Appendix H
Bus Stop Review Report

National Transport Authority

Templeogue / Rathfarnham to City Centre Core Bus Corridor Scheme

Bus Stop Review Report

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1 Introduction

This report has been prepared to present a summary of the Bus Stop Review process which was conducted for the Templeogue / Rathfarnham to City Centre Core Bus Corridor (CBC) Scheme (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 CBC 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 offering a shorter journey time to destinations.

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

- Section 1: Tallaght Road to Rathfarnham Road;
- Section 2: Nutgrove Avenue to Terenure Road North;
- Section 3: Terenure Road North to Charleville Road; and
- Section 4: Charleville Road to Dame Street.

The assessment presented in this report is presented on a sectional basis as identified above.

2 Methodology

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 to 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 proposed.

Each of the study components as outlined below are discussed in more detail in the remainder of this report and applied to the review of bus stops on the proposed scheme.

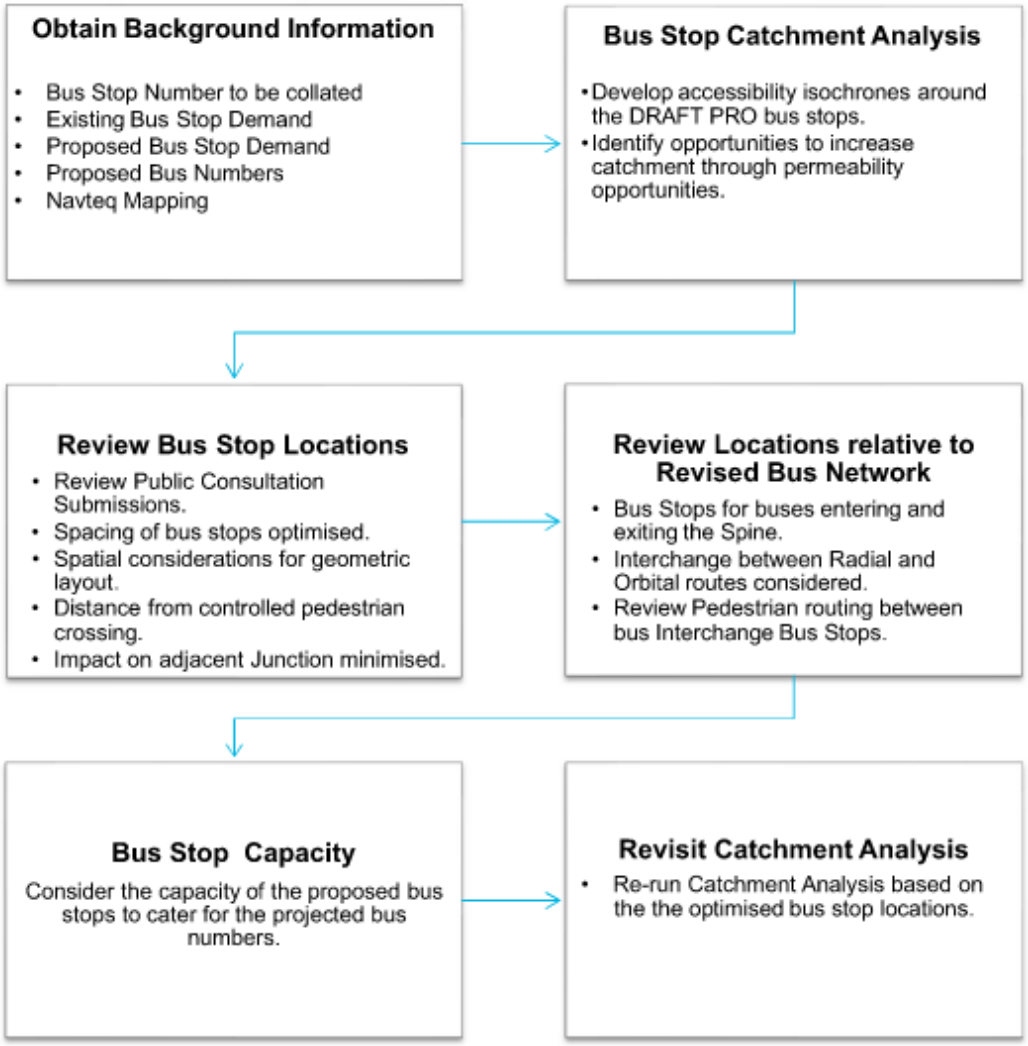


Figure 2.1: Bus Stop Review Methodology Flowchart

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 can be found in Appendix B.

The background information obtained for the study along with the source of the information in 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 Preferred Route Option (PRO) (relative to existing location)	PRO Design Drawings
PRO Distance to previous stop	PRO Design Drawings & Google Maps
Existing Peak Boarding and alighting volumes & Times	NTA Boarding and Alighting Database
Future Buses per Hour	DLAM model inputs
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 undesirable distance to walk to a bus stop for the purposes of this assessment. This analysis was carried out in GIS using Navteq mapping as the network dataset, along with the coordinates of the existing bus stop locations.

For each scheme section, 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 within the subsequent sections.

4.1 Inbound

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

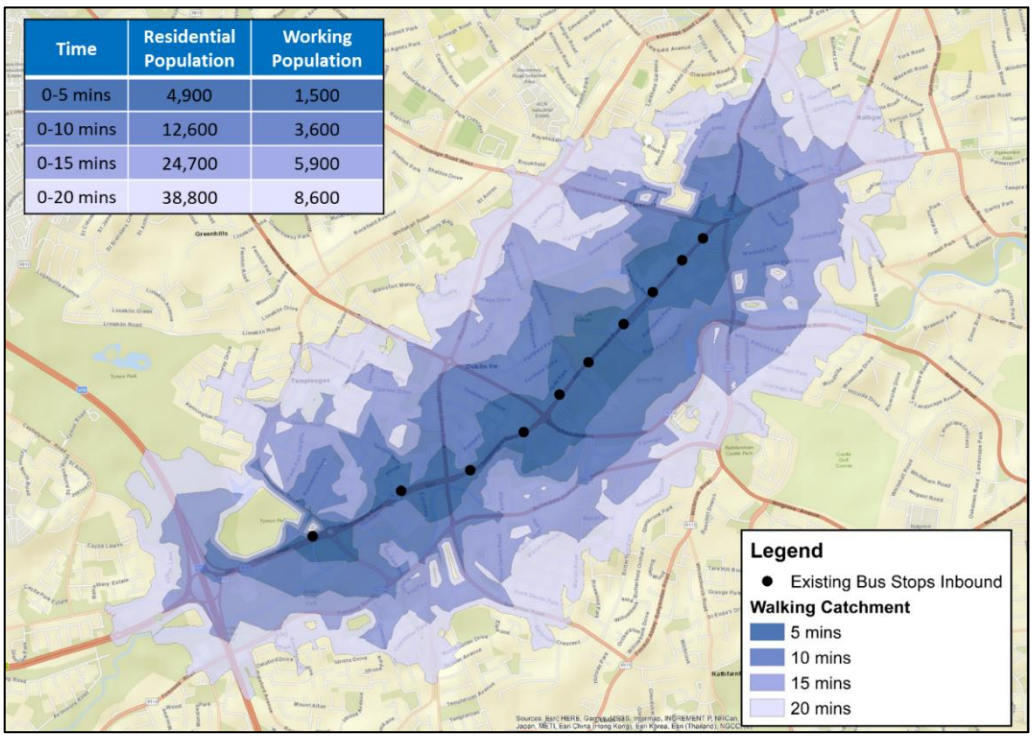


Figure 4.1: Section 1 Existing Inbound Bus Stop Catchments

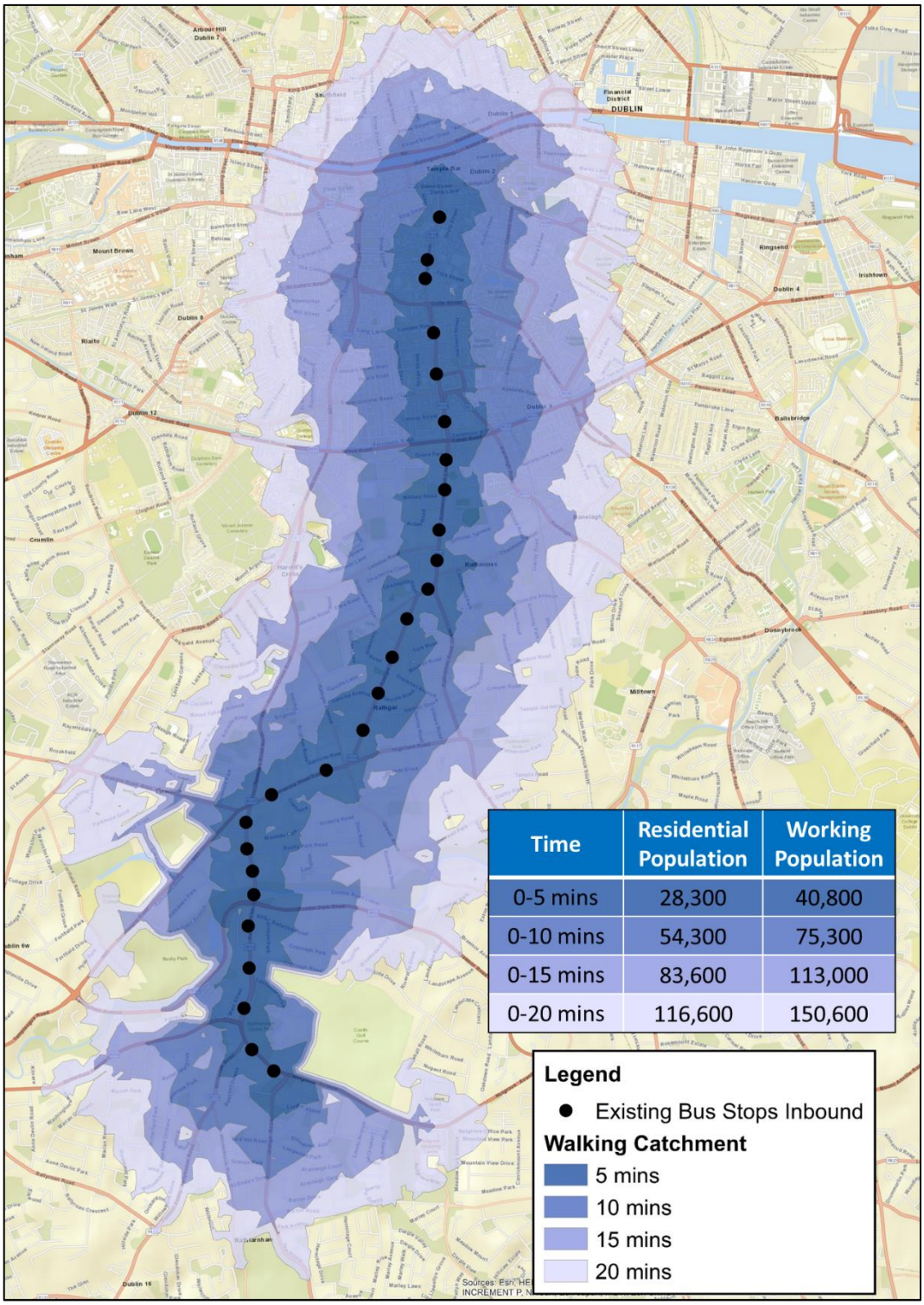


Figure 4.2: Sections 2, 3 and 4 Existing Inbound Bus Stop Catchments

4.2 Outbound

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

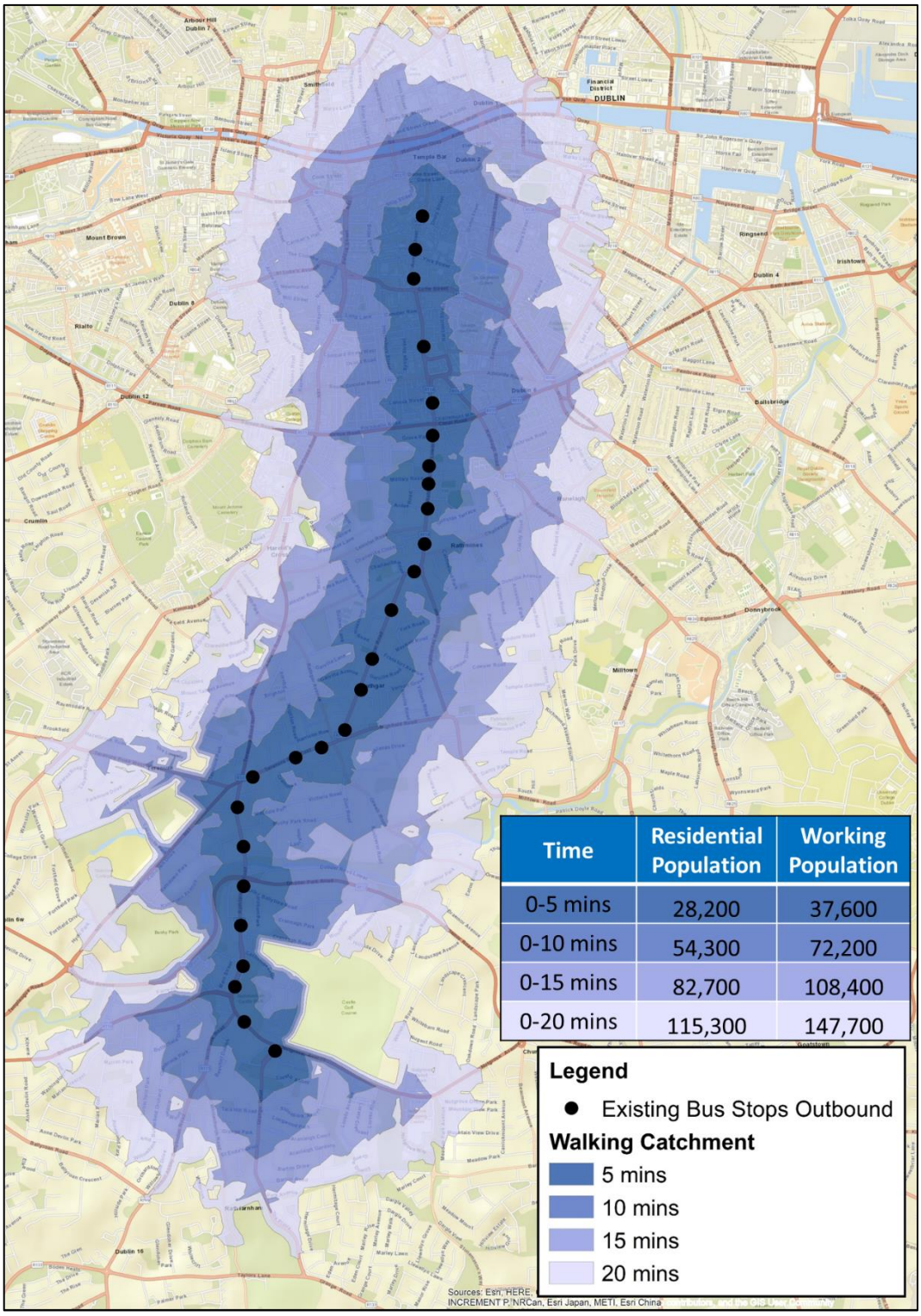


Figure 4.3: Sections 2, 3 and 4 Existing Outbound Bus Stop Catchments

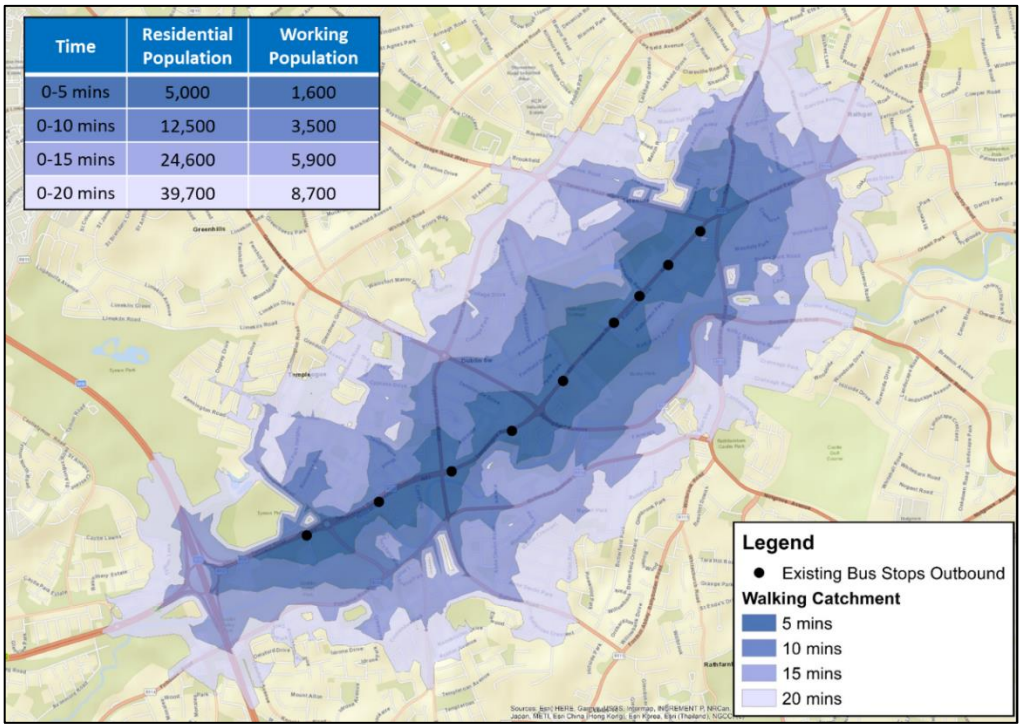


Figure 4.4: Section 1 Existing Outbound Bus Stop Catchments

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 were 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 as close as possible 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 usage 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, be 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 CBC.

The location of existing bus stops and the proposed locations as a result of the review are illustrated in figures C.1 to C.8 in Appendix C.

6 Revisited Catchment Analysis

Following the review of bus stop locations, the catchment analysis was carried out once again in order to understand the impact of the changes on the bus network catchments. The results of the inbound stops are presented in Figure 6.1 and Figure 6.2, with a catchment population comparison presented in Table 6.1 to Table 6.4. The results for the Outbound direction are presented in Figure 6.3and Figure 6.4, with a catchment population comparison presented in Table 6.5 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 below show the catchments for the proposed bus stop locations for the inbound stops on the proposed scheme.

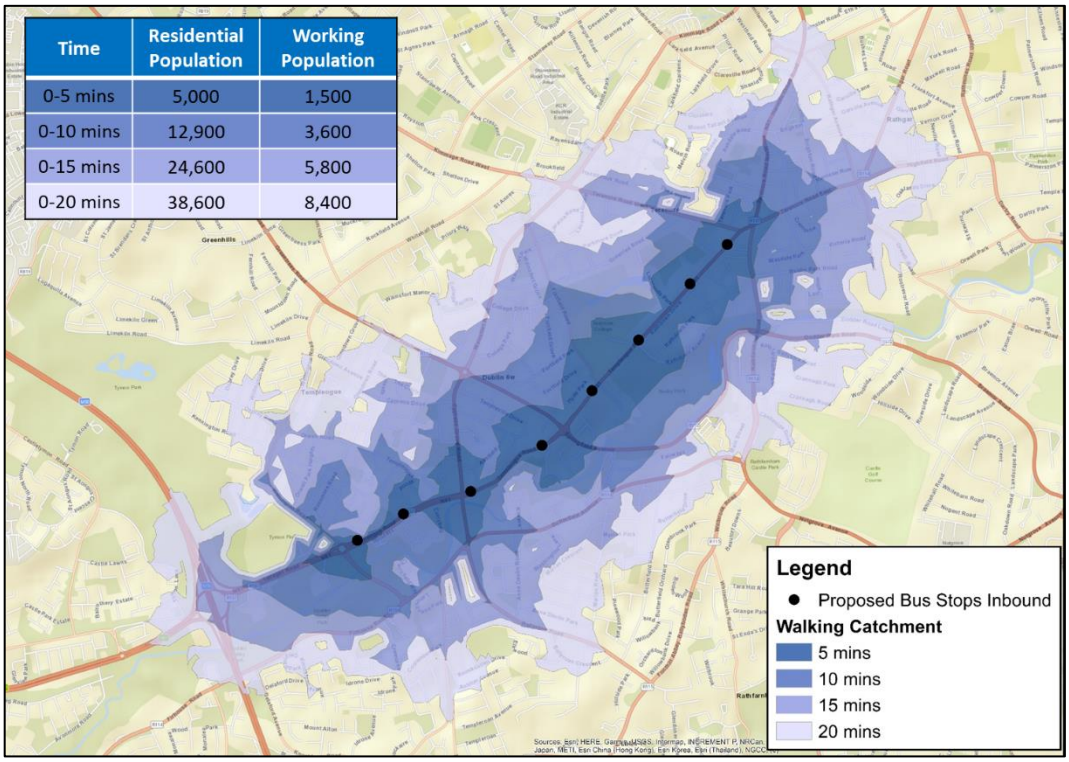


Figure 6.1: Section 1 Proposed Inbound Bus Stop Catchments

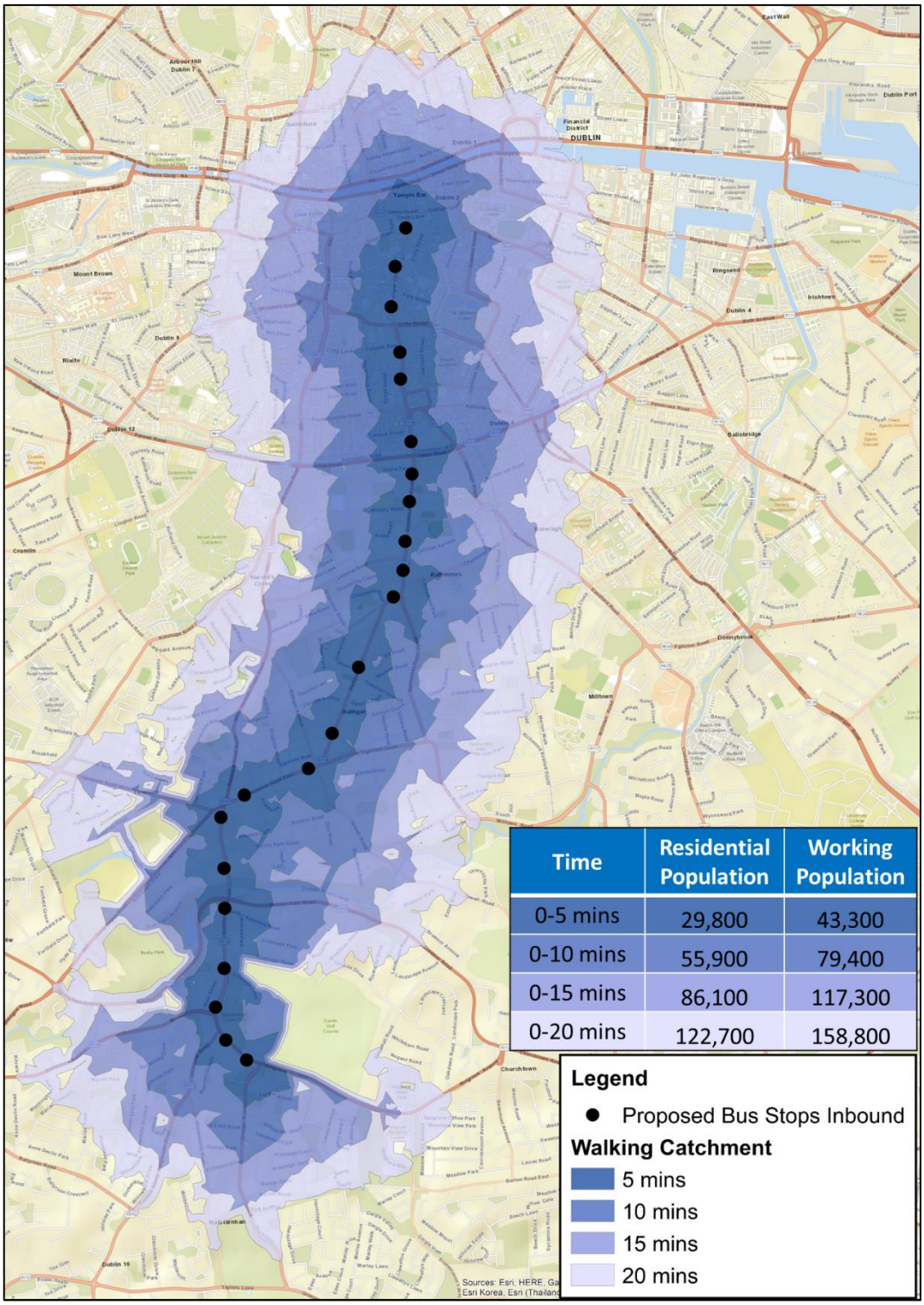


Figure 6.2: Sections 2, 3 and 4 Proposed Inbound Bus Stop Catchments

Table 6.1 to Table 6.4 shows the existing and proposed catchment populations, along with the difference between the two, for both the residential and workplace populations.

