Appendix H
Bus Stop Review Report

National Transport Authority

Belfield / Blackrock to City Centre Core Bus Corridor Scheme

Bus Stop Review Report

Issue | 4 March 2022

Job number 268401-00

Ove Arup & Partners Ireland Ltd

Arup
50 Ringsend Road
Dublin 4
D04 T6X0
Ireland
www.arup.com

ARUP

Contents

Appendices

1 Introduction

This report presents a summary of the Bus Stop Review process which was conducted for the Belfield / Blackrock to City Centre Core Bus Corridor (CBC) Scheme (hereinafter referred to as the 'Proposed Scheme').

The purpose of the process was to review the locations of the existing Dublin Bus stops and to determine whether a stop should be removed, relocated, or remain where it is. This exercise was carried out to optimise the performance of the bus services on the Proposed Scheme by reducing the journey time of the bus service, increasing the walking catchment of the bus stops and ensuring that key trip attractors located along the route are sufficiently covered within the catchment of bus stops.

In a number of locations, existing and proposed bus stops were therefore rationalised based on best practice principles related to bus stop placement. The outcome of this study was to develop a more efficient route which would attract more passengers by creating a wider population catchment and offer a shorter journey time to destinations.

The Proposed Scheme consists of five main sections, as follows:

- Section 1: Stradbrook Road to Booterstown Avenue;
- Section 2: Booterstown Avenue to Nutley Lane;
- Section 3: Merrion Road (Nutley Lane to Ballsbridge);
- Section 4: Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street Lower);
- Section 5: Nutley Lane (R138 to Merrion Road).

The information relating to each of these sections has been included in the analysis in Chapter 4.

2 Methodology

2.1 Overview

The methodology followed as part of this review is set out in the Bus Stop Review Methodology Report which is included in Appendix A of this report. The appended report outlines the methodology which was followed for the bus stop reviews, the various considerations to be made when assessing a stop location, and the background reasoning for those considerations.

Figure 2.1 presents a flowchart which outlines the methodology used.

Each of the study components as outlined below are discussed in more detail in the remainder of this report and applied to the Proposed Scheme.

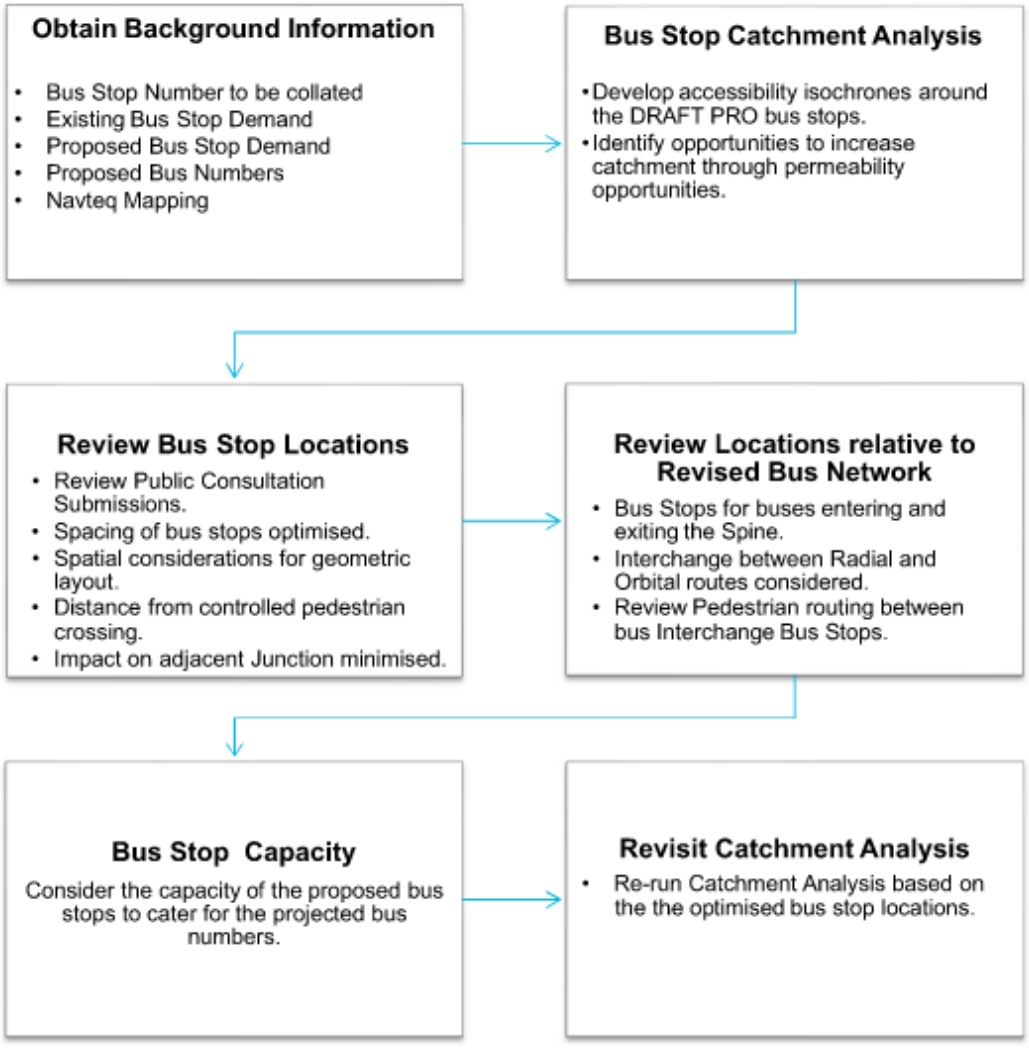


Figure 2.1: Bus Stop Review Methodology Flowchart

3 Background Information

In order to assess the bus stop locations with a variety of considerations in mind, certain key data was acquired, measured, or calculated. This information was compiled in a spreadsheet which is contained in Appendix B.

The background information obtained for the study along with the source of the information is within **Table 3.1**.

Table 3.1: Background information and sources

Information	Source
Stop Numbers for all inbound and outbound stops along the route	Dublin Bus Automatic Vehicle Location (AVL) Data
Stop Names	Dublin Bus AVL Data
Current Stop Location Coordinates	Google Maps (MyMaps .kml export)
Current distance to previous stop	Google Maps (Measured)
Stop location as per PRO (relative to existing location)	PRO Design Drawings
PRO Distance to previous stop	PRO Design Drawings & Google Maps
Peak Boarding and alighting volumes & Times	NTA
Future Buses per Hour	Planned bus schedule based on 2028 modelled scenario (provided by Systra)
Current Distance to junction/ped crossing	Google Maps (Measured)
PRO distance to junction/ped crossing	PRO Design Drawings & Google Maps
Potential for interchange with Orbital Routes	BusConnects Revised Network Layout

4 Existing Bus Stop Catchment analysis

To develop a baseline against which any bus stop relocation recommendations could be tested, a catchment analysis was conducted on existing populations living and working up to a 20-minute walk from existing bus stops. This was chosen as the upper limit as any longer than 20 minutes is deemed to be an unreasonable distance to walk to a bus stop for the purposes of this assessment. This analysis was carried out with Geographic Information System (GIS) software using Navteq mapping as the network dataset, along with the coordinates of the existing bus stop locations. The current catchment of both the inbound and the outbound bus stops at their existing locations are shown in 5 minute walking intervals up to 20 minutes in **Figure 4.1** to **Figure 4.4**.

4.1 Inbound

Figure 4.1 and **Figure 4.2** show the catchments for the existing bus stop locations for the inbound bus stops on the scheme.

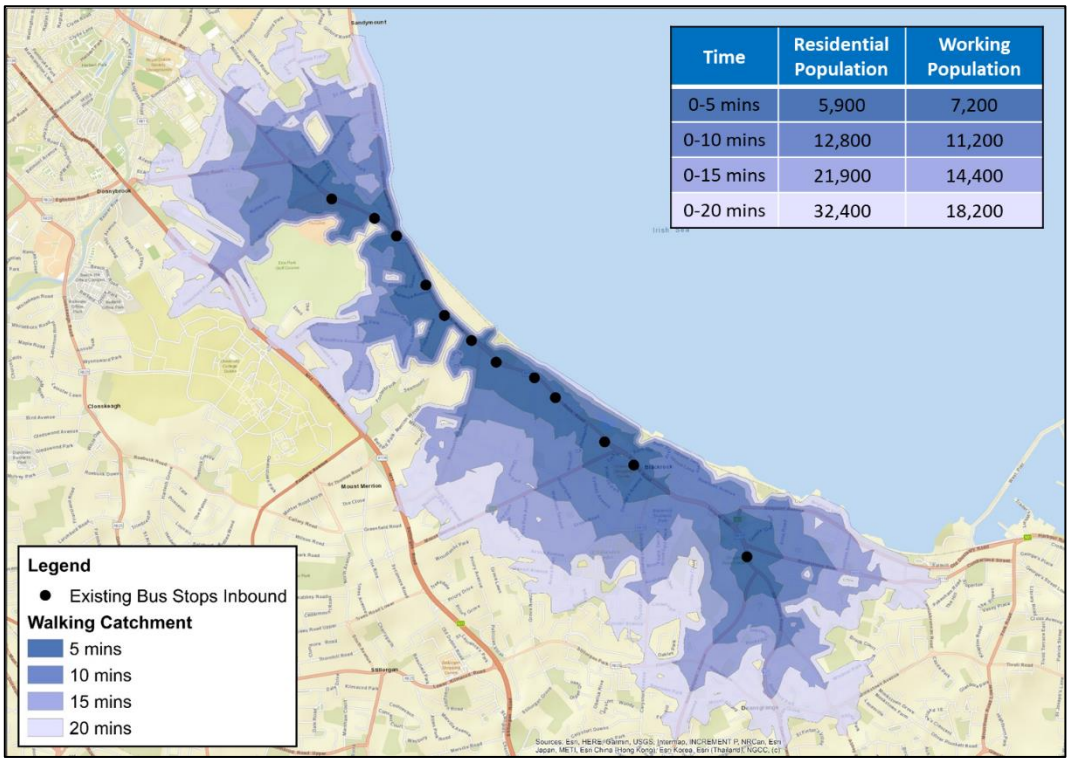


Figure 4.1: Sections 1 and 2 Existing Inbound Bus Stop Catchments

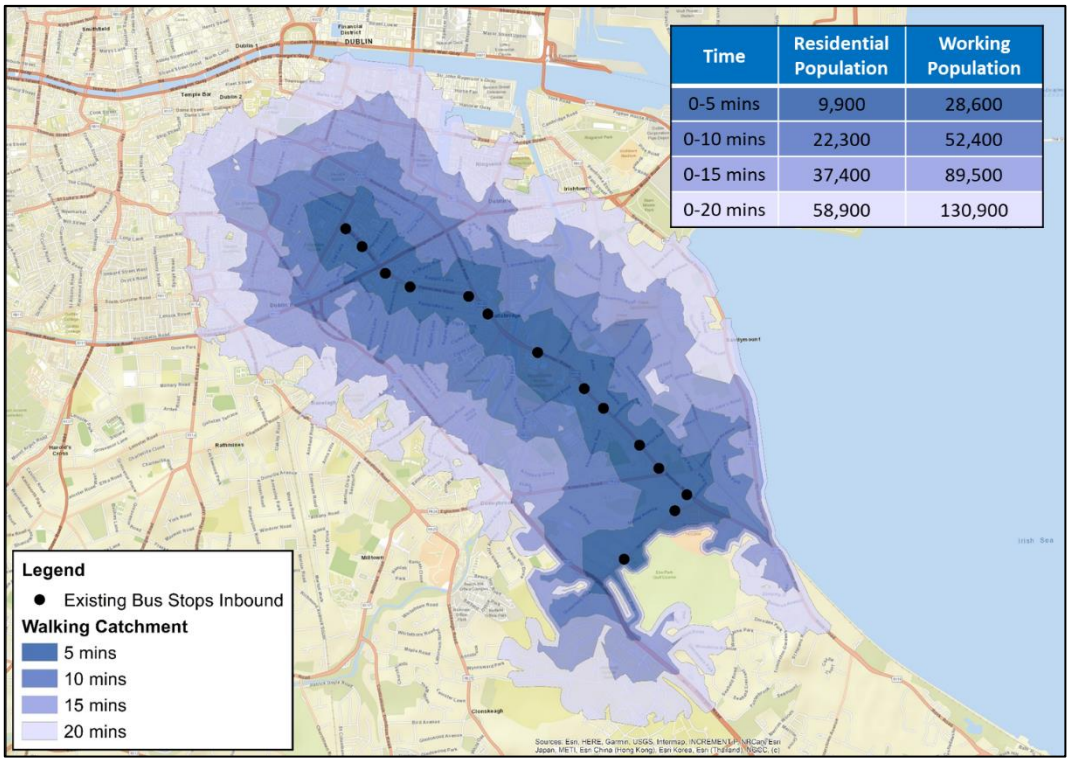


Figure 4.2: Sections 3, 4, and 5 Existing Inbound Catchments

4.2 Outbound

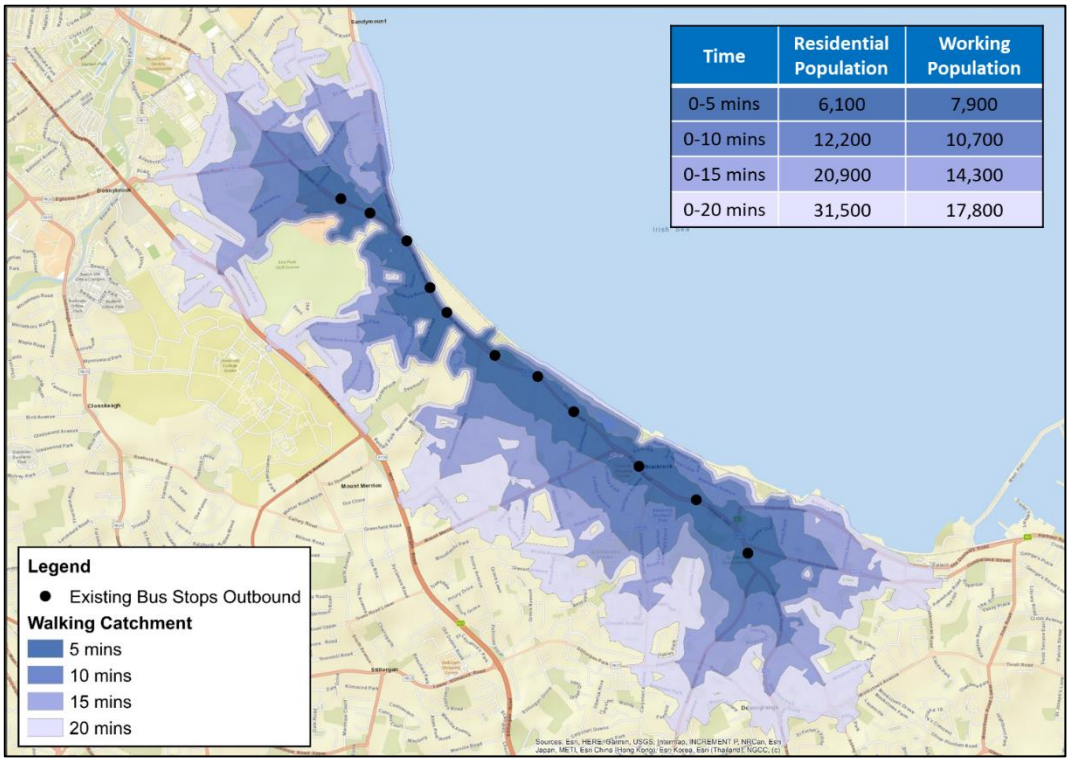


Figure 4.3: Sections 1 and 2 Existing Outbound Bus Stop Catchments

Figure 4.3 and **Figure 4.4** show the catchments for the existing bus stop locations for the outbound stops on the scheme.

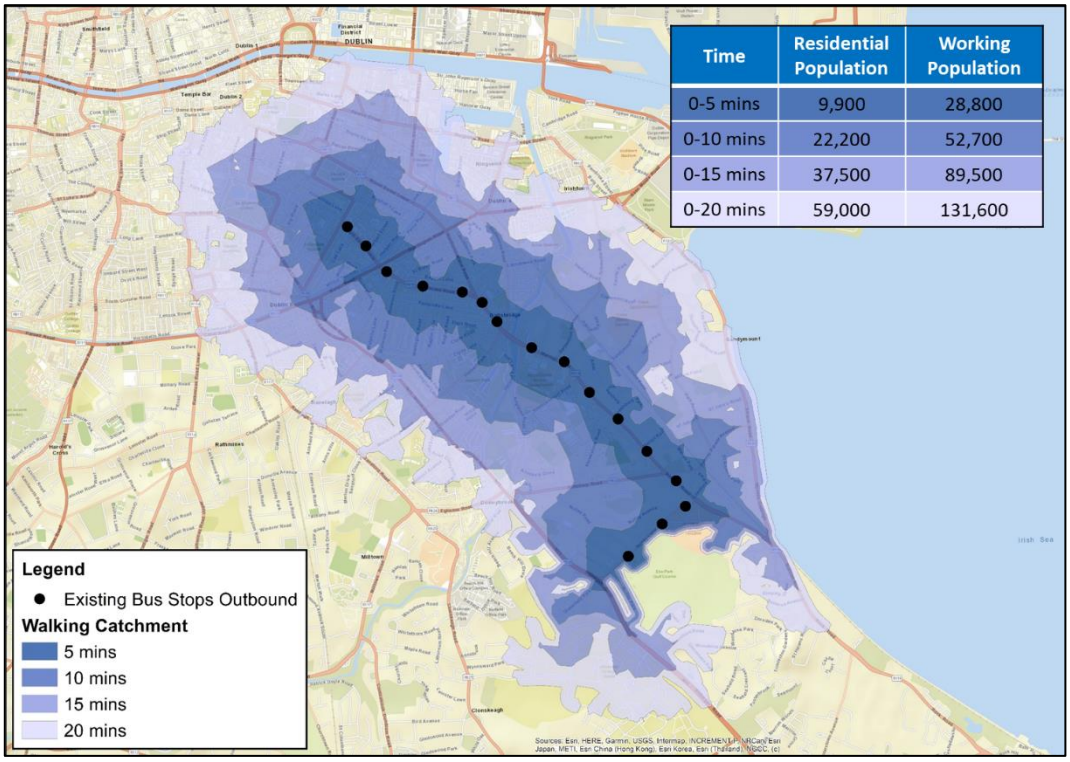


Figure 4.4: Sections 3, 4 and 5 Existing Outbound Bus Stop Catchments

5 Bus Stop Location Review

The locations of the bus stops were reviewed in accordance with the 'Bus Stop Review Methodology Report' included in Appendix A.

Appendix B includes a table of features for each bus stop which was used when considering the possible relocation of each bus stop.

The main principles considered as part of the review are as follows:

- Aim to achieve a bus stop spacing of 400m in suburban locations, and 250m in urban centres;
- Locate bus stop to nearest junction/pedestrian crossing;
- Locate bus stop downstream of junction rather than upstream;
- Consider space requirements to provide bus stop including shelter, waiting area, cycle lane and footpath provision and information displays;
- Review existing and proposed boarding & alighting volumes to determine the size of the bus stop; and
- Consider the potential for interchange with orbital bus services proposed as part of the New Dublin Area Bus Network.

The above principles were considered to determine whether a bus stop should remain where it is, relocated or be removed.

If a bus stop was found to be spaced at an acceptable interval, located optimally in relation to a junction or pedestrian crossing, frequently used, and serving key land uses sufficiently, the default decision was to maintain it in its current position.

If it was found that access to a bus stop could be improved by relocating it to a better proximity in relation to local features or to better align with the principles outlined above, the decision was made to move it if feasible to do so. This would typically include cases where bus stops are currently upstream from a junction or crossing, or when the stop is not located optimally in terms of a catchment area or key land use access.

When a bus stop was found to be too close to a previous or following stop, the decision was made to either remove the bus stop or to consolidate it with another stop to obtain better spacing intervals if feasible to do so. This was an iterative process with the location of bus stops considered on an individual basis, but also within the context of all other bus stops on the scheme.

The location of existing bus stops and the proposed locations as a result of the review are illustrated in Figures C.1 to C.10 in Appendix C.

6 Revisited Catchment Analysis

Following the review of bus stop locations, the catchment analysis was re-run to review the impact of the changes on the bus network. The results of this assessment are presented in **Figure 6.1** to **Figure 6.4** with the catchment population numbers presented in **Table 6.1** to **Table 6.8**.

The catchment population comparison tables present the number of residents and employees within each catchment zone for the existing and proposed bus stop locations, along with the difference between them.

These figures were calculated using Small Areas and Workplace Zones from the 2016 Census. When only part of a zone was located within the catchment zone, the population of the zone was divided proportionally to the area of the zone covered by the catchment.

6.1 Inbound

Figure 6.1 and **Figure 6.2** show the catchments for the proposed bus stop locations for the inbound direction.

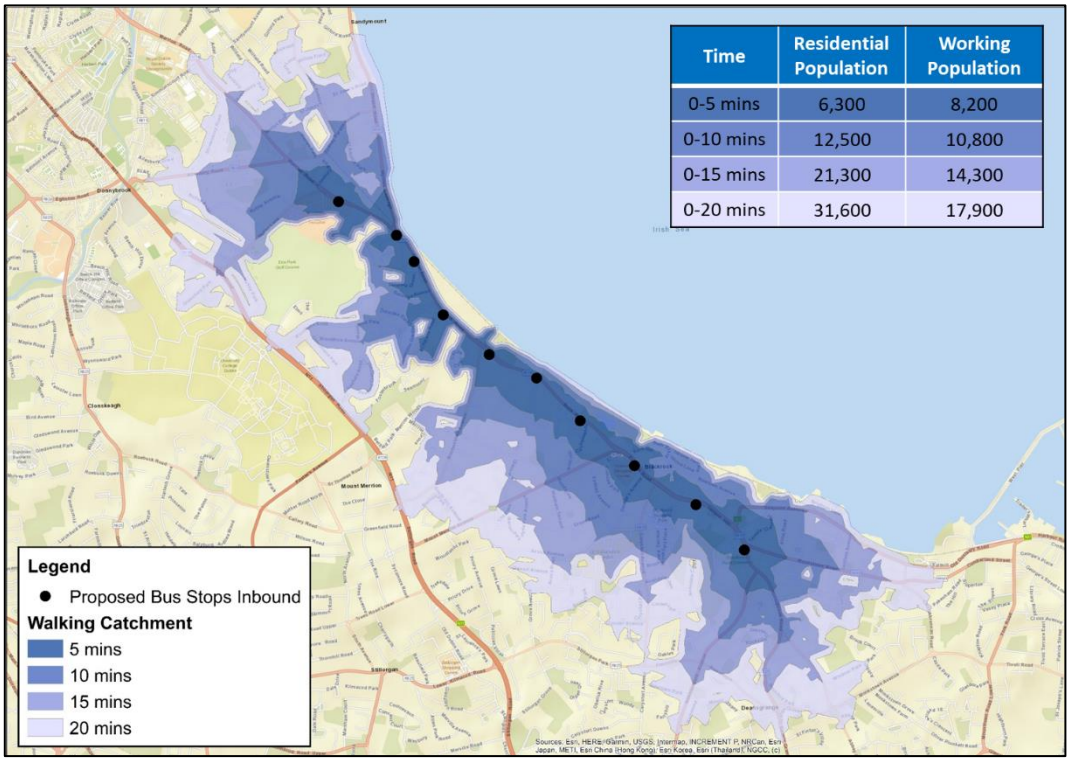


Figure 6.1: Sections 1 and 2 Proposed Inbound Bus Stop Catchments

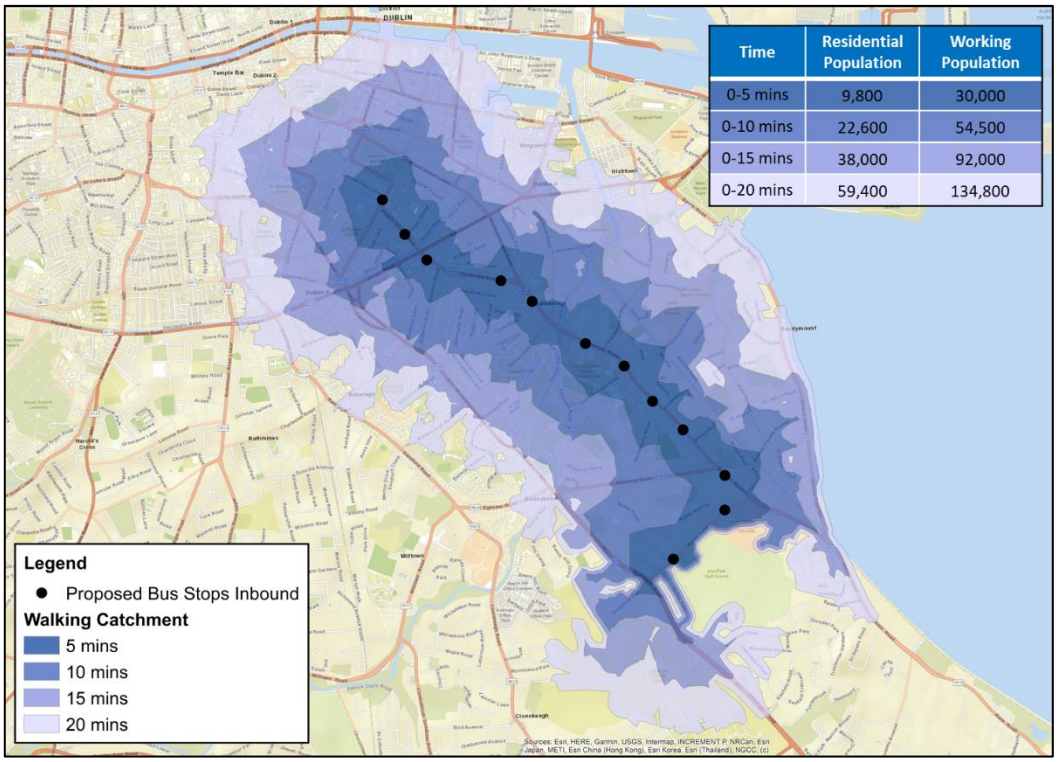


Figure 6.2: Sections 3, 4 and 5 Proposed Inbound Bus Stop Catchments

Table 6.1 to **Table 6.4** show the existing and proposed catchment populations and indicates the change that occurred as a result of the bus stop relocation proposals, for both the residential and workplace populations.

