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Parnell Square Cultural Quarter: New Dublin City Library and Public Realm Works

Options Assessment Report

October 2018

Quality information

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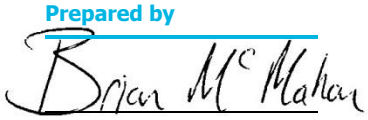	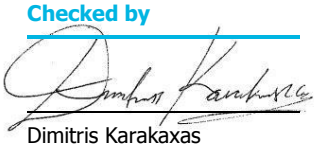	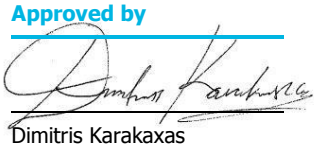
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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	11/06/18	DRAFT	DK	Dimitris Karakaxas	Associate Director
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1. Introduction

1.1 Project Background

Dublin City Council and PSQ Development Ltd commissioned AECOM to develop an options assessment, and prepare a report on the same, for the street configuration options for Parnell Square North.

The Parnell Square Cultural Quarter Project has been identified in a number of Dublin City Council (DCC) documents including the following;

- Dublin City Development Plan (2016 – 2022);
- Your City, Your Space: Dublin City Public Realm Strategy (2012); and
- The Heart of Dublin City Centre Public Realm Masterplan (2016).

The Public Realm Masterplan identifies Parnell Square, see Figure 1.1 below, as part of Phase 1 of Public Realm Projects for which the "Parnell Square Cultural Quarter Project and others will be retained as flagship projects for the city".

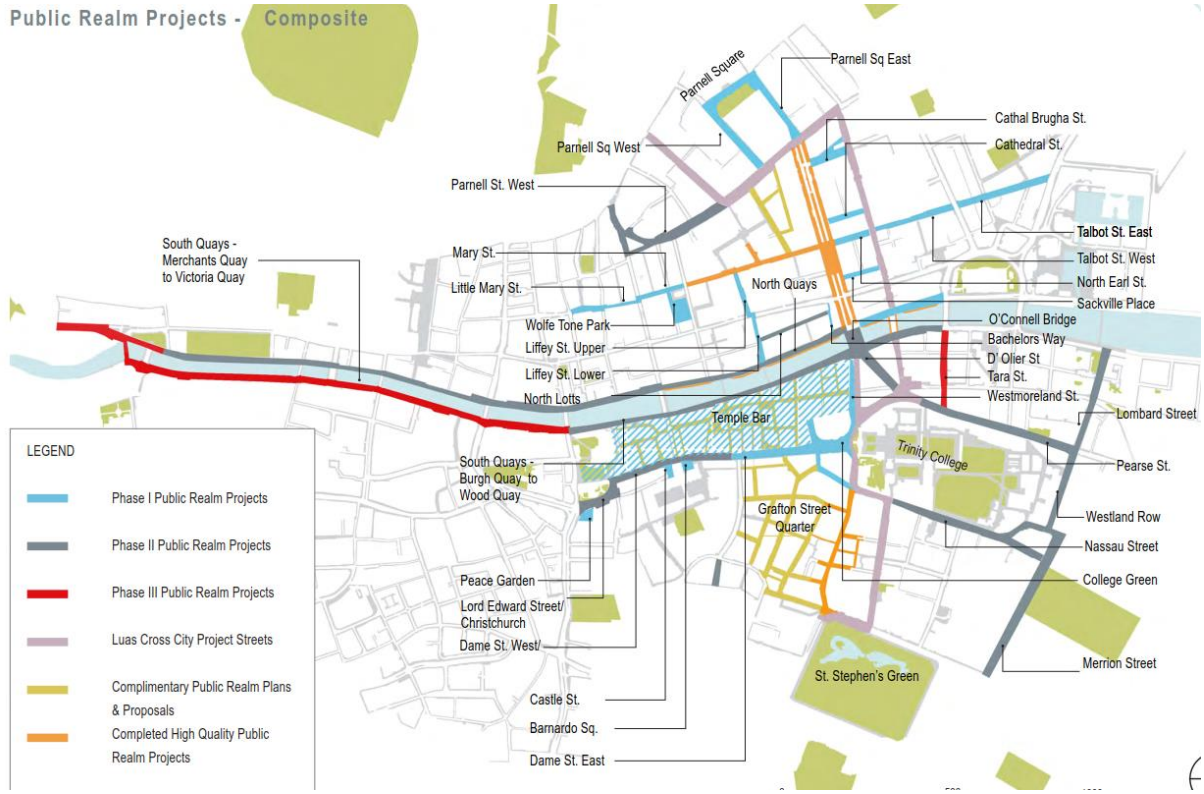

Figure 1.1: Dublin City Centre Public Realm Masterplan

In order to complete this report, AECOM has made reference to the following documents:

- Design Manual for Urban Streets – DMURS (Department of Transport, Tourism and Sport (DTTAS) April 2013);
- The Traffic Management Guidelines (Department of Transport (DoT) 2003);

- The Draft Transport Strategy for the Greater Dublin Area 2016–2035 (NTA);
- Dublin City Centre Transport Study (DCC/NTA June 2015); and
- The Greater Dublin Area Cycle Network Plan (NTA December 2013).

2. Assessment Methodology

2.1 Introduction

The options assessment methodology was based on sustainable safety principles, community impacts, and delivery risks which account for the DTTAS Common Appraisal Framework (CAF) Multi-Criteria Analysis (MCA). The diagram below shows how the proposed criteria match up with the DTTAS CAF MCA.

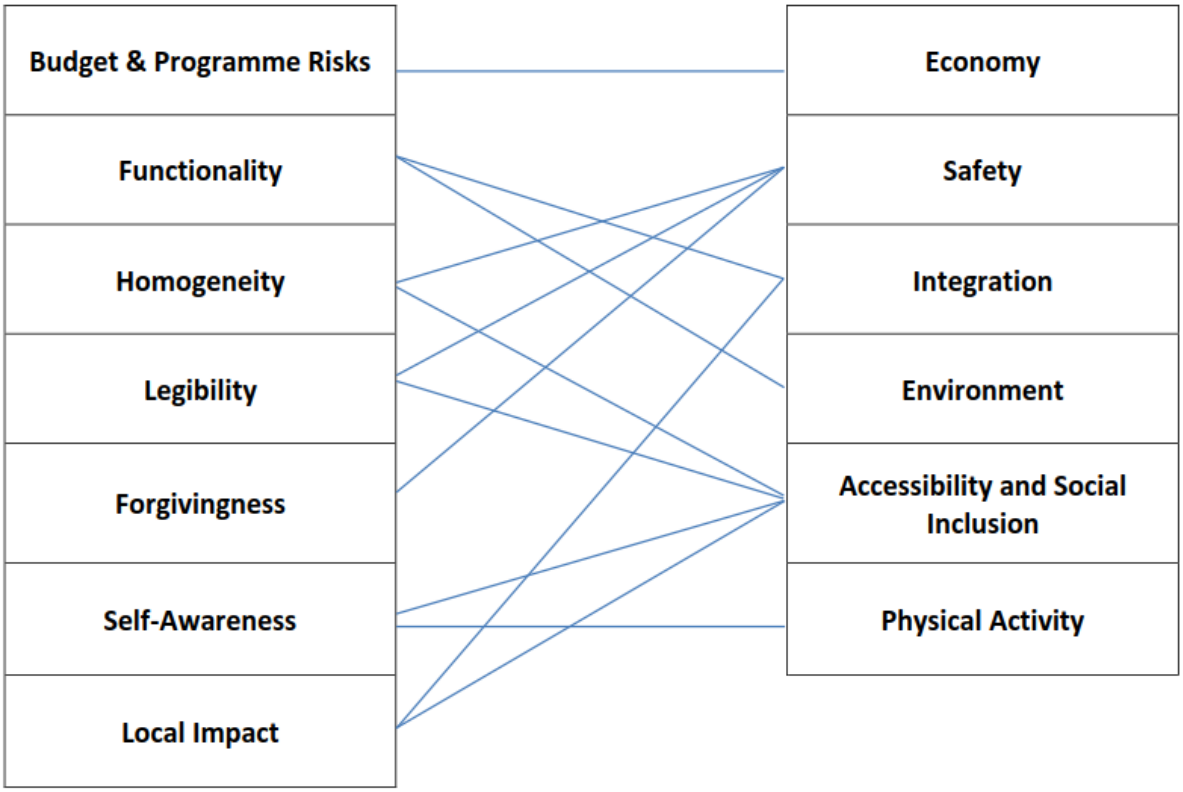

Figure 2.1: Proposed Criteria vs DTTAS MCA

The seven proposed criteria above can be grouped into the following categories:

1. Design context;
2. Traffic context; and
3. Delivery context.

The proposed categories and their respective criteria are presented in Table 2.1.

Table 2.1: Proposed Criteria

Categories	Criteria	Considerations
Design Context	Functionality	The objective for this scheme, in terms of functionality, is to enhance the place functionality, while still providing safe movement through the area for all road users. • Attractiveness of space/Contribution to urban design • Pedestrians and cycle experience • Quality of service for pedestrians and cyclists • Reducing traffic volumes and speed
	Homogeneity	Where any space in the scheme is shared by users of different modes, the design should naturally encourage homogeneity of speed, mass and direction as much as possible. • Minimising relative speed of users • Minimising the number of potential collision points
	Legibility	The design should ensure that confusion is minimised, and all road users are clear on how to proceed through the area. • Clarity of how to use space from all users • Minimise conflicts between cyclist/pedestrian/traffic on links and crossings
	Forgivingness	The layout of the chosen design should be such that the severity of potential collisions are minimised. • Proximity of cyclist/pedestrian to general traffic • Street furniture position • Lighting • Cross falls • Evasion room
	Self-Awareness	The space will naturally draw a large variety of users who will expect to use the space safely. • Accommodation of children/less experienced users • Designed for peak and off-peak use
Traffic Context	Local Impact	• Loading • Parking • Change to traffic arrangement and impact
Delivery Context	Budget and Programme Risks	• Construction Costs • Maintenance Costs

2.2 Scheme Options Summary Table

An options summary table has been prepared which summarises the appraisal of each option under each of the assessment criteria.

For each individual assessment criterion considered, routes have been relatively compared against each other based on a five-point scale, ranging from having significant advantages to having significant disadvantages over other scheme options.

For illustrative purposes, this five-point scale is colour coded, as presented in Table 2.2, with advantageous options graded to 'dark green' and disadvantageous options graded to 'dark red'.

Table 2.2: Design Options Colour Coded Ranking Scale

Colour	Description
	Significant advantages over the other options
	Some advantages over other options
	Neutral compared to other options
	Some disadvantages compared to other options
	Significant disadvantages compared to other options

A qualitative appraisal of options and conclusions from the options assessment is then provided, highlighting the key issues considered in determining the recommended option.

All criteria are considered in undertaking the assessment and a lower ranking on one criterion, for example, does not necessarily mean that the option is not suitable.

3. Options Assessment

Two basic street configuration concepts have been considered by the Design Team, as follows:

- Pedestrianisation of the street, i.e., no access by any type of motorised traffic; and
- Retention of motorised traffic access (this concept has a number of variations that are discussed as options below).

Both concepts would require removal / relocation of the existing parking spaces on PSN.

Initial designs have been developed for both concepts (and their variations) following:

- a number of Design Team workshops;
- further understanding of the overall project requirements, constraints and opportunities; and
- liaison directly with stakeholders and interested parties (e.g. DCC divisions, the NTA, Dublin City Gallery, etc.).

All collaboratively-developed designs have been based on the Design Manual for Urban Roads and Streets (DTTAS, 2013) and other best-practice design standards.

Options and Outline Concept Designs
The option concept designs prepared as part of this assessment provide representations of the intent of the design options for comparative purposes.

- Option 1– Do minimum. Existing situation;
- Option 2 – Two 3m-wide traffic lanes for all traffic;
- Option 2.A – Two 3m-wide traffic lanes, One lane for Public Transport and one for all traffic;
- Option 3 – One 3m-wide traffic lane for all traffic;
- Option 3.A – One 3m-wide traffic lane for Buses, Coaches, Taxis and Cyclists;
- Option 4 – Pedestrianisation of Parnell Square North.