Table 6.1: Section 1 Inbound Residential Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	4900	5000	100
0-10	12600	12900	300
0-15	24700	24600	-100
0-20	38800	38600	-200

Table 6.2: Section 1 Inbound Workplace Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	1500	1500	0
0-10	3600	3600	0
0-15	5900	5800	-100
0-20	8600	8400	-200

Overall, the catchment changes very little between the current and proposed bus stop locations. The 15- and 20-minute inbound catchments see a slight decrease in the catchment populations.

From looking at the overlap maps contained in Appendix D, it can be seen that this decrease is largely due to the first stop on the route being moved further East, leaving some catchment area to the West of the M50 not being covered. Only the stops along the route being used for the catchment analysis, however in reality, the bus stop west of the M50 interchange would cover this ‘lost’ catchment area. As such this reduction in catchment area is not considered to be material.

Table 6.3: Sections 2, 3 and 4 Inbound Residential Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	28300	30000	1700
0-10	54300	56800	2500
0-15	83600	86500	2900
0-20	116600	122900	6300

Table 6.4: Sections 2, 3 and 4 Inbound Workplace Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	40800	44900	4100
0-10	75300	80300	5000
0-15	113000	118000	5000
0-20	150600	159000	8400

6.2 Outbound

Figure 6.3 and Figure 6.4 below show the catchments for the proposed bus stop locations for the outbound direction for section 1, along with sections 2,3 and 4 combined.

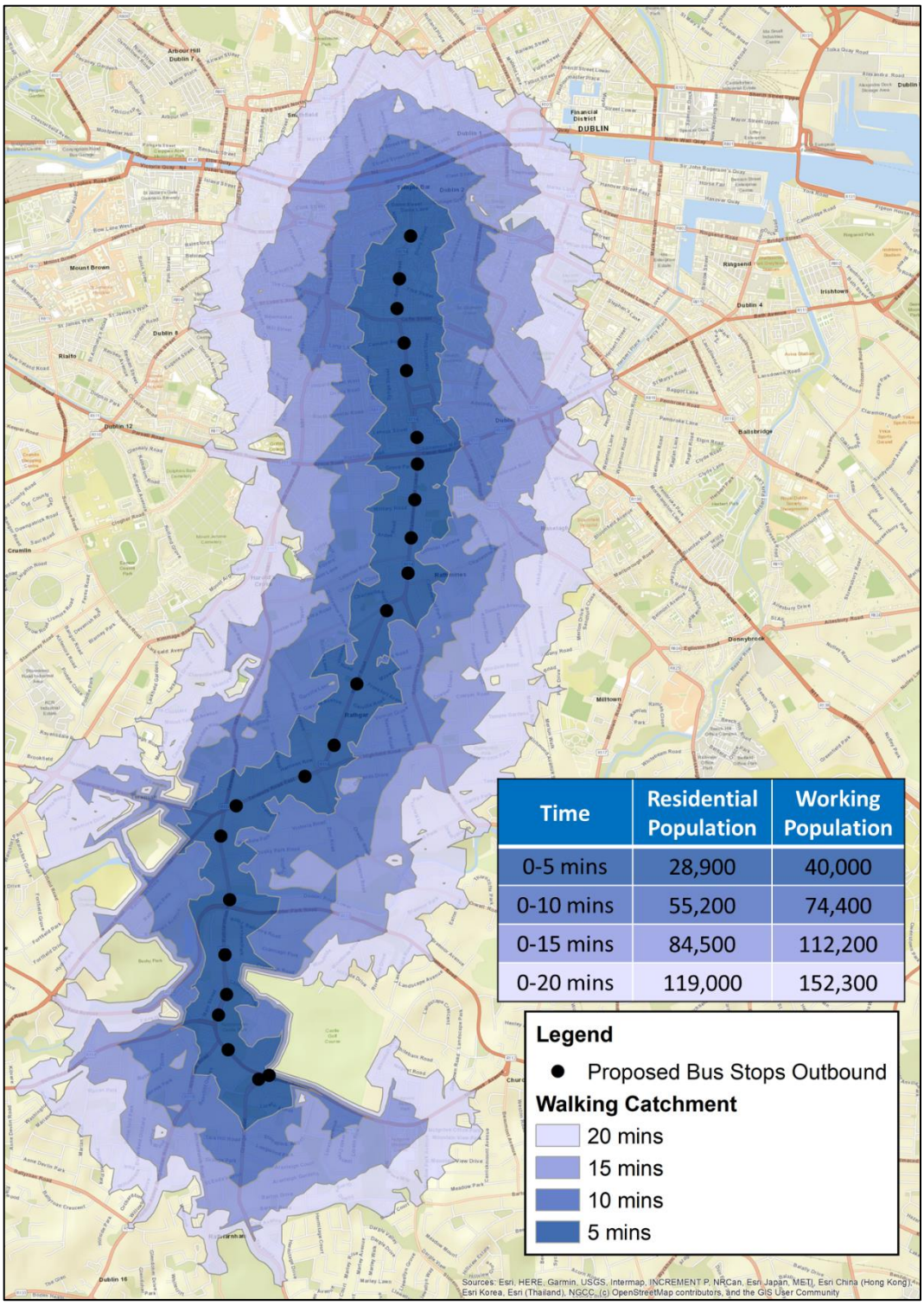


Figure 6.3: Sections 2, 3 and 4 Proposed Outbound Bus Stop Catchments

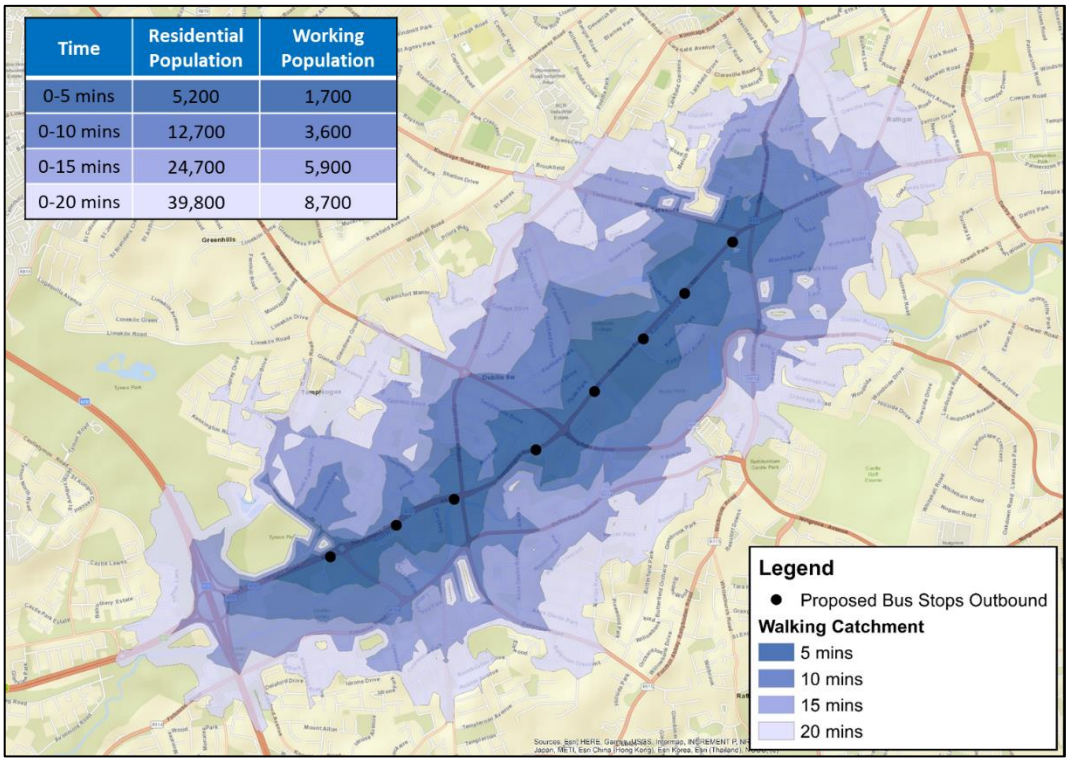


Figure 6.4: Section 1 Proposed Outbound Bus Stop Catchments

Table 6.7 to Table 6.6 shows the existing and proposed catchment populations, along with the difference between the two, for both the residential and workplace populations.

Table 6.5: Sections 2, 3 and 4 Outbound Residential Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	28200	28900	1300
0-10	54300	55200	1200
0-15	82700	84500	2800
0-20	115300	119000	4800

Table 6.6: Sections 2, 3 and 4 Outbound Workplace Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	37600	40000	3900
0-10	72200	74400	5400
0-15	108400	112200	6900
0-20	147700	152300	7900

From the tables above, it can be seen that the proposed bus stop locations bring about an increase in both residential and workplace catchments for all sections.

The workplace population catchment increases to a greater extent than the residential populations, which is likely due to the extent to which the proposed scheme passes through the city centre and the Rathmines commercial centre.

Table 6.7: Section 1 Outbound Residential Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	5000	5200	200
0-10	12500	12700	200
0-15	24600	24700	100
0-20	39700	39800	100

Table 6.8: Section 1 Outbound Workplace Catchment Populations

Catchment (mins)	Existing (persons)	Proposed (persons)	Difference (persons)
0-5	1600	1700	100
0-10	3500	3600	100
0-15	5900	5900	0
0-20	8700	8700	0

7 Scheme Summary

7.1 Inbound

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

Table 7.1: Templeogue / Rathfarnham to City Centre Inbound Route Summary

Number of Existing Stops	37
Number of Stops Moved	15
Number of Stops Removed	7
Number of Stops Added	0

Table 7.2: Templeogue / Rathfarnham to City Centre Outbound Route Summary

Number of Existing Stops	35
Number of Stops Moved	10

Number of Stops Removed	6
Number of Stops Added	1

On the inbound route, of the 37 existing stops, 15 are proposed to be moved and 7 to be removed, with no stops added.

On the outbound route, of the 35 existing stops, 10 are proposed to be moved and 6 to be removed, along with 1 stop added.

8 Conclusion

A bus stop review was carried out for the Templeogue/Rathfarnham 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 25 (35%) of the existing bus stops (inbound and outbound) along the Proposed Scheme. It is also proposed to remove 13 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 72 to 60.

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.

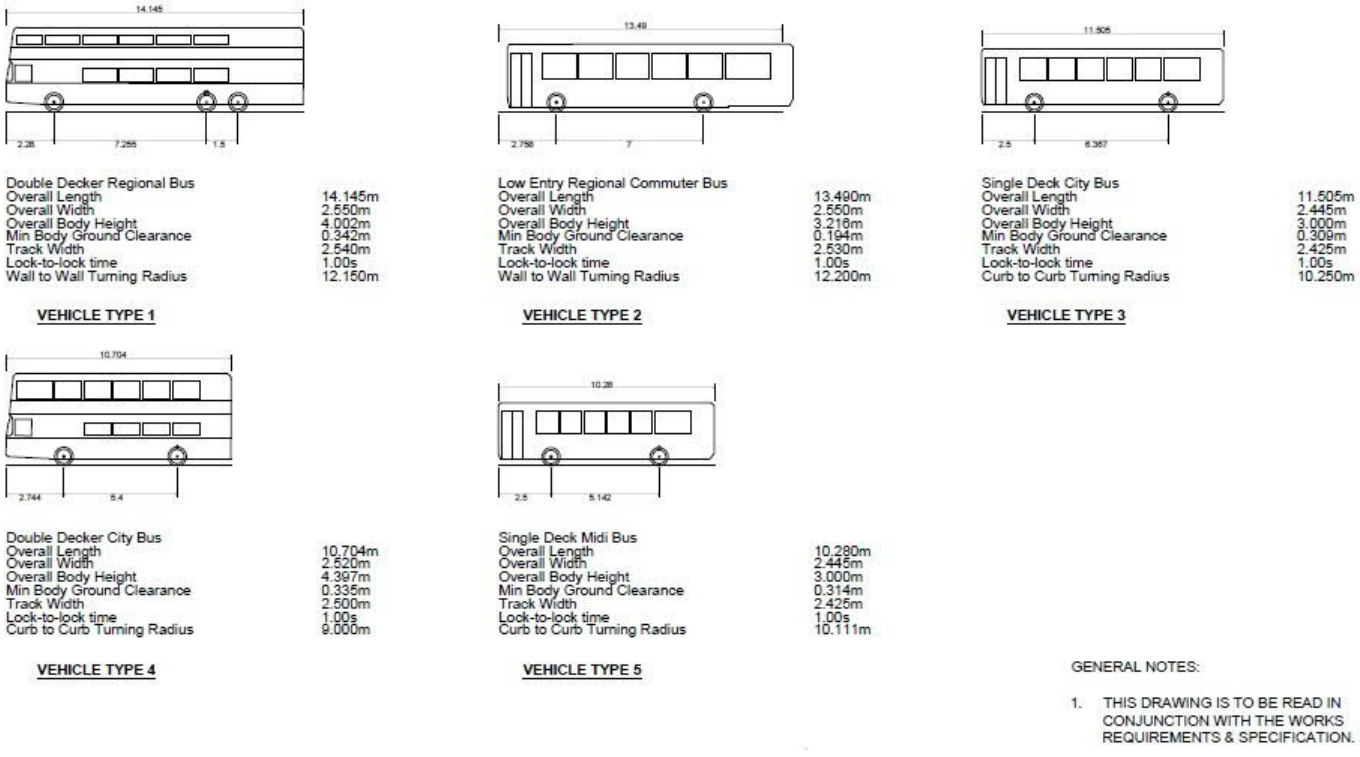


Figure 1.3 Standard Transport for Ireland Bus Specifications.

Considerations for Bus Stop Locations

The basic criteria for consideration when locating a bus stop:

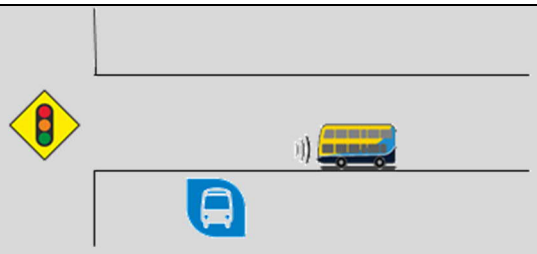
- Driver and waiting passengers are clearly visible to each other;
- Located close to key local facilities;
- Located close to main junctions without affecting road safety or junction operation;
- Located to minimise walking distance between interchange stops;
- Where there is space for a bus shelter;
- 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.

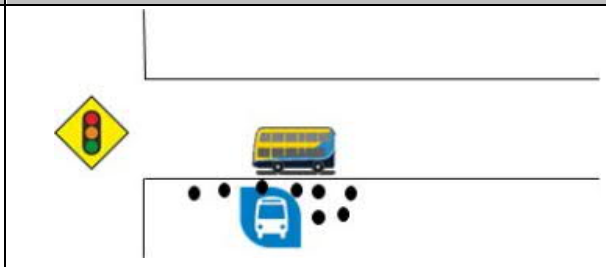
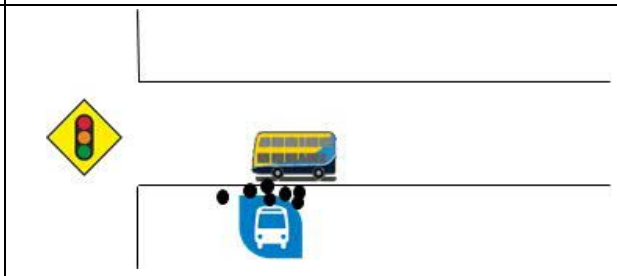
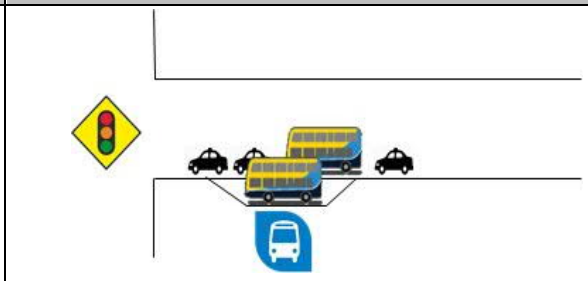
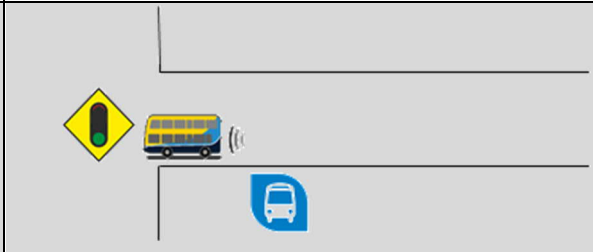
Principals of Bus Stop on high capacity Bus Systems.

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.

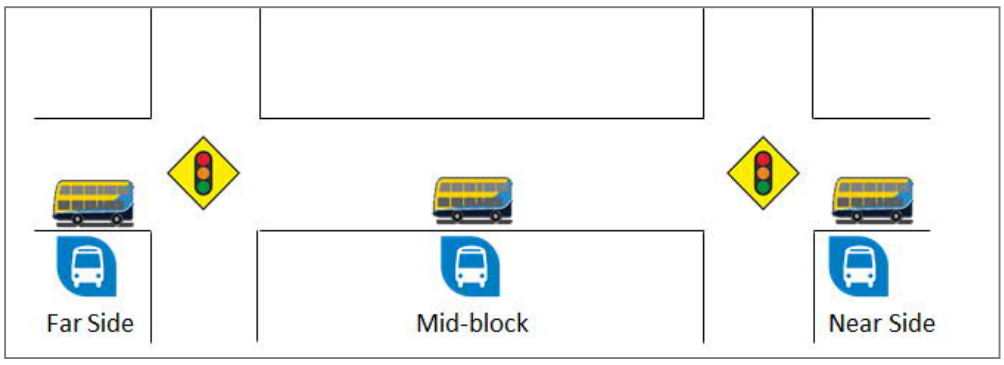


Figure 1.4 Typical Location of Bus Stops.

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).

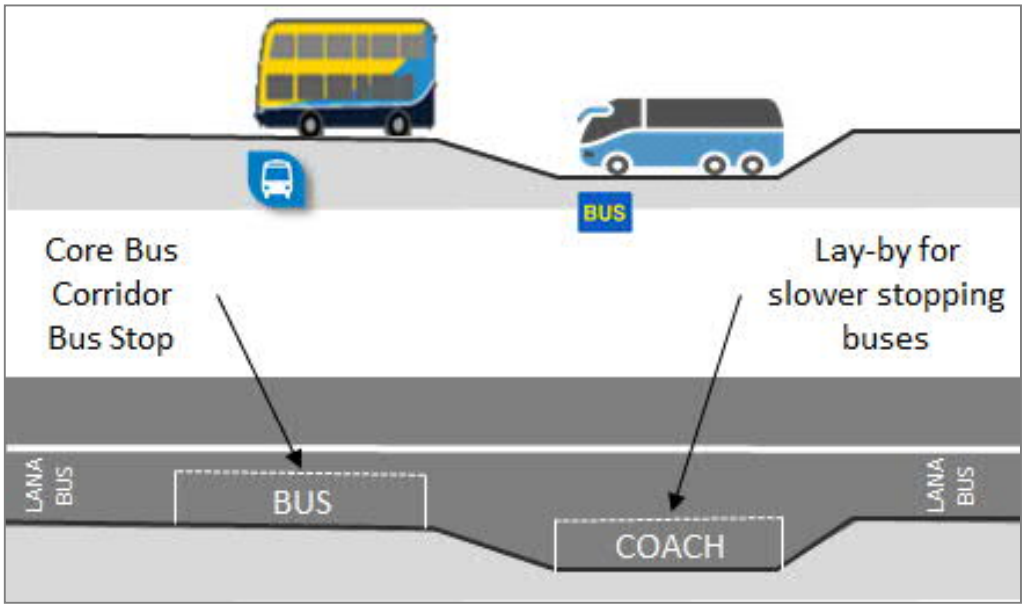


Figure 1.7 Double Bus Stop (in-line for BusConnects routes) concept for locations with buses requiring different dwell times.

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.

