Belfield / Blackrock to City Centre Core Bus Corridor Scheme

March 2022

Preliminary Design Report

BUS CONNECTS

SUSTAINABLE TRANSPORT FOR A BETTER CITY.

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List of Acronyms

Acronym	Definition
AC	Asphalt Concrete
AGI	Above Ground Installation
AIAR	Arboricultural Impact Assessment Report
ASLs	Advance Stacking Locations
AVL	Automatic Vehicle Location
AP	Attenuation Ponds
AT	Attenuation Tanks
AVLS	Automatic Vehicle Location System
AlluvMIN	Alluvial(mineral)
BCPDGB	BusConnects Preliminary Design Guidance Booklet
BEP	Building Information Modelling (BIM) Execution Plan
BGL	Below Ground Level
BIM	Building Information Modelling
BJTR	Bus Journey Time Report
BminDW	Deep well drained (Mainly basic)
BminPD	Mineral poorly drained (Mainly basic)
CBR	California Bearing Ratio
CBC	Core Bus Corridor
CDETB	City of Dublin Educational and Training Board
CSC	Characteristic Skid Coefficient
CIRIA	Construction Industry Research and Information Association,
CPO	Compulsory Purchase Order
CCTV	Close Circuit Television
DB 32	Design Bulletin 32
DSRC	Dedicated Short Range Communications
DCC	Dublin City Council
DLAM	Dublin Local Area Model
DLRCC	Dún Laoghaire-Rathdown County Council
DM	Do Minimum
DMURS	Design Manual for Urban Roads and Streets
DCP	Dynamic Cone Penetrometer
DEHLG	Department of Environment, Heritage and Local Government
DMRB	TII Design Manual for Road and Bridges
DART	Dublin Area Rapid Transit
DTTAS	Department for Transport, Tourism and Sport

Acronym	Definition
DS	Do Something
ESB	Electricity Supply Bord
ED	Engineering Designer
EIAR	Environmental Impact Assessment Report
EPR	Emerging Preferred Route
FTA	Federal Transit Administration
FRA	Flood Risk Assessment
FD	Filter Drains
FCC	Fingal County Council
GNI	Gas Networks Ireland
GSI	Geological Survey of Ireland
GDSDS	Greater Dublin Strategic Drainage Study
GDA	Greater Dublin Area
GDA Transport Strategy	Transport Strategy for the Greater Dublin Area 2016-2035’
GI	Ground Investigation
GPR	Ground Penetration Radar
GDRCoP	Greater Dublin Regional Code of Practice
GDSDS	Greater Dublin Strategic Drainage Study
HRA	Hot Rolled Asphalt
HGV	Heavy Goods Vehicle
ILP	Institution of Lighting Professionals
IRI	International Roughness Index
ITS	Intelligent Transport System
IW	Irish Water
JTC	Junction Turning Count
KFPA	Kerbs, Footways and Paved Areas
LEBM	Low Energy Bound Mixtures
LOD	Level of Detail
LED	Light Emitting Diode
LPV	Longitudinal Profile Variance
MMaRC	Motorway Maintenance and Renewals Contract
msa	Million standard axles
MOVA	Microprocessor Optimise Vehicle Actuation
MPD	Mean Profile Depth
MCA	Multi-Criteria Assessment
MID	Mobility Impaired & Disabled
NCM	National Cycle Manual

Acronym	Definition
NTA	National Transport Authority
NSS	National Spatial Strategy
NCDWC	National Construction and Demolition Waste Council
NPF	National Planning Framework
OPW	Office of Public Works
OSI	Ordnance Survey Ireland
OD	Ordinance Datum
OSP	Oversize pipes
PDR	Preliminary Design Report
PSCI	Pavement Surface Condition Index
PMG	Project Management Guidelines
PMC	People Movement Calculator
RSES	Regional Spatial and Economic Strategies
RC	Rotary Core
RMO	Road Maintenance Office
RSA	Road Safety Audit
RTPI	Real Time Passenger Information
SMA	Stone Mastic Asphalt
SuDS	Sustainable Urban Drainage Systems
SCOOT	Split Cycle Offset Optimisation Technique
SDCC	South Dublin County Council
SCATS	Sydney Coordinated Adaptive Traffic System
SSD	Stopping Sight Distance
TII	Transport Infrastructure Ireland
TSM	Traffic Signs Manual
TP	Trial Pit
UCD	University College Dublin
VMS	Variable Message Signs
WCC	Wicklow County Council

Executive Summary

This Preliminary Design Report has been prepared for the Belfield / Blackrock to City Centre Core Bus Corridor Scheme and builds on the previous Feasibility and Options Reports for two Core Bus Corridors (CBCs) – namely the UCD Ballsbridge to City Centre CBC and the Blackrock to Merrion CBC – and the Preferred Route Options Report for the Belfield / Blackrock to City Centre Core Bus Corridor Scheme.

This report summarises the project background and the need for the scheme in the context of National and Local Planning Policy, summarises the existing physical conditions and documents the surveys undertaken in developing the design.

The report also details the preliminary design, sets out traffic management proposals and outlines the traffic modelling undertaken and the outputs from the junction modelling.

The land use and acquisition requirements are summarised in this report, along with details of affected landowners and property owners, and proposed accommodation works.

The report concludes that the design of the Belfield / Blackrock to City Centre Core Bus Corridor Scheme wholly achieves the scheme objectives. In doing so, it fulfils the aim of providing enhanced walking, cycling and bus infrastructure on a key access corridor in the Dublin region, enabling the delivery of efficient, safe, and integrated sustainable transport movement along the corridor.

1 Introduction and Description

1.1 Introduction

BusConnects is the National Transport Authority's (NTA) programme to improve bus and sustainable transport services. It is a key part of the Government's policies to improve public transport and address climate change. The NTA established a dedicated BusConnects Infrastructure team (the BusConnects Infrastructure team) to advance the planning and construction of the Core Bus Corridor (CBC) Infrastructure Works. It comprises an inhouse team including technical and communications resources and external service providers procured from time-to-time to assist the internal team in the planning and design of the twelve Proposed Schemes.

The CBC Infrastructure Works involves the development of continuous bus priority infrastructure and improved pedestrian and cycling facilities on twelve radial core corridors in the Greater Dublin Area (GDA), across the local authority jurisdictions of Dublin City Council (DCC), South Dublin County Council (SDCC), Dún Laoghaire-Rathdown County Council (DLRCC), Fingal County Council (FCC), and Wicklow County Council (WCC). Overall, the CBC Infrastructure Works encompasses the delivery of approximately 230 km of dedicated bus lanes and 200 km of cycle tracks along sixteen of the busiest corridors in Dublin.

The Belfield / Blackrock to City Centre Core Bus Corridor of the CBC Infrastructure Works (herein after called the 'Proposed Scheme') measures approximately 8.3 km from end to end.

The Proposed Scheme will be comprised of two main alignments in terms of the route it follows, namely from Blackrock to the City Centre and along Nutley Lane.

The Blackrock to City Centre section commences on the R113 at Temple Hill, approximately 80m to the north of R827 Stradbrook Road, travels along the N31 Frascati Road, the R118 Rock Road / Merrion Road / Pembroke Road, the R816 Pembroke Road / Baggot Street Upper / Baggot Street Lower, turns onto Fitzwilliam Street Lower and terminates at the junction of Mount Street Upper / Merrion Square South / Merrion Square East.

The Nutley Lane section of the Proposed Scheme will commence at the tie-in with the signalised junction on the R138 Stillorgan Road on the southern end of Nutley Lane, travels along Nutley Lane and will terminate at the junction with the R118 Merrion Road.

Refer to Figure 1.1 for overall route of the Proposed Scheme.

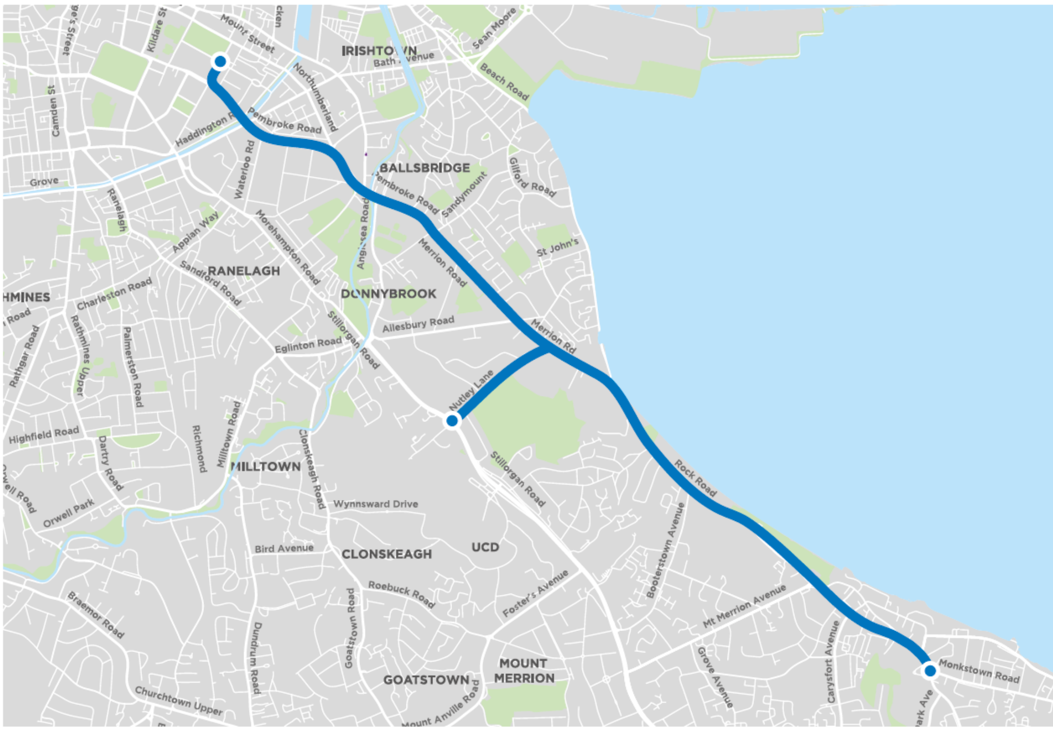


Figure 1.1: Proposed Scheme Route Overview

1.2 Scheme Aims and Objectives

The aim of the Proposed Scheme is to provide enhanced walking, cycling and bus infrastructure on a key access corridor in the Dublin region, which will enable and deliver efficient, safe, and integrated sustainable transport movement along this corridor.

The objectives of the Proposed Scheme are to:

- Enhance the capacity and potential of the public transport system by improving bus speeds, reliability and punctuality through the provision of bus lanes and other measures to provide priority to bus movement over general traffic movements;
- Enhance the potential for cycling by providing safe infrastructure for cycling, segregated from general traffic wherever practicable;
- Support the delivery of an efficient, low carbon and climate resilient public transport service, which supports the achievement of Ireland's emission reduction targets;
- Enable compact growth, regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of safe and efficient sustainable transport networks;
- Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved sustainable connectivity and integration with other public transport services; and

- Ensure that the urban realm is carefully considered in the design and development of the transport infrastructure and seek to enhance key urban focal points where appropriate and feasible.

1.3 Project Background

The Transport Strategy for the Greater Dublin Area 2016 – 2035 sets out a network of the bus corridors forming the “Core Bus Network” for the Dublin region. Sixteen indicative radial CBCs were initially identified for redevelopment. This is shown in Figure 1.2 (extract from Transport Strategy for the Greater Dublin Area 2016-2035).

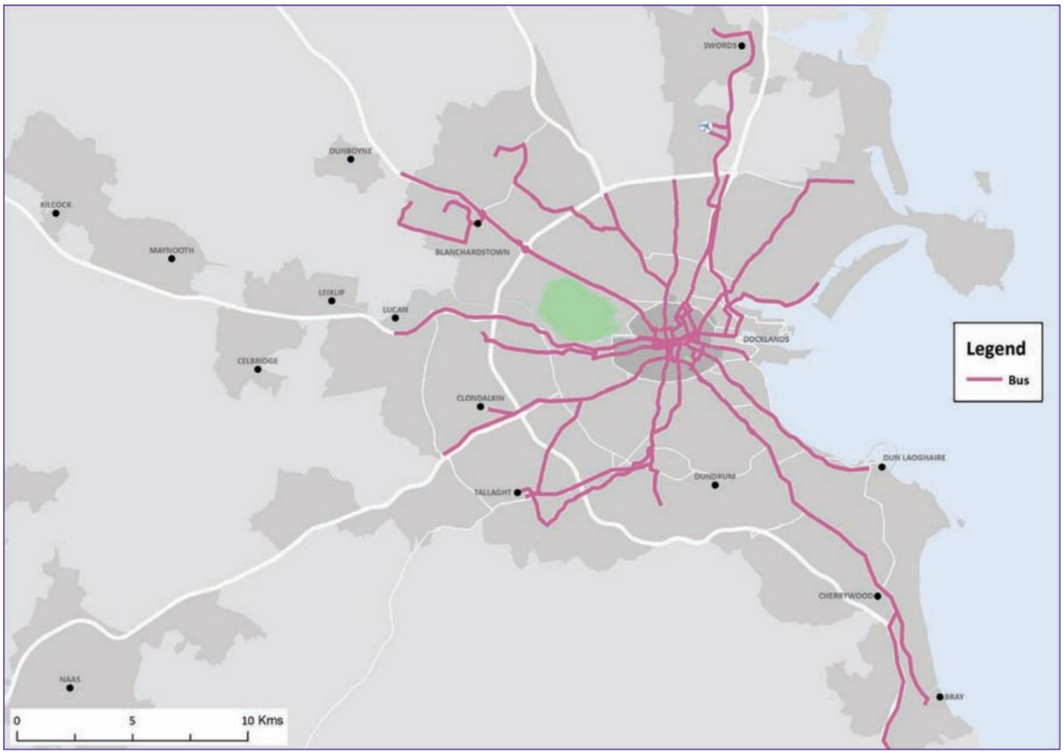


Figure 1.2: 2035 Core Bus Network – Radial Corridors

These corridors currently have dedicated bus lanes along only less than one third of their lengths which means that for most of the journey, buses and cyclists are competing for space with general traffic and are negatively affected by the increasing levels of congestion. This results in delayed buses and unreliable journey times for passengers. Following the completion of feasibility and options studies sixteen radial corridors were taken forward.

In June 2018, the NTA published the Core Bus Corridors Project Report. The report was a discussion document outlining proposals for the delivery of a CBC network across Dublin. The Proposed Scheme is identified in this document as forming part of the Radial Core Bus Network, designated as Belfield / Blackrock to City Centre CBC Scheme.

In the context of the proposed planning applications for the CBC Infrastructure Works, the initial sixteen radial CBCs have been grouped as twelve individual Schemes. The twelve Schemes that will be the subject of separate applications to An Bord Pleanála for approval are listed below:

- Clongriffin to City Centre Core Bus Corridor Scheme;
- Swords to City Centre Core Bus Corridor Scheme;
- Ballymun / Finglas to City Centre Core Bus Corridor Scheme;
- Blanchardstown to City Centre Core Bus Corridor Scheme;
- Lucan to City Centre Core Bus Corridor Scheme;
- Liffey Valley to City Centre Core Bus Corridor Scheme;
- Tallaght / Clondalkin to City Centre Core Bus Corridor Scheme;
- Kimmage to City Centre Core Bus Corridor Scheme;
- Templeogue / Rathfarnham to City Centre Core Bus Corridor Scheme;
- Bray to City Centre Core Bus Corridor Scheme;
- Belfield / Blackrock to City Centre Core Bus Corridor Scheme;
- Ringsend to City Centre Core Bus Corridor Scheme;

The twelve radial routes that form the CBC Infrastructure works is shown in Figure 1.3.

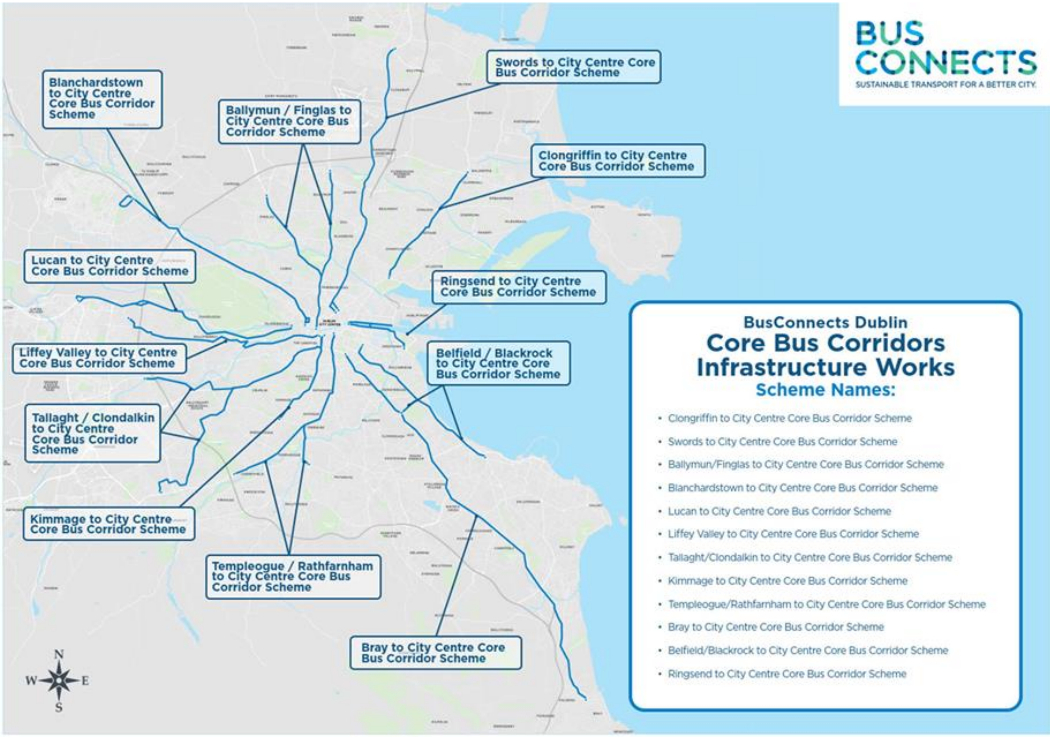


Figure 1.3: BusConnects Radial CBC Network

1.4 Proposed Construction Procurement Method

The Proposed Scheme will proceed on the basis of procurement through a Design-Build tender process.

Consequently, the design information presented in this report ensures that the objectives of the Proposed Scheme are met, in accordance with current design standards and guidance documents. It further ensures that sufficient land will be acquired during the Compulsory Purchase Order process in order to construct a CBC that will fulfil the design requirements.

1.5 Stakeholder Consultation

Three rounds of non-statutory public consultation have taken place over the following dates;

- 26th February 2019 to 31st May 2019 - Consultation on Emerging Preferred Route;
- 4th March 2020 to 17th April 2020 - Consultation on Preferred Route Option;
- 4th November 2020 to 16th December 2020 - Consultation on Preferred Route Option.

Refer to the Blackrock to Merrion Core Bus Corridor and UCD Ballsbridge to City Centre Core Bus Corridor Preferred Route Option Second and Third Public Consultation Submissions Summary Reports for information on the non-statutory consultations.

Consultation with the principal project stakeholders (i.e. Dublin City Council (DCC), Dún Laoghaire-Rathdown County Council (DLRCC), Transport Infrastructure Ireland (TII) and Utility companies) has taken place to date in order to:

- Inform the scheme development process at particular locations;
- Identify constraints and opportunities within the study area, scheme corridor and route options considered;
- Further refine the scheme objectives;
- Discuss potential mitigation measures and options; and
- Identify planning requirements, conditions and implications with respect to the proposed scheme design measures.

Specific scheme requirements have been discussed and agreed during workshops with Local Authorities and meetings, at Steering Group and Programme level. The BusConnects Infrastructure team has taken cognisance of any specific requirements and recommendations emerging from this process when exploring feasible scheme options and preparing the preliminary design.

In addition to the principal project stakeholders, consultations have taken place with:

- Representative Groups;
- Chartered Landowners (i.e. owners of lands at any specific locations); and
- Directly Impacted landowners.

1.6 Audit of the Existing Situation

The following audits, surveys and assessments have been carried out:

- Problem Identification Audit;
- Accessibility Audit;
- Route Infrastructure Audit;
- Existing Pavement Inspection Audit;
- Existing Structures Assessment;
- Existing Route Collision Analysis;
- Cellar Survey;
- Private Landings Survey;
- Baseline Tree Survey;
- Cycle Journey Time Survey;
- Pavement condition;
- Phase 1 Utility Survey;
- Bus Stop Survey including boarding and alighting and AVL;
- Traffic Survey (JTC, pedestrian and cyclists counts);
- Parking survey; and
- Bus Journey Time.

These surveys have been supplemented with secondary record data to include utility information, OPW CFRAM Flood Models, IW Drainage Models and existing traffic signal data from DCC.

A number of environmental surveys have also been carried out by the Environmental Impact Assessment (EIA) team. Refer to the Environmental Impact Assessment Report for further information.

1.7 Purpose of the Preliminary Design Report

The Preliminary Design Report sets out the preliminary design of the Proposed Scheme, and supports the Compulsory Purchase Order (CPO) documentation and Environmental Impact Assessment Report (EIAR) which form part of the Planning Application to An Bord Pleanála.

During the preparation of the preliminary design, designers' risk assessments were undertaken, details of these are included in Appendix A.

The purpose of the risk assessments is to identify significant design risks and mitigate them as part of the design process.

1.8 Report Structure

The structure for the remainder of this report is set out as follows:

- Chapter 2: Policy Context and Design Standards – This chapter identifies the policies and design standards reviewed and applied to the preliminary design;
- Chapter 3: The Proposed Scheme – This chapter describes the five sections of the Proposed Scheme in more detail;
- Chapter 4: Road Geometry – In this chapter, the geometrical alignment and cross-section of the scheme are described, along with an overview of the operational safety process which has been implemented;
- Chapter 5: Junction Layout – The junction design methodology and modelling process is then set out for the major, moderate and minor junctions along the length of the route in this chapter;
- Chapter 6: Ground Investigation and Ground Condition – This chapter provides an overview of the ground investigation process and ground conditions;
- Chapter 7: Pavement, Kerbs, Footpaths and Paved Areas– This chapter gives an overview of the existing pavement situation and proposed pavement, kerbs, footpaths and paved areas design for the scheme;
- Chapter 8: Structures – In this chapter an overview of the structures strategy is provided, along with a summary of principal and miscellaneous structures, retaining walls and embankments;
- Chapter 9: Drainage, Hydrology and Flood Risk – This chapter is an overview of the drainage strategy includes descriptions of existing watercourses and culverts alongside a summary of the drainage design for each catchment along the scheme, including the consideration of drainage at structures and the maximisation of SuDS features;
- Chapter 10: Services and Utilities – This chapter shows the Utilities design strategy documents surveys undertaken to date, identifies conflicts and recommends a number of diversions;
- Chapter 11: Waste Quantities – This chapter provides an overview of the waste quantities for the Proposed Scheme;
- Chapter 12: Traffic Signs, Lighting and Communications – In this chapter the design strategy for traffic signs, road markings, lighting and communications equipment is outlined, alongside descriptions of how these elements can be maintained and monitored safety and securely;
- Chapter 13: Land Use and Accommodation Works – This chapter outlines land use and acquisition requirements, affected land and property owners, and proposed accommodation works;

- Chapter 14: Landscape and Urban Realm – This chapter is an overview of the landscape and urban realm design strategy focussing on the existing trees and proposed mitigation;
- Chapter 15: How we are achieving the Objectives – This chapter sets out the manner in which the Proposed Scheme achieves its objectives; and
- Appendices – Various appendices and background information as referenced throughout the report.

1.9 Preliminary Design Drawings

A set of preliminary design drawings have been prepared to convey the scheme design principles for each discipline and should be read in conjunction with this Preliminary Design Report. Table 1.1 provides a description of the drawings and relevant design content displayed in each of the series as applicable for the Scheme. The drawings have been included in Appendix B for reference. The file naming conventions for the Drawing Series and Volume Codes are as set out in the Building Information Modelling (BIM) Execution Plan (BEP) developed for the CBC Infrastructure Works.

Table 1.1: Preliminary Design Drawings

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
SPW_KP/SPW_ZZ	Site Location Map (1:12500@ A1) & Site Location Plans (1:2500@A1)	Defines the full extent of the works & planning red line boundary. Outlines the scheme chainage structure and provides context for the locality of adjacent Schemes and other notable locations along the route.
SPW_BW	Fencing and Boundary Treatment Plans (1:500@A1)	To be read in conjunction with the GEO_GA General Arrangement series and GEO_CS typical cross-section series. Provides an indication of the locations for the proposed boundary modification works along the route.
GEO_GA	General Arrangement Plans (1:500 @ A1)	Displays information for conveying the overarching scheme design intent, providing information on the proposed pedestrian/cycle/ bus/traffic regime, indicative ultimate tree arrangement (existing trees retained & proposed trees), bus stop/shelter locations, key heritage feature locations, parking and loading arrangements, turn bans, side road treatments in addition to identification of specific items of note to the scheme (structures or significant features which may be further described on other drawing series)
GEO_CS	Typical Cross-sections (1:50 @ A1)	To be read in conjunction with the GEO_GA General Arrangement series. Provides an indication of the proposed cross-section works in comparison to the existing road geometry. Indicative pavement/kerbing, boundary treatments and key street furniture are also provided for context.

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
GEO_HV	Mainline Plan and Profile Drawings (1:500@A1)	To be read in conjunction with the GEO_GA General Arrangement series. Provides an indication of the proposed modification works to the mainline vertical alignment with supplementary information on earthworks/retaining walls and other notable structures along the route (as required).
ENV_LA	Landscaping General Arrangement Plans (1:500@A1)	Provides information relating to urban realm and landscaping proposals including identification of trees to be removed resulting from the arborist assessments, proposed tree/planting regime, proposed footpath surface finishes, locations of proposed SUDs features and proposed boundary treatment and key street furniture notes.
DNG_RD	Proposed Surface Water Drainage Plans (1:500@A1)	Displays information for conveying the design intent for the drainage portion of the works including identification of SuDS measures, requirements for allowable discharge rates to the existing networks (attenuation/detention/flow control) where applicable, catchment assessments and outline design for the proposed drainage discharge strategy along the route.
UTL_UC	Combined Existing Utilities Record Plans (1:500@A1)	Displays information regarding existing Statutory Undertakers records along the length of the scheme with the proposed scheme features shown as background information for context.
UTL_UD	Irish Water Foul Sewer Alteration Plans (1:500@A1)	Provides an indication of the existing trunk foul sewer network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UW	Irish Water Potable Water Alteration Plans (1:500@A1)	Provides an indication of the existing trunk potable water network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UE	ESB Asset Alteration Plans (1:500@A1)	Provides an indication of the existing trunk electrical network (above and below ground) and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UL	Telecommunications Asset Alteration Plans (1:500@A1)	Provides an indication of the existing trunk telecommunications network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.
UTL_UG	Gas Networks Ireland Asset Alteration Plans (1:500@A1)	Provides an indication of the existing trunk gas network and proposed indicative modification/diversion works (where identified) along the route. The existing and proposed kerb lines have been displayed for scheme context.

Drawing Series Volume Code	Drawing Series Description/Scale	Design Content
LHT_RL	Street Lighting Plans (1:500@A1)	Provides an indication of the proposed modification works to the existing street lighting infrastructure along the route in addition to identification of any key heritage lighting column features.
TSM_SJ	Junction System Design Plans (1:250@A1)	Provides a more detailed overview of the proposed junction arrangements for pedestrians, cyclists, buses and general traffic with an indication of the proposed junction staging and associated signal head arrangements for key signalised junctions/signalised crossings along the route.
TSM_GA	Traffic Signs and Road Markings Plans (1:500@A1)	Provides an indication of the proposed key signage (information/directional/regulatory) design requirements and the design intent for the proposed lane marking arrangements along the route.
PAV_PV	Pavement Treatment Plans (1:500@A1)	Provides an indication of the proposed pavement treatment works along the length of the route.
STR_GA	**Bridges and Major Retaining Structures**	**Provides details relating to proposed structural retaining walls along the route.**

The planning red line boundary has been displayed on the Site Location Plans in drawing series SPW_ZZ as designated by the solid red line ‘SITE EXTENTS’. For clarity the various discipline general arrangement drawing series have been displayed with the permanent extent of works boundary line as designated by the solid red line ‘SITE BOUNDARY LINE’. Where construction access or accommodation works are required to facilitate the permanent works this has been displayed by the dashed red line ‘TEMPORARY LAND ACQUISITION’. Construction site compounds outside the ‘SITE BOUNDARY LINE’ are also captured within the dashed red line ‘TEMPORARY LAND ACQUISITION’.

Full details of the compulsory land acquisition required to construct the Proposed Scheme are provided on the various Deposit Maps, Server Maps and associated CPO schedules/documentation for the Proposed Scheme as part of the statutory application documentation.

2 Policy Context and Design Standards

2.1 Policy Context

The following national, regional and local policies have been reviewed and considered in the development of the Proposed Scheme:

- Project Ireland 2040;
- Department of Transport: Statement of Strategy (2016 - 2019);
- Smarter Travel: A Sustainable Transport Future (2009 – 2020);
- National Cycle Policy Framework (2009);
- Road Safety Strategy (2013 – 2020);
- Building on Recovery: Infrastructure and Capital Investment Plan (2016-2021);
- The Sustainable Development Goals National Implementation Plan (2018-2020);
- Climate Action Plan (2019);
- Eastern & Midland Regional Assembly, Regional Spatial & Economic; Strategy (2019-2031);
- Greater Dublin Area Cycle Network Plan;
- Transport Strategy for the Greater Dublin Area (2016-2035);
- Dublin City Council Development Plan (2016-2022);
- Dún Laoghaire-Rathdown County Council Development Plan (2016 – 2022); and
- Blackrock Local Area Plan (2015-2021)

For further information on how the Proposed Scheme meets the policies outlined above, refer to Belfield / Blackrock to City Centre Core Bus Corridor Planning Compliance Report (Document No. BCIDC-JAC-ENV_ZZ-1415-XX-00-RP-ES-0003).

2.2 Design Standards

Design standards applied on the Proposed Scheme are stated within the applicable chapters of this report. In addition to national design standards, the CBC Infrastructure Works has developed the BusConnects Preliminary Design Guidance Booklet (BCPDGB) – included in Appendix O; its purpose is to provide guidance for the various design teams involved in CBC Infrastructure Works, to ensure a consistent design approach across the twelve Proposed Schemes.

The BCPDGB complements existing guidance documents relating to the design of urban streets, bus facilities, cycle facilities and urban realm. A non-exhaustive list of these guidelines is as follows:

- The Design Manual for Urban Roads and Streets (DMURS);
- The National Cycle Manual (NCM);
- TII Publications;
- The Traffic Signs Manual (TSM);
- Guidance on the use of Tactile Paving;
- Building for Everyone: A Universal Design Approach, and
- Greater Dublin Strategic Drainage Study (GDSDS).

The BCPDGB focuses on the engineering geometry and Proposed Scheme operation. It is recognised that the Proposed Scheme has been planned and designed within the context of an existing city, with known constraints.

The BCPDGB provides guidance; however, a more flexible approach to the design of the Proposed Scheme, utilising engineering judgement, may be necessary in some locations due to these constraints.

Where it has been necessary to deviate from the parameters set out in the relevant national design standards or design guidance, these deviations have been noted within Section 4.17.

3 The Proposed Scheme

3.1 Proposed Scheme Description

The Proposed Scheme is approximately 8.31 km long and consists of two main alignments and runs primarily from Blackrock to the City Centre, with Nutley Lane forming a secondary alignment in a south-to-north direction. The General Arrangement drawings within Appendix B show the extent of the infrastructure proposed to deliver the Proposed Scheme. The Proposed Scheme Description has been broken into five sections and the works contained within them are described accordingly.

3.1.1 Section 1: Stradbrook Road to Booterstown Avenue

The Proposed Scheme will commence on the R113 at Temple Hill, approximately 80m to the north of the R827 Stradbrook Road. Between the Monkstown Road and Booterstown Avenue junctions, it is proposed to provide a single bus lane, a single general traffic lane and a segregated cycle track arrangement in each direction, with the inbound bus lane commencing just south of the Monkstown Road junction.

Along with the relocation of an existing inbound bus stop to just north of the Temple Hill / Monkstown Road Junction, a new pedestrian crossing has been introduced on the northern arm of this junction. In the staging of this junction a dedicated on-demand right turn phase for buses only onto Monkstown Road, with detection from northbound general traffic lane, will be provided.

A raised table treatment is proposed at the access road to St. Vincent’s Park, including on the access lane from Temple Hill, in order to improve pedestrian safety on the inbound side of Temple Hill. At this junction the Temple Road approach arm has been reduced to a single all-movements lane to enable the provision of cycle facilities while also providing an appropriate swept path for left-turning vehicles from Frascati Road to Temple Road.

General alterations to junctions along this section are proposed to improve cyclist safety, including the removal of the left turn slip lane from Rock Road to Rock Hill, and the provision of protected cycle tracks at other junctions with a number of additional dedicated cycle crossings provided where practicable.

The Proposed Scheme includes a controlled exit, for authorised vehicles only, provided from George’s Avenue (South) onto Frascati Road. The proposed exit will include restrictions to general traffic in the carriageway of the left turn from George’s Avenue (South) to Frascati Road, however cyclists and pedestrians will be able to pass through. Dedicated cycle crossing infrastructure on Frascati Road at George’s Avenue is included in the design to reflect the existing, recently-constructed, arrangement.

Similarly, it is noted that the access and egress arrangements to the Frascati Centre have been designed so as to reflect the existing, newly-constructed, arrangement.

The Proposed Scheme requires a widening of the carriageway along Rock Road, adjacent to Blackrock Park.

A portion of the existing wall of Blackrock Park currently supports the road embankment, and as such is to be replaced with a new retaining wall at this location – between Ben Inagh Park and Castledawson residential estate.

At the junction of Blackrock Clinic / Emmett Square on Rock Road, a new toucan crossing is proposed across the eastern (outbound) arm with the existing pedestrian crossing on the western (inbound) arm converted to a toucan crossing. It is noted that the existing time-plated turn ban from the outbound lane into Blackrock Clinic will be retained.

It is proposed to reverse the direction of Seafort Parade, including the separate entrance and exit from Rock Road. This intervention is proposed to improve visibility for vehicles exiting from Seafort Parade and remove the cross-road arrangement between Castledawson Avenue and Seafort Parade.

The proposed cross-section from Blackrock Clinic to Booterstown Avenue is such that it reduces the potential need for land acquisition along Willow Park School and reduces the extent of necessary land acquisition along Blackrock College and adjacent properties, while achieving the objectives of the Proposed Scheme.

The gates, railings, and piers forming the existing entrance to Blackrock College are to be rotated on the westernmost pier to accommodate the realigning of the adjacent boundary while preserving the symmetry of the protected entrance. A dedicated mid-block toucan crossing is also proposed immediately west of the Blackrock College entrance.

3.1.2 Section 2: Booterstown Avenue to Nutley Lane

Between the Rock Road / Booterstown Avenue junction and the Merrion Road / Nutley Lane junction, it is proposed to provide a single bus lane, a single general traffic lane and a segregated cycle track arrangement in each direction along the majority of the route.

Between Strand Road and Booterstown Avenue (Booterstown DART Station), a two-way cycle track is proposed on the outbound/eastern side of the route. This integrates with the proposed East Coast Trail (Sutton to Sandycove Greenway) along this section.

The design of the Rock Road cross-section and layout between the junctions of Booterstown Avenue and Trimleston Avenue is such that it avoids the need for land acquisition and provides an improved access to the nearby school, while achieving the objectives of the Proposed Scheme. This also includes the removal of the existing dedicated right turn pocket into the western access to St. Helen’s Road. Right turning into St. Helen’s Road at this location will still be permitted, albeit from the single general traffic lane.

At the junction of the Elmpark Green Development on Merrion Road, along with providing a protected junction for cyclists the arrangement proposes the removal of the left turn slip lanes into and out of the development, as well as introducing a new pedestrian crossing on the western arm.

The Proposed Scheme includes works at the junction of Merrion Road and Strand Road (‘Merrion Gates’), including the provision of segregated cycle facilities, the removal of the slip lane from Strand Road to Merrion Road (southbound) and the control of traffic exiting Strand Road utilising traffic signals. On the southern arm of the junction, a strip of parallel parking spaces is proposed on the outbound side.

The existing cut stone masonry archway located outside the Telford Nursing Home on the Merrion Road at the Merrion Gates junction will be carefully dismantled and re-erected at the back of the proposed footpath.

Between the Strand Road junction and Elm Court, it is proposed to provide a three-lane carriageway along this section with a footpath and cycle track in both directions. The carriageway will comprise two general traffic lanes (one in each direction) and one outbound bus lane. Priority for inbound buses will be provided via signal controlled priority at the Merrion Gates junction. A strip of parallel parking spaces is proposed to be provided on the outbound side in the vicinity of No. 264 to No. 270 Merrion Road.

The cross-section proposed between St. Vincent’s University Hospital and Estate Avenue has been designed so as to minimise the extent of necessary land acquisition. The existing cut stone masonry archway (referred to as the Bloomfield Gate) located outside the Gas Networks Ireland (GNI) Above Ground Installation (AGI) between 133-145 Merrion Road (former Gowan Motors site) and St. Vincent’s University Hospital will, however, need to be relocated due to the proposed road widening. It will be carefully dismantled and re-erected in an adjacent area along the northern boundary of St. Vincent’s University Hospital, sited within the existing hedge fronting onto the plaza at the junction of Merrion Road and Nutley Lane.

At the access junction to St. Vincent’s University Hospital from Merrion Road, it is proposed to reduce the radius of the existing left turn into St. Vincent’s University Hospital and remove the dedicated right-turn lane into Merrion Avenue in order to improve cyclist safety and reduce the necessary land acquisition, while achieving the objectives of the Proposed Scheme.

3.1.3 Section 3: R118 Merrion Road (Nutley Lane to Ballsbridge)

R118 Merrion Road

The R118 Merrion Road from Nutley Lane to Sandymount Avenue is sub-divided into three portions by its main junctions with Ailesbury Road and Shrewsbury Road.

A four-lane cross-section is proposed between Nutley Lane and Ailesbury Road. On the outbound approach to Nutley Lane, it is proposed to provide a bus priority signal at the pedestrian crossing between Ailesbury Road and Nutley Lane.

This will permit buses accessing Nutley Lane to move into the right turn general traffic lane and complete their manoeuvre from this lane. This in turn facilitates continuous bus and cycle lanes along Merrion Road southbound through the junction.

Between Ailesbury Road and Shrewsbury Road, it is proposed to provide a three-lane carriageway along this stretch of Merrion Road with a footpath and cycle track in each direction and partial bus lanes in opposite directions. The carriageway cross-section will comprise of two general traffic lanes (one in each direction) and one bus lane. The bus lane will be inbound (northbound) on the northern half of this stretch of Merrion Road (approaching Shrewsbury Road) and outbound (southbound) on the southern half of this stretch of Merrion Road (approaching Ailesbury Road). Signal controlled priority will be implemented to give buses priority along the stretch of road that buses share with general traffic. The direction in which the bus lanes travel changes in the vicinity of Wanderers Rugby Football Club (WFC). From WFC to Shrewsbury Road, only an inbound bus lane will be provided, while from WRC to Ailesbury Road, only an outbound bus lane is proposed. This will permit the retention of a number of existing trees and avoids the requirement for land acquisition from a number of properties in the vicinity of the Dutch Embassy.

The section between Shrewsbury Road and Sandymount Avenue is proposed as a four-lane carriageway with a bus lane and a general traffic lane in both directions. There are a number of mature trees located along the footway on this section of road and the proposed layout is such that it retains a number of trees where practicable.

A small section of land acquisition is proposed within the grounds of the Clayton Hotel Ballsbridge, Merrion Road, whereby a new footpath and cycle track is proposed to run behind the existing trees at this location, with these trees to be retained. This will require land acquisition of a portion of the grass frontage and the realignment of a section of the boundary wall and railing of this property.

Also, along this section of Merrion Road, it is proposed to reduce the proposed footpath and cycle track widths locally in certain locations which aids in the retention of a number of trees. This locally reduces footpaths to a minimum width of 1.2m and cycle tracks to a minimum width of 1.4m over the short length of each pinch point.

Ballsbridge

The proposed road layout between Sandymount Avenue and Anglesea Road comprises a four-lane carriageway with a bus lane and a general traffic lane in both directions, and includes the removal of the traffic islands on Merrion Road at Serpentine Avenue with associated widening of the proposed footpath.

The left slip road from Merrion Road to Anglesea Road is proposed to be removed, with the relocation of the existing vehicular access to the City of Dublin

Educational and Training Board (CDETB) premises on the corner of the junction to a new proposed vehicular access on Anglesea Road.

The proposed access into the CDETB premises has been positioned to minimise the impact on historic railings. A new internal roadway arrangement is proposed as a result within the CDETB premises.

Entry to Ballsbridge Avenue from Ballsbridge Park is proposed to be located at the current exit, while a new exit to the north is proposed, taking cognisance of the extent to which Ballsbridge Park is a private road.

This will remove the requirement for vehicles to turn right onto Beatty's Avenue from the R118 in Ballsbridge Village.

On the eastern side of the Dodder River, it is proposed to provide a two-way cycle track from Anglesea Road to Beatty's Avenue connected by a toucan Crossing on the R118 in Ballsbridge Village. This integrates with the proposed Dodder Greenway.

3.1.4 Section 4: Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street Lower)

Ballsbridge Village

At the Ballsbridge Village junction of Shelbourne Road, Herbert Park and Elgin Road, it is proposed to introduce a left turn only entry into Elgin Road from Ballsbridge. At this junction, the re-alignment of the Herbert Park arm has been designed so as to minimise the impact on adjacent properties and to retain a number of existing trees to the east of the junction.

Pembroke Road

On Pembroke Road, from Elgin Road to Northumberland Road, 2m wide cycle tracks are proposed where practicable. It is proposed to reduce the width of the cycle tracks to 1.5m in places, in order to facilitate the retention of a number of existing trees along this section of Pembroke Road.

At the junction of Pembroke Road, Northumberland Road and Lansdowne Road, a right turn lane will be introduced from Pembroke Road onto Lansdowne Road to replace the right turn movement at Ballsbridge Junction (Pembroke Road to Shelbourne Road) that will be removed. The western approach to the junction will be reduced from two lanes to one lane. The existing slip lane which currently allows inbound traffic to bypass the junction, will be removed, resulting in all traffic being brought up to the junction to turn left on to Pembroke Road towards Baggot Street Upper. The existing kiosk which is currently located on the existing splitter island on the south-western corner of the junction will be relocated nearby to the new proposed urban realm as part of the proposed works. Any existing services to the existing kiosk will be retained at the new location.

A single bus gate is proposed on Pembroke Road, between the Eastmoreland Place and Waterloo Road junctions. This bus gate will ensure that the only traffic utilising Pembroke Road (during the hours of operation) will be local traffic with a destination on or close to Pembroke Road, as well as through buses and authorised vehicles.

This removes the need for four traffic lanes including dedicated bus lanes along this section of Pembroke Road resulting in a cross-section of a general traffic lane in each direction and a cycle track in each direction, i.e. inbound and outbound buses will use the two general traffic lanes. This reduced quantum of lanes avoids any permanent land take along Pembroke Road which means that existing trees will be retained, with some on-street parking also retained. The existing footpath width along this section of the Proposed Scheme will also be retained and/or widened where practicable.

Access to Pembroke Road, between Northumberland Road and Eastmoreland Place, during the hours of operation of the proposed bus gate, will be maintained via the Lansdowne Road junction. Local access will also be maintained via Eastmoreland Place, Wellington Road and Raglan Road. Offline traffic management measures at Clyde Lane and at the Herbert Park / Pembroke Park junction are also proposed to prevent through traffic diverting inappropriately.

Baggot Street Upper

Along Baggot Street Upper, it is proposed to reduce the width of the existing carriageway. This is facilitated through the proposed installation of the bus gate at the western end of Pembroke Road with a short section of bus lane between the Eastmoreland Place and Waterloo Road junctions.

Eastbound general traffic on Baggot Street Upper will not be permitted to access Pembroke Road and vice versa for westbound traffic on Pembroke Road during the hours of operation of the proposed bus gate. Consequently, the existing right-turn lane from Baggot Street Upper to Waterloo Road will be retained and the existing straight-ahead general traffic lane towards Pembroke Road can be converted to a bus lane. The proposal includes providing dedicated cycle tracks through the Baggot Street Upper retail area while improving the urban realm. Some loading and parking will be retained in the Baggot Street Upper retail area with additional / compensatory parking / loading provided where practicable.

At the Macartney Bridge (Baggot Street Bridge), where Baggot Street Lower meets Baggot Street Upper, it is proposed to widen the existing footpaths on both sides of the bridge and introduce cycle tracks on both sides of the carriageway on the bridge. It is also proposed to reduce the number of lanes to one general traffic lane in each direction crossing the bridge which allows for the provision of improved widths for pedestrians and cyclists crossing the canal.

At Baggot Street Upper on the inbound approach to the Mespil Road junction, it is proposed to reduce the number of lanes at the junction from four to two. Signal controlled priority will be provided approaching the Mespil Road junction, where inbound (northbound) buses will be allowed to cross the bridge ahead of other traffic.

Baggot Street Lower

Along Baggot Street Lower, it is proposed to provide a bus lane in each direction, a general traffic lane in each direction, a cycle track in each direction and a footpath on both sides of the road.

A similar signal controlled priority facility to that on Baggot Street Upper will be provided for buses travelling outbound from Baggot Street Lower to Upper. In order to optimise the operation of this arrangement, left and right turn bans are proposed from Herbert Place and Wilton Terrace respectively onto Macartney (Baggot) Bridge, as well as a right turn ban from Mespil Road onto Baggot Street Upper.

In order to maintain the existing historical lighting columns and the majority of existing trees located in the median, it is proposed to retain the existing median along Baggot Street Lower.

Some recessed parking bays are proposed on both sides of the road where practicable. A new toucan crossing is proposed on Baggot Street Lower near the school (Scoil Chaitríona).

Fitzwilliam Street Lower

Along Fitzwilliam Street Lower the proposed cross-section will provide a bus lanes and a general traffic lane in each direction, together with cycle tracks in each direction. No land acquisition will be required to provide this cross-section, however, it requires the removal of all parking along this section.

This main alignment of the Proposed Scheme ends at the junction of Fitzwilliam Street Lower with Mount Street Upper / Merrion Square South / Merrion Square East where it ties in with the existing environment.

3.1.5 Section 5: Nutley Lane (R138 Stillorgan Road to R118 Merrion Road)

This alignment of the Proposed Scheme ties in with the existing signalised junction of the R138 Stillorgan Road and Nutley Lane. Proposed works to this junction include removing the existing left turn slip lane from Nutley Lane to the R138 Stillorgan Road, and providing a new two-way cycle crossing across the R138 Stillorgan Road on the eastern arm of the junction. Between the R138 Stillorgan Road and Nutley Road, a four lane cross-section is proposed, with a bus lane and a general traffic lane in each direction. It is proposed that a two-way cycle track will be provided on the eastern side of Nutley Lane, continuing north past the entrance to Elm Park Golf & Sports Club. This proposed cross-section includes the requirement for land acquisition from the properties currently occupied by RTÉ and Eir.

Between the entrance to Elm Park Golf & Sports Club and the entrance to St. Vincent’s University Hospital, no footpath is proposed on the Elm Park Golf & Sports Club side of road, however, a toucan crossing will be provided just north of the access to Elm Park Golf & Sports Club. The proposed two-way, 3.0m wide, cycle track will continue on the Elm Park Golf & Sports Club side of Nutley

Lane, as far as the St. Vincent’s University Hospital access junction. The existing footpath and verge on the north-western (residential) side of this stretch of Nutley Lane, is proposed to be retained, which in turn allows the trees on this side of the road to also be retained.

No land acquisition of any residential houses along this stretch of Nutley Lane will be required, however, to achieve the proposed cross section, land acquisition from the Elm Park Golf & Sports Club as well as St. Vincent’s University Hospital will be required.

Boundary treatments at RTÉ and St. Vincent’s University Hospital will match existing. The existing hedgerow and fencing at Elm Park Golf & Sports Club will be replaced with a reinforced concrete wall with climbing vegetation (e.g. ivy) planted on the road side, and a hedgerow reinstated on the golf course side.

Toucan Crossings are proposed at the St. Vincent’s University Hospital access junction to connect the two-way cycle track to the single cycle tracks to the north.

At the access junction to St. Vincent’s University Hospital, a right turn lane into the hospital is proposed which requires a curtailment of the receiving southbound bus lane in order to mitigate potential impact on the operation of internal roadways within the hospital. Southbound bus priority will be enabled through signal controlled priority provided on the northern arm.

From the access junction to St. Vincent’s University Hospital to the junction of Nutley Lane with Merrion Road, the proposed cross-section comprises four lanes, including a bus lane and a general traffic lane in each direction with a single cycle track in each direction also. To achieve the proposed cross section along this stretch of Nutley Lane, land acquisition from the Merrion Shopping Centre as well as St. Vincent’s University Hospital will be required.

3.2 Associated Infrastructure Projects and Developments

The Proposed Scheme will interface with the following under-construction or proposed developments:

3.2.1 Maldron Hotel at Former Tara Towers

This project includes a four-star Maldron hotel with 140 rooms, a restaurant, bar, and meeting facilities being constructed on the former Tara Towers hotel site on Merrion Road. The Proposed Scheme ties in with the proposed boundary and footpath works along Bellevue Avenue at this location.

3.2.2 Blackrock Park Masterplan 2020

A detailed plan has been proposed for Blackrock Park, undertaken by DLRCC Parks Section (with input from other departments within DLRCC) and it includes specific upgrades to the Booterstown DART Station junction and the integration with Blackrock Park. The Proposed Scheme integrates with the proposals for pedestrian and cycling connectivity at this location.

3.2.3 143 Merrion Road (Former Gowan Motors Site)

A private developer has received planning permission from An Bord Pleanála to build 63 apartments at 143 Merion Road on the site formerly occupied by Gowan Motors in Dublin 4. The required road widening at this location associated with the Proposed Scheme has been coordinated with the proposals for this site.

3.2.4 National Maternity Hospital

Planning permission has been granted to build a new national maternity hospital on the site of St Vincent's University Hospital campus. The associated works include the reconfiguration of the access junctions on Nutley Lane and Merrion Road. The Proposed Scheme has been coordinated with the proposals for this site at these junctions.

3.2.5 Dodder Greenway at Ballsbridge

Plans are being developed by DCC for the Dodder Greenway, with the Ballsbridge (Beatty's Avenue to Herbert Park) section being particularly relevant to the Proposed Scheme. Coordination has been carried out between the BusConnects Infrastructure team and DCC on the potential integration opportunities, with the Proposed Scheme including a toucan crossing at this location and portions of two-way cycle tracks.

In the potential interim scenario whereby the Dodder Greenway infrastructure is not in place on Anglesea Road in advance of the Proposed Scheme, minor refinements to kerb extents and line markings relating to the proposed two-way cycle track here shall be implemented on Anglesea Road to tie-in with the existing environment.

3.2.6 ESB Headquarters on Fitzwilliam Street Lower

A new Headquarters for the ESB, is being constructed (and nearing completion at the time of writing) on Fitzwilliam Street Lower in the first block to the south of Merrion Square. The Proposed Scheme has been coordinated with the proposals for this site along this frontage.

3.2.7 East Coast Trail (Sutton to Sandycove Greenway)

The East Coast Trail forms part of a proposed National Cycle Network (NCN), which identifies a network of 13 national cycle routes. NCN Corridor 5 runs along the East Coast from Rosslare through Dublin to the border with Northern Ireland and onward to Belfast and Larne. The Sutton to Sandycove (S2S) Greenway section of the East Coast Trail will interact with the Proposed Scheme between the Merrion Road / Strand Road junction and the Merrion Road / Booterstown DART Entrance junction.

As a result, the Proposed Scheme includes a two-way cycle track on the coast side of Merrion Road between Strand Road and Booterstown DART Entrance to accommodate the S2S section of the East Coast Trail and avoids cyclists travelling on the greenway in either direction from having to cross the road to continue on the East Coast Trail as it interacts with the Proposed Scheme.

3.3 Integration

As part of the Preliminary Design of the Proposed Scheme, consideration has been given to the potential coordination required in relation to other schemes within the BusConnects CBC Infrastructure Works. This section outlines potential interactions of the Proposed Scheme with adjacent scheme(s) and identifies any procedures within the construction strategies that may be required in order to account for various sequencing scenarios in the construction of the schemes.

The closest such scheme to the Proposed Scheme is the Bray to City Centre CBC Scheme, with which the Proposed Scheme interacts at the signalised junction of the R138 Stillorgan Road and Nutley Lane (henceforth referred to as the subject junction).

The BCID Infrastructure Team has coordinated the design tie-ins to ensure a holistic design has been achieved, so that each scheme can be implemented, and integrated, regardless of the sequencing of their construction.

The Proposed Scheme intends to tie-in with the subject junction at the Nutley Lane arm in terms of main carriageway, cycle facilities and footpaths, with some minor interventions required at the junction associated with a new two-way cycle crossing facility. Figure 3.1 shows an extract of the preliminary design of the Proposed Scheme at the subject junction.

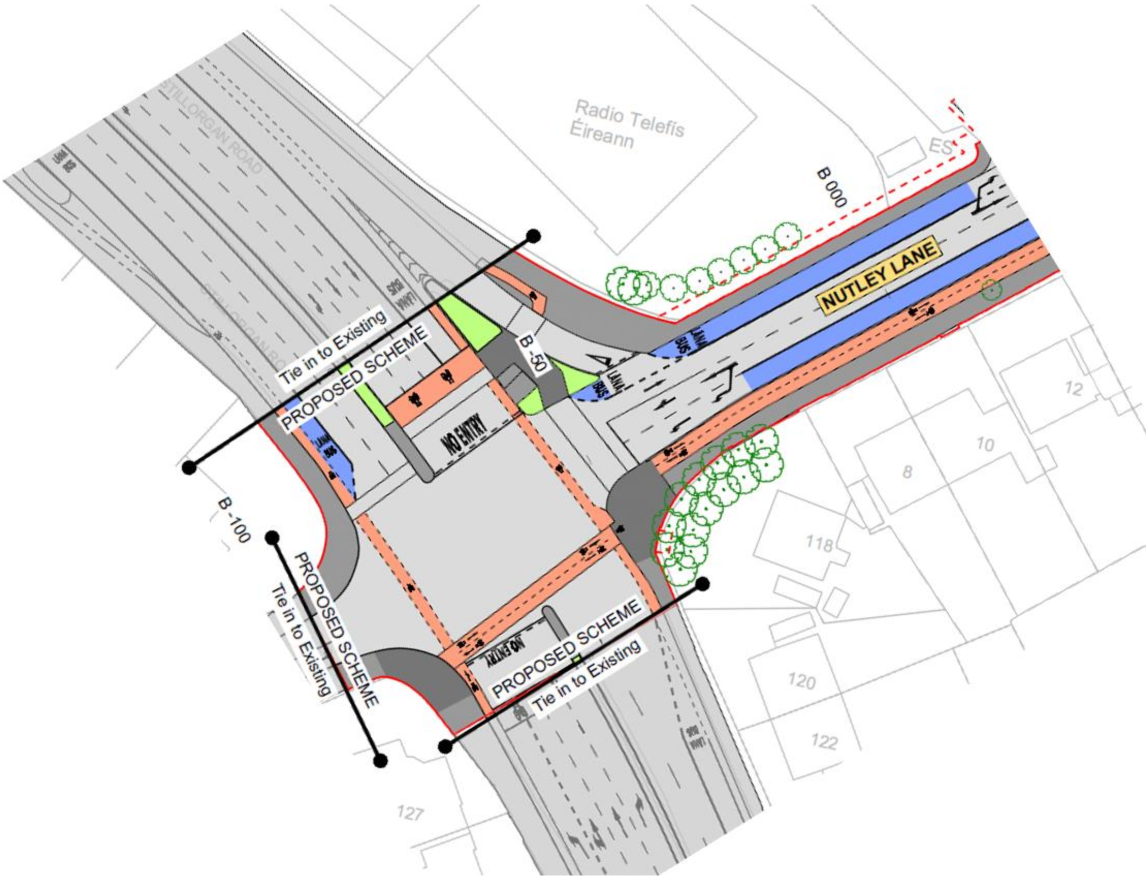


Figure 3.1: Preliminary design of the Proposed Scheme tie-in with the Bray to City Centre Core Bus Corridor Scheme

The Bray to City Centre CBC Scheme proposes significant amendments to the existing junction to bring it in line with the BCPDGB, i.e. bus infrastructure, protected junction for cyclist principles, pedestrian crossing amendments etc. Figure 3.2 shows an extract of the latest design (at the time of writing) of the Bray to City Centre CBC Scheme at the subject junction.

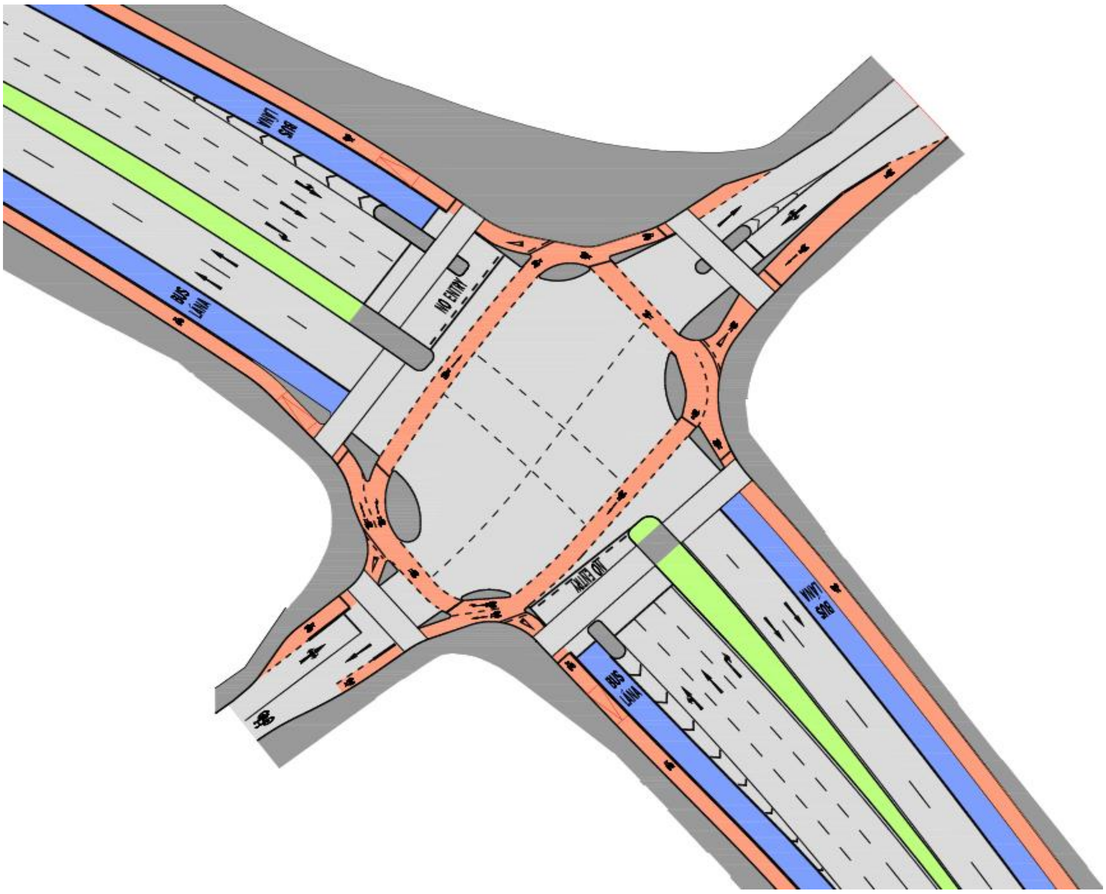


Figure 3.2: Preliminary design of the Bray to City Centre Core Bus Corridor scheme at the subject junction

Figure 3.3 shows an indicative coordinated design of the expected overall arrangement in a scenario in which both schemes have been implemented.

