summary of Heating and Cooling Load Estimates

DESCRIPTION	Area	Peak Capacity (kW)	
	m2	Winter	Summer
Aquatic Centre			
22m x 52m long Lap Pool	1144	-160	-140
19m x 11m Multi Purpose Pool	209	-40	-35
Leisure Pool	390	-55	-50
Outdoor Pools 2 x 19m x 15m	570	-306	-150
Water Slides Allowance	?	-300	-150
Outdoor Pools Ice Rink Estimate	570	700	0
Ground Floor Space	7300	-964	597
Upper Floor Space	2000	-200	300
Aquatic Centre HVAC Total	**12183**	**-2025**	**897**
Aquatic Centre GHX Total	**12183**	***-1325***	***372***
Hotel			
Ground Floor Commercial	1083	-86.64	162.45
Upper Hotel Floors (16 based on GF area)	16947	-1694.7	2033.64
Hotel HVAC and GHX Total	***18030***	***-1781***	***2196***
Pavilions			
Lake Front Pavilions x 3	*972*	*-78*	*146*
Pavilions HVAC and GHX Total	***972***	***-78***	***146***
District GHX Load (kW)	**31185**	**-3184**	**2714**

The summary presented in Table 1 indicates an approximately balanced heating (3184 kW) and cooling (2714 kW) loads over the annual cycle. The presence of the aquatic centre and the ice rink provide the

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opportunity for simultaneous heating / cooling throughout the year. For example, heating rejected from the ice rink (cooling) can be used to heat the adjacent outdoor swimming pool while heat rejected (cooling) from the hotel in summer can be used to heat the pools in the aquatic centre.

The balanced loads and the potential for simultaneous heating / cooling has benefits with respect to overall efficiency as well as reduced infrastructure requirements.

5.2 Aquatic Centre, Hotel and Pavilions Energy Use

Swimming pool energy use was modelled over a year and space conditioning was also modelled for one year using the simplified ASHRAE BIN Method of energy estimation. Estimates for both Geoexchange and alternative heating and cooling methods were made using the same assumptions to obtain quantitative energy comparisons among design alternatives.

A large number of uncontrolled and unknown factors generally preclude the use of such methods for the precise calculation of absolute energy consumption. In no case should these methods be used to predict future utility bills (ASHRAE, 1997b).

5.3 Selection and Design of Ground Heat Exchanger

The immediate proximity of Lake Burley Griffin indicates that water loop systems will be more economical than closed vertical, horizontal and open groundwater ground heat exchangers. As such, these GHX options have been discounted in the assessment of this first stage. However, it is possible that a vertical GHX could be adopted for future stages as the development moves away from the lake front.

The West Basin of Lake Burley Griffin has a surface area of approximately 365 000 m^2. Using a conservative value of 50W / m^2 provides a total thermal capacity of 18.25 MW which is well in excess of the approximately 3 MW capacity required for Stage 1 of the City to the Lake Development. While the Stage 1 developments easily fits within the thermal capacity of the West Basin, the significant addition of future Stages will require a more detailed assessment of the thermal capacity provided by the West Basin and its connection with the rest of Lake Burley Griffin.

Closed water loop (Option 1) and open water loop (Option 2) systems have been considered further. With respect to closed water loops, both closed loop polyethylene (HDPE) coils and lake plate heat exchangers have been investigated.

Indicative sizing of both closed loop HDPE coils and closed loop lake plate heat exchangers has been carried out for the Aquatic Centre, Hotel and Pavilions. As presented in Figure 8, the HDPE coils require a substantial amount of area compared with the lake plate heat exchangers. Further, due to the load and size of the development, lake plate heat exchangers have been identified as the optimum closed water loop solution in terms of economies of scale, simplified installation, negligible maintenance and their relatively compact size. The lake plate heat exchangers would be located beneath one of the boardwalk areas in the front of the Aquatic Centre.

HDPE coils may still be of value where the cost of connecting to the centralised or district lake heat exchanger was higher than installing localised coils directly adjacent to smaller facilities. The example to be considered here is the pavilions. In this instance, it may be more practical to install a small number of HDPE coils under the boardwalks over the lake that serve the individual pavilions only and not connect them to the district system.

An open loop lake heat exchanger is subject to variations in water quality throughout the year and requires regular maintenance of both lake water filtration system and cleaning of the heat exchanger(s). Open water loop systems require the least amount of lake infrastructure, although this is at the expense of regular maintenance.

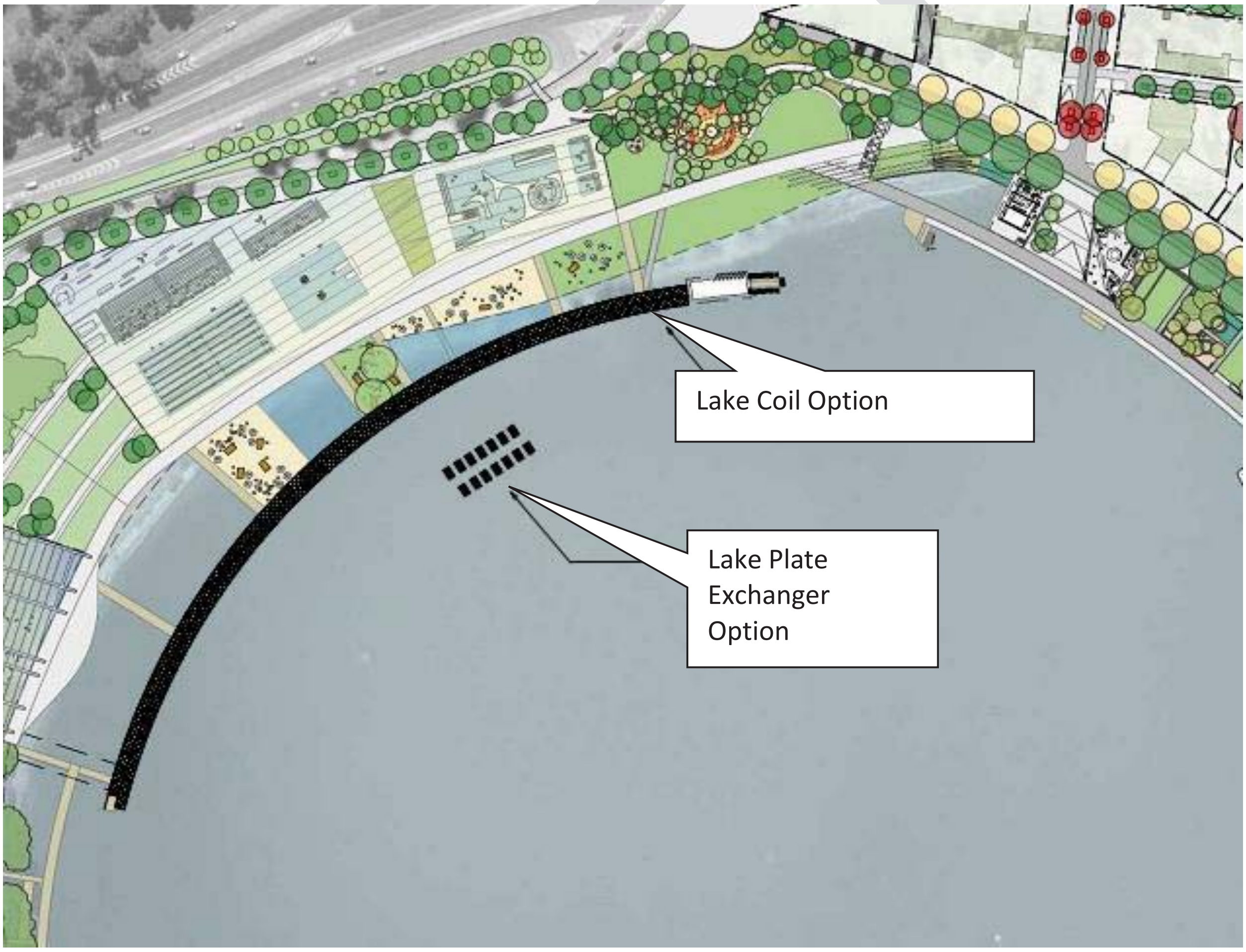

Figure 8: Lake Heat Exchanger Options

The infrastructure within the lake would be connected to the plant room in each building via header pipes that are either submerged in the Lake or within trenches at an approximate depth of 1m when out of the Lake. All header piping would be in polyethylene (PE) pipe.

Pumping Equipment

The interface between the lake GHX and the GSHPs in each building is the variable speed circulating pump in the plant room for each building. This allows for efficient variable flow within each building to suit varying demand through the year.

5.4 Ground Source Heat Pumps Selection

Generally, distributed GSHP systems has been preferred over the central reversible chiller approach due to the higher efficiencies, built in redundancy, typically lower installation costs and simplified controls arrangement.

An overview of how individual systems are connected to the GHX can be seen in Figure 9.

Aquatic Centre

Swimming Pool Heating

900kW of GSHP reversible chillers has been selected for all pool heating demands. The reversible chillers are dual compressor water to water GSHPs and are capable of providing heated water as required for heating the various swimming pools through the Aquatic Centre.

Space Heating, Cooling and Ventilation

1200kW of packaged ducted water to air GSHPs with built in dehumidification have been selected for all space heating and cooling within the Aquatic Centre. Energy Recovery Ventilators have been selected for the ventilation systems to reduce the outside air loads by up to 80%, improve indoor air quality and prevent condensation.

Outdoor Ice Rink

700kW of low temperature GSHP Chillers has been selected for winter outdoor ice skating. Heat rejection from ice chilling will feed back into the pool heating system.

Capital and operating costs for the Ice Rink have not been estimated at this time but as can be seen from Table 1, it is expected that all heat extracted from ice chilling operations will be recovered and used to offset the heating energy demands of the Aquatic Centre.

Hotel

Packaged ducted water to air GSHP’s have been selected to provide independent heating and cooling to each hotel room as well as retail and commercial space on the lower levels.

Pavilions

Packaged ducted water to air GSHP’s have been selected to provide independent heating and cooling to each pavilion.

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5.4.1 Equipment Locations

The proposed locations for equipment are to be finalised during detailed design phase. Equipment locations would include a combination of plantrooms and ceiling spaces or bulkheads. Due to the distributed nature of the design, large plantrooms would not be required. Note also that there is no external plant required.

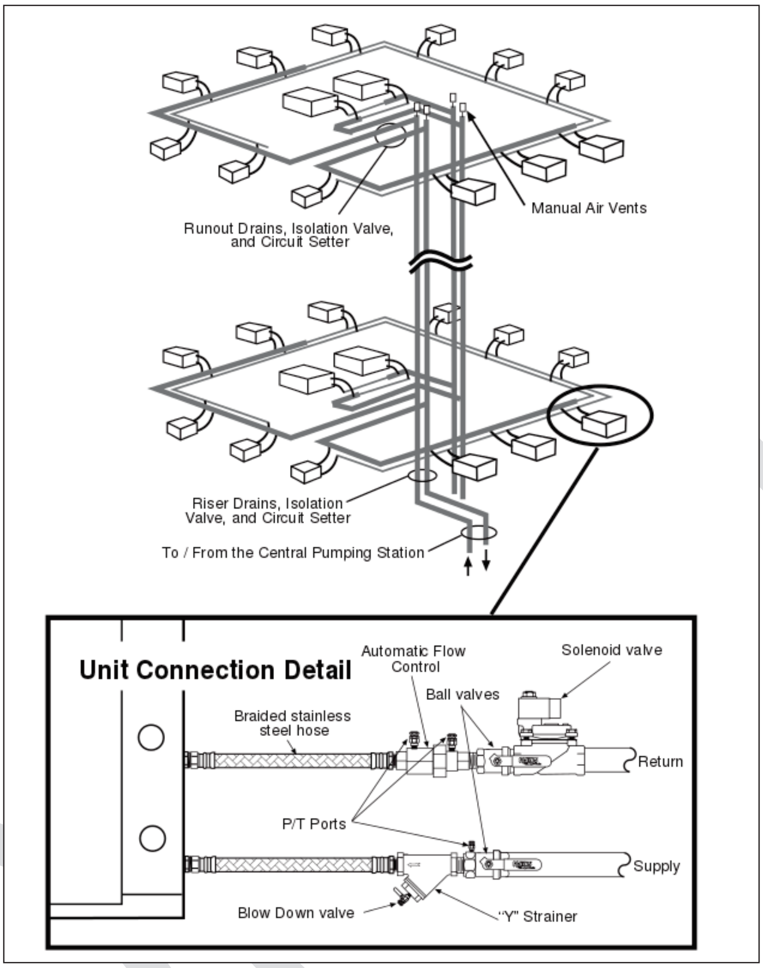

Figure 9: Distributed Ducted GSHP System

5.4.2 Controls

All GSHP's feature microprocessor controls supporting the BACnet protocol for centralised building management and control of all systems.

Individual programmable touch screen zone thermostats have been included in the budgets for the Hotel and Pavilion systems and these will connect directly to the zone GSHP(s) for total zone temperature control. Zone temperature and humidity sensors have been included in the budgets for the Aquatic Centre ducted GSHPs for optimum control of space temperature and humidity via the building management control system.

5.5 *Comparative Analysis*

A comparative analysis has been completed comparing the proposed Geoexchange systems (closed water loop and open water loop) with an alternative conventional solution. Energy use calculations for the proposed geoexchange system were compared to:

1. Natural gas boilers (pool heating) and ducted packaged air cooled air conditioning (space conditioning, administration rooms etc) for the Aquatic Centre;
2. Conventional chiller/ boiler with fan coil units for the Hotel; and
3. Ducted reverse cycle split systems for the Pavilions.

The comparison was made using proprietary energy estimation software (using the ASHRAE BIN Method) that incorporates the performance specifications of the GSHPs, annual weather data and available information on the ground conditions and selected GHX.

5.5.1 The Energy Sources: Electricity, Natural Gas and Carbon Emissions

Table 2 summarises the energy and gas usage for the options as well as annual carbon emissions. Further information is provided in Appendix A.

Table 2: Summary of Energy and Emissions

Description	Annual Electrical Usage (kWh)	Annual Gas Usage (MJ)	Annual CO_2 Emissions (tonnes)
Conventional System	966 604	51 203 437	3 460
Geoexchange: Closed Loop	3 255 195	0	2 799
Geoexchange: Open Loop	3 260 406	0	2 804

Table 2 identifies how the 'all electric' geoexchange system increases the overall electricity requirement while eliminating the requirement for gas. This may provide additional savings associated with connecting gas to the site that have not been included in this assessment.

Despite the higher use of electricity, the geoexchange system offers annual savings in carbon emissions of approximately 660tCO_2. In the current absence of a carbon price, a dollar value for the emissions reduction was not included in the current assessment. This emission reduction will increase over time as a higher mix of renewables is included in the local power supply or on-site renewables are installed.

With respect to on-site renewables, solar PV could be included either as part of this project or separately. This will provide additional energy savings, reductions in carbon emissions and reductions in electrical maximum demand. This has not been included in this assessment but with the removal of all rooftop plant, is a worthy consideration.

Integrating the high electrical efficiency of geoexchange with on-site renewables such as solar PV will have a significant impact upon local energy productivity. The peak demand reduction is an important consideration with respect to capacity requirements for future onsite power generation (eg solar PV) as well as energy pricing that may be based upon peak usage.

5.6 Geoexchange System: Installation

With respect to timing of the installation, the only difference to a conventional system is the timing of the Lake GHX installation and any building penetrations. A typical timeframe for the installation of the proposed lake GHX is four to six weeks with a two week allowance for completion of the earthworks associated with the distribution pipes. Thus, six to eight weeks should be allocated for the Lake GHX installation as a budget timeframe for Stage 1.

Installation of the GSHPs and building services is similar to conventional equipment. The GSHPs should be installed at a time when sufficient access is present in ceiling / roof spaces for the installation of ducted systems and associated electrical and plumbing works.

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6. BUDGETS

The capital and energy costs were calculated on Stage 1 comprising the Aquatic Centre, Hotel and the Pavilions. Modelled parameters were applied to all three buildings.

Table 3 summarises the capital and operating costs of Stage 1. It indicates that the additional capital cost of between approximately $3.9 and $4.2 million is recovered in five years. Further details are presented in Appendix A.

Table 3: Summary of Capital and Operating Costs

Description	Capital Cost	Year 1 Operating Cost[1]	Amortised Annual Cost[2]	Financial Breakeven
Conventional System	$7 695 167	$1 576 756	$2 539 223	-
Geoexchange: Closed Loop	$11 920 702	$843 617	$1 375 429	5.2 Years
Geoexchange: Open Loop	$11 591 983	$860 460	$1 398 445	5.0 years

Note 1: Year 1 cost only included to highlight short term cost comparison. Includes maintenance allocation
Note 2: Average annual cost over 20 year life cycle. Includes operating cost and inflation.

Table 4 provides a basic analysis into the infrastructure investment associated with the geoexchange approach by analysing the capital and operating costs if financed over a nominal 10 years at 7 % interest. As with the capital purchase option, calculations are still relevant to the Stage 1 development to ensure consistency with available data and for the LDA to understand in terms of the overall building requirements. Further details are presented in Appendix A.

Table 4: Summary of Financed Costs

Description	Capital Cost	Year 1 Operating and Financed Cost[1]	Amortised Annual Cost[2]	Financial Breakeven
Conventional System	$7 695 167	$2 672 374	$3 087 033	-
Geoexchange: Closed Loop	$11 920 702	$2 540 857	$2 224 049	Immediate
Geoexchange: Open Loop	$11 591 983	$2 510 898	$2 223 664	Immediate

Note 1: Year 1 cost only included to highlight short term cost comparison. Includes maintenance allocation
Note 2: Average annual cost over 20 year life cycle, includes capital, operating and finance costs

The results summarised in Table 4 indicate that both geoexchange systems, if financed, provide a financial breakeven within the first year. In other words, the energy savings are greater then the cost of finance.

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6.1 Project Delivery Options

Two financial options are provided above to indicate the difference between a direct project delivery, where capital costs are paid during installation, and a nominal financed option where the project is financed over a ten year period.

The financed option could include a service level agreement for system performance and operation and could be managed by the LDA or the system installer.

The scope of this document is not to address project delivery responsibilities. However, it is considered important that they are raised as part of the considerations of the feasibility of the project. Considerations around the ongoing operations of the system include financial, maintenance and legal and there are many models already in place within the utility and energy efficiency sectors to deliver such a project.

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7. STAGING OF THE PROJECT

As per the brief, this assessment has addressed the Stage 1 development that includes the Aquatic Centre, the adjacent hotel and the lake front pavilions. Results to date indicate that the heating, cooling and hot water requirements of the Stage 1 development can be readily achieved through a water loop system utilising the West Basin of Lake Burley Griffin.

With respect to the future development of the City to the Lake project, while there is a good understanding of the types of buildings to be constructed, nothing is yet finalised. Thus, while further detail is difficult to provide it is expected that the geoexchange system could be readily augmented to include future Stages of the City to the Lake project.

This is based on the modular nature of geoexchange systems, whereby future augmentation requires installing additional loop to the system as buildings are developed. It is then a matter of connecting each new building to the district geoexchange system and installing the appropriate GSHPs for that building.

Augmentation considerations with respect to overall site infrastructure are as follows:

- The physical placement of the Stage 1 water loop heat exchangers to consider potential for future augmentation;
- Header pipes and manifolds to have provision for either higher capacity or duplication;
- The district geoexchange pipe network to be included in overall infrastructure services planning;
- Future design to assess thermal capacity of West Basin / Lake Burley Griffin with respect to threshold limitations for the complete City to the Lake development;
- Vertical borehole GHXs to be considered for future stages of the development as required. Noting that the vertical borehole GHXs and water loops can be integrated and thus the overall system optimised depending on relative temperatures across the different types of GHX. For example, there may be building types and times of year when the water loop provides greater energy savings than the vertical borehole GHX and vice versa;
- With respect to the above, it is noted that the ground provides a greater thermal energy storage potential than the Lake and thus may be preferred in some instances.

Augmentation of a closed water loop requires the addition of further heat exchange modules while augmentation of an open loop system requires additional water flow.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

GeoExchange Australia Pty Ltd (GXA) was requested by the Land Development Agency to prepare a pre-feasibility and concept design for the incorporation of Geoexchange heating and cooling systems to Stage 1 of the City to the Lake Development in Canberra.

In accordance with consultations with Land Development Agency, a staged approach that focussed on Stage 1 encompassing the Aquatic Centre, Hotel and Waterfront Pavilions was adopted.

The concept review has indicated that a geoexchange heating and cooling system is suitable for the proposed City to the Lake Development. This is based upon the proposed usage, proximity and availability of the west basin for the Lake GHX, the peak loads of the buildings and the financial analysis.

A water loop using the West Basin of Lake Burley Griffin was preferred over a vertical borehole GHX as they will be lower cost to both install and operate. Both closed and open water loops were considered, with the heat exchanger for the closed water loop further divided into polyethylene and stainless steel plates. The stainless steel plates were preferred due to the lower area required and reduced installation cost.

The economics of the open and closed water loop systems are very similar and it is recommended that both be investigated further if any detailed design work is scheduled. Although the closed water loop is marginally more expensive to install, it provides lower operating costs and a similar financial breakeven. Open loops have higher maintenance costs and risks associated with water quality and for this reason, the closed water loop is preferred with the available information.

The key conclusions were as follows:

- The heating, cooling and hot water loads across the Stage 1 buildings are approximately balanced and provide opportunity for heat transfer both simultaneously and across the annual cycle. For example, heat rejected from the ice rink can be used to heat the adjacent outdoor pool, while heat reject while air conditioning the hotel in summer can be used to heat the main aquatic centre;
- A closed water loop heat exchanger using stainless steel plates located in the West Basin of Lake Burley Griffin is the most suitable GHX for the site due to the availability of the high yielding lake and to eliminate maintenance associated with open loop systems. It would be preferred to locate the plates beneath boardwalk areas;
- A distributed GSHP approach was considered the optimal approach with respect to the building distribution due to higher efficiencies, higher redundancy, lower installation cost and simplified controls;

- The closed loop and the distributed GSHP approach also provide a staged approach across the 3 building types that enables the LDA to stage works and not overcapitaise on infrastructure unnecessarily in Stage 1;
- This staged and modular approach also enables simple augmentation for future stages of the project;
- The additional capital cost for the closed water loop geoexchange system was approximately $4.2 million or 35 % more than the conventional system and the financial breakeven point in terms of operational and maintenance savings was 5.2 years;
- An assessment of a nominal ten year financed option indicates that energy savings exceed finance costs and thus a financed purchase, possibly in accordance with a service level agreement, has merits for the installation and ongoing operation of the system;
- The future addition of on-site renewable energy (*ie* solar PV) will further improve the operating cost of the system. The reduced electrical usage, and in particular peak load, of the geoexchange system will reduce the investment required in solar PV to power the site; and
- In addition to the economic analysis, the geoexchange system will also:
  - Reduce peak loads by approximately 25 to 40 %;
  - Free up roof space for future installation of solar PV;
  - Free up plant room space for greater storage;
  - Have quieter operation;
  - Improved comfort levels with individual temperature and humidity control in each zone;
  - Reduced maintenance as reflected in operating costs;
  - Eliminate requirement for gas at the site as proposed to provide heating;
  - Potentially provide hot water for 'domestic' use in the building; and
  - Be a genuine and proven energy efficient solution.

8.2 Recommendations

Based upon the results of this report, the geoexchange approach presents a strong energy and economic case. In order to progress to the next stage the following is recommended:

- Conduct of detailed design of geoexchange system, including detailed energy modelling of the buildings to be incorporated into Stage 1 and detailed design of the closed water loop heat exchanger; and
- Investigation of project delivery methods to assess the method best suited to the ongoing role of the LDA and the ACT Territory Government with respect to the provision of utility services across the development.

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APPENDIX A:

TECHNICAL AND FINANCIAL CALCULATIONS

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Appendix L – Commonwealth Avenue Intersection Technical Note

Technical Note

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Project title	City to the Lake	Job number	240073-27
cc		File reference	TN01
Prepared by	Vincent Chan	Date	29 July 2015
Subject	Commonwealth Avenue Intersection Options		

1 Introduction

The purpose of this technical note is to discuss and compare potential options for providing vehicular access between Commonwealth Avenue and:

- The existing at-grade car parks at West Basin, during Stage 1A;
- Corkhill Street, and the West Basin development, during future stages;
- Albert Street and the Waterfront Boulevard, for car parking and servicing vehicles; and
- Commonwealth Park.

The options development process was driven by the West Basin development, which removes the existing grade separated crossing of Commonwealth Avenue that currently provides connectivity in the area.

As the replacement options all involve the construction of a signalised intersection along Commonwealth Avenue, all options will lead to queuing and delays for through traffic in an area where there are no existing obstructions to free flow. The assessment documented in this technical note is based on existing (2014) traffic volume data along Commonwealth Avenue from SCATS.

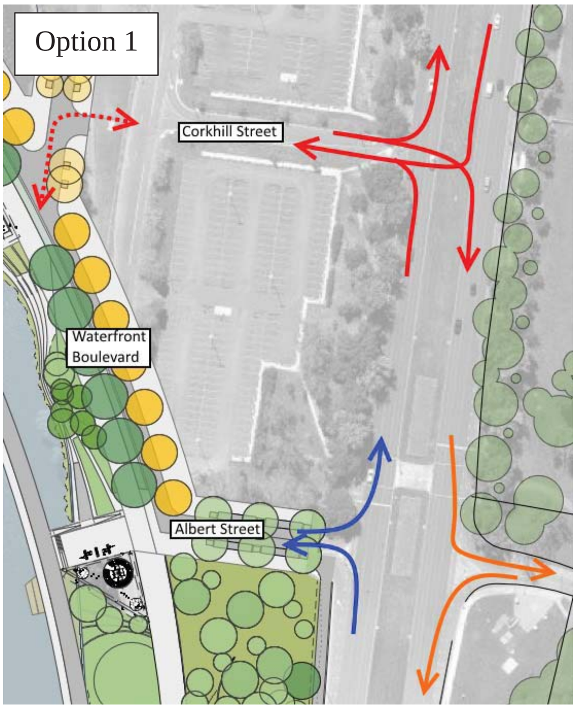
Key objectives of the design are:

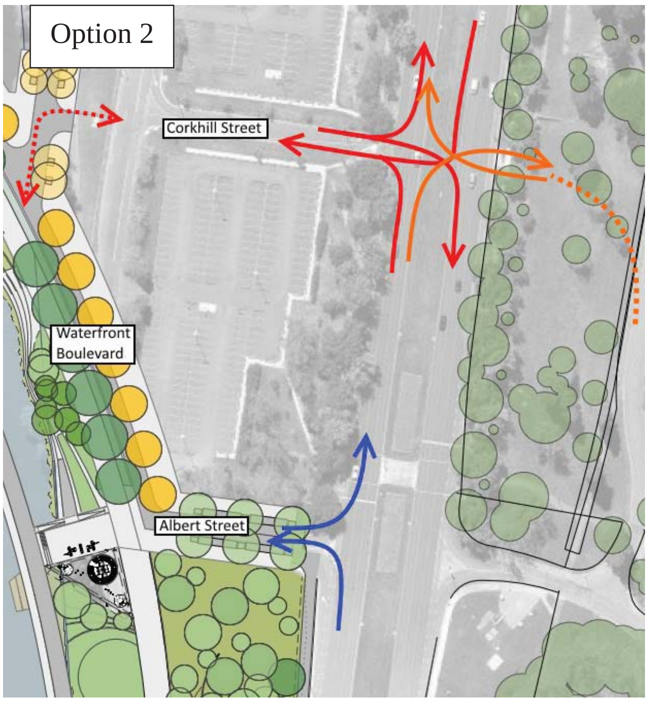
- Safe and legible road layouts – provide a network that offers clear routes to key destinations to minimise the risk of drivers making unsafe manoeuvres;
- Contributing to the urban design objective of a 10km/h, low-traffic, "shared zone" environment on Waterfront Boulevard;
- Acceptable journey times for cars accessing both basins from/to both northbound and southbound carriageways of Commonwealth Avenue;
- Minimising the impact on through traffic on Commonwealth Avenue, and consider the impact on the Parkes Way interchange.

Eleven (11) access options have been developed, and are described in more detail on the following pages. This technical note focusses on access to the West Basin in the short and medium term, and does not consider the implications of longer term development of the estate in detail.

2 Option 1 / Option 2

Option 1 consists of a signalised intersection at Corkhill Street for access to/from the existing at-grade car parks (and future development), and a left-in, left-out intersection at Albert Street for access to the Waterfront Boulevard. It is anticipated that a short right turn bay will be constructed on the southbound carriageway to allow right turning vehicles to queue out of the way of through traffic. Access to Commonwealth Park would be via the existing left-in left-out intersection.





The key benefit of this option is that it avoids the need for car park traffic to use the Waterfront Boulevard, which reduces conflicts between pedestrians/cyclists and vehicles in the 'shared zone' area, improving safety and amenity. In future stages of West Basin development, this option will continue deliver traffic directly into the precinct's internal street network, closer to where cars will access developments. The Waterfront Boulevard will be used only to access local car parking and for servicing vehicles; this low traffic demand will help create the pedestrian-friendly environment that is desired.

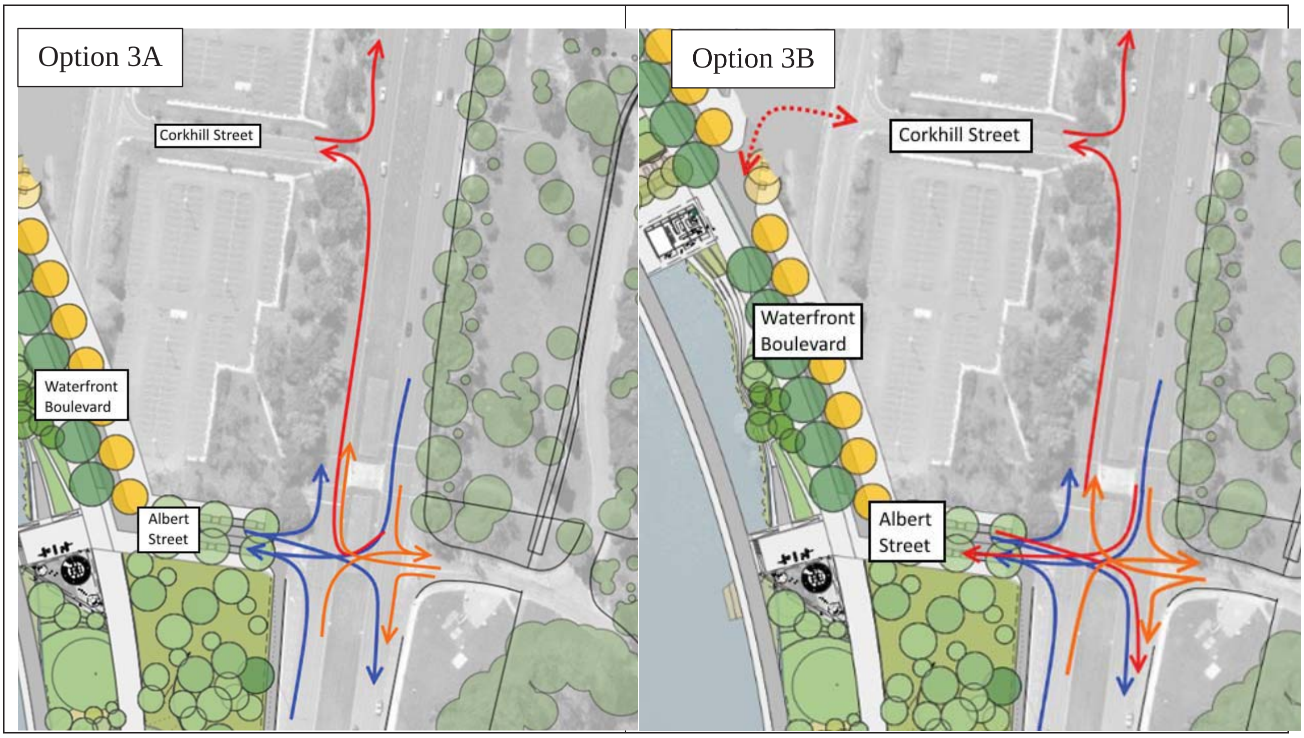
The key disadvantage of Option 1 is that it provides only left-in/left-out access to Commonwealth Park. Visitors are required to perform detours to intersections further along Commonwealth Avenue to complete a u-turn manoeuvre. A variation on this option would be to construct a new link road from the Corkhill Street intersection to the Commonwealth Park (shown dotted on plan above) - this is referred to in following sections of this note as Option 2.

The provision of a signalised intersection on Commonwealth Avenue will reduce the capacity of this road. This impact will be greater if Option 2 is selected, and this intersection also provides right-turn access into and out of Commonwealth Park. Commonwealth Avenue carries a significant volume of southbound traffic during the morning peak hour. The northbound traffic during the evening peak hour is also high, but not as critical. Preliminary assessment using SIDRA Intersection software indicates that very long cycle times (3 mins, compared to 2 mins for Option 1) or additional through lanes are required to accommodate the existing traffic volumes if Option 2 is selected, and signalised access is provided to both West Basin and Commonwealth Park.

3 Option 3A / 3B

Option 3A consists of a signalised intersection at Albert Street and a left-in, left-out access at Corkhill Street providing access to the existing at-grade car parks (and future development). This option would provide no vehicular connection between Waterfront Boulevard and the at-grade car parks. Vehicles travelling from the north would perform a u-turn at the Albert Street signals and turn left into Corkhill Street. Vehicles travelling from the car park to the south would turn left from Corkhill Street and utilise the two existing loop ramps at the Parkes Way interchange.

Option 3B is similar to Option 3A, except with a connection between the Waterfront Boulevard and the existing at-grade car parks. This option allows all users of the West Basin to turn right into and out of the site onto Commonwealth Avenue. The key benefits are that it provides the greatest level of connectivity, allowing visitors to drive between the at-grade car parks (and the future development in the West Basin area) and Commonwealth Park.



*Note: Straight through movements across Albert Street between the West Basin and Commonwealth Park are allowed in both options. They have been omitted from the figures above to reduce visual clutter

Option 3A allows for turns into and out of the West Basin from both directions along Commonwealth Avenue at the Albert Street (Waterfront Boulevard) intersection. It also retains separation between car park traffic and Waterfront Boulevard traffic by providing a convenient access directly into the car park. It does, however, mean that visitors wishing to access the car park need to perform a u-turn manoeuvre at the intersection.

A disadvantage in allowing for turns to and from Commonwealth Park is that it further interrupts through traffic along Commonwealth Avenue (as discussed in the previous section). During the peak hours, Commonwealth Avenue is very sensitive to being stopped by red signals. It is likely that allowance of right turns to and from both sides of Commonwealth Avenue will cause the intersection to operate above capacity based on current traffic volumes, and further mitigation works may be required. This does, however, support the longer-term intent for Commonwealth / Northbourne corridor to have a more urban traffic environment rather than a free-flow environment.

A variation to both Options 3A and 3B with reduced impact on Commonwealth Avenue is to provide a left-in, left-out only access arrangement to Commonwealth Park. This would reduce the interruption to through traffic, especially the critical southbound movement, and allow the intersection to operate with a better level of service.

If Option 3B is selected, further disadvantages include:

- Increased traffic along the first section of Waterfront Boulevard, leading to an increase in potential conflicts between vehicles and pedestrians. In Australia, the typical maximum traffic allowed along a shared zone is 100-200vph or 1000vpd (source: RMS, Vicroads). The existing traffic volumes entering/exiting the peak hour are already over 160vph (from November 2014). There are, however, international examples of shared zones operating with higher traffic volumes;
- Greater levels of traffic will lead to a higher likelihood of turning vehicles encountering a vehicle travelling in the opposing direction. Kerb radii may need to be increased to allow for safe manoeuvres, which may compromise the urban design intent.

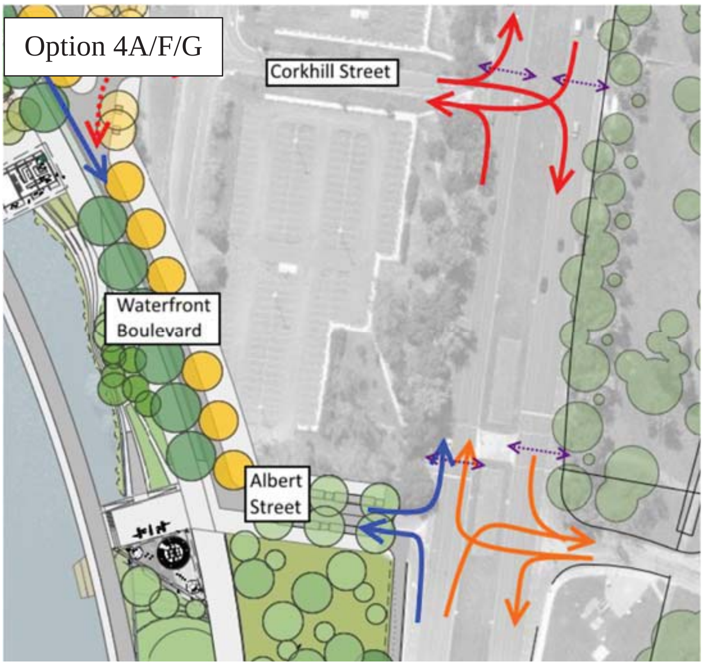
4 Option 4A / 4B / 4C / 4D / 4E / 4F / 4G / 4H

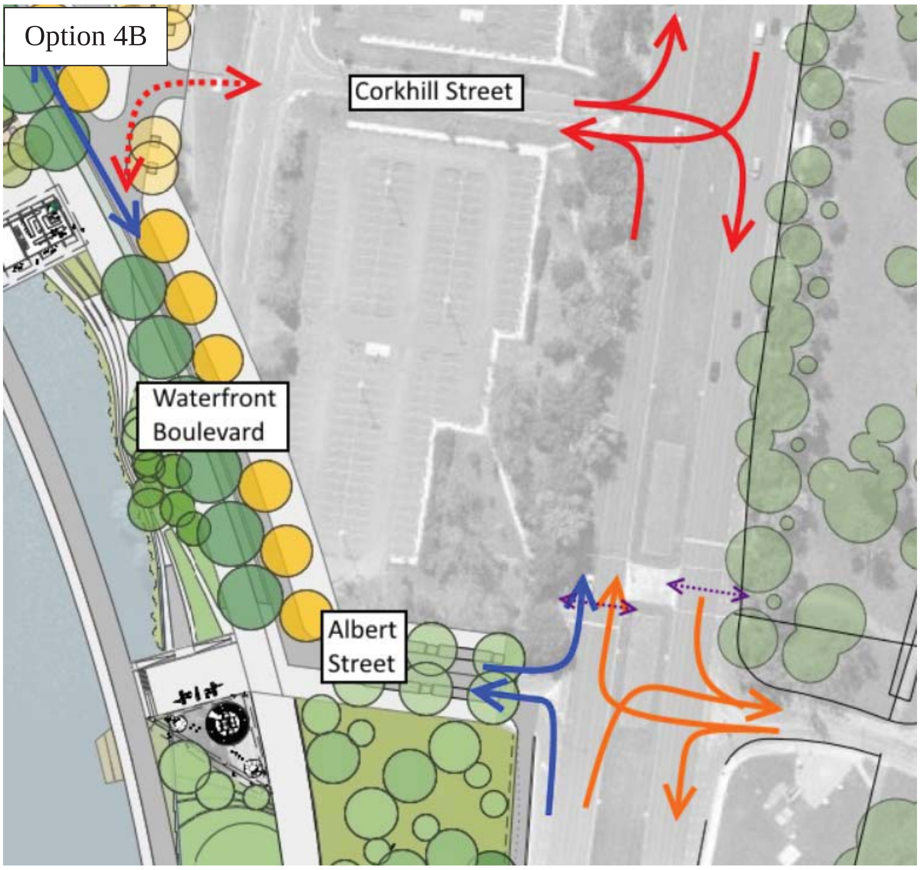
Options 4A to 4H consist of two co-ordinated signalised intersections in a “Staggered T” arrangement:

- The northern intersection provides access to the car park in the short/medium term, and to the development in CttL in the longer term; and
- The southern intersection provides access to Commonwealth Park. Left-in, left-out access would be provided to Waterfront Boulevard at this location. Vehicles may travel between the West Basin and Commonwealth Park by utilising both signalised intersections (by turning right onto Commonwealth Avenue, then turning left to exit into the other side).

This option could be staged if required. In the short term, when traffic volumes are lower, all movements could be allowed at the southern intersection (i.e. similar to Option 3B). Once the traffic volumes start increasing (e.g. due to further development in the West Basin, or if the foreshore is more popular than expected), the northern intersection could be signalised to reduce the demand along the Waterfront Boulevard, and the western Albert Street approach converted to left-in, left-out operation.

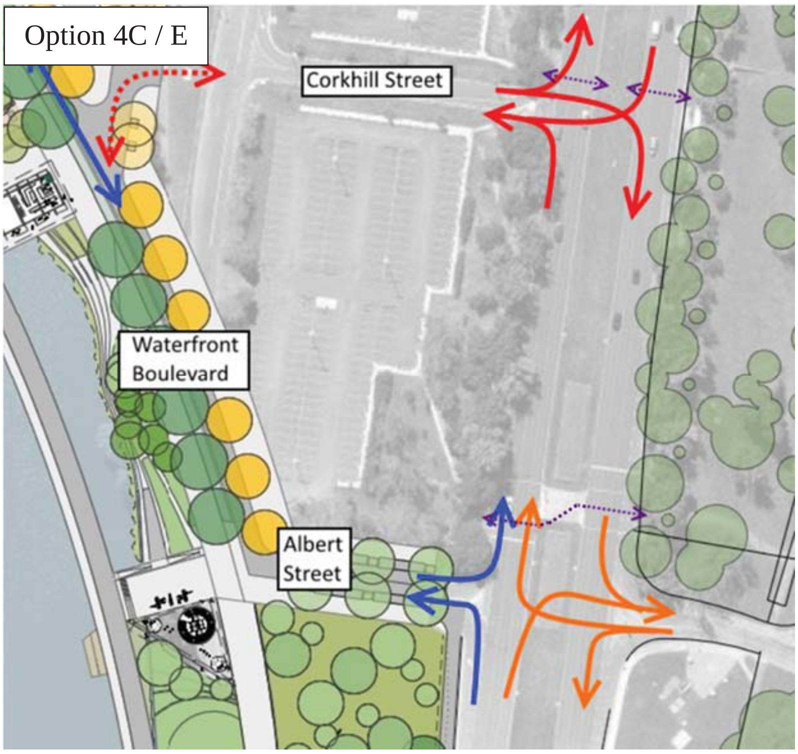
Option 4A consists of a standard all-movements intersection at Corkhill Street. In order to minimise the impact on Commonwealth Avenue, the northern intersection can be designed with a “seagull” layout allowing southbound through traffic to continue uninterrupted. This seagull arrangement would not include a signalised pedestrian crossing across Commonwealth Avenue, with pedestrians being required to cross at Albert Street. This alternative has been designated as Option 4B within this technical note. Another alternative replacing the left turn bays at the Albert Street intersection with simple left turn slip lanes has been designated as Option 4F. A further modification to remove the left turn slip lanes altogether (replacing them with stand-up left turn lanes) has been designated as Option 4G. This option aims to maintain the form of Commonwealth Avenue as much as practical. It is anticipated that further microsimulation modelling will be completed in a future stage of design. This assessment will include reviewing whether left turn slip lanes are required.