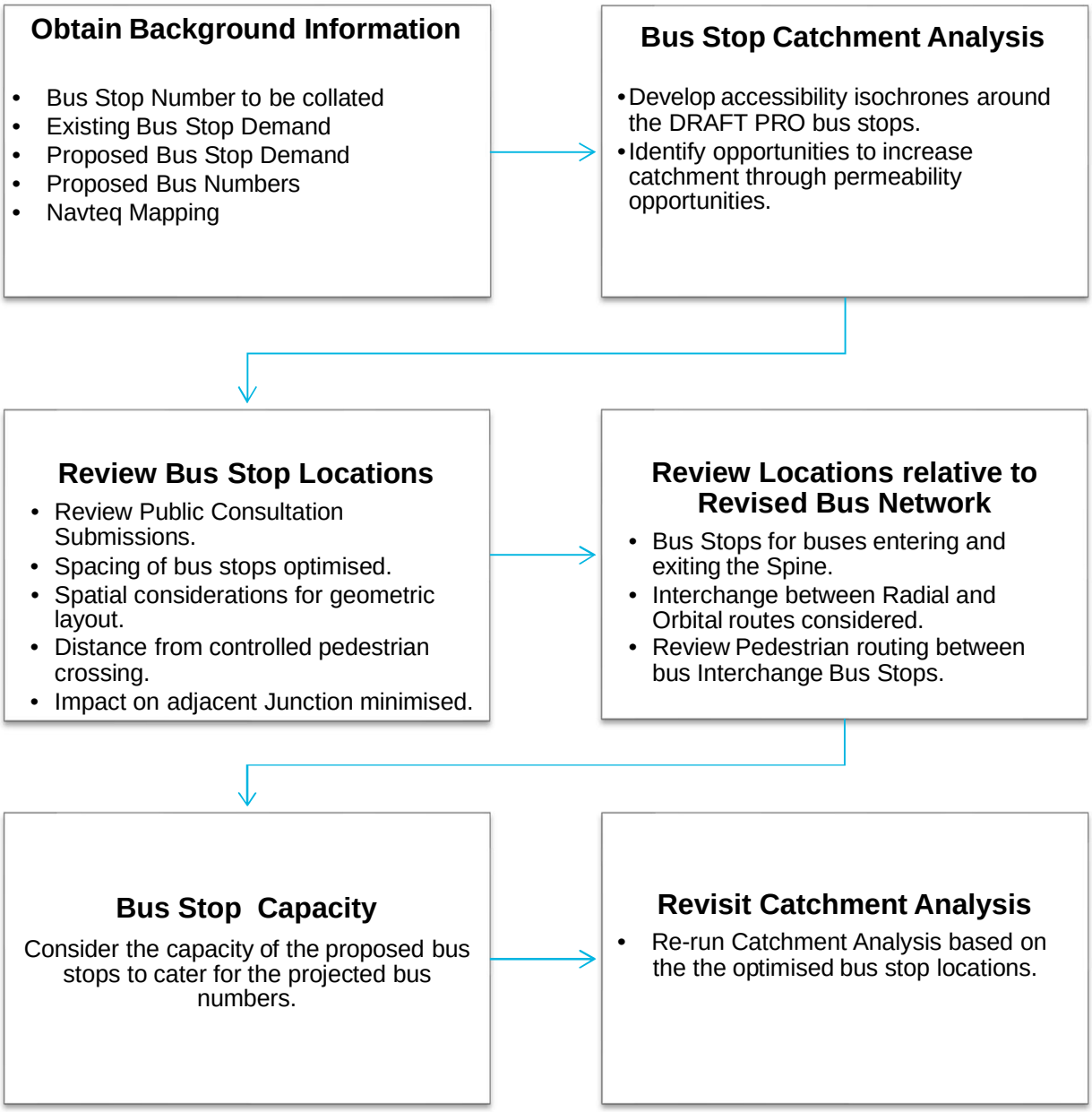
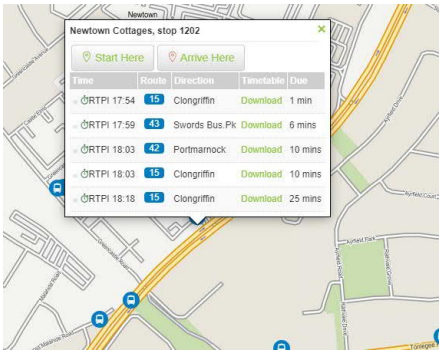


Figure 2.1 Flow Chart for proposed Bus Stop Review.

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.

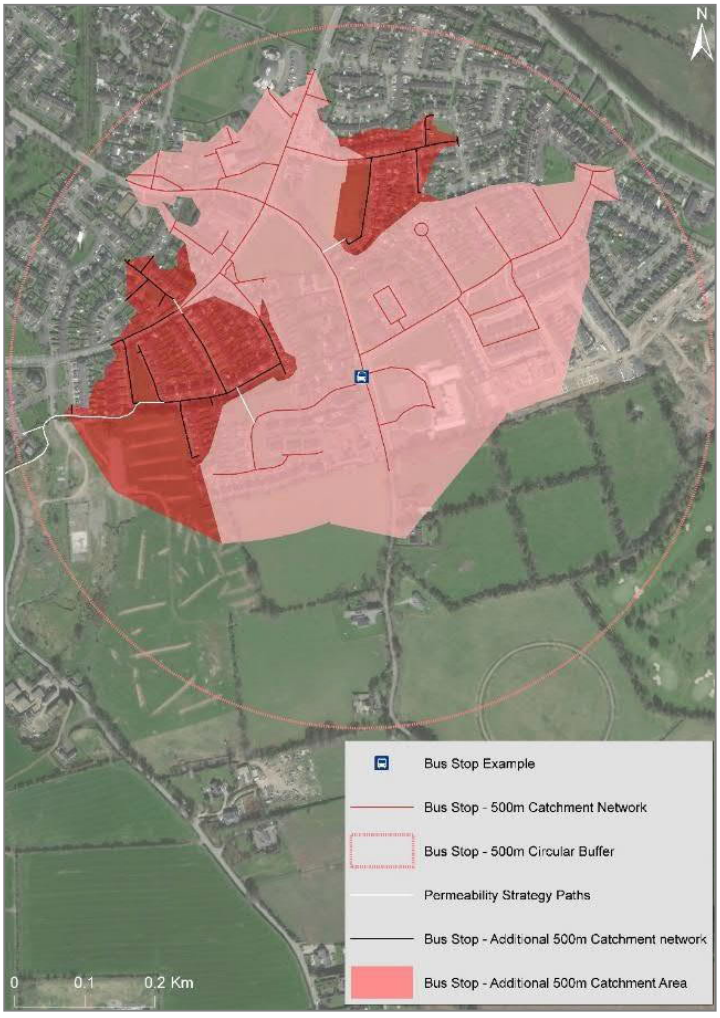


Figure 4.1 Passenger catchment analysis for a bus stop indicating the existing and possible catchment areas assuming permeability improvements can be undertaken.

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.

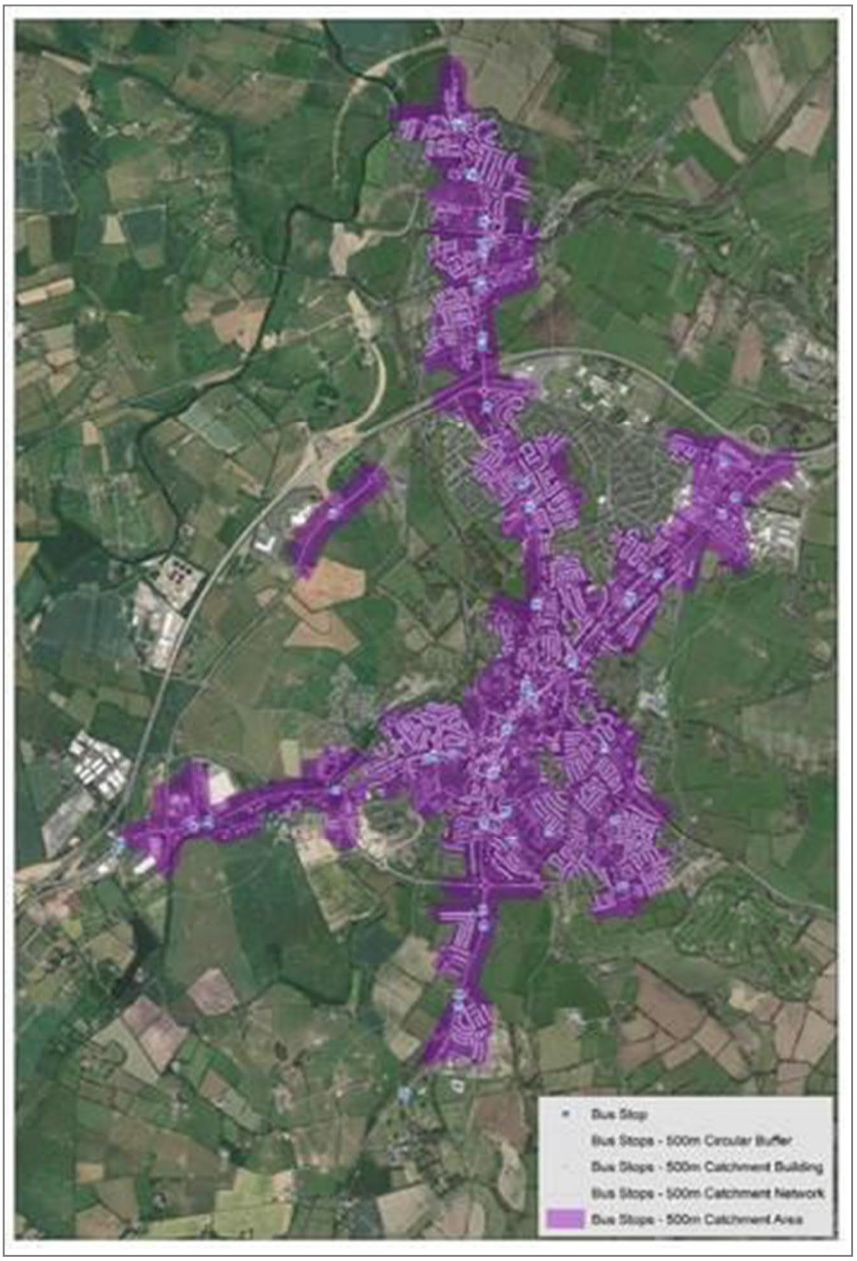


Figure 4.3 Example of catchment analysis run for all bus stops in Naas

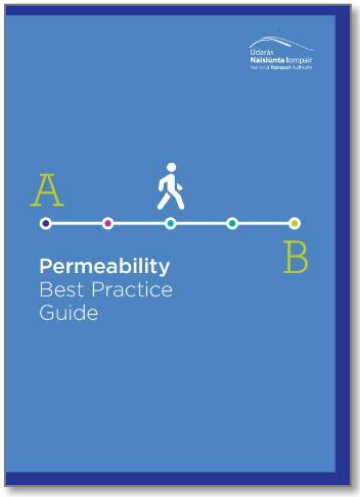
Task 3: Production of catchment tables identifying number of households using Geo Directory or population estimate using census 2016 and Geo Directory to apportion sections of Census Small Area within 400m and 800m catchments of each bus stop. Catchments will be non-overlapping to avoid double counting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

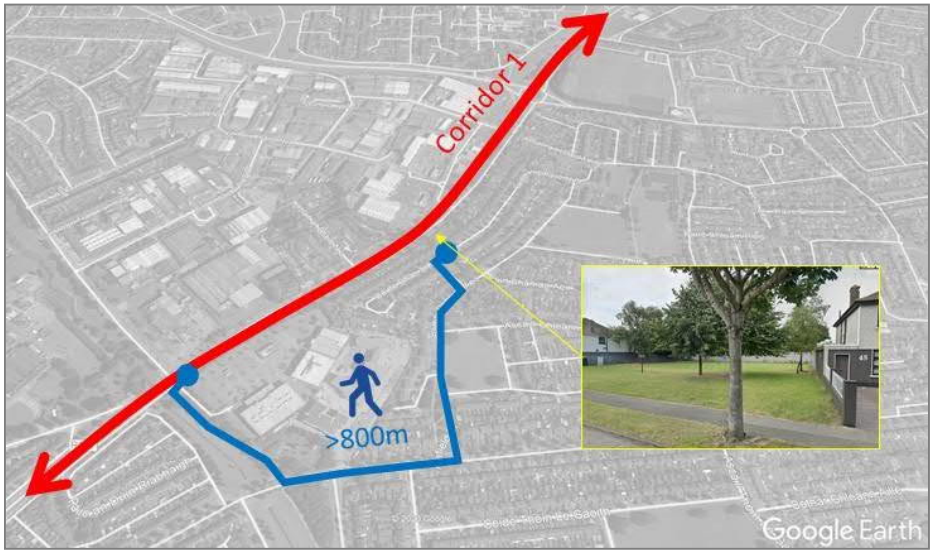


Figure 4.4 Permeability option on the Malahide Road (Source: Google Maps).

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.

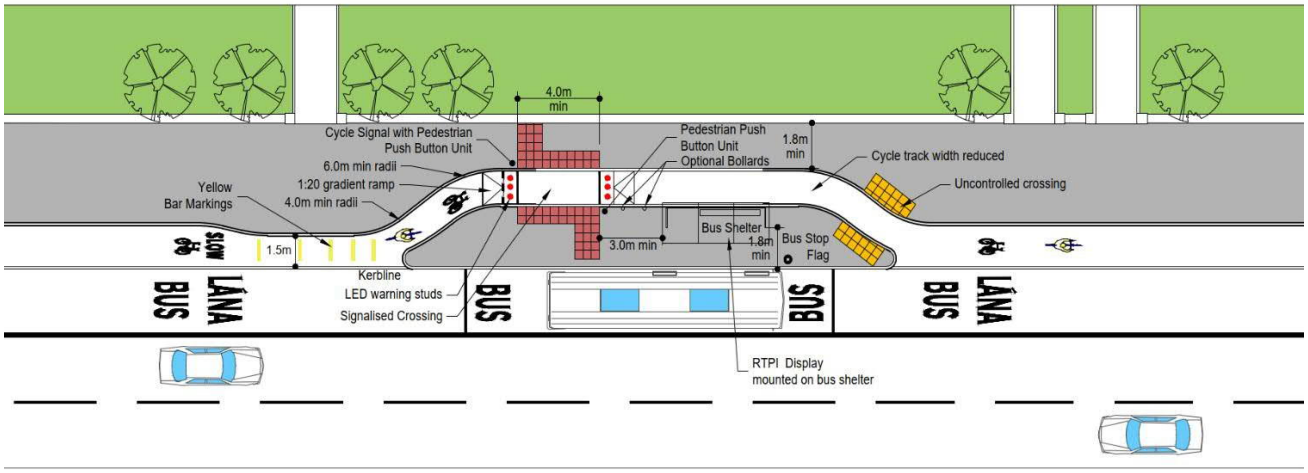


Figure 5.1 Typical Island Bus Stop Arrangement (Bus Connects Design Guideline).

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

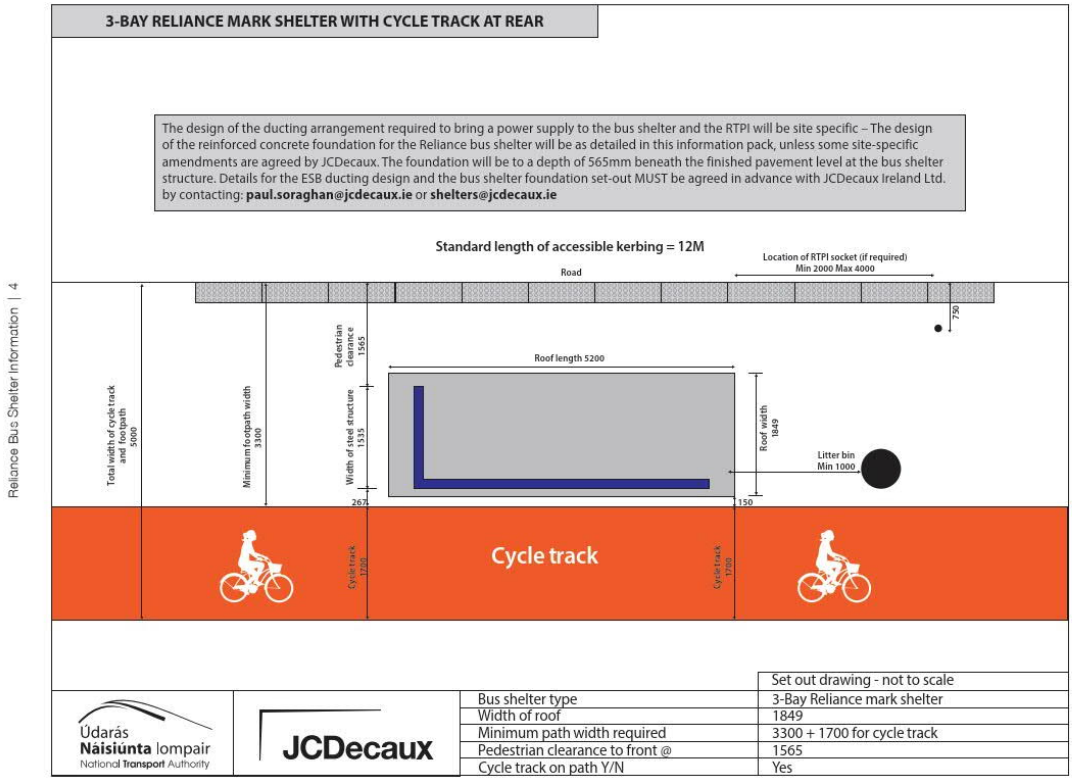


Figure 5.3 Standard layout for a 3 Bay Reliance Mark Shelter with full width advertising panel and cycle lane to the rear (note cycle lane width is to be determined by designers).

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).

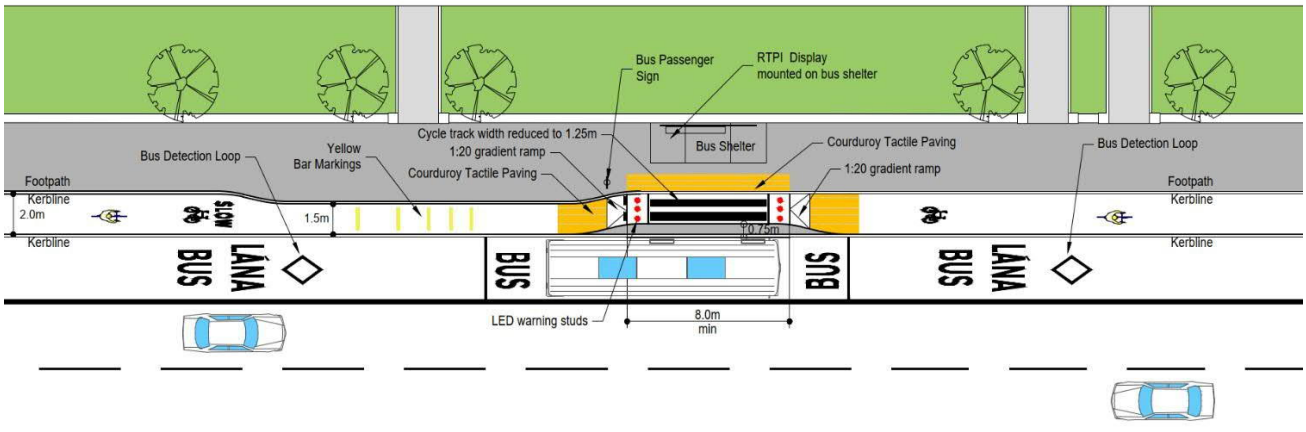


Figure 5.4 Shared Bus Stop Landing Zone Arrangement (Bus Connects Design Guideline).

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.

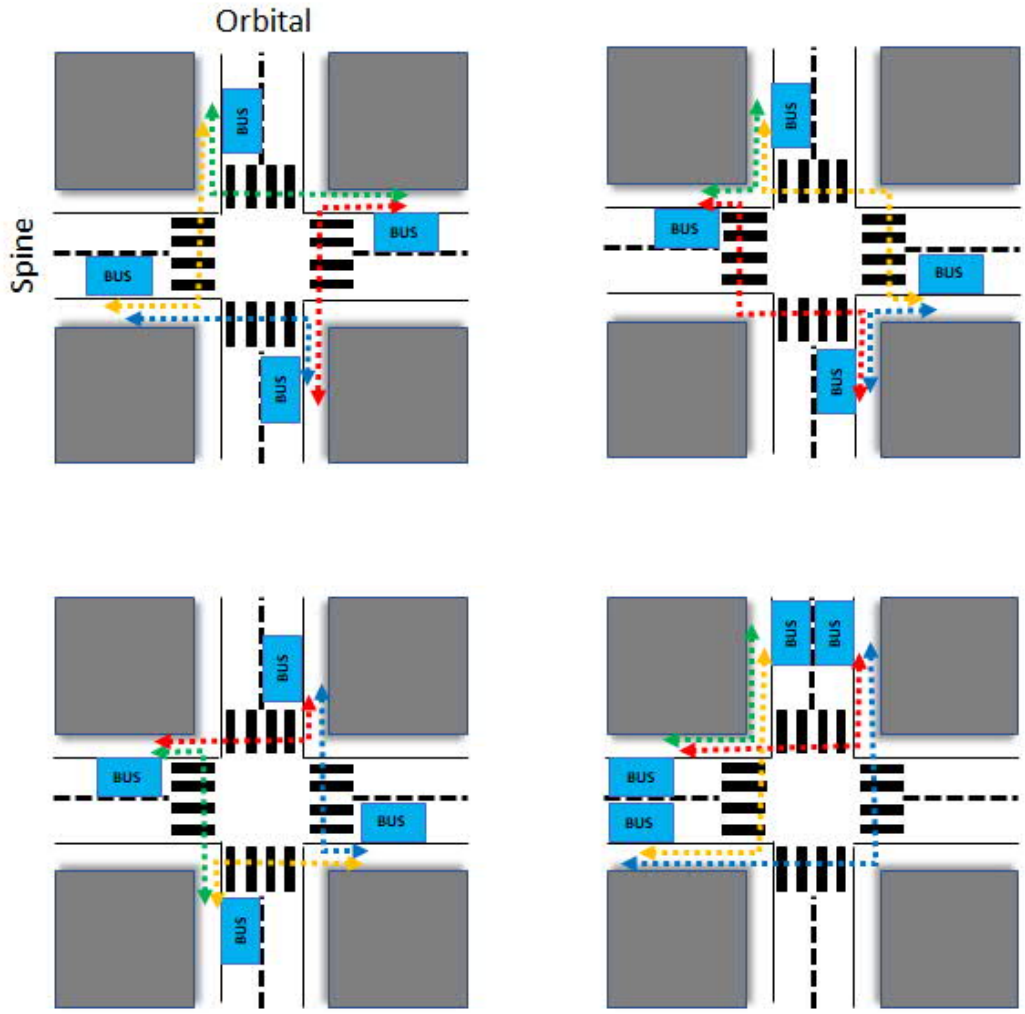


Figure 5.8 Bus stop locations and passenger interchange routes between them.