Table 6.1: Sections 1 and 2 Inbound Residential Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	5900	6300	400
0-10	12800	12500	-300
0-15	21900	21300	-600
0-20	32400	31600	-800

Table 6.2: Sections 1 and 2 Inbound Workplace Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	7200	8200	1000
0-10	11200	10800	-400
0-15	14400	14300	-100
0-20	18200	17900	-300

From the tables above, it can be seen that the proposed bus stop locations on Section 1 and 2 generally bring about an increase in the 0-5 minute catchment, and a minimal decrease in the wider catchments for both the residential and workplace catchments.

The increase is due to the addition of the new stop at Barclay Court, which increases the local 0-5 minute catchment at this area, however, this benefit is less prominent in the larger catchment zones as its catchment zone overlaps with the bus stops before/after. The slight decrease is largely due to the repositioning of both the first and last stops on the route, resulting in a perceived loss in catchment, which in reality will be covered by other bus stops further along the route.

For Section 3, 4 and 5, the only decrease is seen in the 0-5 minute residential catchment. From looking at the overlap maps in Appendix D, it can be seen that this is largely due to some catchment area being lost along Northumberland Road.

Table 6.3: Sections 3, 4 and 5 Inbound Residential Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	9900	9800	-100
0-10	22300	22600	300
0-15	37400	38000	600
0-20	58900	59400	500

Table 6.4: Sections 3, 4 and 5 Inbound Workplace Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	28600	30000	1400
0-10	52400	54500	2100
0-15	89500	92000	2500
0-20	130900	134800	3900

From the tables above, it can be seen that the proposed bus stop locations on Sections 3, 4 and 5 generally bring about an increase for both the residential and workplace catchments, with the exception of the residential 0-5 minute catchment. This is likely due to the consolidation and spacing improvements made in the northern parts of the Proposed Scheme, resulting in a very slight loss in catchment in the local 0-5 minute catchment area, but is not perceived in the wider catchments as the catchment zones for the bus stops overlap more. The increases seen for the workplace populations are higher, which is likely due to the extent to which these sections of the Proposed Scheme pass through the city centre and the Ballsbridge and Baggot Street Upper retail area which have a higher density of commercial uses.

6.2 Outbound

Figure 6.3 and **Figure 6.4** show the catchments for the proposed bus stop locations for the outbound direction.

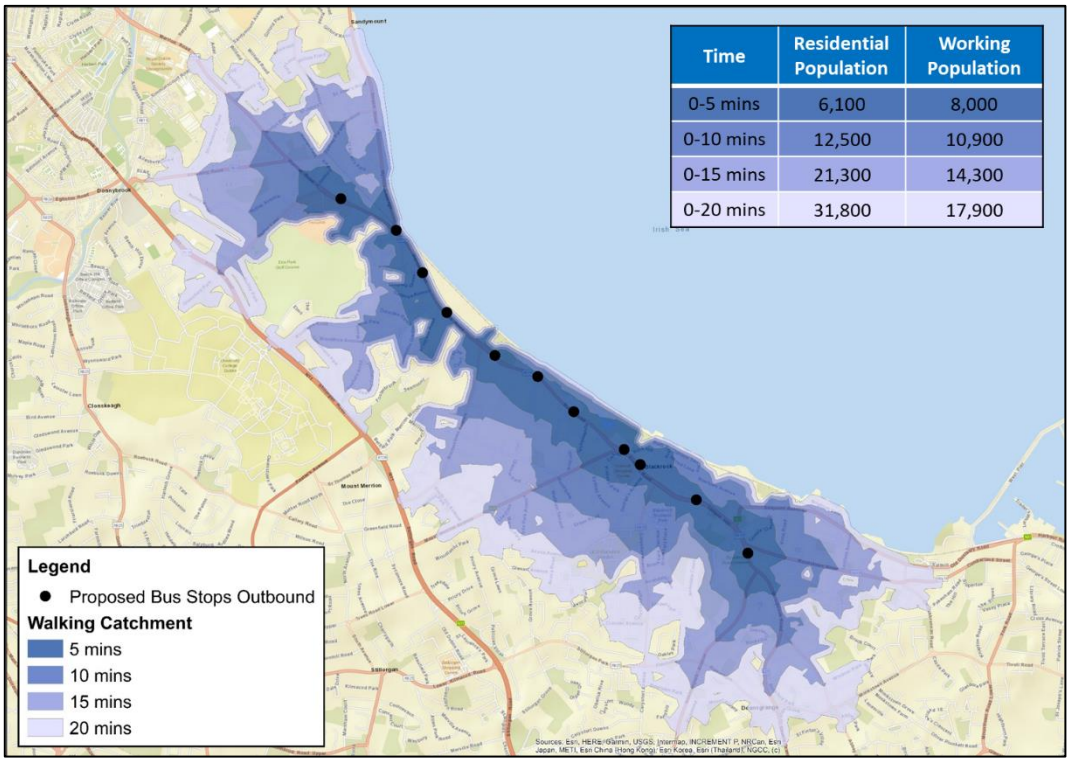


Figure 6.3: Sections 1 and 2 Proposed Outbound Bus Stop Catchments

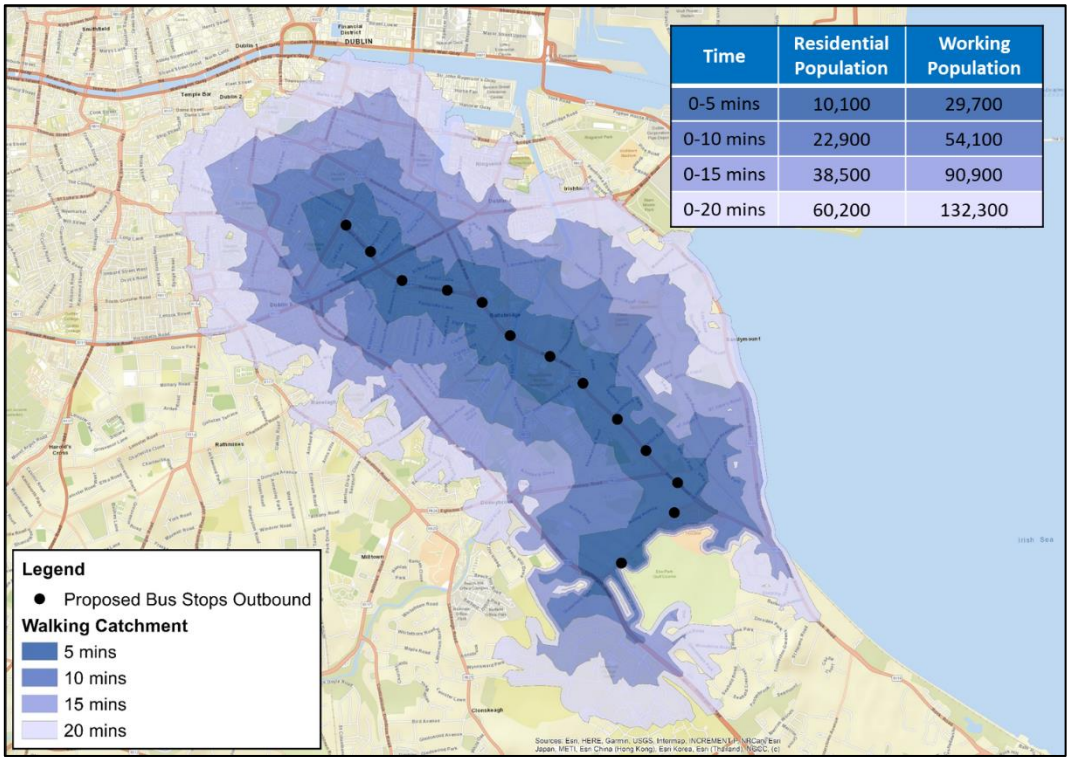


Figure 6.4: Sections 3, 4 and 5 Proposed Outbound Bus Stop Catchments

Table 6.5 to **Table 6.8** show the existing and proposed catchment populations and indicates the change that occurred as a result of the bus stop relocation proposals, for both the residential and workplace populations.

Table 6.5: Sections 1 and 2 Outbound Residential Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	6100	6100	0
0-10	12200	12500	300
0-15	20900	21300	400
0-20	31500	31800	300

Table 6.6: Sections 1 and 2 Outbound Workplace Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	7900	8000	100
0-10	10700	10900	200
0-15	14300	14300	0
0-20	17800	17900	100

From the tables above, it is noted that the proposed bus stop locations bring about an increase in both residential and workplace catchments for Sections 1 and 2.

Table 6.7: Sections 3, 4 and 5 Outbound Residential Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	9900	10100	200
0-10	22200	22900	700
0-15	37500	38500	1000
0-20	59000	60200	1200

Table 6.8: Sections 3, 4 and 5 Outbound Workplace Catchment Populations

Catchment	Existing	Proposed	Difference
0-5	28800	29700	900
0-10	52700	54100	1400
0-15	89500	90900	1400
0-20	131600	132300	700

From the tables above, it can be seen that the proposed bus stop locations generally bring about an increase in both residential and workplace catchments for Sections 3, 4 and 5. The workplace population increases to a greater extent than the residential populations, which is likely due to the extent to which these sections of the Proposed Scheme pass through the city centre and the Ballsbridge and Baggot Street Upper retail area, which have a higher density of commercial uses.

7 Scheme Summary

Table 7.1 and **Table 7.2** outline a summary of the outcome of the bus stop review process.

Table 7.1: Belfield / Blackrock to City Centre Inbound Route Summary

Number of Existing Stops	26
Number of Stops Moved	10
Number of Stops Removed	5
Number of Stops Added	1

Table 7.2: Belfield / Blackrock to City Centre Outbound Route Summary

Number of Existing Stops	28
Number of Stops Moved	12
Number of Stops Removed	4
Number of Stops Added	0

On the inbound route, ten of the 26 bus stops are proposed to be moved. Five bus stops are proposed to be removed from the route, and one to be added, reducing the total number of inbound bus stops from 26 to 22.

On the outbound route, twelve of the 28 bus stops are proposed to be moved. Four bus stops are proposed to be removed, and no bus stop is proposed to be added, reducing the total number of outbound bus stops from 28 to 24.

8 Private Coach Bus Stops

8.1 Overview

Consideration was also given to locations where private coaches may be required to stop along the Proposed Scheme, particularly those serving the airport which could require longer dwell time to allow passengers to load/unload their luggage. In these cases, and where space has permitted, separate lay-by bus stops have been proposed in the locations shown in **Figure 8.1**.

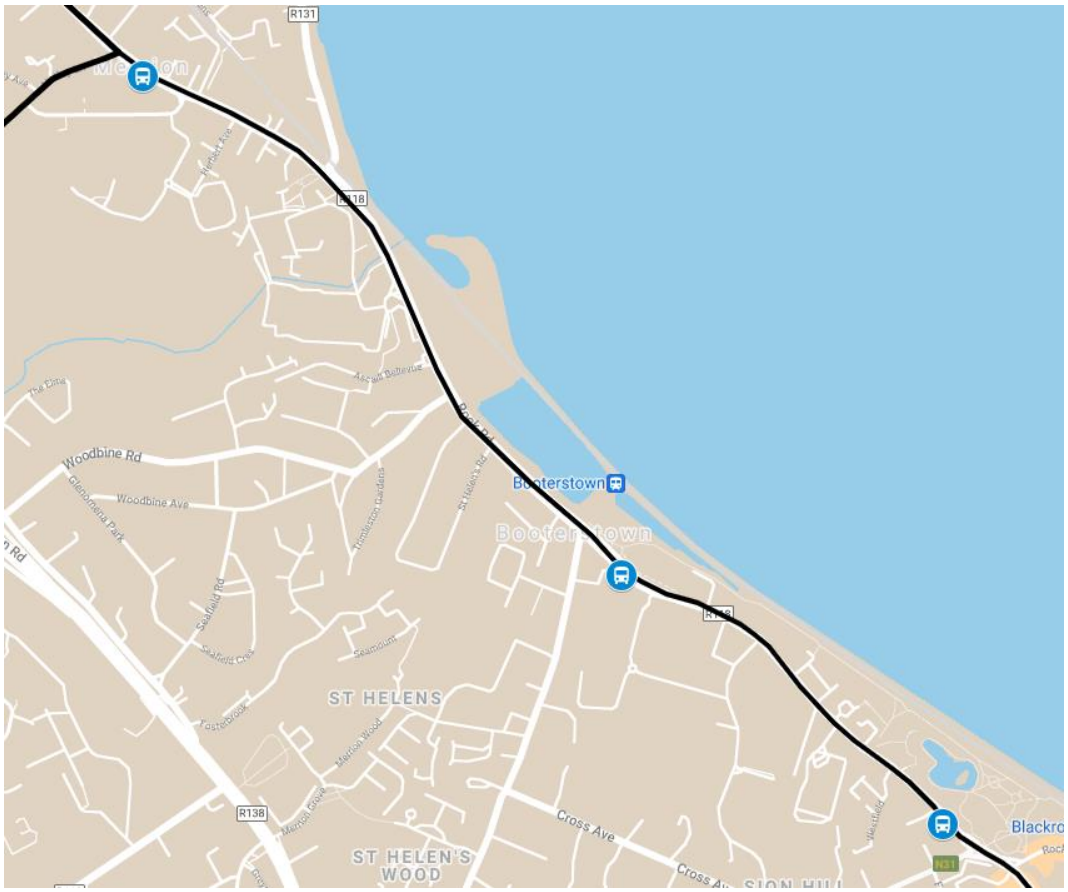


Figure 8.1: Lay-by Bus Stop Landing Zone Arrangement (Private Service Coaches)

Table 8.1 below outlines the name and chainages of the three proposed private coach stops.

Table 8.1: Private Coach Bus Stops

Inbound/ Outbound	Bus Stop Name	Chainage
Inbound	Mount Merrion Avenue	A1325
Inbound	Booterstown Ave	A2275
Inbound	St Vincent's University Hospital	A3900

9 Conclusion

A bus stop review was carried out for the Belfield / Blackrock to City Centre CBC Scheme. The purpose of the exercise was to rationalise the bus stop locations to reduce the total journey time of bus services on the Proposed Scheme and to improve the catchment of the bus stops.

The study was carried out by reviewing key features of the inbound and outbound bus stops including location, proximity to junctions, road crossings and major land use attractions next to the route. The study also reviewed existing and projected passenger volumes and local considerations such as space to provide shelters, waiting areas, footpath and cycle routes.

As part of the exercise, population catchment analysis has been carried out to demonstrate the impact of the proposed recommendations. The results show that the catchment footprints along the routes have increased to some extent to include larger residential and employment populations. This is largely due to the improved spacing of the bus stops, and the fact that bus stops are positioned closer to intersections, resulting in the catchment area spreading further along the orbital/side roads.

It is recommended to relocate 22 (42%) of the existing bus stops (inbound and outbound) along the Proposed Scheme. It is also proposed to remove nine bus stops from the Proposed Scheme, and to add one bus stop, such that in this case the number of stops on the Proposed Scheme will reduce from 54 to 46.

It is expected that the overall bus journey time along the Proposed Scheme will be optimised as a result of these changes, while also maximising catchment. The removal and consolidation of bus stops will lead to less time lost due to dwell times at stops and the associated time lost due to deceleration and acceleration before and after the bus stops. Additionally, operational improvement such as the placement of bus stops after junctions should serve to reduce journey times as well as improve visibility at junctions.

Appendix A

Bus Stop Review Methodology

Bus Stop Review Methodology (REV 3)

Project name	Date	Prepared by
Bus Connects Core Bus Corridor	21 June 2020	Joe Seymour - AECOM

1.0 Introduction

The location and design of bus stops will be critical to the success of the operation of BusConnects Dublin. Bus stop catchment areas and safety will need to be maximised, the size of the stop needs to be sufficient to meet the expected passenger and bus demand, and the bus stop itself must not become a bottle neck to the operation of the corridor. This methodology outlines how each corridor shall be assessed so as the location and operation of bus stops can be optimised.

This Note does not relate to the physical layout of the bus stops which is addressed in Chapter 11 of the Preliminary Design Guidance Booklet, although spatial considerations are discussed in section 5.4. Standard details for bus stop layouts are to be included in the next draft of the Design Guidance Booklet.

It is important to note that existing bus stops located along the Core Bus Corridors will have been subject to considerable thought by Bus Operators, An Garda Siochana, and the Local Authority. For this reason, it is imperative that each location is closely examined before it is considered for relocation or removal.

For avoidance of doubt this manual assumes the standard bus is a twin axle double decker bus (10 to 11m in length) with a front and middle doors. Other vehicles, such as 3-axle double decker, are in use by Dublin Bus and should be considered when undertaking the Geometric Design.

Figure 1.2 Standard Bus being used on the CBC's.

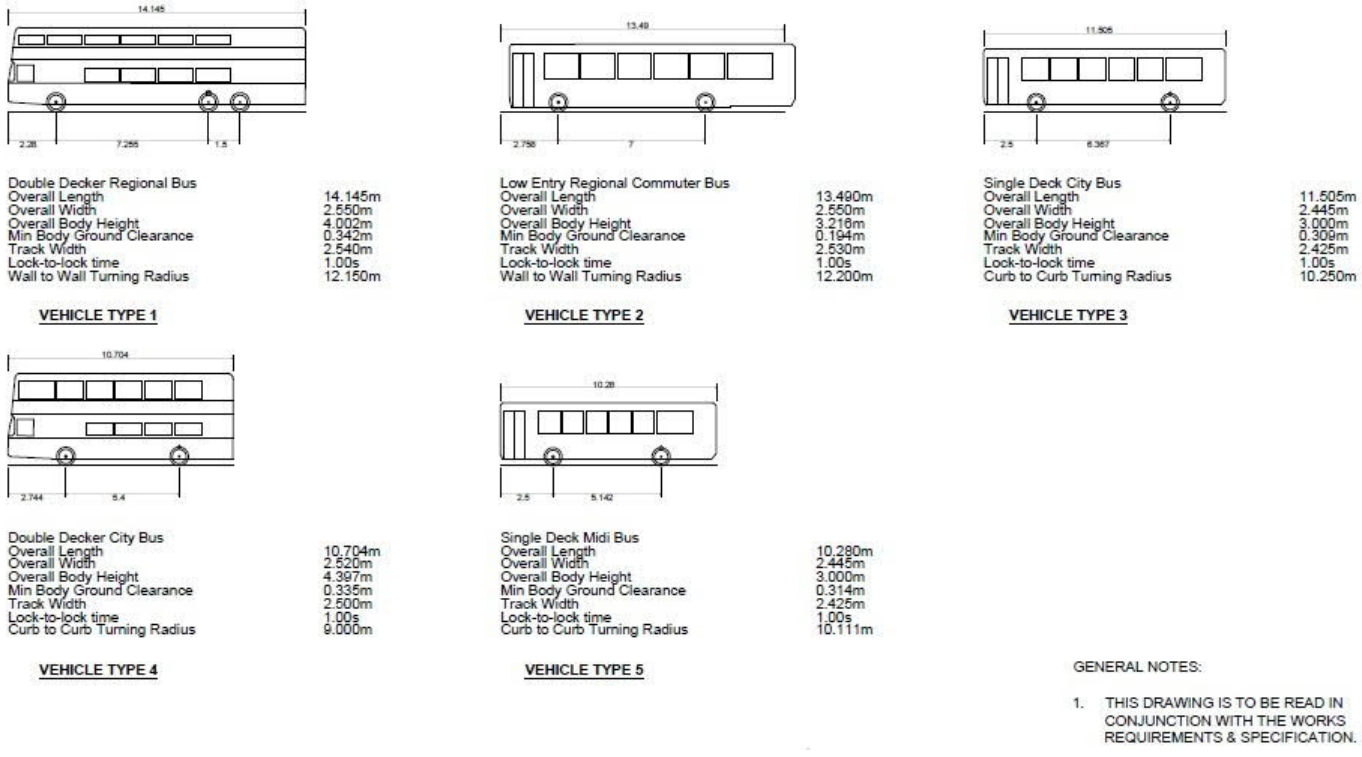


Figure 1.3 Standard Transport for Ireland Bus Specifications.

Considerations for Bus Stop Locations

The basic criteria for consideration when locating a bus stop:

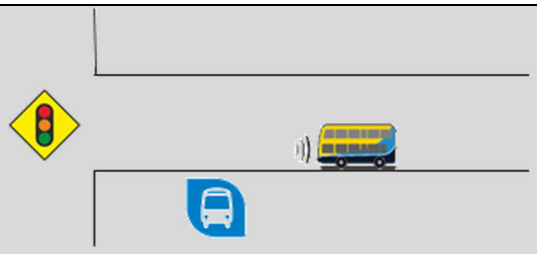
- Driver and waiting passengers are clearly visible to each other;
- Located close to key local facilities;
- Located close to main junctions without affecting road safety or junction operation;
- Located to minimise walking distance between interchange stops;
- Where there is space for a bus shelter;
- Located in pairs, 'Tail to tail' on opposite sides of the road;
- Close to (and on exit side of) pedestrian crossings;
- Away from sites likely to be obstructed; and
- Adequate footway width.

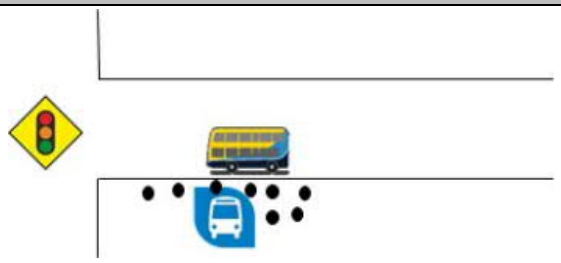
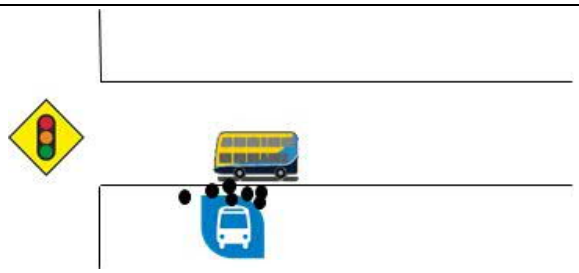
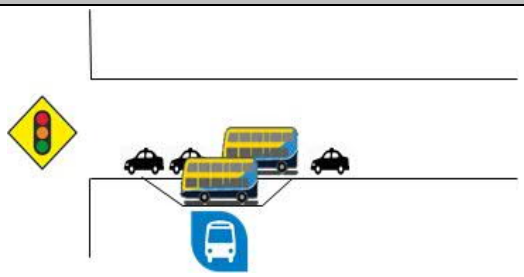
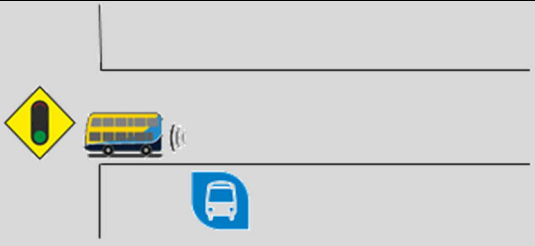
Principals of Bus Stop on high capacity Bus Systems.