3.1 Option 2: Two 3m-wide traffic lanes for all traffic

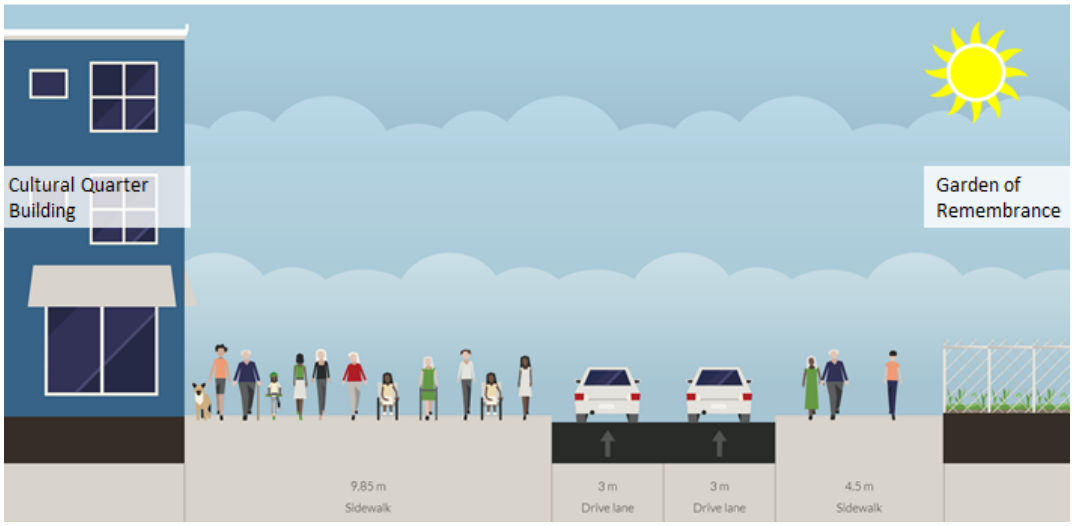

Figure 3.1: Option 2 – Two 3m-wide traffic lanes for all traffic

Option 2 proposes a shared pedestrian and cycle space adjacent to the Parnell Square Cultural Quarter (9.85m). In this option, two traffic lanes are proposed on Parnell Square North. All traffic is proposed to use the two traffic lanes, with a bus stop proposed on the left lane.

3.2 Option 2A: Two 3m-wide traffic lanes, One lane for Public Transport and one for all traffic

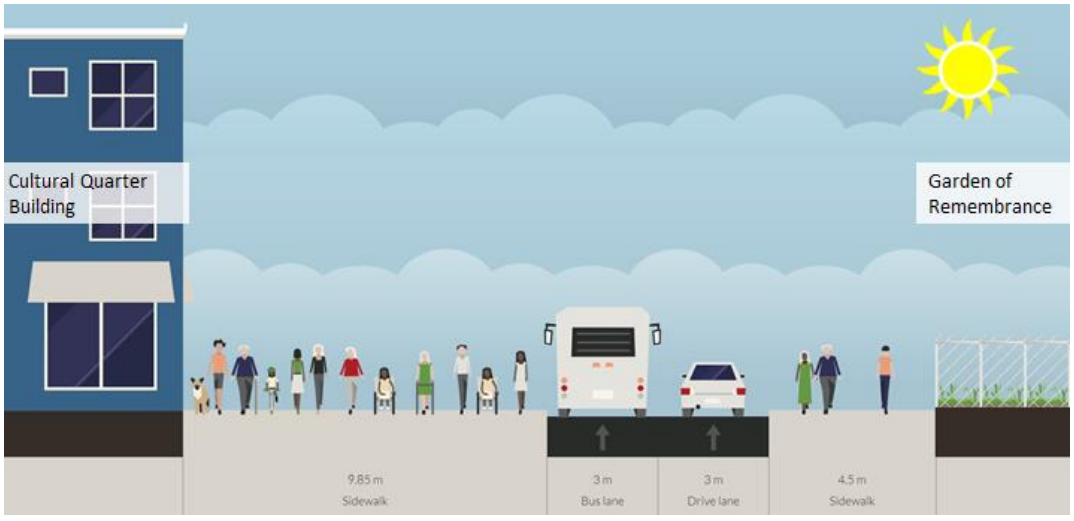

Figure 3.2: Option 2A: – Two 3m-wide traffic lanes, One lane for Public Transport and one for all traffic

Option 2A proposes a shared pedestrian and cycle space adjacent to the Parnell Square Cultural Quarter (9.85m). In this option, two traffic lanes are proposed on Parnell Square North. One traffic lane is for public transport, with the other traffic lane proposed for general traffic.

Designated crossing zones on the carriageway for pedestrians would be provided at the mid-point as well as well as the start of the scheme area by a raised table. A controlled crossing would be required at the end of the scheme to link into the signal

controlled junction with Parnell Square East / Frederick Street North / Gardiner Row junction.

3.3 Option 3: One 3m-wide traffic lane for all traffic

Figure 3.3: Option 3 – One 3m-wide traffic lane for all traffic

Option 3 proposes a larger shared space adjacent to the Parnell Square Cultural Quarter (12.85m), with one traffic lane provided for all traffic.

Designated crossing zones on the carriageway for pedestrians would be provided at the mid-point as well as the start of the scheme area by a raised table. A controlled crossing would be required at the end of the scheme to link into the signal controlled junction with Parnell Square East / Frederick Street North / Gardiner Row junction.

3.4 Option 3A: One 3m-wide traffic lane for Buses, Coaches, Taxis and Cyclists

Figure 3.4: Option 3 – One 3m-wide traffic lane for Buses, Coaches, Taxis and Cyclists

Option 3A proposes the same streetscape design as Option 3, with the exception of only allowing public transport (buses, coaches, taxis and cyclists) to use the traffic lane rather than for all traffic.

Designated crossing zones on the carriageway for pedestrians would be provided at the mid-point as well as at the start of the scheme area by a raised table. A controlled crossing would be required at the end of the scheme to link into the signal controlled junction with Parnell Square East / Frederick Street North / Gardiner Row junction.

3.5 Option 4: Pedestrianisation of Parnell Square North

Figure 3.5: Option 4 – Pedestrianisation of Parnell Square North

Option 4 proposes a fully shared pedestrian and cycle space for the entire scheme area (20.35m), removing the road carriageway. The shared space would be indicated by a constant level and (similar) paving throughout (i.e. a shared surface). The transition areas entering/exiting the scheme area would be denoted by paving differentiation for pedestrians and cyclists. Drivers would be required to reroute away from using Parnell Square North.

4. SWOT Analysis

Table 4.1 summarises the street configuration options and their Strengths, Weaknesses, Opportunities and Threats (SWOT).

Table 4.1: SWOT Analysis

Option	Strengths	Weaknesses	Opportunities	Threats
2 Two traffic lanes (6m-wide+ – kerbs are required): • both lanes for all traffic • additional indentations / lay-bys for drop-off, etc.	• Direct bus/coaches/ Taxis access • Existing traffic movements, patterns and flows are fully retained.	• Not a pedestrian-priority space • Some traffic queues predicted along PSN, due to the road safety requirement to signalise the junction at the eastern end of PSN. • Little additional pedestrian space beyond the existing narrow paths; consideration of the large influx of pedestrians to the library.	• Low traffic speeds could be enforced. • Designation of controlled pedestrian crossings with maximum allocated crossing time would be appropriate.	• Car dominated space at peak commuting hours could impact on noise, emissions and visually. • Inappropriate usage of lay-bys. • Pedestrian and vehicle conflicts due to increase in visitors to the area. • Cost-benefits of how this would compare to the existing space.

Option	Strengths	Weaknesses	Opportunities	Threats
2A Two traffic lanes (6m-wide – kerbs are required): • one lane for private vehicles; and • one lane for buses, coaches, taxis, drop-off and cyclists .	• Direct bus/coaches/ taxis access. • Existing traffic movements, patterns and flows are largely retained.	• Not a pedestrian-priority space • Moderate traffic queues predicted along PSN, due to the road safety requirement to signalise the junction at the eastern end of PSN.	• Low traffic speeds could be enforced. • Designation of controlled pedestrian crossings with maximum allocated crossing time would be appropriate, to facilitate the high pedestrian demand to access the area. • The buses / coaches/taxis lane could be visually mitigated employing a unit paver.	• Car-dominated space at peak commuting hours could impact on noise, emissions and visually.

Option		Strengths	Weaknesses	Opportunities	Threats
3	One 3m-wide traffic lane for all traffic (kerbs are required).	• Pedestrian- and cycle-friendly space. • Direct bus/coaches/Taxis access. • Existing traffic movements are retained to the minimum.	• Significant traffic queues predicted along the entire length of PSN, due to the road safety requirement to signalise the junction at the eastern end of PSN (queuing may extend along Parnell Square West). • Operational risks in case of vehicle breakdown. • Mitigation of operational safety risks during St Patrick's Day parade is required.	• Low traffic speeds could be enforced. • Pedestrians could cross the street informally if low traffic speeds could be enforced.	• Predicted vehicle queues along PSN could impact on noise, emissions, visually and could compromise safety, when pedestrians will try to informally cross the single-lane street.

Option		Strengths	Weaknesses	Opportunities	Threats
3A	One 3m-wide traffic lane for buses, coaches, taxis and cyclists	• Appropriate pedestrian- and cycle-friendly space • Direct bus/coaches/Taxis access • A shared surface allows very adaptable space for events, e.g. parades, markets, performances, etc.	• Considerable immediate traffic impact locally and in the vicinity • Operational risks in case of vehicle breakdown. • Mitigation of operational safety risks during St Patrick's Day parade is required.	• Designation of trafficked space could be achieved without the usage of street kerbs, e.g. flush kerbs possible (in that case the operational risks in case of vehicle breakdown and during St Patrick's parade are minimised). • Pedestrians can cross the street informally as all drivers using the street would be trained professionals.	• Possible strong opposition by NCBI to shared surface unless there is adequate consultation and tactile paving provision. • Enforcement of "no private vehicles access" could be challenging.

Option		Strengths	Weaknesses	Opportunities	Threats
4	Pedestrianisation • space given to pedestrians and cyclists. • vehicular traffic to be re-routed.	• Vision for a new city plaza for the PSCQ achieved and optimum public realm for visitors and users. • Greatest amalgamation between all attractions of the Cultural Quarter (Garden of R, Library, Hugh Lane, Writers' Museum). • Most adaptable space for events, (parades, markets, performances) • Safest option due to least conflict between vehicles and general and vulnerable pedestrians.	• Significant immediate traffic impact locally and in the vicinity. • No direct bus/coaches access. • Lack of passive safety generated by traffic.	• Connections to the Garden of Remembrance and public realm enhancements. • Reducing/removing traffic from PSN could lessen pressures at other junctions (e.g. Parnell Street junctions). • Enhancement of St Patrick's parade starting point.	• opposition by some stakeholders, and business. • Anti-social behaviour risk.

		• Reduced noise and air pollution for the Cultural Quarter and people spending time in the plaza.			

5. Transport Analysis

5.1 NTA Eastern Regional Model

The potential impact of the proposed scheme on Parnell Square has been assessed using the latest NTA Eastern Regional Model (ERM) provided by the NTA. A note provided in Appendix A gives a summary of the preliminary strategic modelling results for the AM Peak for the Do-Minimum and various Do-Something scenarios in terms of journey times on key routes and traffic flow differences within the study area. A summary of the results is provided here.

The various model scenarios assessed as part of this task are set out below. The DoMin was assumed as the most recent version of the ERM, which included for the traffic interventions associated with the recently opened Luas Cross City and the College Green proposals. Four separate layouts were assessed, which are referred to as Scenarios 1 to 4. Table 5.1 show the modelled scenarios match up with the options referred to in the other sections of this report.

Table 5.1: ERM Model Scenarios Compared to the Options Assessment

Scenario	Scenario Name	Option Equivalent
Scenario 1	Do-Min	Option 1 (Do-Minimum)
Scenario 2	Parnell Sq N – Two lane one direction all traffic	Option 2 (Two 3m-wide traffic lanes for all traffic)
Scenario 3	Parnell Sq N – One lane one direction PT only incl. taxi	Option 3A (One 3m-wide traffic lane for all traffic)
Scenario 4	Parnell Sq N – Closed to all traffic	Option 4 (Pedestrianisation of Parnell Square North)

5.1.1 ERM Results Summary

In general, Scenarios 2 and 3 show improvement in local journey times within the study area. While reductions in journey times are seen in both scenarios compared to Do-Minimum, the overall difference between the two scenarios is marginal.

The closure of Parnell Square North in Scenario 4 would bring negative impacts in terms of local journey times. An average increase of 1.5 minutes is seen for routes traveling via Parnell Square West when Parnell Square North is closed for all traffic.

5.2 LinSig Analysis

The potential impact of the proposed scheme on the Parnell Square North / Parnell Square East / Frederick Street North / Gardiner Row junction has also been assessed in LinSig, with a note provided in Appendix B. LinSig models have been built of the existing and proposed junction scenarios and a comparison of the impacts on the Degree of Saturation, Average Queue, Average Delay and Green Time has been provided.

The various model scenarios assessed as part of this task are set out below. The DoMin was assumed as the most recent version of the ERM, which included for the traffic interventions associated with the recently opened Luas Cross City and the College Green proposals. Four separate layouts were assessed, which are referred to as Scenarios 1 to 4. Table 5.1 below shows how the modelled scenarios match up with the options referred to in the other sections of this report.