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.

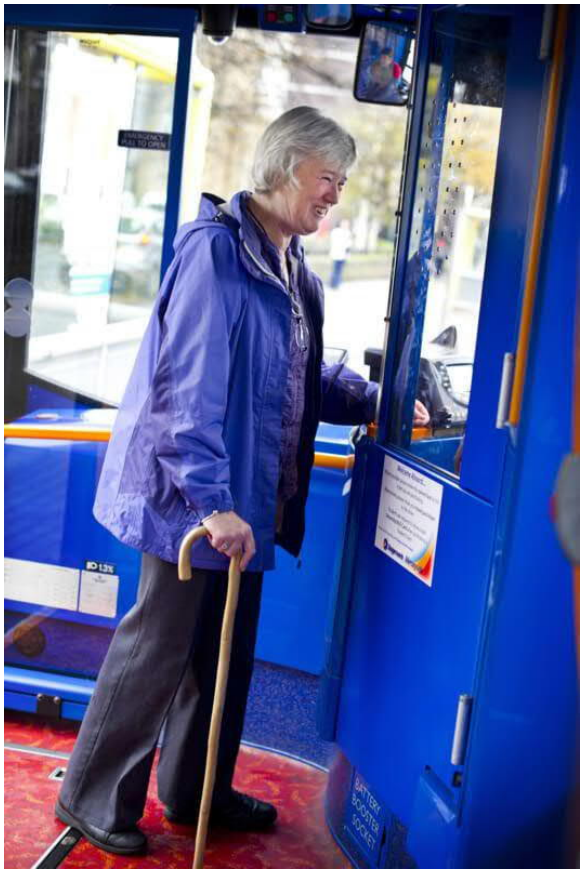


Figure 5.9 Pedestrians using sticks have a limited range of 50m before needing a rest.

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.

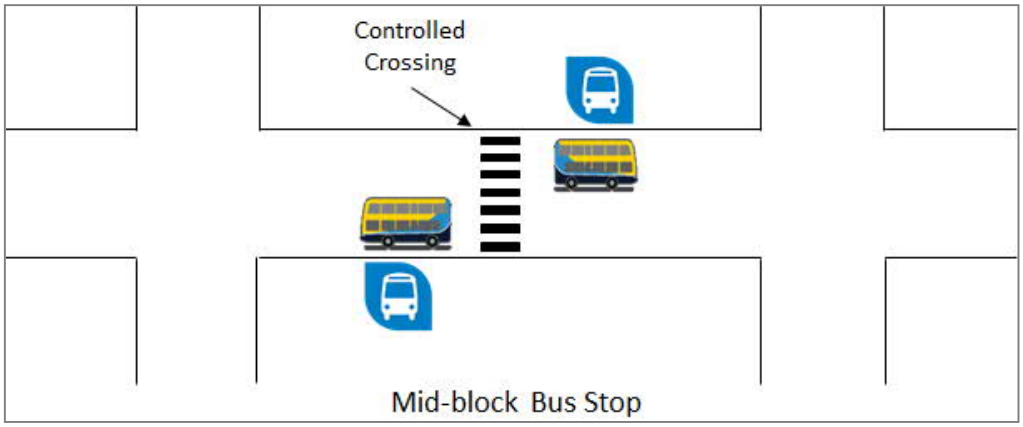


Figure 5.10 Mid-block bus stop optimum layout.

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.

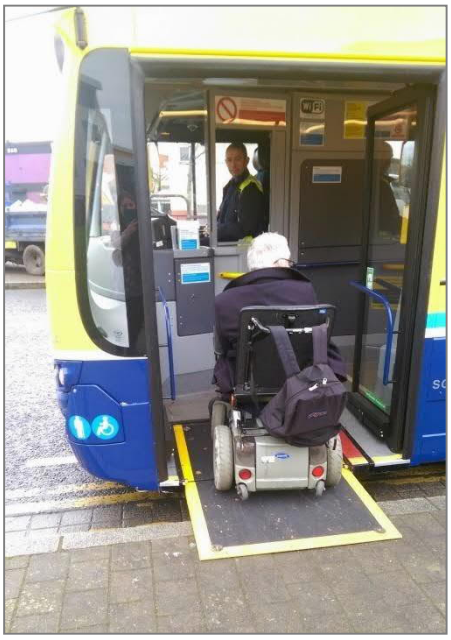


Figure 5.12 Having buses flush with the bus stop is important to allow the ramp to lower correctly, but also to speed up the boarding and alighting of all passengers as gaps slow this down.

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.

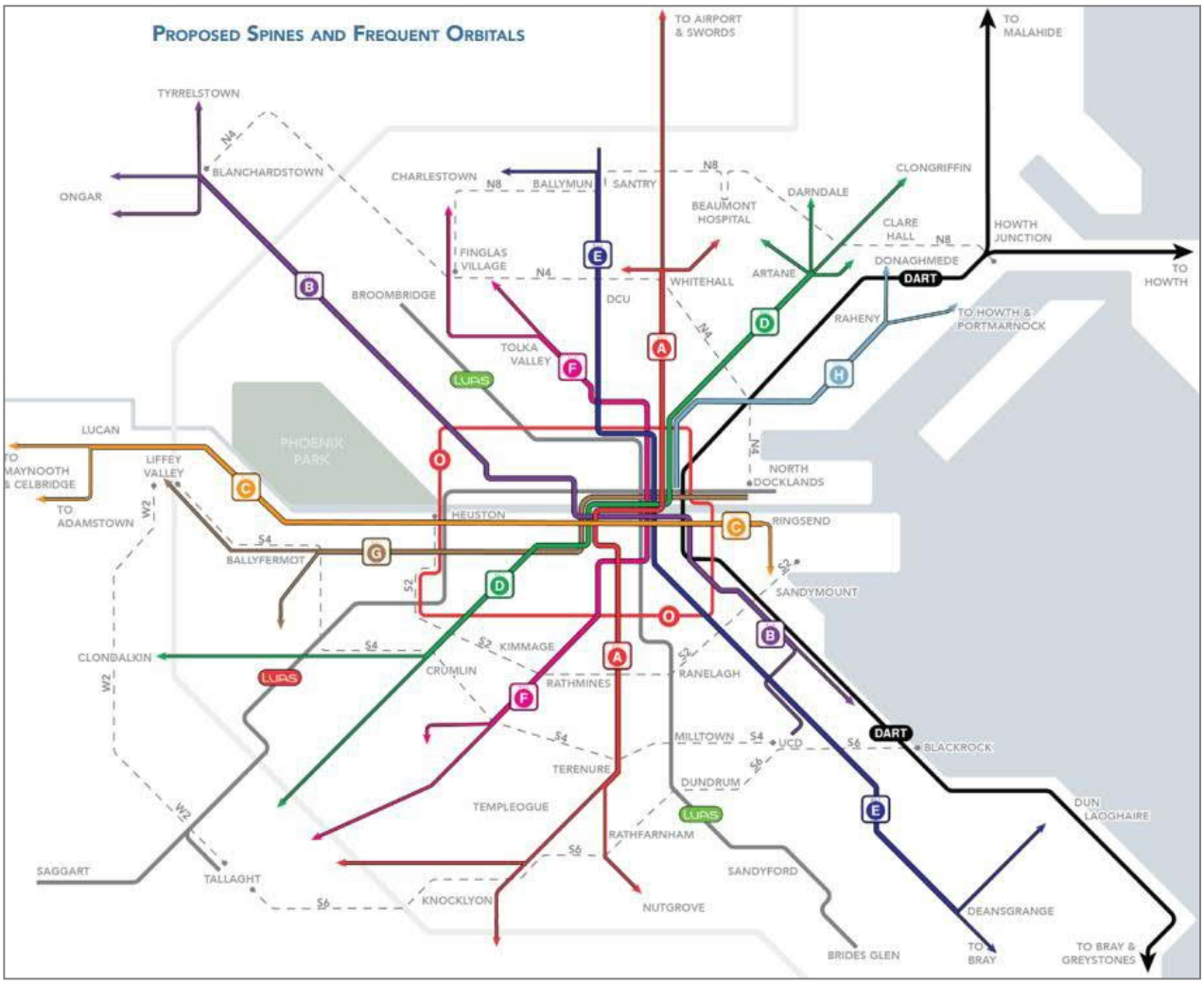


Figure 6.1 Simplified diagram of spines and frequent orbitals in the proposed network

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.

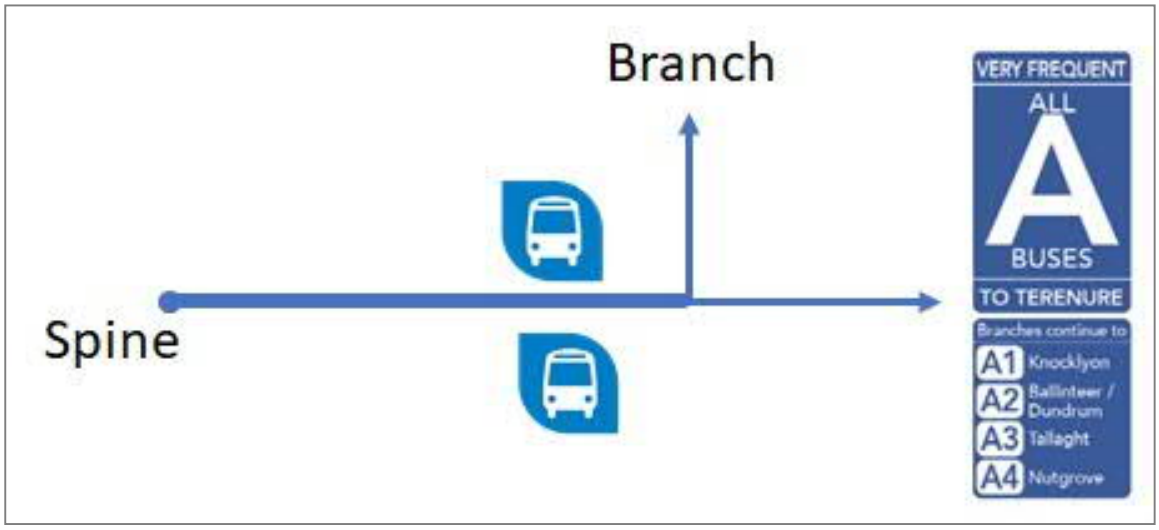


Figure 6.3 Location of Bus Stops Immediately before Branch Route Peels Off Spine

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).

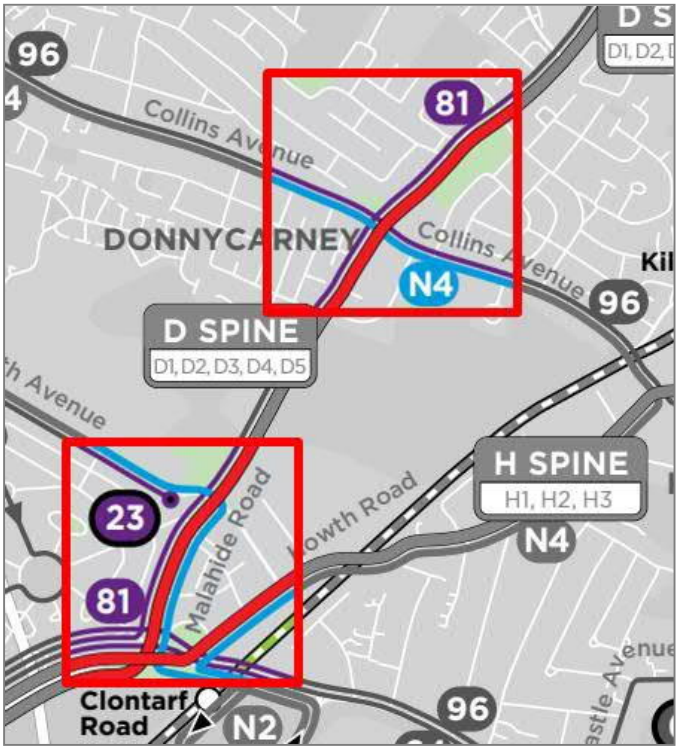


Figure 6.4 Two Different Scenarios for Interchange between orbital and radial corridors.

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.

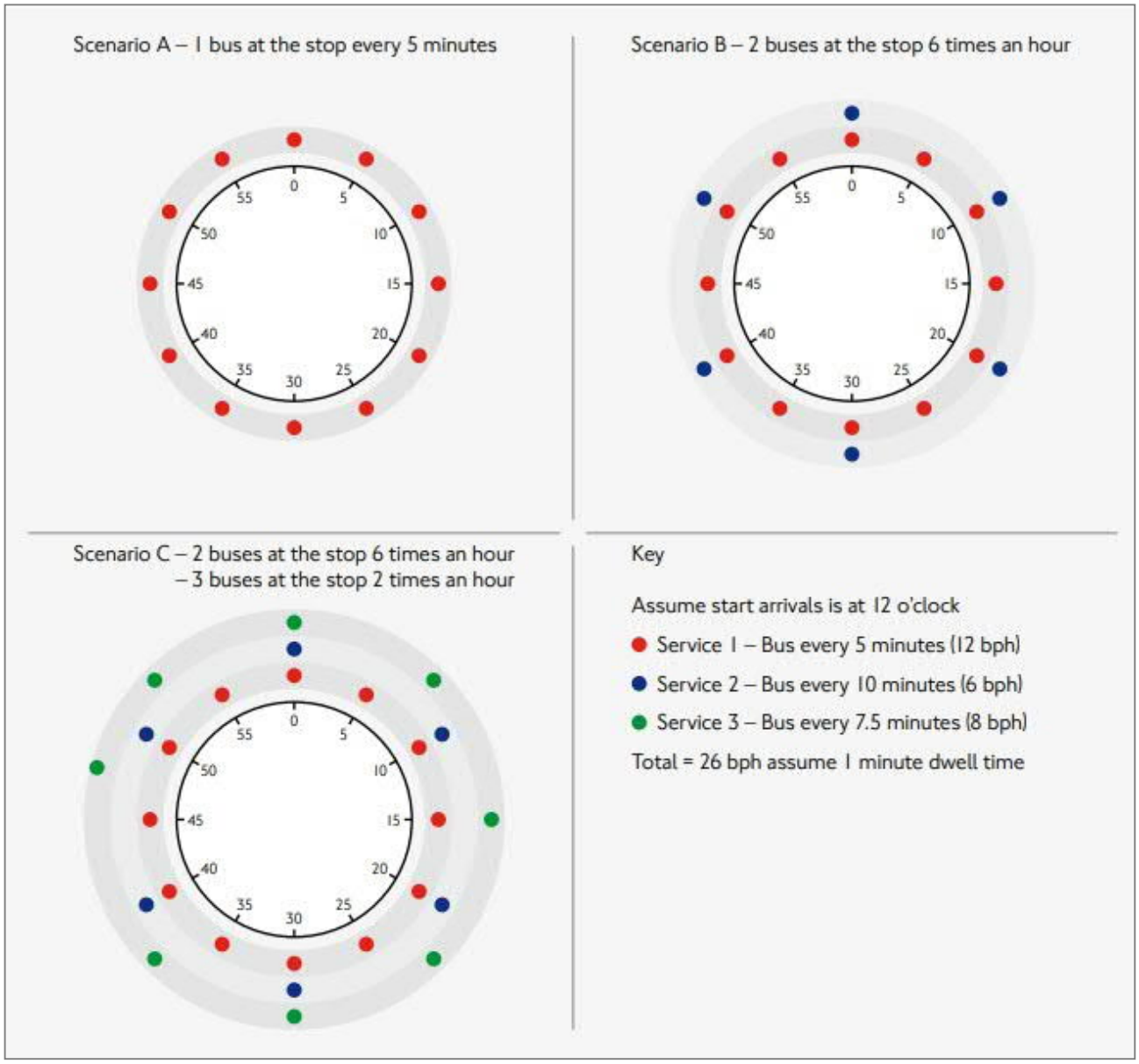


Figure 7.1 Bus Arrival Pattern at a Bus Stop (Source: TFL Bus Stop Design Guidance)

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.

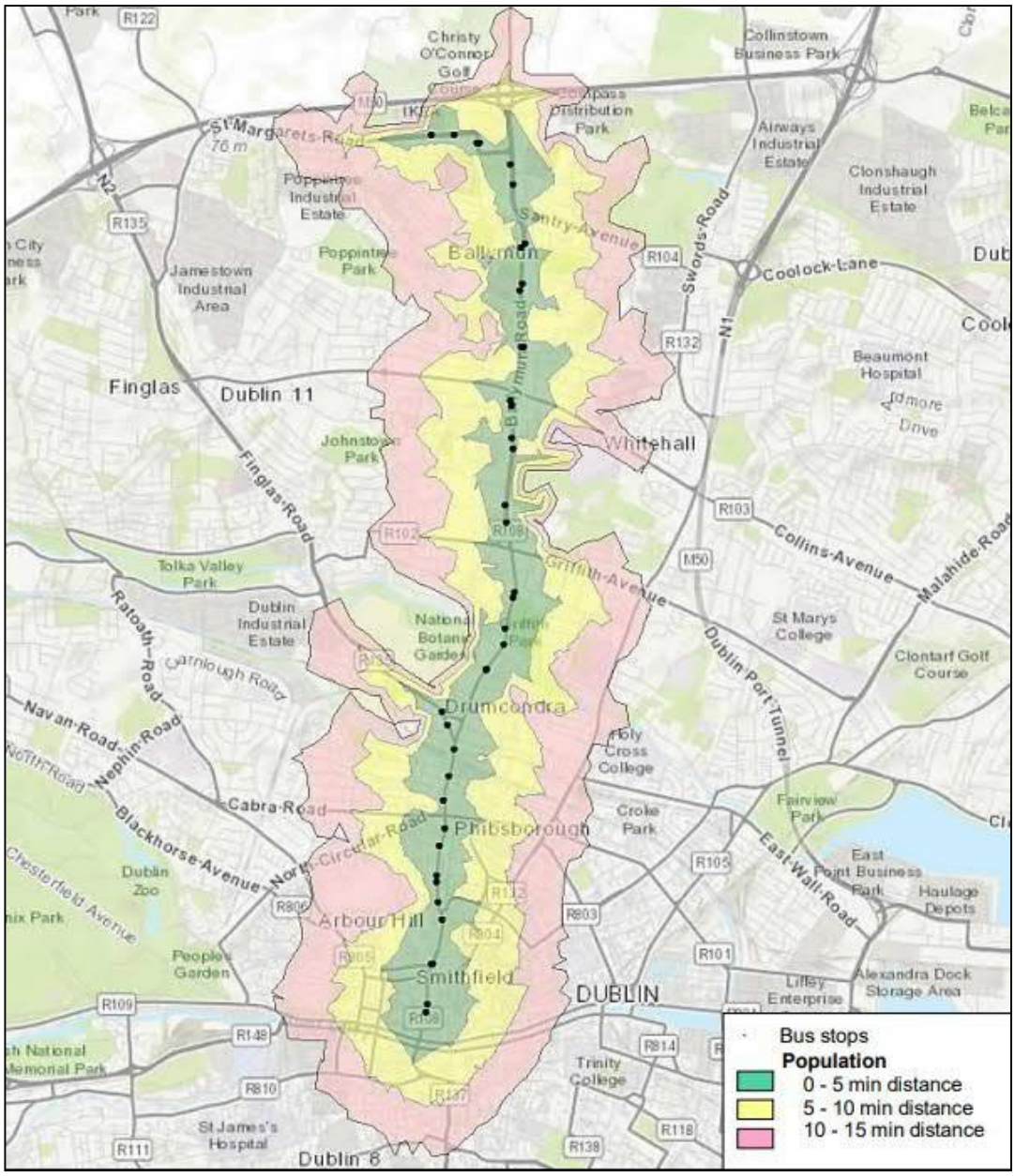


Figure 8.1 Typical map of bus corridor catchment areas

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).

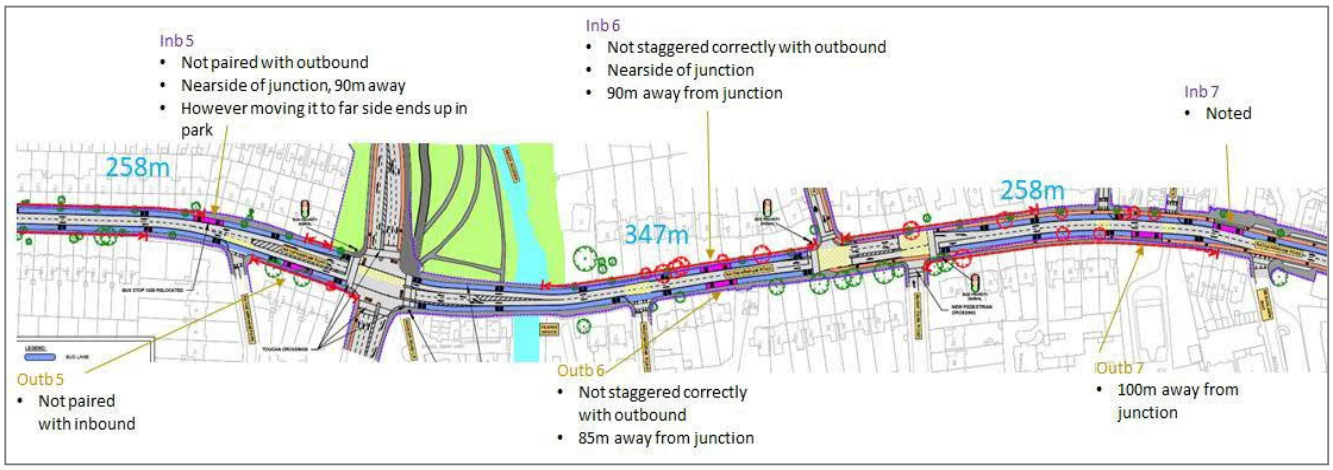


Figure 8.2 Example Review of Bus Stop Locations (Source: ARUP, Rathfarnham CBC).