A further revision to this option was developed to model the signal phasing at the Albert Street intersection to allow pedestrians to cross Commonwealth Avenue in one go rather than in two stages. These options are intended to address periods of high pedestrian flow across Commonwealth Avenue, in particular, during Floriade.

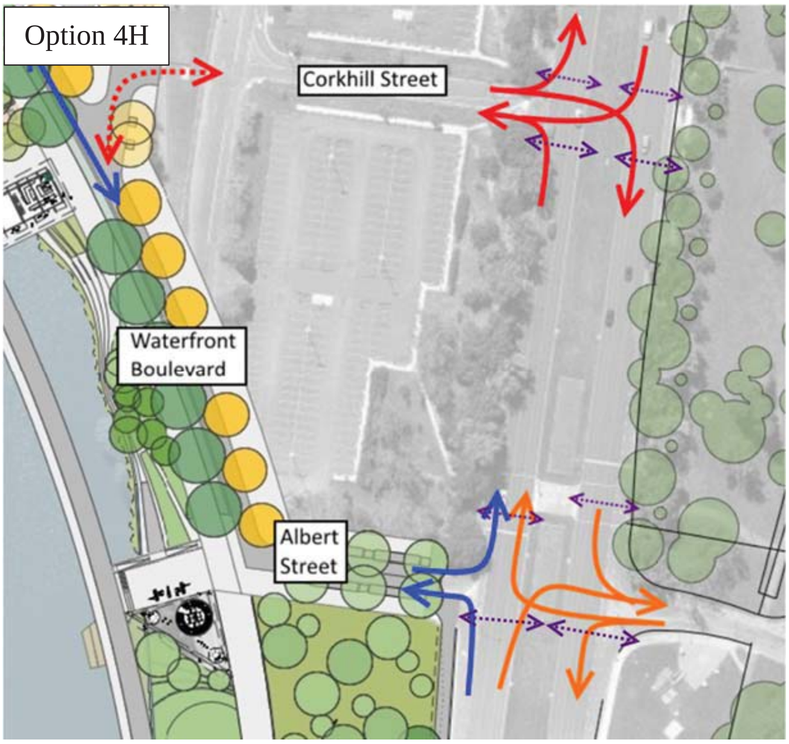
These options were designated as Options 4C (based on Option 4A) and 4D (based on Option 4B). Option 4C is illustrated below. Option 4D is similar, but with a signalised seagull (and omitting the pedestrian crossing) at Corkhill Street. A further refinement of Option 4C (designated as Option 4E) removed the 60m left turn bays from the north and the south.



Option 4H was developed based on Option 4A, except with signalised pedestrian crossings on both sides of the Corkhill Street and Albert Street intersections. This option also involved a rationalisation of the length of the right turn bays from Commonwealth Avenue. At a minimum, the right turn bays should be dimensioned to meet the Austroads requirements for a CHR(S) treatment. For a 60km/h speed limit, this results in a requirement for a:

- 45m bay (inc. taper) for the northbound right turn lane (into Commonwealth Park); and
- 60m bay (inc. taper) for the southbound right turn lane (into West Basin).

The CHR(S) treatment allows for turning vehicles to complete 80% of the deceleration within the turn bay, reducing the risk of rear-end accidents. This type of treatment is suitable where the right turn volumes are minimal. For higher turn volumes, the frequency of turning vehicles is higher, and the Austroads guidelines recommend a full CHR treatment. This allows for 100% of the deceleration to be completed within the turn bay. This type of treatment is recommended especially for the southbound right turn lane (into West Basin), given the higher expected turning volumes (both existing and in the future following further development). The provision of a full CHR treatment would require a 90m long turn bay (inc. taper) for a speed limit of 60km/h.



Benefits of this option include:

- Opportunity to provide two pedestrian crossings across Commonwealth Avenue;
- Provides an opportunity to reduce Waterfront Boulevard traffic volumes in the future if required; and
- A staggered T-intersection layout provides access to/from Commonwealth Park and the West Basin with lower impact to Commonwealth Avenue traffic compared to a single four-arm intersection.

Disadvantages of this option include:

- Increased traffic along the Waterfront Boulevard in the short term (if staged option selected);
- Significant impact on Commonwealth Avenue through traffic due to introduction of signals. Increased impact in short term if the temporary four-arm intersection is built prior to the staggered layout;
- Construction of two signalised intersections may be more costly; and
- (for Option 4B/4D only) Pedestrians may be confused by the lack of a signalised pedestrian crossing at a signalised Commonwealth Avenue / Corkhill Street intersection.

5 Options Comparison

A comparison between the options based on the key objectives was completed to inform the decision regarding the location and form of the future intersection. A summary of the results is provided in the table below, with each option ranked from “low” to “high” based on how well they achieve the objective.

Objective	Option 1	Option 2	Option 3A	Option 3B	Options 4A to 4H
Safe and legible road layouts	**Medium** Provides clear demarcation of access to the Waterfront Boulevard and the rest of the West Basin area, however, access to Commonwealth Park may be difficult to make legible from the northbound side of Commonwealth Avenue	**High** This layout is able to provide clear routes to and from the West Basin and Commonwealth Park.	**Medium** This layout allows people to clearly identify routes to and from the Waterfront Boulevard and Commonwealth Park. However, drivers going southbound on Commonwealth Avenue going to the open-air car parks (short term) or developments in the West Basin (longer term) may inadvertently drive into Waterfront Boulevard instead of performing a u-turn.	**High** This layout is able to provide clear routes to and from the West Basin and Commonwealth Park.	**High (Option 4A/C/E/F/G/H)** This layout is able to provide clear routes to and from the West Basin and Commonwealth Park. **Medium-High (Option 4B/D)** Seagull arrangement increases the difficulty for vehicles driving from the West Basin to Commonwealth Park due to weaving.

Objective	Option 1	Option 2	Option 3A	Option 3B	Options 4A to 4H
Contributes to the objective of a 10km/h shared zone on Waterfront Boulevard	**High** The access arrangement restricts traffic volumes along Waterfront Boulevard, which is consistent with its function as a low speed shared zone	**High** No difference to Option 1	**Medium** The access arrangement restricts traffic volumes along Waterfront Boulevard. However, this is to a lesser extent compared to Option 1, as vehicles leaving the West Basin area travelling southbound must still use Waterfront Boulevard.	**Low** A greater level of traffic will be required to travel through the Waterfront Boulevard to access the open-air car parks (and future developments) compared to Option 1 or Option 2	**High** The access arrangement reduces traffic volumes along Waterfront Boulevard, which is consistent with its function as a low speed shared zone

Objective	Option 1	Option 2	Option 3A	Option 3B	Options 4A to 4H
Acceptable Journey Times – Through Traffic along Commonwealth Avenue	**Medium** Signalisation of Commonwealth Avenue introduces delays to through traffic	**Low** Provision of a fourth approach to the intersection increases the delays to through traffic	**Low** Similar to Option 2. Slightly worse operation because there is reduced opportunity to "overlap" pedestrian phases due to u-turns being allowed	**Low** Similar to Option 2	**Medium (4A/F/G)** **Medium-High (4B)** **Medium-Low (4C/D/E/H)** Staggered layout reduces the impact compared to Options 2, 3A and 3B, as it reduces the time that through traffic is stopped. Option 4B reduces the impact to southbound traffic compared to Option 4A. The full pedestrian crossing in Options 4C/D cause more interruption to traffic. Option 4H has a higher impact due to having pedestrian crossings on both sides of Corkhill St and Albert St.
Acceptable Journey Times – Traffic turning into/out of West Basin	**Medium** Similar to other options	**Medium** Similar to other options	**Medium** Similar to other options	**Medium** Similar to other options	**Medium** Similar to other options

Objective	Option 1	Option 2	Option 3A	Option 3B	Options 4A to 4H
Acceptable Journey Times – Traffic turning into/out of Commonwealth Park	**Low** Some vehicles are required to detour via the Parkes Way / Commonwealth Ave interchange or the Commonwealth Ave / Flynn Place interchange to access or leave Commonwealth Park	**Medium** More direct access to / from Commonwealth Park is possible compared to Option 1.	**Medium** Similar to Option 2	**Medium** Similar to Option 2	**Medium** Similar to Option 2
Impact on Commonwealth / Parkes interchange	**Medium** This option introduces an intersection close to the Parkes Way ramps. There may be issues with queues interrupting the operation of the ramps. There are weaving issues in the short and medium term due to vehicles from the ramps trying to weave from the left to the right hand lane to turn into the West Basin. The weaving issue is less important in the long term as direct access to the West Basin will be possible from Parkes Way (boulevard level).	**High** Greater impact from queuing compared to Option 1 due to additional phase for Commonwealth Park traffic.	**Low** No interruption to southbound traffic at the northern (Corkhill St) intersection.	**Low** Same as Option 3A.	**Medium (Option 4A/C/E/F/G/H)** Similar to Option 1. **Low – Medium (Option 4B/D)** Option 4B/D has a reduced impact compared to 4A/C/E/F/G, as it would tend to reduce the impact of queuing on the Commonwealth Ave / Parkes Way interchange. However, there will still be weaving issues in the short to medium term.

6 Impact of Signalisation

6.1 Background

As noted in Section 1, the introduction of traffic signals will lead to delays and long queues for vehicles along Commonwealth Avenue.

The current left-in, left-out arrangement of intersections along Commonwealth Avenue cause negligible delays and queues for through traffic.

In order to assess the delays and queues associated with each option, the proposed intersection layouts and estimated traffic volumes were modelled using the SIDRA Intersection 6 software package.

6.2 Assumptions

The following assumptions were made in the assessment:

- Right turns into Commonwealth Park and the West Basin from Commonwealth Avenue are facilitated by right turn bays that allow turning vehicle to wait outside of through traffic lanes;
- A cycle time of 130 seconds was adopted as the longest acceptable cycle time,;
- A six (6) second inter-green time was assumed, consisting of four seconds of yellow and two seconds of all-red time. This is based on the assumption that the speed limit along Commonwealth Avenue will be reduced following the introduction of signals;
- Phase times within the 130 second cycle time were optimised using SIDRA. This resulted in the majority of the “green time” assigned to the through movements along Commonwealth Avenue. Phase times for the other movements were mostly either governed by the minimum green time (6 seconds) or green time requirements for the pedestrian crossing;
- The pedestrian crossing across Commonwealth Avenue is staged using the median;
- Phasing of the intersection was designed to allow for maximum overlap of pedestrian crossings with complementary vehicle movements to minimise the impact of the crossings on vehicle traffic;
- Left turn slip lanes have been provided to and from Commonwealth Avenue;
- Filtered turns have not been included. As such, the side streets have been assumed to operate in separate phases, and vehicles are assumed to not filter through active pedestrian crossings; and
- For the “Staggered T” options, the two signalised intersections are assumed to be synchronised such that the turning movements at both intersections occur simultaneously. As such, the southern approach at the Corkhill Street intersection (for all Option 4 variants) and the northern approach at the Albert Street intersection (for Options 4A/C/E/F only) were set within SIDRA to have a “favourable” vehicle arrival profile.

6.3 Pedestrian Crossing

It is noted that the existing pedestrian crossing across Commonwealth Avenue operates such that a person crossing just as the lights turn green should be able to complete the entire crossing in one cycle. While this reduces overall delays for pedestrians and may improve safety due reduced reliance on median storage and reduced incentive to jaywalk, it also has a significant impact on vehicular operations.

It is considered that allowing pedestrians to cross the entire road in a single phase would be ideal during periods of significant demand, such as Floriade or New Years' Eve. During other times, it is considered that the existing median is sufficient to provide pedestrian storage for two-stage crossing.

Guidance from Austroads Guide to Road Design Part 4A suggests that the desirable minimum width for a median refuge for staging pedestrians crossing at an intersection is 2.5m. It is considered that pedestrian volumes would be typically low, and as such, the 12m existing median width would be sufficient. Modifications to the median arrangement may be investigated in future design stages. This could include, for example, construction of a 'stagger' within the central median to dissuade pedestrians from taking shortcuts. However, this may restrict the ability to run the crossing in one phase during events.

During anticipated high pedestrian event modes, the traffic signal arrangement could be switched from a two phase (e.g. Option 4F or 4G) to a one phase (e.g. Option 4E) operation. The intersection may also be staffed by safety marshals to control the crowds as is typical for main events.

6.4 Results

The estimated queue and delay for through traffic is summarised in the table overleaf for each option, with more detailed results attached in an appendix to this note. The results are based on assessment using existing (2014) traffic volumes along Commonwealth Avenue obtained from SCATS. There may be some diversion of traffic to alternative routes (e.g. Kings Avenue) due to the queuing and increase in delay, however, this has not been accounted for in the results.

In addition to the options tested, a "base" option considering the existing signalised mid-block pedestrian crossing was tested. Based on discussions with TAMS, the crossing was modelled using the following parameters:

- Pedestrian phase time (including intergreen) of 34 seconds;
- Cycle time of 130 seconds; and
- Intergreen time of 7 seconds.

In addition, it was assumed that the pedestrian phase would only be called every second cycle during peak hour (effectively one pedestrian phase every 260 seconds). The results for the base option are included in the table below.

Intersection layout	**Assumed Cycle Time (sec)**	**Morning peak hour**		**Evening peak hour**	
		Average Delay (secs)	**95th percentile queue (m)**	**Average Delay (secs)**	**95th percentile queue (m)**
Current (Base case)	130 sec	NB: 9 sec SB: 13 sec	NB: 414m SB: 770m	NB: 9 sec SB: 8 sec	NB: 501m SB: 410m
Single T (Option 1)	130 sec	NB: 9 sec SB: 28 sec	NB: 315m SB: 652m	NB: 11 sec SB: 7 sec	NB: 313m SB: 227m
Four arm intersection (Options 2, 3A, 3B)	130 sec	NB: 29 sec SB: 159 sec*	NB: 520m SB: 1294m*	NB: 25 sec SB: 18 sec	NB: 460m SB: 372m

Intersection layout	Assumed Cycle Time (sec)	Morning peak hour		Evening peak hour	
		Average Delay (secs)	95th percentile queue (m)	Average Delay (secs)	95th percentile queue (m)
Staggered T (Option 4A)	130 sec	NB: 15 sec SB: 50 sec	NB: 386m SB: 652m	NB: 15 sec SB: 8 sec	NB: 353m SB: 227m
Staggered T with seagull (Option 4B)	130 sec	NB: 15 sec SB: 40 sec	NB: 386m SB: 755m**	NB: 15 sec SB: 8 sec	NB: 353m SB: 250m**
Option 4A with full crossing (Option 4C)	130 sec	NB: 85 sec* SB: 270 sec*	NB: 798m* SB: 1545m**	NB: 63 sec SB: 31 sec	NB: 676m SB: 227m
Option 4B with full crossing (Option 4D)	130 sec	NB: 85 sec* SB: 261 sec*	NB: 798m* SB: 1585m**	NB: 63 sec SB: 27 sec	NB: 676m SB: 508m**
Option 4C with left turn bays removed (Option 4E)	130 sec	NB: 85 sec* SB: 271 sec*	NB: 802m SB: 1549m	NB: 63 sec SB: 31 sec	NB: 681m SB: 227m
Option 4A with left turn bays removed (Option 4F)	130 sec	NB: 15 sec SB: 51 sec	NB: 387m SB: 652m	NB: 15 sec SB: 13 sec	NB: 355m SB: 227m
Option 4F with all left turn slip lanes removed (Option 4G)	130 sec	NB: 15 sec SB: 51 sec	NB: 387m SB: 652m	NB: 15 sec SB: 13 sec	NB: 355m SB: 227m
Option 4A with pedestrian crossings on all approaches (Option 4H)	130 sec	NB: 16 sec SB: 132 sec	NB: 398m SB: 944m	NB: 17 sec SB: 15 sec	NB: 374m SB: 312m

*The excessive delay for traffic is indicative of the fact that the signalised intersection will have insufficient capacity to accommodate the existing traffic volumes. These values should be interpreted with caution, as they represent severely constrained situations which are outside the usual modelling parameters of the SIDRA software

**Queue measured from southern intersection of the staggered T arrangement

6.5 Sensitivity Test

It is noted that all of the options lead to significant queuing and delays along Commonwealth Avenue. As such, a number of scenarios were tested which ban movements during the morning peak hour. These scenarios were developed based on the four arm intersection layout (Options 2, 3A, 3B):

- Scenario 1: Ban the right turn into Commonwealth Park;

- Scenario 2: Ban right turns into and out of Commonwealth Park (and also ban through movements from Commonwealth Park to West Basin); and
- Scenario 3: All of the above, plus remove signalised crossing across Commonwealth Avenue.

The results for these scenarios during the critical morning peak hour are presented below.

Intersection layout	**Morning peak hour**	
	Delay (seconds)	**95th percentile queue (m)**
Scenario 1	NB: 27 sec SB: 48 sec	NB: 503m SB: 827m
Scenario 2	NB: 9 sec SB: 48 sec	NB: 315m SB: 827m
Scenario 3	NB: 9 sec SB: 5 sec	NB: 315m SB: 360m

The scenarios were also analysed based on the original staggered-T intersection layout (Option 4A), with the results for the presented overleaf for the critical morning peak hour.

Intersection layout	**Morning peak hour**	
	Delay (seconds)	**95th percentile queue (m)**
Scenario 1	NB: 15 sec SB: 33 sec	NB: 380m SB: 652m
Scenario 2	NB: 7 sec SB: 33 sec	NB: 256m SB: 652m
Scenario 3	NB: 1 sec SB: 28 sec	NB: 46m* SB: 652m

*Queue measured from Corkhill Street intersection rather than Albert Street for other scenarios

It should be noted that removal of the pedestrian crossings at Albert Street will reduce but not eliminate queues and delays for through traffic along Commonwealth Avenue, due to the signalised intersection at Corkhill Street.

7 Allowance for Potential Canberra Light Rail

It is understood that the Canberra Light Rail Master Plan is investigating potential extensions of the light rail network beyond Civic. One potential extension continues the Stage 1 line south to Parliament and beyond, which may run along Commonwealth Avenue. If this extension were to be built, it is likely to run along the central median of Commonwealth Avenue.

The analysis documented in this technical note allowed for the potential construction of a Canberra Light Rail extension along Commonwealth Avenue by ensuring that the intersection signal phasing provides a sufficiently long to allow light rail vehicles to clear the intersection. It has been assumed that a phase time of at least 30 seconds will be sufficient.

8 Conclusions and Recommendations

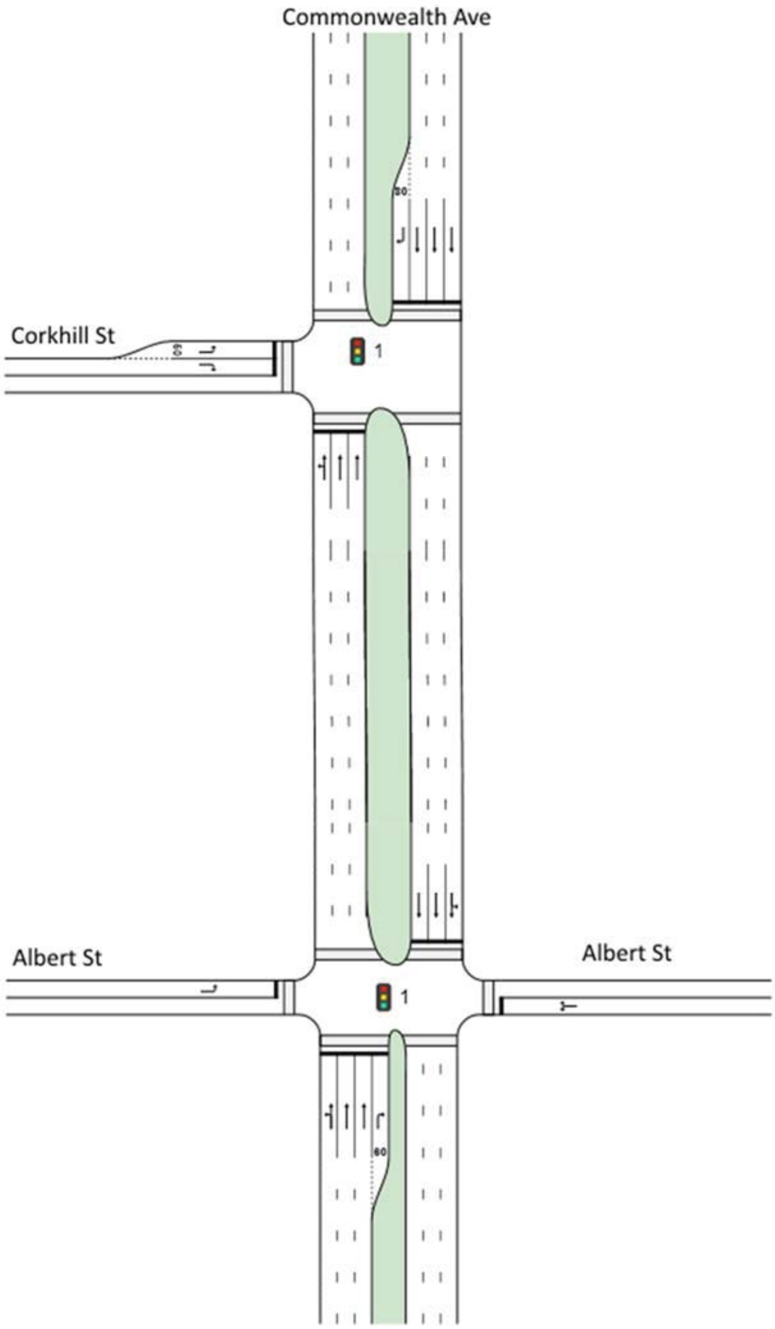
This technical note considered a number of potential options for replacing the existing Barrine Road underpass connecting the West Basin to Commonwealth Park under Commonwealth Avenue. All options considered included the introduction of at least one new signalised intersection along Commonwealth Avenue. Due to this, all of the options will lead to a deterioration in the operation of Commonwealth Avenue for through traffic, with the level of impact depending on the option selected. It should be noted, however, that the mid-block signalised crossing along Commonwealth Avenue near Albert Street was permanently enabled from 18 May 2015. As such, this is the base case against which other options should be tested.

Selection of the preferred intersection option will depend on the weighting given to the different objectives for the design.

The Option 4 variations were found to achieve the design objectives more than the other options considered. It should be noted, however, that Option 4 require the construction of two signalised intersections. If the significant additional cost is not acceptable, consideration should be given to staging of the option by constructing Option 3B in the short term. It should be noted that Option 3B is likely to lead to higher levels of vehicular traffic along the Waterfront Boulevard, which conflicts with the aim of providing a pedestrian-friendly zone along the foreshore. As such, traffic volumes should be monitored to determine when the construction of the remainder of Option 4 is warranted. Another staging option would be to construct Option 4 without the signalised pedestrian crossing at Corkhill Street initially, with the crossing being added at a later date when pedestrian demands warrant its installation.

If the primary objective in the short and long term is to minimise potential works along Commonwealth Avenue, then Option 1 would be the best choice. This option would also reduce the traffic along Waterfront Boulevard, as well as providing more convenient access to future development in the West Basin area. This option would, however, reduce connectivity to Commonwealth Park.

Based on current discussions with the NCA, it is understood that Option 4H is the preferred intersection layout option. An indicative combined layout showing this is shown overleaf.



DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	Vincent Chan	Tim Walker	James O'Reilly
Signature			

BASE CASE

SIDRA RESULTS

MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront - Scenario 5 (peds only)

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 260 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.011	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
2	T1	3563	0.0	0.726	8.6	LOS A	59.1	413.8	0.44	0.43	52.6
Approach		3583	0.0	0.726	8.5	LOS A	59.1	413.8	0.44	0.43	52.6
East: Albert St											
4	L2	11	0.0	0.046	47.9	LOS D	0.8	5.8	0.61	0.70	33.4
Approach		11	0.0	0.046	47.9	LOS D	0.8	5.8	0.61	0.70	33.4
North: Commonwealth Ave											
7	L2	25	0.0	0.014	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
8	T1	4338	0.0	0.885	13.0	LOS B	109.9	769.5	0.68	0.66	49.4
Approach		4363	0.0	0.885	12.9	LOS B	109.9	769.5	0.67	0.66	49.5
West: Albert St											
10	L2	20	0.0	0.087	22.9	LOS C	1.1	8.0	0.45	0.68	43.3
Approach		20	0.0	0.087	22.9	LOS C	1.1	8.0	0.45	0.68	43.3
All Vehicles		7977	0.0	0.885	11.0	LOS B	109.9	769.5	0.57	0.55	50.8

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P3	North Full Crossing	53	124.3	LOS F	0.4	0.4	0.98	0.98
All Pedestrians		53	124.3	LOS F			0.98	0.98

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

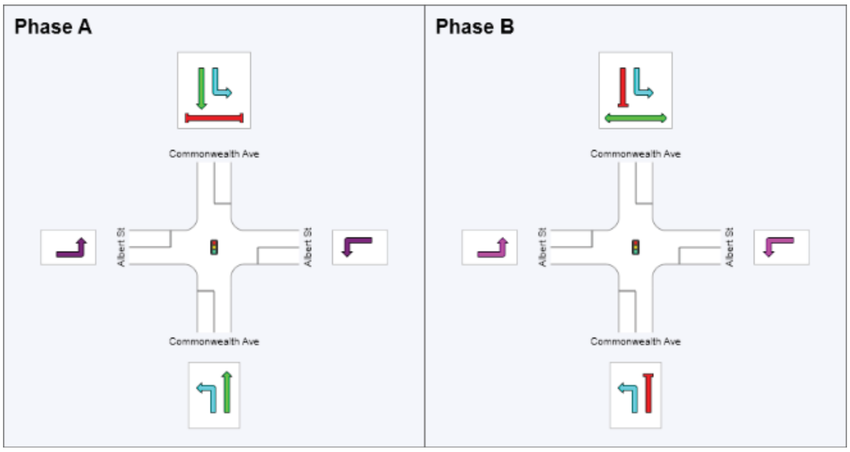
Site: 2014AM - Right Turns Comm Park, LILO Waterfront - Scenario 5 (peds only)

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 260 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B
Output Sequence: A, B

Phase Timing Results

Phase	A	B
Reference Phase	Yes	No
Phase Change Time (sec)	0	226
Green Time (sec)	219	27
Yellow Time (sec)	5	5
All-Red Time (sec)	2	2
Phase Time (sec)	226	34
Phase Split	87 %	13 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront - Scenario 5 (peds only)

Commonwealth Ave / Albert St
Signals - Fixed Time Cycle Time = 260 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.011	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
2	T1	3563	0.0	0.726	8.6	LOS A	59.1	413.8	0.44	0.43	52.6
Approach		3583	0.0	0.726	8.5	LOS A	59.1	413.8	0.44	0.43	52.6
East: Albert St											
4	L2	11	0.0	0.046	47.9	LOS D	0.8	5.8	0.61	0.70	33.4
Approach		11	0.0	0.046	47.9	LOS D	0.8	5.8	0.61	0.70	33.4
North: Commonwealth Ave											
7	L2	25	0.0	0.014	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
8	T1	4338	0.0	0.885	13.0	LOS B	109.9	769.5	0.68	0.66	49.4
Approach		4363	0.0	0.885	12.9	LOS B	109.9	769.5	0.67	0.66	49.5
West: Albert St											
10	L2	20	0.0	0.087	22.9	LOS C	1.1	8.0	0.45	0.68	43.3
Approach		20	0.0	0.087	22.9	LOS C	1.1	8.0	0.45	0.68	43.3
All Vehicles		7977	0.0	0.885	11.0	LOS B	109.9	769.5	0.57	0.55	50.8

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P3	North Full Crossing	53	124.3	LOS F	0.4	0.4	0.98	0.98
All Pedestrians		53	124.3	LOS F			0.98	0.98

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

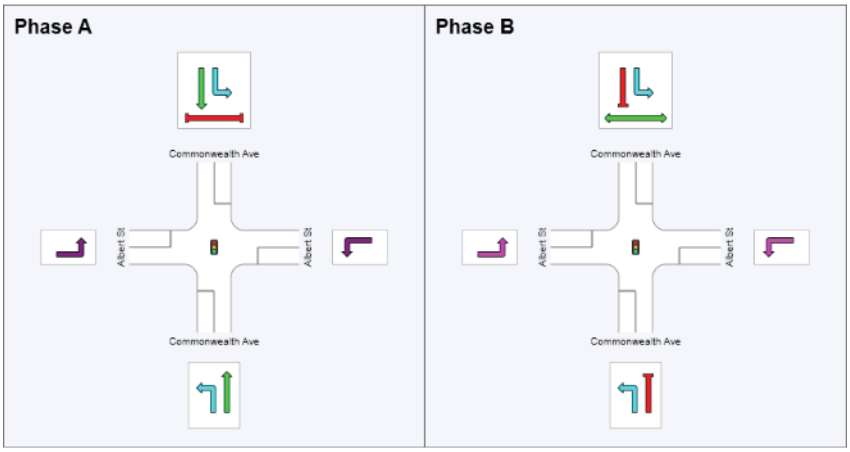
Site: 2014PM - Right Turns Comm Park, LILO Waterfront - Scenario 5 (peds only)

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 260 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B
Output Sequence: A, B

Phase Timing Results

Phase	A	B
Reference Phase	Yes	No
Phase Change Time (sec)	0	226
Green Time (sec)	219	27
Yellow Time (sec)	5	5
All-Red Time (sec)	2	2
Phase Time (sec)	226	34
Phase Split	87 %	13 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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SIDRA INTERSECTION 6

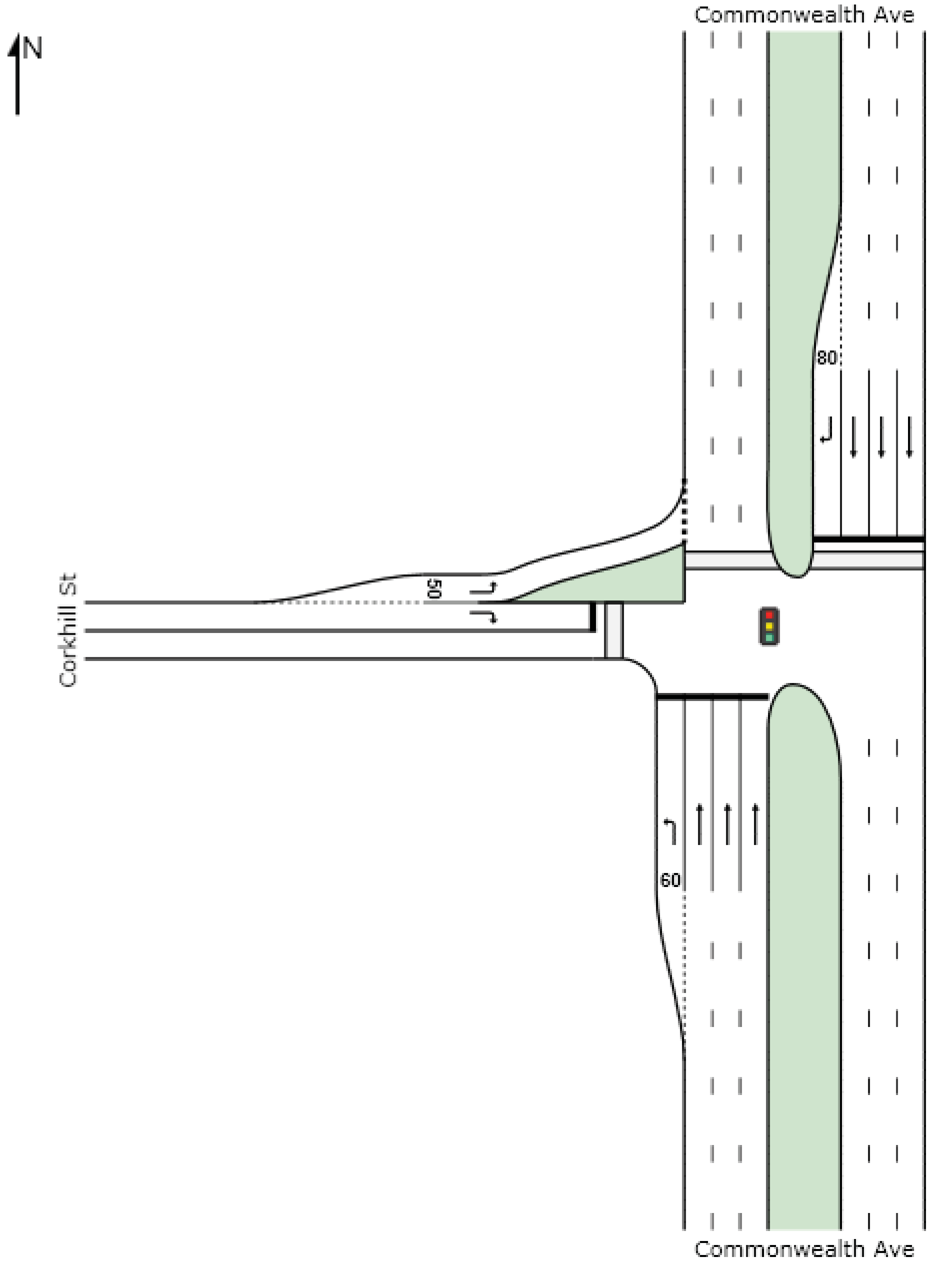
OPTION 1

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.049	9.3	LOS A	1.0	7.3	0.25	0.63	53.5
2	T1	3563	0.0	0.803	9.3	LOS A	45.0	315.1	0.65	0.61	55.7
Approach		3634	0.0	0.803	9.3	LOS A	45.0	315.1	0.64	0.61	55.7
North: Commonwealth Ave											
8	T1	4338	0.0	0.948	27.5	LOS C	93.1	651.8	0.89	0.93	48.9
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	31.6
Approach		4407	0.0	0.948	28.3	LOS C	93.1	651.8	0.89	0.93	48.6
West: Corkhill St											
10	L2	21	0.0	0.064	21.0	LOS C	0.7	4.9	0.54	0.69	48.4
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	32.9
Approach		42	0.0	0.246	47.6	LOS D	1.4	9.6	0.77	0.69	39.1
All Vehicles		8083	0.0	0.948	19.9	LOS B	93.1	651.8	0.78	0.79	51.5

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

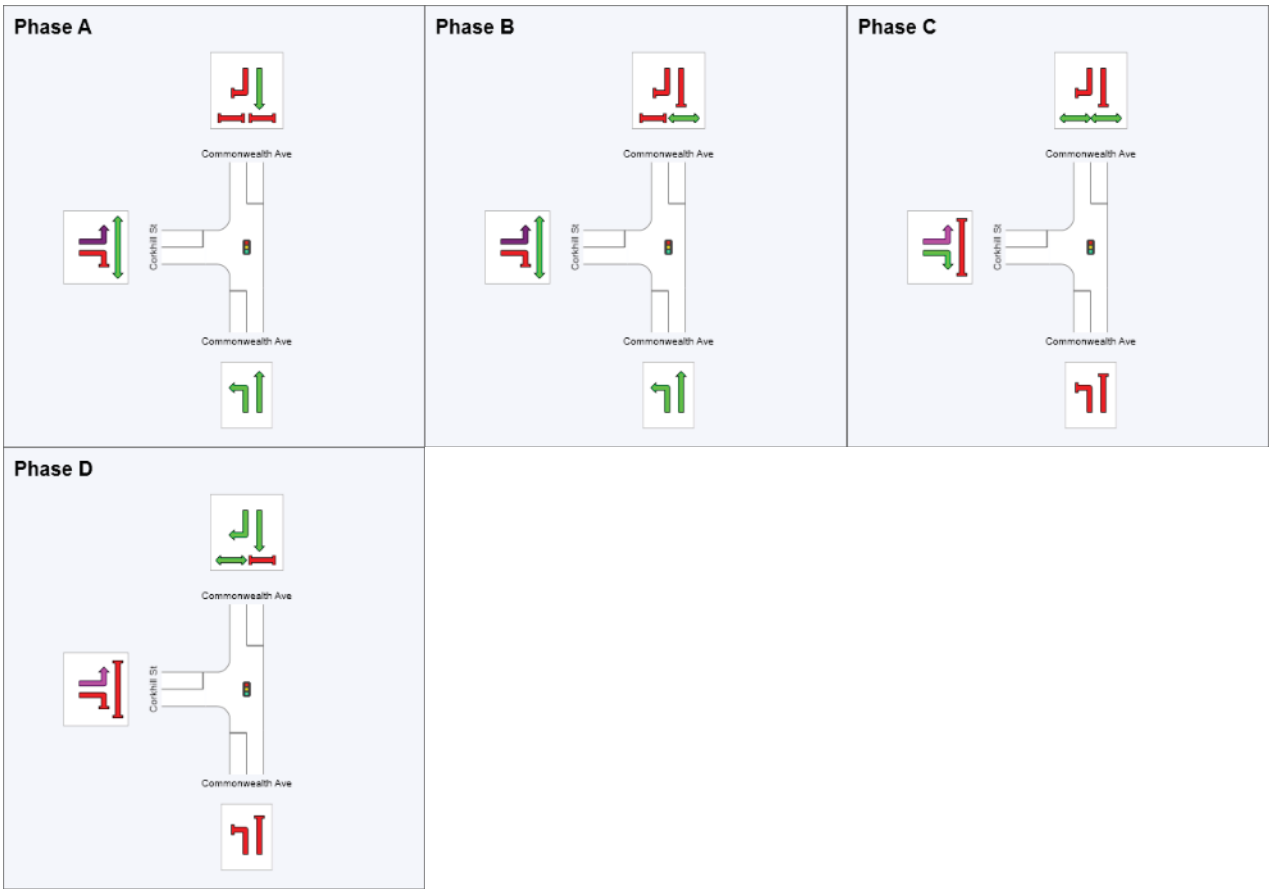
Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	106	118
Green Time (sec)	91	3	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	9	12	12
Phase Split	75 %	7 %	9 %	9 %



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MOVEMENT SUMMARY

Site: 2014PM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.013	6.8	LOS A	0.2	1.2	0.15	0.60	52.6
2	T1	3453	0.0	0.794	10.8	LOS B	44.7	312.6	0.68	0.64	51.0
Approach		3473	0.0	0.794	10.7	LOS B	44.7	312.6	0.67	0.64	51.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.712	6.7	LOS A	32.5	227.3	0.52	0.49	54.0
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.712	7.1	LOS A	32.5	227.3	0.52	0.49	53.7
West: Corkhill St											
10	L2	105	0.0	0.283	35.8	LOS D	6.1	42.5	0.90	0.88	37.6
12	R2	106	0.0	0.827	78.1	LOS E	7.4	51.6	1.00	0.91	26.1
Approach		212	0.0	0.827	57.1	LOS E	7.4	51.6	0.95	0.89	30.8
All Vehicles		6988	0.0	0.827	10.4	LOS B	44.7	312.6	0.61	0.58	51.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	5.6	LOS A	0.1	0.1	0.29	0.29
All Pedestrians		158	41.4	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