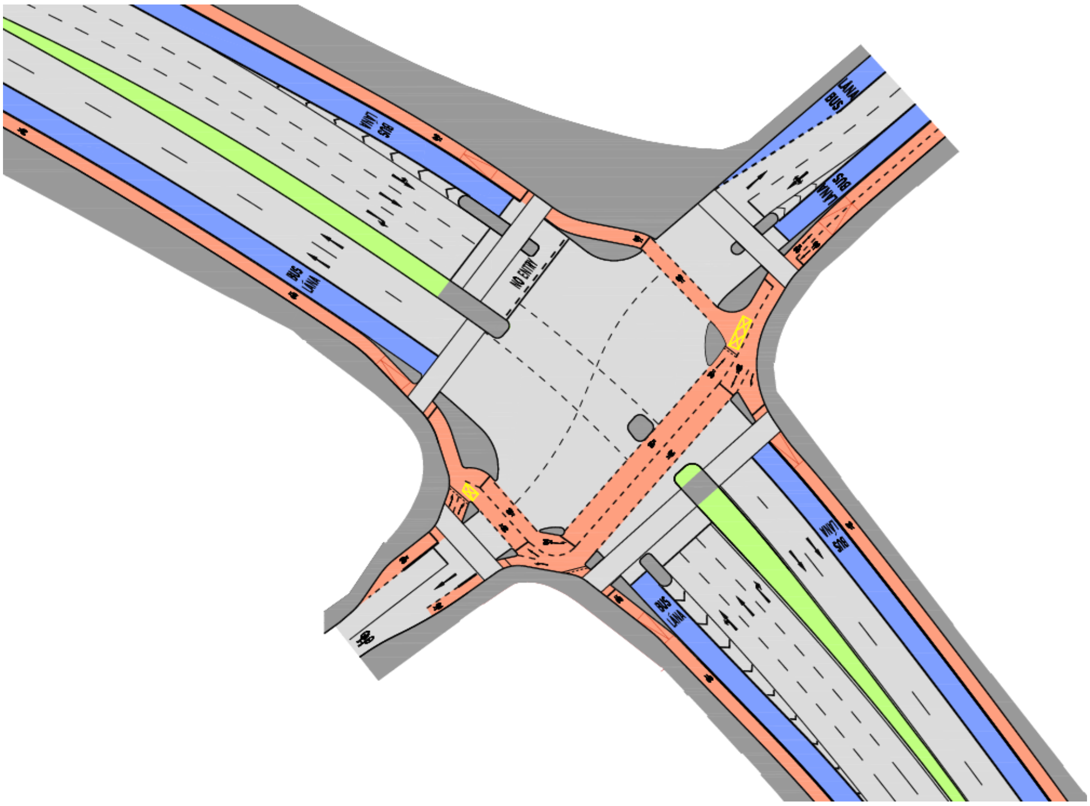


Figure 3.3: Preliminary design of the expected overall arrangement of the Proposed Scheme and the Bray to City Centre Core Bus Corridor

The Bray to City Centre CBC Scheme is subject to a separate planning process, the timing of which is largely independent of that of the Proposed Scheme, and as such no exact sequencing of construction works can be determined at this stage. Table 3.1 presents a matrix of potential interactions and impacts associated with various potential sequencing scenarios in relation to construction and operation of both schemes.

It is considered that access / egress to / from the southern of the two existing driveways of No. 118 Stillorgan Road will need to be amended restricted to pedestrian and cycling access only as part of both the Proposed Scheme and the Bray to City Centre CBC Scheme works, and as such shall be included within the CPO process for both.

Table 3.1: Matrix of potential interactions and impacts associated with different sequencing scenarios

	Bray to City Centre CBC Scheme: Not Yet Commenced	**Bray to City Centre CBC Scheme: Under Construction**	**Bray to City Centre CBC Scheme: Completed**
Proposed Scheme: Not Yet Commenced	N/A	Construction of the Bray to City Centre CBC Scheme shall be carried out in accordance with the Construction Strategy within that scheme's planning application, without any potential interaction with works associated with the Proposed Scheme. The works shall take place within the Red Line Boundary of same and tie-in with the existing environment on Nutley Lane.	The Bray to City Centre CBC Scheme shall be in full operation, designed in accordance with its planning application. Nutley Lane shall remain unchanged, in terms of physical infrastructure, outside of the Bray to City Centre CBC Scheme's Red Line Boundary.
Proposed Scheme: Under Construction	Construction of the Proposed Scheme shall be carried out in accordance with the Construction Strategy within that scheme's planning application, without any potential interaction with works associated with the Bray to City Centre CBC Scheme. The works shall take place within the Red Line Boundary of same and tie-in with the existing environment at the subject junction.	The R138 Stillorgan Road is likely to be required as a route for construction traffic serving the Proposed Scheme, including the route via the subject junction. Therefore, the Bray to City Centre CBC Scheme works could potentially impact upon access for construction traffic if there are significant temporary traffic management (TTM) interventions along the R138 Stillorgan Road. Similarly, portions of the Proposed Scheme, including Nutley Lane, could form part of the required construction traffic route for the Bray to City Centre CBC Scheme, and significant TTM interventions could hinder construction traffic accessibility to that scheme. As such, works at Nutley Lane would need to be coordinated according to the construction timelines of the two schemes.	The Bray to City Centre CBC Scheme will have been completed including the proposed upgrade of the subject junction. A common tie-in point has been determined approximately 40m from the existing stop line on the Nutley Lane arm, up to which the Proposed Scheme works will be constructed as per the coordinated design shown in Figure 3.3. In this scenario it is not envisaged that any significant abortive works will be required, aside from minor works associated with footpath, cycle track, and pavement tie-ins.

	Bray to City Centre CBC Scheme: Not Yet Commenced	**Bray to City Centre CBC Scheme: Under Construction**	**Bray to City Centre CBC Scheme: Completed**
		It is considered that there is sufficient flexibility in the proposed construction programmes to either align (tie-in) construction works here or keep activities staggered to occur at different stages in the programme. The approach taken will need to be determined based on detailed traffic management proposals, which will be coordinated between schemes once the start dates and detailed construction programmes are confirmed. A common tie-in point has been determined approximately 40m from the existing stop line on the Nutley Lane arm. In the scenario whereby construction of both schemes is being carried out in tandem at the subject junction, the works associated with the Proposed Scheme south of the agreed tie-in point would not need to be constructed.	
Proposed Scheme: Completed	The Proposed Scheme shall be in full operation, designed in accordance with its planning application. The subject junction shall remain unchanged, in terms of physical infrastructure, outside of the Bray to City Centre CBC Scheme's Red Line Boundary.	The Proposed Scheme will have been completed up to and including the interventions at the subject junction. As noted previously, the Bray to City Centre CBC Scheme proposes significant interventions at the subject junction, and as such any works carried out by the Proposed Scheme within the confines of the junction will be considered abortive and will be removed as part of the construction work on the Bray to City Centre CBC Scheme. A common tie-in point has been determined approximately 40m from the existing stop line on the Nutley Lane arm, up to which the Bray to City Centre CBC Scheme works will be constructed as per the coordinated design shown in Figure 3.3.	Both schemes shall be in full operation in accordance with each planning application and the arrangement will reflect the coordinated design shown in Figure 3.3.

	Bray to City Centre CBC Scheme: Not Yet Commenced	Bray to City Centre CBC Scheme: Under Construction	Bray to City Centre CBC Scheme: Completed
	Works to the subject junction shall include amendments up to and including the stop line on the Nutley Lane arm, and additional road markings and traffic signals associated with a new two-way cycle crossing across the eastern arm of the junction.		

4 Road Geometry

The following chapter outlines the process by which the geometrical design of the Proposed Scheme was undertaken. This chapter discusses the design speed, cross-section, horizontal and vertical alignment design, stopping sight distance, alignment modelling, active travel provision and corner radii and swept path of the Proposed Scheme.

4.1 Principal Geometric Parameters

The BCPDGB in Appendix O has been used to form the basis of design. Section 2.2 of this PDR lists the standards referenced within the BCPDGB.

The road geometry design of the Proposed Scheme was undertaken in accordance with the Design Manual for Urban Roads and Streets (DMURS) as published by the Department for Transport, Tourism and Sport (DTTAS).

For urban roads with a proposed speed limit equal to or greater than 60 km/h the design was undertaken in accordance with the Transport Infrastructure Ireland (TII) current design publications. In particular, adherence to the following standards is the basis of the Design:

- DN-GEO-03031 – Rural Road Link Design
- DN-GEO-03036 – Cross-sections and Headroom
- DN-GEO-03060 – Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)
- DN-GEO-03044 – 2009 TII addendum to UK DMRB TD 50/04 - Geometric Layout of Signal Controlled Junctions and Signalised Roundabouts

The BCPDGB has also been used to form the basis of the design.

The Proposed Scheme requires the reconfiguration of the existing carriageway and where practicable the existing geometry has been maintained to respect the existing site constraints. Where the existing road geometry does not meet the above design standards this has been highlighted within Section 4.17.

Table 4.1 summarises the key geometric design parameters applicable to all urban roads designed in accordance with DMURS contained within the Proposed Scheme.

Table 4.1: Geometric Design Parameters for Urban Roads designed to DMURS

Road Type	Design Speed (km/h)	Minimum Curve Radius (m) without Super-elevation	Minimum Curve Radius (m) with 2.5% Super-elevation	Minimum Longitudinal Gradient (%)	Maximum Gradient (%)	Minimum Sag Curve Value (K)	Minimum Crest Curve Value (K)
Urban Road with 30 km/h Speed Limit	30	26	-	0.5	5	2.3	N/A
Urban Road with 50 km/h Speed Limit	50	104	82	0.5	5	6.4	4.7
Urban Road with 60 km/h Speed Limit	60	187	136	0.5	5	9.2	8.2

4.2 Accessibility for Mobility Impaired Users

The Proposed Scheme will include the provision of enhanced walking and cycling infrastructure along the route.

The design process has included an Accessibility Audit of the existing road corridor environment, which is enclosed in Appendix I. The audit provided a description of the key accessibility features and potential barriers to mobility impaired people based on good practice, and identified the following issues to be addressed in the design process:

- Accessible Parking - On-street Disabled Parking Space layout should be to the appropriate standard, with dropped kerb access between the parking space and footpath;
- Access Routes on Footpaths - Width of footpaths should be clear of clutter, such as street furniture, and allow unimpeded access for the mobility impaired, and in doing so, meet the minimum standards for widths;
- Drainage - All footpaths should have sufficient cross-fall for drainage purposes but without affecting the ability of mobility-impaired people to move safely along the corridor;
- Guardrails - Guardrails should be located only where needed for safety purposes – and care should be taken not to create narrow spaces which create difficulties for movement;
- Pedestrian Crossing Points - Pedestrian crossing points should be laid out in accordance with standards and make it convenient and safe for mobility impaired users to negotiate crossing of carriageways;
- Controlled and Uncontrolled Crossings - Controlled and Uncontrolled Crossings should have tactile paving laid out correctly to provide tactile and visual assistance to mobility-impaired users approaching crossing points;
- Changes in Level - Any changes in level should be addressed in the design process to ensure that all changes in level, where practicable, comply with standards;
- Shared pedestrian/cyclist areas - Shared pedestrian/cyclist areas should be well laid out, with clear visual and tactile elements included, to ensure that these areas are safe for mobility-impaired users, pedestrians and cyclists;
- Surface Material - Footpath materials should be selected to ensure surfaces are free of undulations, with no trip hazards where there is a transition between surface materials – or where the Proposed Scheme ties into the existing infrastructure; and
- Street Furniture - All poles for signs and street lighting should be carefully located to minimise the effect on the safe and convenient passage of pedestrians and cyclists, with due cognisance to the safe movement of mobility impaired users.

The assessment of the existing street infrastructure and its ability to support access for disabled users have been based mainly on the Irish Wheelchair Association [IWA] '*Best Practice Guidelines, Designing Accessible Environments*' and The National Disability Authority's [NDA] '*Building for Everyone: A Universal Design Approach*'.

4.3 Mainline Cross-section (Lane Widths)

4.3.1 Design Guidance and Requirements

All the roads contained within the Proposed Scheme are urban in location and setting. The proposed road cross-sections were developed based on the guidance outlined in DMURS and DN-GEO-03036. For roads with a design speed of 60 km/h or less, traffic lane widths follow the guidance outlined in DMURS, with the preferred minimum width of traffic lanes on Proposed Scheme being:

- 3.0m in areas with a posted speed limit ≤ 60 km/h; and
- Traffic lane widths of 2.75m are permissible in DMURS but are not desirable. Reduced lane widths have only been applied on straight road sections with very low HGV traffic and where all desirable minimum widths for footpaths, cycle tracks, parking, bus lanes are not achievable without impact on third-party land.

For roads designed to DMURS, bus lanes widths are a minimum of 3m as detailed in the BCPDGB.

Figure 4.1 summarises the optimum road cross-section, while Table 4.2 presents the geometric cross-section requirements for roads design to the BCPDGB.

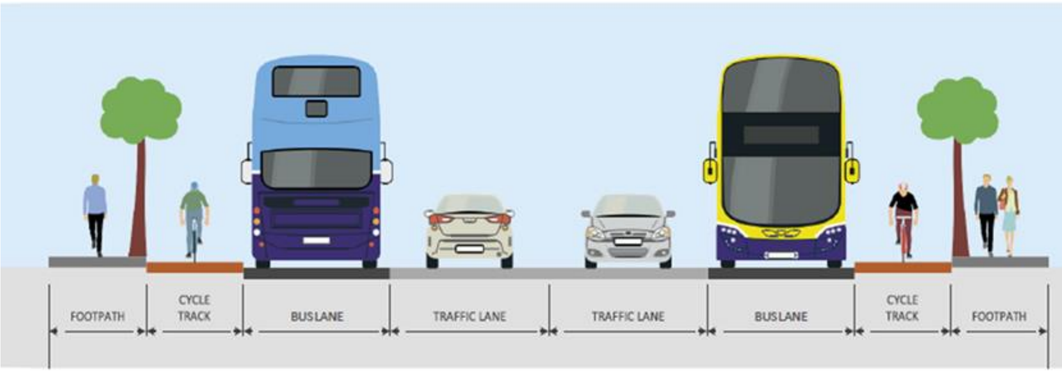


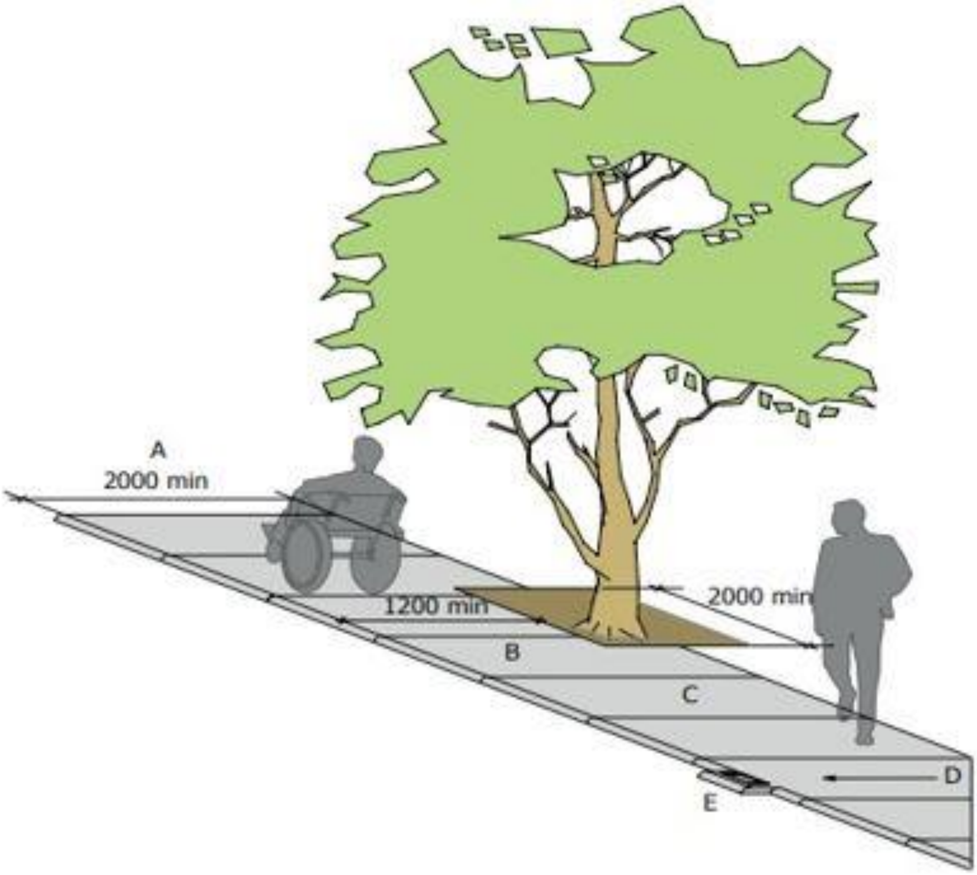
Figure 4.1: Optimum CBC Infrastructure Works Cross-section for this section comprising a traffic lane, bus lane, cycle track and footpath in each direction

The National Cycle Manual (NCM) indicates the desirable minimum width for a single-direction, with-flow, raised-adjacent cycle track is 2.0m which includes a 0.25m kerb. This arrangement allows for two-abreast cycling. Based on the NCM Width Calculator this allows for overtaking within the cycle track. The minimum width is 1.5m, which, based on the NCM Width Calculator, allows for single file cycling. Localised narrowing of the cycle track below 1.5m may be necessary over very short distances to cater for local constraints (e.g. mature trees).

The desirable minimum width for a two-way cycle track is 3.25m. In addition to this, a desirable minimum buffer of 0.5m, with an absolute minimum of 0.3m, should be provided between the two-way cycle track and the carriageway. Using the NCM width calculator, reduction of these desirable minimum widths can be considered on a case-by-case basis, with due cognisance of the volume of cyclists anticipated to use the route as well as the level of service required.

The preferred arrangement for a two-way cycle track is for cyclists to ‘cycle on the left’. This is contrary to the current guidance provided in the National Cycle Manual, which recommends that the with-flow cyclist be placed closest to traffic to reduce relative speeds (i.e. a ‘cycle on the right’ regime). Notwithstanding this, a ‘cycle on the left’ regime is considered best practice in terms of legibility and has been successfully implemented on a number of projects in Ireland to date (e.g. Grand Canal Cycleway, Royal Canal Cycleway and S2S at Clontarf). This arrangement has been implemented on the Proposed Scheme. Refer to Table 4.2 for cycle track widths recommended by DMURS.

DMURS indicates a 2m wide footpath as the recommended limit / desirable minimum width. This width should be increased in areas catering for significant pedestrian volumes where space permits. DMURS defines the absolute minimum footway width for road sections as 1.8m based on the width required for two wheelchairs to pass each other. At specific pinch points, Building for Everyone: A Universal Design Approach, defines acceptable minimum footpath widths as being 1.2m wide over a 2m length of path (Figure 4.2). This minimum of 1.2m allows one wheelchair to pass. Refer to Table 4.2 for footpath widths recommended by DMURS.



Key

A. 2000mm minimum to allow two wheelchairs to pass each other
B. Width reduced to 1200mm minimum for not more than 2m in length around existing obstructions
C. Gradient should either be level along its length or should be gently sloping or incorporate ramp or ramps in accordance with building standards
D. Crossfall gradient not more than 1:50
E. Drainage gratings offset from access route where possible

Figure 4.2: Recommended absolute minimum footpath widths allowable over a short section

Table 4.2: BCPDGB Cross-Section Design Parameters

Design Element	Desirable Minimum	Absolute Minimum	Permitted Reductions at Constraints
Footpath	2.0m	1.8m	1.2m over a 2m length of path (2)
Cycle Track (one-way)	2.0m	1.5m	Local narrowing below 1.5m may be necessary over short distances to cater for local constraints
Cycle Track (two-way)	3.25m+ 0.5m (buffer)	Refer National Cycle Manual width calculator. 0.3m (buffer)	
Bus Lane	3.0m	N/A	N/A
Traffic Lane	Preferred Width: 3.0m where speed ≤ 60 km/h 3.25m where speed limit > 60 km/h	2.75m (3)	Matches

1) Deviations from the desirable minimum parameters in the table have been tabulated in Appendix C.
2) Building for everyone: A Universal Design Approach.
3) Traffic lane widths of 2.75m are permissible but not desirable and should only be permitted on straight road sections with very low HGV percentage and where all desirable minimum widths for footpaths, cycle tracks, parking, bus lanes are not achievable without impacting on third-party lands.

4.3.2 Proposed Design

The geometric design of the Proposed Scheme has been sub-divided into Alignments A to B to account for the Blackrock to the City Centre alignment string (Alignment A) and Nutley Lane alignment string (Alignment B).

Section 1: Stradbrook Road to Booterstown Avenue

The width of the existing carriageway along Temple Hill/Temple Road will be maintained (Ch. A+000 to A+525) with two general traffic lanes converted to two bus lanes, one in each direction. The new cross-section will comprise a 2.5m wide footpath, a 2.2m wide cycle track, a 3.0m wide bus lane and a 3.0m wide traffic lane inbound, a 2.7m wide median and a 2.0m wide footpath, a 2.0m wide cycle track, a 3.0m wide bus lane and a 3.0m wide traffic lane outbound.

The width of the existing carriageway along Frascati Road will be maintained (Ch. A+525 to A+1140), with the cross-section being 1.0m wide verge, a 1.8m wide footpath, a 3.0m wide bus lane and a 3.0m traffic lane inbound, a 2.0m wide median, a 3.0m wide traffic lane, a 3.0m wide bus lane, a 2.0m cycle track and a 1.8m wide footpath outbound.

The proposed carriageway along Rock Road (Ch. A+1140 to A+2850) will be widened into Blackrock Park, Blackrock Clinic, Blackrock College and the car park opposite Willow Terrace to accommodate the following cross-section: a 2.0m wide footpath, a 2.0m wide cycle track (reducing on both sides to 1.5m in front of Blackrock College), a 3.0m wide bus lane and a 3.0m wide traffic lane both inbound and outbound.

Section 2: Booterstown Avenue to Nutley Lane

The proposed carriageway along the R118 Merrion Road, between Trimleston Avenue and Elmpark Green (Ch. A+2850 to A+3130) will be widened into adjacent lands, Merrion House and the associated car park and property in between to accommodate the following cross-section: a 2.0m wide footpath, a 2m wide cycle track, a 3.0m wide bus lane and a 3.0m wide traffic lane inbound with a 2.0m wide footpath, a 3.5m wide two way cycle track, a 3.0m wide bus lane and a 3.0m wide traffic lane outbound.

From Elmpark Green to Strand Road (Ch A+3130 to A+3450) the width of the existing carriageway will be maintained. The width of the inbound footpath will vary from 2.0m to 4.2m, with a 2.0m cycle track (widening at the Strand Road junction to tie into the two way cycle track opposite), a 3.0m wide bus land and a 3.0m wide traffic lane. Right turning pockets are provided into Elmpark Green and Strand Road, separated by a hatched area. Outbound the footpath is generally 2.0m wide minimum, widened in places, with a 3.5m wide two way cycle track, a 3.0m wide bus lane and a 3.0m wide traffic lane.

The width of the existing carriageway is maintained between numbers 183 and 165 Merrion Road (Ch A+3450 to A+3550) providing in the outbound direction a footpath with a minimum width of 2.0m, a 1.5m wide cycle track and a 3.0m wide traffic lane. On the outbound direction the existing footpath width (circa 3.2m) will be maintained to ensure that the existing trees are maintained, a new 1.5m wide cycle track will be provided, a 3.0m wide bus lane (converting to a left turn general traffic lane on approach to Strand road) and a 3.0m wide traffic lane.

On the section of Merrion Road between Elm Court Apartments and Nutley Lane (Ch A+3550 to A+4000) land take is proposed from the following properties: the open green area in front of Elm Court Apartments, the front gardens of numbers 151, 153, 155 and 157 Merrion Road, the former Gowen Motors site, the GNI AGI site and St Vincent’s University Hospital. This land take facilitates the following cross-section: both inbound and outbound a 2.0m (minimum) wide footpath, a 1.5m wide cycle track, a 3.0m wide bus lane and a 3.0m traffic lane with a short right turn pocket from Merrion Road to St Vincent’s Hospital.

Section 3: R118 Merrion Road (Nutley Lane to Ballsbridge)

On the section of the R118 Merrion Road between Nutley Lane and Ailesbury Road (Ch A+4000 to A+4300) land take is proposed from the green area outside the Merrion Shopping Centre and from Merrion View to accommodate the following cross-section: a 2.0m wide (minimum) footpath, a 2.0m wide cycle track, a 3.0m wide out bound bus lane and a 3.0m wide traffic lane in both directions.

On the section of Merrion Road between Ailesbury Road and Shrewsbury Road (Ch +4300 to A +4900) no land take is proposed. The cross-section will comprise 2.0m wide (minimum) footpaths on both sides with 1.5m wide cycle tracks on both sides, two number 3.0m wide traffic lanes and one 3.0m wide bus lane. The bus lane is outbound from Wanderers Rugby Club to Ailesbury Road and inbound from Wanderers Rugby Club towards Shrewsbury Road.

From Shrewsbury Road to Simmonscourt Road (Ch A + 4900 to A + 5200) land-take is proposed from the grounds of the Clayton Hotel. The cross-section will comprise two 2.0m wide (minimum) footpaths, two 3.0m wide bus lanes and two 3.0m wide traffic lanes.

From Simmonscourt Road to Shelbourne Road (Ch A +5200 to A + 5850) the cross-section comprises two footpaths with minimum widths of 2.0m, two 2.0m cycle tracks, two 3.0m wide bus lanes and two 3.0m wide traffic lanes. There is a short section of two way cycle track between Anglesea Road and Beatty's Avenue to tie into the proposed Dodder Cycle Route.

Section 4: Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street Lower)

From Shelbourne Road to Pembroke Road/Lansdowne Road (Ch A+5850 to A + 6200) the cross-section comprises two footpaths, two cycle tracks with 1.5m widths minimum, two 3.0m wide bus lanes and two 3.0m wide traffic lanes.

From Pembroke Road/Lansdowne Road to Waterloo Road (Ch A + 6200 to A + 6730) both existing widths of footpath are retained and there are two 2.0 m wide cycle tracks with two 3.0m wide traffic lanes.

Between Waterloo Road and Haddington Road (Ch A + 6730 to A + 6900) a bus gate will be located at the junction of Baggot Street Upper and Waterloo Road on Baggot Street Upper. The cross-section will comprise maintaining the two existing footpaths with two 2.0m wide cycle tracks, two 3.0m wide bus lanes (loading bays and disabled parking spaces in lieu of outbound bus lane between number 10 and number 20 Baggot Street Upper) and two 3.0m wide traffic lanes.

Between Haddington Road and Herbert Place (Ch A + 6900 to A + 6950) the two existing footpaths on the bridge will be widened and two number 2.0m wide cycle tracks and two number 3.0m wide traffic lanes will be provided.

Between Herbert Place and Fitzwilliam Street Lower (Ch A + 6950 to A + 7300) the cross-section will generally comprise two footpaths (minimum width 2.0m), two cycle tracks (minimum width 2.0m), two 3.0m wide bus lanes, two 3.0m wide traffic lanes with a central median.

On Fitzwilliam Street Lower the cross-section will generally comprise two footpaths (minimum width of 2.0m), two 2.0m cycle tracks, two 3.0m wide bus lanes and two 3.0m wide traffic lanes.

Section 5: Nutley Lane (R138 Stillorgan Road to R118 Merrion Road)

On Nutley Lane (Ch B -50 to B + 600) the cross-section will comprise a footpath (minimum width of 2.0m0 on the north side of the road, a 3.0m wide two way cycle track on the south side of the road, two number 3.0m wide bus lanes and two number 3.0m wide cycle tracks.

On the section of Nutley Lane between the entrance to St. Vincent's University Hospital and Merrion Road (Ch B +600 to B + 810) the cross-section will comprise two number footpaths (minimum width 2.0m), two number 2.0m wide cycle tracks, two number 3.0m wide bus lanes and two number 3.0m wide traffic lanes.

A detailed scheme breakdown of the relevant existing and proposed road cross-section elements is provided in Table 4.3. These tables provide information on the existing facilities for pedestrians, cyclists, bus lanes and general traffic lanes between junctions along the route. A detailed description of the existing and proposed junction arrangements are provided in Chapter 5. The table is intended to provide supplementary information alongside the information presented on the General Arrangement (GEO_GA), Typical Cross-sections (GEO_CS) and Pavement Treatment Plans (PAV_PV) available in Appendix B.

Where the Proposed Scheme cross-section parameters do not satisfy the desirable criteria set out within this section this is considered a deviation from standard. Refer to Section 4.17 for details of Deviations from Standard. Where the footpath width is less than the desirable minimum at tie-in to existing, these are noted in the Deviations from Standard table in Appendix C and not in Table 4.3.

Table 4.3: Proposed Scheme vs Existing Nominal Cross-section Widths

Chainage Reference	Existing Inbound Carriageway / Proposed Inbound Carriageway				Existing Outbound Carriageway / Proposed Outbound Carriageway				Existing Conditions Notes / Proposed Scheme Notes
	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	
(Alignment A) Montpelier Place to Frascati Road - Temple Road									
CH. A+000 to CH. A+525	**2m – 2.6m**	**2m cycle lane**	**N/A**	**2 x 3m lanes**	**2m-2.5m**	**1.6m – 2m cycle lane**	**N/A**	**2 x 3m lanes**	No inbound/outbound bus lane in the existing conditions, with sections of raised adjacent cycle facilities inbound and outbound, along with cycle lanes. Central medians ranging from 0.9m to 5m.
	2.5m – 3m	2m cycle track segregated	3m	1 x 3m lane	2m	2m cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Right turning lanes provided at junctions. Central medians ranging from 0.9m to 5m.
(Alignment A) Temple Road to Rock Hill - Frascati Road									
CH. A+525 to CH. A+1140	**1.8m - 2.9m**	**1.7m – 2m cycle lane**	**N/A**	**2 x 3m lanes**	**1.9m - 2m**	**1.7m – 2m cycle lane**	**N/A**	**2 x 3.m lanes**	No inbound/outbound bus lane in the existing conditions, with sections of raised adjacent cycle facilities inbound and outbound, along with cycle lanes.
	1.8m – 4m	2m cycle track segregated	3m	1 x 3m lane	1.8m – 2m	2m cycle track segregated	3m	1 x 3m lanes	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Central median ranging from 1.5m to 5m.

Chainage Reference	Existing Inbound Carriageway Proposed Inbound Carriageway				Existing Outbound Carriageway Proposed Outbound Carriageway				Existing Conditions Notes Proposed Scheme Notes
	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	
(Alignment A) Rock Hill to Trimlestown Avenue - Rock Road									
CH. A+1140 to CH. A+2850	**1.8m - 3.2m**	**1.2m - 1.5m**	**3m / 1.6m shared with cycle lane**	**1 x 3m / 2 x 3m lanes**	**2m – 3m**	**1.4m - 1.7m**	**2.5m - 3m / 1.6m shared with cycle lane**	**1 x 3m lane / 2 x 3m lanes**	On road cycle lanes provided in both directions with cycle lanes terminating and transitioning to shared facility with bus lanes (white line segregated).
	1.8m – 3m	1.5m – 2m cycle track segregated	3m	1 x 3m lane	1.8m – 3m	1.5m – 2m cycle track segregated / 3m - 3.5m two way cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Two-way cycle track on outbound side commencing at Ch. A+2400.
(Alignment A) Trimlestown Avenue to Elmpark Green – Merrion Road									
CH. A+2850 to CH. A+3130	**2.5m - 3.2m**	**N/A**	**N/A**	**2 x 3m lanes**	**2.6m – 3.2m**	**Shared with bus lane**	**3m**	**1 x 3m lane**	On road cycle lanes provided in outbound direction shared with bus lanes (white line segregated).
	2m – 2.8m	1.5m – 1.2m cycle track segregated	3m	1 x 3m lane	1.8m – 2.8m	3m two way cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Two-way cycle track continuing on outbound side.
(Alignment A) Elmpark Green to Strand Road – Merrion Road									
CH. A+3130 to CH. A+3450	**2.5m – 3m**	**Shared with bus lane**	**3.8m - 4m**	**2 x 3m lanes**	**2.6m – 3m**	**Shared with bus lane**	**3.7m – 4m**	**1 x 3m / 2 x 3m lanes**	On road cycle lanes provided in both directions with cycle lanes in shared facility with bus lanes (white line segregated).

Chainage Reference	Existing Inbound Carriageway Proposed Inbound Carriageway				Existing Outbound Carriageway Proposed Outbound Carriageway				Existing Conditions Notes Proposed Scheme Notes
	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	
	2m - 4.2m	2m cycle track segregated	3m	1 x 3m / 2 x 3m lanes	2m - 4.2m	3.2m – 3.5m two way cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Right turn lane provided onto Strand Road. Two-way cycle track continuing on outbound side, ending at the junction with Strand Road at Ch. A +3425.
(Alignment A) Strand Road to Elm Court Apartments – Merrion Road									
CH. A+3450 to CH. A+3550	**1.8m – 2.2m**	**Shared with bus lane**	**3m**	**1 x 3.5m lane**	**2.3m-2.6m**	**N/A**	**3.5m part time bus lane**	**1 x 3m lanes**	Time plated outbound bus lane / clearway.
	2m – 2.8m	1.5m segregated	N/A	1 x 3m lane	2m-3.6m	1.5m segregated	3m	1 x 3m / 2 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Right turn lane provided onto Strand Road. Outbound bus lane becomes left turning lane at Strand Road Junction.
(Alignment A) Elm Court Apartments to Nutley Lane – Merrion Road									
CH. A+3550 to CH. A+4000	**1.8m – 3m**	**shared with bus lane**	**3m**	**1 x 3m lane**	**2.8 m-3m**	**shared with bus lane**	**3m**	**1 x 3m lane**	Cycle facilities largely shared with bus lane. Left turning slip lanes inbound at junctions.
	2-4m	1.5m cycle track segregated	3m	1 x 3m lane	2m	1.5m cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction.
(Alignment A) Nutley Lane to Ailesbury Road – Merrion Road									
CH. A+4000 to CH. A+4300	**3.5m – 4.5m**	**shared with bus lane**	**2.5m – 3m**	**1 x 3m lane**	**2m – 5m**	**1m cycle lane / shared with bus lane**	**3m**	**1 x 3m lane**	Cycle facilities largely shared with bus lane or consisting of on road cycle lanes. Right turning lane outbound at Nutley Lane Junction.

Chainage Reference	Existing Inbound Carriageway Proposed Inbound Carriageway				Existing Outbound Carriageway Proposed Outbound Carriageway				Existing Conditions Notes Proposed Scheme Notes
	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	
	2m – 2.5m	2m cycle track segregated	3m	1 x 3m lane	2m	2m cycle track segregated	3m	1 x 3m lanes	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Right turn lane outbound approach to Nutley Lane. 2m wide pedestrian refuge at mid-block crossing at Sydney Parade Avenue.
(Alignment A) Ailesbury Road to Shrewsbury Road – Merrion Road									
CH. A+4300 to CH. A+4900	2.5m – 4.2m	shared with bus lane	3.5m	1 x 3m lane	2m-5m	1.2m – 1.4m cycle lane	N/A	1 x 3m lane	On road cycle lanes provided in outbound with inbound cycle lane in shared facility with bus lanes. No outbound bus lane at this location.
	2.9m – 4.7m	1.5m cycle track segregated	0m / 3m	1 x 3m lane	2m-4m	1.5m cycle track segregated	0m / 3m	1 x 3m lane	Inbound bus lane from junction Shrewsbury Road to before junction Merlyn Road, outbound bus lane from junction with Merlyn Road to junction with Ailesbury Road. Cycle track width locally narrowed in a number of locations in order to retain existing semi-mature trees.
(Alignment A) Shrewsbury Road to Simmonscourt Road – Merrion Road									
CH. A+4900 to CH. A+5200	4.5m	shared with bus lane / 1.3m	3.5m	1 x 3m lane	2.5m – 4m	1.5m cycle lane	N/A	1 x 3m lane	On road cycle lane provided in outbound direction with inbound cycle lane in shared facility with bus lanes. No outbound bus lane at this location.
	2m	1.5m – 2m cycle track segregated	3m	1 x 3m / lane	2m – 3m	2m cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Grass verge segregation between bus lane and cycle lane on inbound approach to Simmonscourt Road junction, width 1.8m. Cycle track width locally narrowed in a number of locations in order to retain existing semi-mature trees.

Chainage Reference	Existing Inbound Carriageway Proposed Inbound Carriageway				Existing Outbound Carriageway Proposed Outbound Carriageway				Existing Conditions Notes Proposed Scheme Notes
	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	
(Alignment A) Simmonscourt Road to Shelbourne Road – Merrion Road									
CH. A+5200 to CH. A+5850	**2.4m-3.5m**	**shared with bus lane /1.2m**	**0m / 3.5m**	**1 x 3m / 3 x 3m lanes**	**3m-4m**	**shared with bus lane /1.4m**	**0m / 3.5m**	**1 x 3.2m / 2 x 3m lanes**	Cycle facilities largely shared with bus lane or consisting of on road cycle lanes. Intermittent bus lanes along this section.
	2m – 3.5m	2m cycle track segregated	3m	1 x 3m lane	2m - 3.5m	2m cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Turning lanes and a central median / pedestrian refuge (4m width) provided west of Ballsbridge Ave Junction. Short section of two way cycle track between Anglesea Rd and Beatty's Ave to tie into the Dodder Cycle Route.
(Alignment A) Shelbourne Road to Landsdowne Road – Pembroke Road									
CH. A+5850 to CH. A+6200	**2.7m – 4.7m**	**N/A**	**3m**	**1 x 3m lane**	**2.9m – 4.6m**	**N/A**	**3m**	**2 x 3m lane**	No designated cycle lanes. No existing bus lanes.
	3m – 4m	1.5m – 2m cycle track segregated	3m	1 x 3m / lane	3m - 4m	1.5m – 2m cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction. Turning lanes provided at junctions.
(Alignment A) Lansdowne Road to Waterloo Road – Pembroke Road									
CH. A+62-00 to CH. A+6730	**2.8m – 4m**	**N/A**	**N/A**	**1 x 3m – 4m lane**	**3m – 4.8m**	**N/A**	**N/A**	**1 x 3m - 4m**	No designated cycle lanes. Central median width of 1.5m – 3m. Lane widths flare towards Lansdowne Road Junction.
	2m – 5m	2m cycle track segregated	N/A	1 x 3m lane	3m – 4.8m	2m cycle track segregated	N/A	1 x 3m lane	A bus gate will be located at the junction of Baggot Street Upper and Waterloo Road. No proposed physical bus lanes due to bus priority through implementation of bus gate.

Chainage Reference	Existing Inbound Carriageway / Proposed Inbound Carriageway				Existing Outbound Carriageway / Proposed Outbound Carriageway				Existing Conditions Notes / Proposed Scheme Notes
	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	
(Alignment A) Waterloo Road to Haddington Road – Baggot Street Upper									
CH. A+6730 to CH. A+6900	**3.3m – 7.5m**	**N/A**	**N/A**	**2 x 3m lanes**	**4.5m 5m**	**1.1m partial cycle lane**	**N/A**	**2 x 3m lanes**	No designated cycle facilities inbound. No existing bus lanes.
	3.3m – 8m	2m cycle track segregated	3m	1 x 3m lane	3m – 7.5m	2m cycle track segregated	0m / 3m	1 x 3m lane	Extensive urban realm enhancements proposed in Baggot Street Upper retail area.
(Alignment A) Haddington Road to Herbert Place – Baggot Street Upper									
CH. A+6900 to CH. A+6950	**1.5m**	**N/A**	**N/A**	**2 x 3.2m lane**	**1.5m**	**N/A**	**N/A**	**2 x 3.2m lane**	No designated cycle lanes. No existing bus lanes.
	2.5m	1.5m cycle track segregated	N/A	1 x 3.2m lane	2.5m	1.5m cycle track segregated	N/A	1 x 3.2m lane	Improved pedestrian traffic by widening footpaths across the bridge.
(Alignment A) Herbert Place to Fitzwilliam Street Lower – Baggot Street Lower									
CH. A+6950 to CH. A+7300	**2.7m - 4m**	**N/A**	**N/A**	**1 x 5.5m lane**	**3m – 5.2m**	**N/A**	**N/A**	**2 x ~2.6m lanes**	Central median throughout. No designated cycle lanes. No existing bus lanes.
	2m – 3m	2m cycle track segregated	3m	1 x 3m lane	2m – 4m	2m cycle track segregated	3m	1 x 3m lane	Central median retained. Bus lanes in each direction. Segregated Cycle Tracks in each direction.
(Alignment A) Baggot Street Lower to Merrion Square - Fitzwilliam Street Lower									
	2m-2.5m	**N/A**	**N/A**	**1 x 3.5m lane**	**2m**	**N/A**	**N/A**	**1 x 3.5m lane**	No segregated cycle facilities (noting recent COVID-19 Mobility Measures introduced by DCC as a trial scheme). No existing bus lanes.

Chainage Reference	Existing Inbound Carriageway Proposed Inbound Carriageway				Existing Outbound Carriageway Proposed Outbound Carriageway				Existing Conditions Notes Proposed Scheme Notes
	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	Footway width (m)	Cycle lane/ Track Width (m)	Bus Lane Width (m)	Traffic Lane Width (m)	
CH. A5250 to CH. A6000	2m -2.5m	2m cycle track segregated	3m	1 x 3m lane	3m	2m cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Segregated Cycle Tracks in each direction.
(Alignment B) R138 Stillorgan Road to St. Vincent's University Hospital – Nutley Lane									
CH. B-50 to CH. B+600	**2m – 3.4m**	**N/A**	**N/A**	**1 x 4.4m lane**	**2.8m – 3.7m**	**N/A**	**N/A**	**1 x 4.4m lane**	No designated cycle lanes. No existing bus lanes.
	2m – 2.3m	N/A	3m	1 x 3m lane	2m-2.5m	3m two way cycle track segregated	3m	1 x 3m lane	Bus lanes in each direction. Footpath removed from approximately Elm Park Golf & Sports Club to St. Vincent's University Hospital with appropriate signalised crossings provided. Two-way cycle track proposed on eastern side. Inbound right turning lane provided on approach to St. Vincent's University Hospital.
(Alignment B) St. Vincent's University Hospital to Merrion Road – Nutley Lane									
CH. B+600 to CH. B+810	**3.2 m – 4.5m**	**N/A**	**N/A**	**1 x 4m lanes**	**2.3m – 6m**	**N/A**	**N/A**	**1 x 4m lanes**	No designated cycle lanes. No existing bus lanes.
	2m	2m cycle track segregated	3m	1 x 3m lanes	2m	2m cycle track segregated	3m	1 x 3m lanes	Bus lanes in each direction. Segregated Cycle Tracks in each direction.

4.4 Design Speed and Speed Limits

As outlined in DMURS '*Design speed is the maximum speed at which it is envisaged/intended that the majority of vehicles will travel under normal conditions*'. Therefore, the design speed proposed for urban roads is aligned with the proposed speed limit.

For regional roads (R113 Temple Hill, R118 Rock Road / Merrion Road / Pembroke Road, R816 Pembroke Road / Baggot Street Upper / Baggot Street Lower, and Fitzwilliam Street Lower) and National roads (N31 Frascati Road dual carriageway) the design speed is based on the proposed speed limit. The current speed limit on the Proposed Scheme is 50km/h, with the exception of Baggot Street Lower and Fitzwilliam Street Lower which are both currently located within the existing 30km/h Home Zone. It is not proposed to amend the speed limits throughout the Proposed Scheme. Therefore, the design speed is determined to be 50km/h for the majority of the Proposed Scheme and 30km/h for Baggot Street Lower and Fitzwilliam Street Lower.

The design speeds used for the proposed mandatory speed limits are detailed in Table 4.4.

Table 4.4: Maximum Design Speeds for Mandatory Speed Limits

Speed Limit km/h	Design Speed km/h	Design Standard
30	30	DMURS
50	50	DMURS
60	60	DMURS
50	60	DN-GEO-03031 (Regional roads only)
60	70	DN-GEO-03031 (Regional roads only)
80	85	DN-GEO-03031 (National roads only)

Table 4.5 indicates the speeds limits proposed for all roads within the Proposed Scheme.

Table 4.5: Proposed Scheme speed limits and design speeds

Road Name	Road Type	Design Speed (km/h)	Proposed Speed Limit (km/h)	Existing Speed Limit (km/h)	Reason for speed limit change
Temple Hill	Urban Arterial	50	50	50	n/a
Temple Road (N31 Section)	National	50	50	50	n/a

Road Name	Road Type	Design Speed (km/h)	Proposed Speed Limit (km/h)	Existing Speed Limit (km/h)	Reason for speed limit change
Frascati Road (N31 Section)	National	50	50	50	n/a
Rock Road	Urban Arterial	50	50	50	n/a
Merrion Road	Urban Arterial	50	50	50	n/a
Pembroke Road	Urban Arterial	50	50	50	n/a
Baggot Street Upper	Urban Arterial	50	50	50	n/a
Baggot Street Lower	Urban Arterial	30	30	30	n/a
Fitzwilliam Street Lower	Urban Arterial	50	50	50	n/a
Nutley Lane	Urban Arterial	50	50	50	n/a

4.5 Alignment Modelling Strategy

As part of preliminary design, the 3D road alignment design has been developed on the principles of the Preferred Route Option. The proposed alignment has also taken into consideration public consultation, traffic impact and environmental impact assessments, in addition to a peer review exercise in collaboration with the other Engineering Designers (EDs) for the Proposed Scheme.

The 3D highway design, including the horizontal and vertical alignments, 3D modelling corridors and the associated highways related design features required for all roads included in this preliminary design, has been developed using Civil 3D software. In collaboration with the other EDs for the other CBC schemes, the 3D models have been produced in accordance with the BusConnects BEP.

As part of the alignment design process, the horizontal and vertical design has been optimised to minimise impact to the existing road network and adjoining properties where feasible. Horizontal and vertical alignments have been developed to define the road centrelines for the proposed route layout while also taking cognisance of the existing road network.

In terms of the horizontal alignments, due consideration has been given to aligning the centrelines as close to existing as practicable. However, the overriding determining factor for locating the horizontal alignment is to ensure it is positioned in the centre of the proposed carriageway.

This is ideally along a central lane marking on the carriageway, in order to minimise rideability issues for vehicles crossing the crown line.

In the case of developing the vertical alignment along the route, a refinement process has been undertaken to minimise any impact to existing road network and develop the proposed carriageway levels as close to existing as practicable. In most circumstances however, due to a change in cross-section, due consideration is given to the resulting level difference at the outer extents of the carriageway, particularly through urban areas where a difference in existing and proposed footpath levels will require additional temporary land-take to facilitate tie-in.

Existing ground levels have been obtained using a triangulated surface (the existing ground model) produced from the topographical survey covering the route. This existing ground model is used to inform the differences in levels between the proposed and existing ground while at the scheme boundary it is also used to ensure an appropriate means of tie-in to existing levels. Furthermore, at junctions linking to existing side roads, the existing ground model is used to determine dwell area gradients and lengths to facilitate junction realignment.

The developed alignment design sets parameters for development of other design elements such as drainage, determination of earthworks, utility/services placement etc.

4.6 Summary of Horizontal Alignment

Existing alignments and crossfalls along the Proposed Scheme have been generally retained wherever practical. DMURS provides the following guidance in relation to modifications of existing arterial and link road geometry:

- *Designers should avoid major changes in the alignment of Arterial and Link streets as these routes will generally need to be directional in order to efficiently link destinations.*
- *Major changes in horizontal alignment of Arterial and Link streets should be restricted to where required in response to the topography or constraints of a site.*

In some areas, minor adjustments is required to the horizontal alignment to deliver the requisite width to ensure the provision of the necessary traffic lanes, bus lanes, cyclist and pedestrian facilities which would also allow the drainage of surface water into new/relocated road gullies.

In areas where road widening and minor changes to the horizontal alignment was not pracitcable due to constraints (environmental, residential, geometrical etc.), new construction has been provided to ensure the provision of continuity of design throughout the scheme.

In light of the above, the horizontal alignment of the mainline is generally as per the existing parameters and surveys. The alignment of the scheme is generally compatible with the selected design speed and associated safe stopping sight distances.

The Proposed Scheme commences on the southern side of the Monkstown Road junction with Temple Hill and continues northwest towards the city centre terminating at Merrion Square, as well as including Nutley Lane. The horizontal alignment of the Proposed Scheme generally follows the horizontal alignment of the existing carriageways.

Generally all carriageways have been designed in camber with a fall of 2.5% from the centreline of the road. Superelevation has been applied where the proposed curve radius is below the minimum values specified in Section 4.1 above. In a small number of locations crossfalls/superelevation have been implemented to match existing scenario where the geometry allows, to minimise the impact of the Proposed Scheme on the existing network.

In the sections from Monkstown Road to Mount Merrion Avenue (along the Rock Road) the existing road crossfalls have been maintained as far as practicable to minimise the impact on the central median which accommodates a level change between the inbound and outbound lanes, as well as minimising impact on footpaths, driveways and existing drainage and utility apparatus.

In the sections from the Baggot Street Upper / Haddington Road junction to the end of the Proposed Scheme at Merrion Square, the existing crossfalls have been maintained and the existing kerb lines and heights have largely be retained at the edge of existing footpath, due to the historic nature of the antique granite paving slabs in this area.

4.7 Summary of Vertical Alignment

Due to the nature of the proposed design i.e. the majority of the design proposals involve widening of the existing roadway in order to accommodate additional facilities, every effort has been made to ensure the vertical alignment adheres as closely as possible to the existing arrangement.

DMURS defines the vertical alignment of a road as follows:

“A vertical alignment consists of a series of straight-line gradients that are connected by curves, usually parabolic curves. Vertical alignment is less of an issue on urban streets that carry traffic at moderate design speeds and changes in vertical alignment should be considered at the network level as a response to the topography of a site.”

Visibility concerns associated with adverse vertical crest and sag curves along the have not been identified on the Proposed Scheme due to the nature of the existing urban road network. Notwithstanding, the vertical alignment of the proposed road development has also been assessed to ensure hard standing areas have been designed above the minimum gradient of 0.5% to mitigate localised surface water ponding and facilitate surface run-off drainage measures.

All vertical alignments have been designed using the appropriate set of design guidelines/standards as outlined in Section 4.1.

The vertical geometry of the Proposed Scheme takes cognisance of the existing road layout and, particularly through highly constrained locations, the proposed vertical alignment has been developed to match the existing route.

In instances where the desirable minimum parameters defined by the appropriate guidance have not been met, these locations have been detailed within Section 4.17 Deviations from Standard.

4.8 Forward Visibility

Forward visibility (or Stopping Sight Distance, SSD) has been assessed along the extent of the proposed route against the criteria outlined within the relevant applicable standards of DMURS and TII DN-GEO-03031 for the design speeds listed in Section 4.4.

The desirable minimum forward visibility requirements has been achieved across the majority of the Proposed Scheme. Where the desirable minimum forward visibility requirements will not be achieved, details are provided in Deviations from Standard, refer to Section 4.17.

Table 4.6 summarises the key geometric design parameters applicable to all urban roads designed in accordance with DMURS.

Table 4.6: Forward Visibility/SSD Parameters for roads designed to DMURS

Road Type	Design Speed (km/h)	Forward visibility (m)	Forward visibility on Bus Routes (m)
Urban Road with 30 km/h Speed Limit	30	2.3	N/A
Urban Road with 50 km/h Speed Limit	50	6.4	4.7
Urban Road with 60 km/h Speed Limit	60	9.2	8.2

4.8.1 Junction Visibility

An assessment of visibility at major and minor junctions has been completed along the route. In accordance with DMURS, the SSD parameters for relevant design speeds has been adopted as the Y-Distance visibility to be achieved while an X-Distance of 2.4m (reduced to 2.0m as a relaxation) has been implemented.

An assessment of the junction visibility at accesses serving individual properties and single dwellings has been undertaken, ensuring that the existing visibility splay “X” and “Y” are maintained or improved.

4.8.2 Junction Intervisibility

In the absence of DMURS guidance with respect to visibility at signalised junctions, the principles and parameters of 'Junction Intervisibility' from DN-GEO-03044 (The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts) has been adopted as a benchmark to assess the intervisibility at all signalised junctions.

As many of the junctions along the Proposed Scheme will involve retrofitting of the existing layout in an urban environment to provide additional NMU provisions in addition to the requirements to facilitate vehicle swept-paths, junction intervisibility will be impacted.

4.9 Corner Radii and Swept Path

Generally, on junctions along the Proposed Scheme corner radii of 6m has been implemented. 6m will generally accommodate the swept-path of the design vehicles along the route without the swept-path crossing the centre line of the intersecting road. However, in areas where swept-path analysis has identified constrained areas and larger vehicles are anticipated to make up a higher portion of the usage (i.e. bus lanes, HGV service areas etc.) the corner radii has been increased to 8 or 10m to facilitate this.

Although swept-path analysis is used to inform the junction design, it is not the determining factor.

There are a number of additional factors relating to the junction design which are considered in the overall methodology including junction intervisibility, speed of turning vehicles and in particular pedestrian safety. In line with the scheme objectives of improving facilities for walking and cycling, corner radii along the route have been reduced at some locations in order to lower the speed at which vehicles can turn corners and increase inter-visibility between users (see DMURS Section 4.3.3). Reduced corner radii also assist in the creation of more compact junctions which align crossing points with desire lines and reduce crossing distances.

At some of the larger signalised junctions where multi-lane entries are required, widening to the carriageway has been provided and location of the stop-lines have been placed to facilitate vehicular movements, however this has to be balanced with junction intervisibility. It is accepted that at minor type junctions and residential accesses that larger vehicles may have to cross the centreline however usage is expected to be infrequent.

A summary of the vehicles were used as part of the overall Swept Path Analysis are outlined below:

- **DB32 Private Car** – Analysis undertaken at private residential properties
- **DB32 Refuse Vehicle** – Analysis undertaken to ensure refuse vehicles can make turns in/out of all side roads and entries concerning residential/commercial properties

- **14.1m Double Decker Regional Bus** – Analysis undertaken along the main alignment of the route concerning bus lanes, including junctions.
- **Rigid Truck** – Analysis undertaken in the areas near shopping centres
- **FTA Design Articulated Vehicle (1998)** - Analysis undertaken in the areas near shopping centres
- **Ambulance** - Analysis undertaken in the areas near hospitals such as St. Vincent's University Hospital and Blackrock Clinic

Section 4.16 of this report details areas of turning bans along the Proposed Scheme.

4.10 Kerbing

The kerbing type selected along the Proposed Scheme is primarily dependent upon the presence of a cycle track alongside the carriageway. Where cycle tracks will be present adjacent to the carriageway, the cycle track will be separated by the typical 250mm wide BusConnects kerb, which will have a 120mm upstand to the carriageway and a 60mm upstand to the cycle track (120mm upstand where cycle track is not raised) as shown in Figure 4.3.

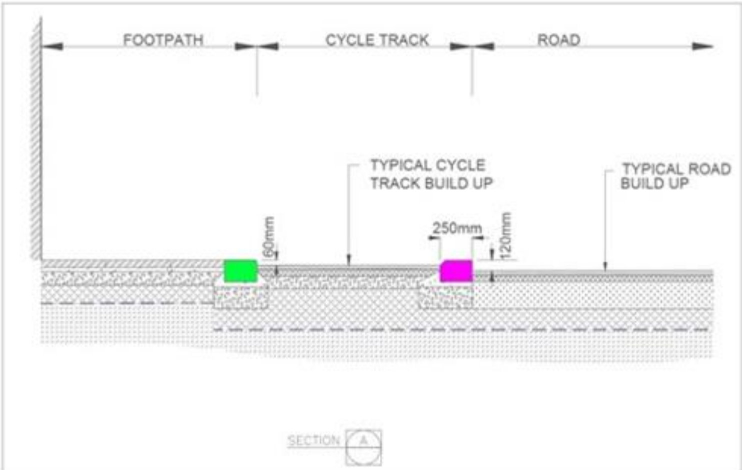


Figure 4.3: Typical Kerb Arrangement

Where this kerb will cross at an uncontrolled junction and at direct accesses, the Raised Table Priority Junction Treatment (Figure 4.4) will be implemented at the majority of locations. At these locations, the kerb will be lowered to a 60mm upstand while the cycle track will be raised throughout. At some locations, where it is necessary to retain the cycle track at carriageway level (e.g. due to cobblestone heritage feature), the kerb will transition to carriageway level and/or terminate as required.

At controlled and signalised junctions, the cycle track will be ramped down to the carriageway level and the kerb will be transitioned to carriageway level and terminated.

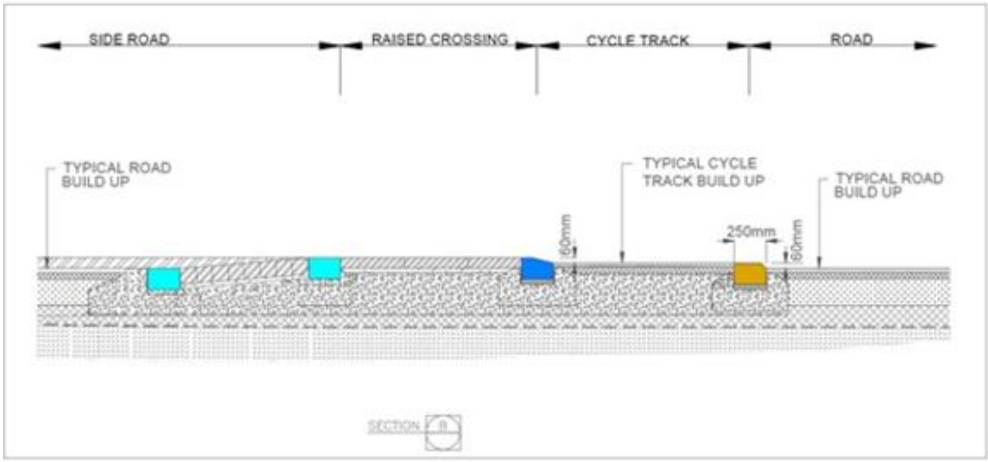


Figure 4.4: Kerb Treatment at Raised Table Priority Junction

At locations where a footpath will be located adjacent to a cycle track, a half battered kerb with a 60mm upstand is proposed. This 60mm high vertical kerb will be required to ensure that the kerb is properly detectable by visually impaired pedestrians using the footpath.