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

	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	2599	Spawell Centre	Inbound	53.293442	-6.321329	245m	2	2:00 pm	4	5:30 pm	(Not Shown)	80m	before	40m	Yes	Yes - stop to be moved to opposite side of junction.	This location aligns with principle of having stop located after junction. The current location serves Spawell well but does not serve the surrounding residential areas as well. This location also improves spacing between this and the next stop. Proposed location also improves potential for interchange with route F2 and 82.
	2600	Cheeverstown House	Inbound	53.295756	-6.313332	600m	5	8:00 am	7	8:00 am	(Not Shown)	mid-block		100m	no	Yes - stop to be moved 80m west.	This location is closer to the pedestrian crossing thus facilitating better access to Cheeverstown House.
	1155	Cypress Grove Road	Inbound	53.296773	-6.307126	430m	25	8:00 am	9	7:30 am	13	mid-block		115m	Yes (Route F1)	Yes - stop to be moved 110m west just east of Cypress Grove	This location would facilitate better access to the stop given proximity to Cypress Grove Road as well as improve potential for interchange with Route F1
	1157	Riverside Cottages	Inbound	53.298745	-6.302277	400m	19	8:00 am	10	7:30 am	13	mid-block		13m	no	No	Consideration was given to moving this stop further west, however this would place the stop within the traffic lane and complicate the proposed queue management system.
	1158	Springfield Road	Inbound	53.300703	-6.299004	320m	14	8:00 am	36	7:30 am	13	mid-block		125m	no	Removed	This stop is being consolidated with 1159 at a location just south of Fortfield Road to improve accessibility to Fortfield Road while providing more consistent stop spacings.
	1159	Bushy Park	Inbound	53.30239	-6.296341	260m	51	8:00 am	5	1:00 pm	13	80m	after	120m	no	Yes - stop to be moved 150m west	This location serves to consolidate stops 1158 and 1159 into one stop, located adjacent to the Fortfield Road junction, which improves accessibility to Fortfield Road while providing more consistent stop spacings. The proposed location is also within a bus lane rather than a traffic lane which will minimise its impact.

Section 1	1160	Terenure College	Inbound	53.304394	-6.293125	300m	6	4:00 pm	11	5:00 pm	13	mid-block		80m	no	Yes - stop to be moved 50m West	This location is closer to the pedestrian crossing better serving the Rathdown Area. Stop is also closer to the Terenure College Entrance
	1161	Lakelands Park	Inbound	53.306063	-6.290462	260m	4	8:00 am	6	7:30 am	13	mid-block		45m	no	Yes - stop to be moved 130m east, after pedestrian crossing	This location is closer to the proposed pedestrian crossing, and better serves the Rathdown Park catchment
	1162	Rathdown Park	Inbound	53.307732	-6.28777	265m	8	9:00 pm	7	4:30 pm	13	mid-block		275m	no	Removed	This stop is located just 250m after the previous stop and serves much of the same catchment area.
	1163	Olney Crescent	Inbound	53.308873	-6.285863	180m	15	8:00 am	28	7:30 am	13	75m	before	75m	75m to junction	No	This stop is located about 320m from both the previous and next stops. It is appropriately located providing access to areas to the south of Terenure Village as well as the village itself with appropriate spacing between stops achieved. Locations enhances potential for interchange with Orbital Route S4.

	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	1329	St. Mary's Boys School	Inbound	53.294967	-6.281994	253m	20	7:30 am	3	9:30 am	14	70m	after	70m	Yes, Same Stop	No	This location has enough space to provide an island bus stop and is located after the junction with good proximity to Grange Road and St, Mary's Boys National School
	1330	Willbrook Road	Inbound	53.296191	-6.283986	180m	10	7:30 am	3	3:30 pm	14	50m	before	50m	Yes, Same Stop	No	Consideration was given for removing this stop, due to it's proximity to the previous and next stops however, it was retained due to its proximity to trip attractors at Willbrook Road (Church, Rathfarnham Castle & Yellow House) as well as the inability to locate the stop slightly further north due to presence of car parking
	1331	Butterfield Avenue	Inbound	53.298519	-6.284627	284m	26	8:00 am	4	7:30 am	18	75m	after	25m	No	Yes - stop to be moved stop 50m south	This location improves the catchment area along Butterfield avenue, and improves access to the southern end of Rathfarnham Village

1332	Castleside	Inbound	53.300758	-6.284058	257m	22	7:30 am	3	11:00 pm	18	65m	after	65m	No	Yes - stop to be moved 60m south	Although it is close to the junction, this location was considered to be more optimal than the existing location as there is more space for congregation and passing pedestrians in this location. It also has less impact on property entrances.
1333	Brookvale Rd	Inbound	53.303104	-6.284054	263m	8	8:00 am	6	4:00 pm	18	115m	before	115m	No	Yes - stop to be moved 80m north of existing	This location is closer to the Junction with Dodder Park Rd and allows for this stop to be combined with existing stop 1334 thus improving bus stop spacing.
1334	Dodder Bridge	Inbound	53.304848	-6.283458	198m	8	8:30 am	2	8:30 am	18	35m	after	35m	No	Removed	Although located on the correct side of the junction, this stop would be located in a shared bus/traffic lane and as such has been removed to optimise the movement of traffic/buses through this section.
7293	Rathdown Park	Inbound	53.306161	-6.283526	134m	2	7:30 am	3	11:00 am	18	60m	before	130m	No	No	Consideration was given to moving this stop further north, however there is insufficient space to locate this stop between the Rathdown park and Bushy Park Rd junctions. Locating it after the Bushy Park junction would place it too close to stop relocated stop 1336, and too far away from relocated stop 1333.
1335	War Memorial Hall	Inbound	53.307417	-6.284001	138m	4	4:00 pm	2	8:00 am	18	15m	after	15m	No	Removed	Due to width constraints, the proposed bus lane is curtailed in this section to minimise land acquisition. Providing a bus stop in this location would likely impact on the operation of the junction for all modes. In addition, the stop is only 150m from stop 7293
1336	Fergus Road	Inbound	53.308901	-6.284031	150m	4	7:30 am	6	4:00 pm	18	90m	before	90m	Yes, 90m to junction	Yes - stop to be moved 50m north	This location brings the stop closer to Terenure Village thus providing better access to the village and improving potential for interchange with Orbital Route S4
1164	Healthfield Road	Inbound	53.310412	-6.281584	239m	42	8:00 am	14	7:30 am	31	120m	after	30m	Yes, Same Stop	No	Consideration was given to moving this stop further west, in lieu of moving stop 1336 further north. However, this would place the stop in a shared bus/traffic lane which also shares with cyclists. A stopped bus would therefore impede movement of all modes and result in a less efficient system. For this reason, the stop is retained in its current location where it is proposed to be located at the start of the bus lane.

	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	1165	Brighton Road	Inbound	53.311712	-6.27643	367m	24	8:00 am	13	8:00 am	31	110m	before	110m	Yes, Same Stop	Yes - stop to be moved 70m East. Closer to Junction.	This location brings the stop closer to Rathgar Village thus providing better access to the village and improving potential for interchange with Route 80
	1166	Winton Avenue	Inbound	53.313891	-6.272905	362m	41	8:00 am	12	8:00 am	25	mid-block		230m	No	Yes - stop to be moved 50m North	There is very limited space between the two garden entrances in the existing location. The proposed location lies in front of gardens with no vehicular entrances, allowing more space for the stop to be located here
	1167	Garville Avenue	Inbound	53.315945	-6.271396	234m	31	8:30 am	14	8:00 am	25	mid-block		140m	No	Remove	This stop is located only 200m to the next stop and 240m from the previous stop
	1168	Grosvenor Road	Inbound	53.317929	-6.27001	229m	19	8:30 am	10	7:30 am	25	75m	after	75m	No	No	This stop is located only 450m to the next stop and 450m from the previous stop which is considered appropriate.
	1169	Rathmines Park	Inbound	53.320056	-6.268558	238m	6	8:30 am	18	7:30 am	25	130m	before	130m	No	Remove	This stop has a low patronage, serves a small catchment and is located approximately 250m from the stops before and after it.
	1170	Rathmines Road	Inbound	53.32169	-6.266525	241m	48	8:00 am	39	7:30 am	32	20m	before	20m	Yes, Same Stop	No	This location serves the lower Rathmines area well, along with the catchments along Grosvenor Rd and Rathmines Rd Upper

Section 4

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
1069	Leinster Road	Inbound	53.323285	-6.26562	202m	47	3:00 pm	42	8:00 am	38	75m	before	75m	No	No	This location serves the key trip attractor of the Swan Centre, along with Castlewood Ave and Leinster Rd Catchments.
1070	Williams Park	Inbound	53.32498	-6.265356	186m	78	8:30 am	45	8:00 am	38	95m	after	50m	No	No	This location allows for an island bus stop to be provided. This location is only 200m from stop 1069, but this is deemed acceptable in this area which is more densely populated and where there are more trip attractors present.
1071	Military Road	Inbound	53.327218	-6.264725	175m	29	8:30 am	32	8:00 am	38	mid-block		70m	No	No	This stop is located in a good location which serves northern parts of Rathmines Village as well as St. Mary's College
4528	Grove Park	Inbound	53.328896	-6.264536	171m	23	8:30 am	52	8:00 am	38	110m	before	140m	No	No	This location serves the northern Rathmines area and is deemed to be in an appropriate location
1072	Lennox Street	Inbound	53.331027	-6.264585	192m	29	5:00 pm	99	8:00 am	38	25m	after	5m	Yes, 160m to Junction	No	Bus stop retained in generally the same location as it is considered to be appropriately located close to the canal and close to nearby trip attractors
7577	Grantham Street	Inbound	53.333697	-6.265243	322m	95	5:00 pm	102	8:00 am	24	35m	after	35m	Yes, 150m to junction	Remove	This stop has been removed due to proximity of stop 1352. Stop 1352 considered to provide a better location for stop in this area as island type arrangement can be provided for cyclists.
1352	Camden St Lower	Inbound	53.334425	-6.265422	54m						mid-block		15m	Yes, 190m to junction	No	Consideration was given to removing this stop in lieu of stop 7577 but was retained due to ability to provide island bus stop.
1353	Pleasant Street	Inbound	53.33601	-6.265419	231m	70	5:30 pm	90	8:00 am	24	mid-block	after	50m	No	No	This location is 175m from previous stop, but this area has a high volume of users and is a location with several trip attractors so this spacing is justified and in line with guidance note
1354	Peter Row	Inbound	53.339048	-6.266077	336m	90	5:00 pm	89	8:00 am	34	mid-block		50m	No	Yes - stop to be moved 40m south	This location utilises space available outside TU Dublin to provide a better bus stop arrangement.
1355	Whitefriars Street	Inbound	53.340096	-6.265828	120m	9	3:30 pm	97	8:00 am						Yes - stop to be moved 100m North	This location better serves the Stephen S lower and King St S area as well as improves spacing between stops

Section 4	7578	Exchequer Street	Inbound	53.34246	-6.264601	375m	79	5:00pm	128	8:00 am	34	90m	After	90m		Yes - stop to be moved 100m North	The location better serves the Exchequer St, Georges St and Dame street area. Additionally, more space is available at this location to provide a better bus stop / footpath arrangement

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 4	1282	Fade Street	Outbound	53.341809	-6.264928	110m	120	6:00 pm	96	7:30 am	#N/A	30m	before	30m	No	No	Stop serves the Exchequer St and Georges St area well
	4456	Whitefriars St	Outbound	53.339929	-6.265746	280m						34m	after	20m	No	No	This location better serves the Stephen S lower and King St S area
	7579	Cuffe Street	Outbound	53.338246	-6.265914	338m	68	5:00 pm	69	7:30 am	34	130m	before	130m	No	No	This location is well positioned to serve the Kevin St area and available space allows an island bus stop to be provided.
	New Stop	Montague Street	Outbound	53.336311	-6.265318												This new stop would provide an outbound equivalent for stop 2353, and improve the stop spacing to bring it closer to the 200m guideline for central locations
	1285	Grantham Street	Outbound	53.334378	-6.265125	438m	142	5:30 pm	182	7:30 am	24	65m	before	65m	No	Yes - stop to be moved 20m north	Minor amendment to stop location
	1016	Lennox Street	Outbound	53.331159	-6.264415	406m	45	6:00 pm	50	7:30 am	13	95m	before	50m	Yes	No	This location is close to canal bridge, there is adequate space in this location and is close to the pedestrian crossing
	1017	Grove Park	Outbound	53.3293	-6.264475	365m	26	6:00 pm	17	7:30 am	47	55m	after	55m	No	No	This location serves the northern Rathmines area and Grove Park. Spacings to adjacent stops considered to be adequate
	1018	Richmond Hill	Outbound	53.327571	-6.264891	195m	7	8:00 am	21	8:00 am	37	mid-block		25m	No	Yes - stop to be moved 30m south	This location facilitates the provision of the proposed bus gate at the location of the existing stop
	1019	Military Road	Outbound	53.326548	-6.264977	200m	20	3:30 pm	10	8:00 am	37	mid-block		30m	No	Removed	This stop is only 120m from stop 1018 and 145m from stop 1020
	1020	Town Centre	Outbound	53.325138	-6.265109	115m	47	3:30 pm	50	8:00 am	37	110m	before	30m	No	No	This stop serves the central Rathmines area, and is located just after a pedestrian crossing. Location and spacings considered to be adequate

Section 4	1076	Castlewood Ave	Outbound	53.323131	-6.265491	152m	65	4:00 pm	38	7:30 am	37	mid-block		60m	Yes	No	This stop serves the southern Rathmines area & Swan Centre. Location and spacings considered to be adequate
	1077	Garda Station	Outbound	53.321573	-6.266545	217m	50	3:00 pm	35	7:30 am	31	35m	after	35m	Yes, Same Stop	Yes - stop to be moved 100m south	The existing stop is located in shared bus/traffic lane and a stopped bus would therefore restrict movement of traffic. This location allows the stop to be located within a bus lane.

	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	1078	Rathgar Place	Outbound	53.319413	-6.268809	194m	3	8:00 am	15	5:30 pm	24	mid-block		210m	No	Removed	This stop would be just 200m from stop 1077, and usage of the stop is very low
	1079	Frankfort Avenue	Outbound	53.316655	-6.270752	292m	8	8:00 am	16	4:30 pm	24	50m	after	50m	No	Yes - stop to be moved 40m North	This location is closer to the junction with Leicester Avenue, thus improving the catchment area for this stop. Greater length available between driveways to provide full stop facilities compared to existing location
	1080	Auburn Villas	Outbound	53.314909	-6.271873	329m	6	8:00 am	18	5:30 pm	24	mid-block		250m	No	Removed	This stop is only 180m from the proposed location of the next stop and is no longer needed
	1081	Highfield Road	Outbound	53.31265	-6.273495	190m	9	4:30 pm	10	6:00 pm	34	60m	before	50m	No	Yes - stop to be moved 90m North	This location improves the spacing from the next stop from 200m to 300m and better provides a pair for stop 1166 across the road. Also improves access to northern part of Rathgar Village with stop 1082 serving the southern part
	1082	Rathgar Park	Outbound	53.311676	-6.275771	200m	15	4:00 pm	10	8:00 am	30	75m	after	75m	Yes, Same Stop	No	Consideration was given to moving this stop due to restricted space available to provide improved stop infrastructure. However, to improve spacings and overall accessibility, this location, in combination with stop 1081 was considered to be the optimum arrangement for Rathgar Village

Section 3	1083	Brighton Road	Outbound	53.311146	-6.278253	207m	5	2:00 pm	10	6:00 pm	30	mid-block		240m	Yes, Same Stop	Removed	This stop is only 175m after stop 1082
	1085	Rathfarnham Road	Outbound	53.310099	-6.282377	176m	12	2:30 pm	17	5:00 pm	30	60m	before	20m	Yes, Same Stop	No	This stop is an important Interchange stop, and best serves Terenure Village

	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	1299	Fergus Road	Outbound	53.308396	-6.283901	299m	4	2:30 pm	7	8:30 pm	18	mid-block		120m	No	No	This location maintains good spacing between previous and next stops and serves southern areas of Terenure Village well.
	1300	Westbourne Road	Outbound	53.306151	-6.283421	246m	7	1:30 pm	18	5:00 pm	18	112m	after	130m	No	Yes - stop to be moved 160m south	The existing location would be present in a shared bus/traffic lane and as such a stopped bus would restrict the flow of traffic on the route. Furthermore, the proposed location would provide a more appropriate spacing between stops in this area.
	1301	Dodder Park Road	Outbound	53.303896	-6.283497	253m	2	8:00 am	15	6:00 pm	18	30m	after	30m	No	Removed	The existing location would be present in a shared bus/traffic lane and as such a stopped bus would restrict the flow of traffic on the route. Furthermore, it would be only 100m from stop 1300 and as such it is more appropriate to remove this stop and retain stop 1302
	1302	Crannagh Road	Outbound	53.301663	-6.283841	249m	2	3:30 pm	19	5:30 pm	18	mid-block		160m	No	No	As noted under stop 1301, this location provides good spacing to bus stops while maintaining adequate accessibility
	1303	Rathfarnham Castle	Outbound	53.299342	-6.283739	245m	3	8:00 am	12	5:30 pm	18	70m	after	70m	No	No	Consideration was given to locating this stop closer to the Main Street junction. However, there is insufficient width to provide a bus lane at the exit from the junction and any bus stop in this location would therefore hamper the movement of traffic. The optimum solution is therefore to retain the current bus stop location

Section 2	1304	Butterfield Avenue	Outbound	53.298177	-6.284551	252m	4	9:00 pm	7	6:00 pm	18	40m	before	60m	Yes	No	This location serves the southern end of Rathfarnham. New pedestrian crossings are proposed at the junction of Butterfield Avenue.
	1305	Willbrook Road	Outbound	53.29617	-6.283746	140m	3	3:00 pm	9	6:00 pm	14	60m	after	60m	Yes, Same Stop	No	This location serves Willbrook Rd area, and is well spaced between previous and next stops
	1306	Rathfarnham Wood	Outbound	53.294652	-6.279878	300m	N/A	N/A	N/A	N/A	N/A	40m	after	40m	yes	no	This stop is located directly after the junction and is an appropriate distance from the previous stop.
	1320	Loretto Terrace	Outbound	53.2946705	-6.2798779	270m	N/A	N/A	N/A	N/A	N/A	25m	after	20m	Yes	No	This stop is located directly after the junction and is an appropriate distance from the previous stop.

	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	1121	Terenure Library	Outbound	53.309002	-6.285408	240m	21	3:30 pm	8	5:00 pm	12	60m	after	60m	60m to junction	No	This stop is already well situated in front of the library, close to the junction with enough distance for cars to queue behind without blocking junction
	1122	Rathdown Park	Outbound	53.30722	-6.288375	285m	2	4:00 pm	6	5:00 pm	12	mid-block		230m	no	Removed	This stop is located just 250m before stop 1123 and serves much of the same catchment area.
	1123	Lakelands Park	Outbound	53.305577	-6.291037	260m	2	4:00 pm	6	4:00 pm	12	mid-block		12m	no	Yes - stop to be moved approx. 130m East.	This location improves stop spacing, is located just after proposed pedestrian crossing and better serves the Rathdown Park Catchment.
	1124	Rathdown Avenue	Outbound	53.304173	-6.293404	220m	4	4:00 pm	12	5:00 pm	12	mid-block		50m	no	No	The stop already serves the Terenure College entrance, spacing between previous and next stop is appropriate.
	1125	Bushy Park House	Outbound	53.301085	-6.298118	470m	27	4:00 pm	23	5:00 pm	12	65m	after	65m	no	Yes - stop to be moved approx. 30m East.	This location is closer to the Fortfield Road junction, and Our Lady's school.
	1127	Riverside Cottages	Outbound	53.298456	-6.302844	430m	8	3:30 pm	17	5:00 pm	12	mid-block		15m	no	No	Bus stop is outside extent of scheme however does align with the guiding principles for bus stop location with appropriate spaces between adjacent stops. Good location serving Templeogue Village.

	1130	Old Bridge Road	Outbound	53.296342	-6.308373	445m	8	3:30 pm	15	4:30 pm	12	30m	before	30m	Yes, 30m to junction	Yes - stop to be moved 160m West.	This location places the stop after the junction, which aligns with the principle of locating stops after junctions
	2550	Cheeverstown House	Outbound	53.294791	-6.314991	490m	2	7:00 am	12	6:00 pm	(Not Shown)	mid-block		45m	no	No	This stop is located immediately adjacent to a pedestrian crossing, providing good connection to the residential area on the northern side of the road
	2551	Wellington Lane	Outbound	53.293068	-6.321584	480m	3	2:00 pm	4	7:00 pm	(Not Shown)	80m	after	80m	Yes, 80m to junction	Yes - stop to be moved approx. 100m East.	This location brings the stop closer to the junction improving access to adjacent side roads. The Roundabout is proposed to be converted to a signalised junction, and so space is available for the stop to be located closer to the junction. Proposed location also improves potential for interchange with route F2 and 82.