Site: 2014PM - Corkhill T

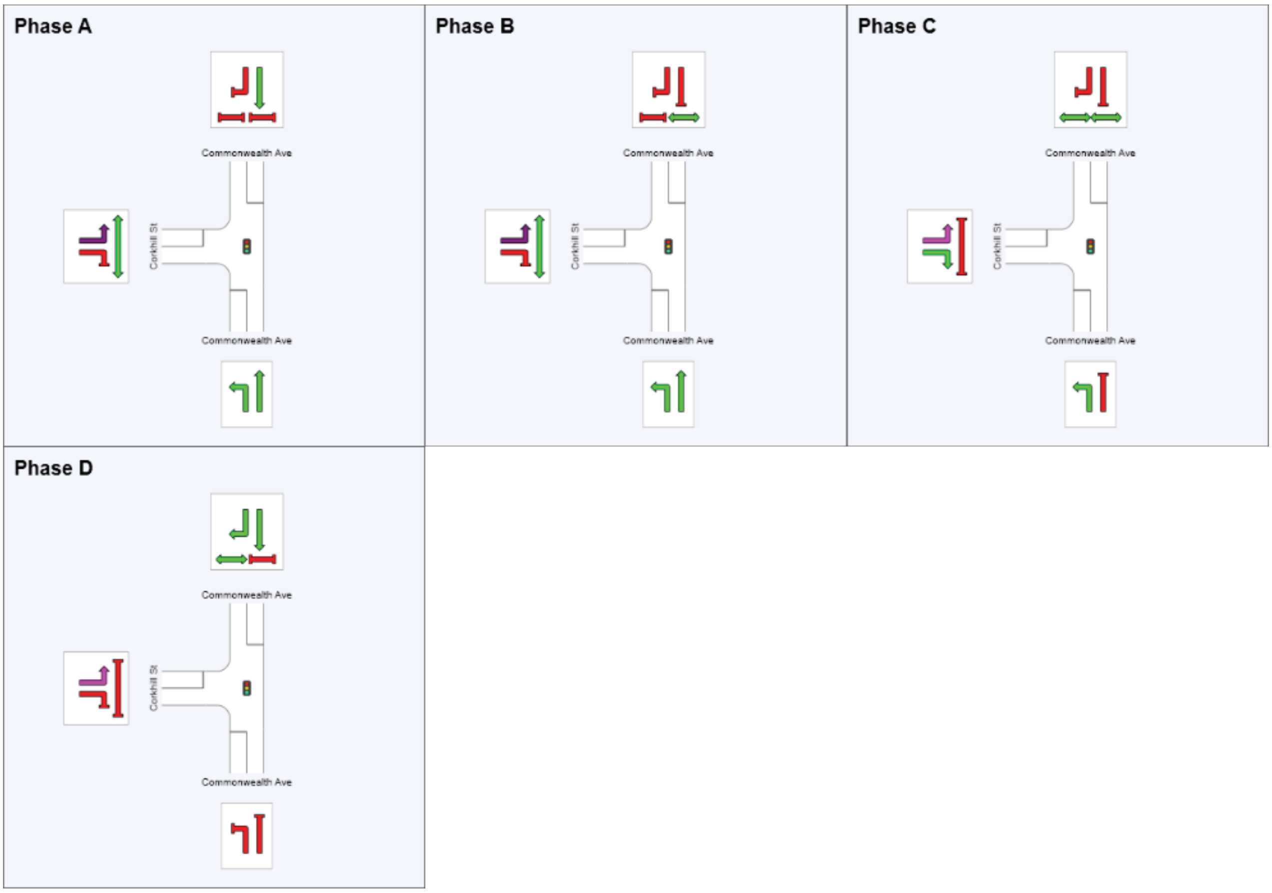
Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	103	118
Green Time (sec)	91	***	9	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	6	15	12
Phase Split	75 %	5 %	12 %	9 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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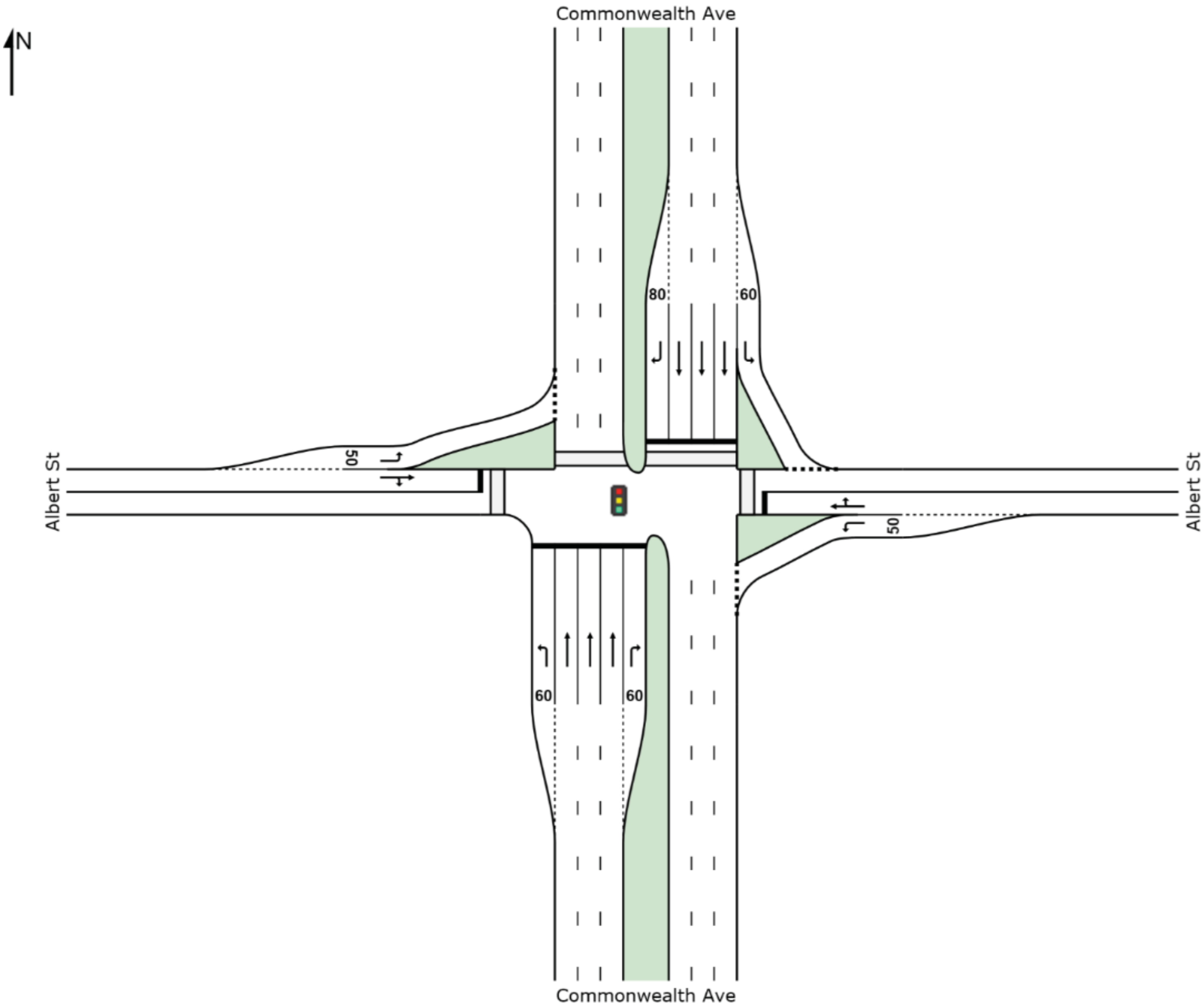
OPTION 2/3

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - All Movements South

Commonwealth Ave / Albert St
Signals - Fixed Time



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SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: 2014AM - All Movements South

Commonwealth Ave / Albert St
Signals - Fixed Time Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.053	8.4	LOS A	0.7	4.9	0.30	0.64	51.5
2	T1	3563	0.0	0.919	28.8	LOS C	74.2	519.6	0.90	0.92	40.7
3	R2	24	0.0	0.282	74.3	LOS E	1.6	11.1	1.00	0.71	26.8
Approach		3658	0.0	0.919	28.7	LOS C	74.2	519.6	0.89	0.91	40.8
East: Albert St											
4	L2	11	0.0	0.028	43.3	LOS D	0.5	3.4	0.81	0.67	34.9
5	T1	11	0.0	0.240	68.4	LOS E	1.4	9.6	1.00	0.70	27.8
6	R2	11	0.0	0.240	74.0	LOS E	1.4	9.6	1.00	0.70	27.7
Approach		32	0.0	0.240	61.9	LOS E	1.4	9.6	0.93	0.69	29.8
North: Commonwealth Ave											
7	L2	25	0.0	0.016	6.0	LOS A	0.1	0.7	0.11	0.57	53.9
8	T1	4338	0.0	1.115	159.8	LOS F	184.8	1293.6	1.00	1.67	16.5
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	25.7
Approach		4433	0.0	1.115	157.7	LOS F	184.8	1293.6	0.99	1.65	16.7
West: Albert St											
10	L2	20	0.0	0.058	30.0	LOS C	0.8	5.3	0.67	0.68	39.9
11	T1	11	0.0	0.350	69.1	LOS E	2.0	14.0	1.00	0.72	27.5
12	R2	20	0.0	0.350	74.7	LOS E	2.0	14.0	1.00	0.72	27.3
Approach		51	0.0	0.350	55.8	LOS E	2.0	14.0	0.87	0.71	31.3
All Vehicles		8173	0.0	1.115	98.9	LOS F	184.8	1293.6	0.95	1.31	22.8

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	8.5	LOS A	0.1	0.1	0.36	0.36
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	8.5	LOS A	0.1	0.1	0.36	0.36
All Pedestrians		211	33.9	LOS D			0.66	0.66

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

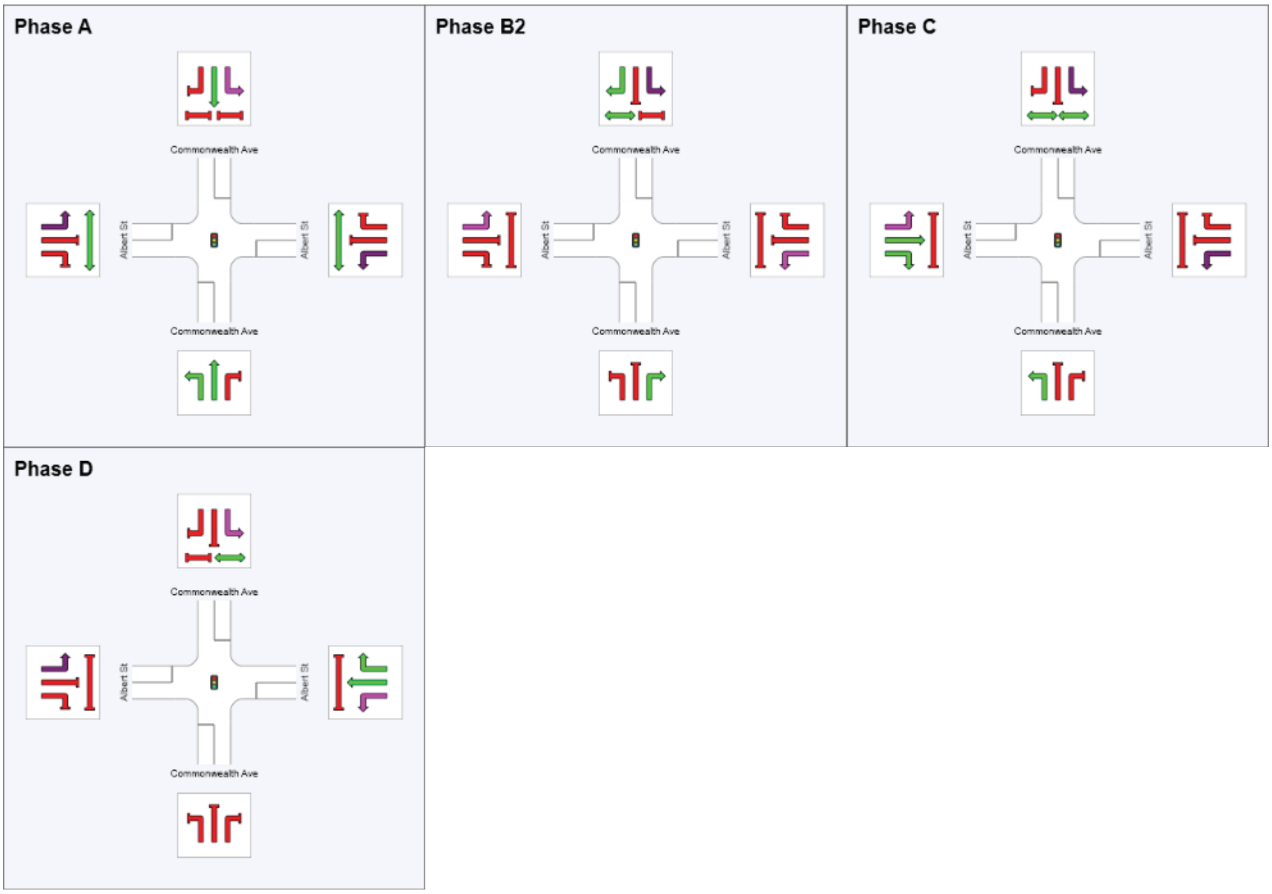
Site: 2014AM - All Movements South

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B1, B2, C, D
Output Sequence: A, B2, C, D

Phase Timing Results

Phase	A	B2	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	94	106	118
Green Time (sec)	88	6	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	94	12	12	12
Phase Split	72 %	9 %	9 %	9 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: 2014PM - All Movements South

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.015	8.3	LOS A	0.2	1.3	0.29	0.62	51.6
2	T1	3453	0.0	0.899	24.8	LOS C	65.7	459.6	0.90	0.89	42.6
3	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		3483	0.0	0.899	24.9	LOS C	65.7	459.6	0.90	0.88	42.6
East: Albert St											
4	L2	31	0.0	0.076	27.0	LOS C	1.1	7.6	0.63	0.69	41.3
5	T1	1	0.0	0.368	69.3	LOS E	2.1	14.6	1.00	0.72	27.1
6	R2	31	0.0	0.368	74.9	LOS E	2.1	14.6	1.00	0.72	26.9
Approach		62	0.0	0.368	51.2	LOS D	2.1	14.6	0.82	0.70	32.5
North: Commonwealth Ave											
7	L2	1	0.0	0.001	5.9	LOS A	0.0	0.0	0.09	0.56	54.0
8	T1	3285	0.0	0.853	17.9	LOS B	53.2	372.1	0.84	0.79	46.3
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3305	0.0	0.853	18.2	LOS B	53.2	372.1	0.84	0.79	46.1
West: Albert St											
10	L2	105	0.0	0.271	31.1	LOS C	4.4	30.5	0.73	0.75	39.5
11	T1	1	0.0	0.939	84.9	LOS F	8.2	57.2	1.00	1.03	24.3
12	R2	106	0.0	0.939	90.5	LOS F	8.2	57.2	1.00	1.03	24.1
Approach		213	0.0	0.939	61.1	LOS E	8.2	57.2	0.86	0.89	29.9
All Vehicles		7063	0.0	0.939	23.1	LOS C	65.7	459.6	0.87	0.84	43.5

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	9.3	LOS A	0.1	0.1	0.38	0.38
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	9.3	LOS A	0.1	0.1	0.38	0.38
All Pedestrians		211	34.3	LOS D			0.67	0.67

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

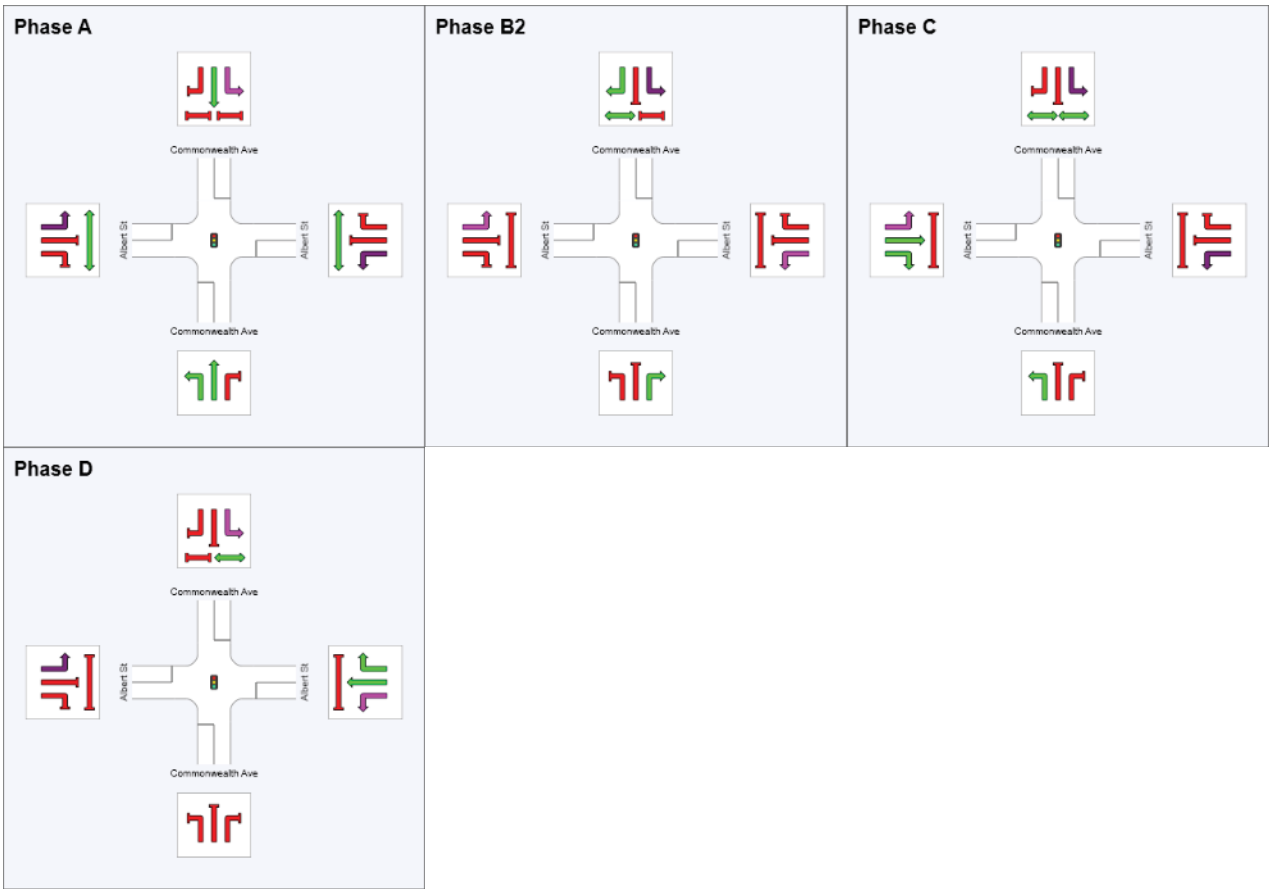
Site: 2014PM - All Movements South

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B1, B2, C, D
Output Sequence: A, B2, C, D

Phase Timing Results

Phase	A	B2	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	92	104	118
Green Time (sec)	86	6	8	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	92	12	14	12
Phase Split	71 %	9 %	11 %	9 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

Processed: Saturday, 13 June 2015 7:34:47 PM
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Project: c:\projectwise\syd_projects\vincent-w.chan\dms69145\Commonwealth Waterfront.sip6
8000047, 6019197, ARUP PTY LTD, PLUS / Floating

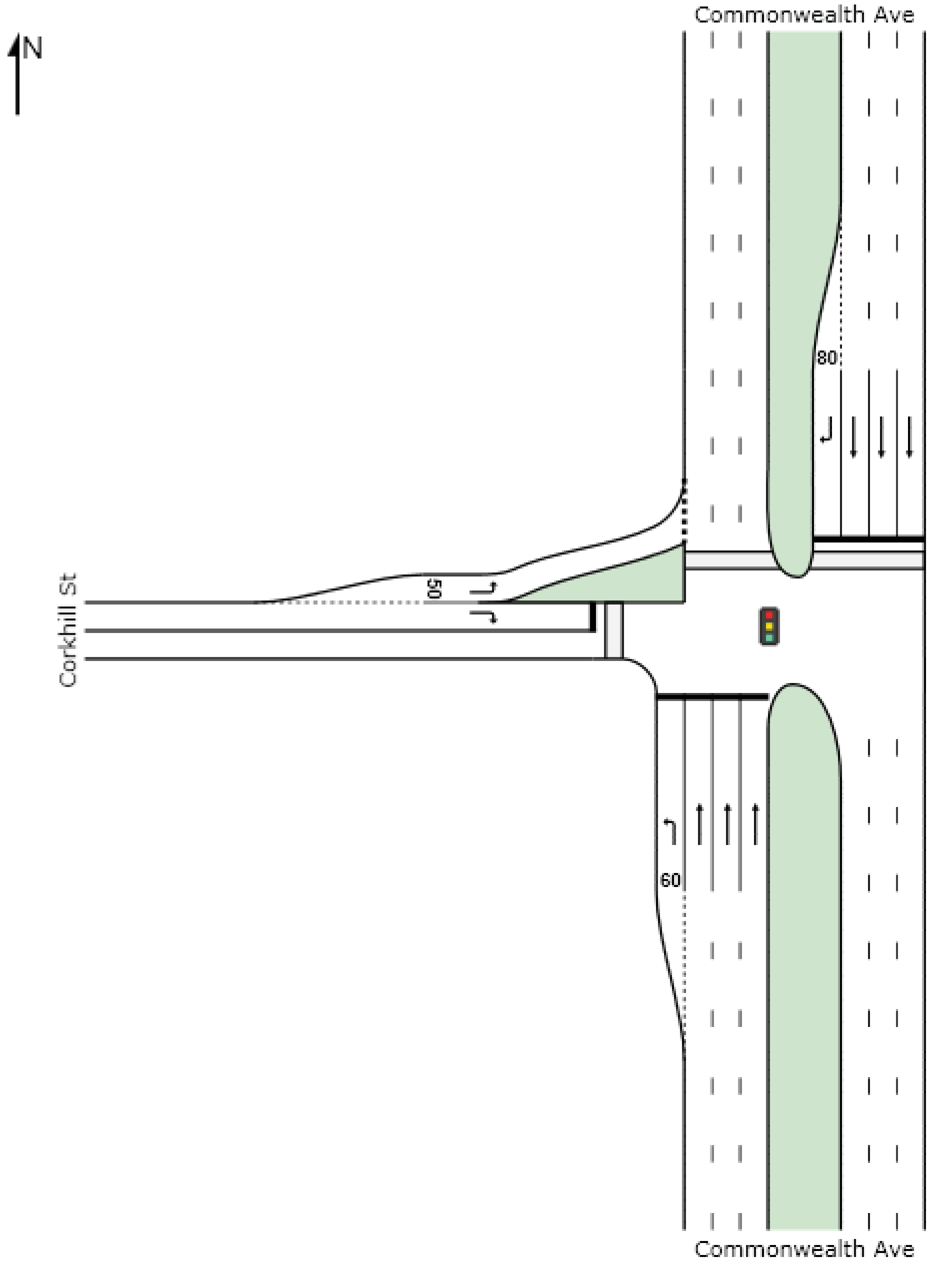
OPTION 4A

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.049	5.9	LOS A	0.1	0.6	0.02	0.58	55.4
2	T1	3563	0.0	0.792	0.9	LOS A	6.6	46.0	0.10	0.09	59.5
Approach		3634	0.0	0.792	1.0	LOS A	6.6	46.0	0.10	0.10	59.5
North: Commonwealth Ave											
8	T1	4338	0.0	0.948	27.5	LOS C	93.1	651.8	0.89	0.93	48.9
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	31.6
Approach		4407	0.0	0.948	28.3	LOS C	93.1	651.8	0.89	0.93	48.6
West: Corkhill St											
10	L2	21	0.0	0.064	6.7	LOS A	0.2	1.3	0.18	0.60	55.4
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	32.9
Approach		42	0.0	0.246	40.4	LOS D	1.4	9.6	0.59	0.65	41.3
All Vehicles		8083	0.0	0.948	16.1	LOS B	93.1	651.8	0.53	0.56	52.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

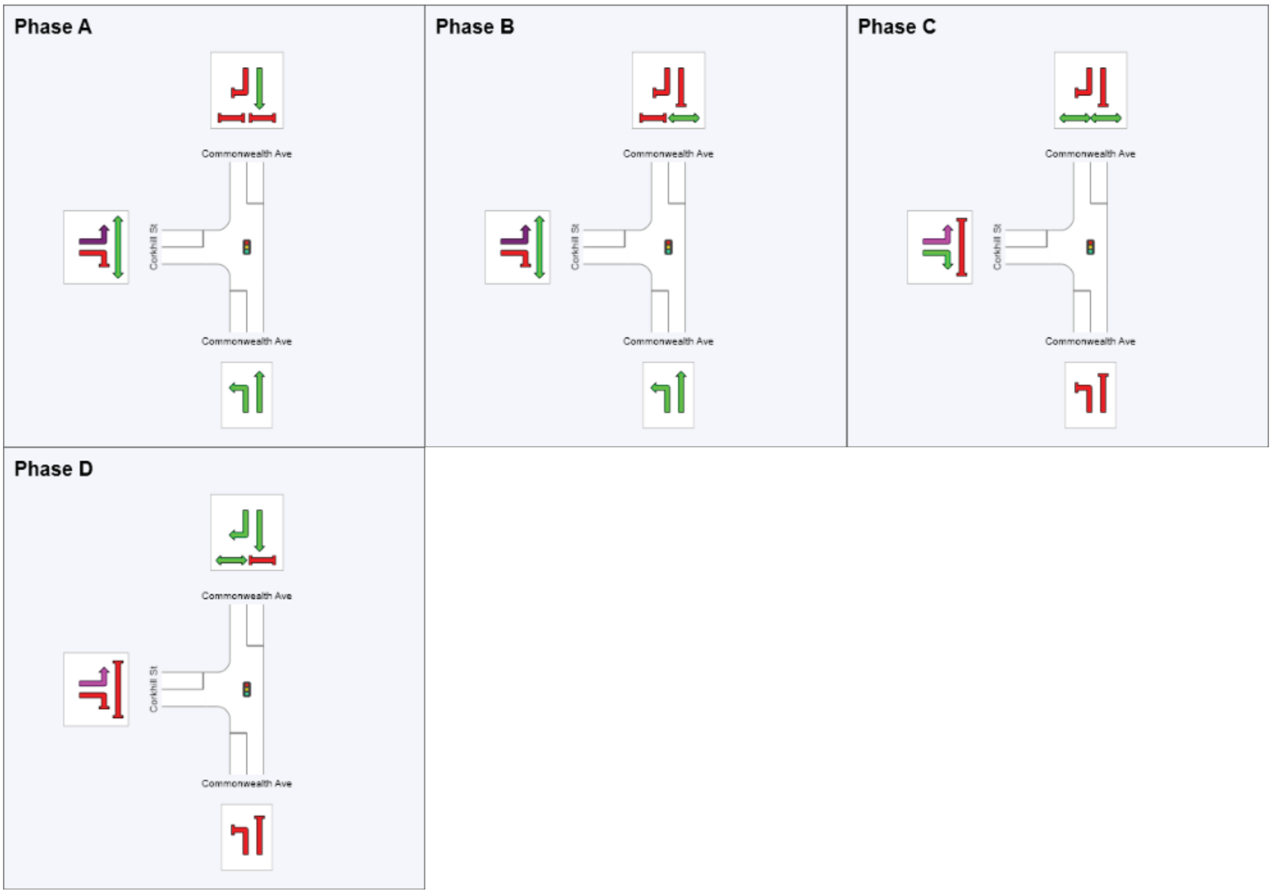
Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	106	118
Green Time (sec)	91	3	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	9	12	12
Phase Split	75 %	7 %	9 %	9 %



- Normal Movement
- Permitted/Opposed
- Slip/Bypass-Lane Movement
- Opposed Slip/Bypass-Lane
- Stopped Movement
- Turn On Red
- Other Movement Class Running
- Other Movement Class Stopped
- Mixed Running & Stopped Movement Classes
- Undetected Movement
- Phase Transition Applied

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MOVEMENT SUMMARY

Site: 2014PM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.013	5.8	LOS A	0.0	0.2	0.02	0.58	53.5
2	T1	3453	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.1
Approach		3473	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.712	6.7	LOS A	32.5	227.3	0.52	0.49	54.0
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.712	7.1	LOS A	32.5	227.3	0.52	0.49	53.7
West: Corkhill St											
10	L2	105	0.0	0.281	17.0	LOS B	6.1	42.8	0.91	0.90	46.5
12	R2	106	0.0	0.827	78.1	LOS E	7.4	51.6	1.00	0.91	26.1
Approach		212	0.0	0.827	47.7	LOS D	7.4	51.6	0.95	0.90	33.4
All Vehicles		6988	0.0	0.827	5.3	LOS A	32.5	227.3	0.32	0.31	55.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	5.6	LOS A	0.1	0.1	0.29	0.29
All Pedestrians		158	41.4	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

Site: 2014PM - Corkhill T

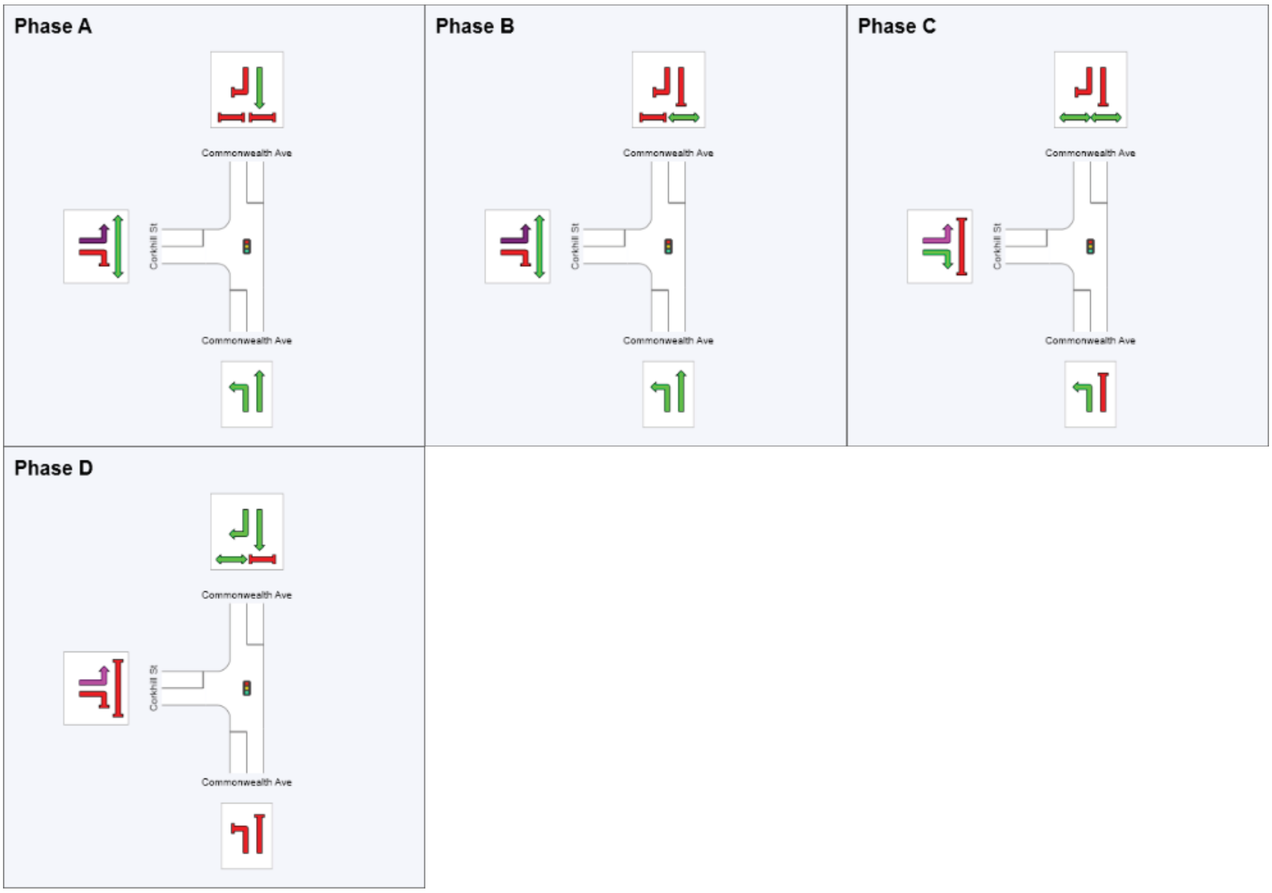
Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	103	118
Green Time (sec)	91	***	9	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	6	15	12
Phase Split	75 %	5 %	12 %	9 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.



Normal Movement
Slip/Bypass-Lane Movement
Stopped Movement
Other Movement Class Running
Mixed Running & Stopped Movement Classes
Undetected Movement
Permitted/Opposed
Opposed Slip/Bypass-Lane
Turn On Red
Other Movement Class Stopped
Phase Transition Applied

Processed: Saturday, 13 June 2015 7:53:36 PM
SIDRA INTERSECTION 6.0.24.4877

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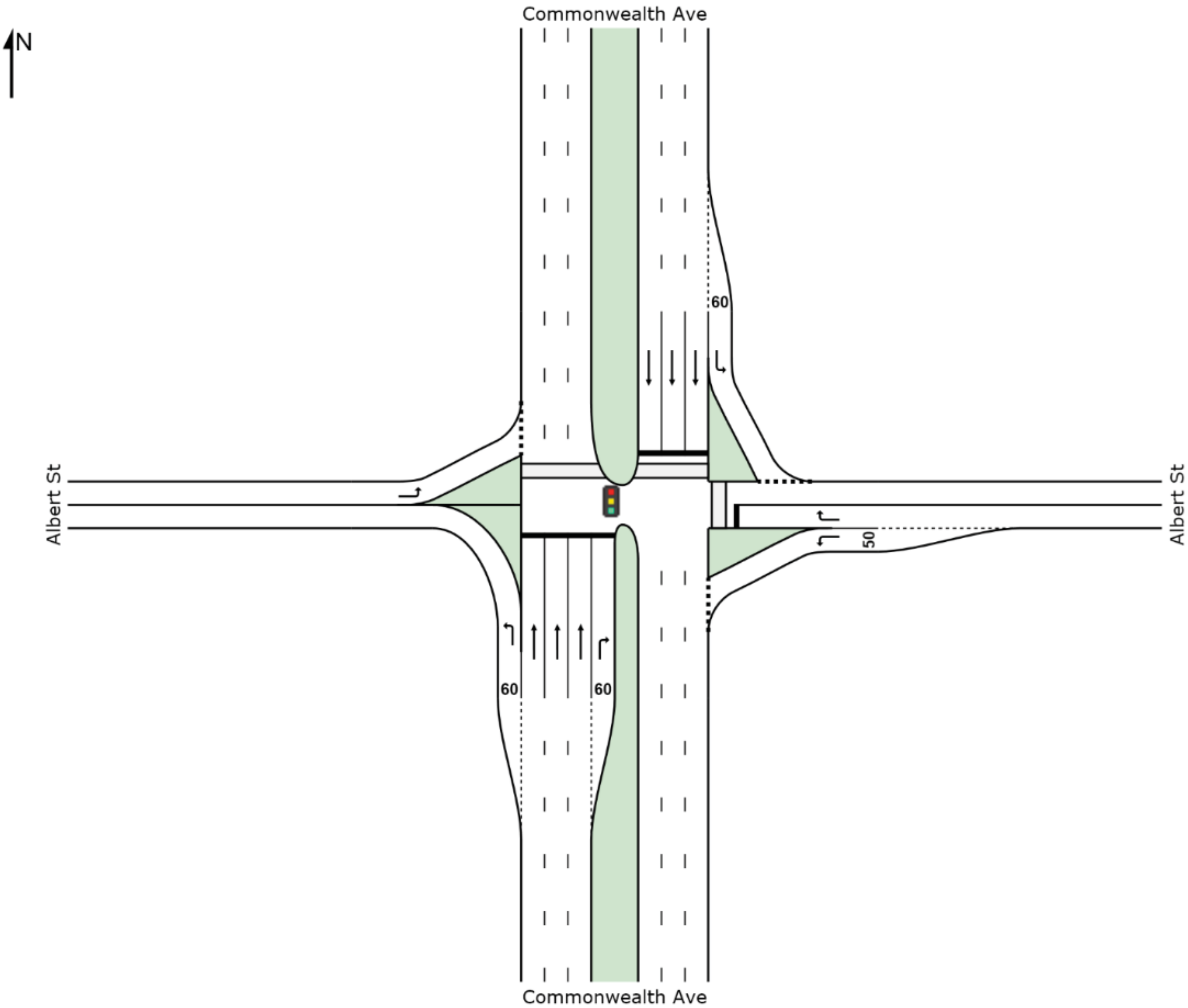
SITE LAYOUT

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Corkhill St
Signals - Fixed Time



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SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.012	5.9	LOS A	0.1	0.4	0.10	0.57	53.9
2	T1	3563	0.0	0.860	14.2	LOS B	55.1	385.8	0.80	0.75	48.6
3	R2	24	0.0	0.282	74.3	LOS E	1.6	11.1	1.00	0.71	26.8
Approach		3607	0.0	0.860	14.6	LOS B	55.1	385.8	0.79	0.75	48.4
East: Albert St											
4	L2	11	0.0	0.009	13.2	LOS B	0.2	1.5	0.39	0.61	48.8
6	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.1
Approach		21	0.0	0.123	43.2	LOS D	0.7	4.7	0.69	0.64	34.8
North: Commonwealth Ave											
7	L2	25	0.0	0.015	5.7	LOS A	0.0	0.1	0.02	0.55	54.2
8	T1	4338	0.0	0.967	22.3	LOS C	55.8	390.7	0.40	0.49	43.9
Approach		4363	0.0	0.967	22.2	LOS C	55.8	390.7	0.40	0.49	44.0
West: Albert St											
10	L2	20	0.0	0.051	26.7	LOS C	0.8	5.3	0.61	0.69	41.4
Approach		20	0.0	0.051	26.7	LOS C	0.8	5.3	0.61	0.69	41.4
All Vehicles		8012	0.0	0.967	18.8	LOS B	55.8	390.7	0.58	0.61	45.8

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

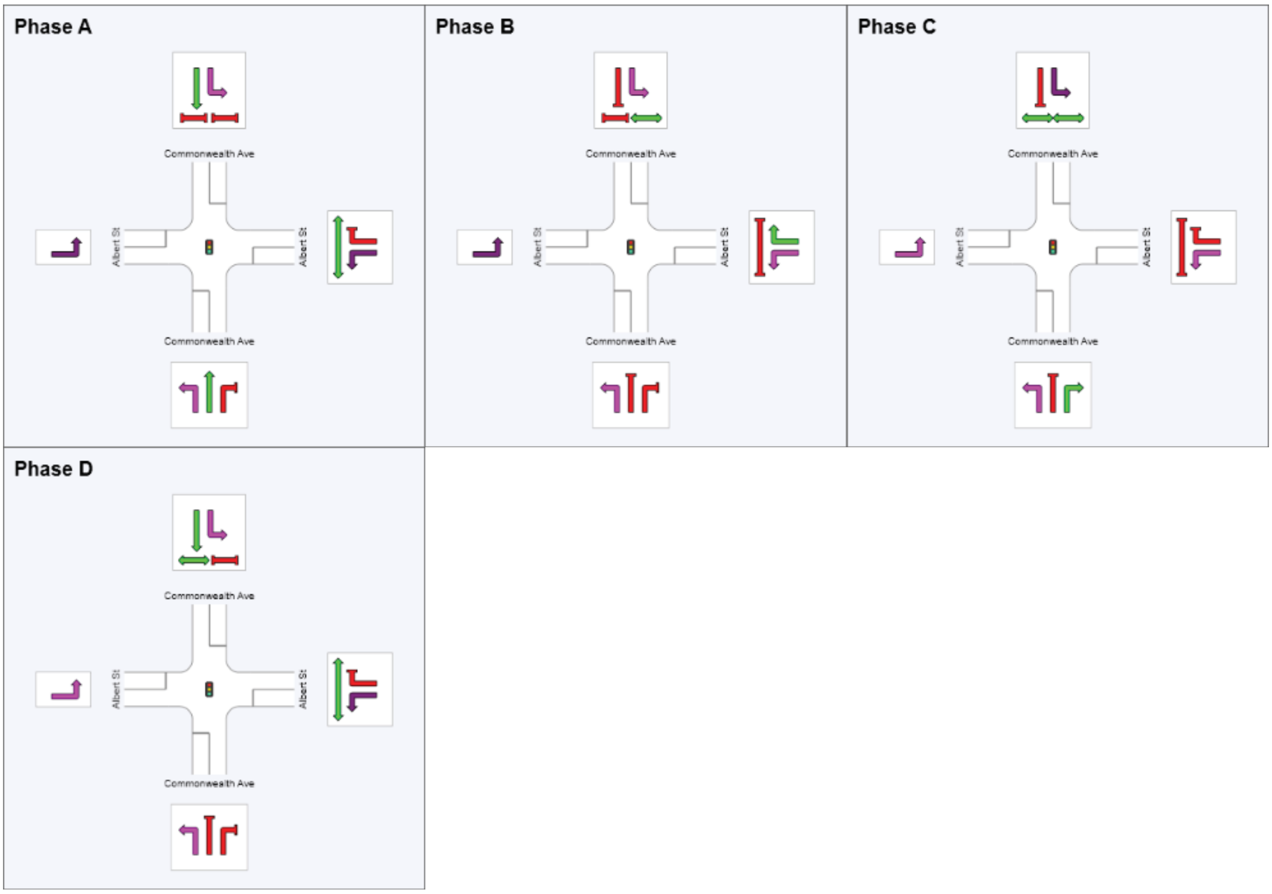
Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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MOVEMENT SUMMARY

Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.012	5.9	LOS A	0.1	0.4	0.10	0.57	53.9
2	T1	3453	0.0	0.831	13.5	LOS B	50.5	353.3	0.76	0.72	49.1
3	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		3483	0.0	0.831	13.7	LOS B	50.5	353.3	0.76	0.72	49.0
East: Albert St											
4	L2	31	0.0	0.019	6.3	LOS A	0.2	1.1	0.14	0.58	53.7
6	R2	31	0.0	0.356	74.8	LOS E	2.0	14.1	1.00	0.72	26.8
Approach		61	0.0	0.356	40.5	LOS D	2.0	14.1	0.57	0.65	35.7
North: Commonwealth Ave											
7	L2	1	0.0	0.001	5.7	LOS A	0.0	0.0	0.02	0.55	54.2
8	T1	3285	0.0	0.730	0.8	LOS A	4.8	33.4	0.08	0.07	59.2
Approach		3286	0.0	0.730	0.8	LOS A	4.8	33.4	0.08	0.07	59.2
West: Albert St											
10	L2	105	0.0	0.285	36.8	LOS D	5.8	40.7	0.88	0.85	37.2
Approach		105	0.0	0.285	36.8	LOS D	5.8	40.7	0.88	0.85	37.2
All Vehicles		6936	0.0	0.831	8.2	LOS A	50.5	353.3	0.43	0.41	52.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

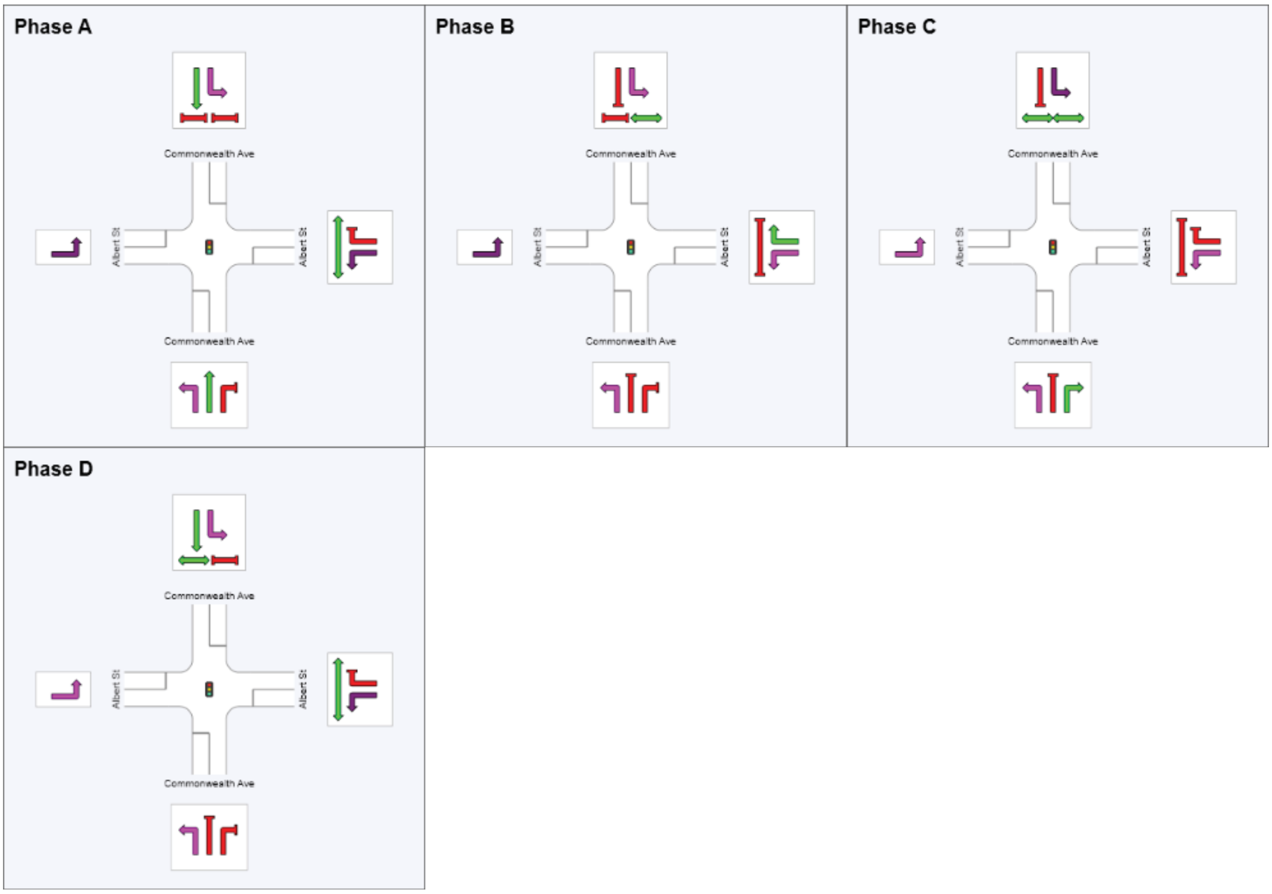
Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