At locations where a cycle track is not present, and the footpath is adjacent to the carriageway, a standard 125mm upstand is proposed. Dropped and transition kerbs will be provided at driveways and pedestrian crossings.

Along certain sections of the route where heritage granite kerbing exists, it is proposed to maximise the retention of the existing kerbing where practicable as the outside edge of the footpath, with proposed cycle track being constructed alongside. This is the case in the Baggot Street and Fitzwilliam Street sections.

4.11 Bus Provision

One of the main objectives of the Proposed Scheme is to enhance the capacity and potential of the public transport system by improving bus speeds, reliability and punctuality through the provision of bus lanes and other measures to provide priority to bus movement over general traffic movements.

The proposed bus provision is shown on the General Arrangement drawings within Appendix B. This provision will increase the bus priority along the Proposed Scheme and is shown below as a percentage of the overall scheme length (8.31km)

Section 1 and 2

- 55% Existing bus priority (outbound)
- 45% Existing bus priority (citybound)
- 99% Proposed bus priority (outbound)
- 97% Proposed bus priority (citybound) *(2% virtual)*

Sections 3, 4, and 5

- 16% Existing bus priority (outbound)
- 33% Existing bus priority (citybound)
- 78% Proposed bus priority (outbound) *(remaining 22% virtual)*
- 81% Proposed bus priority (citybound) *(remaining 19% virtual)*

This increased bus priority will enhance the capacity and potential of the public transport system meeting one of the main objectives of this Proposed Scheme.

4.11.1 Full Bus Priority

Full Bus Priority uses a dedicated lane within the carriageway for the bus to travel unhindered from the general traffic. For full priority the provision will continue through junctions and remain unbroken for left turning traffic. Over the majority of the route, as per the guidance for traffic lane widths outlined in DMURS, a 3m lane will be provided for bus use only. Increased lane widths have been designed where the swept path of the bus requires a greater width to undertake the manoeuvre.

Where continuous bus lanes will not be provided due to constraints, measures such as signal controlled priority and bus gates are proposed to be introduced where feasible.

4.11.2 Signal Controlled Bus Priority

Signal Controlled Bus Priority uses traffic signals to enable buses to get priority ahead of other traffic on single lane road sections, but it is only effective for short distances. This typically arises where the bus lane cannot continue due to obstructions on the roadway. An example might be where a road has pinch-points where it narrows due to existing buildings or structures that cannot be demolished to widen the road to make space for a bus lane. It works through the use of traffic signal controls (typically at junctions) where the bus lane and general traffic lane must merge ahead and share the road space for a short distance until the bus lane recommences downstream. The general traffic will be stopped at the signal to allow the bus pass through the narrow section first and when the bus has passed, the general traffic will then be allowed through the lights.

The bullet points below presents descriptions of a number of the proposed signal controlled priority provisions within the Proposed Scheme which result in buses and general traffic sharing a lane:

- On Merrion Road, in the inbound direction only between the Merrion Gates junction and Elm Court Apartments – Approximately 100m length;
- Merrion Road between Ailesbury Road and Wanderers Rugby Football Club (WFC) (inbound) – Approximately 250m length;
- Merrion Road between Wanderers Rugby Football Club (WFC) and Shrewsbury Road (outbound) – Approximately 305m length;

- Macartney (Baggot) Bridge and Baggot Street Upper between Herbert Place and Baggot Street Upper retail area (inbound and outbound) – Approximately 90m length inbound and Approximately 145m length outbound; and
- On Nutley Lane in the southbound direction from the junction at St. Vincent's University Hospital – Approximately 70m length.

These instances are detailed within Table 4.7.

Table 4.7: Signal controlled bus priority locations

Location	**Reason for Mitigation**
Merrion Road / Strand Road [*Merrion Gates*] (Inbound)	To provide priority for buses through this constrained section taking cognisance of existing built form in close proximity to the carriageway, while also providing footpaths and cycle tracks.
Merrion Road / Ailesbury Road (Inbound)	To provide priority for buses through this constrained section taking cognisance of existing property boundaries and mature trees, while also providing footpaths and cycle tracks.
Merrion Road / Shrewsbury Road (Outbound)	To provide priority for buses through this constrained section taking cognisance of existing property boundaries and mature trees, while also providing footpaths and cycle tracks.
Baggot Street Upper / Haddington Road (Inbound)	To provide priority for buses through this constrained section taking cognisance of the constraints of the existing Macartney (Baggot) Bridge, while also providing footpaths and cycle tracks.
Baggot St Lower / Herbert Place (Outbound)	To provide priority for buses through this constrained section taking cognisance of the constraints of the existing Macartney (Baggot) Bridge, while also providing footpaths and cycle tracks.
Nutley Lane / St. Vincent's University Hospital (Outbound)	To provide priority for buses through this constrained section taking cognisance of the proposed cross-section (delayed onset of bus lane downstream of junction), while also providing footpaths and cycle tracks.

4.11.3 Bus Gate

A Bus Gate is a sign-posted short length of stand-alone bus lane. This short length of road is restricted exclusively to buses, taxis and cyclists plus emergency vehicles. It facilitates bus priority by removing general through traffic along the overall road where the bus gate is located. General traffic will be directed by signage to divert away to other roads before they arrive at the Bus Gate.

A bus gate is proposed on Pembroke Road between the junctions of Eastmoreland Place and Waterloo Road. This results in a shared lane in each direction for buses and general traffic on Pembroke Road between Eastmoreland Place and Northumberland Road (inbound and outbound) – which is approximately 480m in length.

This bus gate is proposed to operate from 06:00 to 20:00 and, as such, proposed line marking has been provided to enable outbound general traffic on Baggot Street Upper enter the bus lane and continue through the bus gate onto Pembroke Road outside of these hours. The adjacent general traffic lane is a right turn only lane onto Waterloo Road. This out-of-hours arrangement will operate on the same signal staging as when the bus gate is in operation.

4.12 Cycling Provision

One of the core objectives of the Proposed Scheme is to enhance the potential for cycling by providing safe infrastructure for cycling, segregated from general traffic wherever practicable. Physical segregation ensures that cyclists are protected from motorised traffic as well as being independent of vehicular congestion, thus improving cyclist safety and reliability of journey times for cyclists. Physical segregation can be provided in the form of vertical segregation, (e.g. raised kerbs), horizontal segregation, (e.g. parking/verge protected cycle tracks), or both.

The ‘preferred cross-section template’ developed for the Proposed Scheme consists of protected cycle tracks, providing vertical segregation from the carriageway to the cycle track and vertical segregation from the cycle track to the footpath.

The principal source for guidance on the design of cycle facilities is the National Cycle Manual (NCM), published by the National Transport Authority.

The desirable minimum width for a single-direction, with-flow, raised-adjacent cycle track is 2.0m. This arrangement allows for two-abreast cycling. Based on the NCM Width Calculator, this allows for overtaking within the cycle track. The minimum width is 1.5m, which based on the NCM Width Calculator, allows for single file cycling.

Localised narrowing of the cycle track below 1.5m may be necessary over very short distances to cater for local constraints (e.g. mature trees).

The desirable minimum width for a two-way cycle track is 3.25m. In addition to this, a buffer of 0.5m should be provided between the two-way cycle track and the carriageway.

Using the NCM width calculator, reduction of these desirable minimum widths can be considered on a case-by-case basis, with due cognisance of the volume of cyclists anticipated to use the route as well as the level of service required.

The Proposed Scheme is approximately 8.31km long from end to end. The General Arrangement drawings included within Appendix B show the improved extent of cycle provision, which is summarised below:

Sections 1 and 2

- 71% Existing cycle priority (outbound) *(37% advisory, 27% mandatory, 7% segregated)*
- 71% Existing cycle priority (citybound) *(37% advisory, 23% mandatory, 11% segregated)*
- 100% Proposed cycle priority (outbound)
- 100% Proposed cycle priority (citybound)

Sections 3, 4, and 5

- *36*% Existing cycle priority (outbound) (*16% mandatory cycle lane – 20% advisory cycle lane*)
- *14*% Existing cycle priority (citybound) (*14% advisory cycle lane*)
- *100*% Proposed cycle priority (outbound)
- *100*% Proposed cycle priority (citybound)

Details of the proposed cycle tracks and cycle lanes throughout the extent of the Proposed Scheme are provided below.

4.12.1 Segregated Cycle Tracks

A cycle track is a segregated track which is physically segregated from the adjacent traffic lane and/or bus lane horizontally and/or vertically, as shown in Figure 4.5, taken from the BCPDGB.

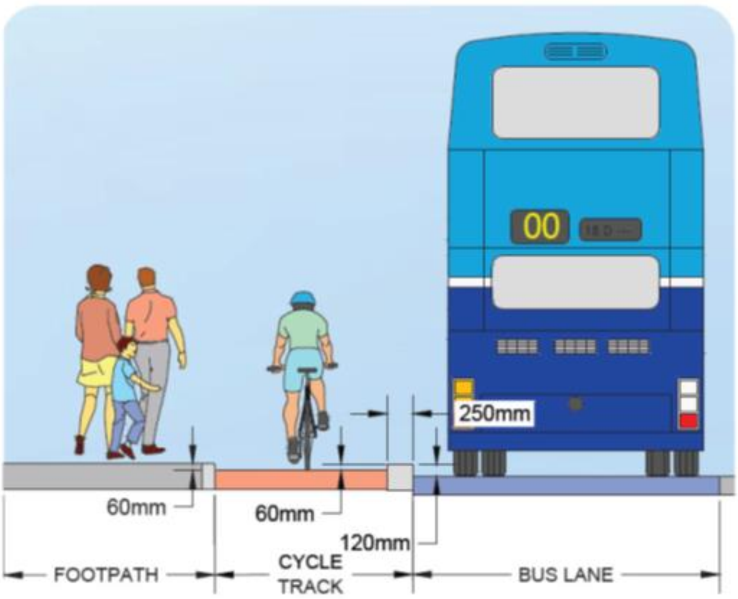


Figure 4.5: Segregated Cycle Track

The desirable minimum width used throughout the Proposed Scheme for a single-direction, with-flow, raised-adjacent cycle track is 2m. This is based on the National Cycle Manual Width Calculator, and allows for overtaking within the cycle track. The minimum width is 1.5m, based on the NCM Width Calculator, allows for single file cycling. In addition, a full height 120mm upstand kerb between the carriageway and the cycle track should be provided (120mm kerb height on the bus lane side and 60mm kerb height on the cycle track side). This provides increased protection of the cycle track as well as allowing for side entry drainage systems where applicable.

Cycle lane construction guidance is given in Section 5.6 of the NCM. The use of machine laid asphalt for cycle tracks has proven to be an effective way of providing a high level of service with a safe, smooth and continuous surface.

Fully segregated cycle tracks have been provided throughout the entirety of the Proposed Scheme.

At grade cycle tracks (as per NCM Section 4.3.4) have been utilised in order to maintain the existing kerb lines as the route approaches the city centre. The cycle tracks will be at carriageway level and segregated from general traffic using bolt-in armadillo style kerbs. At-Grade cycle tracks have not been proposed at any location within the Proposed Scheme, with the exception of localised tie-ins to the existing of environment. This arrangement may be used as an alternative where the appointed arboriculturist instructs that a no-dig technique is required following on-site inspection of a trees root protection area (RPA).

4.12.2 Offline Cycle Track

There are no offline cycle tracks provided as part of the Proposed Scheme.

4.12.3 Quiet Street Treatment

Where roadway widths cannot facilitate cyclists without significant impact on bus priority, alternative cycle routes are explored for short distances away from the Proposed Scheme route. Such offline options may include directing cyclists along streets with minimal general traffic other than car users who live on the street. They are called Quiet Streets due to the low amount of general traffic and are deemed suitable for cyclists sharing the roadway with the general traffic without the need to construct segregated cycle tracks or painted cycle lanes. Such a Quiet Street Treatment would involve appropriate advisory signage for both the general road users and cyclists.

There are no Quiet Street Treatments provided as part of the Proposed Scheme.

4.12.4 Treatment at Constraint Areas

At some locations along the Proposed Scheme, standard width of cycleways cannot be achieved, and localised narrowing is required. All locations where substandard widths are required have been recorded and tabulated in.

4.12.5 Cycle Parking Provision

Cycle stands will be provided, where practicable, at island bus stops and key additional locations as noted in the Landscape General Arrangement Drawings, in Appendix B.

4.13 Pedestrian Provision

Footpath widths are to be a standard 2.0m wide where practicable, as shown in Table 4.2. Where this has not been achieved, all deviations from standard have been recorded and tabulated in Appendix C.

Pedestrian crossings have been designed to accommodate a moderate flow of foot traffic along the mainline desire line where practicable, with a minimum width of 2.8m at both signalised junctions and zebra crossings. Pedestrians will share their manoeuvres with cyclists when using toucan crossings, which are to be provided at signalised junctions which cannot accommodate segregated cycle crossings. To facilitate road users who cannot cross in a reasonable time, the desirable maximum crossing length without providing a refuge island is 19m. Where this is not practicable, refuge islands greater than 4m wide are to be used to allow those who cannot cross in a reasonable time to make the journey in two phases.

At signalised junctions and standalone pedestrian crossings, the footway will be ramped down to carriageway level to facilitate pedestrians who require an unobstructed crossing. At minor junctions, raised tables are provided to raise the road level up to footway level and facilitate unimpeded crossing. Tactile paving is provided at the mouth of each pedestrian crossing and is to be designed in accordance with standards. Audio units are to be provided on each traffic signal push button.

Formal crossing points are to be provided on the upstream side of bus stop islands, consisting of an on-demand signalised pedestrian crossing with appropriate tactile paving, push button units and LED warning studs. A secondary informal crossing should be provided on the desire line on the downstream side of the island.

4.13.1 Footpath Crossfall

Crossfalls have generally been assigned to footpaths in accordance with DN-PAV-03026, Table 2.3 (extract inserted herein as Table 4.8) which recommends a crossfall of 2%-3.3%. This gradient will allow the footpath to suitably drain without affecting the ability of mobility-impaired people to move safely along the corridor.

In certain circumstances dictated by the constraints of existing land boundaries and (particularly at existing residential accesses) to minimise impacts to adjacent properties it has been necessary to deviate from these values in the proposed design. In most cases the maximum crossfall applied to footpath design is 4.0% over a short distance.

Table 4.8: Geometric Parameters for Footpaths

Parameter	Recommended Limits	Extreme Limits
Longitudinal gradient (normally the same as adjacent highway)	1.25% to 5%	8% maximum*
Width	2m minimum	1.3m minimum
Crossfall	2% to 3.3%	1.5% minimum to 7% maximum at crossings

Note: *In some cases it may be necessary to construct a footway with a gradient of more than 8 per cent. Provision of a handrail is recommended if site constraints necessitate a gradient steeper than 10 per cent.

Table 2.3 Geometric Parameters for Footways

4.13.2 Longitudinal Gradient

The longitudinal gradient of the footpaths along the Proposed Scheme is constrained by the longitudinal gradient of the proposed carriageway. DN-PAV-03026, Table 2.3 recommends a longitudinal gradient along footpaths of 1.25%-5%. However, in all scenarios of the Proposed Scheme, the footpath gradient is dictated by that of the main carriageway. Similar to the crossfall, the longitudinal fall in the road has been designed to ensure it can suitably drain without affecting the ability of mobility-impaired people to move safely along the corridor.

4.14 Bus Stops

This section of the report presents a summary of the Bus Stop Review process which was conducted for the Proposed Scheme.

The purpose of the process was to review the location of the existing Dublin Bus stops 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 travelling along the route by reducing the journey time of the bus service, to increase the walking catchment of the bus stops and to ensure key trip attractors located along the route is sufficiently covered within the catchment of bus stops.

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

This section also provides details of the types of bus stop proposed throughout the Proposed Schemes, with reference to Chapter 11 of the BCPDGB within Appendix O, which presents a principle-based approach to the design of bus stops and presents the hierarchy of bus stop options which were considered in designing the Proposed Scheme.

4.14.1 Methodology

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

The main principles considered as part of the review were 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 practicable 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 and 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.

Following the review of bus stop locations, the catchment analysis was run to review the impact of the changes on the bus network. The proposed catchments are presented in Figure 4.6 through to Figure 4.9 with population numbers presented in Table 4.9 to Table 4.16.

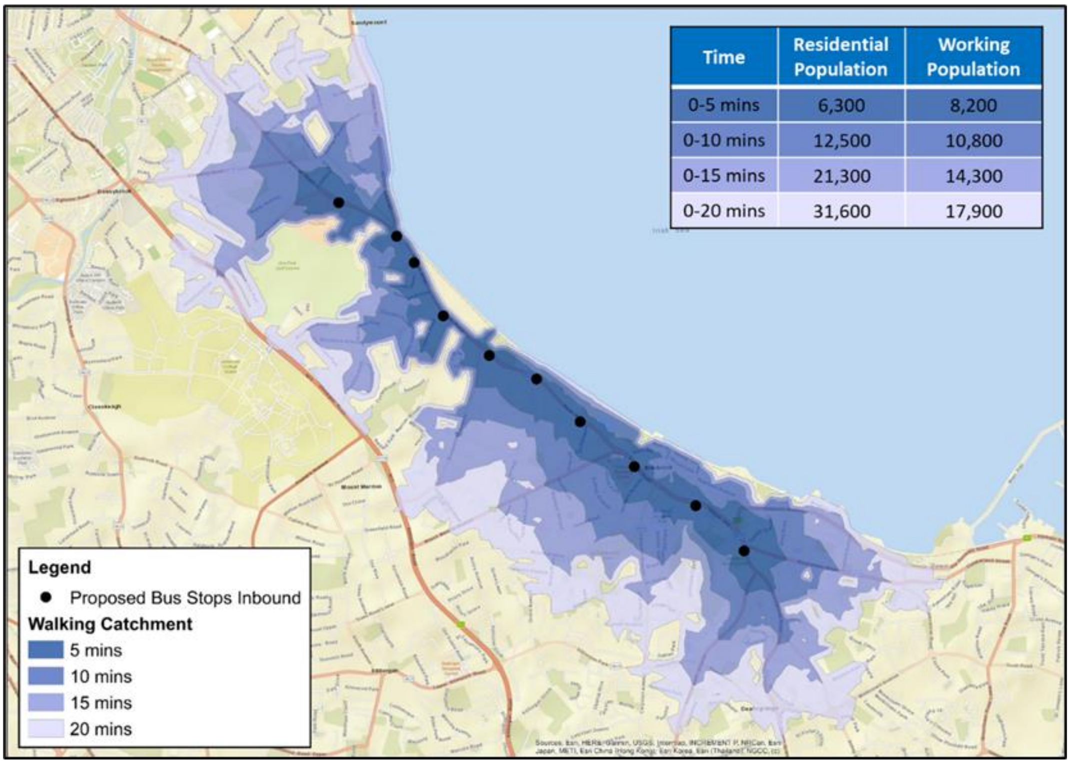


Figure 4.6: Sections 1 and 2 Proposed Inbound Bus Stop Catchments

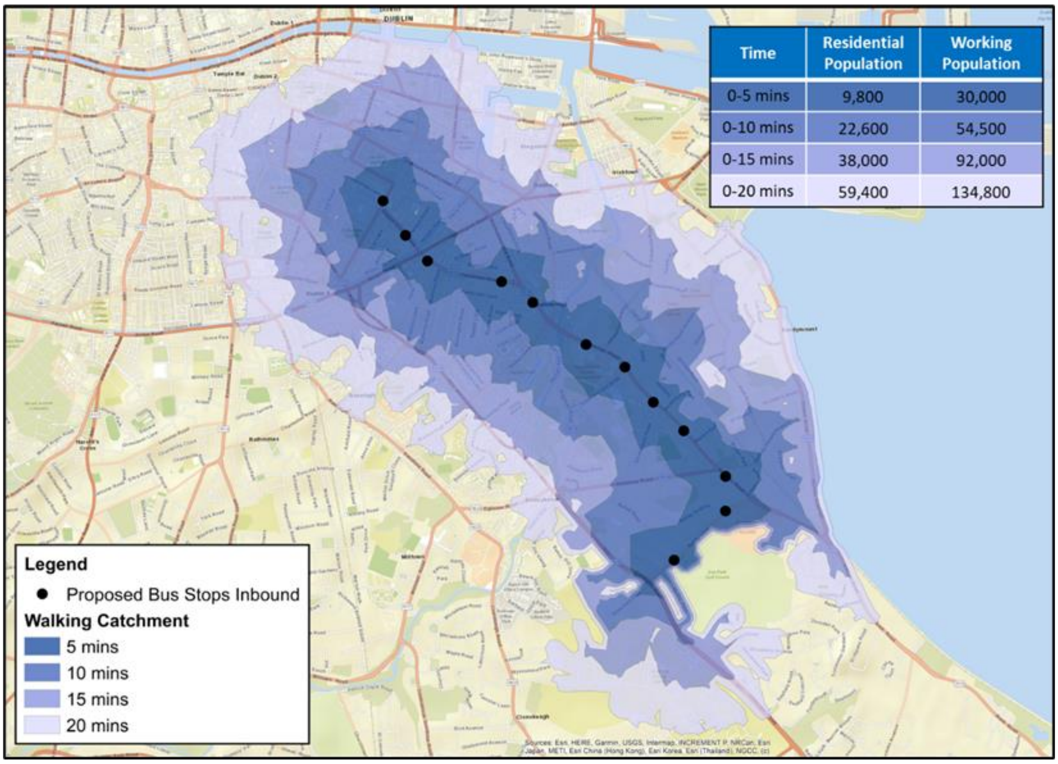
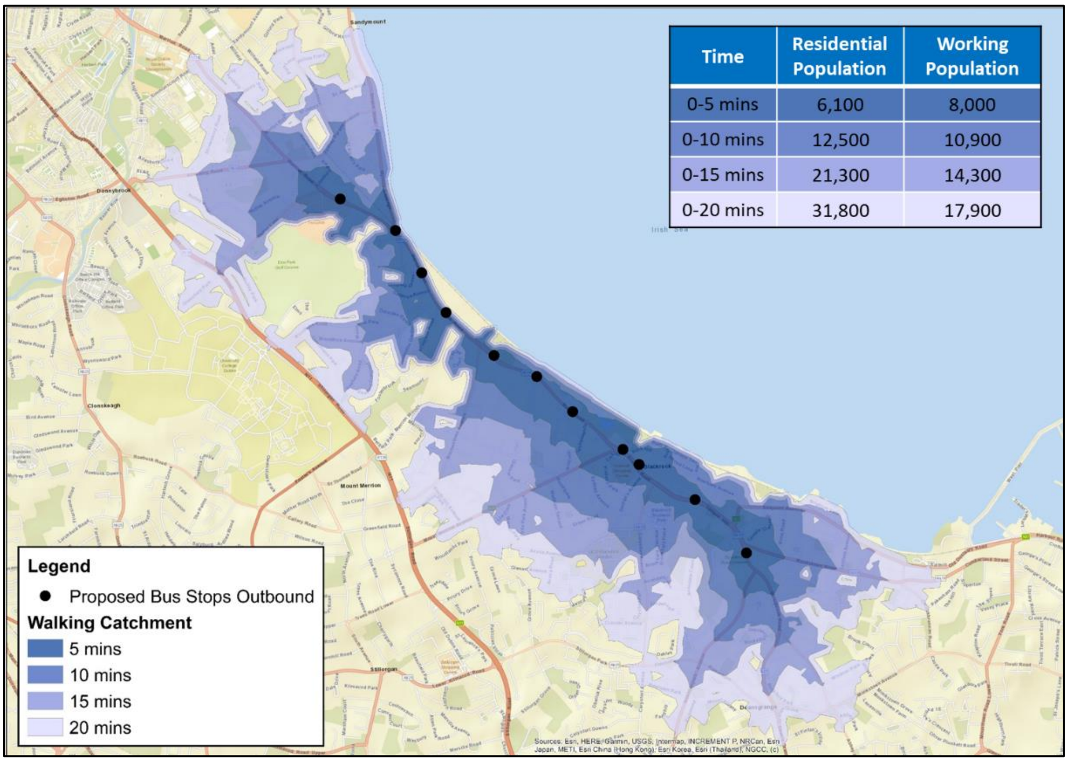
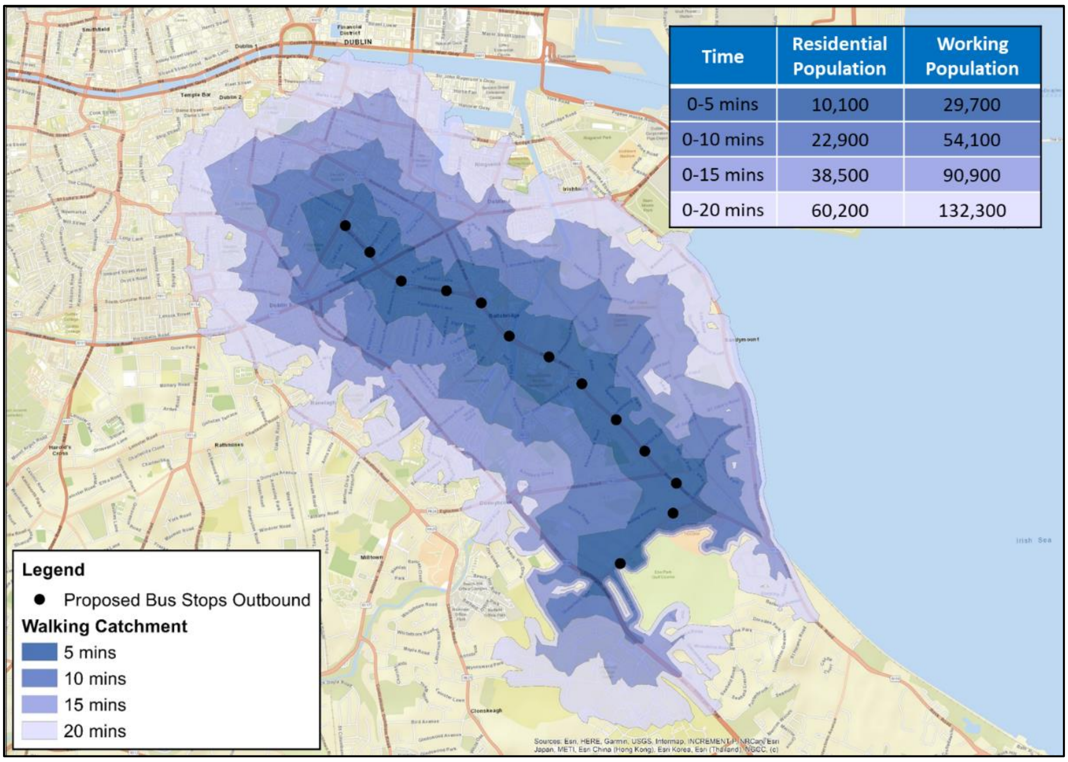


Figure 4.7: Sections 3, 4 and 5 Proposed Inbound Bus Stop Catchments



Time	Residential Population	Working Population
0-5 mins	6,100	8,000
0-10 mins	12,500	10,900
0-15 mins	21,300	14,300
0-20 mins	31,800	17,900

Figure 4.8: Sections 1 and 2 Proposed Outbound Bus Stop Catchments



Time	Residential Population	Working Population
0-5 mins	10,100	29,700
0-10 mins	22,900	54,100
0-15 mins	38,500	90,900
0-20 mins	60,200	132,300

Figure 4.9: Sections 3, 4 and 5 Proposed Outbound Bus Stop Catchments

Table 4.9: Sections 1 and 2 Inbound Residential Catchment Populations

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

Table 4.10: Sections 3, 4 and 5 Inbound Residential Catchment Populations

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

Table 4.11: Sections 1 and 2 Inbound Workplace Catchment Populations

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

Table 4.12: Sections 3, 4 and 5 Inbound Workplace Catchment Populations

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

Table 4.13: Sections 1 and 2 Outbound Residential Catchment Populations

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

Table 4.14: Sections 3, 4 and 5 Outbound Residential Catchment Populations

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

Table 4.15: Sections 1 and 2 Outbound Workplace Catchment Populations

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

Table 4.16: Sections 3, 4 and 5 Outbound Workplace Catchment Populations

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

From the tables above, it is noted that the proposed bus stop locations result in an increase in both residential and workplace catchments for the inbound and outbound directions. The workplace population increases to a greater extent than the residential populations, which is likely due to the extent to which the Scheme passes through the city centre, the Ballsbridge commercial centre, and areas around Blackrock Village which has a higher density of commercial uses.

Each of the study components and proposed bus stops are discussed in more detail in the Bus Stop Review Report in Appendix H.

4.14.2 Route Summary

Table 4.17 and **Table 4.18** outline a summary of the outcome of the bus stop review process.

Table 4.17: Inbound Scheme Summary

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

Table 4.18: Outbound Scheme Summary

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

4.14.3 Bus Shelter

Bus shelters provide an important function in design of bus stops. The shelter will offer protection for people from poor weather, with lighting to help them feel more secure. Seating will be provided to assist ambulant disabled and older passengers and accompanied with Real Time Passenger Information (RTPI) signage to provide information on the bus services. The locations of the bus shelters are presented on the General Arrangement drawing series in Appendix B.

The optimum configuration that provides maximum comfort and protection from the elements to the travelling public is the 3-Bay Reliance 'mark' configuration with full width roof. This shelter is a relatively new arrangement which has been developed by JCDecaux in conjunction with the NTA. The shelter consists mainly of a stainless-steel structure with toughened safety glass and extruded aluminium roof beams. Figure 4.10 provides an example image of the preferred full end panel shelter arrangement. The desirable minimum footpath/island widths required to accommodate the full end panel shelter is 3.3m with an absolute minimum width of 3m to facilitate a minimum 1.2m clearance at the end panel for pedestrians. Alternative arrangements for more constrained footpath widths are considered below.

Figure 4.10: Example of a 3-Bay Reliance full end panel bus shelter (Source: JCDecaux)

The cantilever shelter using full width roof and half end panel arrangement provides a second alternative solution for bus shelters in constrained footpath locations. Figure 4.11 provides an example of this type of shelter. Advertising panels in this arrangement are normally located on the back façade of the shelter compared to the full end panel arrangement. The desirable minimum footpath/island widths required to accommodate the full end panel shelter is 2.75m with an absolute minimum width of 2.4m to facilitate a minimum 1.2m clearance at the end panels for pedestrians.

Figure 4.11: Example of a 3-Bay Reliance Cantilever Shelter with full width roof and half end panels (Source: JCDecaux)

Two alternative narrow roof shelter configurations (Figure 4.12) are also available which offer reduced protection against the elements compared to the full width roof arrangements. These shelter configurations are not preferred but do provide an alternative solution for particularly constrained locations where cycle track narrowing to min 1m width has already been considered and 2.4m widths cannot be achieved to facilitate the full width roof with half end panel shelter. The desirable minimum footpath widths for the narrow roof configuration are 2.75m (with end panel) and 2.1m (no end panel). The absolute minimum footpath widths for these shelters are 2.4m (with end panel) and 1.8m (no end panel) to allow for boarding and alighting passengers in consideration of wheelchair, pram, luggage and other such similar spatial requirements.

Figure 4.12: Example of a 3-Bay Reliance Cantilever shelter with narrow roof configuration with and without half end panels (Source: JCDecaux)

The siting of bus shelters also requires due consideration on a case by case basis. Ideally bus shelters should be located on the island bus stop boarding/alighting area where space permits. Where this is not feasible, the shelters should be located perpendicular to the island to the rear of the footpath. Where bus shelters cannot be located directly on the dedicated island or perpendicular to the island due to spatial and or other constraints, they should ideally be located downstream of the stop area. This will inherently promote eye to eye contact between boarding passengers and oncoming cyclists and buses when signalling the bus and also improve the courtesy arrangement for segregation of boarding and alighting passengers.

Figure 4.13, Figure 4.14 and Figure 4.15 below illustrate each of these scenarios.

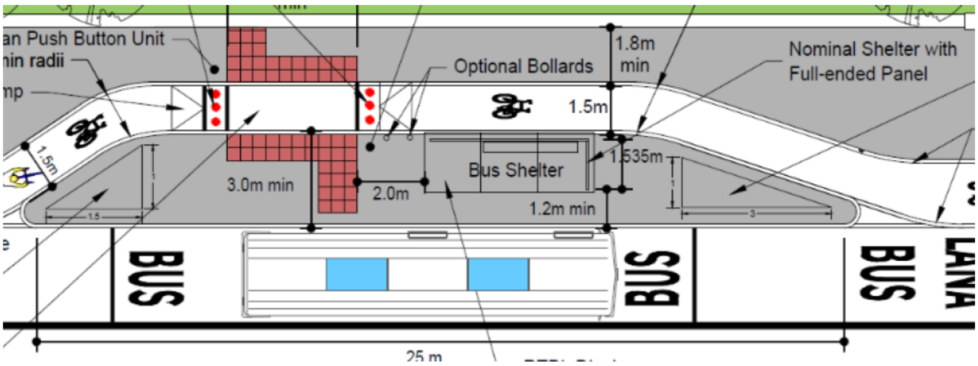


Figure 4.13: Preferred Shelter Location (on island)

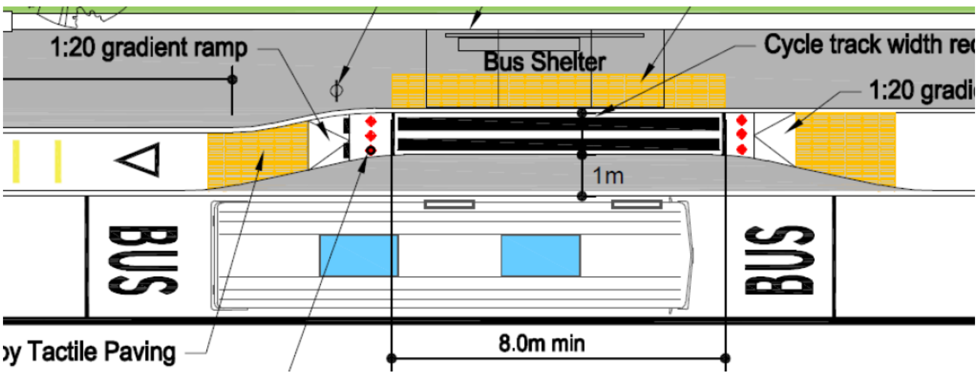


Figure 4.14: Alternative Shelter Location back of footpath (narrow island with adequate footpath widths)

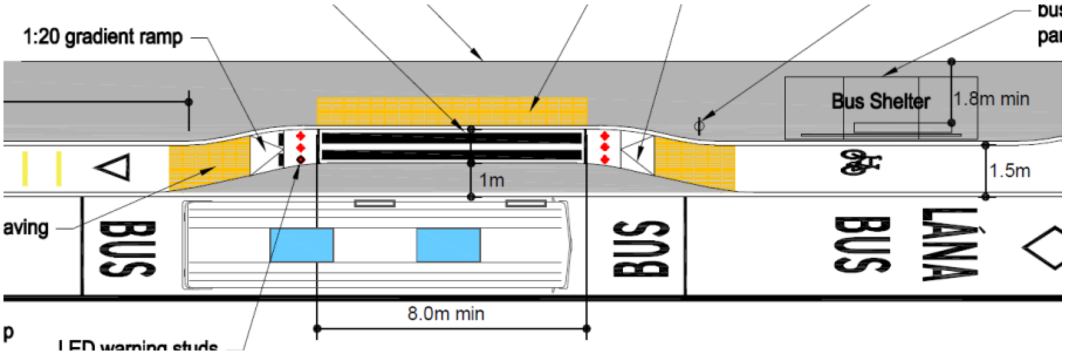


Figure 4.15: Alternative Shelter Location downstream of island (narrow island with narrow footpath widths at landing area)

4.14.4 Island Bus Stops

Where sufficient space is available, Island Bus Stops, as shown in both Figure 4.16 and Figure 4.17, have been proposed, which help to reduce the conflict between users departing the bus and cyclists.

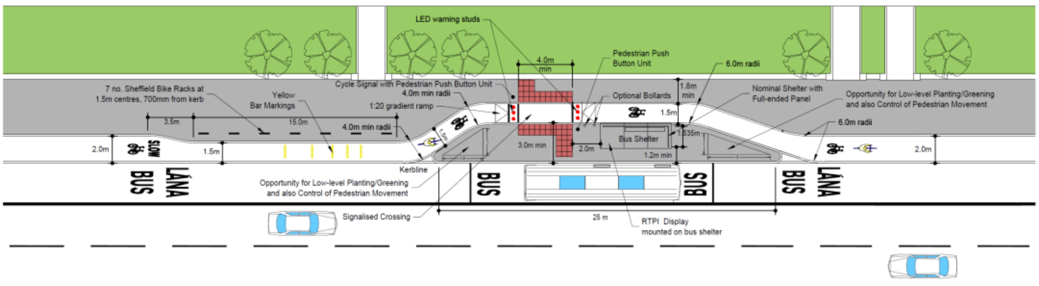


Figure 4.16: Island Bus-Stop Arrangement

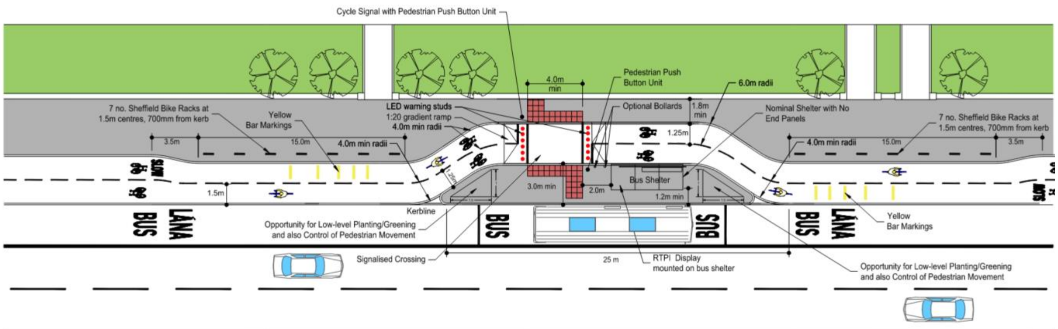


Figure 4.17: Island Bus-Stop Arrangement - Two-way Cycle Track

Island Bus Stops are used at a number of locations along the Proposed Scheme, as shown in Table 4.19.

Table 4.19: Island Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
Inbound					
Section 1					
Inbound	Mount Merrion Avenue	469 Relocated	A1550	Proposed: Yes New location	This new location achieves better spacing from the previous stop, and better serves facilities such as Blackrock Clinic. It is proposed that a lay by be retained in the current location which can cater for existing private coach services
Inbound	Blackrock College	471	A1975	Proposed: Yes Existing: Yes	N/A
Inbound	Booterstown Ave	472 Relocated	A2325	Proposed: Yes New location	This new location is closer to the Booterstown Avenue Junction and the Booterstown Dart Station. It is proposed that a lay by be retained in the current location which can cater for existing private coach services
Section 2					
Inbound	St Vincent's University Hospital	478 Relocated	A3850	Proposed: Yes New location	This new location brings the stop closer to the St Vincent's University Hospital entrance and the junction. It is proposed that a lay by be retained in the current location which can cater for existing private coach services.
Section 4					
Inbound	Pembroke Road	2798 Relocated	A6290	Proposed: Yes New location	Existing stop was on left turn slip lane which has been removed. New location achieves better spacing with the previous stop, and better serves the catchment along Raglan Road
Outbound					
Section 4					
Outbound	Mespil Road	752 Relocated	A6675	Proposed: Yes New location	This new location achieves better spacing from the previous and next stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
Outbound	Northumberland Road	2797	A6350	Proposed: Yes New location	This new location achieves better spacing between the previous and next stops
Section 2					
Outbound	Nature Reserve	426	A2750	Proposed: Yes Existing: Yes	This location serves the catchment of St Helens Road and Trimleston Avenue, and maintains 400m spacing from previous and next stops.
Section 1					
Outbound	DART Station	427	A2300	Proposed: Yes Existing: Yes	This location serves the Booterstown DART Station, and has enough space to provide an island bus stop
Outbound	Blackrock College	428	A1975	Proposed: Yes Existing: Yes	This stop serves the key trip attractor of Blackrock College, and is located close to a proposed pedestrian crossing.
Outbound	Blackrock Park	3032	A1200	Proposed: Yes Existing: Fingerpost	This stop is located adjacent to the pedestrian crossing and serves Blackrock Park.
Outbound	Temple Road	7660	A550	Proposed: Yes Existing: Fingerpost	This location serves Temple road, and is well spaced between the previous and next stops

4.14.5 Shared Landing Area Bus Stops

Shared landing areas, as shown in Figure 4.18, are used where there is insufficient space to provide an island bus stop. The cycle lane width is reduced on the approach to slow cyclists, along with a 1m island being proved for users departing the bus. This is to prevent bus users stepping directly into the cycleway.

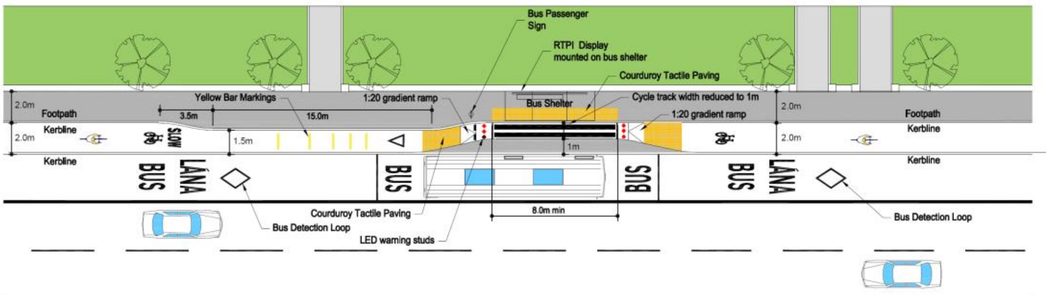


Figure 4.18: Shared Landing Area Bus Stops Arrangement

In particularly constrained locations within urban centres, where the provision of a bus shelter at the rear of the footpath is not practicable due to the presence of frontages, a variation of the Shared Bus Stop Landing Zone arrangement may be considered. This option is presented in Figure 4.19. This option provides a cantilever bus shelter adjacent to the carriageway, to maintain access to frontages at the back of the footpath.

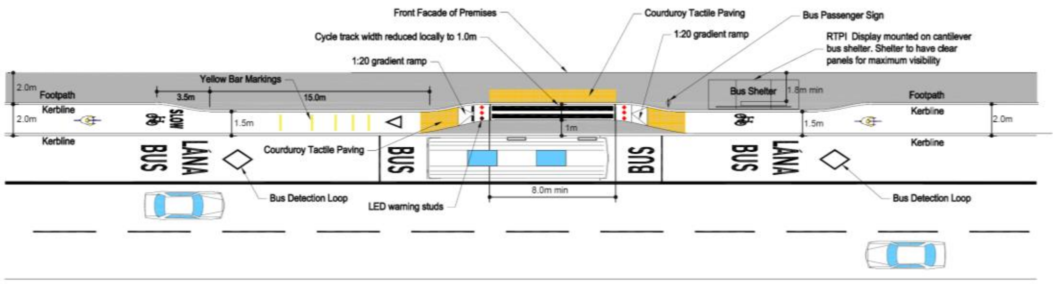


Figure 4.19: Shared Landing Area Bus Stops (Urban Centres)

The locations of each of these types along the Proposed Scheme are recorded in Table 4.20.

Table 4.20: Shared Landing Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
			Inbound		
Section 1					
Inbound	Temple Hill	3164 Relocated	A 0150	Proposed: Yes New location	This location places the stop after the junction
Inbound	*New Stop*	n/a	A 0600	Proposed: Yes New location	This location is immediately after the junction, provides an inbound stop for Barclay Court residents and those coming through Avondale Park, and is well spaced between the stops before and after at a location which is not currently catered for.
Inbound	Frascati Centre	3084	A1050	Proposed: Yes Existing: Yes	N/A
Section 2					
Inbound	St Helen's Road	4705	A2725	Proposed: Yes Existing: Yes	N/A
Inbound	Bellevue Avenue	475 Relocated	A3150	Proposed: Yes New location	This new location better serves Elmpark Green, and is located directly after a junction
Inbound	Merrion Gates	476	A3375	Proposed: Yes Existing: Yes	N/A
Section 3					

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
Inbound	Merrion Centre / Ailesbury Road	479 Relocated	A4210	Proposed: Yes New location	This new location improves the spacing from previous stop, bringing it to 350m. Although the existing location provided for the Merrion Shopping Centre, it is considered that there are sufficiently spaced bus stops both on Nutley Lane and Merrion Road (east of this location)
Inbound	Merlyn Road	481 Relocated	A4625	Proposed: Yes New location	This bus stop is located at the start of a proposed bus lane, and achieves 400m spacing from stop 479
Inbound	Shrewsbury Road	482	A4925	Proposed: Yes Existing: Yes	N/A
Inbound	Simmonscourt Road	483 Relocated	A5225	Proposed: Yes New location	This new location places the bus stop after the junction, and improves the spacing from the previous bus stop
Inbound	RDS	485	A5550	Proposed: Yes x2 Existing: Yes	This location directly serves the Royal Dublin Society (RDS), which is a key trip attractor
Section 4					
Inbound	American Embassy	487	A5975	Proposed: Yes Existing: Yes	N/A
Inbound	Mespil Road	782	A6800	Proposed: Yes Existing: Yes	N/A
Inbound	Pembroke Row	783	A7025	Proposed: Yes Existing: Fingerpost	N/A
Inbound	Fitzwilliam Street Lower	784 Relocation	A7325	Proposed: Yes (Urban Centre Detail) New location	Moving the stop provides better spacing with previous stop, and provides an inbound bus stop on Fitzwilliam Street Lower where there currently is none.
Section 5					
Inbound	Nutley Avenue	2086	B0650	Proposed: Yes Existing: Fingerpost	N/A
Outbound					
Section 5					
Outbound	Nutley Lane	7053 Relocated	B0650	Proposed: Yes New location	The new location better serves the western entrance to St Vincent's University Hospital, and Nutley Avenue which provides access to St. Michael's College

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
Outbound	Nutley Lane, RTÉ	2089 Relocated	B0140	Proposed: Yes New location	The proposed design provides no footpath in the current location and the bus stop has to be relocated to match the proposed footpath location- while also bringing the bus stop closer to RTÉ and the transport corridor on the R138 Stillorgan Road.
Section 4					
Outbound	Fitzwilliam Street Lower	750 Relocated	A7250	Proposed: Yes (Urban Centre Detail) New location	This location serves the Baggot Street Lower area well and is located after a junction
Outbound	Herbert Street	751 Relocated	A7000	Proposed: Yes (Urban Centre Detail) New location	This new location positions the bus stop after the side road junction and close to the Grand Canal Greenway
Outbound	Lansdowne Road	414 Relocated	A6075	Proposed: Yes New location	This location avoids the removal an existing mature tree.
Outbound	Elgin Road	415 Relocated	A5775	Proposed: Yes (Urban Centre Detail) New location	This new location allows more space for waiting pedestrians, and the location on the bridge means that no entrances are blocked. This location is also closer to the Ballsbridge village retail centre.
Section 3					
Outbound	RDS	416 Relocated	A5450	Proposed: Yes New location	This new location is directly after the pedestrian crossing, and serves a key trip attractor outside the adjacent large office developments.
Outbound	British Embassy	418 Relocated	A5125	Proposed: Yes New location	This new location brings the bus stop closer to the junction, an improves the spacing between the previous and next bus stops
Outbound	Shrewsbury Park	419	A4800	Proposed: Yes Existing: Yes	N/A
Outbound	Merlyn Road	420	A4500	Proposed: Yes Existing: Fingerpost	N/A
Outbound	Ailesbury Road	421 Relocated	A4175	Proposed: Yes Existing: Yes	There is more space in this new location for passengers to gather safely.
Section 2					
Outbound	St Vincent’s University Hospital	422	A3825	Proposed: Yes Existing: Yes	N/A

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
Outbound	Merrion Gates	424 Relocated	A3400	Proposed: Yes New location	This new location brings the bus stop closer to the Strand Road Junction and the proposed pedestrian crossing
Outbound	Bellevue Avenue	425 Relocated	A3075	Proposed: Yes New location	This new location better serves Elmpark Green, and is located directly after a junction
Section 1					
Outbound	Blackrock Clinic	429	A1625	Proposed: Yes Existing: Yes	N/A
Outbound	Frascati Centre	6334	A1025	Proposed: Yes Existing: Fingerpost	N/A
Outbound	Temple Hill	3114	A0050	Proposed: Yes Existing: Fingerpost	N/A

4.14.6 Inline Bus Stop

Where there are no cycle tracks provided, inline bus stops are used, where the users departing the bus exit straight on the footway.

An Inline Bus Stop is used at one location along the Proposed Scheme, as shown in Table 4.21.

Table 4.21: Inline Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
Section 5					
Inbound	Nutley Lane, RTE	2085	B0160	Proposed: Yes Existing: Fingerpost	N/A

4.14.7 Lay-by Bus Stop

Consideration was also given to locations where private coaches may be required stop along the Proposed Scheme, particularly those serving the airport which could require longer dwell time to allow passengers to load/unload their luggage. In these cases, and where space has permitted, a separate lay-by bus stop has been Figure 4.20.

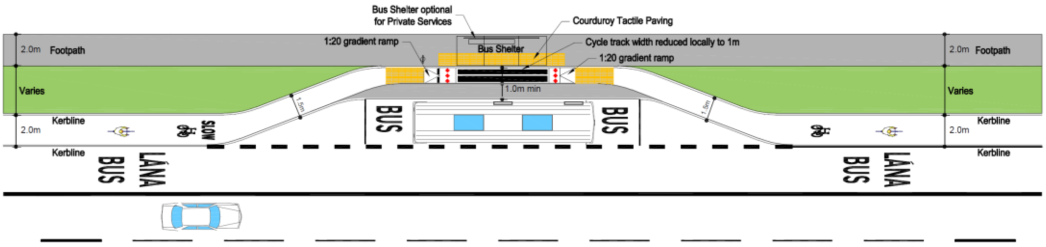


Figure 4.20: Lay-by Bus Stop Arrangement (Private Service Coaches)

Lay-by Bus Stops are used at a number of locations along the Proposed Scheme, as shown in Table 4.22.

Table 4.22: Lay-by Bus Stops

Inbound/ Outbound	Bus Stop Name	Bus Stop No.	Chainage	Bus Shelter	Reason for moving / locating stop
Section 1					
Inbound	Frascati Centre	3084	A1050	Proposed: Yes Existing: Yes	Lay-by bus stop provided at this location to cater for existing (and potential future) private coach services and to allow for greater dwell times in the vicinity of shopping centre.
Inbound	Mount Merrion Avenue	N/a	A1325	Proposed: Yes Existing: Yes	Lay-by bus stop provided at this location to cater for existing (and potential future) private coach services which approach from both Blackrock and Mount Merrion Avenue.
Inbound	Booterstown Avenue	N/a	A2275	Proposed: Yes Existing: Yes	Lay-by bus stop provided at this location to cater for existing (and potential future) private coach services which approach from Blackrock.
Section 2					
Inbound	St Vincent's University Hospital	N/a	A3900	Proposed: Yes New location	Lay-by bus stop provided at this location to cater for existing (and potential future) private coach services

4.15 Parking and Loading

The report contains separate analyses of a number of 'self-contained' corridor sections, where groups of parking bays can be considered to provide a local parking supply. The change in on-street parking supply has been identified and assessed in the context of the local needs and adjacent land uses.

The local off-street parking supply and characteristics have also been noted. For the Proposed Scheme, the self-contained sections where changes are proposed to parking supply are listed below and are illustrated in Figure 4.21:

- Section 1 – Stradbrook Road to Booterstown Avenue;
- Section 2 – Booterstown Avenue to Nutley Lane;
- Section 3 – Merrion Road (Nutley Lane to Ballsbridge);
- Section 4 – Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street); and
- Section 5 – Nutley Lane (R138 Stillorgan Road to R118 Merrion Road).

It should be noted that there are no existing designated on-street parking spaces on Temple Hill / Frascati Road (between Montpellier Place and Mount Merrion Avenue) and this area, therefore, has been excluded from this report.

Figure 4.21: Proposed Scheme Preliminary Parking Survey Study Area

4.15.1 Summary of Parking Changes

With the Proposed Scheme infrastructure in place, there will be an associated need to remove some parking spaces to provide improved facilities for pedestrians, cyclists, and buses – which inevitably requires some reallocation of parking road space. To ensure disabled parking bays required as part of the Proposed Scheme are accessible, all disabled parking bay have been designed to Chapter 7 of the Traffic Signs Manual. Typical disabled parking bays layouts are indicated in Figure 4.22.

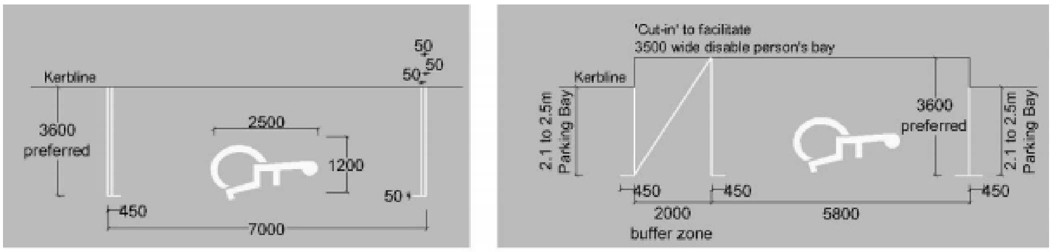


Figure 4.22: Typical disabled parking layout

Refer to Parking summary from the Parking Survey Report in Appendix G.

The proposed changes in parking and loading provision along the Proposed Scheme are summarised in Table 4.23 and Table 4.24.

Table 4.23: Summary of Parking Changes

Location	Baseline		Proposed		Change
	Corridor	Adjacent	Corridor	Adjacent	
Rock Road / Frascati Road (between Stradbrook Road to Booterstown Avenue)	18	31	6	31	-12
Rock Road / Merrion Road (between Booterstown Avenue to Nutley Lane)	39	127	31	127	-8
Merrion Road (between Nutley Lane to Ballsbridge)	10	71	10	71	0
Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)	208	650	107	650	-101
Nutley Lane (between Stillorgan Road to Merrion Road)	44	105	0	105	-44

Table 4.24: Summary of Loading Changes

Location	Loading Bays		Change
	Baseline	Proposed	
Rock Road / Merrion Road (between Booterstown Avenue to Nutley Lane)	1	2	1
Rock Road / Merrion Road (between Booterstown Avenue to Nutley Lane)	0	0	0
Merrion Road (between Nutley Lane to Ballsbridge)	2	3	1
Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)	11	12	+1
Nutley Lane (between Stillorgan Road to Merrion Road)	2	0	-2

4.16 Turning Bans and Traffic Management Measures

Turning bans and other traffic management measures will be implemented on the route to direct traffic away from either the Proposed Scheme corridor (to maximise bus journey time reliability) or to limit use of side streets as a short-cut route by through traffic. All these measures are shown on the General Arrangement Drawings, and are listed in Table 4.25 and Table 4.26. Existing turn bans are not included in the below tables.

Table 4.25: Core bus corridor traffic management measures and turning bans

Location	TM measure implemented	Reason for Mitigation	Impact of Mitigation
Temple Hill (Temple Crescent/Monkstown Road)	Bus priority signals through Temple Hill	To allow for bus priority on Temple Hill	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Temple Road/Newtown Avenue	Bus Priority Signals between Temple Hill and Temple Road	To allow for bus priority between Temple Hill and Temple Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Frascati Road/Temple Road	Bus Priority Signals Between Frascati Road and Temple Road	To allow for bus priority between Frascati Road and Temple Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Frascati Road (Carysfort Avenue)	Bus Priority Signals Through Frascati Road	To allow for bus priority Through Frascati Road	Improved reliability for bus journey times along the corridor, and improved

Location	TM measure implemented	Reason for Mitigation	Impact of Mitigation
			flexibility in junction stage and operation.
Frascati Road (George's Avenue)	No straight ahead for general traffic onto Frascati Road	To mitigate against excessive diverted traffic onto George's Avenue, with associated air and noise implications	Local traffic looking to access Frascati Road to divert via Frascati Park.
Rock Road/Frascati Road	Bus Priority Signals Between Frascati Road and Rock Road	To allow for bus priority between Frascati Road and Rock Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Rock Road Westbound (Mount Merrion Avenue)	Bus Priority Signals Through Rock Road	To allow for bus priority Through Rock Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Rock Road (Blackrock Clinic)	Bus Priority Signals Through Rock Road	To allow for bus priority Through Rock Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road/Rock Road East and West Bound	Bus Priority Signals Between Merrion Road and Rock Road	To allow for bus priority between Rock road and Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road East and West Bound (Trimleston Avenue)	Bus Priority Signals Through Merrion Road	To allow for bus priority Through Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road (Elmpark Green)	Bus Priority Signals Through Merrion Road	To allow for bus priority Through Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road, West bound (Strand Road and Railway Crossing)	Bus Priority Signals Through Merrion Road	Receiving bus lane on Merrion Road has been curtailed due to space restrictions and signal controlled priority therefore required.	Traffic island required for the signal controlled priority and bus must entered short shared section prior to entering bus lane.
Merrion Road, East bound (Strand Road and Railway Crossing)	Bus Priority Signals Through Merrion Road	To allow for bus priority Through Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.

Location	TM measure implemented	Reason for Mitigation	Impact of Mitigation
Merrion Road, East and West Bound (Merrion Avenue/St. Vincent's University Hospital)	Bus Priority Signals Through Merrion Road	To allow for bus priority Through Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road (Sydney Parade)	Bus Priority Signal through Merrion Road at the Junction of Sydney Parade	To allow bus priority for right turning to move from bus lane to right turning traffic lane towards Nutley Lane.	General traffic held back to enable bus movement with yellow box required to ensure bus can enter lane. Improves operation of Merrion Road / Nutley Lane junction as buses are not required to turn right from the bus lane.
Merrion Road North Bound (Ailesbury Road)	Bus Priority Signal through Merrion Road at the Junction of Ailesbury Road	To enable the signal controlled priority required for the operation of the partial bus lane arrangement on Merrion Road.	Shared lane on Merrion Road to be kept clear of queuing traffic, with reduced carriageway width, wider footpaths and retention of a number of existing trees.
Merrion Road South Bound (Ailesbury Road)	Bus Priority Signal through Merrion Road at the Junction of Ailesbury Road	To allow for bus priority at the junction on Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road North Bound (Shrewsbury Road)	Bus Priority Signal through Merrion Road at the Junction of Shrewsbury Road	To allow for bus priority at the junction on Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road South Bound (Shrewsbury Road)	Bus Priority Signal through Merrion Road at the Junction of Shrewsbury Road	To enable the signal controlled priority required for the operation of the partial bus lane arrangement on Merrion Road.	Shared lane on Merrion Road to be kept clear of queuing traffic, with reduced carriageway width, wider footpaths and retention of a number of existing trees.
Merrion Road North Bound (Sandymount Avenue/Simmonscourt Road)	Bus Priority Signal through Merrion Road at the Junction of Sandymount avenue and Simmonscourt Road	To allow for bus priority at the junction on Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road South Bound (Sandymount Avenue/Simmonscourt Road)	Bus Priority Signal through Merrion Road at the Junction of Sandymount avenue and Simmonscourt Road	To allow for bus priority at the junction on Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Merrion Road (Serpentine Avenue)	Bus Priority Signal through Merrion Road at the Junction of Serpentine Avenue	To allow for bus priority at the junction on Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.