Table 5.2: LinSig Model Scenarios Compared to the Options Assessment

Scenario	Scenario Name	Option Equivalent
Scenario 1	Base Do-Minimum – with 2018 Traffic Demand	Option 1 (Do- Minimum)
Scenario 2	Parnell Square North with Two Lanes – with 2018 Traffic Demand	Option 2 (Two 3m-wide traffic lanes for all traffic)
Scenario 3	Parnell Square North with One Lane – with 2018 Traffic Demand	Option 3 (One 3m wide traffic lane for all traffic)
Scenario 4	Parnell Square North Closed to all Traffic (Ped Only) – with 2018 Traffic Demand.	Option 4 (Pedestrianisation of Parnell Square North)

5.2.1 Summary

In all scenarios, the DoS does not exceed 90%, the optimum DOS for a traffic signal controlled junction. However, from a comparison of the potential queues and delays at the proposed junctions, Scenario 2 operates more efficiently than Scenario 3.

Larger queues are formed on Frederick Street North in Scenario 4 compared to the other scenarios, but the total delay to this arm of the junction is reduced given that it has a longer green time.

6. Analysis

Table 6.1: Analysis

Criteria	Option 2 - Two 3m-wide traffic lanes for all traffic	Option 2A - One lane for Public Transport and one for Traffic	Option 3 - One 3m-wide traffic lane for all traffic	Option 3A - One 3m-wide traffic lane for Buses, Coaches, Taxis and Cyclists	Option 4 - Pedestrianisation of Parnell Square North
Functionality	The 9.85m shared pedestrian/cyclist facility would enhance the attractiveness of scheme area. However, it is less than the 12.85m shared space provided in Options 3 and 3A. The raised paved crossing would help reduce vehicular speeds through the scheme area by signifying that there is a change in road user priority in front of the Hugh Lane Gallery. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 9.85m shared area. Allowing all traffic use the road carriageway will result in greater traffic volumes.	The 9.85m shared pedestrian/cyclist facility would enhance the attractiveness of the scheme area. However, it is less than the 12.85m shared space provided in Options 3 and 3A. The raised paved crossing would help reduce vehicular speeds through the scheme area by signifying that there is a change in road user priority in front of the Hugh Lane Gallery. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 9.85m shared area. Limiting the traffic to one lane comprising only public transport limits the impact of traffic.	The 12.85m shared pedestrian/cyclist facility would enhance the attractiveness of scheme area. However, it is less than the 20.35m shared space provided in Option 4. The raised paved crossing would help reduce vehicular speeds through the scheme area by signifying that there is a change in road user priority in front of the Hugh Lane Gallery. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 12.85m shared area. Allowing all traffic use the road carriageway will result in greater traffic volumes.	The 12.85m shared pedestrian/cyclist facility would enhance the attractiveness of the scheme area. However, it is less than the 20.35m shared space provided in Option 4. The raised paved crossing would help reduce vehicular speeds through the scheme area by signifying that there is a change in road user priority in front of the Hugh Lane Gallery. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 12.85m shared area. Limiting the traffic to one lane comprising only public transport lessens the impact of traffic.	The 20.35m shared space would enhance the attractiveness of the scheme area and contribute well to the overall design. Given the removal of all motor vehicles from the area, it will increase the pedestrian and cycle experience. It is noted that at some locations mixing pedestrians with cyclists would reduce the quality of service for cyclists. Traffic will not be permitted through PSN and therefore this option offers the lowest traffic volumes.

Homogeneity	Two lanes of traffic have been provided, both for general traffic. A 6.0m road carriageway is proposed. As both lanes are open to general traffic there will be increased weaving across traffic lanes. The number of conflict points increases compared to Option 2A, given that the two lanes of traffic open to general traffic.	Two lanes of traffic have been provided, one for public transport, and the other for general traffic. A 6.0m road carriageway is proposed. Drivers using this public transport lane are trained professionals and therefore assumed to driver at appropriate speeds and trained in relation to driving with cyclists. The number of conflict points increases compared to Options 3 and 3A given that two lanes of traffic are proposed rather than one.	One lane of traffic has been provided for all traffic. As narrow carriageways are one of the most effective design measures to calm traffic, a narrow 3.0m wide road lane is proposed. However, in this option the lane is open to all traffic and drivers won't be trained professionals. The number of conflict points are reduced given that only one lane of traffic has been provided.	One lane of traffic has been provided for Public Transport only. As narrow carriageways are one of the most effective design measures to calm traffic, a narrow 3.0m wide road lane is proposed. Drivers using this lane are trained professionals and therefore assumed to driver at appropriate speeds. The number of conflict points are reduced given that only one lane of traffic has been provided.	Given the removal of all motor vehicles from the area, the largest relative speed differential between pedestrian/cyclists and motorists has been removed. The potential conflict points only occur between cyclists and pedestrians on the shared space.
Legibility	Two lanes of traffic have been provided, both for general traffic. It will be clear via road markings and signage that both lanes are open for general traffic. Regarding the conflict between pedestrians and cyclists on the shared space, some pedestrians may believe that eastbound cyclists should only be using the traffic lane and this may result in conflicts.	Two lanes of traffic have been provided, one for public transport, and the other for general traffic. It will be clear via road markings and signage which lane is for public transport and which is for general traffic. Regarding the conflict between pedestrians and cyclists on the shared space, some pedestrians may believe that eastbound cyclists should only be using the traffic lane and this may result in conflicts.	The one lane provided will be open to all traffic, it will be clear to all motorists that the lane can be used by all. Regarding the conflict between pedestrians and cyclists on the shared space, some pedestrians may believe that eastbound cyclists should only be using the traffic lane and this may result in conflicts.	With one lane provided for public transport only, it will not be clear to some motorists that they are prohibited from using this lane. Signage will be required to notify motorists that it is a public transport corridor only. Regarding the conflict between pedestrians and cyclists on the shared space, some pedestrians may believe that eastbound cyclists should only be using the traffic lane and this may result in conflicts.	Without any traffic lane, it will be clear to all motorists that this is a zone for pedestrians and cyclists only. Regarding the conflict between pedestrians and cyclists on the shared space, various visual cues will be used to alert cyclists they are entering a shared zone with pedestrians and must give way.

Forgivingness	Two lanes of traffic have been provided, both for general traffic. The risk of collision has been reduced compared to the existing situation. All options would use street furniture, tactile paving and trees/planters to define specific user paths, e.g. pedestrian routes, vehicular routes. Lighting would be used in all options to enhance visibility within the scheme area as well as to indicate conflict areas.	Two lanes of traffic have been provided, one for public transport, and the other for general traffic. The risk of collision has been reduced compared to the existing situation. All options would use street furniture, tactile paving and trees/planters to define specific user paths, e.g. pedestrian routes, vehicular routes. Lighting would be used in all options to enhance visibility within the scheme area as well as to indicate conflict areas.	One lane of traffic has been provided for all traffic; therefore, the risk of collisions has been reduced. All options would use street furniture, tactile paving and trees/planters to define specific user paths e.g. pedestrian routes, vehicular routes. Lighting would be used in all options to enhance visibility within the scheme area as well as to indicate conflict areas.	One lane of traffic has been provided for Public Transport only, therefore, the risk of collisions has been reduced. All options would use street furniture, tactile paving and trees/planters to define specific user paths, e.g. pedestrian routes, vehicular routes. Lighting would be used in all options to enhance visibility within the scheme area as well as to indicate conflict areas.	Given the removal of all motor vehicles from the area, the severity of potential collisions has been minimised. All options would use street furniture, tactile paving and trees/planters to define specific user paths, e.g. pedestrian routes, vehicular routes. Lighting would be used in all options to enhance visibility within the scheme area as well as to indicate conflict areas. The severity of potential collisions is lowest for Option 4 due to the proposed removal of all traffic lanes.
Self-Awareness	The 9.85m shared pedestrian/cyclist facility would provide a safe pedestrian and cycle environment for all road users. However, it is less than the 12.85m shared space provided in Options 3 and 3A. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 9.85m shared area.	The 9.85m shared pedestrian/cyclist facility would provide a safe pedestrian and cycle environment for all road users. However, it is less than the 12.85m shared space provided in Options 3 and 3A. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 9.85m shared area.	The 12.85m shared pedestrian/cyclist facility would provide a safe pedestrian and cycle environment for all road users. However, it is less than the 20.35m shared space provided in Option 4. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 12.85m shared area.	The 12.85m shared pedestrian/cyclist facility would provide a safe pedestrian and cycle environment for all road users. However, it is less than the 20.35m shared space provided in Option 4. Eastbound cyclists could use the traffic lanes, while westbound would still share with pedestrians limited to the 12.85m shared area.	The 20.35m shared space would provide a safe pedestrian and cycle environment for all road users. Given the removal of all motor vehicles from the area, it will increase pedestrian and cycle safety.

Local Impact	This option provides two lanes of traffic, both for general traffic. Therefore, traffic does not have to reroute to other roads in the local area. There will be increased traffic and delays on PSN as the capacity of the Eastern junction is reduced but is greater than Option 2A as both lanes are for general traffic. From the ERM modelling, this option will have marginal impact on the overall journey times, but will have a negative impact on bus journey times. The LinSig Modelling shows that Option 2 operates more efficiently than Option 3. Loading will be possible on Parnell Square North as two lanes are provided on this link. All options would require the removal of parking along Parnell Square North.	This option provides two lanes of traffic, one for public transport, and the other for general traffic. Therefore, traffic does not have to reroute to other roads in the local area. There will be increased traffic and delays on PSN as the capacity of the Eastern junction is reduced but is greater than Options 3 and 3A. Loading will be possible on Parnell Square North as two lanes are provided on this link. All options would require the removal of parking along Parnell Square North.	This option provides one traffic lane for both general traffic and public transport. Therefore, traffic does not have to reroute to other roads in the local area. There will be increased traffic and delays on PSN as the capacity of the Eastern junction is reduced. The LinSig Modelling shows that Option 2 operates more efficiently than Option 3. Loading will not be possible on Parnell Square North and must be relocated during the main working hours. After hours parking will be permitted as per Grafton and Henry Street. All options would require the removal of parking along Parnell Square North.	This option removes general traffic from using Parnell Square North. Therefore, general traffic will have to reroute to other roads in the local area. However, this option allows for public transport to use this route allowing existing bus routes to be maintained. From the ERM modelling, this option will have marginal impact on the overall journey times, but will have a negative impact on bus journey times. Loading will not be possible on Parnell Square North and must be relocated during the main working hours. After hours parking will be permitted as per Grafton and Henry Street. All options would require the removal of parking along Parnell Square North.	This option removes all traffic from using Parnell Square North. Therefore, traffic will have to reroute to other roads in the local area. From the ERM and LinSig Modelling it is shown that this option will have a negative impact on journey and bus times. Loading will not be possible on Parnell Square North and must be relocated. All options would require the removal of parking along Parnell Square North.

Budget and Programme Risks	At this early stage of design it is not possible to accurately quantify construction and maintenance costs. All designs would use similar materials (e.g. paving). Therefore, the budget risk is based on the extent to which the proposed design differs from the existing layout, i.e. the additional works required to modify the existing layout. For example, the wider or greater the paved area departs from existing would increase the likelihood of budget and delivery risks relating to drainage/level issues. Options 2 and 2A would be relatively the closest in terms of design to the existing layout (maintaining a carriageway) and be lower risk.	At this early stage of design it is not possible to accurately quantify construction and maintenance costs. All designs would use similar materials (e.g. paving). Therefore, the budget risk is based on the extent to which the proposed design differs from the existing layout, i.e. the additional works required to modify the existing layout. For example, the wider or greater the paved area departs from the existing would increase the likelihood of budget and delivery risks relating to drainage/level issues. Options 2 and 2A would be relatively closest in terms of design to the existing layout (maintaining a carriageway) and be lower risk.	At this early stage of design it is not possible to accurately quantify construction and maintenance costs. All designs would use similar materials (e.g. paving). Therefore, the budget risk is based on the extent to which the proposed design differs from the existing layout, i.e. the additional works required to modify the existing layout. For example, the wider or greater the paved area departs from the existing would increase the likelihood of budget and delivery risks relating to0 drainage/level issues. Options 3 and 3a would maintain part of the carriageway and hence, would not have as significant an impact as Option 4.	At this early stage of design it is not possible to accurately quantify construction and maintenance costs. All designs would use similar materials (e.g. paving). Therefore, the budget risk is based on the extent to which the proposed design differs from the existing layout, i.e. the additional works required to modify the existing layout. For example, the wider or greater the paved area departs from the existing would increase the likelihood of budget and delivery risks relating to drainage/level issues. Options 3 and 3a would maintain part of the carriageway and hence, would not have as significant an impact as Option 4.	At this early stage of design it is not possible to accurately quantify construction and maintenance costs. All designs would use similar materials (e.g. paving). With this option, it will be possible to close this section of road carriageway during the construction works. Therefore from a construction context the removal of traffic from the area would help the construction programme. However, there is a programme risk with this option as a road closure licence would be required. Option 4 would furthest depart from the existing and require the most works, i.e. greatest risk to budget and delivery.