	Normal Movement		Permitted/Opposed
	Slip/Bypass-Lane Movement		Opposed Slip/Bypass-Lane
	Stopped Movement		Turn On Red
	Other Movement Class Running		Other Movement Class Stopped
	Mixed Running & Stopped Movement Classes		
	Undetected Movement		Phase Transition Applied

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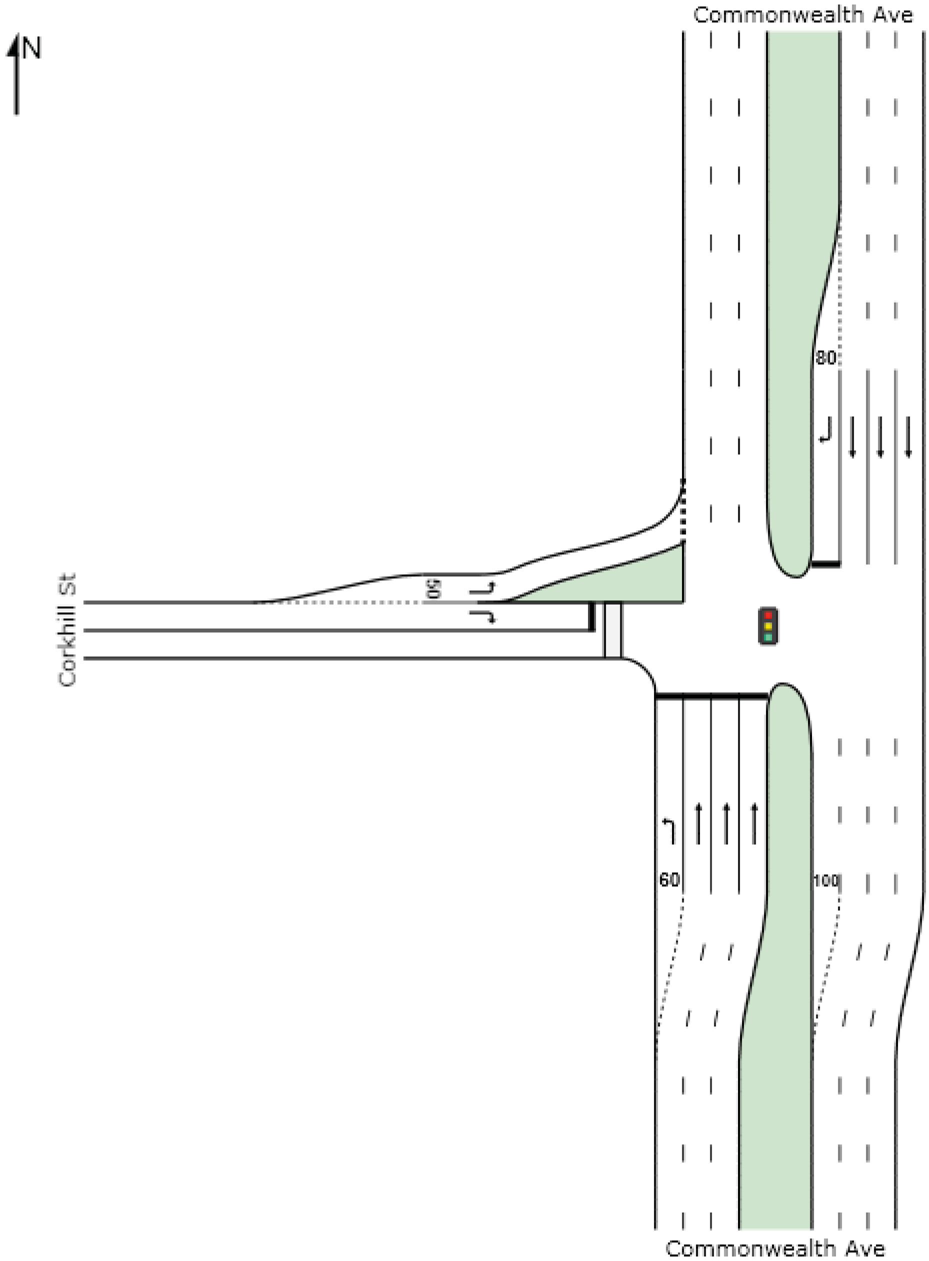
OPTION 4B

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.044	5.8	LOS A	0.1	0.6	0.02	0.58	53.4
2	T1	3563	0.0	0.800	1.0	LOS A	6.8	47.7	0.10	0.10	59.1
Approach		3634	0.0	0.800	1.1	LOS A	6.8	47.7	0.10	0.11	58.9
North: Commonwealth Ave											
8	T1	4338	0.0	0.742	0.2	LOS A	0.0	0.0	0.00	0.00	59.5
9	R2	69	0.0	0.695	76.3	LOS E	4.7	32.9	1.00	0.82	26.4
Approach		4407	0.0	0.742	1.4	LOS A	4.7	32.9	0.02	0.01	58.4
West: Corkhill St											
10	L2	21	0.0	0.061	6.7	LOS A	0.2	1.3	0.18	0.60	53.3
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	26.9
Approach		42	0.0	0.246	40.4	LOS D	1.4	9.6	0.59	0.65	35.8
All Vehicles		8083	0.0	0.800	1.5	LOS A	6.8	47.7	0.06	0.06	58.4

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P4	West Full Crossing	53	5.0	LOS A	0.1	0.1	0.28	0.28
All Pedestrians		53	5.0	LOS A			0.28	0.28

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

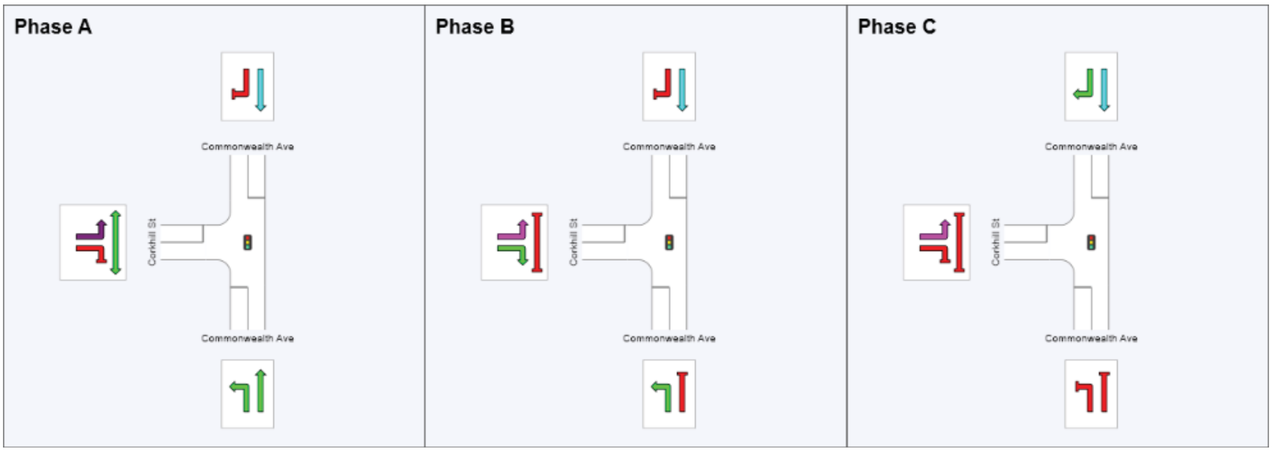
Site: 2014AM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	105	117
Green Time (sec)	99	6	7
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	105	12	13
Phase Split	81 %	9 %	10 %



Normal Movement
Permitted/Opposed
Slip/Bypass-Lane Movement
Opposed Slip/Bypass-Lane
Stopped Movement
Turn On Red
Other Movement Class Running
Other Movement Class Stopped
Mixed Running & Stopped Movement Classes
Undetected Movement
Phase Transition Applied

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SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: 2014PM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.013	5.8	LOS A	0.0	0.2	0.02	0.58	53.5
2	T1	3453	0.0	0.799	1.0	LOS A	6.6	46.1	0.10	0.10	59.0
Approach		3473	0.0	0.799	1.0	LOS A	6.6	46.1	0.10	0.10	59.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.562	0.1	LOS A	0.0	0.0	0.00	0.00	59.8
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.562	0.5	LOS A	1.2	8.6	0.01	0.00	59.4
West: Corkhill St											
10	L2	105	0.0	0.271	16.9	LOS B	6.1	42.4	0.90	0.89	46.5
12	R2	106	0.0	0.744	74.1	LOS E	7.1	49.8	1.00	0.85	26.9
Approach		212	0.0	0.744	45.7	LOS D	7.1	49.8	0.95	0.87	34.1
All Vehicles		6988	0.0	0.799	2.1	LOS A	7.1	49.8	0.08	0.08	57.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P4	West Full Crossing	53	5.9	LOS A	0.1	0.1	0.30	0.30
All Pedestrians		53	5.9	LOS A			0.30	0.30

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

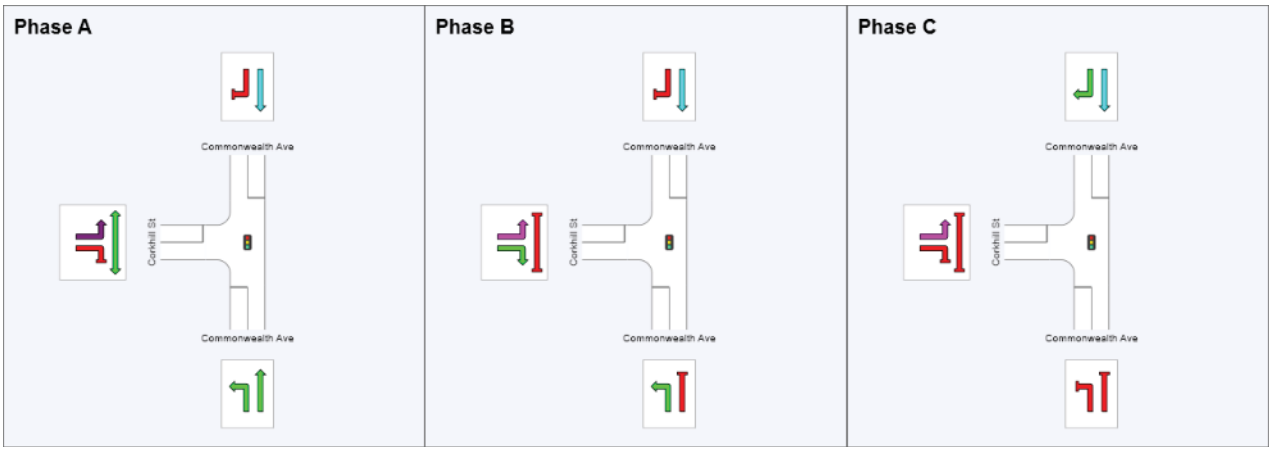
Site: 2014PM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	102	118
Green Time (sec)	96	10	6
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	102	16	12
Phase Split	78 %	12 %	9 %



Normal Movement
Permitted/Opposed
Slip/Bypass-Lane Movement
Opposed Slip/Bypass-Lane
Stopped Movement
Turn On Red
Other Movement Class Running
Other Movement Class Stopped
Mixed Running & Stopped Movement Classes
Undetected Movement
Phase Transition Applied

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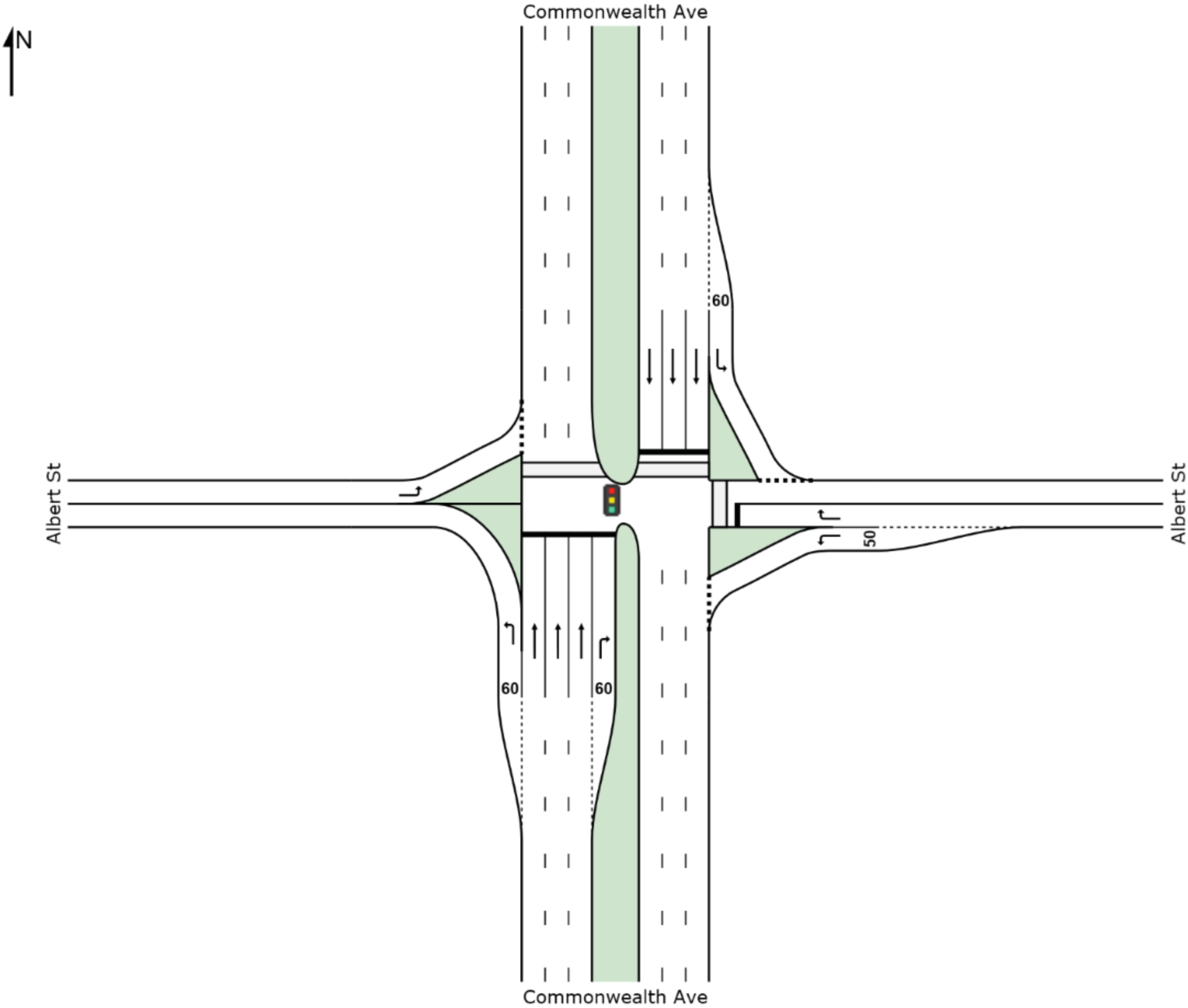
SITE LAYOUT

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Corkhill St
Signals - Fixed Time



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MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.012	5.9	LOS A	0.1	0.4	0.10	0.57	53.9
2	T1	3563	0.0	0.860	14.2	LOS B	55.1	385.8	0.80	0.75	48.6
3	R2	24	0.0	0.282	74.3	LOS E	1.6	11.1	1.00	0.71	26.8
Approach		3607	0.0	0.860	14.6	LOS B	55.1	385.8	0.79	0.75	48.4
East: Albert St											
4	L2	11	0.0	0.024	42.3	LOS D	0.5	3.4	0.79	0.66	35.2
6	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.1
Approach		21	0.0	0.123	57.7	LOS E	0.7	4.7	0.89	0.67	30.6
North: Commonwealth Ave											
7	L2	25	0.0	0.015	6.0	LOS A	0.1	0.7	0.11	0.57	53.9
8	T1	4338	0.0	0.969	40.4	LOS D	107.9	755.4	0.98	1.08	36.0
Approach		4363	0.0	0.969	40.2	LOS D	107.9	755.4	0.98	1.07	36.1
West: Albert St											
10	L2	20	0.0	0.051	26.7	LOS C	0.8	5.3	0.61	0.69	41.4
Approach		20	0.0	0.051	26.7	LOS C	0.8	5.3	0.61	0.69	41.4
All Vehicles		8012	0.0	0.969	28.7	LOS C	107.9	755.4	0.89	0.93	40.8

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

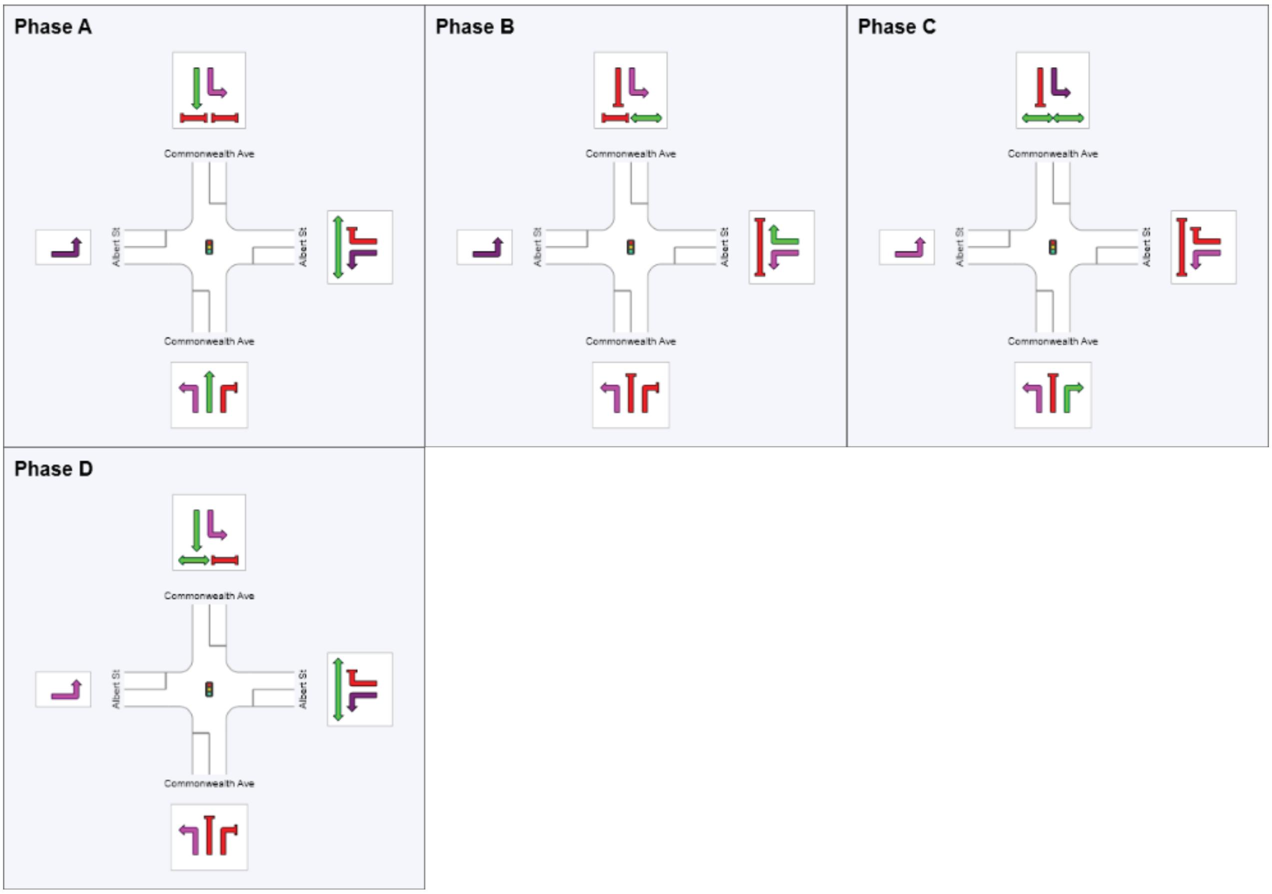
Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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MOVEMENT SUMMARY

Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.012	5.9	LOS A	0.1	0.4	0.10	0.57	53.9
2	T1	3453	0.0	0.831	13.5	LOS B	50.5	353.3	0.76	0.72	49.1
3	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		3483	0.0	0.831	13.7	LOS B	50.5	353.3	0.76	0.72	49.0
East: Albert St											
4	L2	31	0.0	0.027	13.7	LOS B	0.6	4.5	0.41	0.63	48.5
6	R2	31	0.0	0.356	74.8	LOS E	2.0	14.1	1.00	0.72	26.8
Approach		61	0.0	0.356	44.2	LOS D	2.0	14.1	0.70	0.68	34.5
North: Commonwealth Ave											
7	L2	1	0.0	0.001	5.9	LOS A	0.0	0.0	0.09	0.55	54.0
8	T1	3285	0.0	0.730	8.3	LOS A	35.7	250.1	0.58	0.54	52.8
Approach		3286	0.0	0.730	8.3	LOS A	35.7	250.1	0.58	0.54	52.8
West: Albert St											
10	L2	105	0.0	0.285	36.8	LOS D	5.8	40.7	0.88	0.85	37.2
Approach		105	0.0	0.285	36.8	LOS D	5.8	40.7	0.88	0.85	37.2
All Vehicles		6936	0.0	0.831	11.7	LOS B	50.5	353.3	0.67	0.63	50.3

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

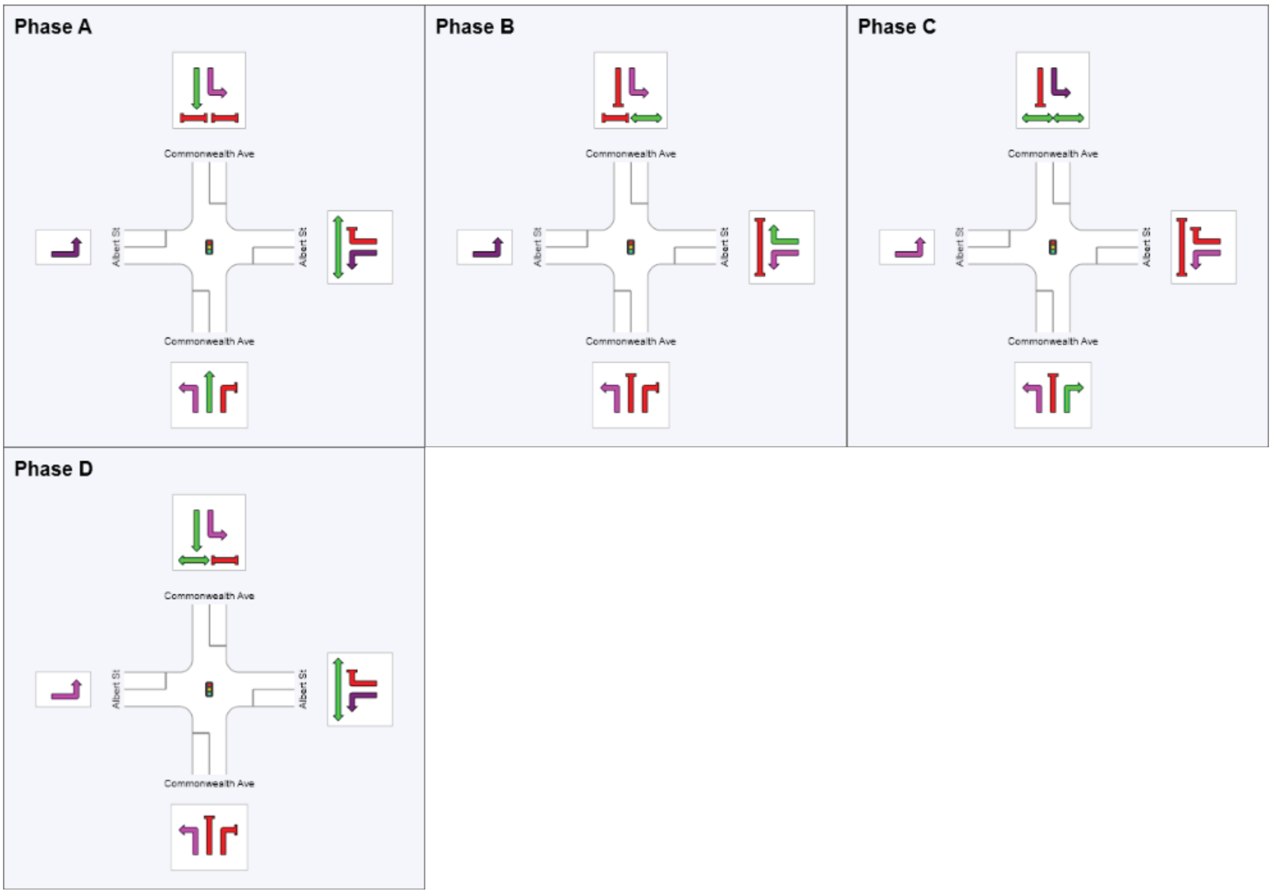
Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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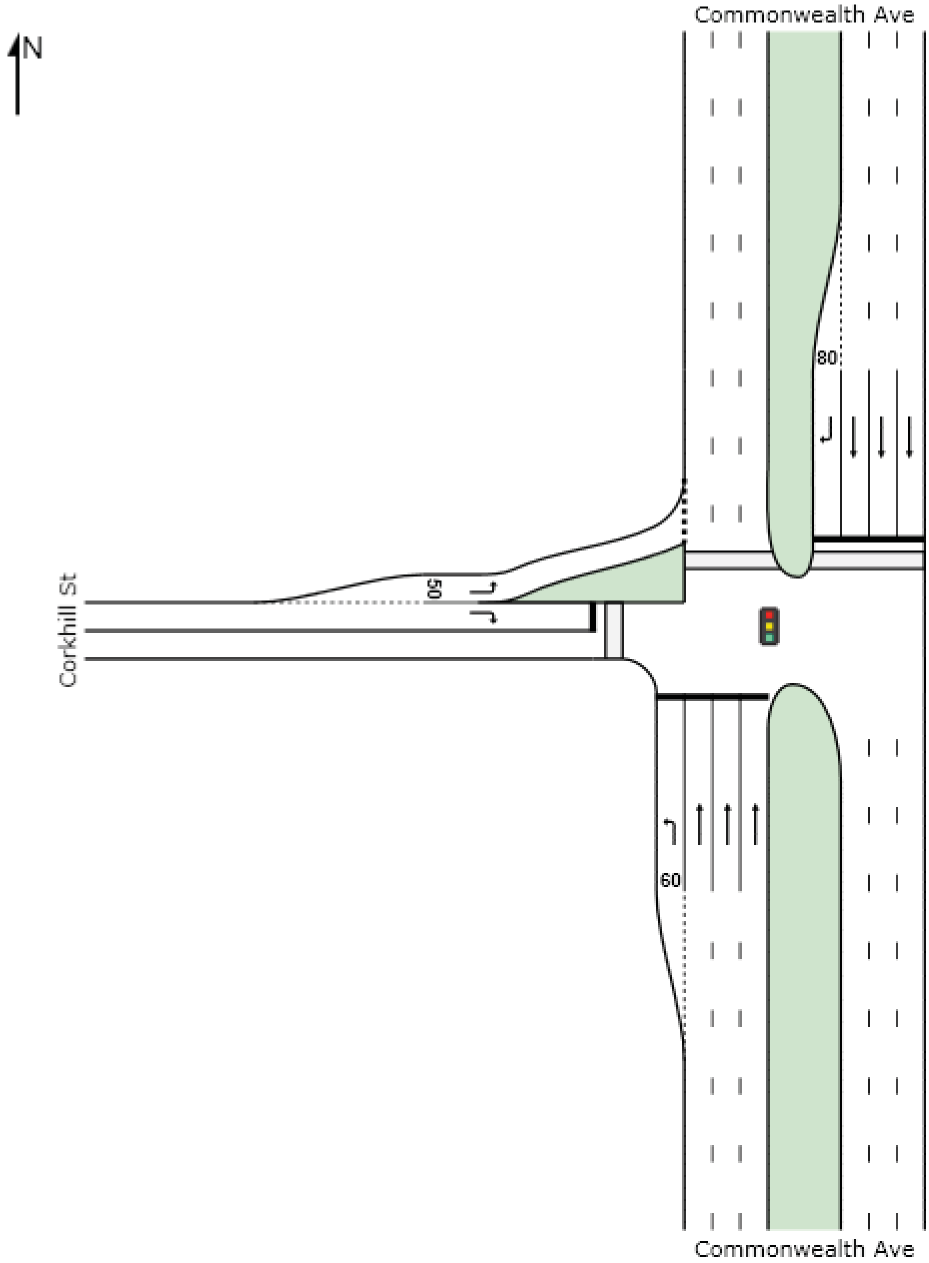
OPTION 4C

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.049	5.9	LOS A	0.1	0.6	0.02	0.58	55.4
2	T1	3563	0.0	0.792	0.9	LOS A	6.6	46.0	0.10	0.09	59.5
Approach		3634	0.0	0.792	1.0	LOS A	6.6	46.0	0.10	0.10	59.5
North: Commonwealth Ave											
8	T1	4338	0.0	0.948	27.5	LOS C	93.1	651.8	0.89	0.93	48.9
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	31.6
Approach		4407	0.0	0.948	28.3	LOS C	93.1	651.8	0.89	0.93	48.6
West: Corkhill St											
10	L2	21	0.0	0.064	6.7	LOS A	0.2	1.3	0.18	0.60	55.4
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	32.9
Approach		42	0.0	0.246	40.4	LOS D	1.4	9.6	0.59	0.65	41.3
All Vehicles		8083	0.0	0.948	16.1	LOS B	93.1	651.8	0.53	0.56	52.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

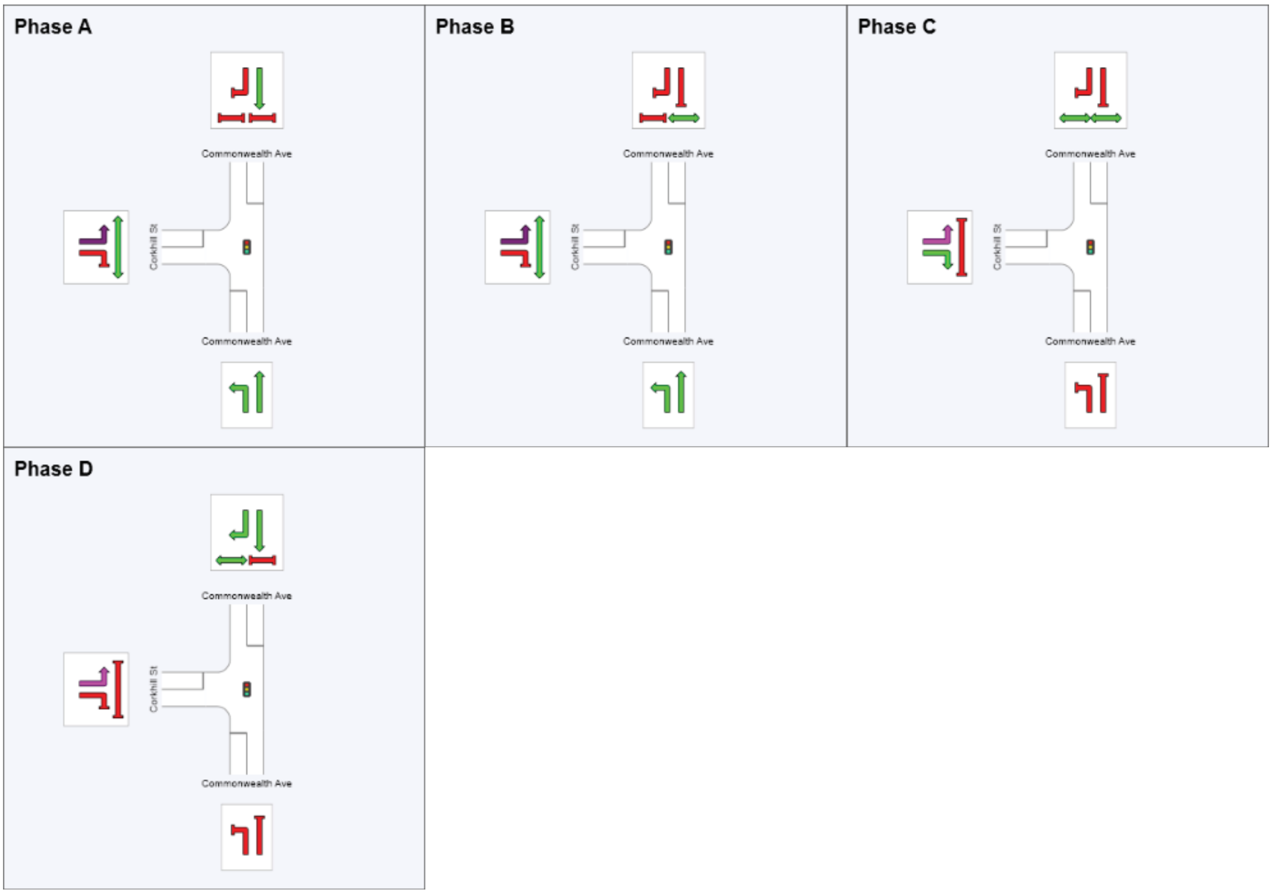
Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	106	118
Green Time (sec)	91	3	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	9	12	12
Phase Split	75 %	7 %	9 %	9 %



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MOVEMENT SUMMARY

Site: 2014PM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.013	5.8	LOS A	0.0	0.2	0.02	0.58	53.5
2	T1	3453	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.1
Approach		3473	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.712	6.7	LOS A	32.5	227.3	0.52	0.49	54.0
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.712	7.1	LOS A	32.5	227.3	0.52	0.49	53.7
West: Corkhill St											
10	L2	105	0.0	0.281	17.0	LOS B	6.1	42.8	0.91	0.90	46.5
12	R2	106	0.0	0.827	78.1	LOS E	7.4	51.6	1.00	0.91	26.1
Approach		212	0.0	0.827	47.7	LOS D	7.4	51.6	0.95	0.90	33.4
All Vehicles		6988	0.0	0.827	5.3	LOS A	32.5	227.3	0.32	0.31	55.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	5.6	LOS A	0.1	0.1	0.29	0.29
All Pedestrians		158	41.4	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

Site: 2014PM - Corkhill T

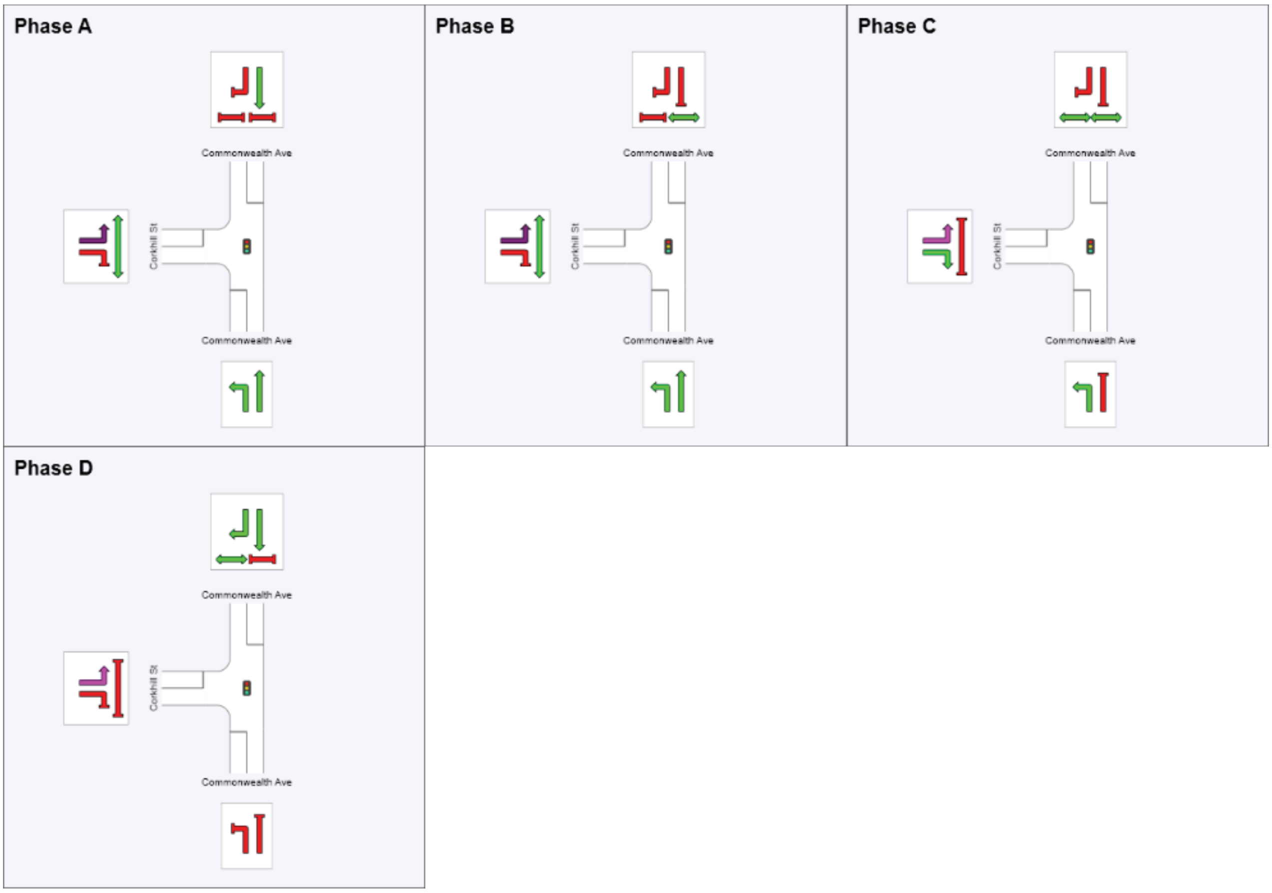
Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	103	118
Green Time (sec)	91	***	9	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	6	15	12
Phase Split	75 %	5 %	12 %	9 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.