Location	TM measure implemented	Reason for Mitigation	Impact of Mitigation
Merrion Road/Ballsbridge	Bus Priority Signal from Merrion Road onto Ballsbridge	To allow for bus priority at the junction on Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Ballsbridge/Merrion Road	Bus Priority Signal from Ballsbridge onto Merrion Road	To allow for bus priority at the junction on Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Ballsbridge/Shelbourne Road	No right turn from Ballsbridge onto Shelbourne Road	Due to space constraints making dedicated right turn lane impractical and to improve junction operation.	Traffic to be redirected through Pembroke Road with replacement new right turn lane onto Lansdowne Road.
Ballsbridge/Pembroke Road	Bus Priority Signal at Ballsbridge/Pembroke Road	To allow for bus priority onto Pembroke Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Pembroke Road/Elgin Road	Left turn entry only onto Elgin Road	To retain local accessibility onto Elgin Road and while consolidating the junction layout and reducing conflicts.	No egress from Elgin Road onto Pembroke Road. Outbound traffic to be diverted to surrounding area.
Pembroke Road/Ballsbridge	Bus Priority Signal at Pembroke Road/Merrion Road	To allow for bus priority through the junction	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Pembroke Road/Northumberland Road	Bus Priority Signal at Pembroke Road/Northumberland Road	To allow for bus priority onto Northumberland Road - noting that there is no receiving bus lane on Northumberland Road.	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Northumberland Road/Pembroke Road	Bus Priority Signal at Northumberland Road/Pembroke Road	To allow for bus priority onto Pembroke Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Eastmoreland Place/Pembroke Road	No right turn from Eastmoreland Place onto Pembroke Road during hours of operation.	Bus gate in place on Pembroke Road	General Traffic to be redirected left onto Pembroke Road

Location	**TM measure implemented**	**Reason for Mitigation**	**Impact of Mitigation**
Pembroke Road/Baggot Street Upper	No straight ahead onto Pembroke Road during hours of operation.	Bus gate in place on Pembrooke Road	General Traffic to be redirected through Eastmoreland Place
Pembroke Road/Baggot Street Upper	No straight ahead onto Baggot Street Upper during hours of operation.	Bus gate in place on Pembrooke Road	General Traffic to be redirected through Eastmoreland Place
Waterloo Road/Pembroke Road	No Right turn from Waterloo Road onto Pembroke Road during hours of operation.	Bus gate in place on Pembrooke Road	General Traffic to be redirected through Baggot Street Upper
Baggot Street Upper/Pembroke Road	Bus Gate and Bus Priority Signal at Baggot Street Upper/Pembroke Road	To allow for bus priority onto Pembroke Road	Reduced carriageway width on Pembroke Road and associated benefits of removing need for land acquisition and the retention / widening of footpath widths. General Traffic to be redirected onto Waterloo Road
Baggot Street Upper/ Macartney (Baggot) Bridge	Bus Priority Signal at Baggot Street Upper/Baggot Street Lower	To allow for bus priority across the Macartney (Baggot) Bridge towards Baggot Street Lower, due to the constrained cross-section.	Enables wider footpaths and cycle facilities over Macartney (Baggot) Bridge due to shared lane.
Mespil Road/Baggot Street Upper	No Right turns onto Baggot Street Upper from Mespil Road	To prevent blocking of the junction from vehicles turning onto the shared lane and provide bus priority on Baggot Street Upper.	Improved operation of the linked junctions and signal controlled priority provided over the shared lane.
Herbert Place/Baggot Street Upper	No Left turns onto Baggot Street Upper from Herbert Place	To prevent blocking of the junction from vehicles turning onto the bridge and provide bus priority from Baggot Street Upper to Lower and vice versa.	Improved operation of the linked junctions and signal controlled priority provided over the shared lane.
Wilton Terrace/Baggot Street Upper	No Right turns onto Macartney (Baggot) Bridge towards Baggot Street Upper from Wilton Terrace.	To prevent blocking of the junction from vehicles turning onto the bridge and provide bus priority from Baggot Street Upper to Lower and vice versa.	Improved operation of the linked junctions and signal controlled priority provided over the shared lane.

Location	TM measure implemented	Reason for Mitigation	Impact of Mitigation
Lower Baggot Street	Bus Priority Signal at Wilton Terrace/Baggot Street Upper	To allow for bus priority across the Macartney (Baggot) Bridge towards Baggot Street Upper, due to the constrained cross-section.	Enables wider footpaths and cycle facilities over Macartney (Baggot) Bridge due to shared lane.
Lower Baggot Street	Bus Priority Signal at Fitzwilliam Street/Baggot Street Lower	To allow bus priority for right turning (from the bus lane) onto Fitzwilliam Street	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Fitzwilliam Street	Bus Priority Signal at Fitzwilliam Street/Baggot Street Lower	To allow for bus priority onto Baggot Street Lower	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.
Nutley Lane (St. Vincent's Hospital)	Bus Priority Signal through Nutley Lane at the Junction of St. Vincent's Hospital	Receiving bus lane on Nutley Lane has been curtailed due to space restrictions and signal controlled priority therefore required.	Traffic island required for the signal controlled priority and bus must entered short shared section prior to entering bus lane.
Nutley Lane/Merrion Road	Bus Priority Signal from Nutley Lane onto Merrion Road	To allow for bus priority onto Merrion Road	Improved reliability for bus journey times along the corridor, and improved flexibility in junction stage and operation.

Table 4.26: Turning bans offline from main Core Bus Corridor

Location	TM measure implemented	Reason for Mitigation	Impact of Mitigation
Seafort Parade	It is proposed to reverse the direction of Seafort Parade, including the separate entrance and exit from Rock Road.	TM intervention proposed to mitigate against the restrictions in visibility for vehicles exiting from Seafort Parade and remove the cross-road arrangement between Castledawson Ave and Seafort Parade.	Change in direction of parking along Seafort Parade. New no entry signage required at the proposed exit to Seafort Parade and at the northern end of Seafort Parade internal T-junction.
Clyde Lane / Clyde Road	It is proposed to make the westernmost c. 70m of Clyde Lane one-way north/westbound on approach to Clyde Road.	TM intervention proposed to mitigate against increased volumes of outbound general traffic redirected onto Clyde Lane as a result of the proposal to provide a bus gate on Pembroke Road and other traffic management proposals. This potential diversion was noted as	Risk of diverted through traffic using this route is removed. New no-entry sign and pole and road markings required at the junction of Clyde Road and Clyde Lane. No. 28A Clyde Lane and eastern yard of St. Conleth's College must be accessed from the east (Herbert Park) and must egress

Location	TM measure implemented	Reason for Mitigation	Impact of Mitigation
		part of the traffic modelling exercise in the absence of this TM intervention on Clyde Lane.	towards Clyde Road. New no right turn sign and pole required at these egresses. All properties on Clyde Lane must be accessed from the east but can egress either east (Herbert Park) or towards Clyde Road.
Pembroke Park / Herbert Park	No Right turn onto Herbert Park from Pembroke Park.	TM intervention proposed to mitigate against increased volumes of outbound general traffic redirected from Pembroke Road area as a result of the proposal to provide a bus gate on Pembroke Road and other traffic management proposals. A potential diversion route - bypassing the proposed bus gate via Eastmoreland Lane, Pembroke Road, Wellington Road, and Pembroke Park - was noted as part of the traffic modelling exercise in the absence of this TM intervention on Pembroke Park.	Risk of diverted through traffic using this route along residential side roads reduced. New no right turn sign and pole required at the junction of Pembroke Park and Herbert Park.

4.17 Deviations from Standards

The design has been developed in accordance with the standards and guidance listed within Section 4.1. However, in some circumstances it has been necessary to digress from the desirable minimum geometric parameters identified.

A schedule of identified deviations from BCPDGB relating to the individual aspects of Road Geometry is included within Appendix C.

4.18 Road Safety and Road User Audit

The TII Publication 'GE-STY-01024 Road Safety Audit' document provides an outline of the typical stages for road safety audits and are noted below as follows:

- Stage F: Route selection, prior to route choice;
- Stage 1: Completion of preliminary design prior to land acquisition procedures;

- Stage 2: Completion of detailed design, prior to tender of construction contract. In the case of Design and Build contracts, a Stage 2 audit shall be completed prior to construction taking place;
- Stage 1 & 2: Completion of detailed design, prior to tender of construction contract, for small schemes where only one design stage audit is appropriate;
- Stage 3: Completion of construction (prior to opening of the scheme, or part of the scheme to traffic wherever possible); and
- Stage 4: Early operation at 2 to 4 months' post road opening with live traffic.

In line with the above, a Stage F Road Safety Audit (RSA) was undertaken at EPR stage. A Stage 1 Road Safety Audit has been undertaken on the preliminary design, and designer responses and appropriate changes made. Refer to the RSA report in Appendix M.

5 Junction Layout

5.1 Overview of Transport Modelling Strategy

The design and modelling of junctions has been an iterative process to optimise the number of people that can pass through each junction, with priority given to pedestrian, cycle and bus movements.

The design for each junction within the Proposed Scheme was developed to meet the objectives of the scheme and to align with the geometric parameters set out in Section 4.1, in conjunction with the junction operation principles described in the BCPDGB. Various traffic modelling tools were used to assess the impact of the proposals on a local, corridor and surrounding road network level which is further described in Section 5.4.

A traffic impact assessment has been undertaken for the Proposed Scheme in order to determine the predicted magnitude of impact Proposed Scheme measures may have against the likely receiving environment. The impact assessments have been carried out using the following scenarios:

- 'Do Minimum' – This scenario represents the likely conditions of the road network with all major committed transportation schemes in place that will impact on the use of public transport and private car, without the Proposed Scheme.
- 'Do Something' – This scenario represents the likely conditions of the road network with all major committed transportation schemes in place that will impact on the use of public transport and private car, with the Proposed Scheme (i.e. the 'Do Minimum' scenario with the addition of the Proposed Scheme) in place.

Both scenarios above comprised of an assessment at opening year (2028) and opening year +15 years (2043). In developing the design proposals for the Proposed Scheme, the 2028 year flows were determined to provide the higher volume of traffic flows for the most part and as such has been generally adopted as the design case scenario for junction development. The final junction design flows have been supplemented with additional cycle volumes to ensure a minimum 10% cycle mode share in terms of people movement at each junction can be achieved in line with the National Cycle Policy Framework.

5.2 Overview of Junction Design

The purpose of traffic signals is to regulate movements safely with allocation of priority in line with transportation policy. For the Proposed Scheme, a key policy is to ensure appropriate capacity and reliability for the bus services so as to maximise the overall throughput of people in an efficient manner. The junctions will provide safe and convenient crossing facilities for pedestrians with as little delay as possible. Particular provisions are required for the protection of cyclists from turning traffic, as well as ensuring suitable capacity for a rapidly increasing demand by this mode.

The design of signalised junctions, or series of junctions, as part of the Proposed Scheme has been approached on a case-by-case basis. There have been a number of components of the design development process that have influenced the preliminary junction designs including:

- The junction operational and geometrical principles described in the BCPDGB;
- Integration of pedestrian and cycle movements at junctions;
- Geometrical junction design for optimal layouts for pedestrians, cyclists and bus priority whilst minimising general traffic dispersion where practical;
- People Movement Calculator (PMC) to inform junction staging and design development;
- LINSIG junction modelling to assess junction design performance and refinement;
- Micro-Sim modelling to assess and refine bus priority designs; and
- Cyclist quantification.

5.3 Junction Geometry Design

5.3.1 Pedestrians

The junction design approach is to minimise delay for pedestrians at junctions, whilst ensuring high quality infrastructure to ensure pedestrians of all ages including vulnerable users can cross in a safe and convenient manner. Pedestrian crossings will be placed as close to pedestrian desire lines as possible. Where pedestrians are required to cross a cycle track, this is proposed to be controlled by traffic signals to manage potential conflicts.

The preferred arrangement for pedestrians at junctions is to have a wrap-around pedestrian signal stage at the start of the cycle. In some instances, this will not be feasible i.e. due to crossing distances and the associated intergreen time for pedestrians to safely clear the junction. A “walk with traffic” system is therefore proposed at certain junctions, in particular where refuge islands have been introduced for a two stage pedestrian crossing. At these locations, controlled crossings for pedestrians is provided across part of the junction, whilst some of the traffic movements that are now in conflict with the pedestrian movement, are allowed to run at the same time. This facility has the advantage of allowing pedestrians to cross during the cycle whilst having less effect on traffic capacity.

5.3.2 Cyclists

The provision for cyclists at junctions is a critical factor in managing conflict and providing safe junctions for all road users. The primary conflict for cyclists is with left turning traffic.

Based on international best practice, the preferred layout for signalised junctions is the “Protected Junction”, which provides physical kerb build-outs to protect cyclists at junctions. The key design features and considerations relating to this junction type are listed below:

- The traffic signal arrangement will remove any uncontrolled conflict between pedestrians and cyclists, assigning clear priority to all users at different stages within a traffic signal cycle;
- Kerbed corner islands should be provided to force turning vehicles into a wide turn and remove the risk of vehicles cutting into the cycle route at the corner, which is a cause of serious accidents at junctions. The raised islands create a protective ring for cyclists navigating the junction, improving safety for right turning cyclists;
- Cycle tracks that are protected behind parking or loading bays will return to run along the edge of the carriageway approaching the junction. Consideration has been given to remove any parking or loading located immediately at junctions to enhance visibility between motorists and cyclists;
- The cycle track will be typically ramped down to carriageway level on approach to the junction and will proceed to a forward stop line. A secondary cycle stop line is also proposed at an advanced location to the vehicular stop line at a number of junctions to cater for right turning cyclists, which will also place the cyclists within view of traffic waiting at the junction. Cycle signals will control the movement of cyclists including the second stage movement i.e. right turners; and
- Cyclist and pedestrian crossings will be kept as close as possible to the mainline desire line. However pedestrian and cyclist crossings will be separated where feasible; in these instances 2-3m separation should be provided between crossings. This is to ensure motorists infer a clear differentiation between a cycle lane crossing through the junction and a pedestrian crossing across the same arm, which will be controlled separately for the most part.

In some junction locations, constraints in respect of physical space and junction configuration has meant that deflection of cycle tracks with kerbed corner islands is not feasible. In these cases, the cycle track will be aligned alongside the adjacent traffic lane on a straight-through path, with box-turns provided for right turning cyclists where appropriate.

5.3.3 Bus Priority

The Proposed Scheme design at junctions is based on typical layouts described in the BCPDGB document, which sets out four different types of junction, referred to as Junction Types 1-4 (in Section 7.4 Signalised Junction Operation of BCPDGB). The following subsections provide an overview of the context and principles for applying all or part of the junction type layouts for the Proposed Scheme design.

5.3.3.1 Junction Type 1

Junction Type 1 (refer to Section 7.4.1 of the BCPDGB) comprises a dedicated bus lane on both inbound and outbound directions which will continue up to the junction stop line. Due to space constraints, general traffic travelling both straight ahead and turning left will be restricted to one lane. Junction Type 1 is typically chosen for the following reasons:

- Volume of left turning vehicles greater than 100 PCUs per hour; and
- Urban setting, no space available for dedicated left turning lane / pocket.

In this instance, mainline cyclists will proceed with the bus phase. The bus lane gets red, allowing the general traffic lane to proceed. If the volume of turning vehicles is greater than 150 PCUs, then the cyclists should also be held on red. If the volume of left turners is approx. 100 – 150 PCUs, left turners will be controlled by a flashing amber arrow and cyclists should receive an early start.

A full Junction Type 1 has not been applied to the Proposed Scheme, however the Proposed Scheme has a number of ‘hybrid’ junctions, which comprise of a Junction Type 1 and another junction type, as shown in Figure 5.1.

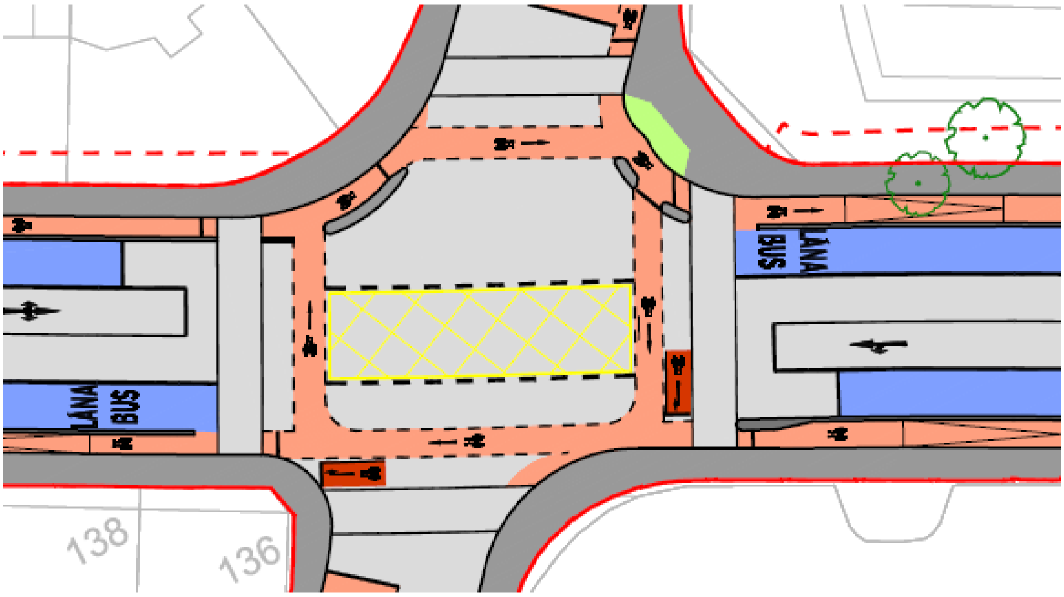


Figure 5.1: Junction Type 1

5.3.3.2 Junction Type 2

Junction Type 2 (refer to Section 7.4.2 of the BCPDGB), shown in Figure 5.2, comprises a signalised junction in a suburban context where there is room for additional lanes. A dedicated bus lane in both inbound and outbound directions will continue up to the junction stop line. On the bus lane approach to the junction a yellow box will be provided to allow left turners to cross the bus lane to enter a dedicated left turn pocket, where space permits. Junction Type 2 has been chosen for the following reasons:

- Suburban setting where space is available for a dedicated left turning lane / pocket; and
- High volume of left turning traffic which can be controlled separately with exiting traffic from side roads.

Figure 5.2: Junction Type 2

5.3.3.3 Junction Type 3

Junction Type 3 (refer to Section 7.4.3 of the BCPDGB) shown in Figure 5.3 illustrates a signalised junction where the inbound and outbound bus lane will terminate just short of the junction to allow left turners to turn left from a short left turn pocket in front of the bus lane. Buses can continue straight ahead from this pocket where a receiving bus lane is proposed. A Junction Type 3 is chosen for the following reasons:

- Volume of left turning vehicles is less than 100 PCUs per hour; and
- Urban setting, no space available for a dedicated left turning lane / pocket.

In this instance, mainline buses and general traffic (including left turners) will proceed together, but before they do, mainline cyclists will be given an early start of approximately 5 seconds to assist with cyclist priority and to minimise potential conflicts. When this early start is complete, the mainline cyclists can still proceed, assuming turning volumes are less than 150 PCUs per hour. Left turning from the left turn pocket will be given a flashing amber.

Figure 5.3: Junction Type 3

5.3.3.4 Junction Type 4

Junction Type 4 (refer to Section 7.4.4 of the BCPDGB), shown in Figure 5.4, is a signalised junction with an inbound and outbound bus lane, but also positions the pedestrian crossings on the inside of the cycle lanes across the arms of the junction. Pedestrian crossing distances will be minimised as a result. Signalised pedestrian crossings are proposed across the cycle tracks to allow pedestrians to cross from the footpath to the pedestrian crossing landing areas, thus avoiding uncontrolled pedestrian – cyclist conflict. Other key design features are that left turning cyclists can effectively bypass the junction, while giving way to pedestrians crossing as well as cyclists already on the orbital cycle track, and the number of crossings for pedestrians is increased as pedestrians must cross the cycle track to access the central signal controlled area.

Junction Type 4 is chosen for the following reasons:

- High incidence of HGV movements e.g. at industrial estates or where two major regional roads meet;
- Suburban setting and lower pedestrian volumes; and
- Appropriate space at junction corners to provide cycle tracks and pedestrian corner islands.

There are no Type 4 junctions within the Proposed Scheme.

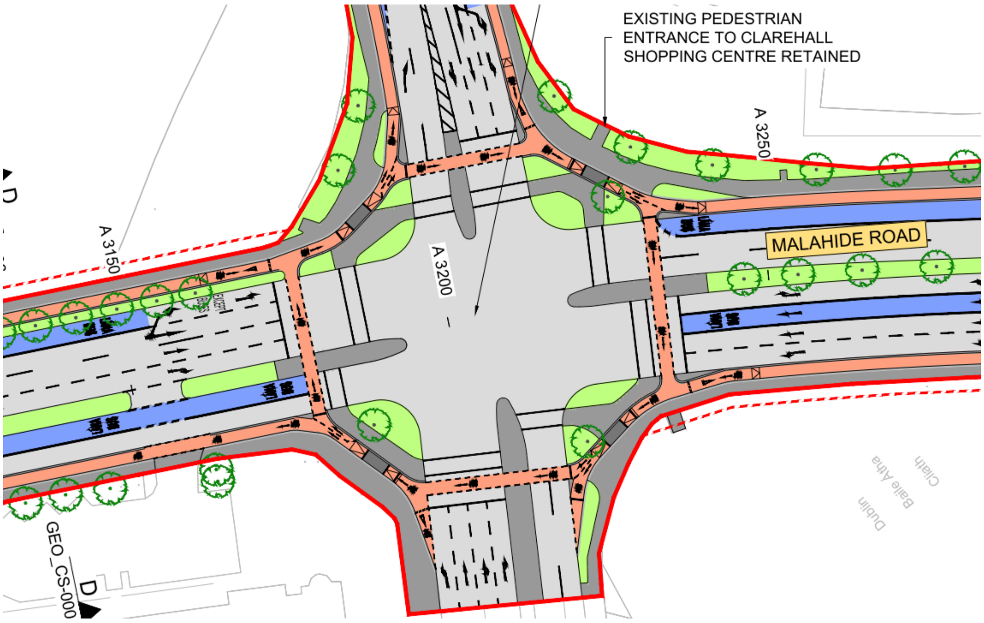


Figure 5.4: Junction Type 4

5.3.4 Staging and Phasing

The optimum staging for each junction is determined by the junction configuration and the level of demand for each movement. One of the key considerations in the design of the signalised junctions is the conflict between left turning traffic and buses, cyclists and pedestrians continuing along the main corridor. The following presents an overview of the design approach:

- Cyclists travelling through the junction across the side road will run with straight ahead traffic movements, including buses in a dedicated bus lane;
- A short early start for straight-ahead cyclists on the main corridor will enable cyclists to advance before general traffic. The amount of green given to cyclists is subject to junction dimensions and signal operation;
- Cycle movements along the main corridor, crossing the side road, can run simultaneously with the bus stage in the same direction, so long as the bus is not permitted to turn left from the bus lane; and
- Cycle movements at junctions are to be controlled by cycle signal aspects where there is an advance stop line ahead of the traffic signals including for hook turns at the far side of the side street crossing. Additional cycle signals are provided for right turning cyclists.

5.3.5 Junction Design Summary

A detailed junction assessment has been undertaken in line with the principles described in Section 5.3. The following summary tables provide an overview of the key design principles adopted at each junction location. More detailed information for each junction location can be found in the Junction Design Report in Appendix L.

The traffic signal junctions considered as having ‘major’ changes are listed in Table 5.1 below. This categorisation is based upon the size of the junction; the extent of physical work required to establish them; and the degree of change compared to the existing layout.

Table 5.1: Major Junctions (Signalised)

Drawing		**Name**	**Summary**
Section 2			
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0010	Merrion Road / Strand Road	The Merrion Gates junction will be altered to a consolidated T-junction with improved cycle facilities and to facilitate Signal Controlled Priority inbound. It will operate based on the Junction Type 1 arrangement inbound and Junction Type 3 outbound. It should be noted that this junction is integrated with the DART level crossing on the Strand Road arm. The design rationale was to improve cyclist facilities and safety at the junction, with accommodation for the two-way cycle facility proposed on Merrion Road, and to improve the safety of vehicles crossing the level crossing by signalising the junction.
Section 4			
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0016	Pembroke Road / Shelbourne Road	The junction will be based on Junction Type 3 and will be rationalised and reduced in size to improve the environment for pedestrians and cyclists. The northbound right-turning lane into Shelbourne Road will be removed and relocated to the junction of Pembroke Road and Lansdowne Road. The design will also include a right turn on to Herbert Park. Adjacent to the junction, the Elgin Road arm (of the existing junction) will be a left-in only priority side road off Pembroke Road. The design rationale was to ensure buses will have more priority at the junction and to reduce potential impacts on local access to Elgin Road and surrounding areas.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0017	Pembroke Road / Northumberland Road	The junction will be based on Junction Type 1. A right turn lane will be introduced from Pembroke Road onto Lansdowne Road to replace the movement at the Ballsbridge Junction (Pembroke Road / Shelbourne Road) that will be removed. The western approach to the junction will be reduced from two lanes to one lane. Bus lanes will be brought up to the junction rather than bypassing it via slip lane to Pembroke Road. The Design Rationale was to improve pedestrian and cyclist safety at the junction, integrate with the traffic management proposals on Pembroke Road, and provide improved bus priority.

Drawing		Name	Summary
			As there will be no receiving bus lane proposed on the Northumberland Road arm, and there may be both left-turning and straight through buses approaching from the southern arm, this southern arm will not be able to allow buses and general traffic run in the same stage.

The remainder of the traffic signal junctions fall into the 'Moderate' category, and are listed in Table 5.2 below:

The operation types described relate to the Typical Protected Junction Types within Section 7.4 of the BCPDGB.

Table 5.2: Moderate Junctions (Signalised)

Drawing		Name	Summary
Section 1			
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0001	Temple Hill / Temple Crescent	The junction will be based on Junction Type 1. The number of general traffic lanes will be reduced for better cycle provision and dedicated bus infrastructure. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety. A dedicated on-demand right turn phase for buses only onto Monkstown Road, with detection from northbound general traffic lane will be provided. This Intelligent Transport Systems (ITS) solution proposed for right turning buses is already being employed by Dublin City Council.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0001	Temple Hill / Newtown Avenue	The junction will be based on Junction Type 1. The segregated left turn lane will be removed to simplify the pedestrian movements. The pedestrian crossing on the western arm will be retained as a staggered crossing; however, the orientation will be reversed from existing. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.

Drawing		Name	Summary
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0002	Frascati Road / Temple Road	The junction will be based on Junction Type 1. The number of general traffic lanes will be reduced for better cycle provision and dedicated bus infrastructure. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety. The pedestrian crossing on the western arm will be retained as a staggered crossing to align with the existing situation with particular 3D geometrical constraints.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0003	Frascati Road / Carysfort Avenue	The junction will be based on Junction Type 1. The number of general traffic lanes will be reduced for better cycle provision and dedicated bus infrastructure. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0003	Rock Road / Rock Hill	The junction will be based on Junction Type 1. The junction will be reduced in size to improve the environment for pedestrians and cyclists including the removal of left turn lanes and flared entries into the junction. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety. The egress from Frascati Centre will be retained as two exit lanes and the existing left turn ban into Frascati Centre from Rock Road will be included.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0004	Rock Road / Mount Merrion Avenue	The junction will be based on Junction Type 1. The number of general traffic lanes will be reduced and the segregated left turn cycle lanes will be brought tighter into the junction for better cycle provision and dedicated bus infrastructure. The central island on Mount Merrion Avenue approach will be removed along with the left turn slip lane to Mount Merrion Avenue. A new pedestrian crossing on the western arm will be introduced. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.

Drawing		Name	Summary
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0005	Rock Road / Emmet Square [*Blackrock Clinic*]	The junction will be based on Junction Type 1. The number of general traffic lanes will be reduced for better cycle provision and dedicated bus infrastructure. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety, as well as reducing land take into adjacent property. The existing time restrictions on the right turn into the Blackrock Clinic from the Rock Road will be retained.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0007	Rock Road / Booterstown Avenue	The junction will be based on Junction Type 1. The number of general traffic lanes will be reduced for better cycle provision and dedicated bus infrastructure. The existing right turn ban to Booterstown DART Station will be retained. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety. The pedestrian crossing on the eastern arm will be converted to a straight across crossing as opposed to the existing staggered crossing. It was considered that a new crossing on the western arm was not required given the width of the crossing on the eastern side and the desire lines from Booterstown DART Station.
Section 2			
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0007	Rock Road / Booterstown Avenue	The junction will be based on Junction Type 1. The number of general traffic lanes will be reduced for better cycle provision and dedicated bus infrastructure. The existing right turn ban to Booterstown DART Station will be retained. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety. The pedestrian crossing on the eastern arm will be converted to a straight across crossing as opposed to the existing staggered crossing. It was considered that a new crossing on the western arm was not required given the width of the crossing on the eastern side and the desire lines from Booterstown DART Station.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0008	Rock Road / Trimleston Avenue	The junction will be based on Junction Type 1. The number of general traffic will be reduced for better cycle provision and dedicated bus infrastructure. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.

Drawing		Name	Summary
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0009	Merrion Road / Elmpark Green	The junction will be based on Junction Type 1. The junction will be reduced in size to improve the environment for pedestrians and cyclists including the removal of left turn lanes and their associated splitter islands. A new pedestrian crossing will also be introduced on the western arm. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0011	Merrion Road / St Vincent's Hospital	The junction will be based on Junction Type 3. The junction will be reduced in size to improve the environment for pedestrians and cyclists including the removal of left turn lanes and flared entries into the junction. A pedestrian crossing is to be introduced on the eastern arm. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety. The right turn pocket lane into Merrion Avenue from the eastern arm of the junction will be removed and the cross-section of the arm reduced as a result, with right turning vehicles turning from general traffic lane.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0012	Merrion Road / Nutley Lane	The junction will be based on Junction Type 3. The junction will be reduced in size to improve the environment for pedestrians and cyclists including the removal of left turn lanes flared entries into the junction. The design includes the continuation of outbound cycle lane along Merrion Road, along with a single traffic lane on the Nutley Lane arm. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety. Provisions have been included in the design to allow an outbound right turning bus enter the right turn lane towards Nutley Lane.
Section 3			
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0012	Merrion Road / Ailesbury Road	The junction will be based on Junction Type 1. The junction will be reduced in size to improve the environment for pedestrians and cyclists including the removal of the segregated left turn lanes and flared entries into the junction. Signal Controlled Priority will be introduced to enable the traffic management measures on Merrion Road between this junction and Shrewsbury Road. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.

Drawing		Name	Summary
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0014	Merrion Road / Shrewsbury Road	The junction will be based on Junction Type 1. This junction is currently a priority T-junction, however Signal Controlled Priority is to be implemented to enable the traffic management measures on Merrion Road between this junction and Ailesbury Road, and to provide pedestrian and cyclist facilities. The existing right turn ban onto Shelbourne Road will be maintained. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0015	Merrion Road / Sandymount Avenue	The junction will be based on Junction Type 3. The number of general traffic lanes will be reduced to improve the environment for pedestrians and cyclists as well as to provide bus priority through the junction, yet with left-turning vehicles to be allowed to turn from the bus lane.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0015	Merrion Road / Serpentine Avenue	The junction will be based on Junction Type 3. The junction will be reduced in size to improve the environment for pedestrians and cyclists including the removal of left turn lanes and flared entries into the junction. The design rationale was to provide more priority to buses and to improve cyclist safety. The traffic islands will be removed on the Merrion Road arms and southern footpath will be widened. The design rationale was to improve the pedestrian environment in an area of occasional high pedestrian activity (RDS events).
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0016	Pembroke Road / Anglesea Road	The junction will be based on Junction Type 1. The junction will be reduced in size to improve the environment for pedestrians and cyclists including the removal of splitter islands and flared entries into the staggered junction. A Toucan Crossing is proposed to connect the Dodder Cycle Route across Merrion Road, along with the removal of the left slip from Merrion Road to Anglesea Road. The design rationale was to allow cyclists to safely cross Merrion Road when cycling on the Dodder Cycleway and improve cyclist safety. The existing vehicular access to City of Dublin Education and Training Board (CDETB) will be relocated south onto Anglesea Road given the proposed removal of the slip lane at from which it is currently accessed.

Drawing		Name	Summary
Section 4			
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0019	Baggot Street Upper / Waterloo Road	The junction will be based on Junction Type 3. The number of general traffic lanes and on street parking will be reduced to improve the environment for pedestrians and cyclists as well as providing bus priority. A bus gate is proposed on Pembroke Road at the junction of Waterloo Road, removing the need for extensive permanent land acquisition along this section and allowing existing trees to be retained. Design rationale was to cater for the extremely high volumes of pedestrians in this area, provide space for trading purposes on Baggot Street Upper while protecting bus priority through this area and improving the urban realm of the Baggot Street Upper retail area. This arrangement will also reduce traffic on Pembroke Road and will give more priority to buses.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0019	Baggot Street Upper / Haddington Road	The junction will be based on Junction Type 1. No bus lanes are proposed through the junction enabled by Signal Controlled Priority on Baggot Street Upper approach and same at Baggot Street Upper / Herbert Place junction outbound. A no right turn from Mespil Road onto Baggot Street Upper will be introduced to assist in junction operation. An additional pedestrian crossing will be included on bridge arm of the junction. The existing advisory cycle lanes on Mespil Road will be upgraded to cycle tracks. Design rationale was to cater for the extremely high volumes of pedestrians in this area, provide space for trading purposes on Baggot Street Upper while protecting bus priority from Baggot Street Upper to Lower and vice versa, and improving the urban realm of the Baggot Street Upper retail area.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0020	Baggot St Upper / Herbert Place	The junction will be based on Junction Type 1. Vehicular turning movement from Herbert Place onto the bridge will be removed. The existing pedestrian crossing on the Baggot Street Lower Arm of the junction will be retained. The right turn from the bridge onto Herbert Place will be removed. There will be Signal Controlled Priority on Baggot Street Lower approach and on inbound approach to the Baggot Street Upper / Haddington Road junction. Design rationale was to improve pedestrians and cyclist facilities and prevent blocking of the junction from vehicles onto the bridge from Herbert Place and provide bus priority from Baggot Street Upper to Lower and vice versa.

Drawing		Name	Summary
BCIDC-ARP-GEO_GA-1415_XX_00-…	...-DR-CR-0021	Baggot Street Lower / Fitzwilliam Street Upper	The junction will be based on Junction Type 1. The number of general traffic lanes and on street parking will be reduced to improve the environment for pedestrians and cyclists as well as the provision of bus priority on the NE and SE arms. Buses turning right from left hand lane onto Fitzwilliam Street Lower will be enabled through Signal Controlled Priority. The on-set of the proposed bus lane on Fitzwilliam Street Lower will be curtailed due to constrained existing cross-section. Design rationale is to improve cyclist facilities at the junction and to provide priority for buses to turn right from Baggot Street Lower to Fitzwilliam Street.
BCIDC-ARP-GEO_GA-1415_XX_00-…	...-DR-CR-0021	Fitzwilliam Street Lower / Merrion Square E	The junction will be based on Junction Type 1. This is where the proposed scheme ends and ties in with Merrion Square and Mount Street Upper. The parking spaces on Fitzwilliam Street Lower will be removed for better cycle provision and dedicated bus infrastructure. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety
Section 5			
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0022	Stillorgan Road / Nutley Lane	The junction will be based on Junction Type 1. This is where the Proposed Scheme ties in with the existing measures on the R138 Stillorgan Road). The design is also such that it aligns with the current proposals within the Bray to City Centre Core Bus Corridor Scheme, and ensures both schemes can be completed independently as well as being compatible when both schemes are constructed. The design will include the incorporation of a two-way cycle crossing on southern arm of Stillorgan Road for better cycle provision and the introduction of controlled pedestrian crossing across Nutley Lane. Left turning vehicles from Nutley Lane will share the bus lane on approach to the junction as the left turn slip lane will be removed. The design rationale is to provide more priority to buses, enable bus priority signalling, and to improve pedestrian and cyclist safety.

Drawing		Name	Summary
BCIDC-ARP-GEO_GA-1415_XX_00-…	...DR-CR-0023	Nutley Lane / St Vincent's Hospital	The junction will be based on Junction Type 1. The junction will be reduced in size by removing flare on entry to the junction in order to maximise the provision for pedestrians and cyclists. Toucan crossings will be introduced on the northern and eastern arms to enable the transition from the two-way cycle track to the two single cycle facilities. The southbound bus lane on the southern arm will be curtailed, with bus priority to be enabled through Signal Controlled Priority, in order to minimise the impact of landtake on the adjacent property. With consideration for granted planning permission for the junction, a right turn lane is proposed from Nutley Lane into St. Vincent's University Hospital.

5.3.6 Minor and Priority Junctions

There are a total of 53 (not including minor access points for properties) minor junctions without signal control across the Proposed Scheme. These are shown in the General Arrangement drawings in Appendix B.

5.3.7 Roundabouts

The Proposed Scheme does not include any proposed nor existing roundabouts.

5.4 Junction Modelling

5.4.1 LinSig Modelling

Junction modelling using industry-standard LinSig software (version 3.2.40) was undertaken to assist the junction design process, as follows:

- To formulate appropriate signal staging for all movements at signal-controlled junctions;
- To understand delays / capacity characteristics for bus movements;
- To ensure that appropriate timings are included within the signal cycle to accommodate the necessary pedestrian and cyclist crossing times.

The LinSig analyses and junction layout design were undertaken on an iterative basis – with each junction subject to a design development process to achieve bus priority and enhanced provision for walking / cycling movements. In respect of general traffic, LinSig analysis was used to ensure that traffic movements could be practically accommodated within the junction signal staging, but without seeking to minimise delays to traffic.

The following assumptions were generally applied in the LinSig modelling:

- Cycle Time of 120s;

- Minimum Pedestrian Green Time 6s;
- Pedestrian Intergreen based on a walking speed of 1.2m per second plus a 2 second safety buffer;
- Cyclist Cruise Speed 15km/h; and
- Cyclist Early Start 5s on the majority of mainline arms, with 3s minimum. On the side roads of junctions, 3s cyclist early start.

Table 5.3 provides an overview of the LinSig junction analysis results. The Junction Design Report in Appendix L provides details of LinSig junction modelling outputs. It is noted that the LinSig models produced provide a basis for finalising junction designs, but that implementation of the proposed junctions will require detailed signal controller specifications and associated phasing plans to be produced.

Table 5.3: Proposed Scheme Signalised Junctions

Junction Name	Proposed Cycle Time (Seconds)	Practical Reserve Capacity (%)	
		AM peak Hour	PM Peak Hour
Temple Hill / Temple Crescent	120	53%	28%
Temple Hill / Newtown Avenue	120	3%	4%
Frascati Road / Temple Road	120	37%	44%
Frascati Road / Carysfort Avenue	120	16%	15%
Rock Road / Rock Hill	120	9%	7%
Rock Road / Mount Merrion Avenue	120	20%	4%
Rock Road / Emmet Square	120	42%	55%
Rock Road / Booterstown Avenue	120	2%	9%
Rock Road / Trimleston Avenue	120	5%	11%
Merrion Road / Elmpark Green	120	-17%	1%
Merrion Road / Strand Road	180	-34%	-34%
Merrion Road / St Vincent’s Hospital	120	85%	230%
Merrion Road / Nutley Lane	120	16%	26%
Merrion Road / Ailesbury Road	120	-13%	46%
Merrion Road / Shrewsbury Road	120	46%	122%
Merrion Road / Sandymount Road	120	6%	76%
Merrion Road / Serpentine Avenue	120	7%	72%
Pembroke Road / Anglesea Road	120	-13%	13%
Pembroke Road / Shelbourne Road	120	-7%	12%
Pembroke Road / Northumberland Road	120	-9%	10%
Baggot Street Upper / Waterloo Road	90	58%	165%
Baggot Street Upper / Haddington Road	90	-15%	9%

Junction Name	Proposed Cycle Time (Seconds)	Practical Reserve Capacity (%)	
		AM peak Hour	PM Peak Hour
Baggot Street Lower / Herbert Place	90	40%	63%
Baggot Street Lower / Fitzwilliam Street Upper	120	-7%	56%
Fitzwilliam Street Lower / Merrion Square E	90	1%	-3%
Stillorgan Road / Nutley Lane	120	-5%	56%
Nutley Lane / St Vincent's Hospital	120	31%	129%

Overall, the junction analyses show that all junctions along the corridor have feasible and functional signal staging plans which will ensure that buses will be able to proceed along the corridor with delays minimised, and that high quality crossing facilities are provided for cyclists and pedestrians. One particular location where some overcapacity issues are noted is:

- Merrion Road / Strand Road: This junction is being upgraded in terms of pedestrian and cyclist facilities, as well as catering for the DART level crossing, and for forecast flows does show some approach arms as overcapacity – but delays to buses are minimised, and provision for cyclists and pedestrians are much improved.

5.4.2 Forecast Traffic Flow Data for Junction Modelling

The EIA process for the Proposed Scheme included a traffic and transport assessment based on strategic area-wide modelling, utilising a Local Area Model (LAM) for the Proposed Scheme, which was a subset model of the NTA's Eastern Regional Model (ERM). The LAM outputs provide projected traffic flows for the situation with the Proposed Scheme in place (the 'Do Something' scenario), which were input to the LinSig junction models for purposes of refining junction designs. An iterative process was followed in which successive draft outputs from LinSig junction modelling (in respect of staging plans and timings) were coded into the LAM and the resultant LAM forecast traffic flow outputs were inputted to the LinSig models (for the AM and PM peak periods for the projected year of opening in 2028).

The Junction Design Report in Appendix L provides summaries of LinSig junction modelling outputs. The LinSig outputs show that the Proposed Scheme junction designs will operate effectively for the forecast flow scenarios with buses not subject to delay, and with appropriate provision within the signal operation for crossing movement of pedestrians and cyclists.

The EIA investigations also included development of a microsimulation model developed for the Proposed Scheme corridor. The LinSig outputs (in respect of staging plans and timings) were inputted to the corridor micro simulation model, which also assisted in assessing and optimising the junction designs and traffic control strategies. Figure 5.5 provides an overview of the LinSig and transport modelling processes for the proposed scheme.

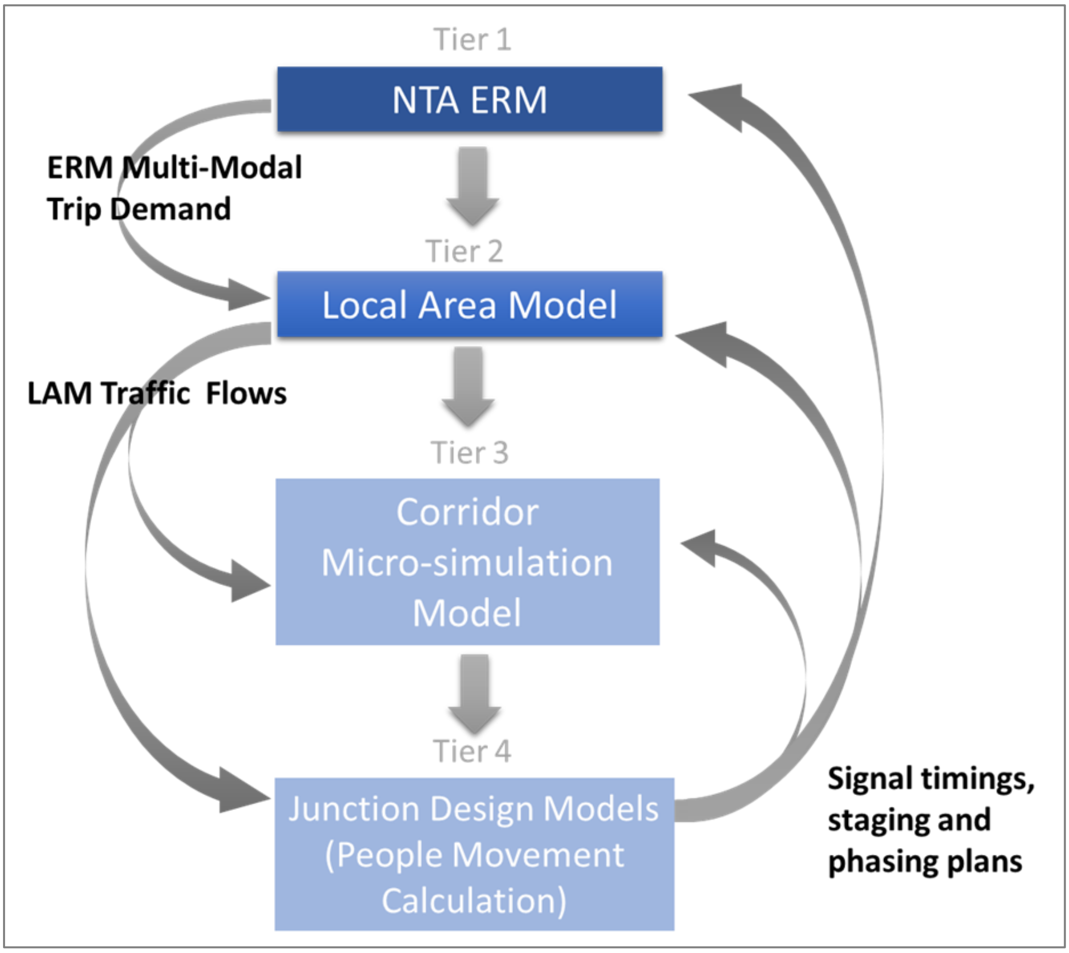


Figure 5.5: Scheme Transport Modelling Hierarchy

5.4.3 People Movement through Junctions

The design process for junctions has included assessments of the potential people movement throughput at each junction on the Proposed Scheme. For this purpose, a bespoke People Movement Calculation tool was developed, in which the number of people that can theoretically be carried through each junction by each mode was assessed, based on the signal green times allocated to each movement and the person-capacity of the car and bus motorised modes. This approach represents a policy-led influence on design iterations, and ensured that the focus of design was to maximise the number of people able to travel through each junction (rather than cars), with priority given in the design process to sustainable modes i.e. walking, cycling and bus – with a lesser priority given to general traffic movements by car.

The information used for the purposes of People Movement Calculation includes the following:

- Number of buses planned to travel on the corridor (informed by the BusConnects network design proposals);
- Estimated cycling demand (from the ERM), with consideration also to a higher policy-based cycle mode share;

- Pedestrian crossing width and resultant crossing timing requirements; and
- Vehicular capacity at each junction (derived by LinSig).

The Junction Design Report in Appendix L provides summaries of total theoretical movement capacity by each mode at each junction.

6 Ground Investigation and Ground Condition

6.1 Ground Investigation Overview

Following a review of the proposed alignments, a desk study was undertaken along the proposed Routes. A Ground Investigation (GI) was scoped and designed based on the findings of the desk study review. The following sections outline the desk study sources, the anticipated ground conditions, the scoped GI, the GI results and their interpretation. A separate section presents hydrogeological information. The last section presents the geotechnical considerations relevant to the proposed structures along the Proposed Scheme.

Refer also to Ground Investigation Report contained in Appendix E.

6.2 Desk Study

The site setting and geotechnical information for the site were obtained from publicly available information. The publicly available sources of information reviewed are as follows:

- 1836 – 1842 Historic map 6 inch (Geohive)
- 1888 – 1913 Historic map 25 inch (Geohive)
- 1830 – 1930 Historic map 6 inch – Cassini (Geohive)
- Contour map (EPA)
- Geological Survey of Ireland (GSI)
- Quaternary Sediments and Geomorphology map (GSI)
- Teagasc Soils map (GSI)
- Unconsolidated Sediments map (GSI)
- Bedrock, Geology100k map (GSI)
- Karst Features map (GSI)
- Depth to Bedrock map (GSI)
- Groundwater Aquifer map (GSI)
- Groundwater Vulnerability map (GSI)
- Groundwater Wells and Springs map (GSI)
- Groundwater Recharge map (GSI)
- Subsoil Permeability map (GSI)
- Active and Historic Pits and Quarries map (GSI)
- Mineral localities map (GSI)
- Historic Ground Investigations map (GSI)

- In-house Ground Investigations database
- Rivers of Dublin (C.L. Sweeney, 1991)

6.2.1 Existing Ground Conditions

6.2.1.1 Sections 1 and 2

The EPA contour map shows that the alignment is relatively flat sitting at less than 10m OD for the majority of the site. The alignment gently slopes up towards 20m OD at the southern end, near Monkstown Road.

The GSI Teagasc Soil map shows primarily Made Ground to be present along the majority of proposed alignment. Till derived from Limestone is shown at Temple Hill. Bedrock at surface is noted northeast to sections of Rock Road. At the southern end of Merrion Road, around Merrion House, Till derived from Limestone and Alluvium is also present. The GSI Quaternary geomorphology map presents Hummocky Sand and Gravel at Monkstown Road, close to Temple Hill and at Booterstown Avenue close to Rock Road. A meltwater channel crosses the Elm Park Golf course and the proposed alignment close to Merrion House. A second meltwater channel is noted south of Elm Park Golf course and approximately 500m west of the Proposed Scheme. The GSI Quaternary Subsoil map shows that the alignment is underlain mainly by Till derived from Limestone. Gravels derived from Limestone are noted close to Monkstown Road and Temple Hill and at the northern part of Booterstown Avenue. Marine Silts and Clays and bedrock outcrops are shown adjacent to the proposed alignment along Rock Road. Alluvium is present at the southern section of Merrion Road. The remaining part of the alignment which crosses along Merrion Road is underlain primarily by Marine Beach Sands and secondly by Till derived from Limestone.

The GSI bedrock- geology 100k map states that the rock type along the Proposed Scheme is Granite and Limestone. The Granite which is labelled as type 2p microcline porphyritic is shown to underlie the Proposed Scheme from Monkstown Road northwards to Mount Merrion Avenue. The bedrock underlying the rest of the proposed alignment is Limestone which is subdivided into two formations. The Ballysteen formation is noted between two faults. The first fault crosses Rock Road close to Ben Inagh Park and the second one at approximately Seafort Parade. The Lucan formation is shown to be present along the remaining part of the proposed alignment. The GSI Depth to Bedrock map presents rockhead to typically range from 0 to 10m BGL. According to the GSI karst database there are no karst features identified within the Proposed Scheme.

6.2.1.2 Sections 3, 4, and 5

The EPA contour map shows that the alignment crosses a relatively flat area the elevation of which is approximately 10m OD.

The GSI Teagasc Soil map shows Made Ground to be present along the proposed alignment.

The GSI Quaternary geomorphology maps do not present any feature along the Proposed Scheme. The GSI Quaternary Subsoil map shows that the southern section, along Nutley Lane, is underlain mainly by Till derived from Limestone. The area starting from approximately the corner of Nutley Lane and Merrion Road to Pembroke Road is underlain predominantly by Alluvial and to a lesser extent by Till derived from Limestone. Till is also recorded close to Ballsbridge. The last section along Pembroke Road, Fitzwilliam Place and Merrion Square South is underlain by Till derived from Limestone and Urban (i.e. Made Ground).

The GSI bedrock- geology 100k map states that the rock type along the Proposed Scheme is Limestone of the Lucan formation. The GSI Depth to Bedrock map presents rockhead to typically vary from 5 to 10m BGL. The rockhead is stated to range from 10 to 15m BGL at a portion of Merrion Road and the intersection of Pembroke Road and Fitzwilliam Place.

According to the GSI karst database there are no karst features identified within the Proposed Scheme.

6.3 Summary of Ground Investigation

6.3.1 Field Investigation

Following a review of the alignments and the findings of the desk study, a GI was specified with one GI being carried out for the areas relating to Sections 1 and 2 of the Proposed Scheme, and a second GI being carried out for the areas relating to Sections 3, 4 and 5 of the Proposed Scheme. The GI scopes for Proposed Scheme are presented herein.

6.3.1.1 Sections 1 and 2

The initial GI scope consisted of:

- 2 No. TPs to a maximum depth of 3m BGL
- 7 No. CP boreholes to a maximum depth of 10m BGL
- *In situ* testing (i.e. SPTs)
- 3 No. standpipe installations with groundwater monitoring
- Geotechnical and geo-environmental laboratory testing
- A geotechnical factual report

As shown below the completed GI was relatively consistent with the initial scope

- 2 No. TPs to a maximum depth of 2.9m BGL
- 7 No. CP boreholes to a maximum depth of 7.5m BGL
- *In situ* testing (i.e. SPTs)
- 3 No. standpipe installation with groundwater monitoring
- Geotechnical and geo-environmental laboratory testing

- A geotechnical factual report

6.3.1.2 Sections 3, 4, and 5

The initial GI scope included the following:

- 4 No. Trial Pits (TPs) to a maximum depth of 3m BGL
- 1 No. Cable Percussion (CP) boreholes to a maximum depth of 10m BGL
- *In situ* testing (i.e. SPTs)
- 1 No. standpipe installations with groundwater monitoring
- Geotechnical and geo-environmental laboratory testing
- A geotechnical factual report

Due to access constraints, investigations could not be completed at some locations. The scope of the completed GI consisted of:

- 3 No. TPs to a maximum depth of 2.9m BGL
- Geotechnical and geo-environmental laboratory testing
- A geotechnical factual report

6.3.2 Geotechnical Laboratory Testing

6.3.2.1 Sections 1 and 2

Scheduled geotechnical and geo-environmental laboratory testing laboratory tests included the following

- 10 No. Moisture content
- 10 No. Particle size distribution
- 10 No. Atterberg limits
- 10 No. Geo-Environmental testing (WAC assessment)
- A geotechnical factual report

6.3.2.2 Sections 3, 4, and 5

Scheduled geotechnical and geo-environmental laboratory testing laboratory tests included the following

- 5 No. Moisture content
- 3 No. Particle size distribution
- 5 No. Atterberg limits
- 9 No. Geo-Environmental testing (WAC assessment)
- A geotechnical factual report

6.4 Ground Summary and Material Properties

6.4.1 Sections 1 and 2

According to the TP logs the stratigraphy comprised Topsoil over Made Ground. The CP boreholes mainly recorded Topsoil and/or Made Ground over Cohesive Deposits. The CP boreholes also encountered Clay, firm Silt and Granular Deposits. Table 6.1 presents the encountered stratigraphy within the study area.

Table 6.1: Summary of GI results - Sections 1 and 2

Stratum	Description	Depth (m BGL)	Thickness (m)
Topsoil	Brown slightly sandy gravelly Topsoil	0.0	0.0 to 0.6
Made Ground	Concrete OR Grey very sandy Gravel OR Brown to brownish grey/greyish brown slightly sandy to sandy slightly gravelly to gravelly Clay with occasional fragments of glass or red and/or yellow brick and occasional mortar and wood	0.0 to 0.2	0.0 to 2.6
Clay	Soft to very soft brownish grey slightly sandy slightly gravelly to gravelly silty CLAY.	1.0	0.0 to 1.8
Granular deposits*	Loose greyish brown silty fine to coarse SAND with some shells.	2.7	0.0 to 1.2
Silt	Soft to firm dark greyish brown slightly gravelly sandy clayey SILT with some organics and shell fragments.	2.6	0.0 to > 1.2
Cohesive deposits	Stiff to very stiff brown slightly sandy gravelly to very gravelly silty Clay with occasional cobbles	0.6 to 3.9	0.0 to > 3.6

*Recorded only in R15-CP07A

6.4.2 Sections 3, 4, and 5

The TP logs recorded Topsoil overlying Made Ground or Cohesive Deposits. In one exploratory location (R14-TP01) Granular Deposits were encountered below Made Ground. The thickness of the Cohesive Deposits and of the Granular Deposits was not verified. Table 6.2 summarises the findings of the GI.

Table 6.2: Summary of GI results - Sections 3, 4 and 5

Stratum	Description	Depth (m BGL)	Thickness (m)
Topsoil	Brown to dark brown slightly sandy slightly gravelly Topsoil with occasional to frequent rootlets	0.0	0.25 to 0.3
Made Ground	Brown to dark brownish grey slightly sandy gravelly Clay with some angular to subangular cobbles, occasional boulders, occasional rootlets and occasional fragments of concrete, glass, plastic and red brick OR Light brown gravelly clayey fine to coarse Sand with some angular to subrounded cobbles, occasional rootlets and occasional fragments of wood	0.25 to 0.3	0.0 to > 1.7
Cohesive Deposits*	Firm to stiff to very stiff brown slightly sandy slightly gravelly to gravelly CLAY with occasional cobbles	0.25	0.0 to > 1.05
Granular deposits**	Brownish grey very gravelly fine to coarse SAND with some cobbles	2.0	0.0 to > 0.9

*Recorded only in R14-TP03

**Recorded only in R14-TP01

6.4.3 Contaminated Land

A ground investigation was carried out from September 2020 to November 2020 (Report reference - Project No:9754-07-20 R15, RevB, Final, 19.March.2021) and October 2020 (Report reference - Project No:9754-07-20 R15, RevC, Final, 08.March.2021) by GII Ltd. In the recent ground investigations, geo-environmental testing was undertaken on 32 No. samples, in natural ground and made ground, from ten ground investigation locations. Waste Acceptance Criteria (WAC) classification was carried out on these samples. The results of the WAC classification are given below:

- 22 No. of 32 No. test results were Inert.
- 5 No. of 32 No. these test results were Non-Hazardous.
  - At Clayton Hotel, near Merrion Road, R14 TP01 (0.5m)
  - Near Applegreen petrol station, Merrion Road, R15 TP01 (2.3m)
  - At Rock Road near Blackrock Park, R15 CP03 (0.5m)
  - Near Applegreen petrol station, Merrion Road, R15 CP06 (2.5m) and CP07 (2.5m)

- 5 No. of 32 No. test results were Hazardous.
  - Near Blackrock College, R15 TP02 (0.5m, 1.5m, 2.4m)
  - Interface of Castledawson Avenue and Rock Road, R15 CP02 (0.5m)
  - Near Applegreen petrol station, Merrion Road, R15 CP07 (0.5m)

However, the ground investigations do not cover the whole alignment and contamination is a possibility. Potential sources are listed in the Ground Investigation Report (GIR) within Appendix E.