The Core Bus Network Report (2015) noted that the distances between bus stops influences the efficiency of the bus network. In general, the lower the distances between stops along a corridor, the higher the delay that is incurred for buses. This delay is caused through acceleration and deceleration and delays associated with pulling in and out of bus stops with some estimates suggesting that stopping at bus stops makes up in excess of 20% of the journey times along the QBC corridors. International literature on bus stop spacing recommends a distance of 300 to 500m (NTA Report on Core Bus Network Infrastructure Network, February 2015) between stops in suburban areas is optimum, whereas in Dublin many routes have bus stops located at far lower spacing. The Core Bus Network Report concluded that increasing spacing between bus stops was part of the solution to reduce delays along the corridors.

The following indicates where delay materialises when accessing bus stops.

Table 1.1 Sources of Bus Delay associated with Bus Stops (TCQoSM, TRB)

1 Deceleration Time spent slowing to serve the stop.	

2 Bus stop failure Waiting for other buses to clear the stop	
3 Boarding lost time Waiting for passengers to reach the bus	
4 Passenger service time (dwell time) Opening the doors, boarding and alighting passengers, and closing the doors	
5 Traffic signal (traffic control) delay Waiting for the signal to turn green, or other traffic control delay	
6 Re-entry delay Waiting for a gap in traffic	
7 Acceleration Time spent getting back up to speed	

Boarding of passengers, layout of stations are not being examined as they are either not relevant in this case or dealt with elsewhere as part of the overall BusConnects Programme.

The acceleration and deceleration will be similar at all stops and clearly the overall impact is dependent on the number of bus stops along a route; this will be dealt with by examining the number of bus stops along a corridor.

Bus Stop failure is linked to the amount of time buses are stopped and the frequency of buses along the route and has a significant impact on the overall corridor capacity and efficiency, particularly where non stopping buses are present (Express or Regional Buses). A situation where a bus arrives at a bus stop to find all loading areas full:

- The bus must wait until space becomes available;
- Slows down the bus and creates schedule reliability issues; and
- Delay can also increase further as bus bunching occurs and bus dwell and traffic control delay times will increase.

The proximity of a bus stop to signalised junctions has an impact on bus speeds with far-side stops having the least negative impact on speed and capacity, and also favored as passengers cross the road behind the bus which increases safety.

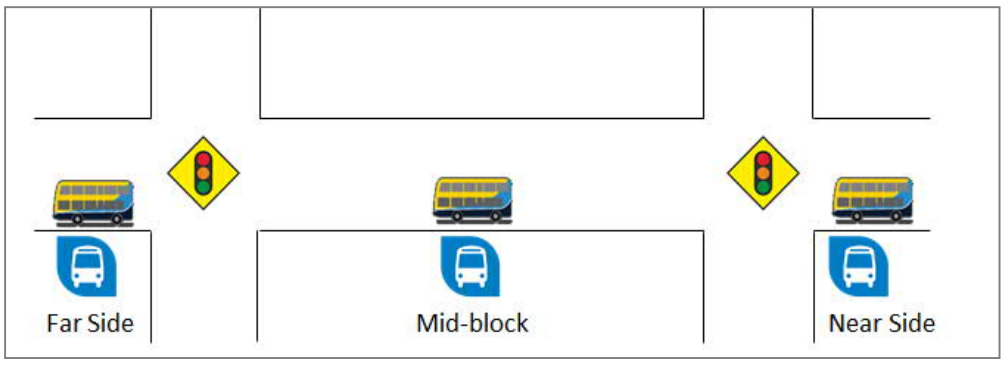


Figure 1.4 Typical Location of Bus Stops.

Ability to overtake slower buses is an important parameter where the route is made up of both express (rarely stopping) and slower (stopping at all stops) buses. For example, on the N11 QBC lay-bys (or passing lanes) were introduced after the original QBC was built to increase the capacity and allow express buses to pass the slower vehicles. On some of the BusConnects schemes this will need to be considered particularly on those routes that include regional and intercity services.

Figure 1.5 Stillorgan QBC with high bus flows and no bus laybys resulted in bus bunching/ platooning; bus lay-by's provided at key locations to allow express buses to pass slower buses. (Source: Google Maps)

Figure 1.6 A typical bus lay-by adjacent to a bus lane; note concrete surface for additional durability.

Consideration should also be given to locations where coaches stop along the Corridors, particularly those serving the airport which could require longer dwell time to allow passengers to load/unload their luggage. In these cases, a layby separate to the CBC Bus Stop maybe desirable (Figure 1.7).

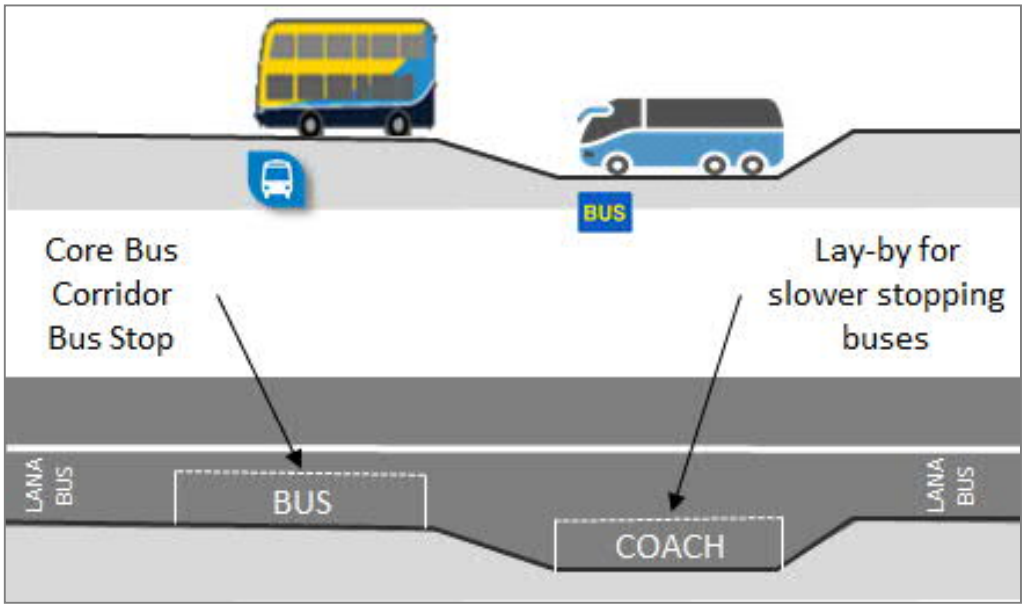


Figure 1.7 Double Bus Stop (in-line for BusConnects routes) concept for locations with buses requiring different dwell times.

Figure 1.8 Multiple bus operators may be using bus stops along the Corridors.

In general, most bus stops along corridors will be in-line (bus stops within the bus lane), as a result re-entry delays will not impact the operation of buses. However, on busier corridors where lay-bys are used re-entry may delay buses. ED's need to consider the flow of buses and taxis passing lay-by's, and where there is increased risk of delay additional measures may be required to generate

gaps in traffic (far-side) or the installation of a yellow box to allow buses to renter the traffic queue (near-side).

Pedestrian accessibility

Another important aspect of bus stop positioning is proximity to pedestrian crossings. Failure to provide high quality pedestrian facilities on the pedestrian desire line may lead to a higher accident risk associated with a bus stop. Therefore, designers need to consider how passengers are going to cross the road to get access to the stop, in general this will require bus stops to be located close to safe crossing points.

2.0 Methodology

This section outlines the process for examining each BusConnects Corridor and assessing and reporting on the bus stops along each route. The flow chart summarises the process and this is followed by a more detailed description of the tasks to be undertaken.

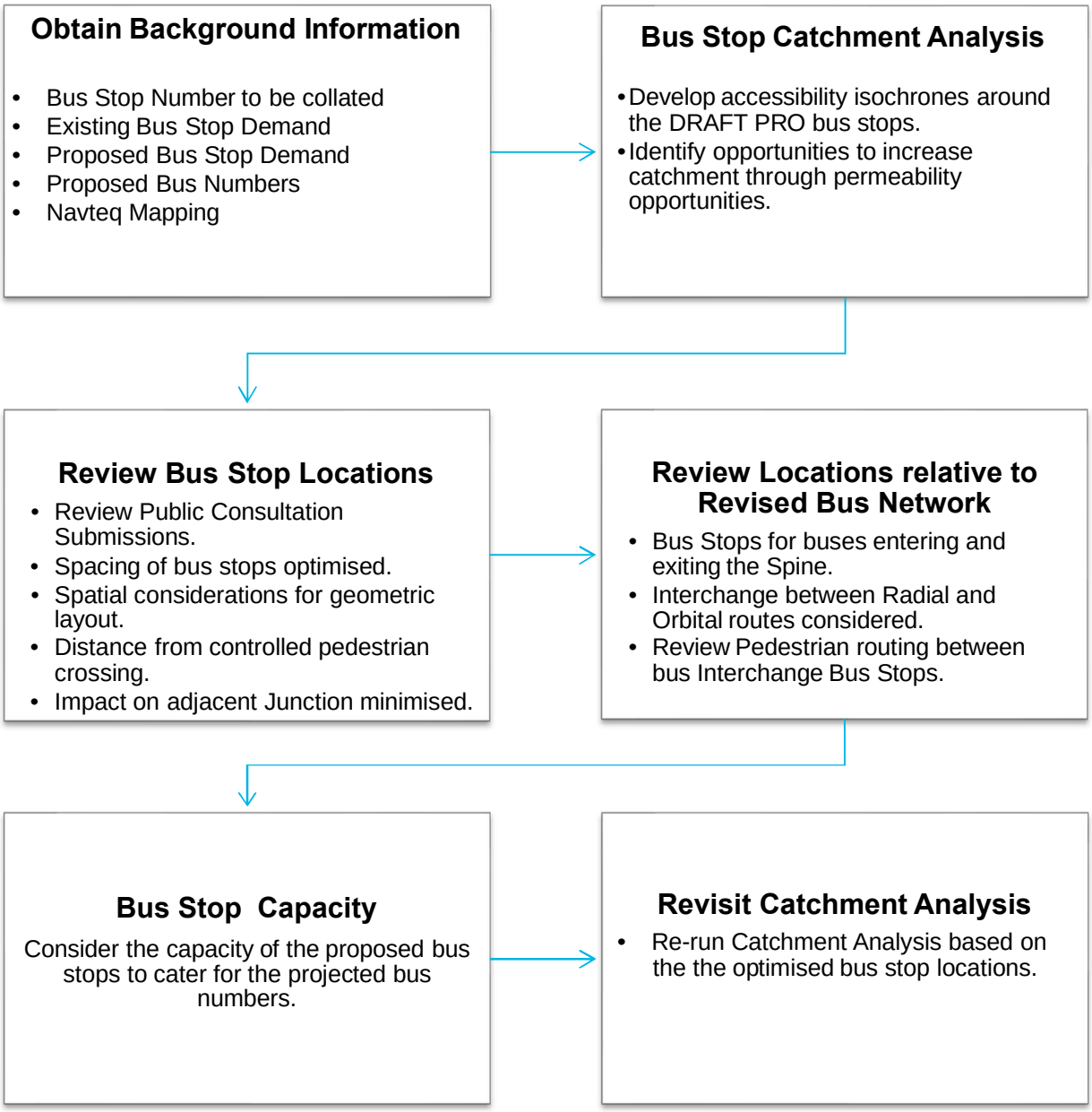
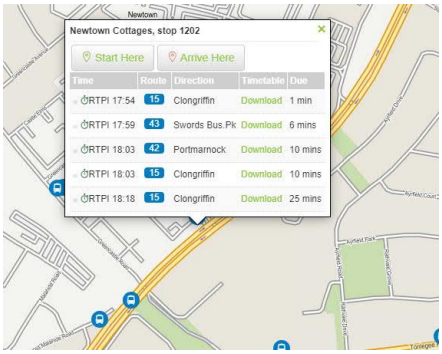


Figure 2.1 Flow Chart for proposed Bus Stop Review.

3.0 Background Information

In order to undertake the review of the bus stops along each corridor background information must be gathered. The following section outlines this information and how to obtain it.

Table 3.1 Information to be gathered to undertake the Bus Stop Review

Item	Description	Location/Contact
Bus Stop Number	Bus Stop Numbers can be obtained from a number of online sources. 	https://www.transportforireland.ie/plan-a-journey/
Existing Bus Stop Demand	Estimated boarding and alighting figures are available from NTA Business Intelligence Unit. Using Leap Card Data and Machine Learning the NTA has recently developed a tool for estimating where passengers are alighting buses along each route. The format that this will be available in is currently under development. This information can include details on use of Free Travel Pass which may help in identifying locations which are a higher priority for the elderly and those with accessibility issues.	**NTA Business Intelligence Unit**
Proposed Bus Stop Demand	Obtain future passenger demand for each corridor, this will come from the ERM. This will not be linked to specific bus stops, but zonal. The bus stop demand will then be linked to bus stops by using the existing bus stop data and factoring up existing boarding and alighting figures.	TIAR Consultant
Proposed Bus Numbers	The number of buses on each corridor is available from the BusConnects Network Redesign Team. This information has already been issued to each ED. It is the ED's responsibility to confirm that these figures are correct at this time.	Confirm that the numbers provided are the revised network data.
Navteq Mapping	The GIS Mapping is required to understand permeability in the area surrounding bus stops. NTA has this information and will provide it to each ED. Note that this base data will need to be reviewed thoroughly as from experience there will be many permeability routes that are missing.	NTA to issue mapping to all teams.

4.0 Bus Stop Catchment Analysis

Bus stop passenger catchment areas are critically important to the success of a high-quality bus corridor. The catchment at each bus stop needs to be maximised so as each stopping movement collects sufficient passengers to justify the loss in journey speed; a bus stopping at each bus stop to pick up one passenger will result in a very slow journey time, the ideal scenario is to stop less often and collect more passengers at each stop. Clearly too few bus stops could also be detrimental to the success of the scheme. To assess if bus stops are optimally spaced to maximise the passenger catchment area it is recommended that a catchment analysis using the NTA Navteq data(or similar process) is undertaken.

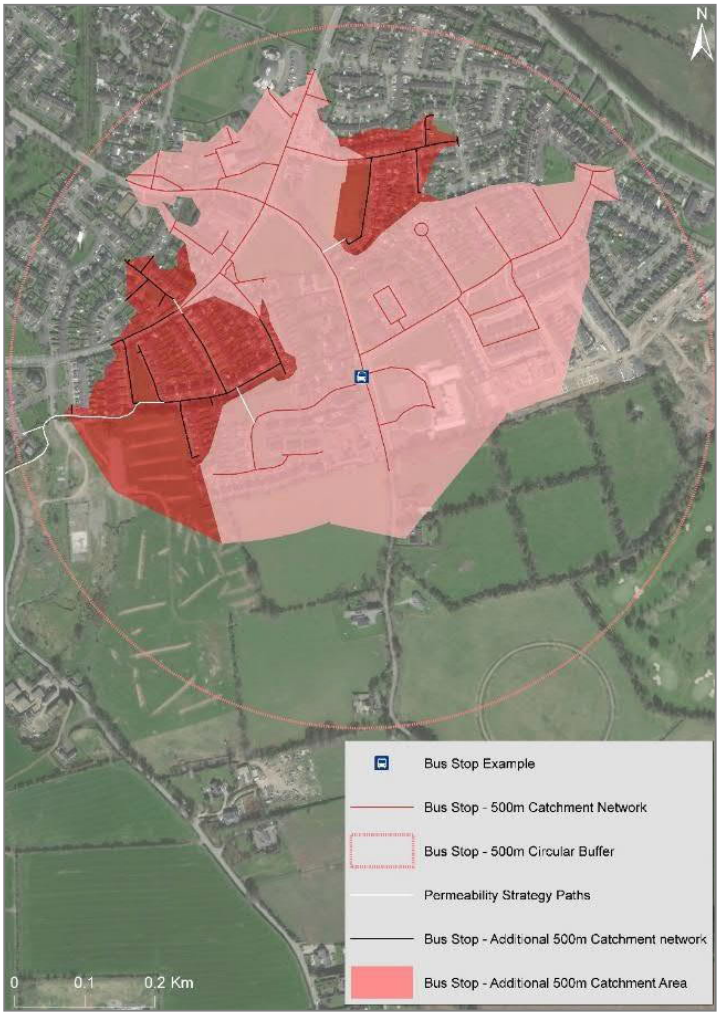


Figure 4.1 Passenger catchment analysis for a bus stop indicating the existing and possible catchment areas assuming permeability improvements can be undertaken.

Figure 4.1 indicates the area that is within a standard walking distance of a bus stop (400m for BusConnects CBC's) based on the actual walking distance rather than "as crow flies" analysis which can be misleading particularly where there are long sections of blank, inaccessible, wall along

corridors. The number of people living within this area can be obtained from GeoDirectory data. In addition, permeability solutions can be identified and the impact of making these changes can be quickly assessed in terms of increased catchment area. The process of undertaking this analysis is outlined below:

Task 1: Enhancing the Navteq network using OpenStreetMap to add footpaths, greenways, cut throughs which are accessible to most people, paths over greens or parks, etc., this is required as the network supplied by the NTA is a primarily a driving network not a pedestrian network.

To do this you will add walk links extracted from OpenStreetMap's data clearly coding these into the Navteq supplied by the NTA. Google Streetview should be used as a check to ensure any link added to the Navteq exist on the ground and are accessible to all. Informal walk links should not be added at this stage.

Figure 4.2 Example of permeability link missing from Navteq mapping on Tallaght/Clondalkin Cor Bus Corridor.

Task 2: Once the Navteq has been enhanced to the required level to capture all major pedestrian movement within bus stop catchment areas, catchment analysis shall be run for the proposed and existing bus stops. Using the Network Analyst Extension in ArcGIS generating 400m and 800m walking bands to reflect 5 and 10-minute walking catchments of bus stops.

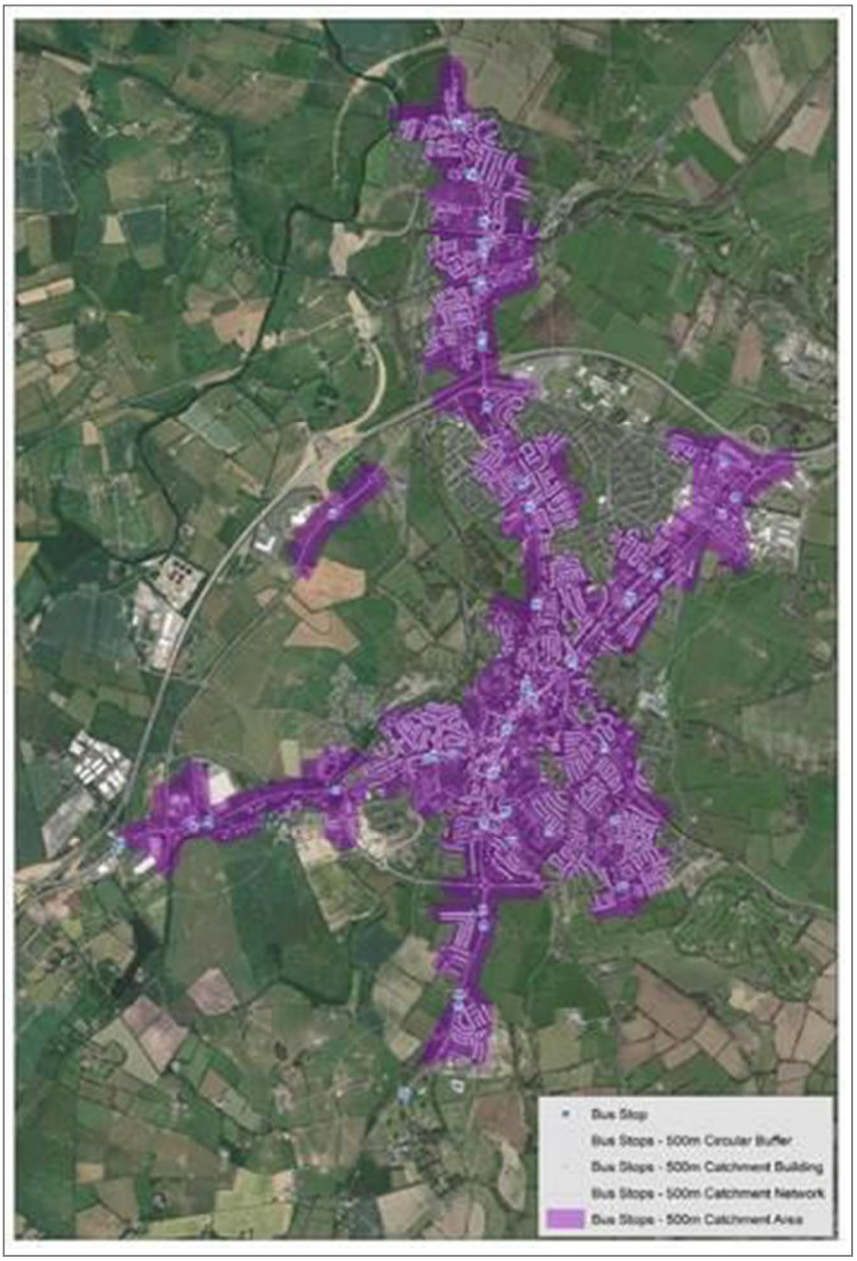


Figure 4.3 Example of catchment analysis run for all bus stops in Naas

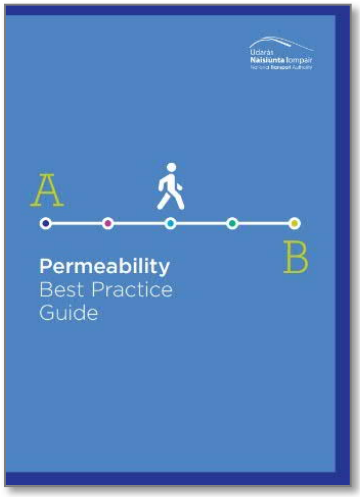
Task 3: Production of catchment tables identifying number of households using Geo Directory or population estimate using census 2016 and Geo Directory to apportion sections of Census Small Area within 400m and 800m catchments of each bus stop. Catchments will be non-overlapping to avoid double counting between stops along the same alignment.

Task 4: Maps will be generated for each stop along each of the alignment, or stops can be grouped together to reflect particular study areas. Maps can be generated in any particular format to match the theme of previous reports (EPR Reports).

Task 5: Quality Assurance and Checking of catchments is critical as missing, or additional, links will be easily identified by the public and could discredit the analysis if there are errors.

Having developed a detailed understanding of the catchment areas consideration should then be given to how the catchments can be widened through identification of permeability opportunities along the corridors. Permeability describes the extent to which an urban area permits the movement of people by walking or cycling. Such an approach is known as “filtered permeability”. Barriers to filtered permeability can include:

- Boundary walls around estates and within residential areas that prevent movement along natural desire lines, being usually the shortest and most direct route connecting two points;
- Cul-de-sacs which prohibit through movement;
- Poorly designed linkages that are difficult or unattractive to use; and
- Connections which require much longer travel distances than direct linkages.



The NTA Permeability Best Practise Guide should be followed for the identification and assessment of these opportunities. Careful consideration should be given to whether or not these proposals should form part of the Bus Connects scheme or if they should be identified to the Local Authority for actioning. Only those linkages that are directly linked to the corridor should be considered as part of this application.

An example from the Clongriffin to City Centre CBC can be seen in Figure 4.4 where a very large housing estate which is located immediately adjacent to the proposed bus corridor has a continuous boundary wall that runs for over 800m preventing easy access to the bus routes and requiring a walk of almost 1km to access the bus routes. Opening a pedestrian access on the boundary wall could create a much shorter route to the buses and substantially increase the bus passenger catchment area.

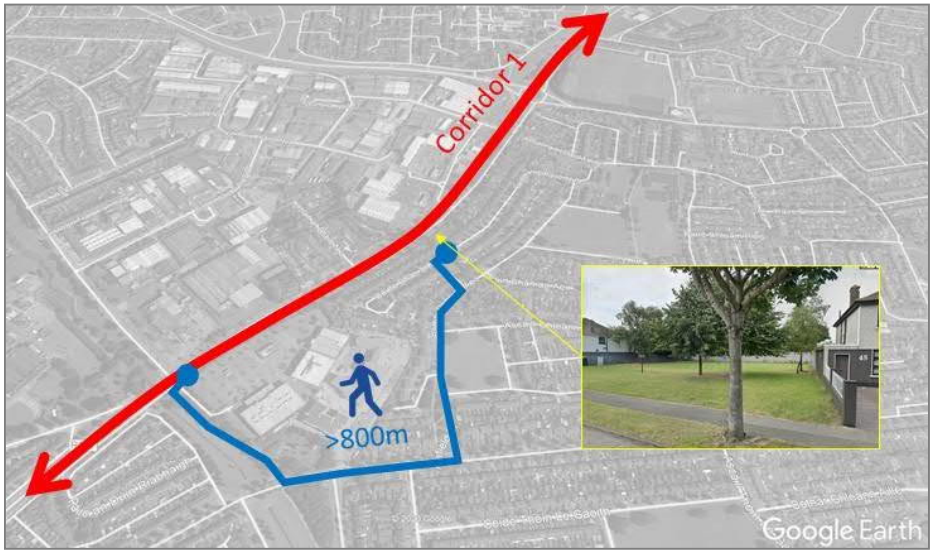


Figure 4.4 Permeability option on the Malahide Road (Source: Google Maps).