7. Conclusion

A summary of the analysis results is presented in Table 7.1, Table 7.2 and Table 7.3 below.

Table 7.1: Analysis summary for each criterion

Categories	Criteria	Option 2 – 2 Traffic Lanes	Option 2A – 2 Lanes Traffic & PT	Option 3 - One lane for all traffic	Option 3A - One traffic lane for PT	Option 4 – Ped & Cycle Only
Design context	Functionality					
	Homogeneity					
	Legibility					
	Forgivingness					
	Self-Awareness					
Traffic context	Local Impact					
Delivery context	Budget and Programme Risks					

Table 7.2: Analysis summary for each category

Categories	Option 2 – 2 Traffic Lanes	Option 2A – 2 Lanes Traffic & PT	Option 3 - One lane for all traffic	Option 3A - One traffic lane for PT	Option 4 – Ped & Cycle Only
Design context (average)					
Traffic context					
Delivery context					

Table 7.3: Overall average scores

Categories	Option 2 – 2 Traffic Lanes	Option 2A – 2 Lanes Traffic & PT	Option 3 - One lane for all traffic	Option 3A - One traffic lane for PT	Option 4 – Ped & Cycle Only
Overall ranking					

Under the design context criteria, Option 4 scored highest due to the proposed removal of the traffic lanes along Parnell Square North. The removal of traffic lanes would help avoid vehicle conflicts and increase the overall attractiveness of the scheme area for cyclists and pedestrians.

Conversely, Option 4 scores lowest under the Traffic criterion due to the proposed restrictions on through traffic on Parnell Square North, the impact on journey times on the local road network, the impact on existing bus routes, and vehicular access to businesses along Parnell Square North.

Options 3 and 3A scored lowest under the delivery context criteria as their proposed designs depart furthest from the existing situation and do not have the advantage of fully closing the road during the construction period as Option 4.

Overall, Options 2 and 2A scored well under the traffic and delivery contexts and are the highest ranked options. The two differ only in terms of whether the near side lane would be used as a bus lane and will require the same geometric design.

In conclusion, it is recommended that Options 2 and 2A are brought forward to the next stage of design development.

Appendix A - NTA Eastern Regional Model

Appendix A - Impact of Proposed Scheme on Journey Times within the Study Area

1. Introduction

The potential impact of the proposed scheme on the Parnell Square has been assessed using the latest NTA Eastern Regional Model (ERM) provided by the NTA. This note provides a summary of the preliminary strategic modelling results for the AM Peak for the Do-Minimum and various Do-Something scenarios in terms of journey times on key routes and traffic flow differences within the study area. It is noted that the ERM AM Peak is the one hour average of peak flows between the hours of 07:00 to 10:00. Localised modelling has also been undertaken and is reported upon separately.

1.1 NTA Eastern Regional Model

The Eastern Regional Model (ERM) is one of five regional models contained within the Regional Modelling System and focuses on the Greater Dublin Area (GDA) developed by the National Transport Authority (NTA). The ERM is represented by 1844 detailed zones in the GDA while the rest of Ireland is covered by 7 external zones. The model covers all surface access modes for personal travel and goods vehicles including private vehicles (taxis and cars), public transport (bus, rail, Luas, BRT, Metro), active modes (walking and cycling) and goods vehicles (light goods vehicles and heavy goods vehicles). The NTA ERM is a multi-modal model and consists of four input elements, as follows:

- Public Transport (PT) Model (e.g. rail/bus/light rail services);
- Walking and Cycling Model;
- Highway Model (e.g. road links/junctions); and
- Demand Model - GDA total transport demand is taken from the National Demand Forecasting Model which outputs travel demand to the ERM for iteration through the choice and assignment modules. During the model run, mode choice is undertaken based on current costs for each mode for each origin and destination pair.

The demand in the NTA ERM is built up based on CSO POWSCAR, NTA Household Travel Surveys, Transport Surveys and other transport related datasets. Figure 1 shows the extent of the ERM model.

Figure 1: Extent of ERM

In this modelling, the assessment focused on Parnell Square which forms part of the ERM. It is noted that due to the relatively minor scale of the proposed Do-Something interventions it was not feasible to extract full network Key Performance Indices (KPIs) such as Total Travel Time as model noise impacts would likely skew localised scheme impacts. The assessment therefore focused on the local impacts within the Parnell Square study area in terms of journey time and link flow differences. Figure 2 shows the Parnell Square in the ERM.

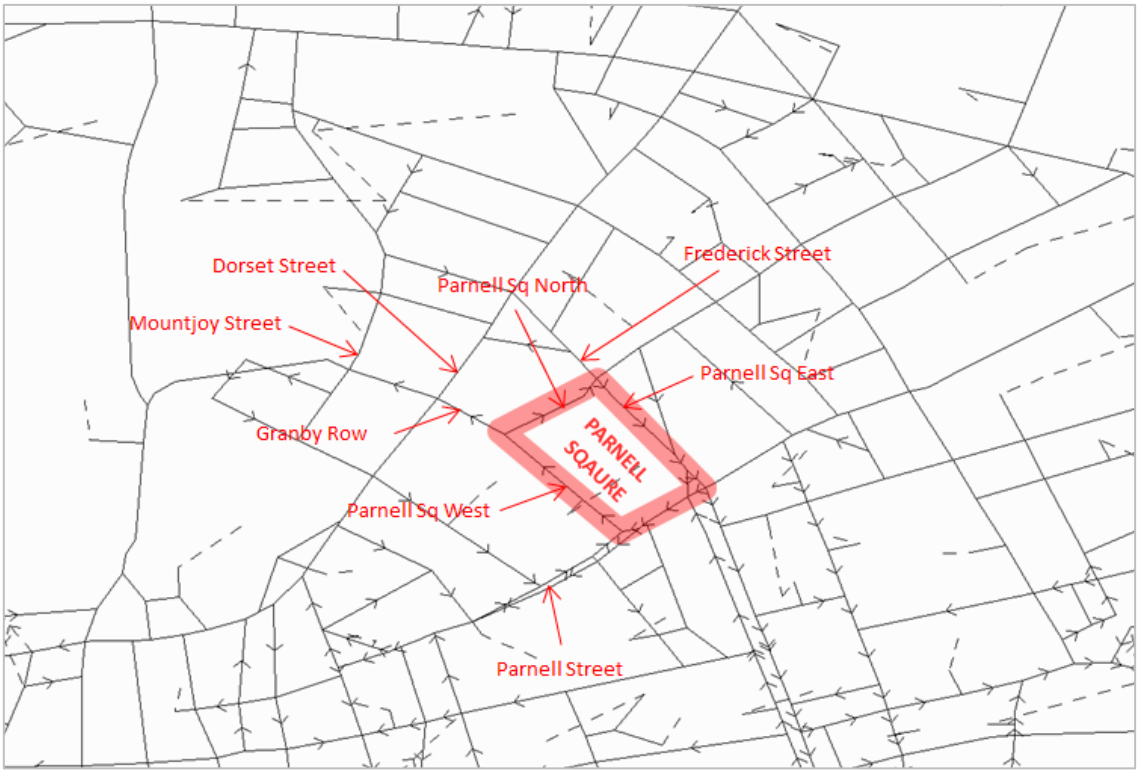

Figure 2: ERM Model with the Parnell Square Study Area

2. Development Scenarios

This Section sets out the various model scenarios assessed as part of this task. The DoMin was assumed as the most recent version of the ERM which included for the traffic interventions associated with the recently opened Luas Cross City and the College Green proposals. Four separate layouts were assessed as Do-Something options, which are referred to as Scenarios 1 to 4 as summarised in Table 1.

Table 1: Model Scenarios

Scenario	Name	Demand Year	Network Year
Scenario 1	Do-Min	2017 as per existing NTA demand	2018
Scenario 2	Parnell Sq N – Two Lane one direction all traffic	2017 as per existing NTA demand	2018
Scenario 3	Parnell Sq N – One Lane one direction PT only incl taxi	2017 as per existing NTA demand	2018
Scenario 4	Parnell Sq N – Closed to all traffic	2017 as per existing NTA demand	2018

3. Modelling Outputs

This section presents the modelling outputs in terms of journey time and link flow differences which provide a good insight to the relative impacts of each Do-Something option.

3.1 Journey Times

The journey time outputs were extracted from the models for 10 no. routes within the study area as illustrated in Figure 3.

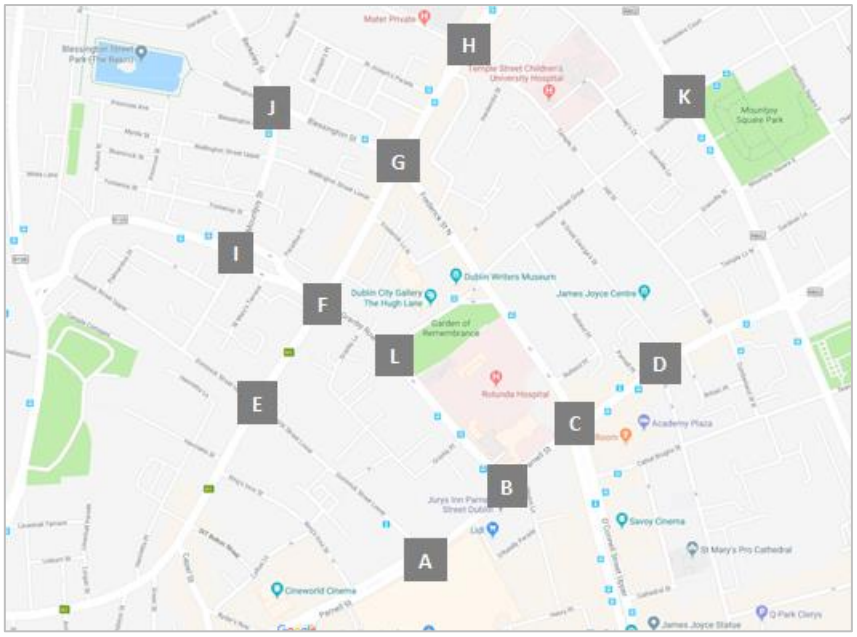

Figure 3: Journey Time Origin-Destination Points

The journey time outputs for 10 routes within the study area are summarised in Table 2. These results are also graphically presented in Figure 4.

Table 2: Journey Time Outputs

Item	Routes	Scenario 1 (DM)	Scenario 2	Scenario 3	Scenario 4
1	A-B-L-F-G-H	06:15	06:03	05:52	08:17
		Diff	-00:12	-00:24	02:02
		% Diff	-3.24%	-6.26%	32.40%
2	E-F-G-H	03:36	03:23	03:12	04:52
		Diff	-00:12	-00:24	01:17
		% Diff	-5.69%	-10.99%	35.56%
3	H-G-F-E	02:03	02:03	02:02	02:00
		Diff	00:00	-00:01	-00:03
		% Diff	0.00%	-0.27%	-2.18%
4	A-B-L-F-I-J	03:53	03:53	04:03	05:06
		Diff	00:00	00:10	01:13
		% Diff	0.00%	4.18%	31.32%
5	D-C-B-L-F-G	06:54	06:41	06:31	08:52
		Diff	-00:13	-00:23	01:58
		% Diff	-3.12%	-5.71%	28.54%
6	J-G-C	07:03	06:11	04:45	03:26
		Diff	-00:51	-02:18	-03:37
		% Diff	-12.16%	-32.63%	-51.23%
7	A-B-L-K*	08:12	08:27	09:01	10:25
		Diff	00:15	00:49	02:14

Item	Routes	Scenario 1 (DM)	Scenario 2	Scenario 3	Scenario 4
		% Diff	3.08%	9.97%	27.18%
8	**K-D-C-B-A**	06:51	06:36	06:32	06:22
		Diff	-00:15	-00:19	00:29
		% Diff	-3.72%	-4.68%	7.12%
9	**E-F-G-H-K**	05:56	05:52	05:25	07:00
		Diff	-00:04	-00:31	01:05
		% Diff	-1.03%	-8.65%	18.21%
10	**K-H-G-F-E**	04:05	04:03	04:05	04:02
		Diff	-00:02	00:00	-00:03
		% Diff	-0.62%	0.00%	-1.37%