6.4.4 Summary of Ground Investigation Report

6.4.4.1 Sections 1 and 2

The GI along Sections 1 and 2 recorded the following strata.

6.4.4.2 Topsoil

No interpretation is required for Topsoil. Wherever encountered it will be excavated and removed.

6.4.4.3 Made Ground

No interpretation is required for the Made Ground. Wherever encountered it will be excavated and removed.

6.4.4.4 Clay

Clay was encountered at R15-CP05 and 07A. The laboratory classification tests and the soil descriptions as included in the CP logs indicated that this material is a low plasticity Clay with silt, sand, gravel and boulder content. The laboratory results and above soil descriptions are very similar to the Dublin Boulder Clay stratum presented previously. Yet, the stiffness of this material is very low which is uncommon for a Dublin Boulder Clay. This material is believed to be poorly reworked Boulder Clay/ Made Ground. As a result, no interpretation is required for. Wherever encountered it will be excavated and removed.

6.4.4.5 Granular Deposits

Granular deposits were encountered only in R15-CP07A which is located close to the beach. This proximity to the sea, the low SPT values and the presence of shells suggested that these deposits were of estuarine or marine origin. The PSD results showed that the material is granular with low content of fines. Taking the above into account, this layer is interpreted as Marine Beach Sands.

The following parameters will be provided for the Marine Beach Sands.

Weight density

Based on the available GI results this stratum is described as a loose sand below the groundwater table. This leads to a γ value ranging between 18 to 20kN/m^3 (BS8002: 2015). A value of 19kN/m^3 is adopted.

In situ stress

As described in previous sections the K_0 will be calculated as a function of φ.

$K_0 = 1 - \sin\varphi = 0.50$*

*φ value is presented below as $\varphi'_{cv,k}$

Effective strength

Peck *et al* established a relationship between the SPT N and $\varphi'_{cv,k}$ for coarse-grained soils. Following from that a graph was introduced corelating the above parameters. An SPT test was carried out within the examined stratum and an SPT N value of 8 was recorded. This value, according to the graph mentioned above, corresponds to a $\varphi'_{cv,k}$ of approximately 29°.

The approach presented in BS8002: 2015 leads to a $\varphi'_{cv,k}$ of 30° as the angularity of the particles is not described in the logs and there is only one available PSD graph. A $\varphi'_{cv,k}$ value of 30° is selected. Due to the nature of this layer (coarse-grained) c´= 0kPa

Stiffness

For the estimation of the stiffness the following empirical relationship will be used:

E´ = 1.5 SPT N (in MPa) which leads to an E´ of 12MPa.

6.4.4.6 Silt

Soft to firm Silt was recorded in R15-CP06 and 07A which are both located close to the beach. This proximity to the sea, the low to medium SPT values and the presence of shells suggested that this layer was of estuarine or marine origin. The PSD results showed that the material is fine-grained with high sand and gravel content which is typical for Estuarine Silts.

The following parameters will be provided for the Estuarine Silts.

Weight density

According to BS8002: 2015 a silt has a weight density which ranges from 15 to 21kN/m^3. A value of 17kN/m^3 is adopted.

In situ stress

No *in situ* testing or laboratory testing in which K_0 is directly or indirectly measured was carried out as part of the GI. The following empirical formula will be used for the estimation of the K_0.

$K_0 = 1 - \sin\varphi = 0.53$*

*φ value is presented below as $\varphi'_{cv,k}$.

Total strength

In the absence of geotechnical laboratory testing like triaxial testing, the total strength parameter will be estimated based on the soil descriptions following a same approach as described in previous sections. Logs describe the stiffness of this layer as soft to firm. According to BS5930:2015, a soft clay has a c_u which varies from 20 to 40kPa while a stiff clay has a c_u value which ranges from 40 to 75kPa. A c_u value of 40kPa is selected.

Effective strength

For the calculation of the angle of shearing resistance ($\varphi'_{cv,k}$) in fine soils BS8002:2015 presents the following equation:

$\varphi'_{cv,k} = (42° - 12.5\log10IP)$

where IP is the plasticity index

The classification tests showed a IP of 13% which leads to a $\varphi'_{cv,k}$ of 28°. This value is adopted. In terms of the c´ a value of 0kPa is adopted.

Stiffness

No stiffness parameter will be attributed to Estuarine Silts due to insufficient data.

6.4.4.7 Cohesive Deposits

Cohesive Deposits were recorded at multiple locations. The laboratory classification tests and the soil descriptions as included in the CP logs indicated that this material is a low plasticity brown to grey Clay with silt, sand, gravel and boulder content. This material is known as Dublin Boulder Clay.

The following parameters will be provided for the Dublin Boulder Clay.

Weight density

Similarly, to section 6.5.1.3 a value of 20kN/m^3 is adopted.

In situ stress

Similarly, to section 6.5.1. 3 a value of 1.5 is chosen.

Total strength

The soil descriptions in the logs at the geotechnical report are in accordance with BS5930:2015. R15-CP03 log describes the stiffness of the Boulder Clay primarily as stiff. A stiff clay, according to BS5930:2015, has a c_u value which varies from 75 to 150kPa. The recorded SPTs values shown at the borehole log were 19, 17 and refusal. Due to the limited number of SPTs the lowest value will be adopted. The classification testing carried out at samples taken from this stratum showed a PI varying from 14 to 17%. Based on Stroud and Butler graph (1975) such PI values correspond to an f_1 value of around 6.

The c_u can be calculated as SPT N x f_1 which will lead to 102kPa. Taking the above into account a c_u value of 90kPa is chosen for design.

Effective strength

Following a same approach as in section 6.5.1.3 a value of $\varphi'_p = \varphi'_{cs} = 34°$ is chosen for design.

Stiffness

As presented in section 6.5.1.3

$E_u = 600 \times c_u = 54MPa$

The drained stiffness (E´) can be approximated by taking 80% of this value which leads to a value of approximately 43MPa.

6.4.4.8 Sections 3, 4, and 5

As stated earlier the GI along Sections 3, 4, and 5 encountered Topsoil, Made Ground, Cohesive and Granular Deposits.

6.4.4.9 Topsoil

No interpretation is required for Topsoil. Wherever encountered it will be excavated and removed.

6.4.4.10 Made Ground

No interpretation is required for the Made Ground. Wherever encountered it will be excavated and removed.

6.4.4.11 Cohesive Deposits

Cohesive deposits were only encountered at R14-TP03. The laboratory classification tests and the soil descriptions as included in the TP log indicated that this material is a low plasticity brown Clay with silt, sand, gravel and boulder content. This material is known as Dublin Boulder Clay which is a subdivision of Till derived from Limestone.

The following parameters will be provided for the Dublin Boulder Clay.

Weight density

In the absence of laboratory testing which could measure the weight density (γ) directly or indirectly reference is made to BS8002: 2015. According to this document a clay with high undrained shear strength, like the one examined herein, has a weight density which typically varies from 17 to 22kN/m^3. A value of 20kN/m^3 is adopted.

In situ stress

No *in situ* testing or laboratory testing in which K_0 is directly or indirectly measured was carried out as part of the GI. Long & Menkiti (2007) recommended a K_0 value in the range of 1.0 to 1.5 for design. Taking the above into account a value of 1.5 is chosen.

Total strength

In the absence of *in situ* testing such as SPTs and geotechnical laboratory testing like triaxial testing, the total strength parameter will be estimated based on the soil descriptions. The soil descriptions in the logs at the geotechnical report are in accordance with BS5930:2015. R14-TP03 log describes the stiffness of the Boulder Clay as firm to stiff to very stiff. Due to the very limited data only the firm an stiff clay will be examined herein. According to BS5930:2015, a firm clay has a c_u which varies from 40 to 75kPa while a stiff clay has a c_u value which ranges from 75 to 150kPa. Taking the above into account a c_u value of 75kPa is selected.

Effective strength

No effective stress shear strength laboratory testing was carried out on samples of Dublin Boulder Clay as part of this project. Long and Menkiti (2007) report a value of 44° for the peak compressive angle of shearing resistance (φ'_p) for all formations of the Dublin Boulder Clay. Long and Mentiki (2007) also report a value of 36° for the critical state angle of shearing resistance (φ'_{cs}). This value of φ'_{cs} compares favourably with the findings of Lehane and Faulkner (1998) and Farrell and Wall (1990) who report values of 34°±1° and 35° respectively. In all cases a $c' = 0$kPa is recommended. Taking the above into account a value of $\varphi'_p = \varphi'_{cs} = 34°$ is chosen for design.

Stiffness

For stiff consolidated clays, the soil undrained stiffness (E_u) can be calculated based on the relationship with undrained shear strength. Published data suggests a value of E_u between 500 c_u and 1000 c_u. In the examined case the E_u will be calculated as follows:

$E_u = 600 \times c_u = 45$MPa

The drained stiffness (E') can be approximated by taking 80% of this value which leads to a value of approximately 36MPa.

6.4.4.12 Granular Deposits

Granular deposits were only encountered at R14-TP01. The laboratory classification tests and the soil descriptions as included in the TP log stated that this material is very gravelly Sand without fines. This Particle Size Distribution (PSD) is typical for Alluvial Deposits.

The following parameters will be provided for the Alluvial Deposits.

Weight density

In the absence of laboratory testing reference is made to BS8002: 2015. According to it the γ of a sand ranges from 14 to 22kN/m^3 depending on its density and whether or not is above groundwater table. These two parameters are not included into the factual geotechnical report. A value of 18kNm^3 is proposed for this stage.

In situ stress

No *in situ* testing or laboratory testing in which K_0 is directly or indirectly measured was carried out as part of the GI. The following empirical formula will be used for the estimation of the K_0.

$K_0 = 1 - \sin\varphi = 0.47$*

*φ value is presented below as $\varphi'_{cv,k}$

Effective strength

For the calculation of the angle of shearing resistance ($\varphi'_{cv,k}$) the following formula, as presented in BS8002: 2015, will be used:

$\varphi'_{cv,k}=30°+\varphi'_{ang}+\varphi'_{PSD}$

where

φ'_{ang} is contribution to $\varphi'_{cv,k}$ from the angularity of the particles

φ'_{PSD} is contribution to $\varphi'_{cv,k}$ from the soil's particle size distribution.

The angularity of the stratum is described as sub-angular to sub-rounded which corresponds to a φ'_{ang} value of 2°. The PSD results are not available at the time of writing therefore φ'_{PSD} will not be taken into account. A $\varphi'_{cv,k}$ value of 32° is selected.

Due to the nature of this layer (coarse-grained) c´= 0kPa.

Stiffness

Stiffness cannot be provided due to insufficient data.

6.4.5 Geotechnical Parameters

6.4.5.1 Sections 1 and 2

Table 6.3 below presents the geotechnical parameters for the strata encountered during the GI along Sections 1 and 2.

Table 6.3: Geotechnical parameters – Sections 1 and 2

Stratum	γ (kN/m³)	K_0	c_u (kPa)	φ (°)	c´ (kPa)	E_u (MPa)	E´ (MPa)
Topsoil	No geotechnical parameters will be provided for these layers						
Made Ground (including the soft clay)							
Marine Beach Sands	19	0.5	N/A	30	0	N/A	12
Estuarine Silts	17	0.53	40	28	0	Not provided	
Dublin Boulder Clay	20	1.5	90	34	0	54	43

6.4.5.2 Sections 3, 4, and 5

Table 6.4 summarises the geotechnical parameters for the strata encountered during the GI for Sections 3, 4, and 5.

Table 6.4: Geotechnical parameters – Sections 3, 4, and 5

Stratum	γ (kN/m³)	K_0	c_u (kPa)	φ (°)	c´ (kPa)	E_u (MPa)	E´ (MPa)
Topsoil	No geotechnical parameters will be provided for these layers						
Made Ground							
Dublin Boulder Clay	20	1.5	75	34	0	45	36
Alluvial Deposits	18	0.47	N/A	32	0	N/A	Not provided

6.5 Overview of Soil Classification

6.5.1 Sections 1 and 2

The ground conditions along Sections 1 and 2 are as follows:

- Topsoil and/or Made Ground are expected to present along proposed Route.
- Marine Beach Sands and Estuarine Silts are expected to be encountered below Made Ground at the northeast part of Rock Road and Merrion Road.

- Dublin Boulder Clay is expected to be present Made Ground and/or natural material and to extend up to rockhead. Dublin Boulder Clay is expected to be present along Sections 1 and 2.

It should be noted that the desk study showed Alluvium which was not confirmed by the conducted GI.

6.5.2 Sections 3, 4, and 5

The ground conditions along Sections 3, 4, and 5 are as follows:

- Topsoil and/or Made Ground is expected to be present along proposed Route.
- Alluvial is expected to be encountered below Topsoil and/or Made Ground along Merrion Road.
- Dublin Boulder Clay is expected to be present below Topsoil, Made Ground and/or Alluvial deposits and to extend up to rockhead. Dublin Boulder Clay is expected to be present along Sections 3, 4, and 5.

6.6 Groundwater

6.6.1 Section 1 and 2

3 No. standpipe installations was carried out during the ground investigation. Groundwaters were measured only one time per borehole. Measured groundwater depts are listed below;

- R15-CP05 Borehole drilled to 4.3m below ground level. Groundwater was not encountered.
- R15-CP06 2.6m below ground level
- R15-CP07A 2.5m below ground level

Groundwater was encountered at 1.9m below ground level during excavation od R15-TP01.

6.6.2 Section 3, 4 and 5

Groundwater was not encountered during excavation of the three trial pits.

Based on the findings of the desk study the groundwater level anticipated to be between 1.5m BGL and 7m BGL based on limited groundwater monitoring and observations during the Ground Investigations.

6.7 Hydrogeology

6.7.1 Sections 1 and 2

The GSI Groundwater Aquifer map states that the aquifer is poor, as the bedrock is generally unproductive except for local zones, along the southern section of the Proposed Scheme. The aquifer changes to locally important from around the corner of Mount Merrion Avenue and Frascati Road. At that point a bedrock aquifer faults crosses the alignment. A second bedrock aquifer faults crosses Rock Road between Mount Merrion and Booterstown Avenue. The groundwater vulnerability is classified typically as high to extreme. Yet, from Merrion House and for the remaining northern section it is shown as moderate. Based on the relevant GSI map the subsoil permeability is assessed as low. It is noted that that the permeability has not been mapped/assessed for the southern and central section of Rock Road. This section is approximately located between Mount Merrion and Booterstown Avenue.

The GSI map (Wells and Springs) does not record any other well/spring within Sections 1 and 2. The route does not lie within a Group Scheme or Public Supply Source Protection Area.

6.7.2 Sections 3, 4, and 5

Based on the GSI Groundwater Aquifer map the Proposed Scheme crosses areas where the aquifer is classified as locally important. The bedrock is moderately productive only in local zones. According to the relevant GSI map the groundwater vulnerability varies from low to moderate. The subsoil permeability along the Route is classified as low (GSI; Subsoil Permeability map). The GSI Wells and Springs map shows a feature approximately 100m east of Nutley Lane and Merrion Road corner. A well is also present within Elm Park Golf Course, approximately 600m east to Nutley Lane.

6.8 Geotechnical Inputs to Structures

The Proposed Scheme includes widening of existing and construction of new pavements. In the absence of *in situ* testing such as California Bearing Ratio (CBR) tests, the CBR values will be estimated taking into account the existing GI results. Based on them the anticipated CBR values are expected to typically range from 2.5 to 3.5%. These values will have to be confirmed at a later stage.

The following presents geotechnical inputs to the new structure(s) within Section 1 of the Proposed Scheme. The current design does not include any structures within Sections 2 to 5 of the Proposed Scheme.

6.8.1 Retaining Walls

6.8.1.1 Retaining Wall 01 (RW01)

RW01, shown in Figure 6.1, will be a new retaining wall proposed within Section 1 of the Proposed Scheme along Rock Road at Blackrock Park.

Figure 6.1: Location of RW01

The retaining wall will be constructed adjacent to Rock Road from approximate chainage A1320 to A1550. Based on the desk study the ground condition comprise Made Ground over Till derived from Limestone over Limestone. Exploratory locations R15-CP03 verified the stratigraphy of the overburden (rockhead and rock type was not verified) as it recorded a 1.7m thick layer of Made Ground over a 2.4m thick layer of Dublin Boulder Clay. Taking into account the stratigraphy and the height of the proposed retaining wall a slope of 1:1.5 is proposed for the initial calculations of the land take. The proposed retaining wall is expected to be founded on Dublin Boulder Clay. In case localised softer material is encountered during construction works this material will have to be excavated and replaced with a granular fill material (i.e. 6N).

Table 6.5 summarises the geotechnical input to the proposed structure.

Table 6.5: Geotechnical input parameters

Stratum	γ (kN/m^3)	K_0	c_u (kPa)	c (kPa)	φ (°)	E_u (kPa)	E´ (kPa)
Dublin Boulder Clay	20	1.5	90	0	35	54	43

Estuarine Silts and Clays are noted in the vicinity of the examined section.

The relevant drawing of RW01 is contained within Appendix B.

7 Pavement, Kerbs, Footways and Paved Areas

7.1 Pavement

7.1.1 Overview of Pavement

This section covers the preliminary design for the following pavement assets:

- General traffic lanes,
- Bus lanes,
- On-road cycle tracks, and
- Other specific trafficked areas (e.g. off-line bus stops, bus terminals, off-line parking and loading bays).

For the Proposed Scheme, two pavement networks are being considered, the primary and the secondary networks. The primary network refers to the bus corridor under consideration, while the secondary network refers to the roads impacted by the re-routing of existing traffic from the Proposed Scheme to the nearby road network.

The preliminary design of pavement assets is based on the following standards:

- DN-PAV-03021 (Dec. 2010) – Pavement and Foundation Design;
- DN-PAV-03023 (Jun. 2020) – Surfacing Materials for New and Maintenance Construction for use in Ireland;
- AM-PAV-06050 (Mar. 2020) – Pavement Assessment, Repair and Renewal Principles;
- PE-SMG-02002 (Dec. 2010) – Traffic Assessment;
- CC-SPW-00600 (Mar. 2013) – Specification for Road Works Series 600 – Earthworks;
- CC-SPW-00700 (Jan. 2016) – Specification for Road Works Series 700 – Road Pavements – General;
- CC-SPW-00800 (Mar. 2013) – Specification for Road Works Series 800 – Road Pavements – Unbound and Cement Bound Mixtures;
- CC-SPW-00900 (Sep. 2017) – Specification for Road Works Series 900 – Road Pavements – Bituminous Materials.

This section identifies the proposed pavement strategy, setting out the design development considerations for the pavement works in current and future design stages. It also outlines the key elements for consideration for future testing requirements, and consideration for the valorisation of reusable and recyclable materials in new pavement materials in the detailed design stage.

The different pavement assets are designed taking consideration of:

- Traffic loads
- Changes in road geometry;
- Existing pavement construction build-up;
- Existing pavement condition;
- Landscape Architect’s requirements;
- The impact of other assets such as drainage, utilities and structures.

7.1.2 Design Constraints

7.1.2.1 Traffic Loading Considerations

Use of current Traffic Count data (Traffic Count Data 2019-2020) has been undertaken, to understand the current traffic loads and how they link with the existing pavement construction build-up. A representation of traffic counts along the Proposed Scheme is displayed in Figure 7.1 and Figure 7.2

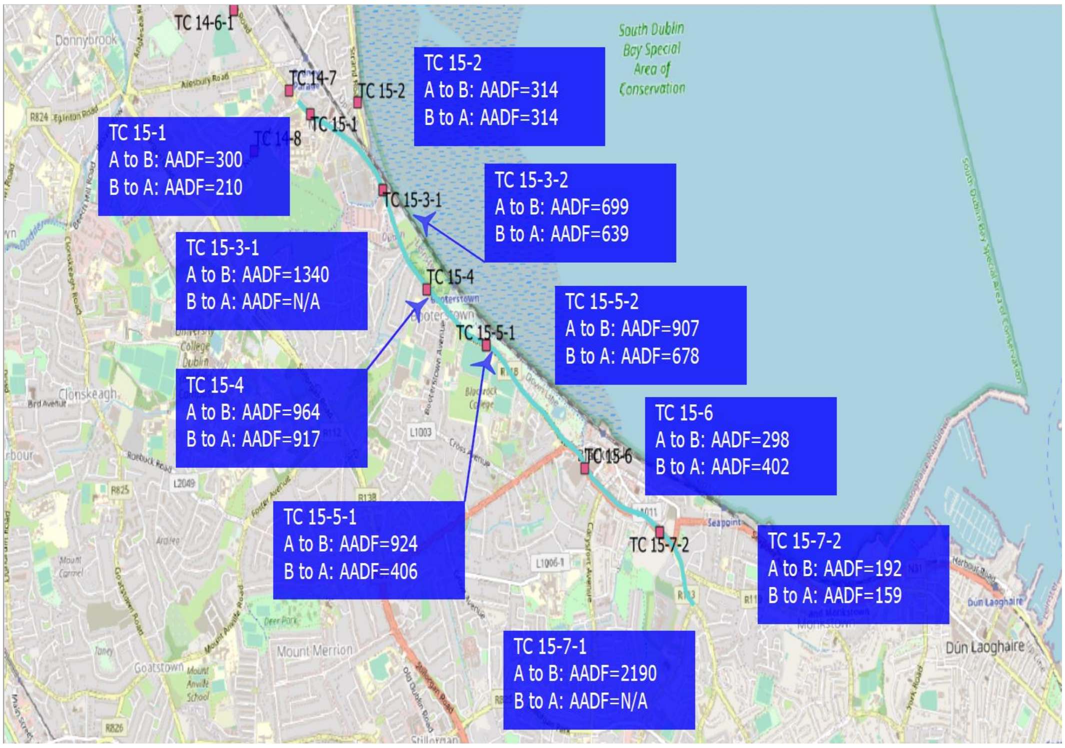


Figure 7.1: 2019-2020 AADF – Sections 1 and 2

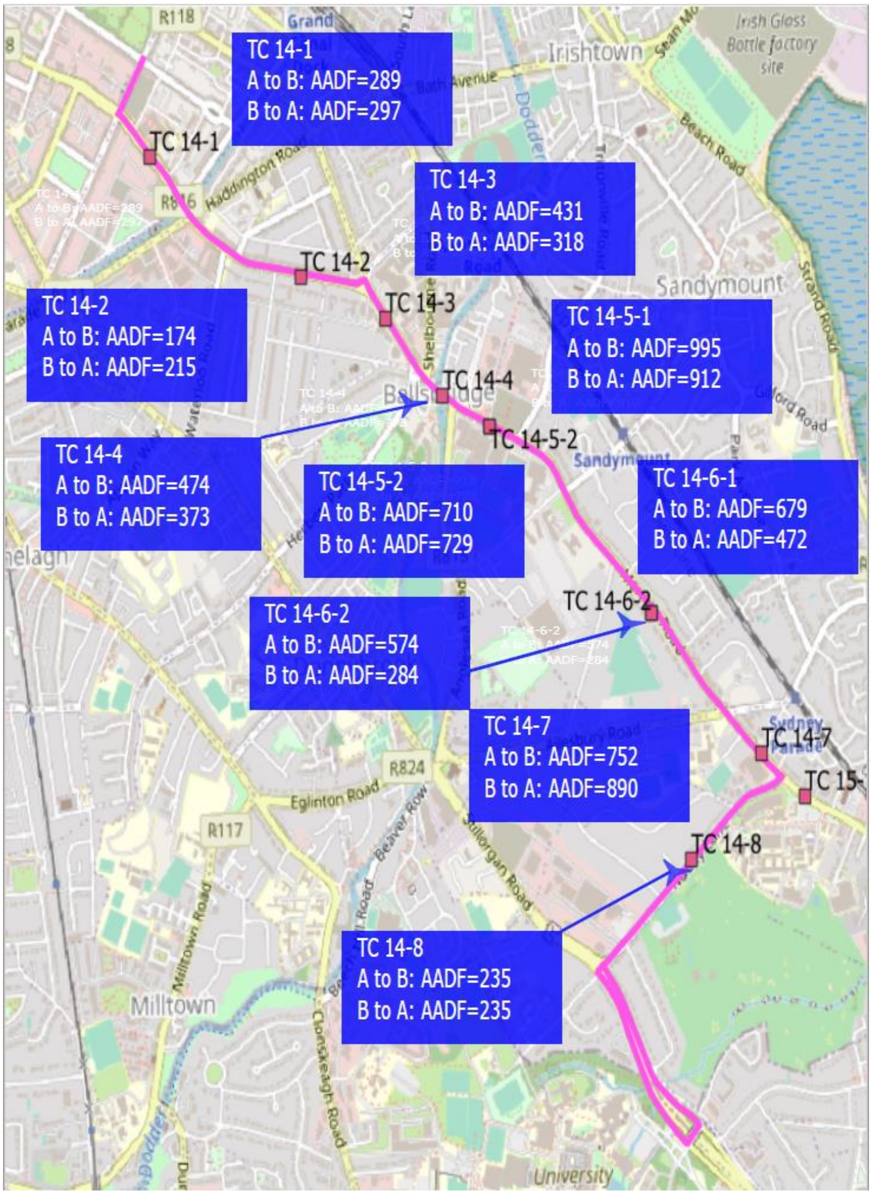


Figure 7.2: 2019-2020 AADF – Sections 3, 4, and 5

Assuming that all works were built for 20-, 30- or 40-year Design Life, the following Design Traffics were estimated.

Table 7.1: Estimated Design Traffic ranges for the Proposed Scheme.

Scheme Section(s)	Design Life		
	20 Years	30 Years	40 Years
1 - 2	1.5 to 16 msa	2 to 24 msa	2.5 to 32 msa
3 - 4 - 5	1.5 to 7.5 msa	2 to 11 msa	3 to 15 msa
Note: “msa” stands for million standard axles.			

The Design Traffic ranges displayed in Table 7.1 above are to be read in conjunction with the Construction data given in Section 7.1.2.10. Analysis of those two sets of data will allow the pavement designer to assess the probability of an existing pavement being fit for current purpose or not.

BusConnects bus traffic data (Revised Network Frequencies) have been used to design bus only permitted lanes. This traffic data does not account for other commercial vehicle use such as non-BusConnects buses.

Traffic Designs have initially been calculated for four different Design Lives: 20 years, 30 years and 40 years and "long life" as per Table 7.2 below.

The Growth Factor for BusConnects buses has been assumed to be 1.

Table 7.2: BusConnects Buses only Traffic Design in Million Standard Axles (msa)

BusConnects Buses only Traffic Design (msa)				
Scheme Section(s)	**20-year Design Life**	**30-year Design Life**	**40-year Design Life**	**"Long life"**
1 - 2	4.5	6.5	8.5	80+
3 - 4 - 5	11	16.5	22	80+

Specific loading areas will be identified and characterised along the Proposed Scheme:

- Bus stops (on- and off-line);
- Terminus;
- Loading / Unloading areas for delivery vehicles;
- Off-line parking areas; and
- Traffic calming features.

7.1.2.2 Geometry Considerations

The Proposed Scheme is proposed to be constructed on existing pavement assets, within constrained urbanised environments. It is therefore essential for the preliminary pavement design to consider the current road geometry and how it is proposed to be amended for the purpose of the Proposed Scheme.

The following road geometry changes expected to have an impact on the preliminary pavement design are:

- Widening;
- Narrowing;
- Horizontal realignment leading to relocation of pavement longitudinal joints (in relation to location of wheel tracks);
- Increase in vertical alignment;
- Decrease in vertical alignment;
- Relocation of traffic islands; and
- Any combination of the above.

These are expanded upon in the subsequent sections.

7.1.2.3 Widening

- Widening is about extending transversely a rehabilitated existing pavement ensuring that the pavement structure shall be consistent from kerb to kerb and drainage paths are being maintained. It is therefore essential to understand what the existing pavement construction and condition is, as well as how it will be rehabilitated, before finalising the design of any widening.
- It is proposed that any widening will be the full width of any proposed new lane, be it a cycle lane, a bus lane or a general traffic lane. The widened lane shall be tied to the existing pavement as per transverse and longitudinal joint details CC-SCD-00704 (Dec. 2010) and CC-SCD-00703 (Sep. 2010).

7.1.2.4 Narrowing

- Narrowing the pavement is probably the least disturbing geometrical change. Attention should however be given to the location of longitudinal joints in the existing pavement, if the alignment of the traffic lanes is being shifted one way or the other. No longitudinal joint should be located in the wheel tracks.
- It is proposed for any narrowing to be limited, in terms of excavation, to the area between the existing and the proposed kerblines.

7.1.2.5 Horizontal Alignment

Usually combined with a widening or a narrowing, a change in lanes alignment will result in the relocation of wheel tracks on the transverse profile of the pavement. If it leads to the relocation of the wheel tracks above an existing pavement joint, pavement works are required to prevent accelerated deterioration. Those pavement works could consist of the relocation of longitudinal joints in the binder and surface courses, by renewal of both layers. A geotextile will also be installed on top of the longitudinal joint in the base course to delay reflective cracking.

7.1.2.6 Increase in Vertical Alignment

Depending on the level of rehabilitation works required, it is proposed that the existing surface course be removed, as a minimum, before overlaying to the new finish level. The use of regulating layers and materials is likely to be required.

7.1.2.7 Decrease in Vertical Alignment

Depending on the level of rehabilitation works required, it is proposed that the existing pavement be cold milled down to the proposed finished level of the binder course, as a minimum. If the bond between the layer being cold milled into and the underlying layer is weak (i.e. the planer removed the material down to the interface at some locations), cold milling should be extended to this interface.

7.1.2.8 Relocation of Traffic Islands

Existing traffic islands to be relocated or removed should be fully excavated, while proposed traffic islands may use the existing pavement as foundation where appropriate.

7.1.2.9 Existing Pavement Considerations

7.1.2.10 Construction

- As mentioned in the section above on geometrical constraints, as the Proposed Scheme runs on existing pavement assets, it is essential to gather intelligence on those existing assets in terms of construction build-up and condition.
- For the portion of Section 1 of the Proposed Scheme running on the N31 national route, carriageway depth data is available from TII's 2013 GPR survey as shown in Table 7.3. It provides overall depth of bituminous materials (upper pavement) as well as overall depth of underlying unbound granular materials (foundation). It is important to note that the survey does not give any additional information on either the bituminous or the unbound granular materials (e.g. number of layers and associated thickness, specific type of materials, bond between layers, condition of the materials). Educated assumptions are therefore required to identify the pavement types. The age of the pavement structure and its structural maintenance history are also unknown, making it impossible at this stage to estimate how much life is left in each pavement asset.
- In addition, no information about tar contaminated material was made available.

Table 7.3: Expected Pavement Construction Build-ups on the Proposed Scheme

Scheme Section(s)	TII Chainage (km)	Thickness of Bituminous Materials (mm)	Thickness of Granular Materials (mm)	Likely Pavement Type
1	3.3 to 4.4	98 to 256 (180 average)	482 to 670 (581 average)	Possibly a mix of legacy pavement and <3 msa fully flexible pavement
2 – 3 – 4 – 5	N/A	N/A	N/A	N/A

For the sections of the Proposed Scheme running on non-national roads, limited construction data is available on the Road Maintenance Office (RMO) portal:

- "Surface Inventory Material Type": this provides information on which type of surface material or treatment is present;
- "Completed Pavement Interventions": this provides the location of where the carriageway has been resealed, surface restored, structurally overlaid, fully reconstructed or if a different treatment has been applied as per Table 7.4 below;

- "Planned Pavement Interventions": this provides the location of where the carriageway is planned to undergo routine maintenance, surface restoration or full depth reconstruction as per Table 7.4 below.

Table 7.4: Lengths of Completed and Planned Interventions on Local Authorities' networks

Scheme Section(s)	Pavement Interventions (in linear metres)	
	Completed	**Planned**
1 - 2	Surface restoration: 400 in 2017.	No planned works
3 - 4 - 5	Surface restoration: 7580 in 2011.	No planned works

The surface materials recorded against Sections 1 and 2 of the Proposed Scheme is SMA. The surface material recorded against Sections 3, 4, and 5 of the Proposed Scheme is essentially SMA apart from portions of concrete surfaced roads north of the Grand Canal.

It is therefore proposed for a Ground Penetration Radar (GPR) survey to be procured. Cores will be taken at regular intervals to allow for the calibration of the GPR. Such survey would generate the following datasets essential for the pavement design:

- Depth of unbound granular materials;
- Depth of rigid materials (concrete);
- Depth of bituminous materials;
- Detailed pavement build-up (number of layers and their associated thicknesses – bound materials only);
- Condition of the bound materials;
- Condition of the interlayer bonds;
- Condition of the foundation layer(s) through the use of Dynamic Cone Penetrometer (DCP) testing;
- Likely presence of tar contaminated materials.

Local Pavement Asset Managers have also been contacted to establish if tar contaminated materials have been encountered on previous projects in the area. No known issues were identified, notwithstanding future testing will need to be undertaken to confirm the presence of tar contaminated materials.

The age of the pavement structure of the N31 carriageway, and its structural maintenance history are unknown, as such estimating how much life is left in each pavement asset is unfeasible at this stage.

7.1.2.11 Condition - National Roads

For the sections of the Proposed Scheme running on the N31 national road, various pavement related data sets are available from TII's Pavement Asset Management System (PAMS). Stripmaps were provided by TII for chainages 4.3 (eastern end of red line) to 3.3 (km) (western end of red line) of the N13 westbound carriageway as per Figure 7.3 below:

- **RSP data (July 2019):** International Roughness Index (IRI), Mean Profile Depth (MPD), Rutting, Longitudinal Profile Variance at 3 and 10 metres (LPV3 and LPV10) and geometry parameters (grade, crossfall land radius);
- **LCMS data (Sept. 2017):** Alligator, Longitudinal and Transverse cracking, Ravelling;
- **SCRIM data (Aug. 2019):** Characteristic Skid Coefficient (CSC).

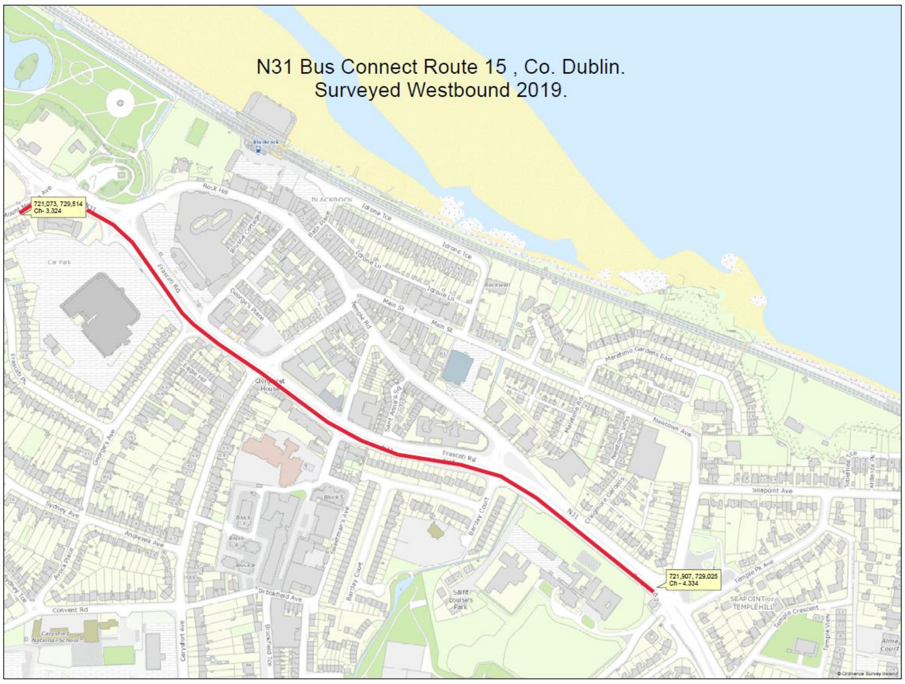


Figure 7.3: Extent of TII Pavement Condition data provided for the N31 (X-ITM 721,907 / Y-ITM 729,025 to X-ITM 721,073 / Y-ITM 729,574) [*image provided by TII*]

Pavement Surface Condition:

Surface condition data for the N31 eastbound carriageway has not been made available. Therefore data for the N31 westbound carriageway was analysed.

From a skid resistance perspective, the stretch of N31 under consideration is in good condition. The texture depth is good to very good with values above 1 millimetre. The Characteristic Scrim Coefficient (CSC) is mostly in the 0.40 to 0.50 bracket, which can be considered to be good. The only area where the CSC falls below 0.40 is at chainage 3.86 to 3.94.

Very little to no ravelling has been reported for the section of the N31 under consideration.

Similarly, rutting has not been reported as a concern along that length of the N31.

Pavement Structural Condition:

In 2017, a small number of longitudinal or transverse cracks were reported along the 1 kilometre stretch of road which could mean that the road is in sound structural condition or that it had just been rehabilitated.

The longitudinal profile of the 1 kilometre length of road in terms of IRI and LPV3 is pretty poor for the first 300 metres. This is likely due to the series of ramps and raised tables. That length of road had recently been rehabilitated.

Due to the uncertain structural condition of the pavement and the limited amount of information made available, further investigation will be undertaken at Specimen Design stage (Visual Condition Survey) and recommendations made for the Detailed Design stage.

7.1.2.12 Condition – Non-National Roads

For the sections of the Proposed Scheme running on the network of non-national roads, access to the Road Maintenance Office (RMO) datasets was granted. Available datasets include:

- **SCRIM data:** Characteristic Skid Coefficient (CSC);
- **RCI Scanner (DCC area only):** Road Condition Index giving an idea of general pavement condition from the analysis of surface observed defects (covering only the Trimleston Avenue to Nutley Lane within Section 2, and the entirety of Sections 3 to 5 of the Proposed Scheme);
- **PSCI:** Pavement Surface Condition Index giving an idea of general pavement condition from the analysis of surface observed defects; and
- **RSP data:** International Roughness Index (IRI), Mean Profile Depth (MPD), Rutting Depth and Longitudinal Profile Variance (LPV).

From a general pavement condition perspective, Figure 7.4 and Figure 7.5 give the following PSCI breakdown for Sections 1 and 2, and Sections 3, 4, and 5, respectively – while the currency of the data is provided in Table 7.5.

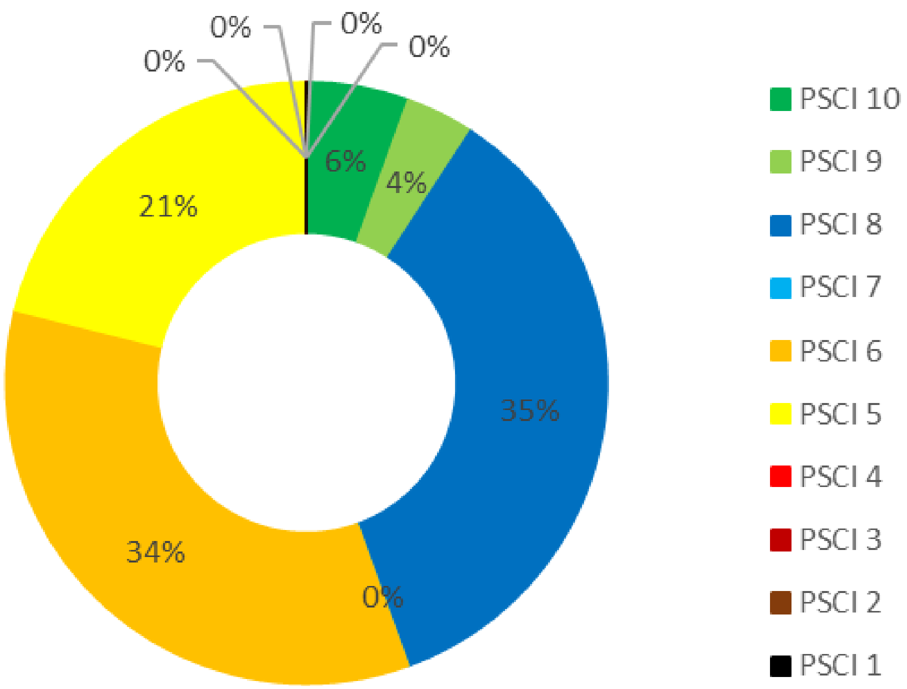


Figure 7.4: Pavement Surface Condition Index (PSCI) – Sections 1 and 2

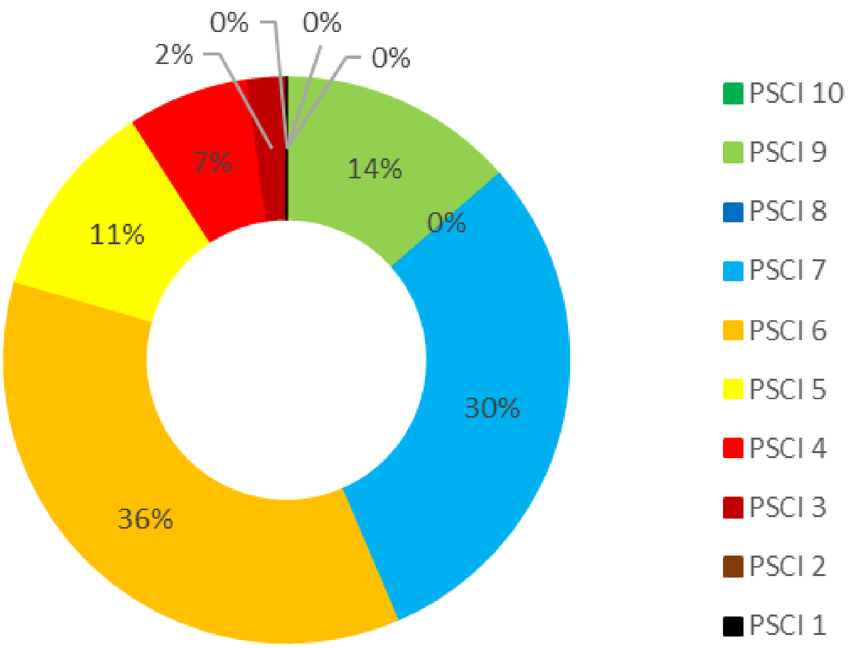


Figure 7.5: Pavement Surface Condition Index (PSCI) – Sections 3, 4, and 5

Table 7.5: Currency of PSCI data

Scheme Section(s)	1 – 2	3 – 4 – 5
Currency of PSCI data (Years of survey)	2018	2011 2014 2018 2019

For fully flexible pavements, sections of roads with a score of 9 or 10 require routine maintenance, a score of 7 or 8 could trigger resealing and/or restoration of skid resistance works, scores of 5 or 6 surface restoration works, scores of 3 or 4 structural overlay or inlay works, while scores of 1 or 2 require a full depth reconstruction of the road. (As per "Urban Flexible Roads Manual - Pavement Surface Condition Index" - Volume 2 of 3 -DTTAS – RMO).

For rigid pavements, no maintenance is required for scores of 9 or 10, routine maintenance is required at scores of 7 or 8, surface restoration is needed for scores of 5 or 6, scores of 3 or 4 would trigger a structural rehabilitation, while full depth reconstruction of the road is required at scores of 1 or 2. (As per "Urban Concrete Roads Manual - Pavement Surface Condition Index" - Volume 3 of 3 -DTTAS – RMO).

The PSCI provides a good indication of the general pavement condition by assessing defects recorded at the surface of the pavement structure. Adopting this method, the pavement surface condition is directly assessed while the pavement structural condition is indirectly estimated. A PSCI score on its own is not sufficient to design and specify a pavement rehabilitation.

The proportion of each group of Proposed Scheme sections per PSCI score shown in Figure 7.4 and Figure 7.5 is a reflection of the overall pavement condition at a point in time. The percentages are expected to remain constant over the following years, as long as the Local Authorities' pavement maintenance strategies remain unchanged. The geographical distribution of sections with various PSCI will evolve between now and the commencement of Proposed Scheme works. This is because pavement assets deteriorate over time and the Local Authorities currently and are expected to continue maintenance of those roads in the interim period.

The other pavement condition indicators are as noted in Figure 7.6 and Figure 7.7:

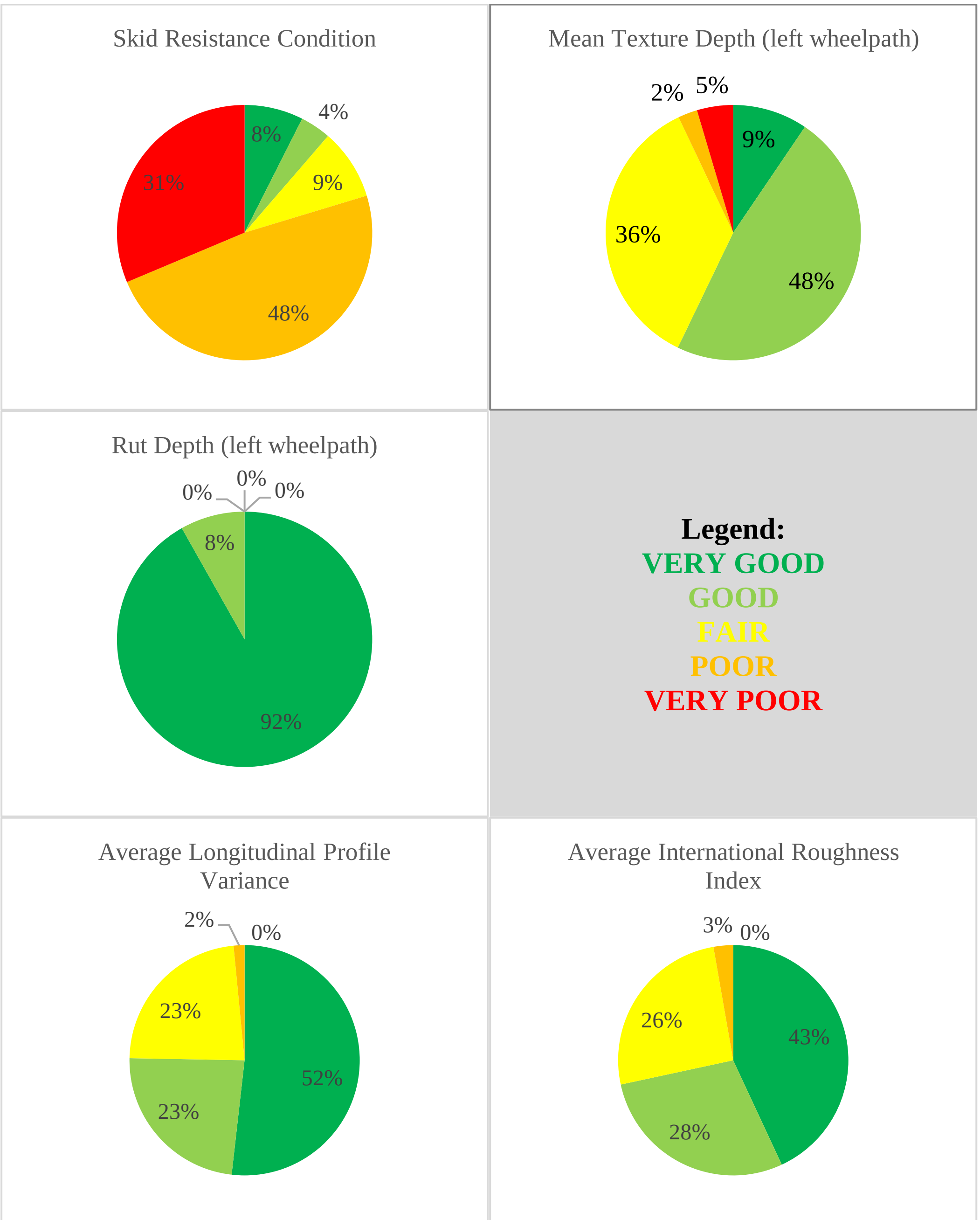


Figure 7.6: Pavement Condition through five Pavement Indicators – Sections 1 and 2

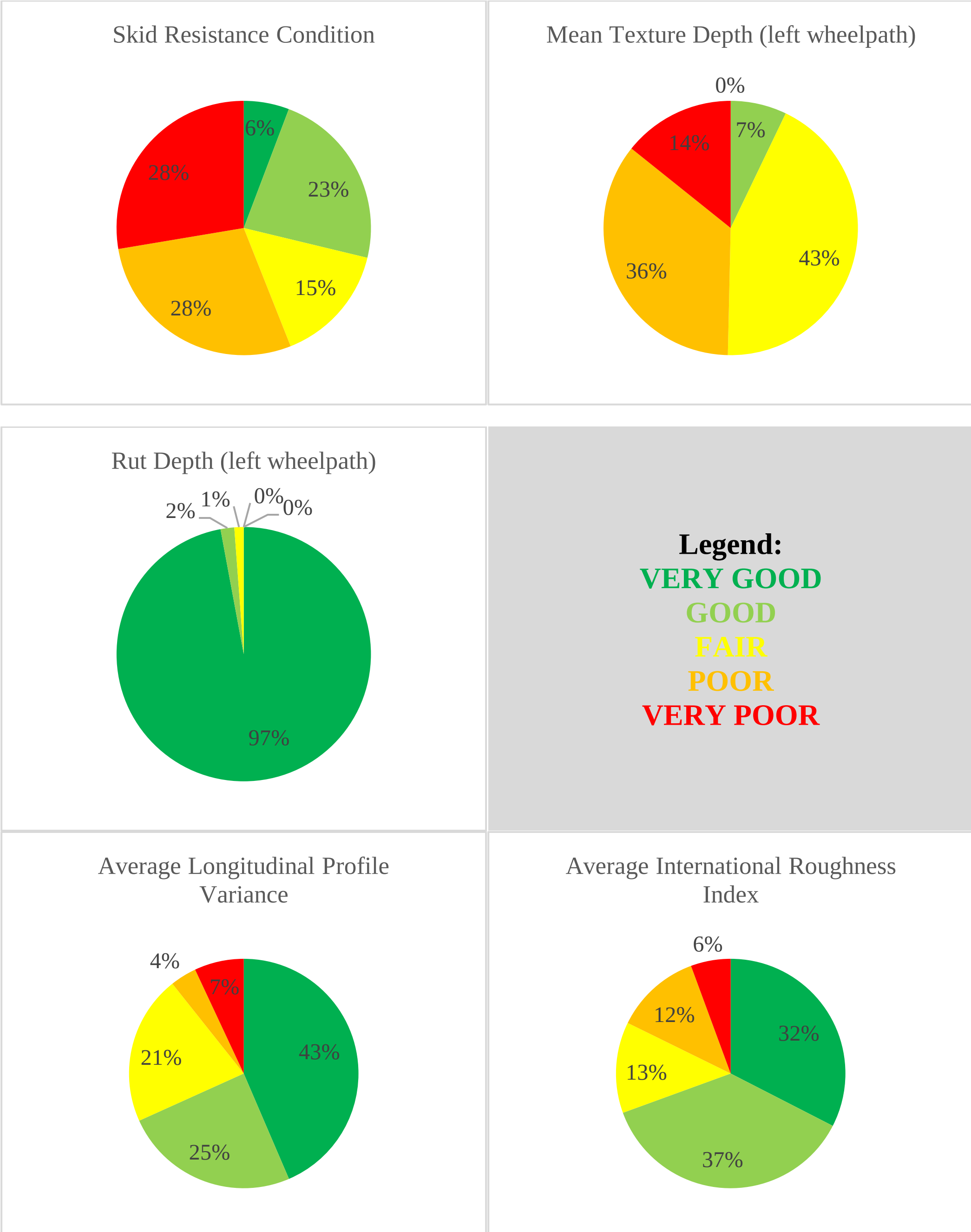


Figure 7.7: Pavement Condition through five Pavement Indicators – Sections 3, 4, and 5

Pavement Surface Condition:

Both the SCRIM and texture depth indicators reflect the skid resistance of the pavement when a road user brakes or turns. On one hand, the SCRIM indicator measures the skid resistance provided by the micro-texture of the pavement surface and is a proxy for skid resistance at low speed and/or in dry weather conditions. On the other hand, the texture depth indicator is a direct measurement of the macro-texture of the pavement surface and is a proxy for skid resistance at higher speeds and/or in wet weather conditions.

Over 40% of Sections 1 and 2 and 50% of Sections 3, 4, and 5 are in a poor to very poor condition in terms of texture depth while 80% of Sections 1 and 2 and 60% of Sections 3, 4, and 5 are in a poor to very poor SCRIM condition.

Poor skid resistance of the pavement surface may become an issue for vulnerable road users such as pedestrians and cyclists, especially where motorised and non-motorised traffic interact.

The rut depth indicator is showing that over 99% of the Proposed Scheme is in good or very good condition. From a pavement surface perspective, this is positive as little to no transversal surface irregularities are expected and little to no water is expected to be ponding in the ruts.

Pavement Structural Condition:

The structural condition of the pavement can only be reported on and assessed from indirect condition indicators taken from the surface of the pavement: rut depth, International Roughness Index (IRI) and Longitudinal Profile Variance (LPV).

The rut depth being at about 99% in the good or very good categories, thus no structural issue can be identified through this indicator. It does not however mean that there are no structural issues.

Both the IRI and LPV indicators are a reflection of the ride quality of the road, in other words, how smooth the road surface is. Those indicators are in most part influenced by surface defects such as potholes, large cracks or networks of cracks, open joints, poor or failing reinstatements, depression that can originate from the surface or the pavement structure below. Features like gullies, manhole covers or other ironworks and if not filtered out of the survey data, ramps, can also influence the IRI and LPV indicators.

Where high levels of profile variance are observed over long sections of road, it is likely for structural failure to have occurred.

Less than 2% of Sections 1 and 2, and less than 11% of Sections 3, 4, and 5 are displaying poor or very poor LPV condition, while less than 3% of Sections 1 and 2, and less than 18% of Sections 3, 4, and 5 are displaying poor or very poor IRI condition.

Every effort should be made to address, at the source, all structural failures along the Proposed Scheme in order to guarantee a high ride quality for all bus passengers, cyclists and other road users.

Subgrade Condition:

No information about the subgrade is currently available for Proposed Scheme in terms of bearing capacity (California Bearing Ratio – CBR).

The foundation for all widening and full depth reconstruction pavement structures is designed on the assumption that the Design CBR is the minimum permitted in Clause 3.23 of DN-PAV-03021 (Dec. 2010): 2.5%.

Additional condition data is expected to become available at Specimen Design stage in the form of core logs taken as part of the GPR survey (Ground Penetrating Survey).

The delivery of Proposed Scheme works is expected to commence in 2022. The condition of all pavements is therefore expected to change – deteriorating in most cases and improving where Local Authorities' interventions occur.

7.1.2.13 Required Complementary Surveys

Additional condition data requirements, including surveys, will be required both at Specimen Design and Detailed Design stages in order to develop and implement Pavement Rehabilitation strategies. Those requirements shall be in line with AM-PAV-06050 (Mar. 2020).

7.1.3 Pavement Design

7.1.3.1 Pavement Materials

At Specimen Design stage, the selection of appropriate pavement materials will be made with the following considerations:

- Which pavement structure is the most appropriate and compatible with the existing pavement? (i.e. Fully flexible vs. Flexible Composite vs. Rigid pavement);
- Which materials are most appropriate from a noise, permeability, colour, texture, etc. perspective?; and
- Which materials, from a lifecycle perspective, provide the best value in terms of environmental impact, durability, maintainability, repairability, recyclability, cost, etc.?

Specific materials will be selected for specific loading areas.

The ambition in terms of pavement materials is to reuse or recycle all of the excavated materials. The specification of materials and processes with a reduced environmental impact will be prioritised.

The choice of surfacing materials will be discussed with the Landscape Architect.

7.1.3.2 Pavement Strategy

7.1.3.3 New Pavement and Bus Interchange Strategy

No new pavement or bus interchanges are proposed on the Proposed Scheme.

7.1.3.4 Pavement Rehabilitation Strategy

At Specimen Design stage, different pavement strategies will be developed for:

- areas to be widened or fully reconstructed; and

- areas to be rehabilitated (do minimum, intermediary strategies, fully reconstruct).

Additional testing requirements in line with AM-PAV-06050 will be specified for the successful Contractor to complete the Detailed Pavement Design.

The risk of tar contaminated material presence in the existing pavement is expected to be mitigated at Specimen Design stage with the delivery of the GPR survey through the testing of the calibrating cores for tar.

In order to estimate the waste quantities and the carbon emissions from the Proposed Scheme pavement works, the following assumptions were taken:

- Where full depth reconstruction is anticipated (e.g. widening, traffic island relocation…), a conservative fully flexible pavement design is assumed: 350mm of bituminous mixtures on top of 150mm of subbase material and 400mm of capping material.
- Where the existing pavement is anticipated to only require rehabilitation, the assumed materials and associated depths depend on the PSCI for the pavement design:
  - Fully Flexible Carriageway

    PSCI ⩾ 7: no works

    PSCI = 5 or 6: 50mm Bituminous Inlay

    PSCI = 3 or 4: 200mm Bituminous Inlay

    PSCI = 1 or 2: 350mm Bituminous Inlay + 150mm Subbase Inlay + 400mm Capping Inlay
  - Rigid Carriageway

    PSCI ⩾ 5: no works

    PSCI ⩽ 4: 200mm Concrete Inlay.

7.1.3.5 Opportunities for Innovation

Innovative materials and processes delivering enhanced environmental, social and financial benefits are being promoted in the ongoing pavement design process.

7.1.3.6 Reuse and Recycling Considerations

Opportunities for reuse and recycling of secondary materials have and will continue to be identified and quantified throughout the Specimen Design process.

Current opportunities include but are not limited to:

- Incorporation of minimum 20% of Reclaimed Asphalt into new base and binder layers of the pavement;

- Excavated capping layer material to be reused as new capping material if compliant with current standards; and
- Excavated subbase layer material to be reused as new subbase material if compliant with current standards.

7.2 Kerbs, Footways and Paved Areas

7.2.1 Overview of Kerbs, Footways and Paved Areas

This section covers the preliminary design for the kerbs, footways and paved areas (KFPA) assets:

- Kerbs,
- Footways (concrete, bituminous and paved), and
- Segregated Cycle tracks.

For the Proposed Scheme, two pavement networks are being considered, the primary and the secondary networks. The primary network refers to the bus corridor under consideration while the secondary network refers to the roads impacted by the re-routing of existing traffic from the Proposed Scheme to the nearby road network.

The preliminary design of KFPA assets is based on the following standards:

- DN-PAV-03021 (Dec. 2010) – Pavement and Foundation Design;
- DN-PAV-03026 (Jan. 2005) – Footway Design;
- Construction Standards for Road and Street Works in Dublin City Council (May 2016) – Revision 1;
- PE-SMG-02002 (Dec. 2010) – Traffic Assessment;
- CC-SPW-00600 (Mar. 2013) – Specification for Road Works Series 600 – Earthworks;
- CC-SPW-00700 (Jan. 2016) – Specification for Road Works Series 700 – Road Pavements – General;
- CC-SPW-00800 (Mar. 2013) – Specification for Road Works Series 800 – Road Pavements – Unbound and Cement Bound Mixtures;
- CC-SPW-00900 (Sep. 2017) – Specification for Road Works Series 900 – Road Pavements – Bituminous Materials;
- CC-SPW-01000 (Mar. 2013) – Specification for Road Works Series 1000 – Road Pavements – Concrete Materials;
- CC-SPW-01100 (Feb. 2012) – Specification for Road Works Series 1100 – Kerbs, Footways and Paved Areas; and
- BS 7533 series of standards (1999 – 2021) – Pavement Constructed with Clay, Natural Stone or Concrete Pavers.