Figure 4.5 Boundary wall along Malahide Road (Corridor 1) where local residents have opened up individual doors to access the existing QBC route.

5.0 Review Bus Stop Locations

5.1 Public Consultation Feedback.

An important aspect of the bus stop review is to review feedback received from the general public in relation to the position of an existing, or proposed, bus stop along the corridor. This may identify a specific issue that the reviewer should be aware of before beginning the review. For example, the relocation of a bus stop away from a destination for people with mobility impairments may not have been identified during the preliminary design process and should now be considered. It is also important to review these comments against commitments that may have been given during the "one to one" meetings held during the initial, and subsequent, consultation stages.

Please note that some bus stops were relocated after the EPR public consultation as a result of public consultation comments, if a bus stop is being considered for relocation please also check whether it had been relocated previously by checking the EPR drawings and discussing with the NTA IPO.

5.2 Usage of Bus Stops.

In order to help the reviewer, understand the passenger movements at a bus stop it is recommended that the existing Boarding and Alighting Data is reviewed at this early stage and is used as an approxi for future passenger movements. This will provide an indication of the numbers using a bus stop in an area and would indicate the number of pedestrians movements having to be catered for. It will also indicate those bus stop locations that are relatively lightly used and could be considered for amalgamation with a nearby bus stop, relocation to a more convenient location, or removal completely.

5.3 Spacing of Bus Stops.

The spacing of bus stops has a significant impact on the average speed of a bus corridor, clearly the more times a bus stops the slower the overall journey time will be. A bus incurs a minimum of 15 seconds delay with each stop on an urban street just to decelerate, open and close the bus doors, and accelerate back to speed (25 seconds on a busway). Table 5.1 uses information extracted from the Transit Capacity and Quality of Service Manual (TRB) and indicates the estimated average speed on an 80kph busway. This clearly indicates that bus stop spacing, and dwell time have a large impact on average speed on bus corridors.

Table 5.1 Average Bus Speed (km/h) in Bus Priority Corridors, 80km/h running speed.

Average Stop Spacing (km)	Average Dwell Time (s)				
	0	15	30	45	60
0.8	50	37	32	27	24
1.6	61	51	45	40	37
2.4	68	58	53	48	45

For BusConnects it is proposed that bus stops should be spaced approximately **400m** apart on typical suburban sections of the route, dropping to approximately **250m** in urban centres (CIHT Buses in Urban Developments, January 2018). This spacing should be seen as a recommended spacing rather than an absolute minimum spacing.

The ability to increase stop spacing depends in part on the quality of the pedestrian connectivity in the area and also the availability of safe crossing points in the vicinity of the proposed bus stop. It may also depend on the characteristics of the passengers using the stop, e.g. persons with limited mobility may find it difficult to walk to the next stop. It is therefore recommended that for locations that may generate high number of elderly or mobility impaired bus passengers (health facilities, local businesses) consideration should be given to locating the bus stop within **100m** of the location if spatial considerations permit.

5.4 Spatial considerations for geometric layout.

The provision of high-quality bus stop infrastructure that is customer orientated is considered an essential part of the BusConnects offering, including:

- Being fully accessible for all bus passengers;
- Having a bus shelter for waiting passengers;
- Having both timetable and real time passenger information (RTPI) available to passengers;
- Having sufficient footpath space to allow the free movement of pedestrians passed the bus stop;
- Continuous cycle lane past the bus stop; and
- Provision of Cycle Parking at, or close to, the bus stop.

All of which requires significant space along the already congested radial routes that the Core Bus Corridors run along. Therefore, an important aspect of locating bus stops is identifying locations that have sufficient space to accommodate all, or most, of these elements.

The BusConnects Design Guide suggests that an Island Bus Stop (Figure 34) is the preferred bus stop option to be used as standard on the CBC project where space constraints allow. The **minimum footpath width within which an island bus stop can be implemented is 5.4m** (1.8m footpath + 1.2m cycle track + 2.4m island with shelter). This option assumes a shelter with half bay end panels. Should full panels (as seen on Figure 5.2) be required the width requirement will increase to approximately 6.3m.

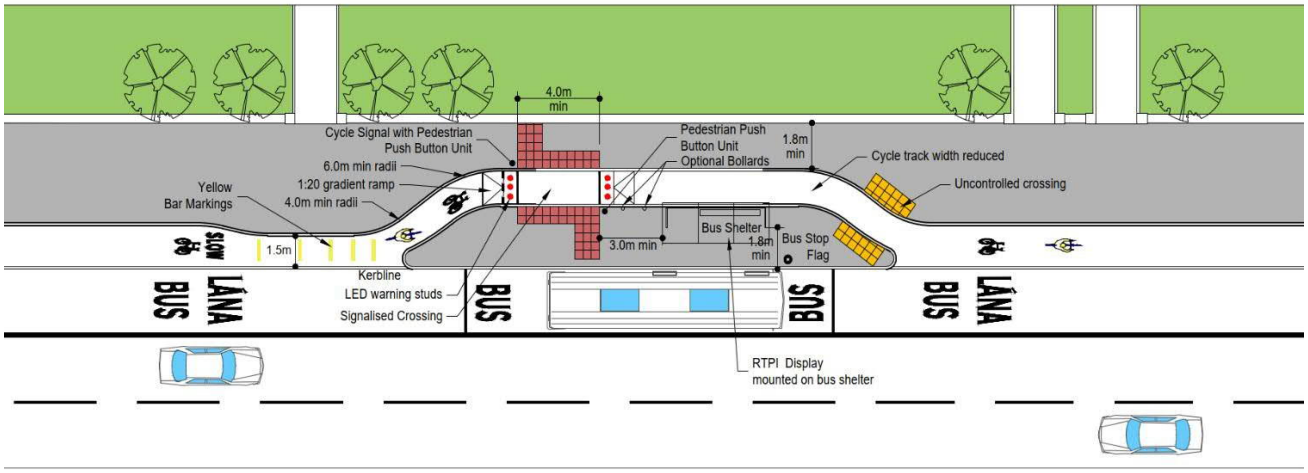


Figure 5.1 Typical Island Bus Stop Arrangement (Bus Connects Design Guideline).

Figure 5.2 Standard 3 Bay Reliance Mark Shelter with full width advertising panel.

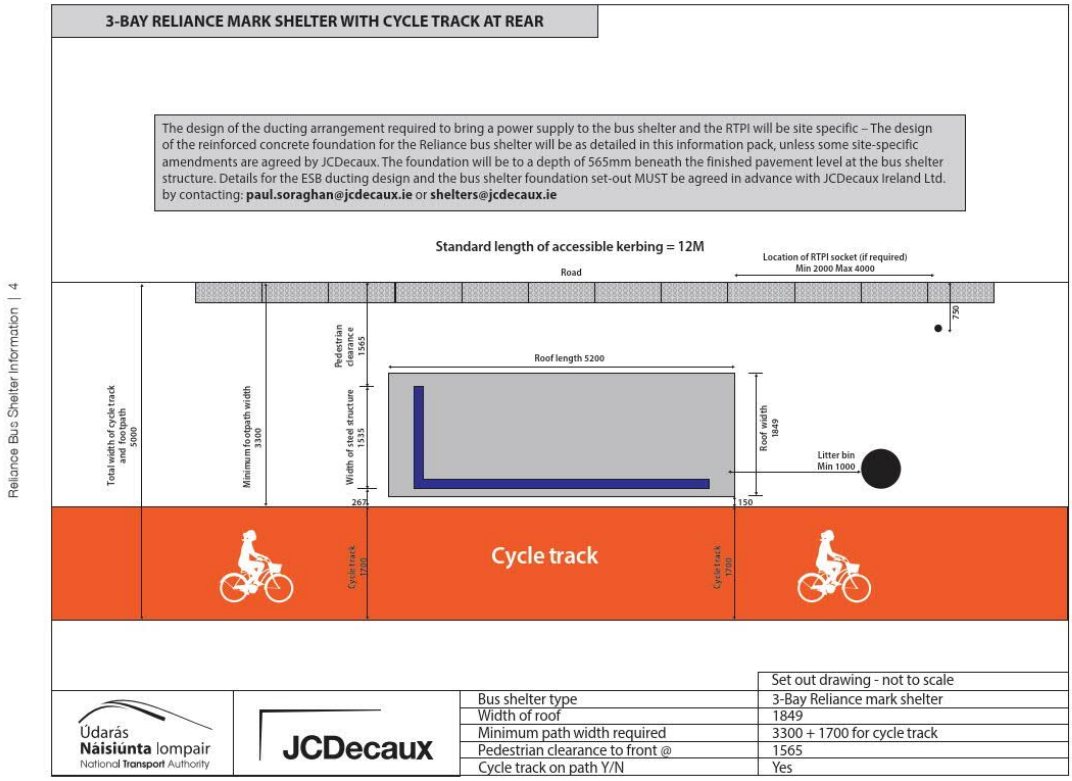


Figure 5.3 Standard layout for a 3 Bay Reliance Mark Shelter with full width advertising panel and cycle lane to the rear (note cycle lane width is to be determined by designers).

For locations where space is constrained an option consisting of a shared bus stop landing zone can be considered. This option is indicated in Figure 5.4 and should only be considered on a case-by-case basis to ensure suitability with particular attention paid to the volume of cyclists and volumes of boarding and alighting passengers. **Using the narrowest non-standard bus shelter this would require a minimum width of approximately 4.0m** (1.9m footpath with shelter + 1.2m cycle track + 0.75m island).

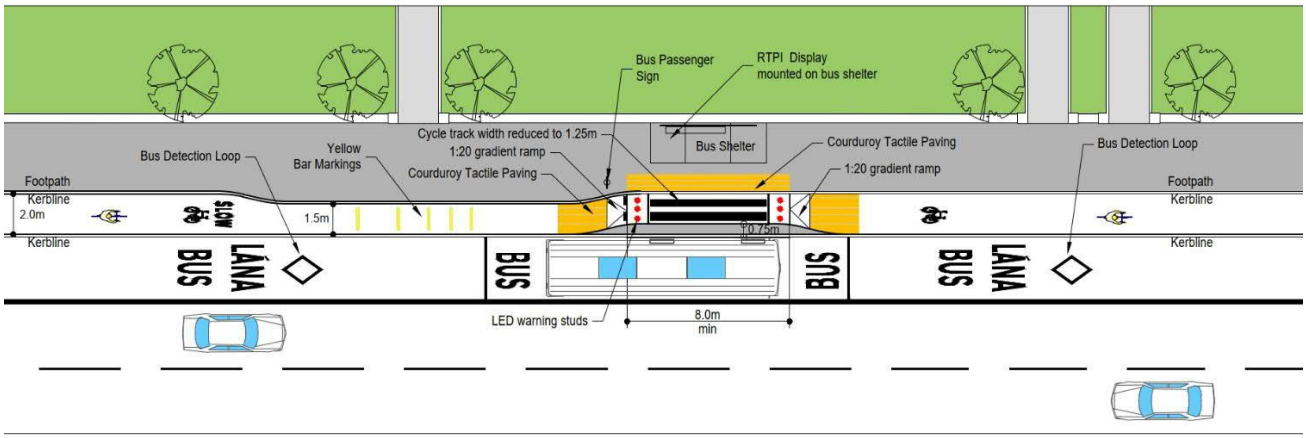


Figure 5.4 Shared Bus Stop Landing Zone Arrangement (Bus Connects Design Guideline).

Figure 5.5 Cantilever narrow roof Bus Shelter

It is important that ED's do not immediately choose the minimum sized shelter as this will impact on the weather protection provided to bus passengers and potentially advertising revenue share received by the NTA. Where there are a substantial number of bus stops using the nonstandard bus shelter it is recommended that the NTA IPO are consulted prior to finalising the proposals.

Providing cycle parking at bus stops has the potential to increase the catchment area of a bus corridor by providing a safe place for cyclists to secure their bike for the duration of their trip. ED's should look to provide cycle parking at all bus stops along the BusConnects Corridors where space permits. The **minimum provision is 3 Sheffield Stands** (accommodating 6 bicycles) in the vicinity of a bus stop. Where larger numbers of cyclists can be expected consideration should be given to providing a larger covered area of approximately 10 Sheffield Stands (accommodating 20 bicycles).

Figure 5.6 Sheffield Bicycle Stands provided at a Bus Stop on the N11.

Figure 5.7 Covered Sheffield Bicycle Stands provided at a Bus Stop on the N11.

5.4 Distance from controlled pedestrian crossing.

Pedestrians by their nature often take the quickest route to their destination rather than the safest route, particularly if they feel the safety risk is low. This results in bus passengers leaving buses stepping out in front of, or behind, buses and crossing the road in a hazardous manner. The placement of bus stops near safe pedestrian crossing points is therefore a critical aspect of bus stop design. Providing a bus stop where there is no, or an indirect, pedestrian crossing will lead to “jaywalking” and pedestrians making higher risk movements.

There are many examples of bus stop located immediately outside a pedestrian opening into a housing estate which makes it easy for passengers to access the bus stop in the morning, however on the return journey the passenger can often be isolated on the other side of the road with no safe crossing point available. While this may be satisfactory on some roads, it may not be on others, and how is a person with a mobility impairment to cross a busy radial route? **All bus stops along the CBC’s should be located within a short distance of a controlled crossing point.**

The optimum location to locate a bus stop is adjacent to junctions which have signalised pedestrian crossings provided on all desire lines. Much research has been undertaken in relation to the optimum location for a bus stop adjacent to a junction, either before (near-side) or after a junction (far-side), while there are advantages and disadvantages of both, all guidance recommends that locating the bus stop on the **far-side of a junction is the optimum solution**. While this may be theoptimum location in terms of the operation of a corridor a near-side bus stop may still be appropriatewhen spatial constraints, routing, or distance from junction are considered.

Figure 5.8 indicates various locations for bus stops at junctions with particular consideration for interchange between Spine and Orbital Core Bus Corridors. This indicates that all options which require passengers to interchange will require passengers to cross at least one arm of a junction (on average over both legs of their journey), emphasizing the importance of locating bus stops at junctions and providing controlled crossings on all desire lines between interchanging bus stops.

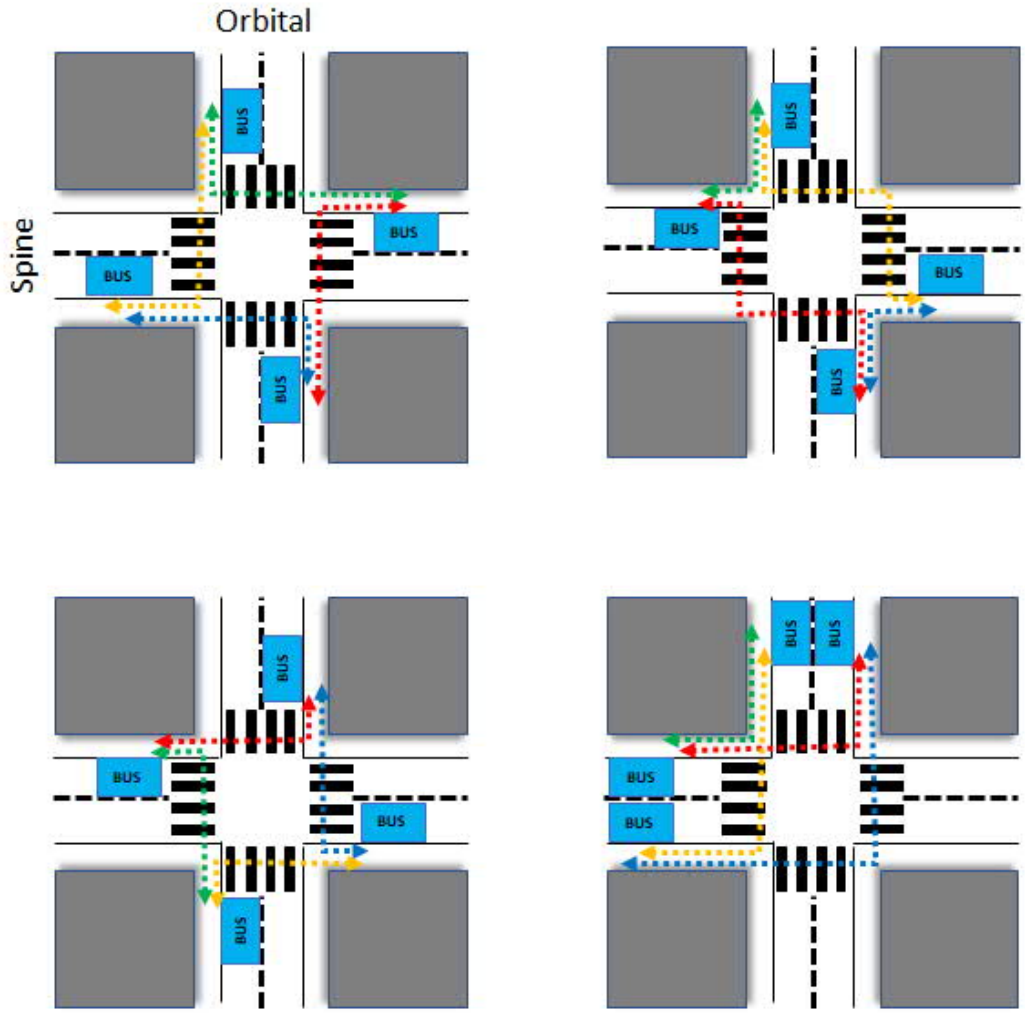


Figure 5.8 Bus stop locations and passenger interchange routes between them.

The DfT document Inclusive Mobility (2005) suggests recommended distance limits without rest for various Mobility Impaired Groups that ranges from 50 to 150m, which limits the distance between interchanging bus stops significantly. It is therefore recommended that the distance between the key interchange bus stops is limited to approximately **100m walking distance** where possible to enable all impaired groups to be able to interchange, consideration must be given to providing a rest spots at approximately 50m between the bus stops to cater for those that will not make this distance without a rest.

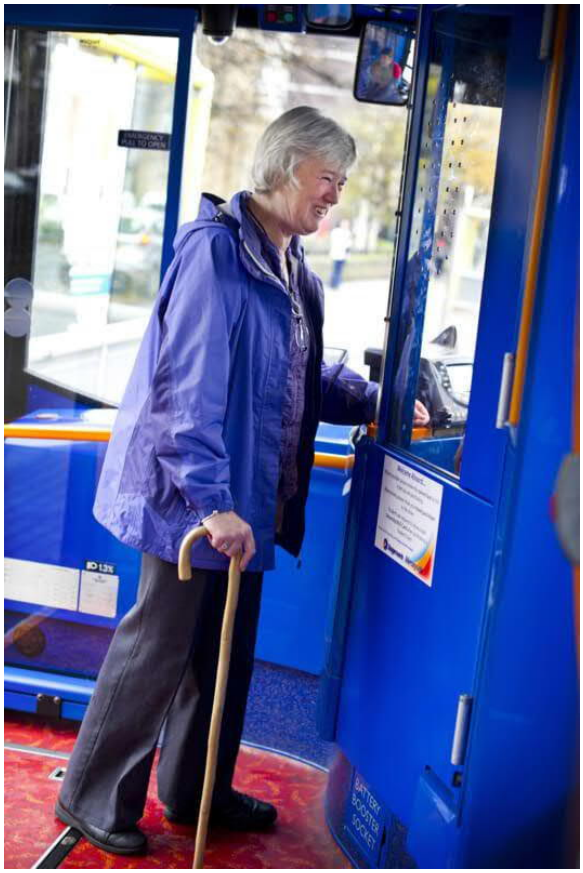


Figure 5.9 Pedestrians using sticks have a limited range of 50m before needing a rest.

For mid-block (between junctions) bus stops it is important that consideration is given to the location of a safe crossing point. It is recommended that a signalised crossing is located in close proximity to these stops to allow all passengers to cross the road safely. It is also recommended that bus stops are positioned upstream of this crossing to avoid buses blocking visibility to the crossing and that passengers walk to the back of the bus where they are more visible to oncoming traffic.

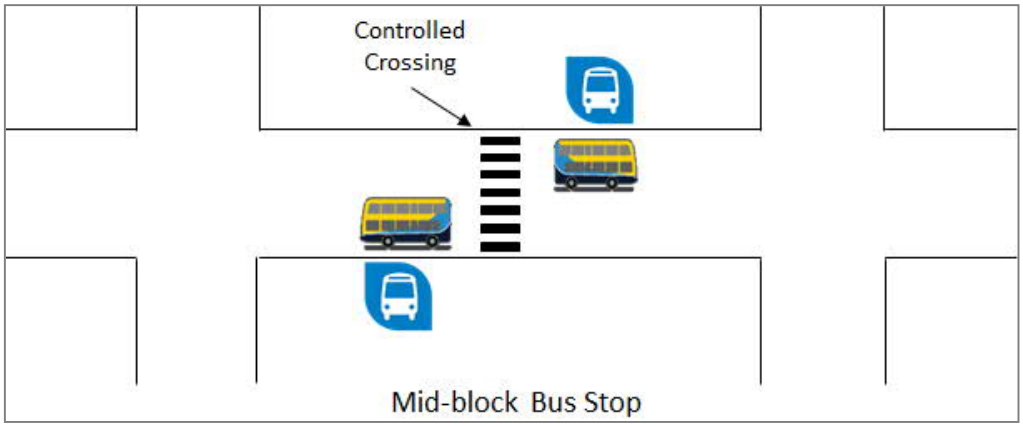


Figure 5.10 Mid-block bus stop optimum layout.

5.5 Impact on Adjacent Junction.

Locating bus stops close to junctions is optimum for pedestrian connectivity and safety, however it clearly can impact on the capacity of a junction and may result in increased congestion. Designers will need to review the location of the bus stops in order to minimise the impact on the operation and capacity of the junctions; things to consider include:

- Distance from the far-side bus stop to the junction. Buses will be running at headways of approximately 2 minutes at peaks on some corridors, while every effort will be made to avoid bunching it is likely that buses will end up meeting each other as they wait for a green signal. As a result, it is important that sufficient space for a bus to wait behind a stopped bus is provided at all junctions. Importantly this offset should start beyond the pedestrian crossing point in order to avoid blocking the crossing. Table 2.2 provides guidance on offset distance from key features.
- For near-side bus stops it is important that the location is reviewed in the context of visibility to the traffic signals for general traffic (bus, or the bus stop infrastructure, impacting on visibility to primary traffic signals) and also interaction with left turning traffic. Reference DMRB DN-GEO-03044 and DTTaS Traffic Signs Manual Chapter 9.
- Where a bus is joining a Spine from a side road it is important that the bus stops are fully accessible by the turning vehicle and sufficient space is provided to allow the bus to pull in flush with the bus stop so as the gap between the kerb and the bus is minimised (both doors). It is also important to ensure that the manoeuvring bus does not require the bus to sweep over the kerb line.

Figure 5.11 Tracking of a turning bus entering a bus stop.

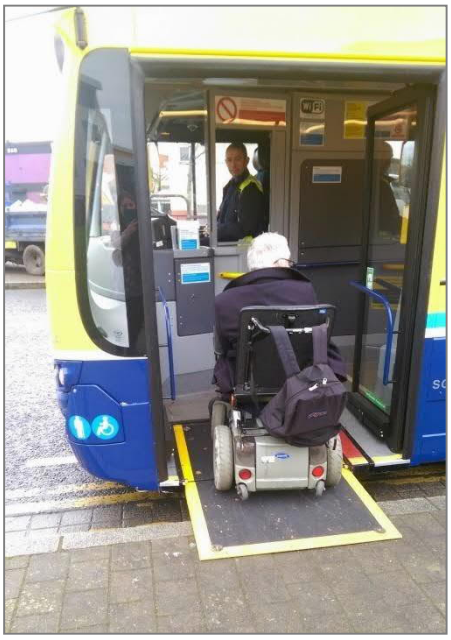


Figure 5.12 Having buses flush with the bus stop is important to allow the ramp to lower correctly, but also to speed up the boarding and alighting of all passengers as gaps slow this down.