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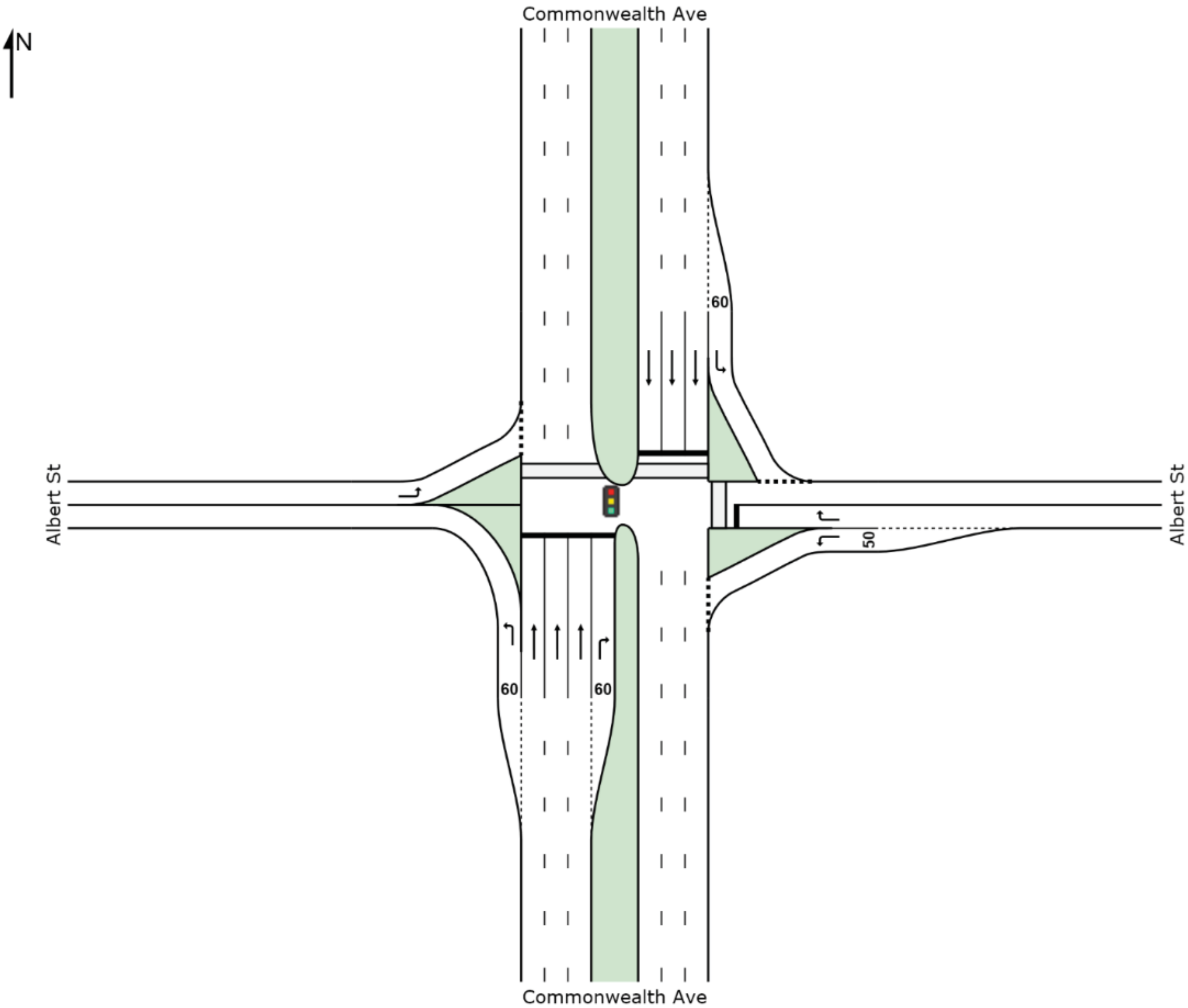
SITE LAYOUT

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time



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8000047, 6019197, ARUP PTY LTD, PLUS / Floating

MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.011	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
2	T1	3563	0.0	1.013	84.1	LOS F	114.0	798.0	1.00	1.27	25.2
3	R2	24	0.0	0.063	49.8	LOS D	1.2	8.6	0.83	0.70	32.6
Approach		3607	0.0	1.013	83.5	LOS F	114.0	798.0	0.99	1.26	25.3
East: Albert St											
4	L2	11	0.0	0.018	36.7	LOS D	0.5	3.3	0.70	0.63	37.2
6	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.1
Approach		21	0.0	0.123	54.9	LOS D	0.7	4.7	0.84	0.65	31.4
North: Commonwealth Ave											
7	L2	25	0.0	0.015	5.7	LOS A	0.0	0.1	0.02	0.55	54.2
8	T1	4338	0.0	1.226	242.2	LOS F	220.7	1544.8	1.00	2.06	12.0
Approach		4363	0.0	1.226	240.8	LOS F	220.7	1544.8	0.99	2.05	12.1
West: Albert St											
10	L2	20	0.0	0.036	35.8	LOS D	0.9	6.0	0.70	0.64	37.6
Approach		20	0.0	0.036	35.8	LOS D	0.9	6.0	0.70	0.64	37.6
All Vehicles		8012	0.0	1.226	169.0	LOS F	220.7	1544.8	0.99	1.69	15.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	12.1	LOS B	0.1	0.1	0.43	0.43
P3	North Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		105	35.7	LOS D			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

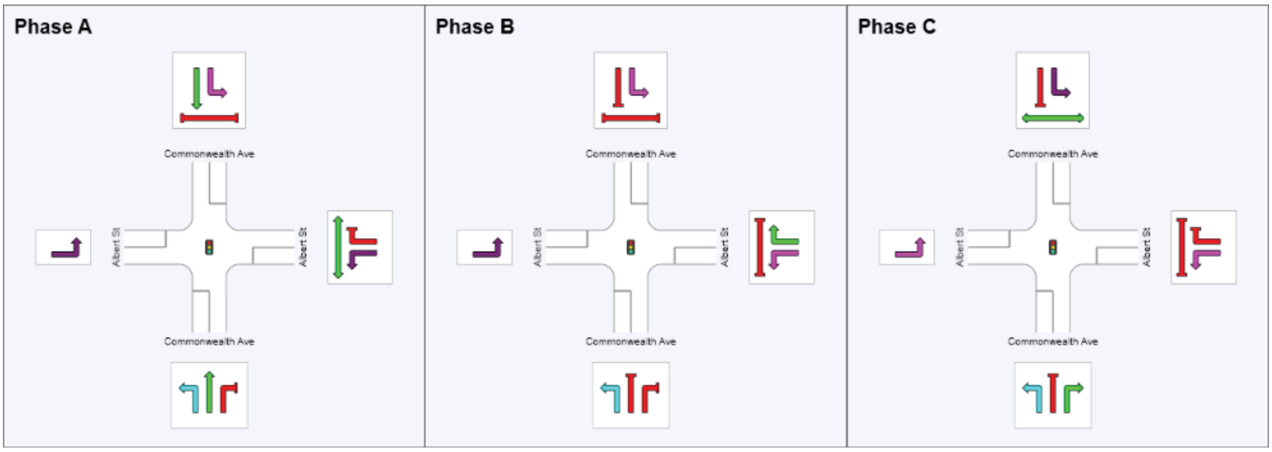
Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	85	97
Green Time (sec)	79	6	27
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	85	12	33
Phase Split	65 %	9 %	25 %



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MOVEMENT SUMMARY

Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.011	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
2	T1	3453	0.0	0.978	61.6	LOS E	96.6	676.1	1.00	1.16	29.8
3	R2	11	0.0	0.027	49.2	LOS D	0.5	3.7	0.82	0.67	32.8
Approach		3483	0.0	0.978	61.2	LOS E	96.6	676.1	0.99	1.15	29.9
East: Albert St											
4	L2	31	0.0	0.034	21.4	LOS C	0.9	6.5	0.54	0.65	44.0
6	R2	31	0.0	0.356	74.8	LOS E	2.0	14.1	1.00	0.72	26.8
Approach		61	0.0	0.356	48.1	LOS D	2.0	14.1	0.77	0.69	33.3
North: Commonwealth Ave											
7	L2	1	0.0	0.001	5.7	LOS A	0.0	0.0	0.02	0.55	54.2
8	T1	3285	0.0	0.924	23.8	LOS C	60.6	424.4	0.82	0.84	43.1
Approach		3286	0.0	0.924	23.8	LOS C	60.6	424.4	0.82	0.84	43.1
West: Albert St											
10	L2	105	0.0	0.199	37.0	LOS D	4.8	33.8	0.75	0.72	37.1
Approach		105	0.0	0.199	37.0	LOS D	4.8	33.8	0.75	0.72	37.1
All Vehicles		6936	0.0	0.978	43.0	LOS D	96.6	676.1	0.91	0.99	35.1

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	12.1	LOS B	0.1	0.1	0.43	0.43
P3	North Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		105	35.7	LOS D			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

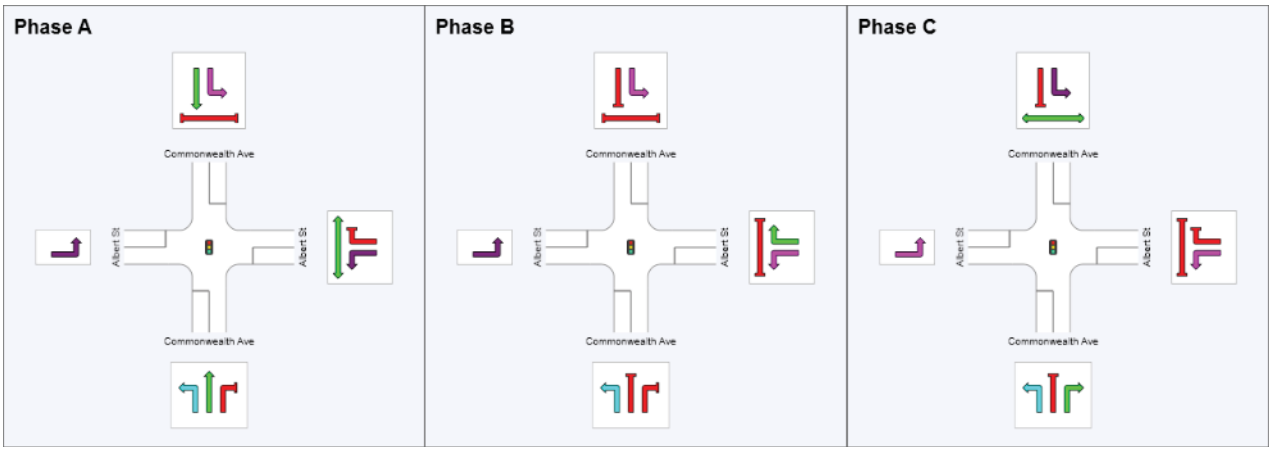
Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	85	97
Green Time (sec)	79	6	27
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	85	12	33
Phase Split	65 %	9 %	25 %



- Normal Movement
- Permitted/Opposed
- Slip/Bypass-Lane Movement
- Opposed Slip/Bypass-Lane
- Stopped Movement
- Turn On Red
- Other Movement Class Running
- Other Movement Class Stopped
- Mixed Running & Stopped Movement Classes
- Undetected Movement
- Phase Transition Applied

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SIDRA INTERSECTION 6

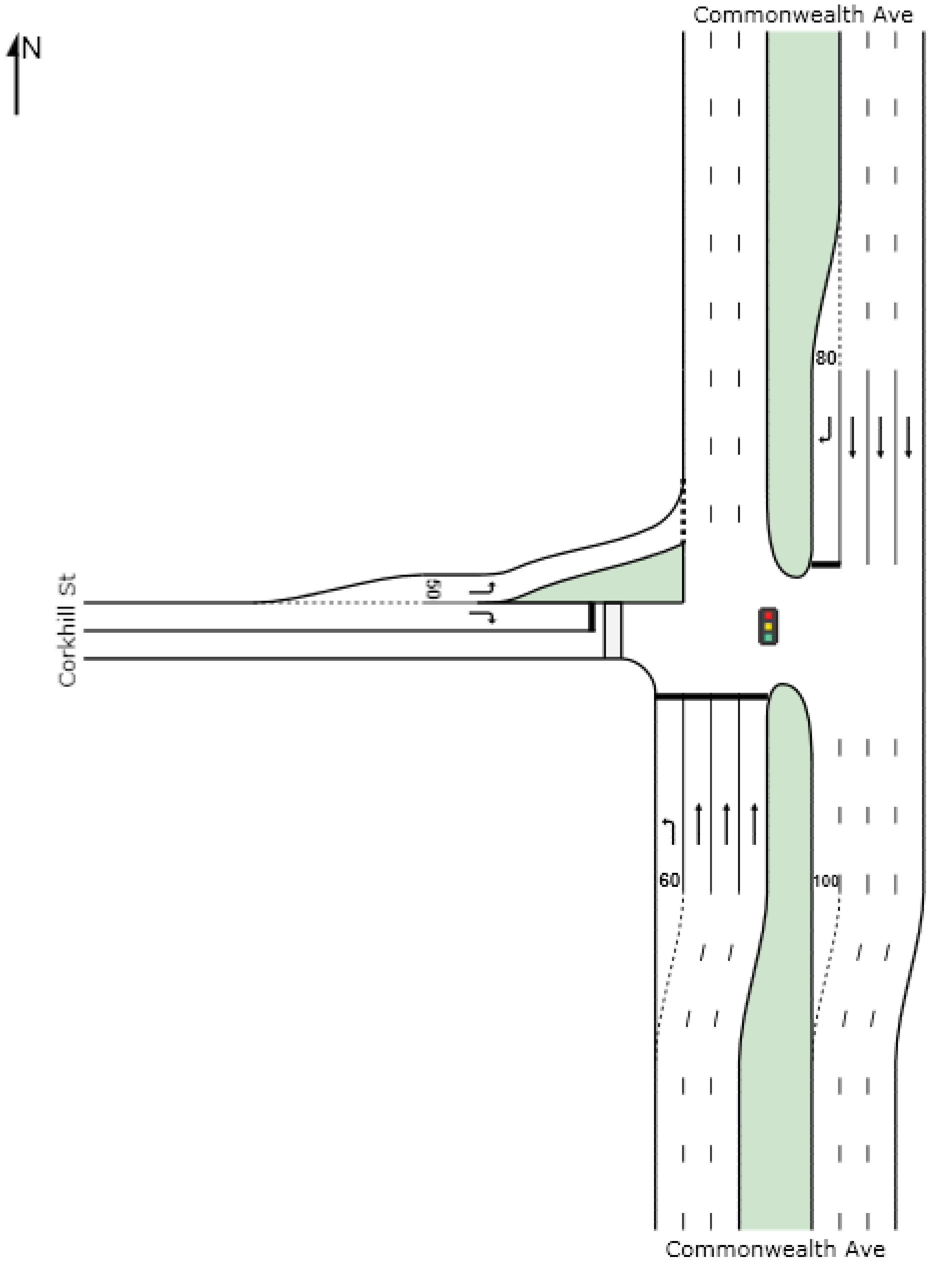
OPTION 4D

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.044	5.8	LOS A	0.1	0.6	0.02	0.58	53.4
2	T1	3563	0.0	0.800	1.0	LOS A	6.8	47.7	0.10	0.10	59.1
Approach		3634	0.0	0.800	1.1	LOS A	6.8	47.7	0.10	0.11	58.9
North: Commonwealth Ave											
8	T1	4338	0.0	0.742	0.2	LOS A	0.0	0.0	0.00	0.00	59.5
9	R2	69	0.0	0.695	76.3	LOS E	4.7	32.9	1.00	0.82	26.4
Approach		4407	0.0	0.742	1.4	LOS A	4.7	32.9	0.02	0.01	58.4
West: Corkhill St											
10	L2	21	0.0	0.061	6.7	LOS A	0.2	1.3	0.18	0.60	53.3
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	26.9
Approach		42	0.0	0.246	40.4	LOS D	1.4	9.6	0.59	0.65	35.8
All Vehicles		8083	0.0	0.800	1.5	LOS A	6.8	47.7	0.06	0.06	58.4

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P4	West Full Crossing	53	5.0	LOS A	0.1	0.1	0.28	0.28
All Pedestrians		53	5.0	LOS A			0.28	0.28

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

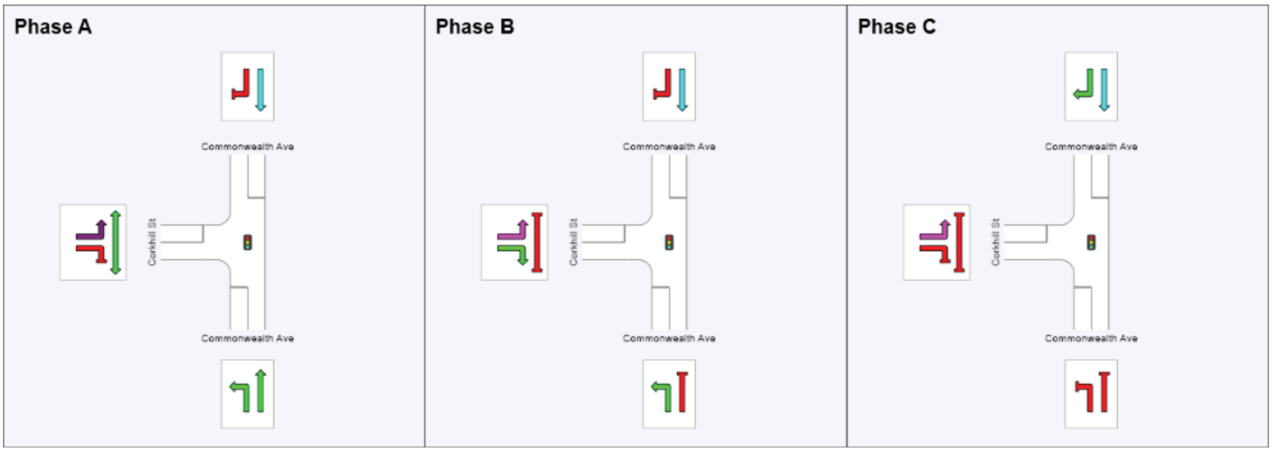
Site: 2014AM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	105	117
Green Time (sec)	99	6	7
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	105	12	13
Phase Split	81 %	9 %	10 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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MOVEMENT SUMMARY

Site: 2014PM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.013	5.8	LOS A	0.0	0.2	0.02	0.58	53.5
2	T1	3453	0.0	0.799	1.0	LOS A	6.6	46.1	0.10	0.10	59.0
Approach		3473	0.0	0.799	1.0	LOS A	6.6	46.1	0.10	0.10	59.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.562	0.1	LOS A	0.0	0.0	0.00	0.00	59.8
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.562	0.5	LOS A	1.2	8.6	0.01	0.00	59.4
West: Corkhill St											
10	L2	105	0.0	0.271	16.9	LOS B	6.1	42.4	0.90	0.89	46.5
12	R2	106	0.0	0.744	74.1	LOS E	7.1	49.8	1.00	0.85	26.9
Approach		212	0.0	0.744	45.7	LOS D	7.1	49.8	0.95	0.87	34.1
All Vehicles		6988	0.0	0.799	2.1	LOS A	7.1	49.8	0.08	0.08	57.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P4	West Full Crossing	53	5.9	LOS A	0.1	0.1	0.30	0.30
All Pedestrians		53	5.9	LOS A			0.30	0.30

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

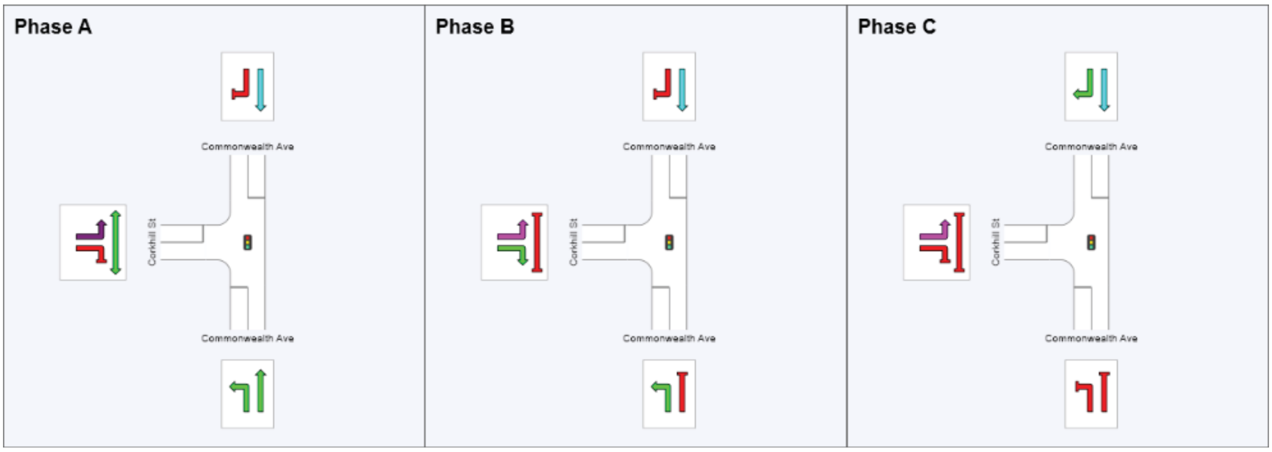
Site: 2014PM - Corkhill T - seagull

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	102	118
Green Time (sec)	96	10	6
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	102	16	12
Phase Split	78 %	12 %	9 %



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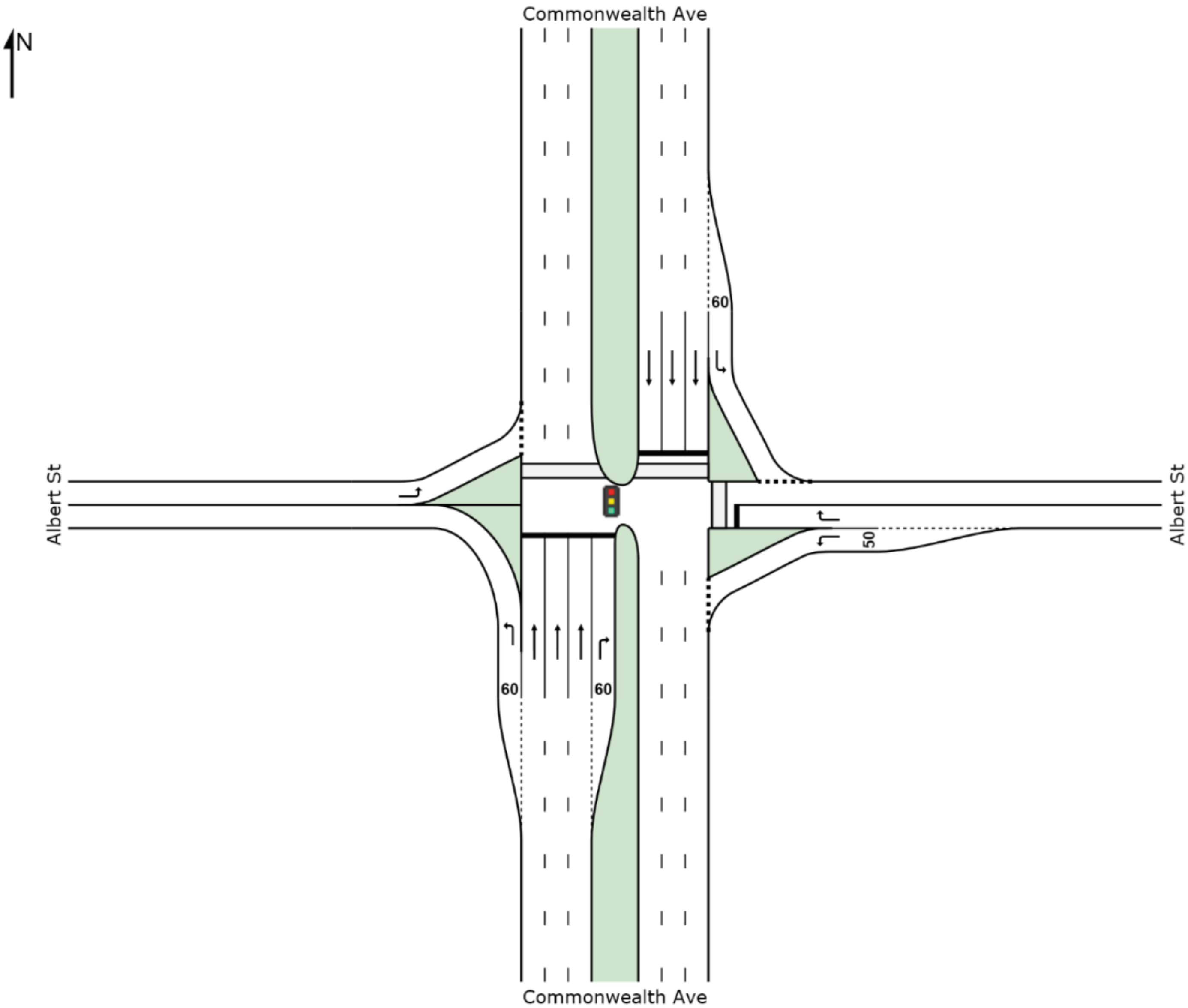
SITE LAYOUT

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time



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MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.011	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
2	T1	3563	0.0	1.013	84.1	LOS F	114.0	798.0	1.00	1.27	25.2
3	R2	24	0.0	0.063	49.8	LOS D	1.2	8.6	0.83	0.70	32.6
Approach		3607	0.0	1.013	83.5	LOS F	114.0	798.0	0.99	1.26	25.3
East: Albert St											
4	L2	11	0.0	0.018	36.7	LOS D	0.5	3.3	0.70	0.63	37.2
6	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.1
Approach		21	0.0	0.123	54.9	LOS D	0.7	4.7	0.84	0.65	31.4
North: Commonwealth Ave											
7	L2	25	0.0	0.015	6.0	LOS A	0.1	0.6	0.11	0.57	53.9
8	T1	4338	0.0	1.226	261.1	LOS F	226.4	1585.0	1.00	2.09	11.3
Approach		4363	0.0	1.226	259.6	LOS F	226.4	1585.0	0.99	2.08	11.4
West: Albert St											
10	L2	20	0.0	0.036	35.8	LOS D	0.9	6.0	0.70	0.64	37.6
Approach		20	0.0	0.036	35.8	LOS D	0.9	6.0	0.70	0.64	37.6
All Vehicles		8012	0.0	1.226	179.2	LOS F	226.4	1585.0	0.99	1.71	15.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	12.1	LOS B	0.1	0.1	0.43	0.43
P3	North Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		105	35.7	LOS D			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

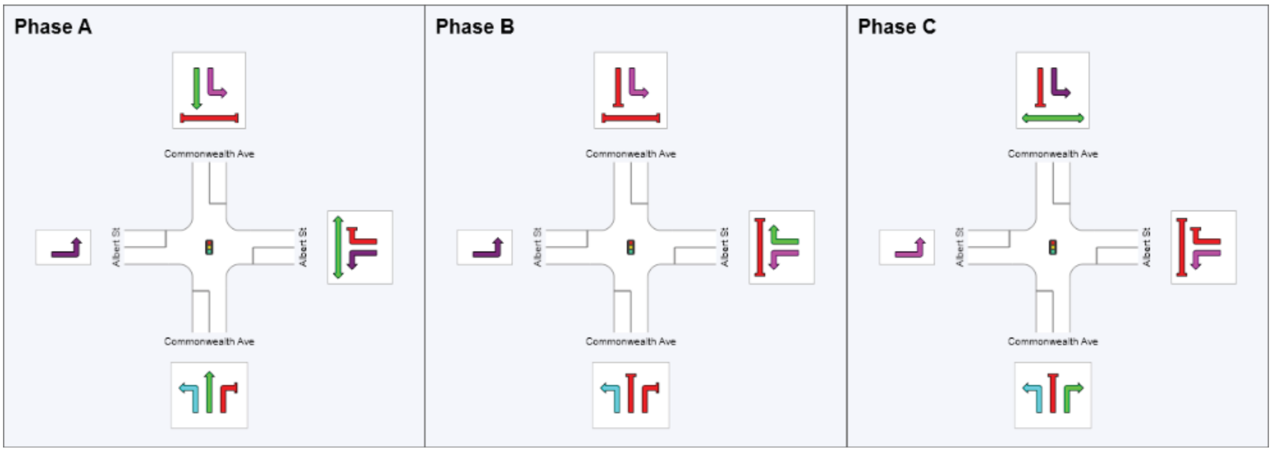
Site: 2014AM - Right Turns Comm Park, LILO Waterfront

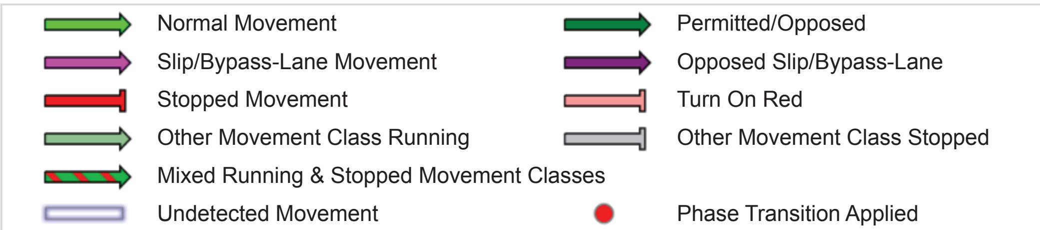
Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	85	97
Green Time (sec)	79	6	27
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	85	12	33
Phase Split	65 %	9 %	25 %





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MOVEMENT SUMMARY

Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.011	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
2	T1	3453	0.0	0.978	61.6	LOS E	96.6	676.1	1.00	1.16	29.8
3	R2	11	0.0	0.027	49.2	LOS D	0.5	3.7	0.82	0.67	32.8
Approach		3483	0.0	0.978	61.2	LOS E	96.6	676.1	0.99	1.15	29.9
East: Albert St											
4	L2	31	0.0	0.040	27.4	LOS C	1.1	7.7	0.62	0.66	41.1
6	R2	31	0.0	0.356	74.8	LOS E	2.0	14.1	1.00	0.72	26.8
Approach		61	0.0	0.356	51.1	LOS D	2.0	14.1	0.81	0.69	32.4
North: Commonwealth Ave											
7	L2	1	0.0	0.001	5.9	LOS A	0.0	0.0	0.09	0.56	54.0
8	T1	3285	0.0	0.924	37.4	LOS D	72.5	507.8	0.98	1.00	37.1
Approach		3286	0.0	0.924	37.4	LOS D	72.5	507.8	0.98	1.00	37.1
West: Albert St											
10	L2	105	0.0	0.199	37.0	LOS D	4.8	33.8	0.75	0.72	37.1
Approach		105	0.0	0.199	37.0	LOS D	4.8	33.8	0.75	0.72	37.1
All Vehicles		6936	0.0	0.978	49.5	LOS D	96.6	676.1	0.98	1.07	33.1

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	12.1	LOS B	0.1	0.1	0.43	0.43
P3	North Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		105	35.7	LOS D			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

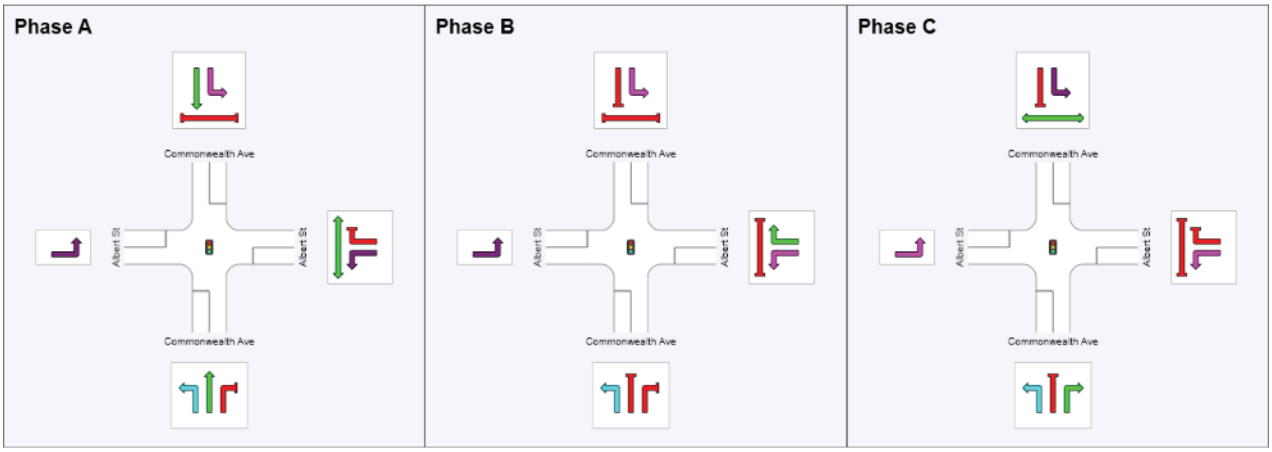
Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	85	97
Green Time (sec)	79	6	27
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	85	12	33
Phase Split	65 %	9 %	25 %



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Project: c:\projectwise\syd_projects\vincent-w.chan\dms69145\Commonwealth Waterfront.sip6
8000047, 6019197, ARUP PTY LTD, PLUS / Floating

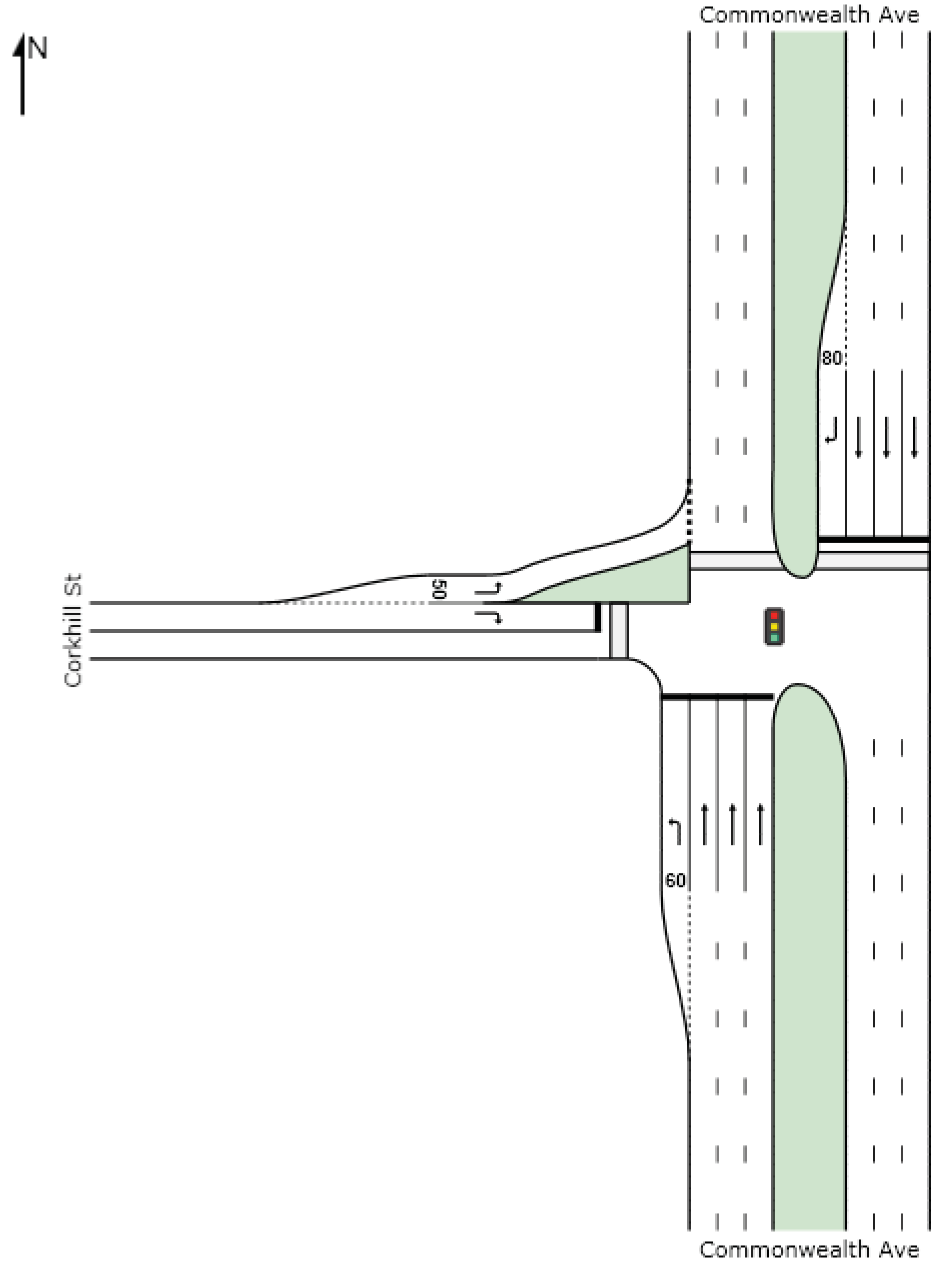
OPTION 4E

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.049	5.9	LOS A	0.1	0.6	0.02	0.58	55.4
2	T1	3563	0.0	0.792	0.9	LOS A	6.6	46.0	0.10	0.09	59.5
Approach		3634	0.0	0.792	1.0	LOS A	6.6	46.0	0.10	0.10	59.5
North: Commonwealth Ave											
8	T1	4338	0.0	0.948	27.5	LOS C	93.1	651.8	0.89	0.93	48.9
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	31.6
Approach		4407	0.0	0.948	28.3	LOS C	93.1	651.8	0.89	0.93	48.6
West: Corkhill St											
10	L2	21	0.0	0.064	6.7	LOS A	0.2	1.3	0.18	0.60	55.4
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	32.9
Approach		42	0.0	0.246	40.4	LOS D	1.4	9.6	0.59	0.65	41.3
All Vehicles		8083	0.0	0.948	16.1	LOS B	93.1	651.8	0.53	0.56	52.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

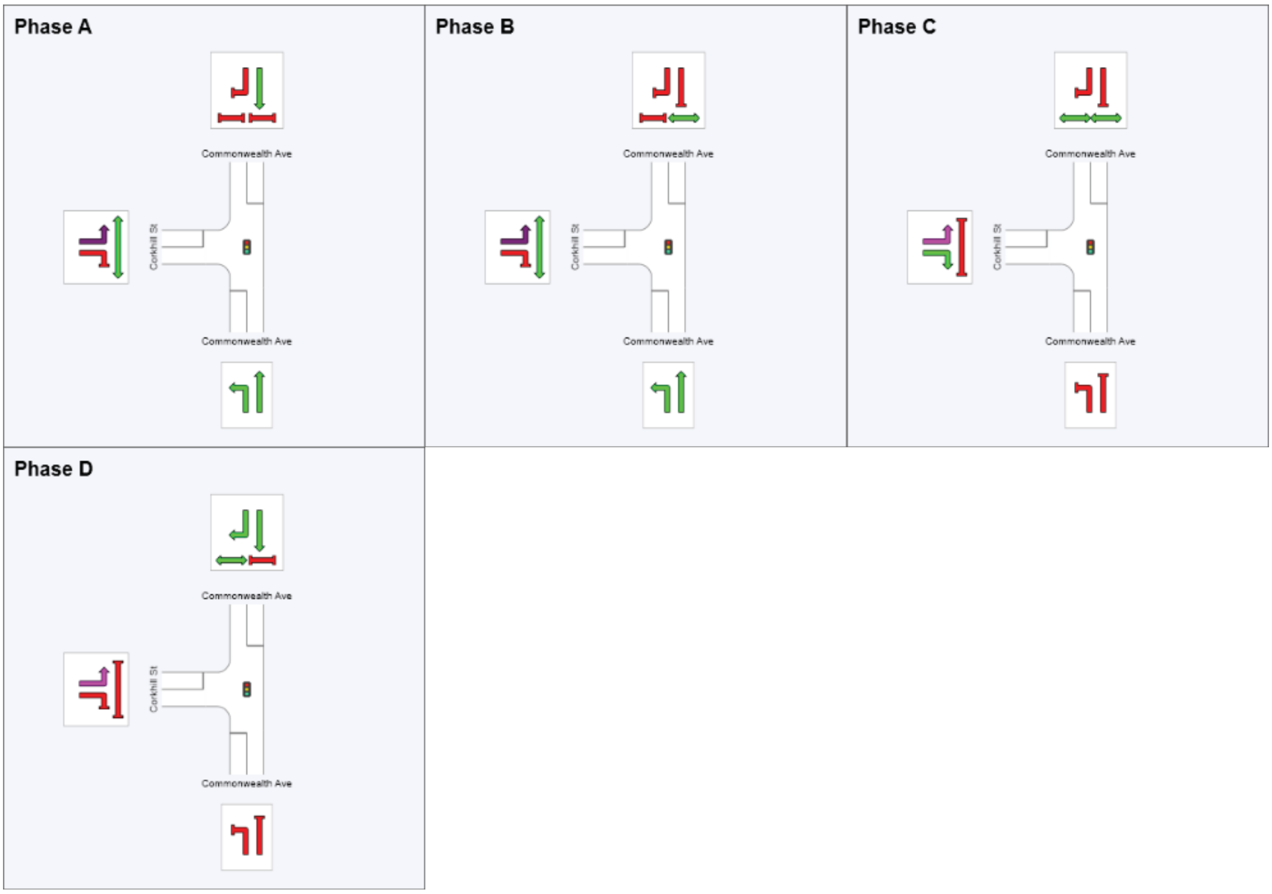
Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	106	118
Green Time (sec)	91	3	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	9	12	12
Phase Split	75 %	7 %	9 %	9 %



	Normal Movement		Permitted/Opposed
	Slip/Bypass-Lane Movement		Opposed Slip/Bypass-Lane
	Stopped Movement		Turn On Red
	Other Movement Class Running		Other Movement Class Stopped
	Mixed Running & Stopped Movement Classes		
	Undetected Movement		Phase Transition Applied

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SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: 2014PM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.013	5.8	LOS A	0.0	0.2	0.02	0.58	53.5
2	T1	3453	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.1
Approach		3473	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.712	6.7	LOS A	32.5	227.3	0.52	0.49	54.0
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.712	7.1	LOS A	32.5	227.3	0.52	0.49	53.7
West: Corkhill St											
10	L2	105	0.0	0.281	17.0	LOS B	6.1	42.8	0.91	0.90	46.5
12	R2	106	0.0	0.827	78.1	LOS E	7.4	51.6	1.00	0.91	26.1
Approach		212	0.0	0.827	47.7	LOS D	7.4	51.6	0.95	0.90	33.4
All Vehicles		6988	0.0	0.827	5.3	LOS A	32.5	227.3	0.32	0.31	55.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	5.6	LOS A	0.1	0.1	0.29	0.29
All Pedestrians		158	41.4	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

Site: 2014PM - Corkhill T

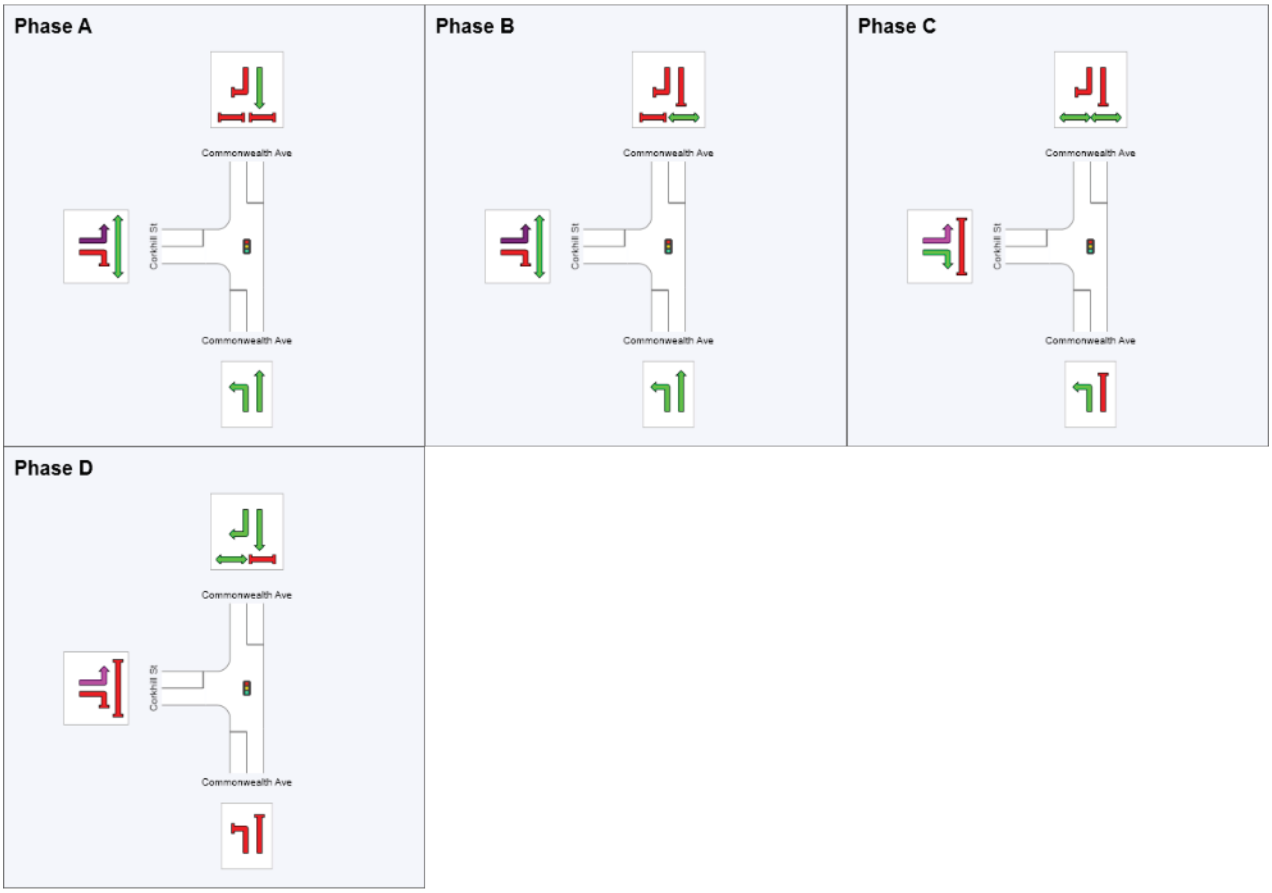
Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	103	118
Green Time (sec)	91	***	9	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	6	15	12
Phase Split	75 %	5 %	12 %	9 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.