This section identifies the proposed pavement strategy, setting out the design development considerations for the pavement works in current and future design stages. It also outlines the key elements for consideration for future testing requirements, and consideration for the valorisation of reusable and recyclable materials in new pavement materials in the detailed design stage.

The different KFPA assets are designed taking consideration of:

- Traffic loads;
- Changes in road geometry;
- Existing KFPA construction build-up;
- Existing KFPA condition;
- Landscape Architect's requirements; and
- The impact of other assets such as drainage, utilities and structures.

7.2.2 Design Constraints

7.2.2.1 Traffic Loading Considerations

Depending on the expected traffic characteristics (volumes, pedestrian vs. vehicular) and the proposed surface material, the Design Traffic may be categorised slightly differently as illustrated on Figure 7.8.

For bituminous footways and segregated cycle tracks, the Design Traffic will be calculated in accordance with PE-SMG-02002 (Dec. 2010) and categorised as per DN-PAV-03026 (Jan. 2005) if the Design Traffic is below 50,000 standard axles over their lifetime (40 years).

For concrete footways, the Design Traffic will be calculated in accordance with PE-SMG-02002 (Dec. 2010) for a 40-year design life.

And for paved footways, the Design Traffic will be calculated in accordance with PE-SMG-02002 (Dec. 2010) and categorised as per BS 7533 series.

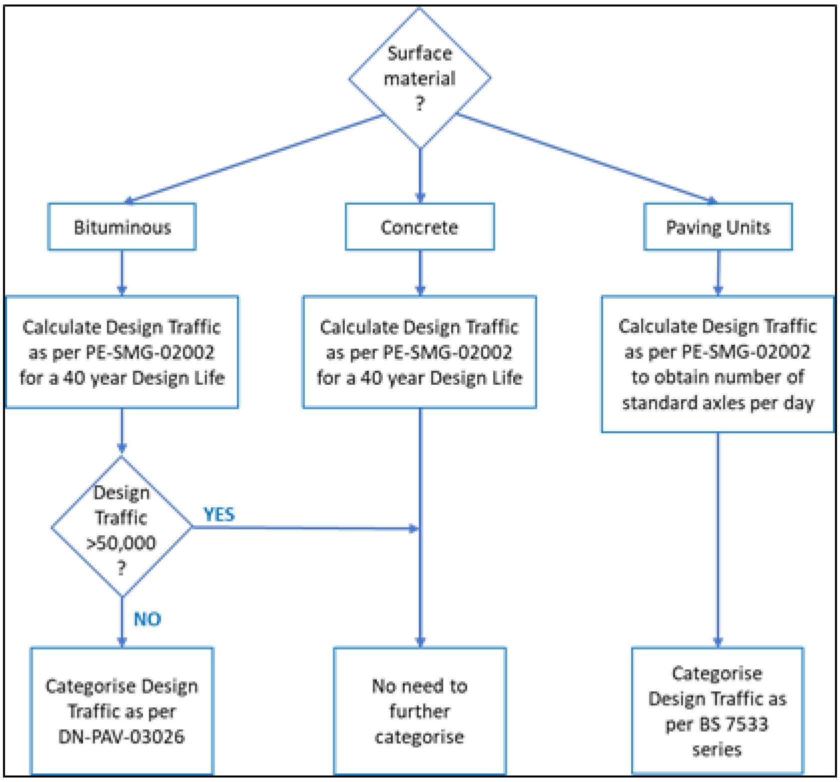


Figure 7.8 Traffic Design and Categorisation for KFPA

7.2.2.2 Geometry Considerations

At Specimen Design stage, the 3D geometry model will be further analysed to identify footways and segregated cycle tracks requiring full depth reconstruction and those that can be maintained in place.

The current assumption for footpaths and segregated cycle tracks is for full depth reconstruction.

7.2.2.3 Existing Pavement Condition Considerations

For the footways and segregated cycle tracks that will be fully reconstructed, the design of the foundation will be based on an assumed Design CBR of 2.5%, the minimum permitted value as per Clause 3.23 of DN-PAV-03021 (Dec. 2010).

If some existing footways and segregated cycle tracks are proposed to be maintained, their condition will be assessed visually before proposing any potential rehabilitation works.

7.2.3 Pavement Design

7.2.3.1 Pavement Materials

At Specimen Design stage, the selection of appropriate pavement materials will be undertaken with the following considerations:

- Which pavement structure is the most appropriate and compatible with the existing pavement? (i.e. Fully flexible vs. Rigid pavement structure);
- Which materials are most appropriate from a noise, permeability, colour, texture, etc. perspective?;
- Which materials, from a lifecycle perspective, provide the best value in terms of environmental impact, durability, maintainability, repairability, recyclability , cost, etc.?

Specific materials will be selected for specific loading areas.

The ambition in terms of pavement materials is to reuse or recycle all of the excavated materials. The specification of materials and processes with a reduced environmental impact will be prioritised.

The Landscape Architect's design will be considered at Specimen Design stage to identify the choice of surfacing materials which will in turn dictate the choice of materials used for the underlying footpath and segregated cycle track structure.

For bituminous footways and segregated cycle tracks, the bituminous layer(s) will make use of as much recycled material as practicable. Low Energy Bound Mixtures (LEBM) will be considered as an alternative to the conventional Asphalt Concrete (AC), Hot Rolled Asphalt (HRA) and Stone Mastic Asphalt (SMA) mixtures.

As per Section 5.5 of the BCPDGB, in order to provide a visual differentiation between the carriageway and cycle tracks and cycle lanes, it is proposed that all cycle tracks and cycle lanes are to have red coloured epoxy type surfacing, or red coloured HRA, or similar in accordance with the National Cycle Manual.

7.2.3.2 Pavement Structures

The appropriate pavement structures for footpaths and segregated cycle tracks will be defined at Specimen Design stage.

7.2.3.3 Opportunities for Innovation

Innovative materials and processes delivering enhanced environmental, social and financial benefits are being promoted in the ongoing pavement design process.

7.2.3.4 Reuse and Recycling Considerations

Opportunities for reuse and recycling of secondary materials have and will continue to be identified and quantified throughout the Specimen Design process.

Current opportunities include but are not limited to:

- Excavated capping layer material could be reused as new capping material if compliant with current standards;
- Excavated subbase layer material could be reused as new subbase material if compliant with current standards;

- Up to 50% of capping and subbase materials could be substituted with Reclaimed Asphalt;
- Concrete base to paved areas could make use of Recycled Aggregate, Recycled Concrete Aggregate and more sustainable hydraulic binders (e.g. CEM III/A);
- Concrete footways could also make use of more sustainable hydraulic binders;
- Jointing and bedding mortars used in the construction of paved areas could contain recycled materials;
- Aggregate for base/binder layer for segregated cycle tracks could be 100% Reclaimed Asphalt (Low Energy Bound Material – LEBM).

8 Structures

8.1 Overview of Structures Strategy

The Proposed Scheme requires new structures at various locations along the scheme. The sections below summarise where new structures are required. A separate Preliminary Design Report for the principal structures has been prepared, following the guidance set out in TII publication DN-STR-03001 (Technical Acceptance of Road Structures on Motorways and Other National Roads). This is included in Appendix J of this report.

8.2 Summary of Principal Structures

Principal Structures are defined as those that require technical approval following the processes outlined in TII Publication DN-STR-03001.

8.2.1 Bridges and Bridge Sized Culverts

There is no impact on existing bridges, nor is there a requirement for new bridges on this scheme.

8.2.2 Retaining Walls

Retaining walls with a retained height greater than 1.5 m are classified as principal structures and are described below.

There is a requirement for one wall greater than 1.5 m on this scheme, shown in Figure 8.1 (RW01). The proposal along Rock Road, adjacent to Blackrock Park, requires a widening of the carriageway. The existing wall, which currently supports the road embankment, will need to be replaced with a new 97.5m long retaining wall at this location, with a maximum retained height of 4.0m.

Figure 8.1: Location of principal retaining wall

8.2.3 Sign Gantries

There are no existing gantries being impacted along the Proposed Scheme.

8.3 Summary of Miscellaneous Structures

8.3.1 Existing Archways

Blackrock College Archway Reorientation

The existing railings and boundary wall to Blackrock College will be carefully dismantled and re-erected along the proposed back of footpath. The gates, railings, and piers forming the existing entrance to Blackrock College are to be rotated on the westernmost pier to accommodate the realigning of the adjacent boundary while preserving the symmetry of the protected entrance.

Merrion Gates Junction Archway Relocation

The existing cut stone masonry archway located outside the Telford Nursing Home on the Merrion Road at the Merrion Gates junction will be carefully dismantled and re-erected at the back of the proposed footpath.

Bloomfield Gate (Gas Networks Ireland) Archway Relocation

The existing cut stone masonry archway (referred to as the Bloomfield Gate) located outside the GNI AGI between 133-145 Merrion Road (former Gowan Motors site) and St. Vincent's University Hospital will be carefully dismantled and re-erected in an adjacent area along the northern boundary of St. Vincent's University Hospital, sited within the existing hedge fronting onto the plaza at the junction of Merrion Road and Nutley Lane.

8.3.2 Retaining Walls (<1.5m)

Figure 8.2 and Figure 8.3indicate the locations of proposed retaining walls less than 1.5m high. Further details about each retaining wall is summarised within Table 8.1.

Figure 8.2: Retaining Walls RW 01 to RW 02 <1.5m - locations

Figure 8.3: Retaining Wall RW 03 <1.5m - location

Table 8.1: Summary of Minor Retaining Walls <1.5m

Ref.	Location	Chainage Start/ Chainage End	Length (m)	Max Retained Height (m)
MRW1	Plot at Castledawson Avenue	A1685 / A1715	30m	0.8m
MRW2	St. Mary’s Nursing Home, Rock Road	A3410 / A3435	24m	0.9m
MRW3	Grand Canal Walkway	A6925	42.3m	0.9m

8.3.3 Other

Pembroke Kiosk Relocation

The existing kiosk located at the junction of Pembroke Road, Lansdowne Road and Northumberland Road will be carefully dismantled and re-erected at its new location at the same junction. The kiosk will be set back, to facilitate a new junction layout at this location. Any existing services to the existing kiosk will be retained at the new location.

9 Drainage, Hydrology and Flood Risk

9.1 Overview of Drainage Strategy

The drainage preliminary design was developed following consultation with the relevant Local Authorities and Irish Water where applicable. The strategy and design parameters to be adopted throughout Dublin BusConnects is summarised in the Drainage Design Basis Document No. BCIDX_ARP-PMG_PS-0000_XX_00-SD-ZZ-0002 included in Appendix K. The Design Basis Document was developed whilst taking the Greater Dublin Regional Code of Practice (GDRCoP), Greater Dublin Strategic Drainage Study (GDSDS), planning requirements of local authorities within the Dublin region, Transport Infrastructure Ireland (TII) requirements and international best practices such as CIRIA The SUDS MANUAL (C753).

The principal objectives of drainage design are as follows:

- To drain surface water from existing and proposed pavement areas throughout the BusConnects Development and maintain the existing standard of service.
- To maintain existing runoff rates from existing and newly paved surfaces using Sustainable Urban Drainage Systems (SuDS).
- To minimise the impact of the runoff from the roadways on the surrounding environment using SuDS and/or silt traps.

No drainage features like gullies or manholes will be located at, or any ponding will be allowed to occur at, pedestrian cross-walk locations or at bus-stop locations. Where any such drainage features currently exist at such locations, they will be relocated. Drainage of newly paved areas will include SuDS measures to treat and attenuate any additional runoff. These measures will ensure that there is:

- No increase in existing run off rates from newly paved areas; and
- Appropriate treatment to ensure runoff quality.

A hierarchical approach to the selection of SuDS measures has been adopted with ‘Source’ type measures e.g. tree pits implemented in preference to catchment type measures e.g. attenuation tanks. Further details of the SuDS hierarchy are provided in Drainage Design Basis.

9.2 Existing Watercourses and Culverts

All watercourses in the vicinity of the proposed area have been identified as shown in the Table 9.1 below.

A Stage 1 Flood Risk Assessment (FRA) has been completed on the Preliminary Design and is summarised in Section 9.7, with the full Stage 1 FRA Report included in Appendix N.

The location of existing watercourses and culverts has been identified using OS Mapping (www.osi.ie). The Proposed Scheme crosses the following watercourses:

Table 9.1: Location of Existing Watercourses

Watercourse	Chainage	Crossing Detail
Grand Canal	A6907	Bridge
River Dodder	A5748	Bridge
Elm Park Stream	A3200	Culvert
Booterstown Stream	A2805	Culvert
Priory Stream	A1162	Culvert
Brewery Stream	A480	Culvert

9.3 Existing Drainage Description

Based on the information received from Irish Water, the Proposed Scheme is serviced by surface water and combined drainage networks. The surface water drainage system is managed by the local authority, whilst combined sewers systems are managed by Irish Water. Flows are typically collected in standard gully grates and routed via a gravity network to outfall points. There are no SuDS/attenuation measures on the existing drainage networks to treat or attenuate runoff from the existing highway.

The existing drainage network along the Proposed Scheme can be split into the 17 catchment areas based on topography and the existing pipe network supplied by Irish Water. The approximate catchment areas, existing sewer networks, outfalls and watercourses are shown on Surface Water drawings, BCIDC-ARP-DNG_RD-1415_XX_00-DR-CD-1001 to BCIDC-ARP-DNG_RD-1415_XX_00-DR-CD-1004 which can be found in Appendix B**.** The catchments are summarised in Table 9.2 .

Table 9.2: Summary of Existing Catchments

Existing Catchment Reference	Chainage	Approx. Drainage Catchment Area (km2)	Existing Network Type	Existing Outfalls
Catchment 1	A0000 – 0915	0.149	Surface Water (Storm)	Network outfalls to Brewery Stream
Catchment 2	A0915 – 1035	0.001	Surface Water (Storm) & Combined	Network outfalls to West Pier Pumpstation which discharges to Ringsend Treatment Works
Catchment 3	A1035 – 1265	0.923	Surface Water (Storm)	Network outfalls to Priory stream
Catchment 4	A1265 – 1695	0.157	Surface Water (Storm)	Network outfalls to Priory stream and onto Dublin bay south
Catchment 5	A1695 – 2212 (both sides) A2212 – 2404 (RHS)	0.124	Surface Water (Storm)	Network outfalls to Booterstown Stream and onto Dublin Bay South

Existing Catchment Reference	**Chainage**	**Approx. Drainage Catchment Area (km2)**	**Existing Network Type**	**Existing Outfalls**
	A2404 - 3006 (both sides)			
Catchment 6	A2212 – 2404 (LHS)	0.552	Combined	Network outfalls to Blackrock WWPS - Ringsend
Catchment 7	A3006 - 3534 (both sides) A3759 - 3591 (LHS) B-100 - B832 (both sides)	0.349	Surface Water (Storm)	Network outfalls to Elm Park Stream
Catchment 8	A3534 – 3759 (both sides) A3759 - 3991 (RHS) A3991 - 4100 (both sides)	0.412	Combined	Network outfalls to London Bridge PS, Ringsend Main Lift PS and onto Ringsend WWTP
Catchment 9	A4100 - 4842	0.347	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works
Catchment 10	A4842 - 5395	0.288	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works
Catchment 11	A5395 - 5715	0.030	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works
Catchment 12	Anglesea Road & A5715 - 5770	0.062	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works
Catchment 13	A5770 – 5862 & Herbert Park	1.256	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works
Catchment 14	A5805 – Branch RHS	0.002	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works
Catchment 15	A5862 - A6495 & A6495 to A6654 (right)	0.228	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works
Catchment 16	A6495 to A6654 (left) & A6654 to A6905	0.242	Combined	Network outfalls to London Bridge Pumphouse which discharges to Ringsend Treatment Works

Existing Catchment Reference	Chainage	Approx. Drainage Catchment Area (km2)	Existing Network Type	Existing Outfalls
Catchment 17	A6905 – 7325 C0000 - C0188	0.345	Combined	Network discharges to Ringsend Treatment Work

9.4 Overview of Impacts of Proposed Works on Drainage / Runoff

Whilst in some areas the proposed development increases the impermeable areas, additional permeable areas are also provided by the softening of urban realm along the Proposed Scheme. The drainage design aims to sustain flow levels within the existing pipe network after a rainfall event by controlling discharge rates within each catchment. Flows will be controlled by the implementation of SuDS techniques. One of the principal objectives of the road drainage system is to minimise the impact of the runoff from the roadways on the surrounding environment via the position of: filter drains, swales, bio retention areas, tree pits, silt traps and attenuation features if necessary. The welfare of pedestrians and cyclists is a high priority in the consideration of the drainage system design.

The proposed surface water drainage works are shown on the drawings **BCIDC-ARP-DNG_RD-1415_XX_00-DR-CD-9001**.

Table 9.3 provides information of the proposed additional catchments (new paved areas) against the proposed permeable areas (current paved areas to become grassed).

Each catchment area has been broken down into sub-catchments in order to define the change in impermeable surface area as a result of the proposed scheme. Where there is a net increase in impermeable surface area, a form of attenuation will be required prior to discharge. Where there is no net change or net decrease, then no form of attenuation will be required prior to discharge. A summary list of the sub-catchments, the associated chainage, and impermeable surface area differential is given in the table below. The following table contain a column entitled “Net change” which takes account of the change of use from impermeable to permeable areas and vice versa.

Table 9.3: Summary of Increased Permeable and Impermeable areas

Existing Catchment Reference	Chainage	Road Corridor Area (m^2)	Change of use to Impermeable areas (m^2)	Change of use to permeable areas (m^2)	Net change (m^2)	Percentage change (%)
Catchment **1**	A0000 – 0915	28,305	0	200	-200	-0.7
Catchment 2	A0915 – 1035	3,788	0	25	-25	-0.7
Catchment 3	A1035 – 1265	8,168	0	524	-524	-6.4
Catchment 4	A1265 – 1695	11,208	666	652	14	0.1
Catchment 5	A1695 – 2212 (both sides) A2212 – 2404	28,191	1,438	1011	427	1.5

Existing Catchment Reference	**Chainage**	**Road Corridor Area (m^2)**	**Change of use to Impermeable areas (m^2)**	**Change of use to permeable areas (m^2)**	**Net change (m^2)**	**Percentage change (%)**
	(RHS) A2404 - 3006 (both sides)					
Catchment 6	A2212 – 2404 (LHS)	2,717	48	32	16	0.6
Catchment 7	A3006 - 3534 (both sides) A3759 - 3591 (LHS) B-100 - B832 (both sides)	37,421	3103	1124	1979	5.3
Catchment 8	A3534 – 3759 (both sides) A3759 - 3991 (RHS) A3991 - 4100 (both sides)	10,550	105	150	-45	-0.4
Catchment 9	A4100 - 4842	16,863	315	64	251	1.5
Catchment 10	A4842 - 5395	13,260	45	131	-86	-0.6
Catchment 11	A5395 - 5715	9,955	0	80	-80	-0.8
Catchment 12	Anglesea Road & A5715 - 5770	2,901	193	147	46	1.6
Catchment 13	A5770 – 5862 & Herbert Park	5,610	270	465	-195	-3.5
Catchment 14	A5805 – Branch RHS	1,131	0	0	0	0.0
Catchment 15	A5862 - A6495 & A6495 to A6654 (right)	20,275	150	679	-529	-2.6
Catchment 16	A6495 to A6654 (left) & A6654 to A6905	12,151	0	155	-155	-1.3
Catchment 17	A6905 - 7325 & C0000 to C0188	15,434	0	434	-434	-2.8

9.5 Preliminary Drainage Design

The existing drainage network will be maintained and used as the main discharge point for the new drainage system. The purpose of the design will be to replicate the existing situation. Where new multiple gully connections discharging to a combine sewer are required, a new surface water pipe will be provided where practicable and connected to the combine sewer as per Irish Water requirements.

The following drainage systems were considered for the Proposed Scheme where new paved areas are proposed:

- **Sealed Drainage (SD)** comprised of side entry gullies and sealed pipes. They will collect, convey and discharge runoff. The side entry gullies will be located within the kerb line mostly between the cycle track and bus lane and/or the footpath and the cycle track depending on the carriageway profile. Their location will also depend on the bicycle and/or bus wheel-track in consideration of the cycling safety and ride-quality.
- **Grass Surface Water Channels, Swales and Bio Retention Areas/Rain Gardens (SW/RG)** are provided as road edge/footpath edge drainage collection systems. They will provide treatment and might provide attenuation if required. A filter drain can be laid below the swales to keep the swale dry during low return period rainfall events.
- **Filter Drains (FD)** are provided as road edge channels. These comprise a perforated pipe with granular surround and are designed to convey, attenuate and treat runoff prior to discharge.
- **Tree Pits (TP)** are provided in close proximity to the road, where practicable. These receive flows from the sealed pipe network and from footpaths. They are designed to convey, attenuate and treat runoff prior to discharge.
- **Attenuation Tanks/Oversize Pipes (AT/OSP)** – Where there is insufficient attenuation volume provided by the proposed SuDS drainage measures, hard attenuation measure such as concrete attenuation tanks and/or oversize pipes can be provided to meet the required attenuation volume.

9.5.1 Summary of Surface Water Drainage

The proposed drainage types for the Proposed Scheme are listed on Table 9.4.

Table 9.4: Summary of Proposed Surface Water Infrastructure

Catchment	Chainage	Drainage Type
Asset owner/Location: Dún Laoghaire-Rathdown County Council		
Catchment 1	A0118 (right)	Bio retention areas/rain gardens
Catchment 1	A0270 (right)	Bio retention areas/rain gardens
Catchment 1	A0526 to A0768 (right)	Bio retention areas/rain gardens
Catchment 1	A0850 (right)	Bio retention areas/rain gardens
Asset owner/Location: Irish Water/ Dún Laoghaire-Rathdown County Council		
Catchment 2	A0971 (left)	Bio retention areas/rain gardens

Catchment	Chainage	Drainage Type
Asset owner/Location: Dún Laoghaire-Rathdown County Council		
Catchment 3	A1035 to A1162 (both sides)	Bio retention areas/rain gardens
Catchment 3	A1162 to A1245 (both sides)	Bio retention areas/rain gardens
Catchment 4	A1245 to A1365 (both sides)	Bio retention areas/rain gardens
Catchment 4	A1365 to A1438 (both sides)	Filter drain, tree pits, sealed pipe network & oversized pipe
Catchment 4	A1438 to A1578 (left)	Bio retention areas/rain gardens
Catchment 4	A1578 to A1695 (both sides)	Bio retention areas/rain gardens, tree pits, filter drain, sealed pipe network & oversized pipe
Catchment 5	A1695 to A1827 (both sides)	Bio retention areas/rain gardens, sealed pipe network, tree pits & filter drain
Catchment 5	A1827 to A1943 (both sides)	Bio retention area/rain garden, sealed pipe network, tree pits & filter drain
Catchment 5	A1943 to A2067 (both sides)	Bio retention areas/rain gardens, sealed pipe network, tree pits & filter drain
Catchment 5	A2200 (left)	Bio retention area/rain garden
Catchment 5	A2210 to A2280 (right)	Bio retention area/rain garden
Catchment 5	A2280 to A2340 (right)	Bio retention areas/rain gardens
Catchment 6	A2285 to A2340 (left)	Bio retention areas/rain gardens
Catchment 5	A2405 to A2560 (left)	Bio retention areas/rain gardens
Catchment 5	A2560 to A2630 (both sides)	Bio retention areas/rain gardens
Catchment 5	A2630 to A2815 (both sides)	Bio retention areas/rain gardens
Catchment 5	A2880 to A3015 (right)	Tree pits & filter drain
Asset owner/Location: Dublin City Council		
Catchment 7	A3015 to A3122 (right)	Tree pits & filter drain
Catchment 7	A3100 (left)	Bio retention areas/rain gardens
Catchment 7	A3140 (left)	Bio retention areas/rain gardens
Catchment 7	A3255 to A3320 (both sides)	Bio retention areas/rain gardens
Catchment 7	A3319 to A3452 (right)	Bio retention areas/rain gardens
Catchment 7	A3320 to A3410 (left)	Sealed pipe network
Catchment 7	A3452 to A3535 (right)	Bio retention areas/rain gardens & sealed pipe network
Asset owner/Location: Irish Water/Dublin City Council		
Catchment 8	A3660 to A3772 (left)	Bio retention area/rain garden, tree pit and filter drain
Asset owner/Location: Dublin City Council		
Catchment 7	A3772 to A3900 (left)	Bio retention areas/rain gardens
Asset owner/Location: Irish Water /Dublin City Council		

Catchment	Chainage	Drainage Type
Catchment 8	A3969 to A4082 (both sides)	Bio retention areas/rain gardens & sealed pipe network & sealed pipe network
Catchment 9	A4082 to A4310 (both sides)	Bio retention areas/rain gardens, tree pits, filter drains, sealed pipe network & oversized pipe
Catchment 9	A4430 (right)	Bio retention area/rain garden
Catchment 10	A4850 to A5153 (both sides)	Sealed pipe network and bio retention areas/rain gardens.
Catchment 10	A5170 (left)	Bio retention areas/rain gardens
Catchment 11	A5400 (left)	Bio retention areas/rain gardens
Catchment 11	A5627 (right)	Bio retention areas/rain gardens
Catchment 12	Anglesea Road & A5770	Bio retention areas/rain gardens and sealed pipe network
Catchment 13	A5770 to A5810 (both sides)	Bio retention areas/rain gardens
Catchment 13	A5810 to A5920 Herbert Park	Bio retention areas/rain gardens
Catchment 15	A5870 to A6150 (both sides)	Bio retention areas/rain gardens & sealed pipe network
Catchment 15	A6142 to A6214 (left)	Bio retention areas/rain gardens
Catchment 15	A6175 Branch	Bio retention areas/rain gardens
Catchment 15	A6195 to A6530 (both sides) & A6530 to A6660 (right)	Bio retention areas/rain gardens
Catchment 16	A6530 to A6660 (left) & A6660 to A6875 (both sides)	Bio retention areas/rain gardens
Catchment 17	A6910 to A7331 (right)	Sealed pipe network
Catchment 17	A6910 to A7331 (left)	Sealed pipe network
Catchment 17	C0000 to C0150 (both sides)	Tree pit and filter drain
Asset Owner/Location: Dublin City Council		
Catchment 7	B0-050 to B0+160 (both sides)	Sealed pipe network, tree pits, filter drain & oversized pipe
Catchment 7	B160 to B0285 (both sides)	Bio retention areas/rain gardens & oversized pipe
Catchment 7	B0285 to B0483 (both sides)	Bio retention areas/rain gardens & oversized pipe
Catchment 7	B0483 to B0590 (both sides)	Oversized pipe
Catchment 7	B590 to B0705 (both sides)	Bio retention areas/rain gardens, sealed pipe networks, tree pits & filter drain
Catchment 7	B0705 to B0832 (both sides)	Bio retention areas/rain gardens, sealed pipe network, tree pits & filter drain

9.5.2 Summary of Attenuation Features, SuDS and Outfalls

Where practicable, and in new areas of urban realm gained as part of the design, a sustainable drainage system is considered in the form of rain gardens, bioretention areas, filter drains, swales, tree pits, permeable paving etc. SuDS is also considered in existing areas, where practicable.

The attenuation measures for the Proposed Scheme are summarised for each catchment in Table 9.5. Chainage locations not shown in the table below do not require attenuation or SuDS.

Table 9.5: Summary of Proposed Attenuation Features, SuDS & Outfalls

Chainage	Existing Catchment Reference (Refer to Tables 10.2)	Approx. Impermeable Surface Area		Permitted Discharge (l/s)	Possible SuDS solution/ attenuation measure	Catchment Outfall
		Existing (m^2)	Change (m^2)			
Asset owner/Location: Dún Laoghaire-Rathdown County Council						
A1365 to A1438 (both sides)	Catchment 4	1487	152	20	DN225 64m long FD and TP, DN300 63m long OSP	Existing SW, Ch A1445
A1578 to A1695 (left)	Catchment 4	2819	271	39.2	TP, DN225 88m long FD, DN300 78m long OSP	Existing SW, Ch A1585
A1695 to A1827 (left)	Catchment 5	2568	364	35.7	DN225 124m long FD and TP, DN225 94m long SD	Existing SW, Ch A1822
A1827 to A1928 (left)	Catchment 5	2069	181	28.8	DN225 88m long FD and TP, DN225 91m long SD	Existing SW, Ch A1928
A1928 to A2067 (right)	Catchment 5	1279	241	17.8	DN225 43m long FD and TP, DN225 48m long SD	Existing SW, Ch A2060
A2880 to A3015 (right)	Catchment 5	854	446	11.9	DN225 103m long FD and TP	Existing SW, Ch A2880
Asset owner/Location: Irish Water/ Dublin City Council						

Chainage	Existing Catchment Reference (Refer to Tables 10.2)	Approx. Impermeable Surface Area		Permitted Discharge (l/s)	Possible SuDS solution/ attenuation measure	Catchment Outfall
		Existing (m^2)	Change (m^2)			
A3660 to A3772 (left)	Catchment 8	1231	79	17.1	DN225 21m long FD, DN300 28m long OSP and TP	Existing Combined, Ch A3706
A4082 to A4310 (both sides)	Catchment 9	3727	200	51.8	DN225 99m long FD and TP, DN225 89m long SD & DN300 64m long OSP	Existing Combined, Ch A4258
Anglesea Road	Catchment 12	187	52	2.7	OGCR 3.1 m^3	Existing Combined, Ch A5678
Asset Owner/Location: Dublin City Council						
B0-100 to B0+160 (both sides)	Catchment 7	3281	799	45.7	DN225 62m long FD & TP, DN300 158m long OSP, DN225 1m long SD	Existing SW, Ch B160
B160 to B285 (both sides)	Catchment 7	2724	326	37.9	DN375 90m long OSP	Existing SW, Ch B285
B285 to B483 (right)	Catchment 7	3288	562	45.8	DN300 90m long OSP, DN375 87m long OSP.	Existing SW, Ch B483
B483 to B590 (right)	Catchment 7	1769	291	24.6	DN375 90m long OSP.	Existing SW, Ch B590
B590 to B705 (right)	Catchment 7	1219	391	17	DN225 31m long FD and TP, DN225 63m long SD	Existing SW, Ch B735
B705 to B832 (right)	Catchment 7	1178	162	16.4	DN225 82m long FD and TP, DN225 24m long SD	Existing SW, Ch A3980

9.6 Drainage at New Bridge Structures

There are no new bridge structures in the Proposed Scheme that require special surface water management techniques.

9.7 Flood Risk

The Stage 1 FRA for the Proposed Scheme, included in Appendix N, consisted of a study carried out for the areas relating to Sections 1 and 2 of the Proposed Scheme, and another carried out for the areas relating to Sections 3, 4 and 5 of the Proposed Scheme. The Stage 1 FRA is a high-level study of the Proposed Scheme to identify flood risks to the project and any potential flooding issues arising due to the project. The report informs the planning process and identifies whether a further Stage 2 FRA is required.

The FRA includes the following:

- Confirmation of the sources of flooding which may affect the site;
- A qualitative assessment of the risk of flooding to the site and to adjacent sites as a result of construction of the proposed development,
- Review of the availability and adequacy of existing information,
- Identification of possible measures which could mitigate the flood risk to acceptable levels, and;
- Areas for further investigation (Stage 2 FRA) if required.

Sections 9.7.1 and 9.7.2 below summarises the Stage 1 FRA.

9.7.1 Flood Risk Assessment – Sections 1 and 2

There are a number of historic flood events at different locations along or near to Sections 1 and 2 of the proposed scheme. The proposed scheme is largely on existing roads and will result in minimal additional paved areas and will therefore not increase the risk of these events reoccurring compared to the current scenario.

The groundwater vulnerability varies along the proposed scheme. As most of the scheme is on existing roads with no known flooding specifically due to groundwater, it is not expected that this risk will increase with the construction of the scheme.

The pluvial flood risk along the majority of the proposed route is medium, however, this risk exists in the current scenario and will be reduced as a result of the proposed scheme.

All new surface water sewers provided as part of the scheme shall be designed so that no flooding will occur for a return period up to 30 years. This is an improvement when compared to some of the existing historical drainage infrastructure to be replaced and will reduce the risk of pluvial flooding.

Also, as part of the scheme, new drainage infrastructure will be provided which will include new Sustainable (Urban) Drainage Systems (SuDS) such as rain gardens, swales and tree pits. These SuDS features will provide some surface water storage and thus reduce the risk of pluvial flooding.

There are two areas along the proposed scheme where there is a risk of fluvial flooding as identified in the Stage 1 FRA. The two areas consist of Area 1 at Merrion Road and Area 2 at Frascati Road which lies within Flood Zone B.

There is one area identified along the proposed scheme where there is a risk of coastal flooding as identified in the Stage 1 FRA. Area 3 at Merrion Strand falls within Flood Zone A.

As areas of the scheme are identified as being within Flood Zone A and Flood Zone B, the Justification Test is required. The Plan-Making Justification Test and Development Management Justification have been assessed and passed, therefore, further investigation of the flood risk in the form of a Stage 2 FRA does not need to be carried out.

9.7.2 Flood Risk Assessment – Sections 3, 4, and 5

There are a number of historic flood events at different locations along or near to Sections 1, 2 and 3 of the proposed scheme. Parts of the River Dodder Flood Alleviation Scheme and upgrades to the local drainage network have since been carried out, reducing the risk of flooding in this area.

The pluvial flood risk along the majority of the proposed route is medium to high, however, this risk exists in the current scenario and will be reduced as a result of the proposed scheme.

As with Sections 1 and 2, all new surface water sewers provided as part of the scheme shall be designed so that no flooding will occur for a return period up to 30 years. This is an improvement when compared to some of the existing historical drainage infrastructure to be replaced and will reduce the risk of pluvial flooding. Also, as part of the scheme, new drainage infrastructure will be provided which will include new Sustainable (Urban) Drainage Systems (SuDS) such as rain gardens, swales and tree pits. These SuDS features will provide some surface water storage and thus reduce the risk of pluvial flooding.

The groundwater vulnerability varies along the proposed scheme from low to moderate. As most of the scheme is on existing roads with no known flooding specifically due to groundwater, it is not expected that this risk will increase with the construction of the scheme.

There are two areas along the proposed scheme where there is a risk of fluvial flooding as identified in the Stage 1 FRA. There are two areas along the proposed route where there is a risk of fluvial flooding. The two areas consist of Area 1 at Ballsbridge which lies within Flood Zone A and Area 2 at Merrion Road which lies in Flood Zone B.

As areas of the scheme are identified as being within Flood Zone A and Flood Zone B, the Justification Test is required.

The Plan-Making and Development Management Justification Tests have been assessed and passed, therefore, further investigation of the flood risk in the form of a Stage 2 FRA does not need to be carried out.

10 Services & Utilities

10.1 Overview of Utilities Strategy and Survey

Utility records from all providers were sought at an early stage of the scheme design. These records combined with topographic survey records, walk over inspections and desktop analysis of the Proposed Scheme identified areas of risk to existing assets. Where risk was initially identified to high value assets, such as high voltage ESB cables, high pressure gas mains and trunk water mains, a review was undertaken to ascertain if the risk could be mitigated by amending the highways design whilst still meeting the objectives of the scheme. Some areas of conflict were designed out at this stage; however, some remain and will be accommodated within the overall scheme design.

10.1.1 Record information

Available utility records were submitted by service providers and reviewed by Arup along the Routes. These records have assisted with informing the scheme design. Utility records were received from the following service providers:

- Irish Water;
- Gas Networks Ireland (GNI);
- Electrical Supply Board (ESB);
- Eir;
- Virgin Media;
- BT;
- Vodafone;
- Enet;
- Dún Laoghaire-Rathdown County Council;
- Dublin City County Council.

10.1.2 Phase 1 Utility Survey

A targeted utility survey to PAS 128A, including GPR (Ground Penetrating Radar), was commissioned by the NTA to investigate areas where there is risk identified to existing high value assets such as high voltage ESB cables, high pressure gas mains and trunk water mains due to the proposed carriageway alignment. Some areas where there is a high concentration of utility diversions proposed were also surveyed to ensure that adequate spacing is available for relocation of assets. The results of the utility survey have been reviewed to confirm the adequacy of design provisions made with respect to diversion proposals. Additionally, a more extensive utility survey will be required to inform the detailed design phase of the scheme.

10.1.3 Consultation with Utility Service Providers

Consultation with all relevant utility service providers was undertaken to evaluate the impact of the Proposed Scheme on existing utilities.

Based on records and topographical survey that was available, utility diversions and areas where protection measures might be required were identified. These potential impacts were documented on a set of consultation drawings and a technical note which was prepared for each utility company.

Consultation meetings were held with ESB, Gas Networks Ireland, Irish Water and Eir. The Proposed Scheme proposals were outlined to them and scenarios where utility infrastructure might be impacted by the Proposed Scheme were discussed.

10.2 Overview of Service Diversions

The construction of the Proposed Scheme will result in conflicts with several existing utility assets.

These conflicts have been identified, and preliminary consultation has been undertaken with the relevant service providers so that the conflict can be resolved by relocating or diverting the services where necessary and protecting in-situ where appropriate.

The principal statutory and other service providers affected are:

- ESB;
- Irish Water (Water & Public Sewer);
- GNI;
- Telecommunications Services – Eir, Virgin Media, eNet & BT.

In addition to the above, it will be necessary to relocate and upgrade some of the existing public lighting and traffic signalling network and equipment along the extents of the scheme.

The services conflicts and the associated diversions will need to be considered in the design and construction of the scheme. The design considerations have been taken into account as much as possible at this stage, but it is likely that design modifications will be required at detailed design stage when further site investigations have taken place.

During construction, it may be necessary to maintain supply to certain services. This will require the retention and protection of existing utility supplies until such time as permanent diversions can be commissioned, or alternatively the construction of temporary diversions to facilitate completion of the works including the permanent diversion of services. The sequence of works must also take into account the need to liaise with service providers and, subject to their availability to carry out diversions, staging of the works may be necessary.

The service diversions required for this development are discussed in the following paragraphs and are summarised in Table 10.1, Table 10.2, Table 10.3, Table 10.4 and Table 10.5. The locations of all known services from records provided from the service providers are shown on Combined Utility Drawings (Ref. Appendix B)

10.3 Summary of Recommended Diversions

10.3.1 Gas Networks Ireland

No impacts to high pressure gas mains have been identified. There are two location where GNI medium pressure gas mains require a diversion. There are four locations where GNI low pressure gas mains require a diversion. Table 10.1 below outlines potential diversions of GNI services, and are illustrated on drawing series BCIDC-ARP-UTL_UG-1415__XX_00-DR-CU-0001 to 0023.

Table 10.1: GNI Potential Diversion Schedule

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R15-UG-LP-001	GNI	A1+725 – A1+915 LHS	Low pressure gasmain along Rock Road.	Proposed diversion length of 190m for GNI utility.
R15-UG-DRI-002	GNI	A3+735 LHS	GNI AGI on Merrion Road at St. Vincents Hospital.	Existing archway entrance to GNI AGI to be relocated and access arrangements modified.
R14-UG-LP-001	GNI	A5+810 LHS	Low pressure gasmain at Herbert Park.	Proposed diversion length of 55m for GNI utility.
R14-UG-LP-002	GNI	A6+750 – A6+800 LHS	Low pressure gasmain on Baggot Street Upper.	Proposed diversion length of 50m for GNI utility.
R14-UG-MP-003	GNI	B0-040 – B0-005 LHS	Low pressure gasmain on Nutley Lane.	Proposed diversion length of 45m for GNI utility.
R14-UG-LP-004	GNI	B0+020 – B0+170 LHS	Low pressure gasmain on Nutley Lane.	Proposed diversion length of 165m for GNI utility.
R14-UG-MP-005	GNI	B0+250 – B0+530 RHS	Medium pressure gasmain on Nutley Lane.	Proposed diversion length of 295m for GNI utility.

10.3.2 ESB

There is one section of high voltage underground cabling, eight sections of medium voltage underground cabling and there are eighteen sections of low voltage underground cabling requiring diversions along the route. Table 10.2 below outlines several potential diversions for ESB services, and are illustrated on drawing series BCIDC-ARP-UTL_UE-1415_XX_00-DR-CU-0001 to 0023.

Table 10.2: ESB Diversion Schedule

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R15-UE-LV-001	ESB	A1+310 – A1+350 LHS	Low voltage ducting on Rock Road.	Proposed diversion of 41m for ESB utility.
R15-UE-LV-002	ESB	A1+625 – A1+910 LHS	Low voltage ducting on Rock Road.	Proposed diversion length of 288m for ESB utility.
R15-UE-LV-003	ESB	A1+950 – A2+230 RHS	Low voltage ducting on Rock Road.	Proposed diversion length of 82m for ESB utility.
R15-UE-LV-004	ESB	A2+260 – A2+300 LHS	Low voltage ducting on Rock Road.	Proposed diversion length of 40m for ESB utility.
R15-UE-LV-005	ESB	A2+730 – A2+745 LHS	Low voltage ducting along Rock Road.	Proposed diversion length of 15m for ESB utility.
R15-UE-MV-006	ESB	A2+730 – A2+745 LHS	Low voltage ducting along Rock Road.	Proposed diversion length of 15m for ESB utility.
R15-UE-HV-007	ESB	A3+005 – A3+080 RHS	High voltage ducting along Merrion Road.	Proposed diversion length of 75m for ESB utility.
R15-UE-LV-008	ESB	A3+090 RHS	ESB micropillar on Merrion Road.	ESB micropillar to be relocated.
R15-UE-MV-009	ESB	A3+740 LHS	ESB substation on Merrion Road at St. Vincent's University Hospital.	ESB substation to be relocated.
R14-UE-LV-001	ESB	B0+765 – B0+805 LHS	Low voltage ducting along Nutley Lane.	Proposed diversion length of 33m for ESB utility.
R14-UE-LV-002	ESB	A4+130 – A4+175 LHS	Low voltage ducting along Merrion Road.	Proposed diversion length of 47m for ESB utility.
R14-UE-LV-003	ESB	A4+890 – A5+060 LHS	Low voltage ducting along Merrion Road.	Proposed diversion length of 173m for ESB utility.
R14-UE-LV-004	ESB	A4+930 – A5+060 LHS	Low voltage ducting along Merrion Road.	Proposed diversion length of 130m for ESB utility.
R14-UE-MV-005	ESB	A5+805 LHS	ESB substation at Herbert Park.	ESB substation to be relocated.
R14-UE-MV-006	ESB	A5+805 – A5+820 LHS	Medium voltage ducting at Herbert Park.	Proposed diversion length of 69m for ESB utility.
R14-UE-MV-007	ESB	A6+775 – A6+790 LHS	Medium voltage ducting along Baggot Street Upper.	Proposed diversion length of 17m for ESB utility.
R14-UE-LV-008	ESB	A6+755 – A6+790 LHS	Low voltage ducting along Baggot Street Upper.	Proposed diversion length of 39m for ESB utility.
R14-UE-MV-009	ESB	A6+755 – A6+775 LHS	Medium voltage ducting along Baggot Street Upper.	Proposed diversion length of 21m for ESB utility.
R14-UE-LV-010	ESB	B0+000 LHS	Low voltage ducting along Nutley Lane.	Proposed diversion length of 4m for ESB utility.
R14-UE-LV-011	ESB	B0+025 – B0+035 RHS	Low voltage overhead on Nutley Lane.	Proposed diversion length of 9m for overhead ESB.

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R14-UE-LV-012	ESB	B0+060 – B0+065 RHS	Low voltage overhead on Nutley Lane.	Proposed diversion length of 25m for overhead ESB.
R14-UE-MV-013	ESB	B0-035 – B0+160 LHS	Medium voltage ducting on Nutley Lane.	Proposed diversion length of 200m for ESB utility.
R14-UE-LV-014	ESB	B0+000 – B0+200 LHS	Low voltage overhead on Nutley Lane.	Proposed diversion length of 200m for overhead ESB.
R14-UE-LV-015	ESB	B0+275 – B0+290 RHS	Low voltage overhead on Nutley Lane.	Proposed diversion length of 20m for overhead ESB.
R14-UE-LV-016	ESB	B0+510 – B0+520 RHS	Low voltage overhead on Nutley Lane.	Proposed diversion length of 18m for overhead and 8m for underground ESB.
R14-UE-MV-017	ESB	B0+600 – B0+640 RHS	Medium voltage ducting along Nutley Lane.	Proposed diversion length of 80m for ESB utility.
R14-UE-LV-018	ESB	B0+640 – B0+770 LHS	Low voltage overhead poles along Nutley Lane.	Proposed diversion length of 135m for overhead ESB.

10.3.3 Irish Water- Watermain

There are nine sections of watermains requiring diversions along the route. Table 10.3 below outlines several potential diversions for watermain services, and are illustrated on drawing series BCIDC-ARP-UTL_UW-1415_XX_00-DR-CU-0001 to 0023.

Table 10.3: Irish Water- Watermain Potential Diversion Schedule

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R15-UW-001	Irish Water	A0+140 – A0+150 LHS	Watermain on Temple Hill.	Proposed diversion length of 14m for watermain.
R15-UW-002	Irish Water	A1+050 – A1+060 LHS	Watermain on Frascati Road.	Proposed diversion length of 13m for watermain.
R15-UW-003	Irish Water	A2+280 – A2+300 RHS	Watermain on Rock Road.	Proposed diversion length of 18m for watermain.
R15-UW-004	Irish Water	A2+320 – A2+330 LHS	Watermain on Rock Road.	Proposed diversion length of 17m for watermain.
R15-UW-005	Irish Water	A2+735 – A2+745 RHS	Watermain on Rock Road	Proposed diversion length of 11m for watermain.
R14-UW-001	Irish Water	B0+160 – B0+760 RHS	Watermain on Nutley Lane.	Proposed diversion length of 596m for watermain.
R14-UW-002	Irish Water	A6+350 – A6+365 RHS	Watermain on Pembroke Road.	Proposed diversion length of 17m for watermain.
R14-UW-003	Irish Water	A6+750 – A6+800 LHS	Watermain on Baggot Street Upper	Proposed diversion length of 50m for watermain.
R14-UW-004	Irish Water	A7+035 – A7+050 LHS	Watermain on Baggot Street Lower.	Proposed diversion length of 17m for watermain.

10.3.4 Irish Water- Foul Sewers

Table 10.4 below outlines a number of potential manhole adjustments for foul sewer services, and are illustrated on drawing series BCIDC-ARP-UTL_UD-1415_XX_00-DR-CU-0001 to 0023. No diversions of foul sewer pipelines are proposed.

Table 10.4: Irish Water-Foul Sewer Diversion Schedule

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R15-UD-001	Irish Water	A0+020 LHS	Foul sewer located along Temple Hill.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R15-UD-002	Irish Water	A1+150 RHS	Foul sewer located along Frascati Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R15-UD-003	Irish Water	A2+180 LHS	Foul sewer located along Rock Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R15-UD-004	Irish Water	A2+250 LHS	Foul sewer located along Rock Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R15-UD-005	Irish Water	A2+390 LHS	Foul sewer located along Rock Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R15-UD-006	Irish Water	A2+530 LHS	Foul sewer located along Rock Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R15-UD-007	Irish Water	A3+510 RHS	Foul sewer located along Merrion Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R14-UD-001	Irish Water	A4+730 LHS	Foul sewer located along Merrion Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R14-UD-002	Irish Water	A5+330 RHS	Foul sewer located along Merrion Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.
R14-UD-003	Irish Water	A6+330 RHS	Foul sewer located along Pembroke Road.	Proposed manhole cover adjustment to avoid clash with new kerbline.

10.3.5 Telecommunication

There are one hundred and six locations along the route where conflicts with telecommunications infrastructure occur, and diversions or relocations will be required.

In addition to chambers identified as Eir assets on the topographical survey that are identified as requiring modification, there are other chambers that might contain telecommunications asset that are impacted by the scheme. Further investigation is required to confirm at the construction design stage. Table 10.5 below outlines several potential diversions for telecoms services, and are illustrated on drawing series BCIDC-ARP-UTL_UT-1415_XX_00-DR-CU-0001 to 0023.

Table 10.5: Telecom Diversion Schedule

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R15-UT-001	EIR	A0+535 LHS	EIR chamber on Frascati Road.	Proposed chamber relocation required.
R15-UT-002	EIR	A0+535 RHS	EIR chamber at Temple Road junction.	Proposed chamber relocation required.
R15-UT-003	EIR	A0+850 RHS	EIR chamber on Carysfort Avenue.	Proposed chamber relocation required.
R15-UT-004	EIR	A0+850 RHS	EIR chamber on Carysfort Avenue.	Proposed chamber relocation required.
R15-UT-005	EIR	A0+880 RHS	EIR chamber on Frascati Road.	Proposed chamber relocation required.
R15-UT-006	EIR	A1+160 RHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-007	EIR	A1+345 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-008	EIR	A1+580 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-009	EIR	A1+640 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-010	EIR	A1+650 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-011	EIR	A1+700 RHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-012	EIR	A1+685 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-013	EIR	A1+710 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-014	EIR	A1+715 LHS	Kiosk on Rock Road.	Proposed kiosk relocation required.
R15-UT-015	EIR	A1+620 – A1+855 LHS	EIR ducts on Rock Road.	Proposed diversion length of 236m for telecoms.
R15-UT-016	EIR	A1+820 RHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-017	EIR	A1+910 LHS	EIR chamber on Rock Road	Proposed chamber relocation required.
R15-UT-018	EIR	A1+925 RHS	EIR chamber on Rock Road	Proposed chamber relocation required.
R15-UT-019	EIR	A1+915 RHS	EIR chamber on Rock Road	Proposed chamber relocation required.
R15-UT-020	EIR	A1+905 RHS	EIR chamber on Rock Road	Proposed chamber relocation required.
R15-UT-021	EIR	A1+915 - A2+020 RHS	EIR ducts on Rock Road.	Proposed diversion length of 60m for telecoms.

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R15-UT-022	EIR	A2+025 RHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-023	EIR	A2+120 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-024	EIR	A2+260 – A2+290 LHS	EIR ducts on Rock Road.	Proposed diversion length of 32m for telecoms.
R15-UT-025	EIR	A2+340 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-026	EIR	A2+455 RHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-027	EIR	A2+470 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required
R15-UT-028	EIR	A2+480 RHS	EIR chamber on along Rock Road.	Proposed chamber relocation required
R15-UT-029	EIR	A2+725 LHS	EIR chamber on St. Helen's Road.	Proposed chamber relocation required
R15-UT-030	EIR	A2+835 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required
R15-UT-031	EIR	A2+845 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required
R15-UT-032	EIR	A2+850 LHS	EIR chamber on Trimleston Avenue.	Proposed chamber relocation required
R15-UT-033	EIR	A2+860 LHS	EIR chamber on Rock Road.	Proposed chamber relocation required.
R15-UT-034	EIR	A2+925 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-035	EIR	A2+940 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-036	EIR	A3+070 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-037	EIR	A3+120 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-038	EIR	A3+125 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-039	EIR	A3+150 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-040	EIR	A3+205 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-041	EIR	A3+275 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-042	EIR	A3+320 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-043	EIR	A3+380 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-044	EIR	A3+450 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-045	EIR	A3+450 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-046	EIR	A3+550 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-047	EIR	A3+625 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R15-UT-048	EIR	A3+590 LHS	EIR chamber at junction with Estate Avenue.	Proposed chamber relocation required.
R15-UT-049	EIR	A3+685 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-050	EIR	A3+680 – A3+750 LHS	EIR ducts on Merrion Road.	Proposed diversion length of 76m for telecoms.
R15-UT-051	EIR	A3+760 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-052	EIR	A3+710 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-053	EIR	A3+735 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R15-UT-054	EIR	A3+750 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-001	EIR	B0+555 – B0+790 RHS	EIR ducts on Nutley Lane.	Proposed diversion length of 233m for telecoms.
R14-UT-002	EIR	B0+300 – B0+790 RHS	EIR ducts on Nutley Lane.	Proposed diversion length of 493m for telecoms.
R14-UT-003	EIR	B0+165 – B0+780 RHS	EIR ducts on Nutley Lane.	Proposed diversion length of 575m for telecoms.
R14-UT-004	EIR	B0+740 – B0+755 LHS	EIR ducts on Nutley Lane.	Proposed diversion length of 17m for telecoms.
R14-UT-005	EIR	A4+010 – A4+125 LHS	EIR ducts on Merrion Road.	Proposed diversion length of 115m for telecoms.
R14-UT-006	EIR	A4+340 LHS	Kiosk present on Merrion Road.	Proposed kiosk relocation required.
R14-UT-007	EIR	A4+350 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-008	EIR	A4+820 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-009	EIR	A8+880 LHS	Kiosk at Shrewsbury Road junction.	Proposed kiosk relocation required.
R14-UT-010	EIR	A5+135 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-011	EIR	A5+170 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-012	EIR	A5+180 RHS	Kiosk on Merrion Road.	Proposed kiosk relocation required.
R14-UT-013	EIR	A5+395 LHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-014	EIR	A5+390 RHS	Kiosk on Merrion Road.	Proposed kiosk relocation required.
R14-UT-015	EIR	A5+395 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-016	EIR	A5+450 RHS	Kiosk on Merrion Road.	Proposed kiosk relocation required.
R14-UT-017	EIR	A5+480 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R14-UT-018	EIR	A5+650 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-019	EIR	A5+640 RHS	EIR chamber on Merrion Road.	Proposed chamber relocation required.
R14-UT-020	EIR	A5+800 – A5+805 LHS	EIR ducts at Herbert Park.	Proposed diversion length of 140m for telecoms.
R14-UT-021	EIR	A5+820 LHS	3 no. EIR chambers at Herbert Park.	Proposed chamber relocations required.
R14-UT-022	EIR	A5+865 RHS	EIR chamber on Pembroke Road.	Proposed chamber relocation required.
R14-UT-023	EIR	A6+175 RHS	EIR chamber on Pembroke Road.	Proposed chamber relocation required.
R14-UT-024	EIR	A6+175 RHS	EIR chamber on Lansdowne Road junction.	Proposed chamber relocation required.
R14-UT-025	EIR	A6+175 RHS	EIR chamber on Lansdowne Road.	Proposed chamber relocation required.
R14-UT-026	EIR	A6+720 LHS	EIR chamber on Baggot Street Upper.	Proposed chamber relocation required.
R14-UT-027	EIR	A6+720 LHS	EIR chamber on Baggot Street Upper.	Proposed chamber relocation required.
R14-UT-028	EIR	A6+775 LHS	Kiosk on Baggot Street Upper.	Proposed kiosk relocation required.
R14-UT-029	EIR	A6+845 RHS	EIR chamber on Baggot Street Upper.	Proposed chamber relocation required.
R14-UT-030	EIR	A6+875 RHS	EIR chamber at junction with Haddington Road.	Proposed chamber relocation required.
R14-UT-031	EIR	A6+880 LHS	EIR chamber at junction with Haddington Road.	Proposed chamber relocation required.
R14-UT-032	EIR	A6+880 RHS	EIR chamber at junction with Haddington Road.	Proposed chamber relocation required.
R14-UT-033	EIR	A6+950 RHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-034	EIR	A7+025 LHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-035	EIR	A7+105 LHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-036	EIR	A7+110 RHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-037	EIR	A7+115 RHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-038	EIR	A7+210 LHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-039	EIR	A7+210 RHS	EIR chamber at junction with James Street East.	Proposed chamber relocation required.
R14-UT-040	EIR	A7+215 RHS	EIR chamber at junction with James Street East.	Proposed chamber relocation required.
R14-UT-041	EIR	A7+215 RHS	EIR chamber at junction with James Street East.	Proposed chamber relocation required.

Reference No.	Utility Provider	Chainage	Asset/ Apparatus Impacted	Description of Works
R14-UT-042	EIR	A7+215 RHS	EIR chamber at junction with James Street East.	Proposed chamber relocation required.
R14-UT-043	EIR	A7+265 LHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-044	EIR	A7+300 LHS	EIR chamber on Fitzwilliam Street Upper.	Proposed chamber relocation required.
R14-UT-045	EIR	A7+285 RHS	EIR chamber on Baggot Street Lower.	Proposed chamber relocation required.
R14-UT-046	Virgin Media	B0-030 – B0+000	Virgin Media ducts on Nutley Lane.	Proposed diversion length of 38m for telecoms.
R14-UT-047	EIR	B0+130 RHS	Telecom pole on Nutley Lane.	Proposed telecom pole relocation to facilitate new bus shelter.
R14-UT-048	EIR	B0-025 – B0+160 LHS	EIR ducts on Nutley Lane.	Proposed diversion length of 190m for telecoms.
R14-UT-049	Virgin Media	B0+0145 – B0+170 LHS	Virgin Media ducts on Nutley Lane.	Proposed diversion length of 18m for telecoms.
R14-UT-050	EIR	B0+280 RHS	Kiosk on Nutley Lane.	Proposed kiosk relocation required.
R14-UT-051	EIR	B0+300 RHS	Kiosk on Nutley Lane.	Proposed kiosk relocation required.
R14-UT-052	EIR	B0+630 RHS	Kiosk on Nutley Lane.	Proposed kiosk relocation required.

11 Waste Quantities

11.1 Introduction

The majority of the waste arisings from the construction of the Proposed Scheme will accumulate from excavation related activities and demolition works due to proposed public domain street works. A waste calculator was developed for the Proposed Scheme to quantify and classify the likely material types in accordance with TII GE-ENV-01101 and the European Waste Catalogue waste codes.

Excavation waste will arise from the following activities:

- Excavation of existing pavements and carriageways;
- Removal of existing structures including bridges and overhead gantries;
- Construction and reconstitution of cycle tracks, footpaths, road widening and urban realm improvements;
- Alteration of roundabouts to signalised junctions; and
- Utility diversions and / or protections.

Waste material resulting from these activities will include concrete (waste code 17 01 01), bitumen/ asphalt (waste code 17 06 02), and soil and stones (waste code 17 05 04). The waste quantities associated with the excavation of soil and stones have been further broken down into the likely TII material specification to establish an understanding of the volume of materials that could potentially be reused/recycled.

Demolition waste will arise from the following activities:

- Removal of street furniture including bus shelters, bins, gates, fences, railings and walls;
- Removal of roadside infrastructure including traffic signals, road signs, safety barriers, street lighting poles and ESB/EIR poles; and
- Removal of trees.

Waste materials resulting from these activities will include masonry brick/blocks (waste code 17 01 02), metal (waste code 17 04 07), plastic (waste code 17 02 03), wood (waste code 17 02 01) and glass (waste code 17 02 02).

In developing the waste estimate quantities, a number of assumptions were required to undertake the assessment which are outlined in Section 11.2.

11.2 Waste Calculation Assumptions

The following tables provide an overview of the various material weights and densities that have been applied to calculate the overall material waste estimate quantities for the Proposed Scheme.