Table 5.2 Indicative Distances of Features from Bus Stops

(DRAFT NTA Bus Stop Design Guidance)

Feature	**Distance (m) to bus stop sign**
Prior to isolated pedestrian crossing signals or Zebra	18m
After pedestrian crossing signals or Zebra	10m + bus length*
Prior to signalised junction	20-30m
After signalised junction	20m + bus length*
Prior to or after a side road	20m
After a side road	10m + bus length*
Prior to a roundabout (no diverge)	20-30m
After a roundabout (no merge)	20m + bus length*

***the bus length should be the longest bus using the stop**

6.0 Review Locations relative to Revised Bus Network

The revised BusConnects Network is based on the Connective Network Principle which will rely on some interchange between routes to reduce journey times across the City. This Interchange will primarily occur in the City Centre where the spines overlap rather than along the Spines. However, some interchange will occur between the High Frequency Spines and the Frequent Orbital routes and also between the routes before Branches peel off the spine. Seamless interchange between these bus routes will be critical for the successful operation of this system.

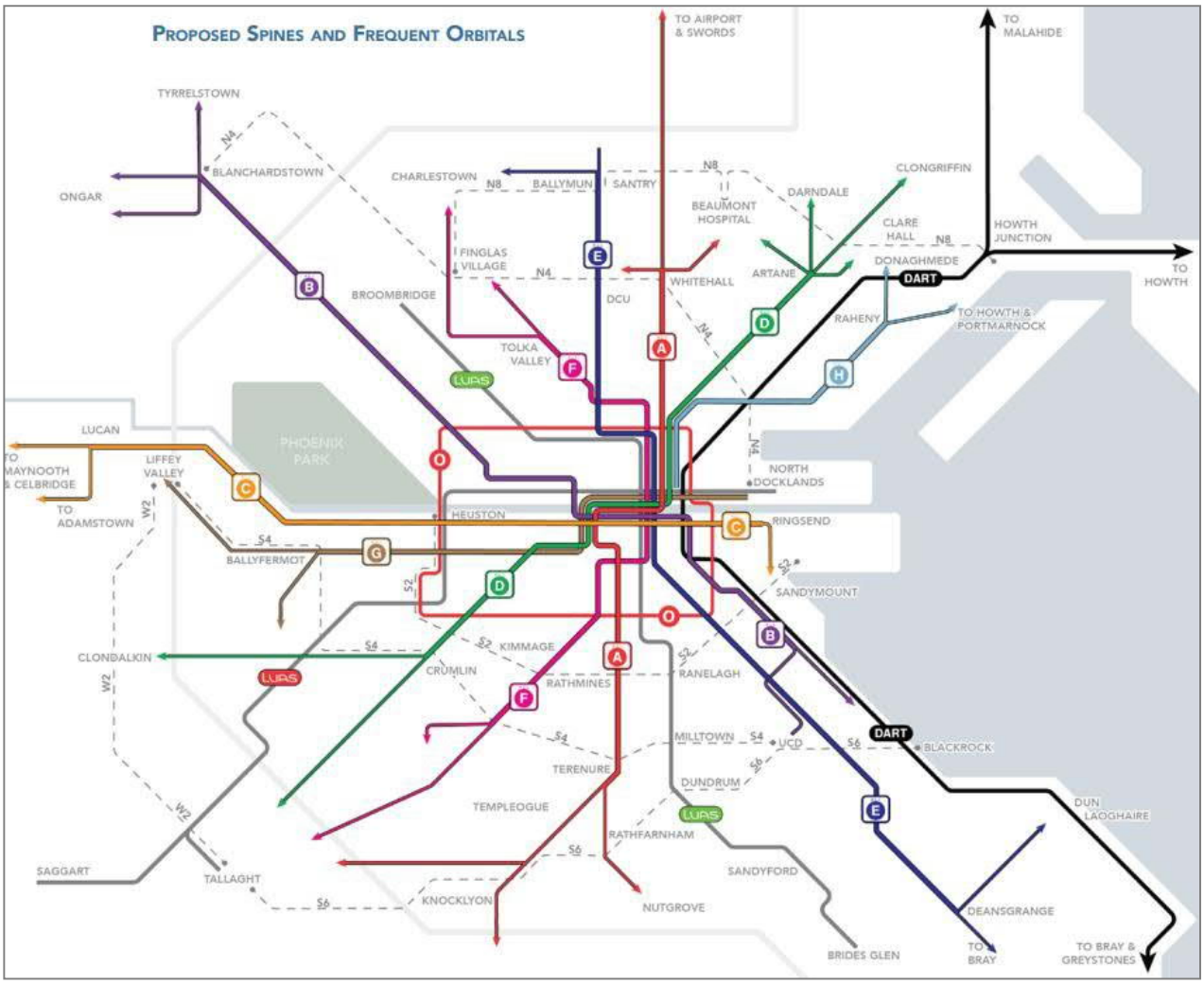


Figure 6.1 Simplified diagram of spines and frequent orbitals in the proposed network

The latest maps need to be obtained by each ED from the NTA IPO. In addition, the ED's can make use of the NTA's Remix system, which is an on-line route and stop information system for the proposed bus network.

6.1 Buses entering and exiting the Spine.

For buses entering and exiting the Spine, consideration should be given to how passengers may switch from one branch to another branch route. While this can happen anywhere along the Spine it will most regularly occur at the last stop before the branch route peels off the Spine. An existing example of this can be seen at Foxrock Church where two high frequency routes (46A/145) deviate at this point. At the last stop before the 46A deviates to Kill Avenue significant numbers switch from one route to the other.

Figure 6.2 Foxrock Church Bus Stop on the N11 QBC

For the Core Bus Corridors consideration should be given to the size and location of the stops before branch routes leave the main Spine. The optimum location of stops at this location will allow all routes to overlap prior to the junction thus removing the necessity for passengers to walk to anotherbus stop.

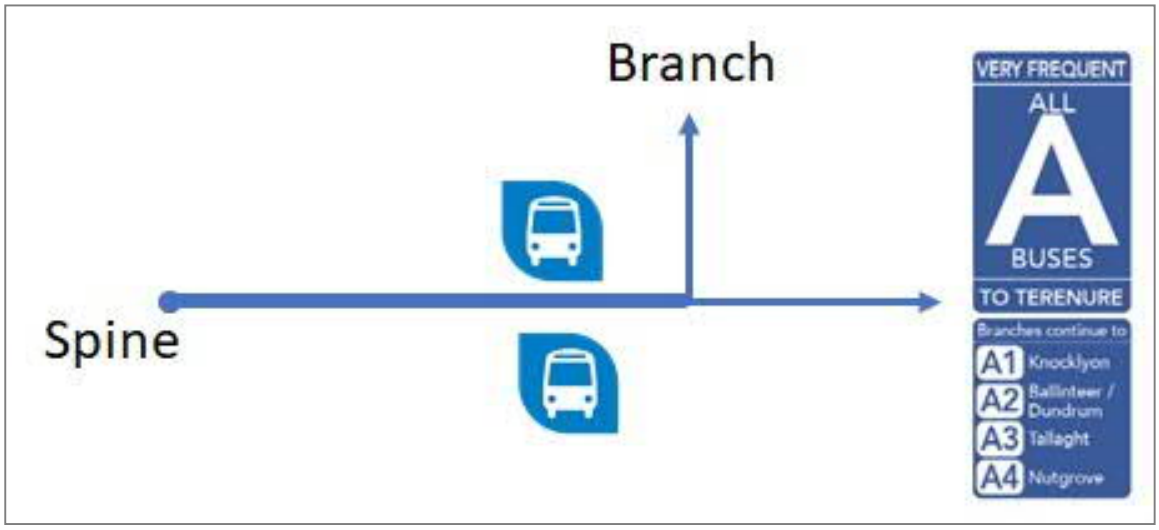


Figure 6.3 Location of Bus Stops Immediately before Branch Route Peels Off Spine

6.2 Interchange between Radial and Orbital routes.

The movement of passengers from one corridor to another is critically important to make Dublin more accessible by public transport. Making this interchange as easy as possible is thus critical to the successful delivery of the BusConnects Programme. Figure 3.4 indicates two typical scenarios that will arise on this project; the crossing movement (D/N4) and the overlapping movement (D/N2).

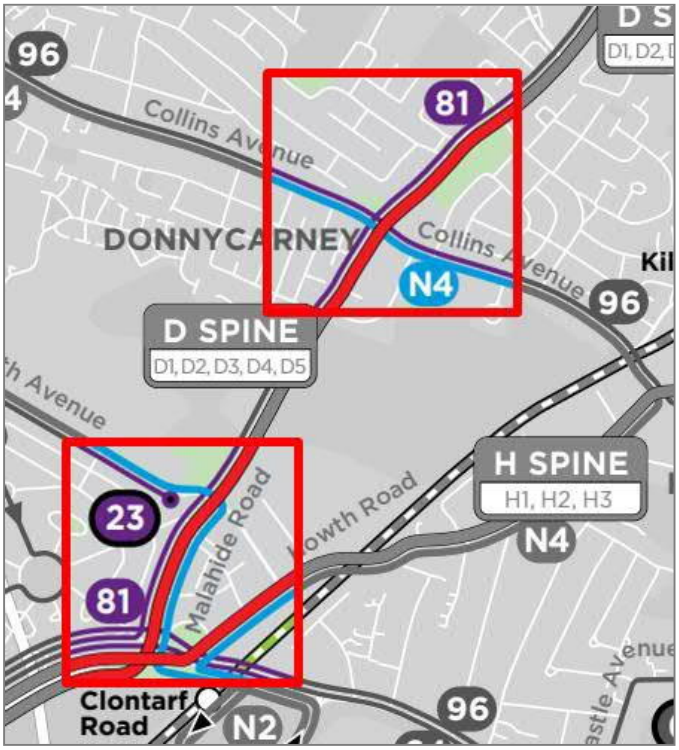


Figure 6.4 Two Different Scenarios for Interchange between orbital and radial corridors.

The optimum solution, but the less likely one, is the overlapping of routes which will allow passengers to leave one route and access another one via the same bus stop (or the opposite pair) making it a very easy interchange. For this option it is important that the designer considers the location of bus stops in a similar manner to the previous section on peeling off of branch lines.

For the more common crossing of routes the location of the bus stops needs to be carefully considered to minimise the distance passengers have to walk and to ensure there is a safe crossing location to facilitate this movements. This was outlined in section 5.4. **For locations where interchange is expected it is recommended that the desirable maximum distance between the interchanging bus stops is 100m,** with rest stops provided at 50m for those with impairments that restrict the maximum walking distance to below 100m.

7.0 Bus Stop Capacity

The capacity of bus stops is a complex and dependent on many variables which may constantly vary throughout a typical peak hour. For this reason it is proposed to undertake a high level assessment of bus stop capacity at this time and a more detailed assessment at a later stage when the Microsimulation Models are available for each corridor which can include the interaction between junctions and bus stops (potential bunching of buses), taxi numbers on the corridor, and the number of express or stopping coaches. Information on the calculation of capacities is available in the TRB, Transit Capacity and Quality of Service Manual, 3rd Edition and for complex locations it is recommended that the designer review applicable sections of this document to gain an understanding of the critical parameters.

7.1 Number of Bus Bays

The TFL Bus Stop Design Guidance states that bus stop capacity is a function of bus length, service frequency, the number of serving routes and their average dwell time. The BusConnects Dublin Corridors will generally carry between 15 to 20 buses per hour at peak times, which equates to a bus every 3 minutes. Assuming a maximum dwell time of 1 minute it could be assumed that one bus stop will be sufficient in most cases. However, the spine corridors will have multiple branches joining at different points with buses running at different frequencies resulting in buses not running at a constant headway. Figure 7.1 below indicates a bus arrival scenario from the TFL Bus Stop Design Guideline which shows how buses may arrive at a stop. This shows the estimated volume of buses at a single bus stop, depending on the frequency of the respective services. For example, Scenario C shows that although there is a frequency of 26 buses per hour, the stop, would theoretically operate well below capacity, however the arrival pattern of buses means that at times more than one bus will be on the stop. For this reason, it would be recommended that this bus stopshould have sufficient space to board and alight two buses at once.

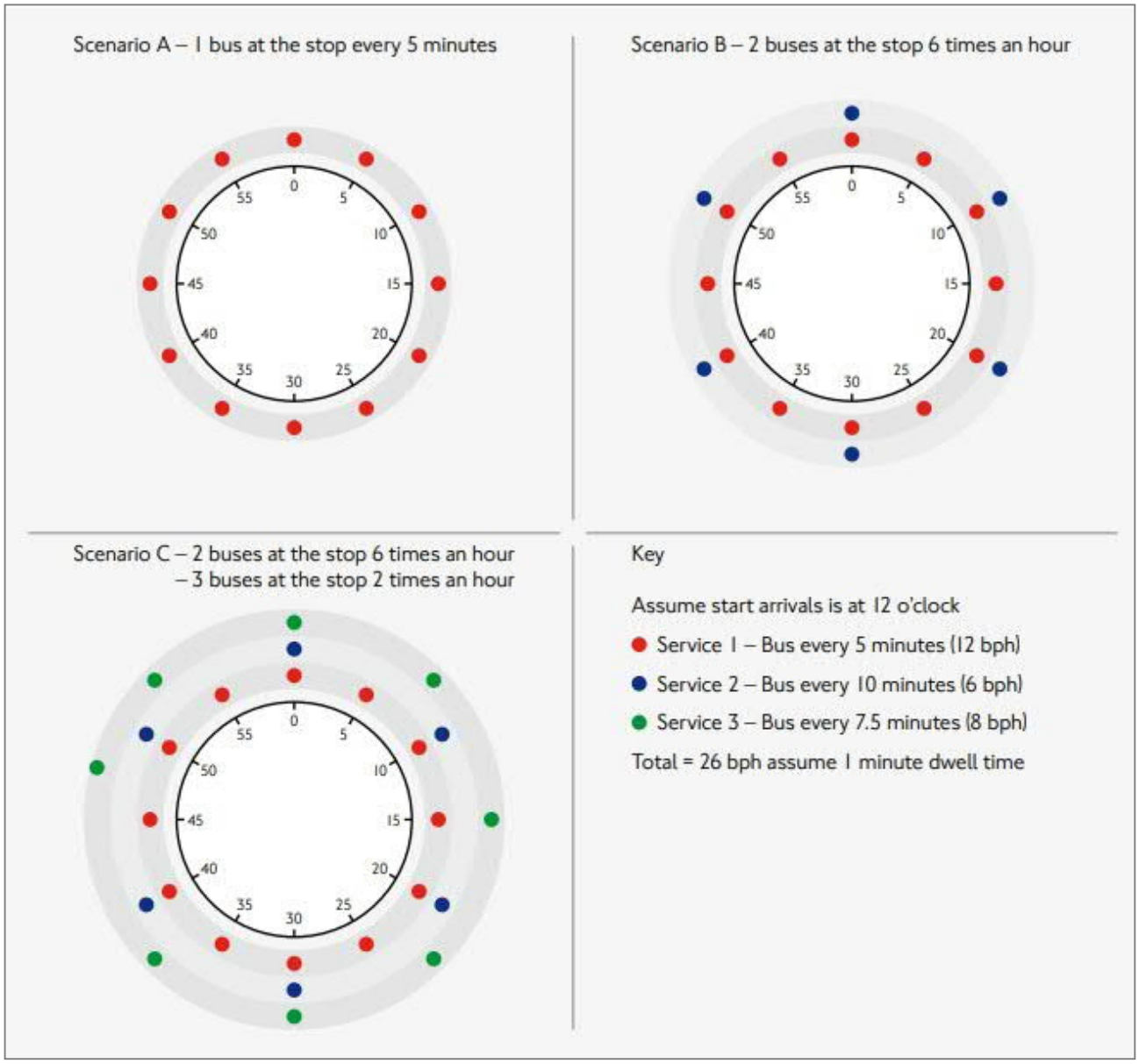


Figure 7.1 Bus Arrival Pattern at a Bus Stop (Source: TFL Bus Stop Design Guidance)

Detail on the buses using each corridor can be obtained from the NTA Remix site (obtain access from NTA IPO), or the frequency information from the BusConnects website. This can be used to make an estimate of the number of bays required at a bus stop by generating scenarios for the stops based on the headways for each route similar to Figure 7.1 above. These assessments will be superseded on completion of the micro-simulation analysis of each route, for this reason it is proposed to undertake this initial assessment based on the assumption that 2 bus bays will likely be required where there are between 25 and 30 buses on the route. This would require a longer bus cage that will accommodate two buses stopped simultaneously, approximately 24m in length (end to end bus), with Kassel Kerbs provided over its length to assist passengers, particularly those with a mobility impairment, to board and alight with ease from both buses.

Number of Bays at a Bus Stop	Where a Corridor is carrying approximately **25 to 30 buses** or more per hour, consideration be given to lengthened the bus stop cage and kerbing to provide space for 2 buses stopping simultaneously. Independent arrival and departure is not required.

Figure 7.2 Where space permits double bus bay should be provided where more than one bus is expected to arrive at a bus stop simultaneously (source: Google)

7.2 Passing Lanes

For corridors with large number of buses, particularly express buses that are not stopping at bus stops it may be necessary to provide a passing lane, or to indent the bus stop in a lay-by, to allow these faster moving buses to overtake the slower ones. This is likely to be particularly important on high capacity corridors where Regional Buses are accessing the City Centre. The TIAR Consultant has undertaken an initial assessment of this and have concluded that where the **hourly bus numbers exceed 40 the addition of a bus stop layby** will help maintain bus capacity and reliability along the corridor. The specific number for each corridor will be obtained from detailed microsimulation analysis at a later date.

Requirements for passing Lanes	Where a section of corridor is carrying approximately **40 to 50 buses** or more an hour**,** consideration should be given to providing passing lanes at bus stops.

Figure 7.3 In-line bus stops on a heavily used bus corridor can lead to express, or non-stopping buses, being delayed or making overtaking manoeuvres. (source: Dublin Bus Stuff).

8.0 Revisit Catchment Analysis

On completion of the review of bus stops along each corridor the catchment analysis for each corridor should be undertaken. The process was detailed in Section 4.0. The analysis should be undertaken and presented on a corridor basis with both Residential and Employment/Education population within 5 and 10 minutes presented.

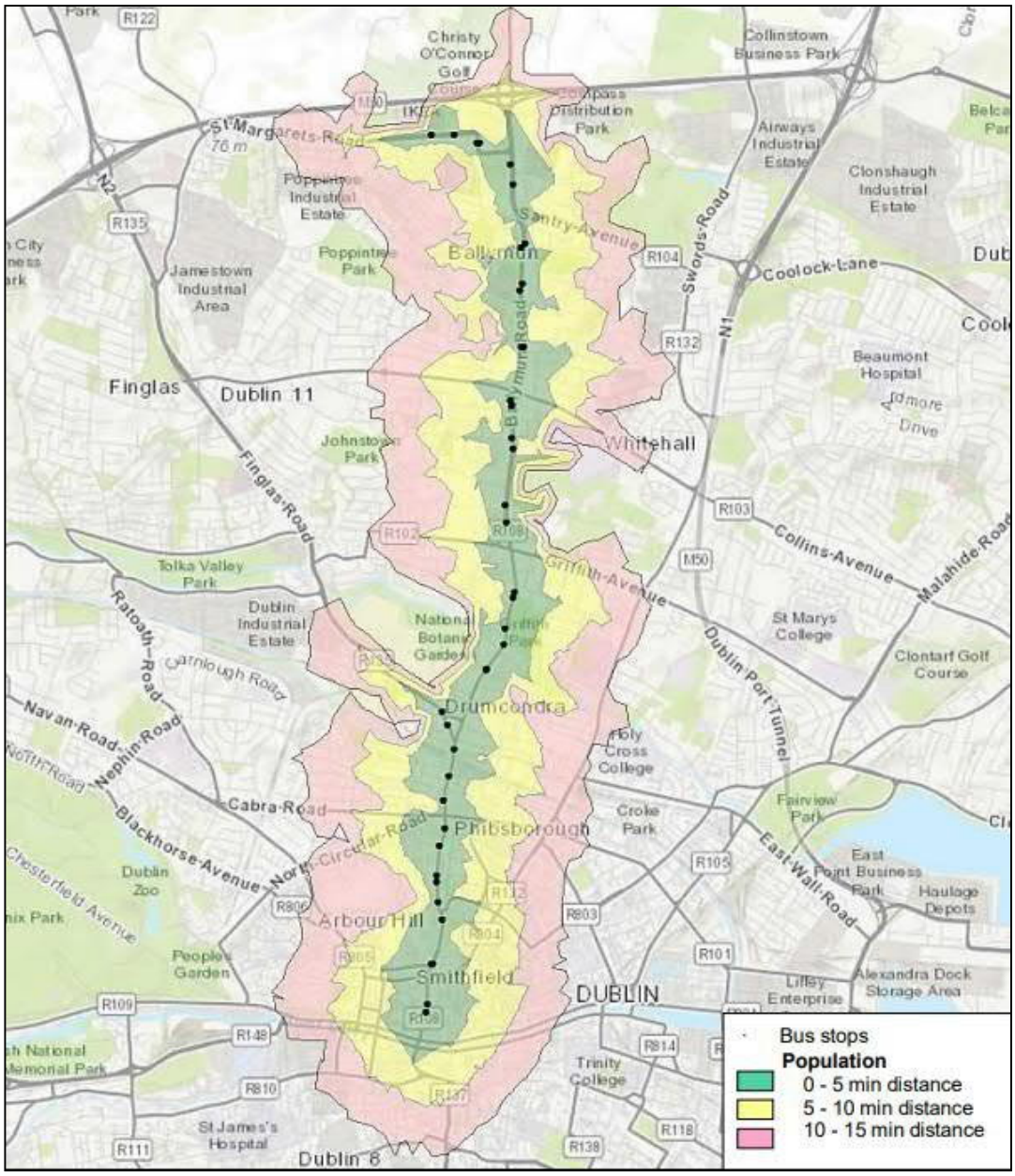


Figure 8.1 Typical map of bus corridor catchment areas

8.1 Presentation of Review

For consistency it is recommended that this review is undertaken, and presented, on the PRO drawings. High-level comments can be listed against each stop with distance between stops also noted (Document 1).

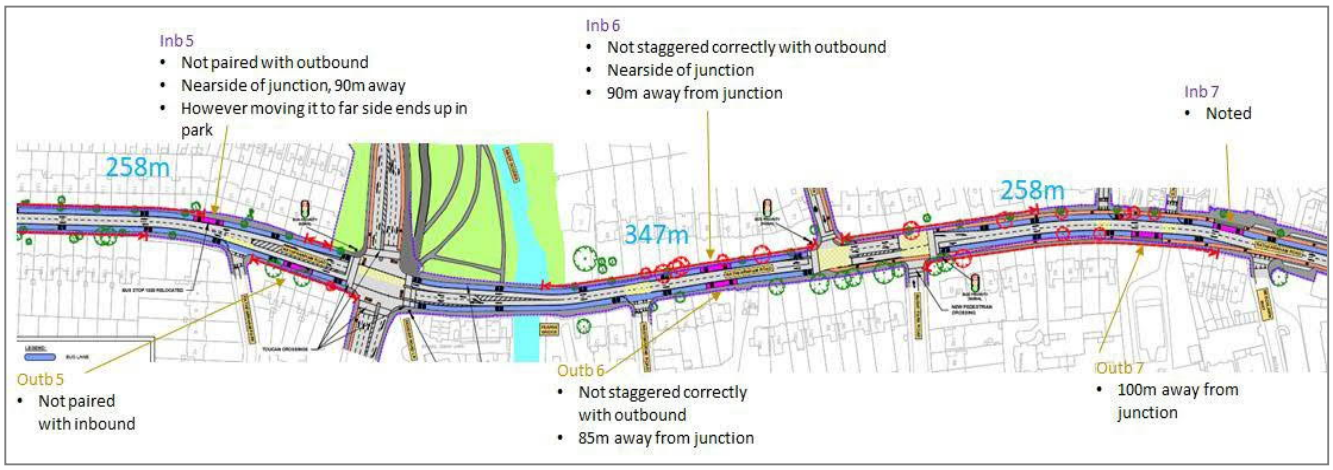


Figure 8.2 Example Review of Bus Stop Locations (Source: ARUP, Rathfarnham CBC).