Appendix C

Bus Stop Location Maps

C1 Section 1

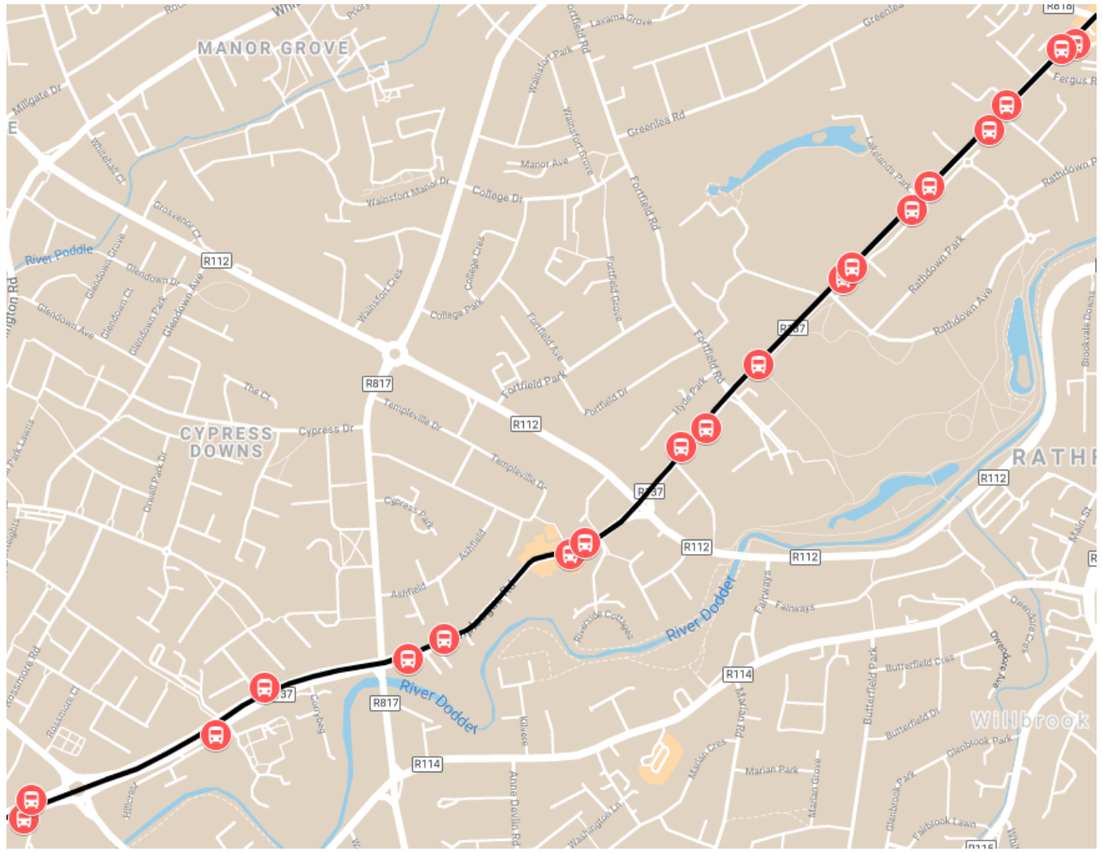


Figure C.1:Section 1 Existing Stop Locations

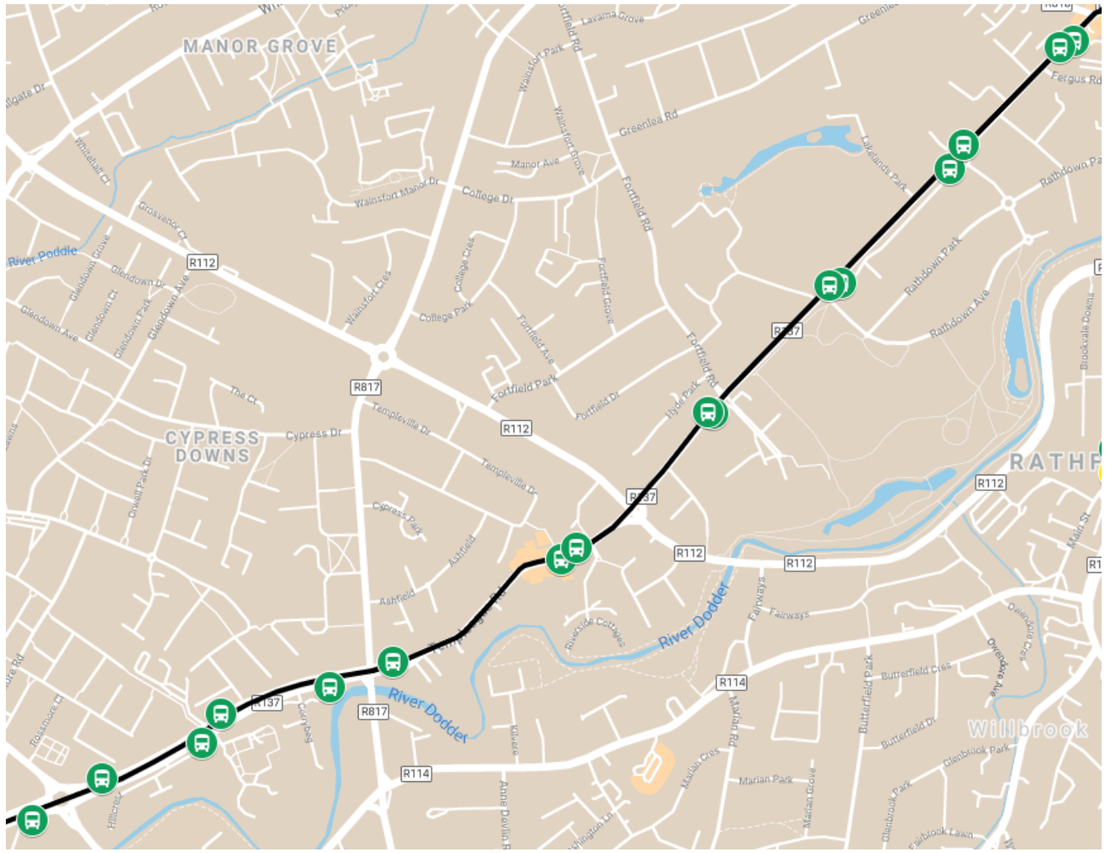


Figure C.2: Section 1 Proposed Stop Locations

C2 Section 2

Figure C.3: Section 2 Existing Stop Locations

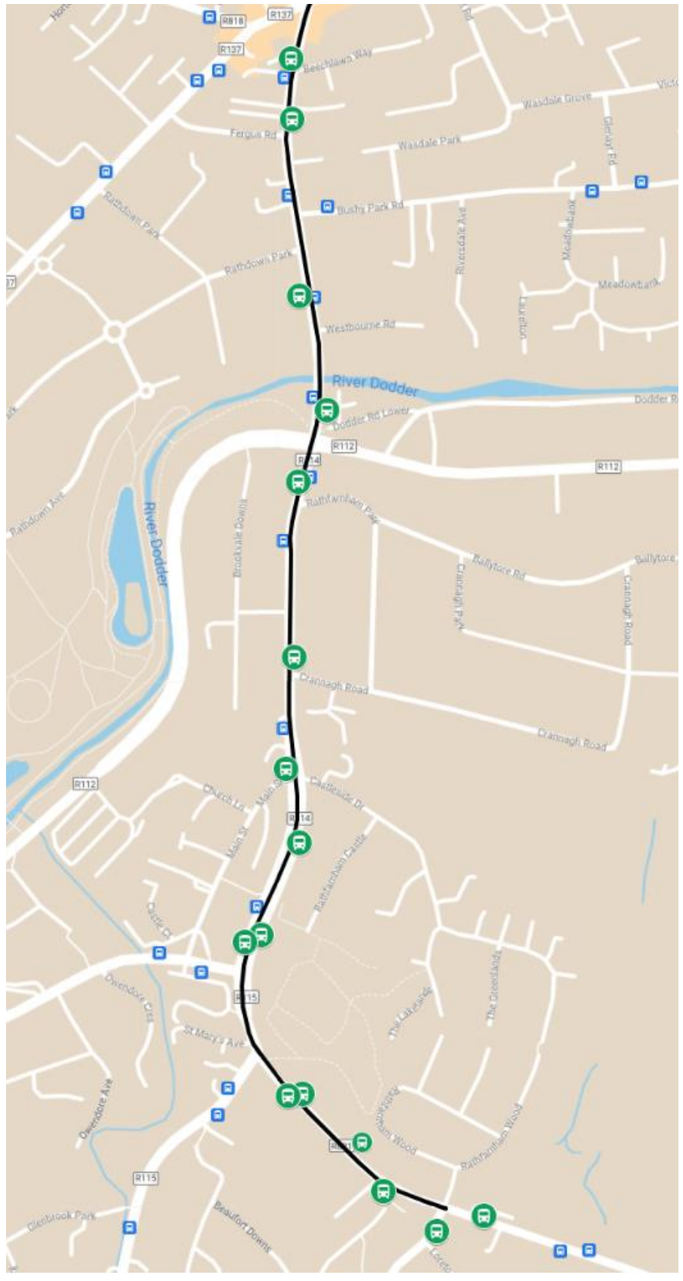


Figure C.4: Section 2 Proposed Stop Locations

C3 Section 3

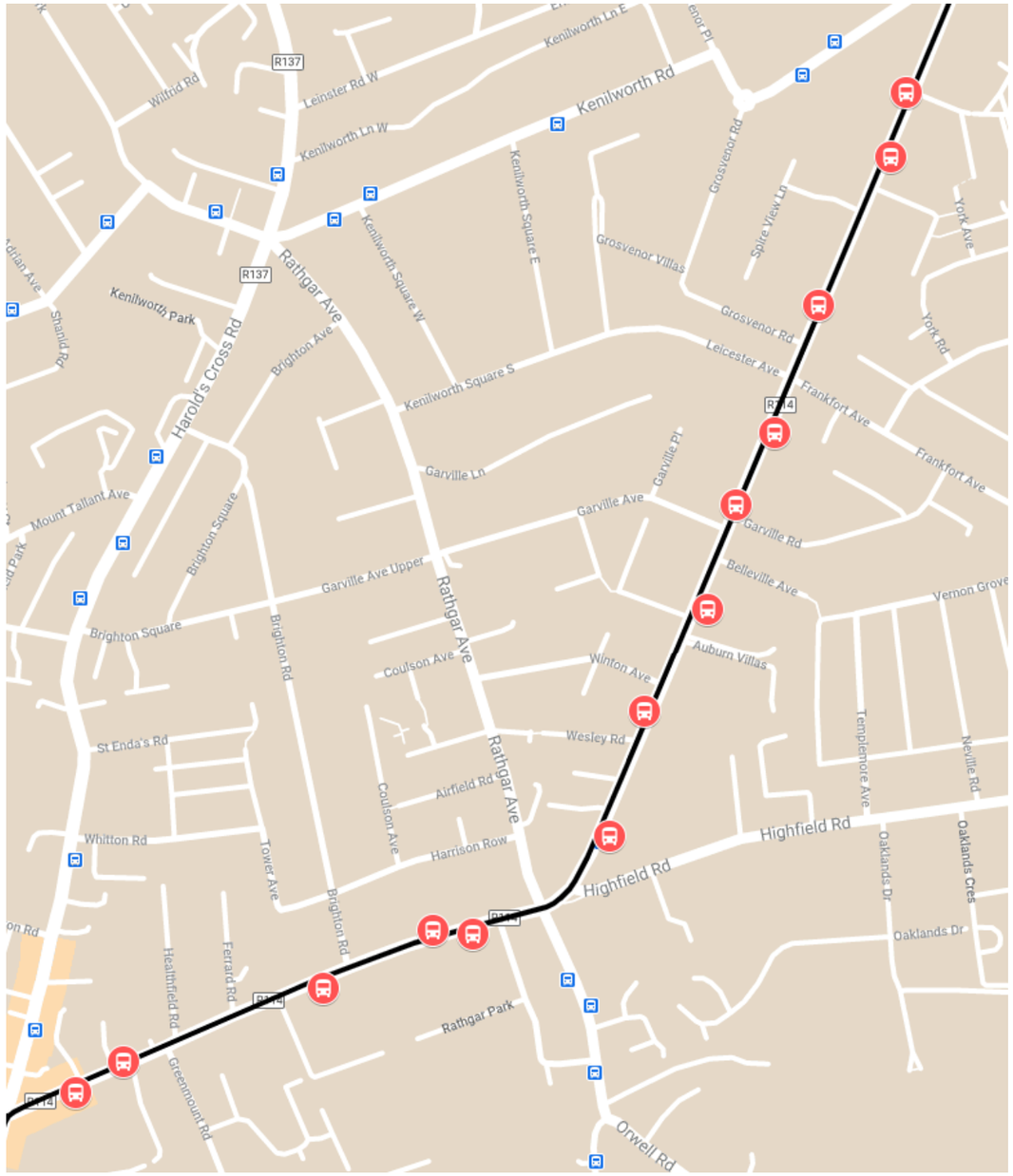


Figure C.5: Section 3 Existing Stop Locations

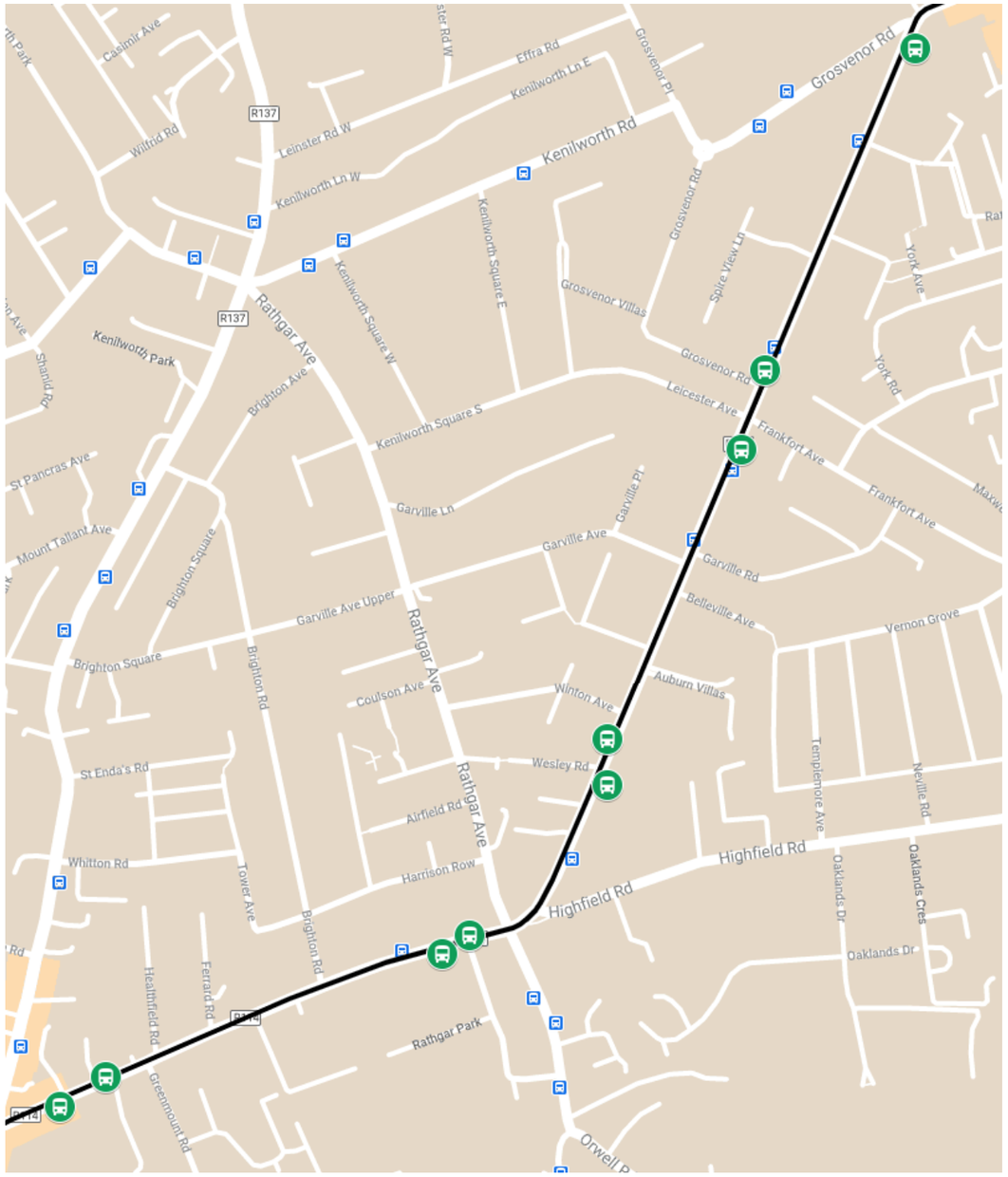


Figure C.6: Section 3 Proposed Stop Locations

C4 Section 4

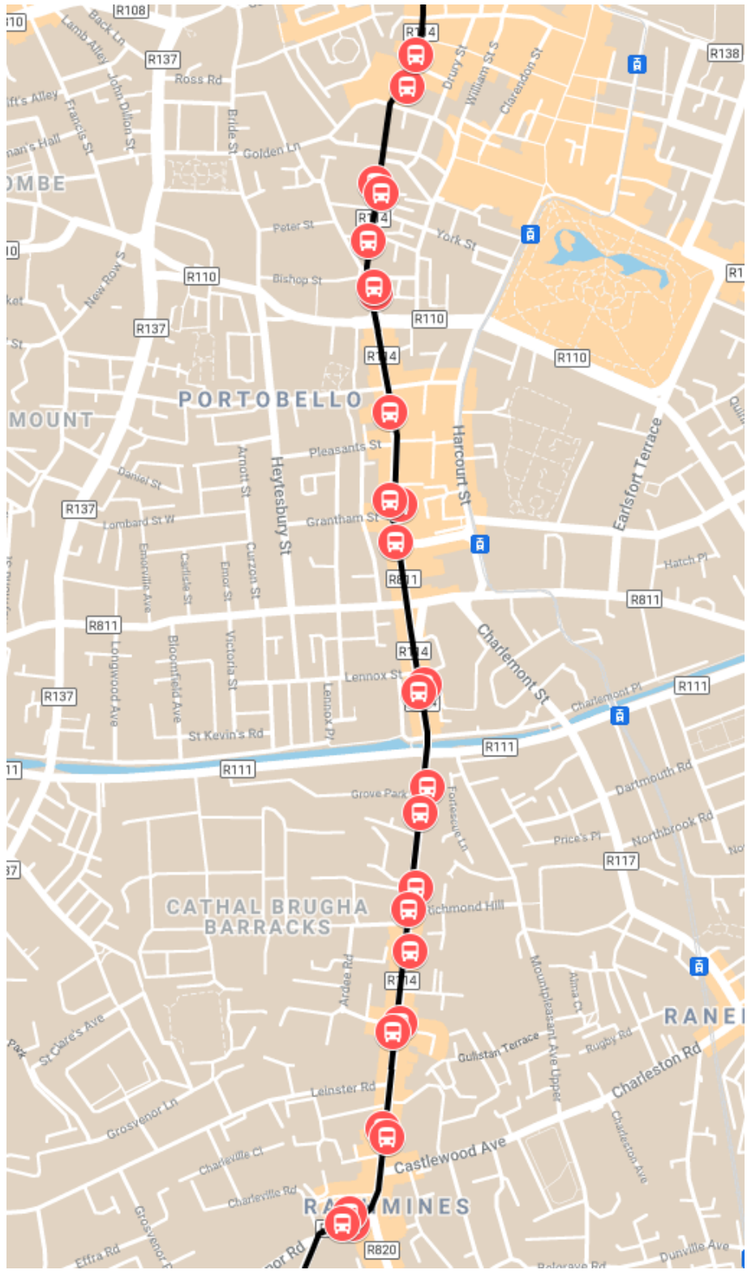


Figure C.7: Section 4 Existing Stop Locations

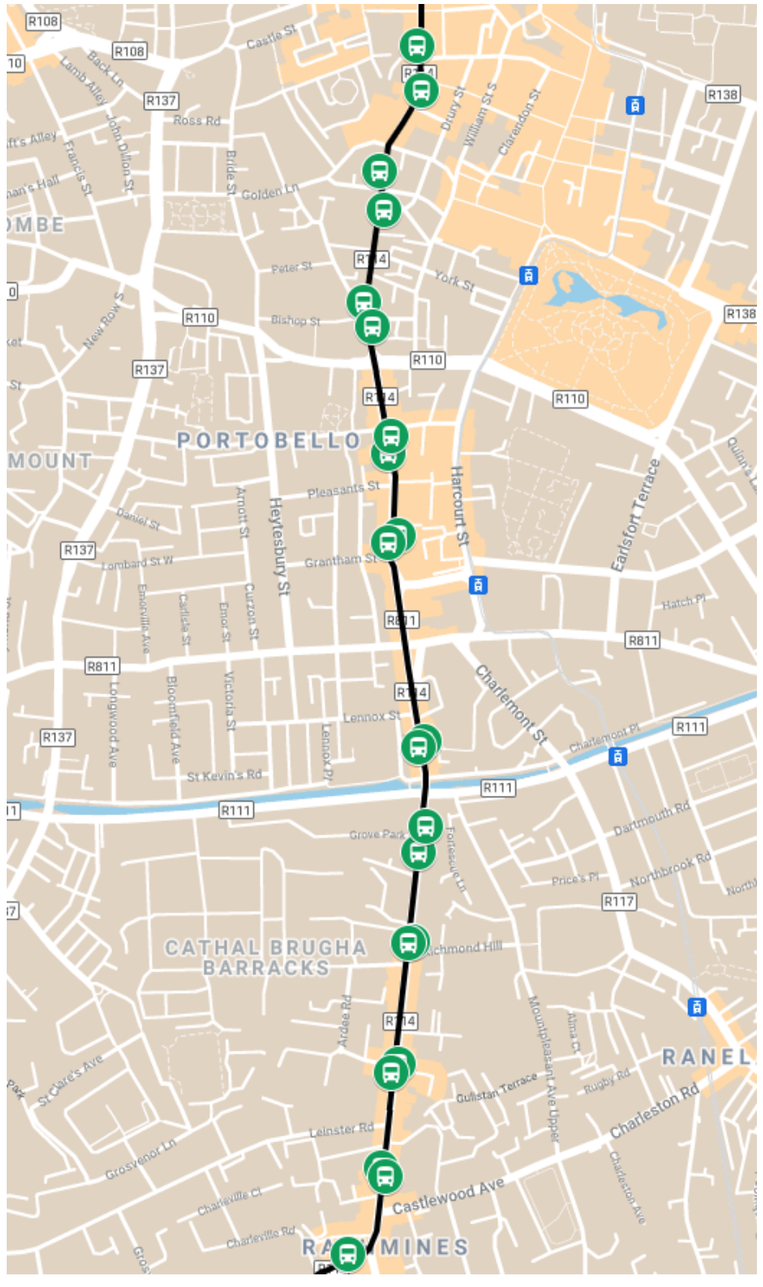
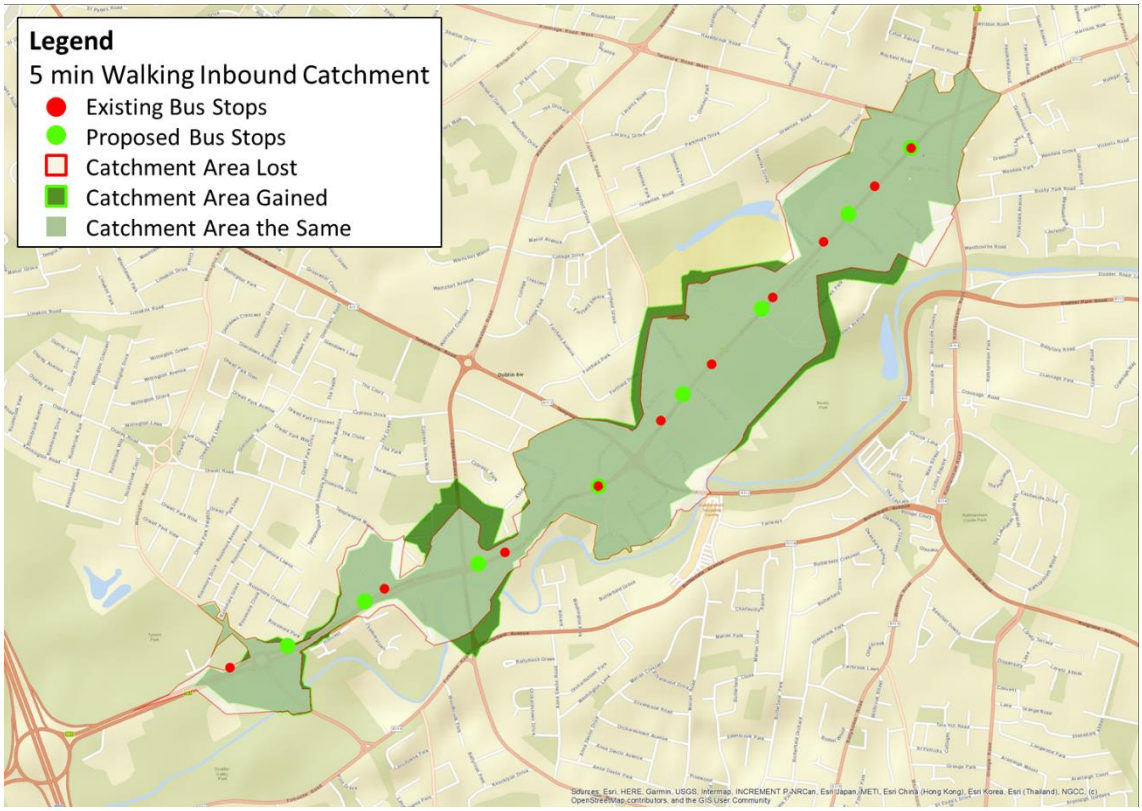