Table 11.1: Street Furniture Unit Weights

Item	Material	Assumed nominal weight	Notes
Timber arising from trees	Timber/ Wood	100 kg per tree	Average value per tree across the entire route
Vegetation (eg hedges, shrubs, leaves and branches)	Organic	N/A	Organic material from hedges, shrubs, leaves and branches have not been quantified. It is assumed that this material will be collected and mulched before removal from site to organic treatment facility. Therefore, the quantity of organic waste will be minimal and not significant for the assessment.
Walls	Masonry/ Bricks	1.5m height 0.3m width	Nominal assumed dimensions for purposes of assessment
Gates	Metal	100 kg/unit	Nominal assumed average weight per gate over scheme
Metal railings	Metal	15 kg/m	Nominal assumed average weight per railing over scheme
Fencing	Metal	40 kg/m	Nominal assumed average weight per railing over scheme
Traffic Signals	Metal	68 kg per 4m pole 15kg per traffic signal head Assumed 2 heads per pole	Source: Siemens Helios General Handbook Issue 18. Nominal assumed average scenario per signal over scheme length
Traffic Signs	Metal	20kg per 3m pole 0.75 m sign height 0.01 m sign thickness	Nominal assumed average scenario per traffic sign over scheme length
Lighting poles	Metal	100 kg per 8m pole	Nominal assumed average scenario over scheme length
ESB/EIR poles	Timber/wood	250 kg per 9m pole	Nominal assumed average scenario over scheme length
Bus stops	Plastic	365 kg per bus stop	JCDecaux and NTA (2017) Reliance Bus Shelter information

Item	Material	Assumed nominal weight	Notes
	Metal	2400 kg per bus stop	JCDecaux and NTA (2017) Reliance Bus Shelter information
	Glass	54 kg per bus stop	JCDecaux and NTA (2017) Reliance Bus Shelter information
Litter bins	Metal	60 kg per bin	Omos specification. Nominal assumed average scenario over scheme length
Safety barrier	Metal	20 kg/m	Nominal assumed average scenario over scheme length
Cabinets	Metal	85 kg	ESB (2008). National Code of Practice for Customer Interface 4th Edition. Available online: https://www.esbnetworks.ie/docs/default-source/publications/national-code-of-practice.pdf (Accessed on 6 May 2021)
Benches	Metal	32kg	Lost Art (2016). Benches: Product information operation and maintenance instructions. Available online: https://www.lostart.co.uk/pdf/lost-art-limited-product-information.pdf (Accessed on 6 May 2021)
	Wood	8kg	
Cameras	Metal	35 kg	2b Security Systems (2021) PTZ-7000 Long range IP PTZ camera. Available online: https://www.2bsecurity.com/product/long-range-ptz-camera/ (Accessed on 6 May 2021)
Overhead Gantry (steel)	Metal	27.9 kg per m width of road	TII (nb). CC- SCD-01804-02. Available online:https://www.tiipublications.ie/library/CC-SCD-01804-

Item	Material	Assumed nominal weight	Notes
			02.pdf (Accessed on 6 May 2021) TII (nb). CC- SCD-0180-02. Available online:https://www.tiipublications.ie/library/CC-SCD-01805-02.pdf (Accessed on 6 May 2021)
Cast Iron Bollard	Metal	50 kg	Furnitubes (2013) Cast Iron Bollards: Product Brochure. Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf (Accessed on 6 May 2021)
Non Assigned Bollard	Metal	40kg	Furnitubes (2013) Cast Iron Bollards: Product Brochure. Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf (Accessed on 6 May 2021)
Stainless Steel Bollard	Metal	30kg	Furnitubes (2013) Cast Iron Bollards: Product Brochure. Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf (Accessed on 6 May 2021)
Vehicle Restraint Bollard	Metal	130 kg	Furnitubes (2013) Cast Iron Bollards: Product Brochure. Available online: https://www.furnitubes.com/uploads/assets/brochures-2013/furnitubes-e-008-01-13-cast-iron-bollard-brochure.pdf

Item	Material	Assumed nominal weight	Notes
			(Accessed on 6 May 2021)
Bike Railings/hand rails	Metal	16 kg	Dublin City Council (2016) Construction Standards for Road and Street Works in Dublin City Council
Gully grates	Metal	40 kg	Pam Saint- Gobain (2016). Ductile Iron Access Covers and Gratings: Product selection and specification guide. Available online: https://www.saint-gobain-pam.co.uk/sites/pamline_uk/files/access_covers_and_gratings_product_guide_0.pdf (Accessed on 6 May 2021) Greater Dublin Region (2012) Greater Dublin Regional Code of Practice for Drainage works. Available online: (https://www.sdcc.ie/en/download-it/guidelines/greater-dublin-regional-code-of-practice-for-drainage.pdf (Accessed on 6 May 2021)
Chamber covers and frame	Metal	50kg	Pam Saint- Gobain (2016). Ductile Iron Access Covers and Gratings: Product selection and specification guide. Available online: https://www.saint-gobain-pam.co.uk/sites/pamline_uk/files/access_covers_and_gratings_product_guide_0.pdf (Accessed on 6 May 2021) Greater Dublin Region (2012) Greater Dublin Regional Code of Practice for

Item	Material	Assumed nominal weight	Notes
			Drainage works. Available online: (https://www.sdcc.ie/en/download-it/guidelines/greater-dublin-regional-code-of-practice-for-drainage.pdf (Accessed on 6 May 2021)
Manholes	Metal	50kg	Pam Saint- Gobain (2016). Ductile Iron Access Covers and Gratings: Product selection and specification guide. Available online: https://www.saint-gobain-pam.co.uk/sites/pamline_uk/files/access_covers_and_gratings_product_guide_0.pdf (Accessed on 6 May 2021) Greater Dublin Region (2012) Greater Dublin Regional Code of Practice for Drainage works. Available online: https://www.sdcc.ie/en/download-it/guidelines/greater-dublin-regional-code-of-practice-for-drainage.pdf (Accessed on 6 May 2021)

Table 11.2: In-Situ Pavement and Earthworks Densities

Material	Densities (tonnes/m3)	Notes
Soil	2.2	Professional judgement (Dublin boulder clay), laboratory testing - Nominal assumed average scenario over scheme length
Bitumen containing material	2.4	Professional judgement (Engineering Designers) - Nominal assumed average scenario over scheme length
Concrete	2.4	Professional experience (Bath Inventory - Version 2.0 (2011)) - Nominal assumed average scenario over scheme length
Granite	2.7	https://pubs.usgs.gov/of/1983/0808/report.pdf - Nominal assumed average scenario over scheme length

Material	Densities (tonnes/m3)	Notes
Paving stones (assumed concrete or natural stone)	2.4	Professional judgement (Engineering Designers) Nominal assumed average scenario over scheme length
Granular material	1.6	Nominal assumed average scenario over scheme length

Table 11.3: Utilities Material Excavation Assumptions

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
Drainage Pipe Bedding Excavation Assessment (assumed at 1.2m cover i.e obvert at 0.35m under capping layer of road)	0.9	Class 2/4/U1 Cohesive subgrade material	1.25	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
Foul Sewer Pipe Bedding Excavation Assessment (assumed at 1.2m cover i.e obvert at 0.35m under capping layer of road)	0.9	Class 2/4/U1 Cohesive subgrade material	1.25	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
Potable water Pipe Bedding Excavation Assessment (assumed at 1.2m cover i.e obvert at 0.35m under capping layer of road)	0.9	Class 2/4/U1 Cohesive subgrade material	1.25	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
Road Pavement Excavation (extra over in addition to road widening allowances e.g	0.9	Bitumen (surface+binder and base)	0.35	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
transverse trenching)				Standard-Details.pdf (Accessed on 6 May 2021)
		Class 1/2 Granular Subbase material	0.3	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
		Class 6 Granular Capping material	0.2	Irish Water (2020) Water Infrastructure Standard Details: Connections and Developer Services. Available online: https://www.water.ie/connections/Water-Standard-Details.pdf (Accessed on 6 May 2021)
Electric/Power bedding excavation Assessment (assumed at 0.75m cover under footpath i.e obvert at 0.55m under subbase layer of footpath/cycle track)	0.5	Class 2/4/U1 Cohesive subgrade material	0.925	ESB (2008) Standard Specification for ESB MV/LV Network Duction (Minimum Standards). Available online: https://www.esbnetworks.ie/docs/default-source/publications/summary-of-standard-specification-for-esb-networks-mvlv-ducting.pdf?sfvrsn=f34b33f0_4 (Accessed on 6 May 2021)
Comms bedding Excavation Assessment (assumed at 0.75m cover under footpath i.e obvert at 0.55m subbase layer of footpath)	0.5	Class 2/4/U1 Cohesive subgrade material	0.925	ESB (2008) Standard Specification for ESB MV/LV Network Duction (Minimum Standards). Available online: https://www.esbnetworks.ie/docs/default-source/publications/summary-of-standard-specification-for-esb-networks-mvlv-

Asset type	Assumed nominal average trench width (m)	Assumed material spec. (TII)	Assumed nominal average trench depth under pavement layer (m)	Notes
				ducting.pdf?sfvrsn=f34b33f0_4 (Accessed on 6 May 2021)
Street Lighting/Comms/Traffic Excavation Assessment (assumed at 0.6m cover under footpath i.e obvert at 0.4m subbase layer of footpath)	0.5	Class 2/4/U1 Cohesive subgrade material	0.56	South Dublin County Council (2016) Public Lighting Specification. Available online: https://www.sdcc.ie/en/services/transport/public-lighting/sdcc-public-lighting-specification.pdf (Accessed on 6 May 2021)
Gas Excavation Assessment (assumed at 0.6m cover i.e obvert at 0.4m under subbase layer of footpath)	0.45	Class 2/4/U1 Cohesive subgrade material	0.7	Gas Network Ireland (2018) Guidelines for Designers and Builders- Industrial and Commercial (Non-domestic) Sites. Available online: https://www.gasnetworks.ie/Guidelines-for-Designers-and-Builders-Industrial-and-Commercial-Sites.pdf (Accessed 6 May 2021)

Table 11.4: Footpath and Verge Widening Excavation Assumptions

Layer	Assumed Layer thickness (m)	Assumed material spec. (TII)
Footpath surface treatment due to all works (remove and replace)	0.1	Concrete
Footpath sub-layer excavation due to Full Depth Construction (FDC) widening (material under footpath)	0.1	Granular material- Class 1/2 Granular Subbase material
	0.75	Soil and stones- Class 2/4/U1 Cohesive subgrade material
	0.3	Soil and stones- Class 5 Topsoil material

Layer	Assumed Layer thickness (m)	Assumed material spec. (TII)
Verge and sub-layer excavation due to FDC widening (material under verge)	0.55	Soil and stones- Class 4/U1 Cohesive subgrade material
Verge and sub-layer excavation due to footpath widening (material under verge)	0.3	Soil and stones- Class 5 Topsoil material
	0	Soil and stones- Class 4/U1 Cohesive subgrade material
Road surface treatment due to road markings and utilities trench reinstatement (mill & re-sheet)	0.05	Bitumen containing material - Bitumen (surface)
Road sub-layer excavation due to FDC (material under road)	0.3	Bitumen containing material - Bitumen (binder and base)
	0.3	Class 1/2 Granular Subbase material
	0.2	Granular material - Class 6 Granular Capping material
	0	Soil and stones- Class 2/4/U1 Cohesive subgrade material

11.3 Waste Estimate Summary

The majority of the waste arisings from the construction of the Proposed Scheme accumulates from excavation related activities and demolition works due to proposed public domain street works. The waste produced as a result of the Proposed Scheme has been summarised below along with an outline of how this waste will be managed.

In line with current practice in Ireland, surplus materials and wastes from the Proposed Scheme will be managed as follows:

- Where feasible, naturally occurring excavated material will be reused within construction in the Proposed Scheme in accordance with Article 2 of the Waste Directive Regulations, Waste Framework Directive and Section 3 of the Waste Management Act 1996, as amended;
- Where practicable, excavation material will be used as engineering and landscaping material within the Proposed Scheme where practicable and on other projects requiring the types of materials generated. Reuse of topsoil and excavated material within the Proposed Scheme is proposed where practicable. The material will also be subject to testing to ensure it is suitable for its proposed end use;
- Article 28 (End-of-Waste) (EPA 2020) criteria may be met by the excavation material, should such facilities become available by the time of commencement of construction of the Proposed Scheme, ensuring that the material will meet the acceptance criteria set out in Article 28 of the Waste Directive Regulations;

- All excavation wastes requiring removal from site for recycling or recovery will be delivered to facilities which are authorised under the Waste Management Act 1996 (i.e. which hold a Certificate of Registration, Waste Facility Permit or EPA Licence). Examples of recycling / recovery activities for excavation material may include:
- Processing of stone to produce construction aggregate;
- Backfilling of quarries; and
- Raising land for site improvement or development.
- There is no crushing and screening of material planned for the Proposed Scheme;
- All wastes removed from site will be delivered to recovery or disposal facilities holding a Certificate of Registration, Waste Facility Permit or EPA Waste Licence; and
- All wastes removed from site will be transported by the holder of the appropriate waste collection permit, granted in accordance with S.I. No. 820/2007 - Waste Management (Collection Permit) Regulations 2007.

It will be the responsibility of the appointed contractor to secure agreements for acceptance of surplus excavation materials from the Proposed Scheme in authorised and regulated facilities, in accordance with the Waste Management Act 1996 and associated regulations.

11.3.1 Demolition

Table 11.5 shows the estimated quantity and type of waste that will be generated by demolition activities in connection with the Proposed Scheme along with how much of this material could potentially be reused or recovered.

Table 11.5: Estimated Demolition Waste Types and Quantities

Waste Type	Approximate Waste and Material Quantity (tonnes)	Potential Recoverable/ Reusable Material	Recoverable/ Reusable Quantities (tonnes)
Concrete, bricks, tiles and similar	1,600	100%	1,600
Metals	160	100%	160
Segregated wood, glass and plastic	60	100%	60
Total	**1,820**		**1,820**

Potentially 100% of material generated from the demolition phase of the Proposed Scheme could be considered for reuse for construction within the Proposed Scheme or in other construction projects in accordance with Article 27 of the Waste Directive Regulations. It will be the responsibility of the appointed contractor to review feasibility of reuse of materials and ensure that the necessary testing is undertaken to demonstrate compliance with Article 27, as appropriate.

Where feasible, street and roadside infrastructure such as bus stops, lighting poles, traffic signals, and signs will be reused within the Proposed Scheme and will not become a waste. The appointed contractor will be responsible for ensuring compliance with all relevant legislation.

Materials will require on-site segregation by waste classification and if not suitable for onsite or offsite reuse, will be delivered to an authorised recycling or recovery facility. Where street furniture is a waste, it may be necessary to separate elements at source such as lightbulbs from luminaires and metals from other components and deliver these separately to suitable authorised recycling or recovery facilities.

Where metal railings and gates are removed, typically these have inherent value due to their metal content. These will be source-segregated and delivered for metal recycling to an authorised waste facility. Some example facilities which are currently authorised to accept metal and electronic waste include:

- Irish Lamp Recycling Co. Ltd, Woodstock Industrial Estate, Kilkenny Road, Athy, Co. Kildare; and
- Hammond Lane Metal Company, Pigeon House Road, Dublin 4, Dublin

The least preferable option is disposal to an authorised facility which will only take place when all viable opportunities for reuse and recycling have been investigated by the appointed contractor for feasibility, and ruled out.

Prior to commencing construction, the appointed contractor will undertake vegetation clearance and street furniture removal. Limited demolition will be undertaken as part of the construction works for the Proposed Scheme.

11.3.2 Excavation

Table 11.6 shows the estimated quantity and type of waste that will be generated by the excavation activities of the Proposed Scheme.

Table 11.6: Summary of Excavation Material Type and Quantities

Waste Type	Approximate Waste and Material quantity (tonnes)
Bituminous mixtures	24,000
Concrete, bricks, tiles and similar	7,000
Class 1/2 Granular Subbase material from footway and road	9,000
Class 6 Granular Capping material from road widening	4,000
Class 2/4/U1 Cohesive subgrade material (made ground material under footpath/road	29,000
Class 4/U1 Cohesive subgrade fill material (made ground material under verge)	1,000
Class 5 topsoil material (surface material from verge)	2,000
Total	**76,000**

It is estimated that a total of 76,000 Tonnes of material will be excavated as part of the construction works. Due to the nature of the works in an urban environment there are limited opportunities to achieve a cut/fill balance of materials that could be more readily accommodated on a greenfield project where earthworks embankments/ bunds are more common.

Where material is excavated, it is envisaged that the contractor will seek to reuse or recycle it, where practicable, within the Proposed Scheme through implementation of the measures set out below for each waste type identified within Table 11.6. To further establish an understanding of how soil and stone waste materials could potentially be reused/recovered, they have been further broken down into the likely TII material specification and class.

Excavated materials such as capping, subbase, bituminous and concrete materials could be reused or recycled in line with TII specifications:

- capping, subbase, bituminous and concrete materials could be reused or recycled in fill and capping materials (e.g. 6A, 6B, 6C, 6F, 6G, 6H ,6I, 6M, 6N) providing they comply with the Specification for Road Works Series 600 – Earthworks (CC-SPW-00600);
- subbase, bituminous and concrete materials could be reused or recycled in subbase or base materials (e.g. Granular Material Type A to Clause 803) providing they comply with the Specification for Road Works Series 800 – Unbound and Cement Bound Mixtures (CC-SPW-00800); and
- subbase and bituminous materials could be recycled in base or binder materials (e.g. Asphalt Concrete base and binder products to Clause 3 or Low Energy Bound Mixtures to Clause 8.1) providing they comply with Road Pavements – Bituminous Materials (CC-SPW-00900).

It is assumed that some of the granular subbase and capping materials will contain excessive cohesive material due to the excavation process and therefore unsuitable for direct reuse. This excess material could be sent to a suitable recovery facility and reused as Class 2 general fill or Class 4 landscape fill material, depending on excavation methods employed by the contractor and existing ground conditions.

Excavated cohesive subgrade material is likely to be unacceptable for direct reuse for pavement construction, however, this material can be tested for quality and contamination and could potentially be reused as Class 2 general fill or Class 4 landscape fill under the provisions of Article 27. Material which meets the necessary acceptance criteria may be delivered to an authorised soil recovery facility. Material which requires recycling will be sent to an authorised waste facility and may be used in accordance with Article 28 of the European Communities (Waste Directive) Regulations 2011 - S.I. 126 of 2011 as amended. Article 28 sets the criteria which must be complied with and the EPA must use to determine, when a waste reaches “end of waste” status and becomes a material. Large quantities of this type of material is unlikely to be reused on site due to the nature of the works in an urban environment with limited embankments / earthworks bunds being constructed. Therefore, excavated cohesive subgrade material may be recovered and used on future projects in the industry.

Topsoil material could be reused in new landscaped areas. It is assumed that some of this material will be contaminated with unsuitable material during the excavation process and therefore will be sent to a suitable recovery facility and reused as Class 2 general fill or Class 4 landscape fill, along with the excavated cohesive subgrade material.

Future design stages will undertake additional site investigations to inform the detailed pavement design and associated excavation quantity assessment.

11.3.3 Municipal Waste

It is anticipated that there will be approximately 200, up to 250 at peak, construction staff employed over the Construction Phase of the Proposed Scheme. Small volumes of general municipal wastes will be generated by construction staff during the Construction Phase (e.g., from offices and welfare facilities). Segregation facilities will be provided on the construction site to ensure that recovery and recycling of such wastes is maximised.

11.3.4 Operational Phase

Operational waste may arise as a result of carriageway maintenance which will be undertaken at regular intervals, or as necessary. This will primarily consist of bitumen containing material due to maintenance of carriageway pavement. Only waste generated from the areas where road widening and narrowing, undertaken as part of the Proposed Scheme, have taken place will be considered in this assessment, as routine maintenance, and associated waste generated, would be carried out on the existing road irrespective of the Proposed Scheme. It is important to note that maintenance operations will be undertaken by the relevant Local Authority.

It is envisaged that bitumen containing material will be reused within new carriageway construction as far as practicable and in accordance with all applicable legislation. Bitumen containing materials which are not incorporated into the Proposed Scheme are likely to be reused where feasible off-site as a by-product in accordance with Article 27, of the Waste Framework Directive. Bitumen containing materials may be recycled in accordance with the provisions of an Article 28 (End of Waste) decision by the EPA (EPA 2020).

The quantity of bitumen containing material generated, over the assumed lifetime of the Proposed Scheme (60 years), will increase by approximately 9,871 tonnes. Therefore, there will be an increase in maintenance needs during operation of the Proposed Scheme, in comparison to required maintenance of the existing carriageway. This is largely due to converting existing concrete footpaths to bitumen cycle tracks.

12 Traffic Signs, Lighting and Communications

12.1 Introduction

The existing signage and road markings along the extents of the Proposed Scheme will be modified to clearly communicate information, regulatory and safety messages to the corridors users. In addition, the existing lighting and communication equipment along the Proposed Scheme has been reviewed and proposals developed to upgrade where necessary.

12.2 Traffic Signage Strategy

A preliminary traffic signage design has been undertaken to identify the requirements of the Proposed Scheme. A combination of Information, Regulatory and Warning signs have been assessed taking consideration of key destinations/centres; intersections/decision points; built and natural environment. In line with DMURS, the signage proposals have been kept to the minimum requirements of the Traffic Signs Manual (TSM) to avoid sign congestion within the Proposed Scheme corridor.

A review of the existing regulatory and warning signs in the vicinity of the Proposed Scheme was carried out to identify unnecessary repetitive and redundant signage to be removed. This includes rationalising signage structures by better utilising individual sign poles and clustering signage together on a single pole.

Prior to assessing the requirements for individual signs, a review was carried out on the impact that proposed traffic restrictions and changes to the road layout will have on the key traffic routes in the vicinity of the Proposed Scheme. One area of the Proposed Scheme was identified as undergoing significant design changes and these changes will be applied to the road layouts and imposed road restrictions, causing a change to existing traffic routes:

- The proposed bus gate on Pembroke Road; and
- The restrictions of vehicular movements from George’s Avenue (South) onto Frascati Road.

These changes are outlined within the Traffic Signs and Road Marking drawing series in Appendix B, which outlines the associated signage requirements.

12.3 Traffic Signage and Road Markings

12.3.1 Traffic Signage General

A preliminary assessment was undertaken which involved an assessment of major road traffic signage, including requirements for all information signs (TSM Chapter 2), regulatory signs (TSM Chapter 5), warning signs (TSM Chapter 6), and road markings (TSM Chapter 7).

On review of the existing traffic signs, it is determined that the main changes to regulatory signage will be the proposed introduction of turning bans from or to the Proposed Scheme as indicated within the Traffic Signs and Road Marking drawing series in Appendix B.

An amendment to a directional sign is proposed on Pembroke Road approaching the Pembroke Road / Northumberland Road / Lansdowne Road Junction to direct road users to the N4, N5, N6, N7, N8, and N9 via Northumberland Road, due to the bus gate restricting such journeys via Pembroke Road within the Proposed Scheme.

In addition to the sign identified above, the existing signs within the Proposed Scheme are being revised to accommodate the change in road cross-section communicating the following:

- Information Signs to include geographical information signs, signs indicating facilities, road layout signs, traffic calming signs and cycle network signs;
- Regulatory signage –e.g. parking regulation signs, bus lanes, pedestrian and cycle facilities;
- Warning signs – e.g. Stop and Yield Ahead.

As stated in TSM Chapter 1, in urban areas the obstruction caused by posts located in narrow pedestrian footways should be minimised ensuring that pedestrian and cycle access is unimpeded by any such signage infrastructure. Therefore, where practicable, signs are to be placed on single poles, or larger signs will be cantilevered from a post at the back of the footway using H-frames where necessary. Passively safe posts will be introduced where practicable to eliminate the need for vehicle restraint systems.

12.3.2 Gantry Signage

No gantry signage exists along the route, and the development of the Proposed Scheme did not identify the requirement for any new gantry signage.

12.3.3 Road Marking

A preliminary design of road markings has been undertaken in accordance with TSM Chapter 7. Refer to the Traffic Signs and Road Marking drawing series contained within Appendix B for details. This exercise includes the preliminary road marking design of the following items:

- Bus lanes;
- Cycle tracks – the pavement will be marked according to best practice guidelines such as DMURS and the National Cycle Manual with particular attention given to junctions. Advance Stacking Locations (ASLs) have been designed, where practicable, to provide a safer passage for cyclists at signal-controlled junctions for straight ahead or right turn movements; and

- Pedestrian crossings will be incorporated to connect the network of proposed and existing footpaths. Wider pedestrian crossings are provided in locations expected to accommodate a high number of pedestrians.

12.4 Public Lighting

A high-level review of the existing lighting provision along the extent of the route has been carried out to understand the impact of the proposed scheme on lighting columns and associated infrastructure. A number of existing columns are proposed to be relocated or replaced to accommodate the Proposed Scheme, as shown on the Street Lighting drawings within Appendix B.

12.4.1 Existing Lighting

Light Emitting Diode (LED) lanterns will be the light source for any new or relocated public lighting provided.

The lighting design involves works on functional, heritage and contemporary lighting installations, on a broad spectrum of lighting infrastructure along the Proposed Scheme. This will include, but not exclusively, luminaires supplied by underground and overhead cable installations and those located on ESB Infrastructure.

In locations where road widening and/or additional space in the road margin is required, it is proposed that the public lighting columns be replaced and relocated to the rear of the footpath to eliminate conflict with pedestrians, and the existing lighting columns removed once the new facility is operational.

Where significant alterations are proposed to the existing carriageways, the preliminary street lighting design ensures that the current standard of public lighting is maintained or improved.

For existing columns that have specific aesthetic requirements, the intent for the replacement of such columns will include:

- Replacing the existing heritage columns and brackets with identical replica columns and brackets;
- Replacing existing luminaires with approved LED heritage luminaires; and
- Ensuring the electrical installation is compliant with the latest version of the National Rules for Electrical Installations, I.S. 10101'.

12.4.2 New Lighting

All new public lighting will be designed and installed in accordance with the specific lighting and electrical items set out the following National Standards and guides, including but not limited to:

- Local Authority Guidance Specifications;
- EN 13201: 2014 Road Lighting (all sections);

- ET211:2003 'Code of Practice for Public Lighting Installations in Residential Areas';
- BS 5489-1 'Code of practice for the design of road lighting';
- Volume 1 - NRA Specification for Road Works, Series 1300 & 1400;
- Volume 4 - NRA Road Construction Details, Series 1300 & 1400;
- IS EN 40 – Lighting Columns;
- Institution of Lighting Professionals "GN01 Guidance Notes for Reduction of Obtrusive Light".

All new lighting will aim to minimise the effects of obtrusive light at night and reduce visual impact during daylight. Lighting schemes will comply with the 'Guidance notes for the Reduction of Light Pollution' issued by the Institution of Lighting Professionals (ILP).

12.4.3 Lighting at Bus Stops

The Proposed Scheme will include for the provision of lighting in covered areas, open areas and passenger waiting areas.

The location of the lighting columns shall be dictated by the output from the fitting to adhere to the required uniformity and illuminance required for the specific lighting class for the associated road. The columns positioned at bus stops will ensure adequate clearances from moving vehicles.

12.5 Traffic Signals

12.5.1 Above Ground Infrastructure

The Preliminary design shows the proposed locations of above ground infrastructure. This is included in the Junction Systems Design drawings in Appendix B.

Above ground infrastructure will include:

Traffic Signal Poles

All traffic signal equipment has been designed in accordance with Chapter 9 of the Department of Transports Traffic Signs Manual. The Traffic Signs Manual clearly defines the requirements and positioning of traffic signal heads, detection equipment, and associated traffic signal poles.

The Traffic signal modelling, including LinSig models, has been used to determine the signal head configuration to achieve the required phasing and staging of the traffic signals. This contributed to the determination of the design and positioning of the traffic signal heads.

Single height Traffic Signal poles typically 3m (as measured from the ground) have predominantly been proposed on the Proposed Scheme to mount traffic signal heads, push button units, and other equipment.

Double height poles, (typically 6m) have been proposed at locations where additional visibility of the signals is required by the motorist, e.g. high-speed approaches.

Cantilever Traffic Signal Poles

Cantilever poles will be installed on multi-lane approaches where there is a potential for a high sided vehicle, including buses, to block the clear visibility of the primary traffic signal of vehicles in the outer lanes. They will also be installed at locations where a median island is not available to mount a second primary, required to control separate streams on a particular arm of a junction.

Cantilever poles may also be used to provide a mounting structure for secondary signals, where a median is not available and a position on opposing primary pole is outside the required line of sight.

Roadside Cabinets

Most equipment locations will require a roadside cabinet to house and protect electronic, electrical and communications equipment. Due to health and safety, design, space, operational and maintenance constraints, it is often necessary to separate these cabinets in accordance with their function. Typically, a junction will have cabinets for:

- Traffic Signal Control Cabinets;
- Fibre Breakout Cabinets; and
- Electricity supply Metering, Mini and Micro pillars.

Cabinets will be positioned to allow for ease of access by maintenance personnel and to minimise their impact on the receiving environment. When accessing cabinets, maintenance personnel will require a clear view of the associated equipment and of approaching vehicles, pedestrians, and cyclists. Cabinets are often positioned at the back of footpaths, to minimise the impact on the effective width of the footpath. They are often clustered together at a junction to minimise the amount of cabling between cabinets and to allow maintenance personnel to quickly shift operations from one cabinet to another.

In all cases the consideration of the siting of such roadside equipment shall prioritize the access for pedestrians and cyclists in the area and balance the aesthetics of the urban realm with maintenance requirements.

12.5.2 Underground Infrastructure

The Proposed Scheme includes for a continuous underground ducting network to provide the necessary communications for devices including traffic signals and CCTV. Where practicable the Proposed Scheme shall utilise existing ducting and chambers to provide this continuity. Below ground infrastructure will include:

Ducts

Each device, mounting structure, and cabinet will have associated underground infrastructure including ducts for:

- **Power Cables –** installed equipment will require a power supply to function, this is facilitated by a ducting connection between the electricity supply point and equipment location. This connection is normally a single power supply duct.
- **Communication Cables –** where it is not practicable to use existing network, to ensure the provision of a continuous fibre optic cable, the Proposed Scheme will require a new telecommunication ducting network consisting of two communication ducts, with chambers at 180m centres, along one side of the carriageway. This longitudinal ducting will be continuous along the length of the Proposed Scheme, with local duct spurs to connect to cabinets and devices.
- **Device Cables –** devices will require cabling between field equipment and control equipment. For example, a ring of six ducts will be provided at each junction to allow for cabling between the traffic signal controller and the traffic signal poles. It is necessary when designing the ducting provision that sufficient spare capacity is provided to allow for changes to the field equipment, deployment of additional equipment, or damage to the ducting provision.

Chambers

Chambers will be required at the termination points of ducts, at regular intervals along ducts (180m), at changes in direction, and at breakout points for devices.

The position of chambers will be designed to be away from carriageways, pedestrian and cycle desire lines, and tactile paving. It is important when positioning chambers that they can be accessed in a safe manner, without the need for extensive traffic and pedestrian management.

Individual chambers will be designed and sized with consideration given to the number of ducts and cables that will be routed through the chamber, and the need to provide maintenance loops of cables within the chambers.

Unless prior agreement is in place, chambers will be not be shared between users.

Foundations

All cabinets, poles and mounting structures will require a foundation or mounting frame to be constructed to allow for their installation. It is envisaged that for traffic signal poles, 5m -8m CCTV poles, cantilever signal poles and other lightweight mounting structures that retention sockets will be installed to allow for the easy installation, maintenance and replacement of structures.

For larger structures, such as high CCTV masts, bespoke mass concrete foundations will be designed for incorporation into the works.

Cabinet mountings will be designed and constructed in accordance with the manufacturer’s and local authorities’ standard details, including the incorporation of required vaults, chambers, earthing rods and mats.

12.5.3 Traffic Signal Priority

Public transport priority will be provided through a number of passive and active means. The means of passive priority are discussed elsewhere in this document and are based on the design of the geometry, signing and road markings of the junctions. These include measures such as bus gates and bus lanes. Active priority will be facilitated through the detection of the public transport vehicle and communicating their presence to the Traffic Signal Controller for the implementation of measures on site.

The Local Authorities utilise different controllers and adaptive Urban Traffic Control systems. The systems can operate in several modes including adaptive, linked, vehicle actuated, scheduled plans and fixed time modes. Dublin City Council and Dún Laoghaire- Rathdown County Council use Sydney Coordinated Adaptive Traffic System (SCATS) traffic signal controllers.

Detection will be based on the use of several different technologies, working in concert to provide comprehensive detection solutions. The detection types will include:

- Embedded Inductive loop detectors – induction detectors will be cut into the road surface at discrete positions around the junction to detect vehicles approaching, or departing from, the junction. The position and number of detectors will be dependent on the lane configuration and the type of traffic signal controller at the junctions. These embedded induction detectors will require ducting, chambers, and carriageway loop pots, to route the cables associated with the detector to the traffic signal controller.
- Specialised induction detectors – these can be utilised to detect cyclists on particular approaches to junctions. These detectors use a concentrated induction pattern to detect the passage of cyclists.

Above ground detection, including:

- Optical Detection – where it is impractical to install embedded inductive loop detectors into the carriageway, optical detection may be installed. Using these devices, a virtual detector is set up in the field of view that trigger alerts to the traffic signal controller. Optical detectors are generally installed on existing traffic signal poles, or cantilever traffic signal masts, to provide a clear view of the approach. Additional poles may need to be installed to provide the optimum field of view for particular approaches.
- Microwave/Radar Detection – Radar detection is used for pedestrian crossings, pedestrian wait areas, and cycle detection. Similar to the optical detection, virtual detection zones are set up in the radar field of view that trigger alerts to the traffic signal controller. Radar detectors are generally installed on existing traffic signal poles, or cantilever traffic signal masts, to provide a clear view of the approach. Additional poles may need to be installed to provide the optimum field of view for particular approaches.
- Push Button Units will be installed on traffic signal poles at pedestrian and cycle crossing points to allow the user to manually alert the traffic signal controller of their presence.

Additional inputs from the Automatic Vehicle Location System (AVLS) and Dedicated Short Range Communications (DSRC) devices can be provided to notify the Traffic Signal Controller of the presence of particular vehicles.

The Traffic Signal Controllers will detect the presence of vehicles, including identification of particular vehicles classes, and use this data to determine the timing to be applied to the junction in the current and upcoming cycles, including the provision of priority to particular traffic signal phases as programmed into the traffic signal plans.

12.6 Communications

Communications will be used to connect on-street devices with the appropriate traffic control rooms. The communications will comprise:

- Fibre Optic Cable network;
- All local authorities operate fibre optic cable networks. It is envisaged that each of these networks extend along the length of the Proposed Scheme, providing high bandwidth/low latency communication to Traffic Signal Controllers, CCTV Cameras, and other apparatus deployed on the Proposed Scheme. Where this is not the case and it is not practicable to utilise the existing network, new longitudinal ducting, provisionally two communications ducts, is required with access chambers at 180m centres;
- Fibre breakout cabinets will be provided at each Traffic Signal Controller, or CCTV camera;
- Microwave Wireless Point-to-Point Links - Where it is not practicable to install ducting for fibre optic cable, or there is a need to provide a high bandwidth/low latency communication to a remote site or cell, point-to-point microwave communications will be provided to facilitate the communications link; and
- Cellular Subscriber Networks (3G/4G/5G) - Cellular communications will be provided to low bandwidth devices such as Real-Time Passenger Information (RTPI) and Variable Messages Signs (VMS).

12.7 Traffic Monitoring

The preliminary design proposes a comprehensive CCTV camera deployment along the length of the Proposed Scheme at key locations including junctions. These cameras will enable the monitoring of traffic flows along the route and provide rapid identification of any events that are causing, or are likely to cause, disruption to bus services on the route and to road users in general.

The preliminary design for the CCTV locations has been prepared based on the use of high-definition cameras with a fibre-optic based communications network for the transmission of video. Additionally, a mains power source will be required at each location where a camera is installed. The cameras may be fixed position or pan, tilt and zoom (PTZ) depending on the most suitable option for a given location as well as general operational preferences for fixed or PTZ.

Poles, between 5m - 8m, will be provided at each signalised junction, unless it is directly adjacent to another observed junction, and as such all approaches are covered by that closed-circuit television (CCTV). These CCTV poles will be erected using a retention socket as a foundation.

Higher CCTV masts may be provided at locations where longer fields of view are required, or where there is a need to mount wireless communications devices at positions to enable clear line of sight between linked devices. These CCTV masts will require a bespoke mass concrete foundation.

CCTV poles will be placed at positions, within the junction, to minimise the impact of solar glare, and to maximise the field of view of the CCTV. In all cases the consideration of the siting of such roadside equipment shall prioritize the health and safety for pedestrians and cyclists, access for pedestrians and cyclists in the area and the aesthetics of the street urban landscape.

12.8 Real-Time Passenger Information

RTPI will be provided at all of the proposed bus stops. This will comprise a “live” display identifying the estimated arrival time of each bus at the stop.

12.8.1 RTPI Display Positioning and Mounting

The RTPI display, where present, is typically located adjacent to the shelter on the same side as approaching buses so that people waiting at the stop can simultaneously view both the display and the oncoming buses. Figure 12.1 below illustrates this.

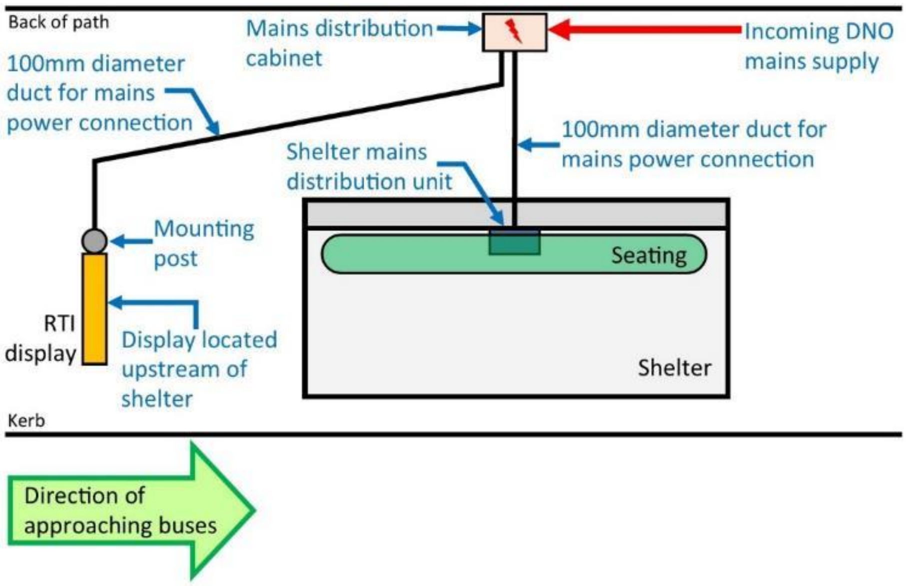


Figure 12.1: Typical layout for bus stop with RTPI display

The display is often placed around 4-5m from the shelter to maintain pedestrian access to the shelter while also enabling a clear view of the display from within the shelter.

However, although this is considered the optimum position for a display, the precise location of it will be dictated by other site-based factors such as pedestrian and cyclist access (both to/from the stop and for those passing by) as well as requirements for other bus stop facilities such as waste bins, cycle storage and signage. Other physical restrictions (e.g. narrow footway, other street furniture, walls, and buildings) may also influence the exact location of the display at each stop.

12.8.2 Power Supply for RTPI Display and Bus Shelter

The stand-alone design of the proposed RTPI display means that a physical link between the display and the bus shelter is not required. However, the display will nonetheless require a connection to a mains power supply. This can be shared with the supply to the bus shelter, as shown in Figure 12.1, from a mains distribution cabinet or feeder pillar located at the bus stop, where the mains service provider (DNO) will terminate its incoming connection. This cabinet / pillar will provide mains power to both the RTPI display and the shelter, given that the bus shelter needs a mains power supply.

The bus shelter will commonly include a mains power distribution unit for all of the equipment in the shelter that requires mains power - usually lighting and/or advertising. Most often this distribution unit is located under the seating although it can vary according to the shelter design.

The shelter installer will provide a connection from this unit to the cabinet/pillar containing the mains power supply for the bus stop, as shown in Figure 12.1.

12.8.3 Data Communications for RTPI Display

The majority of RTPI systems currently in operation now use the mobile phone (GPRS/3G/4G) network as the method of data communication between each display and the central (“back office”) bus location/passenger information system. This comprises a small mobile network comms device (including the SIM card) installed within the RTPI display housing. It is assumed for the purpose of this design that such connectivity will be used for provision of RTPI on the Proposed Scheme with the mains power for the display - as described above – also providing power for this comms device. In this case no ducting will be required for data comms at the bus stop and the only physical connection to the display (i.e. ducting and cabling) will therefore be as described above for mains power.

12.9 Roadside Variable Message Signs

Consideration was also given to the inclusion of roadside Variable Message Signs (VMS) to provide traffic information to road users.

An existing VMS sign location at the Ballsbridge junction is proposed to be relocated to a suitable location within the proposed junction layout, while an existing VMS sign to the south of the Merrion Gates junction (Merrion Road / Strand Road junction) is proposed to be retained in its current location.

12.10 Safety and Security

The requirement for a pleasant, safe and secure environment for passengers waiting at Bus Stops and undertaking their journeys is a key component of the proposed public transport service. This is facilitated by the provision of:

- RTPI – Each stop will be provided with Real Time Passenger Information showing the estimated time of arrival of subsequent buses; and
- Public Lighting – each stop will have public lighting designed to ensure the safe operation of the stops in all lighting conditions and to enhance the sense of security at the stops.

12.11 Maintenance

All traffic signal, CCTV, and communications equipment will be designed and located to be accessed and maintained frequently. All equipment will be accessible without disrupting pedestrian, bicycle, or vehicle traffic and without the use of special equipment.

Apparatus will be designed and located to allow for easy access and the safe maintenance of the Proposed Scheme into the future. This will include:

- Use of retention sockets, where applicable, for the erection of Traffic Signals, CCTV, Above Ground Detection, and other equipment mounting poles to allow for the ease of installation, maintenance and replacement;
- The use of lightweight equipment poles, where appropriate, such as cantilever signal poles. Consideration will be given to the selection of products that allow for maintenance activities to be undertaken from ground level, such as tilt down poles or poles with wind-down mechanisms;
- Placement of poles and retention sockets within 7m of chambers to provide ease of installation and replacement of cables;
- Locating chambers away from pedestrian desire lines, and areas of tactile paving. This is to provide for a reduced impact of Traffic Management;
- On longitudinal duct runs, chambers to be placed at 180m centres to allow for the ease of installation and replacement of cables;
- Safe areas to be provided for the access and parking of maintenance vehicles; and
- Locating controller, and other, cabinets in positions that allow for safe access and clear visibility of the operation of the junction.

13 Land Use and Accommodation

13.1 Summary of Land Use

The land use along the Proposed Scheme comprises a mix of residential and commercial properties. The various land uses are described in the sections below. The extent of the impact due to the Proposed Scheme on a landowner's holding is shown on the Compulsory Purchase Order maps.

The following is a description of the land use along the Proposed Scheme within the five scheme sections.

Section 1: Stradbrook Road to Booterstown Avenue

The Proposed Scheme commences south of the junction of Temple Hill and Monkstown Road, in a largely suburban area. It continues north through Blackrock Village along Frascati Road, fronted either side by commercial developments such as the Frascati and Blackrock Village Centres (both recently redeveloped).

The Proposed Scheme follows the Rock Road passing amenity areas of Blackrock Park and education centres of Blackrock College and Willow Park, as well as Blackrock Clinic.

Permanent land take is required through this section to facilitate the scheme, including minor encroachment into the green area between Newtownpark Avenue And Temple Park Avenue, including junction reconfiguration at the Frascati Centre, widening works into Blackrock Park, widening works into Blackrock Clinic, including the plot at Castledawson Avenue, widening works into Blackrock College, entry treatment at the entrance to Willow Park and widening into the adjacent portion of landscaped area at the back of footpath.

Temporary land take is required within this section to facilitate:

- Footpath works and road regrading at the southern vehicular entrance to Frascati Centre;
- Construction of new retaining wall and boundary wall along the Blackrock Park frontage;
- Footpath works, road regrading, and construction of new entry treatment at entrance to Castledawson residential site;
- Road widening and boundary works at Blackrock Clinic and Castledawson Avenue;
- Road widening and boundary works at Blackrock College, including reconfiguring existing gate and piers;
- Road widening and boundary works at the existing DLRCC Car Park opposite Blackrock College;
- The establishment of construction compound within the existing DLRCC Car Park opposite Blackrock College;

- Works within a portion of landscaped area at the back of footpath in front of Willow Park; and
- Footpath regrading / resurfacing works at the Booterstown Avenue junction.

Section 2: Booterstown Avenue to Nutley Lane

This section of the Proposed Scheme passes the residential areas along the Rock Road, as well as commercial developments such as the Elmpark Green Development. It also runs adjacent to the Booterstown Marsh, with no encroachment proposed into the marsh. The Proposed Scheme continues past the Merrion Gates junction, along Merrion Road, which is fronted by residential properties, before passing through Merrion Village.

Permanent land take is required through this section to facilitate the Proposed Scheme, including junction reconfiguration at the Elmpark Green Development, and widening works into the lands opposite Bellevue Avenue and the Elmpark Green Development, the St. Mary's Centre (Telford) – Religious Sisters Of Charity lands – at the Merrion Gates junction, the entrance area and landscaping in front of Elm Court Apartments residential site, a number of residential properties on Merrion Road, lands at 133-145 Merrion Road (previously occupied by Gowan Motors), a site occupied by Gas Networks Ireland, and a portion of lands in St. Vincent's University Hospital as well as the entrance area off Merrion Road.

Temporary land take is required within this section to facilitate:

- Boundary works in the plots opposite Bellevue Avenue and the Elmpark Green Development;
- Boundary works in the St. Mary's Centre (Telford), Religious Sisters Of Charity lands;
- Road and footpath reconfiguration works across the DART rail line at the Merrion Gates junction;
- Roadway and landscaped area regrading at the Elm Court Apartments residential site;
- Boundary and driveway regrading works at the residential properties along Merrion Road;
- Boundary works at 133-145 Merrion Road, previously occupied by Gowan Motors;
- Boundary works and regrading within the site occupied by Gas Networks Ireland;
- Boundary works and regrading within St. Vincent's University Hospital lands including relocation of existing ESB sub-station; and
- The reconstruction of the Bloomfield Gate and Archway within the plaza owned by St. Vincent's University Hospital fronting onto Merrion Road.

Section 3: R118 Merrion Road (Nutley Lane to Ballsbridge)

This section of the Proposed Scheme is fronted by the Merrion Shopping Centre and St. Michael's College and is then primarily fronted by residential properties and a number of embassies as far as the junction with Serpentine Avenue, from whence it enters Ballsbridge Village. This section runs along the RDS. There is a newly developed commercial site opposite the RDS.

Permanent land take is required through this section to facilitate the scheme, including junction reconfiguration, and widening works into the Merrion Shopping Centre, a residential property and adjacent laneway on Merrion Road, and into the Clayton Hotel Ballsbridge.

Temporary land take is required within this section to facilitate:

- Footpath regrading / resurfacing at areas in front of the Merrion Shopping Centre;
- Boundary works and regrading within a residential property and adjacent laneway on Merrion Road;
- Footpath works, road regrading, and construction of new entry treatment at entrance to a residential site on Merrion Road;
- Boundary works within the Clayton Hotel Ballsbridge;
- Footpath works, road regrading, and construction of new entry treatment at entrance to a commercial site on Merrion Road;
- Construction of new vehicular entrance to the CDETB site off Anglesea Avenue, and associated internal roadway, parking, and footpath reconfiguration.

Section 4: Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

This section of the Proposed Scheme commences in Ballsbridge Village and continues northwards along Pembroke Road, fronted by commercial properties, a hotel, and a number of embassies as far as the Lansdowne Road junction, from whence it is largely fronted by residential properties. It then passes through Baggot Street Upper retail area, followed by Baggot Street Lower and Fitzwilliam Street Lower (both consisting largely of commercial and residential properties). This section includes the newly developed Miesian Plaza commercial site.

Permanent land take is required through this section to facilitate the scheme, including, an area at the Herbert Park junction adjacent to Roly's Bistro, the lands currently housing the existing kiosk on Pembroke Road which is to be relocated, and the grassed open space at the junction of Pembroke Road and Pembroke Lane.

Temporary land take is required within this section to facilitate:

- Boundary works to amend vehicular entrance arrangements to properties on Pembroke Road;

- Walking ramp upgrades along the Grand Canal edge at the Macartney (Baggot) Bridge, as well as roadworks on the bridge; and
- Works to the coal hole and roof of an existing cellar on Baggot Street Lower.

Section 5: Nutley Lane (R138 Stillorgan Road to R118 Merrion Road)

The section of the Proposed Scheme runs along Nutley Lane, which is largely a residential road, as well as being fronted onto by RTÉ Studios, Elm Park Golf & Sports Club, and St. Vincent's University Hospital.

Permanent land take is required through this section to facilitate the scheme, including junction reconfiguration, and widening works into the Eir telephone exchange, RTÉ Studios, Elm Park Golf & Sports Club, the Merrion Shopping Centre and St. Vincent's University Hospital. There is no permanent land take from residential properties proposed on this section.

Temporary land take is required within this section to facilitate:

- Boundary works to amend one of two vehicular entrances to a residential property on Nutley Lane;
- Widening works and boundary construction at RTÉ Studios, and construction of new entry treatment at entrances;
- Widening works and boundary construction at Elm Park Golf & Sports Club;
- Widening works, boundary construction, and regrading at St. Vincent's University Hospital; and
- Footpath regrading / resurfacing at areas in front of the Merrion Shopping Centre.

13.2 Summary of Compulsory Land Acquisition

From the commencement of the design of the Proposed Scheme, every effort has been made to minimise compulsory land acquisition. However, there are a number of public and private lands that are required to meet the objectives of the Proposed Scheme.

In total approximately 0.87ha. of land will be required to be permanently acquired, of which approximately 0.05ha is currently in DCC ownership and 0.08ha is currently in DLRCC ownership, to construct the scheme. There will also be an additional 1.4Ha of Temporary land required to allow for construction of boundary treatment and surface tie in work. This includes approximately 0.06ha is currently in DCC ownership and 0.08ha is currently in DLRCC ownership.

Reference should be made to the 'Compulsory Purchase Order (CPO) Documents' prepared as part of the planning application for further details.

13.3 Summary of Impacted Landowners/Properties

In order to determine what existing landowners/properties would be impacted by the scheme, a desktop study has been carried out.

This desktop study highlighted any property within 5m of the Proposed Scheme, whether they would be impacted by the infrastructure works or otherwise.

This list has then been reduced to landowners/properties being impacted by the scheme on the basis of the preliminary design. The final determination of the lands to be acquired for purposes of constructing the Proposed Scheme was as a result of an iterative design process, including non-statutory public consultation and detailed engagement with potentially impacted owners and occupiers.

These landowners/properties have received notification, via mail, of the potential impact on their property. The list of properties that have received notification are summarised in Table 13.1.

Table 13.1: List of affected properties

Address	Permanent land take	Temporary land take
Open Space between Newtown Avenue and Temple Park Avenue	Y	Y
Frascati Centre, Frascati Rd, Blackrock, Co. Dublin	Y	Y
Lios an Uisce, Rock Road, Blackrock, Co. Dublin	Y	Y
Blackrock Park, Rock Road, Blackrock, Co. Dublin	Y	Y
Sion Hill (Castledawson), Rock Rd, Blackrock, Co. Dublin		Y
Blackrock Clinic, Rock Road, Blackrock, Co. Dublin, A94 E4X7	Y	Y
Glenalla, Casteldawson Avenue, Rock Road, Blackrock, Co. Dublin	Y	Y
College House, 71/73 Rock Road, Blackrock, Co. Dublin, A94 F9X9	Y	Y
Blackrock College, Rock Road, Blackrock, Co. Dublin, A94 FK84	Y	Y
Open space, Rock Road (car park beside Carroll & Kinsella, Blackrock) including adjacent Entrance to Rock Road Halting Site, Rock Road, Blackrock, Co. Dublin	Y	Y
Willow Park School, Rock Rd, Williamstown, Blackrock, Co. Dublin	Y	Y
115 & 115B, Rock Road, Blackrock, Co. Dublin		Y
Grounds to east of Rock Road, Dublin 4	Y	Y
Merrion House, Merrion Road, Dublin 4, D04 R2C5	Y	Y
Railway level crossing, Merrion Gates, Merrion Road		Y
Landing/entrance to Elmpark Green Development	Y	
St. Mary's Centre (Telford), Merrion Road, Dublin 4	Y	Y
157 Merrion Road, Dublin 4, D04 T0C6	Y	Y
155 Merrion Road, Dublin 4, D04 R5X5	Y	Y
153 Merrion Road, Dublin 4, D04 W526	Y	Y
151 Merrion Road, Dublin 4, D04 N1F9	Y	Y

Address	Permanent land take	Temporary land take
Elm Court Apartments, Merrion Road, Dublin 4, D04 E088	Y	Y
143 Merrion Road, Dublin 4 (Former Gowan Motors Site)	Y	Y
Top of Old Bloomfield Avenue & Entrance gates, (next to Carew House), Merrion Road, Dublin 4	Y	Y
Saint Vincent's University Hospital, Elm Park, Nutley Lane, D04 T6F4 including HSE Day Hospital, Carew House, Merrion Road, Dublin 4, D04 TC63	Y	Y
The Merrion Shopping Centre, Merrion Road, Dublin 4, D04 W8W2 including Nutley Building, Merrion Road, Dublin 4 & AIG House, Merrion Road, Dublin 4	Y	Y
85 Merrion Road, Dublin 4, D04 Y2N8 (including adjacent laneway off Merrion View Avenue)	Y	Y
Malton, 31-33 Merrion Road, Dublin 4		Y
Clayton Hotel Ballsbridge, Merrion Road, Ballsbridge, Dublin 4, D04 P3C3	Y	Y
Entrance to Former AIB Centre, Merrion Road		Y
CDETB Administrative Offices, Town Hall, 1-3 Merrion Road, Ballsbridge, Dublin 4		Y
Open space outside Roly's Bistro, Junction of Merrion Road and Herbert Park	Y	Y
Kiosk at Pembroke Road, Dublin 4, D04 NR29	Y	Y
Open space, Junction of Pembroke Road and Pembroke Lane	Y	
11 Pembroke Road, Dublin 4		Y
1 Pembroke Road, Dublin 4		Y
Macartney Bridge, Baggot Street Upper including walkway along Grand Canal near Macartney (Baggot) Bridge & Wilton Terrace		Y
95 Baggot Street Lower, Dublin 2, D02 HE14		Y
118 Stillorgan Rd, Dublin 4, D04 CC01		Y
Raidió Teilifís Éireann, Donnybrook, Dublin 4, D04 FD39	Y	Y
Eir Exchange, RTE Lands, Nutley Lane	Y	Y
Elm Park Golf & Sports Club, Nutley House, 22 Nutley Lane, Dublin 4, D04 WE09	Y	Y

13.4 Demolition

It is envisaged that demolition works will be limited to the demolition of boundary walls along the Proposed Scheme.

The demolition works shall be in accordance with the specific demolition items set out the following National Standards and guides:

- I.S EN 1991-1-6:2005 – Actions on Structures: General Actions – Actions During Execution (Including National Annex)
- BS 6187:2011 – Code of practice for full and partial demolition
- BS 5228 – Code of practice for noise and vibration control on construction and open sites – Part 1: Noise
- BS 5228 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

All reasonable precautions to prevent pollution of the site, works and the general environment including streams and waterways to be taken.

All demolition waste shall be segregated and, where practicable, sent for recycling. All in accordance with guidelines as set out by the National Construction and Demolition Waste Council (NCDWC).

A waste management plan following guidelines as set out by the NCDWC shall be produced outlining the proposals with respect to waste recycling, segregation and details of landfill proposals with target percentage of each element. The following legislation should be noted:

- Protection of the Environment Act 2003.
- Waste Management (Amendment) Act 2001.
- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste.
- EU Council Decision on Waste Acceptance (2003/33/EC).
- WMA Amendment Act (#2) 2001.
- Protection of the Environment Act No. 27 2003.
- Best practice Guidelines on the preparation of Waste Management Plans for Construction and Demolition Waste
- Department of Environment, Heritage and Local Government July 2006

13.5 Summary of Accommodation Works and Boundary Treatment

This section outlines the proposed design of the accommodation works along the Proposed Scheme. All directly impacted landowners have been written to and follow-up telephone calls offered to each directly impacted landowner. A number of meetings and telephone calls has taken place with directly impacted landowners.

All requests made by the directly impacted landowners and the general public have been evaluated and, where it was deemed appropriate, in the context of not impacting on the objectives of the Proposed Scheme, have been included in the preliminary design.

The proposed accommodation works consist of relocated boundary walls and gates, and the regrading of driveways and adjacent grass areas, where deemed necessary. Where driveways are proposed to be regraded a maximum gradient of 5% in accordance with Recommendations for Site Development Works for Housing Areas, Dept of the Environment and Local Government, 1998 has been adopted, where practicable.

Where boundary walls are being relocated and the existing access is less than 3.6 m in width, the maximum width of new accesses will be 3.6 m, with the new driveway tying in with the existing driveway at the temporary land acquisition boundary. The proposed maximum width is consistent with Dublin City Council's 'Parking Cars in Front Gardens' document.

Where cellars and private landings are affected by the Proposed Scheme, pre-construction and post-construction surveys will be performed by the appointed contractor. It will be determined during the detailed design stage if strengthening works are required to these existing structures.

To maintain the character and setting of the Proposed Scheme, the approach to undertaking the new boundary treatment works along the corridor is replacement on a 'like for like' basis in terms of material selection and general aesthetics, unless otherwise noted on the drawings. Final details of boundary walls, gates, driveways and grassed areas where affected, will be agreed between the directly impacted landowners and the NTA. Final details of boundary walls, gates and driveways will be agreed between the affected landowners and NTA during the accommodation works negotiations.

14 Landscape and Urban Realm

14.1 Overview of Landscape and Urban Realm

Urban Realm refers to the everyday street spaces that are used by people to shop, socialise, play, and use for activities such as walking, exercise or to commute to/from work. The Urban Realm encompasses all streets, public spaces, junctions and other rights-of-way, whether in residential, commercial or civic use. Well-designed urban realm contributes to the identity of localities and enhances the everyday lives of local communities and those passing through. It typically relates to the space between buildings to which the public has free access and may include seating, trees, planting and other features that enhance the experience for all.

Successful urban realms or public open space tend to have certain characteristics including:

- being welcoming and appealing;
- having a distinct identity;
- being pleasant and safe; and
- are easy to move through.

Guidance

The Dún Laoghaire-Rathdown County Development Plan 2016-2022 and the Dublin City Development Plan 2016 2022 include a range policies and objectives that have been considered in developing landscape and urban realm proposals, along with the 'BusConnects Dublin - Urban Realm Concept Designs' [available at https://busconnects.ie/media/2089/busconnects-urban-realm-concept-designs.pdf].