This document should then be followed by a recommended bus stop strategy (Document 2) for each corridor indicating where bus stop are to be located and that all variables have been considered for each stop. This should be in a similar drawing to the review drawing in Figure 8.2, but focused on those stops that have been altered from the original PRO drawings. A summary table for each corridor should be placed on the front drawing of the recommendations summarising the existing and proposed bus stop strategy:

Corridor Name			
Number of Existing Bus Stops		**Length (KM)**	
	Existing	**Proposed**	**Comment**
Average Spacing of Bus Stops (m)			
All stops located adjacent to a controlled crossing?	Y/N	Y/N	
Have all accessibility / spatial requirements and consultation suggestion been accommodated?	-	Y/N	

Document 2 shall include a report providing specific details of each bus stop along a corridor and detailing the results of the catchment analysis for the optimised bus stops.

Appendix B

Bus Stop Locations Tables

B1 Inbound

Section 1

Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
3164	Temple Hill	Inbound	53.295584	-6.169890	400m	N/A	N/A	N/A	N/A	14	70m	Before	70m	Yes, Same Stop	Yes, move 100m north	This location places the stop after the junction
	New Stop	Inbound	53.29884	-6.17494	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		New Stop	This location is immediately after the junction, provides an inbound stop for Barclay Court residents and those coming through Avondale Park, and is well spaced between the stops before and after which is not currently catered for
3084	Frascati Centre	Inbound	53.301381	-6.181163	1000m	58	5:00 pm	25	7:30 am	11	mid-block		94m	Yes, Same stop	No	This stop is located in close proximity to the pedestrian crossing, and serves the key trip attractors of Blackrock Shopping Centre and the Frascati Centre
469	Mount Merrion Avenue	Inbound	53.302846	-6.184072	254m	17	8:30 am	5	7:30 am	11	77m	before	77m	Yes, 90m to junction	Yes, move 200m west	This new location achieves better spacing from the previous stop, and better serves facilities such as Blackrock Clinic. It is proposed that a lay by be retained in the current location which can cater for existing private coach services
470	Blackrock Clinic	Inbound	53.305626	-6.188981	450m	13	6:00 pm	16	7:30 am	11	50m	before	50m	No	Remove	This stop is located very close to stop 472 and the proposed location for stop 469. With this stop removed in the consolidation, a 400m distance is still maintained. This location is also constrained in terms of space for bus users
471	Blackrock College	Inbound	53.306871	-6.191059	179m	4	1:00 pm	6	7:30 am	11	mid-block		285m	No	No	This stop serves the key trip attractor of Blackrock College.
472	Booterstown Ave	Inbound	53.307882	-6.194918	287m	6	1:00 pm	17	7:30 am	11	105m	after	105m	No	Yes, move 70m West	This new location is closer to the Booterstown Ave. Junction and the Booterstown Dart Station. It is proposed that a lay by be retained in the current location which can cater for existing private coach services

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 2	473	Grotto Avenue	Inbound	53.309241	-6.197382	232m	23	7:30 am	12	11:00 pm	11	72m	before	72m	No	Remove	This stop is located very close to stop 472, which is being proposed to move even closer bringing the spacing down to 150m. As such this stop was deemed superfluous in the consolidation
	4705	St Helen's Road	Inbound	53.310818	-6.200077	245m	13	8:00 am	4	9:00 am	11	92m	after	92m	No	No	This location serves the catchment of St Helens and Trimleston Ave. and maintains 400m spacing from previous and next stops.
	475	Bellevue Avenue	Inbound	53.312706	-6.201889	248m	25	8:00 am	13	8:00 am	11	mid-block		110m	No	Yes, Move 190m North	This new location better serves Elmpark Green, and is located directly after a junction
	476	Merrion Gates	Inbound	53.315752	-6.204763	423m	32	5:00 pm	6	8:00 am	11	45m	after	74m	No	No	This location serves St. Marys Nursing Home and the catchment along Strand Road
	477	Estate Avenue	Inbound	53.316863	-6.206952	198m	13	8:00 am	6	7:30 am	11	78m	after	78m	No	Remove	This stop has a relatively low level of usage, and is located only 180m from the previous stop
	478	St. Vincent's Hospital	Inbound	53.318114	-6.211268	322m	27	5:00 pm	21	7:00 am	11	80m	after	80m	No	Move 40m east	This new location brings the stop closer to the St Vincent's University Hospital entrance and the junction. It is proposed that a lay by be retained in the current location which can cater for existing private coach services

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 3	479	Merrion Centre	Inbound	53.319144	-6.213401	505m	26	5:00 pm	12	8:00 am	0	60m	before	27m	Yes, Same stop	Yes, Move 140m North	This new location improves the spacing from previous stop, bringing it to 350m. Although the existing location provided for the Merrion Centre, it is considered that there are sufficiently spaced bus stops both on Nutley Lane and Merrion Road (east of this location)
	480	Ailesbury Road	Inbound	53.32085	-6.216287	468m	7	11:00 am	5	8:00 am	0	37m	before	37m	Yes, Same stop	Remove	This stop is spaced very close to the proposed location of stop 479 and as such was considered superfluous
	481	Merlyn Road	Inbound	53.322345	-6.218266	226m	8	10:30 pm	6	7:00 am	0	mid-block		24m	No	Yes move 50m North	This stop is located at the start of bus lane, and achieves 400m spacing from stop 479
	482	Shrewsbury Road	Inbound	53.324728	-6.221965	355m	8	7:30 am	6	7:30 am	40	mid-bock		49m	No	No	This location serves the catchment along Shrewsbury Road, and is located directly after the junction
	483	Simmonscourt Road	Inbound	53.325998	-6.223939	207m	21	5:30 pm	12	8:00 am	40	45m	after	45m	Yes, 72m to junction	Yes, move 120m north	This new location places the stop after the junction, and improves the spacing from the previous stop
	485	RDS	Inbound	53.328352	-6.228751	428m	44	6:00 pm	20	8:00 am	44	75m	after	75m	Yes, Same stop	No	This location directly serves the RDS, which is a key trip attractor

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 4	487	American Embassy	Inbound	53.330801	-6.233875	450m	86	5:30 pm	46	7:30 am	24	mid-block		111m	Yes, Same stop	No	Sufficient space is available in current location to house bus shelter, and it would be difficult to provide the same further south due to the positioning of the American Embassy
	2798	Pembroke Road	Inbound	53.332	-6.235882	200m	N/A	N/A	N/A	N/A	24	38m	before	15m	Yes, Same stop	Yes, move 70m West	Existing stop was on left turn slip lane which has been removed. New location achieves better spacing with the previous stop, and better serves the catchment along Raglan Road
	2799	Pembroke Road	Inbound	53.33269	-6.235882	416m	N/A	N/A	N/A	N/A	31	84m	after	84m	Yes, Same stop	Remove	This stop is located approximately 200m from the previous and next stops and is therefore deemed to be superfluous
	782	Mespil Road	Inbound	53.33358	-6.244601	205m	N/A	N/A	N/A	N/A	31	mid-block		48m	Yes, 125m to junction	No	This stop is well spaced from the previous stop, and serves the Baggot St. Upper area
	783	Pembroke Row	Inbound	53.33531	-6.246978	250m	N/A	N/A	N/A	N/A	31	mid-block		114m	Yes, 130m to junction	No	This stop is located 250m from the previous stop, which follows the standard for the city centre area
	784	Fitzwilliam Street	Inbound	53.33646	-6.248657	185m	N/A	N/A	N/A	N/A	31	34m	after	34m	No	Yes, move around corner onto Fitzwilliam St, 35m from junction	Moving the stop provides better spacing with previous stop and provides an inbound bus stop on Fitzwilliam Street where there currently is none.

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 5	2085	RTE	Inbound	53.315174	-6.220186	374m	3	8:30 am	14	8:00 am	30	mid-block		216m	Yes, Same stop	No	Kept in existing location with direct access to/from RTÉ
	2086	Nutley Avenue	Inbound	53.318157	-6.214703	520m	10	3:30 pm	16	7:00 am	30	92m	after	82m	Yes, Same stop	No	This location was raised as being preferable to residents, is closer to Nutley Ave. which provides access to St. Michael's College, and brings the stop spacing closer to 400m optimum spacing

B2 Outbound

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 1	427	DART Station	Outbound	53.30827	-6.195037	421m	17	3:30 pm	12	5:30 pm	11	77m	before	77m	No	No	This location serves the Booterstown DART Station, and has enough space to provide an island bus stop
	428	Blackrock College	Outbound	53.306911	-6.190727	320m	4	4:00 pm	12	6:00 pm	11	mid-block		278m	No	No	This stop serves the key trip attractor of Blackrock College, and is located close to a proposed pedestrian crossing
	429	Blackrock Clinic	Outbound	53.304708	-6.187144	341m	24	3:30 pm	14	4:00 pm	11	50m	before	50m	No	No	This location is directly after a junction, and maintains 400m spacing between previous and next stops
	3032	Blackrock Park	Outbound	53.302319	-6.182122	415m	N/A	N/A	N/A	N/A	11	40m	before	35m	Yes, Same Stop	No	This stop is located adjacent to the pedestrian crossing and serves Blackrock Park
	6334	Frascati Centre	Outbound	53.301274	-6.180643	190m	10	4:00 pm	23	6:00 pm	11	mid-block		47m	Yes, Same stop	No	This stop is located in close proximity to the pedestrian crossing, and serves the key trip attractors of Blackrock Shopping Centre and the Frascati Centre
	7660	Temple Road	Outbound	53.299146	-6.174882	440m	6	9:00 pm	9	11:30 pm	11	36m	after	36m		No	This location serves Temple Road, and is well spaced between the previous and next stops
	3114	Temple Hill	Outbound	53.2958	-6.16977	550m	N/A	N/A	N/A	N/A	14	40m	After	40m	Yes, Same Stop	No	This stop serves the Monkstown Road catchment and is located directly after the junction

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 2	422	St Vincent's Hospital	Outbound	53.318064	-6.210324	344m	21	5:00 pm	23	6:30 am	11	25m	after	25m	No	No	This stop serves the entrance to St. Vincent's University Hospital and is located close to the pedestrian crossing
	423	Herbert Avenue	Outbound	53.317149	-6.207406	214m	5	4:00 pm	8	5:00 pm	11	mid-block		33m	No	Remove	This stop is located very close to the previous and proposed location for the next stop and is therefore deemed superfluous in the consolidation
	424	Merrion Gates	Outbound	53.315394	-6.203727	309m	3	9:00 am	23	8:00 am	11	mid-block		115m	No	Move 100m west	This new location brings the stop closer to the Strand Road Junction and the pedestrian crossing
	425	Bellevue Avenue	Outbound	53.312502	-6.201477	357m	9	5:00 pm	14	7:00 pm	11	80m	after	80m	No	Move 125 m North	This new location better serves Elmpark Green, and is located directly after a junction
	426	Nature Reserve	Outbound	53.310967	-6.199831	203m	4	8:00 am	13	7:30 pm	11	81m	before	81m	No	No	This location serves the catchment of St. Helen's Road and Trimleston Avenue, and maintains 400m spacing from previous and next stops.

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 3	416	RDS	Outbound	53.32864	-6.22937	310m	11	8:00 am	31	6:00 am	46	30m	before	30m	Yes, Same stop	Yes, move 150m East, in front of Bank centre	This new location is directly after the pedestrian crossing and serves a key trip attractor outside the adjacent large office developments.
	417	Serpentine Avenue	Outbound	53.3277	-6.22597	173m	8	7:30 am	7	6:00 pm	46	60m	before	60m	Yes, Same stop	Remove	The relocation of stop number 416 would position this stop just 100m after it and this stop is therefore deemed superfluous in the consolidation.
	418	British Embassy	Outbound	53.32572	-6.223395	248m	5	4:00 pm	19	7:00 am	42	85m	before	85m	Yes, Same stop	Yes, move 80m north	This new location brings the stop closer to the junction, an improves the spacing between the previous and next stops
	419	Shrewsbury Park	Outbound	53.323995	-6.22045	285m	3	7:30 am	9	6:00 pm	42	mid-block		58m	Yes, 108m to junction	No	This location serves the catchment along Shrewsbury Road, and is located directly after the junction
	420	Merlyn Road	Outbound	53.321911	-6.217504	270m	3	7:30 am	11	4:00 pm		mid-block		54m	No	No	This location is well spaced, and is located after a mid-block pedestrian crossing
	421	Ailesbury Road	Outbound	53.320005	-6.214491	290m	21	7:00 am				54m	before	54m	Yes, 100m to junction	Yes, move 30m East	There is more space in this new location for passengers to gather

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 4	750	Fitzwilliam Street	Outbound	53.336571	-6.248488	193m	N/A	N/A	N/A	N/A	31	32m	before	32m	No	No	This location serves the Baggot Street Lower area well and is located after a junction
	751	Herbert Street	Outbound	53.335321	-6.246572	190m	N/A	N/A	N/A	N/A	31	99m	after	99m	Yes, 108m to junction	Yes, move 50m south	This new location positions the stop after the side road junction and close to the Grand Canal Greenway
	752	Mespil Road	Outbound	53.333672	-6.244462	223m	N/A	N/A	N/A	N/A	31	34m	before	34m	Yes, 125m to junction	Yes, move 130m East	This new location achieves better spacing from the previous and next stops
	2796	Pembroke Road	Outbound	53.332699	-6.240673	284m	N/A	N/A	N/A	N/A	31	mid-block		163m	Yes, Same stop	Remove	This stop is located just 150m from the proposed locations of the previous and next stops and is therefore considered superfluous
	2797	Northumberland Road	Outbound	53.33226	-6.236532	270m	N/A	N/A	N/A	N/A	25	66m	after	66m	Yes, Same stop	Yes, move 100m West	This new location achieves better spacing between the previous and next stops
	414	Lansdowne Road	Outbound	53.331522	-6.234595	394m	15	8:00 am	9	6:00 pm	25	100m	before	100m	No	Yes, move 20m South	This location avoids the removal an existing mature tree.
	415	Elgin Road	Outbound	53.330338	-6.232948	183m	8	4:00 pm	32	8:30 am	25	27m	after	27m	Yes, Same stop	Yes, Move 150m South, on bridge	This new location allows more space for waiting pedestrians, and the location on the bridge means that no entrances are blocked. This location is also closer to the Ballsbridge Village centre.

	Stop Number	Stop Name	Direction	Latitude	Longitude	Current Distance to previous stop	Current Peak Passenger Demand (Boarding)	Peak Boarding Time	Current Passenger Demand (Alighting)	Peak Alighting Time	Modelled Future Buses per hour (Peak)	Location (mid-block or within 100m of junction)	Before/ After Junction	Distance to controlled pedestrian crossing	Potential for interchange with Orbital Routes	Stop to be amended?	Reason for decision
Section 5	7053	Nutley Lane	Outbound	53.318313	-6.213801	300m	N/A	N/A	N/A	N/A	N/A	60m	before	50m	yes, 210m to junction	Yes, move 80m west	This new location better serves the western entrance to St. Vincent's University Hospital, and Nutley Avenue which provides access to St. Michael's College
	2088	St Vincent's Hospital	Outbound	53.317322	-6.216018	192m	N/A	N/A	N/A	N/A	N/A	26m	before	26m	No	Remove	Stop 7053 already serves St. Vincent's University Hospital and therefore this stop is deemed to be superfluous
	2089	RTE	Outbound	53.315287	-6.219687	322m	N/A	N/A	N/A	N/A	N/A	mid-block		245m	No	Yes, move 60m West	The proposed design provides no footpath in the current location and the bus stop has to be relocated to match - while also bringing the bus stop closer to RTÉ and the public transport corridor on the R138 Stillorgan Road.