*** A-B-L-F-G-H-K for Scenario 4 due to Parnell Sq North closure**

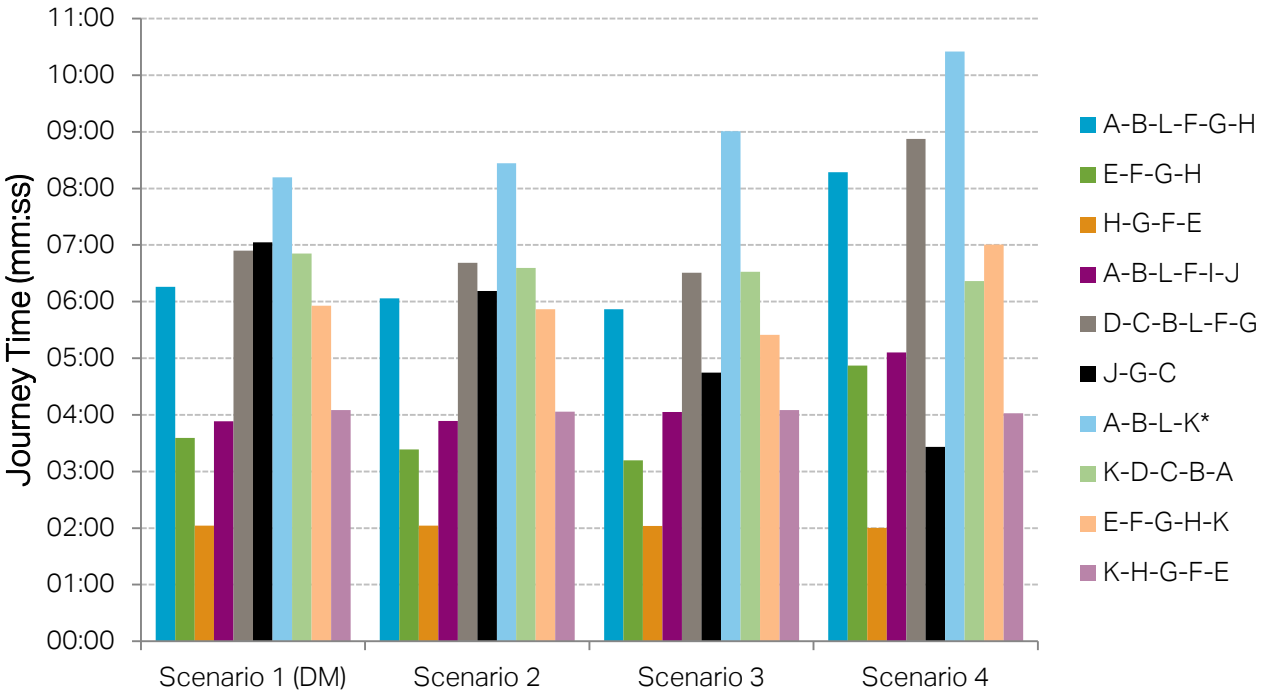

Figure 4: Journey Time Outputs Chart

It should be noted that the above results do not account for any interventions that may be implemented along diversion routes or signal optimisation.

The results above show that Scenario 2 generally shows improvement compared to Scenario 1. The highest decrease in journey time is 12% and is seen on the J-G-C along Frederick Street. This is due to the reduced conflict on Parnell Sq North/Frederick St Junction brought on by the removal of the existing right-turn flashing arrow and replacing it with the signal control. It is noted that journey time impacts on all routes are less than 1 minute. The journey time for routes A-B-F-I-J (Parnell St to Dorset Street) and H-G-F-E (Dorset Street southbound) remain unchanged.

Scenario 3 also shows improvement compared to Scenario 1 in general. The highest decrease in journey time is 32% and is seen on route J-G-C Frederick Street. This is due to the reduced flows on Parnell Sq North and reduced conflict on Parnell Sq North/Frederick St Junction brought by the vehicle restrictions and signal control changes. Apart from the route J-G-C Frederick Street, the journey time impacts are less than 1 minute. While Scenarios 2 and 3 both shows improvement compared to Scenario 1, the difference between the two scenarios is marginal.

In Scenario 4, the results show increases in journey time in general. The highest increase is 35% and is seen on route E-F-G-H Dorset Street northbound due to the additional delays at junctions caused by traffic diversions within the area when Parnell Sq North is closed for all traffic. The closure of Parnell Sq North is seen to add an average of 1.5 minutes based on routes with increased journey time.

3.1.1 Impact on Buses

In order to assess the impact of the schemes on buses, the journey time outputs for the existing and proposed bus routes on Parnell Sq North were also extracted from the model. The outputs are summarised in Table 3 and graphically presented in Figure 5. It is noted that when Parnell Sq North is closed to all traffic, the buses would have to traverse Mountjoy Street from Parnell Sq West and have to turn right onto Frederick Street. Figure 6 illustrates the proposed bus route when the Parnell Sq North is closed (Scenario 4).

Table 3: Journey Time Outputs for Buses

Item	Routes	Scenario 1 (DM)	Scenario 2	Scenario 3	Scenario 4
1	**A-B**	03:25	03:59	05:23	-
		Diff	00:34	01:58	-
		% Diff	16.6%	57.3%	-
2	**A-C-D-B**	-	-	-	05:55
		Diff	-	-	02:30
		% Diff	-	-	73.1%

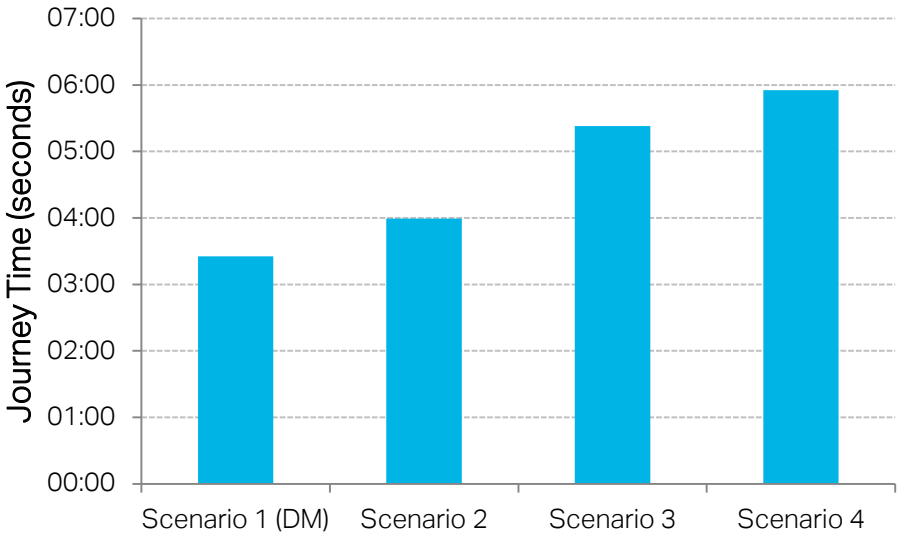

Figure 5: Journey Time Outputs for Buses

The lowest impact on bus journey time is 34 seconds and is seen on Scenario 2. In Scenario 3, even Parnell Sq North is only allowed for public transport, having a single lane is seen to increase the journey time by 2 minutes. In Scenario 4, the diversion route through Mountjoy Street when Parnell Sq North is closed is seen to increase the journey time by 2.5 minutes.

Figure 6: Existing and Proposed Bus Routes

3.2 Link Flows

Table 4 summarises the modelled link flows within the study area for all scenarios. In Scenario 1, there are 377 vehicles using the Parnell Sq North. The link flows for Scenario 1 is illustrated in Figure 7.

Table 4: Link Flows

Link	Dir	Scen 1 (DM)	Scen 2	Diff	% Diff	Scen 3	Diff	% Diff	Scen 4	Diff	% Diff
Parnell Sq North	EB	377	372	-5	-1.3%	270	-107	-28.4%	0	-377	-100.0%
Parnell Sq West	NB	911	904	-7	-0.8%	831	-80	-8.8%	637	-274	-30.1%
Parnell Sq East	SB	186	183	-3	-1.6%	161	-25	-13.4%	77	-109	-58.6%
Frederick St Nth	SB	90	94	4	4.4%	91	1	1.1%	119	29	32.2%
Dorset Street	NB	1433	1398	-35	-2.4%	1328	-105	-7.3%	1210	-223	-15.6%
	SB	1098	1083	-15	-1.4%	1091	-7	-0.6%	1048	-50	-4.6%
Mountjoy Street	NB	389	418	29	7.5%	547	158	40.6%	819	430	110.5%
	SB	233	233	0	0.0%	242	9	3.9%	234	1	0.4%
Parnell Street	EB	885	891	6	0.7%	836	-49	-5.5%	761	-124	-14.0%
	WB	515	535	20	3.9%	565	50	9.7%	673	158	30.7%

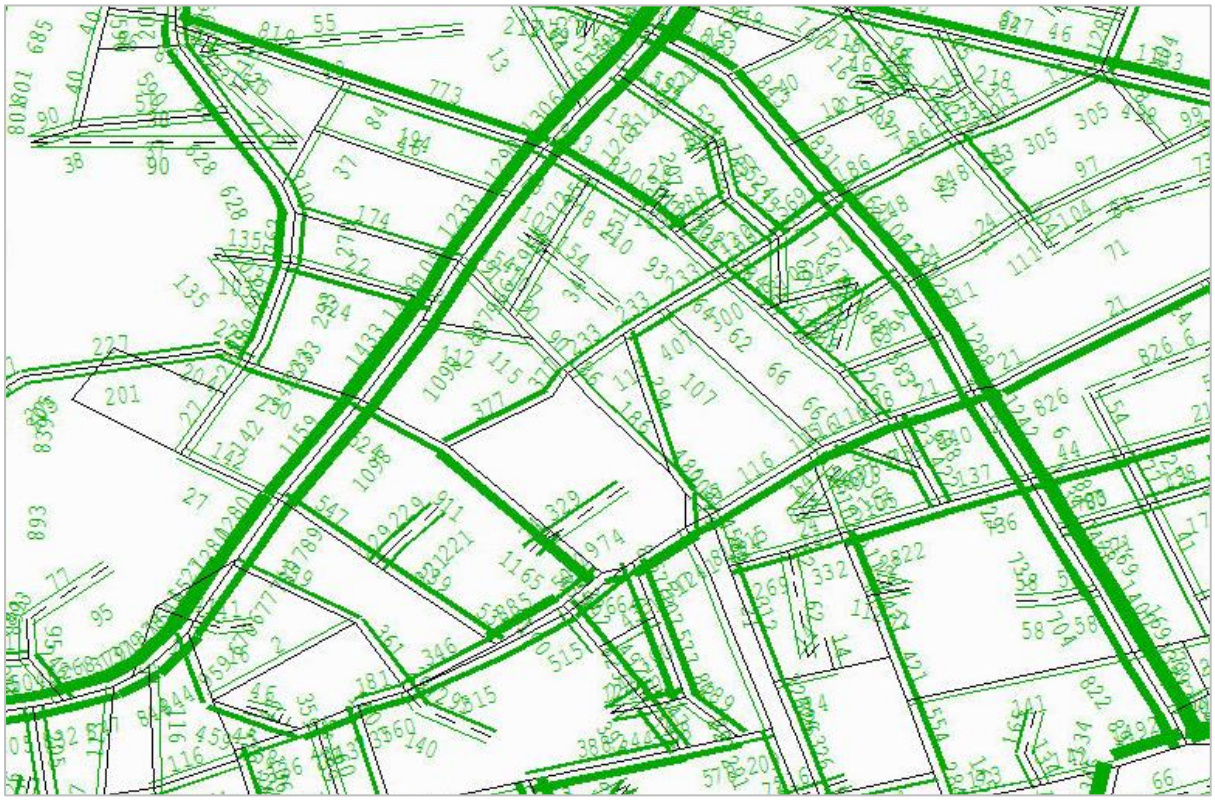

Figure 7: Link Flows – Scenario 1

The link flows difference plots for Scenarios 2, 3 and 4 are illustrated in Figures 8, 9 and 10, respectively. In the figures, green lines indicate an increase in flows while blue lines indicate a decrease as a result of each proposed intervention.

The difference plots, and Link Flows presented in the summary table above, show that in all scenarios, the highest increase in flows is seen on Mountjoy Street. Decreases are seen on Parnell Sq West. These impacts are generally caused by the diversion of flows from Parnell Sq due to the proposed layout in each scenario. In addition, the increase in flows on Granby Row introduced additional delay in the junction with Dorset Street particularly for the right-turn movement. There is a potential however that these delays could be minimised by increasing the right-turn throughput and the capacity of the junction.

It should be noted that the model shows up some route choice differences unrelated to the proposed schemes due to the strategic nature of the ERM and finely balanced route choice decisions which can alter based on minor unrelated impacts.