Dún Laoghaire-Rathdown County Development Plan 2016-2022

The Dún Laoghaire-Rathdown County Development Plan 2016-2022 is the county level planning framework applicable to the southern portion of the Proposed Scheme from Blackrock to Booterstown Marsh.

- Chapter 4 Green County Strategy sets out policies in relation to landscape, landscape character areas, conservation and enhancement of high amenity areas, protection and enjoyment of views and prospects including objectives to preserve views of the coast from the R118 Rock Road, and protection and preservation of trees and woodlands
- Chapter 6 Built Heritage Strategy sets out policies relating to protection of archaeological and architectural heritage including buildings, estates, protected structures, monuments, street furniture, industrial heritage and Architectural Conservation Areas. There are a number of entrance gates and boundaries along the route identified as protected structures.

- Chapter 8 Principles of Development sets out policies requiring that new development and redevelopment proposals in the County adhere to the principles of good urban design and contribute to the delivery of a 'sense of space', through the promotion of a high-quality built environment utilising considered design and development standards. Policy UD3 requires that development proposals should contribute positively to an enhanced urban realm and should demonstrate that the highest quality in urban realm design is achieved. Policy UD7 promotes urban tree planting throughout the County in accordance with the provisions of 'dlr TREES: A Tree Strategy for Dún Laoghaire-Rathdown 2011 – 2015' and to preserve existing trees where practicable and appropriate.
- Chapter 9 Specific Local Objectives includes Objective No.7: To develop Blackrock Park in accordance with a Masterplan approved by the Council. Objection No. 138 requires that no residential or commercial building development be permitted on this site, in recognition of its close proximity to Booterstown Marsh.

Dublin City Development Plan 2016-2022

The Dublin City Development Plan 2016-2022 is the county level planning framework applicable from north of the Booterstown Marsh to the City Centre and including Nutley Lane connecting the R138 Stillorgan Road to the R118 Merrion Road.

- Chapter 9 Sustainable Environmental Infrastructure includes Policy SI18 to use SuDS in all new developments where appropriate, as set out in the Greater Dublin Regional Code of Practice for Drainage Works.
- Chapter 10 Green Infrastructure includes Objective GIO24 to support the implementation of the Dublin City Biodiversity Action Plan 2015-2020 and reflects the Strategic Objectives of Ireland's National Biodiversity Plan (Actions for Biodiversity 2011-2016)
- Chapter 10 Green Infrastructure also includes the Dublin City Tree Strategy 2016-2020 incorporating a set of policies for the long-term promotion and management of public trees in Dublin and Objective GIO28 to identify opportunities for new tree planting.

Dublin City Tree Strategy 2016-2020

A set of policies for the long-term promotion and management of public trees in Dublin.

"Within the city, trees clean the air, provide natural flood defences, mask noise and promote a general sense of wellbeing".

Dublin City Biodiversity Action Plan 2015-2020

Covers all areas of the City including roadsides and footpaths and reflects the Strategic Objectives of Ireland's National Biodiversity Plan (Actions for Biodiversity 2011-2016)

1. Strengthen the knowledge base of decision makers to protect species and habitats;
2. Strengthen the effectiveness of collaboration between all stakeholders for the conservation of biodiversity in the greater Dublin region;
3. Enhance opportunities for biodiversity conservation through green infrastructure and promote ecosystem services in appropriate locations throughout the City; and,
4. Develop greater awareness and understanding of biodiversity and identify opportunities for engagement with communities and interest groups.

14.2 Consultation with Local Authority

Consultation has taken place with DLRCC and DCC during the design process to understand the Landscape and Urban Design objectives of the Local Authority in the context of the Proposed Scheme.

14.3 Landscape and Character Analysis

The landscape and urban realm proposals are derived from analysis of the existing urban realm, including existing street and public space character, heritage features, boundaries, tree planting and vegetation, and the range of contemporary and heritage materials in use that inform the quality and character of different parts of the overall route.

The design team identified the range of character areas along different parts of the route informed by adjacent land uses fronting onto the route; the character and heritage of buildings including any protected structures and private gardens or grounds; the nature and presentation of any boundary walls, railings or hedgerows; existing street trees or vegetation and the nature and quality of streetscape materials.

This analysis provided an understanding of the existing character areas along the route and facilitated detailed and iterative consideration as to the integration of the proposed scheme. This analysis informed design changes to the initial proposals so as to avoid adverse impacts of existing streetscape character, and also identified opportunities for enhancement and creation of new spaces along the route. Character analysis also informed the development of mitigation proposals where public or private property would be directly impacted by the preferred scheme.

14.4 Arboricultural Survey

14.4.1 Scope of Assessment

An Arboricultural Impact Assessment Report (AIAR) included in Appendix D was prepared based on a detailed tree survey along the proposed scheme corridor and following the requirements of BS5837:2012 *Trees in relation to design demolition and construction – Recommendations.*

The AIAR documents the nature, quality and condition of existing trees along and adjacent to the route and identifies the likely direct and indirect impacts of the proposed development on such trees. It then makes recommendations as to trees that should and/or will need to be removed and identifies trees in relative proximity to the proposed works and construction wayleaves that should be protected during construction, with suitable mitigation measures, as appropriate. The AIAR identifies trees to be removed, and the Arboricultural Method Statement sets out how retained trees are to be successfully protected.

The AIAR includes the following:

- Description of the site/route and summary of the trees surveyed;
- Summary of any statutory or non-statutory designations affecting trees within the survey area;
- A brief summary of trees to be removed;
- Outline guidance for the design team and any key considerations, or issues which need to be addressed;
- Schedule and corresponding drawings of surveyed trees and key;
- Recommendations for tree works and incursions related to the proposed development; and
- Tree Protection Plans.

14.5 Hardscape

Throughout the design process, a palette of materials has been developed to create a consistent yet locally relevant design response appropriate to different locations along the route. The proposed materials are based on the existing materials and treatments along various parts of the route to match existing material treatments, while also identifying areas of opportunity for enhancement through the use of higher quality materials. Material palettes are described by reference to different typologies appropriate to different sections of the route.

14.5.1 Material Typologies

The proposed material typologies employed in the preliminary design are described as:

- **Poured in situ concrete footpath.** Used extensively on existing footpaths. Concrete footpath can be laid with or without a kerb, can have neatly trowelled edges and textured surface for a clean, durable, slip resistant surface;
- **Asphalt footpath**. Used locally on existing footpaths and will tie in with other sections of urban realm. Laid with a road kerb, can have a smooth finish or textured aggregate surface, provides a strong flexible slip resistant surface.

- **Precast concrete unit paving.** Concrete paving slabs and bricks available in a wide variety of sizes, colours and finishes to provide an enhanced urban realm. Can be used with matching concrete kerbs or with salvaged natural stone kerbs as appropriate.
- **Natural stone paving**. Employed for high quality urban realm areas, mostly in city centre locations. This typology represents new or re-used natural stone paving and kerbs surface and is used to create enhanced public spaces for major urban realm interventions.
- **Stone or Concrete setts.** Proposed for distinguishing features such as pedestrian crossing points, raised tables and parking/set-down areas.
- **Self-binding gravel.** Proposed for some pedestrian pathways that are off-road and leading through informal landscaped areas.
- **No change.** At some locations, the proposed scheme does not necessitate any alteration to the alignment of the existing footpath or roadway. These include established and more recently constructed sections of streetscape.

Detailing

The design considers re-use of existing high-quality and natural stone kerbs so as to maintain streetscape character, reduce construction costs and maximise sustainability.

Pedestrian crossings at side streets will be raised where practicable and will be distinguished using stone or concrete setts as appropriate to the locality.

In some locations, existing street trees have disturbed or broken footpath surfaces. The footpath around such trees will be replaced where appropriate with self-binding gravel so as improve the vitality of the trees and ensure accessible pedestrian facilities.

Sustainable Drainage Systems (SuDS) will be incorporated within hardscape areas to locally manage surface water run-off and reduce demand for piped surface water drainage infrastructure.

Informal footpaths through landscaped areas that are set back from the main carriageway will be formed using self-binding gravel as an alternative to asphalt or concrete.

Where private or commercial property boundaries are realigned, boundary walls and railings will be reinstated to match the existing and may be extended to other properties along the same street to enhance streetscape character.

Existing street furniture such as seating will be relocated within the revised streetscape and new street furniture will be provided at locations where opportunity sites have been identified to establish or enhance public spaces.

Hardscape works will be complemented by soft landscaping including trees, hedgerows, native planting, ornamental planting, amenity grass areas and species rich grasslands as appropriate. Soft landscaping will enhance the amenity value and visual character of streets and spaces, mitigate the loss of existing trees, and enhance ecological value along the route.

14.6 Softscape

Softscape refers to existing trees including street trees and groups of trees or woodland areas, new tree planting, hedgerows, ornamental planting and amenity grasslands. Softscape plays an important role in ensuring that streets and public spaces are attractive and healthy spaces for the local community, but also in providing better air quality, managing surface water run-off and in maintaining and creating habitats.

14.6.1 Planting Strategy

The planting strategy has been developed in response to the objectives of the Proposed Scheme and the objectives set out in both the Dún Laoghaire-Rathdown County Development Plan 2016-2022 and the Dublin City Development Plan 2016 – 2022, and also in response to landscape and urban realm opportunities arising from the proposed scheme to integrate new infrastructure within the existing local context and to enhance the visual and amenity value of streets and spaces.

The overarching planting strategy is to retain established trees and vegetation wherever practicable for their arboricultural, amenity and biodiversity value.

The Arboricultural Survey described in Section 14.4 above identified trees and groups of trees along the project route and provided a detailed schedule of the characteristics, vitality and quality of trees. The AIAR was prepared by overlaying the Proposed Scheme General Arrangement with the tree survey so as to identify trees or groups of trees that might be impacted by the scheme. The AIAR includes recommendations for the retention, removal or management of trees and identifies trees that will be impacted by virtue of the proposed scheme. It also sets out tree protection measures for trees adjacent to the proposed scheme that might otherwise risk damage during construction.

The planting strategy includes replacement of street trees and groups of trees that may be impacted by the proposed scheme, but also the introduction of new tree planting and street trees within other spaces and along streets. Reinforcement of green infrastructure along the route will improve the overall amenity, character and appeal of the route corridor and localities along it, as well as enhancing biodiversity.

In addition to trees and street trees, other vegetation is also proposed along the route including hedgerows, ornamental planting and amenity grassland, shrub and meadow grass areas. These will, in part, be utilised to reinstate property boundaries altered by the Proposed Scheme, but also to create new landscape spaces along the route where existing junctions are to be rationalised yield increases in pedestrian and amenity space.

Throughout the design process, collaboration between the Landscape and Urban Realm designers and the Drainage Engineers has sought to adopt Sustainable Drainage Solutions (SuDS) to manage storm water run-off. SuDS features have been considered along the route and incorporated within suitable landscape areas in the form of rain gardens, bioretention areas, filter drains, swales, tree pits and permeable paving.

Please see Table 14.1 for Tree and Woodland/Tree Group Schedule for an overview of the net increase in tree planting along the route that will result from the Proposed Scheme and Table 14.2 for Proposed Tree Planting Species, noting Benefit for Wildlife – each table included at the end of this Chapter.

14.6.2 Typical Planting Typologies

A range of general planting typologies are incorporated into the proposed scheme as appropriate to localities and character areas along the route. In some instances, planting is focussed on reinstatement and repair of existing woodland or tree group areas that will be impacted to facilitate construction of new footpaths, cycle tracks and road infrastructure. In other cases, planting is focussed on enhancing the amenity, green infrastructure and biodiversity along the route and in providing distinctive and attractive places for people to gather and relax.

New Street Trees

A range of urban street tree species (Figure 14.1) have been incorporated into the overall route design depending on location and whether trees are to be planted in grass verges or in tree pits within paved urban environments as appropriate, and also to ensure diversity of species and provide habitats for urban wildlife. Typically, trees will be semi-mature and 14/16 or 16/20 and where appropriate, selected for having a clear stem height to facilitate visual permeability. The full range are included in Tables of Plant Species

The following tables document the plant species proposed as part of the Proposed Scheme.

Table 14.1 and Table 14.2 at the end of this Chapter.

		
Acer campestre Field maple	***Sorbus aucuparia 'Streetwise'*** Rowan	***Tilia cordata*** Small-leaved lime

		
Platanus x acerifolia London plane	***Crataegus monogyna*** Hawthorn	***Corylus colurna*** Turkish hazel

Figure 14.1: Street tree species

New Woodland/Parkland Areas and Tree Groups

The Proposed Scheme corridor includes existing mature woodland/parkland, street trees and scrub areas, some of which will be impacted where the existing carriageway is to be widened or cycling infrastructure is to be provided. It is proposed to reinstate construction working areas and also to replant the edges of impacted areas to as to reinstate the streetscape or roadway character.

Woodland/parkland tree planting will typically comprise bare-root native tree species including *Alnus glutinosa* (Black Alder), *Salix aurita*, *Salix cinerea oleifolia*, *Salix caprea*, *Salix petrandra* (Willow sp.), *Betula pendula* (Silver Birch), *Pinus sylvestris* (Scots Pine), *Crataegus monogyna* (Hawthorn), *Quercus petraea* (Sessile Oak) and *Prunus spinosa* (Blackthorn).

Elsewhere along the Proposed Scheme there are a range of existing mature and immature street trees. While it is proposed to retain and protect existing trees wherever practicable, some will be impacted. The Proposed Scheme includes replacement and additional planting of semi-mature street trees to mitigate the loss of existing trees and to maintain the long-term tree-lined character of streets.

The Proposed Scheme incorporates additional landscaping arising from junction reconfiguration, reinforcement of existing vegetation areas, and the establishment of new urban realm and landscape opportunity areas. Tree species will be determined by location and will comprise either native woodland/parkland trees as set out above, or selected street trees as set out in Table 14.2. Landscaping proposals respond to the different localities and may include grass planting, hedgerows, trees, grasses, ornamental planting and swathes of bulbs.

Boundary Planting

The Proposed Scheme corridor is bounded by a wide range of established private, institutional, commercial and public land boundaries. While the design development has sought to avoid impacts on such boundaries, the Proposed Scheme will nonetheless require both temporary and permanent access to lands beyond the carriageway boundary.

Impacted property boundaries will be reinstated following construction. In some instances, boundaries will be re-built along their original alignments. In other cases, boundaries will be re-built on a new setback alignment. In general, property boundaries will be reinstated on a ‘like for like’ basis, including any walls, piers, fences, railings, gates, driveway finishes and private landscaping. Private grounds that are utilised in part for construction access will be reinstated following completion of the works to match the existing landscaping of the property. Where private grounds are reduced by permanent land take required for the scheme, the remaining grounds will be reinstated to match the landscape and character of the existing grounds in consultation with the property owner.

14.7 Proposed Landscape and Urban Realm Design

This section outlines the landscape and urban realm proposals along the Proposed Scheme. The landscape design is presented on a series of 1:500 scale drawings Landscaping General Arrangement drawings in Appendix B that include the combined hard and soft landscaping proposals for the entire route. The proposed planting areas are quantified in Table 14.3 at the end of this chapter.

These drawings include the general arrangement of the proposed layout and identify in particular:

- existing trees and woodland/parkland tree group areas;
- tree and woodland/parkland tree group felling;
- the location and extent of existing hard landscaping surfaces to be retained;
- the location and extent of new hard landscaping surfaces to be formed using different materials;

- proposed trees and woodland/parkland tree groups;
- Proposed grass verges, amenity areas and species rich grass land;
- Proposed hedgerows, native planting, and ornamental planting – with species as set out in Table 14.4, Table 14.5 and Table 14.6, respectively, at the end of this chapter; and,
- Sustainable Urban Drainage (SuDS) infrastructure.

Additionally, along the scheme corridor, a number of Urban Realm Opportunity Sites have been identified where existing spaces can be enhanced or new spaces created. These are included and further illustrated in the descriptions below as appropriate.

Codes of Practice and Recommendations

All tree planting works will be undertaken in accordance with the following British Standard Codes of Practice:

- BS 3936-1:1992 Nursery stock specification for trees and shrubs
- BS 3998:2010 Tree work.

Recommendations:

- BS 4043:1989 Recommendations for Transplanting Root-Balled Trees
- BS 4428:1989 (Section 7)
- BS 8545:2014 Trees: from nursery to independence in the landscape – Recommendations.

Mitigation Measures

Mitigation measures are an inherent part of the multi-disciplinary design proposals and have been considered iteratively throughout the design process. Mitigation measures are informed by understanding existing conditions including the range of land uses, the nature and quality of existing built and landscape features and dimensional constraints and other opportunities. That information is used to identify the optimum integration of initial and evolving design proposals for carriageways, streetscapes, infrastructure including pedestrian and cycle facilities.

Mitigation includes minimising adverse impacts on private and public property and landscapes through avoidance and reduction; identifying opportunities to create improvements along streets and at other public spaces; and seeking opportunities to mitigate unavoidable impacts of trees, landscapes and property through reinstatement and new planting. Underlying landscape and urban realm design and mitigation is the concept of Plackemaking that seeks to ensure that streets, public spaces and amenities are developed to create attractive and safe places of people to use as destinations and for commuting.

Mitigation, as an integral part of the design process, includes:

- reinstatement of impacted built or other features on a 'like for like' basis so as to restore established streetscape and spatial character;
- upgrading the condition and/or quality of built elements to retore or enhance overall character and amenity;
- introduction of new and reconfigured public spaces and streetscapes to provide more coherent, attractive and useable urban realm;
- Planting new street trees, woodland/parkland tree groups and other landscaping to offset any unavoidable impacts on existing landscape features along the scheme; and,

Enhancing the sustainability of public spaces through improving biodiversity and introduction of Sustainable Drainage Systems (SuDS) wherever practicable.

14.7.1 Section 1: Stradbrook Road to Booterstown Avenue

Existing Character: This is the start of the route and is characterised as being a high-capacity suburban distributor road leading through the established and developing built urban environments of Blackrock and Booterstown and along the coast road comprising a mix of parklands, institutional and community establishments and clusters, blocks and terraces of traditional and modern residential buildings together with occasional commercial buildings.

This section of the route typically has four lanes, including sections of dual carriageway and more conventional wide carriageways and wide roads with minimal active interfaces. While it is a wide and busy roadway, the variety of uses directly adjoining the road is such that there are substantial numbers of pedestrians and cyclists. Mature trees, particularly north of Blackrock, are a characteristic of the route as they are present along the boundaries with Blackrock Park and Blackrock College and also in the open space between the road and the coast.

Design Proposals: Towards the southern end of the route where there is an existing dual carriageway with dedicated cycle facilities, the Proposed Scheme will have negligible physical alteration, with the primary change being the re-allocation of traffic lanes as bus lanes.

North of Blackrock, the junctions with Rock Hill and Mount Merrion Avenue will be modified to remove slip lanes and increase the quantum of public space and use of hard and soft landscaping to make a more attractive and pedestrian friendly character (refer to **Figure 14.2**).

Figure 14.2: Rock Road junctions with Rock Hill (bottom) and Mount Merrion Avenue (top)

There will be encroachment into the boundary of Blackrock Park and the existing low boundary pillar and wall will be reinstated to maintain the open aspect over the park to the sea. Similarly, there will be encroachment into the grounds of Blackrock Clinic and Blackrock College requiring felling of the outermost trees at the hospital entrance and realignment of the college boundary plinth wall railing further back into the college grounds. The entrance gateway to the college, a protected structure, will be rebuilt to maintain the same relationship with the revised railing alignment (refer to **Figure 14.3**).

Figure 14.3: Rock Road along frontage of Blackrock College

Booterstown Avenue junction will be rationalised to improve pedestrian and cycle facilities with connection to a two-way cycle track along the seaward side. The urban realm will be upgraded with hard and soft landscaping, including median landscaping to the south of the junction, to create a more attractive pedestrian environment (refer to Appendix B).

Figure 14.4: Rock Road at Booterstown Avenue

14.7.2 Section 2: Booterstown Avenue to Nutley Lane

Existing Character: This section of the route is similar in character to the preceding comprising a wide road with open aspects over Booterstown Marsh to the sea, however there is a finer grain of established semi-detached dwellings along the western side. After the marsh, modern commercial buildings on both sides enclose the corridor which then continues with stone walls and trees on the seaward side and the landscaped grounds of St. Mary’s Centre nursing home on the landward side. The roadway widens substantially approaching the Merrion Gates junction level crossing.

The character then changes to a narrower and more traditional streetscape with one and two-story terraced and detached period dwellings on both sides and mature street trees set within the footpath. A terrace of shops then defines the village before the road opens up to the grounds of Our Lady Queen of Peace where the street trees continue on the eastern side and the grounds of St. Vincent’s University Hospital opposite defined by mature beech hedges.

Design Proposals:

The Proposed Scheme will continue the same cross-section up to the Merrion Gates junction and will require encroachment into the field immediately north of Booterstown Marsh as well as the adjoining commercial property. The stone boundary wall will be rebuilt along the new alignment and boundary vegetation will be re-established.

The wider approach to the Merrion Gates junction will be re-configured with the seaward side redesigned to incorporate a bus stop, two-way cycle tracks and footpaths integrated with the adjacent landscaping. The junction will incorporate safe cycle facilities to connect Merrion Road and the coastal Strand Road and will require localised realignment of the boundary of St. Mary’s Centre including rebuilding the stone arched entrance gate (refer to **Figure 14.5**).

Figure 14.5: Rock Road at the Merrion Gates junction

Moving into Merrion Village, a number of existing street trees will need to be felled on either side of the road and private property boundaries will be slightly set back to provide continuous footpaths, cycle tracks and bus stop facilities. Property boundaries will be reinstated as existing and new trees will be planted to mitigate those felled.

Beyond the traditional village, the hospital entrance will be rationalised to reduce carriageway widths and improve pedestrian and cycle amenity as well as upgrading the urban realm to be more consistent with the hospital frontage at the junction with Nutley Lane further north and incorporating hard and soft landscaping.

14.7.3 Section 3: R118 Merrion Road (Nutley Lane to Ballsbridge)

Existing Character: Merrion Road is a tree-lined period residential street with substantial dwellings and typically high-quality materials set is landscaped gardens presenting distinctive and mature streetscape environment. Approaching Ballsbridge, larger properties including hotels, the RDS and (former) AIB bank centre establish a greater mixed-use profile and then leads to the village core itself comprising a greater diversity of uses in terraces and clusters of typically two storey buildings. Ballsbridge spans the River Dodder at the centre of the village and the street continues northwards characterised by mature street trees but with a mixture of traditional and contemporary residential and commercial buildings.

Design Proposals: Along Merrion Road, the Proposed Scheme includes a carriageway varying from three to four traffic lanes together with cycle lanes and will provide bus priority either directly or through signalisation.

To achieve this, there will be a need to fell mature trees at different locations along the road. The design of the road alignment has been an iterative process seeking wherever practicable to retain the higher quality trees and also to facilitate new tree planting post construction.

At Ballsbridge, the design seeks to rationalise the junction arrangements north and south of the bridge and to improve the quality and provision for pedestrians and cyclists at this urban village core. Junctions will be substantially reduced by removing slip lanes to increase pedestrian space. A palette of materials commensurate with the existing materials of the village core will be used so as to establish a continuous and high-quality streetscape and village presentation that connects and draws together the two different parts of the village north and south of the bridge with new hard and soft landscape areas that will enhance pedestrian and passive amenity within the village (refer to Figure 14.6).

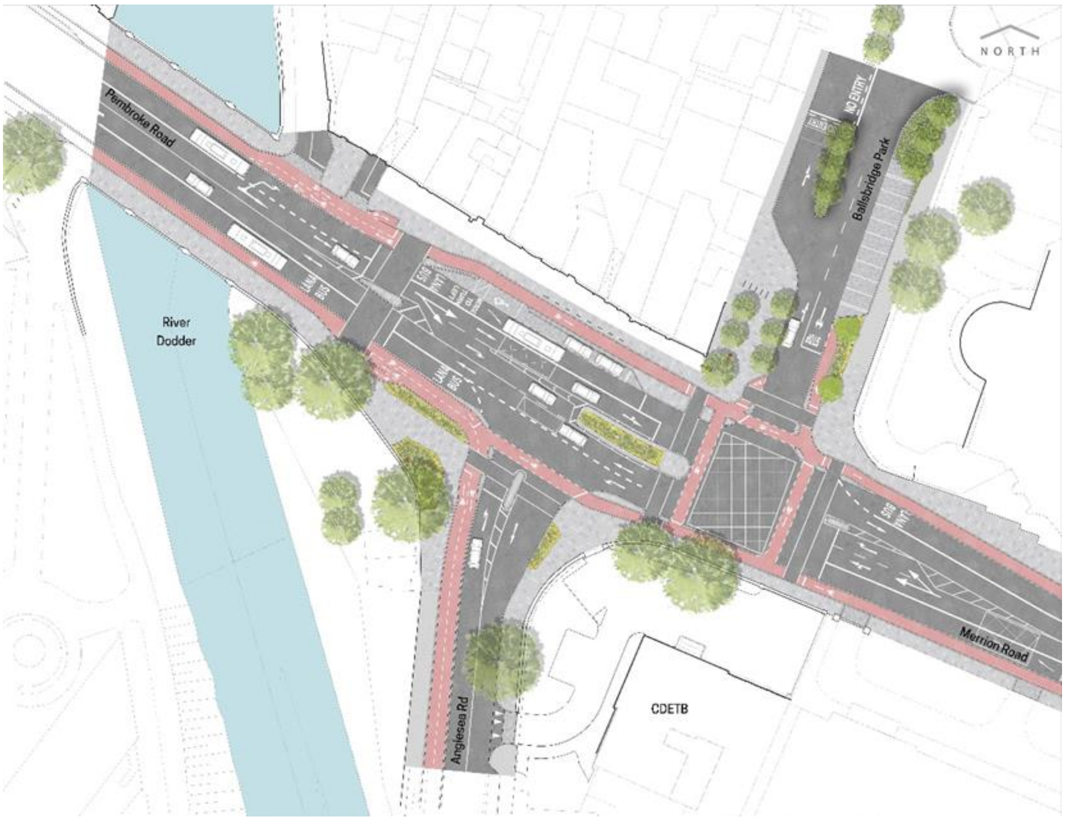


Figure 14.6: Ballsbridge at Anglesea Road

On the northern side of Ballsbridge, at the junction of Pembroke Road, Herbert Park, Shelbourne Road and Elgin Road, a similar approach will be applied to reduce vehicular dominance of the junction and to enhance pedestrian amenity and the standard of urban realm.

The northern end of Herbert Park which currently forks into two separate sections of road will be rationalised to become a single carriageway facilitating a substantial increase in the size of public space between Herbert Road and Elgin

Road. This new space will incorporate the existing mature tree and provide a network of paved areas and passive public spaces that are segregated from the roadway.

The junction at Elgin Road will become left-in entry only facilitating inbound traffic only and the carriageway on Elgin Road will be substantially reduced in favour of increased pedestrian and landscape space along the southern side of the road (refer to Figure 14.7).

Figure 14.7: Ballsbridge at Herbert Park, Shelbourne Road and Elgin Road

14.7.4 Section 4: Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

Existing Character: Pembroke Road, Baggot Street and Fitzwilliam Street are all important streets within the south Georgian Core of Dublin City. Pembroke Road is a generous streetscape defined by terraced Georgian residences along one side and by a combination of larger detached dwellings and shorter terraces set back from the street by landscaped gardens on the other. Mature street trees are a characteristic of the street and large canopies contribute strongly to the overall streetscape character. Baggot Street Upper is more urban in character and comprises the retail and commercial core but within a typically fine grained and traditional building streetscape. The roadway including parking is particularly wide and gives the impression of separating both sides of the street.

The route crosses the Grand Canal and leads to Baggot Street Lower which is a distinctly Georgian urban streetscape defined by almost continuous terraced red brick buildings and with mature street trees set within the central median.

Design Proposals: Urban realm and landscape proposals have evolved iteratively with the traffic engineers to re-balance the carriageway along Pembroke Road so as to reduce the effective vehicular space and to use the space for dedicated cycle and pedestrian facilities. The existing street trees are all retained and new trees will also be planted.

By elimination of the left turning slip road onto Pembroke Road, the kiosk that is presently located on a traffic island will be incorporated within a more generous and attractive urban realm (refer to Figure 14.8).

Figure 14.8: Pembroke Road at Lansdowne Road and Northumberland Road

At Baggot Street Upper, pedestrian footpath space is to be increased so as to create a more accessible, attractive and pedestrian friendly village environment in which both sides of the street are more strongly connected (refer to **Figure 14.9**).

Additional urban realm space will permit new tree planting, bicycle parking and spill out areas that will establish a more cohesive village environment and with high quality materials that reflect those of the traditional built environment. Improvement is pedestrian facilities and urban realm will extend to incorporate the bridge crossing Grand Canal and leading into Baggot Street Lower.

At Baggot Street Lower, the existing streetscape cross-section is to be retained including the central median and trees. On-street parking will be removed to facilitate the provision of cycle segregated tracks alongside footpaths.

This will reduce and increase the perceived width of carriageway and the pedestrian zone along both sides of the street and will be able to accommodate pedestrian and cyclists on a day-to-day basis and larger volumes of pedestrians when crowds are making their way to and from events at Lansdowne Road and the city centre.

Figure 14.9: Baggot Street (Upper) Village

14.7.5 Section 5: Nutley Lane (R138 Stillorgan Road to R118 Merrion Road)

Existing Character: Nutley Lane is substantially a suburban residential streetscape with Elm Park Golf & Sports Club on the southern side forming a green edge. St. Vincent’s University Hospital is also located on the southern side, and the one-sided nature of the street is such that on-street parking along Nutley Lane is commonplace. The eastern end of Nutley Lane joins Merrion Road with St. Vincent’s University Hospital to the south and a Tesco supermarket and commercial development to the north.

Design Proposals: The Proposed Scheme includes widening into the golf course and hospital frontage along Nutley Lane to retain the character and integrity of the residential side of the street and provide a two-way cycle track on the opposite side. The existing hedgerow boundaries to the hospital grounds will be reinstated along the revised boundary alignment. The existing hedgerow and fencing at Elm Park Golf & Sports Club will be replaced with a reinforced concrete wall with climbing vegetation (e.g. ivy) planted on the road side, and a hedgerow reinstated on the golf course side.

14.7.6 Tables of Plant Species

The following tables document the plant species proposed as part of the Proposed Scheme.

Table 14.1: Tree and Woodland/Parkland Tree Group Schedule

Trees	
Existing Trees to be removed	329
New Trees to be planted (comprising as follows:)	349

<table>
<tr><th>Species - Scientific name</th><th>Common names in English</th><th>Size</th><th>Qty.</th><th>Qty. 10%</th><th>Genus</th><th>Qty.</th><th>Qty. 20%</th><th>Family</th><th>Qty.</th><th>Qty. 30%</th></tr>
<tr><td>Acer campestre ‘Elegant’</td><td>Field maple</td><td>16/20</td><td>21</td><td>6%</td><td rowspan="3">Acer</td><td rowspan="3">56</td><td rowspan="3">16%</td><td rowspan="3">Sapindaceae</td><td rowspan="3">56</td><td rowspan="3">16%</td></tr>
<tr><td>Acer campestre ‘Elsrijk’</td><td>Field maple</td><td>16/20</td><td>12</td><td>3%</td></tr>
<tr><td>Acer rubrum</td><td>Red maple</td><td>16/20</td><td>23</td><td>7%</td></tr>
<tr><td>Betula pendula</td><td>Silver birch</td><td>16/20</td><td>9</td><td>3%</td><td>Betula</td><td>9</td><td>3%</td><td rowspan="3">Betulaceae</td><td rowspan="3">35</td><td rowspan="3">10%</td></tr>
<tr><td>Carpinus betulus ‘Frans Fontaine’</td><td>Hornbeam</td><td>16/20</td><td>17</td><td>5%</td><td>Carpinus</td><td>17</td><td>5%</td></tr>
<tr><td>Corylus colurna</td><td>Turkish hazel</td><td>16/20</td><td>9</td><td>3%</td><td>Corylus</td><td>9</td><td>3%</td></tr>
<tr><td>Pinus sylvestris</td><td>Scots pine</td><td>16/20</td><td>8</td><td>2%</td><td>Picea</td><td>8</td><td>2%</td><td>Pinaceae</td><td>8</td><td>2%</td></tr>
<tr><td>Amelanchier arborea 'Robin Hill'</td><td>Shadbush</td><td>2.0 - 3.0m</td><td>4</td><td>1%</td><td>Amelanchier</td><td>4</td><td>1%</td><td rowspan="7">Rosaceae</td><td rowspan="7">94</td><td rowspan="7">27%</td></tr>
<tr><td>Crataegus monogyna ‘Stricta’</td><td>Hawthorn</td><td>14/16</td><td>10</td><td>3%</td><td>Crataegus</td><td>10</td><td>3%</td></tr>
<tr><td>Sorbus aria ‘Majestica’</td><td>Whitebeam</td><td>14/16</td><td>7</td><td>2%</td><td rowspan="2">Sorbus</td><td rowspan="2">42</td><td rowspan="2">12%</td></tr>
<tr><td>Sorbus aucuparia ‘Streetwise’</td><td>Rowan</td><td>14/16</td><td>35</td><td>10%</td></tr>
<tr><td>Prunus avium ‘Plena’</td><td>Wild cherry</td><td>14/16</td><td>11</td><td>3%</td><td rowspan="3">Prunus</td><td rowspan="3">23</td><td rowspan="3">7%</td></tr>
<tr><td>Prunus cerasifera ‘Nigra’</td><td>Cherry plum</td><td>14/16</td><td>5</td><td>1%</td></tr>
<tr><td>Prunus padus</td><td>Bird cherry</td><td>14/16</td><td>7</td><td>2%</td></tr>
</table>

Pyrus calleryana 'Chanticleer'	Callery pear	16/20	15	4%	Pyrus	1	4%			
Cercis Canadensis ‘Forest Pansy’	Redbud	14/16	3	1%	Cercis	3	30%	Plantae	3	0%
Ginkgo biloba	Maidenhair tree	16/20	12	3%	Ginkgo	14	3%	Ginkgoaceae	12	3%
Species - Scientific name	**Common names in English**	**Size**	**Qty.**	**Qty. 10%**	**Genus**	**Qty.**	**Qty. 20%**	**Family**	**Qty.**	**Qty. 30%**
Gleditsia triacanthos 'Street Keeper'	Honey locust	16/20	5	1%	Gleditsia	5	1%	Fabaceae	5	1%
Platanus x acerifolia	London plane	16/20	14	4%	Platanus	14	4%	Platanaceae	14	4%
Quercus palustris ‘Fastigiata’	Pin oak	16/20	14	4%	Quercus	39	11%	Fagaceae	39	11%
Quercus robur ‘Fastigiata Koster’	Common oak	16/20	25	7%						
Thuja Occidentalis	White cedar	1.75 - 2m	25	7%	Thuja	25	7%	Cupressaceae	25	7%
Tilia cordata ‘Green Spire’	Small-leaved lime	16/20	21	6%	Tilia	48	14%	Malvaceae	48	14%
Tilia cordata ‘Rancho’	Small-leaved lime	16/20	19	5%						
Tilia tomentosa ‘Brabant’	Silver lime	16/20	8	2%						
Ulmus 'New Horizon'	Elm	16/20	8	2%	Ulmus	10	3%	Ulmaceae	10	3%
Ulmus ‘Columella’	Elm	16/20	2	1%						
		Total	349			349			349	

Woodland / Tree Groups					
Existing Woodland / Tree Groups to be removed	No. features	12	Total Area	0.38 ha.	
New Woodland / Tree Groups to be planted	No. features	6	Total Area	0.12 ha.	

Table 14.2: Proposed Tree Planting Species, noting Benefit for Wildlife

Scientific name **Common name**	**Size**	**Qty.**	**Criteria for use**	**Photo**
Acer campestre 'Elegant' Field maple	16/20	21	Compact and elegant ascending structure of the branches Intense yellow and orange autumn colour A good avenue tree for use on green belts, road verges, streets, housing estates and squares Tolerates air pollution and resists drought *Attractive to a number of invertebrates and pollinating insects. Fruits are eaten by small mammals*	 
Acer campestre 'Elsrijk' Field maple	16/20	12	Upright oval to widely conical shaped, dense crown Intense yellow and orange autumn colour Suitable for narrow streets Tolerates air pollution and resists drought Attractive to pollinating insects	 
Acer rubrum Red Maple	16/20	23	Medium-sized tree with a spherical to conical crown, dense and closed Feature accent in urban environment Low maintenance architectural tree Bright red autumn colour Acid soils will give the best autumn colour Tolerates air pollution and resists drought Attractive to pollinating insects	 

Scientific name Common name	Size	Qty.	Criteria for use	Photo
Betula pendula Silver birch	16/20	9	Irish native tree Intense yellow autumn colour with striking white, pink, or peeling brown bark Important tree for reforestation projects and soil protection *Birch trees support over 200 different types of insects. Catkins are a good food source for a variety of birds*	 
Carpinus betulus 'Frans Fontaine' Hornbeam	16/20	17	Uniquely upright and dense foliage 'Frans Fontaine' is the narrowest of all the Carpinus Ideal for narrow streets and avenues The autumnal colours are a varied mixture of yellows and oranges The tough tree is suitable for many locations *Attractive to a number of invertebrates. Seeds eaten by birds. Can provide a dense nesting cover*	 
Corylus colurna Turkish hazel	16/20	9	Extremely tolerant of exposure and paved areas which make it a perfect candidate for urban planting Seasonal interest is provided by elegant long yellow catkins in spring, clusters of edible nuts in frilly cups and good yellow autumn foliage colour Low maintenance architectural tree Generally, disease free *Attractive to a number of invertebrates and pollinating insects. It produces and drops nuts in large beaked husks that are popular with wildlife, especially squirrels*	 

Scientific name **Common name**	**Size**	**Qty.**	**Criteria for use**	**Photo**
Pinus sylvestris Scots pine	16/20	6	Irish native tree Best suited in parks, gardens, heath land, woodlands and coastal areas Low maintenance architectural tree *Creates habitats for native Irish fauna, including many bird species and squirrels*	 
Amelanchier arborea 'Robin Hill' Shadbush	2.0-3.0m	4	Feature accent element on urban squares and parks Small ornamental tree with decorative pink and white flowers Bright red and orange autumn colour Available as a multi-stem and a standard tree Attracts a wide assortment of birds and wildlife	 
Crataegus monogyna 'Stricta' Hawthorn	14/16	10	Irish native tree Because of its columnar growth this tree is suitable for narrow streets and small gardens White flowers in late spring followed by conspicuous red berries in autumn Tolerant of exposed locations such as windy and coastal sites *It provides food for more than 150 different insect species. Attractive to pollinating insect*	 
Sorbus aria 'Majestica' Whitebeam	14/16	9	Forms a compact, broad, pyramidal crown Stands up well to hard surfaces 'Majestica' is a good avenue and street tree Tolerant of atmospheric pollution and dry conditions *Attractive to a number of invertebrates and pollinating insects. Berries provide a valuable food source for birds*	 

Scientific name **Common name**	**Size**	**Qty.**	**Criteria for use**	**Photo**
Sorbus aucuparia 'Streetwise' Rowan	14/16	33	Irish native tree Ideal for tighter urban locations with a very neat upright habit Tolerant of atmospheric pollution and dry conditions *Attractive to pollinating insects. It produces an important berry crop for wildlife*	 
Prunus avium 'Plena' Wild cherry	14/16	11	Irish native tree Double flowered Wild Cherry, produces no fruit Rounded and regularly branched closed crown Feature accent element on urban squares, parks and avenues *Attractive to a number of invertebrates and pollinating insects. Berries provide a valuable food source for birds*	 
Prunus cerasifera 'Nigra' Black cherry plum	14/16	5	Ornamental tree with a round, dense, spreading head and dark purplish-black branches and twigs Feature accent element on urban squares, parks and avenues Great for attracting native wildlife	 
Prunus padus Bird cherry	14/16	7	Irish native tree Popular native hedge plant commonly used in mixed native hedgerows *Attractive to a number of invertebrates and pollinating insects. Berries provide a valuable food source for birds*	 

Scientific name **Common name**	**Size**	**Qty.**	**Criteria for use**	**Photo**
Pyrus calleryana 'Chanticleer' Callery pear	16/20	13	Narrow conical to ovoid, half-open crown Perfect for avenue planting due to its slender form Great for attracting native wildlife	 
Cercis Canadensis ‘Forest Pansy’ Redbud	14/16	3	Large deciduous shrub or small, often multi-stemmed or standard tree with purple, heart-shaped leaves which turn yellow in autumn before falling Grown mainly for striking foliage effects Feature accent element on urban parks and squares *Attractive to pollinators*	 
Ginkgo biloba Maidenhair tree	16/20	14	The World's Oldest Tree Species Intense yellow autumn colour Feature accent element on urban parks and avenues Pests and diseases free Resistant to air pollution	 
Gleditsia triacanthos 'Street keeper' Honey locust	16/20	5	Suitable for urban streets with ascending branches and a narrowly pyramidal growth habit Vivid yellow autumn colour Feature accent element on urban parks and avenues Resistant to drought and pollution	 

Scientific name **Common name**	**Size**	**Qty.**	**Criteria for use**	**Photo**
Platanus x acerifolia London plane	16/20	14	A large tree for a large space Coherence with existing planting scheme Tolerates air pollution and resists drought and heavy pruning Great for attracting native wildlife	 
Quercus palustris 'Fastigiata' Pin oak	16/20	14	Columnar, half-open crown Perfect for avenues and narrow streets planting due to its slender upright habit Low maintenance architectural tree *Oak trees provide food and shelter to over 450 species of insects. Attractive to a range of invertebrates and are important for insect eating birds. Acorns are eaten by a variety of birds and mammals*	 
Quercus robur 'Fastigiata Koster' Common oak	16/20	25	Irish native tree Tall narrow pyramidal version of the Common Oak -Ideal for growing along an avenue or where space is at a premium *Oak trees provide food and shelter to over 450 species of insects. Attractive to a range of invertebrates and are important for insect eating birds. Acorns are eaten by a variety of birds and mammals*	 

Scientific name **Common name**	**Size**	**Qty.**	**Criteria for use**	**Photo**
Thuja Occidentalis White cedar	1.75-2m	25	Replacement tree to match existing Perfect for a screen or hedge Evergreen, makes a dense, pyramid shape Provides food and shelter for wildlife	 
Tilia cordata 'Green Spire' Small-leaved lime	16/20	21	Pyramidal, later oval to ovoid, half-open crownCoherence with existing planting scheme Popular choice for urban planting Tolerates air pollution and resists heavy pruning *Attractive to many invertebrates and pollinating insects*	 
Tilia cordata 'Rancho' Small-leaved lime	16/20	19	Narrow conical, later narrow ovoid, half-open crown Coherence with existing planting scheme Popular choice for urban planting Tolerates air pollution and resists heavy pruning *Attractive to many invertebrates and pollinating insects*	 

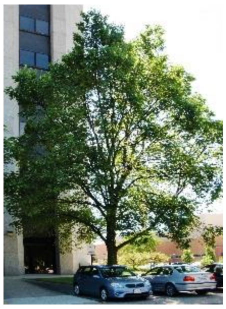
Scientific name **Common name**	**Size**	**Qty.**	**Criteria for use**	**Photo**
Tilia tomentosa 'Brabant' Silver lime	16/20	8	Coherence with existing planting scheme It is very versatile, being suitable for urban settings, avenues, verges and parks Tolerates air pollution and resists heavy pruning *Attractive to many invertebrates and pollinating insects*	 
Ulmus 'New Horizon' Elm	16/20	8	Fast-growing tree with dense pyramidal crown High resistance to Dutch elm disease (DED) Tolerant of urban conditions Support over 80 different types of insects. The early flowers of elm are visited by many insects and the seeds are valued by red squirrels	 
Ulmus 'Columella' Elm	16/20	2	- Remarkably slim columnar crown, fairly open The leaf is scalloped and often twisted Perfect for avenues and narrow streets High resistance to Dutch elm disease (DED)	 

Table 14.3: Schedule of Proposed Planting Areas

Planting Type	**Length (m) / Area (m^2)**
Hedgerow	558 m
Native Planting	176 m^2
Ornamental Planting	4,990 m^2
Grass Verge and Amenity Areas	2,928 m^2
Species Rich Grassland	1,241 m^2

Table 14.4: Proposed Hedgerow species, noting Benefit for Wildlife

Latin name	Common name	Benefit
Buxus sempervirens	Common Box	Attractive to pollinators. Can provide a dense nesting cover.
Ceanothus species	Lilac Bush	Provide nectar and pollen for butterflies, bees and other pollinators in their dense flower clusters in spring.
Cornus sanguinea	Dogwood	The flowers produce a scent that is attractive to many species of invertebrates. The berries are eaten by some species of birds.
Corylus avellana	Hazel	Reddish-brown nuts in a green husk are seen on hazel in the late summer and autumn; but these are generally eaten quickly by birds and mammals.
Crataegus monogyna	Hawthorn	Provides a source of nectar and berries providing food for birds including thrushes. If allowed to grow dense it will provide good nesting opportunities for birds.
Euonymus europaeus	Spindle	Spindle produces flowers that provide a good source of food for bees and other insects. The fruits attract aphids which in turn attract insect-eating birds.
Ilex aquifolium	Holly	The berries are greatly enjoyed by birds and mammals. Holly also plays a crucial part in the life cycle of the beautiful butterfly the holly blue, which lays eggs on holly leaves in spring and is a frequent visitor to gardens in town. Requires male and female plants to produce berries.
Ligustrum vulgare	Privet	Wild privet is the preferred choice for wildlife and may provide nesting sites for blackbirds and other species. Left to grow a little less tidily than many gardeners allow, the structure will become more open and also offer nesting opportunities for many more species. Good for bees and butterflies.
Pyracantha coccinea	Scarlett Firethorn	Very valuable to birds as a source of food and as a nesting site. Also, a good security plant due to the thorns.
Rosa species	Roses	Provides nectar for bees and butterflies. Hips are valuable for small birds and mammals.
Salix aegyptiaca	Musk Willow	Winter-flowering shrub pollinated by bees and other insects.
Sambucus nigra	Common Elder	Provides flowers for insects and berries for birds.
Sarcococca confusa	Sweet Box	Flowering in winter, followed by black berries eaten by birds.
Viburnum spp	Viburnum	Excellent for attracting hoverflies and are a good source of nectar for bees. The shiny berries provide a food source for birds and mammals alike.

Table 14.5: Proposed Native Planting species, noting Benefit for Wildlife

Latin name	Common name	Benefit
Cornus sanguinea	Dogwood	The flowers produce a scent that is attractive to many species of invertebrates. The berries are eaten by some species of birds.
Corylus avellana	Hazel	Reddish-brown nuts in a green husk are seen on hazel in the late summer and autumn; but these are generally eaten quickly by birds and mammals.
Crataegus monogyna	Hawthorn	Provides a source of nectar and berries providing food for birds including thrushes. If allowed to grow dense it will provide good nesting opportunities for birds.
Euonymus europaeus	Spindle	Spindle produces flowers that provide a good source of food for bees and other insects. The fruits attract aphids which in turn attract insect-eating birds.
Hypericum androsaemum	Tutsan	Flowers attract insects especially bees while the berries are eaten by birds and small mammals.
Ilex aquifolium	Holly	The berries are greatly enjoyed by birds and mammals. Holly also plays a crucial part in the life cycle of the beautiful butterfly the holly blue, which lays eggs on holly leaves in spring and is a frequent visitor to gardens in town. Requires male and female plants to produce berries.
Ligustrum vulgare	Privet	Wild privet is the preferred choice for wildlife and may provide nesting sites for blackbirds and other species. Left to grow a little less tidily than many gardeners allow, the structure will become more open and also offer nesting opportunities for many more species. Good for bees and butterflies.
Rosa species	Roses	Provides nectar for bees and butterflies. Hips are valuable for small birds and mammals.
Salix aegyptiaca	Musk Willow	Winter-flowering shrub pollinated by bees and other insects.
Sambucus nigra	Common Elder	Provides flowers for insects and berries for birds.
Thymus species	Thyme	The rose-purple flowers grow in long, whorled, upright spikes and are very attractive to bees, hoverflies and butterflies.
Viburnum spp	Viburnum	Excellent for attracting hoverflies and are a good source of nectar for bees. The shiny berries provide a food source for birds and mammals alike.

Table 14.6: Ornamental Planting Species, noting Benefit for Wildlife

Latin name	Common name	Benefit
Abelia chinensis	Bee Bush or Chinese Abelia	Attractive to pollinators. Flowering in October.
Ajuga reptans	Bugle	Bugle is excellent for ground cover under shrubs since it prefers semi-shade, and is attractive to a wide range of insects.

Latin name	Common name	Benefit
Anemone nemorosa	Wood Anemone	Provides a good early source of pollen and nectar for bees and other insects.
Armeria maritima	Thrift, Sea Pink	Attractive to pollinators.
Aster novi-belgii	Michaelmas Daisy	Attractive to a range of bees, butterflies, moths and birds.
Aubrieta deltoidea	Purple Rock-cress	Provides a good early food source for bees and adds colour to edges of flower beds, prefers full sunlight.
Bergenia purpurascens	Elephant's Ear or Purple Bergenia	Attractive to pollinators.
Campanula glomerata	Clustered Bellflower	Attractive to pollinators.
Clematis vitalba	Clematis 'Old Man's Beard'	Provides nectar for bee and butterflies.
Conopodium majus	Pignut	Attractive to pollinators.
Crocus tommasinianus	Early Crocus	As a winter-flowering, provides a good early source of pollen and nectar for bees and other insects.
Cynoglossum officinale	Hound's Tongue	Attractive to pollinators.
Digitalis purpurea	Foxglove	Attractive to pollinators.
Filipendula vulgaris	Dropwort	Attractive to pollinators.
Galanthus nivalis	Common Snowdrop	As a winter-flowering, provides a good early source of pollen and nectar for bees and other insects.
Hedera helix	Ivy	Provides a late nectar source and cover / hibernating sites for many species of invertebrates.
Humulus lupulus	Hop	Provides nectar for bee and butterflies.
Hyacinthoides non-scripta	Bluebell	Provides a source of pollen and nectar for bees and other insects. Ensure that suppliers do not provide either Spanish bluebell or the hybrid between this and Bluebell (or any other hybrids) and have not stripped native bluebells from the wild.
Hypericum perforatum	Perforate St John's Wort	Attractive to pollinators.
Jasminus officinale	Summer Jasmine	Night-scented. The scent from jasmine at night can attract bats.
Lathyrus pratensis	Meadow Vetchling	Attractive to pollinators.
Leucanthemum vulgare	Ox-eye Daisy	Attractive to pollinators.
Linaria vulgaris	Common Toadflax	Attractive to pollinators.

Latin name	Common name	Benefit
Lonicera periclymenum	Honeysuckle	The flowers of the Honeysuckle attract night flying moths and other insects which in turn can provide food for bats. Honeysuckle can provide nest sites for small garden bird species while the bark is often used in nest building by species including the House Sparrow.
Lunaria biennis	Honesty	Attractive to butterflies.
Malva moschata	Musk Mallow	Attractive to pollinators.
Matthiola longipetala	Night-scented Stock	Night-scented. emits a pleasant scent in the evening and through the night attracting night-flying pollinators and insects and therefore bats.
Mahonia species	Mahonia	Flowering occurs in autumn, winter and early spring benefiting winter-active pollinators (like bumblebees or some hoverflies). Flowers produce abundant nectar. Berries are eaten by birds.
Monarda didyma	Bergamot	Provides a good source of pollen and nectar.
Nicotiana	Tobacco Plant	Attractive to night pollinators like moths (beneficial for bats).
Oenothera biennis	Evening Primrose	Particularly attractive to night flying insects (therefore can attract bats).
Persicaria bistorta	Common Bistort	Attractive to pollinators.
Rudbeckia hirta	Black-eyed Susan	Attractive to pollinators. Flowering in October.
Silene vulgaris	Bladder Campion	Attractive to pollinators.
Thalictrum flavum	Meadow Rue	Attractive to pollinators.
Viola riviniana	Dog Violet	Flowers from April to June and is attractive to bees and other insects.

15 How we are achieving the Objectives

This section sets out the manner in which the Proposed Scheme described herein will achieve the following Objectives as set out:

- Enhance the capacity and potential of the public transport system by improving bus speeds, reliability and punctuality through the provision of bus lanes and other measures to provide priority to bus movement over general traffic movements;
- Enhance the potential for cycling by providing safe infrastructure for cycling, segregated from general traffic wherever practicable;
- Support the delivery of an efficient, low carbon and climate resilient public transport service, which supports the achievement of Ireland's emission reduction targets;
- Enable compact growth, regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of safe and efficient sustainable transport networks;
- Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved sustainable connectivity and integration with other public transport services; and
- Ensure that the urban realm is carefully considered in the design and development of the transport infrastructure and seek to enhance key urban focal points where appropriate and feasible.

Currently, bus priority is characterised by discontinuity. Bus priority is only provided along certain sections and a number of pinch-points cause significant delays which result in a negative impact on the performance of the bus service as a whole. Within the extents of the Proposed Scheme route, bus lanes are currently provided on only approximately 35% and 39% of route outbound and inbound respectively.

Issues related to frequency, reliability and a complex network have persisted for many years and will continue to do so without further intervention. As such, there are a number of high frequency public bus services along the routes to be improved by the Proposed Scheme (including the 4, 7, and 7a bus routes), as well as multiple private and coach services, notably two Aircoach routes serving Dublin Airport. In addition to this there are multiple other bus services which run along this corridor intermittently, providing interchange opportunities with other bus services and DART stations. Many of these services suffer from journey time unreliability, particularly in peak times, due to the lack of bus priority provision.

The route from UCD via Nutley Lane and into the City Centre via Ballsbridge along Merrion Road, already has a number of existing public bus services (including the 47 and 27x bus routes), as well as private services including shuttle buses connecting UCD with other transport services such as the DART at Sydney Parade. These services suffer from poor journey time reliability, again particularly at peak commuter times when demand is highest as there are currently no bus lanes on Nutley Lane.

The UCD Belfield to DART shuttle bus operates from 8:00 to 10:10 and 16:00 to 18:10, while the 27x leaves the UCD terminus at 7:35 and 17:05.

In addition to the level of service improvements the Proposed Scheme will facilitate for existing bus services, the ongoing Dublin Area Bus Network Redesign will see continued investment in bus services into the future, which will also be afforded similar journey-time reliability and therefore improve their attractiveness as an alternative to private car usage.

Without the interventions of the Proposed Scheme there would likely be an exacerbation of the issues which informed the need for the Proposed Scheme itself. The capacity and potential of the public transport system would remain restricted by the existing deficient and inconsistent provision of bus lanes and the resulting sub-standard levels of bus priority and journey-time reliability. Thus, the unreliability of bus services would continue. As such the Proposed Scheme is actively enhancing the capacity and potential of the public transport system, and supports the delivery of an efficient, low carbon and climate resilient public transport service, which supports the achievement of Ireland’s emission reduction targets.

A key objective of the Proposed Scheme is to enhance the potential for cycling along the route. Without the provision of safe cycling infrastructure, intended as part of the Proposed Scheme, there would continue to be an insufficient level of safe, segregated provision for cyclists who currently, or in the future would be attracted to use the route of the Proposed Scheme.

In terms of the need to improve facilities for cyclists along the route of the Proposed Scheme, the design intent is that segregated facilities should be provided where practicable to do so. Within the extents of the Proposed Scheme there are segregated cycle tracks provided on only approximately 4% and 5% of the route outbound and inbound respectively, mandatory cycle lanes provided on only approximately 21% and 11% of the route outbound and inbound respectively, while advisory cycle lanes are provided on only approximately 28% and 25% of the route outbound and inbound respectively. The remaining extents have no dedicated cycle provision or cyclists must cycle within the bus lanes provided.

The GDA Cycle Network Plan also aims to provide high quality links to DART stations from the surrounding areas in order to increase the catchment area of these stations, assuming high quality cycle parking is available at all stations. One such example is the route from UCD to Sydney Parade, which was identified within the GDA Cycle Network Plan as requiring further development – noting that Nutley Lane (which is a key link in this route) currently has no cycle facilities.

The Proposed Scheme is implementing safe, segregated. infrastructure throughout – with segregated cycle tracks along 100% of the length including protected junctions for cyclists – and as such is greatly enhancing the potential for cycling.

Within the extents of the Proposed Scheme there are a number of amenities, village and urban centres which experience high pedestrian usage including Blackrock Village, Ballsbridge Village and the Baggot Street area.

In order to improve accessibility to jobs, education and other social and economic opportunities through the provision of an integrated sustainable transport system, there needs to be a high quality pedestrian environment, including specifically along the route of the Proposed Scheme. There are a number of uncontrolled crossings along the route of the Proposed Scheme, particularly at side roads which are generally of poor standard, including lack of provision for the mobility and visually impaired. There are multiple incidences of 'patch repairs' along footpaths that in some instance has led to undulating, uneven surfaces caused by settlement of patch repair material. This is often a hazard to pedestrians, particularly the mobility impaired. A number of submissions were also received as part of the non-statutory consultation in which members of the public indicated specific locations where the existing provision is unsafe for pedestrians – many of which are proposed to be addressed by the Proposed Scheme.

Along with these interventions, the proposals include significant improvements to the pedestrian environment, both along links and at both signalised and priority junctions and crossings. As such the Proposed Scheme will improve accessibility to jobs, education and other social and economic opportunities not only through improvement to the public transport network and cycling infrastructure but through improvements to the pedestrian environment.

The Landscape and Urban Realm proposals for the Proposed Scheme are based on an urban context and landscape character analysis of the route. The proposals have been informed through discussions with the Local Authorities and stakeholders. The proposals have been developed amongst the BCID Infrastructure Team so that the preliminary landscape design is integrated into the overall Proposed Scheme design.

The overall landscape and urban realm design strategy for the Proposed Scheme was developed to create attractive, consistent, functional and accessible places for people alongside the core bus and cycle facilities. It aims to mitigate any adverse effects that the proposals may have on the streets, spaces, local areas and landscape through the use of appropriate design responses. In addition, opportunities have been sought to enhance the urban realm and landscape design where practicable.

Through a combination of the above benefits, such as the provision of safe and efficient sustainable transport networks, improved infrastructure for walking and cycling, and urban realm strategies, the Proposed Scheme specifically facilitates improvements to encourage more journeys generally at a local level by active travel, including connecting to and from bus stops for all pedestrians, and in particular improving facilities for the mobility and visually impaired. Therefore, it is considered that the Proposed Scheme as described enables compact growth, regeneration opportunities and more effective use of land in Dublin, for present and future generations.

It is therefore considered that the design of the Proposed Scheme wholly achieves the objectives set out herein. In doing so it fulfils the aim of the Proposed Scheme in providing enhanced walking, cycling and bus infrastructure on key access corridors in the Dublin region, enabling the delivery of efficient, safe, and integrated sustainable transport movement along these corridors.