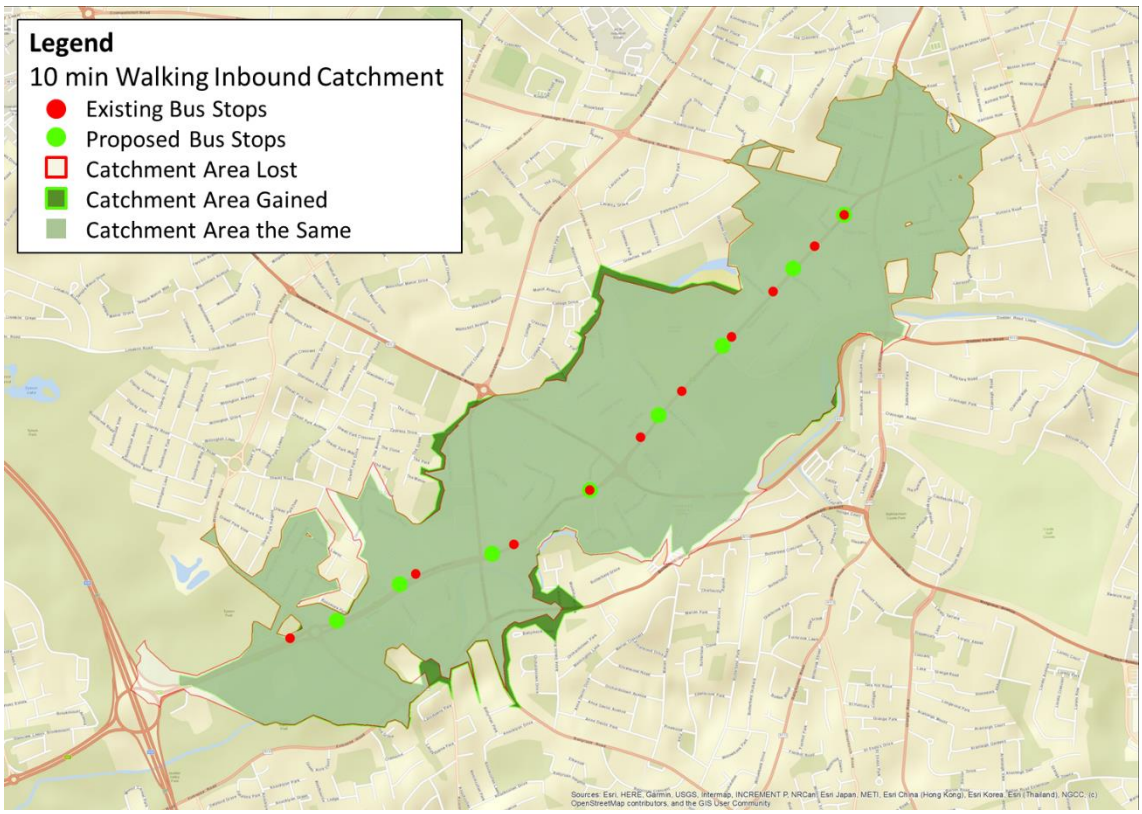
Figure C.8: Section 4 Proposed Stop Locations

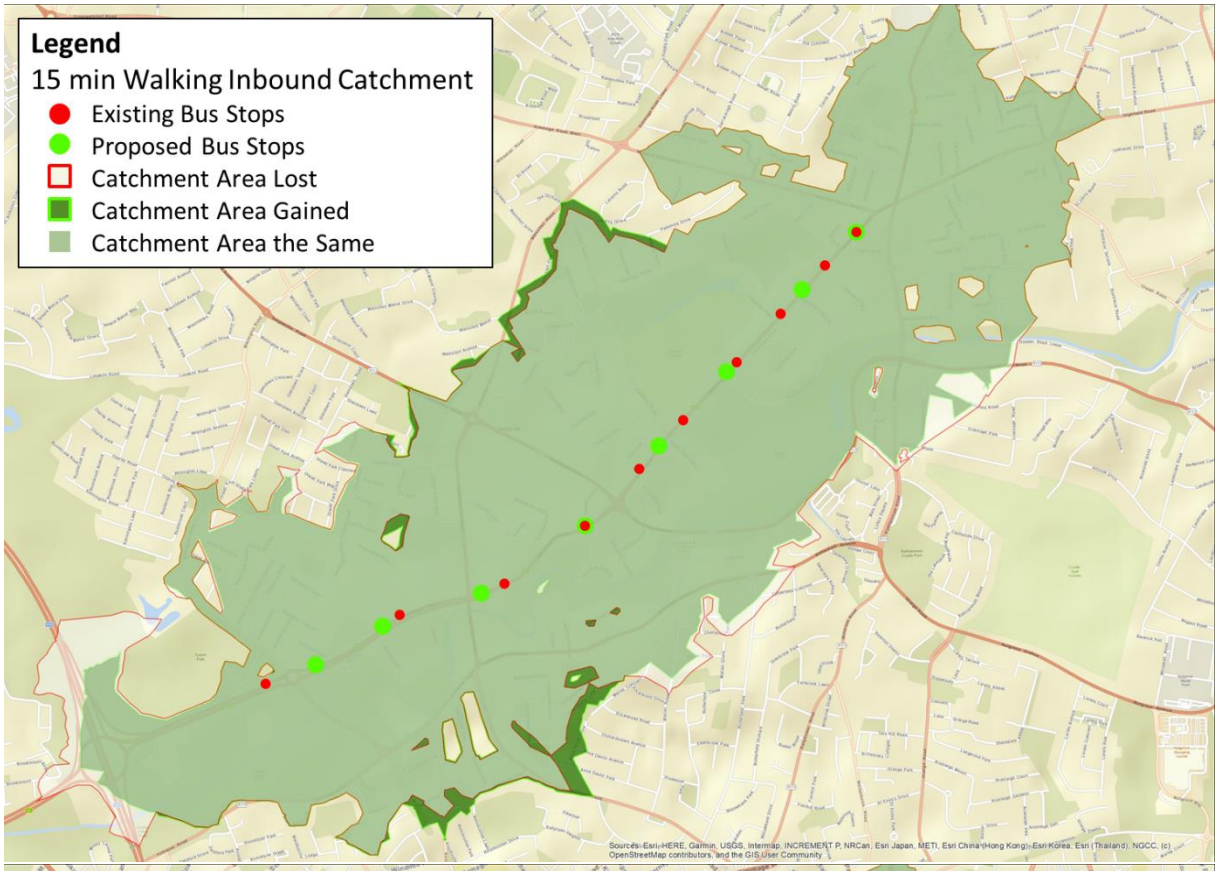
Appendix D

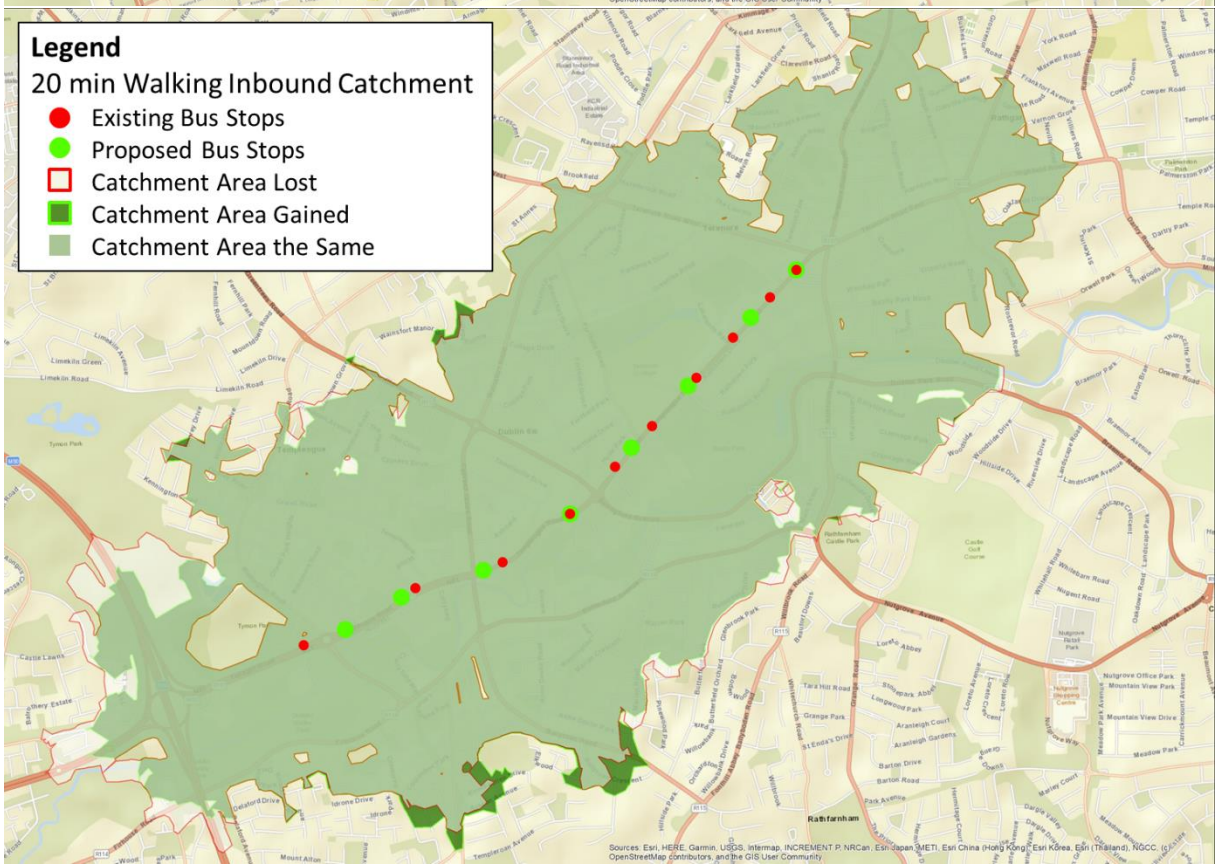
Overlap Maps

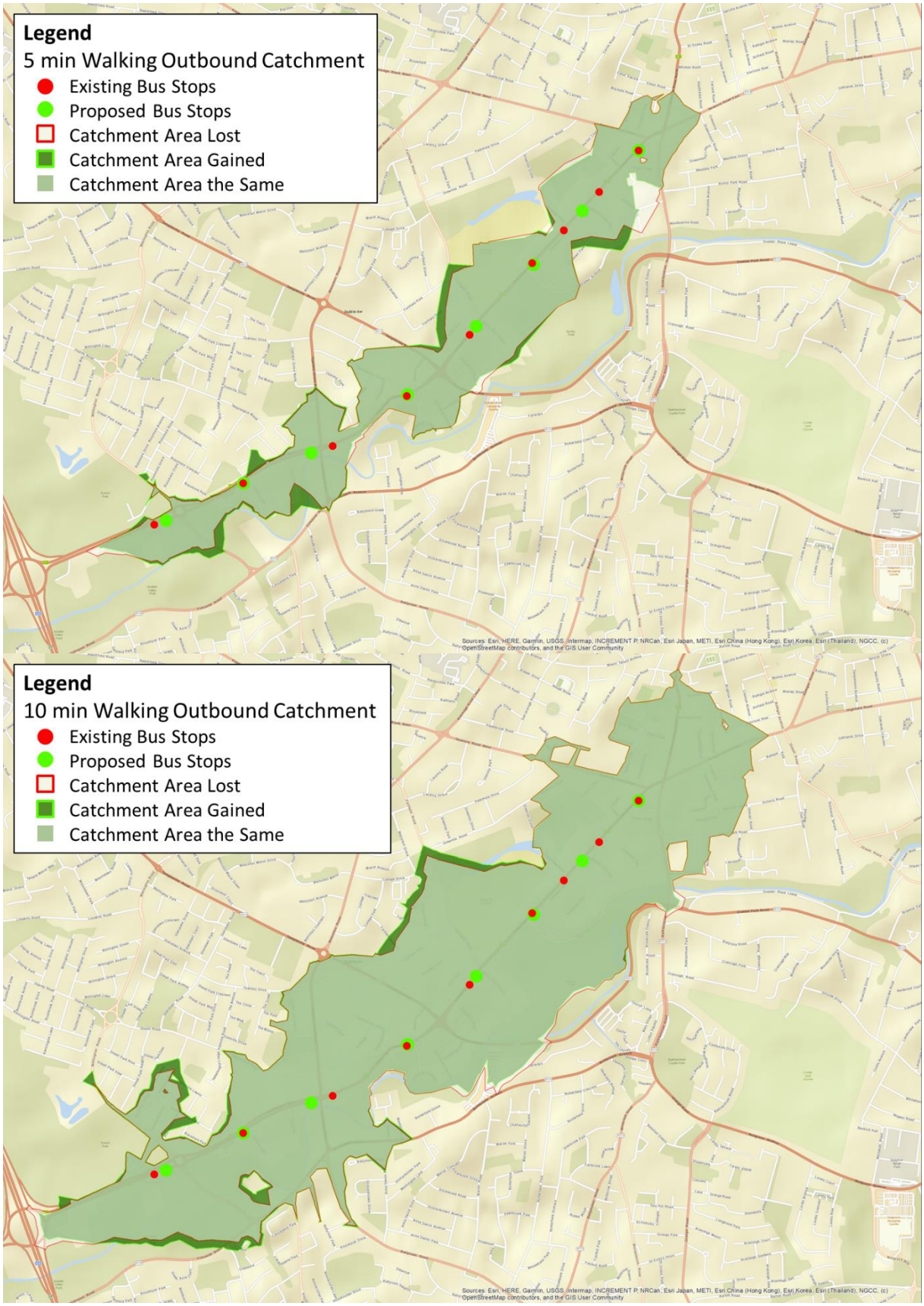
D1 Section 1

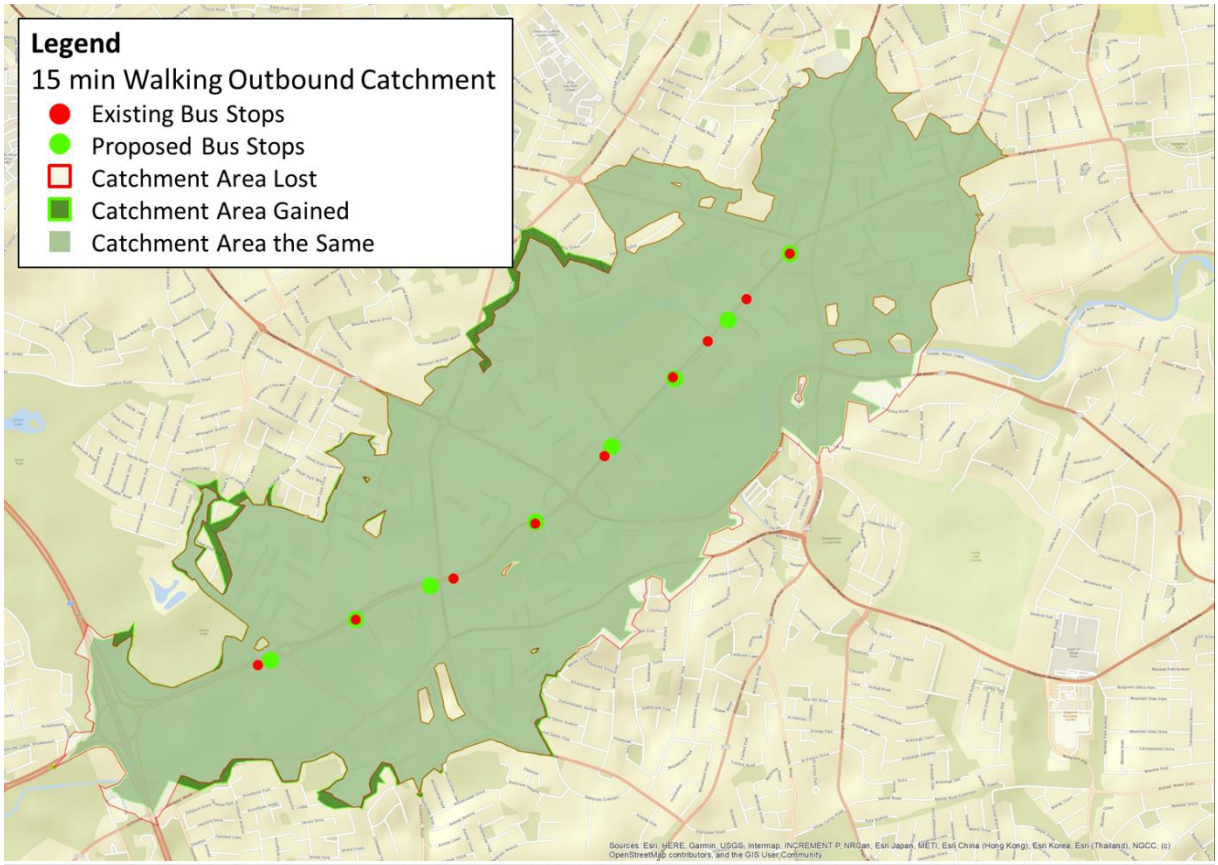

Legend
5 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same

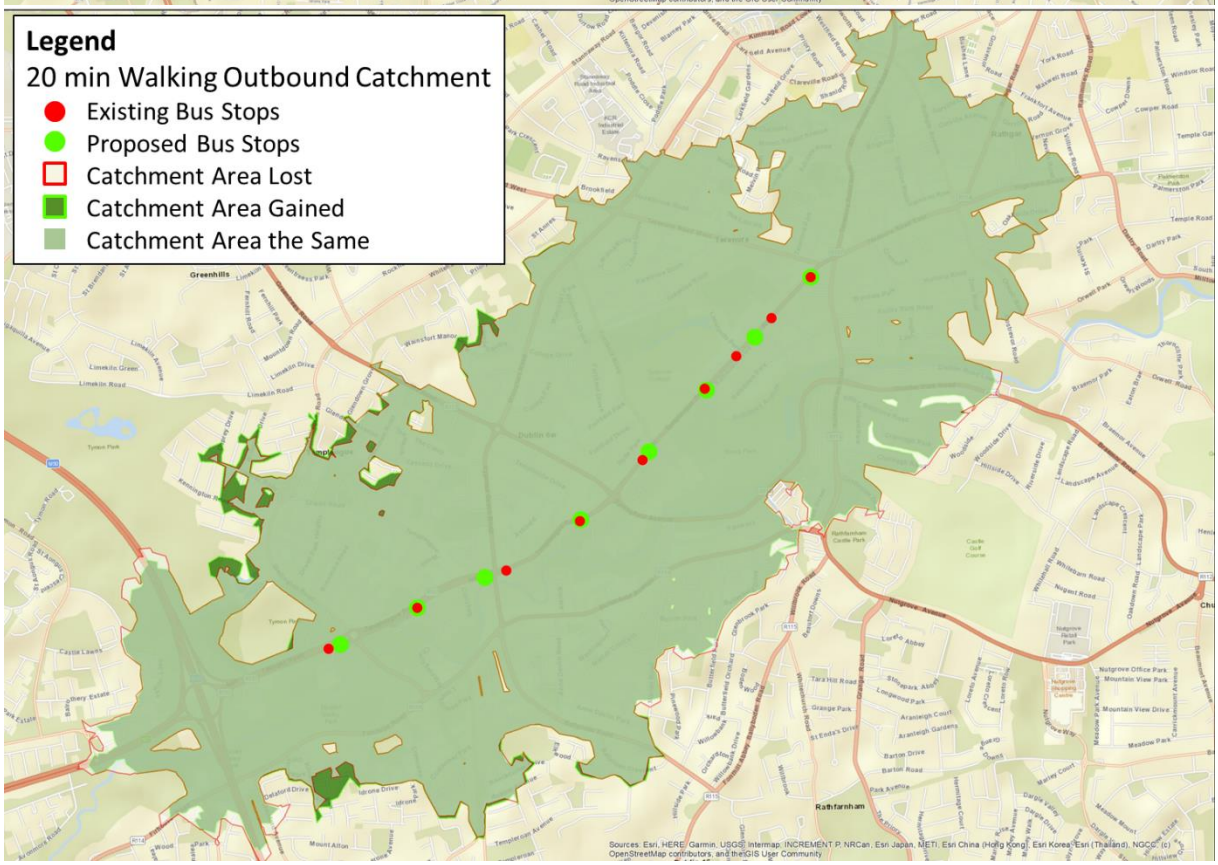

Legend
10 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same


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
Rathfarnham

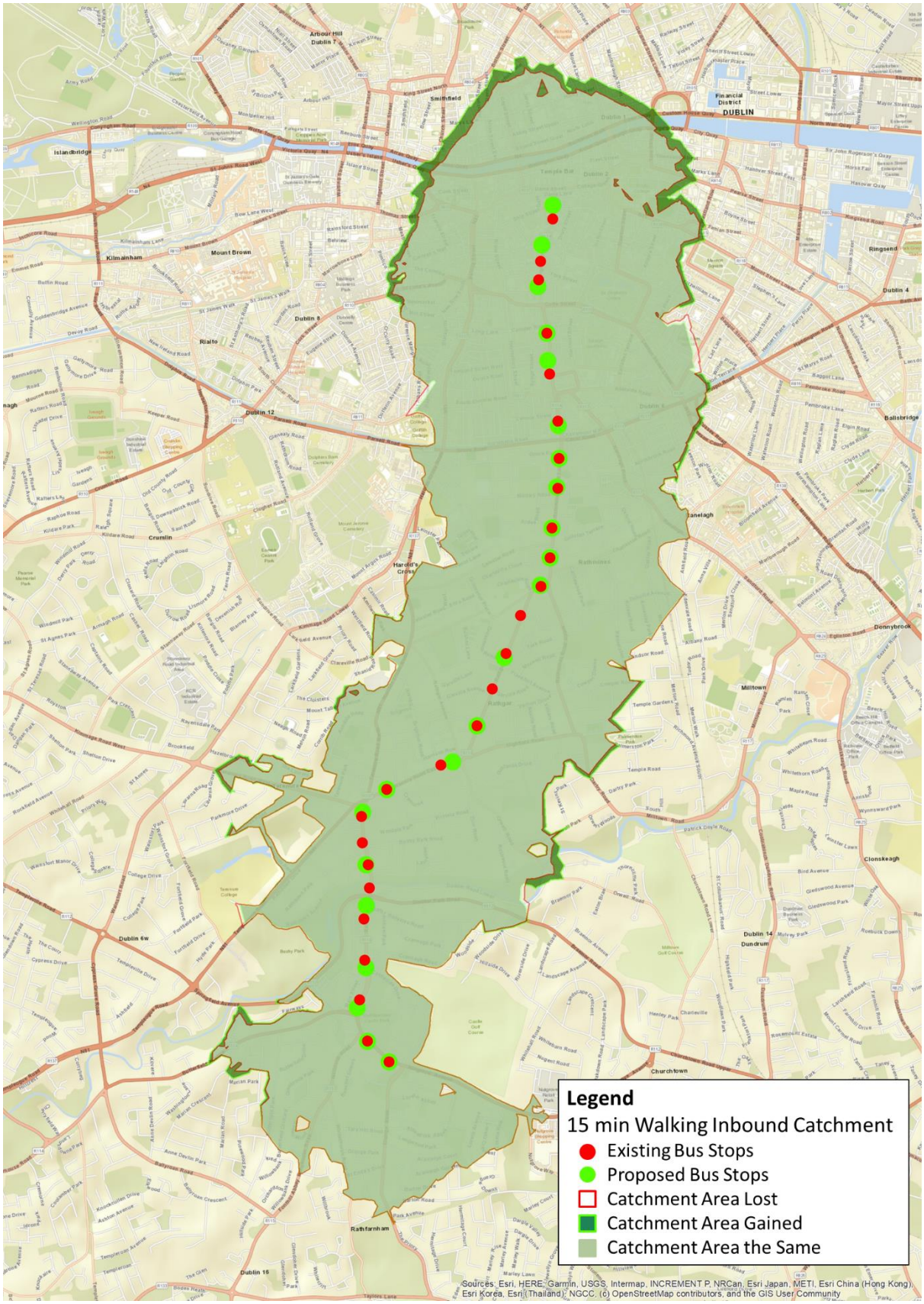

Legend
5 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Legend
10 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same