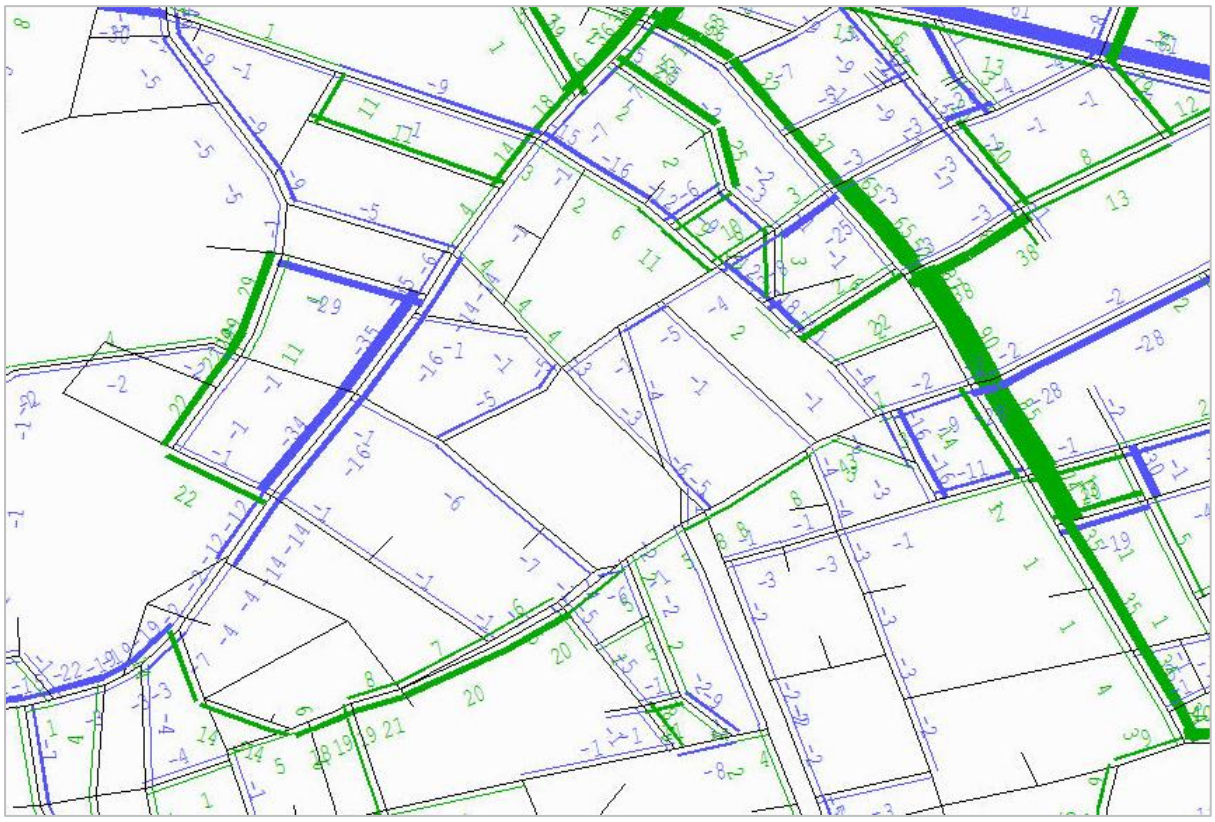

Figure 8: Link Flows Difference – Scenario 2 vs Scenario 1

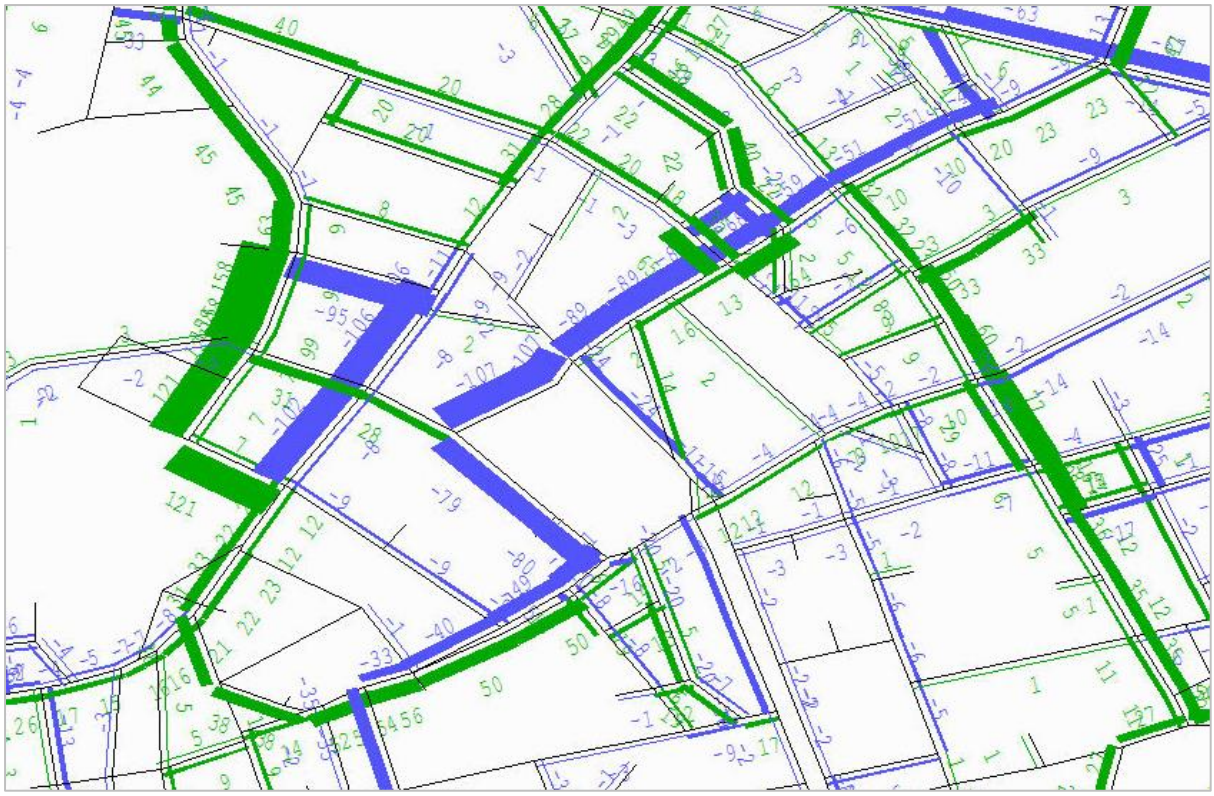

Figure 9: Link Flows Difference – Scenario 3 vs Scenario 1

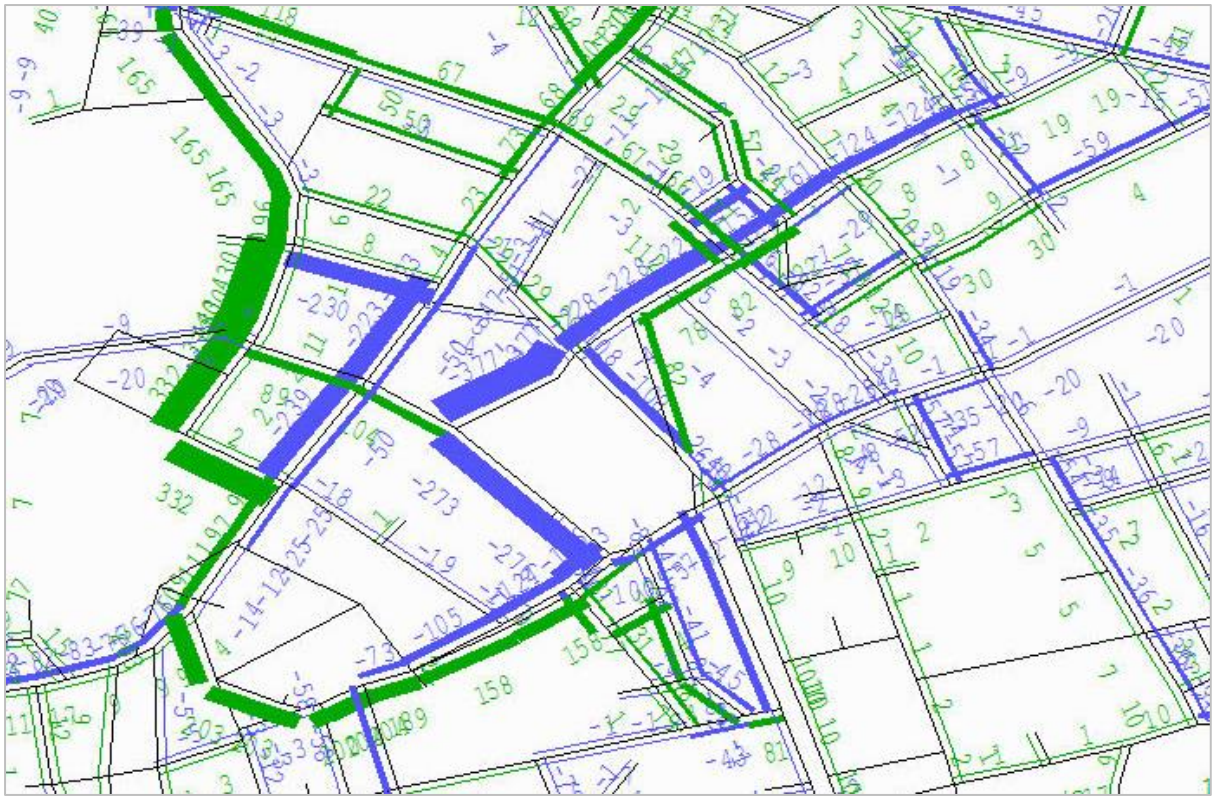

Figure 10: Link Flows Difference – Scenario 4 vs Scenario 1

4. Summary

In general, Scenarios 2 and 3 show improvement in local journey times within the study area. While decreases in journey times are seen in both scenarios compared to Do-Minimum, the overall difference between the two scenarios is marginal.

The closure of Parnell Sq North in Scenario 4 would bring negative impacts in terms of local journey times. An average increase of 1.5 minutes is seen for routes travelling via Parnell Sq West when Parnell Sq North is closed for all traffic.

The modelling also suggests that the schemes would bring additional delays on Granby Row/Dorset Street junction. These delays could be minimised by increasing the right-turn throughput and the capacity of the junction. This will also maximise the usage of the Parnell Sq West in all scenarios. Overall Scenarios 2 and 3 would appear to be preferred based on the strategic traffic assessment set out within this note. Other variables, such as local junction modelling and impact on active modes, should be taken into account as part of the final multi-criteria analysis to identify preferred scenario.

Appendix B - LinSig Analysis

Appendix B - Impact of Proposed Scheme on the Parnell Square North/Parnell Square East/Frederick Street North / Gardiner Row Junction

Introduction

The potential impact of the proposed scheme on the Parnell Square North/Parnell Square East/Frederick Street North/Gardiner Row junction has been assessed in this section. LinSig models have been built of the existing and proposed junction scenarios and a comparison of the impacts on the Degree of Saturation, Average Queue, Average Delay and Green Time has been provided. Figure 1 shows the location and existing layout of the modelled junction.

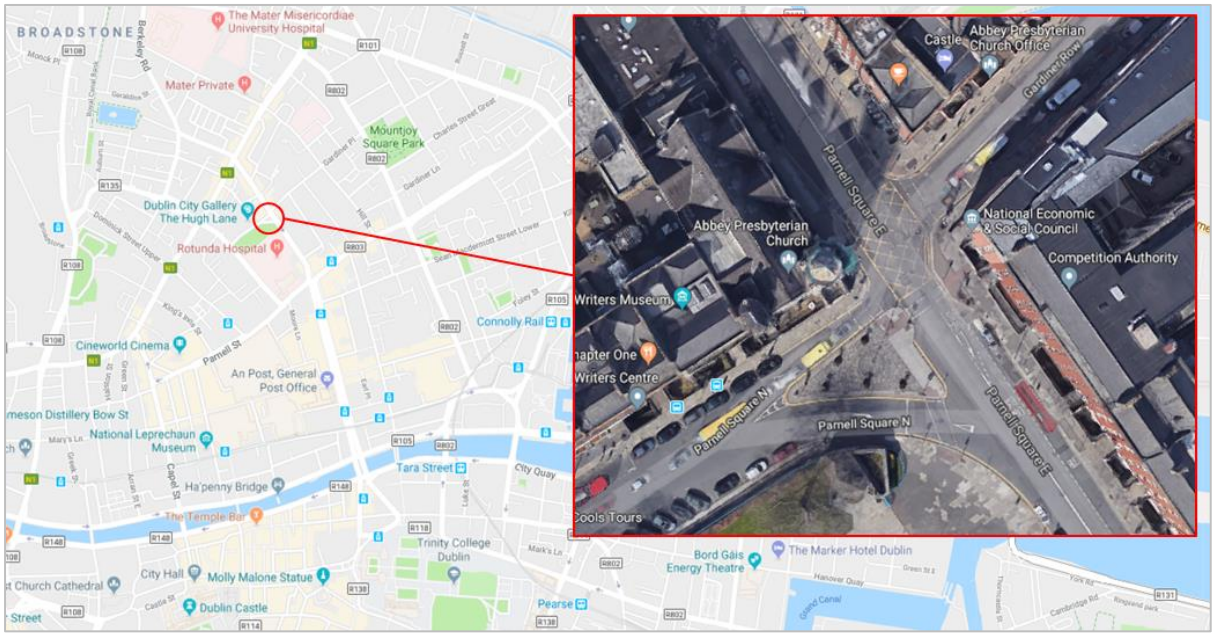

Figure 1: Parnell Square North/Parnell Square East/Frederick Street North/Gardiner Row Junction

Development Scenarios

This section presents the comparative traffic assessment of the impact of the proposed changes to the road layout on Parnell Square North. Four separate layouts were assessed, which are referred to as Scenarios 1 to 4 as outlined below.