Appendix C

Bus Stop Location Maps

C1 Section 1

Figure C.1: Section Existing Stop Locations

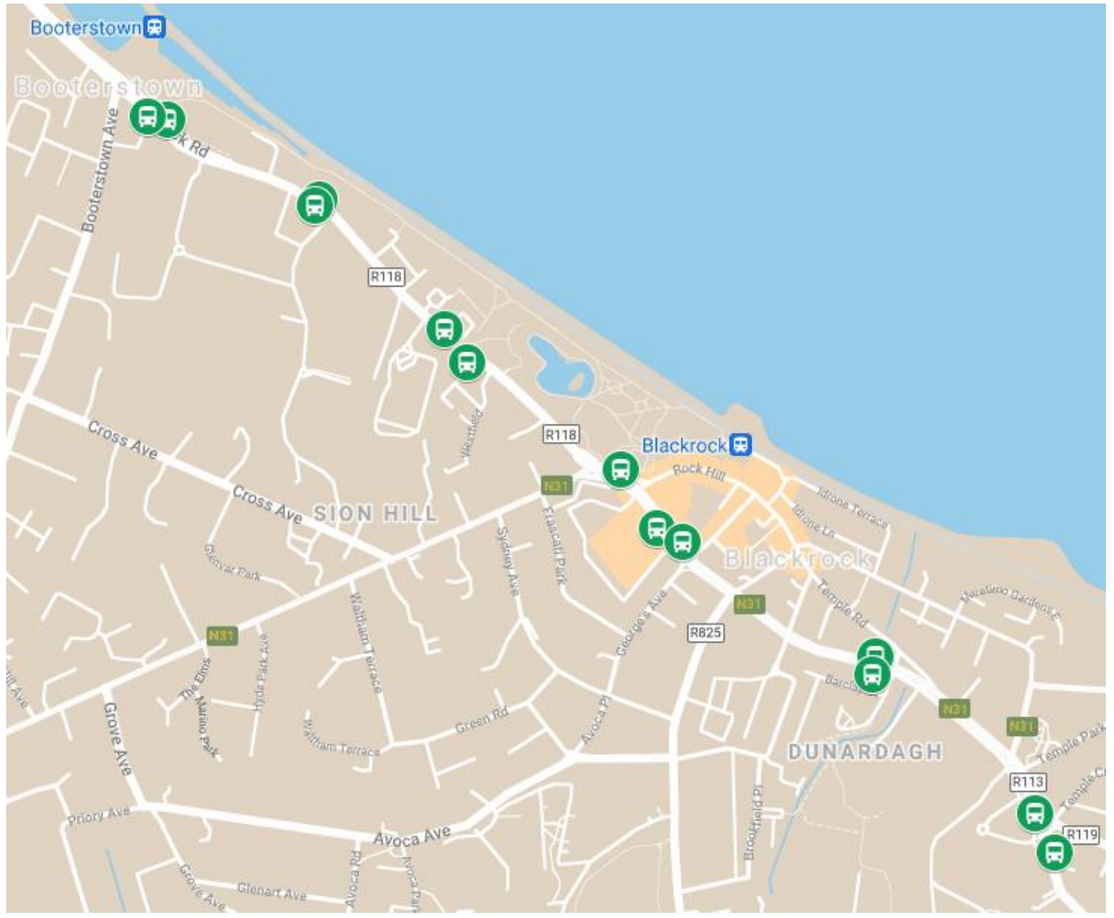


Figure C.2: Section 1 Proposed Stop Locations

C2 Section 2

Figure C.3: Section 2 Existing Stop Locations

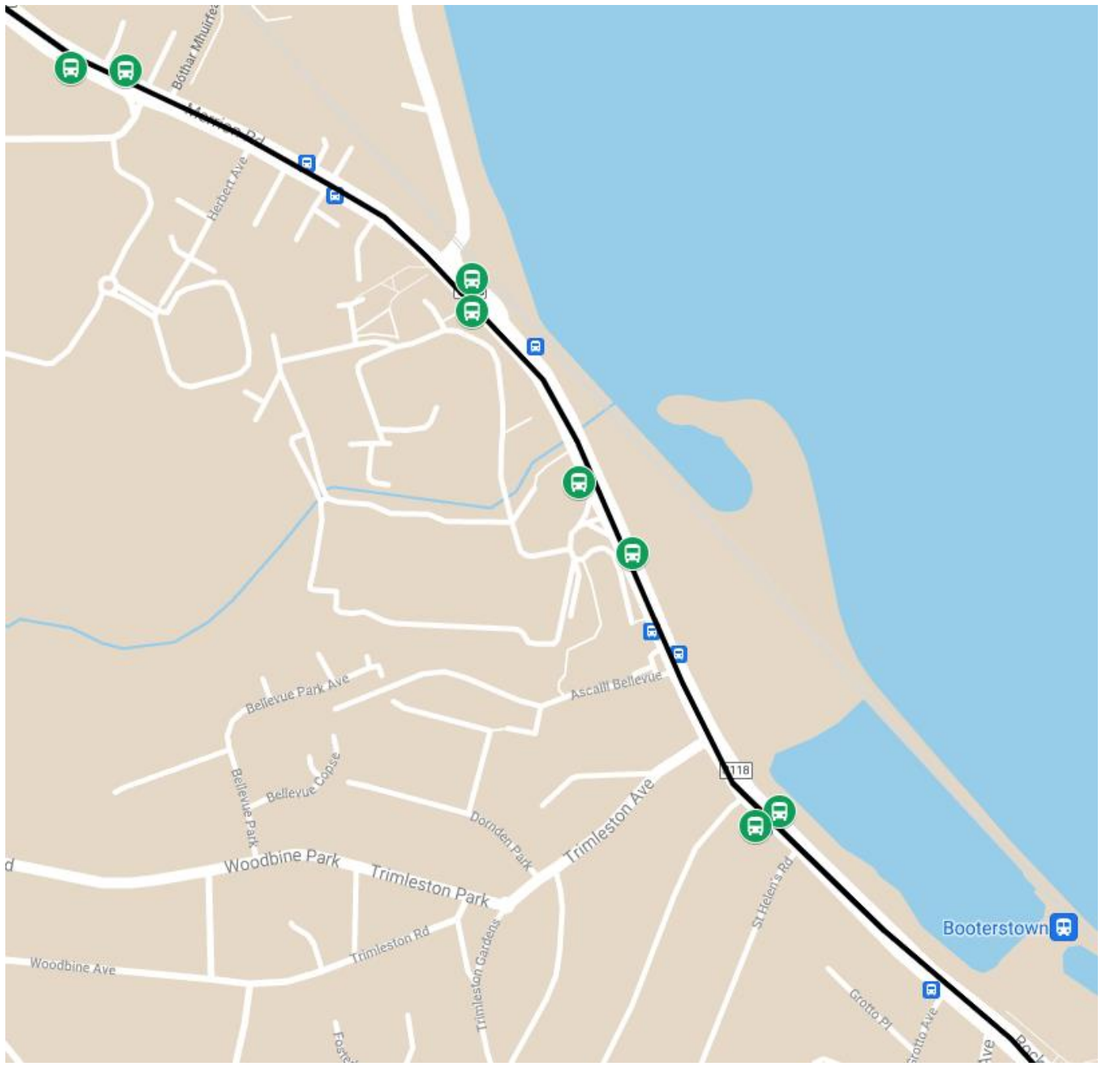


Figure C.4: Sections 2 Proposed Stop Locations

C3 Section 3

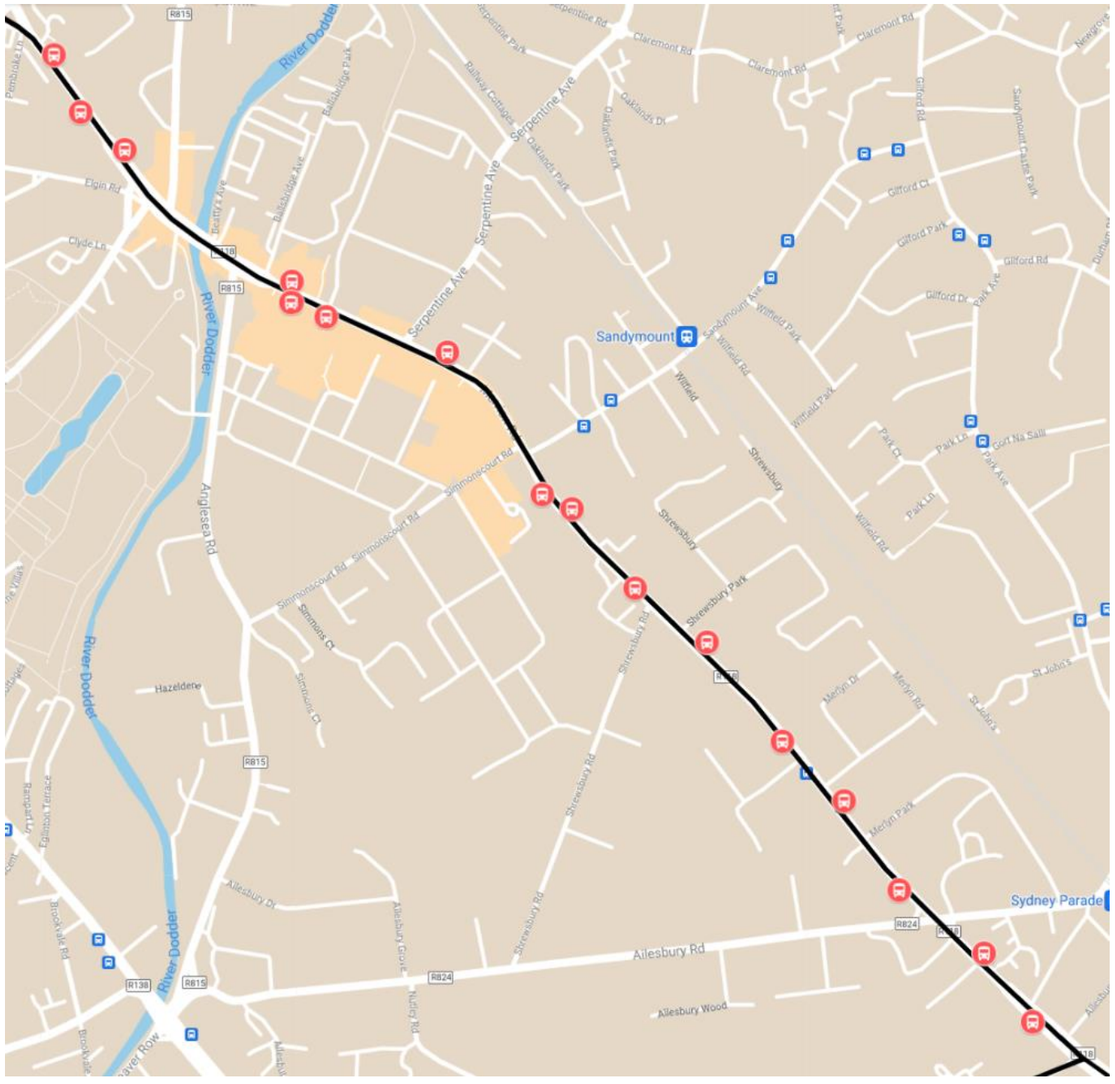


Figure C.5: Section 3 Existing Stop Locations

Figure C.6: Sections 3 Proposed Stop Locations

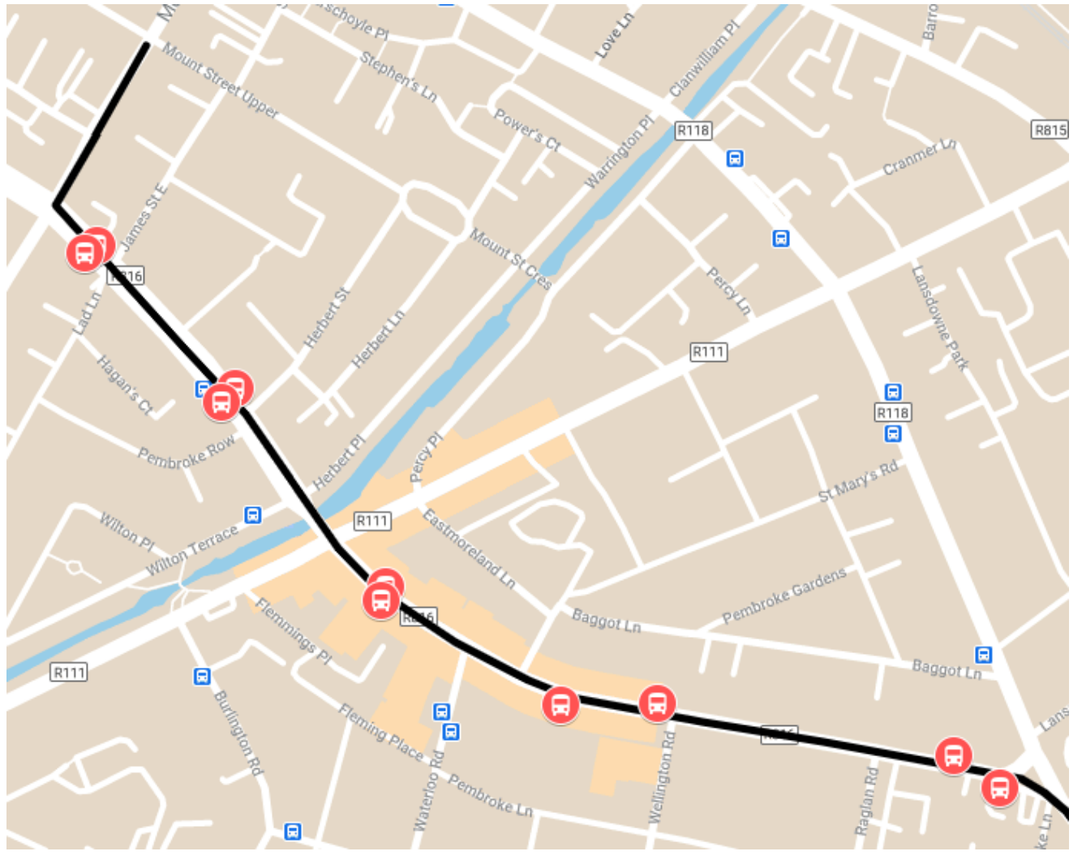


Figure C.7: Section 4 Existing Stop Locations

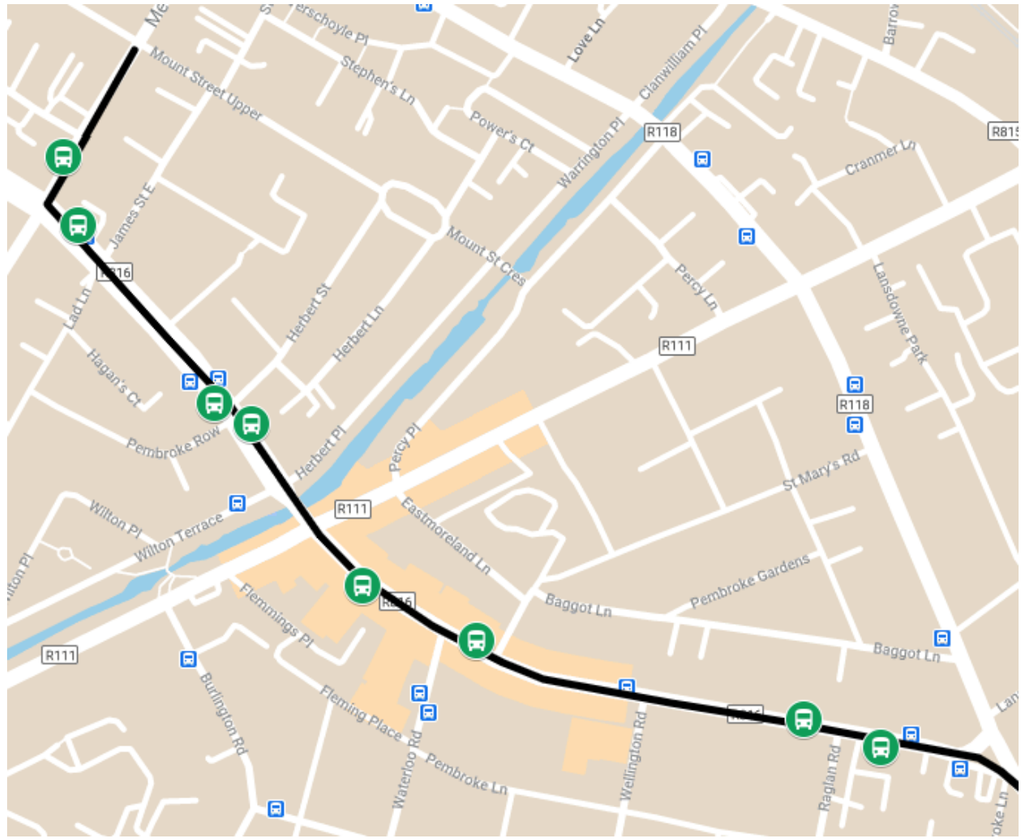


Figure C.8: Section 4 Proposed Stop Locations

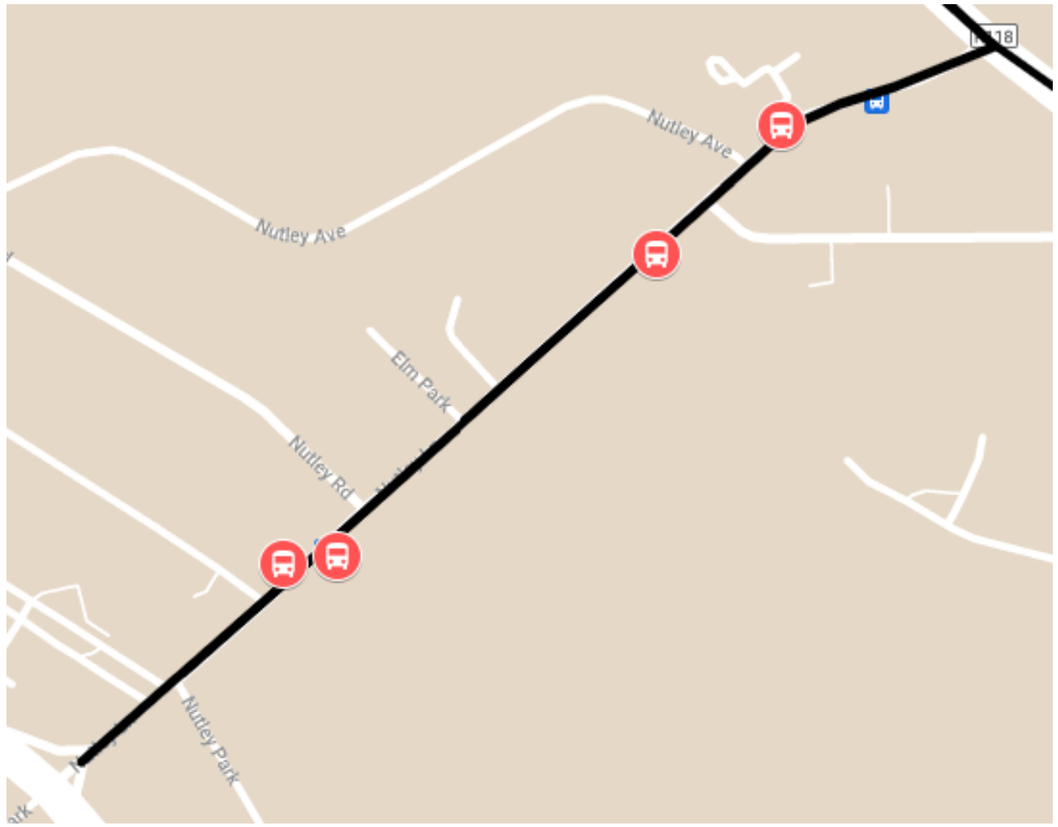


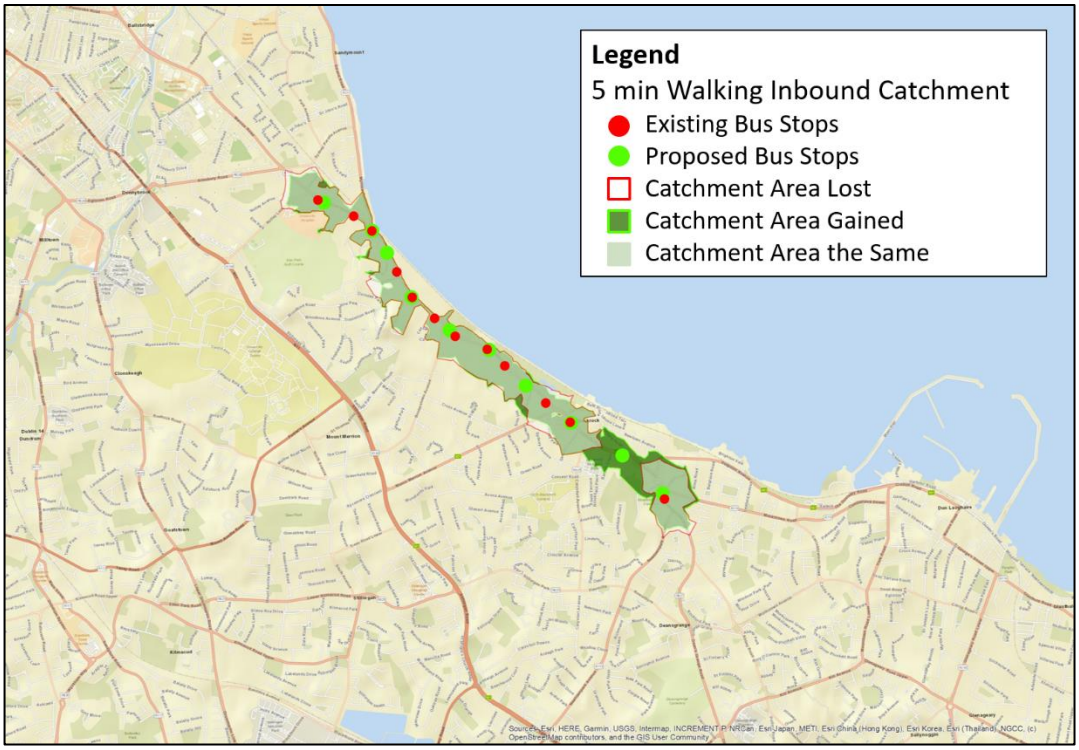
Figure C.9: Section 5 Existing Stop Locations

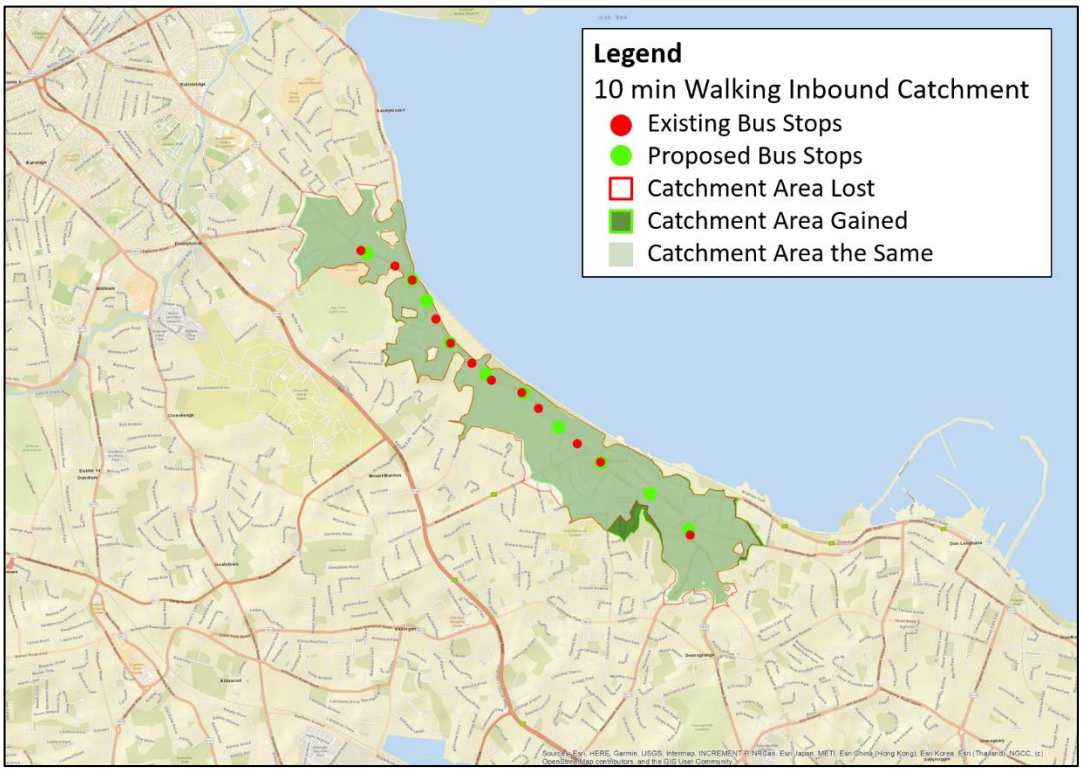
Figure C.10: Section 5 Proposed Stop Locations