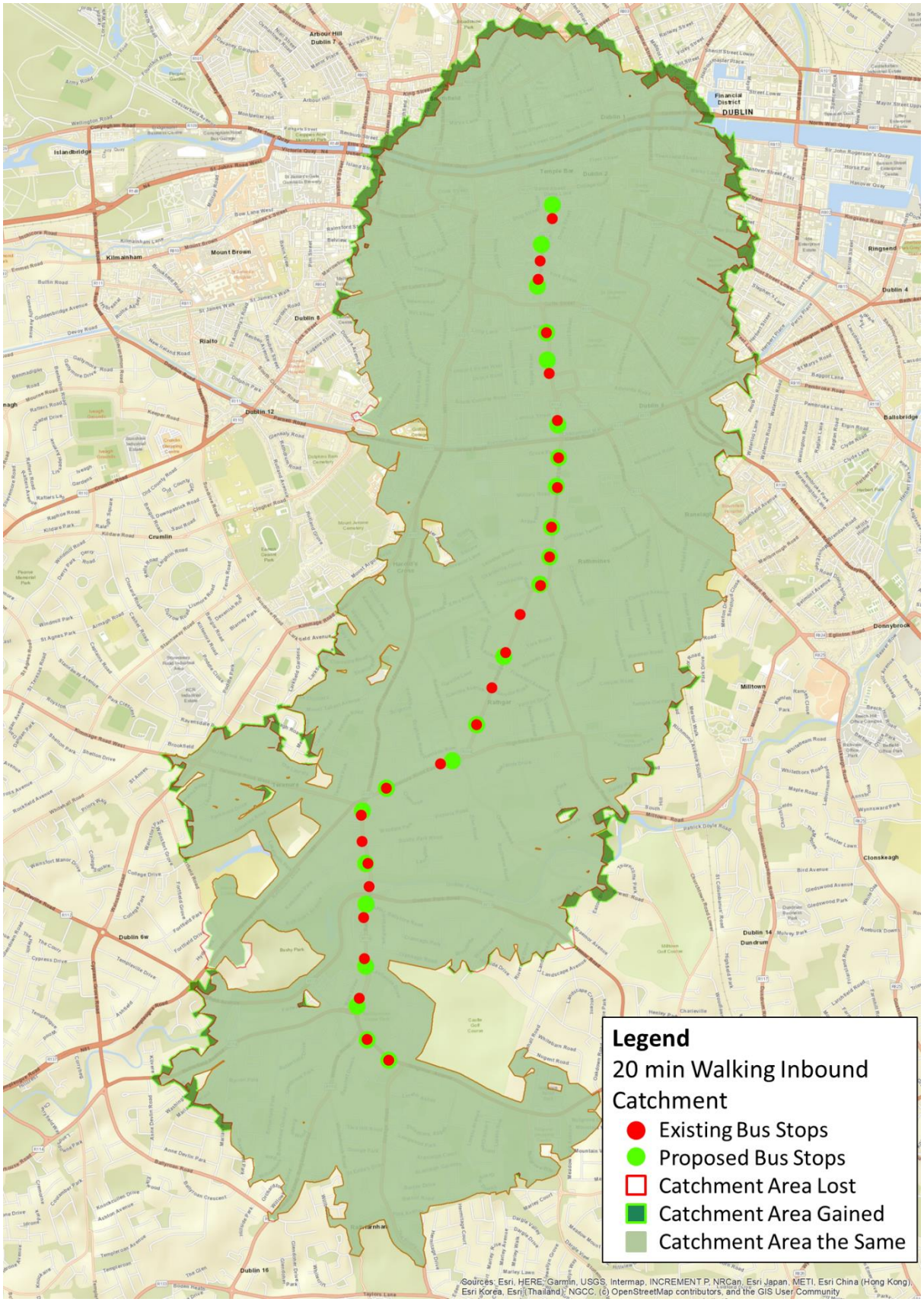

Legend
15 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

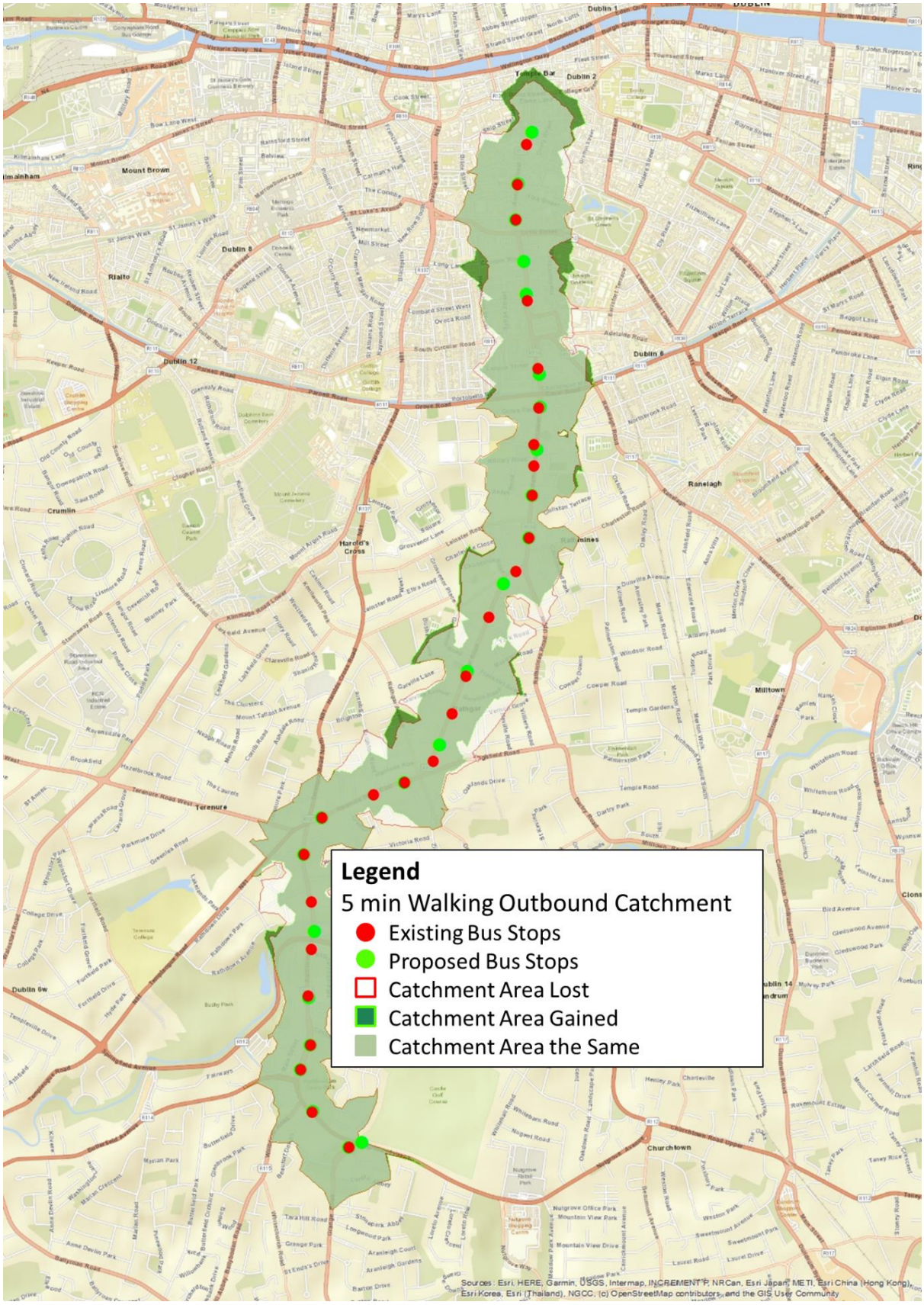

Legend
20 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Greenhills
Rathfarnham
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

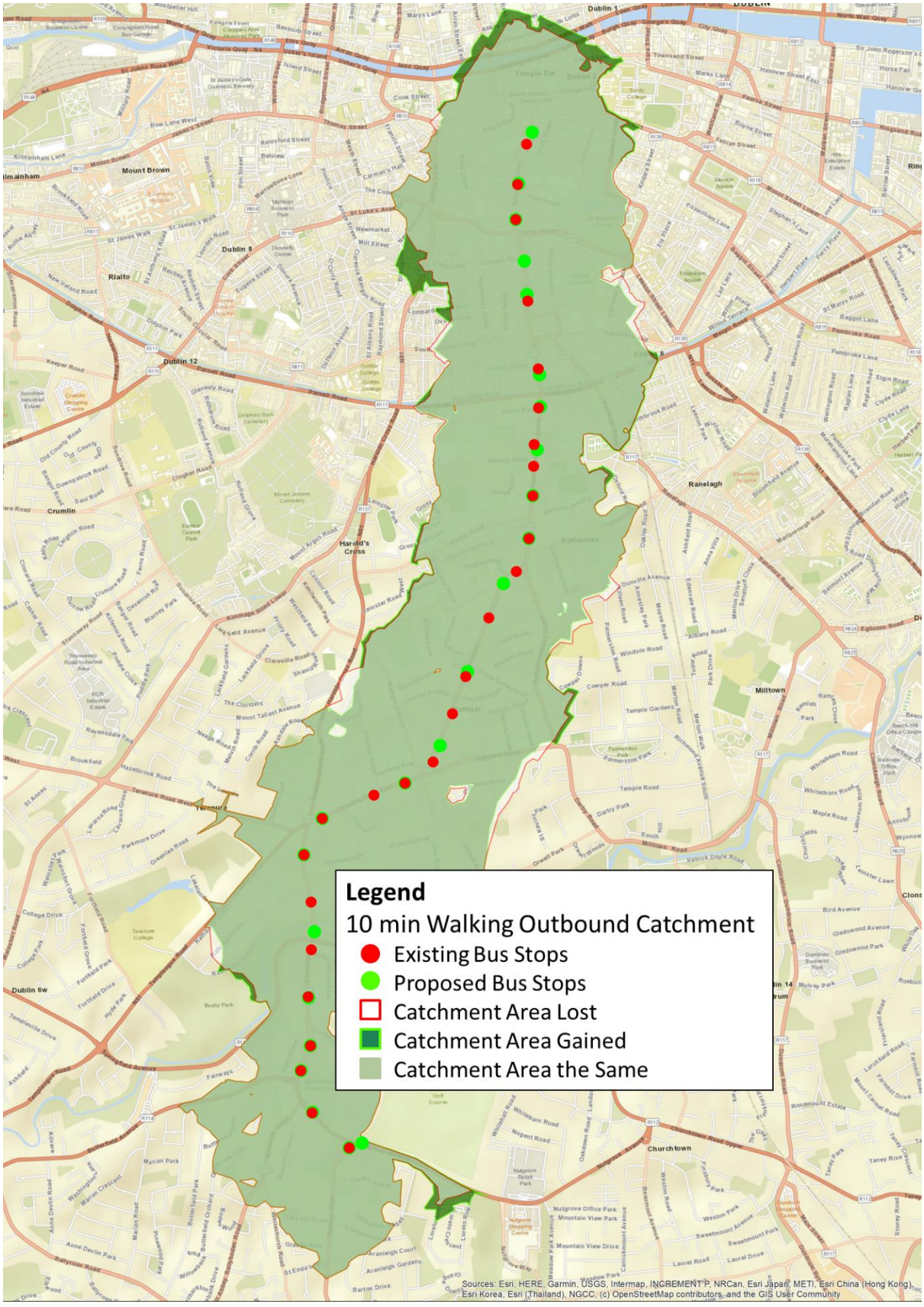
D2 Sections 2, 3 and 4

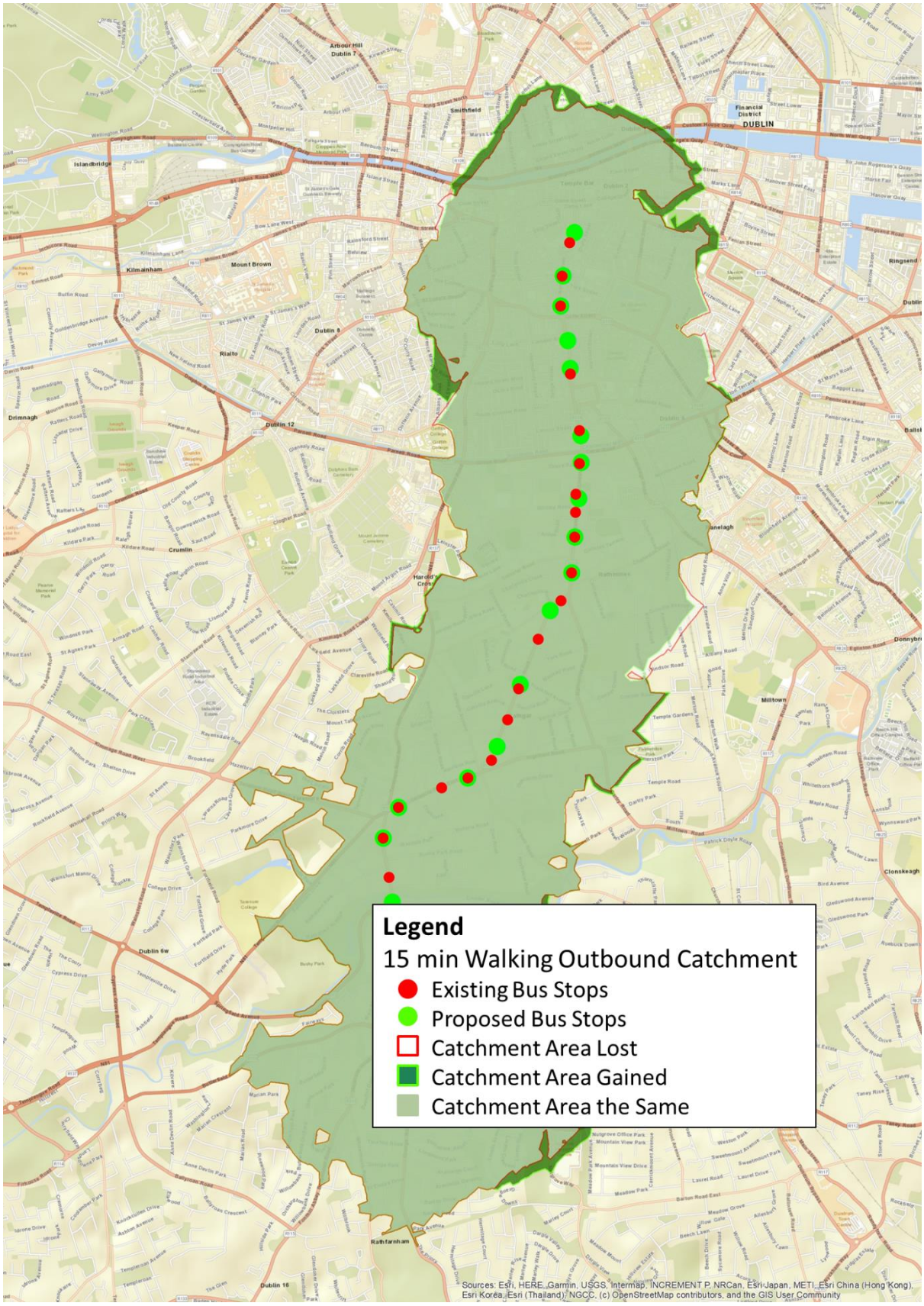

Legend
5 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

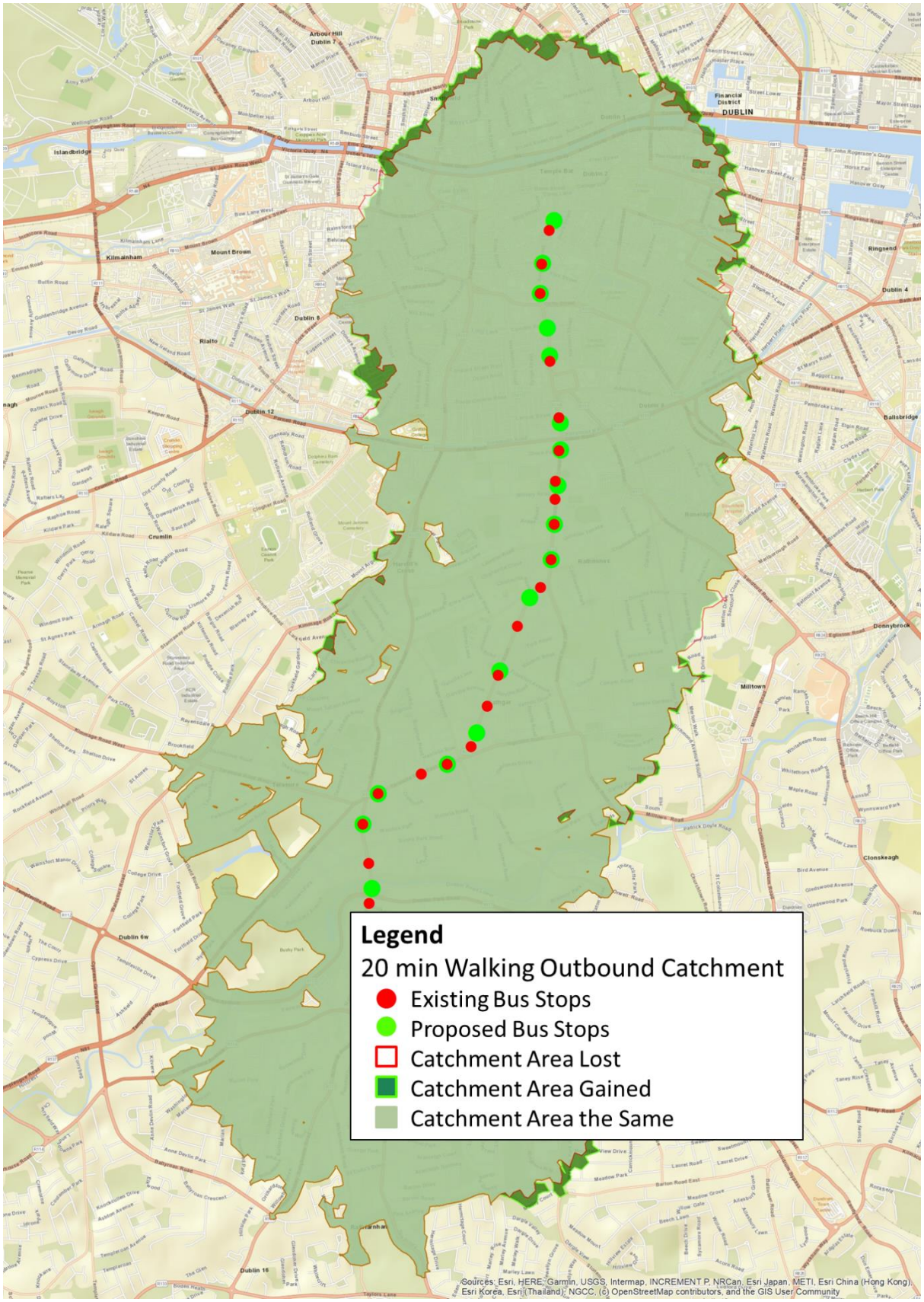

Legend
15 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community


Legend
20 min Walking Inbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community


Legend
5 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community


Legend
10 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community


Legend
15 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community


Legend
20 min Walking Outbound Catchment
Existing Bus Stops
Proposed Bus Stops
Catchment Area Lost
Catchment Area Gained
Catchment Area the Same
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community