Scenarios are set out as follows:

- Scenario 1 – Base Do-Minimum – with 2018 Traffic Demand;
- Scenario 2 – Parnell Square North with Two Lanes – with 2018 Traffic Demand;
- Scenario 3 – Parnell Square North with One Lane – with 2018 Traffic Demand; and
- Scenario 4 – Parnell Square North Closed to all Traffic (Ped Only) – with 2018 Traffic Demand.

In Scenario 4, it was assumed that all traffic currently running through Parnell Square North would divert to Frederick Street North.

LinSig Analysis

The outputs from the LinSig software present Degree of Saturation (DoS) and queue lengths as indicators of the operational efficiency of the junction. A Degree of Saturation of 100% indicates that the junction is operating at its theoretical maximum capacity; however, a value of approximately 90% is considered to be the optimum DOS for a traffic signal controlled junction.

Degree of Saturation

The comparison of maximum Degree of Saturation extracted from the LinSig models for the four scenarios are summarised in Table 1. These results are also graphically presented in Figures 2 and 3.

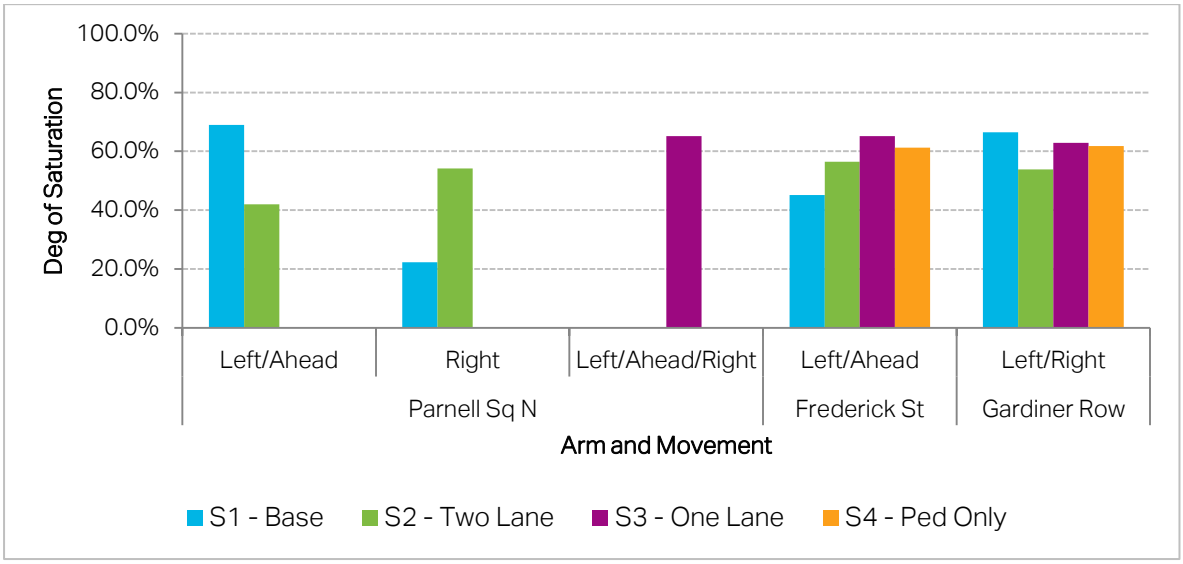

Figure 2: Degree of Saturation Results – AM Peak

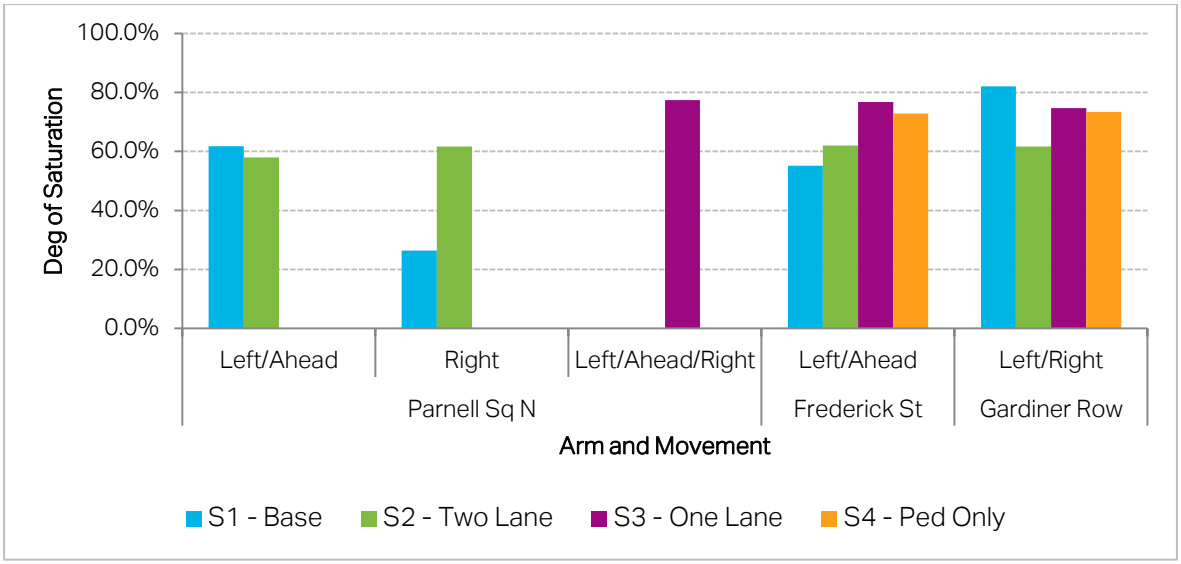

Figure 3: Degree of Saturation Results – PM Peak

There is a significant increase in DoS on the Parnell Square North Right Turning Lane between the Base and Scenario 2 in the AM and PM peak, given that it is removing the existing flashing arrow and replacing it with a signal control. Overall, the DoS increases again comparing Scenario 3 to Scenario 2, as it is proposed to further reduce the capacity on this arm of the junction by reducing the number of lanes from two to one.

On Frederick Street North, the DoS steadily increases from the Base scenario, to Scenario 2 and then Scenario 3. However, the DoS during Scenario 4 is slightly less than that of Scenario 3.

Table 1: Degree of Saturation Results

Peak Period	Lane	Movement	Deg Sat (%)									
			S1 - Base	S2	Diff	% Diff	S3	Diff	% Diff	S4	Diff	% Diff
AM Peak (08:15 - 09:15)	Parnell Sq N	Left/Ahead	69.0%	42.0%	-27.0%	-39.1%	-	-	-	-	-	-
		Right	22.3%	54.2%	31.9%	143.0%	-	-	-	-	-	-
		Left/Ahead/Right	-	-	-	-	65.2%	-3.8%	-5.5%	-	-	-
	Frederick St	Left/Ahead	45.2%	56.5%	11.3%	25.0%	65.2%	20.0%	44.2%	61.3%	16.1%	35.6%
	Gardiner Row	Left/Right	66.5%	53.9%	-12.6%	-18.9%	62.9%	-3.6%	-5.4%	61.8%	-4.7%	-7.1%
PM Peak (16:45 - 17:45)	Parnell Sq N	Ahead	61.8%	58.0%	-3.8%	-6.1%	-	-	-	-	-	-
		Right	26.4%	61.7%	35.3%	133.7%	-	-	-	-	-	-
		Left/Ahead/Right	-	-			77.4%	15.6%	25.2%	-	-	-
	Frederick St	Left/Ahead	55.1%	62.0%	6.9%	12.5%	76.7%	21.6%	39.2%	72.8%	17.7%	32.1%
	Gardiner Row	Left/Right	82.1%	61.7%	-20.4%	-24.8%	74.7%	-7.4%	-9.0%	73.4%	-8.7%	-10.6%

On Gardiner Row, the Base Scenario has the largest DoS. The DoS drops significantly from the Base to Scenario 2. Scenarios 3 and 4 have slightly higher DoS than Scenario 2, but still less than the Base scenario.

In must be noted that on all arms of the junction, in all scenarios, the DoS does not exceed 90%, the optimum DOS for a traffic signal controlled junction.

Delay

The comparison of Delay per Passenger Car Unit (PCU) were extracted from the LinSig models for the four scenarios which are summarised in Table 2 and graphically presented in Figures 4 and 5.

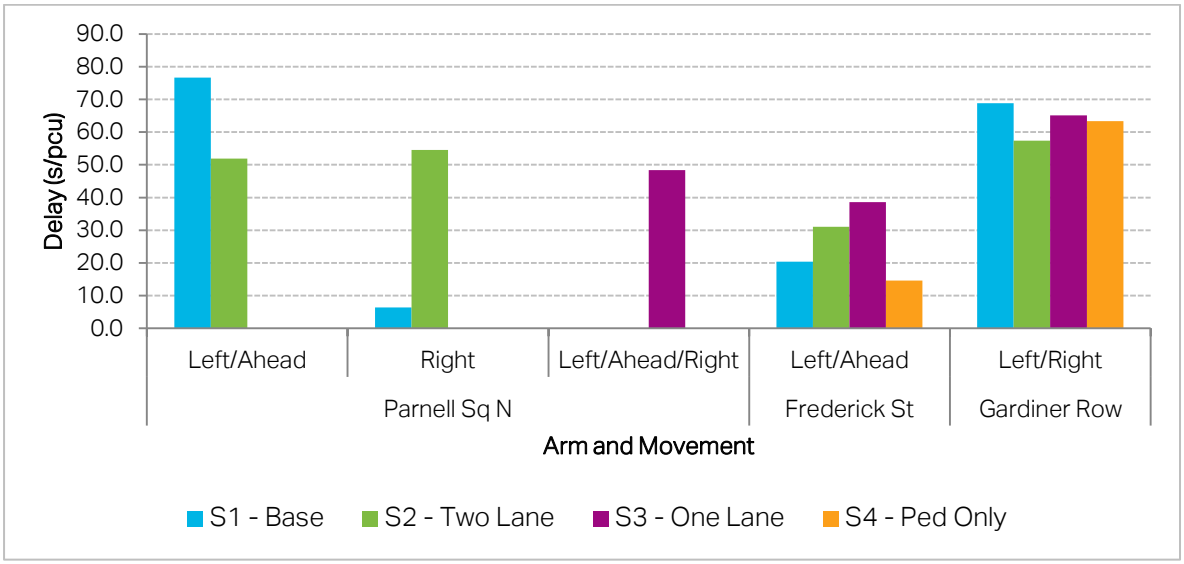

Figure 4: Delay Results – AM Peak

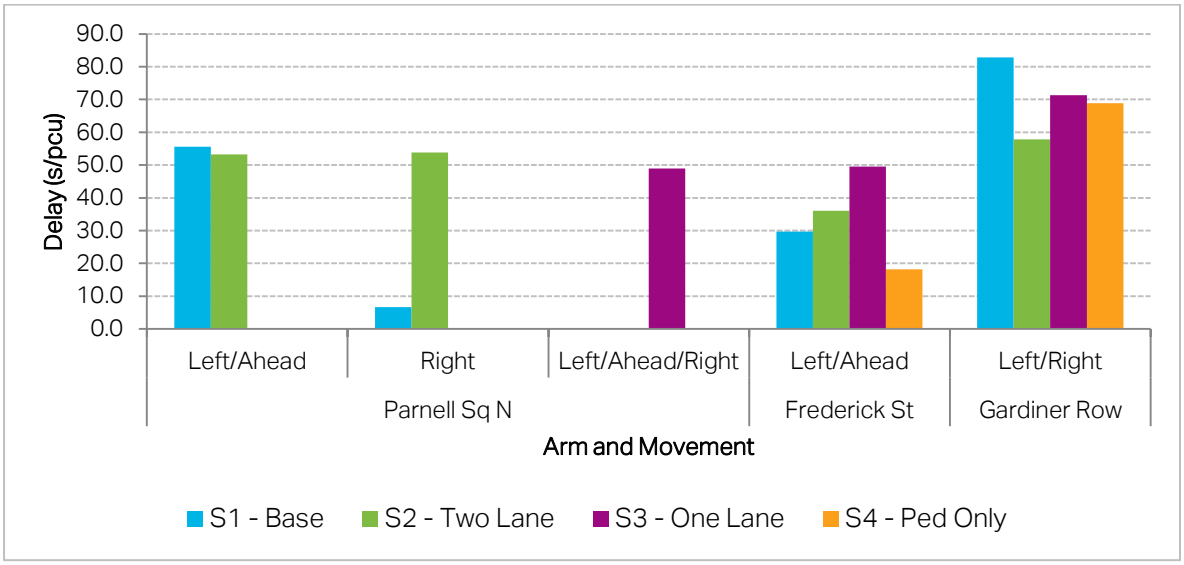

Figure 5: Delay Results – PM Peak

There is a significant increase in Delay on the Parnell Square North Right Turning Lane between the Base and Scenario 2 in the AM and PM peaks, given that it is removing the existing flashing arrow and replacing it with a signal control. The delay for the Left / Ahead arm is less in the AM but remains similar in the PM peak. There is a slight reduction in delay during Scenario 3 compared to Scenario 4.