- Normal Movement
- Permitted/Opposed
- Slip/Bypass-Lane Movement
- Opposed Slip/Bypass-Lane
- Stopped Movement
- Turn On Red
- Other Movement Class Running
- Other Movement Class Stopped
- Mixed Running & Stopped Movement Classes
- Undetected Movement
- Phase Transition Applied

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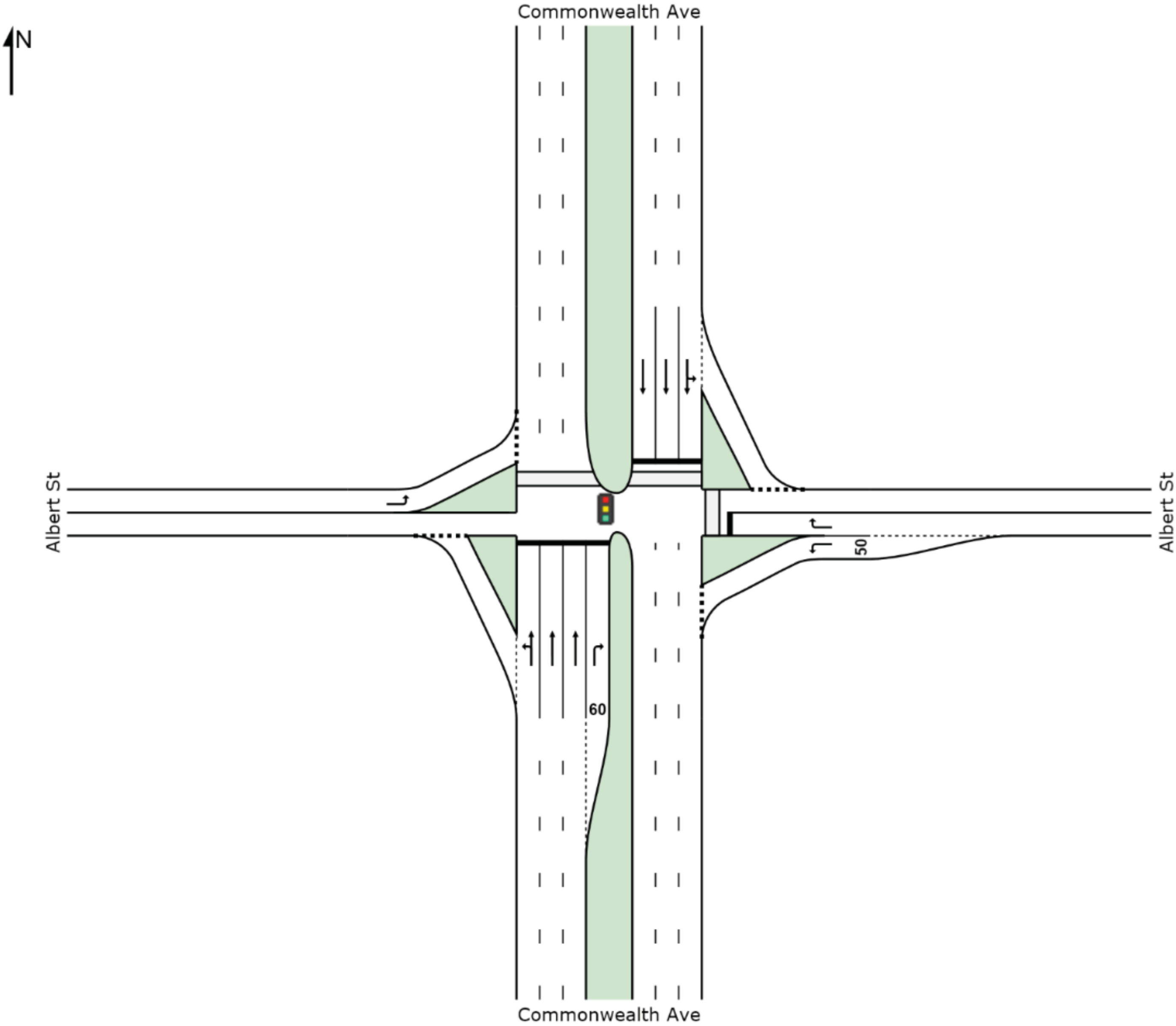
SITE LAYOUT

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time



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MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	1.014	86.5	LOS F	110.7	774.6	1.00	1.26	25.6
2	T1	3563	0.0	1.014	83.5	LOS F	114.5	801.5	1.00	1.27	25.3
3	R2	24	0.0	0.063	49.8	LOS D	1.2	8.6	0.83	0.70	32.6
Approach		3607	0.0	1.014	83.3	LOS F	114.5	801.5	1.00	1.27	25.3
East: Albert St											
4	L2	11	0.0	0.018	36.7	LOS D	0.5	3.3	0.70	0.63	37.2
6	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		21	0.0	0.123	54.9	LOS D	0.7	4.7	0.84	0.65	31.3
North: Commonwealth Ave											
7	L2	25	0.0	1.227	242.7	LOS F	208.5	1459.7	1.00	1.92	12.2
8	T1	4338	0.0	1.227	241.1	LOS F	221.3	1549.4	1.00	2.02	12.1
Approach		4363	0.0	1.227	241.1	LOS F	221.3	1549.4	1.00	2.02	12.1
West: Albert St											
10	L2	20	0.0	0.037	35.8	LOS D	0.9	6.0	0.70	0.64	37.6
Approach		20	0.0	0.037	35.8	LOS D	0.9	6.0	0.70	0.64	37.6
All Vehicles		8012	0.0	1.227	169.0	LOS F	221.3	1549.4	1.00	1.67	15.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	12.1	LOS B	0.1	0.1	0.43	0.43
P3	North Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		105	35.7	LOS D			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

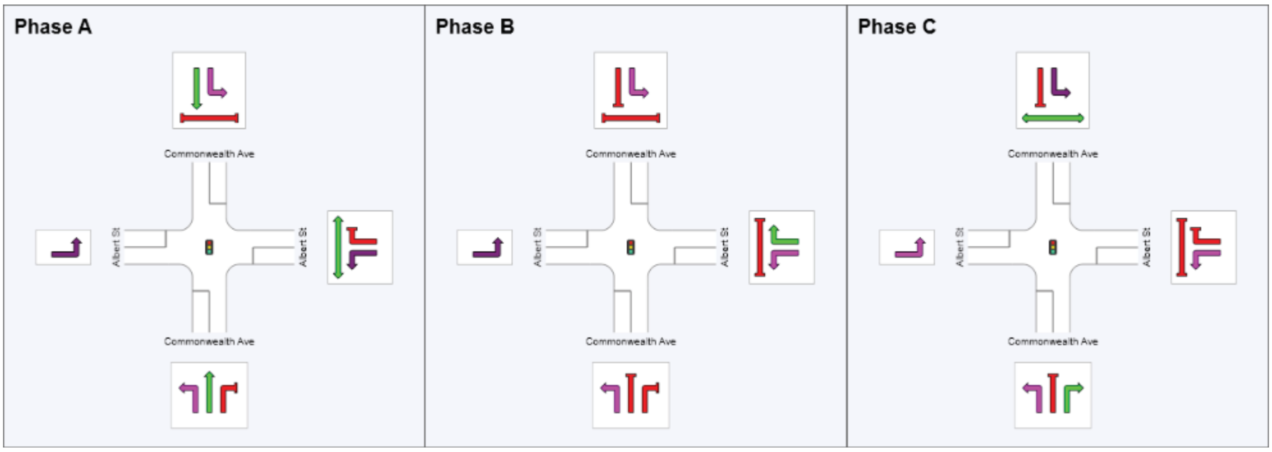
Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	85	97
Green Time (sec)	79	6	27
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	85	12	33
Phase Split	65 %	9 %	25 %



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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MOVEMENT SUMMARY

Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.979	68.3	LOS E	97.3	681.1	1.00	1.16	29.3
2	T1	3453	0.0	0.979	62.4	LOS E	97.3	681.1	1.00	1.16	29.6
3	R2	11	0.0	0.027	49.2	LOS D	0.5	3.7	0.82	0.67	32.8
Approach		3483	0.0	0.979	62.4	LOS E	97.3	681.1	1.00	1.16	29.6
East: Albert St											
4	L2	31	0.0	0.034	21.4	LOS C	0.9	6.5	0.54	0.65	44.0
6	R2	31	0.0	0.356	74.7	LOS E	2.0	14.1	1.00	0.72	26.6
Approach		61	0.0	0.356	48.1	LOS D	2.0	14.1	0.77	0.69	33.2
North: Commonwealth Ave											
7	L2	1	0.0	0.924	28.9	LOS C	59.2	414.5	0.80	0.82	42.9
8	T1	3285	0.0	0.924	23.6	LOS C	60.7	424.7	0.82	0.83	43.2
Approach		3286	0.0	0.924	23.6	LOS C	60.7	424.7	0.82	0.83	43.2
West: Albert St											
10	L2	105	0.0	0.198	36.9	LOS D	4.8	33.8	0.74	0.72	37.1
Approach		105	0.0	0.198	36.9	LOS D	4.8	33.8	0.74	0.72	37.1
All Vehicles		6936	0.0	0.979	43.5	LOS D	97.3	681.1	0.91	0.99	35.0

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	12.1	LOS B	0.1	0.1	0.43	0.43
P3	North Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		105	35.7	LOS D			0.69	0.69

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

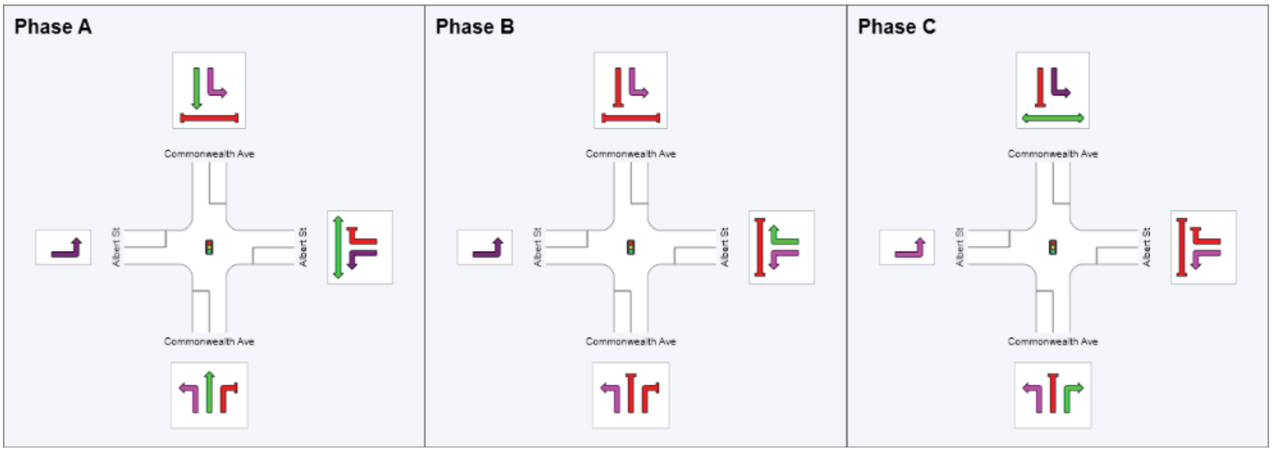
Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy (phase reduction applied)
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	Yes	No	No
Phase Change Time (sec)	0	85	97
Green Time (sec)	79	6	27
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	85	12	33
Phase Split	65 %	9 %	25 %



- Normal Movement
- Slip/Bypass-Lane Movement
- Stopped Movement
- Other Movement Class Running
- Mixed Running & Stopped Movement Classes
- Undetected Movement
- Permitted/Opposed
- Opposed Slip/Bypass-Lane
- Turn On Red
- Other Movement Class Stopped
- Phase Transition Applied

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SIDRA INTERSECTION 6

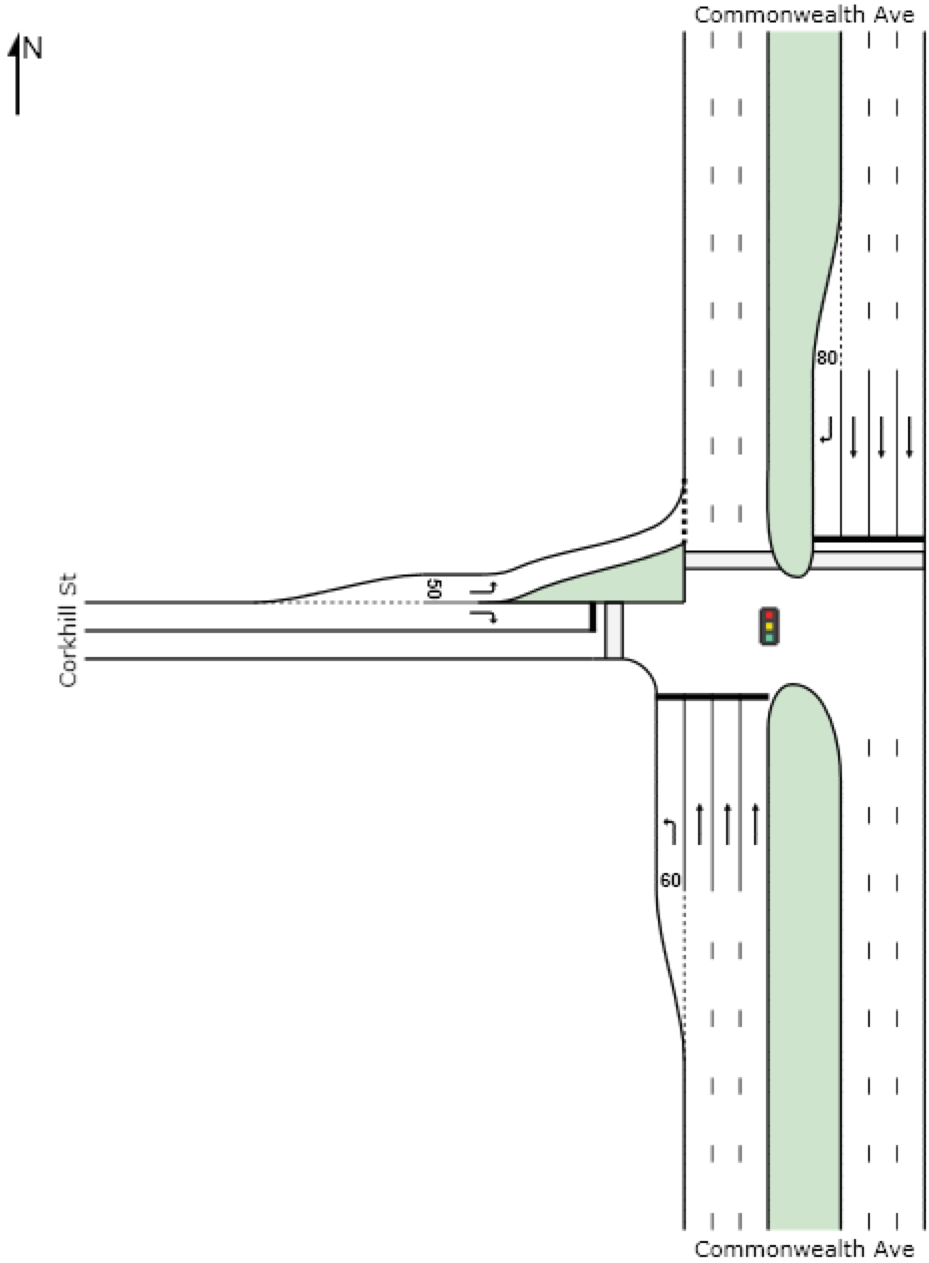
OPTION 4F

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.049	5.9	LOS A	0.1	0.6	0.02	0.58	55.4
2	T1	3563	0.0	0.792	0.9	LOS A	6.6	46.0	0.10	0.09	59.5
Approach		3634	0.0	0.792	1.0	LOS A	6.6	46.0	0.10	0.10	59.5
North: Commonwealth Ave											
8	T1	4338	0.0	0.948	27.5	LOS C	93.1	651.8	0.89	0.93	48.9
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	31.6
Approach		4407	0.0	0.948	28.3	LOS C	93.1	651.8	0.89	0.93	48.6
West: Corkhill St											
10	L2	21	0.0	0.064	6.7	LOS A	0.2	1.3	0.18	0.60	55.4
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	32.9
Approach		42	0.0	0.246	40.4	LOS D	1.4	9.6	0.59	0.65	41.3
All Vehicles		8083	0.0	0.948	16.1	LOS B	93.1	651.8	0.53	0.56	52.9

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

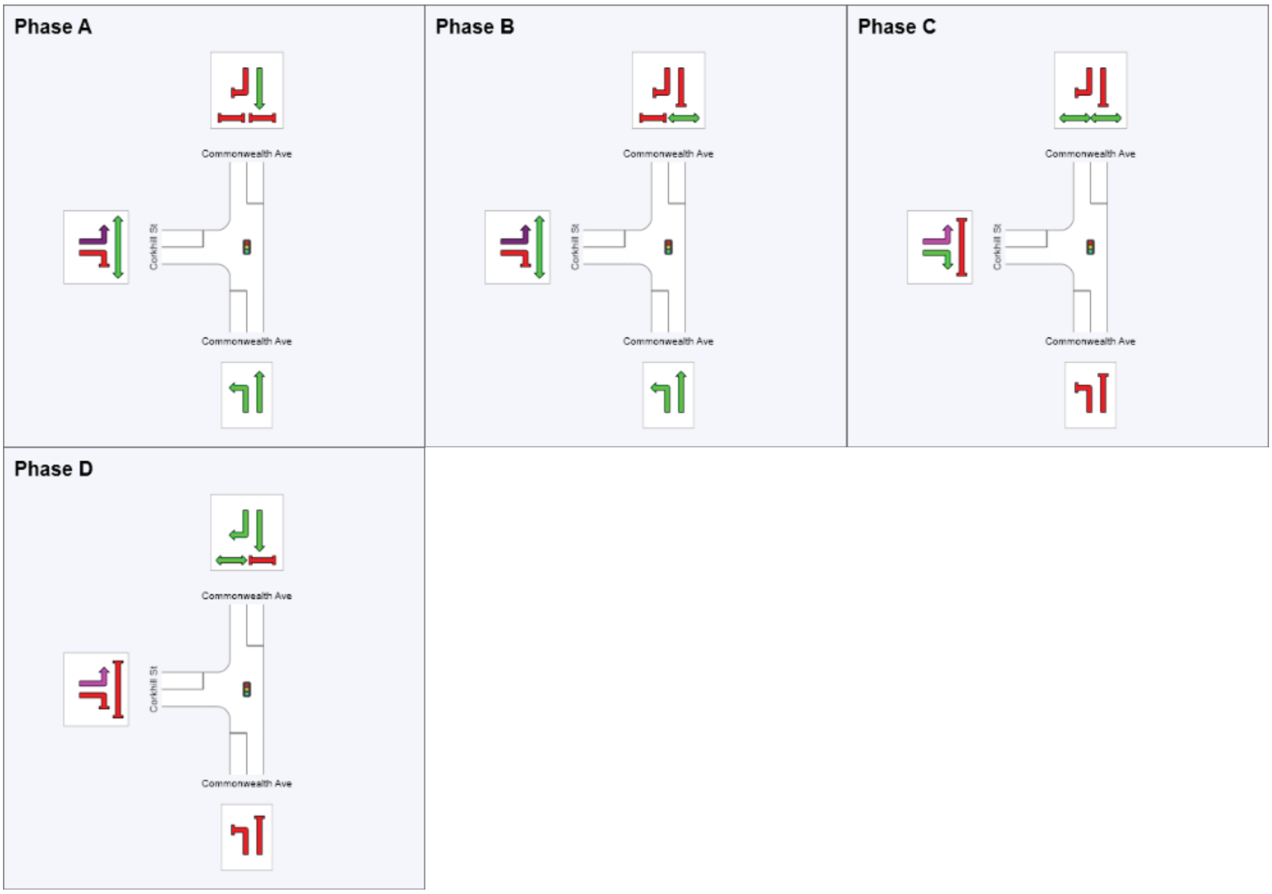
Site: 2014AM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	106	118
Green Time (sec)	91	3	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	9	12	12
Phase Split	75 %	7 %	9 %	9 %



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MOVEMENT SUMMARY

Site: 2014PM - Corkhill T

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.013	5.8	LOS A	0.0	0.2	0.02	0.58	53.5
2	T1	3453	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.1
Approach		3473	0.0	0.791	1.0	LOS A	6.3	44.4	0.10	0.09	59.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.712	6.7	LOS A	32.5	227.3	0.52	0.49	54.0
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.712	7.1	LOS A	32.5	227.3	0.52	0.49	53.7
West: Corkhill St											
10	L2	105	0.0	0.281	17.0	LOS B	6.1	42.8	0.91	0.90	46.5
12	R2	106	0.0	0.827	78.1	LOS E	7.4	51.6	1.00	0.91	26.1
Approach		212	0.0	0.827	47.7	LOS D	7.4	51.6	0.95	0.90	33.4
All Vehicles		6988	0.0	0.827	5.3	LOS A	32.5	227.3	0.32	0.31	55.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	5.6	LOS A	0.1	0.1	0.29	0.29
All Pedestrians		158	41.4	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

Site: 2014PM - Corkhill T

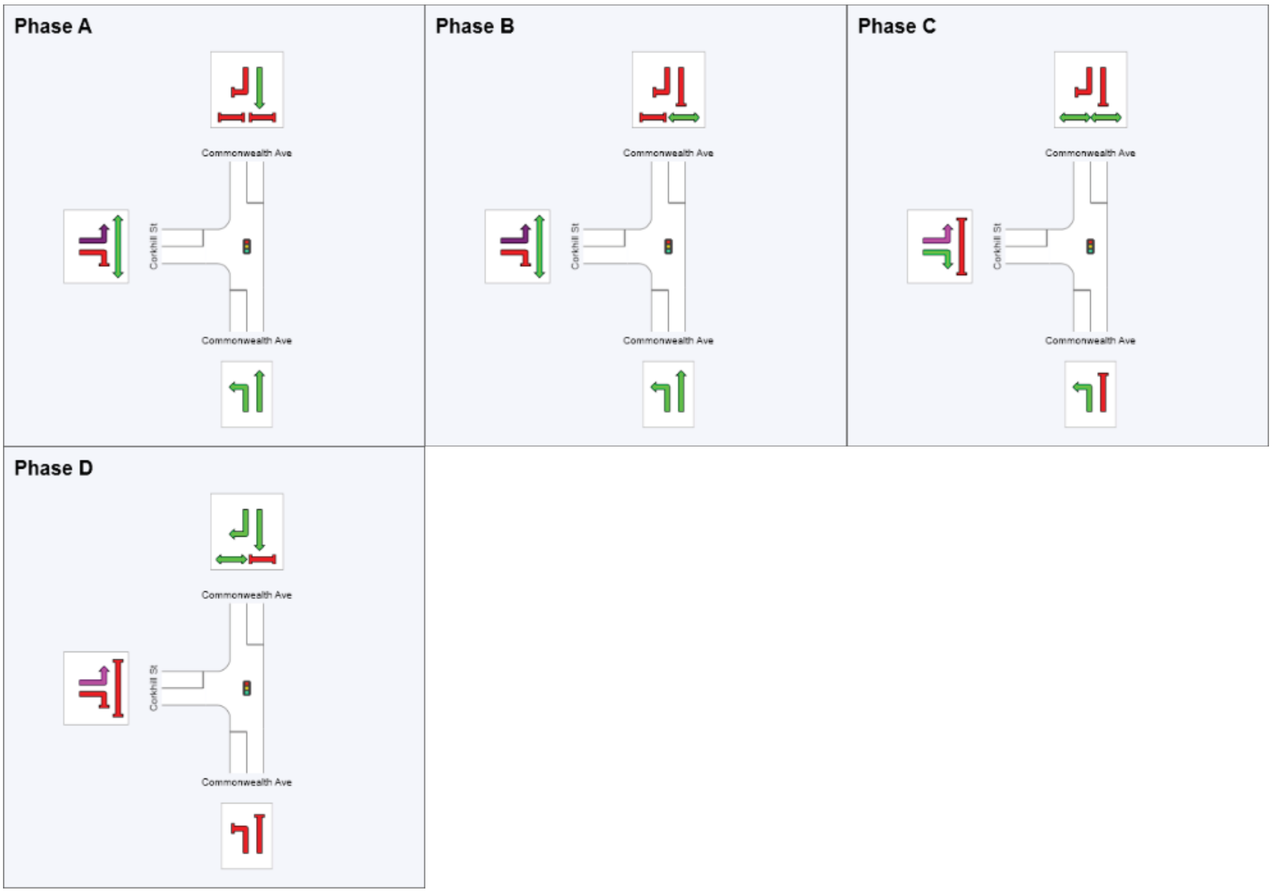
Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	103	118
Green Time (sec)	91	***	9	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	6	15	12
Phase Split	75 %	5 %	12 %	9 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.



Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class Running	Other Movement Class Stopped
Mixed Running & Stopped Movement Classes	
Undetected Movement	Phase Transition Applied

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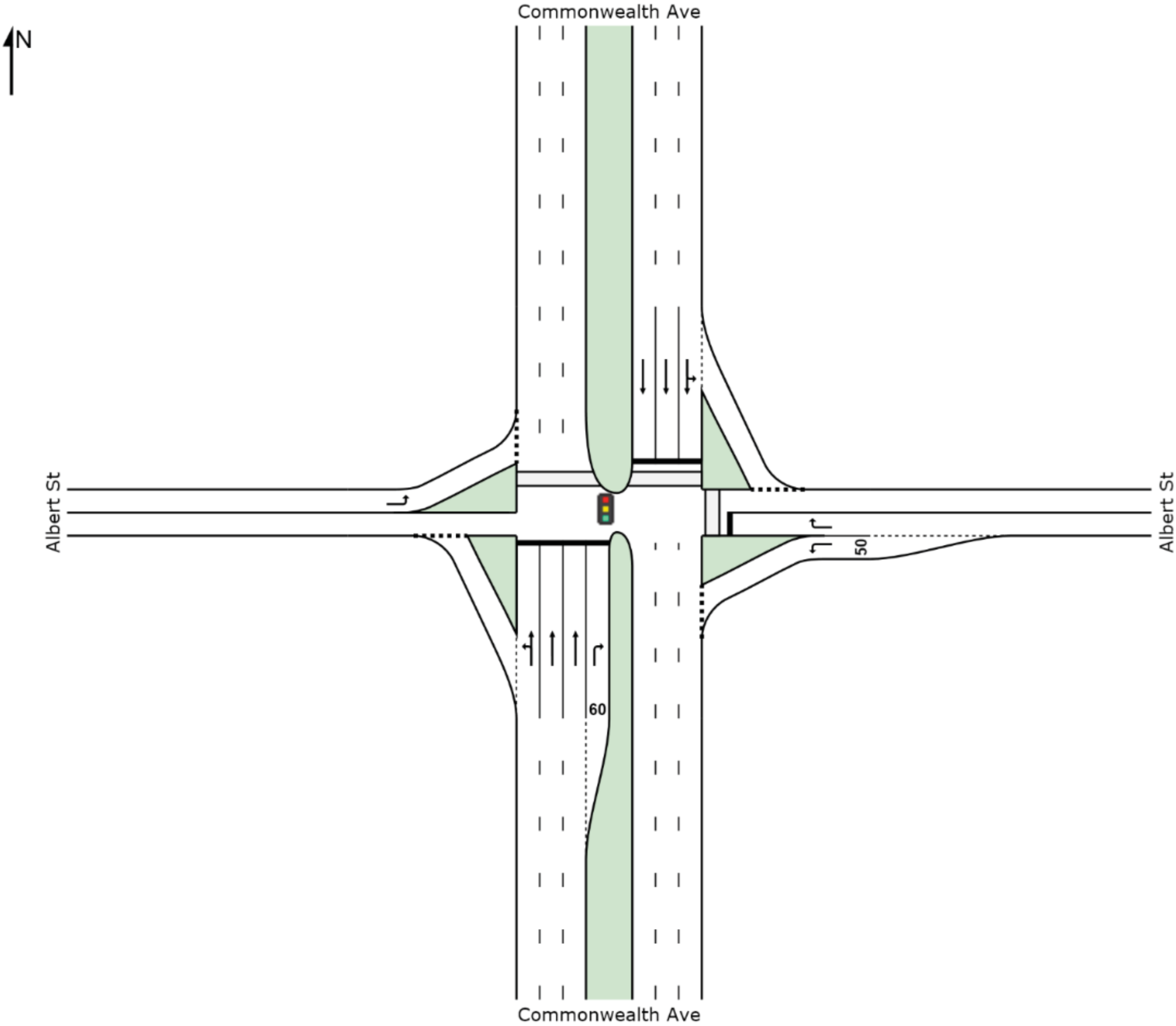
SITE LAYOUT

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time



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MOVEMENT SUMMARY

Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.861	20.2	LOS C	55.3	386.8	0.81	0.77	47.8
2	T1	3563	0.0	0.861	14.4	LOS B	55.3	387.3	0.80	0.76	48.5
3	R2	24	0.0	0.282	74.3	LOS E	1.6	11.1	1.00	0.71	26.8
Approach		3607	0.0	0.861	14.8	LOS B	55.3	387.3	0.81	0.76	48.2
East: Albert St											
4	L2	11	0.0	0.009	13.6	LOS B	0.2	1.5	0.40	0.61	48.6
6	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		21	0.0	0.123	43.3	LOS D	0.7	4.7	0.69	0.64	34.7
North: Commonwealth Ave											
7	L2	25	0.0	0.970	29.3	LOS C	58.9	412.1	0.44	0.55	42.7
8	T1	4338	0.0	0.970	23.4	LOS C	58.9	412.1	0.44	0.54	43.3
Approach		4363	0.0	0.970	23.5	LOS C	58.9	412.1	0.44	0.54	43.3
West: Albert St											
10	L2	20	0.0	0.052	26.7	LOS C	0.8	5.3	0.61	0.69	41.4
Approach		20	0.0	0.052	26.7	LOS C	0.8	5.3	0.61	0.69	41.4
All Vehicles		8012	0.0	0.970	19.6	LOS B	58.9	412.1	0.61	0.64	45.4

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

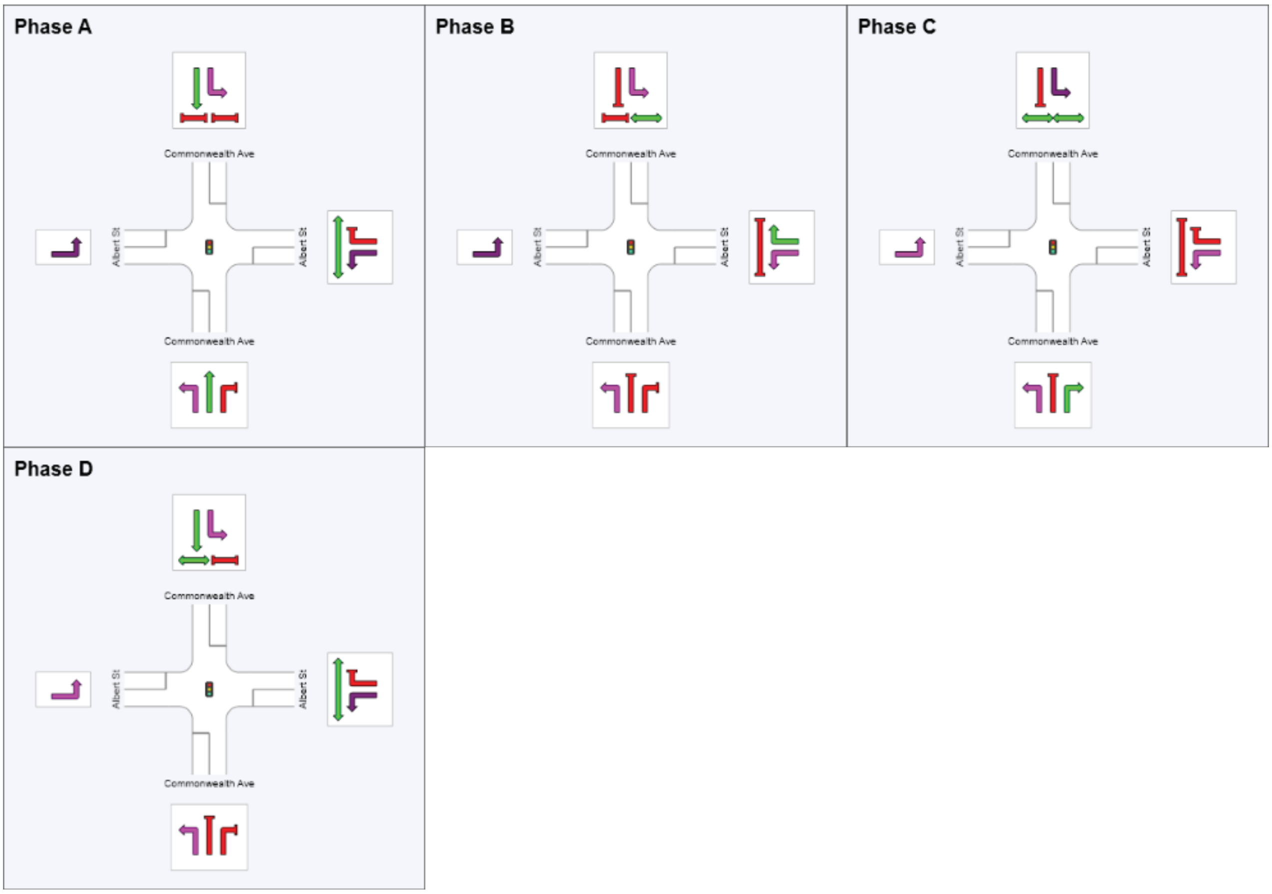
Site: 2014AM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



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MOVEMENT SUMMARY

Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.832	19.4	LOS B	50.6	354.3	0.77	0.73	48.3
2	T1	3453	0.0	0.832	13.7	LOS B	50.7	354.8	0.77	0.72	48.9
3	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		3483	0.0	0.832	13.9	LOS B	50.7	354.8	0.77	0.72	48.8
East: Albert St											
4	L2	31	0.0	0.019	6.3	LOS A	0.2	1.1	0.14	0.58	53.7
6	R2	31	0.0	0.356	74.7	LOS E	2.0	14.1	1.00	0.72	26.6
Approach		61	0.0	0.356	40.5	LOS D	2.0	14.1	0.57	0.65	35.7
North: Commonwealth Ave											
7	L2	1	0.0	0.730	6.6	LOS A	4.9	34.2	0.08	0.08	58.3
8	T1	3285	0.0	0.730	0.9	LOS A	4.9	34.2	0.08	0.07	59.2
Approach		3286	0.0	0.730	0.9	LOS A	4.9	34.2	0.08	0.07	59.2
West: Albert St											
10	L2	105	0.0	0.282	36.6	LOS D	5.8	40.7	0.88	0.85	37.3
Approach		105	0.0	0.282	36.6	LOS D	5.8	40.7	0.88	0.85	37.3
All Vehicles		6936	0.0	0.832	8.3	LOS A	50.7	354.8	0.44	0.42	52.8

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	4.7	LOS A	0.1	0.1	0.27	0.27
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
All Pedestrians		158	41.1	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

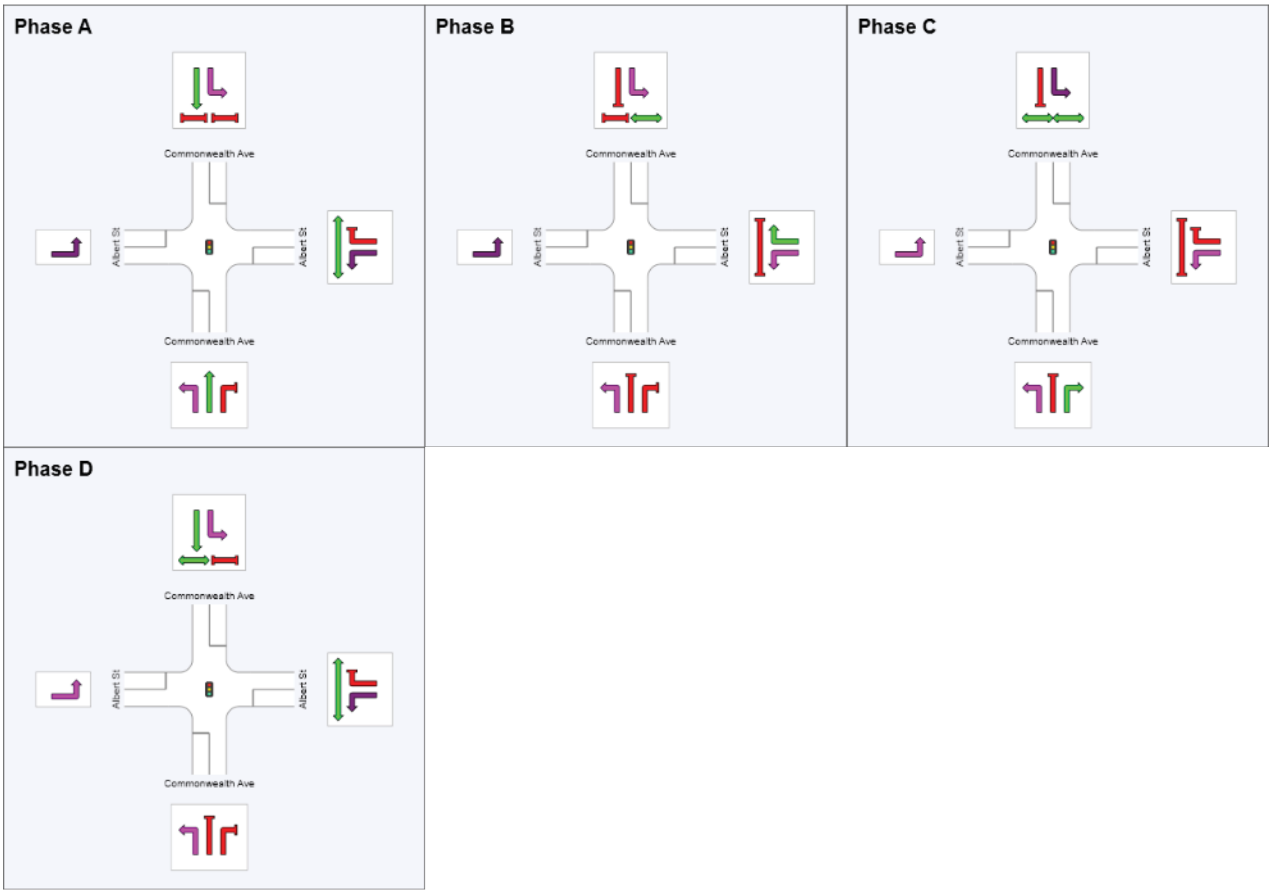
Site: 2014PM - Right Turns Comm Park, LILO Waterfront

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



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SIDRA INTERSECTION 6

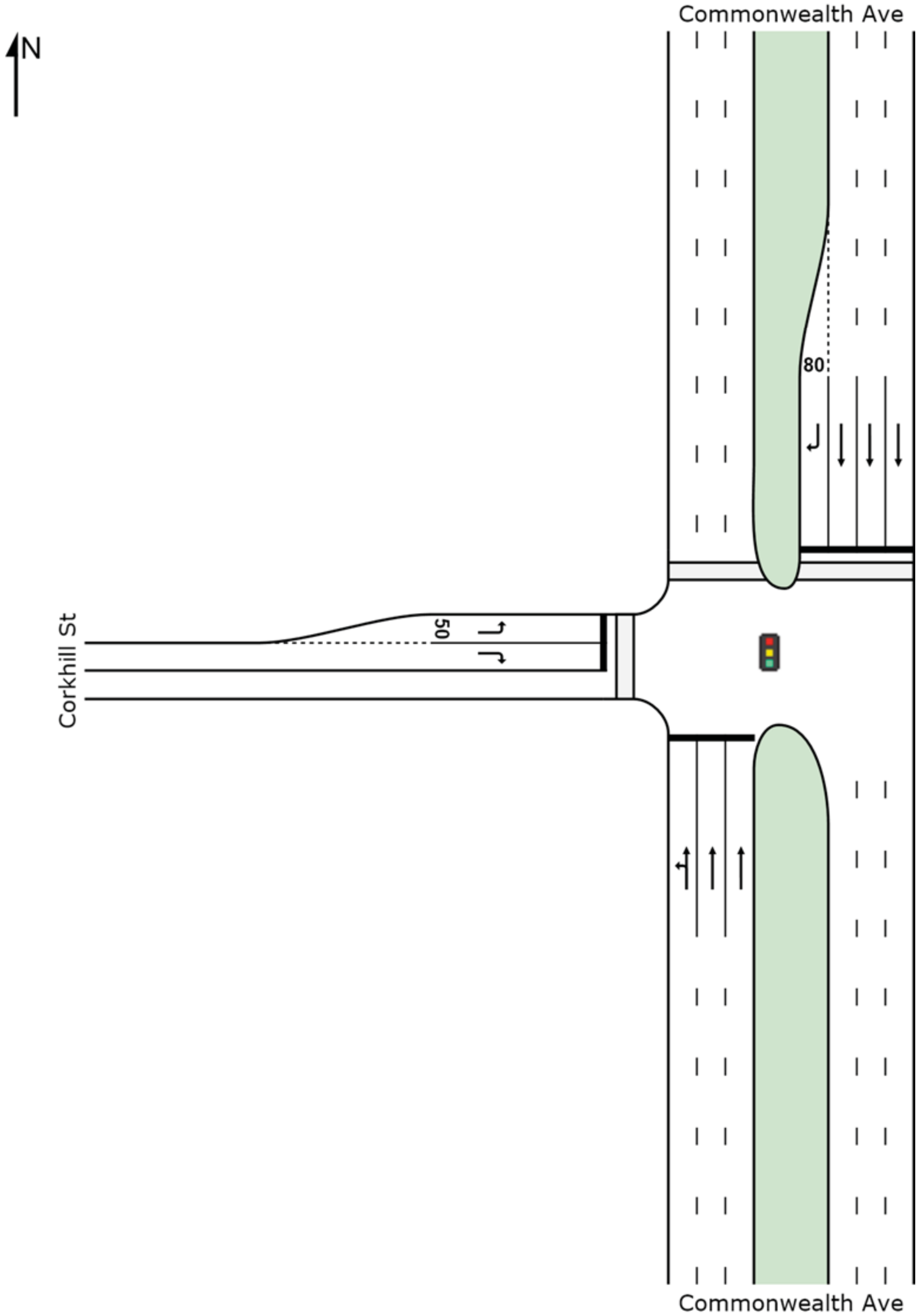
OPTION 4G

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T - Option 4G

Commonwealth Ave / Corkhill St
Signals - Fixed Time



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SIDRA INTERSECTION 6.0.24.4877 www.sidrasolutions.com
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8000047, 6019197, ARUP PTY LTD, PLUS / Floating

MOVEMENT SUMMARY

Site: 2014AM - Corkhill T - Option 4G

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.808	6.5	LOS A	7.2	50.5	0.11	0.13	58.1
2	T1	3563	0.0	0.808	1.0	LOS A	7.2	50.6	0.11	0.11	59.5
Approach		3634	0.0	0.808	1.1	LOS A	7.2	50.6	0.11	0.11	59.5
North: Commonwealth Ave											
8	T1	4338	0.0	0.948	27.5	LOS C	93.1	651.8	0.89	0.93	48.9
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	31.6
Approach		4407	0.0	0.948	28.3	LOS C	93.1	651.8	0.89	0.93	48.6
West: Corkhill St											
10	L2	21	0.0	0.082	58.4	LOS E	1.2	8.2	0.90	0.71	36.1
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	32.8
Approach		42	0.0	0.246	66.2	LOS E	1.4	9.6	0.95	0.70	34.4
All Vehicles		8083	0.0	0.948	16.3	LOS B	93.1	651.8	0.54	0.56	52.8

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	5.3	LOS A	0.1	0.1	0.29	0.29
All Pedestrians		158	41.3	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