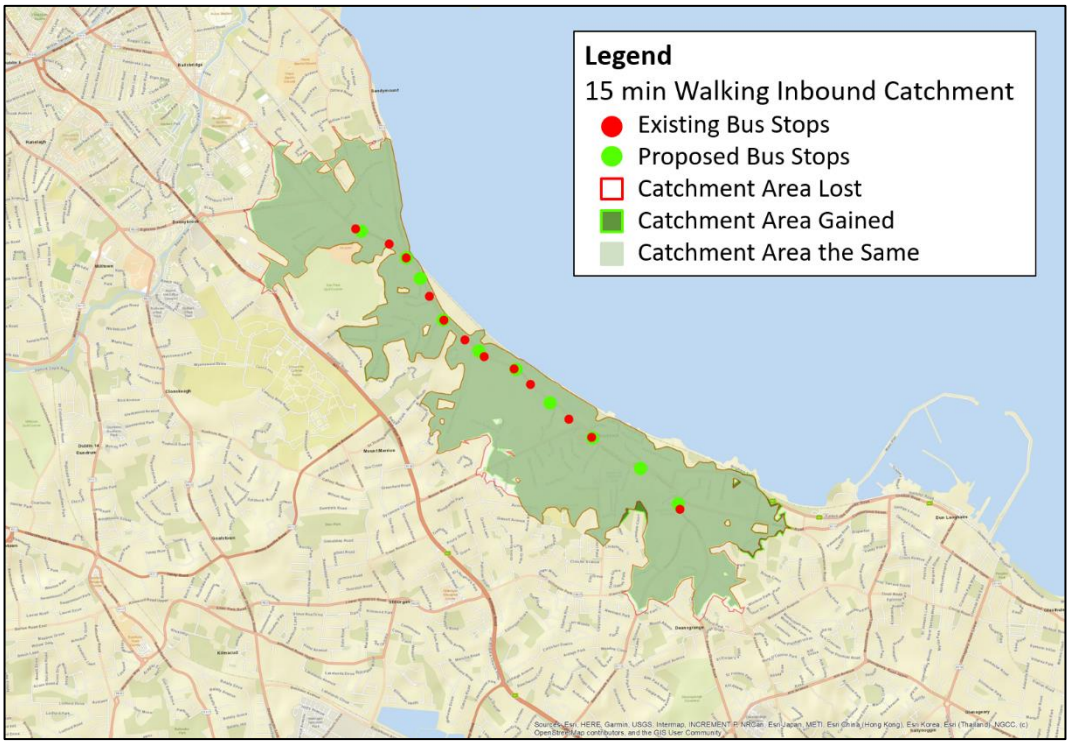
Appendix D

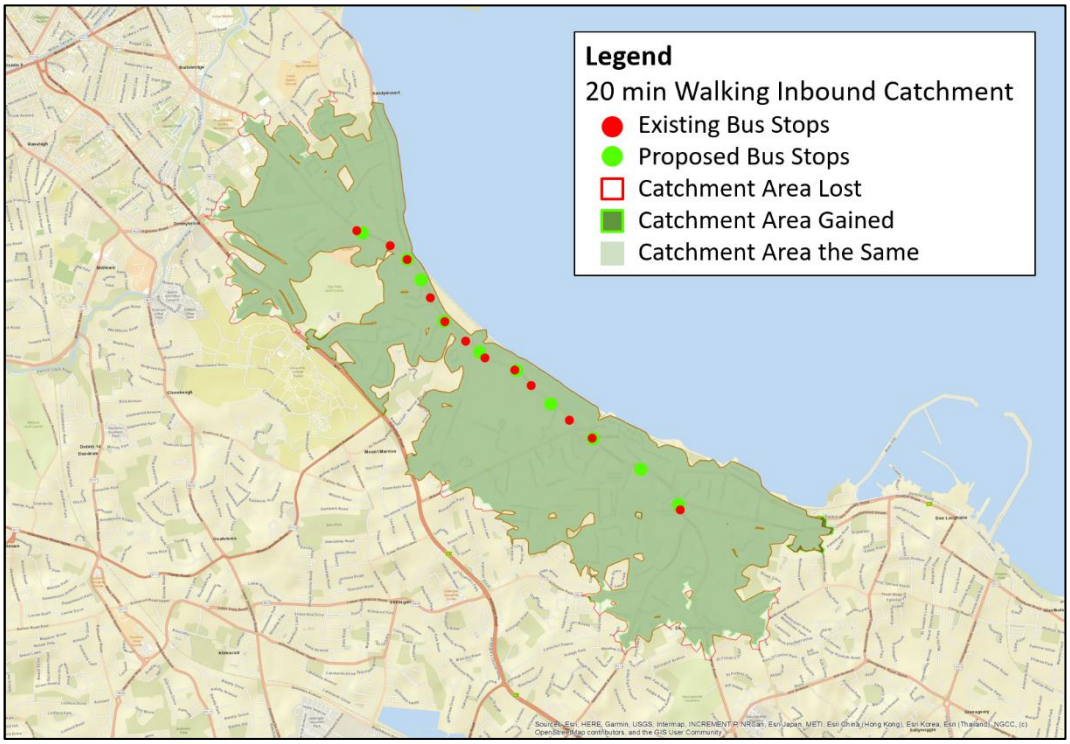
Overlap Maps

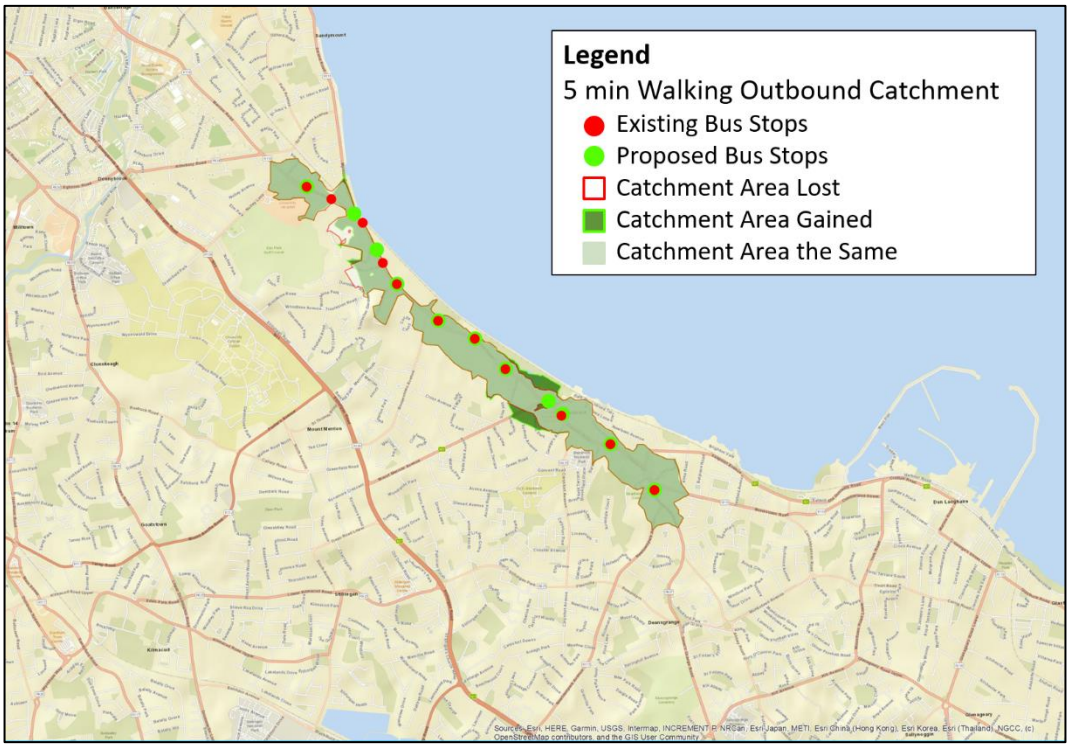
D1 Sections 1 and 2

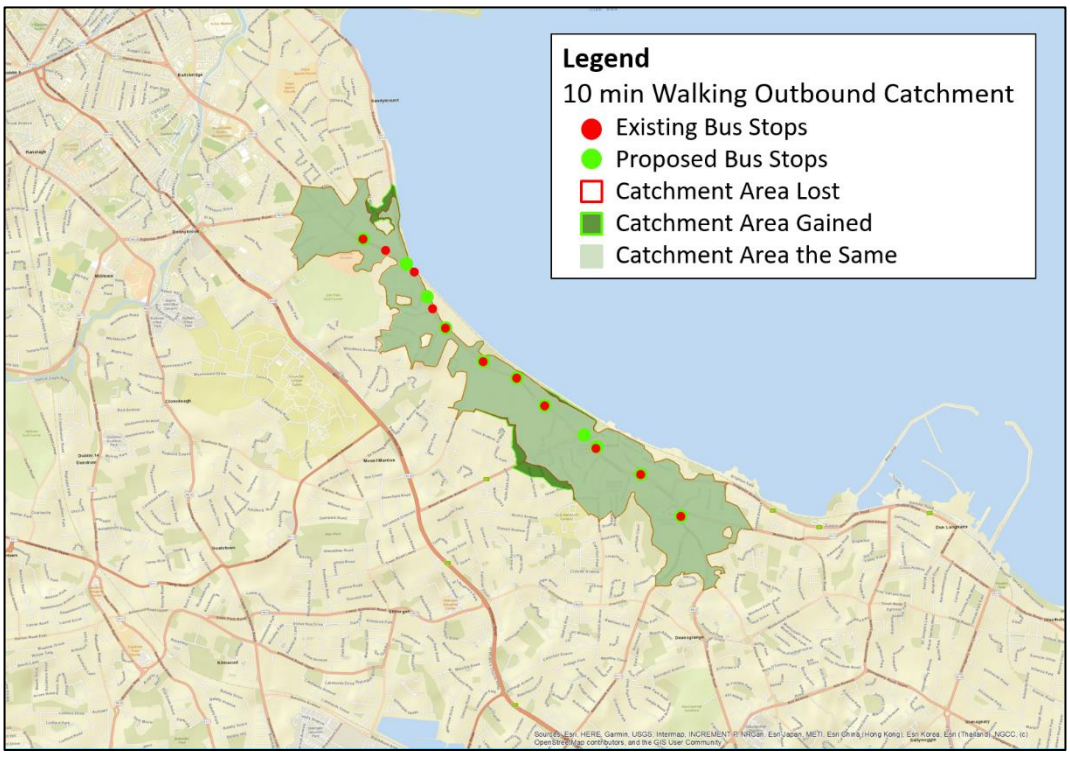


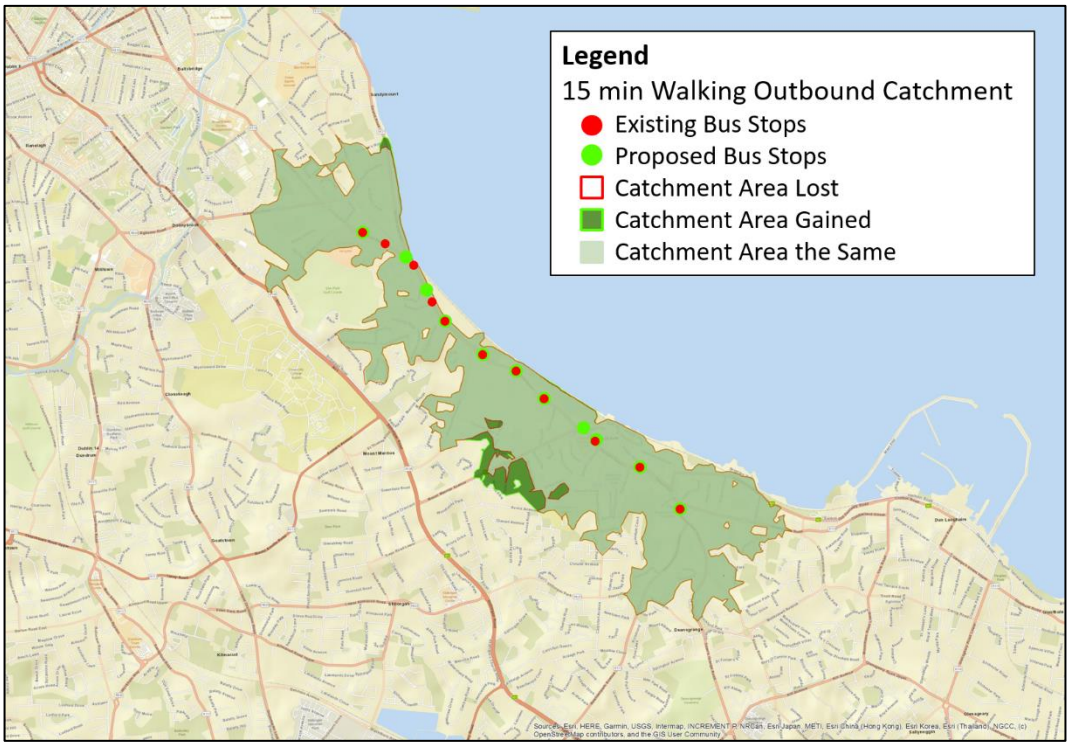


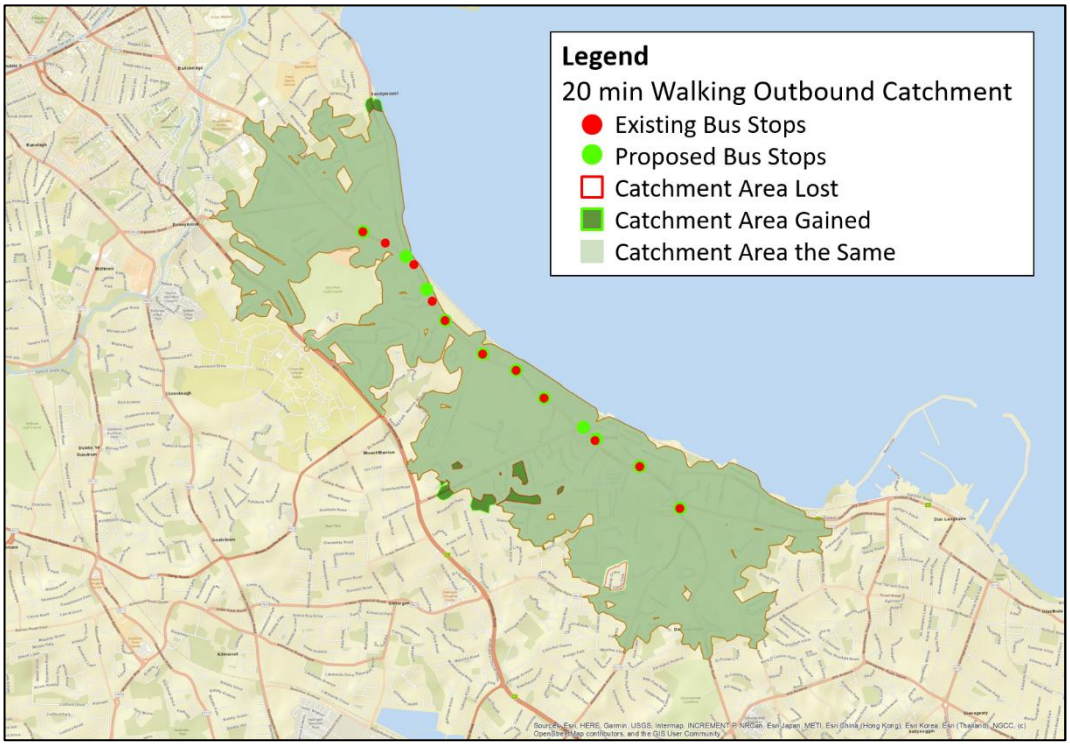

Legend
15 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same


Legend
20 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same

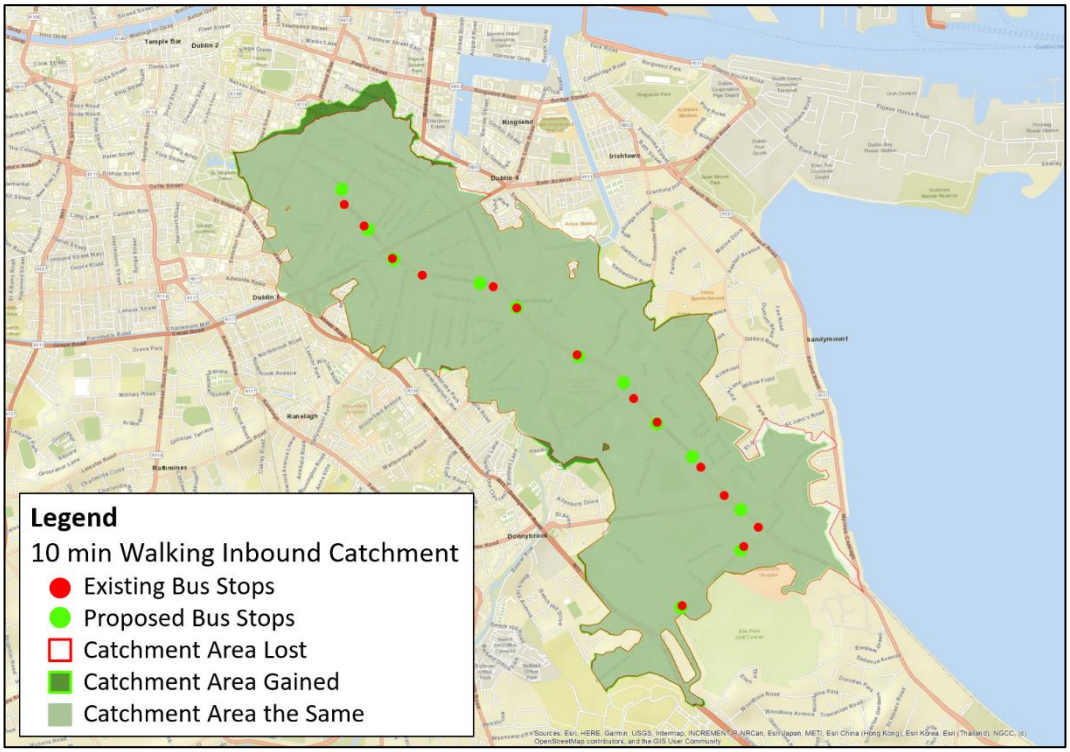

Legend
5 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same

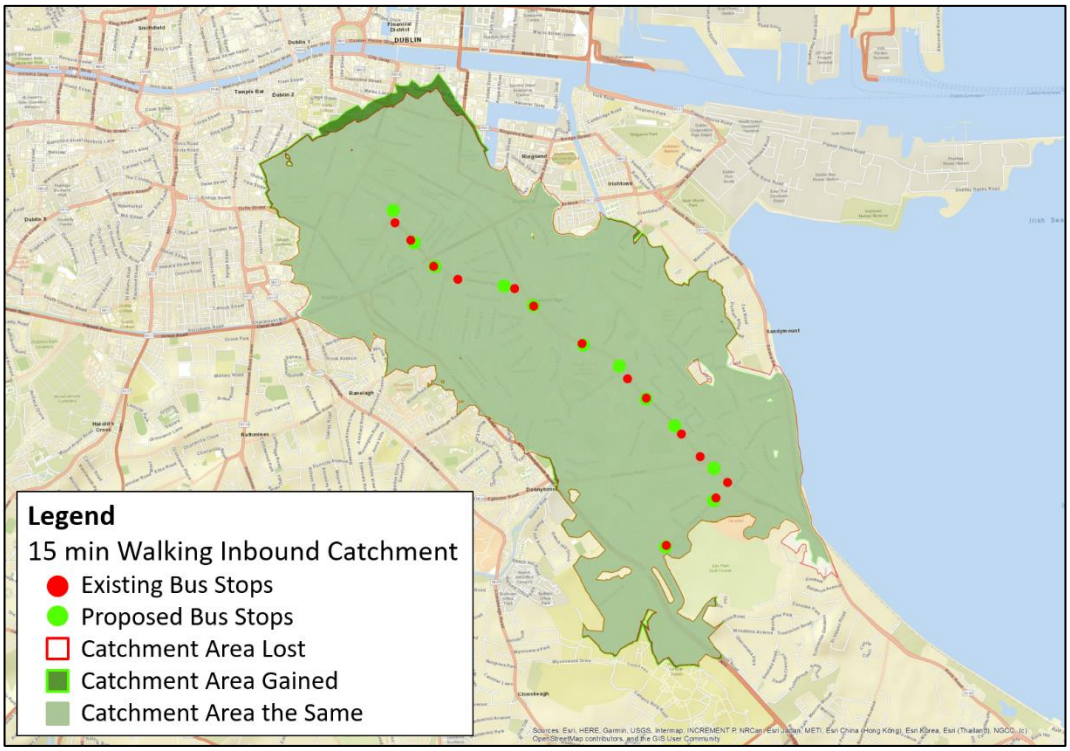

Legend
10 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same

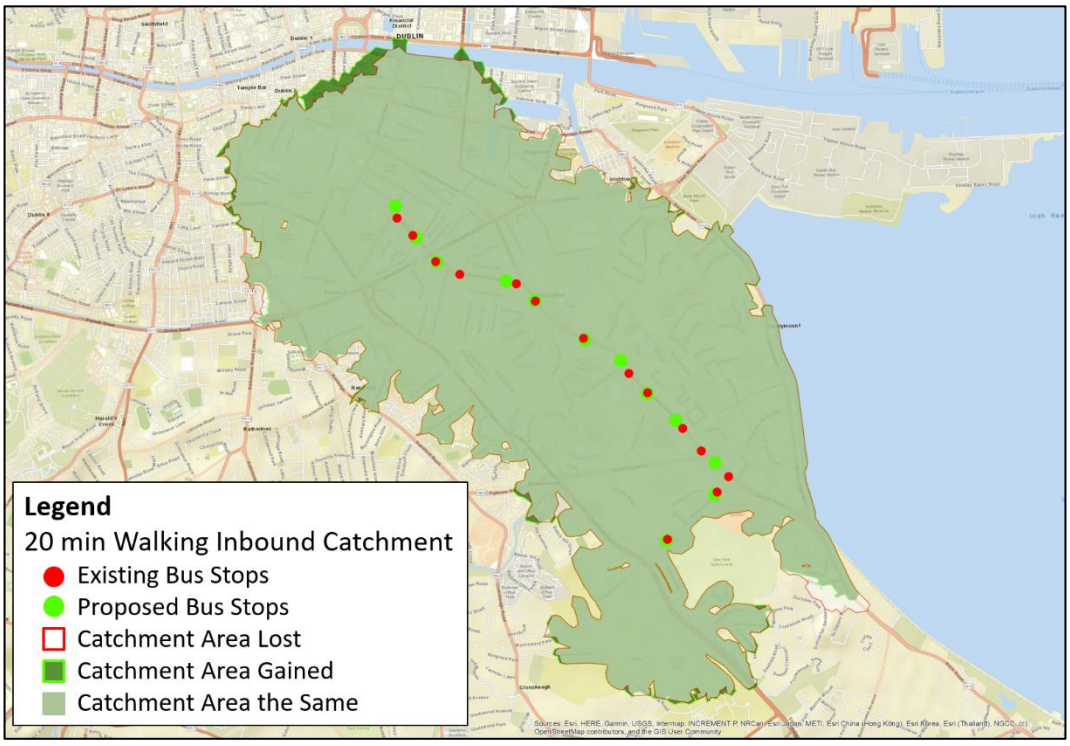

Legend
15 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same

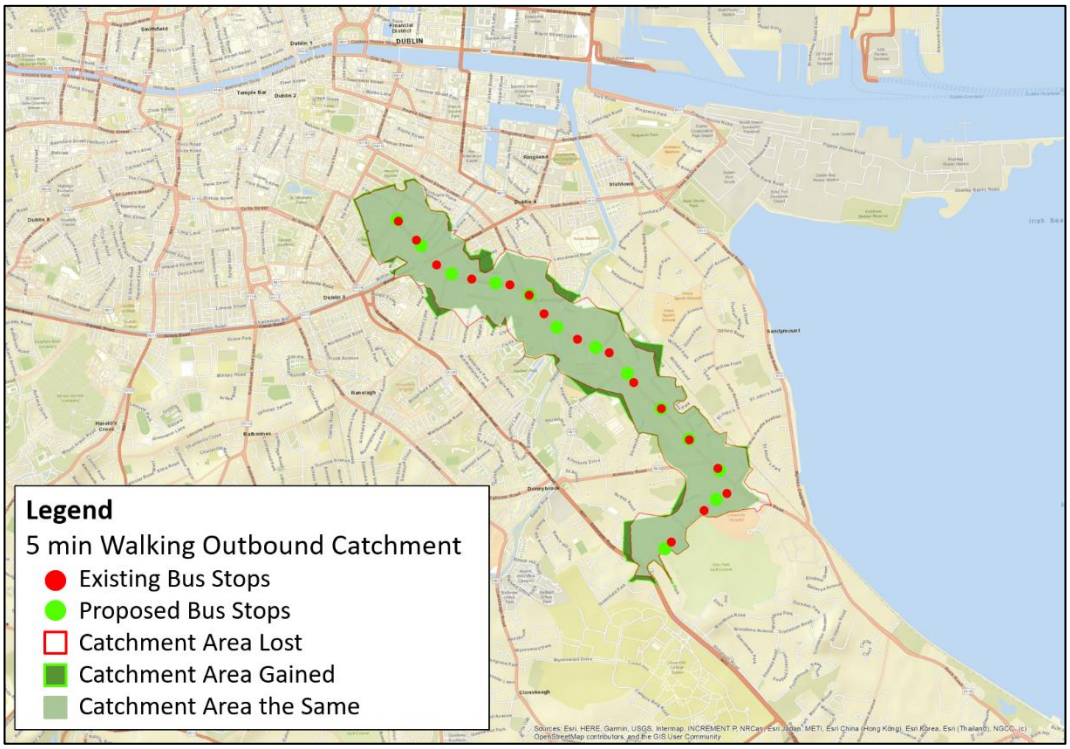

Legend
20 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same

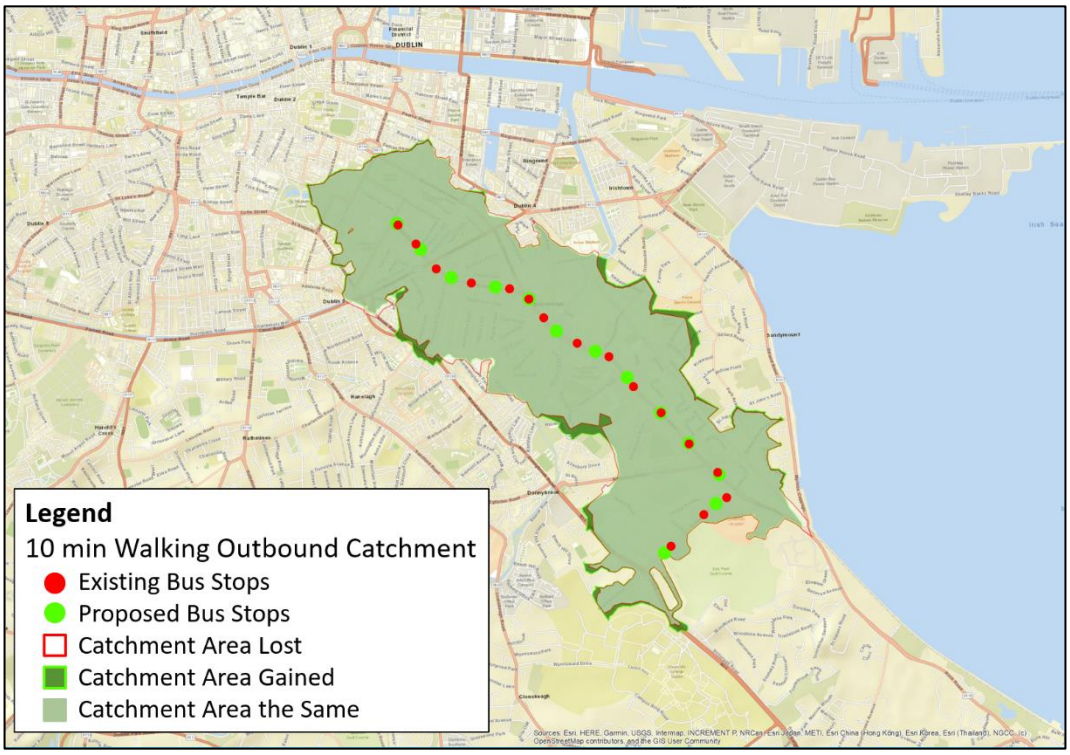
D2 Sections 3, 4 and 5

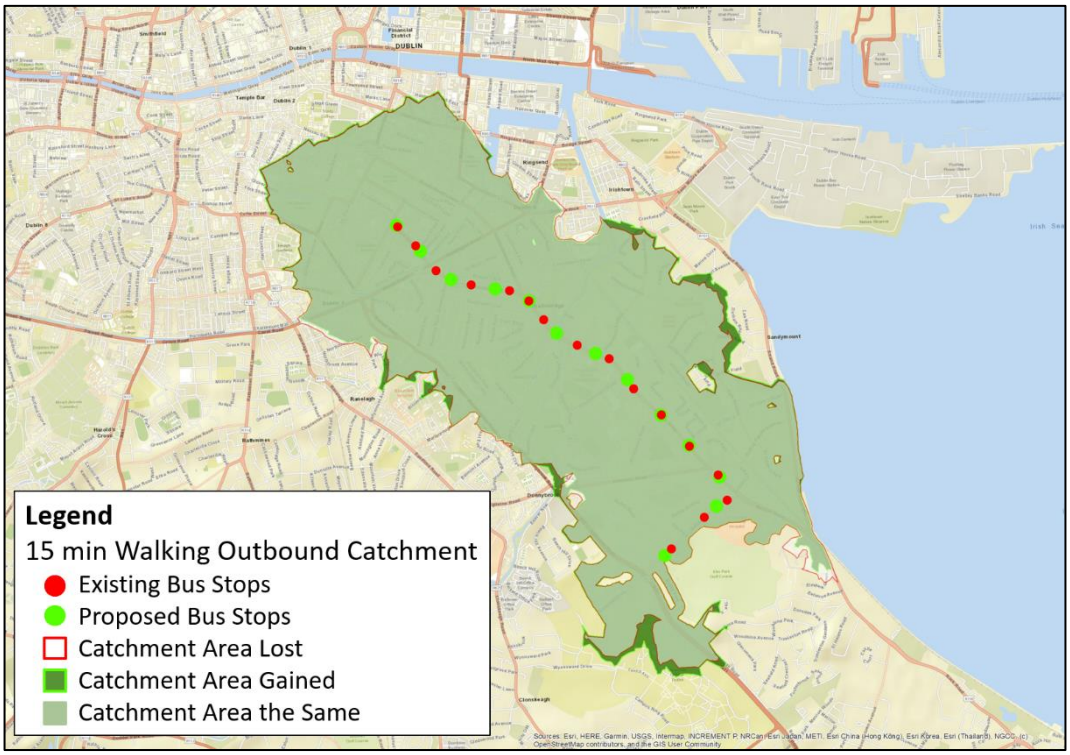


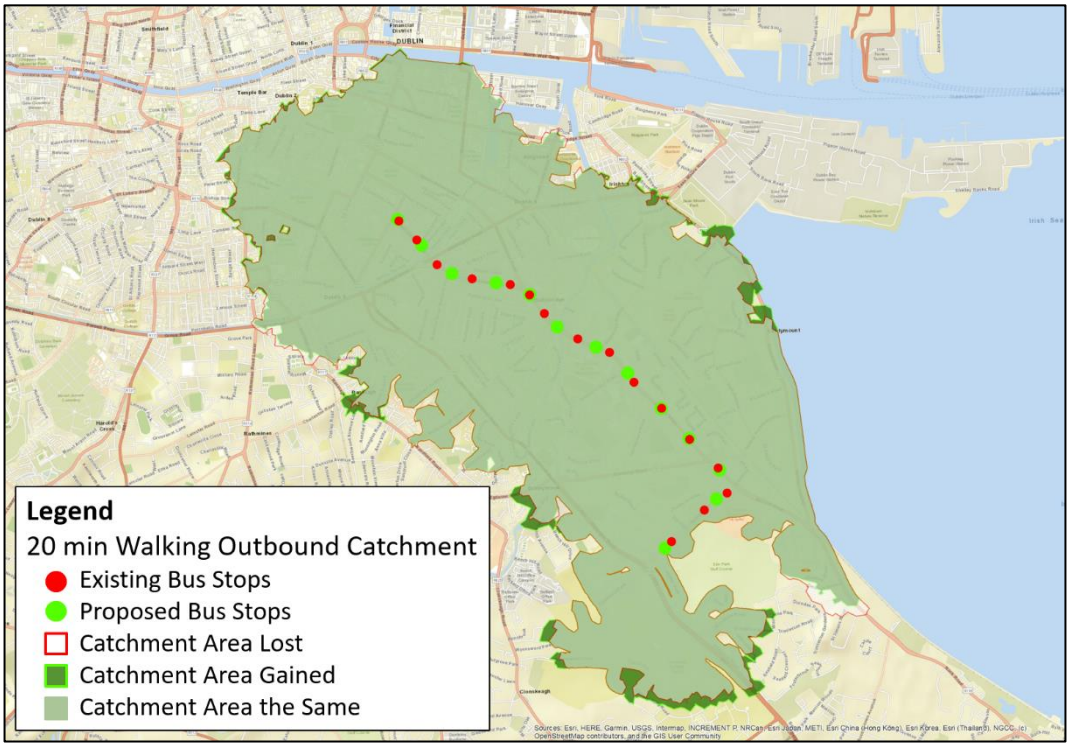

Legend
15 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same


Legend
20 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same


Legend
5 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same


Legend
10 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same


Legend
15 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same


Legend
20 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same