Table 2: Delay Results

Peak Period	Lane	Movement	Ave. Delay (s/pcu)									
			S1 - Base	S2	Diff	% Diff	S3	Diff	% Diff	S4	Diff	% Diff
AM Peak (08:15 - 09:15)	Parnell Sq N	Left/Ahead	76.7	51.9	-24.8	-32.3%	-	-	-	-	-	-
		Right	6.4	54.5	48.1	751.6%	-	-	-	-	-	-
		Left/Ahead/Right	-	-	-	-	48.4	-28.3	-36.9%	-	-	-
	Frederick St	Left/Ahead	20.4	31.0	10.6	52.0%	38.6	18.2	89.2%	14.6	-5.8	-28.4%
	Gardiner Row	Left/Right	68.8	57.4	-11.4	-16.6%	65.1	-3.7	-5.4%	63.3	-5.5	-8.0%
PM Peak (16:45 - 17:45)	Parnell Sq N	Ahead	55.6	53.2	-2.4	-4.3%	-	-	-	-	-	-
		Right	6.7	53.8	47.1	703.0%	-	-	-	-	-	-
		Left/Ahead/Right	-	-			49.0	-6.6	-11.9%	-	-	-
	Frederick St	Left/Ahead	29.7	36.1	6.4	21.5%	49.5	19.8	66.7%	18.2	-11.5	-38.7%
	Gardiner Row	Left/Right	82.8	57.8	-25.0	-30.2%	71.3	-11.5	-13.9%	68.9	-13.9	-16.8%

On Frederick Street North, the delay steadily increases from the Base scenario, to Scenario 2 and then Scenario 3. However, the delay during Scenario 4 is significantly reduced compared to the other three scenarios.

On Gardiner Row, the Base Scenario has the largest delay. The delay drops significantly from the Base to Scenario 2. Scenarios 3 and 4 have slightly higher DoS than Scenario 2, but still less than the Base scenario.

Queue Length

Table 3 summarises the comparison of queue length extracted from the LinSig models for the four scenarios. These are also graphically presented in Figures 6 and 7.

Figure 6: Queue Results – AM Peak

Figure 7: Queue Results – PM Peak

The largest impact for Scenario 3 can be seen on the Parnell Square North arm of the junction, with an increase of 1 to 7 vehicles in the AM, and from 2 to 9 in the PM, given the scenario will upgrade this junction from a flashing arrow to signal controlled. Overall, the queueing remains the same comparing Scenarios 2 and 3, except as it is proposed to reduce the number of lanes from two to one, the queuing on the link will extend further down the road.

Table 3: Queue Results

Peak Period	Lane	Movement	Ave. Queue (pcu)									
			S1 - Base	S2	Diff	% Diff	S3	Diff	% Diff	S4	Diff	% Diff
AM Peak (08:15 - 09:15)	Parnell Sq N	Left/Ahead	6	5	-1	-19.4%	-	-	-	-	-	-
		Right	1	7	6	453.8%	-	-	-	-	-	-
		Left/Ahead/Right	-	-	-	-	12	5.9	95.2%	-	-	-
	Frederick St	Left/Ahead	11	14	3	24.5%	15	4	38.2%	17	6	53.6%
	Gardiner Row	Left/Right	7	6	-1	-8.7%	7	0	-2.9%	7	0	-4.3%
PM Peak (16:45 - 17:45)	Parnell Sq N	Ahead	8	8	0	-1.2%	-	-	-	-	-	-
		Right	2	9	8	416.7%	-	-	-	-	-	-
		Left/Ahead/Right	-	-			18	10	115.9%	-	-	-
	Frederick St	Left/Ahead	13	15	2	11.5%	17	4	29.8%	23	10	77.9%
	Gardiner Row	Left/Right	10	8	-2	-16.7%	9	-1	-7.3%	9	-1	-9.4%

On Frederick Street North, the queue length steadily increases from the Base scenario, to Scenario 2 and then Scenario 3. This is due to the reduced green time on the link, as more green time is given to Parnell Street North, as the capacity on this arm is reduced (explained further in the next section). Scenario 4 shows an increase in queuing as for this LinSig Analysis it was assumed that all the traffic currently using Parnell Square North will divert to Frederick Street.

On Gardiner Row, the queue length does not have a significant difference between the various scenarios, although it is at its lowest with Scenario 2.

Green Time

The comparison of green time extracted from the LinSig models for the four scenarios is summarised in Table 4 and graphically presented in Figures 8 and 9.

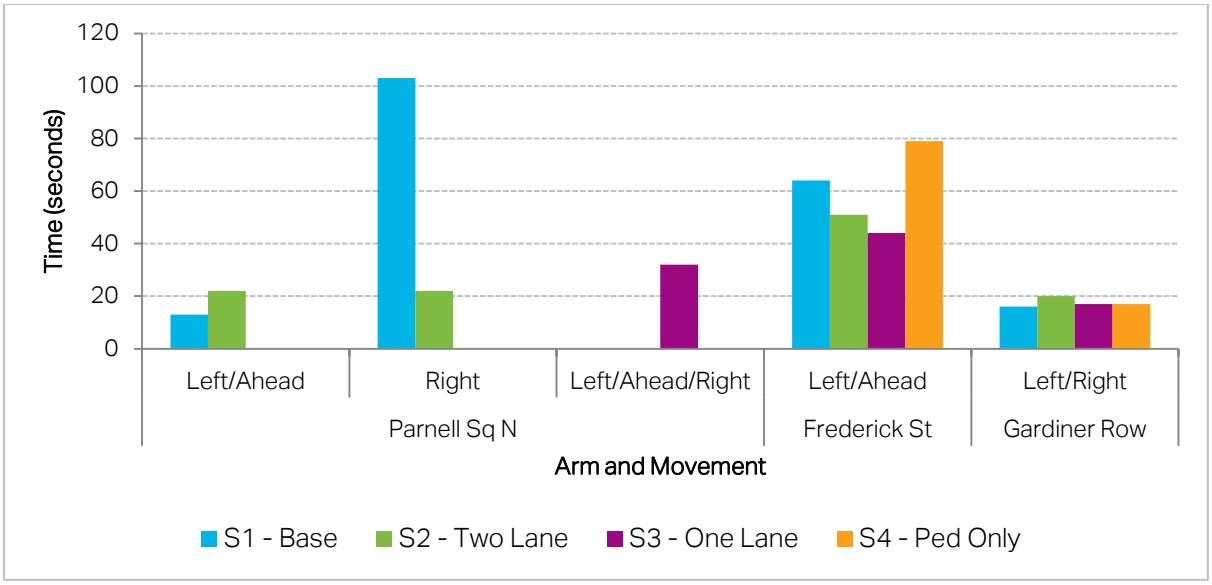

Figure 8: Green Time Results – AM Peak

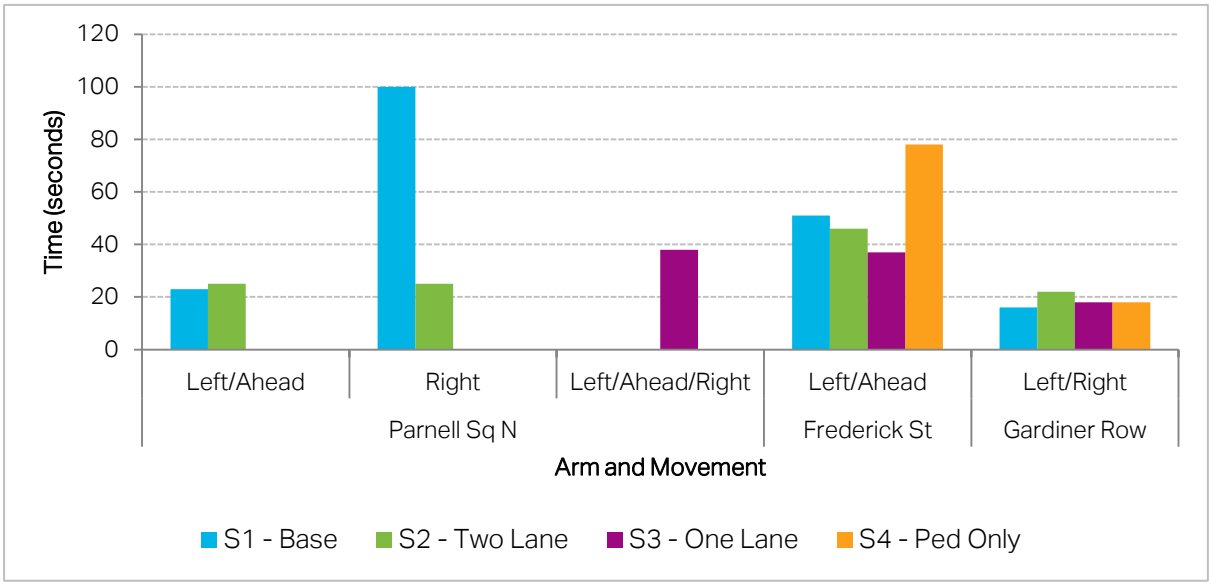

Figure 9: Green Time Results – PM Peak

Table 4: Green Time Results

Peak Period	Lane	Movement	Green Time (s)									
			S1 - Base	S2	Diff	% Diff	S3	Diff	% Diff	S4	Diff	% Diff
AM Peak (08:15 - 09:15)	Parnell Sq N	Left/Ahead	13	22	9	69.2%	-	-	-	-	-	-
		Right	103	22	-81	-78.6%	-	-	-	-	-	-
		Left/Ahead/Right	-	-	-	-	32	-71	-68.9%	-	-	-
	Frederick St	Left/Ahead	64	51	-13	-20.3%	44	-20	-31.3%	79	15	23.4%
	Gardiner Row	Left/Right	16	20	4	25.0%	17	1	6.3%	17	1	6.3%
PM Peak (16:45 - 17:45)	Parnell Sq N	Ahead	23	25	2	8.7%	-	-	-	-	-	-
		Right	100	25	-75	-75.0%	-	-	-	-	-	-
		Left/Ahead/Right	-	-	-	-	38	-62	-62.0%	-	-	-
	Frederick St	Left/Ahead	51	46	-5	-9.8%	37	-14	-27.5%	78	27	52.9%
	Gardiner Row	Left/Right	16	22	6	37.5%	18	2	12.5%	18	2	12.5%

The Base scenario shows the longest green time (100–103s) on Parnell Sq North right-turn movement during the peak periods, as this arm is currently on a flashing amber signal. However, in Scenario 2, the green time given to the right turners is dramatically reduced, at between 22 and 25 seconds.

In Scenario 3, additional green time is given to Parnell Square North, with a reduction in green time provided for Frederick Street North. In order to facilitate this increase in green time for Parnell Square North in Scenarios 2 and 3, less green time is provided for Frederick Street North.

There is a large increase of green time for Frederick Street North for Scenario 4. As Parnell Street is closed off to all traffic in this scenario, and there is an assumption that all its traffic is rerouted via Frederick Street North, this green time is needed to ensure large queues and delays do not form on this arm of the junction, and the Degree of Saturation remains under 90%.

Summary

In all scenarios, the DoS does not exceed 90%, the optimum DOS for a traffic signal controlled junction. However, from a comparison of the potential queues and delays at the proposed junctions, Scenario 2 operates more efficiently than Scenario 3.

Larger queues are formed on Frederick Street North in Scenario 4, compared to the other scenarios, but the total delay to this arm of the junction is reduced given that it has a longer green time.

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