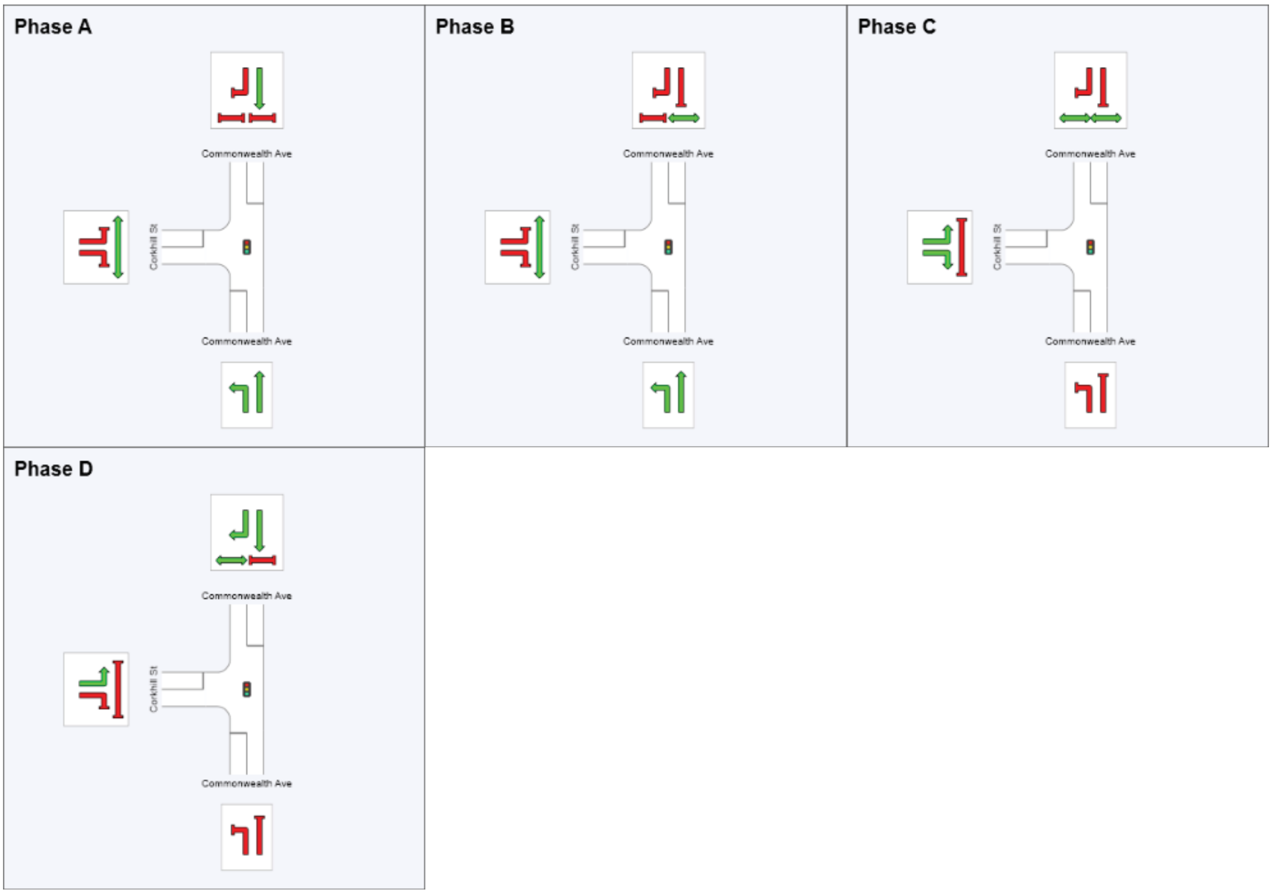
Site: 2014AM - Corkhill T - Option 4G

Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	106	118
Green Time (sec)	91	3	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	9	12	12
Phase Split	75 %	7 %	9 %	9 %



Normal Movement
Permitted/Opposed
Slip/Bypass-Lane Movement
Opposed Slip/Bypass-Lane
Stopped Movement
Turn On Red
Other Movement Class Running
Other Movement Class Stopped
Mixed Running & Stopped Movement Classes
Undetected Movement
Phase Transition Applied

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MOVEMENT SUMMARY

Site: 2014PM - Corkhill T - Option 4G

Commonwealth Ave / Corkhill St
Signals - Fixed Time Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.796	6.5	LOS A	6.5	45.6	0.10	0.10	57.4
2	T1	3453	0.0	0.796	1.0	LOS A	6.5	45.6	0.10	0.10	59.0
Approach		3473	0.0	0.796	1.0	LOS A	6.5	45.6	0.10	0.10	59.0
North: Commonwealth Ave											
8	T1	3285	0.0	0.712	6.7	LOS A	32.5	227.3	0.52	0.49	54.0
9	R2	19	0.0	0.221	73.9	LOS E	1.2	8.6	0.99	0.70	26.9
Approach		3304	0.0	0.712	7.1	LOS A	32.5	227.3	0.52	0.49	53.7
West: Corkhill St											
10	L2	105	0.0	0.351	58.4	LOS E	6.0	42.1	0.93	0.78	30.2
12	R2	106	0.0	0.827	78.0	LOS E	7.4	51.6	1.00	0.91	26.0
Approach		212	0.0	0.827	68.3	LOS E	7.4	51.6	0.97	0.84	27.9
All Vehicles		6988	0.0	0.827	5.9	LOS A	32.5	227.3	0.32	0.30	54.6

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	6.2	LOS A	0.1	0.1	0.31	0.31
All Pedestrians		158	41.6	LOS E			0.74	0.74

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

Site: 2014PM - Corkhill T - Option 4G

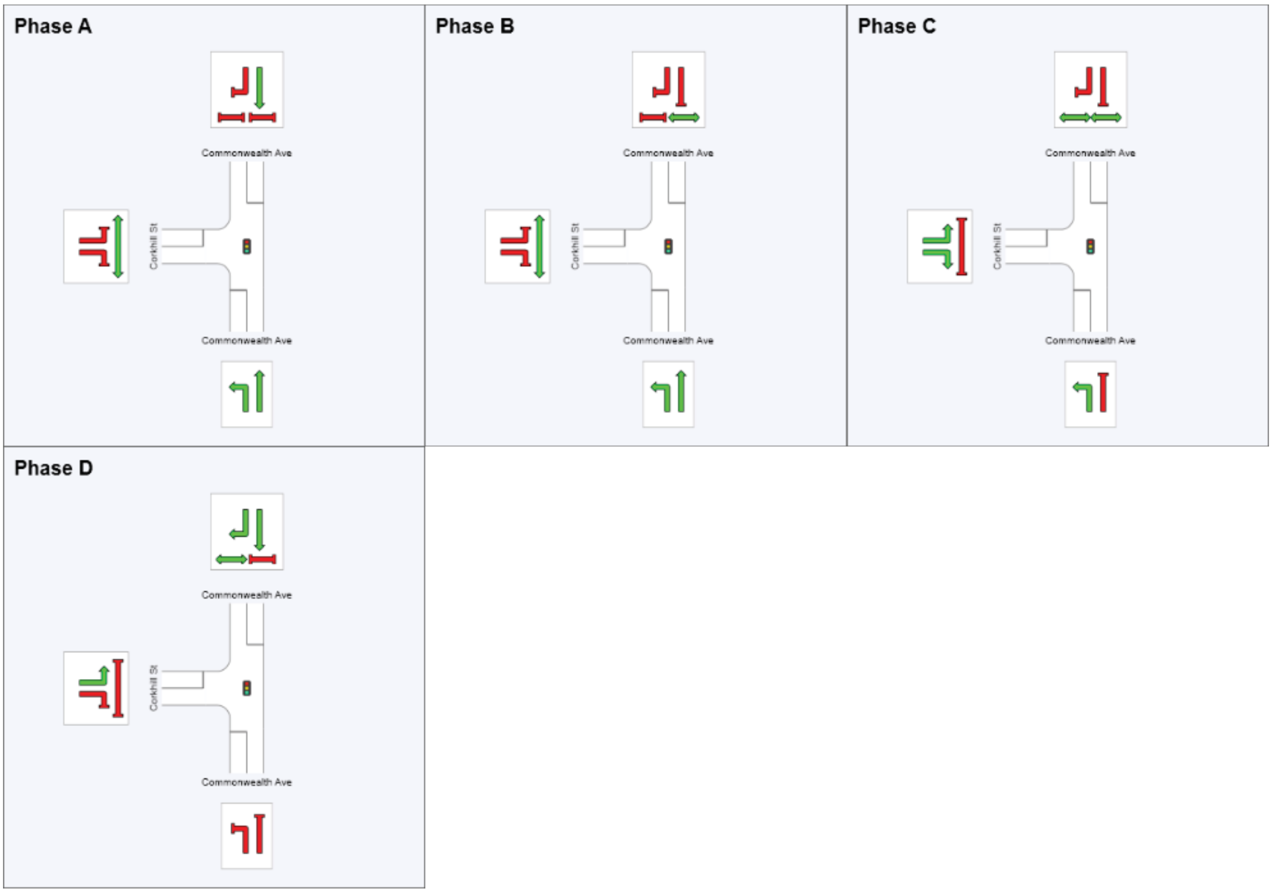
Commonwealth Ave / Corkhill St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

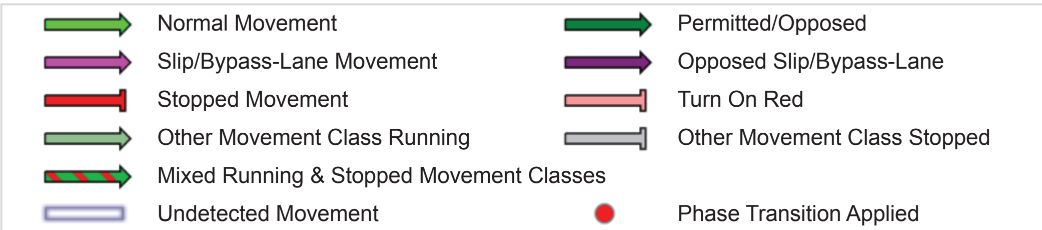
Phase times determined by the program
Sequence: Split Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	103	118
Green Time (sec)	91	***	9	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	6	15	12
Phase Split	75 %	5 %	12 %	9 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.





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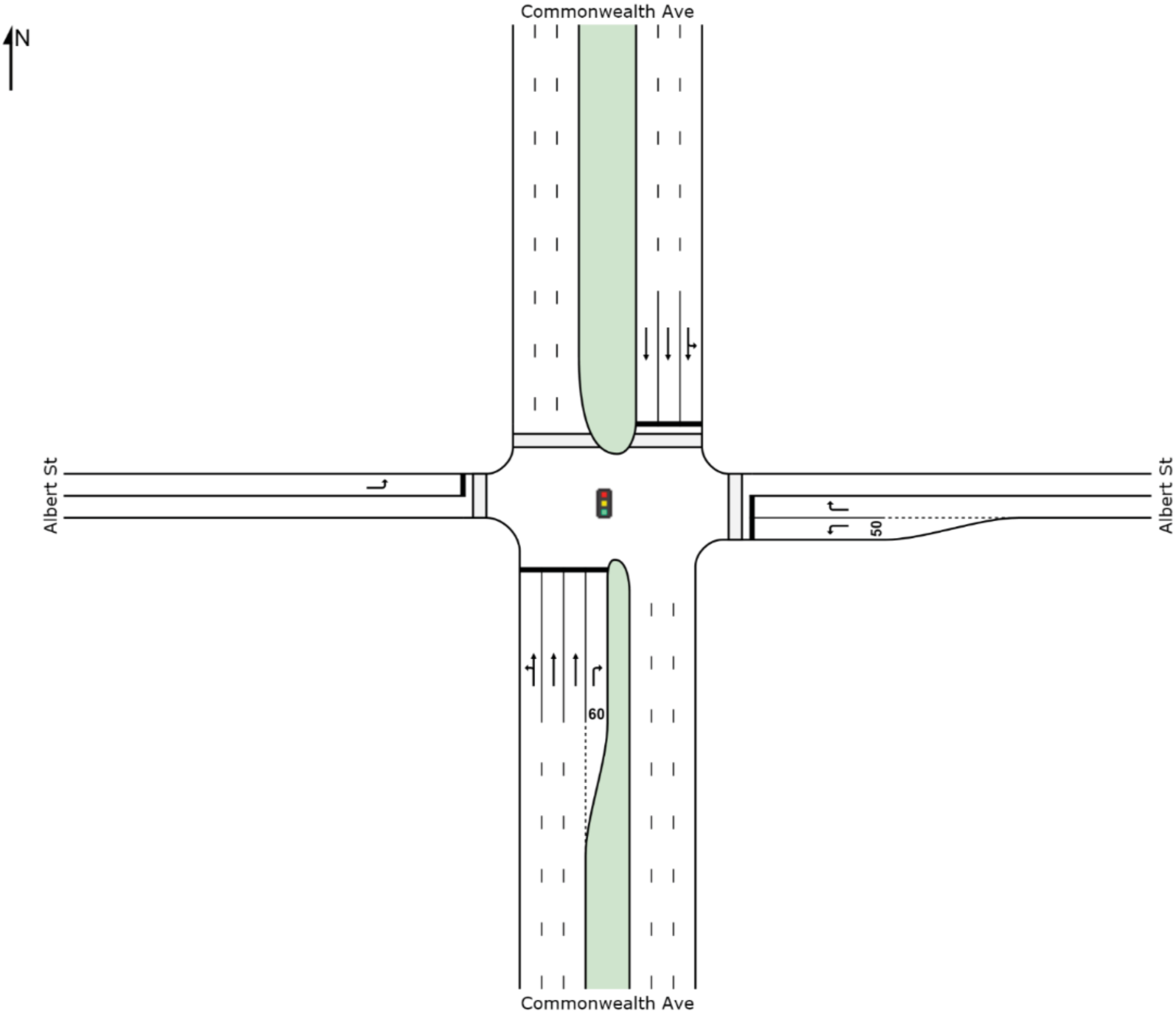
SITE LAYOUT

Site: 2014AM - Albert - Option 4G

Commonwealth Ave / Albert St
Signals - Fixed Time



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Project: c:\projectwise\syd_projects\vincent-w.chan\dms69145\Commonwealth Waterfront.sip6
8000047, 6019197, ARUP PTY LTD, PLUS / Floating

MOVEMENT SUMMARY

Site: 2014AM - Albert - Option 4G

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.861	20.0	LOS C	55.3	387.1	0.81	0.77	47.3
2	T1	3563	0.0	0.861	14.3	LOS B	55.3	387.4	0.80	0.76	48.5
3	R2	24	0.0	0.282	74.3	LOS E	1.6	11.1	1.00	0.71	26.8
Approach		3607	0.0	0.861	14.8	LOS B	55.3	387.4	0.81	0.76	48.3
East: Albert St											
4	L2	11	0.0	0.041	57.9	LOS E	0.6	4.1	0.89	0.68	30.3
6	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		21	0.0	0.123	65.5	LOS E	0.7	4.7	0.94	0.68	28.6
North: Commonwealth Ave											
7	L2	25	0.0	0.971	29.5	LOS C	59.7	417.8	0.45	0.55	42.2
8	T1	4338	0.0	0.971	23.9	LOS C	59.8	418.4	0.45	0.55	43.1
Approach		4363	0.0	0.971	23.9	LOS C	59.8	418.4	0.45	0.55	43.1
West: Albert St											
10	L2	20	0.0	0.108	64.0	LOS E	1.2	8.2	0.94	0.70	28.9
Approach		20	0.0	0.108	64.0	LOS E	1.2	8.2	0.94	0.70	28.9
All Vehicles		8012	0.0	0.971	20.0	LOS B	59.8	418.4	0.61	0.65	45.1

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	5.3	LOS A	0.1	0.1	0.29	0.29
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	3.5	LOS A	0.0	0.0	0.23	0.23
All Pedestrians		211	31.8	LOS D			0.61	0.61

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 6

PHASING SUMMARY

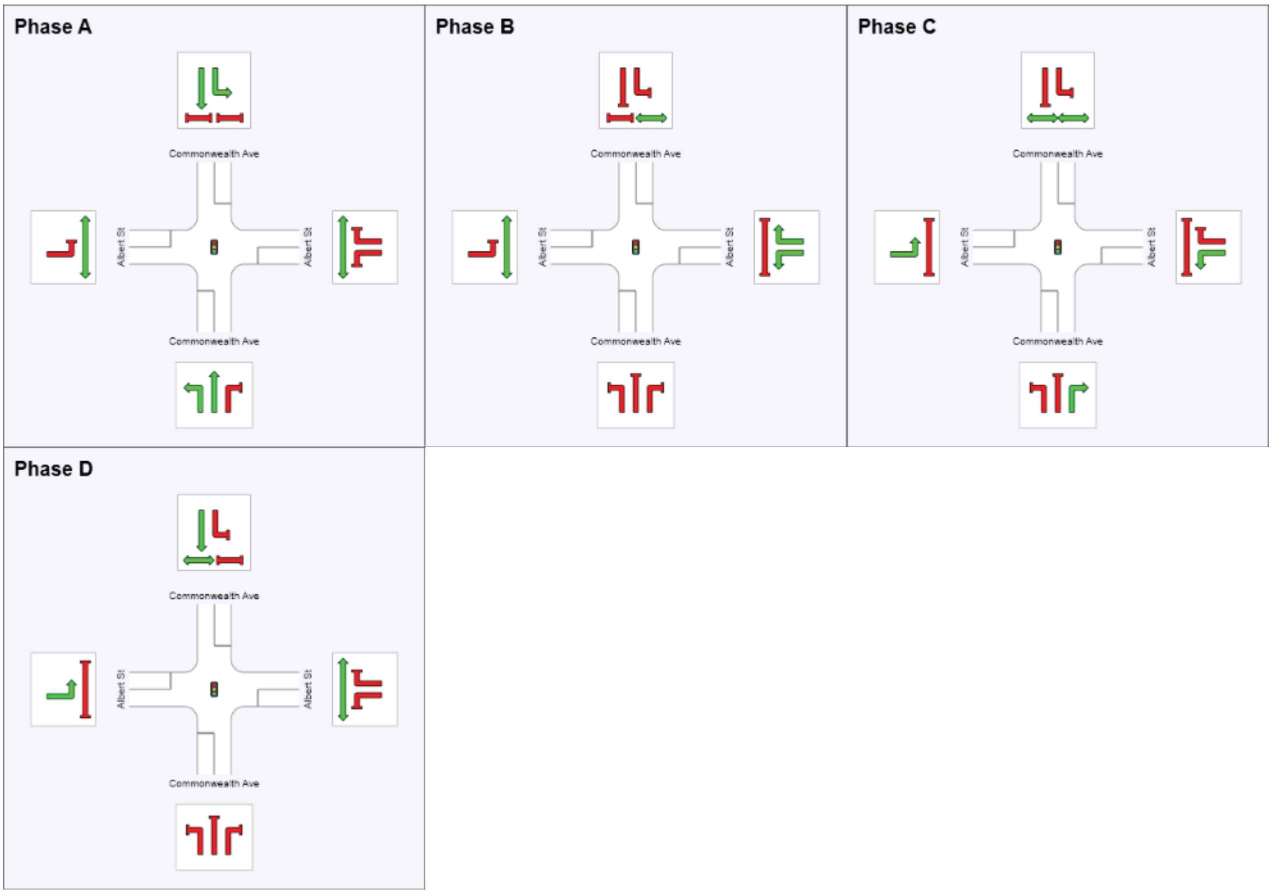
Site: 2014AM - Albert - Option 4G

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



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MOVEMENT SUMMARY

Site: 2014PM - Albert - Option 4G

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.832	19.3	LOS B	50.7	354.6	0.77	0.73	47.8
2	T1	3453	0.0	0.832	13.7	LOS B	50.7	354.9	0.77	0.72	49.0
3	R2	11	0.0	0.123	73.1	LOS E	0.7	4.7	0.99	0.67	27.0
Approach		3483	0.0	0.832	13.9	LOS B	50.7	354.9	0.77	0.72	48.8
East: Albert St											
4	L2	31	0.0	0.119	58.9	LOS E	1.7	12.0	0.91	0.72	30.1
6	R2	31	0.0	0.356	74.7	LOS E	2.0	14.1	1.00	0.72	26.6
Approach		61	0.0	0.356	66.8	LOS E	2.0	14.1	0.95	0.72	28.3
North: Commonwealth Ave											
7	L2	1	0.0	0.730	6.4	LOS A	4.8	33.4	0.08	0.07	57.6
8	T1	3285	0.0	0.730	0.8	LOS A	4.8	33.4	0.08	0.07	59.2
Approach		3286	0.0	0.730	0.8	LOS A	4.8	33.4	0.08	0.07	59.2
West: Albert St											
10	L2	105	0.0	0.567	67.8	LOS E	6.6	46.2	1.00	0.79	28.0
Approach		105	0.0	0.567	67.8	LOS E	6.6	46.2	1.00	0.79	28.0
All Vehicles		6936	0.0	0.832	9.0	LOS A	50.7	354.9	0.45	0.42	52.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P2	East Full Crossing	53	5.3	LOS A	0.1	0.1	0.29	0.29
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	3.5	LOS A	0.0	0.0	0.23	0.23
All Pedestrians		211	31.8	LOS D			0.61	0.61

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

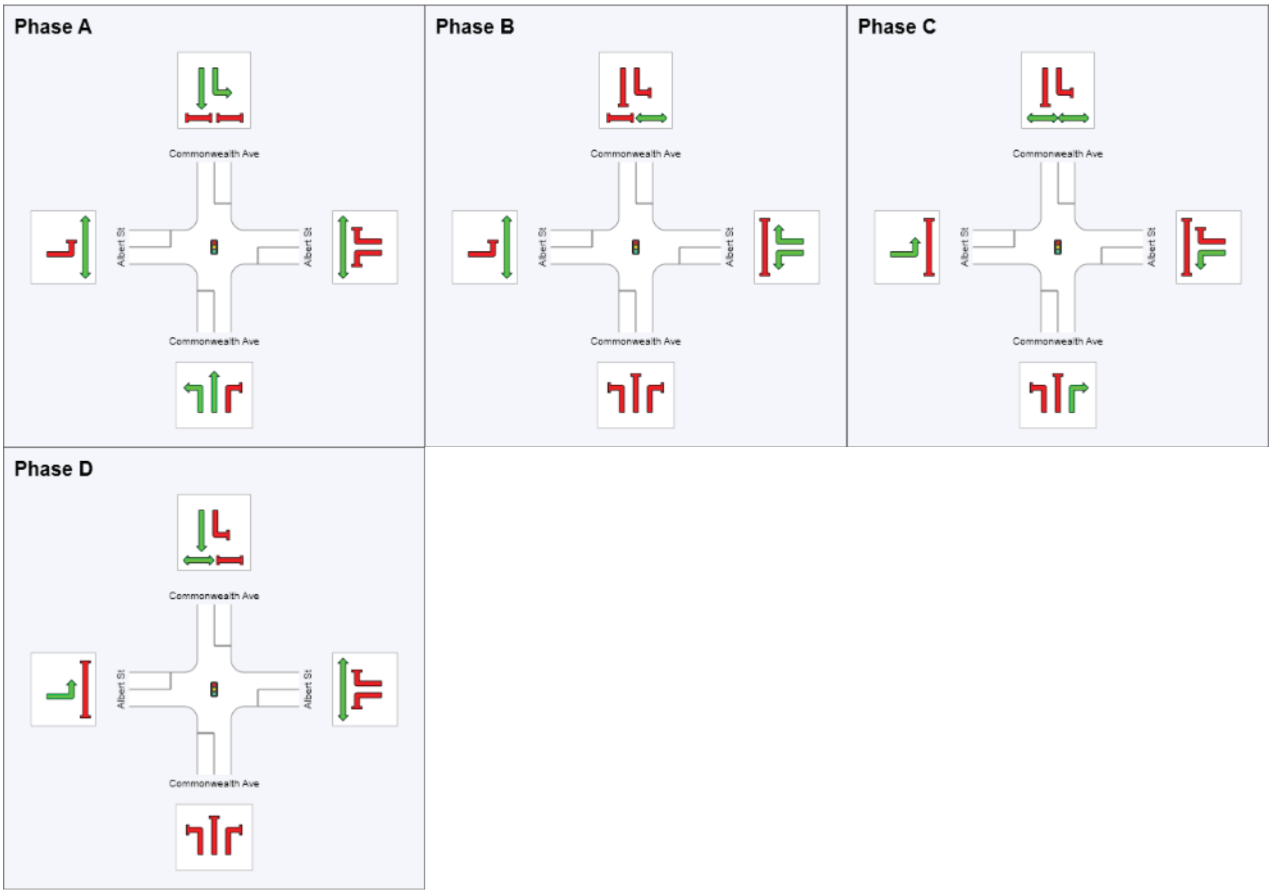
Site: 2014PM - Albert - Option 4G

Commonwealth Ave / Albert St
Signals - Fixed Time   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	99	111	123
Green Time (sec)	93	6	6	1
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	99	12	12	7
Phase Split	76 %	9 %	9 %	5 %



- Normal Movement
- Permitted/Opposed
- Slip/Bypass-Lane Movement
- Opposed Slip/Bypass-Lane
- Stopped Movement
- Turn On Red
- Other Movement Class Running
- Other Movement Class Stopped
- Mixed Running & Stopped Movement Classes
- Undetected Movement
- Phase Transition Applied

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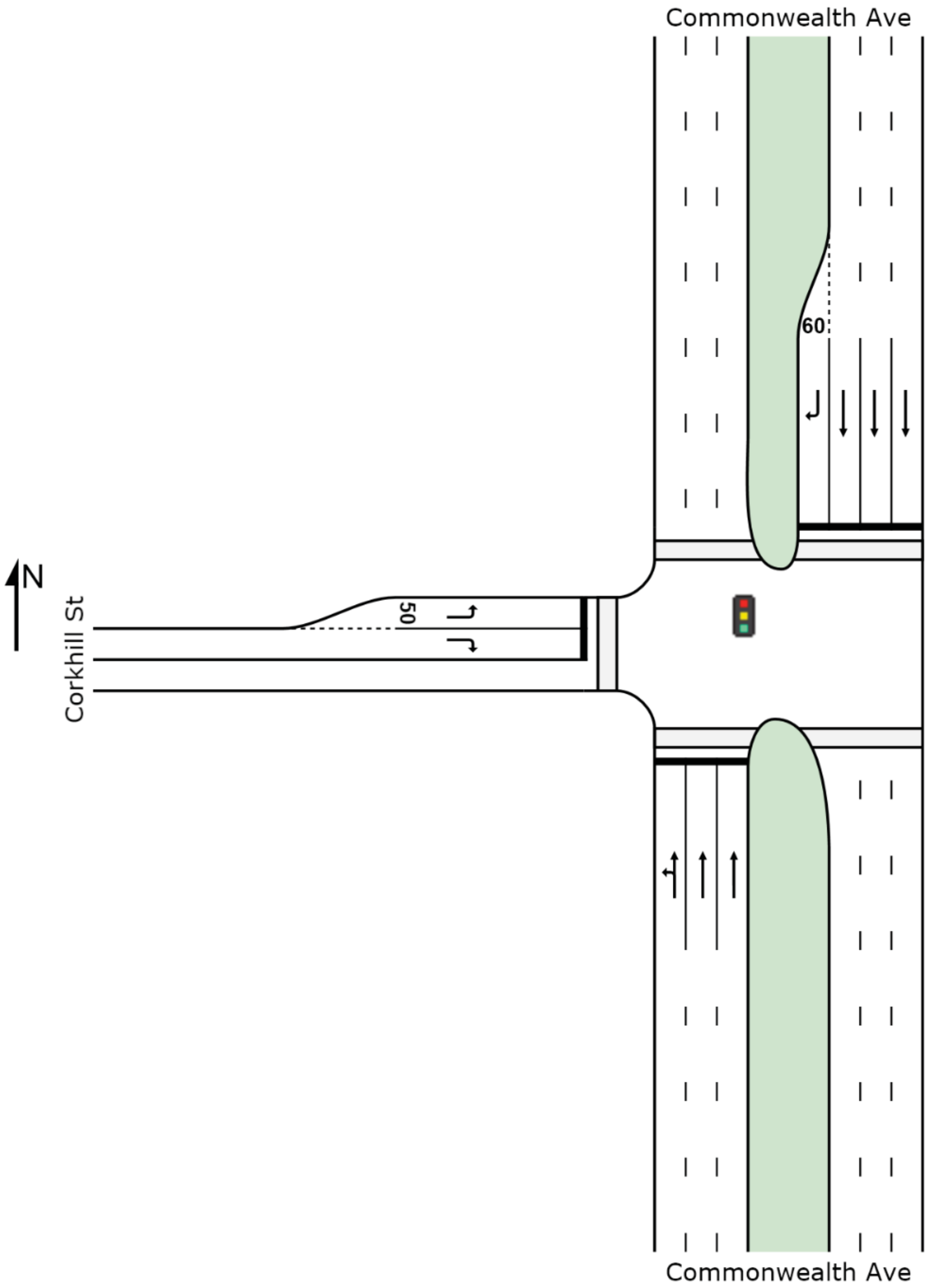
OPTION 4H

SIDRA RESULTS

SITE LAYOUT

Site: 2014AM - Corkhill T - Option 4H

Commonwealth Ave / Corkhill St
Signals - Fixed Time Coordinated



MOVEMENT SUMMARY

Site: 2014AM - Corkhill T - Option 4H

Commonwealth Ave / Corkhill St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	71	0.0	0.808	6.5	LOS A	7.2	50.5	0.11	0.13	55.8
2	T1	3563	0.0	0.808	1.0	LOS A	7.2	50.6	0.11	0.11	59.1
Approach		3634	0.0	0.808	1.1	LOS A	7.2	50.6	0.11	0.11	59.1
North: Commonwealth Ave											
8	T1	4338	0.0	1.018	77.1	LOS E	140.2	981.7	1.00	1.27	28.4
9	R2	69	0.0	0.811	80.3	LOS F	4.9	34.1	1.00	0.88	31.6
Approach		4407	0.0	1.018	77.1	LOS E	140.2	981.7	1.00	1.27	28.4
West: Corkhill St											
10	L2	21	0.0	0.082	58.4	LOS E	1.2	8.2	0.90	0.71	36.1
12	R2	21	0.0	0.246	74.1	LOS E	1.4	9.6	1.00	0.70	20.5
Approach		42	0.0	0.246	66.2	LOS E	1.4	9.6	0.95	0.70	29.4
All Vehicles		8083	0.0	1.018	42.9	LOS D	140.2	981.7	0.60	0.74	37.0

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P11	South Stage 1	53	54.6	LOS E	0.2	0.2	0.92	0.92
P12	South Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	5.3	LOS A	0.1	0.1	0.29	0.29
All Pedestrians		263	47.5	LOS E			0.81	0.81

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average pedestrian delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

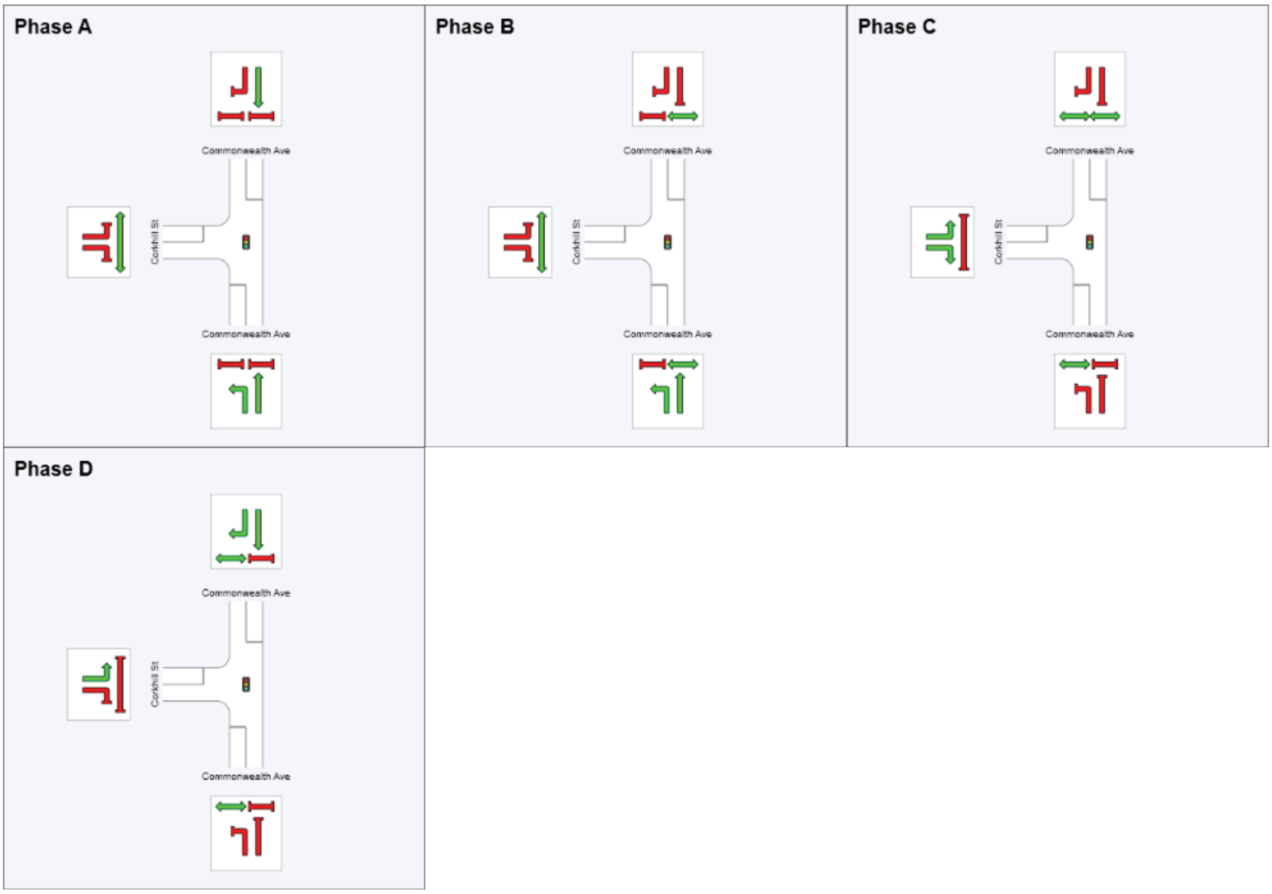
Site: 2014AM - Corkhill T - Option 4H

Commonwealth Ave / Corkhill St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	90	106	118
Green Time (sec)	84	10	6	6
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	90	16	12	12
Phase Split	69 %	12 %	9 %	9 %



MOVEMENT SUMMARY

Site: 2014PM - Corkhill T - Option 4H

Commonwealth Ave / Corkhill St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.830	7.5	LOS A	13.0	90.8	0.20	0.19	54.7
2	T1	3453	0.0	0.830	2.4	LOS A	16.0	111.9	0.23	0.22	56.5
Approach		3473	0.0	0.830	2.4	LOS A	16.0	111.9	0.23	0.22	56.5
North: Commonwealth Ave											
8	T1	3285	0.0	0.789	12.7	LOS B	44.6	312.4	0.71	0.67	45.4
9	R2	19	0.0	0.133	67.8	LOS E	1.2	8.1	0.96	0.70	28.1
Approach		3304	0.0	0.789	13.0	LOS B	44.6	312.4	0.71	0.67	45.1
West: Corkhill St											
10	L2	105	0.0	0.295	54.3	LOS D	5.8	40.3	0.90	0.78	31.3
12	R2	106	0.0	0.827	78.0	LOS E	7.4	51.6	1.00	0.91	19.8
Approach		212	0.0	0.827	66.2	LOS E	7.4	51.6	0.95	0.84	25.5
All Vehicles		6988	0.0	0.830	9.3	LOS A	44.6	312.4	0.48	0.45	48.5

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P11	South Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P12	South Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	7.5	LOS A	0.1	0.1	0.34	0.34
All Pedestrians		263	48.9	LOS E			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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PHASING SUMMARY

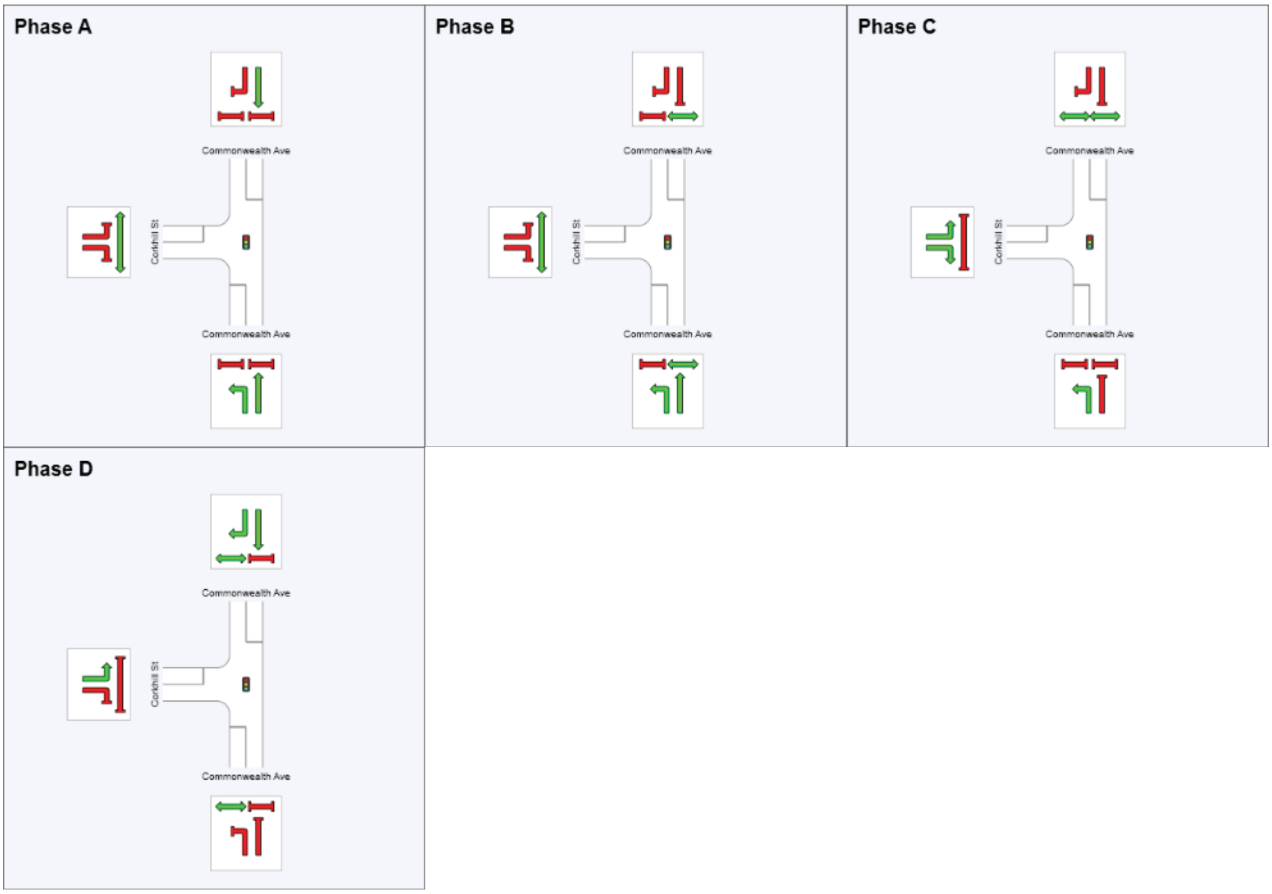
Site: 2014PM - Corkhill T - Option 4H

Commonwealth Ave / Corkhill St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	83	99	114
Green Time (sec)	77	10	9	10
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	83	16	15	16
Phase Split	64 %	12 %	12 %	12 %



Normal Movement
Permitted/Opposed
Slip/Bypass-Lane Movement
Opposed Slip/Bypass-Lane
Stopped Movement
Turn On Red
Other Movement Class Running
Other Movement Class Stopped
Mixed Running & Stopped Movement Classes
Undetected Movement
Phase Transition Applied

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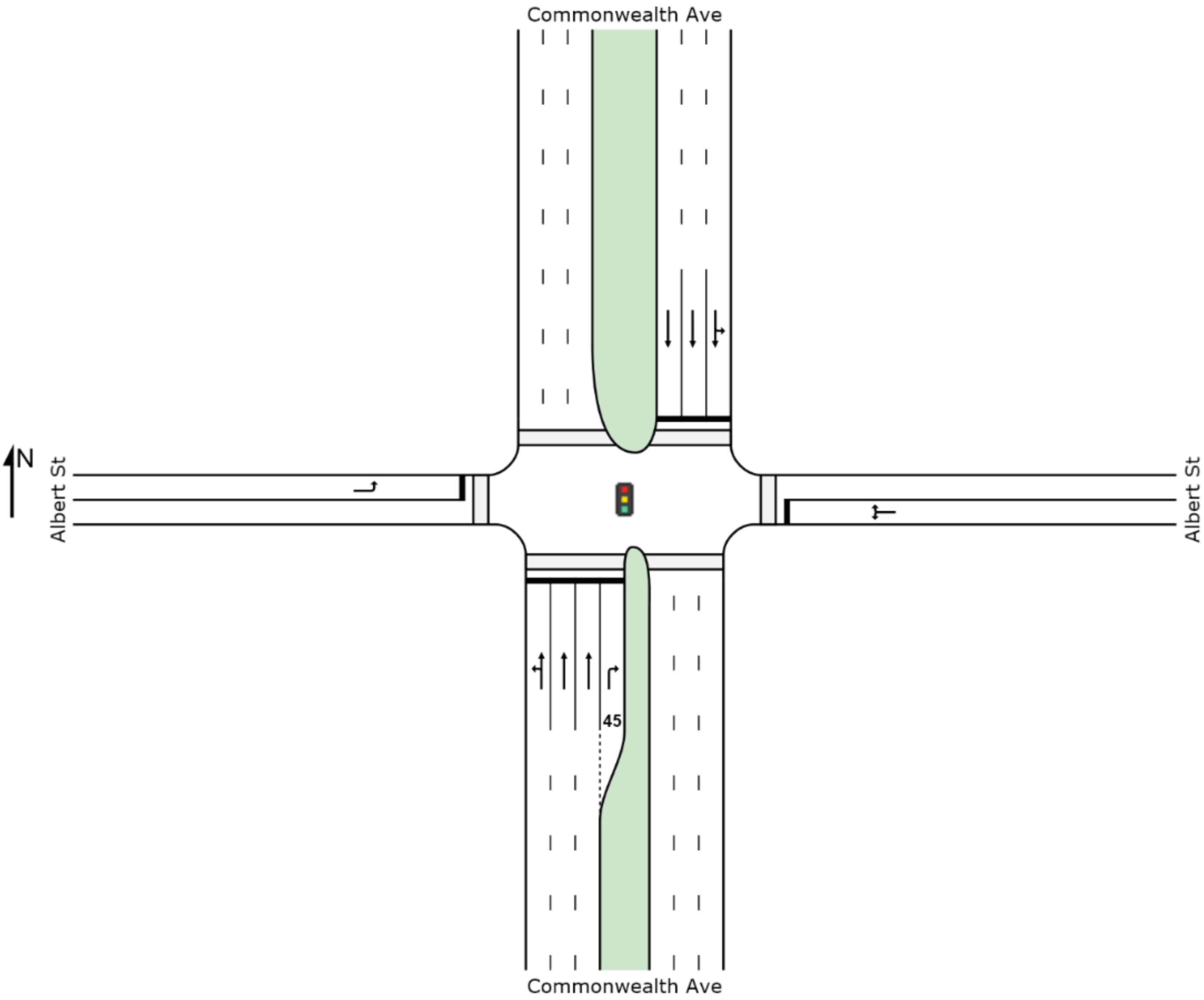
SITE LAYOUT

Site: 2014AM - Albert - Option 4H

Commonwealth Ave / Albert St
Signals - Fixed Time Coordinated



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MOVEMENT SUMMARY

Site: 2014AM - Albert - Option 4H

Commonwealth Ave / Albert St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.871	20.8	LOS C	56.9	398.0	0.83	0.79	46.8
2	T1	3563	0.0	0.871	15.1	LOS B	56.9	398.3	0.83	0.78	43.2
3	R2	24	0.0	0.282	74.3	LOS E	1.6	11.1	1.00	0.71	26.7
Approach		3607	0.0	0.871	15.6	LOS B	56.9	398.3	0.83	0.78	43.0
East: Albert St											
4	L2	11	0.0	0.134	66.5	LOS E	1.3	8.9	0.96	0.71	28.3
6	R2	11	0.0	0.134	66.6	LOS E	1.3	8.9	0.96	0.71	22.0
Approach		21	0.0	0.134	66.5	LOS E	1.3	8.9	0.96	0.71	25.4
North: Commonwealth Ave											
7	L2	25	0.0	1.021	61.8	LOS E	134.7	943.1	1.00	1.25	24.1
8	T1	4338	0.0	1.021	56.2	LOS E	134.9	944.2	1.00	1.25	24.6
Approach		4363	0.0	1.021	56.2	LOS E	134.9	944.2	1.00	1.25	24.6
West: Albert St											
10	L2	20	0.0	0.156	69.2	LOS E	1.2	8.7	0.97	0.70	21.4
Approach		20	0.0	0.156	69.2	LOS E	1.2	8.7	0.97	0.70	21.4
All Vehicles		8012	0.0	1.021	38.0	LOS D	134.9	944.2	0.92	1.03	30.4

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P11	South Stage 1	53	46.1	LOS E	0.2	0.2	0.91	0.91
P12	South Stage 2	53	50.1	LOS E	0.2	0.2	0.88	0.88
P2	East Full Crossing	53	6.2	LOS A	0.1	0.1	0.31	0.31
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	2.6	LOS A	0.0	0.0	0.20	0.20
All Pedestrians		316	37.3	LOS D			0.70	0.70

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

Site: 2014AM - Albert - Option 4H

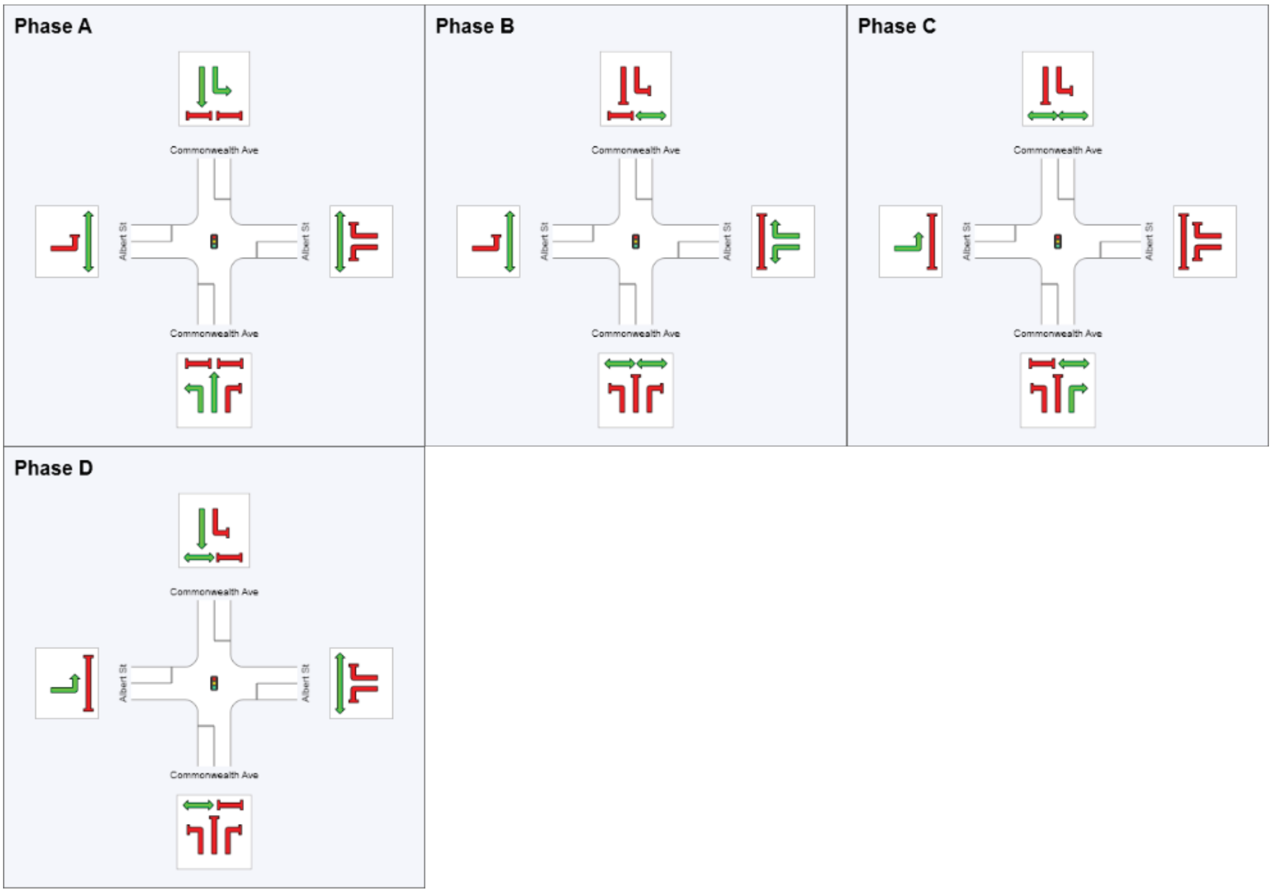
Commonwealth Ave / Albert St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	98	115	127
Green Time (sec)	92	11	6	***
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	98	17	12	3
Phase Split	75 %	13 %	9 %	2 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.



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MOVEMENT SUMMARY

Site: 2014PM - Albert - Option 4H

Commonwealth Ave / Albert St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Commonwealth Ave											
1	L2	20	0.0	0.851	20.8	LOS C	53.4	374.1	0.81	0.77	46.8
2	T1	3453	0.0	0.851	15.2	LOS B	53.5	374.4	0.81	0.76	43.2
3	R2	11	0.0	0.105	71.4	LOS E	0.7	4.7	0.98	0.67	27.3
Approach		3483	0.0	0.851	15.4	LOS B	53.5	374.4	0.81	0.76	43.1
East: Albert St											
4	L2	31	0.0	0.331	66.0	LOS E	3.7	26.0	0.97	0.76	28.4
6	R2	31	0.0	0.331	66.0	LOS E	3.7	26.0	0.97	0.76	22.1
Approach		61	0.0	0.331	66.0	LOS E	3.7	26.0	0.97	0.76	25.5
North: Commonwealth Ave											
7	L2	1	0.0	0.777	7.3	LOS A	9.8	68.5	0.16	0.15	55.1
8	T1	3285	0.0	0.777	1.8	LOS A	9.8	68.5	0.16	0.15	57.4
Approach		3286	0.0	0.777	1.8	LOS A	9.8	68.5	0.16	0.15	57.4
West: Albert St											
10	L2	105	0.0	0.737	73.9	LOS E	7.0	49.2	1.00	0.85	20.5
Approach		105	0.0	0.737	73.9	LOS E	7.0	49.2	1.00	0.85	20.5
All Vehicles		6936	0.0	0.851	10.3	LOS B	53.5	374.4	0.50	0.47	47.5

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P11	South Stage 1	53	45.3	LOS E	0.2	0.2	0.91	0.91
P12	South Stage 2	53	49.2	LOS E	0.2	0.2	0.87	0.87
P2	East Full Crossing	53	6.5	LOS A	0.1	0.1	0.32	0.32
P31	North Stage 1	53	59.3	LOS E	0.2	0.2	0.96	0.96
P32	North Stage 2	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	2.8	LOS A	0.0	0.0	0.21	0.21
All Pedestrians		316	37.1	LOS D			0.70	0.70

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

Site: 2014PM - Albert - Option 4H

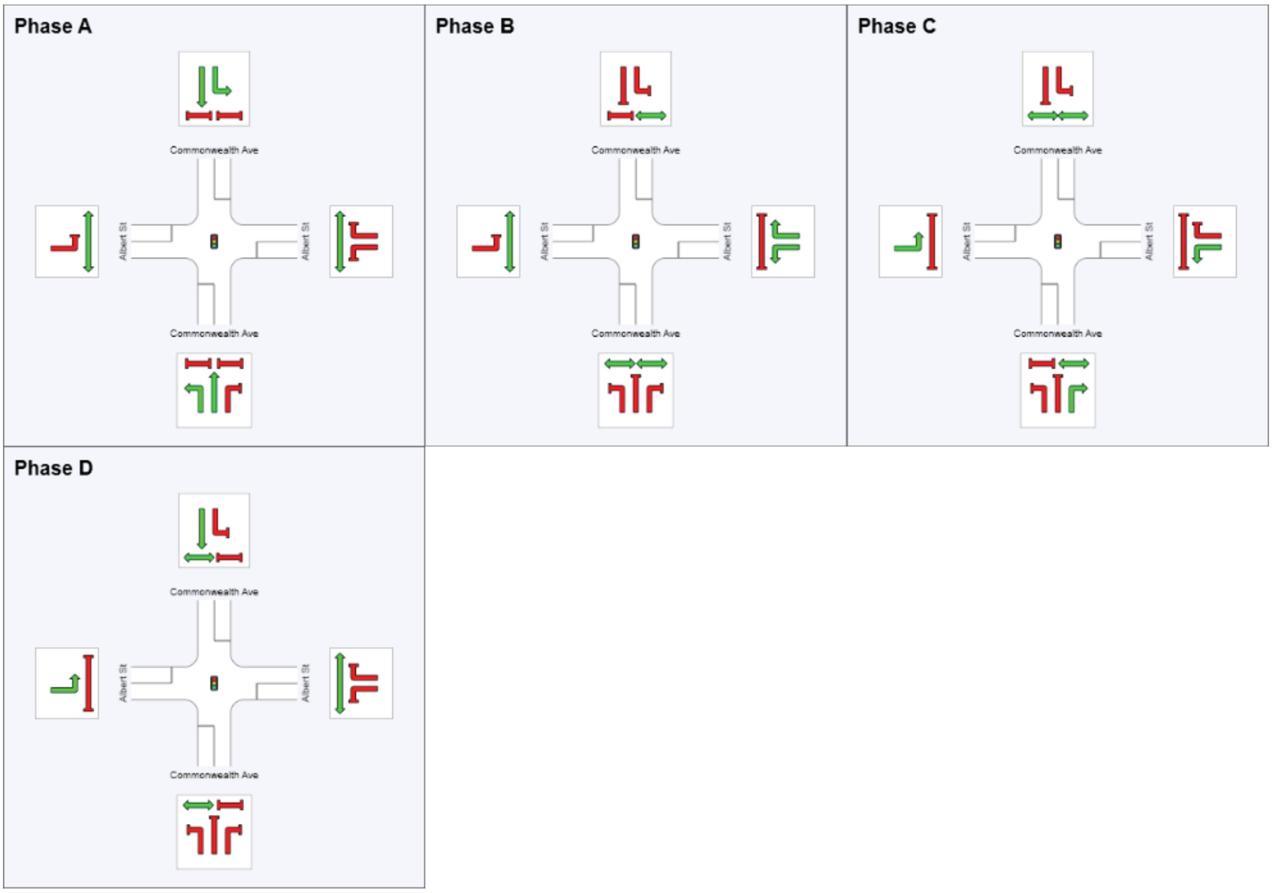
Commonwealth Ave / Albert St
Signals - Fixed Time Coordinated   Cycle Time = 130 seconds (User-Given Cycle Time)

Phase times determined by the program
Sequence: Split Phasing - Copy
Movement Class: All Movement Classes
Input Sequence: A, B, C, D
Output Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	97	114	127
Green Time (sec)	91	11	7	***
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	97	17	13	3
Phase Split	75 %	13 %	10 %	2 %

*** No green time has been calculated for this phase because the next phase starts during its intergreen time.
This occurs with overlap phasing where there is no single movement connecting this phase to the next, or where the only such movement is a dummy movement with zero minimum green time specified.
If a green time is required for this phase, specify a dummy movement with a non-zero minimum green time.



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Appendix M – Lighting Concept Design and Luminaire Report

Arup Lighting
City to the Lake
Concept Design Report
June 2015

TABLE 2.1

LIGHTING CATEGORIES FOR ROAD RESERVES IN LOCAL AREAS

1	2	3	4	5	6
Type of road or pathway		Selection criteria[a,b]			Applicable lighting subcategory[c,d]
General description	Basic operating characteristics	Pedestrian/ cycle activity	Risk[f] of crime	Need to enhance prestige	
Collector roads or non-arterial roads which collect and distribute traffic in an area, as well as serving abutting properties	Mixed vehicle and pedestrian traffic	N/A	High	N/A	P1
		High	Medium	High	P2
		Medium	Low	Medium	P3
		Low	Low	N/A	P4
Local roads or streets used primarily for access to abutting properties, including residential properties	Mixed vehicle and pedestrian traffic	N/A	High	N/A	P1
		High	Medium	High	P2
		Medium	Medium	Medium	P3
		Low	Low	N/A	P4
		Low	Low	N/A	P5[e]
Common area, forecourts of cluster housing	Mixed vehicle and pedestrian traffic	N/A	High	N/A	P1
		High	Medium	High	P2
		Medium	Low	Medium	P3
		Low	Low	N/A	P4

TABLE 2.6

VALUES OF LIGHT TECHNICAL PARAMETERS AND PERMISSIBLE LUMINAIRE TYPES FOR ROADS IN LOCAL AREAS AND FOR PATHWAYS

1	2	3	4	5	6
	Light technical parameters				
Lighting subcategory	Average horizontal illuminance[a,b] ($\overline{E}_h$) lux	Point horizontal illuminance[a,b] (E_{Ph}) lux	Illuminance (horizontal) uniformity[c] Cat. P (U_{E2})	Point vertical illuminance[a,b] (E_{Pv}) lux	Permissible luminaire type (see Table 2.10)
P1	7	2	10	2	Type 4 where part of a road reserve or Types 2, 3, 4 or 6
P2	3.5	0.7	10	0.7	
P3[e]	1.75	0.3	10	0.3[d]	
P4[e]	0.85	0.14	10	N/A	

Road, cyclepaths, footpahs and and boardwalk

TABLE 2.3

LIGHTING CATEGORIES FOR PUBLIC ACTIVITY AREAS (EXCLUDING CAR PARKS)

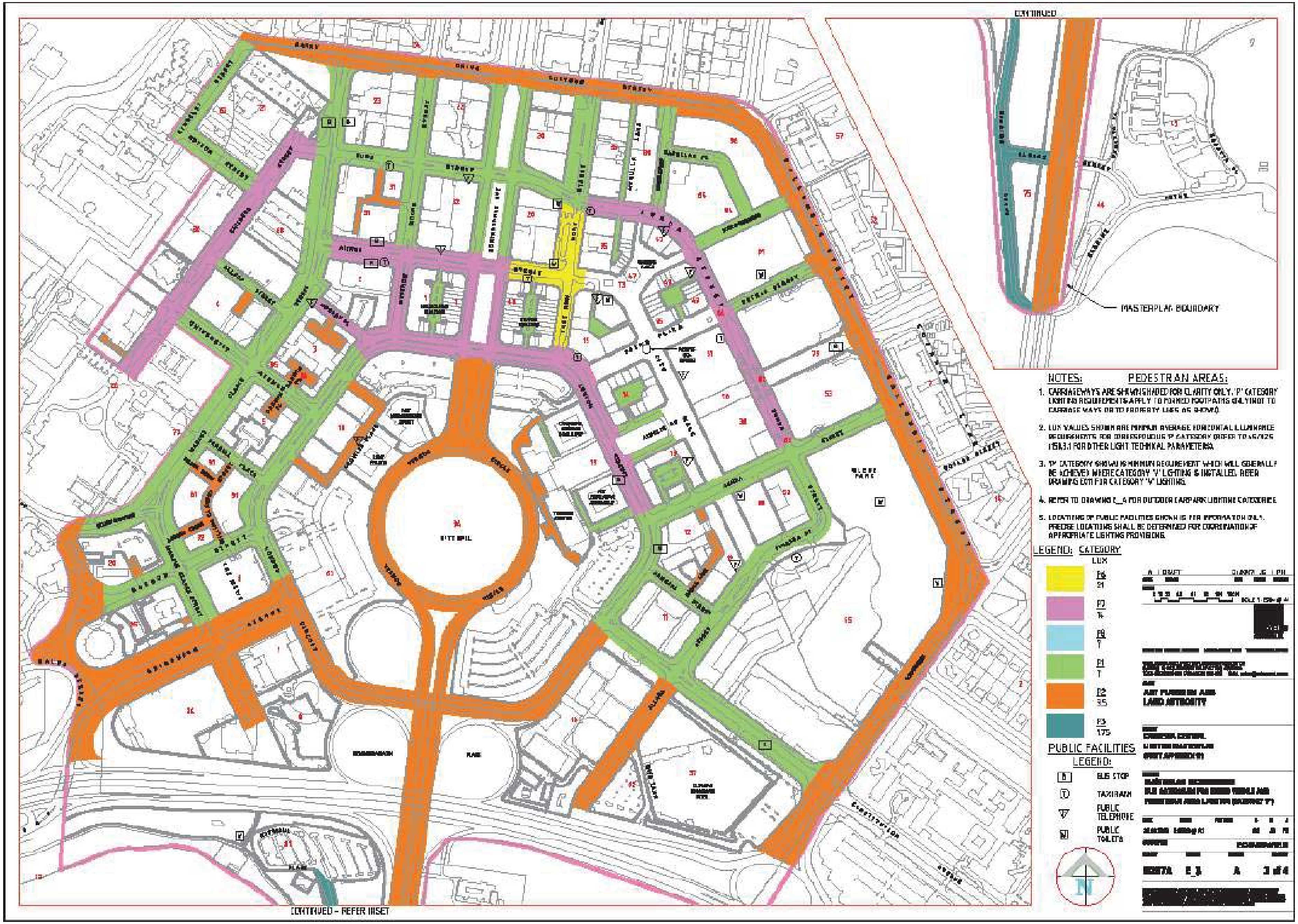
1	2	3	4	5	6
Type of area or activity		Selection criteria[a,b]			Applicable lighting subcategory
General description	Basic operating characteristics	Night time vehicle movements	Risk of crime[c]	Need to enhance prestige	
Areas primarily for pedestrian use, e.g. city, town, suburban centres, including outdoor shopping precincts, malls, open arcades, town squares, civic centres	Generally pedestrian movement only	N/A	High	High	P6
		Medium	Medium	Medium	P7
		Low	Low	N/A	P8
Transport terminals and interchanges, service areas	Mixed pedestrian and vehicle movement	High	High	High	P6
		Medium	Medium	Medium	P7
		Low	Low	N/A	P8

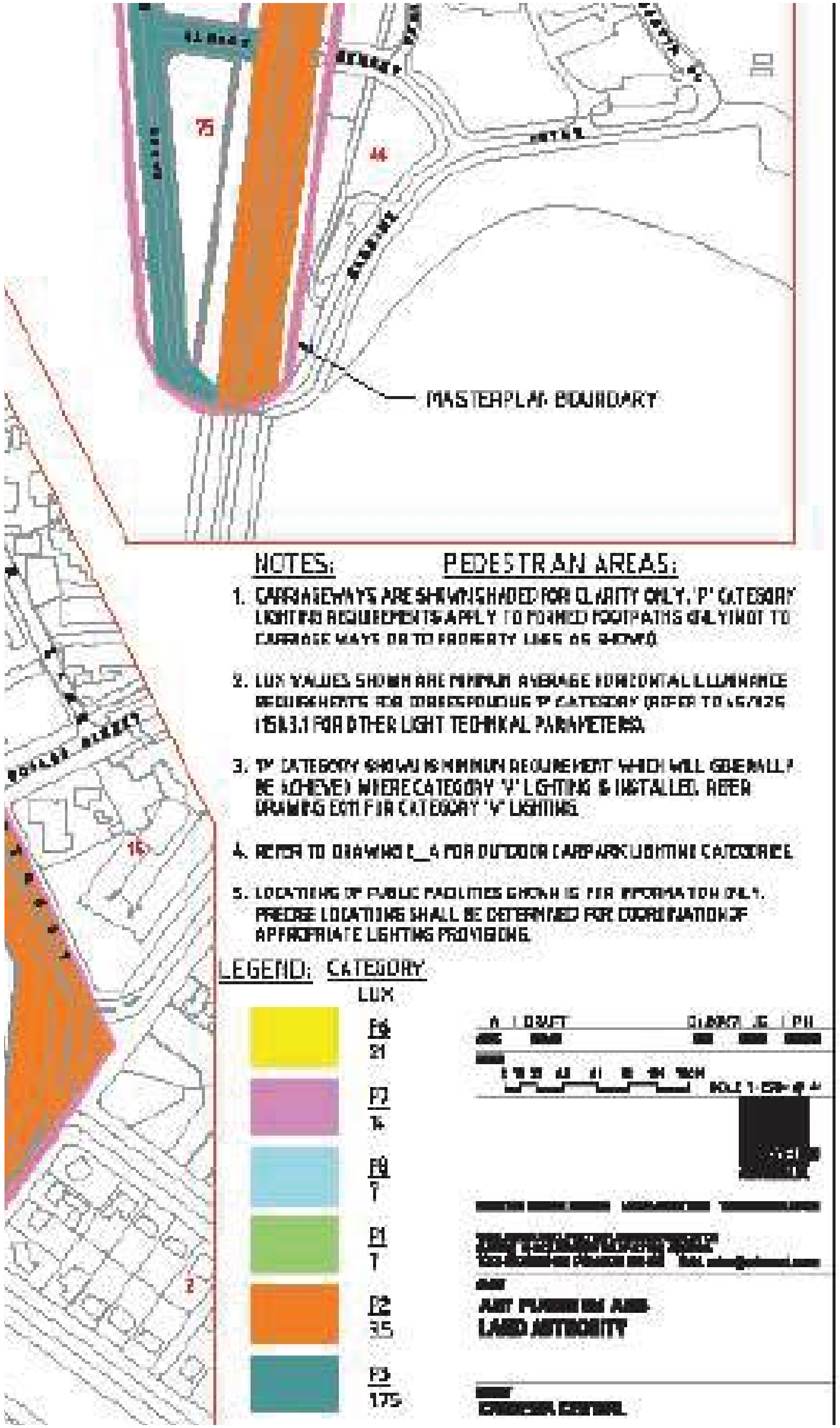
TABLE 2.7

VALUES OF LIGHT TECHNICAL PARAMETERS AND PERMISSIBLE LUMINAIRE TYPES FOR PUBLIC ACTIVITY AREAS (EXCLUDING CAR PARKS)

1	2	3	4	5	6
	Light technical parameters				
Lighting subcategory	Average horizontal illuminance[a,b] ($\overline{E}_h$) lux	Point horizontal illuminance[a,b] (E_{Ph}) lux	Illuminance (horizontal) uniformity[c] Cat. P (U_{E2})	Point vertical illuminance[a,b] (E_{Pv}) lux	Permissible luminaire type (see Table 2.10)
P6	21	7	10	7	Types 2, 3, 4, 5 or 6
P7	14	4	10	4	
P8	7	2	10	2	

Urban rooms, plazas

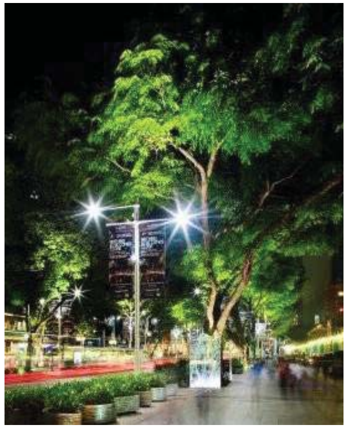

CONTINUED
MASTERPLAN BOUNDARY
CONTINUED - REFER INSET
NOTES:
PEDESTRIAN AREAS:
1. CARRIAGEWAYS ARE SHOWN SHADED FOR CLARITY ONLY. 'P' CATEGORY LIGHTING REQUIREMENTS APPLY TO FORMED FOOTPATHS ONLY (NOT TO CARRIAGE WAYS OR TO PROPERTY LINES AS SHOWN).
2. LUX VALUES SHOWN ARE MINIMUM AVERAGE HORIZONTAL ILLUMINANCE REQUIREMENTS FOR CORRESPONDING 'P' CATEGORY (REFER TO AS/NZS 1158.3.1 FOR OTHER LIGHT TECHNICAL PARAMETERS).
3. 'P' CATEGORY SHOWN IS MINIMUM REQUIREMENT WHICH WILL GENERALLY BE ACHIEVED WHERE CATEGORY 'V' LIGHTING IS INSTALLED. REFER DRAWING E01 FOR CATEGORY 'V' LIGHTING.
4. REFER TO DRAWING E_4 FOR OUTDOOR CARPARK LIGHTING CATEGORIES.
5. LOCATIONS OF PUBLIC FACILITIES SHOWN IS FOR INFORMATION ONLY. PRECISE LOCATIONS SHALL BE DETERMINED FOR COORDINATION OF APPROPRIATE LIGHTING PROVISIONS.
LEGEND: CATEGORY
LUX
P6 21
P7 14
P8 7
P1 7
P2 35
P3 175
PUBLIC FACILITIES LEGEND:
BUS STOP
TAXI RANK
PUBLIC TELEPHONE
PUBLIC TOILETS
CITY HILL

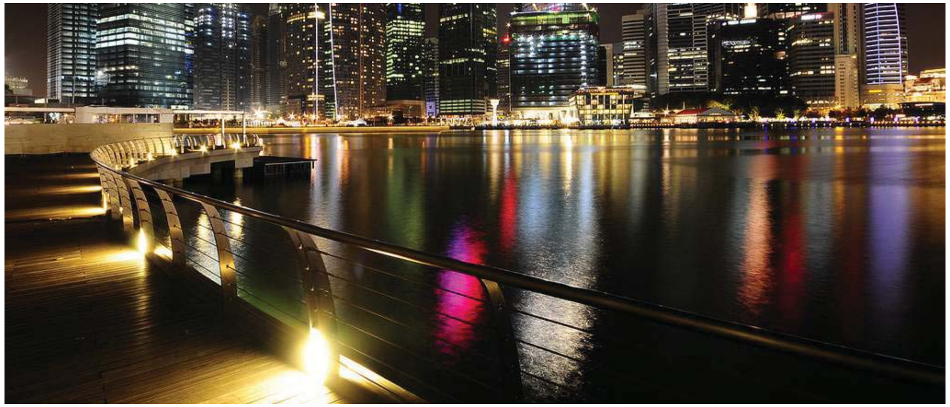

MASTERPLAN BOUNDARY
NOTES:
PEDESTRIAN AREAS:
1. CARRIAGEWAYS ARE SHOWN SHADED FOR CLARITY ONLY. 'P' CATEGORY LIGHTING REQUIREMENTS APPLY TO FORMED FOOTPATHS ONLY (NOT TO CARRIAGE WAYS OR TO PROPERTY LINES AS SHOWN).
2. LUX VALUES SHOWN ARE MINIMUM AVERAGE HORIZONTAL ILLUMINANCE REQUIREMENTS FOR CORRESPONDING 'P' CATEGORY (REFER TO AS/NZS 1158.3.1 FOR OTHER LIGHT TECHNICAL PARAMETERS).
3. 'P' CATEGORY SHOWN IS MINIMUM REQUIREMENT WHICH WILL GENERALLY BE ACHIEVED WHERE CATEGORY 'V' LIGHTING IS INSTALLED. REFER DRAWING E01 FOR CATEGORY 'V' LIGHTING.
4. REFER TO DRAWING E_4 FOR OUTDOOR CARPARK LIGHTING CATEGORIES.
5. LOCATIONS OF PUBLIC FACILITIES SHOWN IS FOR INFORMATION ONLY. PRECISE LOCATIONS SHALL BE DETERMINED FOR COORDINATION OF APPROPRIATE LIGHTING PROVISIONS.
LEGEND:
CATEGORY
LUX
P6
2.1
P7
1.4
P8
7
P1
7
P2
3.5
P3
17.5
A DRAFT

Moon light	Public Park	Pathway	Bar	Lounge	Lobby	Office
0.5 Lux	3.5 + Lux	7 + Lux	10 - 30 Lux	40 - 50 Lux	160 Lux	320 Lux

Lighting Precedents








NCA - Outdoor Lighting Policy

We have found the following main objectives in the Outdoor Lighting Policy.

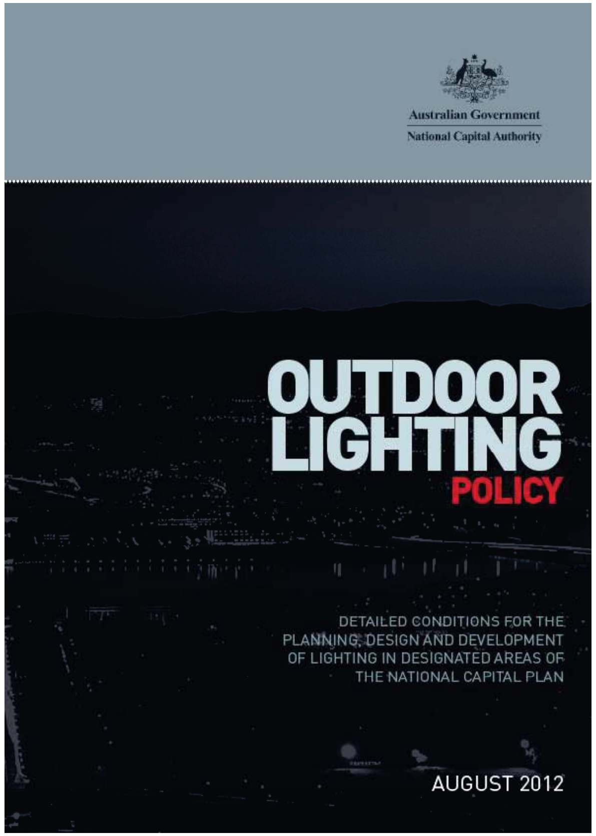
Policy Objective 1
Lighting must reinforce the planned geometry of the National Capital, its heritage and its relationship with the landscape.

Policy Objective 2
Lighting must contribute to the creation of a high quality public realm.

Policy Objective 3
Lighting must provide a safe night time environment for residents of, and visitors to the National Capital.

Policy Objective 4
Minimise the obtrusive effects of artificial lighting on the natural environment.

Policy Objective 5
Provide opportunities for celebration and commemoration through lighting.

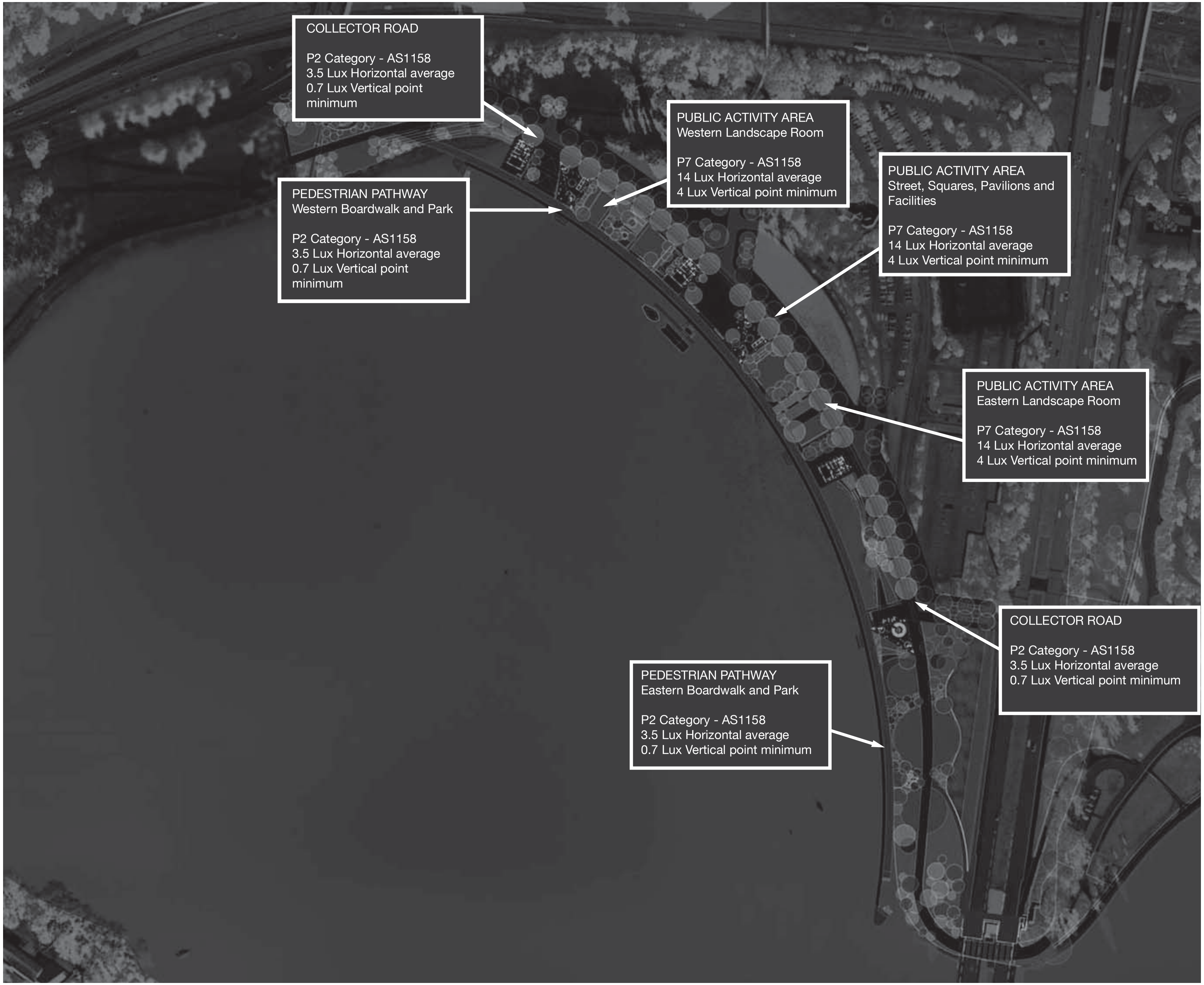


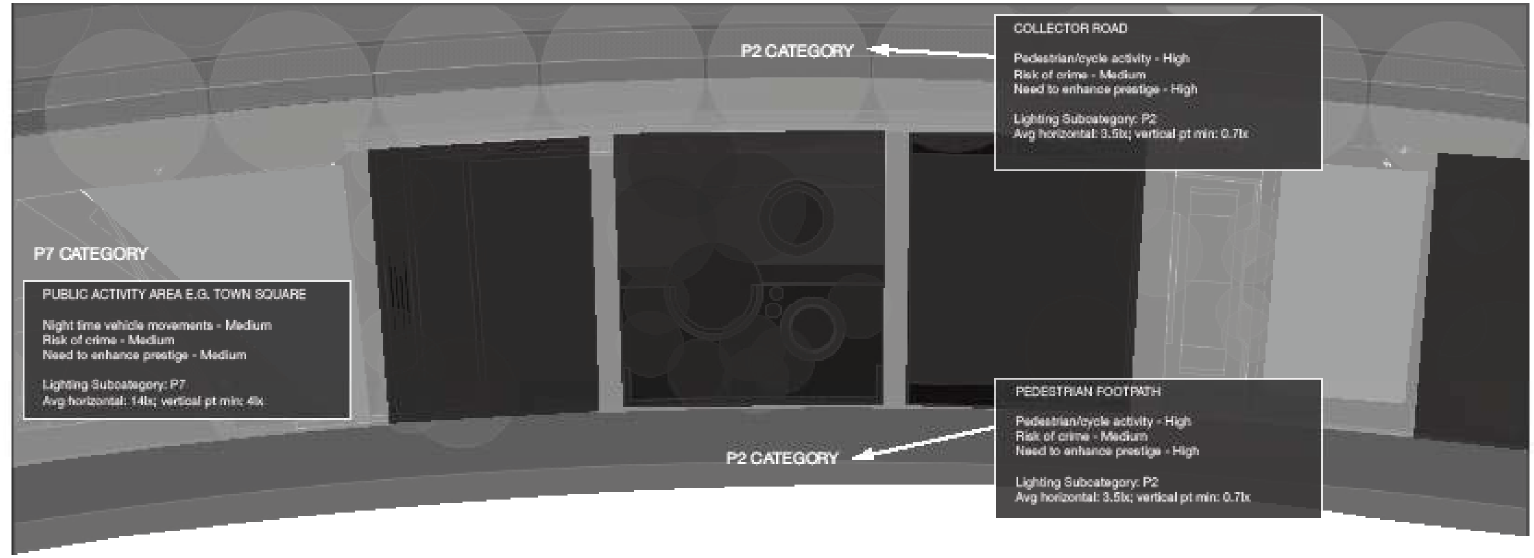
STRATEGY 1B CREATE A CLEAR HIERARCHY OF BUILT ENVIRONMENT ILLUMINATION IN CENTRAL CANBERRA.

DESIGN REQUIREMENTS:

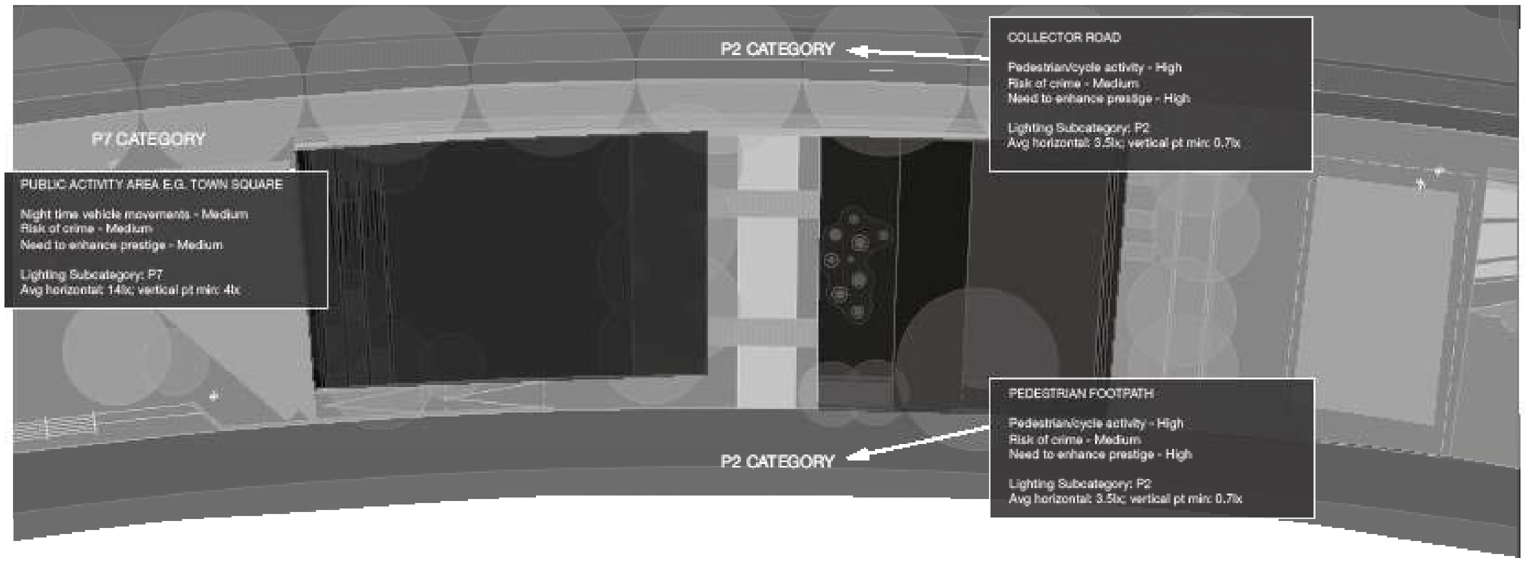
i] Illuminate the exterior of key built elements to reflect their relationship to Griffin's National Triangle and their symbolic function, according to the following comparative luminance values in candela per square metre (cd/m²):

Level One (20 cd/m2)	Parliament House
Level Two (15cd/m2)	Old Parliament House Australian War Memorial National Carillon Captain Cook Memorial Jet City Hill Flag Pole Australian-American Memorial
Level Three (10cd/m2)	City Hill Precinct landmark buildings (RL617) Russell Offices National Library of Australia National Science and Technology Centre High Court of Australia National Gallery of Australia National Portrait Gallery Anzac Park East and West portal buildings Commonwealth Place
Level Four (5cd/m2)	East and West Block Offices John Gorton Building Treasury Building Commonwealth and Kings Avenue bridge parapets Canadian Flag Pole All other buildings adjacent to Constitution Avenue, Parkes Way or Lake Burley Griffin West Basin.


COLLECTOR ROAD
P2 Category - AS1158
3.5 Lux Horizontal average
0.7 Lux Vertical point minimum
PUBLIC ACTIVITY AREA
Western Landscape Room
P7 Category - AS1158
14 Lux Horizontal average
4 Lux Vertical point minimum
PEDESTRIAN PATHWAY
Western Boardwalk and Park
P2 Category - AS1158
3.5 Lux Horizontal average
0.7 Lux Vertical point minimum
PUBLIC ACTIVITY AREA
Street, Squares, Pavilions and Facilities
P7 Category - AS1158
14 Lux Horizontal average
4 Lux Vertical point minimum
PUBLIC ACTIVITY AREA
Eastern Landscape Room
P7 Category - AS1158
14 Lux Horizontal average
4 Lux Vertical point minimum
COLLECTOR ROAD
P2 Category - AS1158
3.5 Lux Horizontal average
0.7 Lux Vertical point minimum
PEDESTRIAN PATHWAY
Eastern Boardwalk and Park
P2 Category - AS1158
3.5 Lux Horizontal average
0.7 Lux Vertical point minimum



Western Landscape



Eastern Landscape

Waterfront Squares and Places

Public Squares - Place and Purpose
150206 - NCA DRP 5 - Session 2 and 3

Waterfront Squares and Places;
At the end to the streets
Open to the water
Connected to the waterfront promenade
Framed by Pavilions
Enlivened activities
Event spaces
Paved with trees
Gentle change of level (900mm) articulated ground plane
West Basin waterfront sets a new standard for Canberra's public spaces,
and will be a legacy for the city